MET Laboratories, Inc. *Safety Certification - EMI - Telecom Environmental Simulation*
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December 10, 2014

iControl Networks Canada
300-353 Dalhousie Street
Ottawa, ON K1N 7G1

Dear Heather McIntosh,

Enclosed is the EMC Wireless test report for compliance testing of the iControl Networks Canada, Piper nv North America as tested to the requirements of Title 47 of the CFR, Ch. 1 (10-1-06 ed.), Part 15, Subpart B and ICES-003, Issue 5 August 2012 for a Class B Digital Device, and FCC Part 15 Subpart C and RSS-210, Issue 8, Dec. 2010 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.

Amy Graziano
Documentation Department

Reference: (\iControl Networks Canada\EMC83715-FCC247 REV. 3)

Electromagnetic Compatibility Criteria
Test Report

for the

iControl Networks Canada
Piper nv North America

Tested under
the FCC Certification Rules
contained in
Title 47 of the CFR, Parts 15 Subpart B & ICES-003
for Class B Digital Devices
&
15.247 Subpart C & RSS-210, Issue 8, Dec. 2010
for Intentional Radiators

MET Report: EMC83715-FCC247 REV. 3

December 10, 2014

Prepared For:

iControl Networks Canada
300-353 Dalhousie Street
Ottawa, ON K1N 7G1

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

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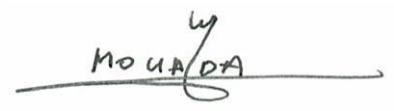

Djed Mouada, Project Engineer
Electromagnetic Compatibility Lab

Amy Graziano
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 Parts 15B, 15.247 and Industry Canada standards ICES-003, Issue 5 August 2012, RSS-210, Issue 8, Dec. 2010 under normal use and maintenance.

Asad Bajwa,
Director, Electromagnetic Compatibility Lab

Report Status Sheet

Revision	Report Date	Reason for Revision
∅	November 18, 2014	Initial Issue.
1	November 19, 2014	Revised FCC ID Number
2	December 1, 2014	Revised to reflect engineer corrections.
3	December 10, 2014	Revised to reflect engineer corrections.

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List of Terms and Abbreviations

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

I. Executive Summary

A. Purpose of Test

An EMC evaluation was performed to determine compliance of the iControl Networks Canada Piper nv North America, 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 Piper nv North America. iControl Networks Canada should retain a copy of this document which should be kept on file for at least two years after the manufacturing of the Piper nv North America, 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 iControl Networks Canada, purchase order number PO-CAN 0127. All tests were conducted using measurement procedure ANSI C63.4-2003.

FCC Reference 47 CFR Part 15.247:2005	IC Reference RSS-210 Issue 8: 2010; RSS-GEN Issue 3: 2010	Description	Compliance
47 CFR Part 15.107 (a)	ICES-003 Issue 5 August 2012	Conducted Emission Limits for a Class B Digital Device	Compliant
47 CFR Part 15.109 (a)	ICES-003 Issue 5 August 2012	Radiated Emission Limits for a Class B Digital Device	Compliant
Title 47 of the CFR, Part 15 §15.203	N/A	Antenna Requirement	Compliant
Title 47 of the CFR, Part 15 §15.207(a)	RSS-GEN (7.2.4)	Conducted Emission Limits	Compliant
Title 47 of the CFR, Part 15 §15.247(a)(2)	RSS-Gen(4.6)	6dB Occupied Bandwidth	Compliant
		99% Occupied Bandwidth	Compliant
Title 47 of the CFR, Part 15 §15.247(b)	RSS-210(A8.4)	Peak Power Output	Compliant
Title 47 of the CFR, Part 15 §15.247(d); §15.209; §15.205	RSS-210(A8.5)	Radiated Spurious Emissions Requirements	Compliant
Title 47 of the CFR, Part 15 §15.247(d)	RSS-210(A8.5)	RF Conducted Spurious Emissions Requirements	Compliant
Title 47 of the CFR, Part 15; §15.247(e)	RSS-210(A8.2)	Peak Power Spectral Density	Compliant

Table 1. Executive Summary of EMC Part 15.247 ComplianceTesting

II. Equipment Configuration

A. Overview

MET Laboratories, Inc. was contracted by iControl Networks Canada to perform testing on the Piper nv North America, under iControl Networks Canada's purchase order number PO-CAN 0127.

This document describes the test setups, test methods, required test equipment, and the test limit criteria used to perform compliance testing of the iControl Networks Canada, Piper nv North America.

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

Model(s) Tested:	Piper nv North America	
Model(s) Covered:	Piper nv North America	
EUT Specifications:	Primary Power: 5DC	
	FCC ID: 2AA5P-P01A015 IC: 11477A-P01A015	
	Type of Modulations:	OFDM, 802.11b/g/n
	Equipment Code:	DTS
	Peak RF Output Power:	15.55 dBm
	EUT Frequency Ranges:	2400MHz-2483.5MHz
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):	December 10, 2014	

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
CFR 47, Part 15, Subpart B	Electromagnetic Compatibility: Criteria for Radio Frequency Devices
RSS-210, Issue 8, Dec. 2010	Low-power Licence-exempt Radiocommunications Devices (All Frequency Bands): Category I Equipment
RSS-GEN, Issue 3, Dec. 2010	General Requirements and Information for the Certification of Radio Apparatus
ICES-003, Issue 5 August 2012	Information Technology Equipment (ITE) — Limits and methods of measurement
ANSI C63.4:2003	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 C63.10-2009	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 iControl Networks Canada Piper nv North America, Equipment Under Test (EUT), is a consumer electronic device that monitors a user's home.
It can sit on a table or be mounted to a wall.
It connects to the user's home wifi network and can be controlled via an app on the user's smart phone.
It has a night vision camera.
Piper also has a z-wave radio to control z-wave home automation devices, if the user chooses.
Piper has a battery backup (3xAA) for power outages.

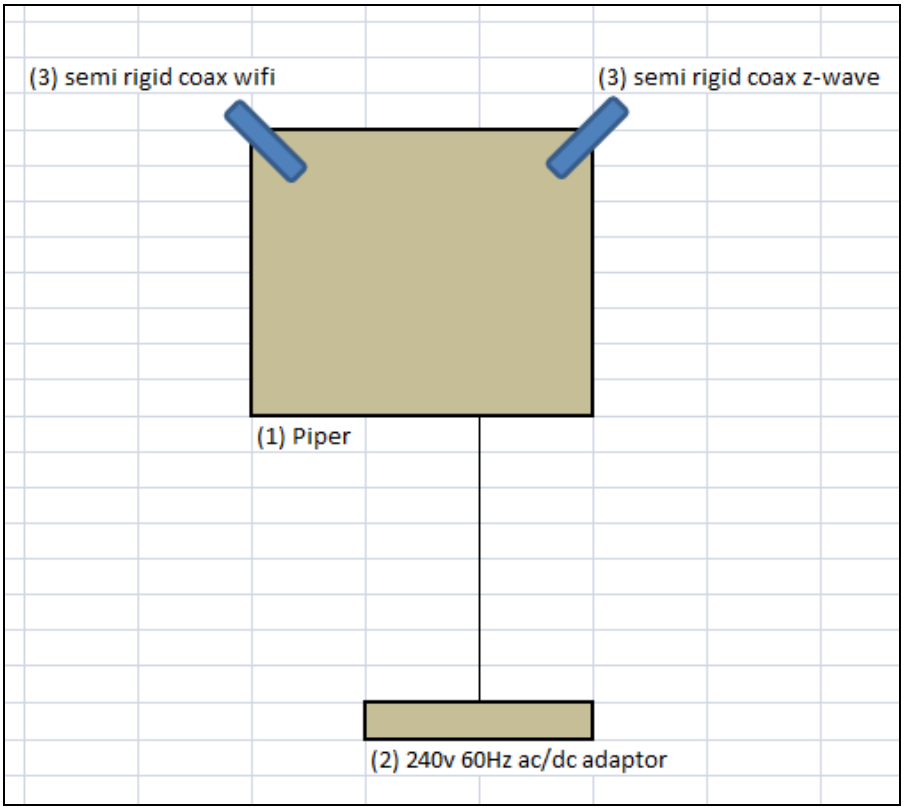


Figure 1. Block Diagram of Test Configuration

E. Equipment Configuration

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

Ref. ID	Slot #	Name / Description	Model Number	Part Number	Serial Number	Rev. #
1	N/A	Piper nv North America in Enclosure	--	80-00009	--	0.01
2	N/A	Piper nv North America with semi-rigid coax – not in enclosure	--	80-00009	--	0.01
3	N/A	North America AC/DC adaptor	SA110D-05	42-00035	--	--
4	N/A	Serial to USB cable	n/a	n/a	--	--
5	N/A	3 AA batteries	Rayovac 815 BLKE	42-00008	--	--
6	N/A	QTY = 2 Aluminum stand assembly	AS315	42-00027	--	--
7	N/A	EU open/close sensor	DSB04100-ZWEU	n/a	--	--
8	N/A	EU open/close sensor with semi-rigid coax	DSB04100-ZWEU	n/a	--	--
9	N/A	Kit for wall mount (wall mount, screws, anchor)	n/a	n/a	--	--
10	N/A	European AC/DC adaptor with UK, EU plate	SA110D-05	42-00029	--	--
11	N/A	Piper nv European Union in Enclosure	--	80-00011	--	0.01
12	N/A	Piper nv European Union with semi-rigid coax – not in enclosure	--	80-00011	--	0.01

Table 4. Equipment Configuration

F. Support Equipment

The EUT did not require any support equipment for operation or monitoring.

G. Ports and Cabling Information

Ref. ID	Port name on EUT	Cable Description or reason for no cable	Qty	Length as tested (f)	Max Length (f)	Shielded? (Y/N)	Termination Box ID & Port Name
1	Piper nv North America	DUT	1	--	--	--	--
2	Piper nv North America - AC input	North America AC/DC adaptor	1	6	6	--	mains
3	Piper nv North America -Semi-rigid coaxs	Access to wifi RF (rx/tx) and z-wave (rx/tx)	2	2”	--	Y	--
4	Piper nv European Union	DUT	1	--		--	--
5	Piper nv European Union - AC input	European AC/DC adaptor with UK, EU plate	1	8	8	--	mains
6	Piper nv European Union -Semi-rigid coaxs	Access to wifi RF (rx/tx) and z-wave (rx/tx)	2	2”	--	Y	--

Table 5. Ports and Cabling Information

H. Mode of Operation

1. All radios off
2. Z-wave transmitting, Wifi off
3. Z-wave transmitting + Wifi transmitting
4. Wifi transmitting

I. Method of Monitoring EUT Operation

1. If the LED on Piper is ON, the device is powered and working. An antenna and spectrum analyzer is used to confirm Piper is transmitting on the correct channels.
2. If the LED on Piper of OFF, the device is not powered and not working.

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 iControl Networks Canada upon completion of testing.

III. Electromagnetic Compatibility Criteria for Unintentional Radiators

Electromagnetic Compatibility Criteria

§ 15.107 Conducted Emissions Limits

Test Requirement(s):

15.107 (a) Except for Class A digital devices, for equipment 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 30 MHz shall not exceed the limits in Table 6. Compliance with this provision shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminals.

15.107 (b) For a Class A digital device 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 30 MHz shall not exceed the limits in Table 6. Compliance with this provision shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminals. The lower limit applies at the band edges.

Frequency range (MHz)	Class A Conducted Limits (dBµV)		*Class B Conducted Limits (dBµV)	
	Quasi-Peak	Average	Quasi-Peak	Average
* 0.15- 0.45	79	66	66 - 56	56 - 46
0.45 - 0.5	79	66	56	46
0.5 - 30	73	60	60	50
Note 1 — The lower limit shall apply at the transition frequencies. Note 2 — The limit decreases linearly with the logarithm if the frequency in the range 0.15 MHz to 0.5 MHz.				

Table 6. Conducted Limits for Radio Frequency Devices calculated from FCC Part 15 Subsections 15.107(a) (b)

Test Procedures: The EUT was placed on a non-metallic table, 80 cm above the ground plane inside a semi-anechoic chamber. The method of testing, test conditions, and test procedures of ANSI C63.4 were used. The EUT was powered through a 50Ω/50µH LISN. An EMI receiver, connected to the measurement port of the LISN, scanned the frequency range from 150 kHz to 30 MHz in order to find the peak conducted emissions. All peak emissions within 6 dB of the limit were re-measured using a quasi-peak and/or average detector as appropriate.

Test Results: The EUT was compliant with the Class B requirement(s) of this section. Measured emissions were below applicable limits.

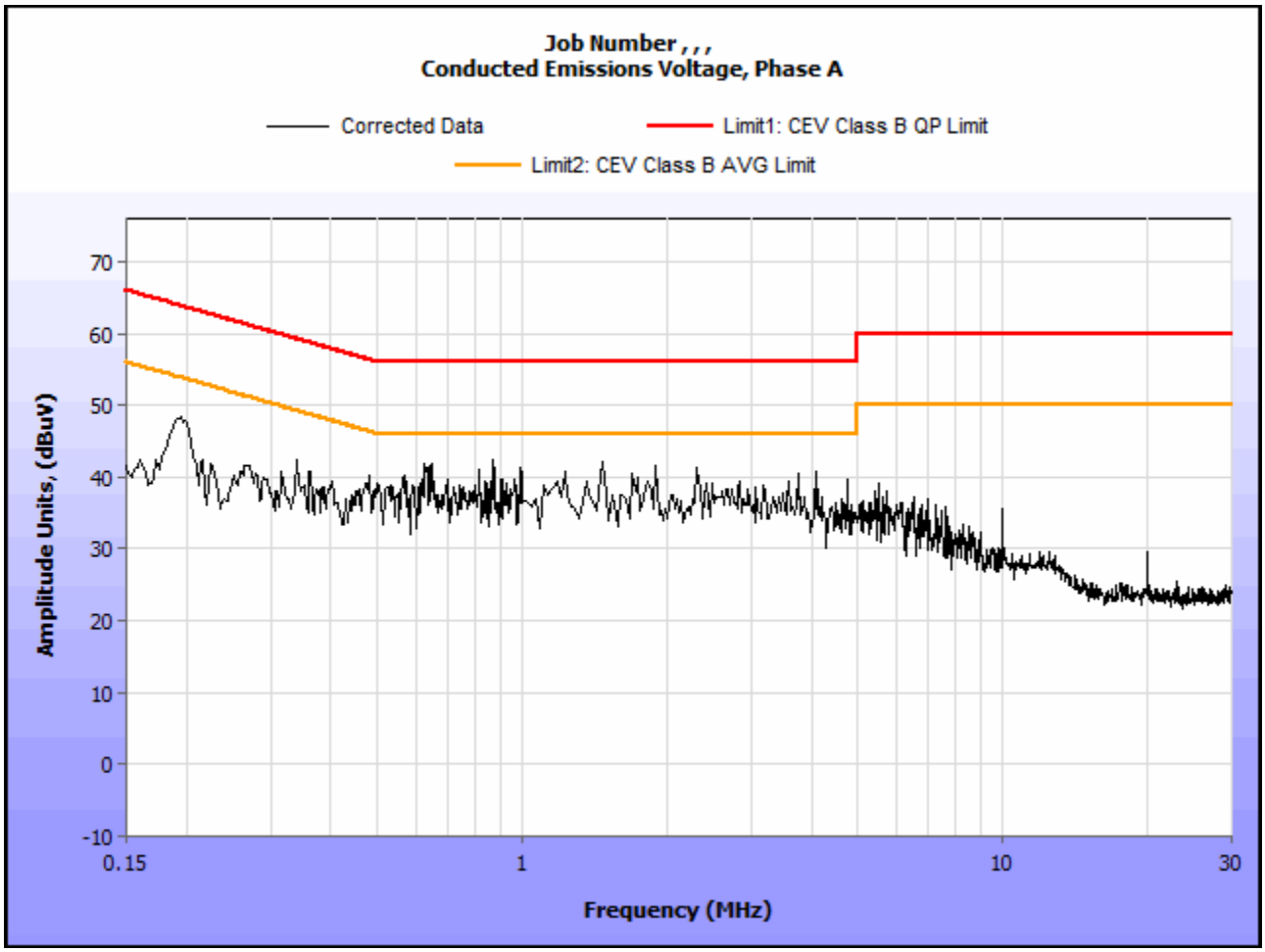
Test Engineer(s): Djed Mouada

Test Date(s): 10/07/2014

Conducted Emissions - Voltage, AC Power, Phase Line (120VAC, 60 Hz)

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
0.1924	44.56	0	44.56	63.93	-19.37	37.93	0	37.93	53.93	-16
0.3175	32.58	0	32.58	59.77	-27.19	20.9	0	20.9	49.77	-28.87
0.7825	32.3	0	32.3	56	-23.7	19.6	0	19.6	46	-26.4
1.067	32.78	0	32.78	56	-23.22	18.45	0	18.45	46	-27.55
10.68	33.94	0	33.94	60	-26.06	24.08	0	24.08	50	-25.92
20.31	20.31	0	20.31	60	-39.69	17.69	0	17.69	50	-32.31

Table 7. Conducted Emissions - Voltage, AC Power, Phase Line (120VAC, 60 Hz)

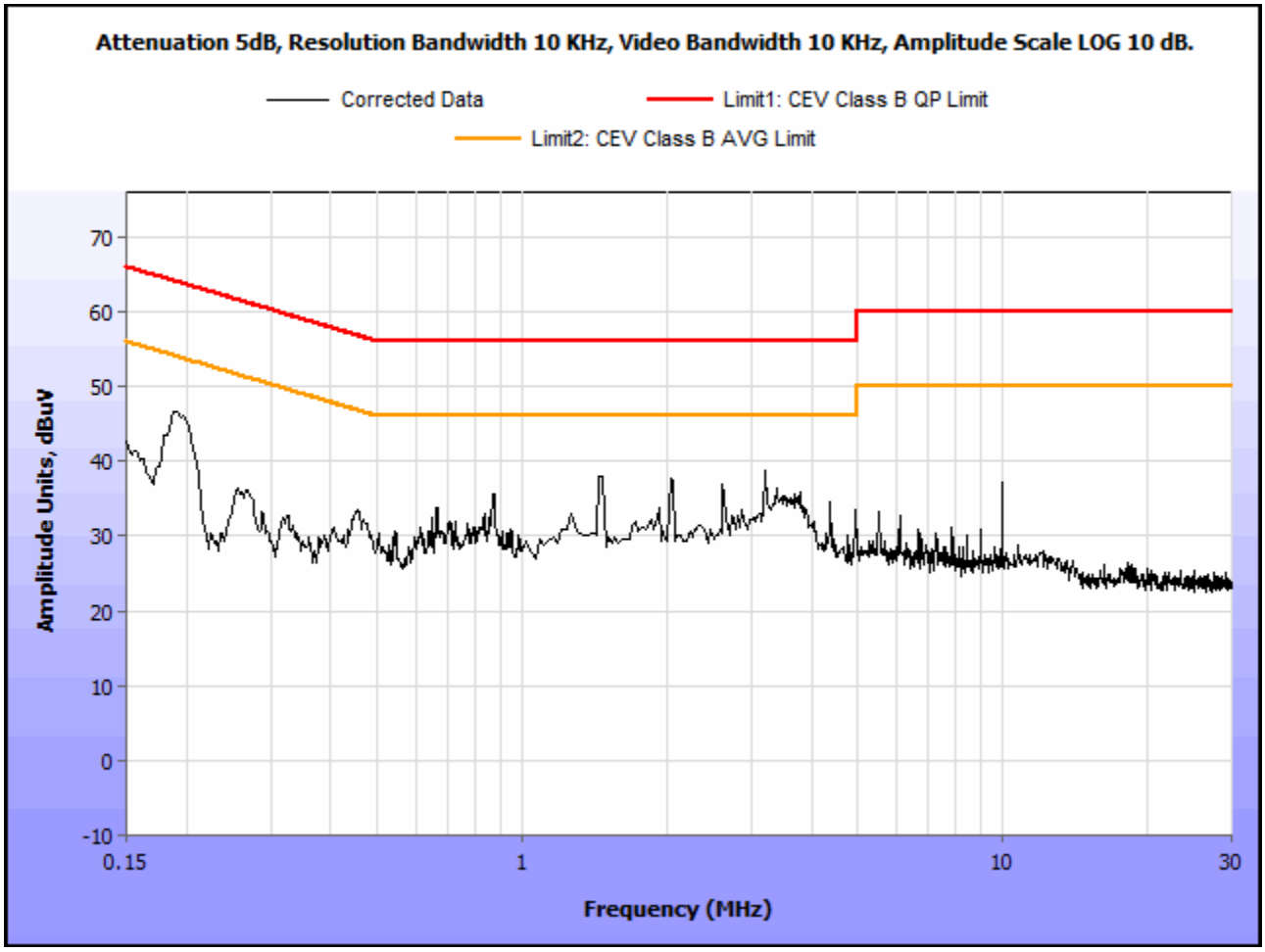


Plot 1. Conducted Emission, Phase Line Plot

Conducted Emissions - Voltage, AC Power, Neutral Line (120VAC, 60 Hz)

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
0.1946	18.9	0	18.9	63.84	-44.94	15.08	0	15.08	53.84	-38.76
0.337	20.13	0	20.13	59.28	-39.15	18.98	0	18.98	49.28	-30.3
0.776	29.81	0	29.81	56	-26.19	19.76	0	19.76	46	-26.24
5.77	26.02	0	26.02	60	-33.98	15.76	0	15.76	50	-34.24
12.75	21.83	0	21.83	60	-38.17	12.75	0	12.75	50	-37.25
23.38	17.73	0	17.73	60	-42.27	17.8	0	17.8	50	-32.2

Table 8. Conducted Emissions - Voltage, AC Power, Neutral Line (120VAC, 60 Hz)



Plot 2. Conducted Emission, Neutral Line Plot

Conducted Emission Limits Test Setup

Photograph 1. Conducted Emissions, Test Setup

Radiated Emission Limits

§ 15.109 Radiated Emissions Limits

Test Requirement(s): **15.109 (a)** Except for Class A digital devices, the field strength of radiated emissions from unintentional radiators at a distance of 3 meters shall not exceed the Class B limits expressed in Table 9.

15.109 (b) The field strength of radiated emissions from a Class A digital device, as determined at a distance of 10 meters, shall not exceed the Class A limits expressed in Table 9.

Frequency (MHz)	Field Strength (dBµV/m)	
	§15.109 (b), Class A Limit (dBµV) @ 10m	§15.109 (a),Class B Limit (dBµV) @ 3m
30 - 88	39.00	40.00
88 - 216	43.50	43.50
216 - 960	46.40	46.00
Above 960	49.50	54.00

Table 9. Radiated Emissions Limits calculated from FCC Part 15, §15.109 (a) (b)

Test Procedures: The EUT was placed on a non-metallic table, 80 cm above the ground plane inside a semi-anechoic chamber. The method of testing and test conditions of ANSI C63.4 were used. An antenna was located 3 m from the EUT on an adjustable mast. A pre-scan was first performed in order to find prominent radiated emissions. For final emissions measurements at each frequency of interest, the EUT was rotated and the antenna height was varied between 1 m and 4 m in order to maximize the emission. Measurements in both horizontal and vertical polarities were made and the data was recorded. Unless otherwise specified, measurements were made using a quasi-peak detector with a 120 kHz bandwidth.

Test Results: The EUT was compliant with the Class B requirement(s) of this section. Measured emissions were below applicable limits.

Test Engineer(s): Djed Mouada

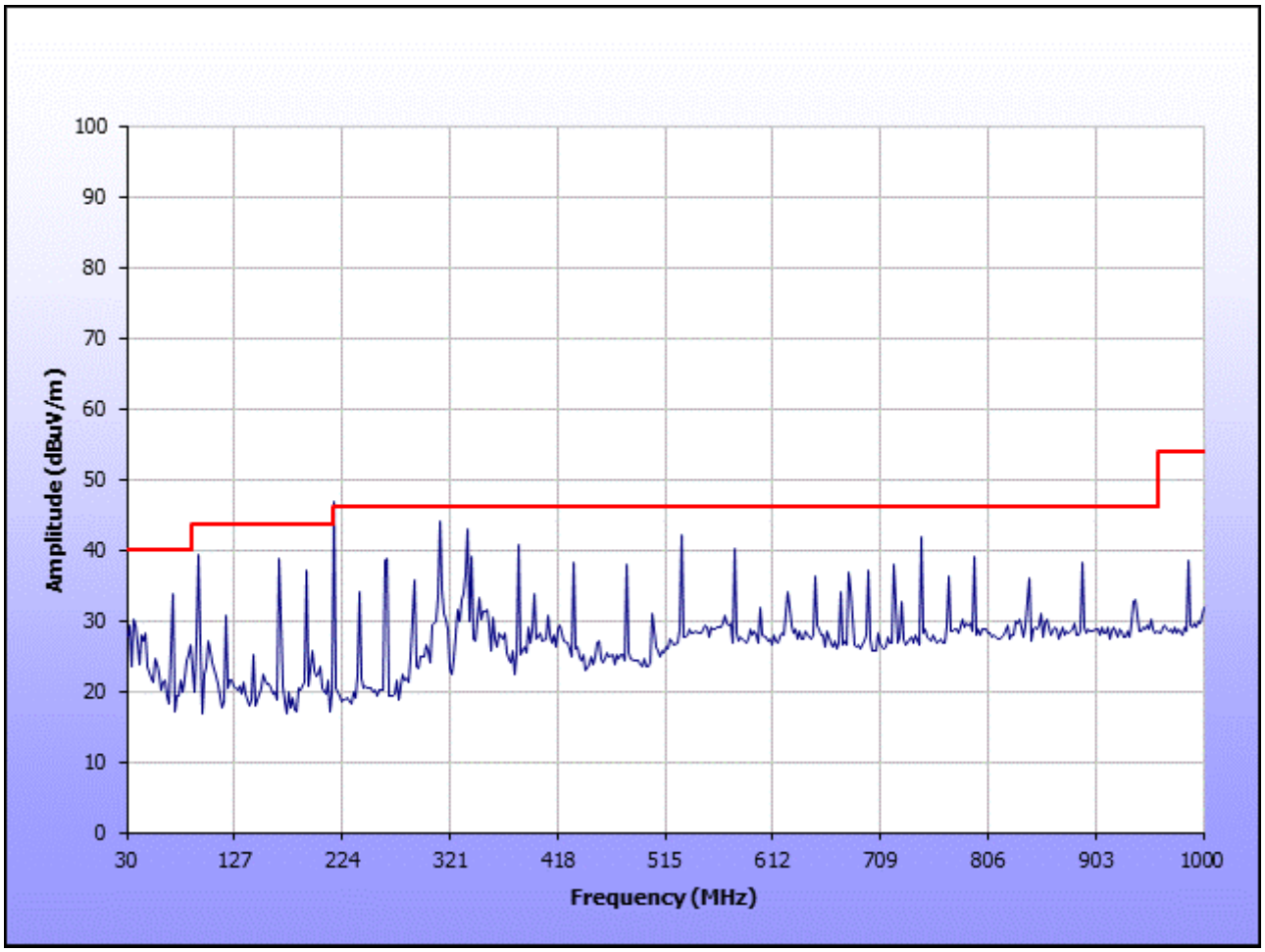
Test Date(s): 10/14/2014

Radiated Emissions Limits Test Results, Class B

Frequency (MHz)	EUT Azimuth (Degrees)	Antenna Polarity (H/V)	Antenna HEIGHT (m)	Uncorrected EMI Meter Reading (dBuV)	Antenna Correction Factor (dB/m) (+)	Cable Loss/Pre-amp (dB) (+)	Distance Correction Factor (dB) (-)	Corrected Amplitude (dBuV/m)	Limit (dBuV/m)	Margin (dB)
95.1028	11	H	2.0795	33.45	8.83	-20.14	0	22.14	43.5	-21.36
95.1028	194	V	2.0878	43.29	8.83	-20.14	0	31.98	43.5	-11.52
167.9778	69	H	2.3995	42.64	12.40	-19.93	0	35.11	43.5	-8.39
167.9778	198	V	2.2726	39.87	12.40	-19.93	0	32.34	43.5	-11.16
215.98	109	H	2.2091	47.65	11.44	-19.88	0	39.21	43.5	-4.29
215.98	94	V	1.6608	49.93	11.44	-19.88	0	41.49	43.5	-2.01
311.968	144	H	3.4678	37.66	14.44	-19.51	0	32.59	46	-13.41
311.968	160	V	2.5521	38.96	14.44	-19.51	0	33.89	46	-12.11
527.952	112	H	2.6104	29.92	18.66	-19.54	0	29.04	46	-16.96
527.952	38	V	1.8239	33.78	18.66	-19.54	0	32.90	46	-13.10
713.41	166	H	1.9486	25.4	20.97	-19.87	0	26.50	46	-19.50
713.41	111	V	1.6608	26.32	20.97	-19.87	0	27.42	46	-18.58

Table 10. Radiated Emissions Limits, Test Results, 30 MHz – 1 GHz, FCC Limits

Note: The EUT was tested at 3 m.



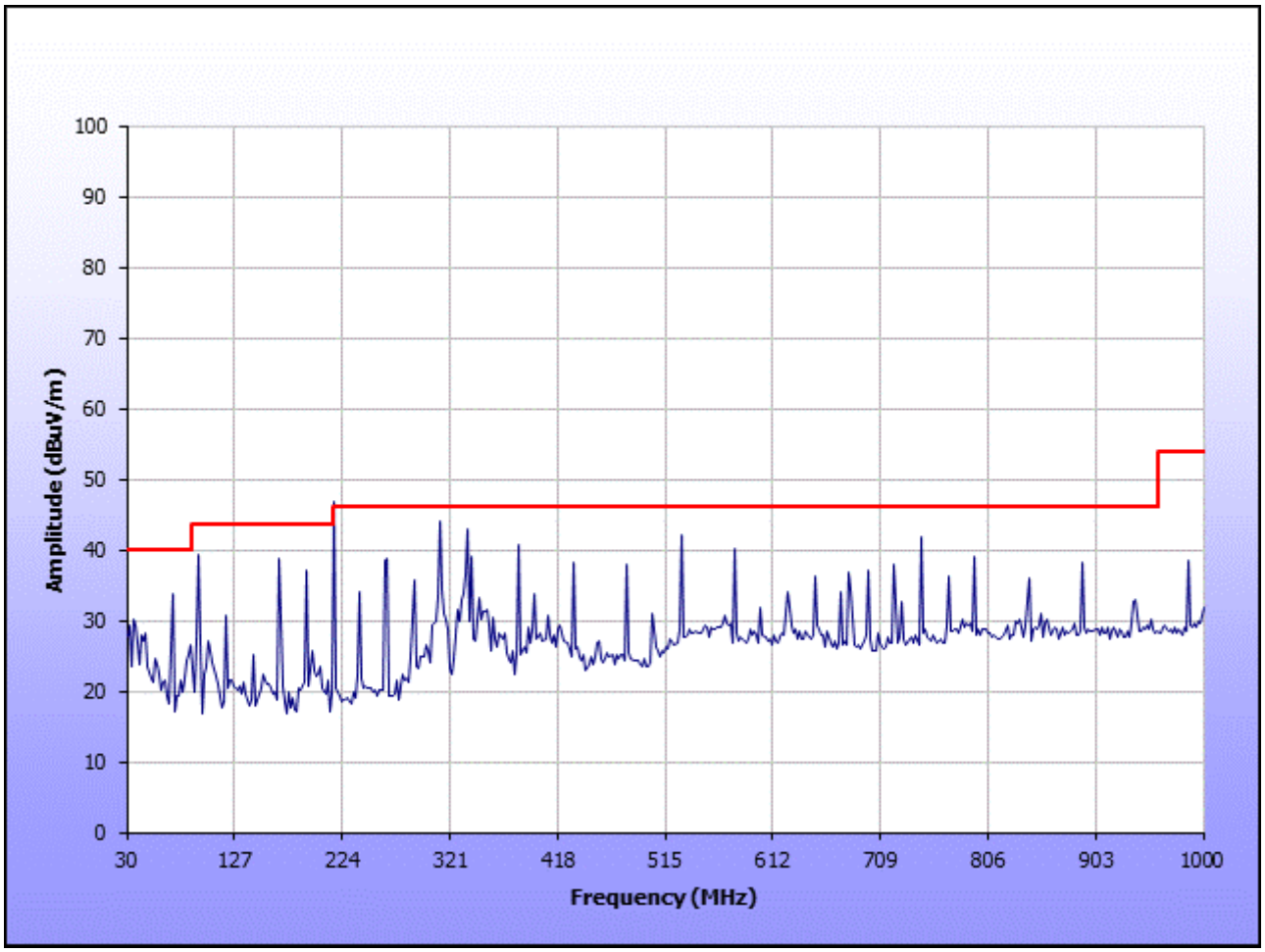
Plot 3. Radiated Emissions, 30 MHz - 1 GHz, FCC Limits

Radiated Emissions Limits Test Results, Class B

Frequency (MHz)	EUT Azimuth (Degrees)	Antenna Polarity (H/V)	Antenna HEIGHT (m)	Uncorrected Amplitude (dBuV)	Antenna Correction Factor (dB) (+)	Cable Loss (dB) (+)	Distance Correction Factor (dB) (-)	Corrected Amplitude (dBuV/m)	Limit (dBuV/m)	Margin (dB)
95.1028	11	H	2.0795	33.45	8.83	-20.14	0	22.14	43.5	-21.36
95.1028	194	V	2.0878	43.29	8.83	-20.14	0	31.98	43.5	-11.52
167.9778	69	H	2.3995	42.64	12.40	-19.93	0	35.11	43.5	-8.39
167.9778	198	V	2.2726	39.87	12.40	-19.93	0	32.34	43.5	-11.16
215.98	109	H	2.2091	47.65	11.44	-19.88	0	39.21	43.5	-4.29
215.98	94	V	1.6608	49.93	11.44	-19.88	0	41.49	43.5	-2.01
311.968	144	H	3.4678	37.66	14.44	-19.51	0	32.59	46	-13.41
311.968	160	V	2.5521	38.96	14.44	-19.51	0	33.89	46	-12.11
527.952	112	H	2.6104	29.92	18.66	-19.54	0	29.04	46	-16.96
527.952	38	V	1.8239	33.78	18.66	-19.54	0	32.90	46	-13.10
713.41	166	H	1.9486	25.4	20.97	-19.87	0	26.50	46	-19.50
713.41	111	V	1.6608	26.32	20.97	-19.87	0	27.42	46	-18.58

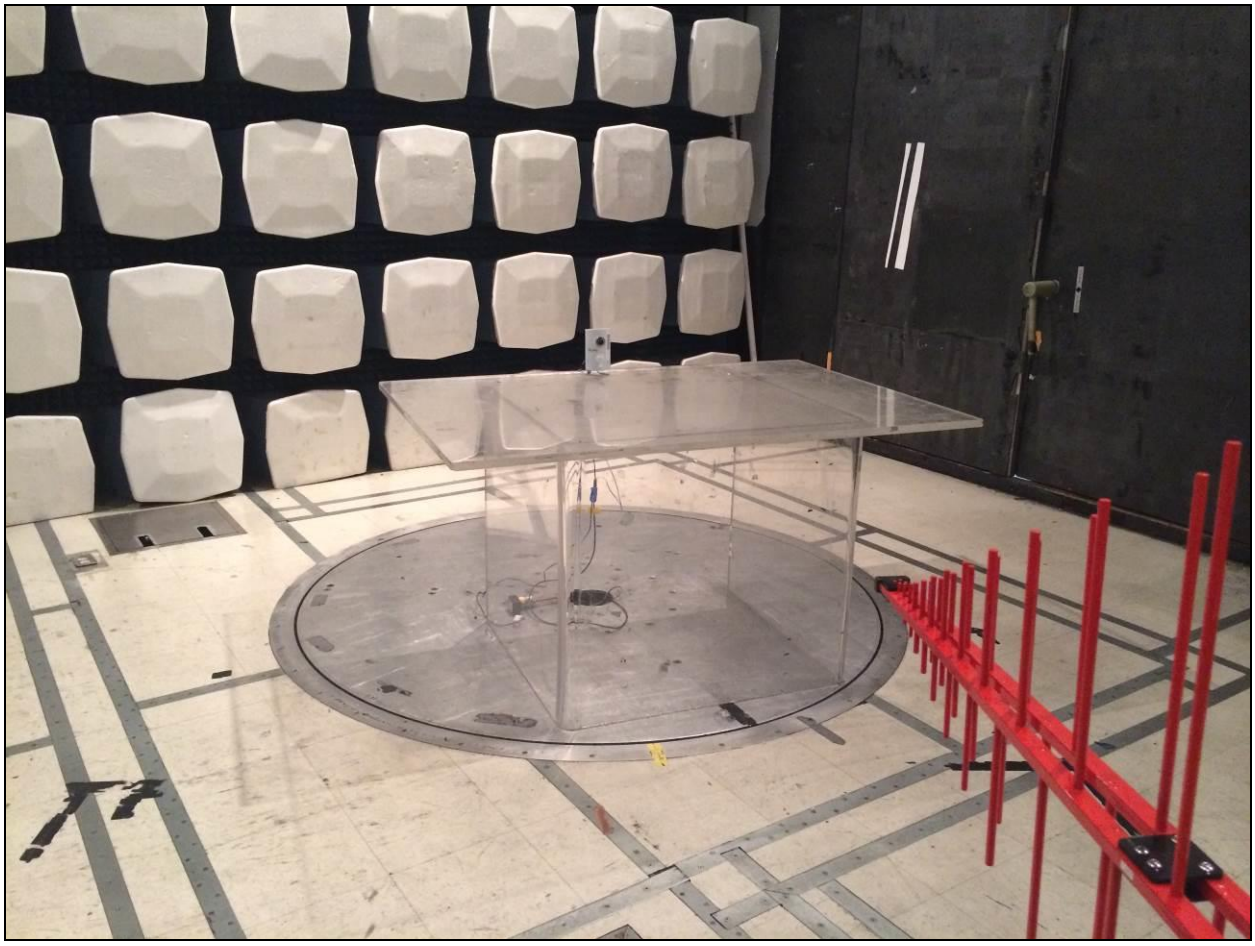
Table 11. Radiated Emissions Limits, Test Results, ICES-003 Limits

Note: The EUT was tested at 3 m.



Plot 4. Radiated Emissions, ICES-003 Limits

Radiated Emissions Limits Test Setup



Photograph 2. Radiated Emissions, Test Setup

IV. 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 is compliant the criteria of §15.203. The EUT has an integral antenna.

Test Engineer(s): Djed Mouada

Test Date(s): 10/06/2014

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 12. 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 C63.4-2003 "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 below applicable limits.

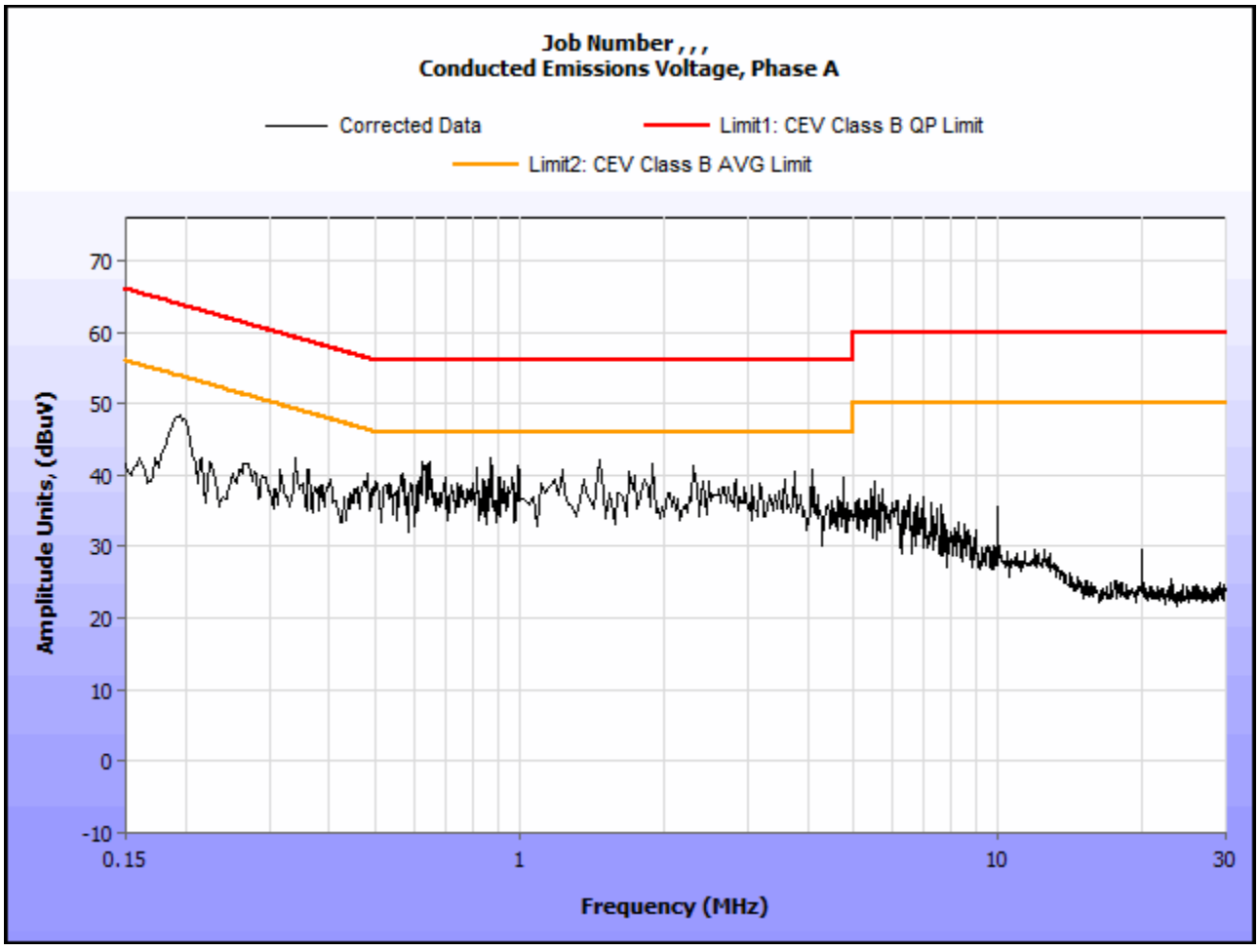
Test Engineer(s): Djed Mouada

Test Date(s): 10/07/2014

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
0.1924	44.56	0	44.56	63.93	-19.37	37.93	0	37.93	53.93	-16
0.3175	32.58	0	32.58	59.77	-27.19	20.9	0	20.9	49.77	-28.87
0.7825	32.3	0	32.3	56	-23.7	19.6	0	19.6	46	-26.4
1.067	32.78	0	32.78	56	-23.22	18.45	0	18.45	46	-27.55
10.68	33.94	0	33.94	60	-26.06	24.08	0	24.08	50	-25.92
20.31	20.31	0	20.31	60	-39.69	17.69	0	17.69	50	-32.31

Table 13. Conducted Emissions, 15.207(a), Phase Line, Test Results

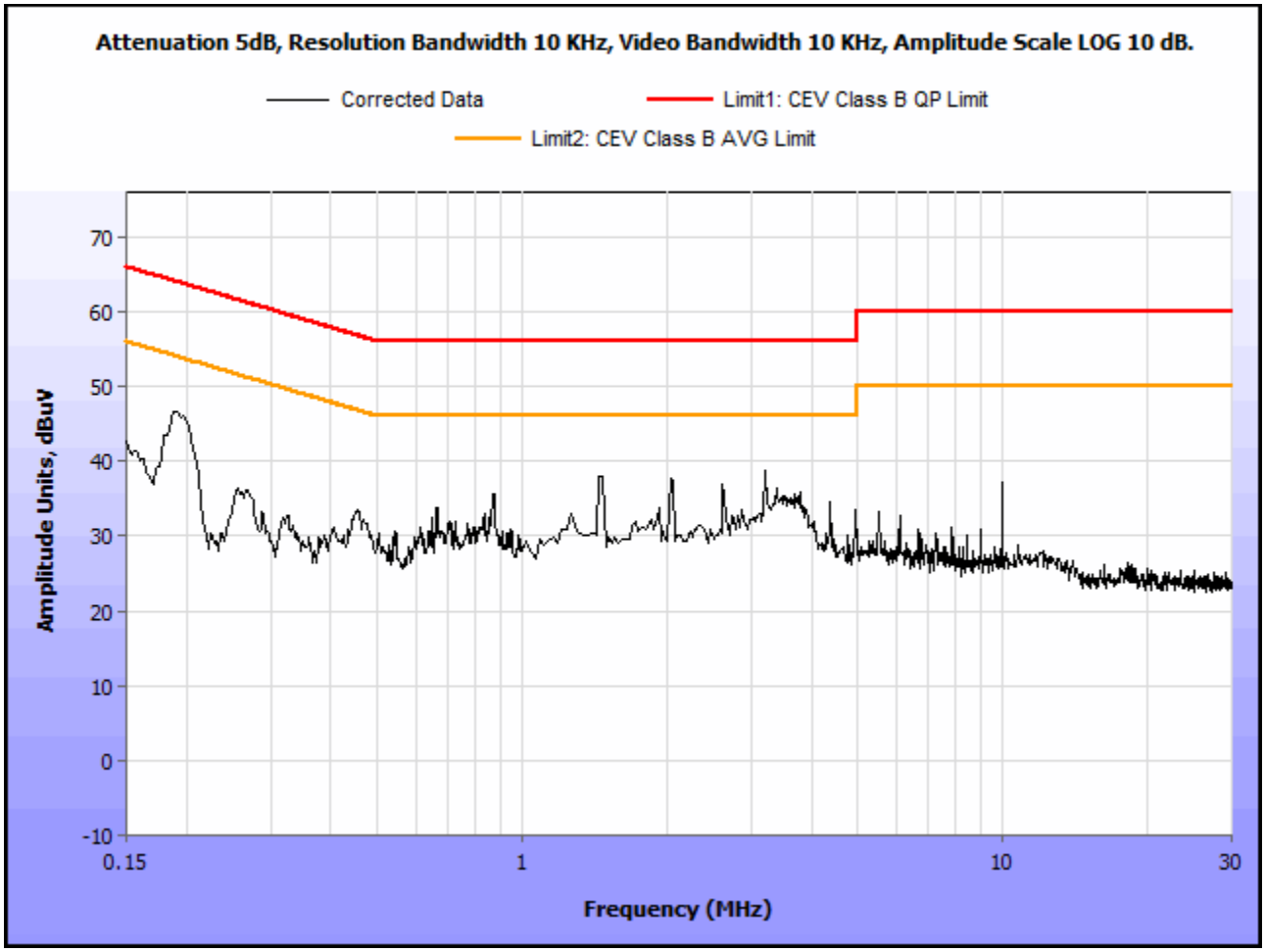


Plot 5. Conducted Emissions, 15.207(a), Phase Line

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
0.1946	18.9	0	18.9	63.84	-44.94	15.08	0	15.08	53.84	-38.76
0.337	20.13	0	20.13	59.28	-39.15	18.98	0	18.98	49.28	-30.3
0.776	29.81	0	29.81	56	-26.19	19.76	0	19.76	46	-26.24
5.77	26.02	0	26.02	60	-33.98	15.76	0	15.76	50	-34.24
12.75	21.83	0	21.83	60	-38.17	12.75	0	12.75	50	-37.25
23.38	17.73	0	17.73	60	-42.27	17.8	0	17.8	50	-32.2

Table 14. Conducted Emissions, 15.207(a), Neutral Line, Test Results



Plot 6. Conducted Emissions, 15.207(a), Neutral Line

15.207(a) Conducted Emissions Test Setup Photo

Photograph 3. Conducted Emissions, 15.207(a), Test Setup

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(a)(2) 6 dB and 99% 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 approximately 1% of the total emission bandwidth, 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 were noted during testing.

The 6 dB and 99% Bandwidth was determined from the plots on the following pages.

Test Engineer(s): Djed Mouada

Test Date(s): 10/08/2014 – 10/09/2014

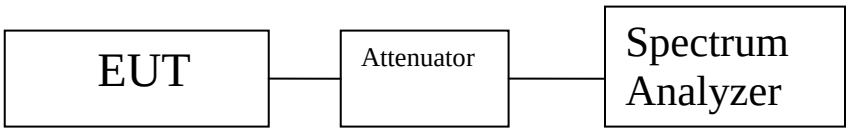


Figure 2. Block Diagram, Occupied Bandwidth Test Setup

Occupied Bandwidth Test Results

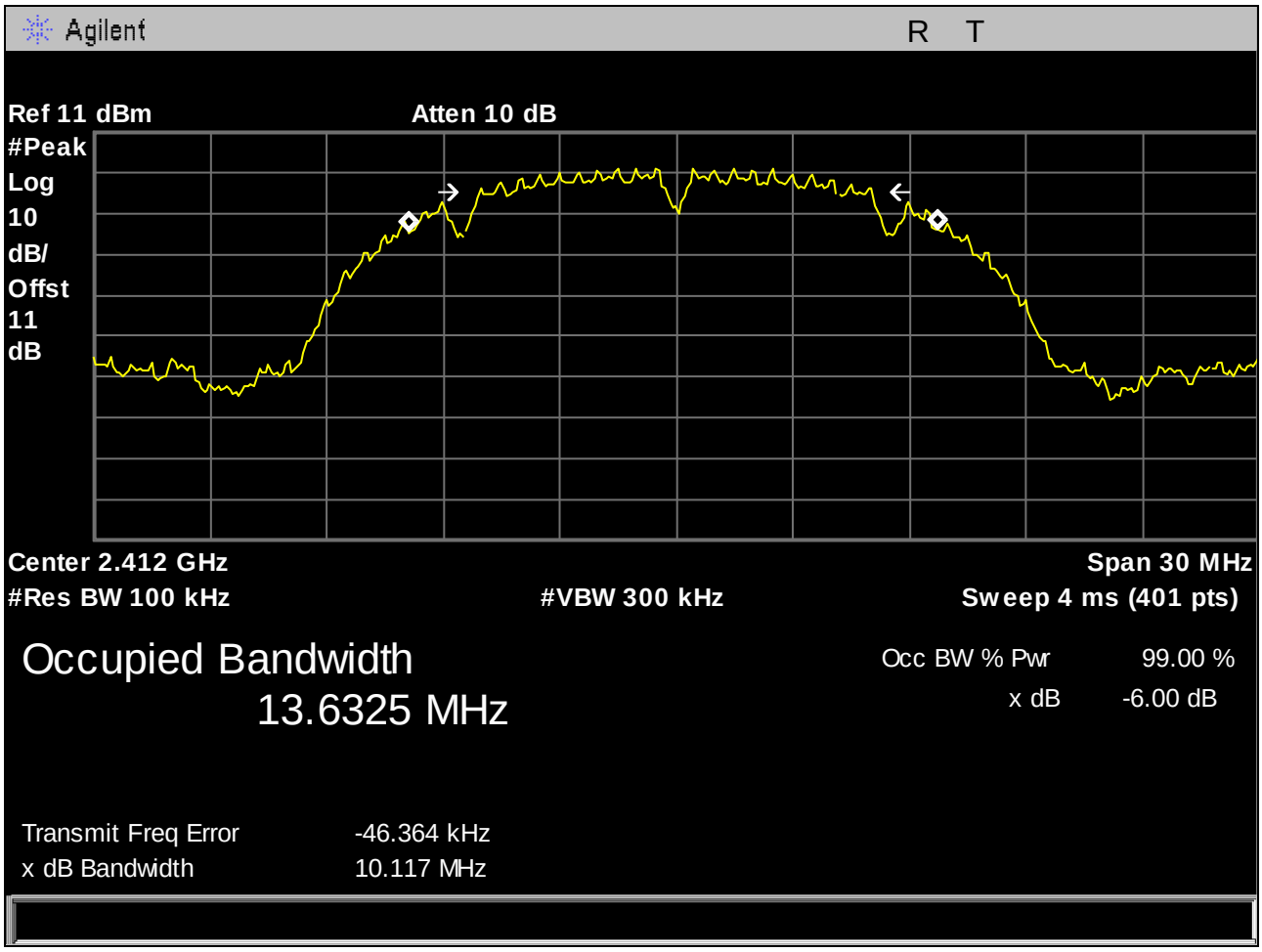
Occupied Bandwidth		
Carrier Channel	**Frequency (MHz)**	**Measured 6 dB Bandwidth (MHz)**
b mode Low	2412	10.117
b mode Mid	2437	10.131
b mode High	2462	10.123
g mode Low	2412	16.609
g mode Mid	2437	16.546
g mode High	2462	16.566
n mode (20 MHz) Low	2412	17.645
n mode (20 MHz) Mid	2437	17.643
n mode (20 MHz) High	2462	17.6
n mode (40 MHz) Low	2422	36.547
n mode (40 MHz) Mid	2437	36.569
n mode (40 MHz) High	2452	36.537

Table 15. 6 dB Occupied Bandwidth, Test Results

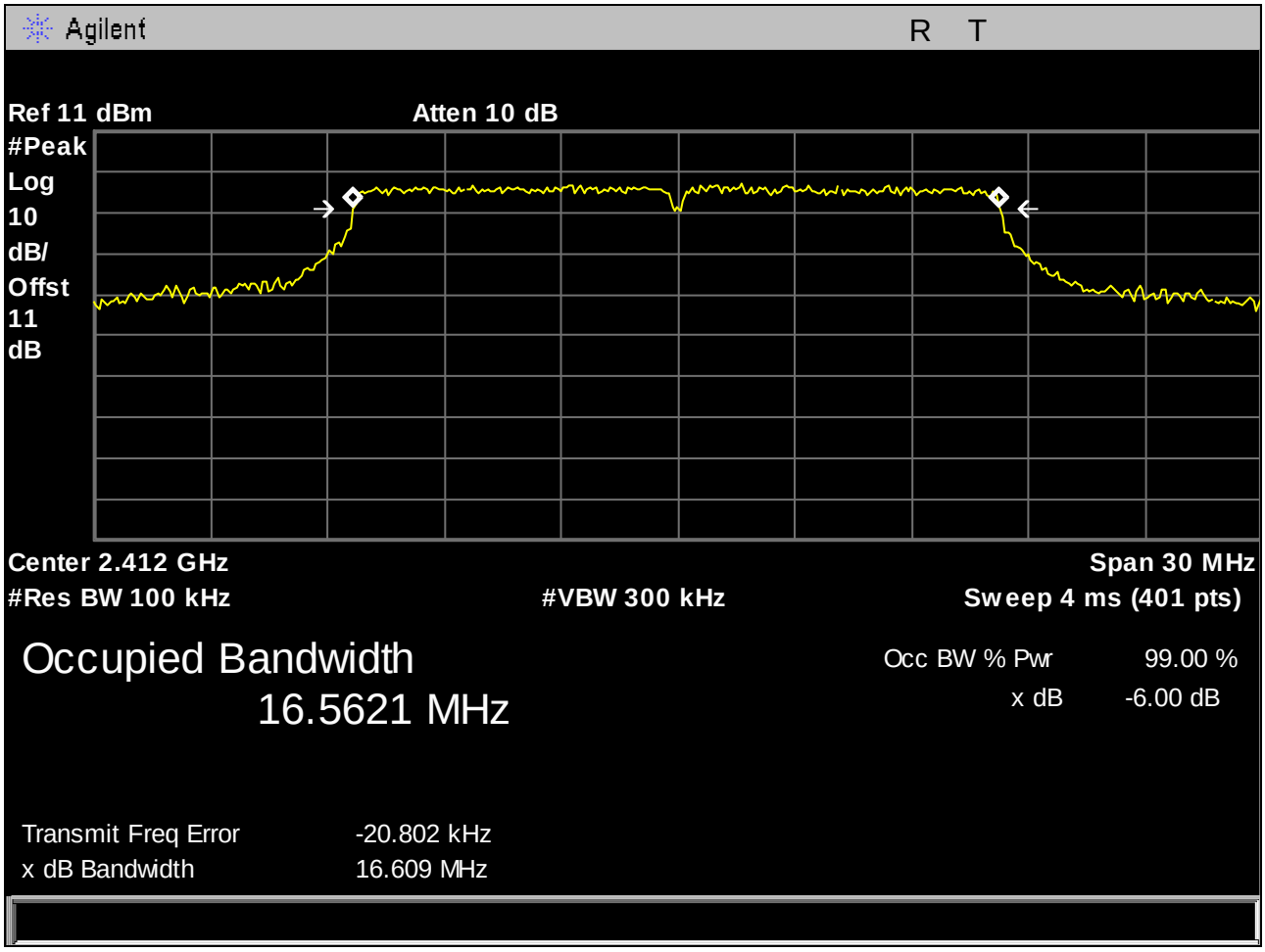
Occupied Bandwidth		
Carrier Channel	**Frequency (MHz)**	**Measured 99% dB Bandwidth (MHz)**
b mode Low	2412	13.4983
b mode Mid	2437	13.5504
b mode High	2462	13.5038
g mode Low	2412	16.5461
g mode Mid	2437	16.5305
g mode High	2462	16.4986
n mode (20 MHz) Low	2412	17.666
n mode (20 MHz) Mid	2437	17.6924
n mode (20 MHz) High	2462	17.6711
n mode (40 MHz) Low	2422	36.1529
n mode (40 MHz) Mid	2437	36.0728
n mode (40 MHz) High	2452	36.148

Table 16. 99% Occupied Bandwidth, Test Results

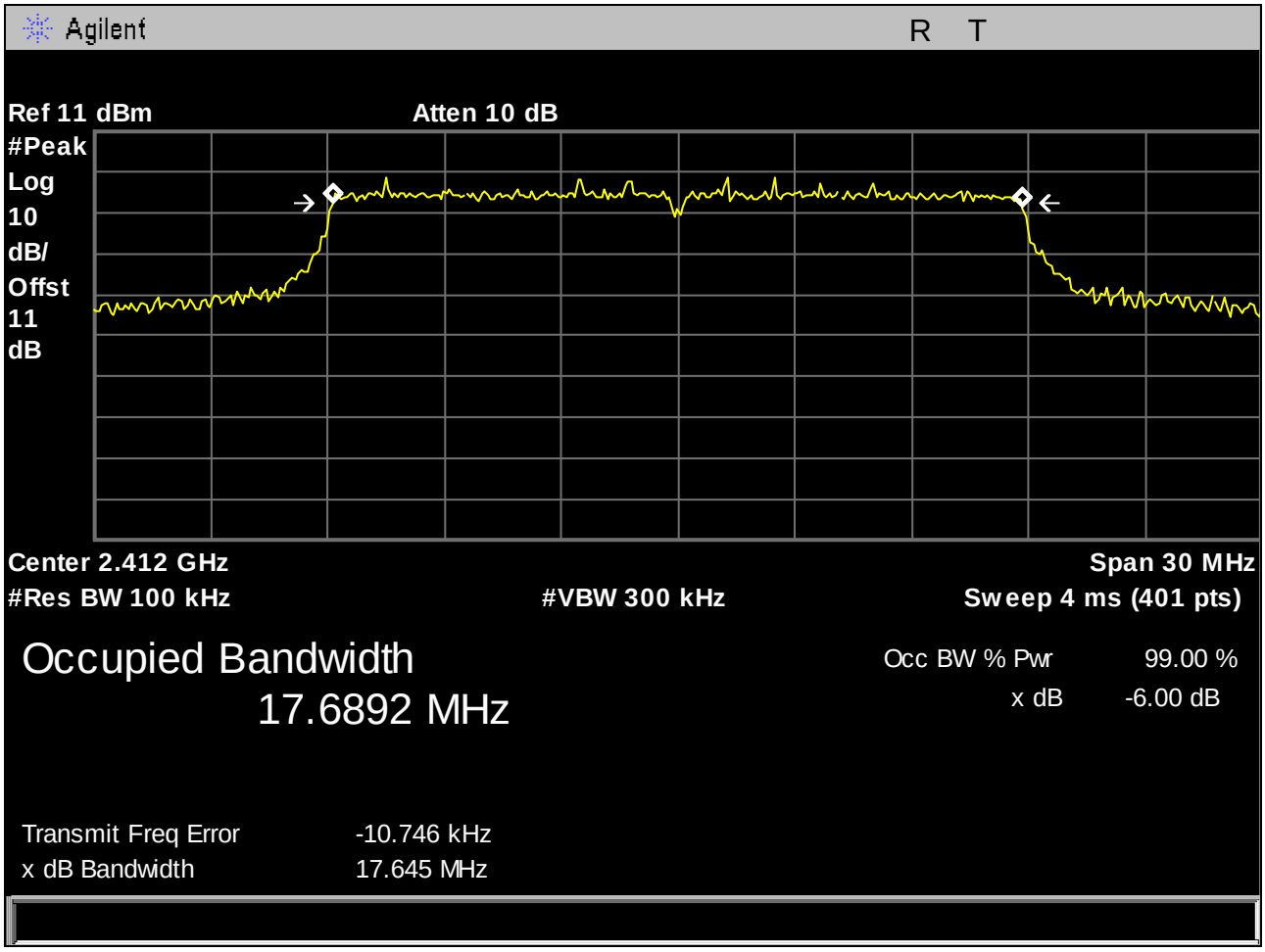
6 dB Occupied Bandwidth Test Results



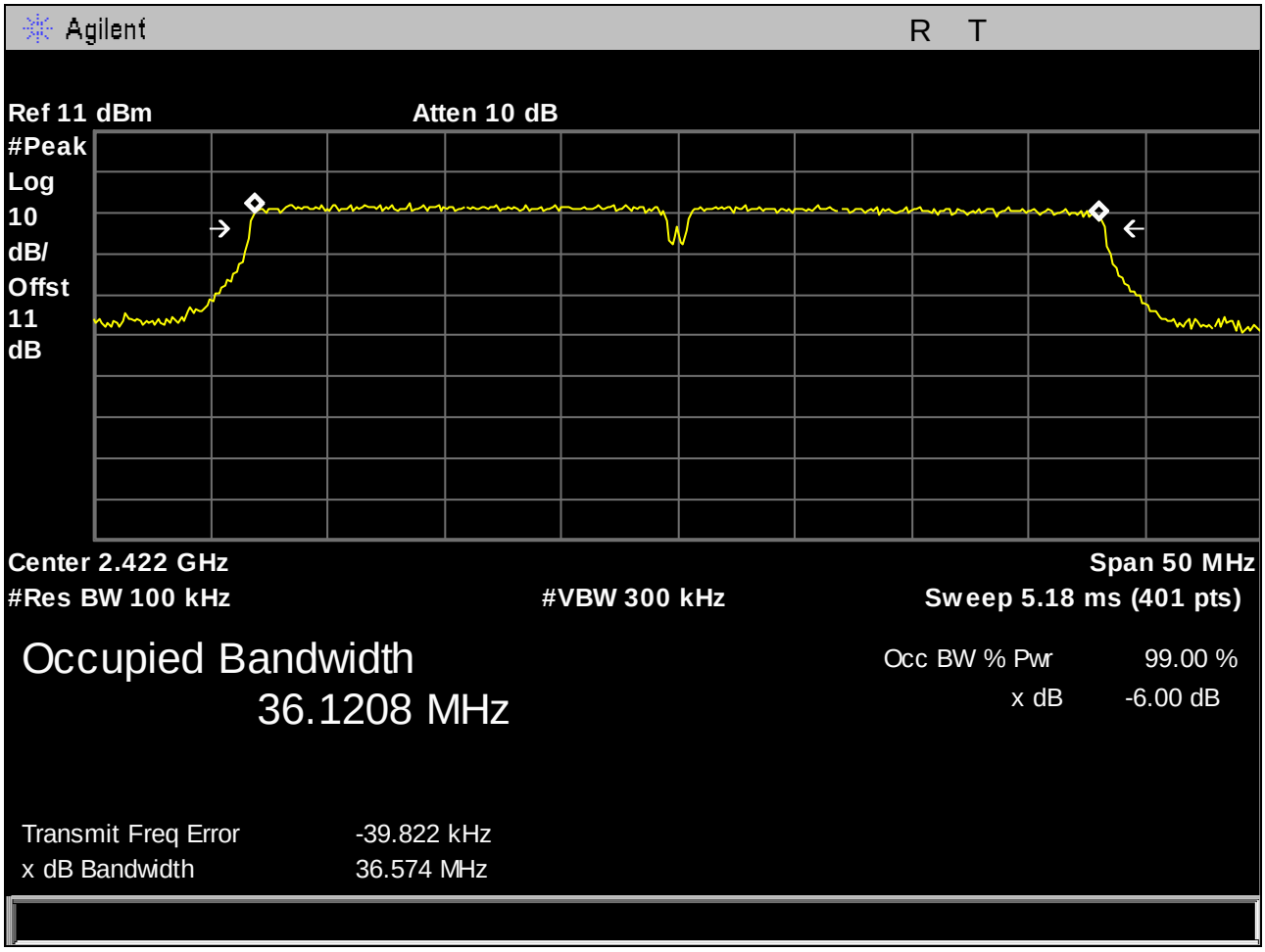
Plot 7. 6 dB Occupied Bandwidth, b Mode, 20 MHz, Low Channel



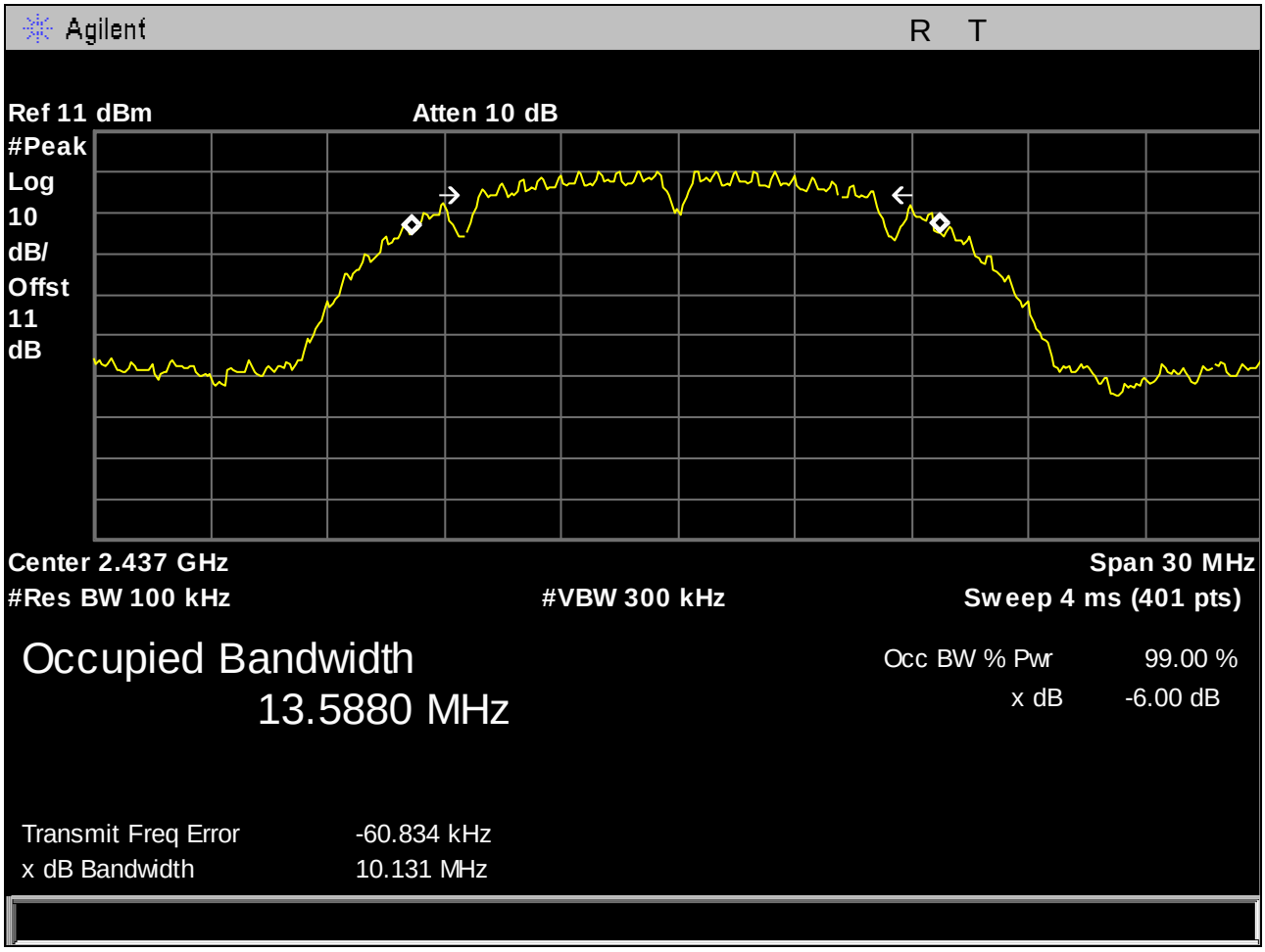
Plot 8. 6 dB Occupied Bandwidth, g Mode, 20 MHz, Low Channel



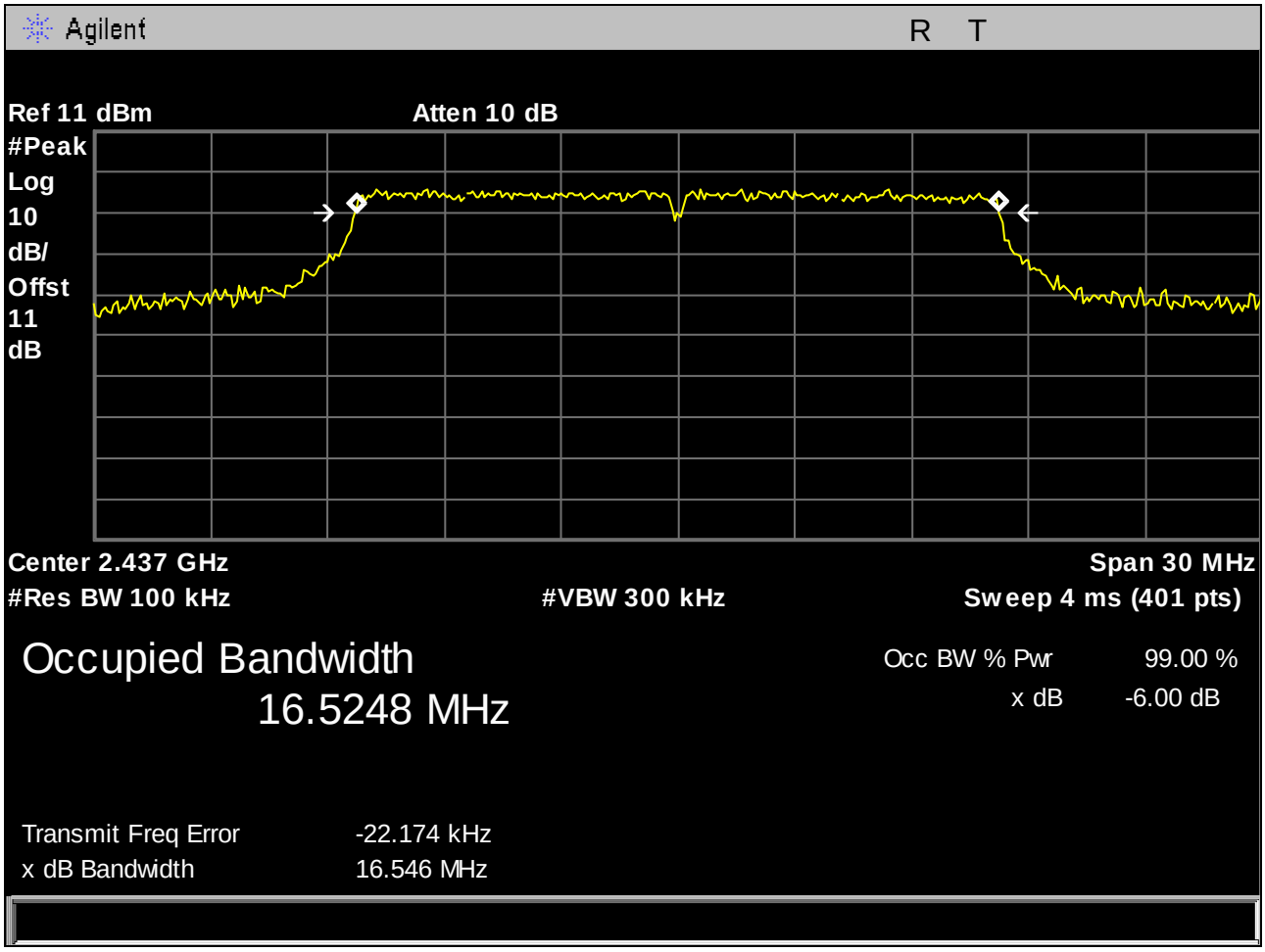
Plot 9. 6 dB Occupied Bandwidth, n Mode, 20 MHz, Low Channel



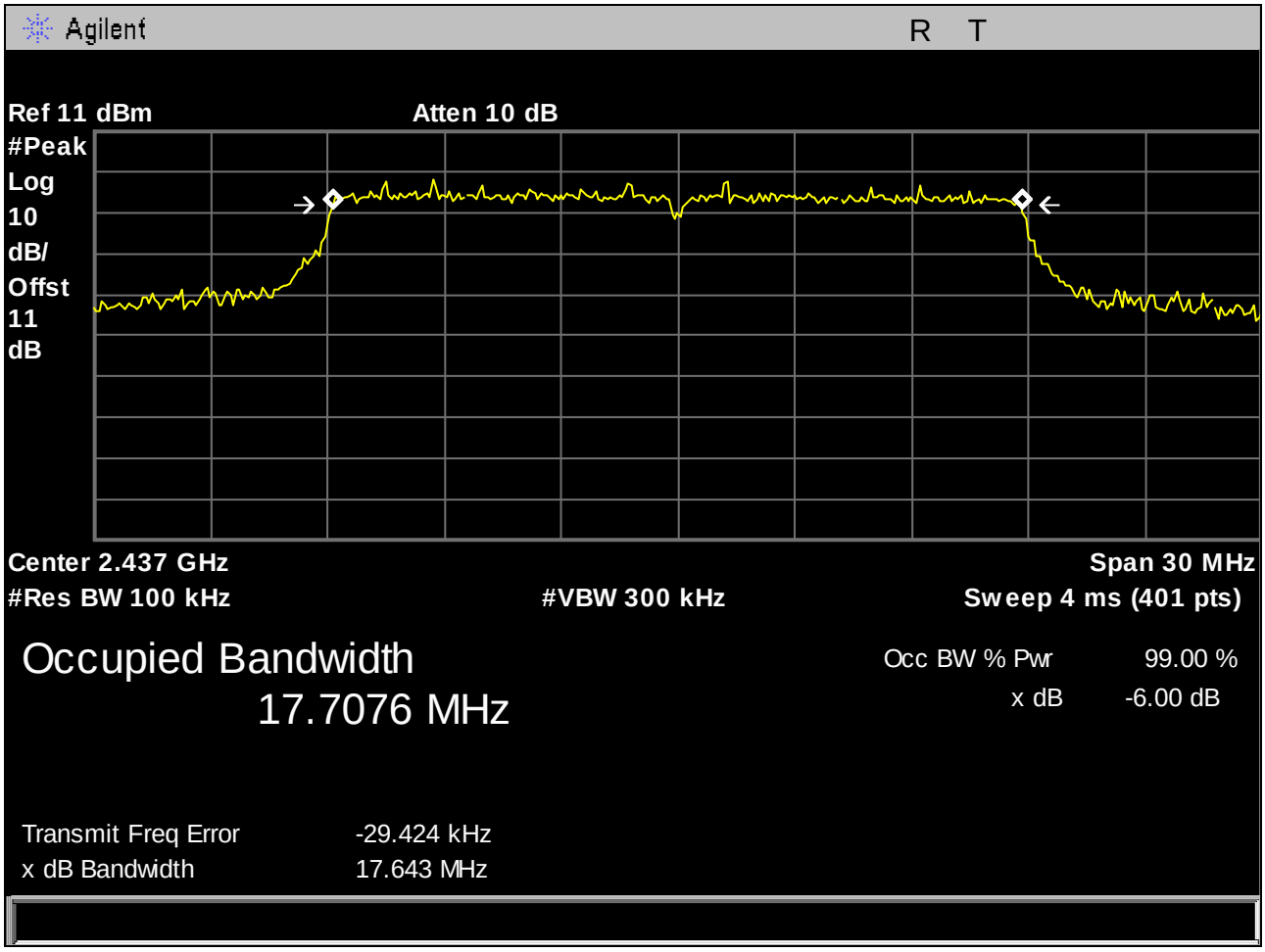
Plot 10. 6 dB Occupied Bandwidth, n Mode, 40 MHz, Low Channel



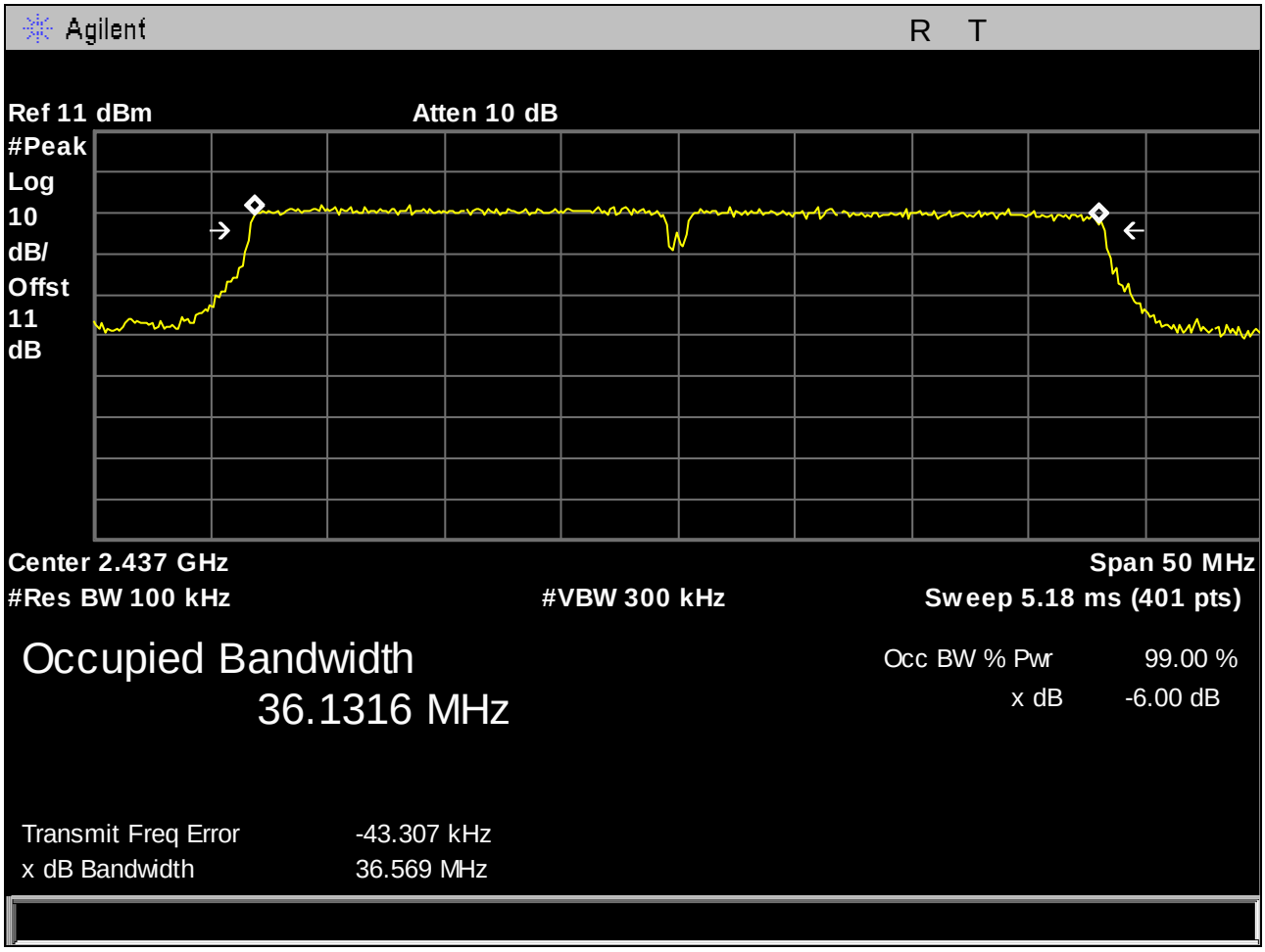
Plot 11. 6 dB Occupied Bandwidth, b Mode, 20 MHz, Mid Channel



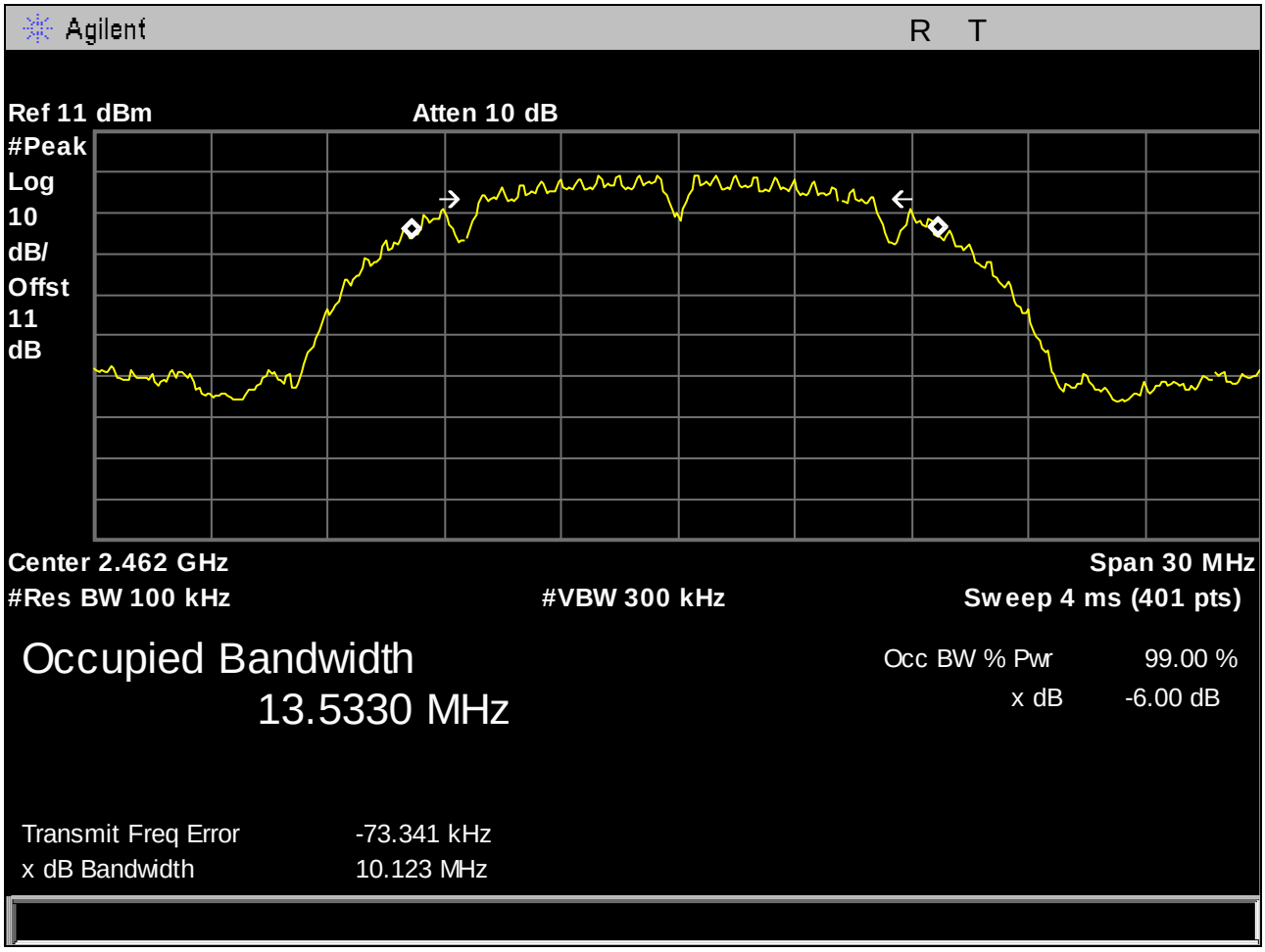
Plot 12. 6 dB Occupied Bandwidth, g Mode, 20 MHz, Mid Channel



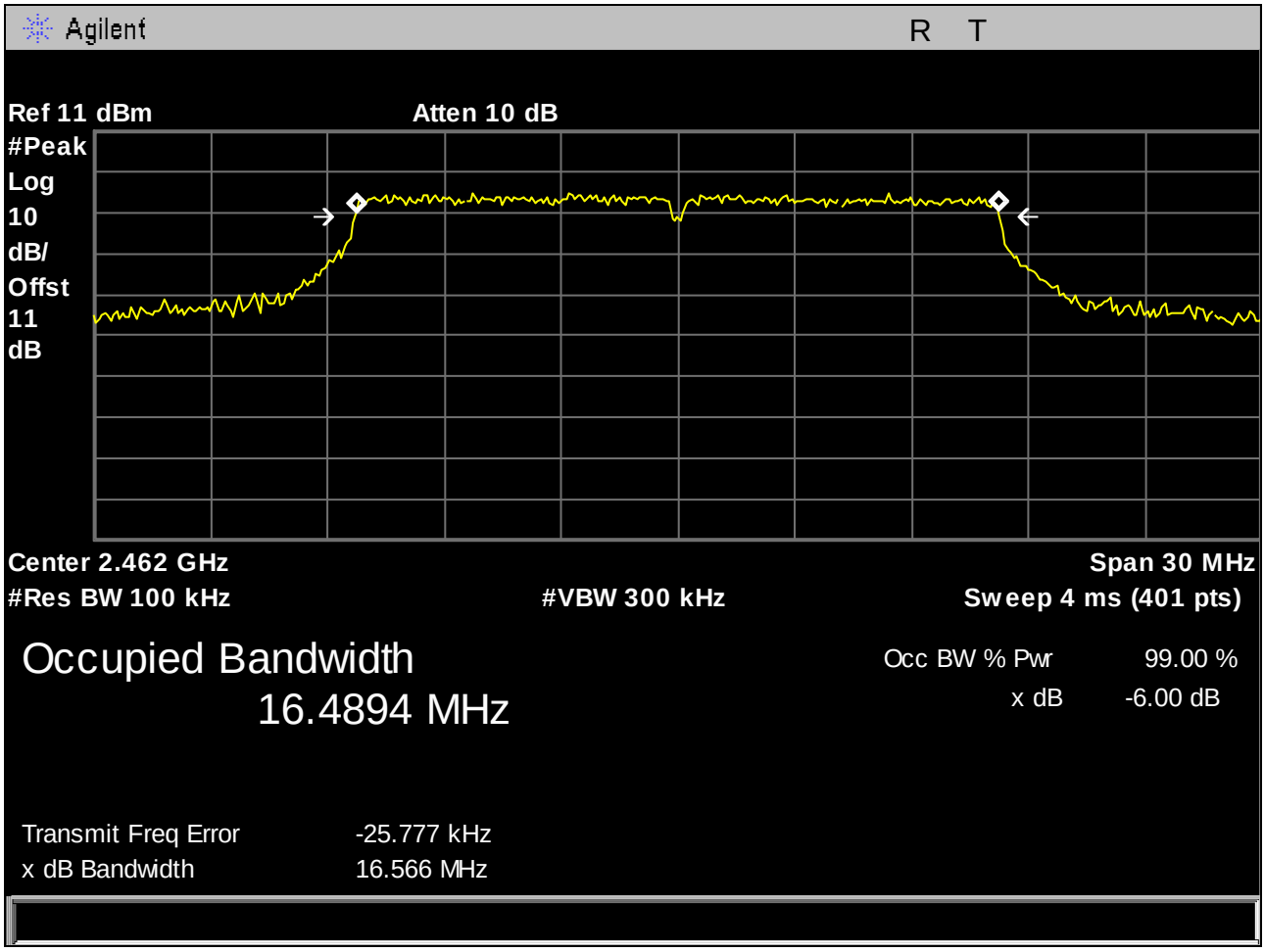
Plot 13. 6 dB Occupied Bandwidth, n Mode, 20 MHz, Mid Channel



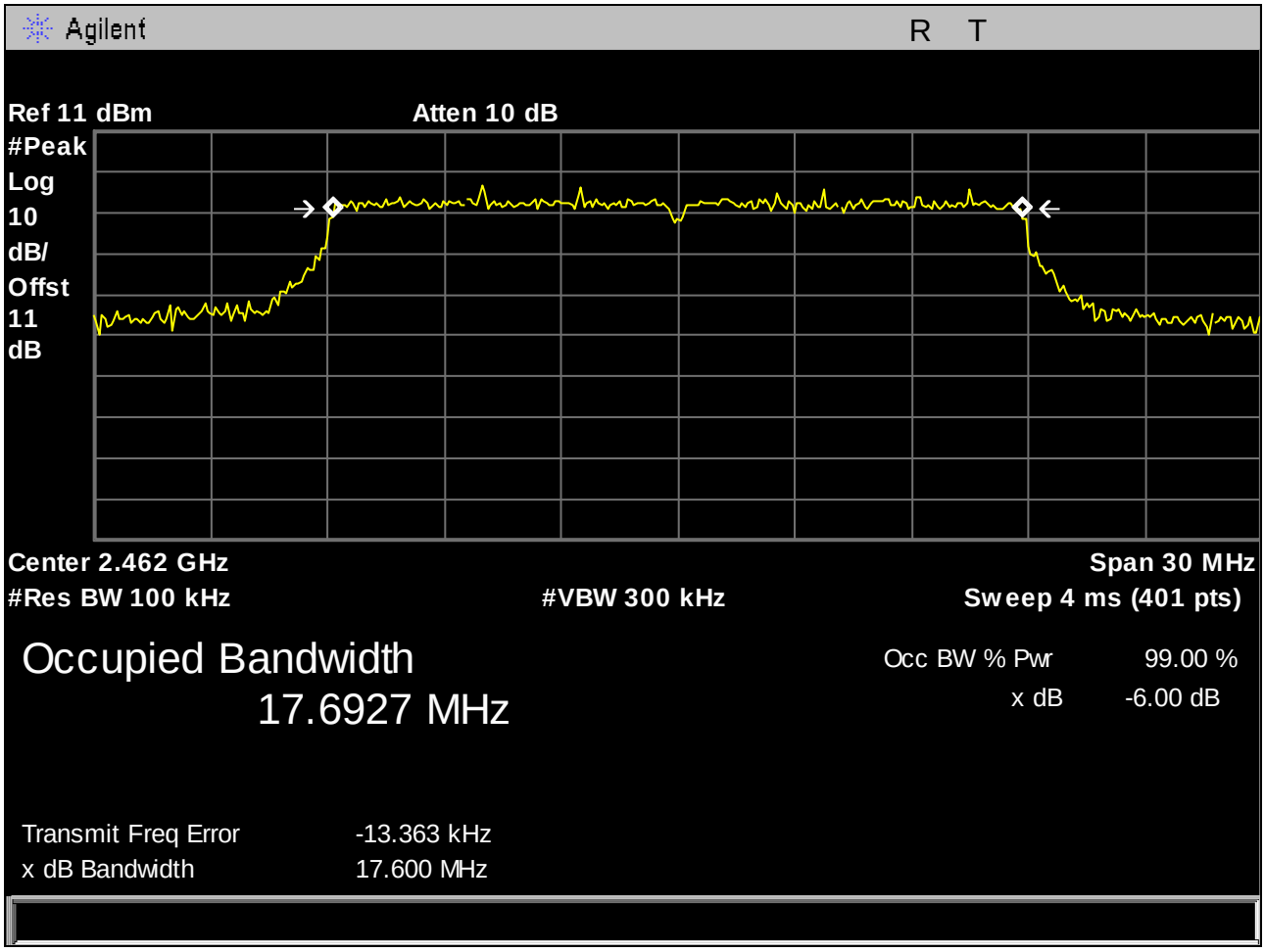
Plot 14. 6 dB Occupied Bandwidth, n Mode, 40 MHz, Mid Channel



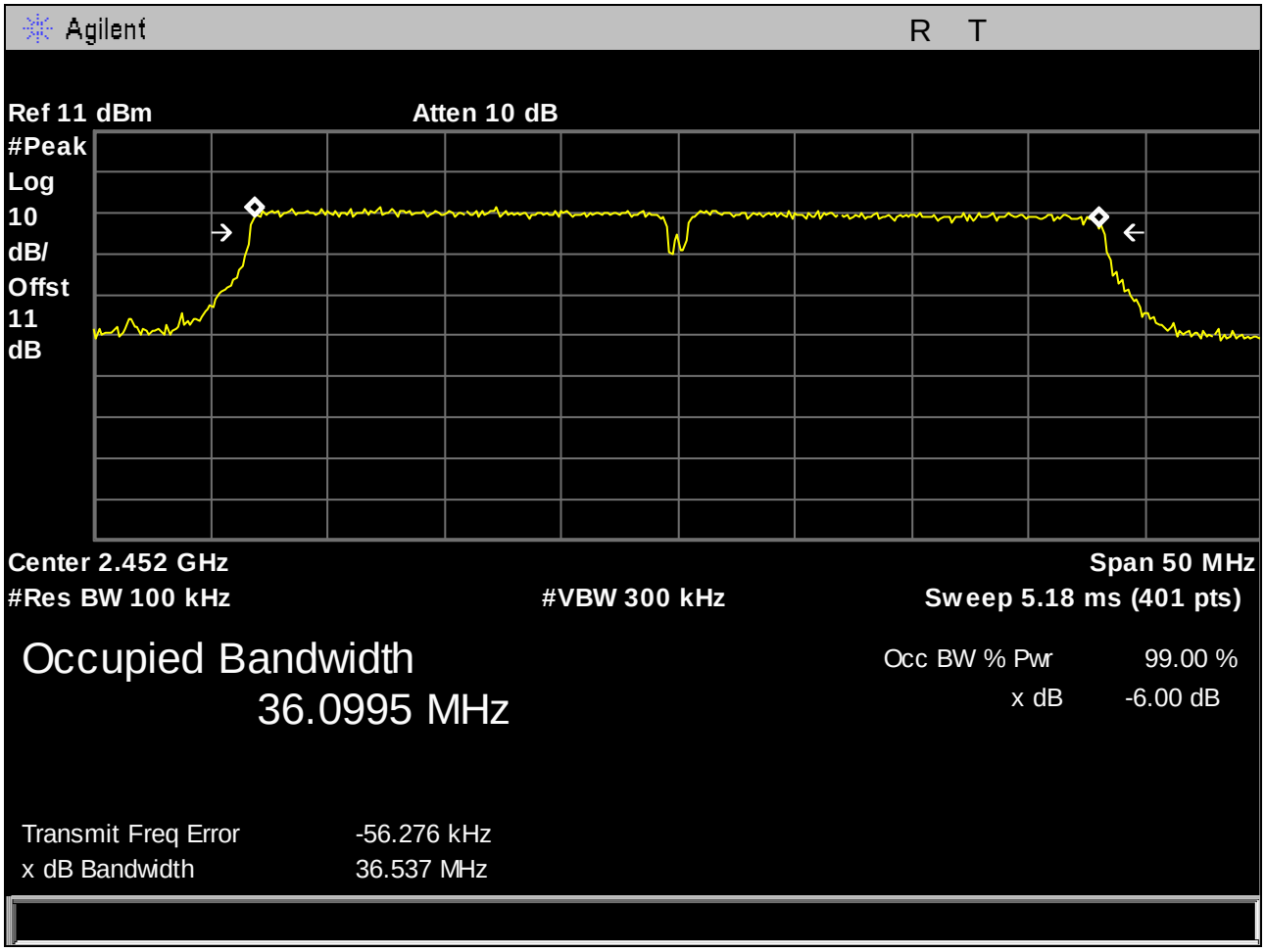
Plot 15. 6 dB Occupied Bandwidth, b Mode, 20 MHz, High Channel



Plot 16. 6 dB Occupied Bandwidth, g Mode, 20 MHz, High Channel

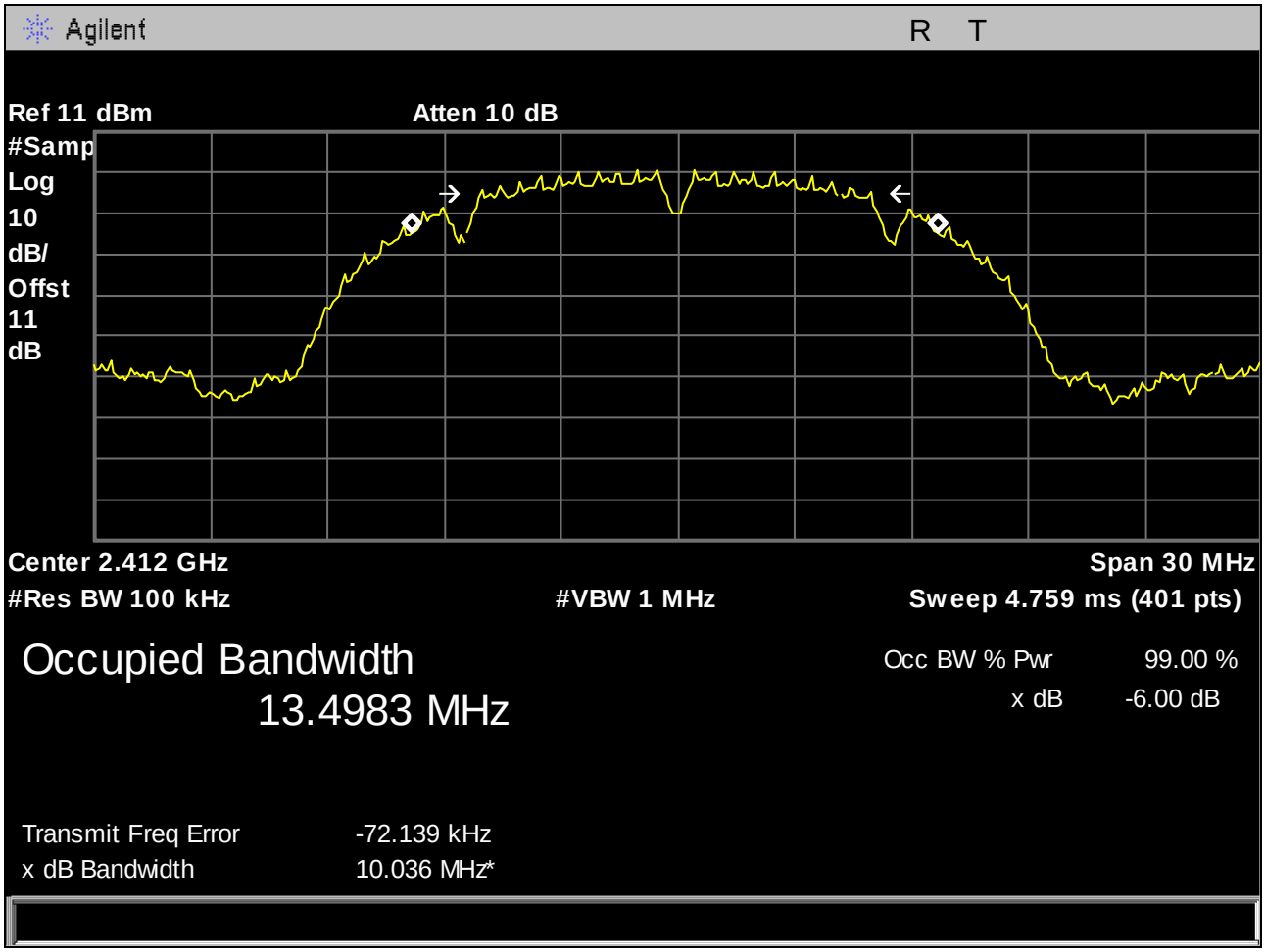


Plot 17. 6 dB Occupied Bandwidth, n Mode, 20 MHz, High Channel

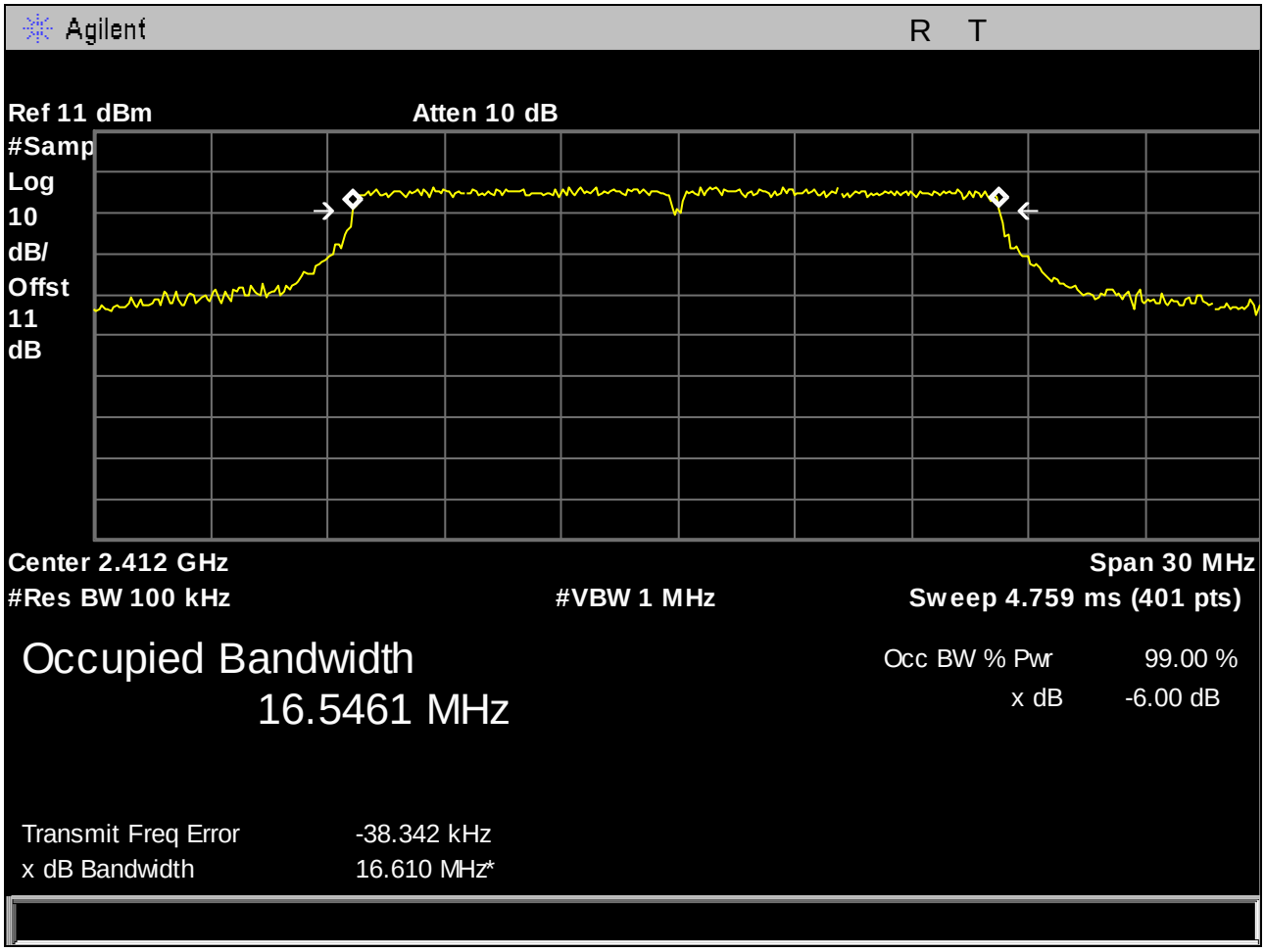


Plot 18. 6 dB Occupied Bandwidth, n Mode, 40 MHz, High Channel

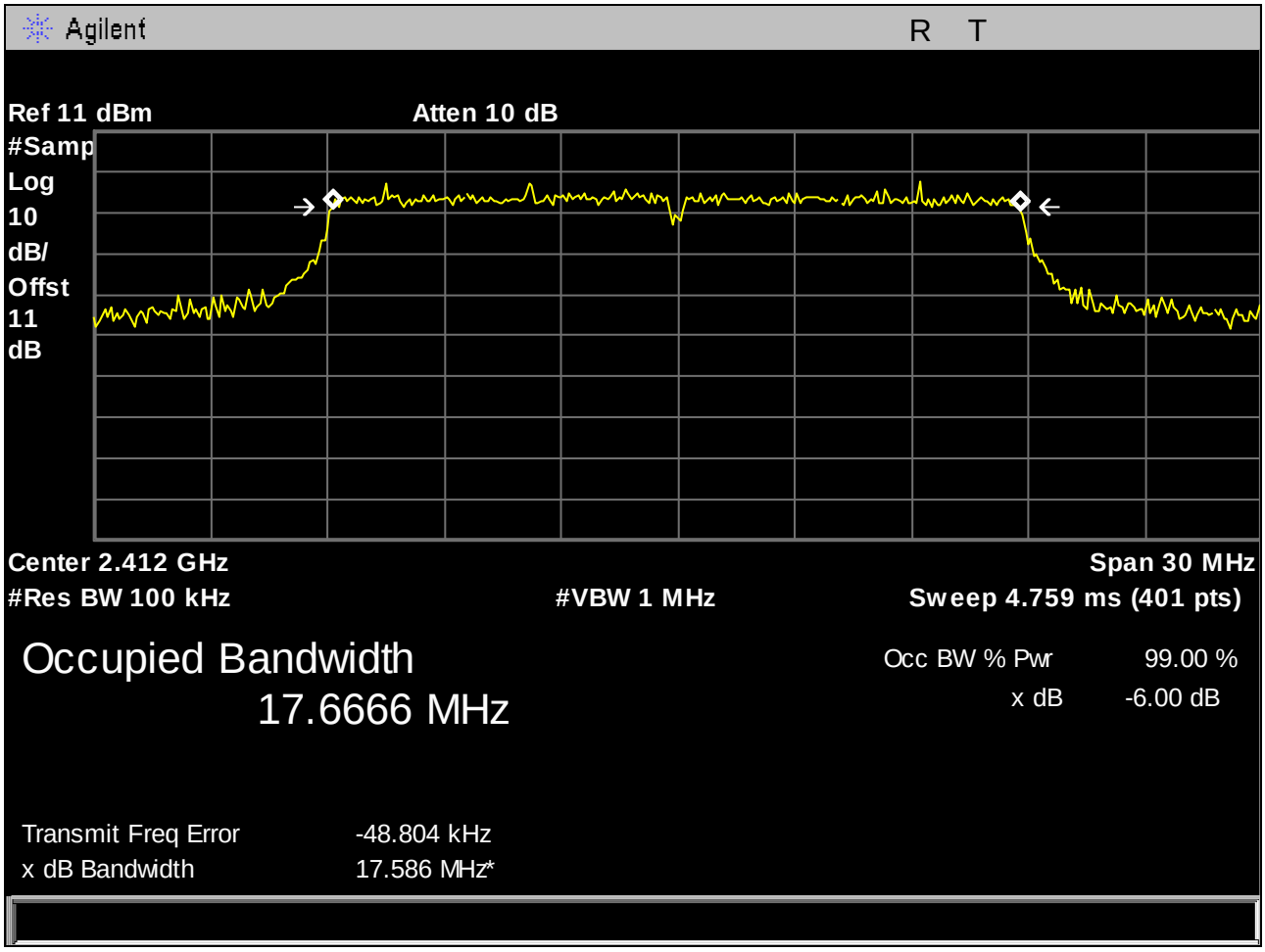
99% Occupied Bandwidth Test Results



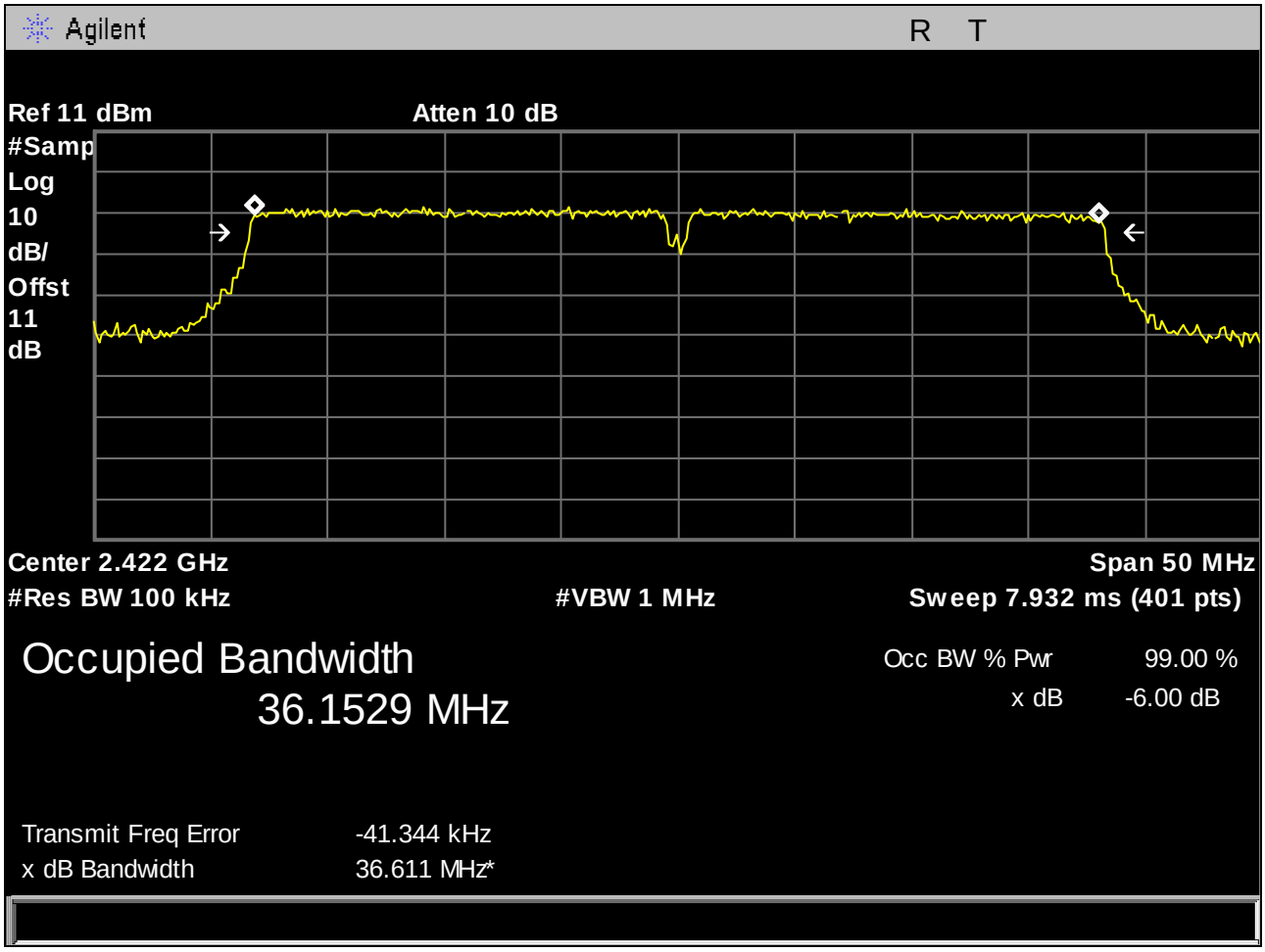
Plot 19. 99% Occupied Bandwidth, b Mode, 20 MHz, Low Channel



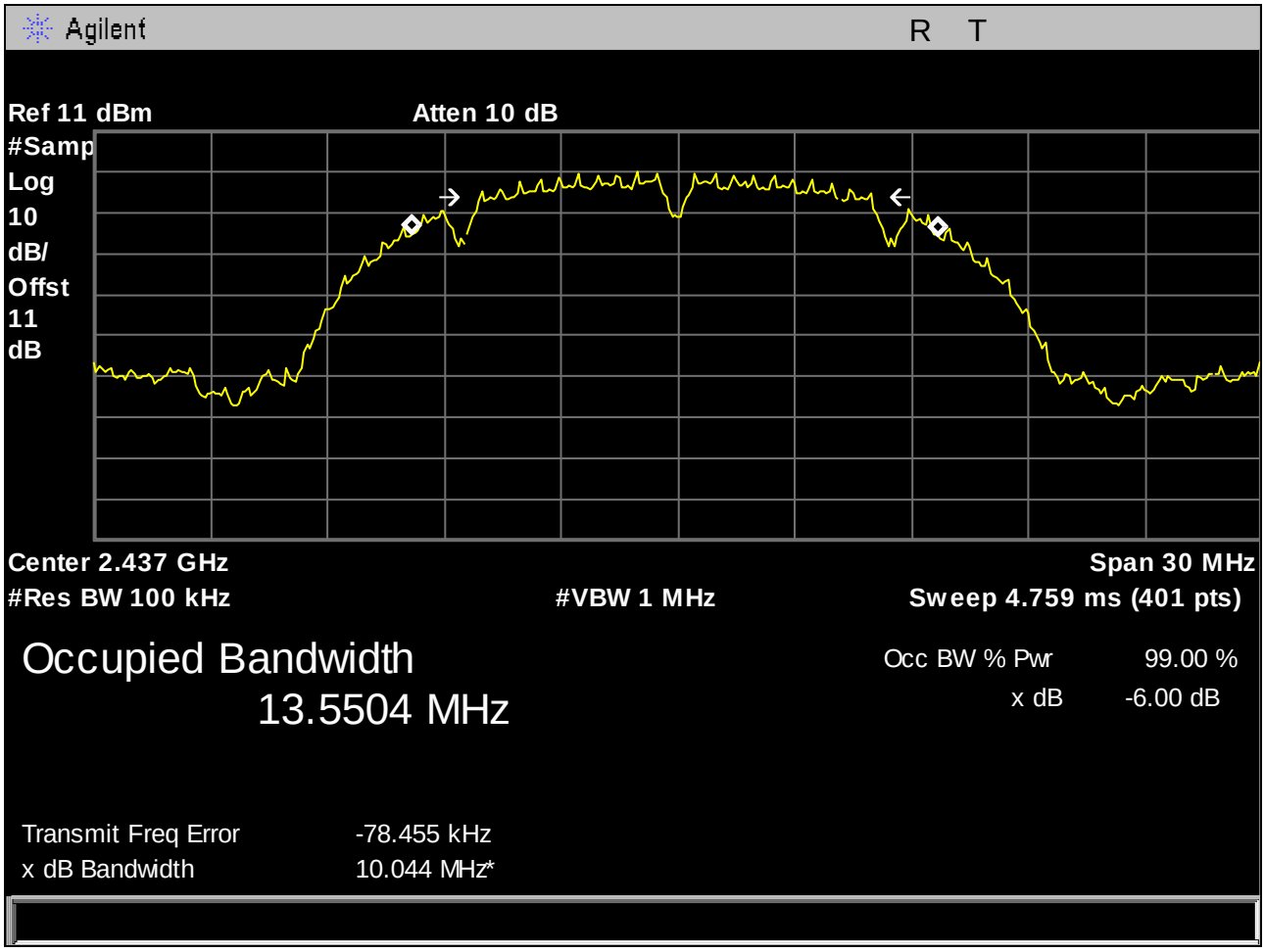
Plot 20. 99% Occupied Bandwidth, g Mode, 20 MHz, Low Channel



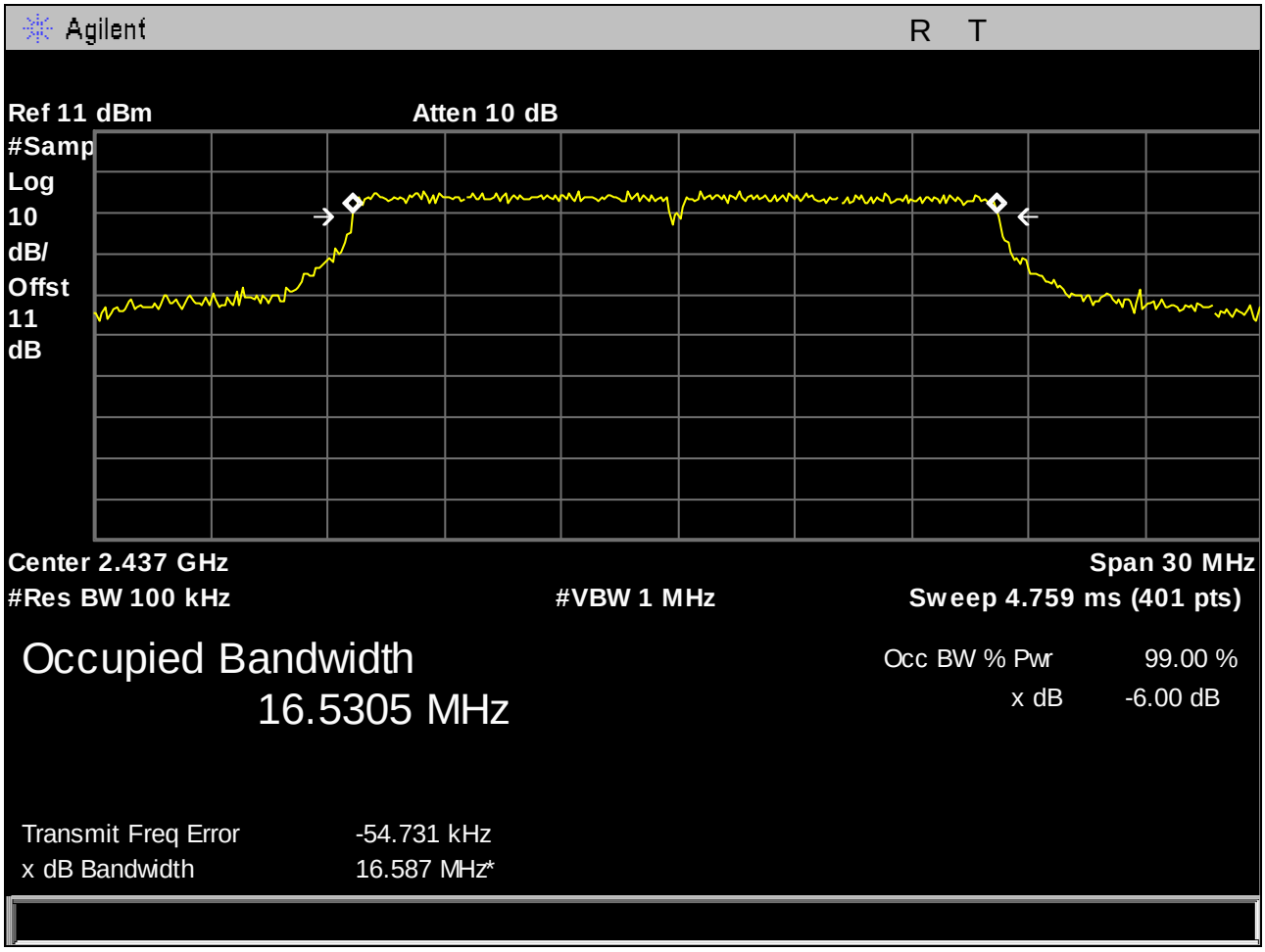
Plot 21. 99% Occupied Bandwidth, n Mode, 20 MHz, Low Channel



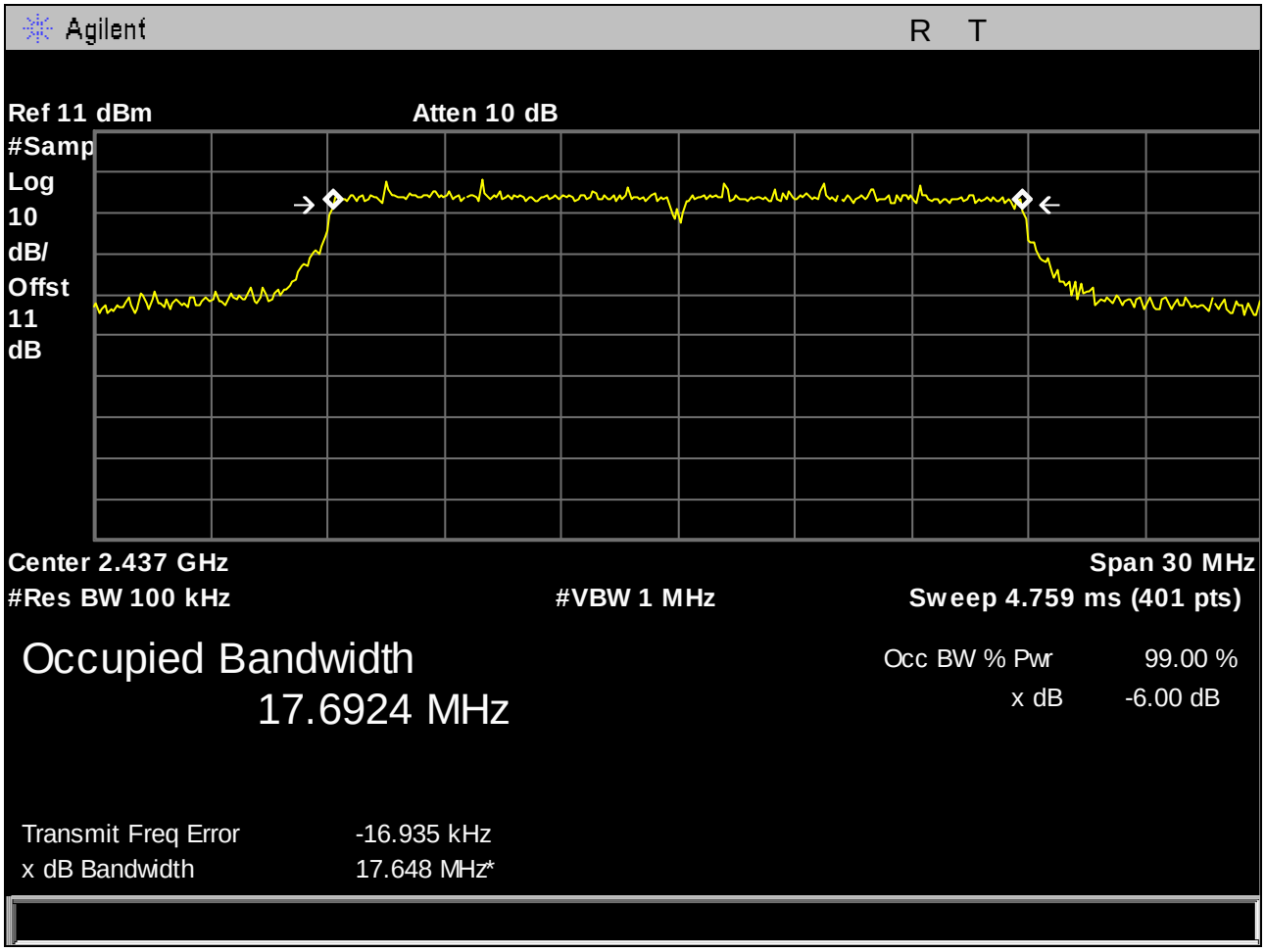
Plot 22. 99% Occupied Bandwidth, n Mode, 40 MHz, Low Channel



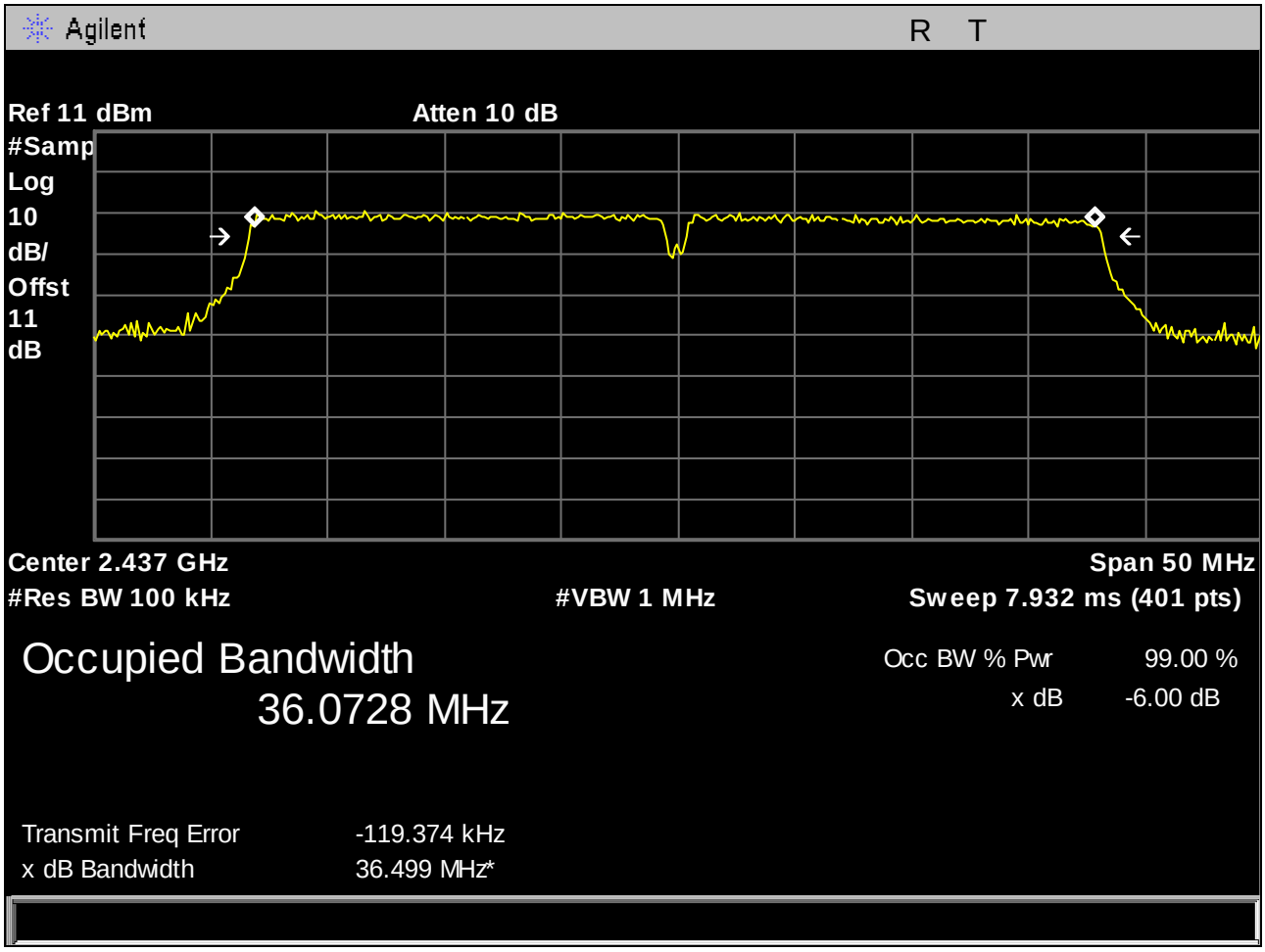
Plot 23. 99% Occupied Bandwidth, b Mode, 20 MHz, Mid Channel



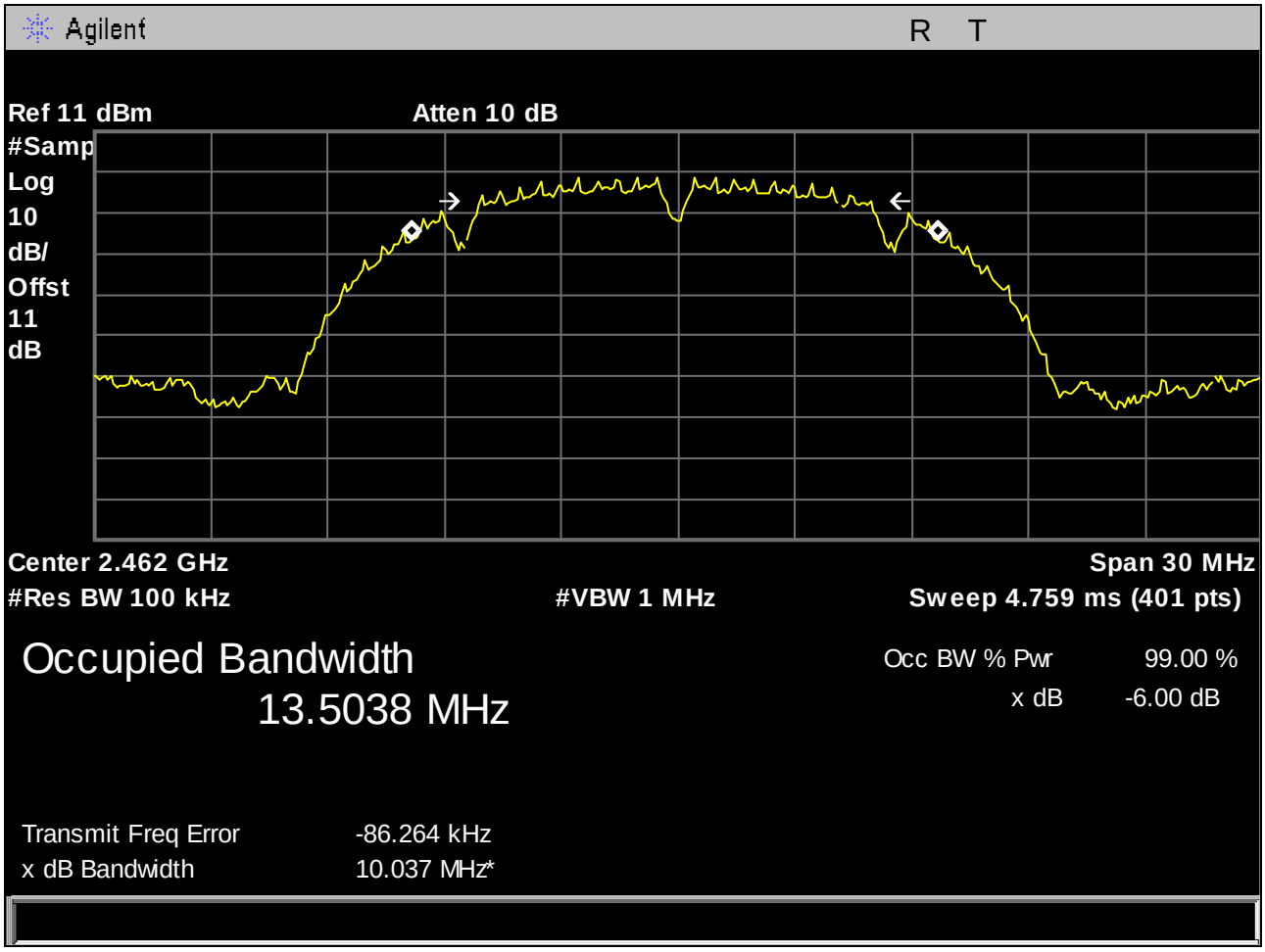
Plot 24. 99% Occupied Bandwidth, g Mode, 20 MHz, Mid Channel



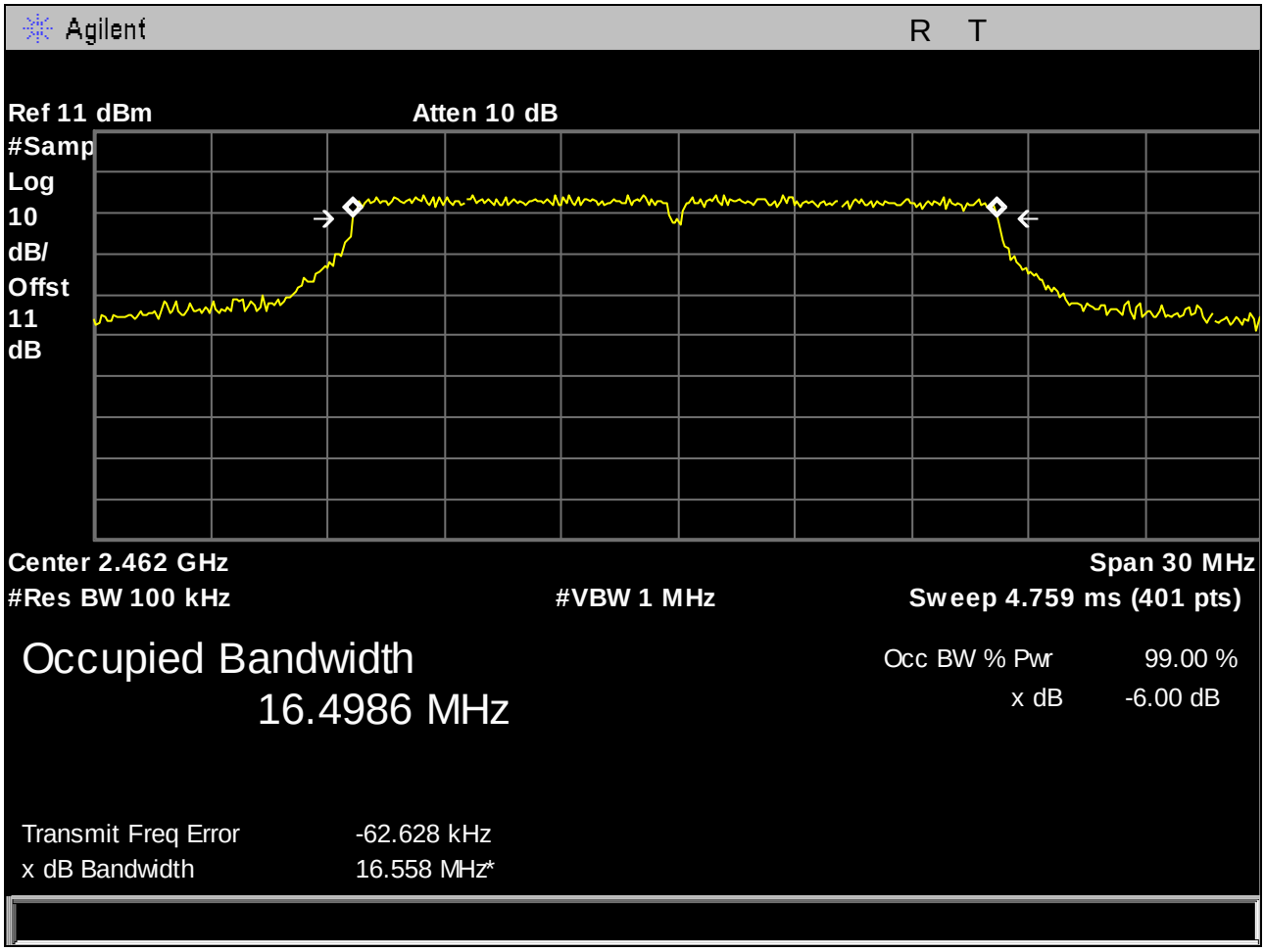
Plot 25. 99% Occupied Bandwidth, n Mode, 20 MHz, Mid Channel



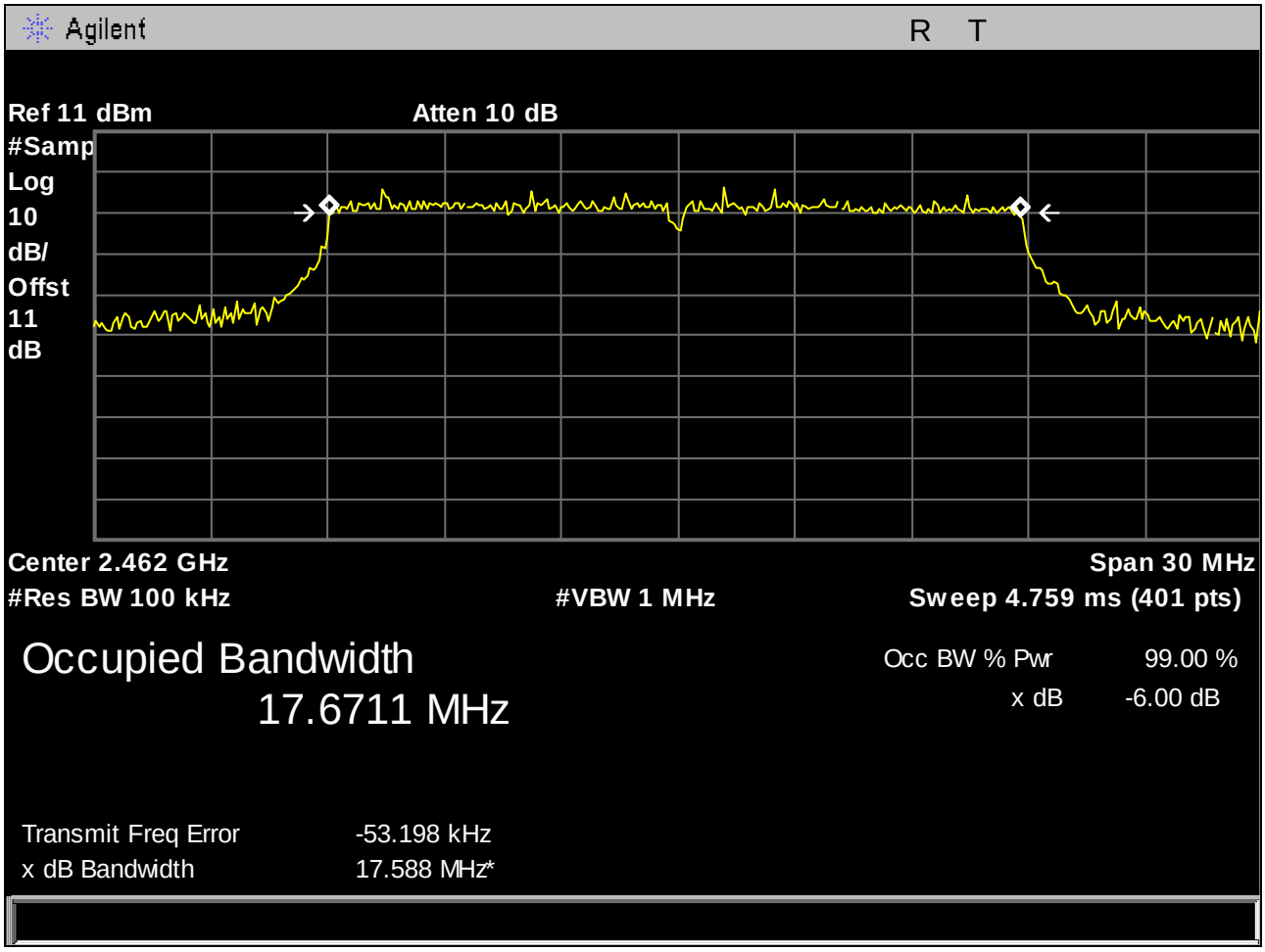
Plot 26. 99% Occupied Bandwidth, n Mode, 40 MHz, Mid Channel



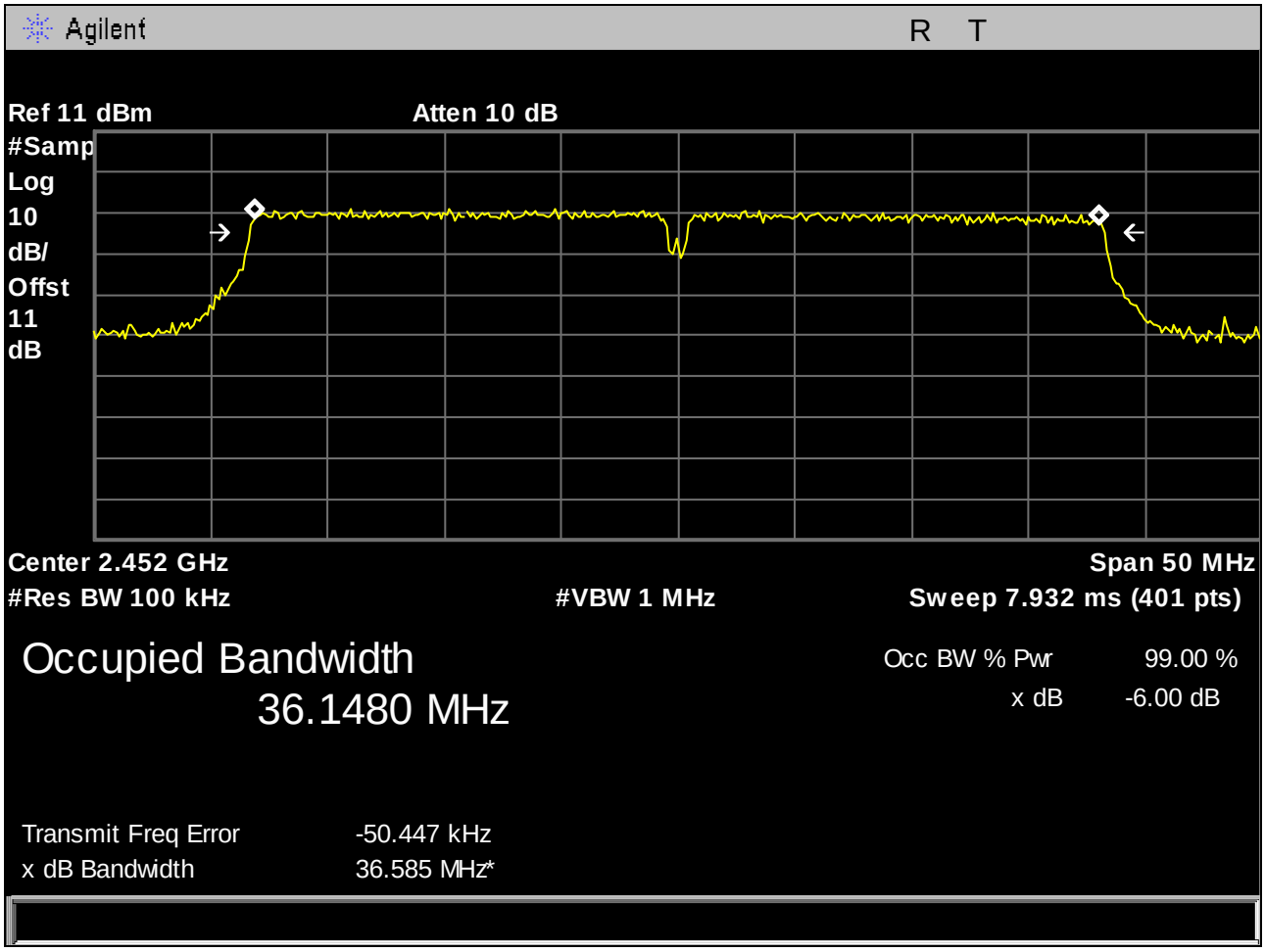
Plot 27. 99% Occupied Bandwidth, b Mode, 20 MHz, High Channel



Plot 28. 99% Occupied Bandwidth, g Mode, 20 MHz, High Channel



Plot 29. 99% Occupied Bandwidth, n Mode, 20 MHz, High Channel



Plot 30. 99% Occupied Bandwidth, n Mode, 40 MHz, High Channel

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 17. Output Power Requirements from §15.247(b)

§15.247(b)(4): The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

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)**. No anomalies were noted during testing.

Test Engineer(s): Djed Mouada

Test Date(s): 10/06/2014 – 10/09/2014

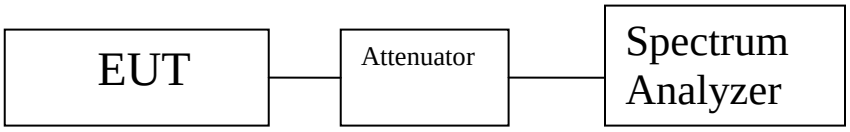


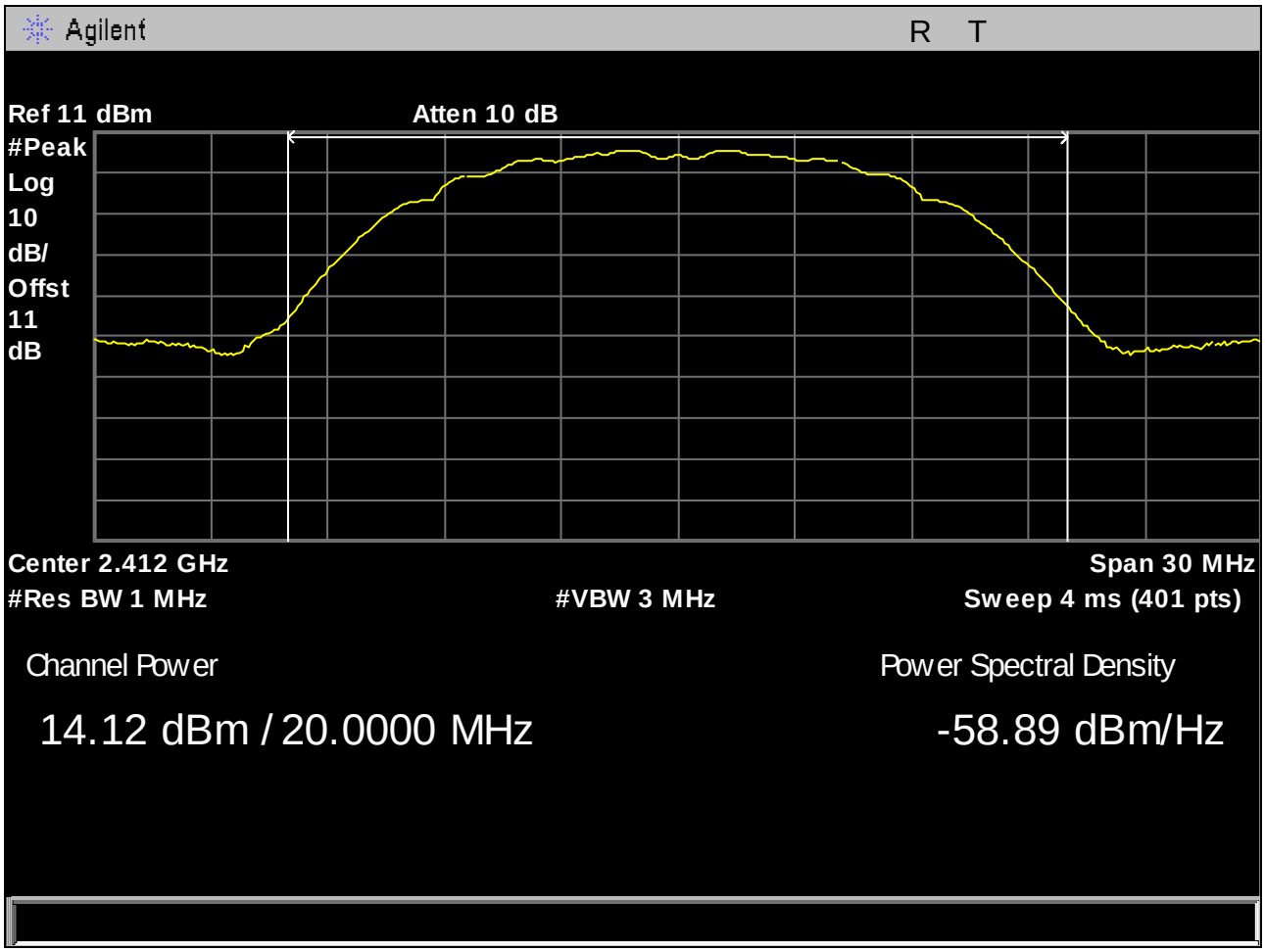
Figure 3. Peak Power Output Test Setup

Peak Power Output Test Results

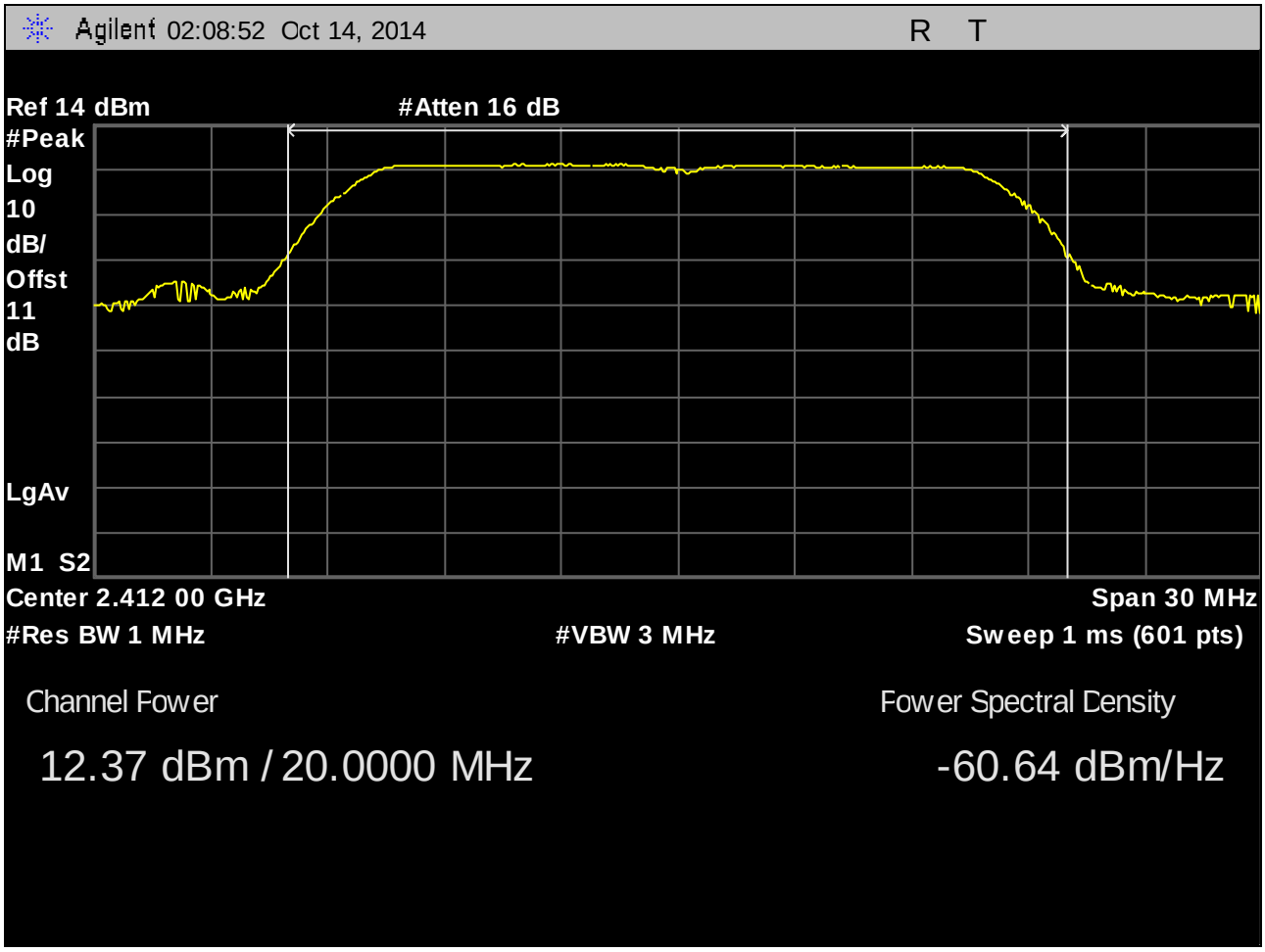
Peak Conducted Output Power		
Carrier Channel	**Frequency (MHz)**	**Measured Peak Output Power dBm**
b mode Low	2412	14.12
b mode Mid	2437	13.78
b mode High	2462	12.84
g mode Low	2412	12.37
g mode Mid	2437	15.55
g mode High	2462	10.5
n mode (20 MHz) Low	2412	12.29
n mode (20 MHz) Mid	2437	14.49
n mode (20 MHz) High	2462	10.37
n mode (40 MHz) Low	2422	13.07
n mode (40 MHz) Mid	2437	14.38
n mode (40 MHz) High	2452	12.63

Table 18. Peak Power Output, Test Results

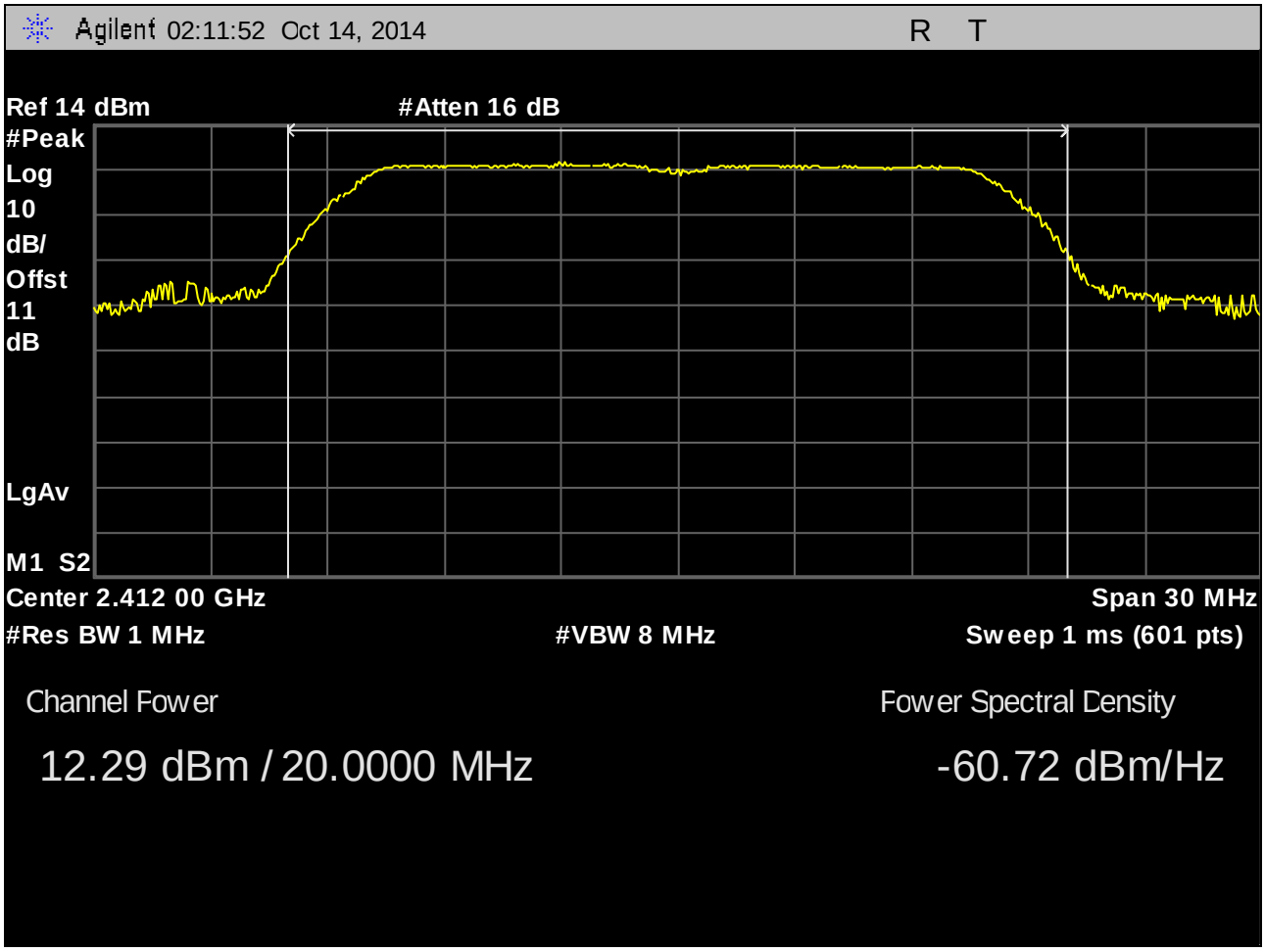
Peak Power Output Test Results



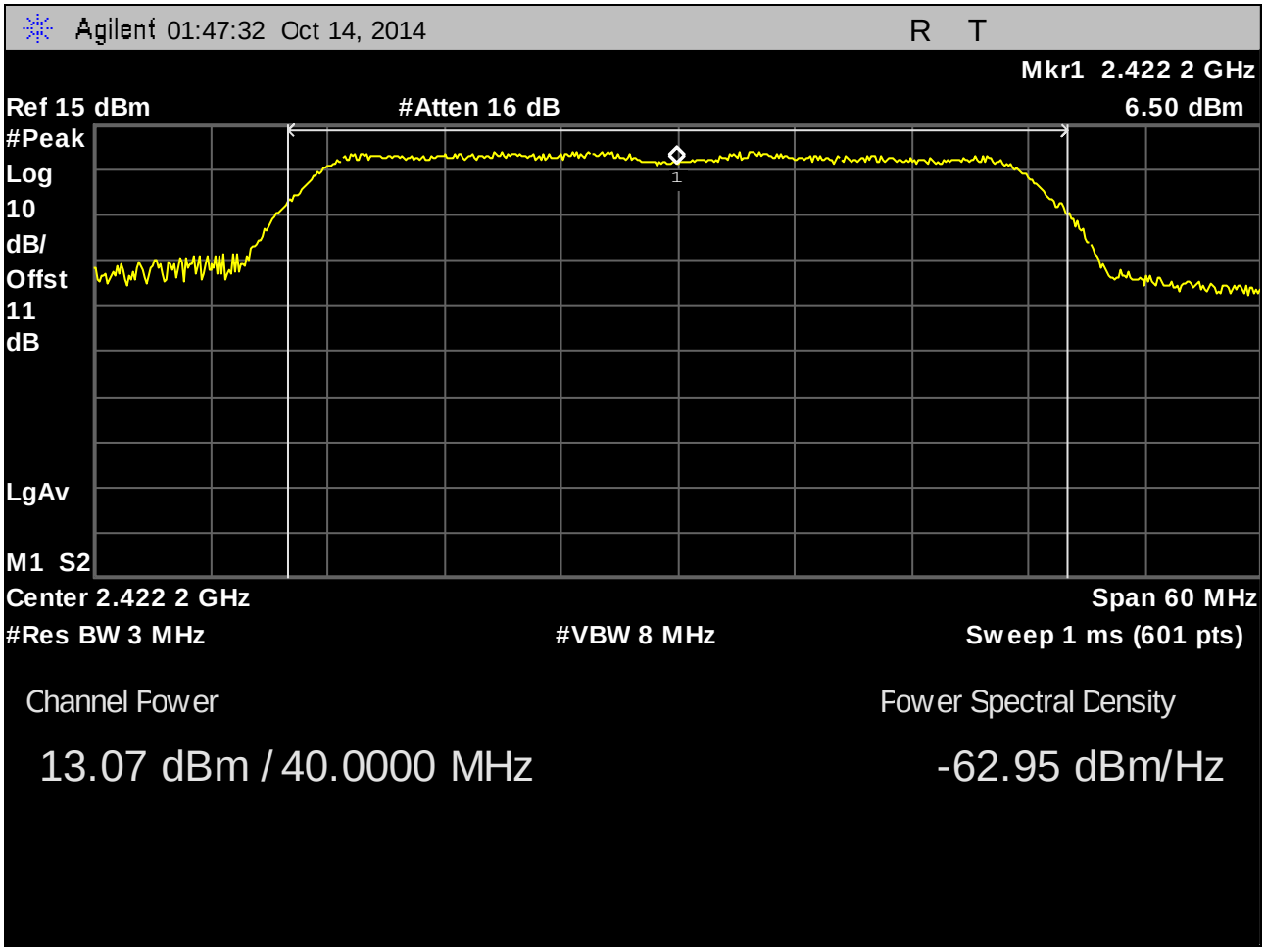
Plot 31. Peak Power Output, b Mode, 20 MHz, Low Channel



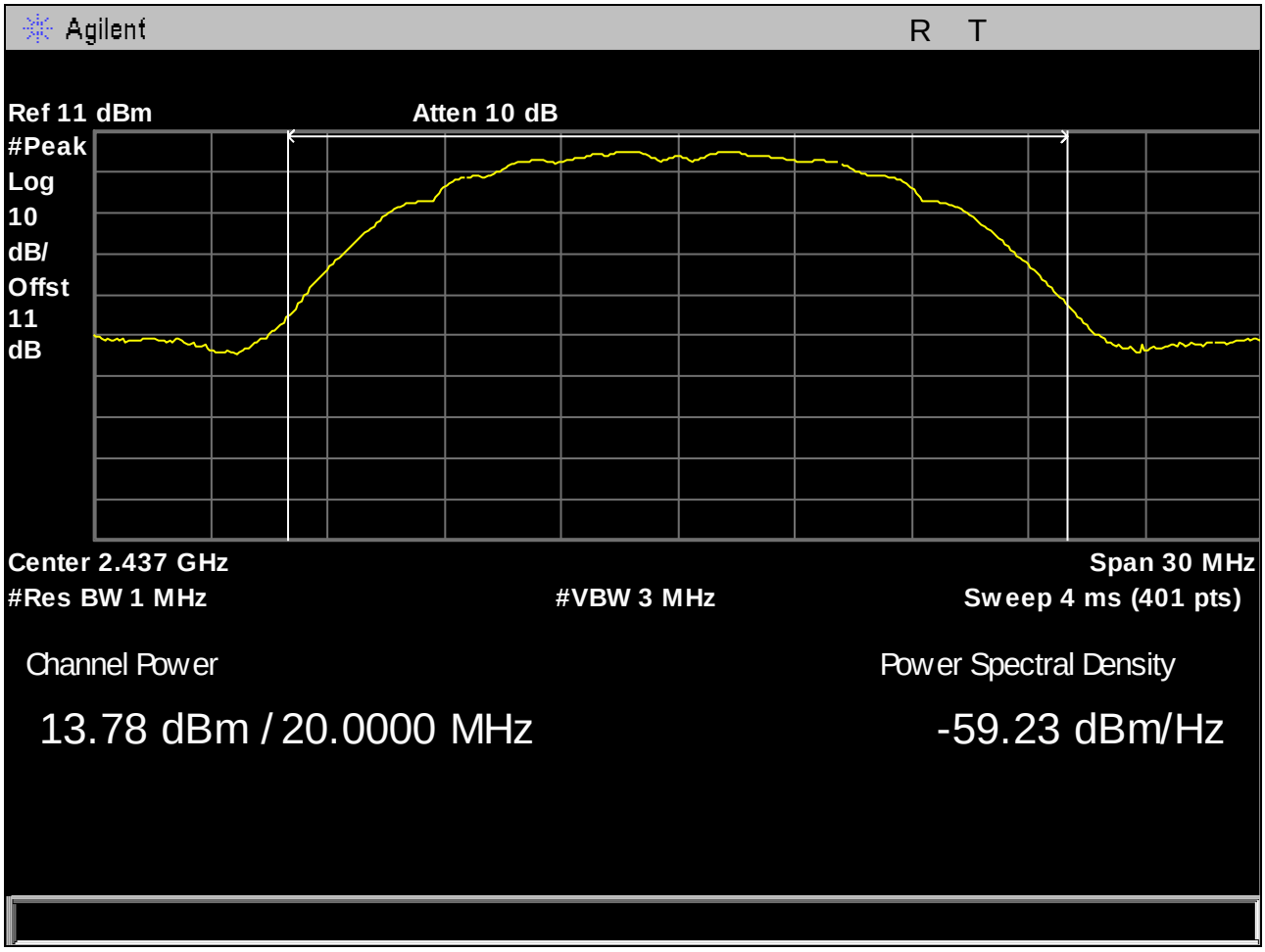
Plot 32. Peak Power Output, g Mode, 20 MHz, Low Channel



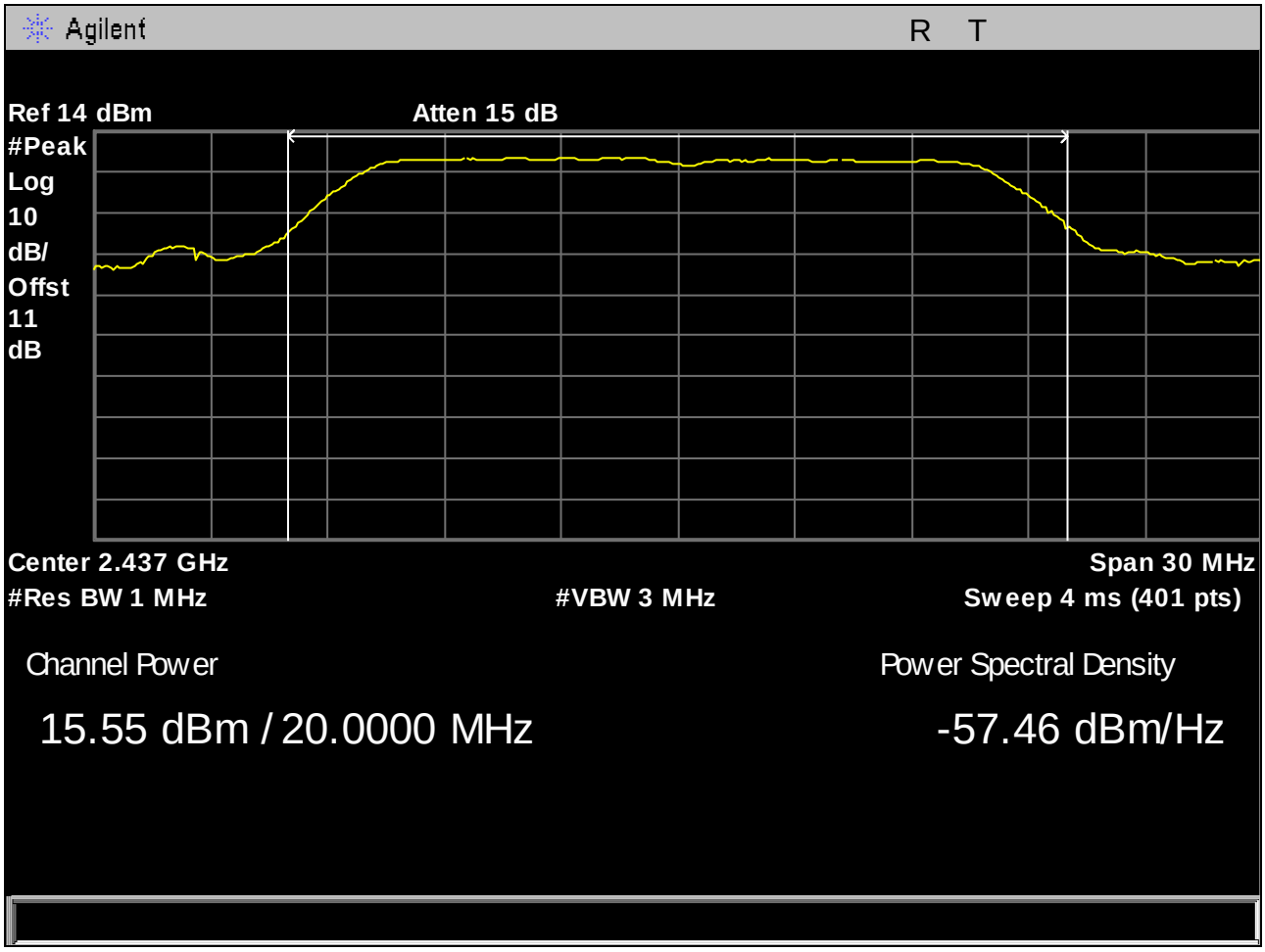
Plot 33. Peak Power Output, n Mode, 20 MHz, Low Channel



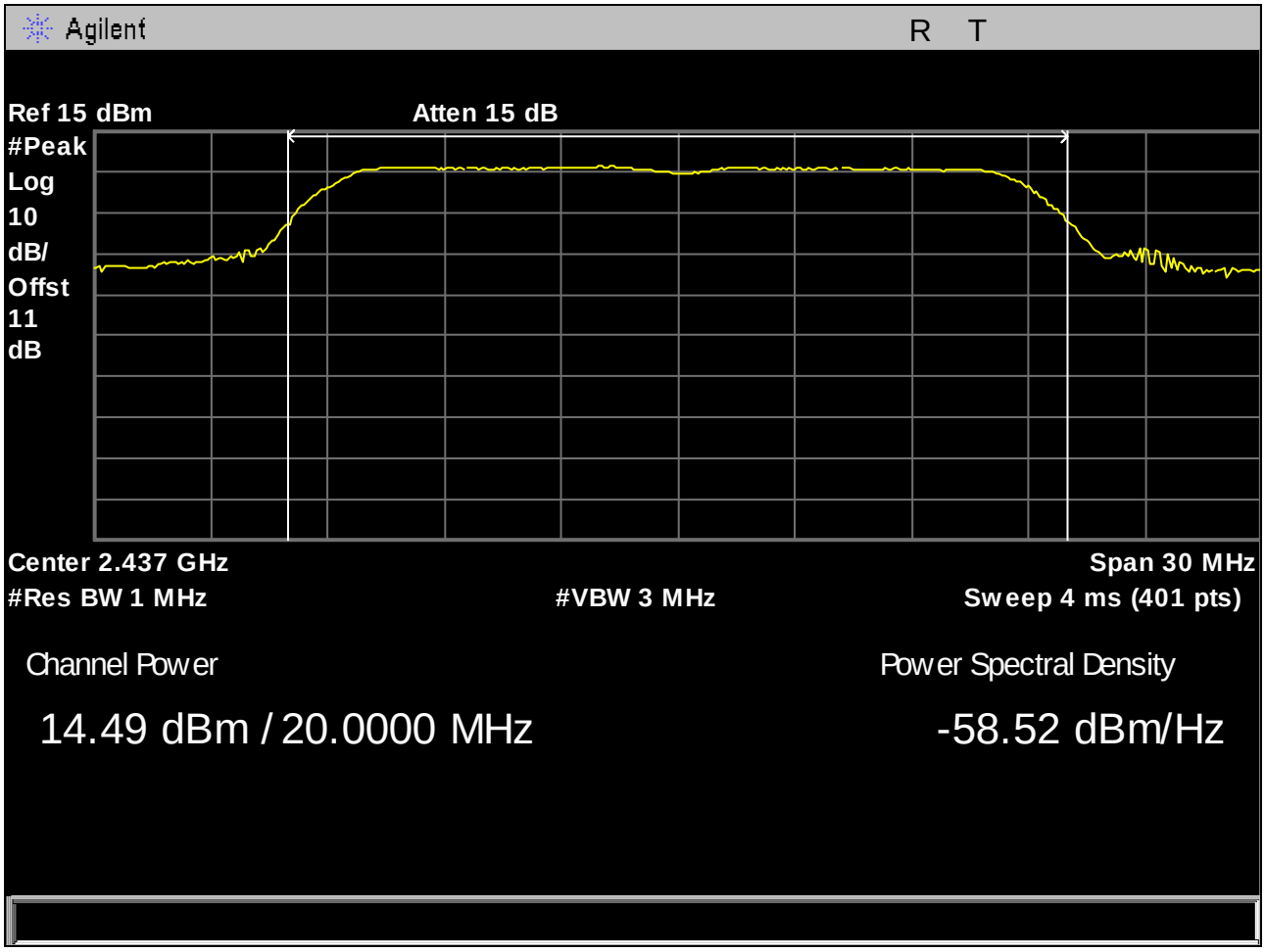
Plot 34. Peak Power Output, n Mode, 40 MHz, Low Channel



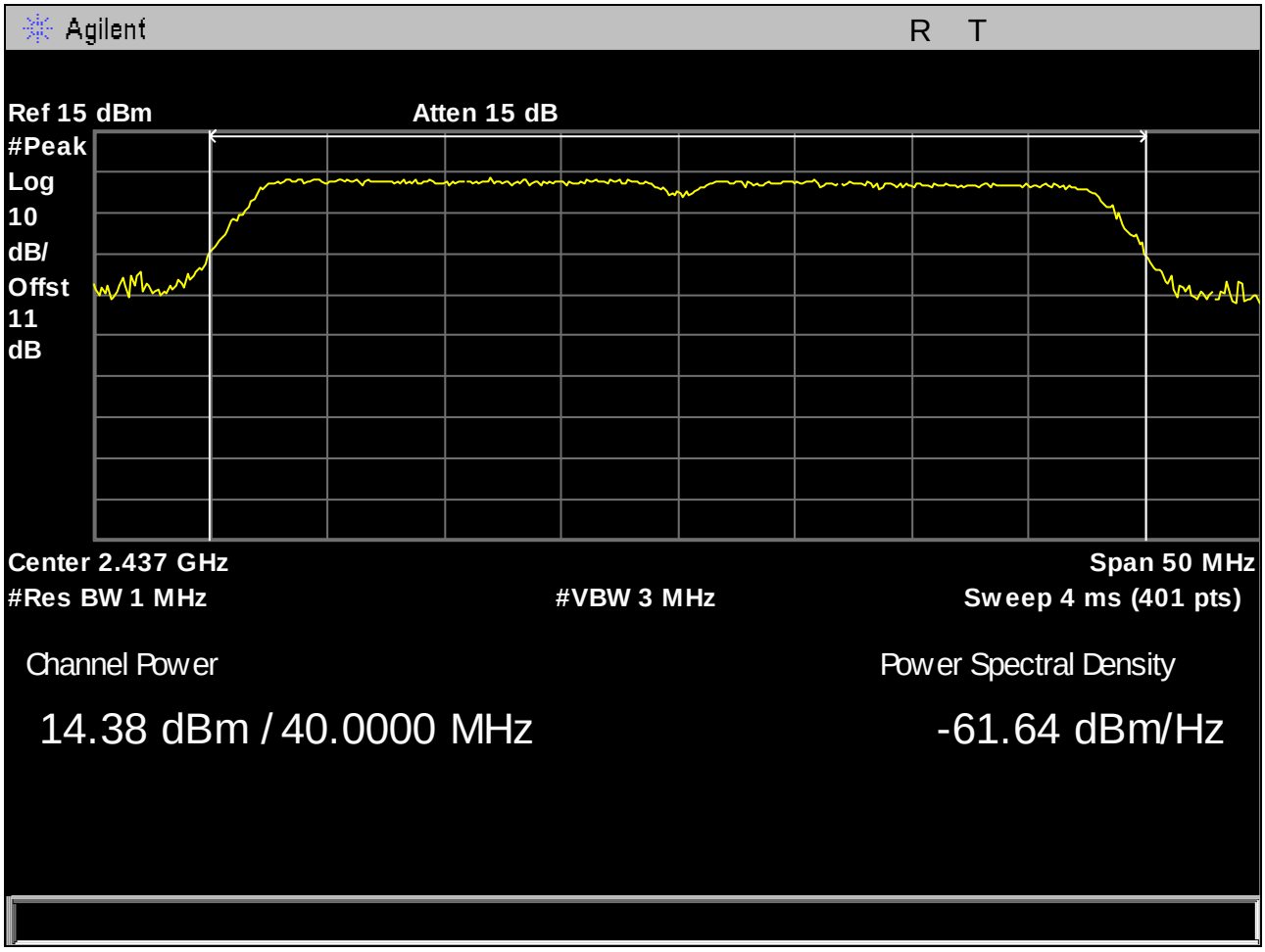
Plot 35. Peak Power Output, b Mode, 20 MHz, Mid Channel



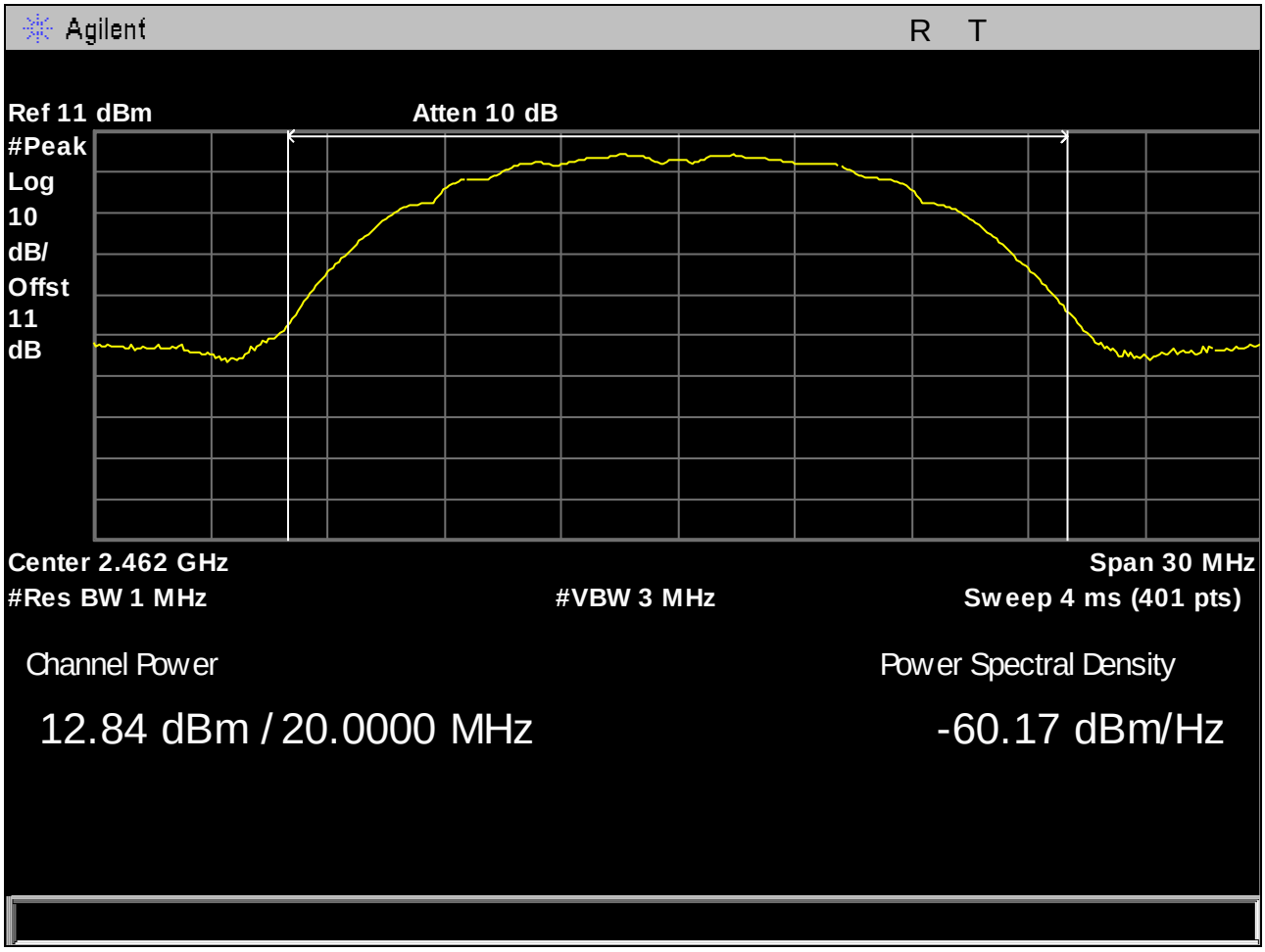
Plot 36. Peak Power Output, g Mode, 20 MHz, Mid Channel



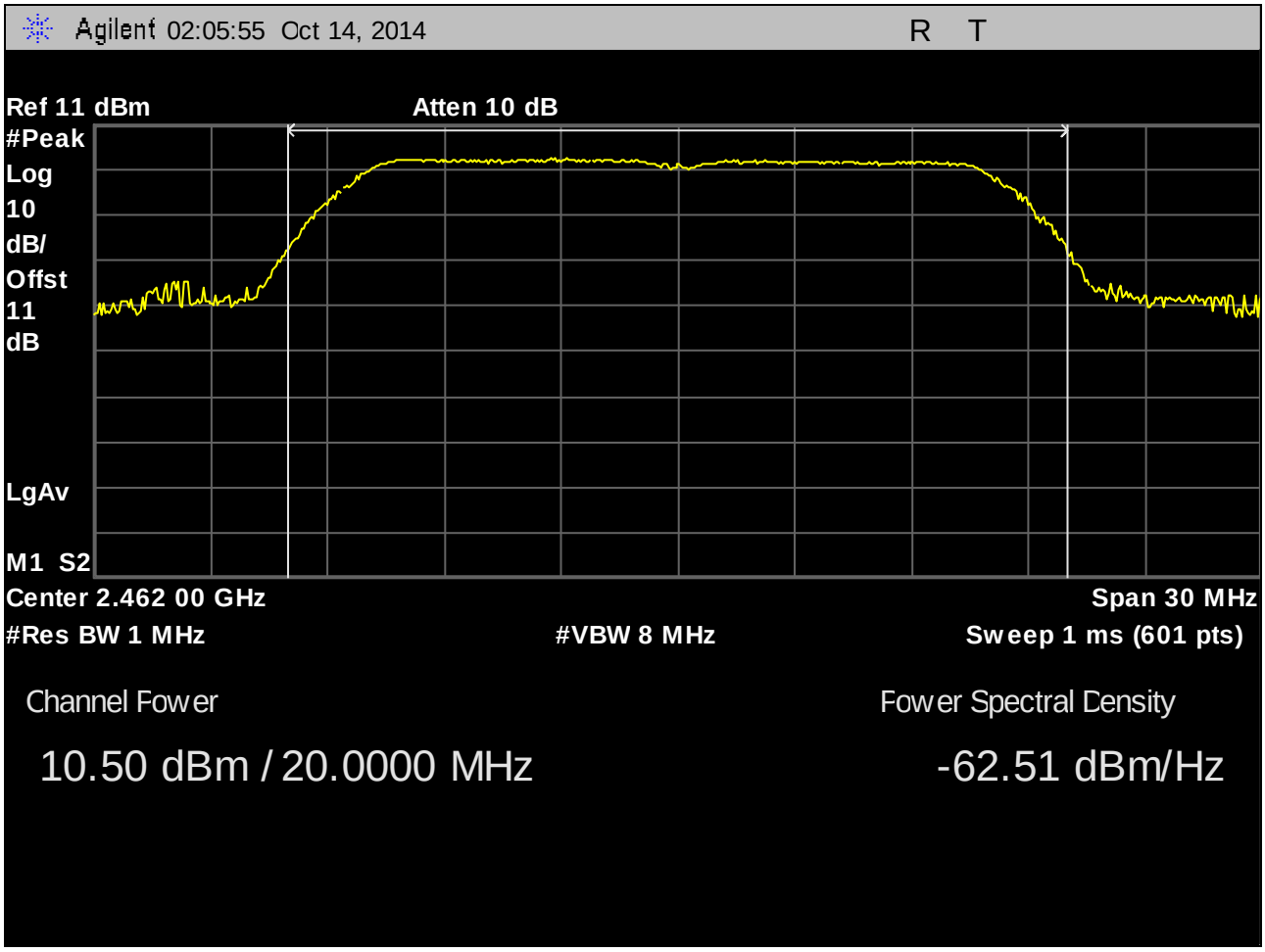
Plot 37. Peak Power Output, n Mode, 20 MHz, Mid Channel



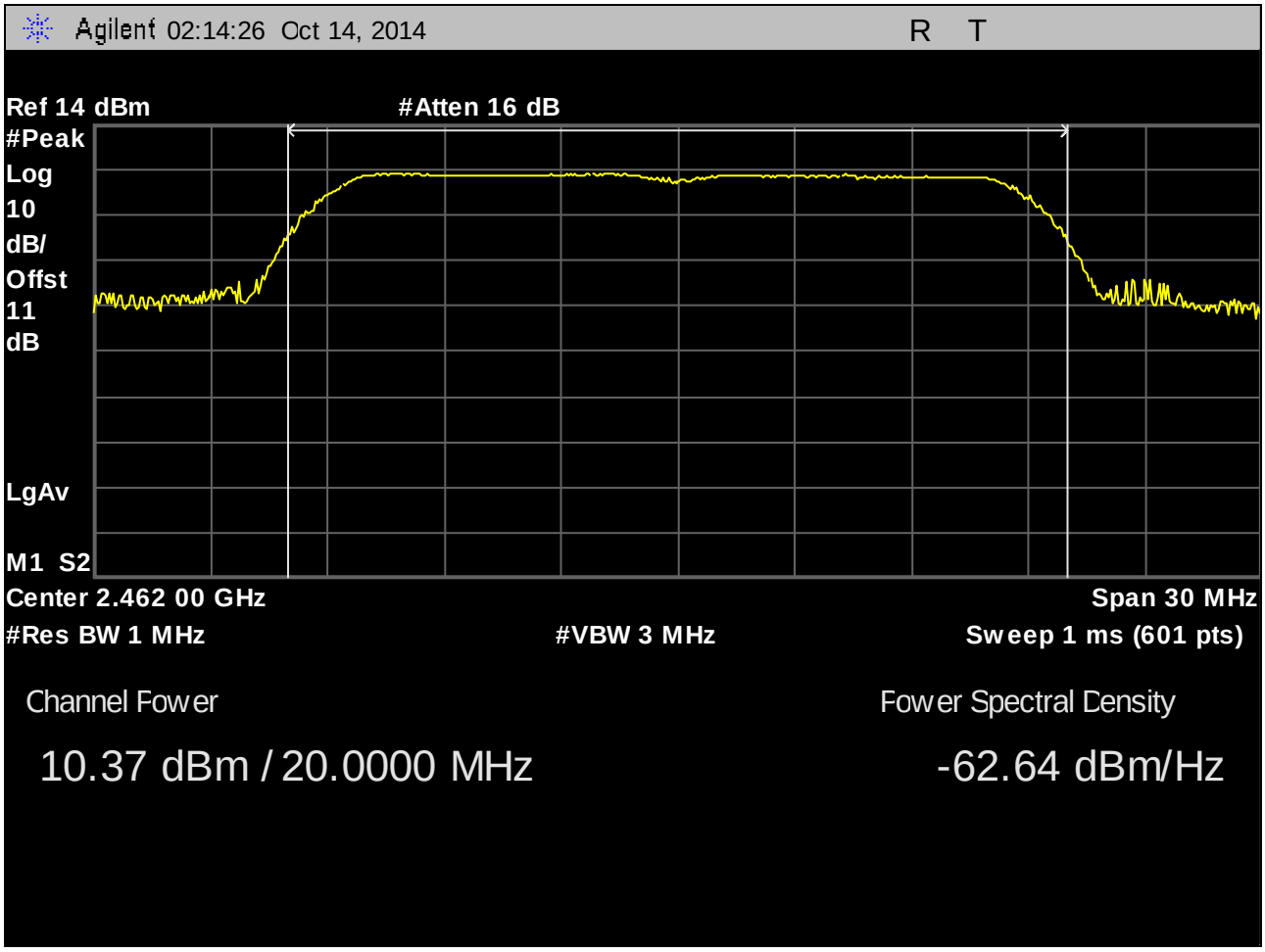
Plot 38. Peak Power Output, n Mode, 40 MHz, Mid Channel



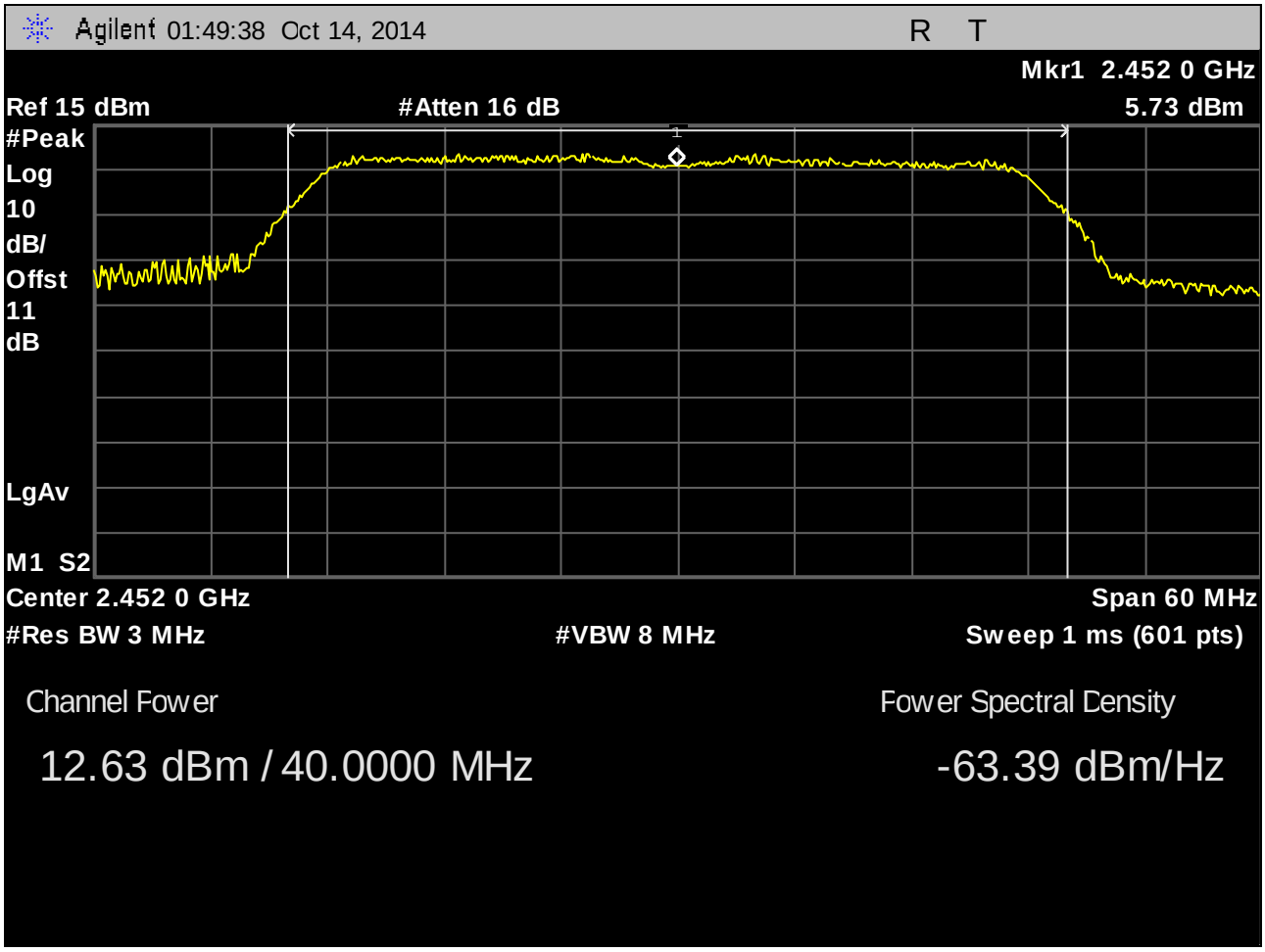
Plot 39. Peak Power Output, b Mode, 20 MHz, High Channel



Plot 40. Peak Power Output, g Mode, 20 MHz, High Channel



Plot 41. Peak Power Output, n Mode, 20 MHz, High Channel



Plot 42. Peak Power Output, n Mode, 40 MHz, High Channel

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 19. 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 20.

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

Table 20. Radiated Emissions Limits Calculated from FCC Part 15, § 15.209 (a)

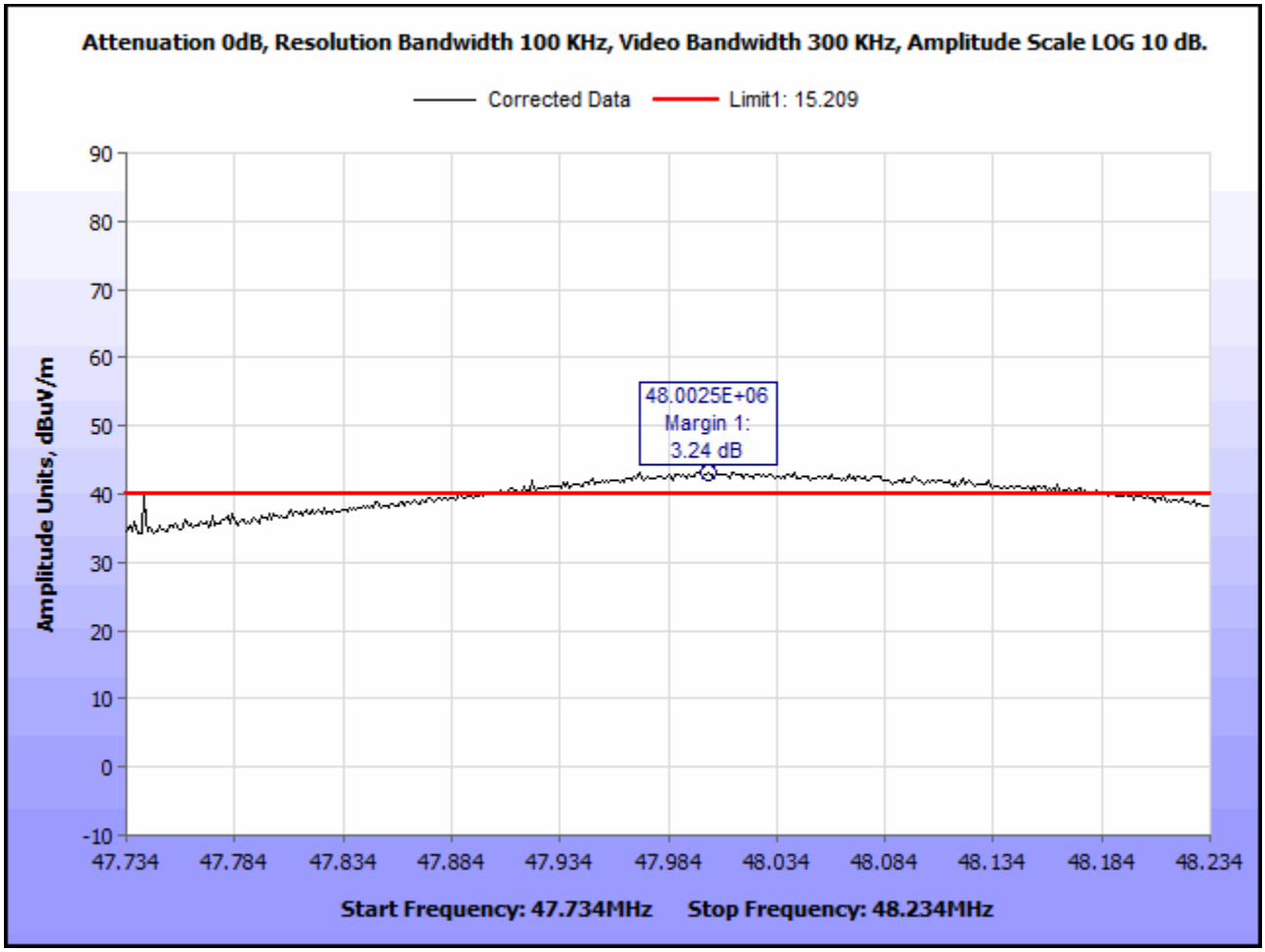
Test Procedures: The transmitter was turned on. Measurements were performed of the low, mid and high Channels. The EUT was rotated orthogonally through all three axes. Plots shown are corrected for both antenna correction factor and distance and compared to a 3 m limit line. Only noise floor was measured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

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

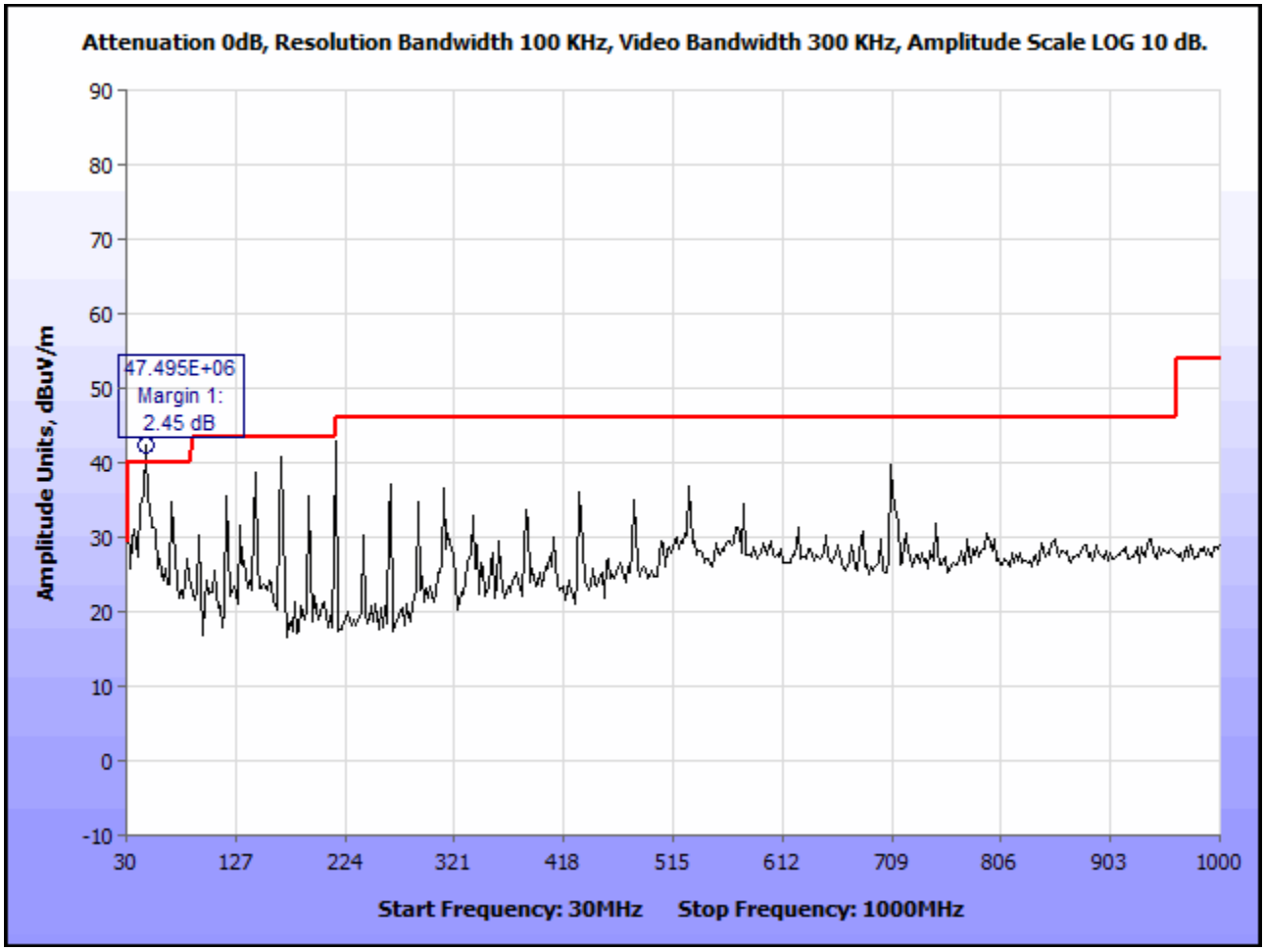
Test Engineer(s): Djed Mouada

Test Date(s): 10/10/2014 – 10/16/2014

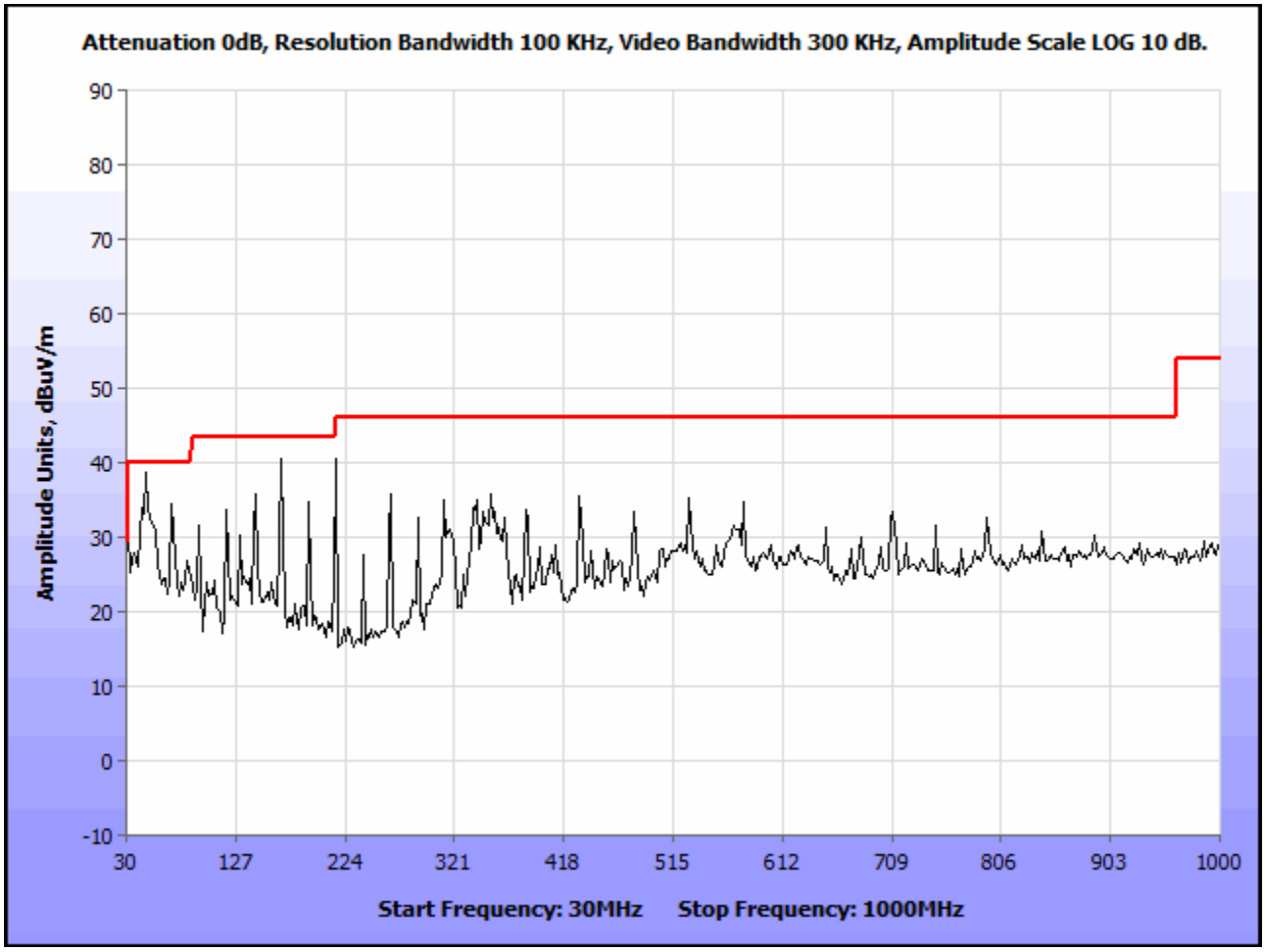
Radiated Spurious Emissions Test Results



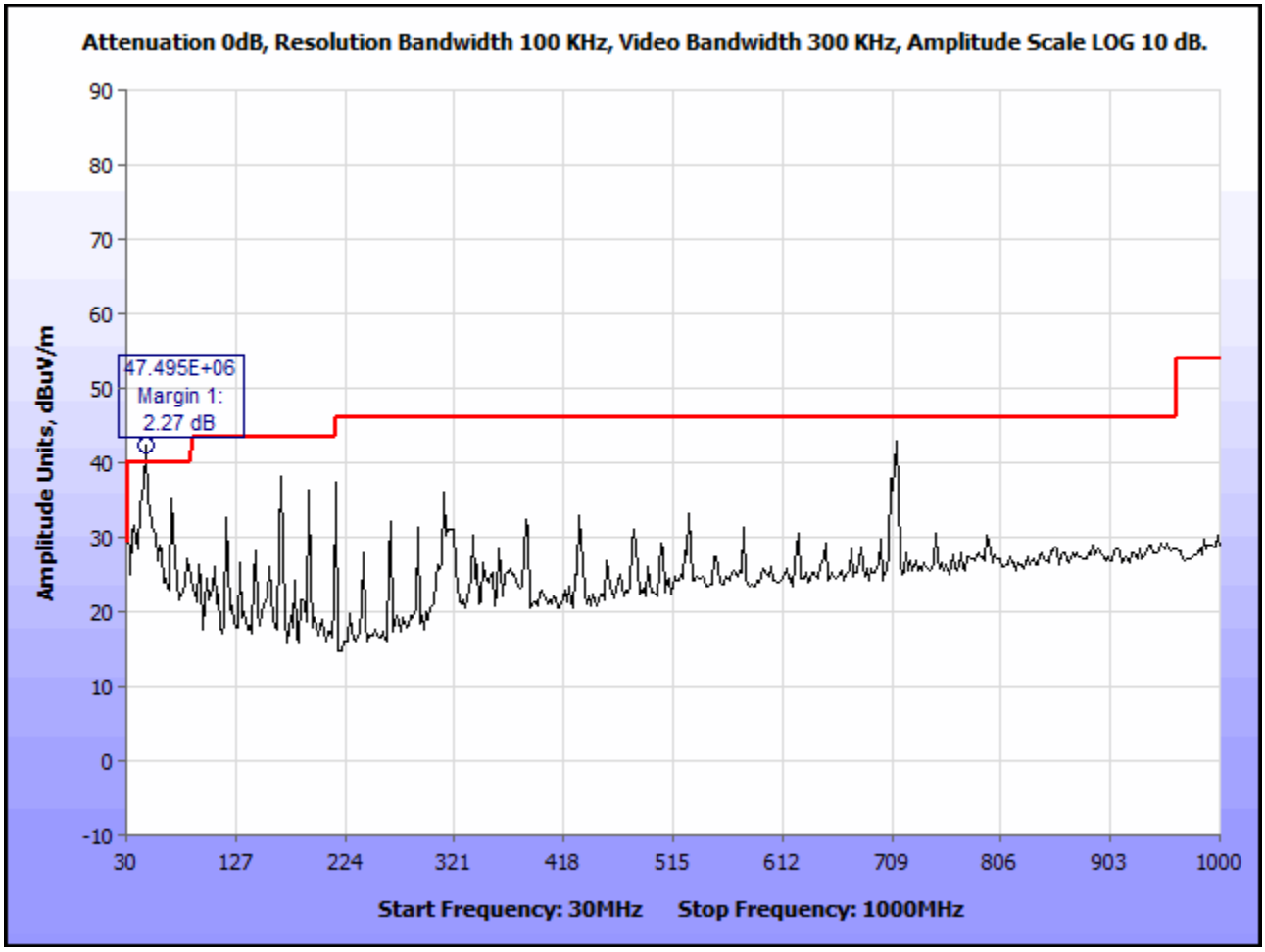
Plot 43. Radiated Spurious Emissions, 47.984 MHz, Zoomed In



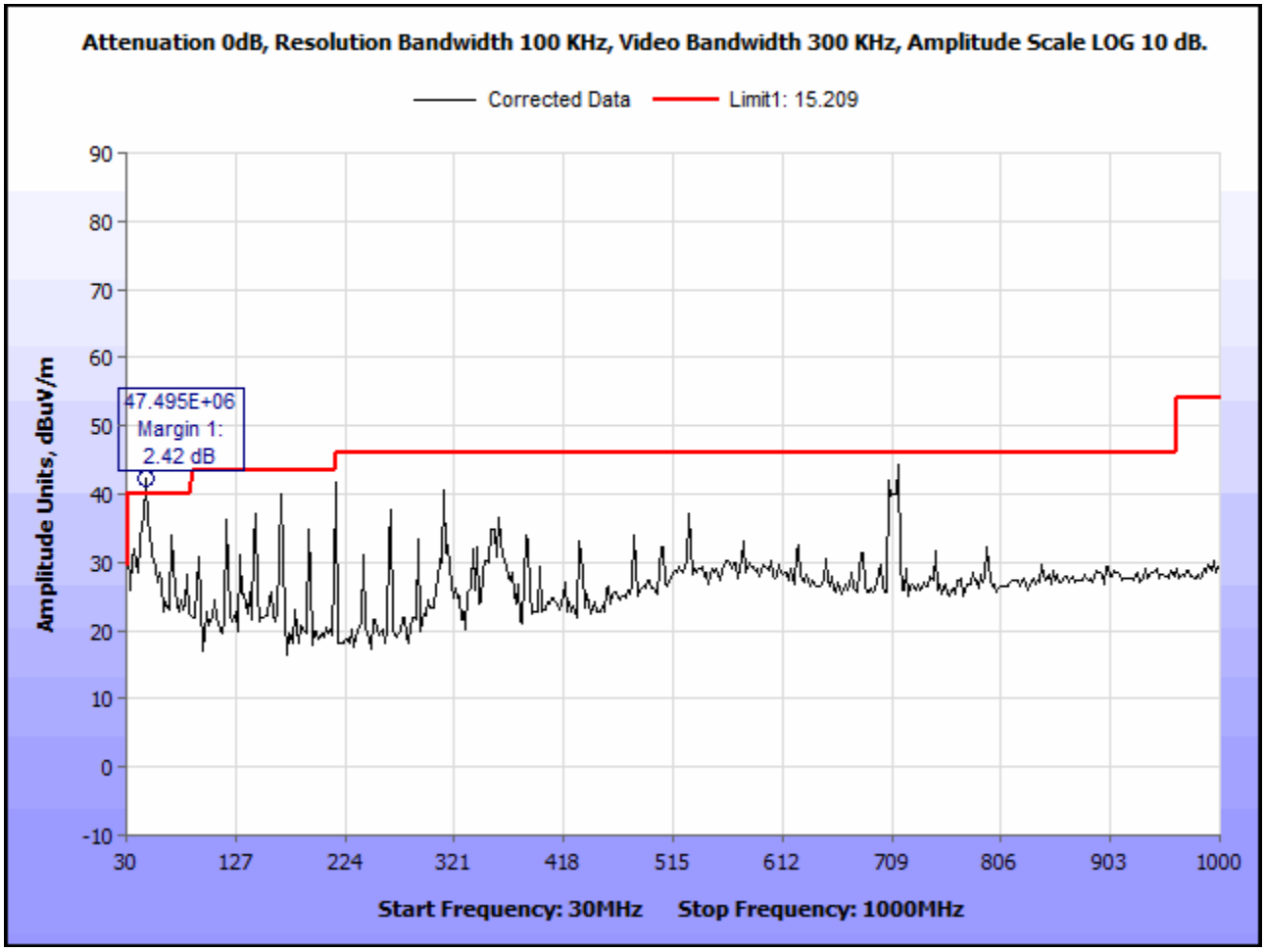
Plot 44. Radiated Spurious Emissions, Radio Off



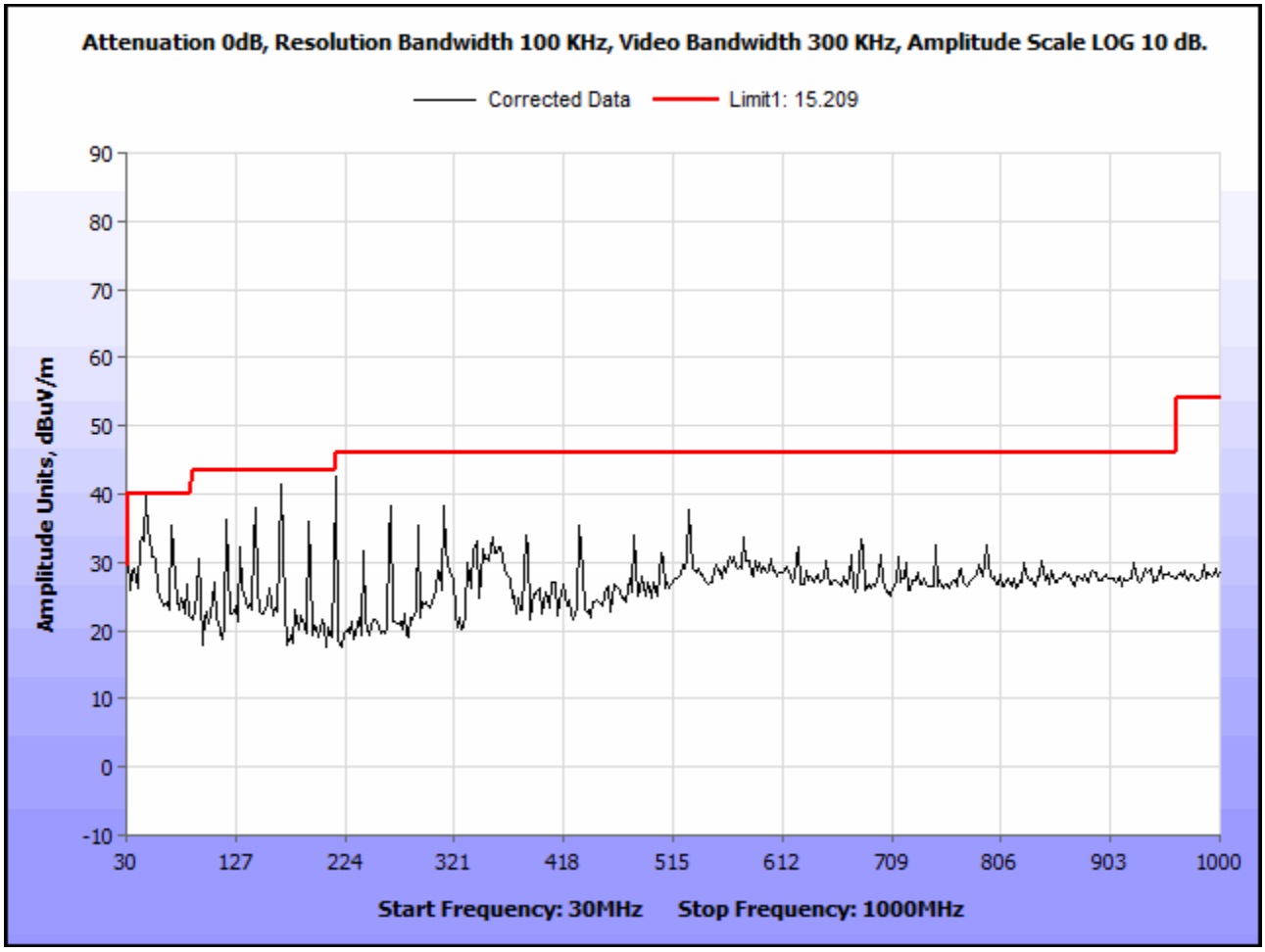
Plot 45. Radiated Spurious Emissions, b Mode, 30 MHz to 1 GHz, Low Channel



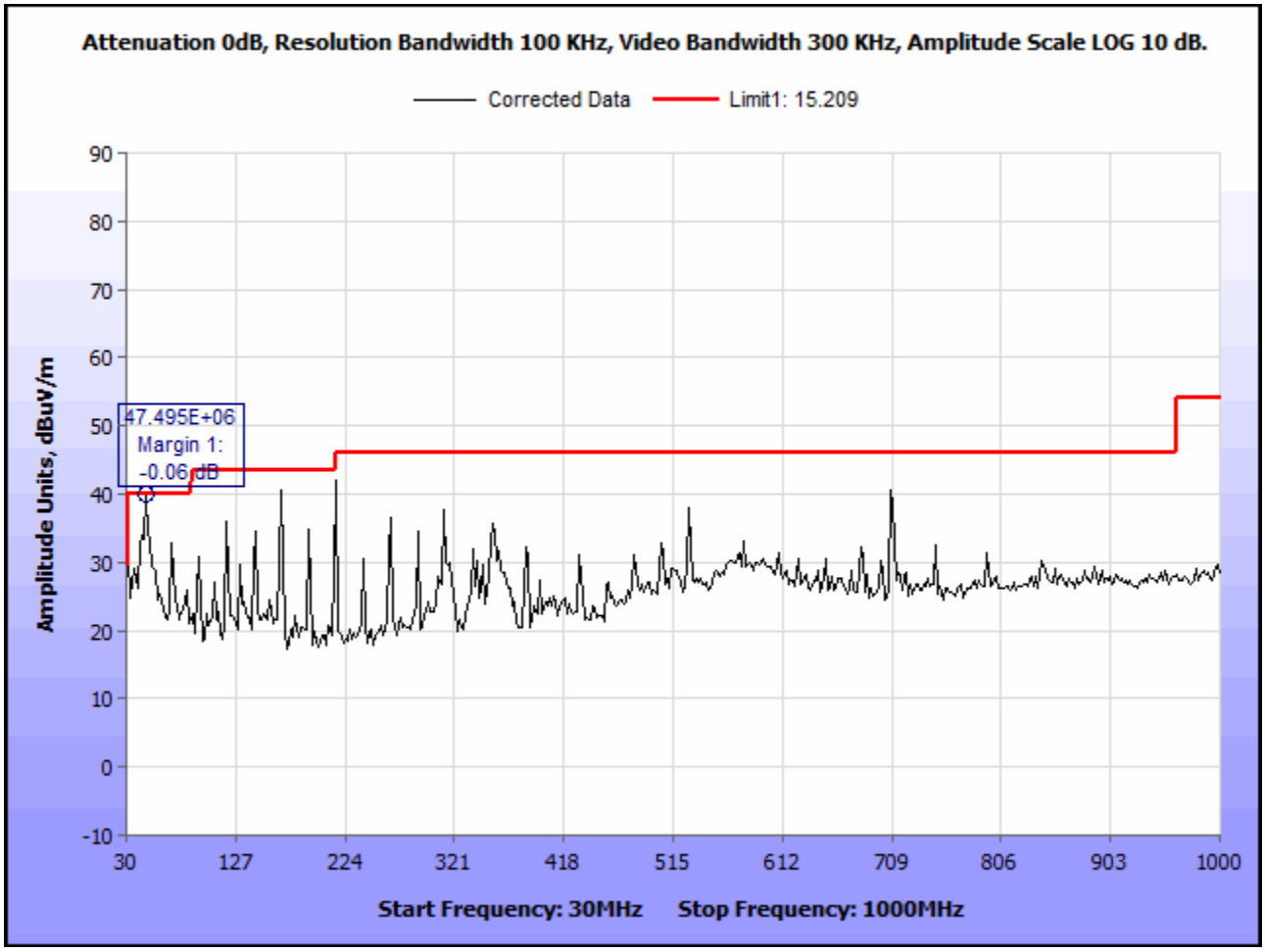
Plot 46. Radiated Spurious Emissions, g Mode, 30 MHz to 1 GHz, Low Channel



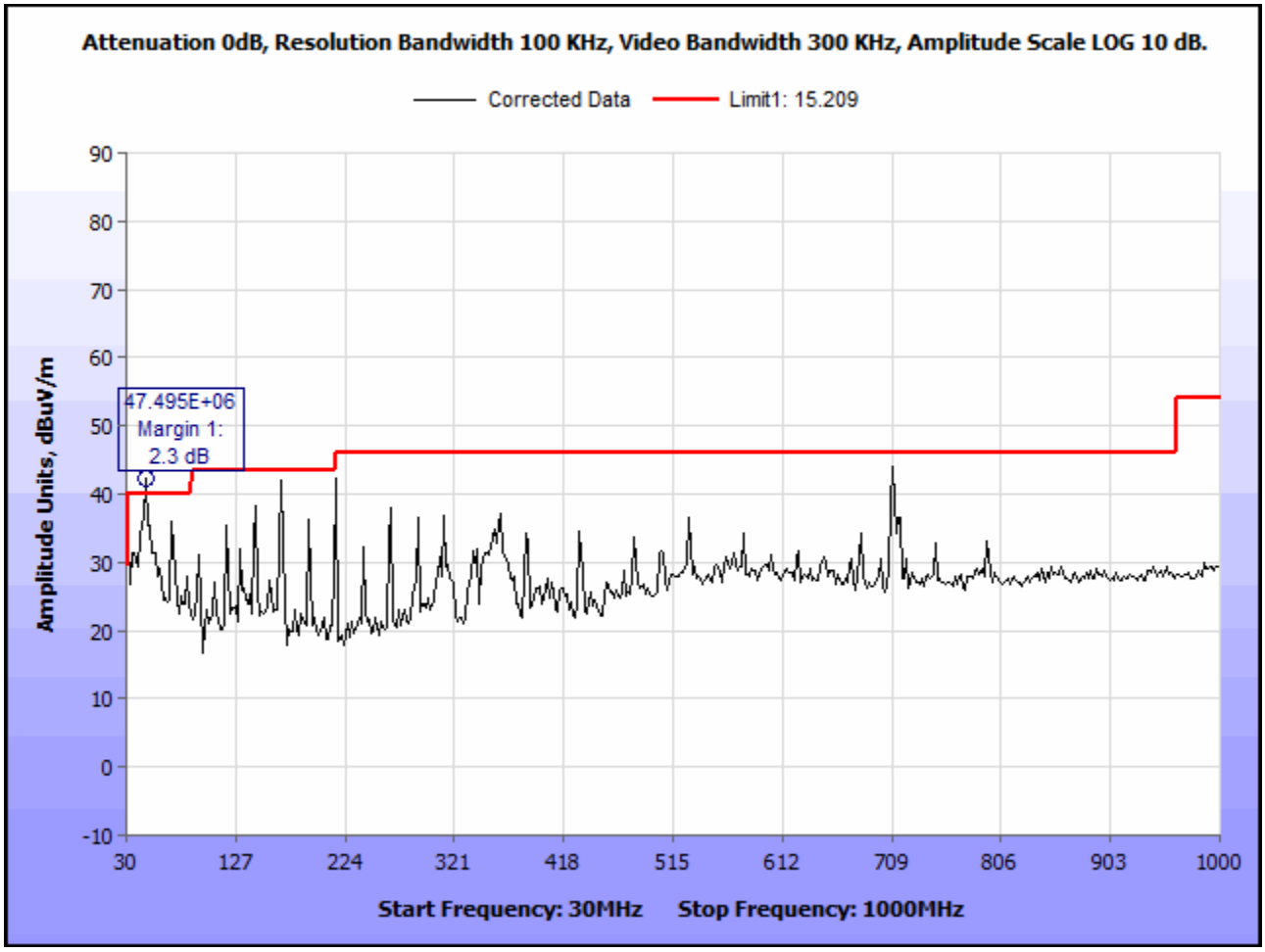
Plot 47. Radiated Spurious Emissions, n Mode, 30 MHz to 1 GHz, 20 MHz, Low BW Channel



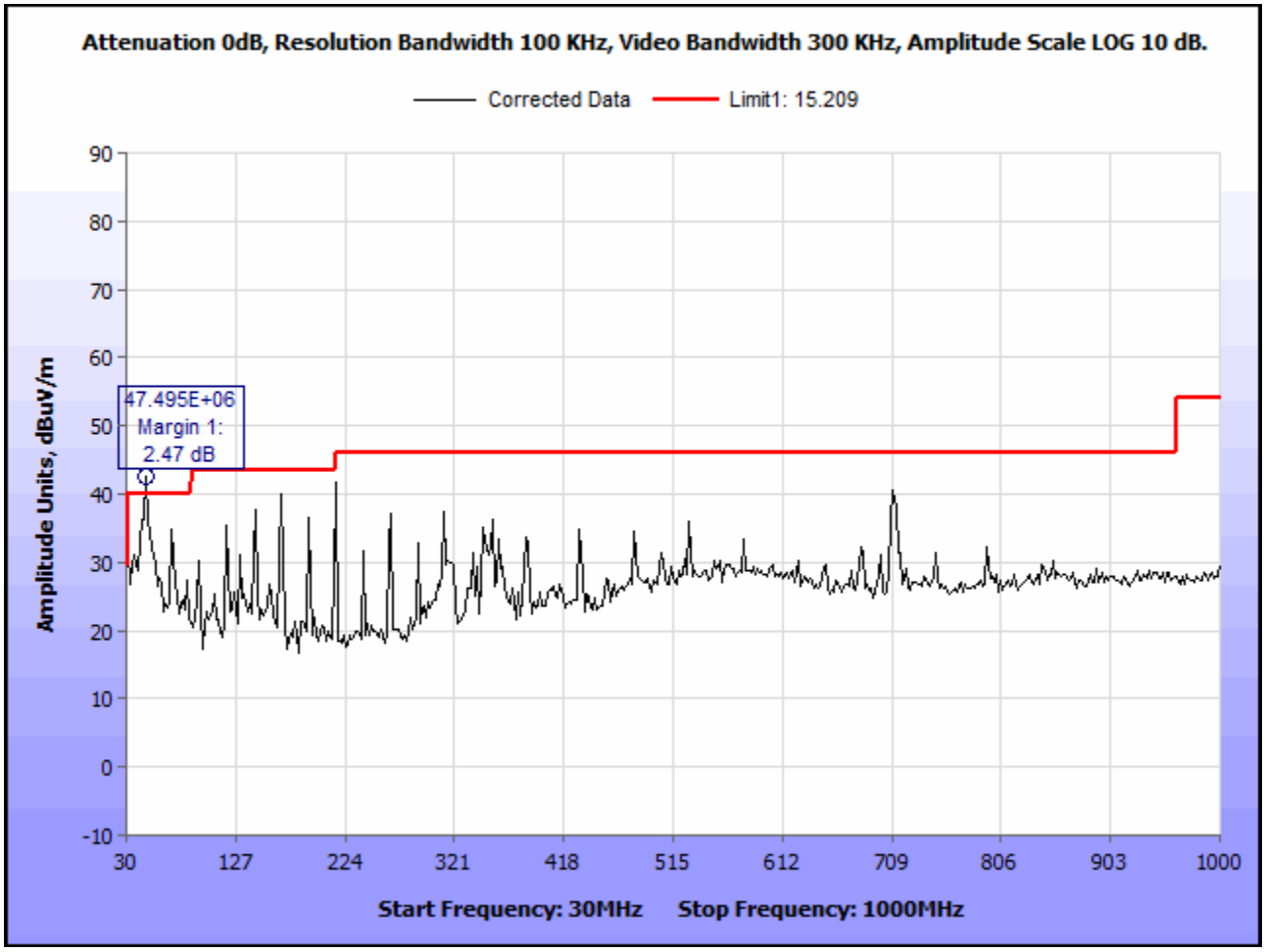
Plot 48. Radiated Spurious Emissions, n Mode, 30 MHz to 1 GHz, 40 MHz, Low BW Channel



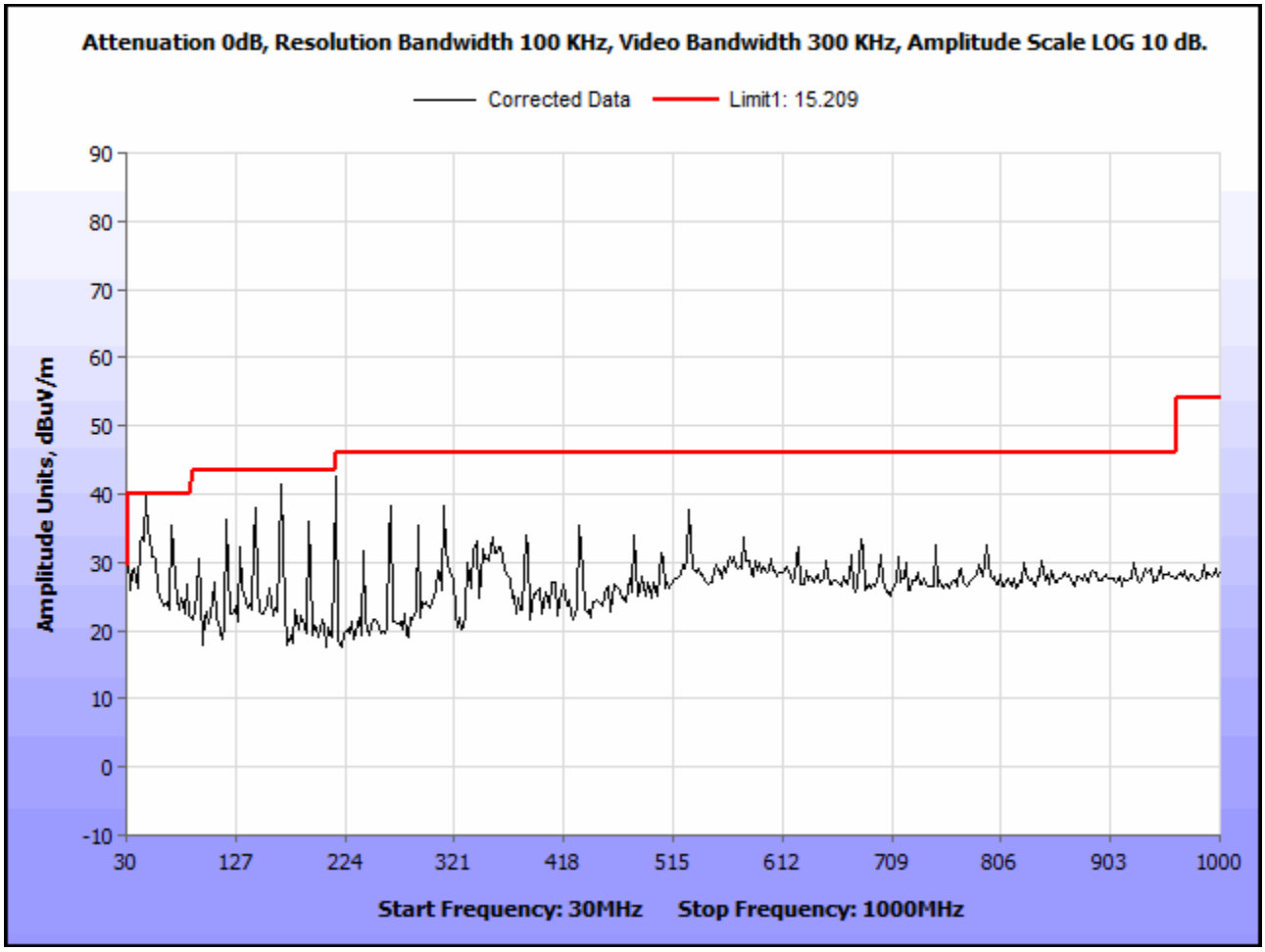
Plot 49. Radiated Spurious Emissions, b Mode, 30 MHz to 1 GHz, Mid Channel



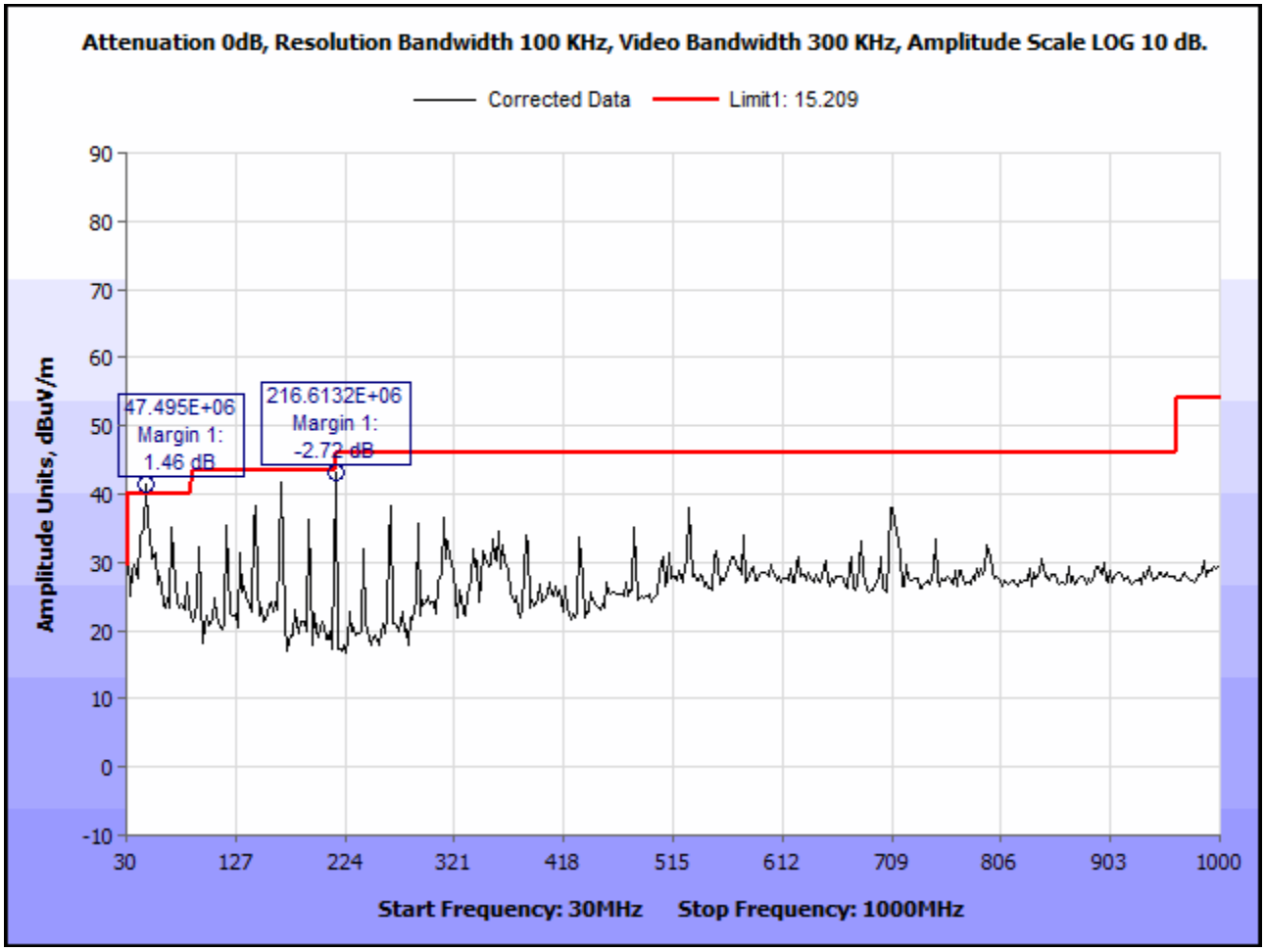
Plot 50. Radiated Spurious Emissions, g Mode, 30 MHz to 1 GHz, Mid Channel



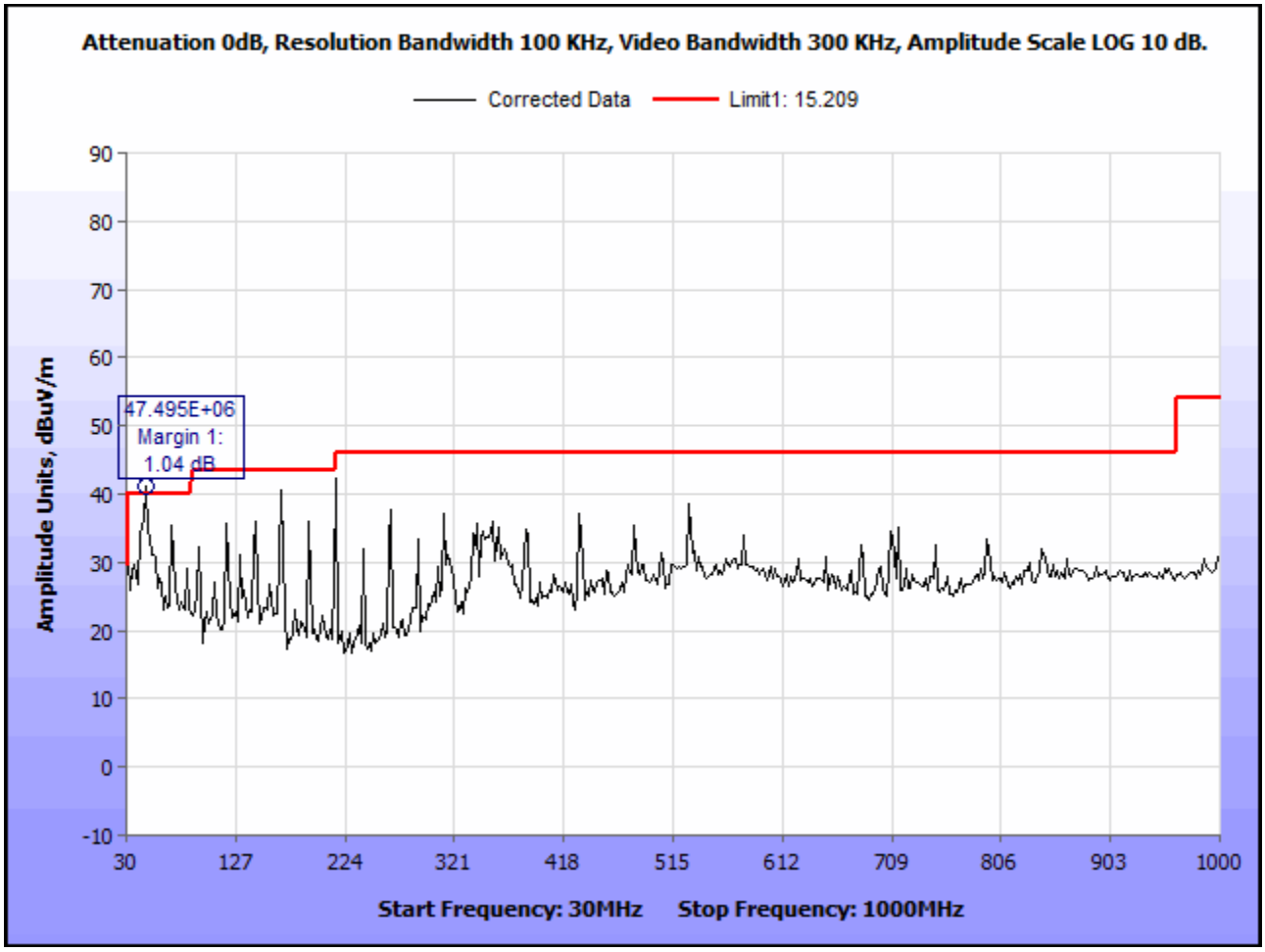
Plot 51. Radiated Spurious Emissions, n Mode, 30 MHz to 1 GHz, 20 MHz, Mid BW Channel



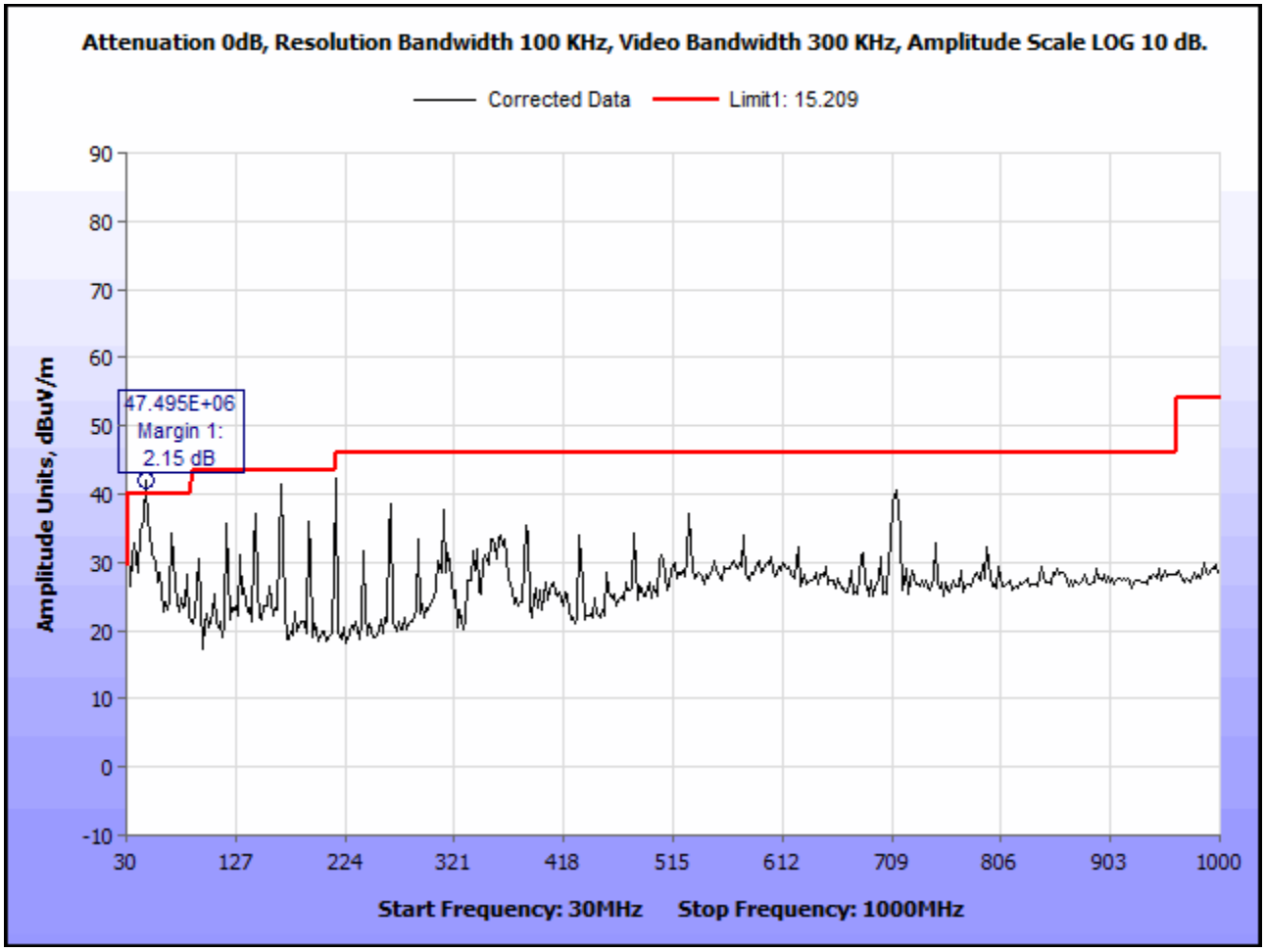
Plot 52. Radiated Spurious Emissions, n Mode, 30 MHz to 1 GHz, 40 MHz, Mid BW Channel



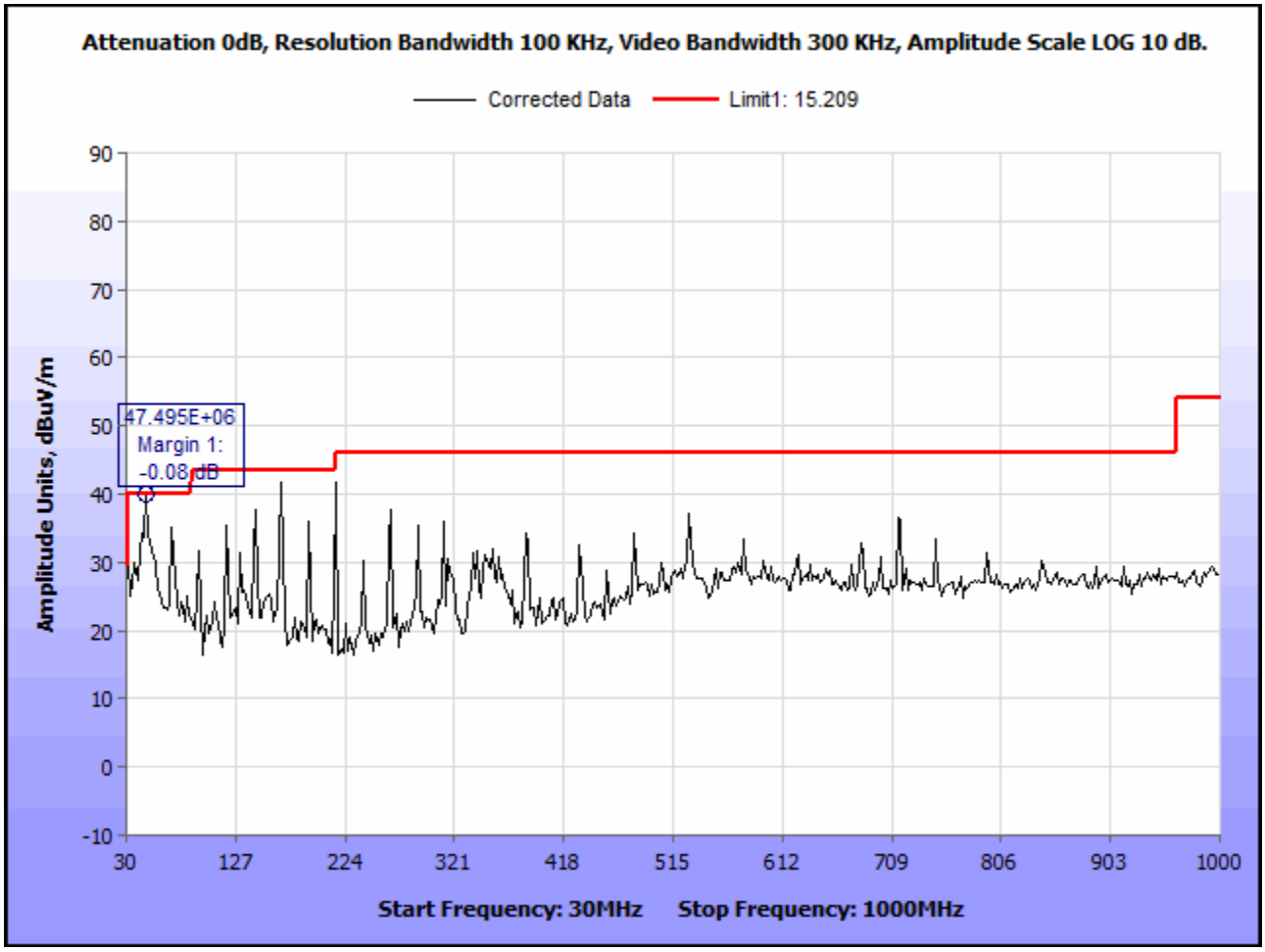
Plot 53. Radiated Spurious Emissions, b Mode, 30 MHz to 1 GHz, High Channel



Plot 54. Radiated Spurious Emissions, g Mode, 30 MHz to 1 GHz, High Channel



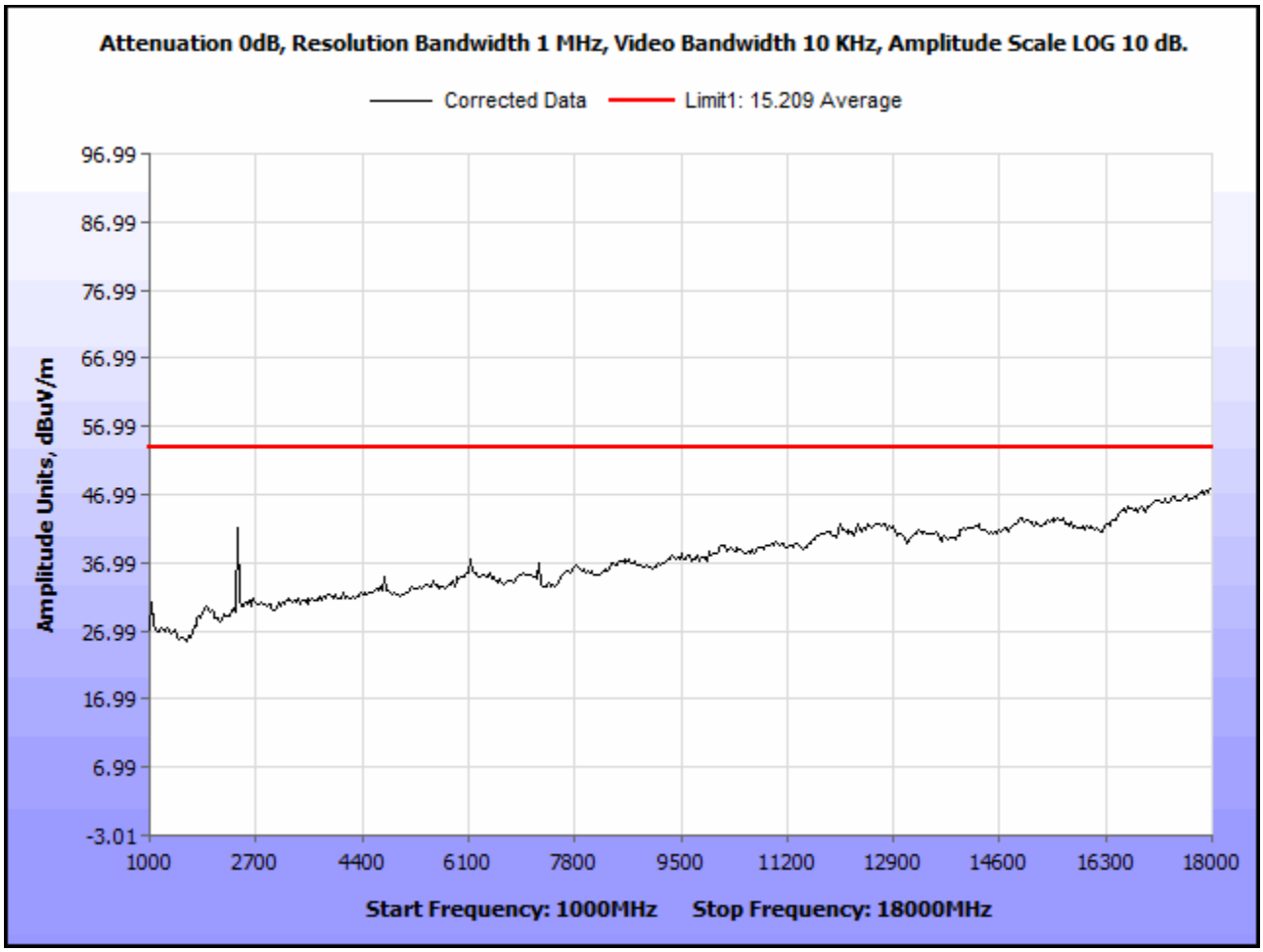
Plot 55. Radiated Spurious Emissions, n Mode, 30 MHz to 1 GHz, 20 MHz, High BW Channel



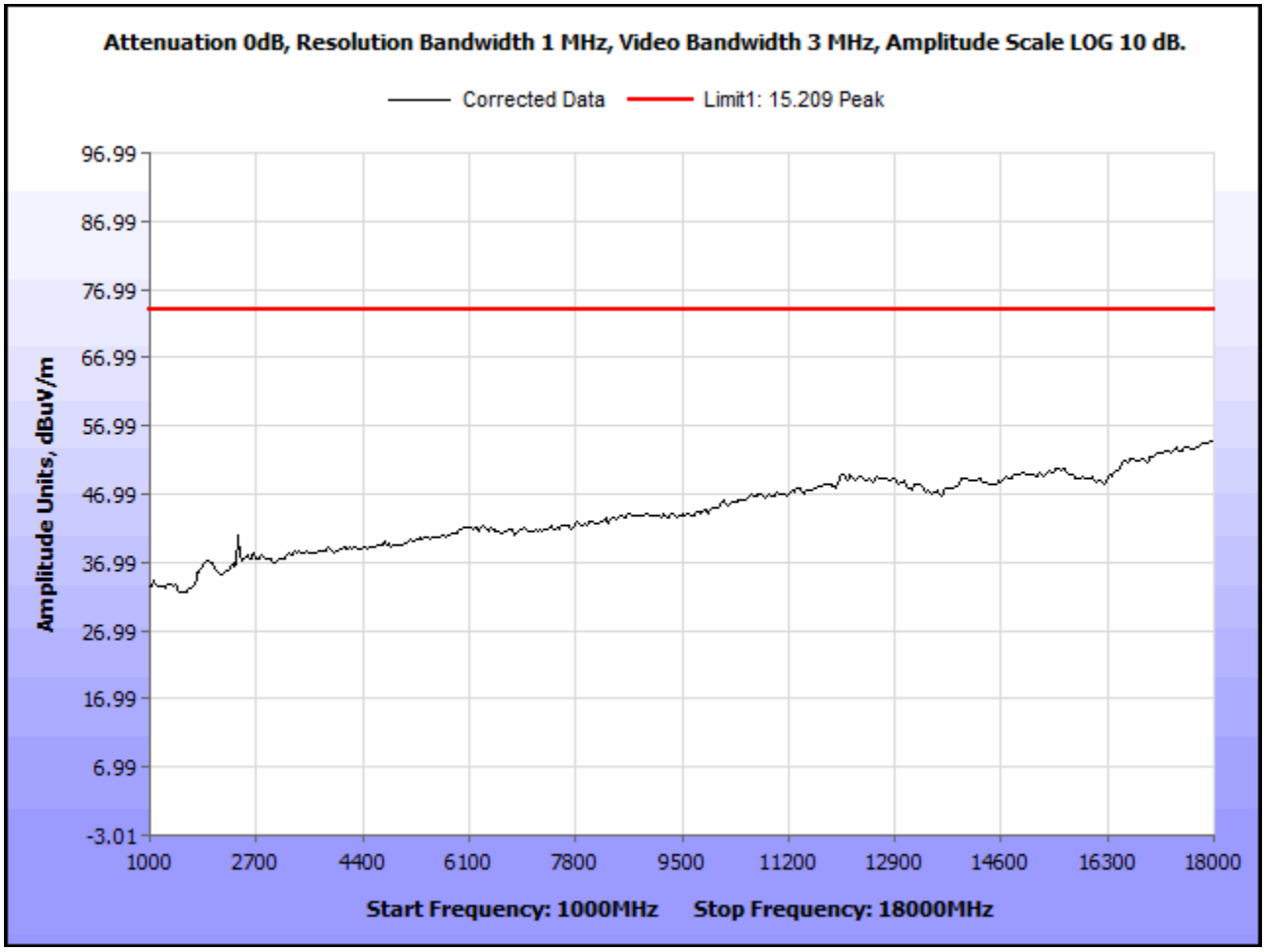
Plot 56. Radiated Spurious Emissions, n Mode, 30 MHz to 1 GHz, 40 MHz, High BW Channel

Radiated Band Edge Measurements

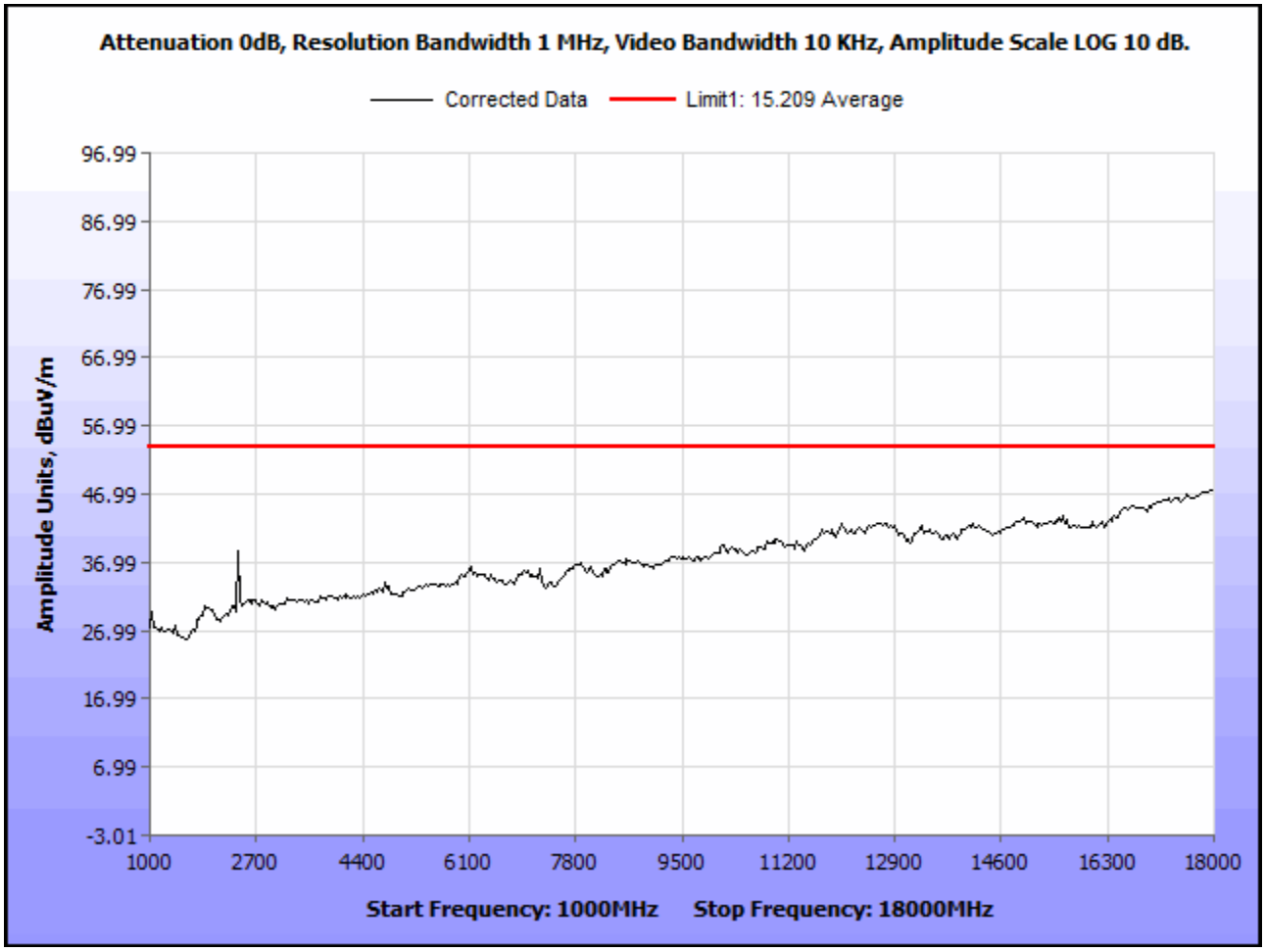
Test Procedures: The transmitter was turned on. Measurements were performed of the low, mid and high Channels. The EUT was rotated orthogonally through all three axes. Plots shown are corrected for both antenna correction factor and distance and compared to a 3 m limit line.



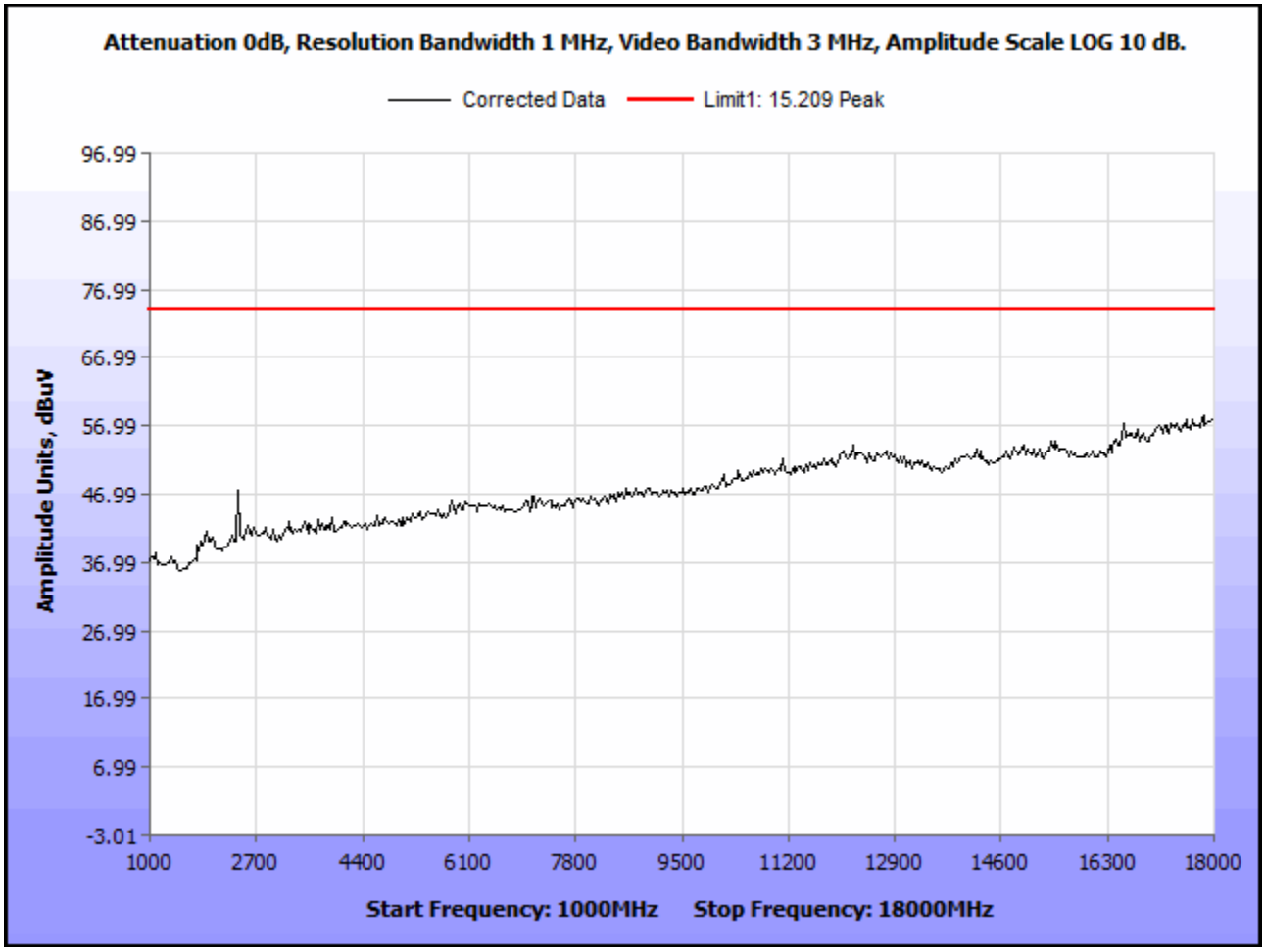
Plot 57. Radiated Spurious Emissions, b Mode, 1 GHz to 18 GHz, Low Channel, Average



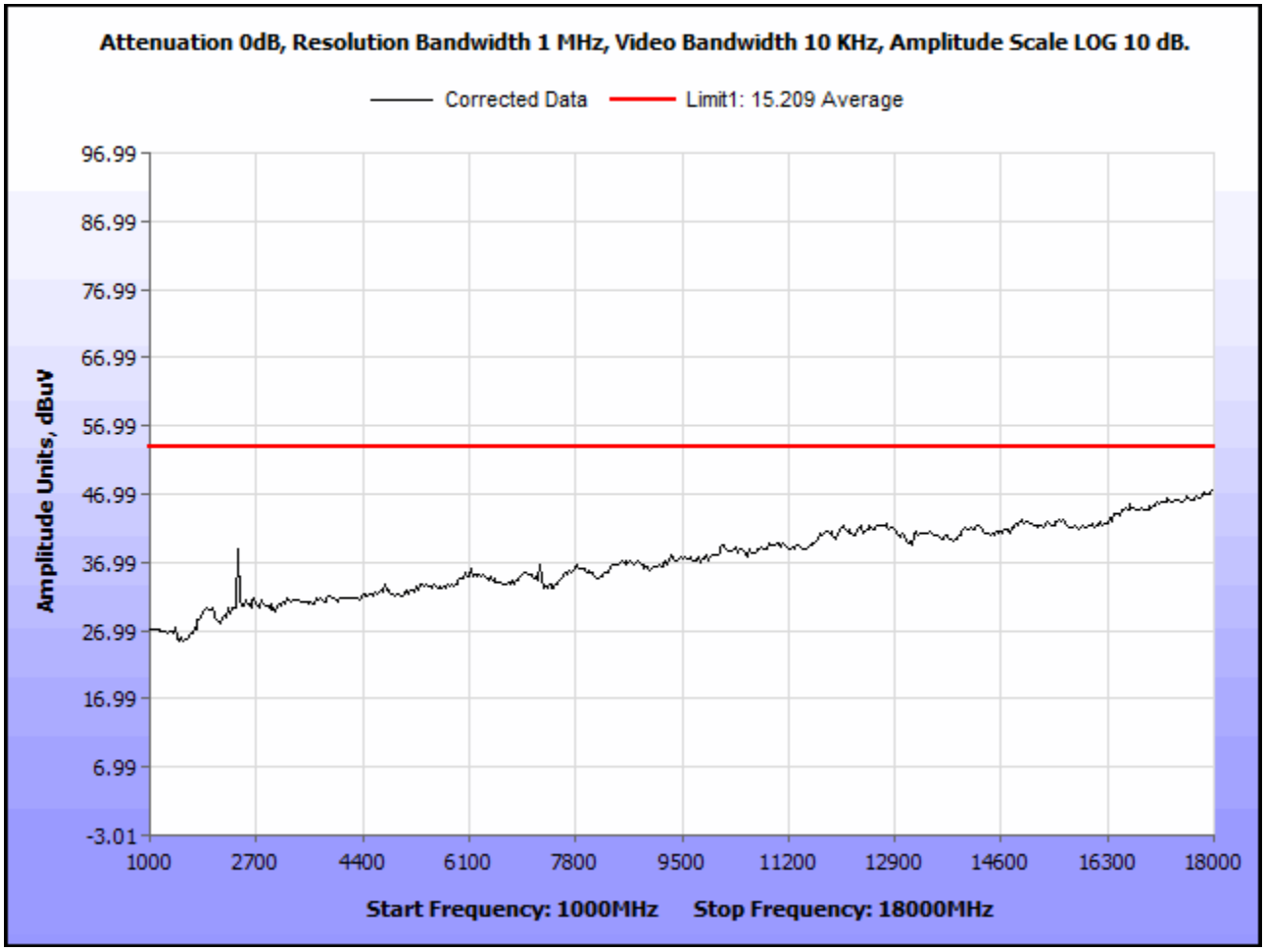
Plot 58. Radiated Spurious Emissions, b Mode, 1 GHz to 18 GHz, Low Channel, Peak



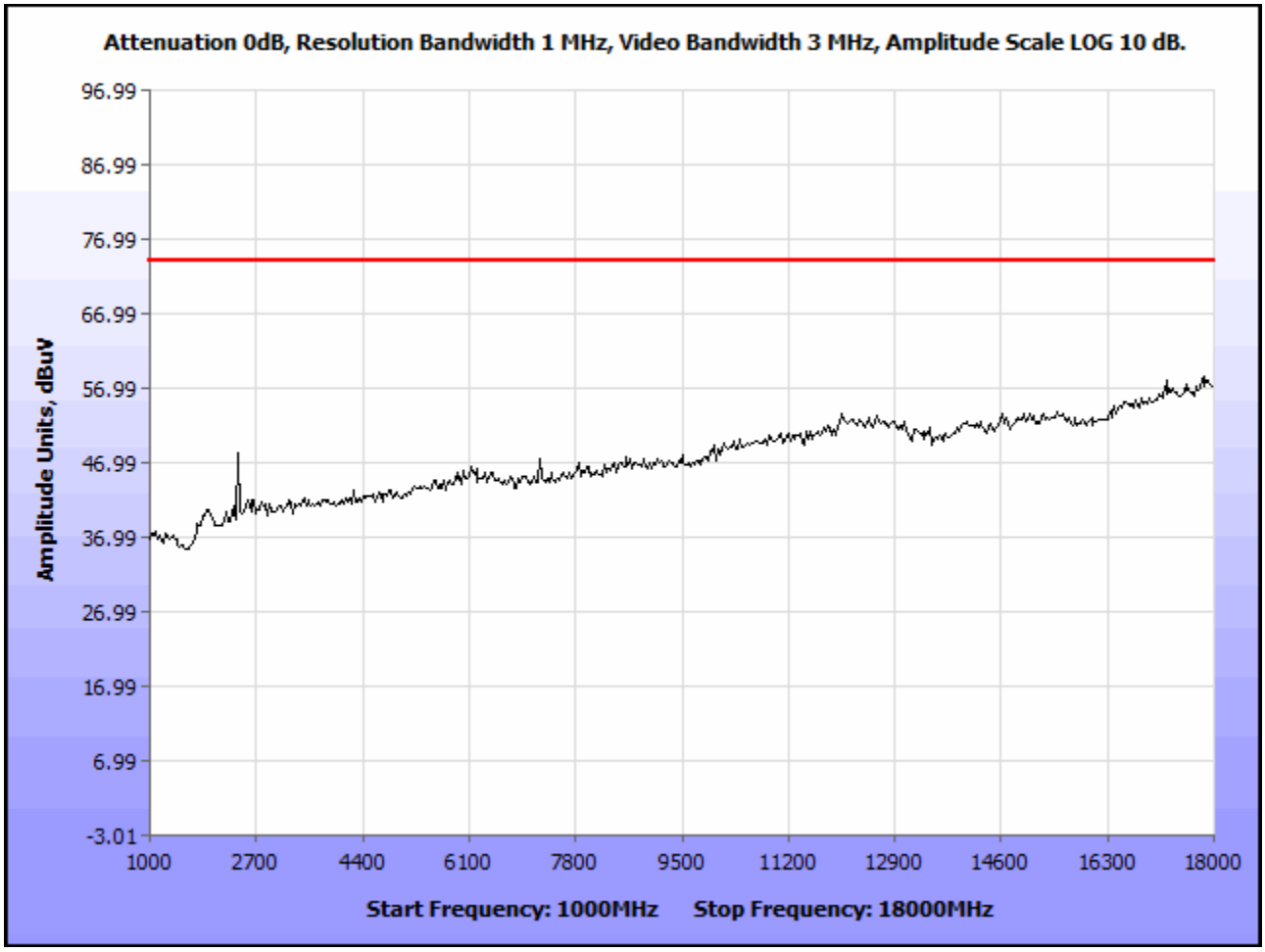
Plot 59. Radiated Spurious Emissions, g Mode, 1 GHz to 18 GHz, Low Channel, Average



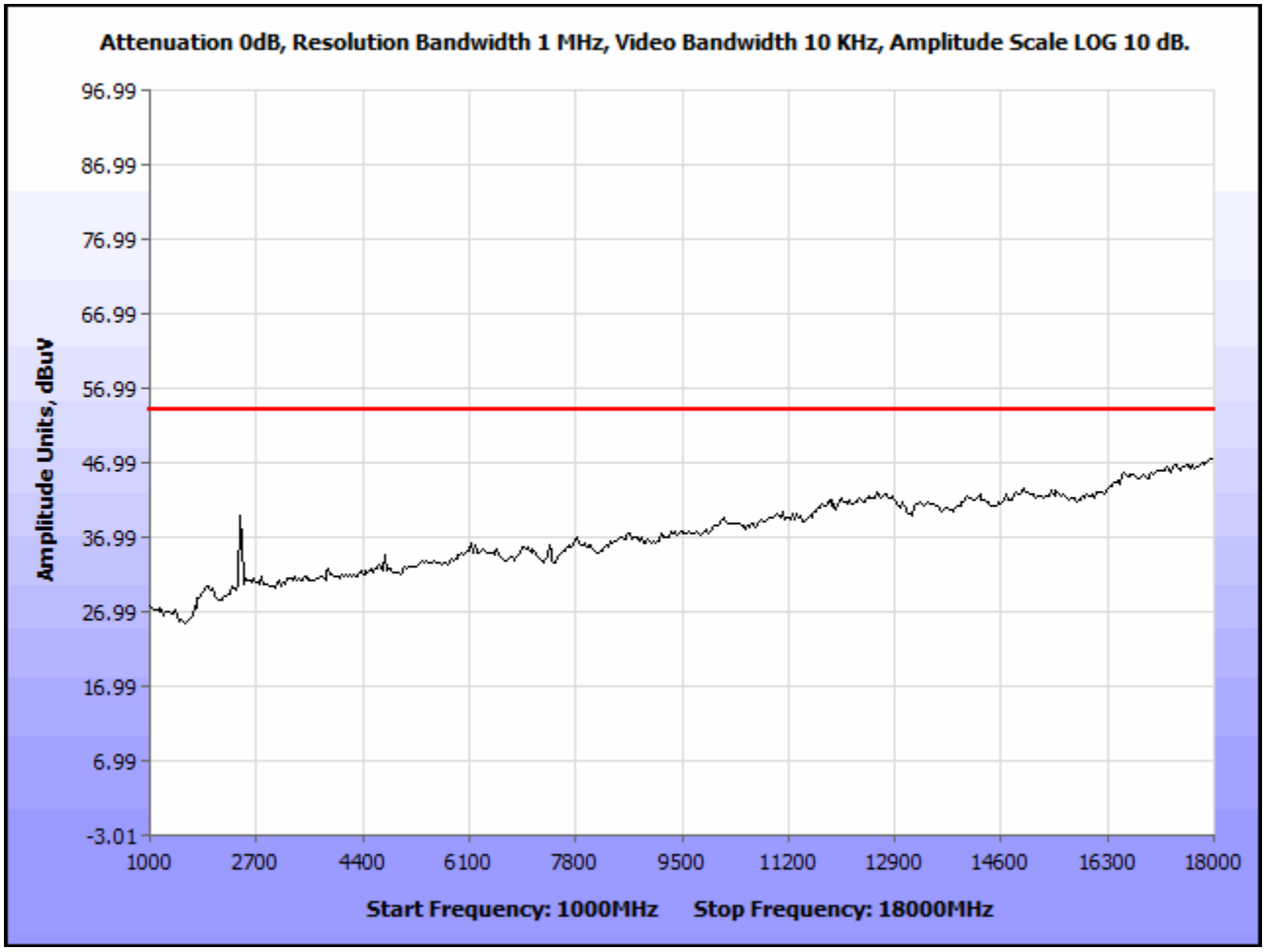
Plot 60. Radiated Spurious Emissions, g Mode, 1 GHz to 18 GHz, Low Channel, Peak



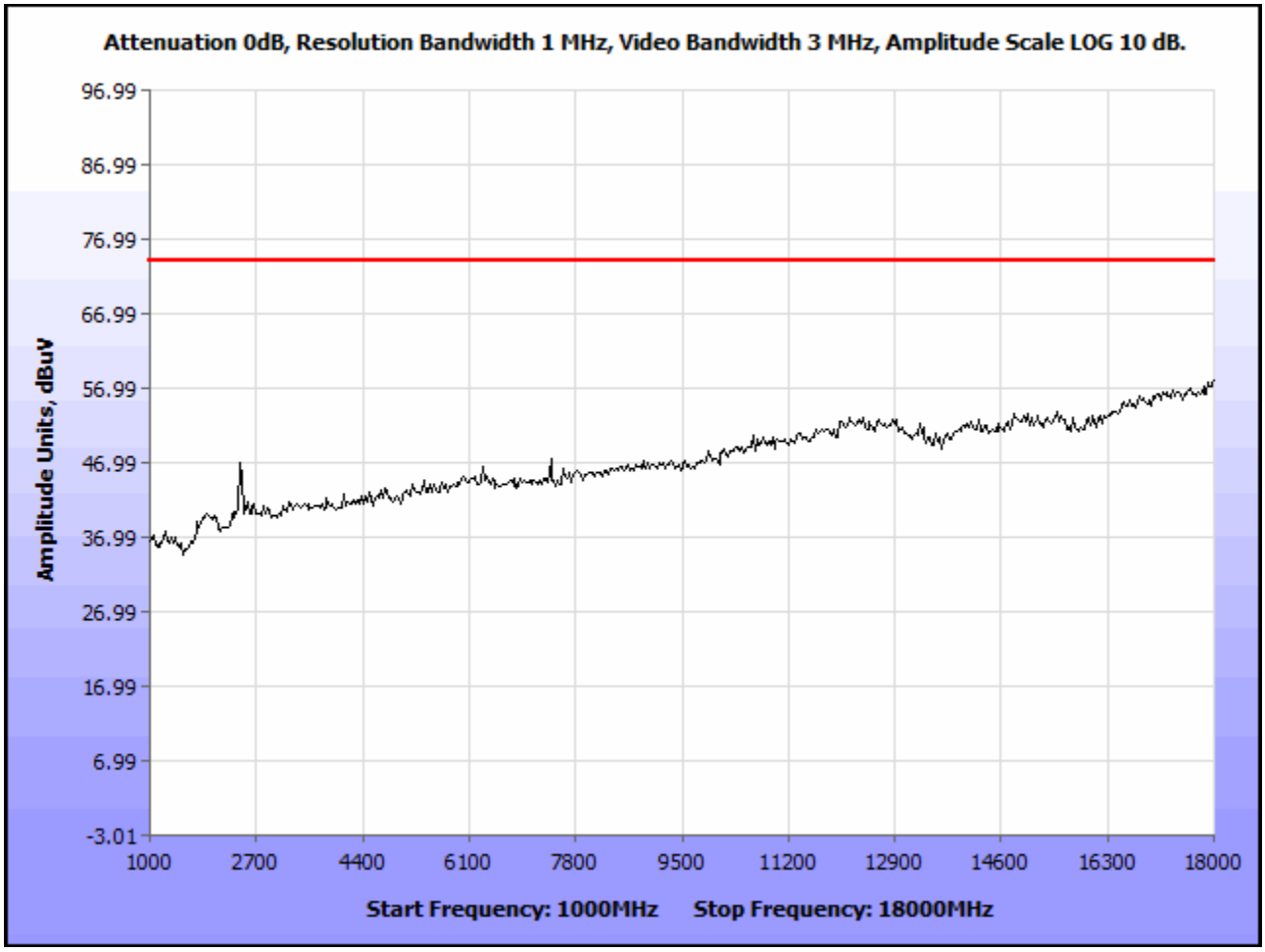
Plot 61. Radiated Spurious Emissions, n Mode, 1 GHz to 18 GHz, Low Channel, Average



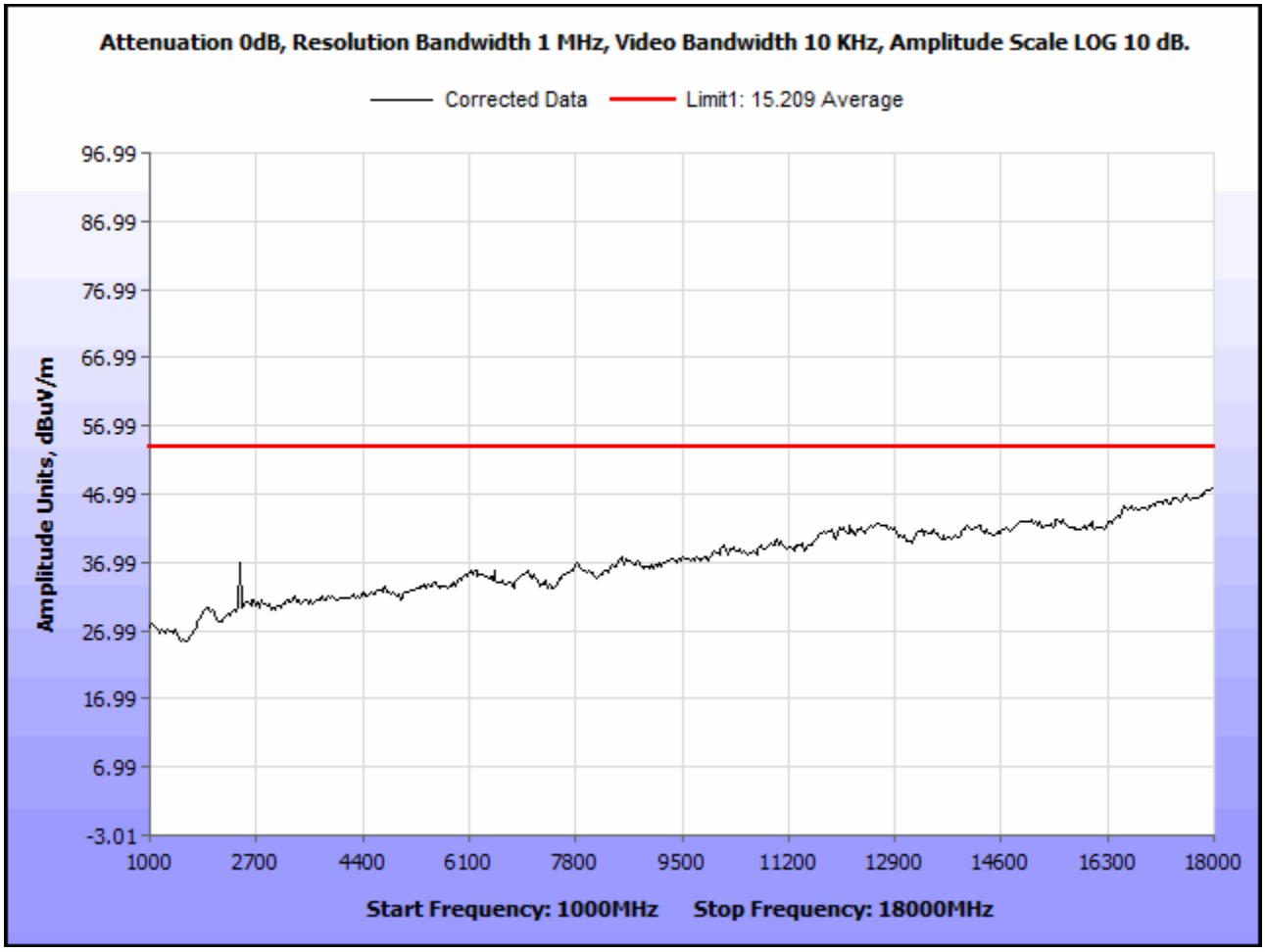
Plot 62. Radiated Spurious Emissions, n Mode, 1 GHz to 18 GHz, Low Channel, Peak



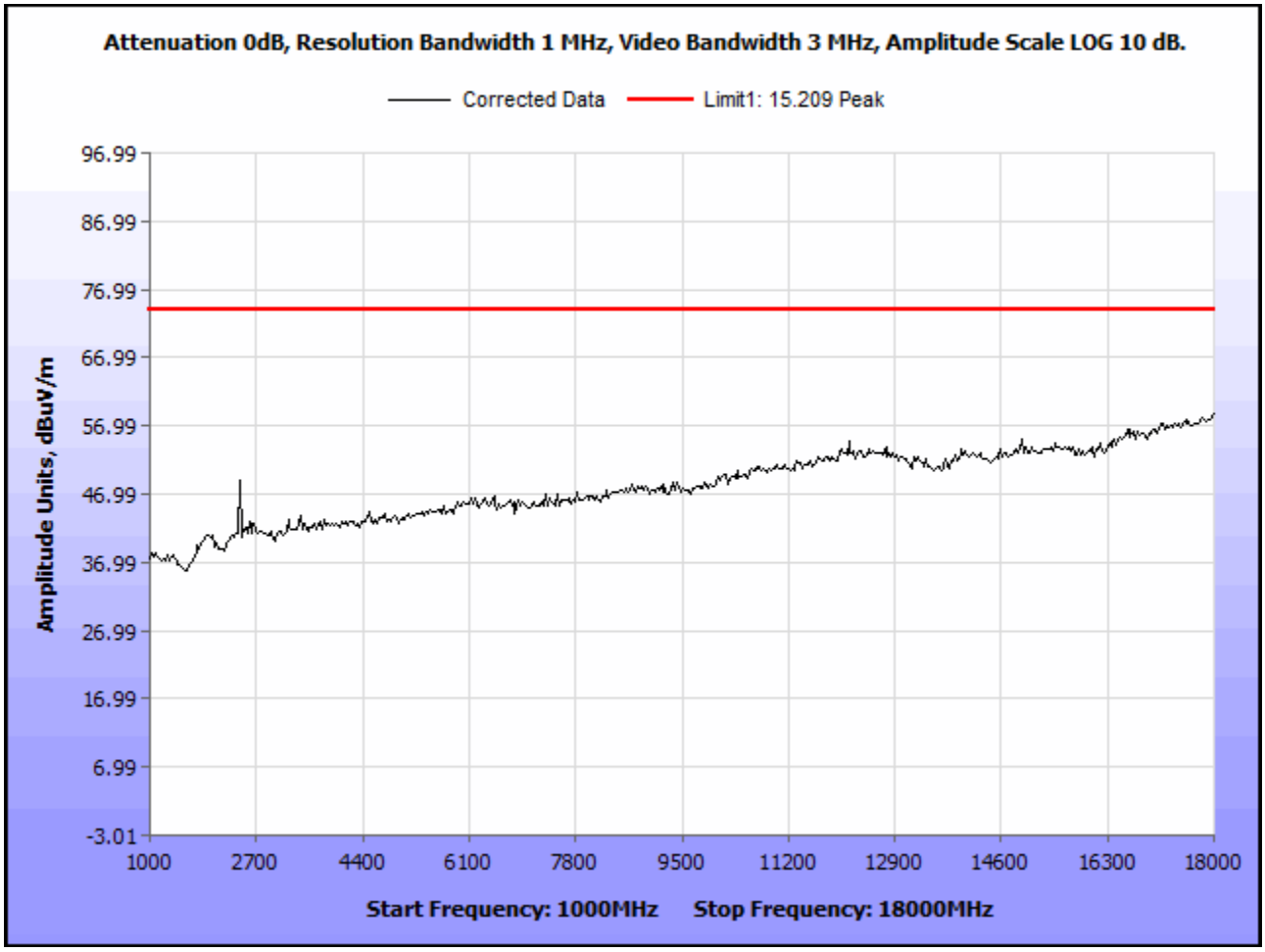
Plot 63. Radiated Spurious Emissions, n Mode, 40 MHz BW, 1 GHz to 18 GHz, Low Channel, Average



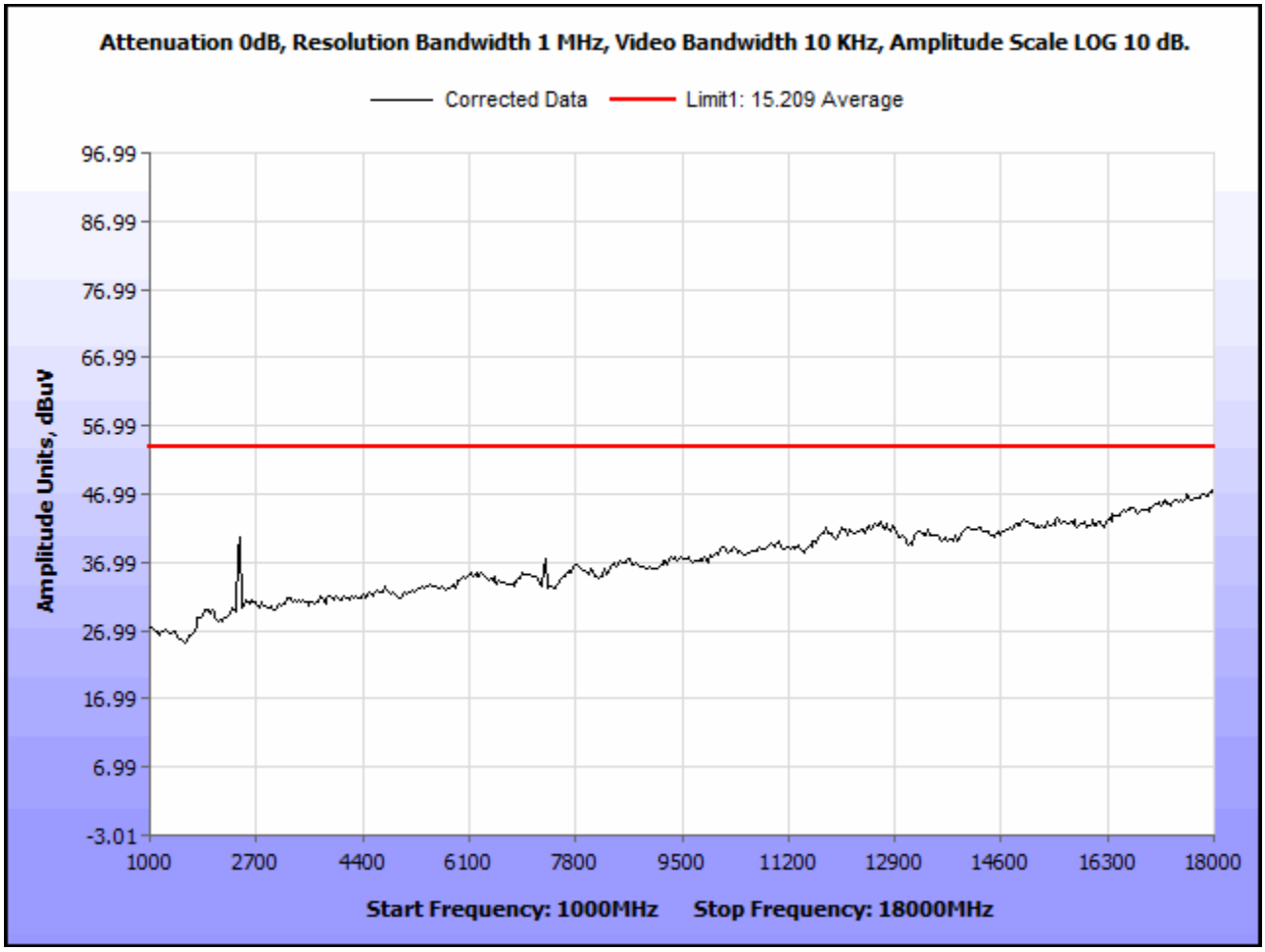
Plot 64. Radiated Spurious Emissions, n Mode, 40 MHz BW, 1 GHz to 18 GHz, Low Channel, Peak



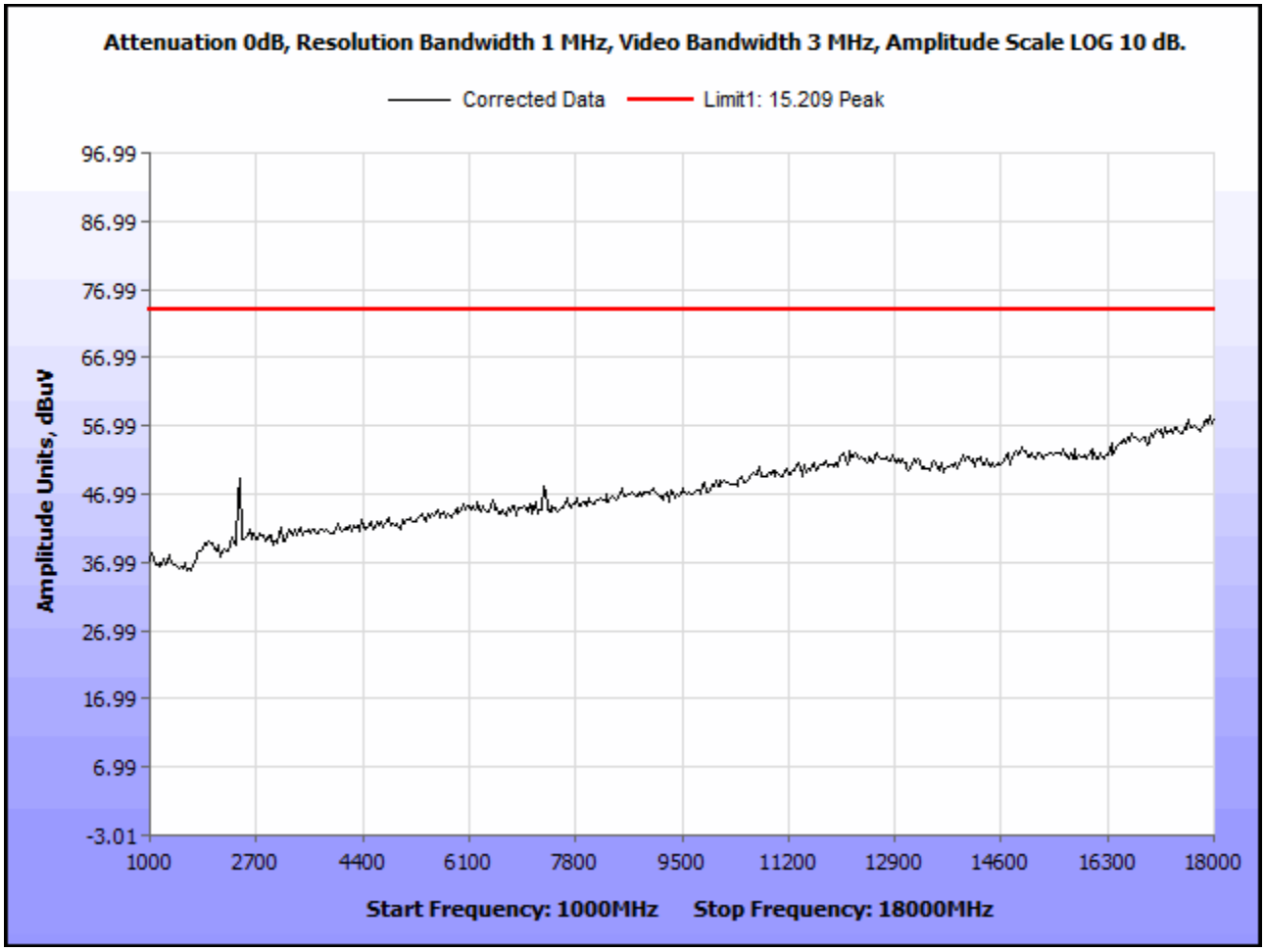
Plot 65. Radiated Spurious Emissions, b Mode, 1 GHz to 18 GHz, Mid Channel, Average



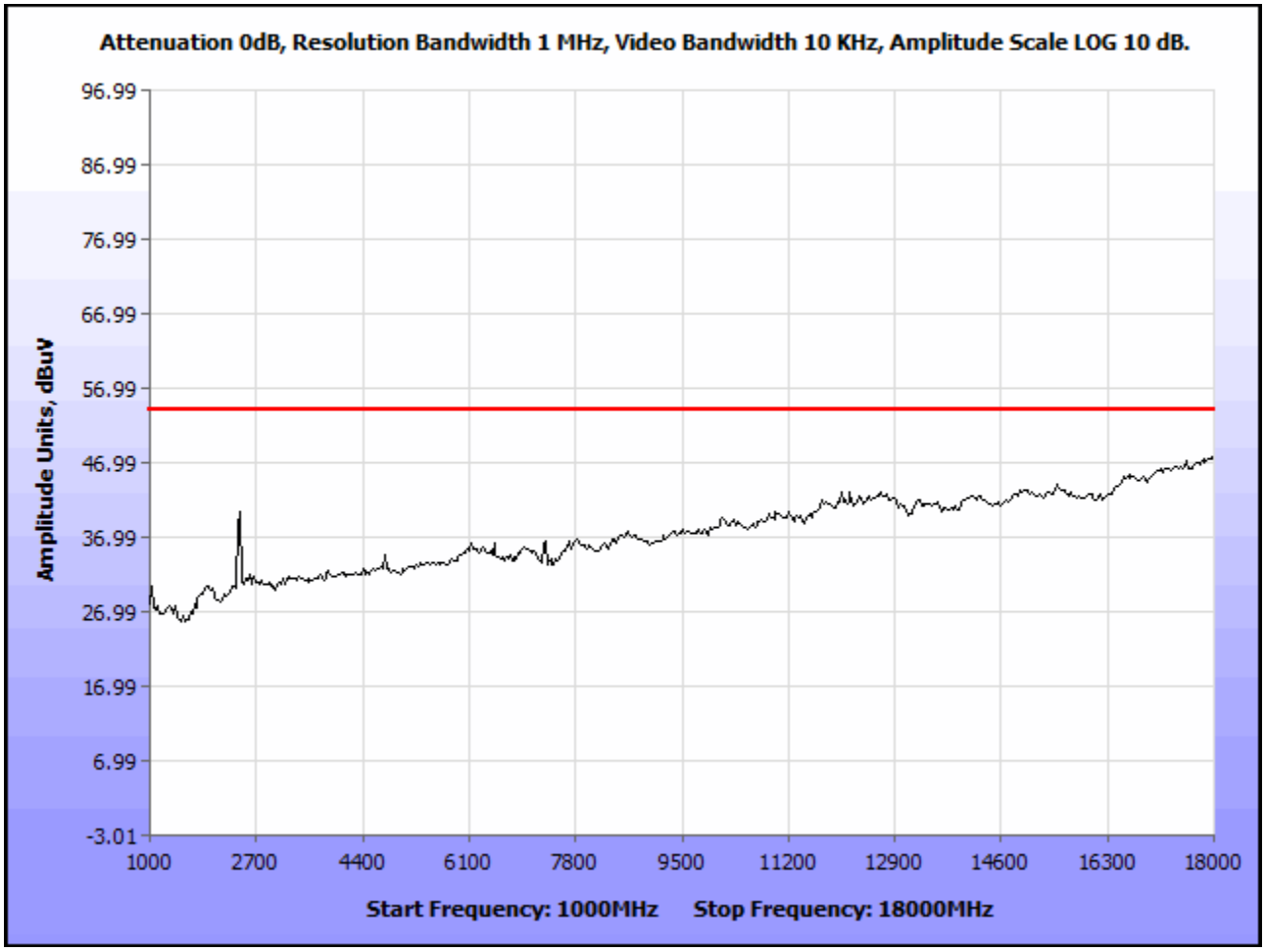
Plot 66. Radiated Spurious Emissions, b Mode, 1 GHz to 18 GHz, Mid Channel, Peak



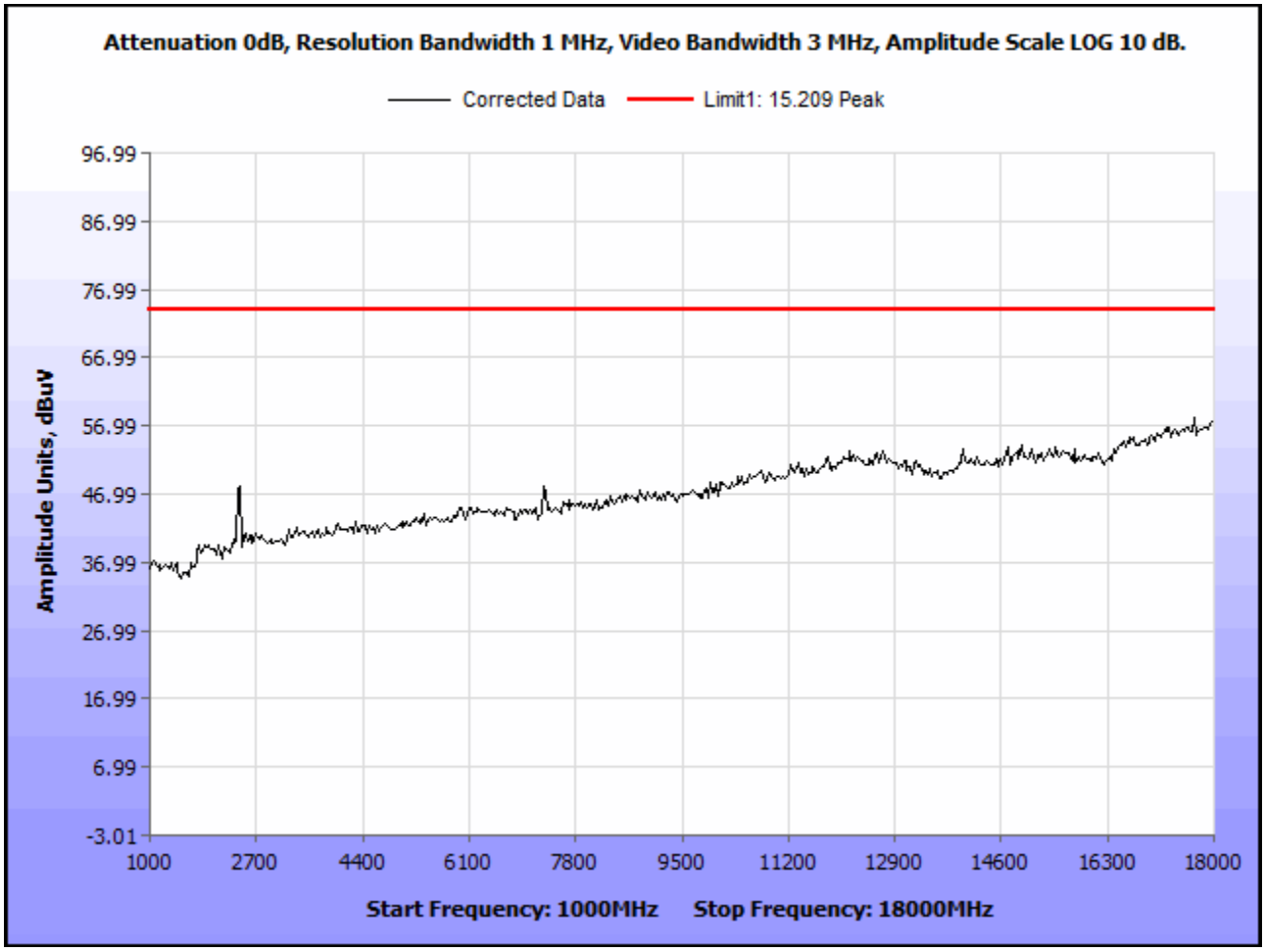
Plot 67. Radiated Spurious Emissions, g Mode, 1 GHz to 18 GHz, Mid Channel, Average



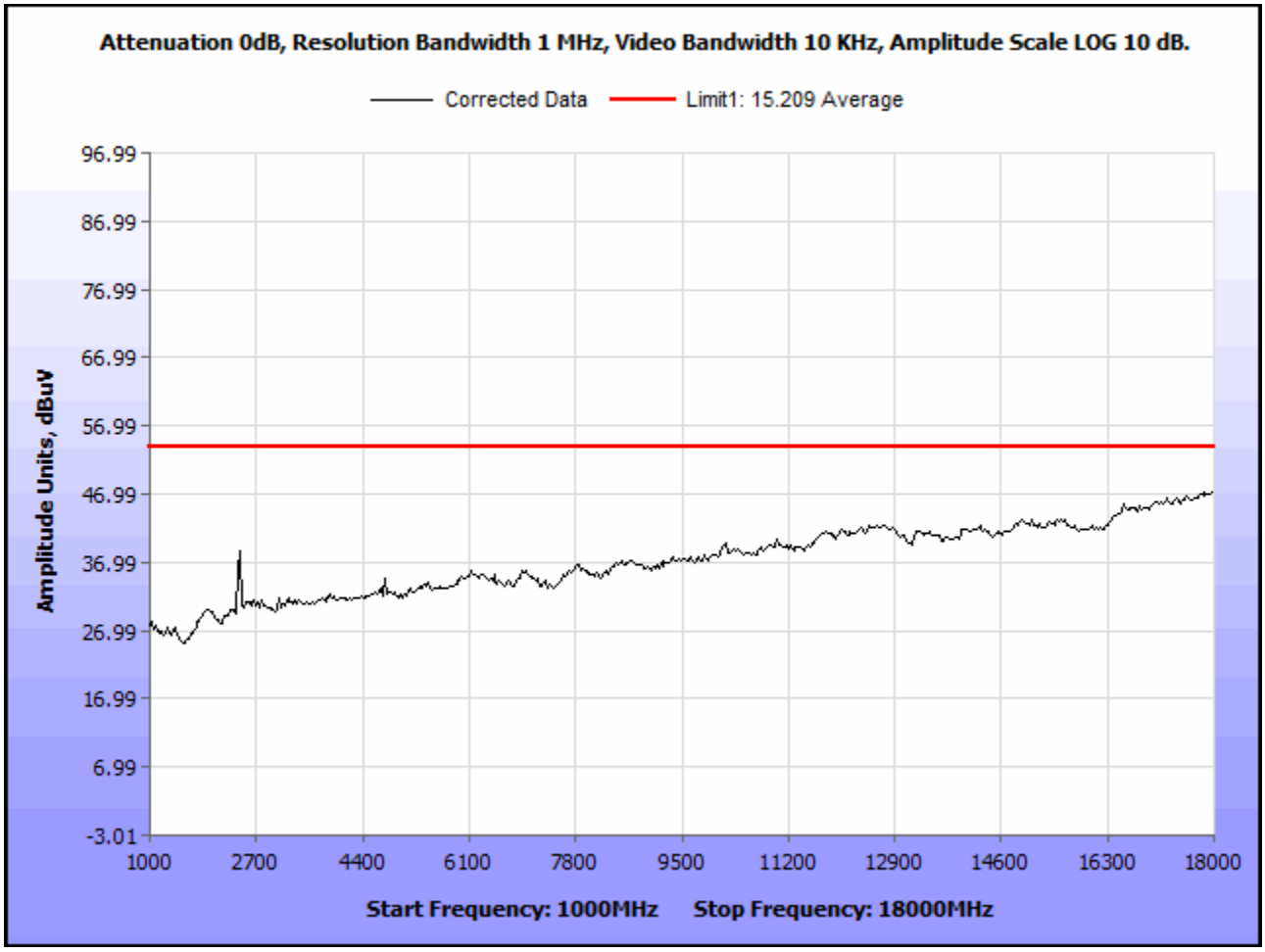
Plot 68. Radiated Spurious Emissions, g Mode, 1 GHz to 18 GHz, Mid Channel, Peak



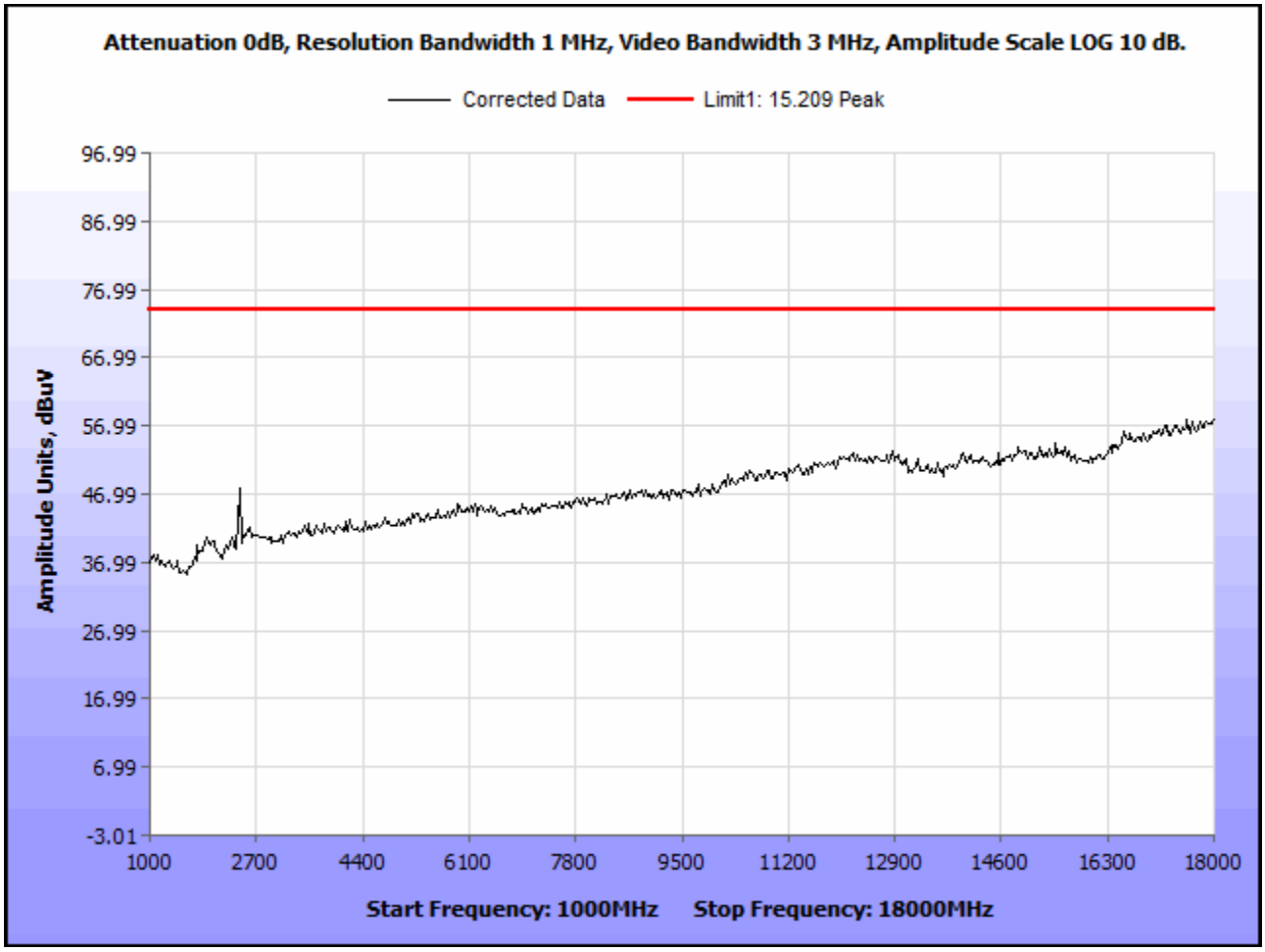
Plot 69. Radiated Spurious Emissions, n Mode, 1 GHz to 18 GHz, Mid Channel, Average



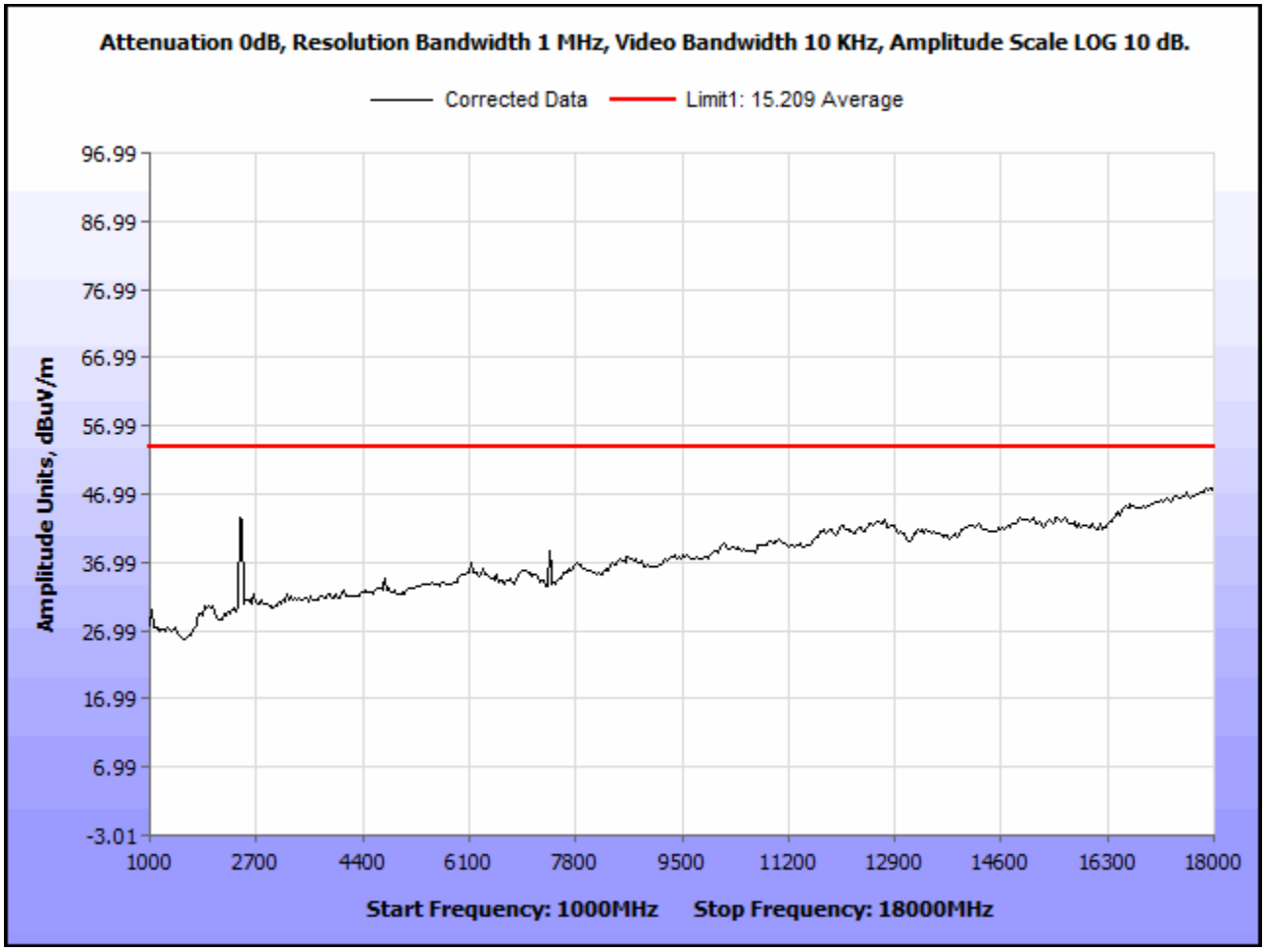
Plot 70. Radiated Spurious Emissions, n Mode, 1 GHz to 18 GHz, Mid Channel, Peak



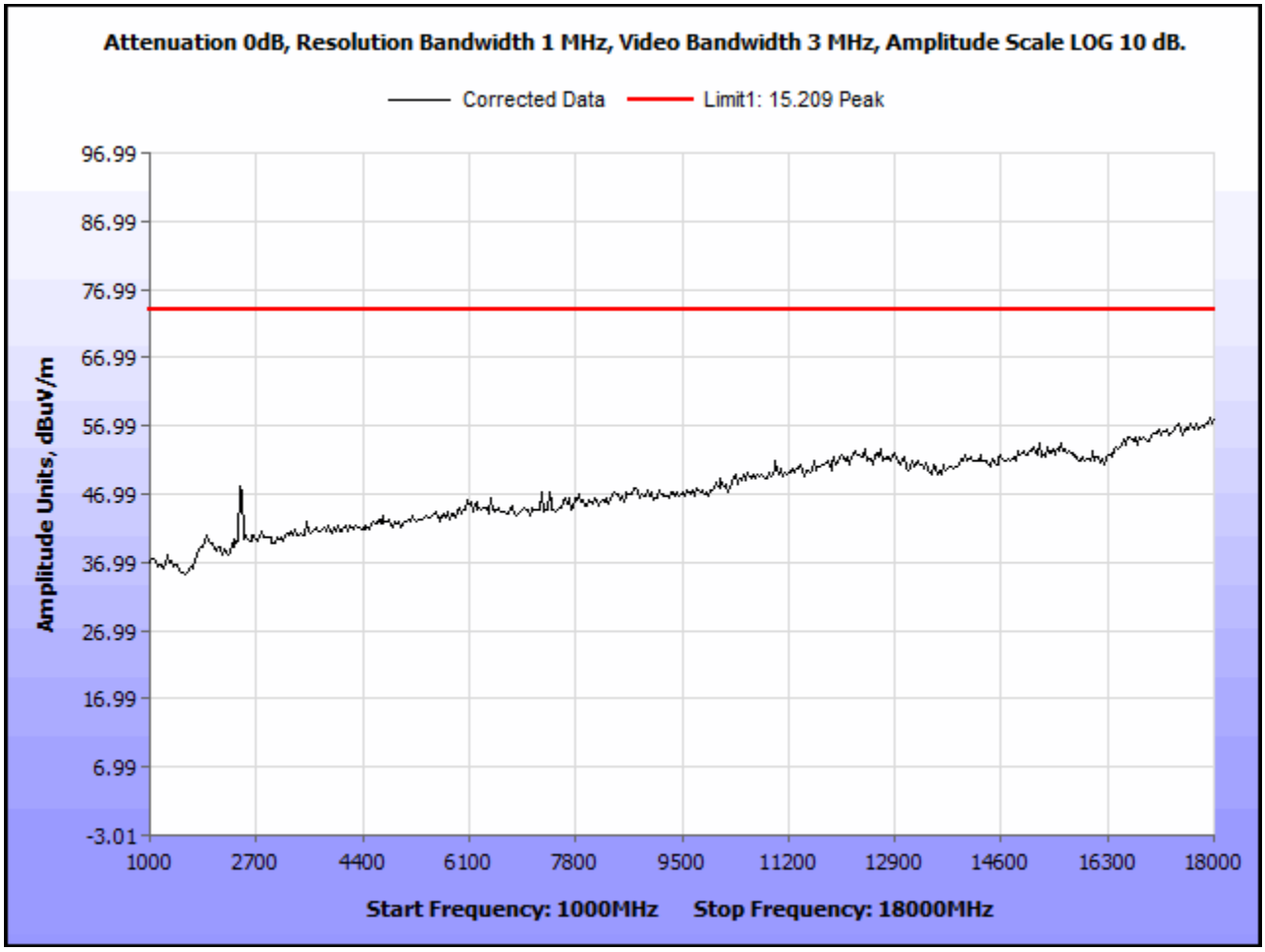
Plot 71. Radiated Spurious Emissions, n Mode, 40 MHz BW, 1 GHz to 18 GHz, Mid Channel, Average



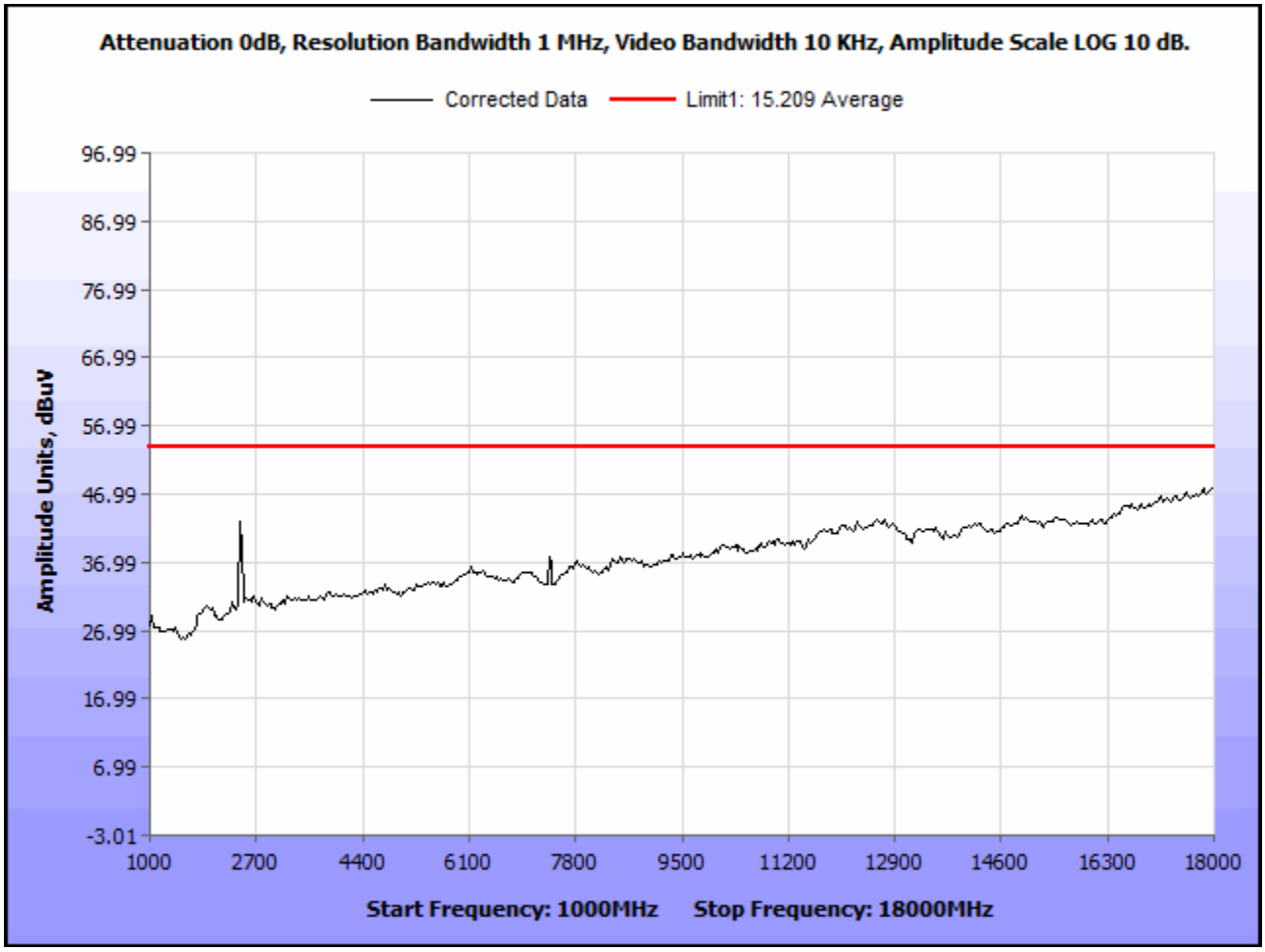
Plot 72. Radiated Spurious Emissions, n Mode, 40 MHz BW, 1 GHz to 18 GHz, Mid Channel, Peak



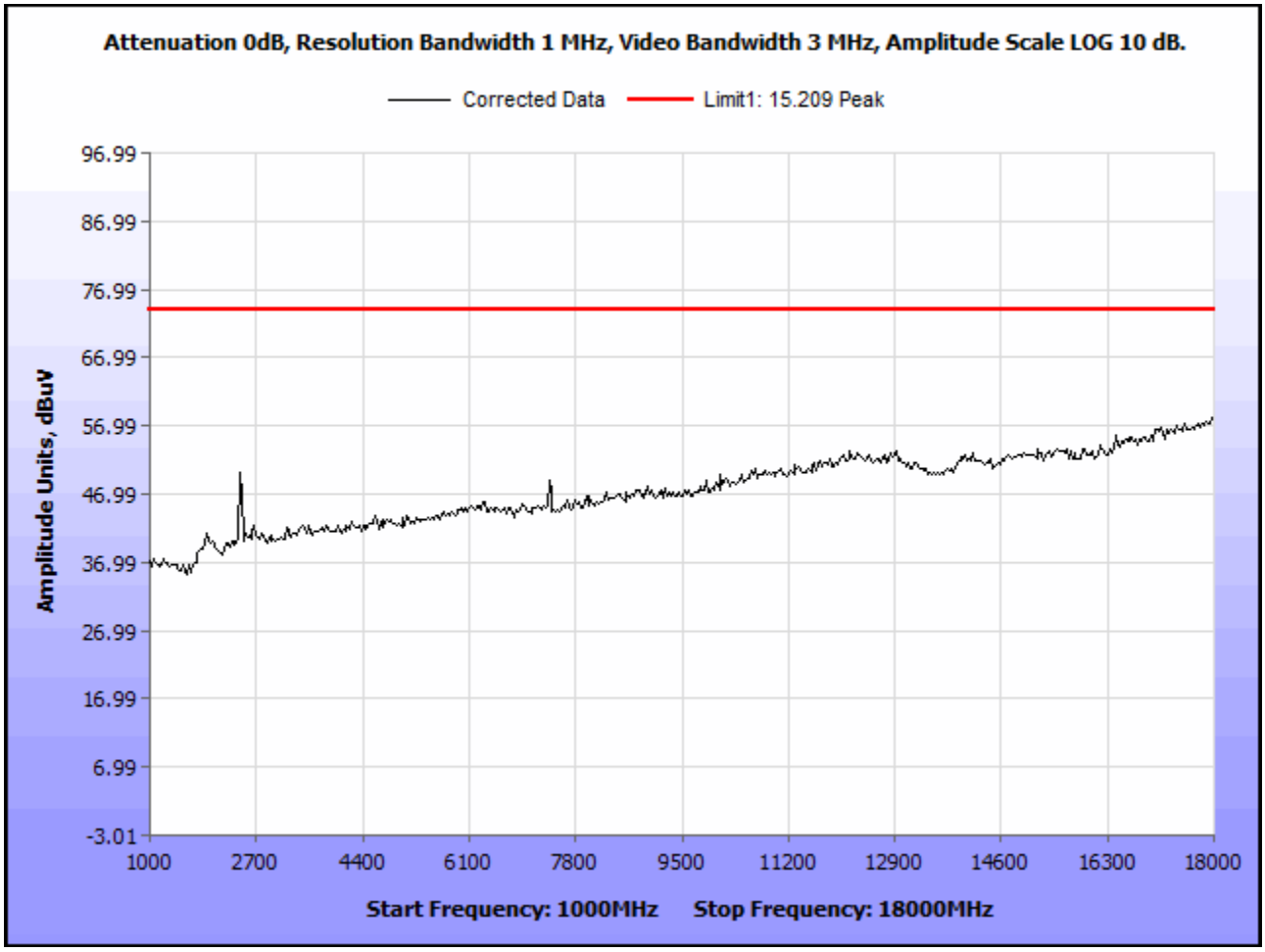
Plot 73. Radiated Spurious Emissions, b Mode, 1 GHz to 18 GHz, High Channel, Average



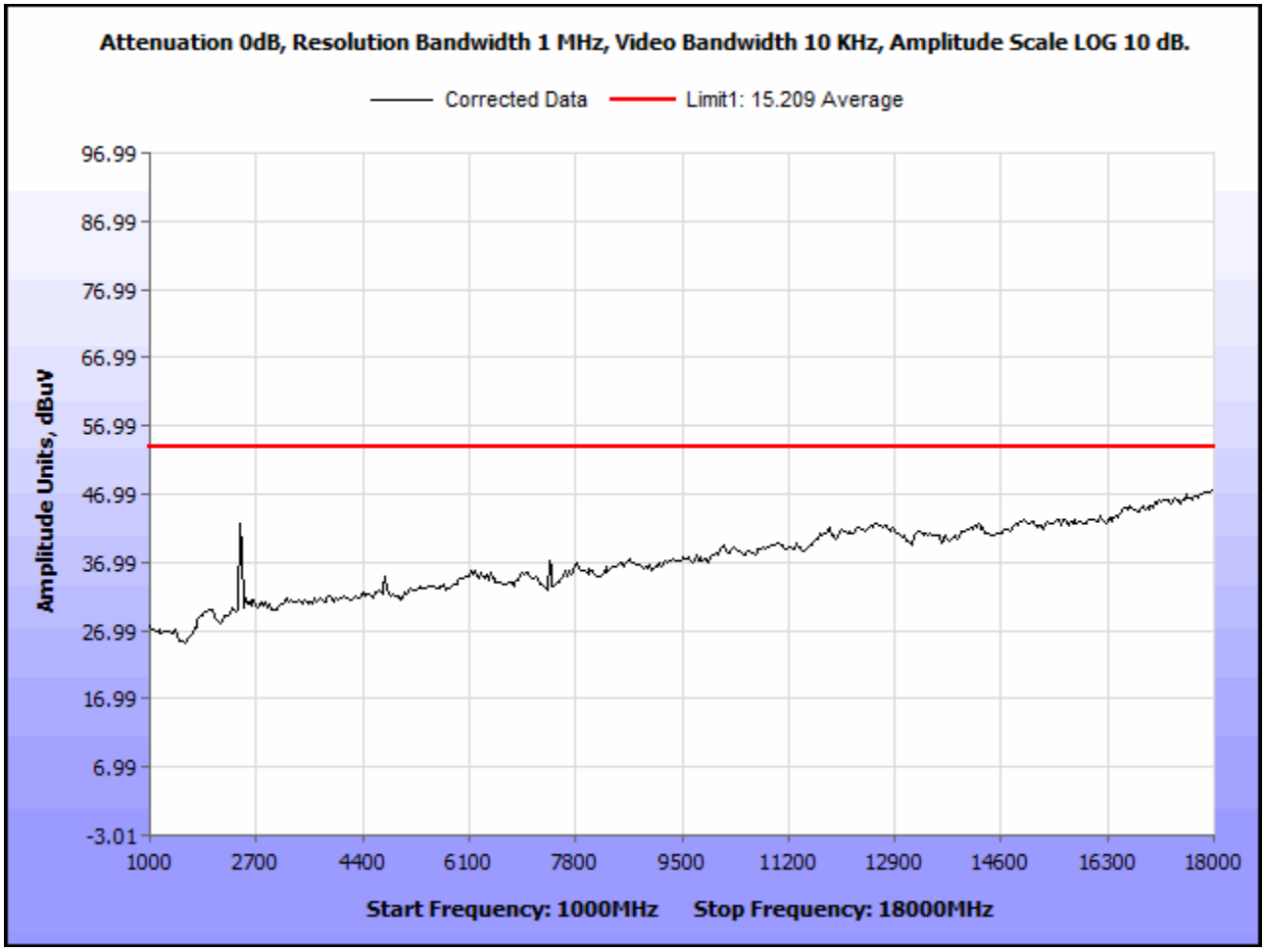
Plot 74. Radiated Spurious Emissions, b Mode, 1 GHz to 18 GHz, High Channel, Peak



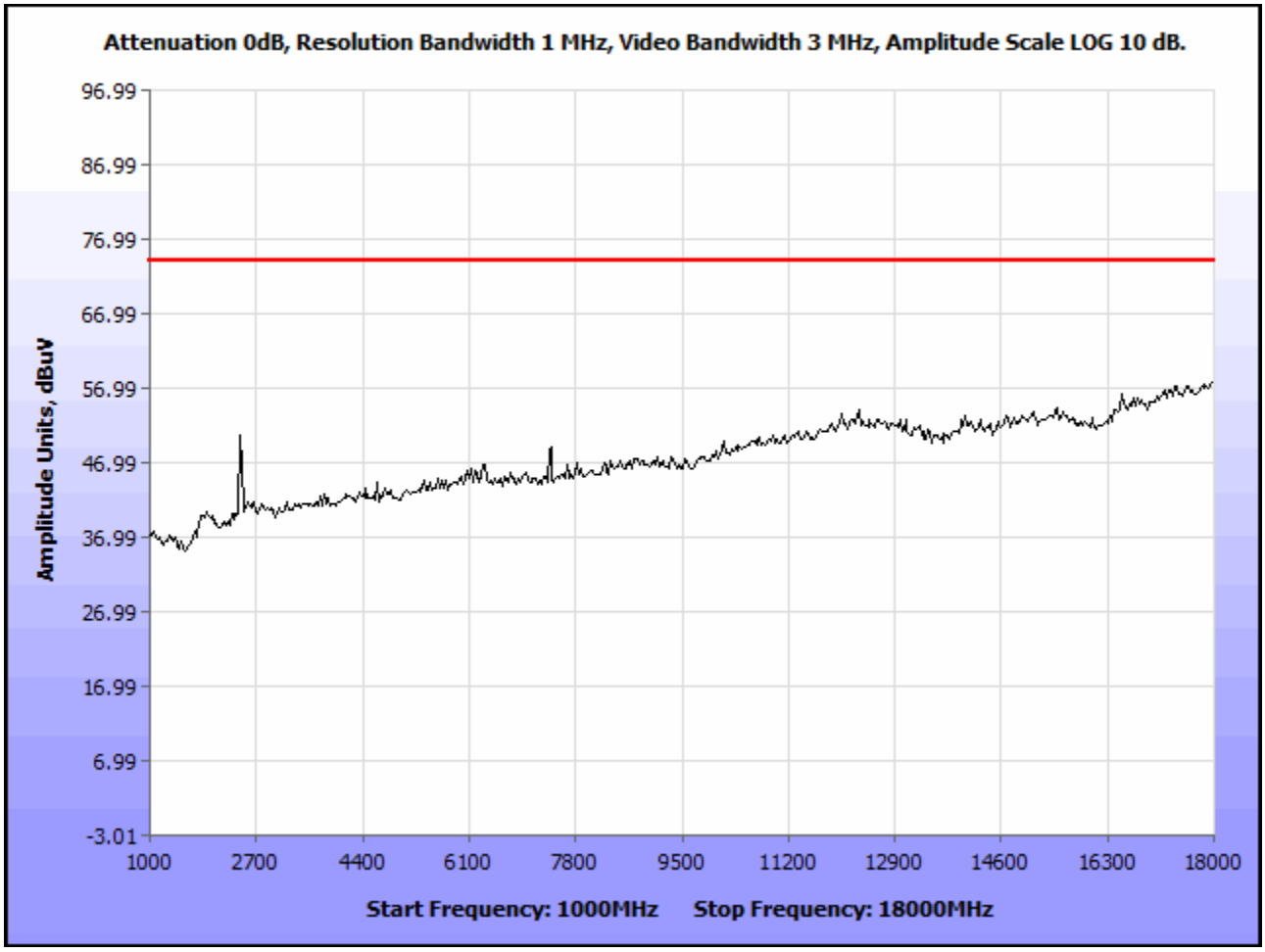
Plot 75. Radiated Spurious Emissions, g Mode, 1 GHz to 18 GHz, High Channel, Average



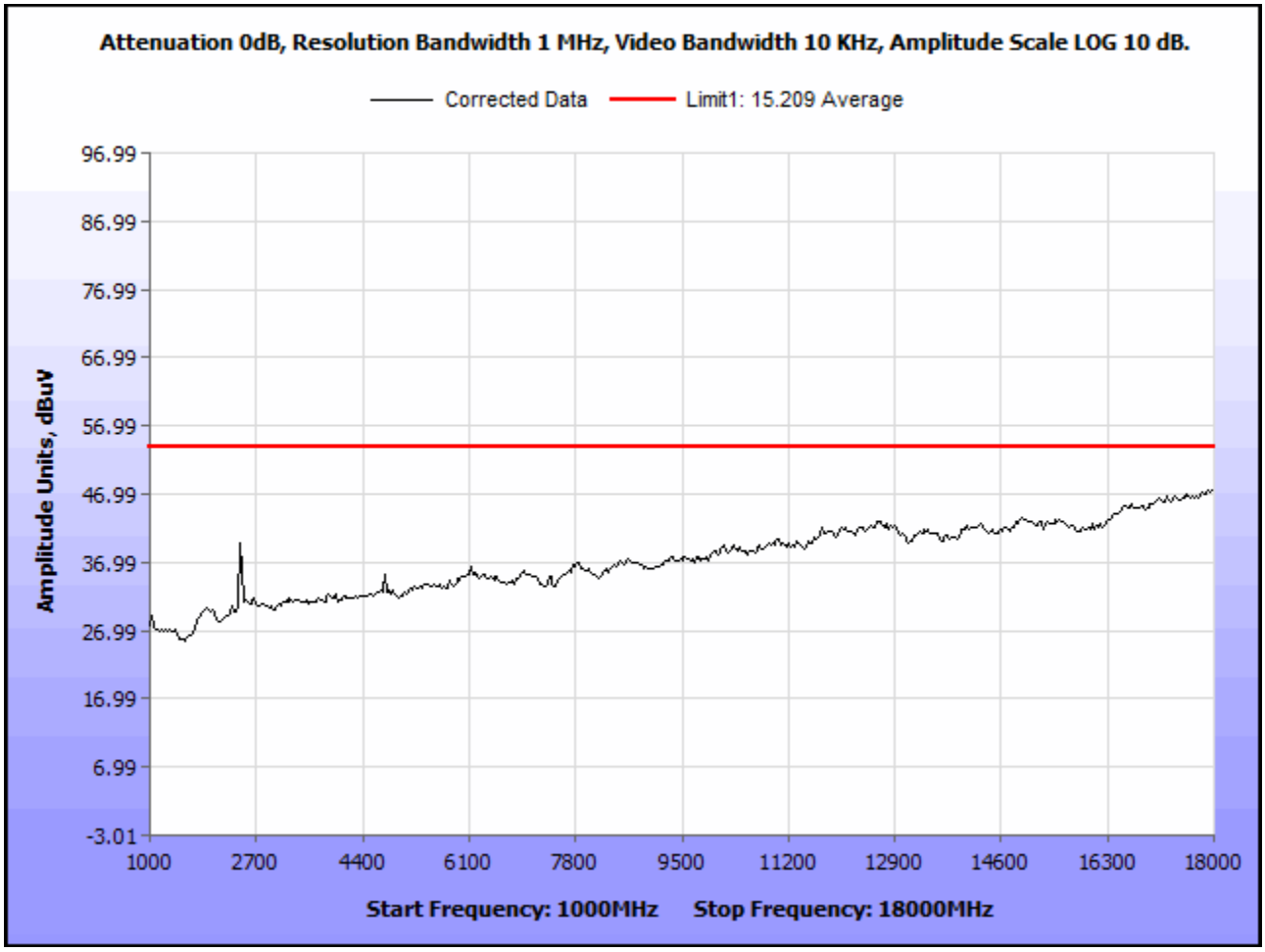
Plot 76. Radiated Spurious Emissions, g Mode, 1 GHz to 18 GHz, High Channel, Peak



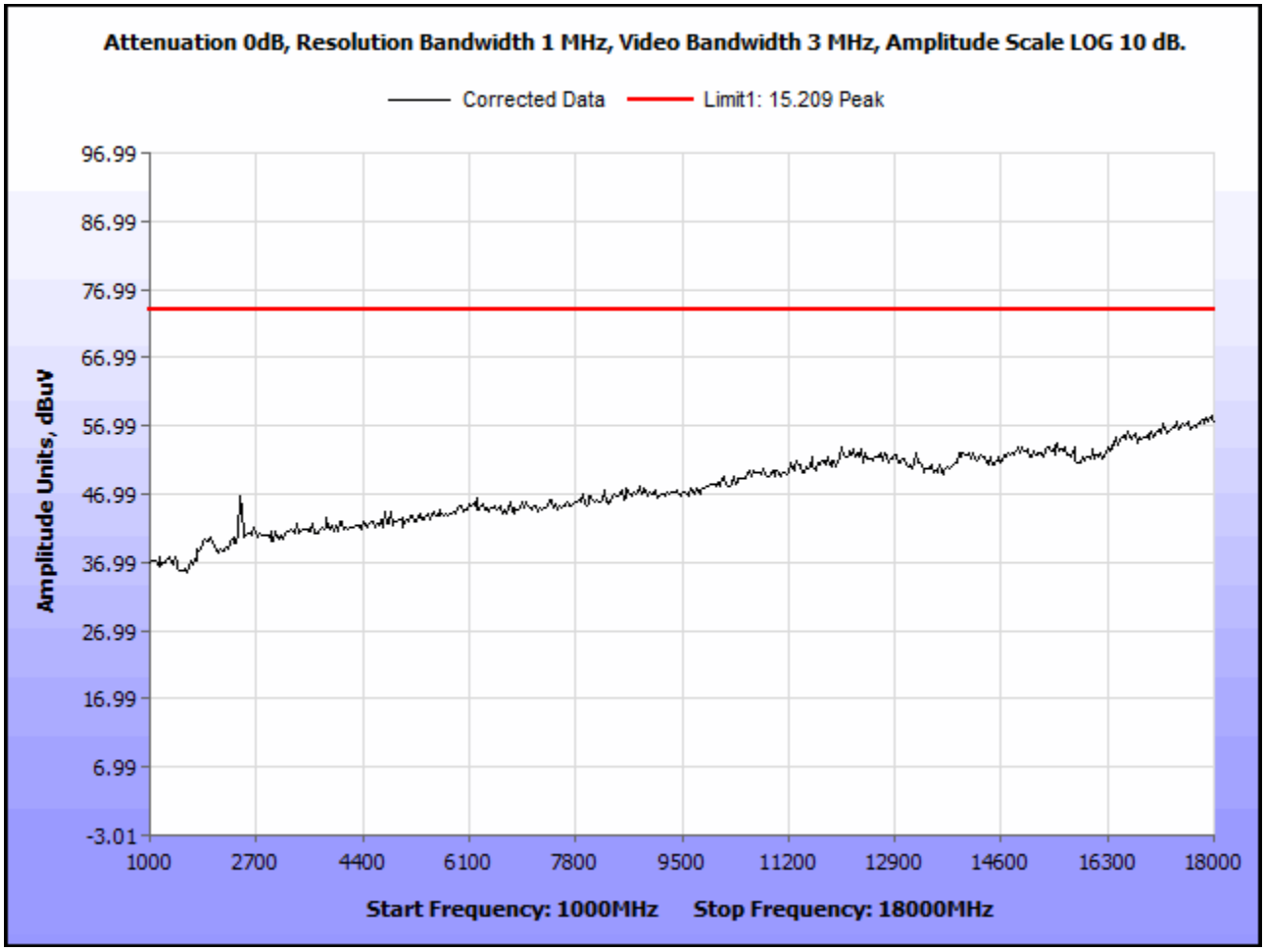
Plot 77. Radiated Spurious Emissions, n Mode, 1 GHz to 18 GHz, High Channel, Average



Plot 78. Radiated Spurious Emissions, n Mode, 1 GHz to 18 GHz, High Channel, Peak



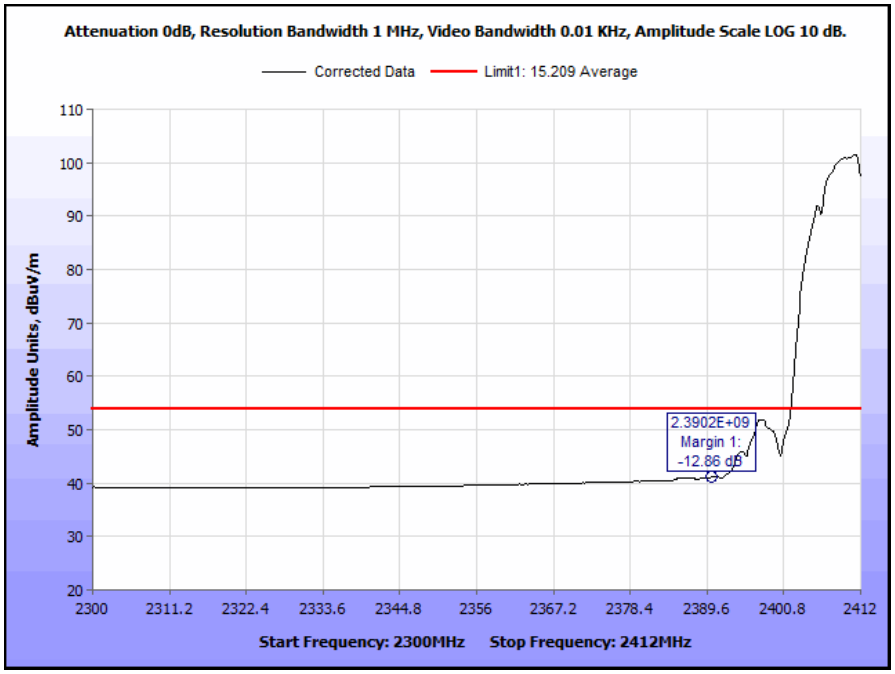
Plot 79. Radiated Spurious Emissions, n Mode, 40 MHz BW, 1 GHz to 18 GHz, High Channel, Average



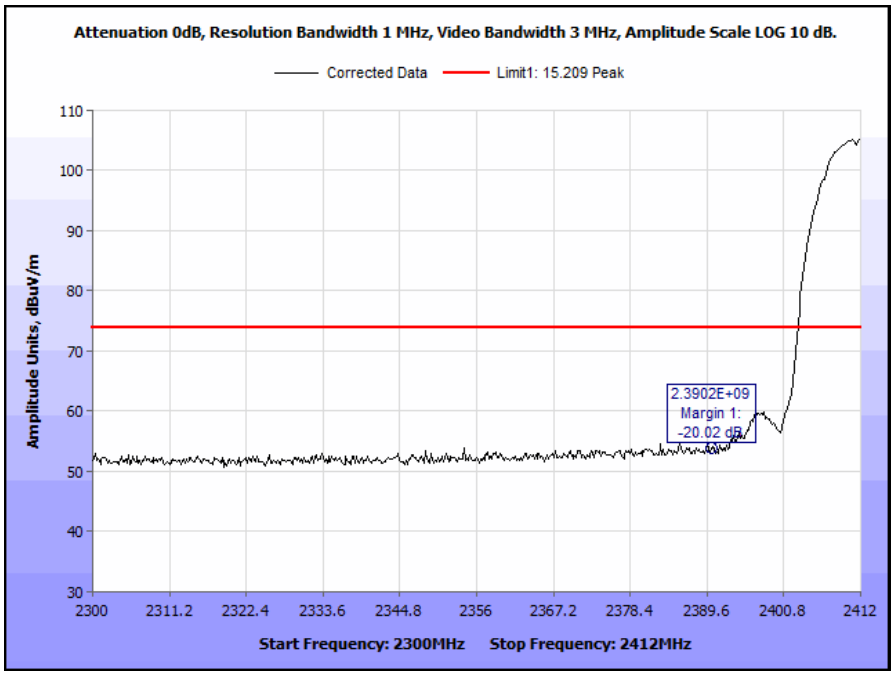
Plot 80. Radiated Spurious Emissions, n Mode, 40 MHz BW, 1 GHz to 18 GHz, High Channel, Peak

Radiated Band Edge Measurements

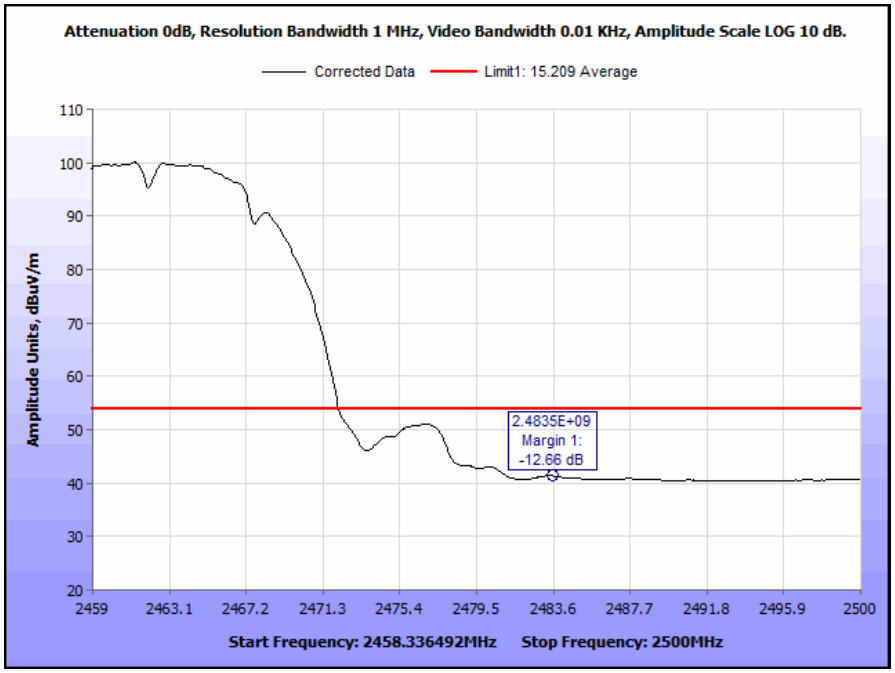
Test Procedures: The transmitter was turned on. Measurements were performed of the low and high Channels. The EUT was rotated orthogonally through all three axes. Plots shown are corrected for both antenna correction factor and distance and compared to a 3 m limit line.



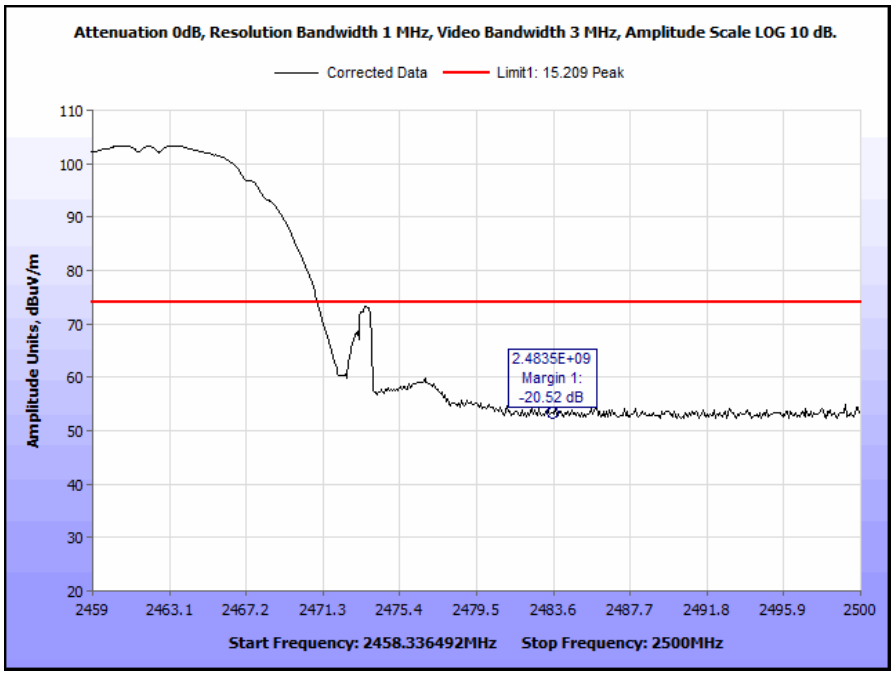
Plot 81. Radiated Restricted Band Edge, 802.11b 20 MHz, Low Channel, Average



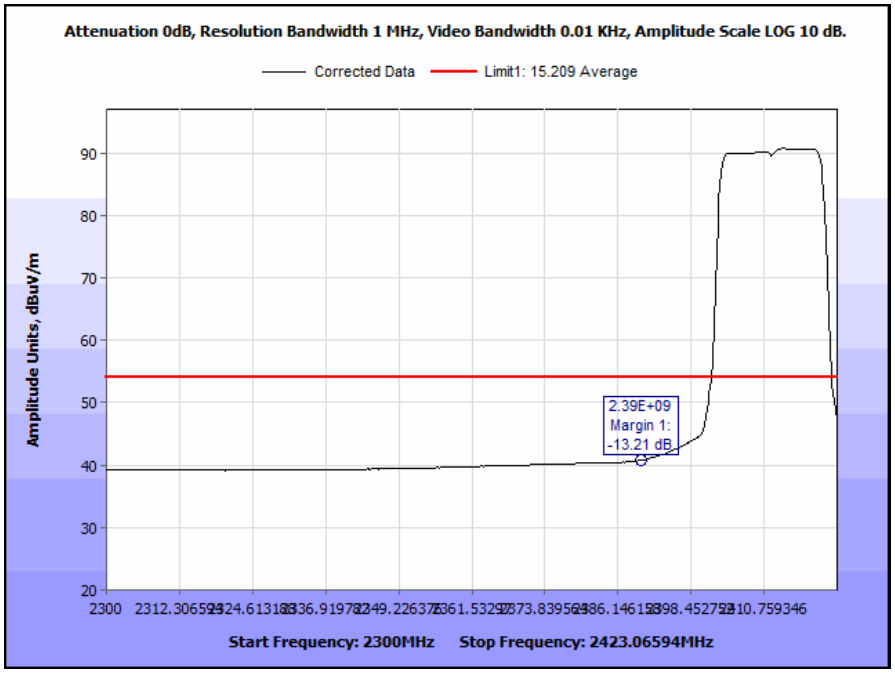
Plot 82. Radiated Restricted Band Edge, 802.11b 20 MHz, Low Channel, Peak



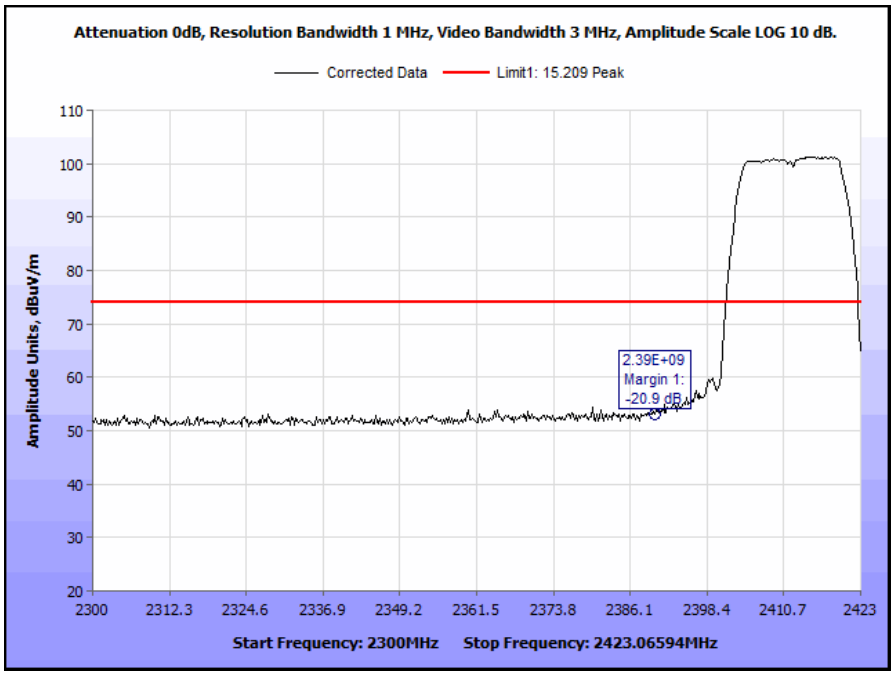
Plot 83. Radiated Restricted Band Edge, 802.11b 20 MHz, High Channel, Average



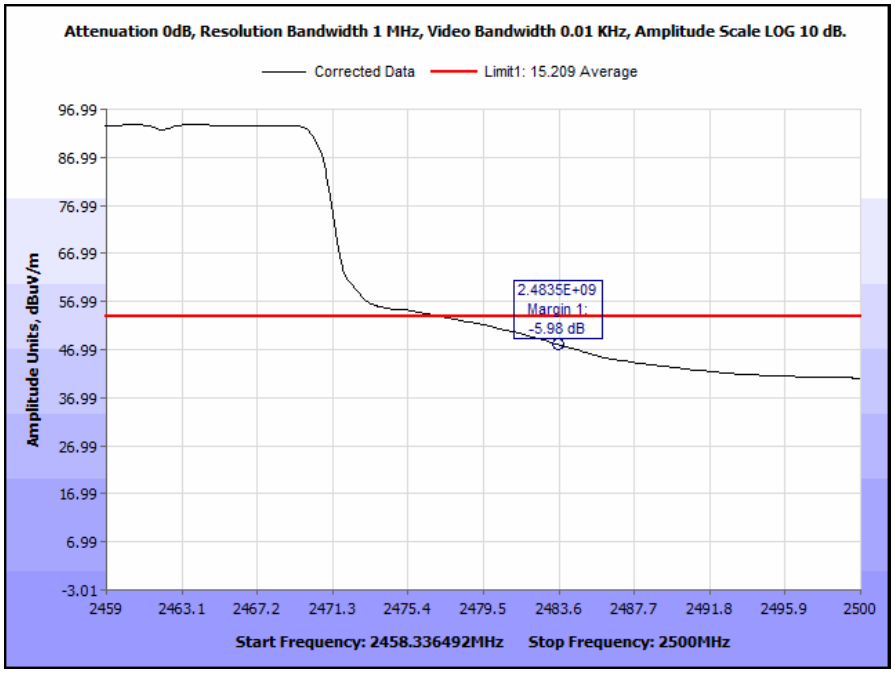
Plot 84. Radiated Restricted Band Edge, 802.11b 20 MHz, High Channel, Peak



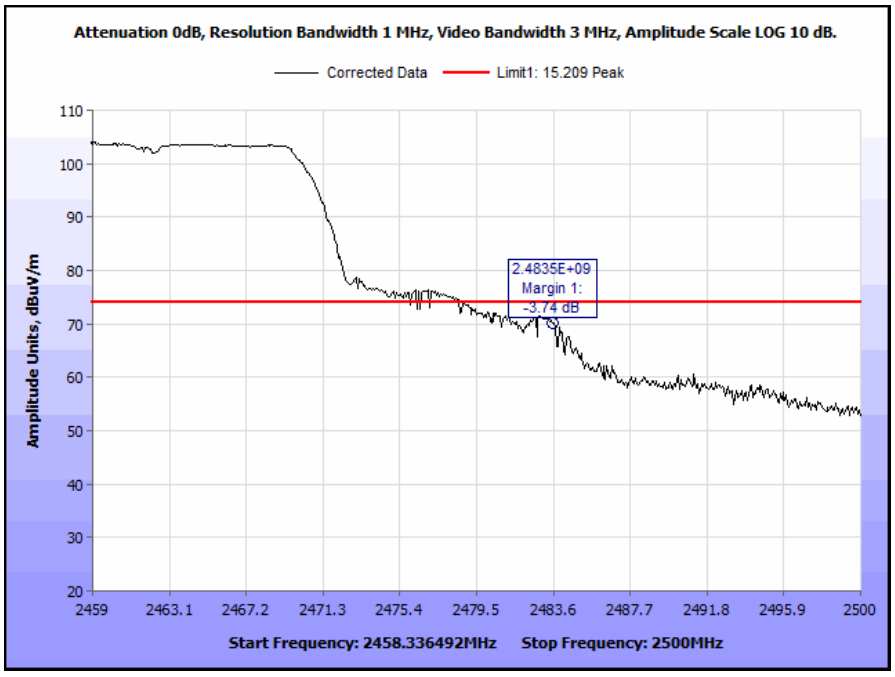
Plot 85. Radiated Restricted Band Edge, 802.11g 20 MHz, Low Channel, Average



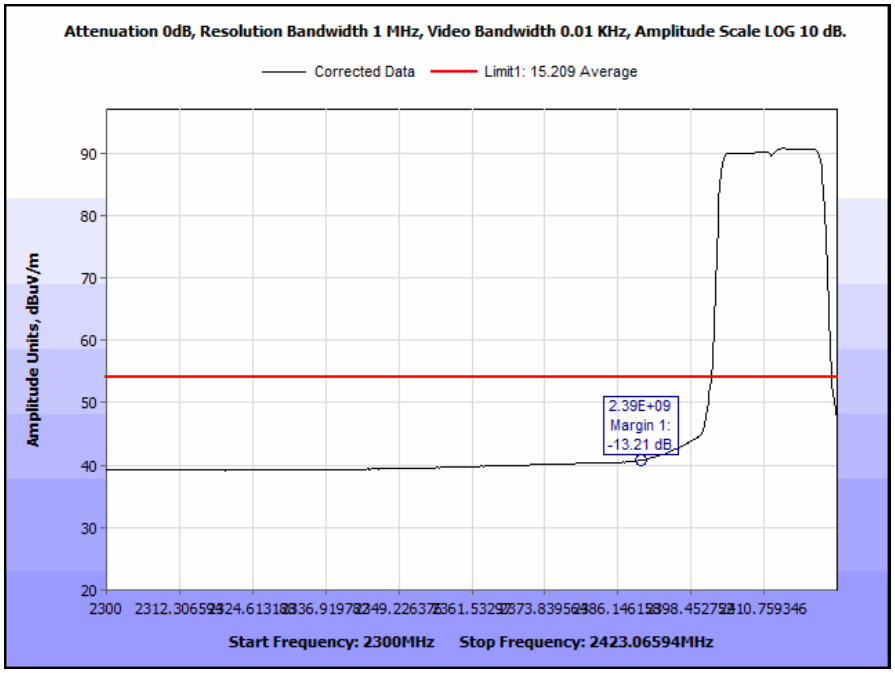
Plot 86. Radiated Restricted Band Edge, 802.11g 20 MHz, Low Channel, Peak



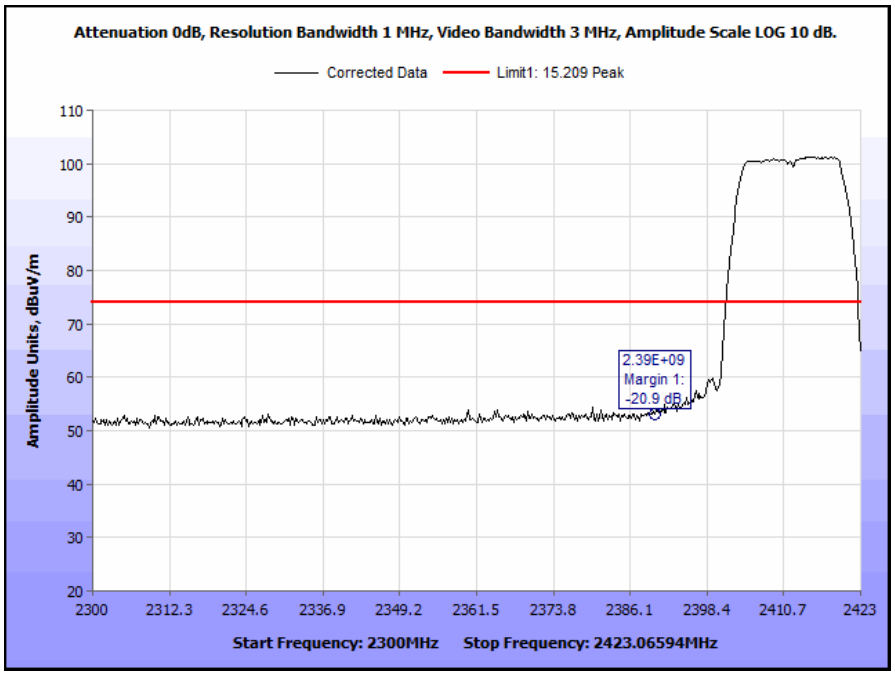
Plot 87. Radiated Restricted Band Edge, 802.11g 20 MHz, High Channel, Average



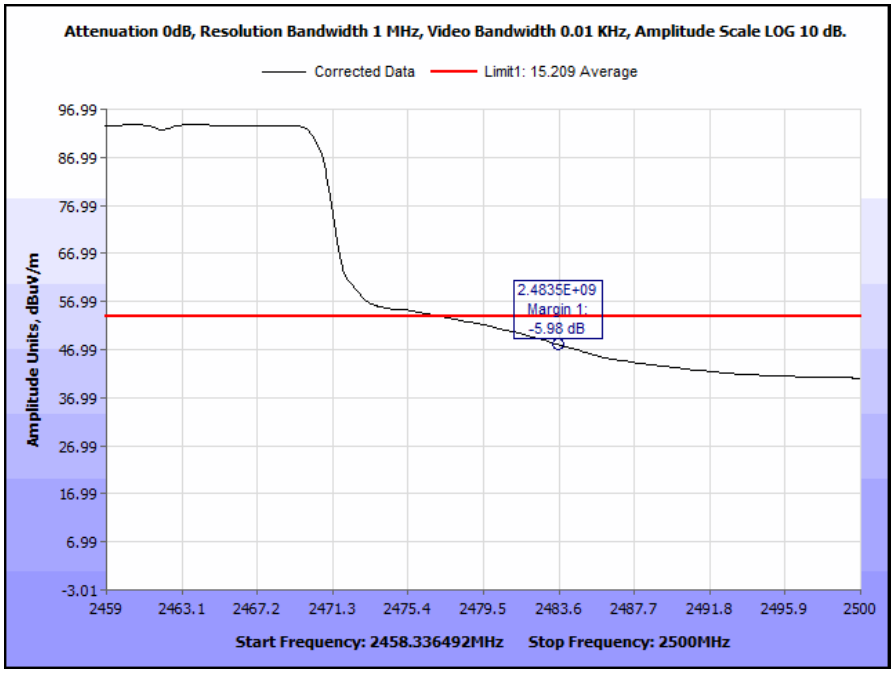
Plot 88. Radiated Restricted Band Edge, 802.11g 20 MHz, High Channel, Peak



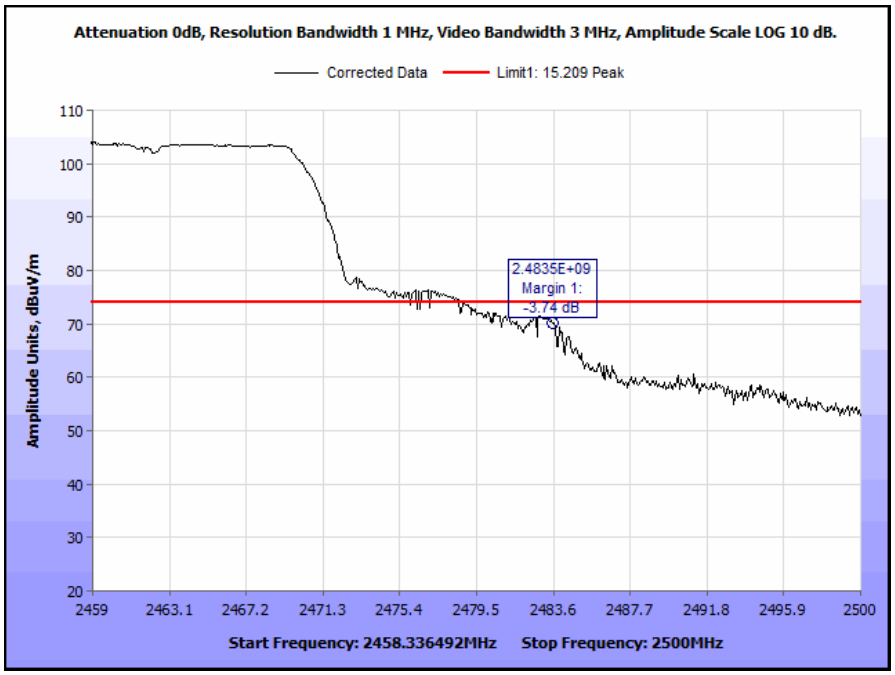
Plot 89. Radiated Restricted Band Edge, 802.11g 20 MHz, Low Channel, Average



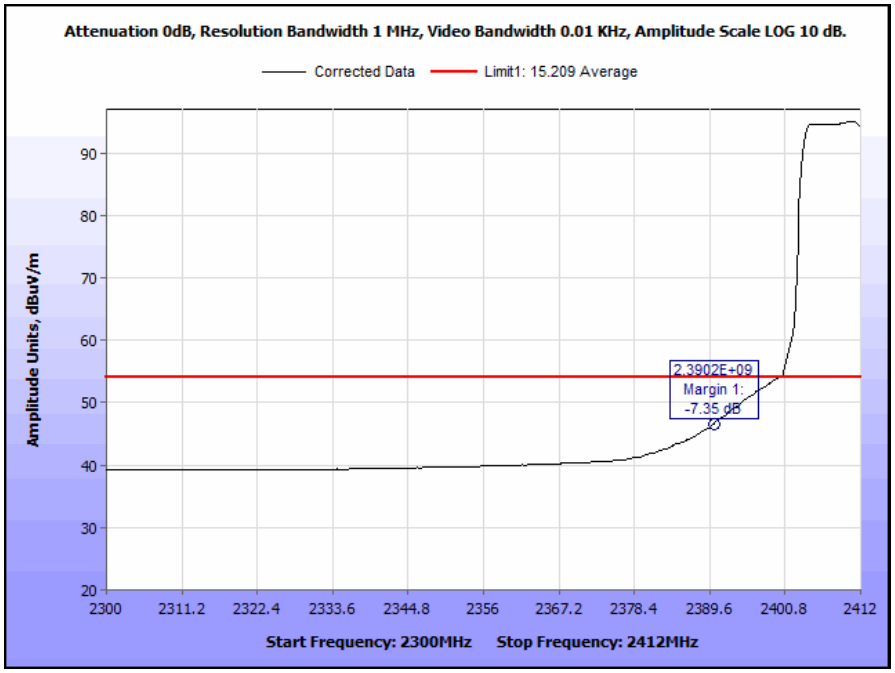
Plot 90. Radiated Restricted Band Edge, 802.11g 20 MHz, Low Channel, Peak



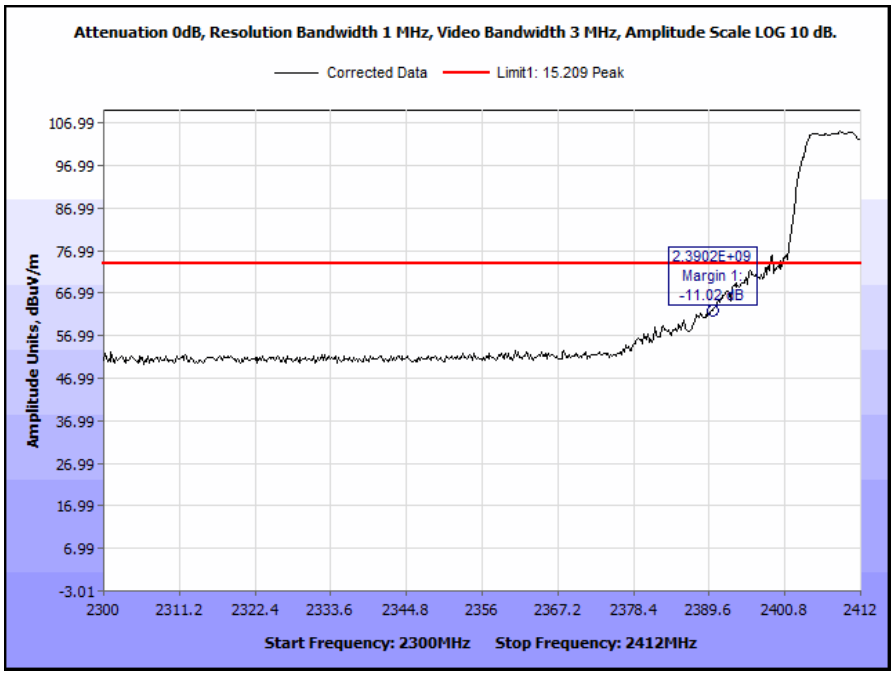
Plot 91. Radiated Restricted Band Edge, 802.11g 20 MHz, High Channel, Average



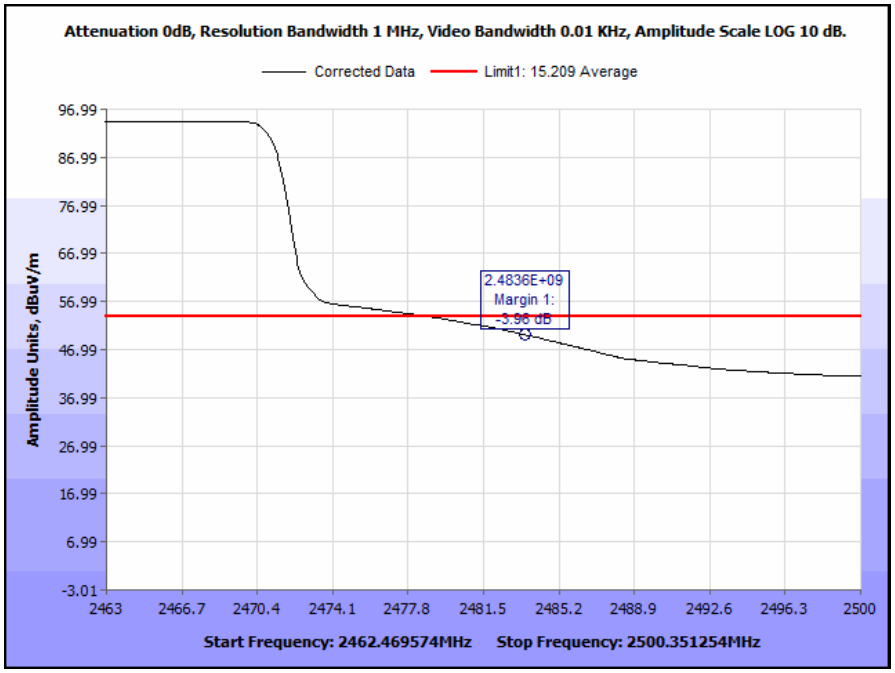
Plot 92. Radiated Restricted Band Edge, 802.11g 20 MHz, High Channel, Peak



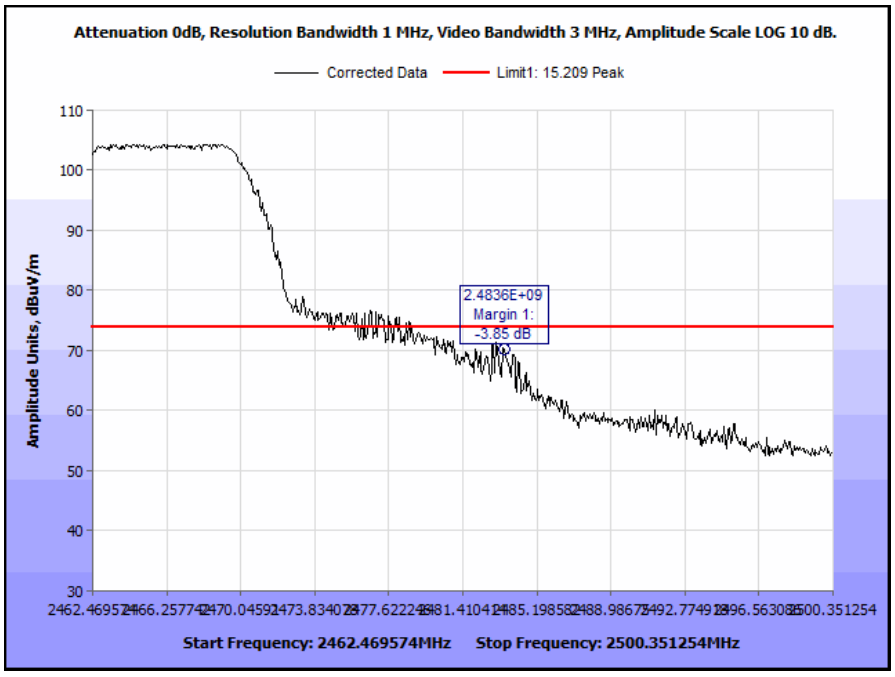
Plot 93. Radiated Restricted Band Edge, 802.11n 20 MHz, Low Channel, Average



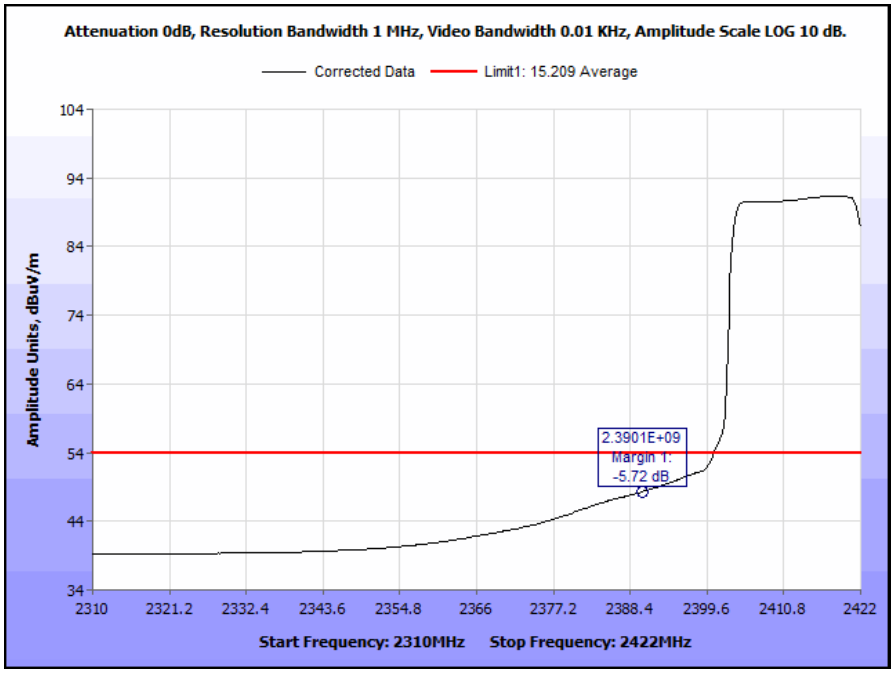
Plot 94. Radiated Restricted Band Edge, 802.11n 20 MHz, Low Channel, Peak



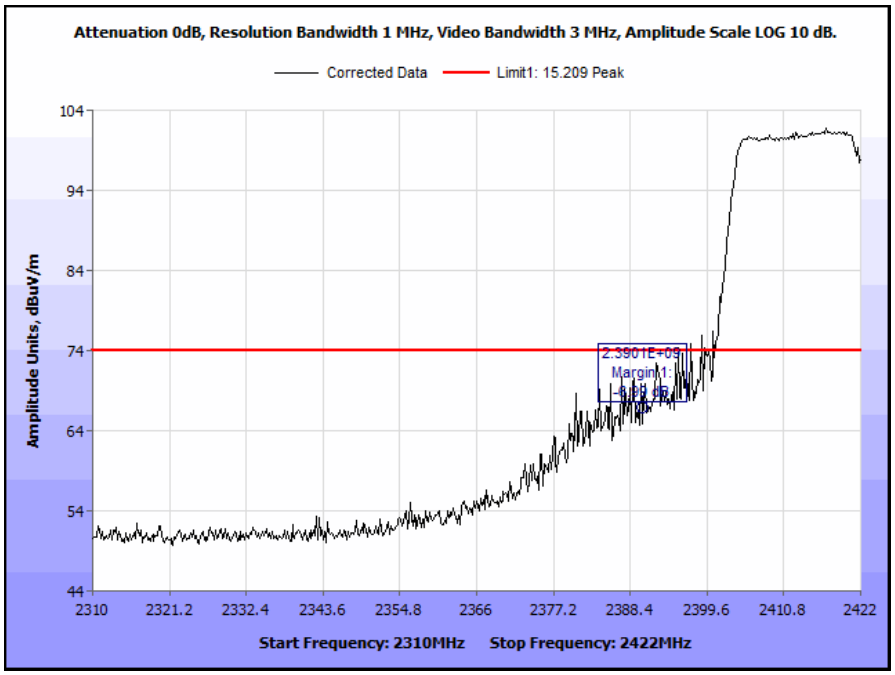
Plot 95. Radiated Restricted Band Edge, 802.11n 20 MHz, High Channel, Average



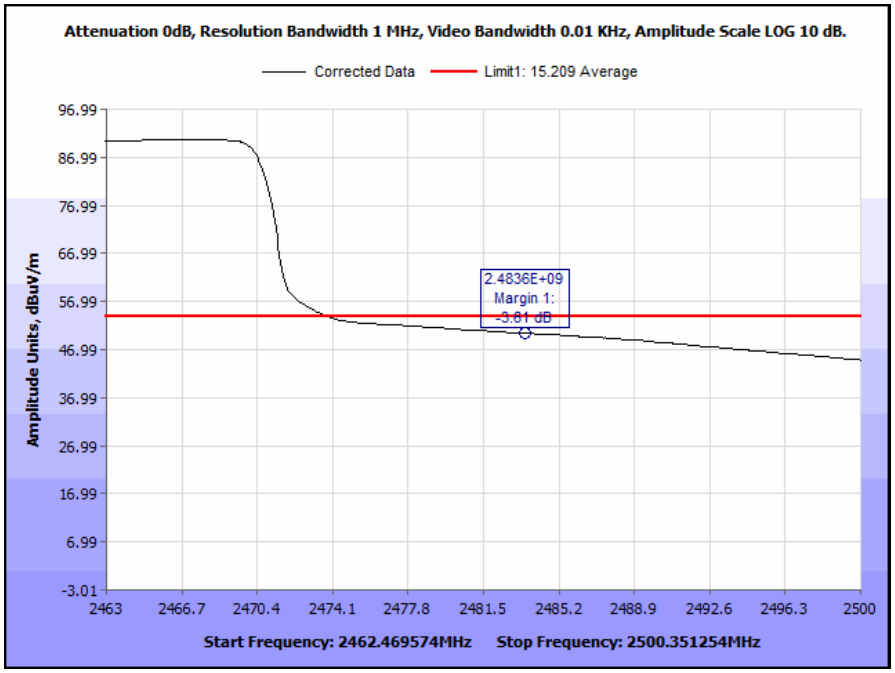
Plot 96. Radiated Restricted Band Edge, 802.11n 20 MHz, High Channel, Peak



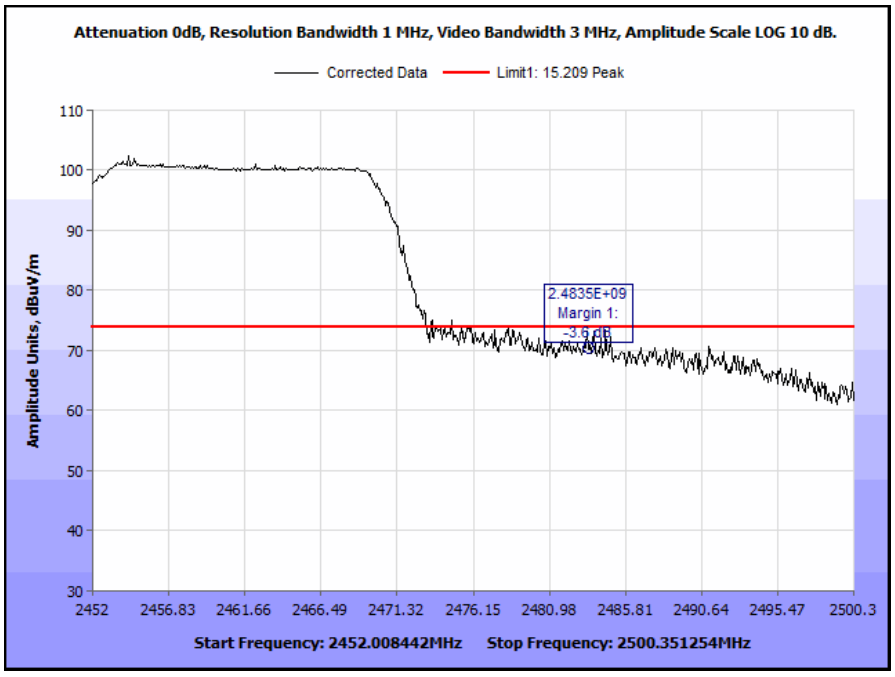
Plot 97. Radiated Restricted Band Edge, 802.11n 40 MHz, Low Channel, Average



Plot 98. Radiated Restricted Band Edge, 802.11n 40 MHz, Low Channel, Peak



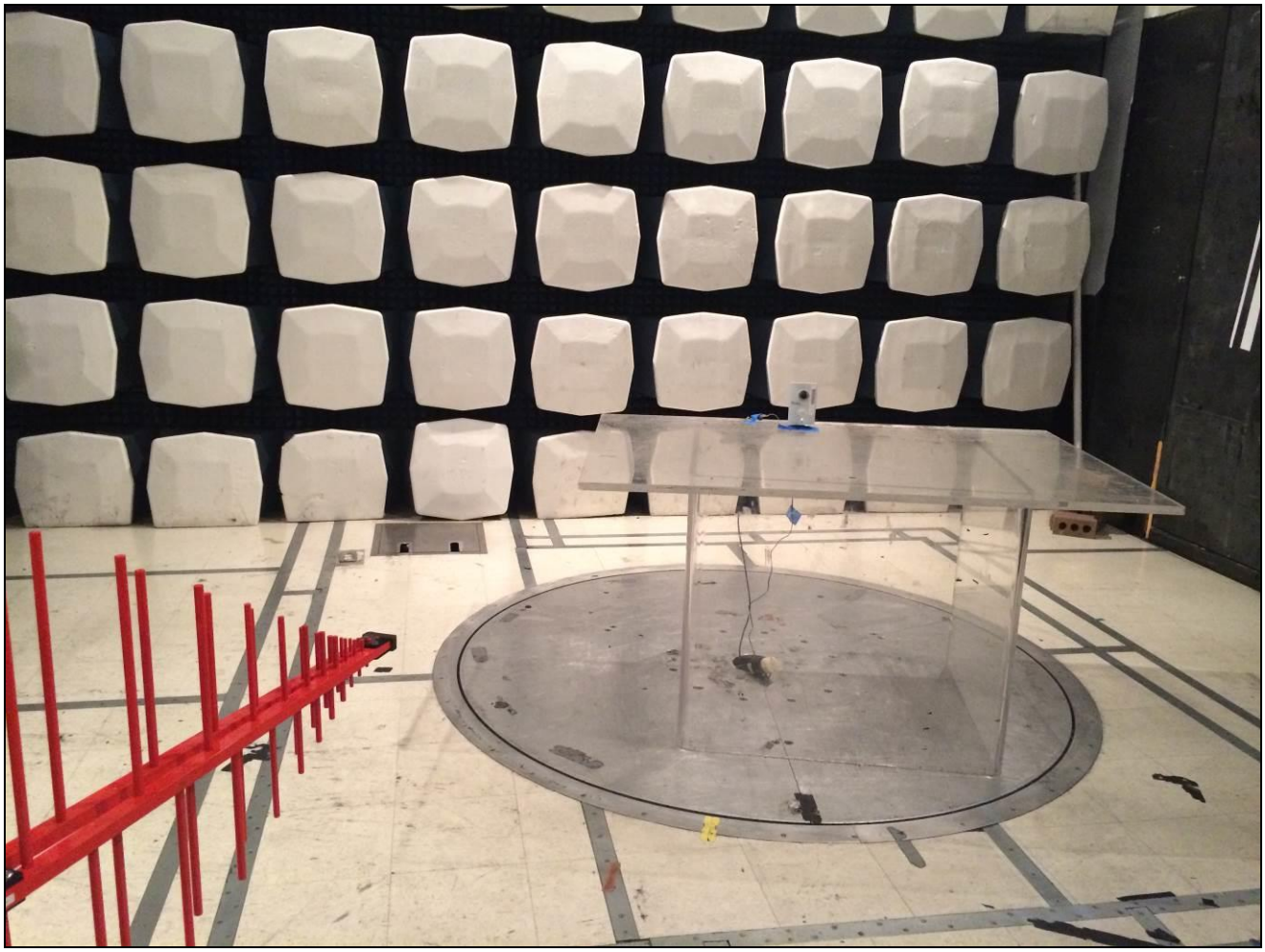
Plot 99. Radiated Restricted Band Edge, 802.11n 40 MHz, High Channel, Average



Plot 100. Radiated Restricted Band Edge, 802.11n 40 MHz, High Channel, Peak

Radiated Spurious Emissions Test Setup

Photograph 4. Radiated Spurious Emissions, Test Setup, 1



Photograph 5. Radiated Spurious Emissions, Test Setup, 2

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.

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 below applicable limits.

Test Engineer(s): Djed Mouada

Test Date(s): 10/09/2014 – 10/14/2014

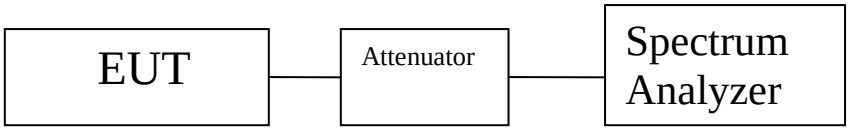
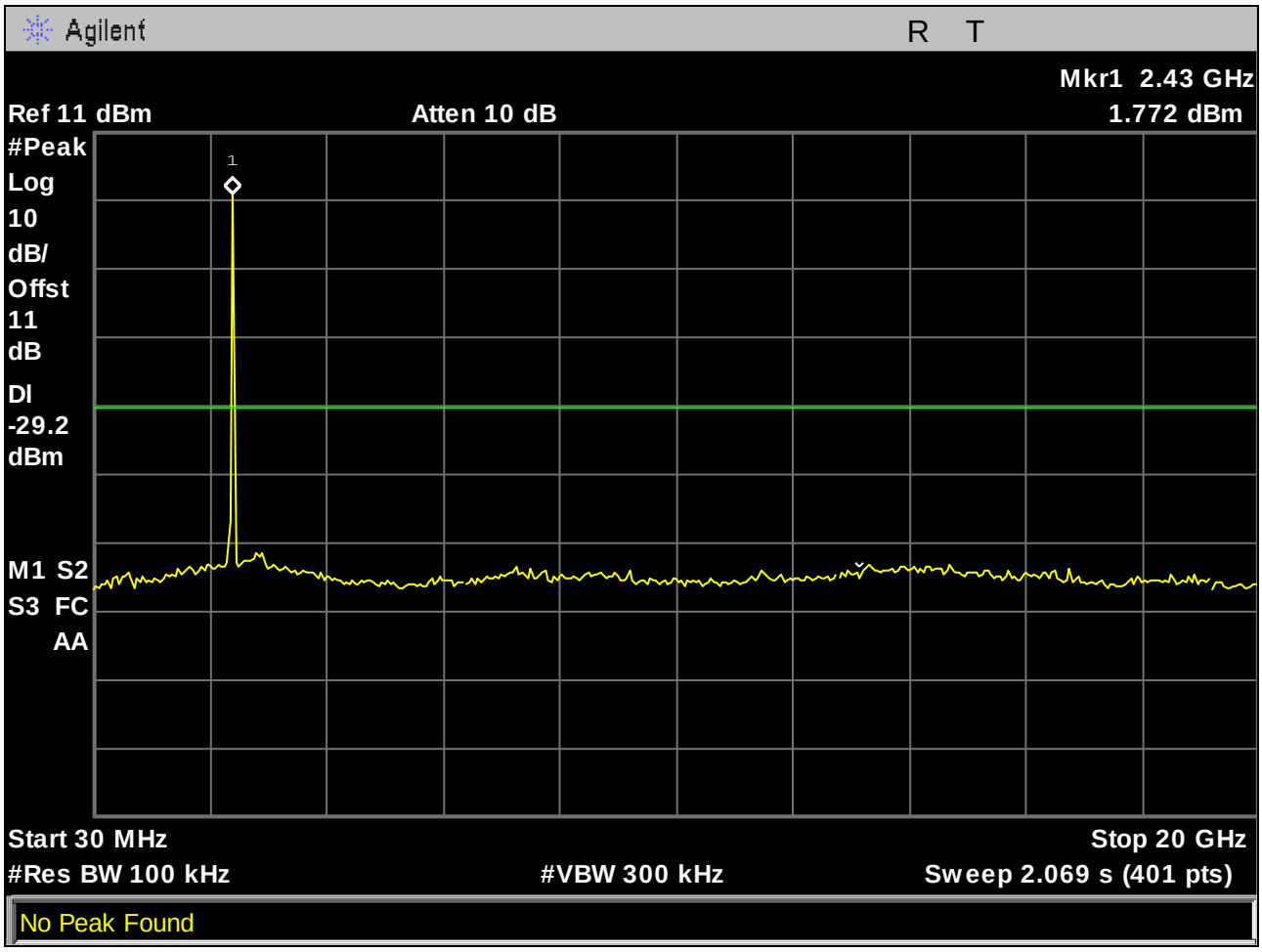
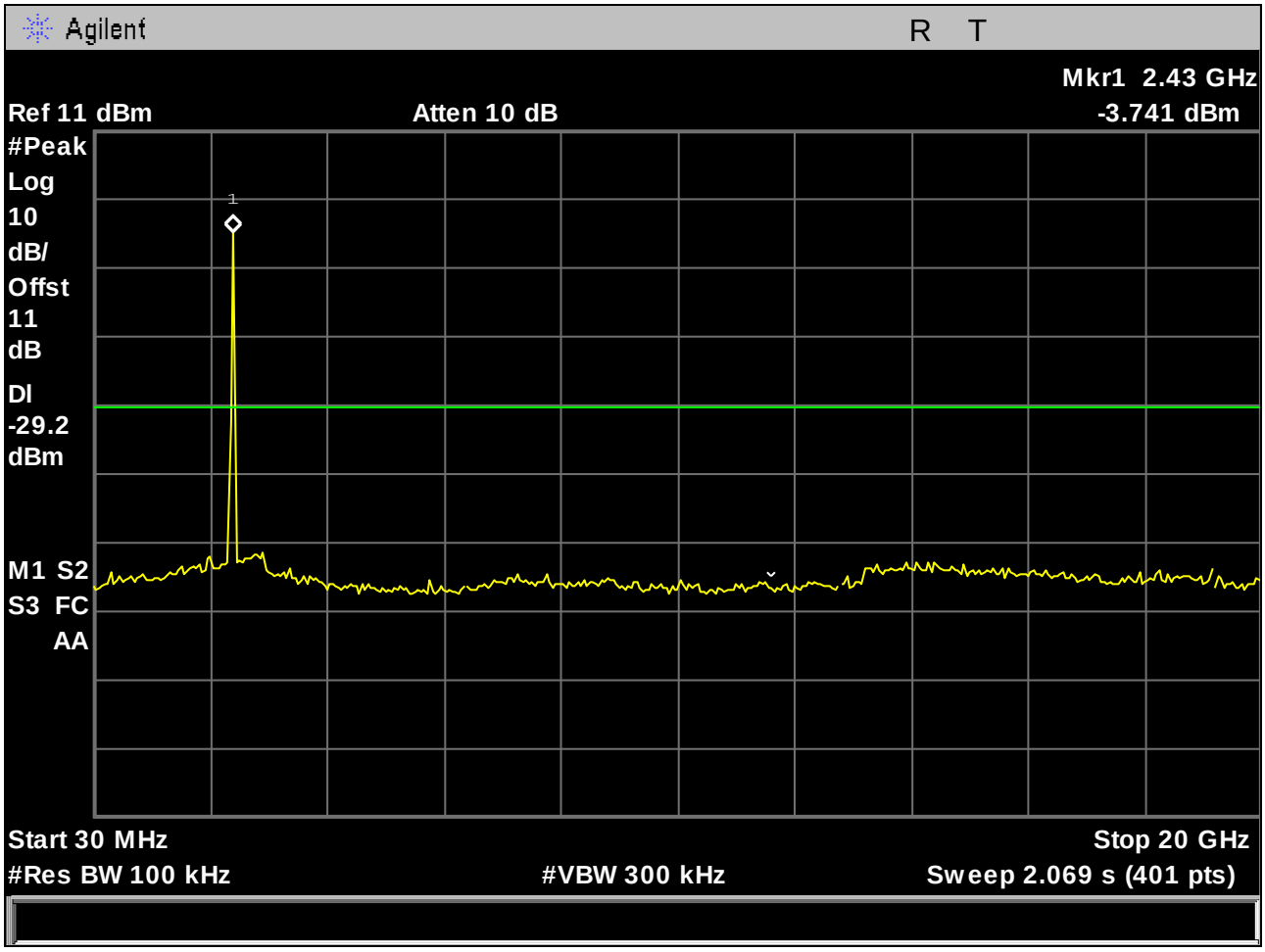


Figure 4. Block Diagram, Conducted Spurious Emissions Test Setup

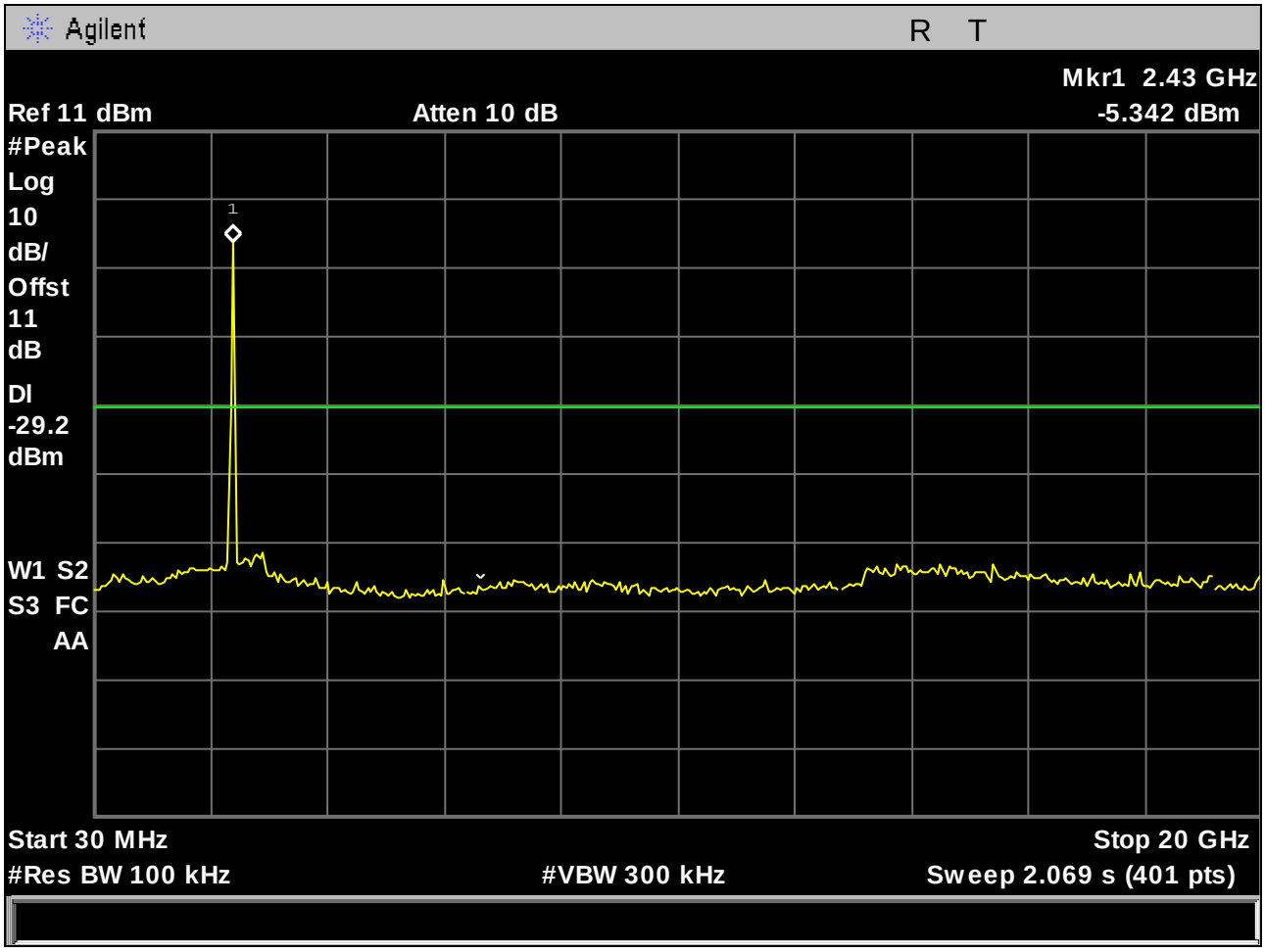
Conducted Spurious Emissions Test Results



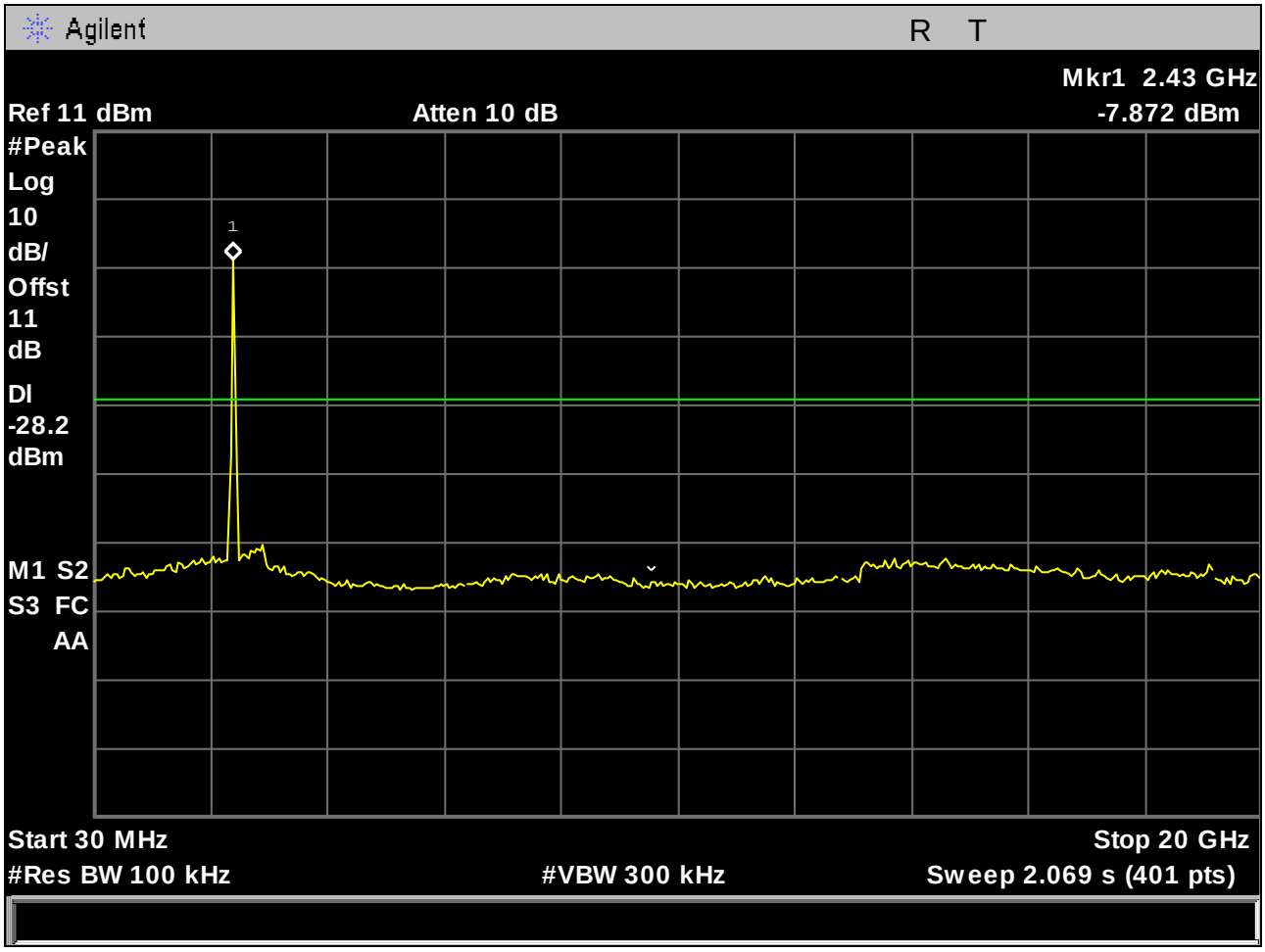
Plot 101. Conducted Spurious Emissions, b Mode, 20 MHz, Low Channel



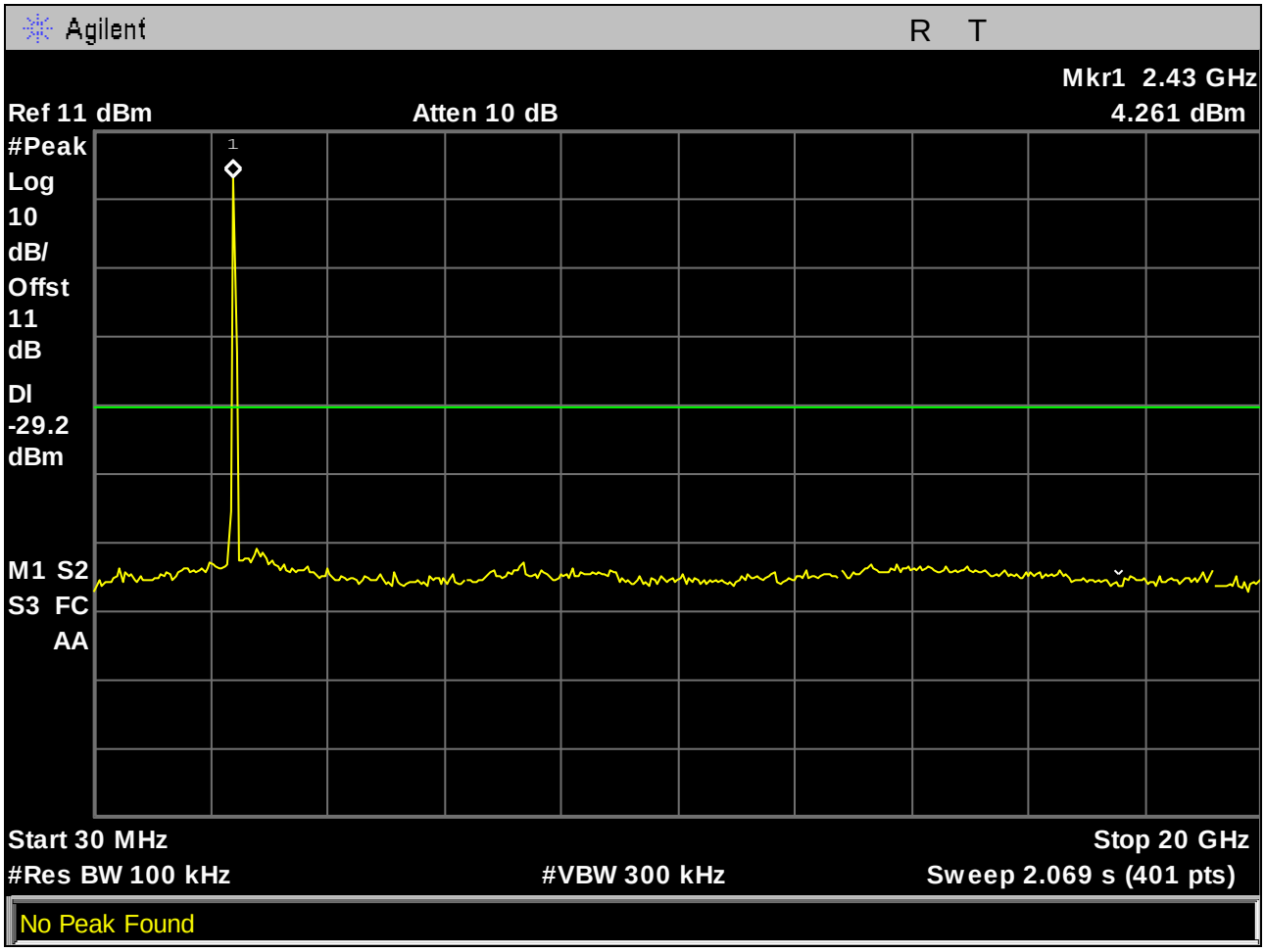
Plot 102. Conducted Spurious Emissions, g Mode, 20 MHz, Low Channel



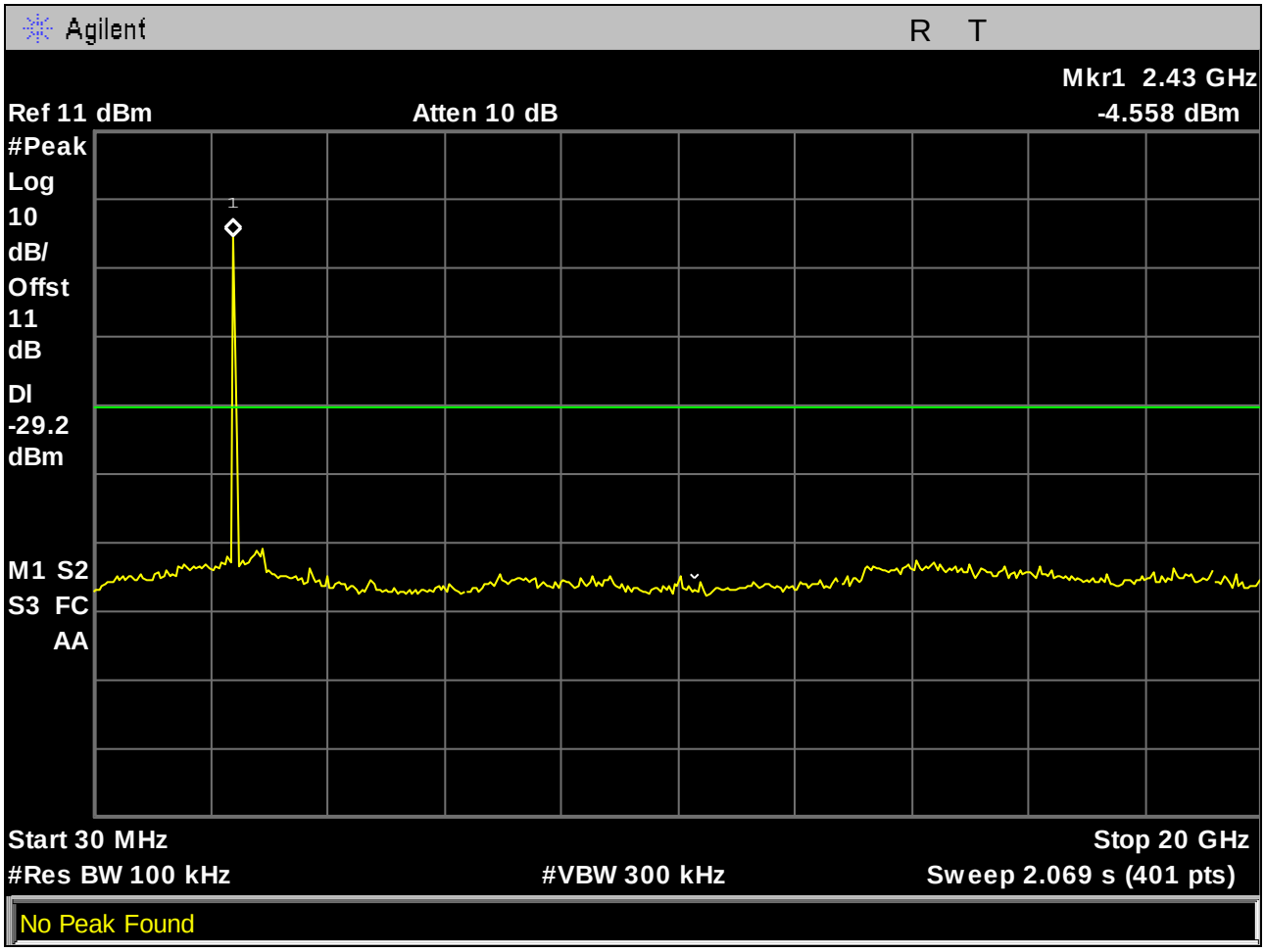
Plot 103. Conducted Spurious Emissions, n Mode, 20 MHz, Low Channel



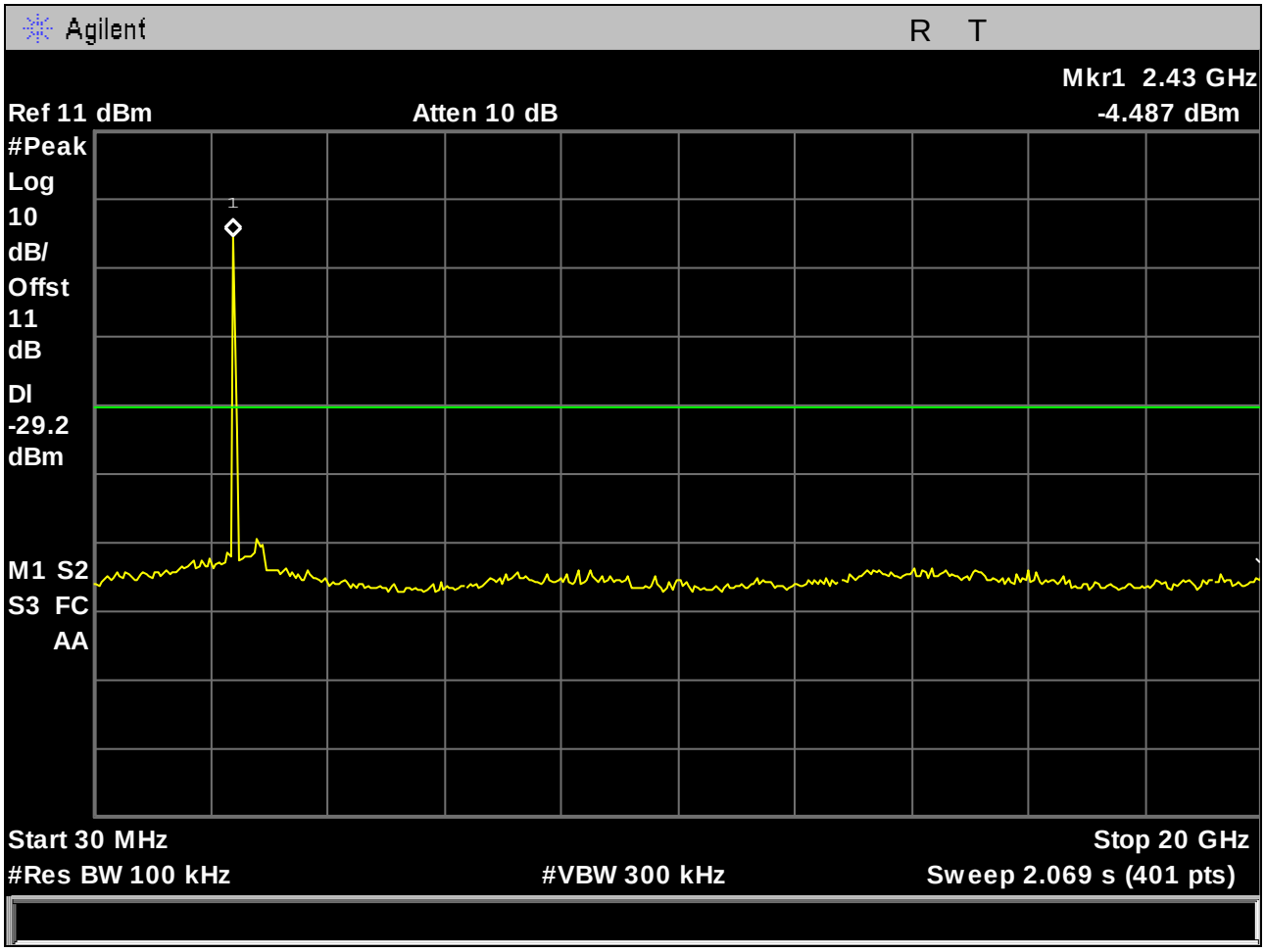
Plot 104. Conducted Spurious Emissions, n Mode, 40 MHz, Low Channel



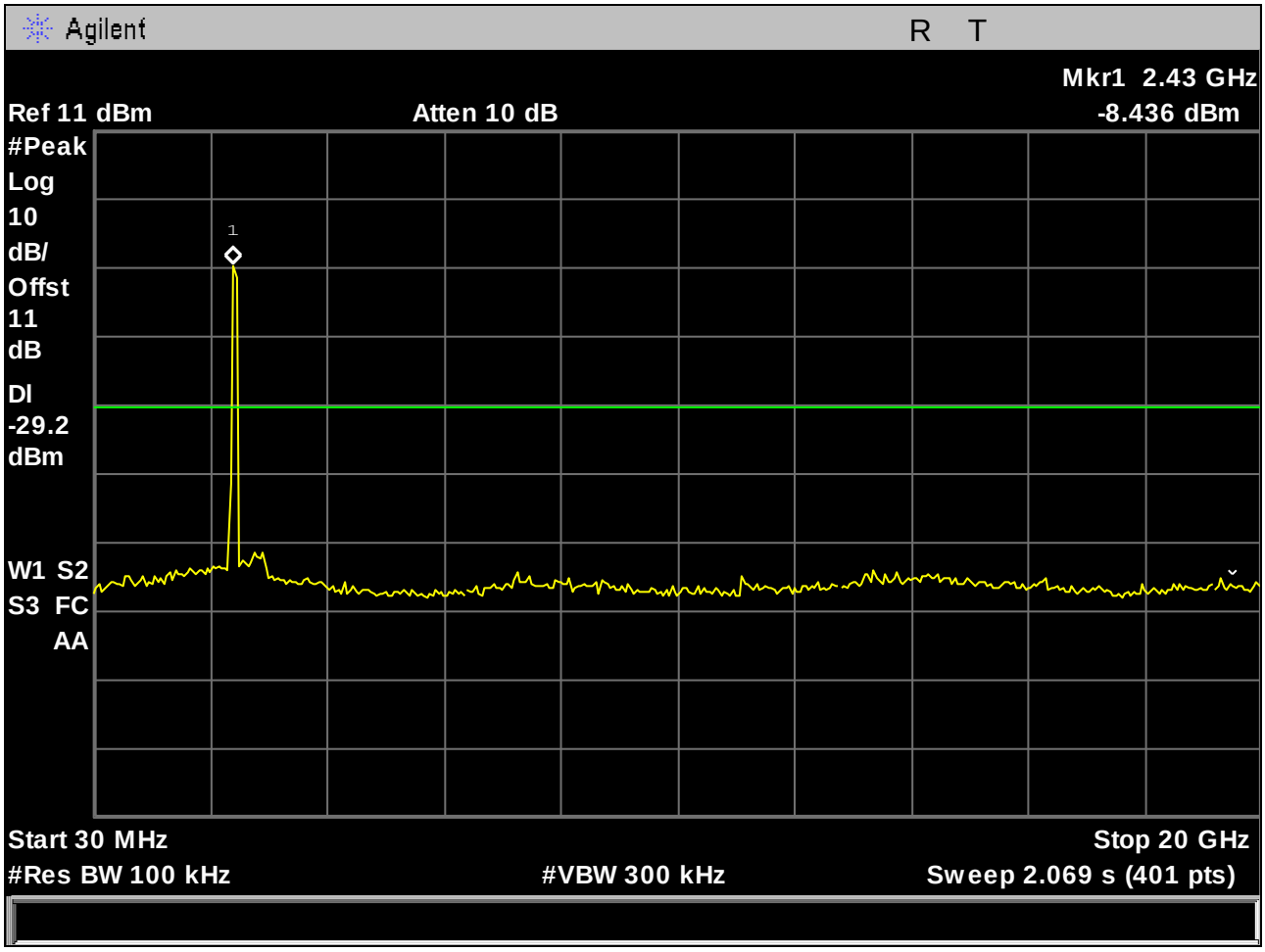
Plot 105. Conducted Spurious Emissions, b Mode, 20 MHz, Mid Channel



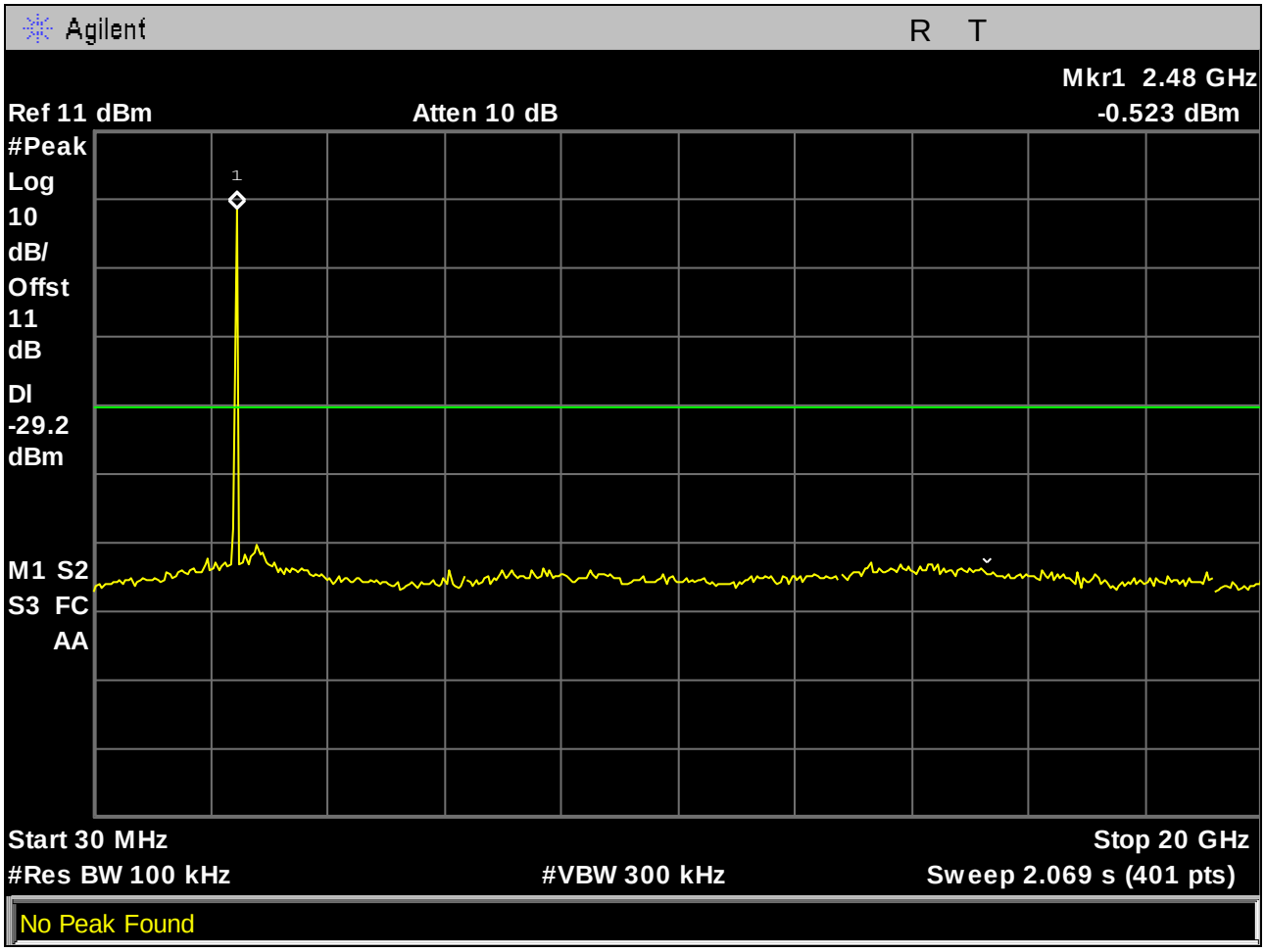
Plot 106. Conducted Spurious Emissions, g Mode, 20 MHz, Mid Channel



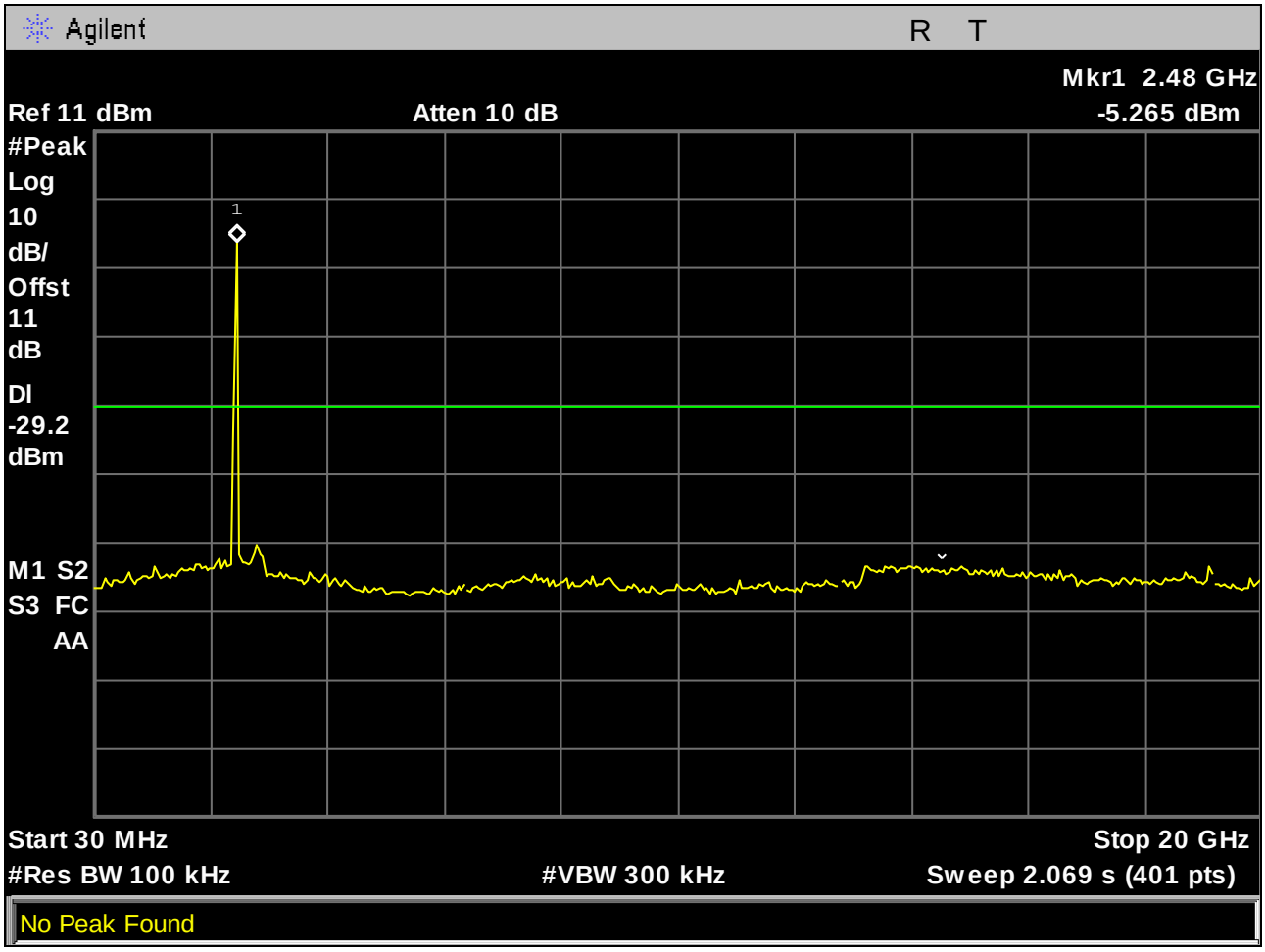
Plot 107. Conducted Spurious Emissions, n Mode, 20 MHz, Mid Channel



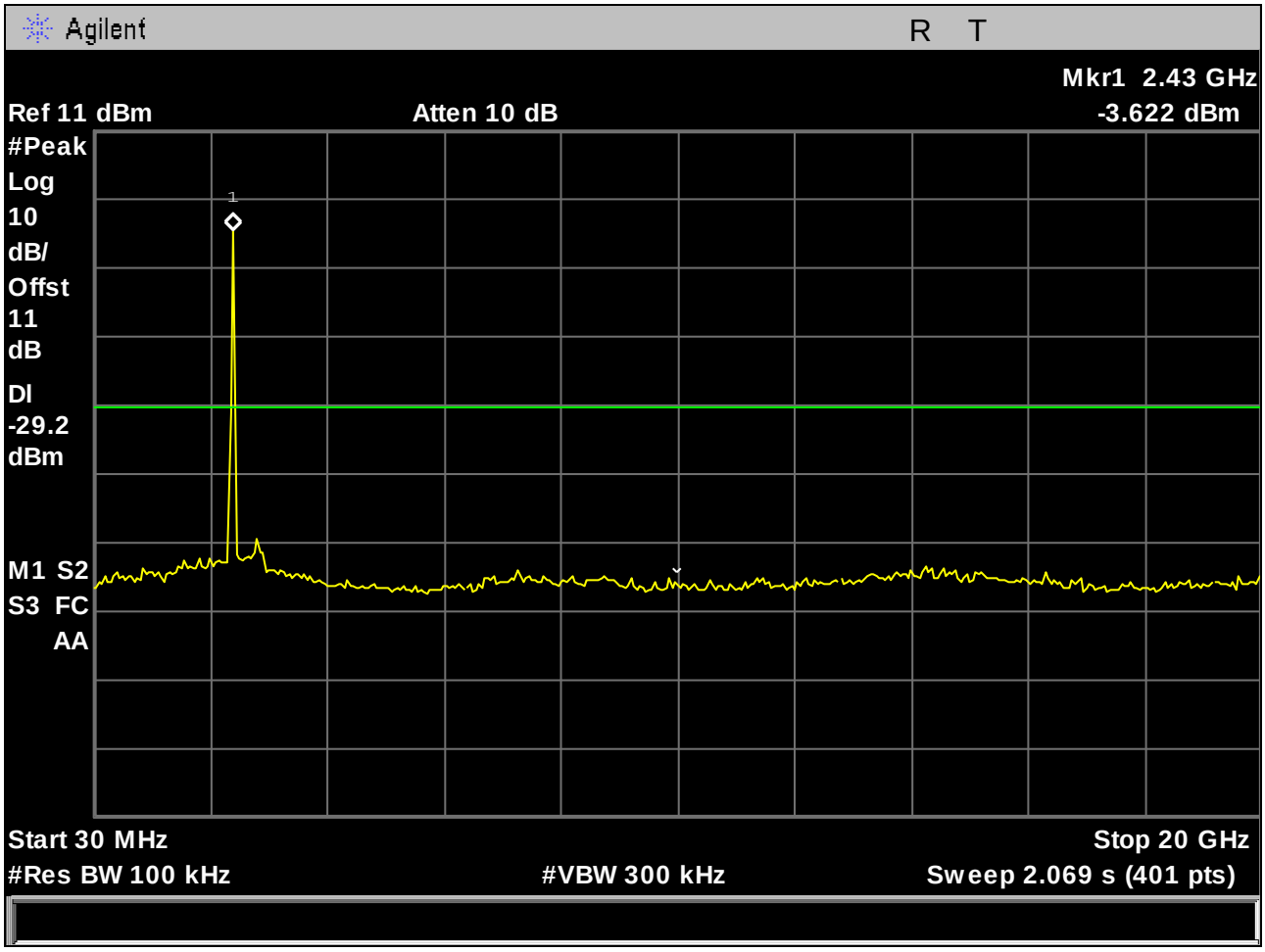
Plot 108. Conducted Spurious Emissions, n Mode, 40 MHz, Mid Channel



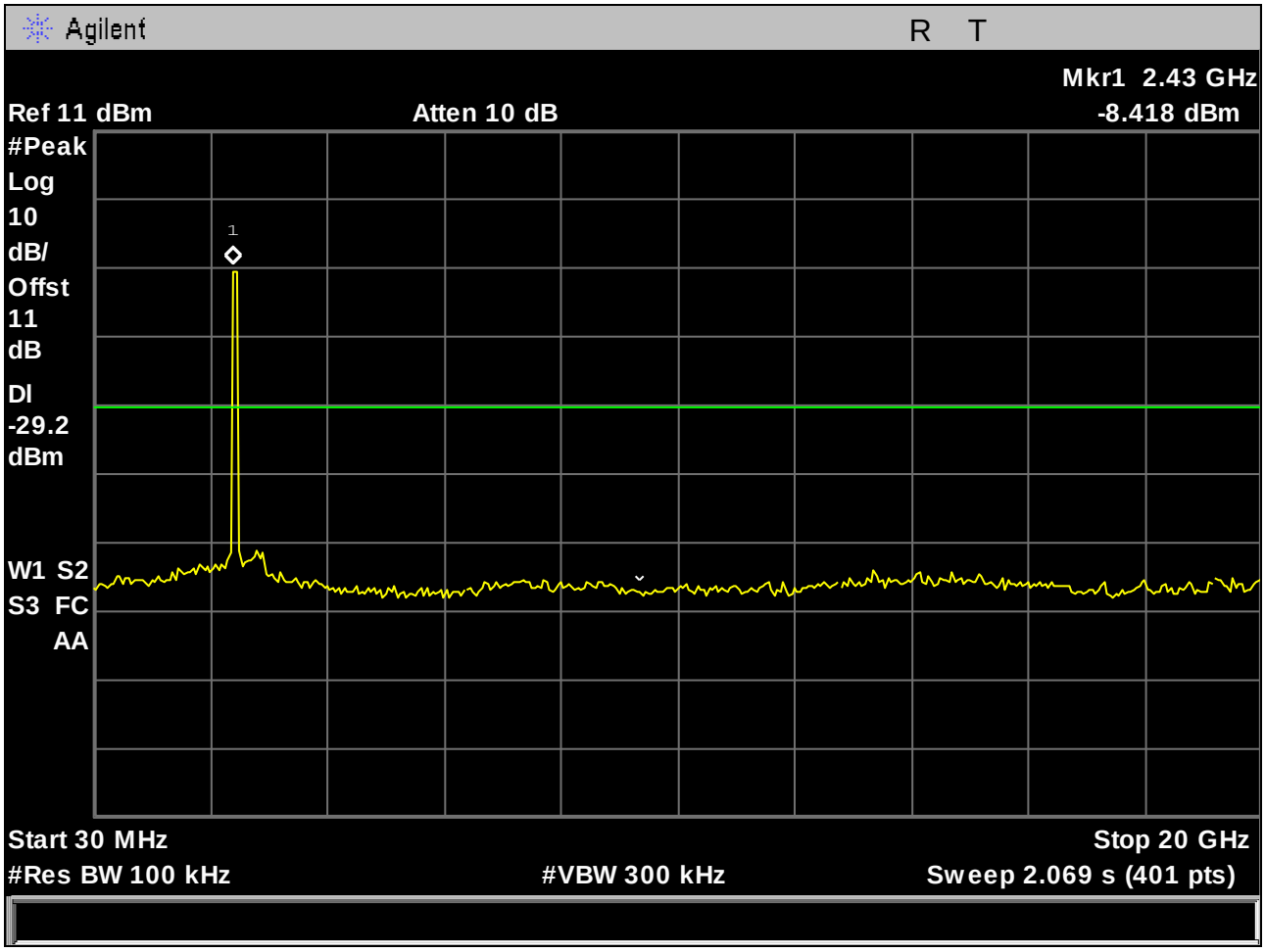
Plot 109. Conducted Spurious Emissions, b Mode, 20 MHz, High Channel



Plot 110. Conducted Spurious Emissions, g Mode, 20 MHz, High Channel

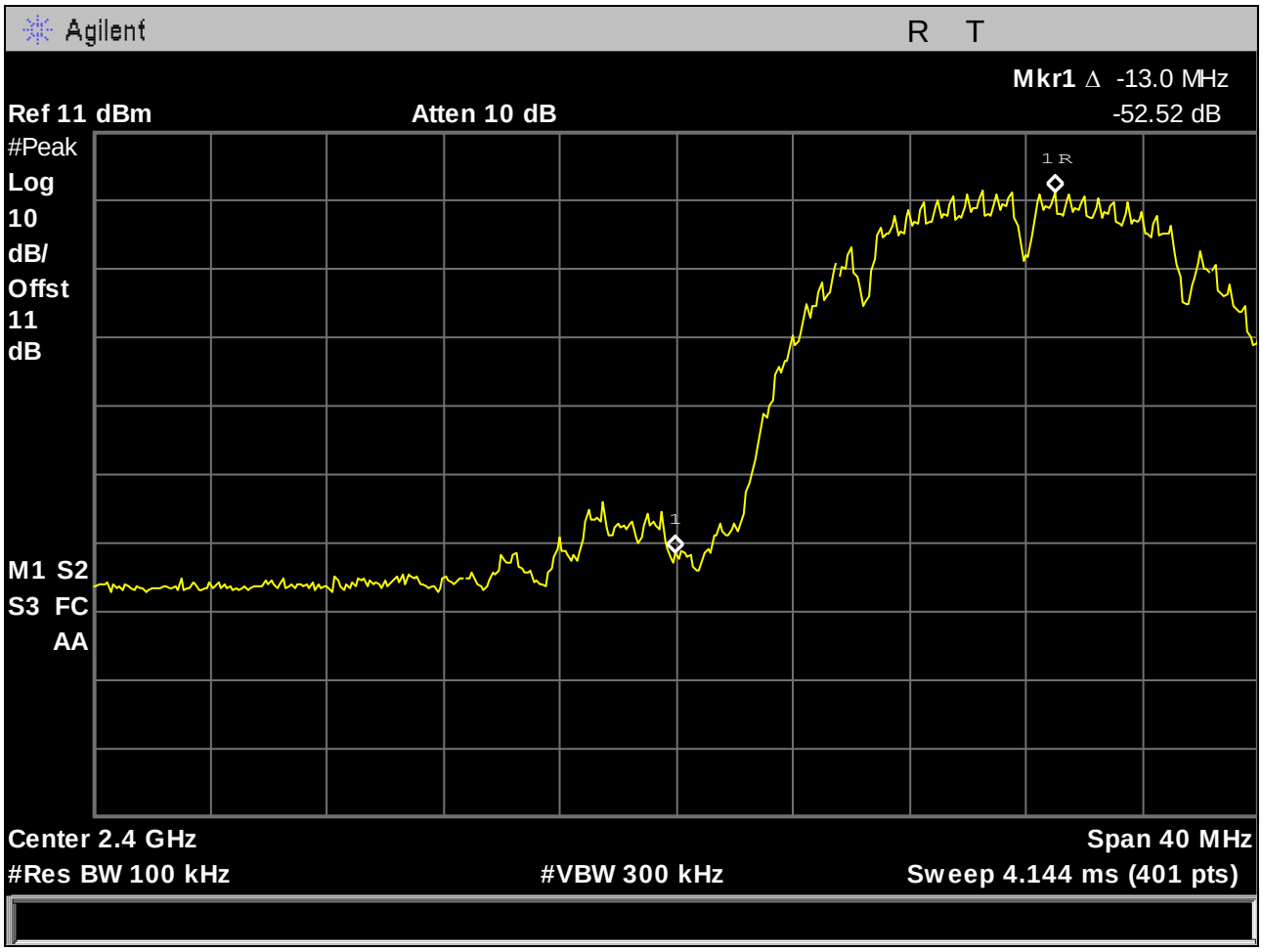


Plot 111. Conducted Spurious Emissions, n Mode, 20 MHz, High Channel

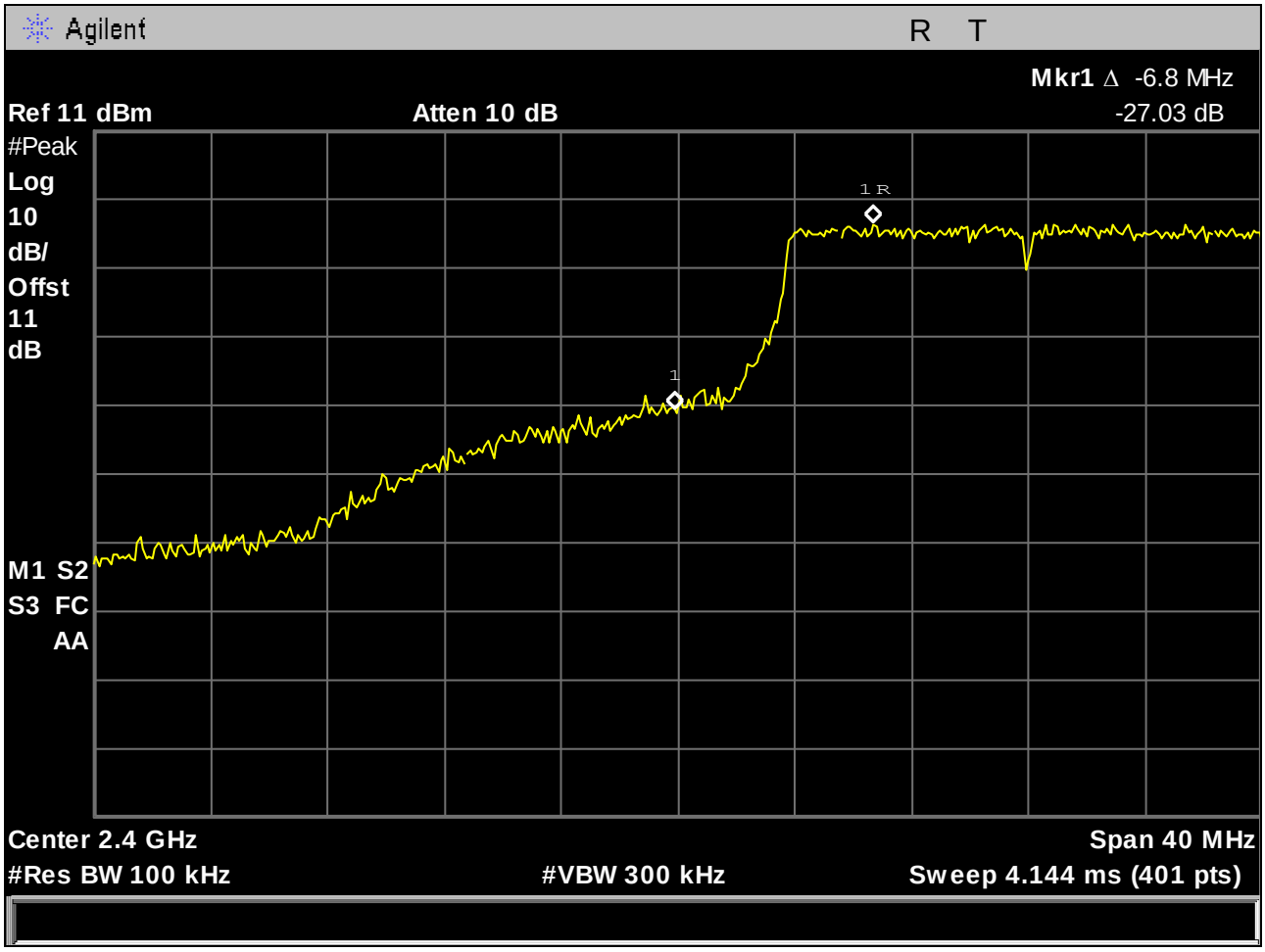


Plot 112. Conducted Spurious Emissions, n Mode, 40 MHz, High Channel

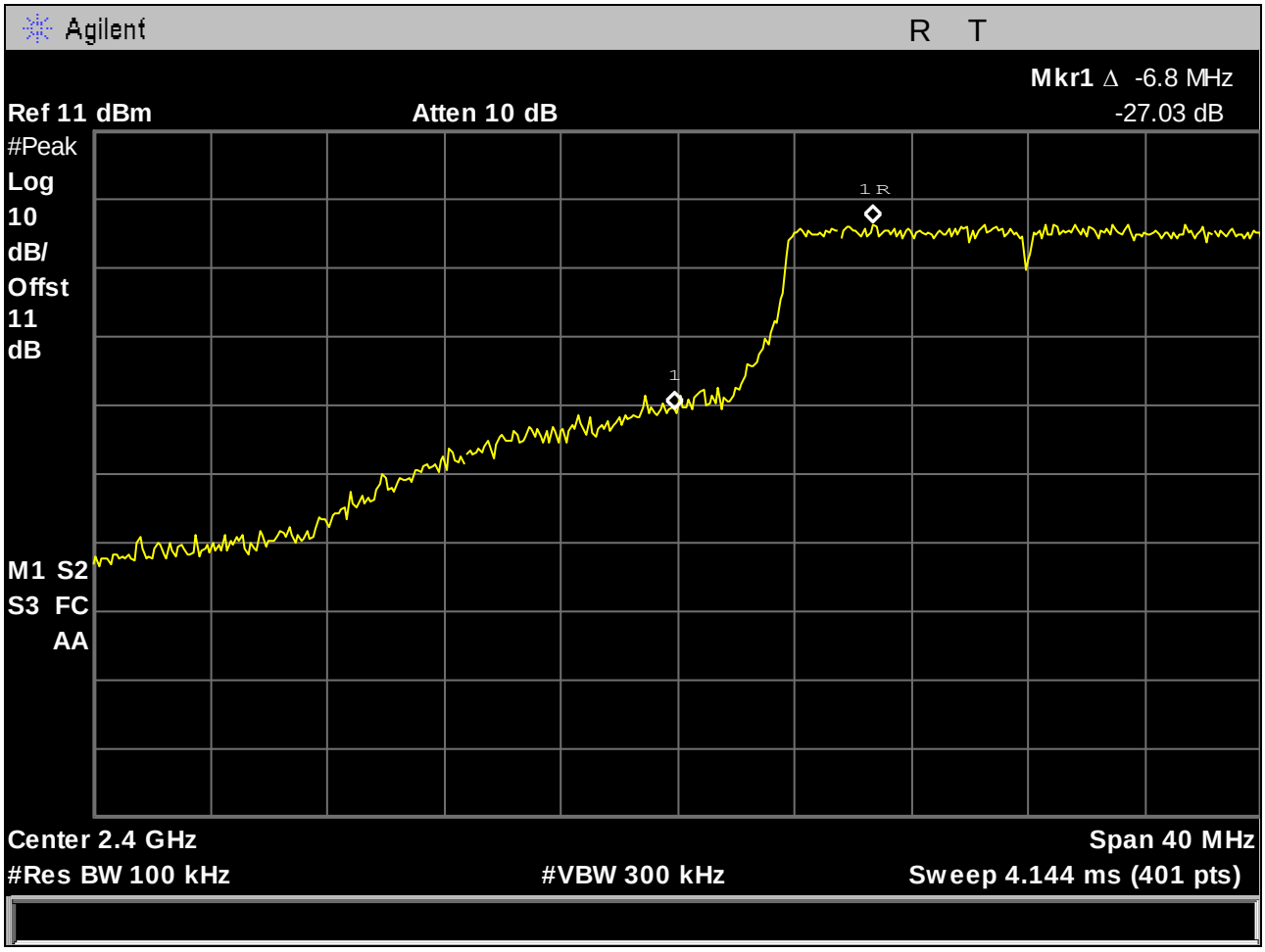
Conducted Band Edge Test Results



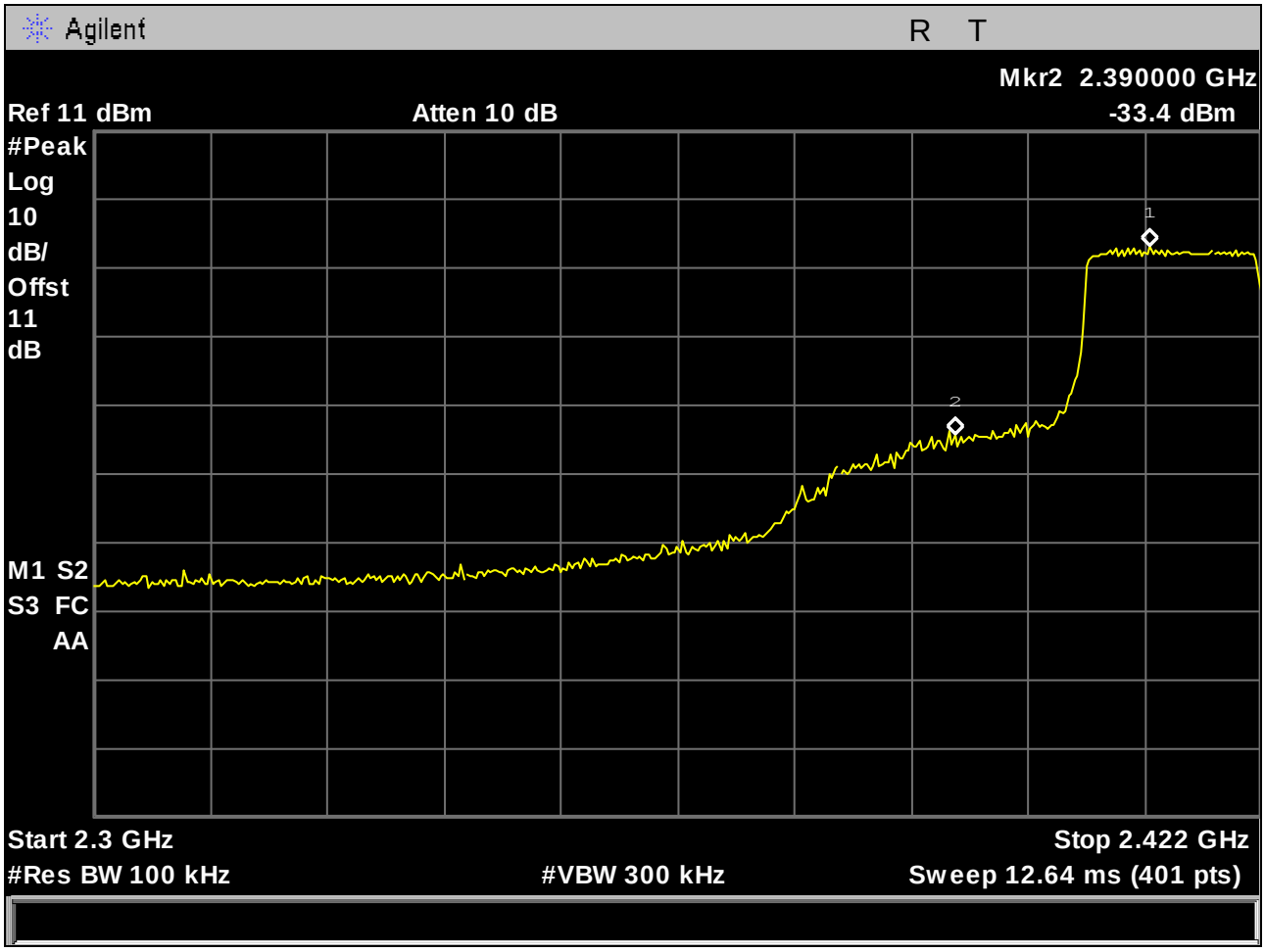
Plot 113. Conducted Band Edge, b mode Low



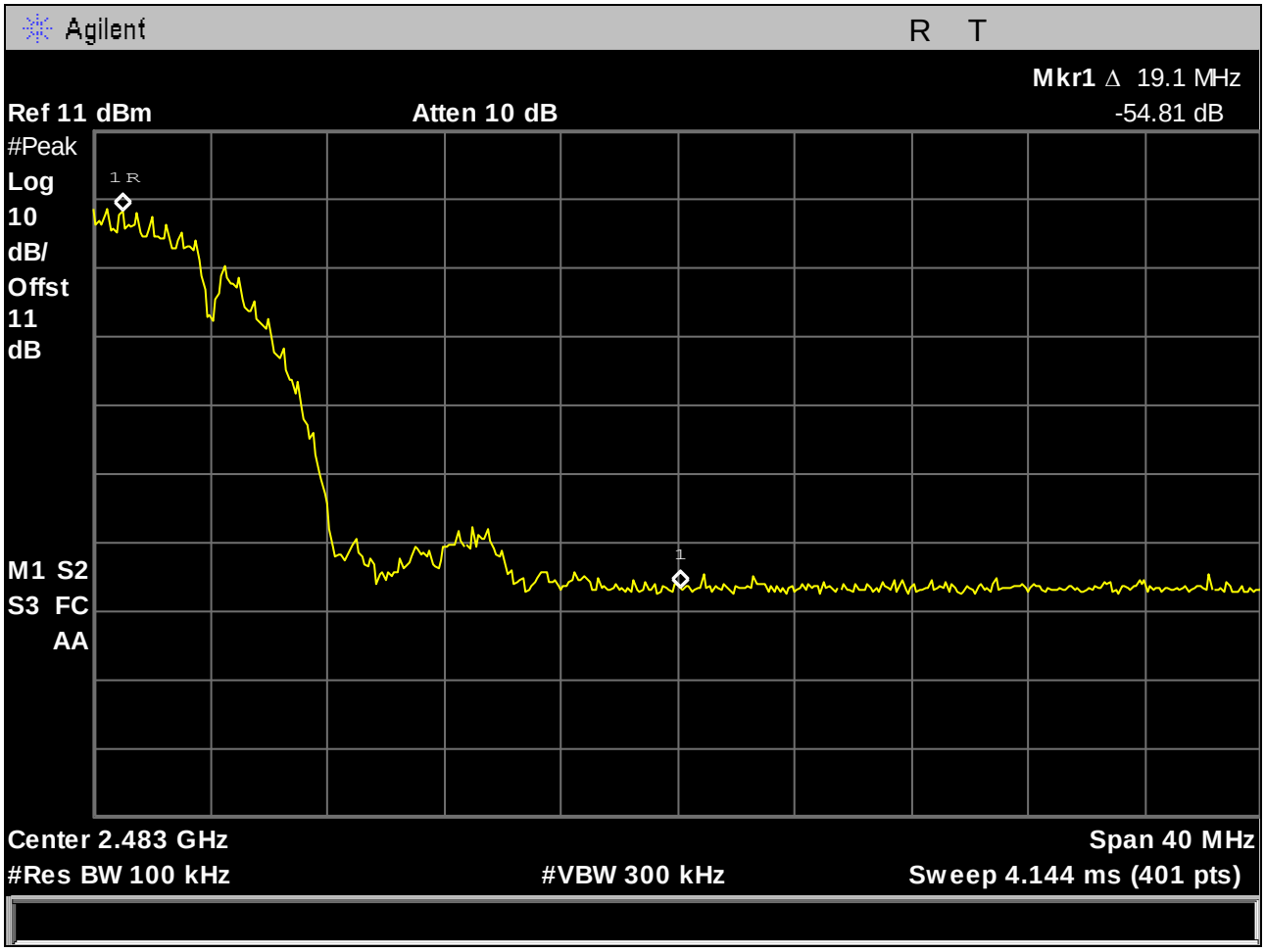
Plot 114. Conducted Band Edge, g mode Low



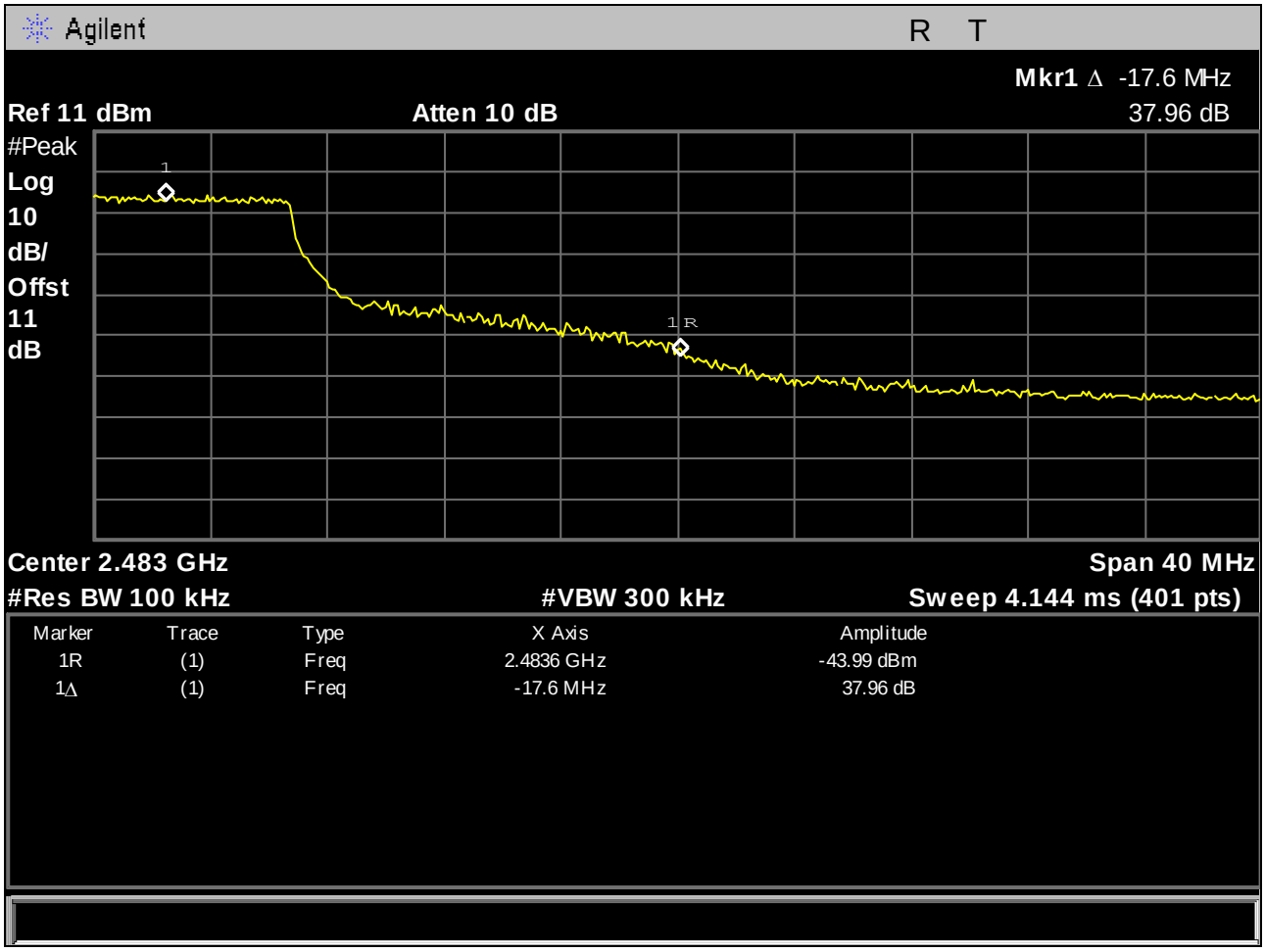
Plot 89. Conducted Band Edge, n mode (20 MHz) Low



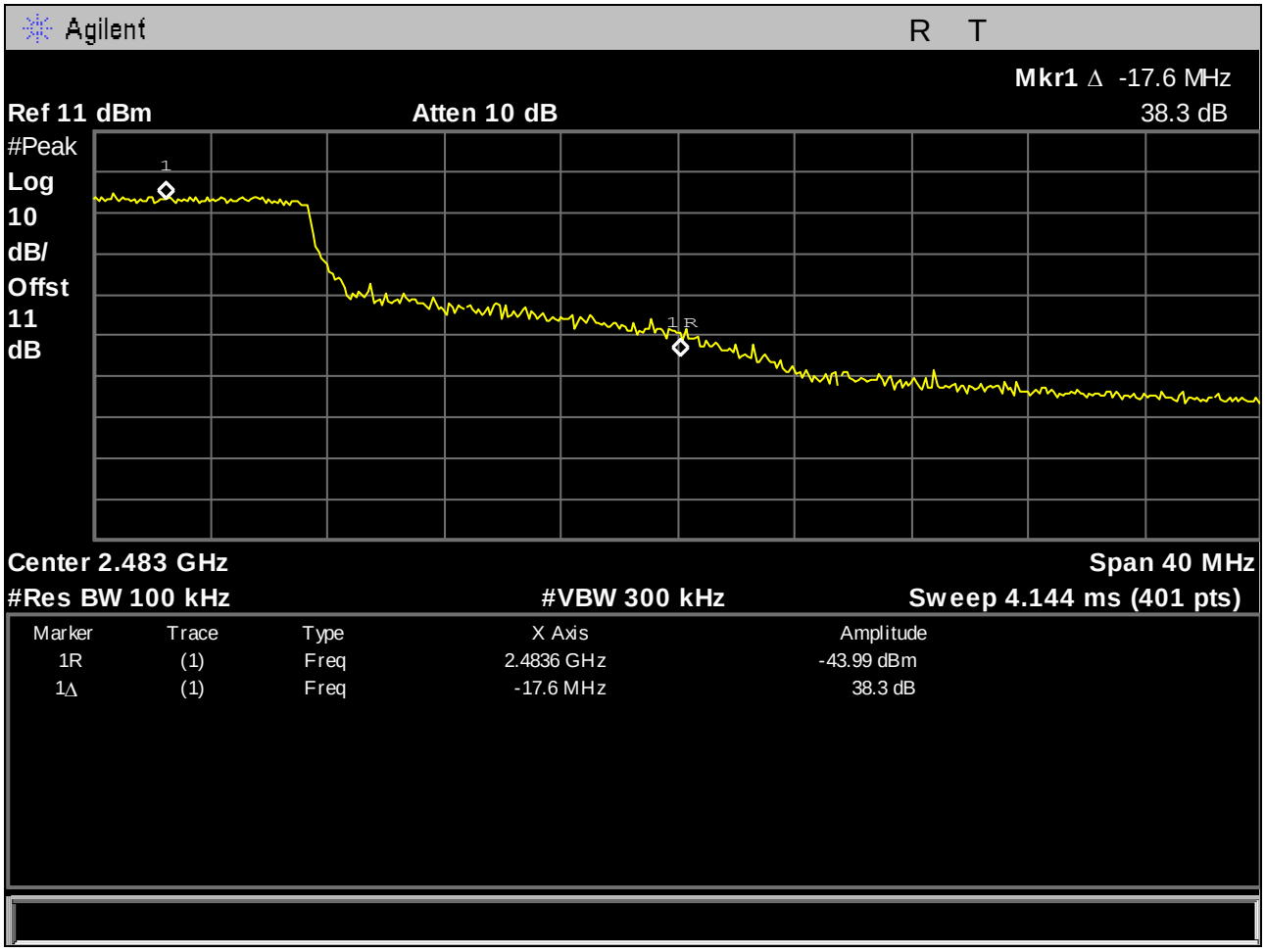
Plot 90. Conducted Band Edge, n mode (40 MHz) Low



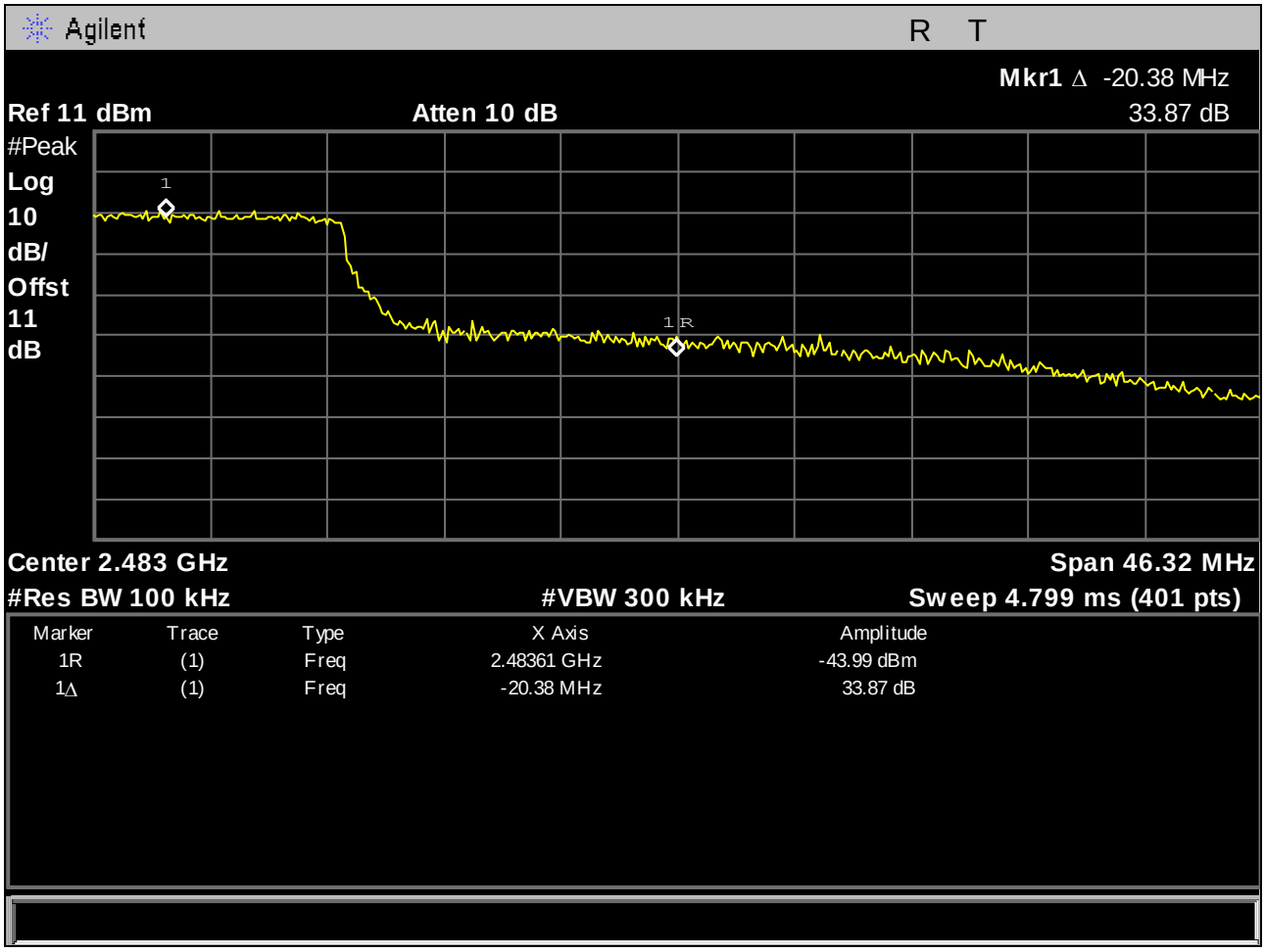
Plot 91. Conducted Band Edge, b mode (20 MHz) High



Plot 92. Conducted Band Edge, g mode (20 MHz) High



Plot 93. Conducted Band Edge, 2 mode (20 MHz) High



Plot 94. Conducted Band Edge, n mode (40 MHz) High

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 throughout each of the 100 sweeps of power averaging. 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)**. No anomalies were noted during testing.

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

Test Engineer: Djed Mouada

Test Date: 10/09/2014 – 10/16/2014

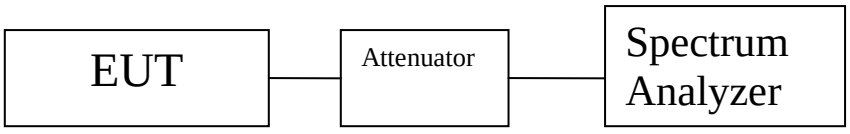


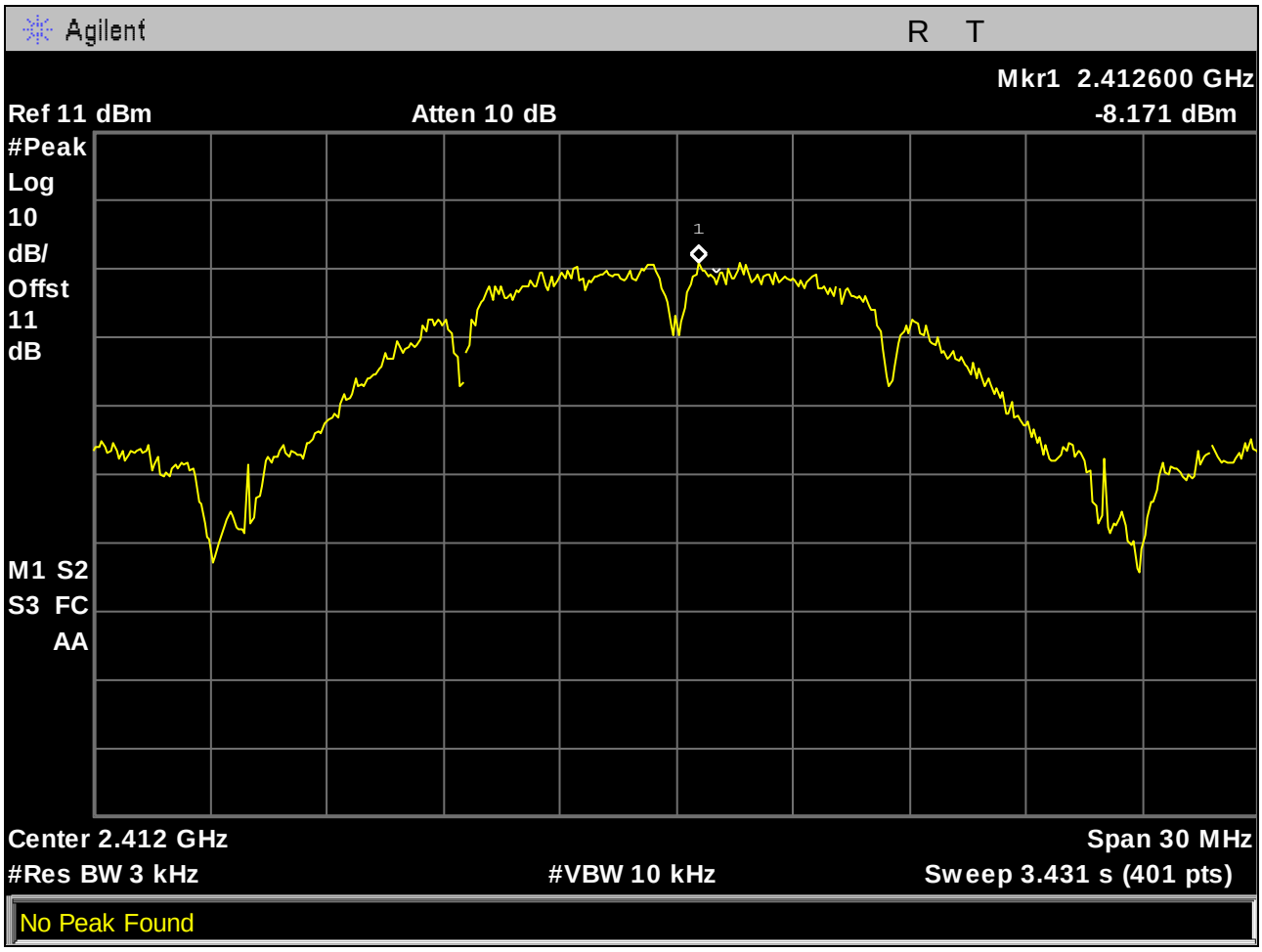
Figure 5. Block Diagram, Peak Power Spectral Density Test Setup

Peak Power Spectral Density Test Results

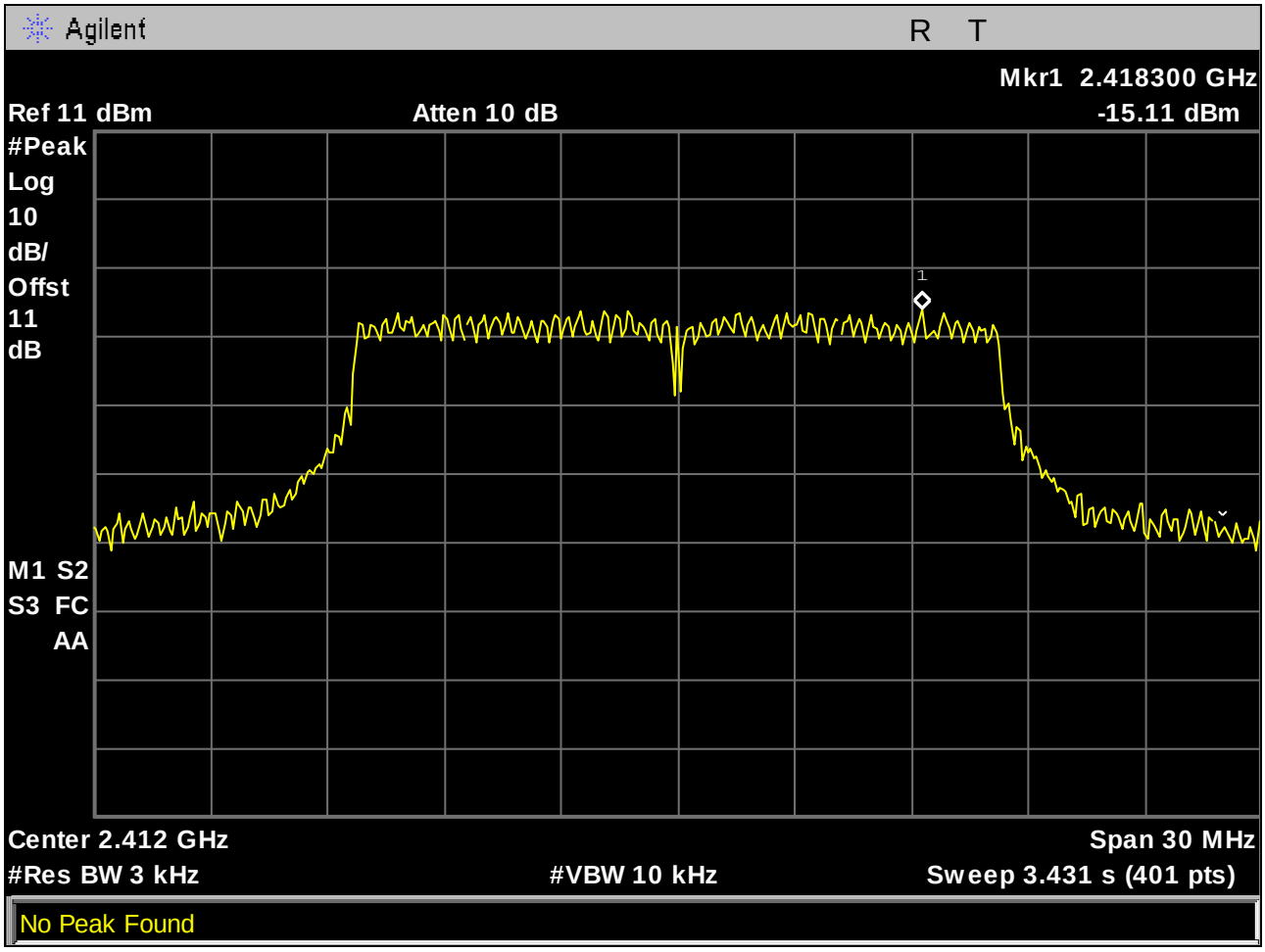
Peak Power Spectral Density				
Carrier Channel	**Frequency (MHz)**	**Measured PPSD (dBm)**	**Limit (dBm)**	**Margin (dB)**
b mode Low	2412	-8.171	8	-16.171
b mode Mid	2437	-12.82	8	-20.82
b mode High	2462	-13.89	8	-21.89
g mode Low	2412	-15.11	8	-23.11
g mode Mid	2437	-16.38	8	-24.38
g mode High	2462	-17.14	8	-25.14
n mode (20 MHz) Low	2412	-15.21	8	-23.21
n mode (20 MHz) Mid	2437	-17.31	8	-25.31
n mode (20 MHz) High	2462	-15.69	8	-23.69
n mode (40 MHz) Low	2422	-17.07	8	-25.07
n mode (40 MHz) Mid	2437	-18.23	8	-26.23
n mode (40 MHz) High	2462	-18.35	8	-23.35

Table 21. Peak Power Spectral Density, Test Results

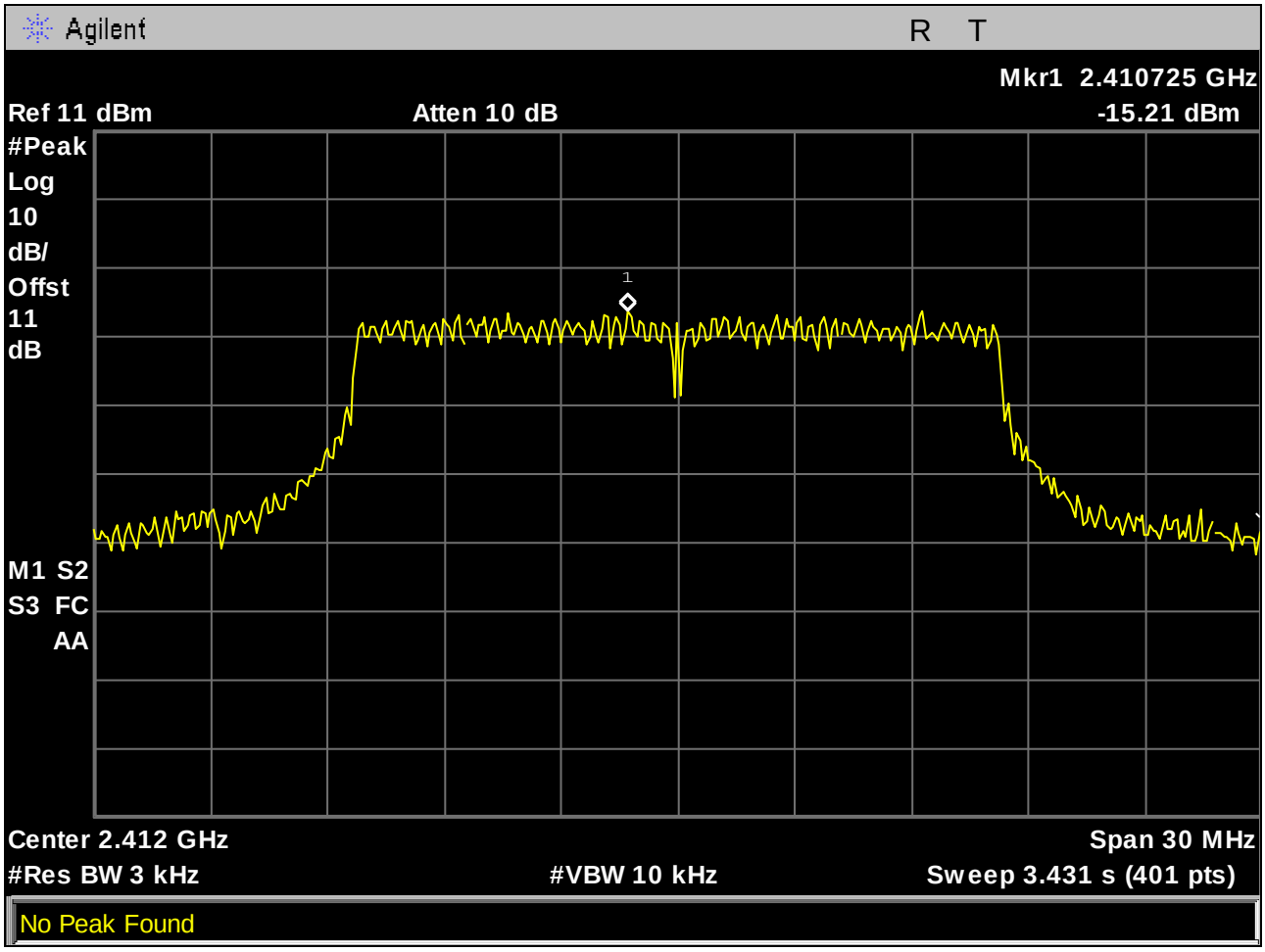
Peak Power Spectral Density



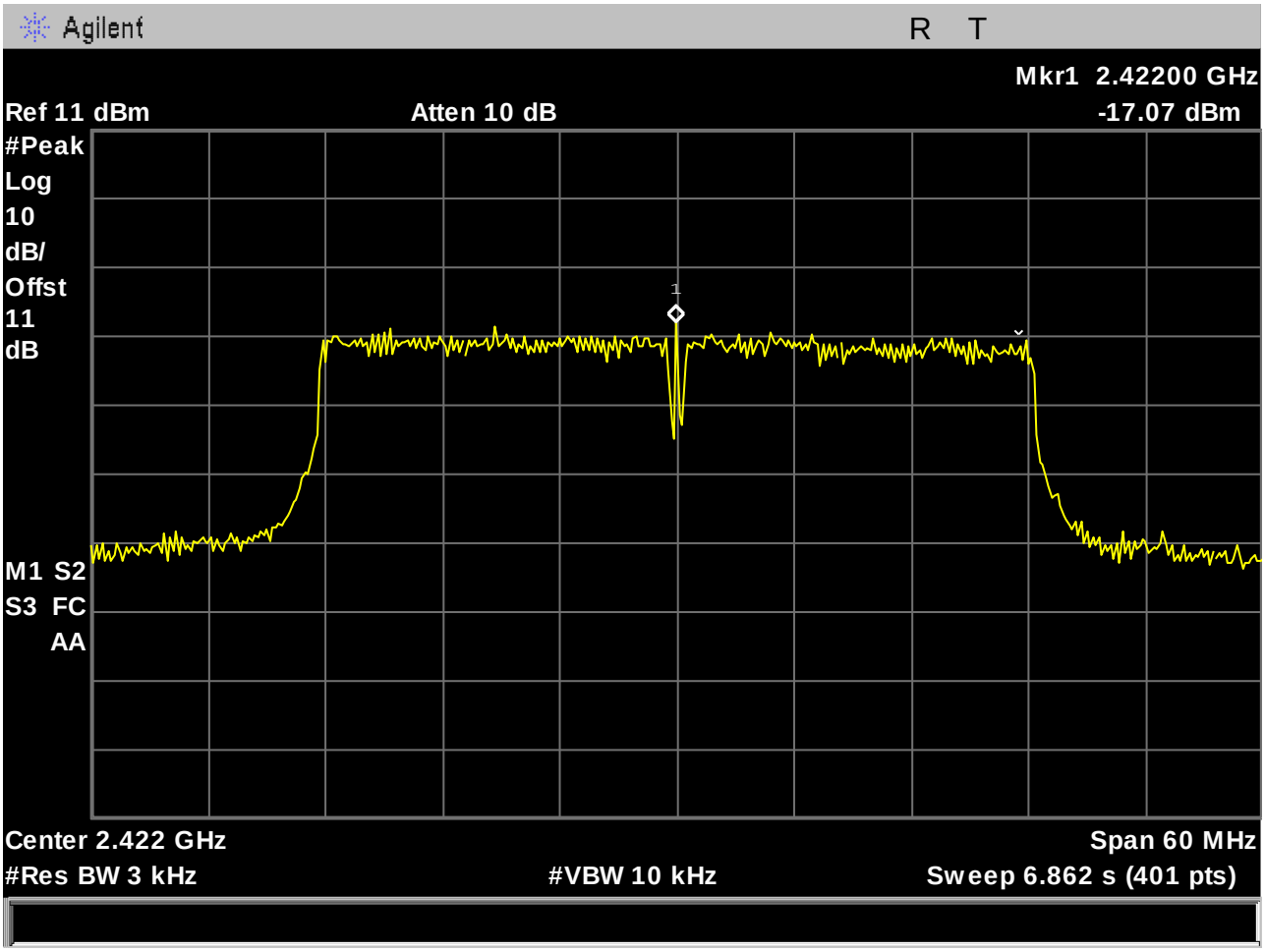
Plot 115. Peak Power Spectral Density, b mode, 20 MHz, Low Channel



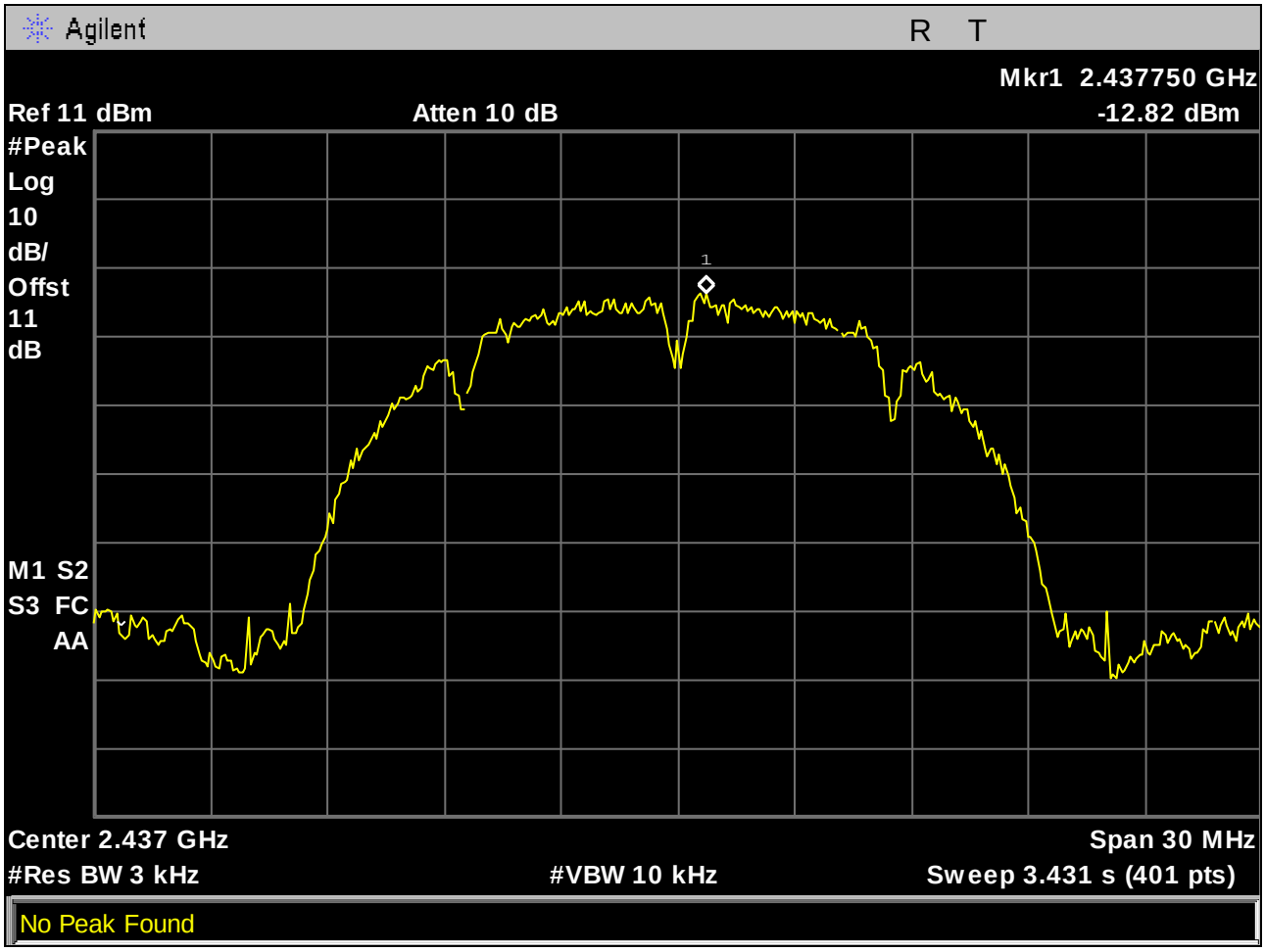
Plot 116. Peak Power Spectral Density, g mode, 20 MHz, Low Channel



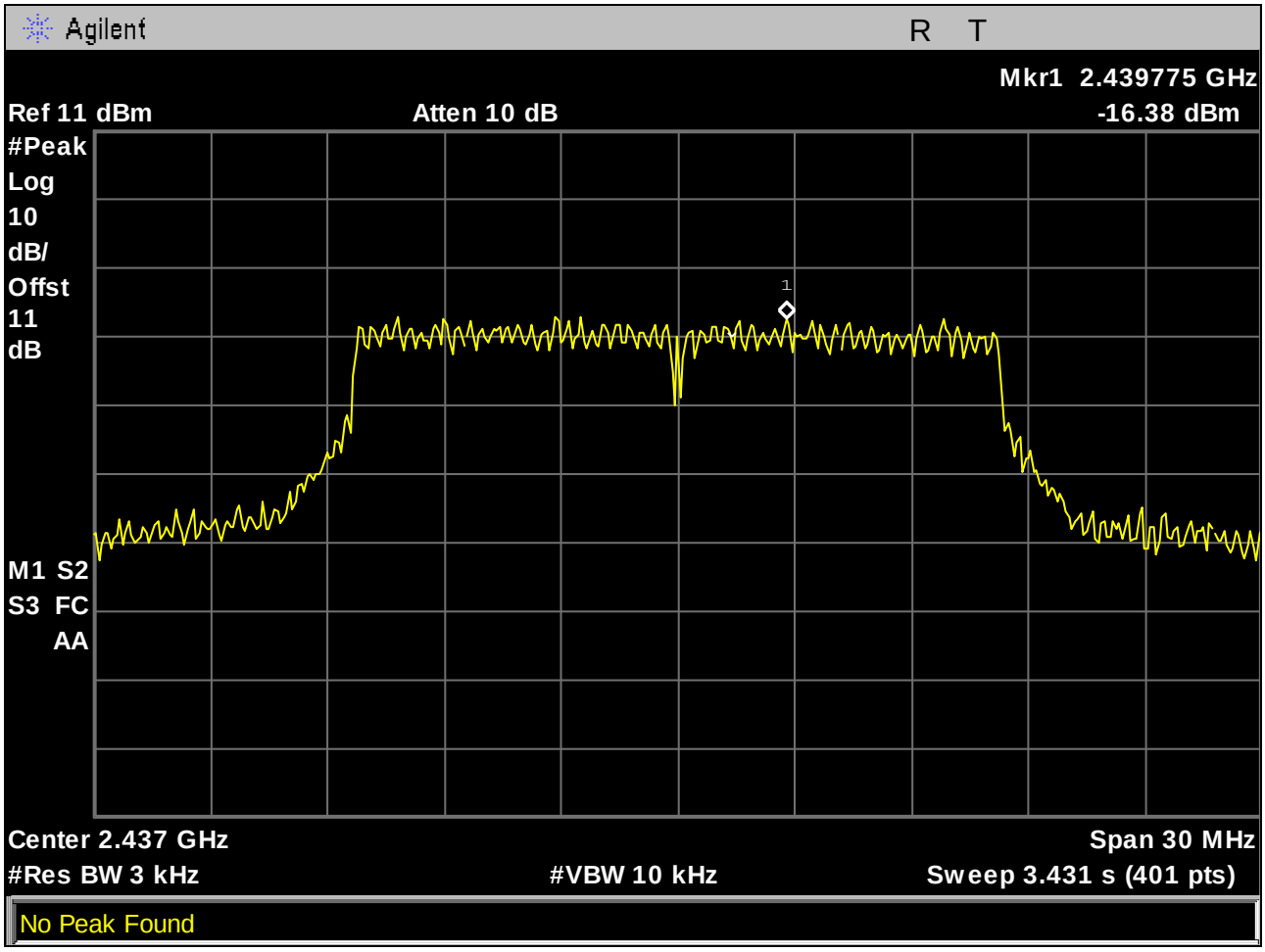
Plot 117. Peak Power Spectral Density, n mode, 20 MHz, Low Channel



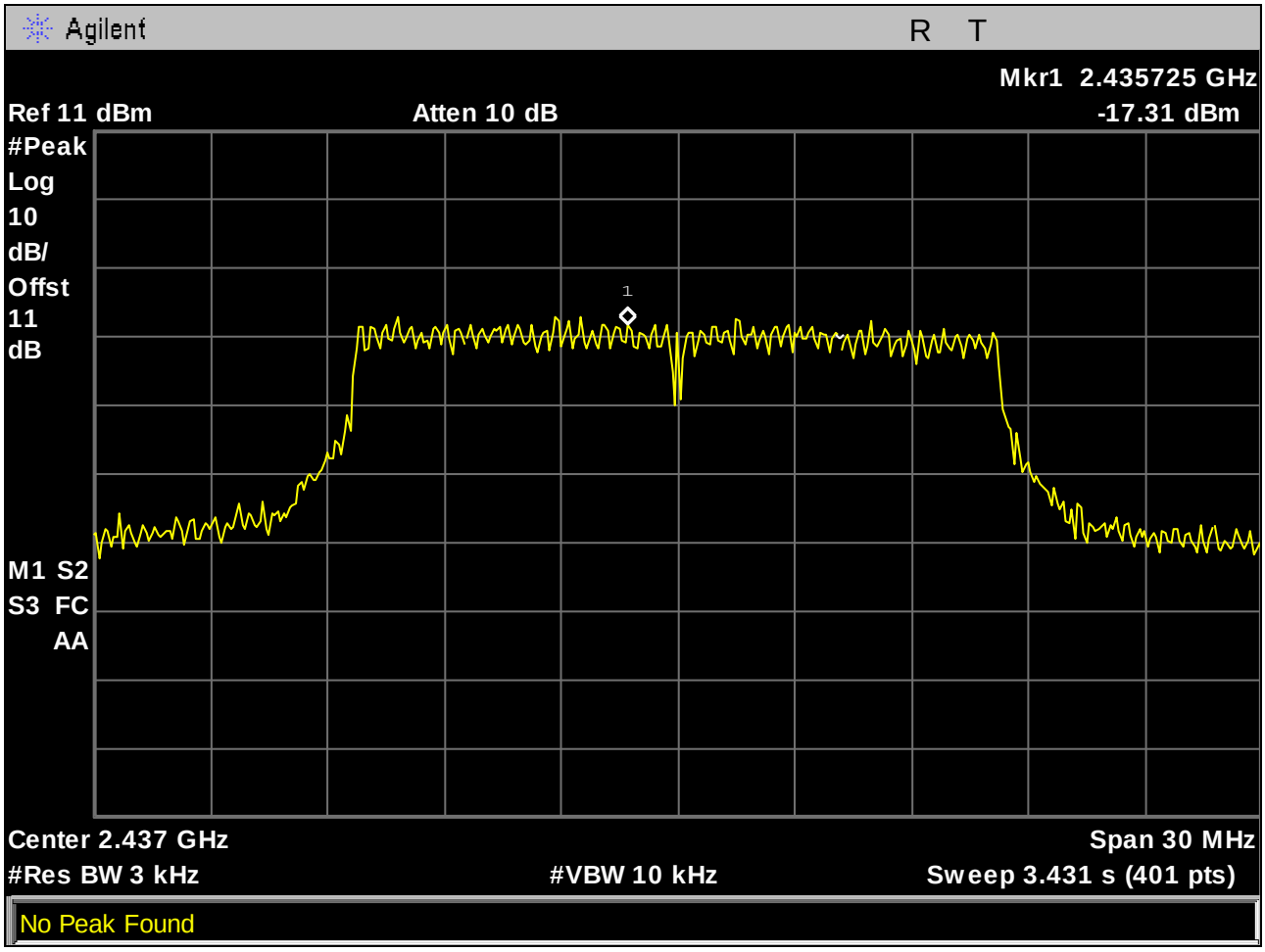
Plot 118. Peak Power Spectral Density, n mode, 40 MHz, Low Channel



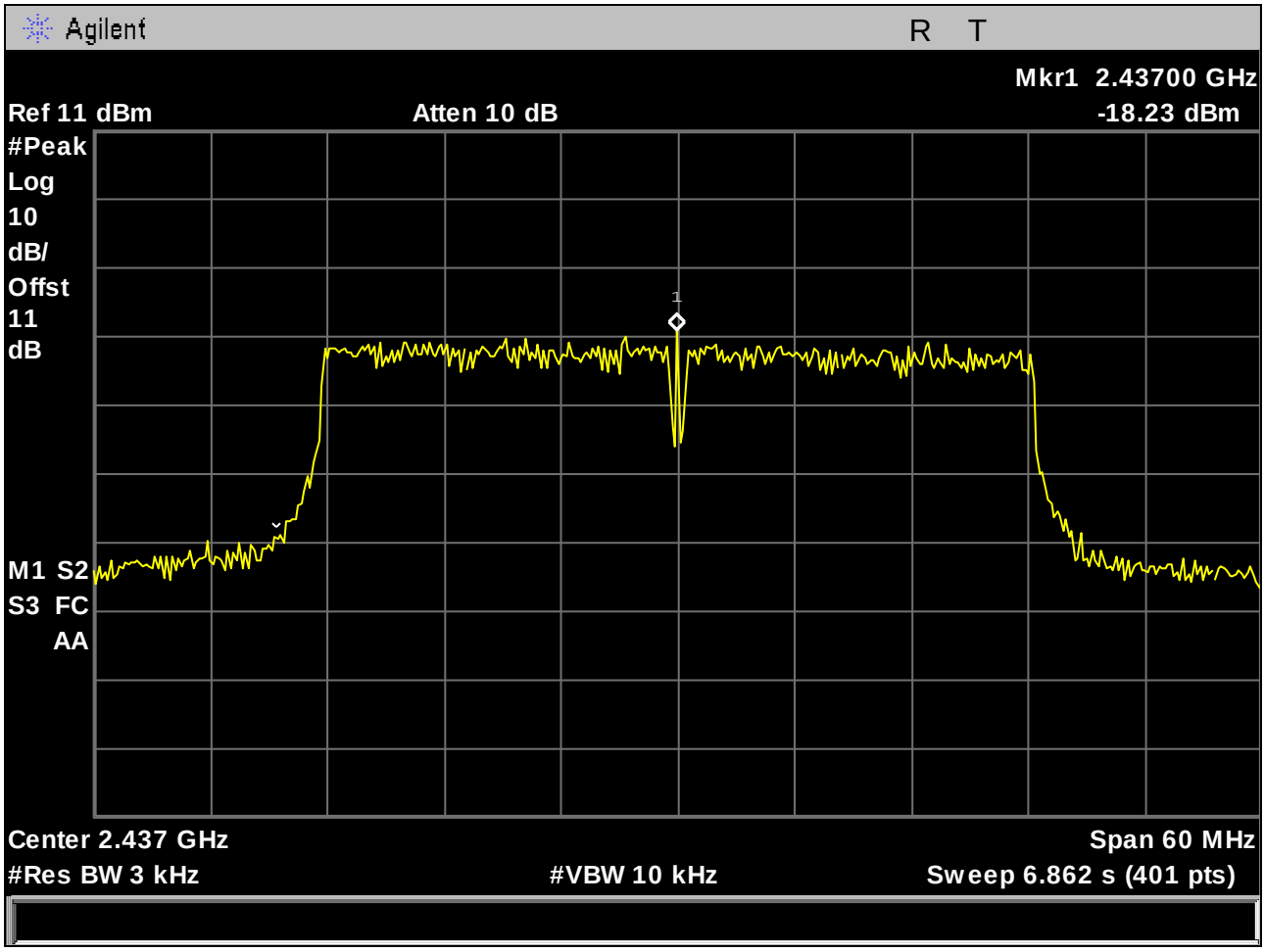
Plot 119. Peak Power Spectral Density, b mode, 20 MHz, Mid Channel



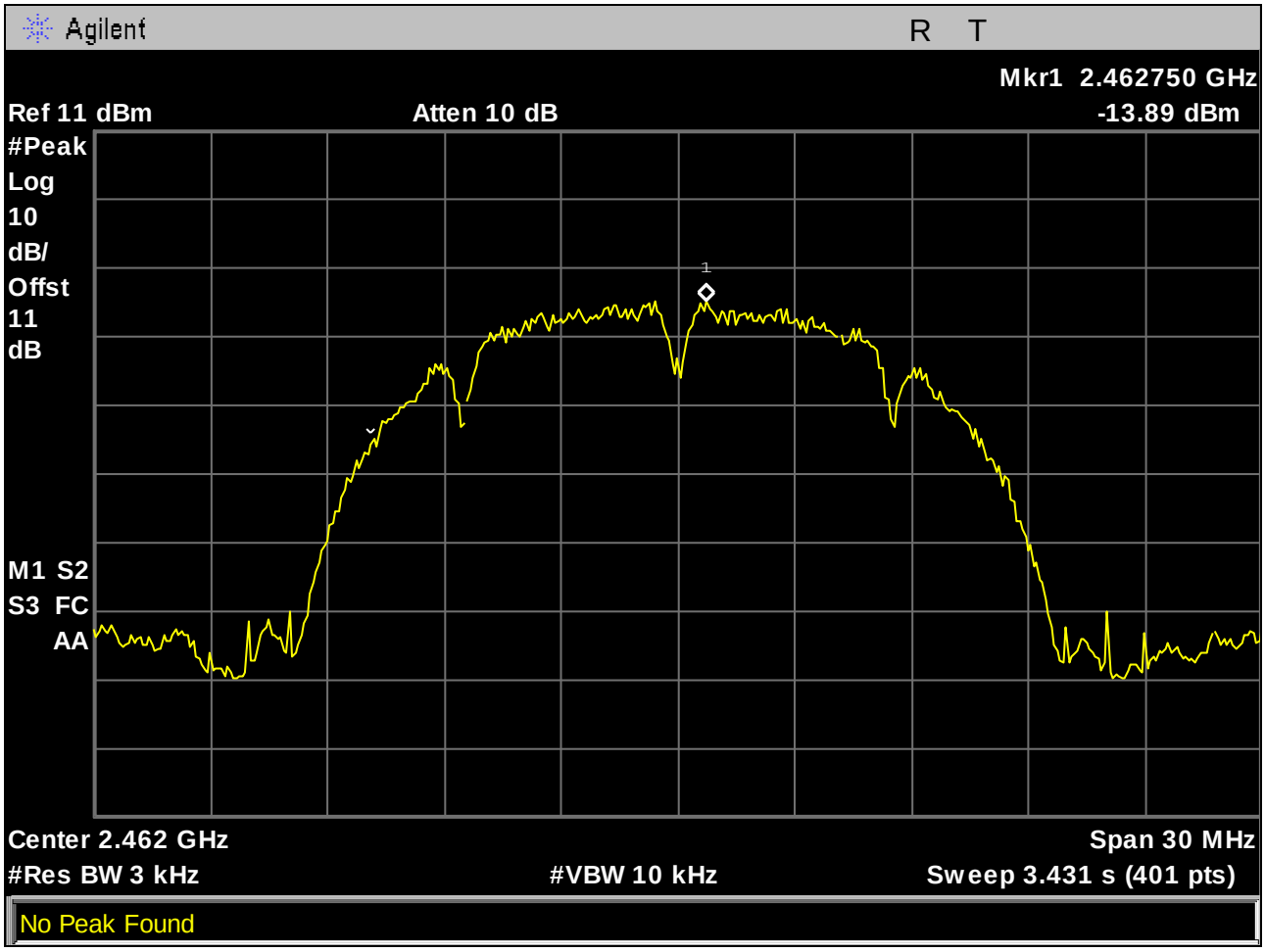
Plot 120. Peak Power Spectral Density, g mode, 20 MHz, Mid Channel



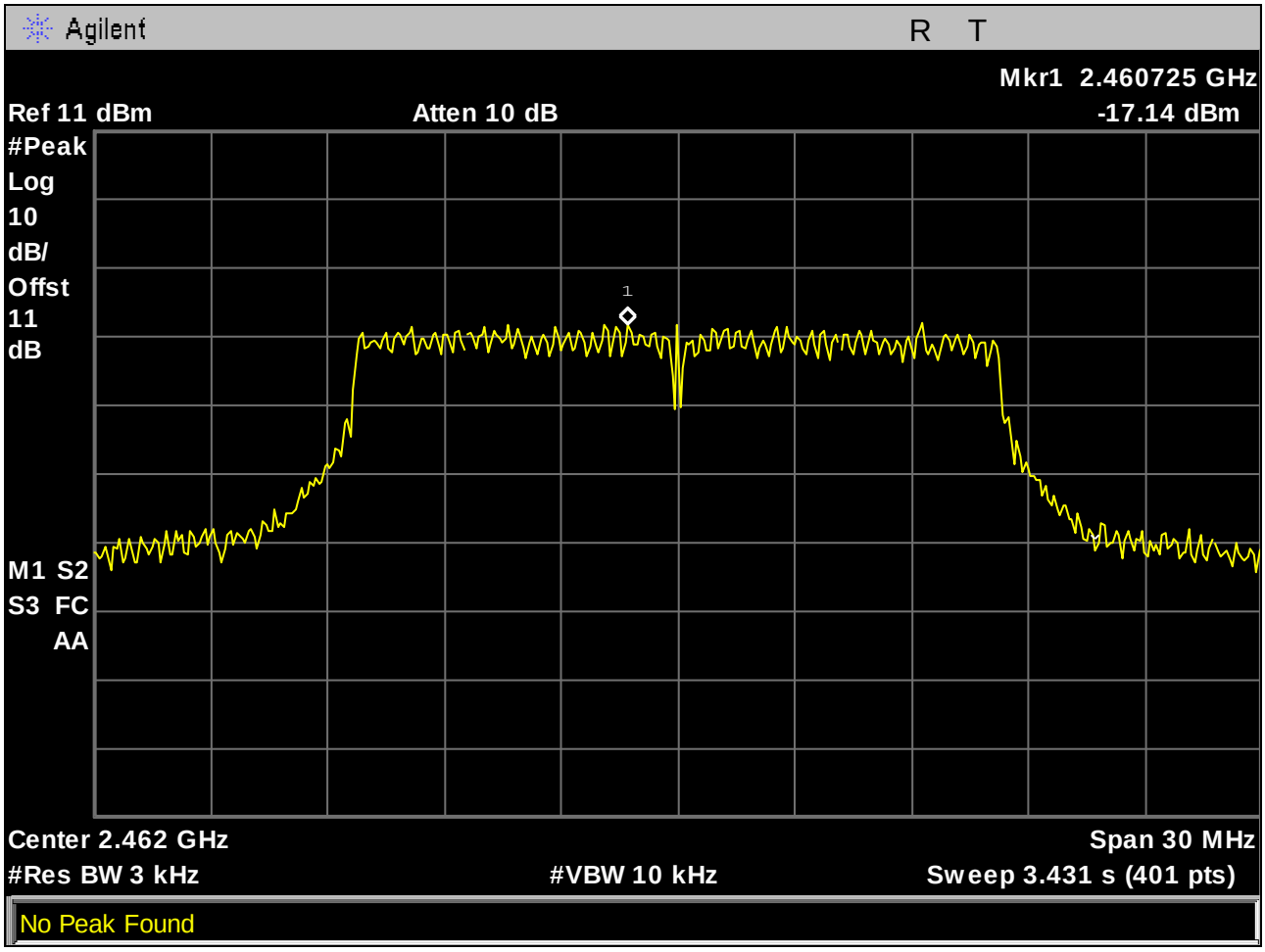
Plot 121. Peak Power Spectral Density, n mode, 20 MHz, Mid Channel



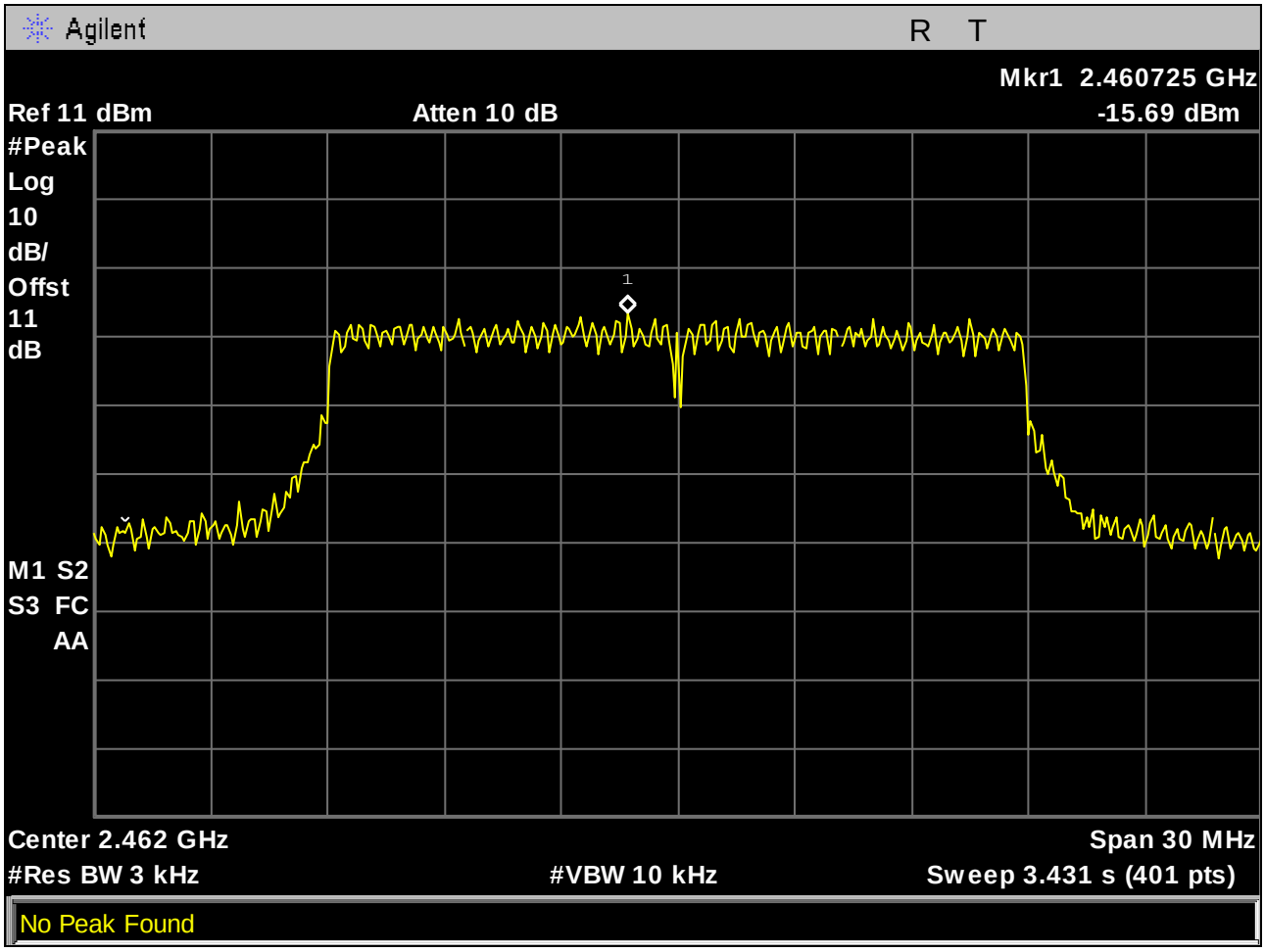
Plot 122. Peak Power Spectral Density, n mode, 40 MHz, Mid Channel



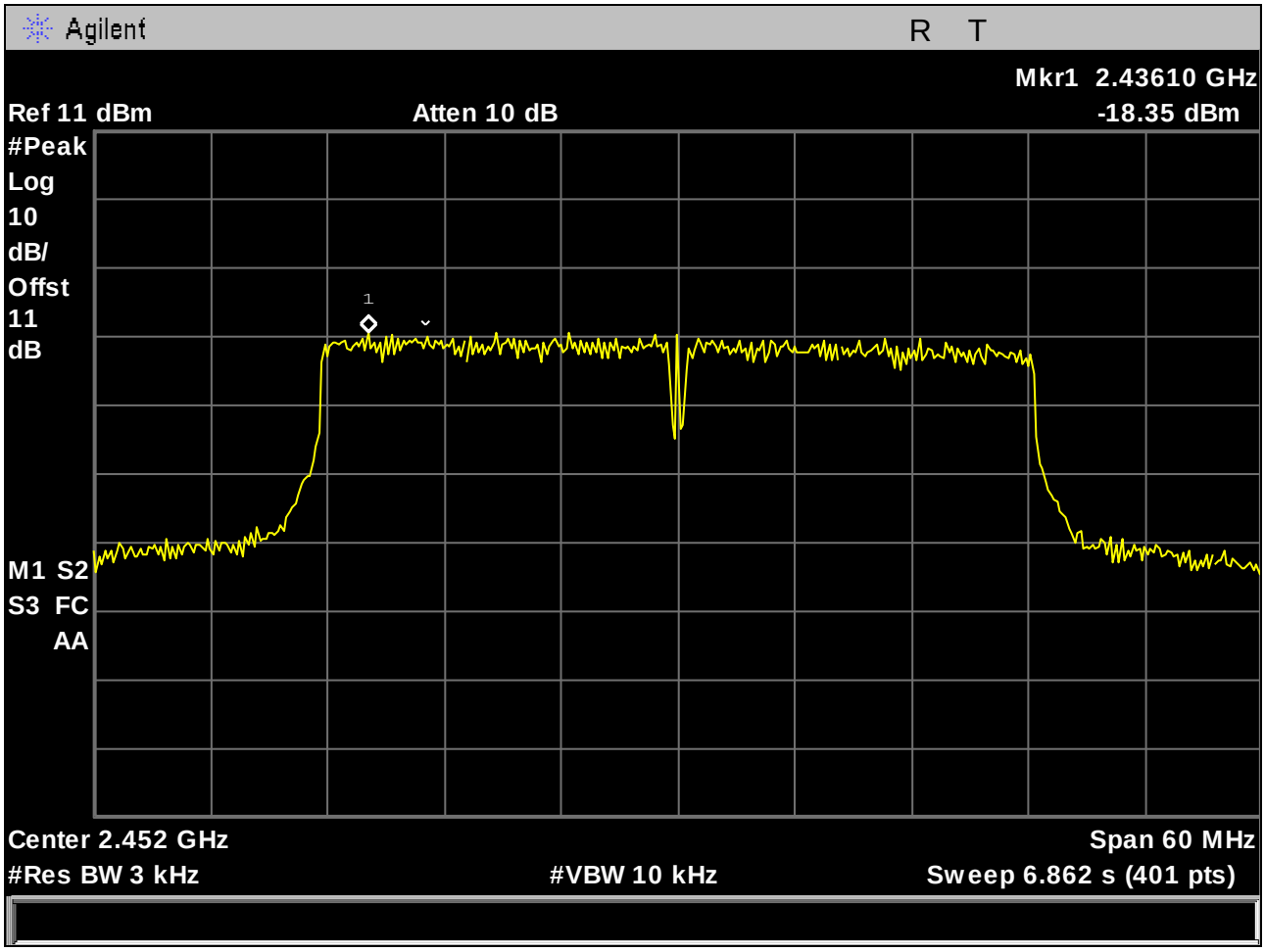
Plot 123. Peak Power Spectral Density, b mode, 20 MHz, High Channel



Plot 124. Peak Power Spectral Density, g mode, 20 MHz, High Channel



Plot 125. Peak Power Spectral Density, n mode, 20 MHz, High Channel



Plot 126. Peak Power Spectral Density, n mode, 40 MHz, High Channel

Electromagnetic Compatibility Criteria for Intentional Radiators

§ 15.247(i) Maximum Permissible Exposure

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

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

MPE Limit Calculation: EUT's operating frequencies @ 2400-2483.5 MHz; highest conducted power = 35.89 mW (i.e. 15.55dBm) (peak) therefore, Limit for Uncontrolled exposure: 1 mW/cm2 or 10 W/m2

EUT maximum antenna gain = 1.7 dBi.

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

$S = PG / 4\Pi R2$

where, S = Power Density (1 mW/cm2)
P = Power Input to antenna (35.89mW)
G = Antenna Gain (1.47 numeric)
R = Distance to the center of Radiation of the antenna

P = 35.89 mW
R = 20 cm
G = 1.47

S = 35.89*1.47 / 4(3.1416)(20)^2
S = 0.010566 mW/cm^2

Therefore, EUT meets the Uncontrolled Exposure limit at 20cm

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
1T4497	SIGNAL GENERATOR	AGILENT TECHNOLOGIES	E4432B	10/6/2014	4/6/2016
1T4744	ANTENNA, HORN	ETS-LINDGREN	3116	9/9/2014	9/9/2015
1T4771	PSA SPECTRUM ANALYZER	AGILENT TECHNOLOGIES	E4446A	3/15/2013	11/15/2014
1T4745	ANTENNA, HORN	ETS-LINDGREN	3116	11/14/2013	5/14/2015
1T4505	Temperature Chamber	Test Equity	115	1/5/2014	1/5/2015
1T4377	True RMS Multimeter	Fluke	189	7/25/2013	1/25/2015
1T4612	Spectrum Analyzer	Agilent Technologies	E4407B	7/25/2014	7/25/2015
1T4483	Antenna; Horn	ETS-Lindgren	3117	2/28/2014	8/28/2015
1T2665	Antenna; Horn	EMCO	3115	4/3/2014	10/3/2015
1T4565	LISN (24 AMP)	Solar Electronics	9252-50-R-24-BNC	6/26/2014	12/26/2015

Table 22. Test Equipment List

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.

ICES-003 Procedural & Labeling Requirements

From the Industry Canada Electromagnetic Compatibility Advisory Bulletin entitled, "Implementation and Interpretation of the Interference-Causing Equipment Standard for Digital Apparatus, ICES-003" (EMCAB-3, Issue 2, July 1995):

> "At present, CISPR 22: 2002 and ICES technical requirements are essentially equivalent. Therefore, if you have CISPR 22: 2002 approval by meeting CISPR Publication 22, the only additional requirements are: to attach a note to the report of the test results for compliance, indicating that these results are deemed satisfactory evidence of compliance with ICES-003 of the Canadian Interference-Causing Equipment Regulations; to maintain these records on file for the requisite five year period; and to provide the device with a notice of compliance in accordance with ICES-003."

Procedural Requirements:

According to Industry Canada's Interference Causing Equipment Standard for Digital Apparatus ICES-003 Issue 5 August 2012:

Section 6.1: A record of the measurements and results, showing the date that the measurements were completed, shall be retained by the manufacturer or importer for a period of at least five years from the date shown in the record and made available for examination on the request of the Minister.

Section 6.2: A written notice indicating compliance must accompany each unit of digital apparatus to the end user. The notice shall be in the form of a label that is affixed to the apparatus. Where because of insufficient space or other constraints it is not feasible to affix a label to the apparatus, the notice may be in the form of a statement in the users' manual.

Labeling Requirements:

The suggested text for the notice, in English and in French, is provided below, from the Annex of ICES-003:

> This Class [2] digital apparatus complies with Canadian ICES-003.
>
> Cet appareil numérique de la classe [1] est conforme à la norme NMB-003 du Canada.

[2] Insert either A or B but not both as appropriate for the equipment requirements.

End of Report

