Test Report

47 CFR FCC Part 15 subpart C
Intentional Radiators

Report reference no...... :	28111054-005
FCC Designation Number ..... :	IT0008
FCC Test Firm Registration # ..... :	804595
Tested by (name + signature)…….:	
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Approved by (name + signature)……:	
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Testing Laboratory ..... :	TÜV Rheinland Italia S.r.l.
Address..... :	Via Mattei 3 - 20010 - Pogliano Milanese (MI) – Italy
Applicant's name ..... :	Power-One Italy S.p.A.
Address..... :	Via S. Giorgio, 642 - 52028 Terranuova Bracciolini, Arezzo, Italy
Test item description..... :	WiFi radio module
Trade Mark..... :	ABB
Manufacturer..... :	Power One Italy S.p.a.
Model/Type reference..... :	VSN300S
Ratings..... :	24Vdc (powered by inverter)
Sample ..... :	
Samples received on ..... :	October, 31th 2017
TUV reference samples..... :	170606 (sampled by the customer)
Samples tested n. ..... :	1
Testing ..... :	
Start Date: ..... :	November, 17th 2017
End Date: ..... :	November, 30th 2017

The results in this Test Report are exclusively referred to the tested samples. Without the written authorization of TÜV Rheinland Italia S.r.l., this document can be reproduced only integrally

RELEASE CONTROL RECORD		
TEST REPORT NUMBER	REASON OF CHANGE	DATE OF ISSUE
28111054-001	Original release	12/12/2017
28111054-003	(1) Page 4, reference standards, correct the version of ANSI C63.10 (2) Page 7, Item 4, delete table and added extract from antenna datasheet (3) Item 11, correct table (4) Page 23, correct table (5) Page 25, added test equipment (6) Page 26, correct table (7) For conducted and radiated antenna port spurious emission, added graphic for middle channel (8) Item 17 page 91, correct table	27/03/2018
28111054-004	Correct table pag. 26	04/04/2018
28111054-005	Correct item description at pag.1 and pag.6	16/04/2018

SUMMARY

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1. Reference Standards	
Standard	**Description**
FCC Part 15 (Subpart C)	§15.247 Operation within the bands 902-928 MHz, 2400-2483,5 MHz, and 5725-5850 MHz.
FCC Part 15 (Subpart C)	§15.207 Conducted Limits
FCC Part 15 (Subpart C)	§15.209 Radiated emission limits; general requirements
FCC Part 15 (Subpart C)	§15.203 Antenna Requirement
ANSI C63.4:2009	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
ANSI C63.10:2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
FCC GUIDE 15.247 (DTS): April 8,2016	Guidance for performing compliance measurements on digital transmission systems (dts) operating under §15.247

2. Summary of testing:

FCC Rule Part	Test Item	Result	Remarks
15.207	AC POWER CONDUCTED EMISSION	N/A	---
15.205 15.209 15.247(d)	RADIATED EMISSIONS	PASS	Meet the requirement of limit
15.247(a)(2)	6dB BANDWIDTH	PASS	Meet the requirement of limit
15.247(b)(3)(4)	OUTPUT POWER	PASS	Meet the requirement of limit
15.247(d)	CONDUCTED ANTENNA PORT SPURIOUS EMISSION	PASS	Meet the requirement of limit
15.247(d)	RADIATED SPURIOUS EMISSION	PASS	Meet the requirement of limit
15.247(e)	POWER SPECTRAL DENSITY	PASS	Meet the requirement of limit
15.203	ANTENNA REQUIREMENT	PASS	Professional equipment (RP SMA)
15.247(b)	RF EXPOSURE REQUIREMENTS	PASS	Meet the requirement of limit

Possible test case verdicts:

- test case does not apply to the test object ....: N/A
- test object does meet the requirement .....: PASS
- test object does not meet the requirement ....: FAIL

General remarks:

The test results presented in this report relate only to the object tested.

The results contained in this report reflect the results for this particular model and serial number. It is the responsibility of the manufacturer to ensure that all production models meet the intent of the requirements detailed within this report.

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"(see Enclosure #)" refers to additional information appended to the report.
"(see appended table)" refers to a table appended to the report.

Throughout this report a comma (point) is used as the decimal separator.

3. General product information

Radio module

4. General Chipset information

ModuloRadio */Radio Module*	
Costruttore */Manufacturer*	Murata
Modello */Model*	LBEP5CLXRC-701
N°serie */Serial no.*	YCU.00123

Antenna */Main Antenna*	
Costruttore */Manufacturer*	Comepoch Technology Corp.
Modello */Model*	EA-79F (2.4GHz with Swivel RP-SMA)
N°serie */Serial no.*	---
Caratteristiche tecniche */Technical details*	See datasheet "zfa.00008.pdf"

EA-79F E-Plane

Freq(MHz)	peak (dBi)	Angle(0)	Avg(dBi)
2400	3.11	73.99	-2.37
2450	2.95	73.99	-2.35
2500	3.32	75.99	-1.87

5. General Antenna information

6. Equipment Used During Test

Use*	Product Type	Manufacturer	Model	Comments
EUT	Radio module	Power One Italy S.p.a.	VSM300S	---
AE	Q1 board	Power One Italy S.p.a.	VKA.V1Q04.0	Used to set the WiFi Module
AE	PC	Lenovo	T430	Used to set the WiFi Module

Note:

* Use :

EUT - Equipment Under Test,
AE - Auxiliary/Associated Equipment, or
SIM - Simulator (Not Subjected to Test)

No other Auxiliary/Associated Equipment was connected/installed on the EUT

7. Input/Output Ports:

CONNECTIONS

Port		Description	Connection	Cable lenght
1	Enclosure	Port not present	----	----
2	AC Power Port	Port not present	----	----
3	DC Power Port	24Vdc	Powered by inverter	---

*Note: AC = AC Power Port DC = DC Power Port N/E = Non-Electrical
I/O = Signal Input or Output Port (Not Involved in Process Control)
TP = Telecommunication Ports

8. Power Interface						
Mode #	**Voltage (V)**	**Current (A)**	**Power (W)**	**Frequency (DC/AC-Hz)**	**Phases (#)**	**Comments**
Rated	24Vdc	0,5	12	DC	---	---

9. EUT Operation Modes	
Operation mode	**Description**
#1	EUT turn on with Wi-Fi Module in transmission mode

10. EUT Configuration Modes:	
Mode #	**Description**
---	---

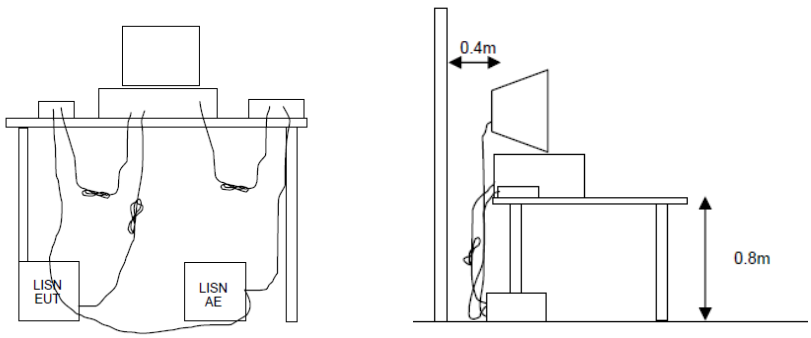
11. Test Conditions and Results – AC POWER CONDUCTED EMISSION

12	TEST: AC Power Conducted Emission		N/A
Parameters required prior to the test	Laboratory Ambient Temperature (°C)	15 to 35 °C	
	Relative Humidity (%)	30 to 60 %	
Parameters recorded during the test	Laboratory Ambient Temperature (°C)	21°C	
	Relative Humidity (%)	56%	
	Air pressure (hPa)	1020	
—	Frequency	Application Point	
Fully configured sample tested at the power line frequency	24Vdc	AC Mains	
Equipment mode:	Operation mode	#1	
FCC Standard	§15.207		
Frequency (MHz)	Quasi-peak (dBuV)	Average (dBuV)	Result
0.15-0.5	66 to 56	56 to 46	N/A
0.5-5	56	46	N/A
5-30	60	50	N/A

Except as shown in paragraphs (b) and (c) of this section, 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 30 MHz, shall not exceed the limits in the following table, as measured using a 50 µH/50 ohms 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 of emission (MHz)	Conducted limit (dBµV)	
	Quasi-peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50

Further information to test setup



12. Test Conditions and Results – RADIATED EMISSION

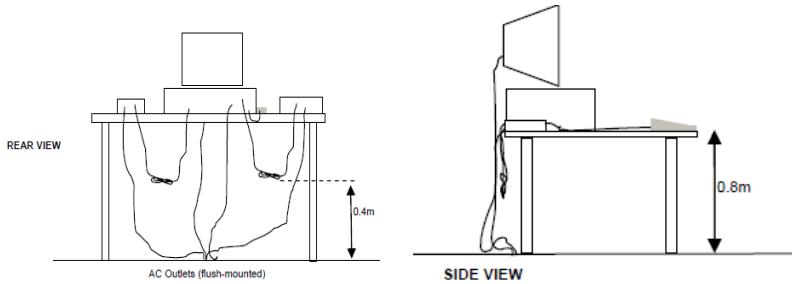
13	TEST: Radiated Emission		PASS
Parameters required prior to the test	Laboratory Ambient Temperature (°C)	15 to 35 °C	
	Relative Humidity (%)	30 to 60 %	
Parameters recorded during the test	Laboratory Ambient Temperature (°C)	22°C	
	Relative Humidity (%)	54%	
	Air pressure (hPa)	1020	
—	Frequency	Application Point	
Fully configured sample tested at the power line frequency	24Vdc	Enclosure	
Equipment mode:	Operation mode	#1	
FCC Standard	§15.205; §15.209; §15.247		
Frequency (MHz)	Quasi-peak (dBuV)	Average (dBuV)	Result
0.15-0.5	66 to 56	56 to 46	PASS
0.5-5	56	46	PASS
5-30	60	50	PASS

Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table :

Frequency (MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	30
30-88	100**	3
88-216	150**	3
216-960	200**	3
Above 960	500	3

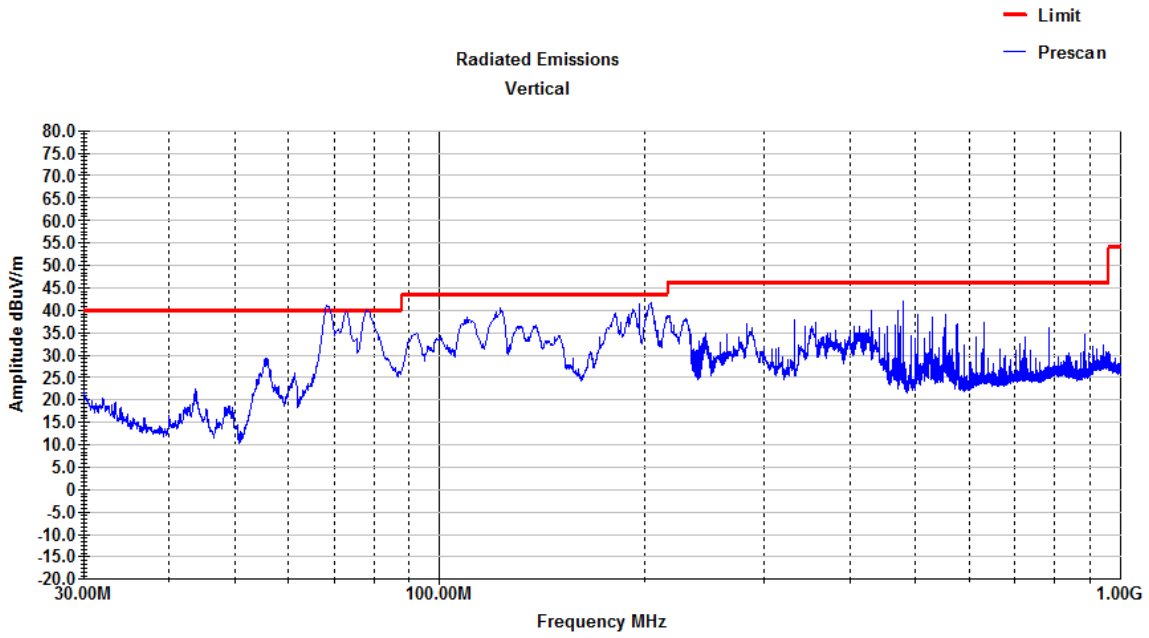
**Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this part, e.g., §§15.231 and 15.241.

Further information to test setup

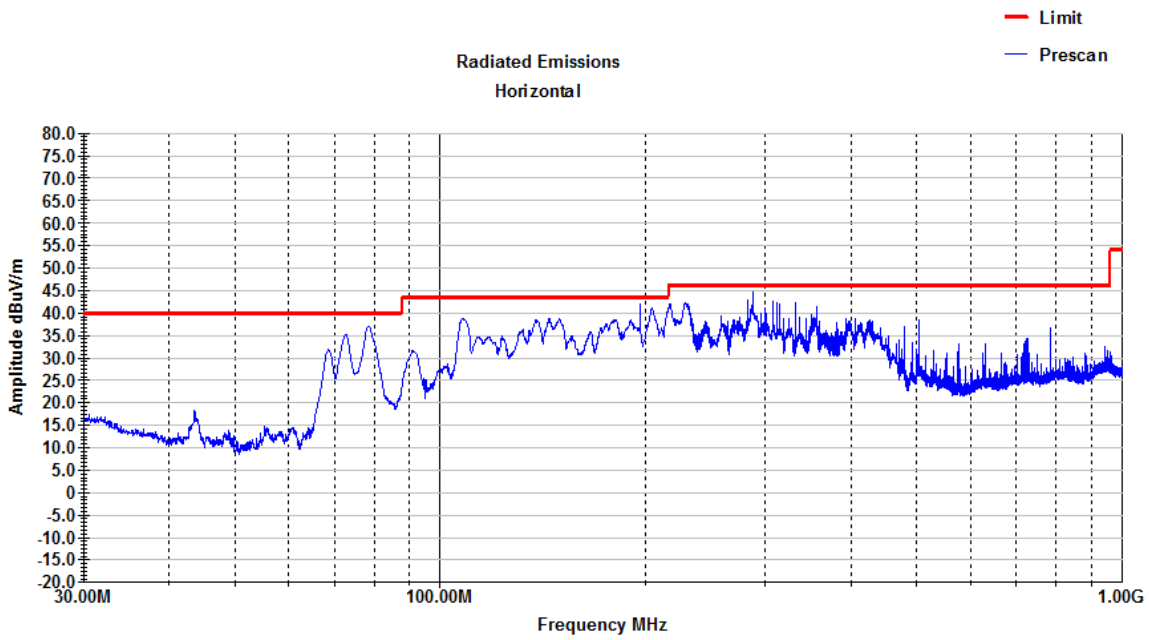


Test Equipment Used					
Description	Manufacturer	Model	Identifier	Calibration date	Calibration due
CSSA	ETS Lindgren	FACT3	87020484	10/2016	10/2018
EMI Test Receiver	R&S	ESW44	87020967	06/2017	06/2018
Antenna BiConiLog	ETS Lindgren	3124E	87020457	05/2017	05/2020
Antenna Horn with Preamplifier	ETS Lindgren	3117-PA	87020458	05/2017	05/2020
2xAntenna Horn with Preamplifier	ETS Lindgren	114514 120722	87020459 87020460	05/2017	05/2020

Graphical representation of Radiated Emission Measurement
Operation Mode: #1
Frequency: 30MHz – 1GHz
Antenna Polarization: Vertical
Channel: Low / Standard: IEE 802.11g (worst case)



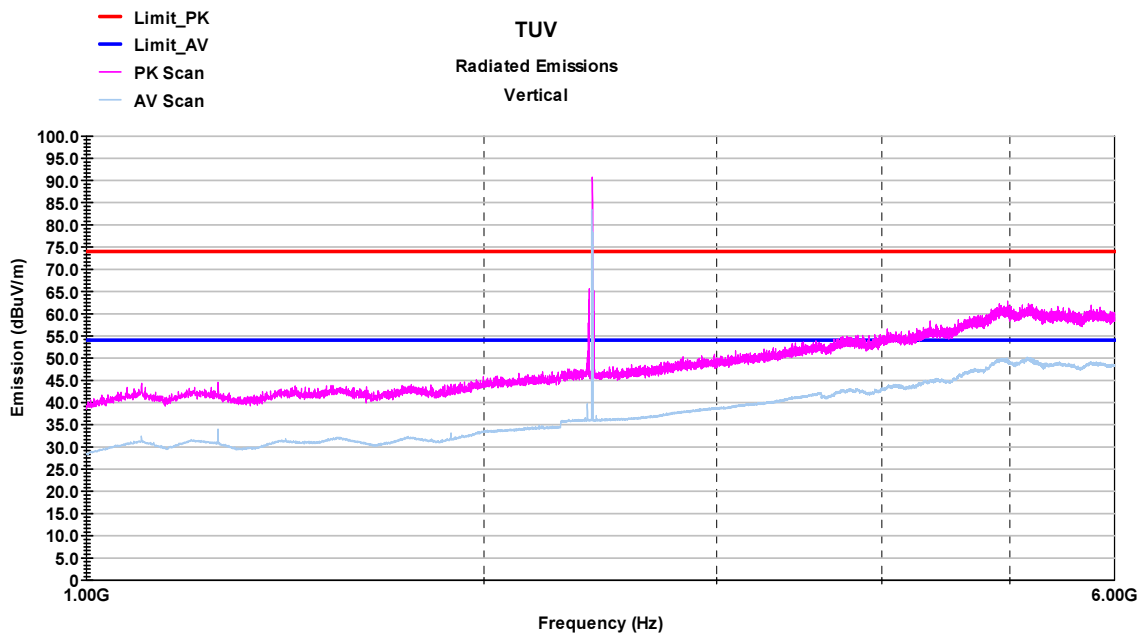
Graphical representation of Radiated Emission Measurement
Operation Mode: #1
Frequency: 30MHz – 1GHz
Antenna Polarization: Horizontal
Channel: Low / Standard: IEE 802.11g (worst case)



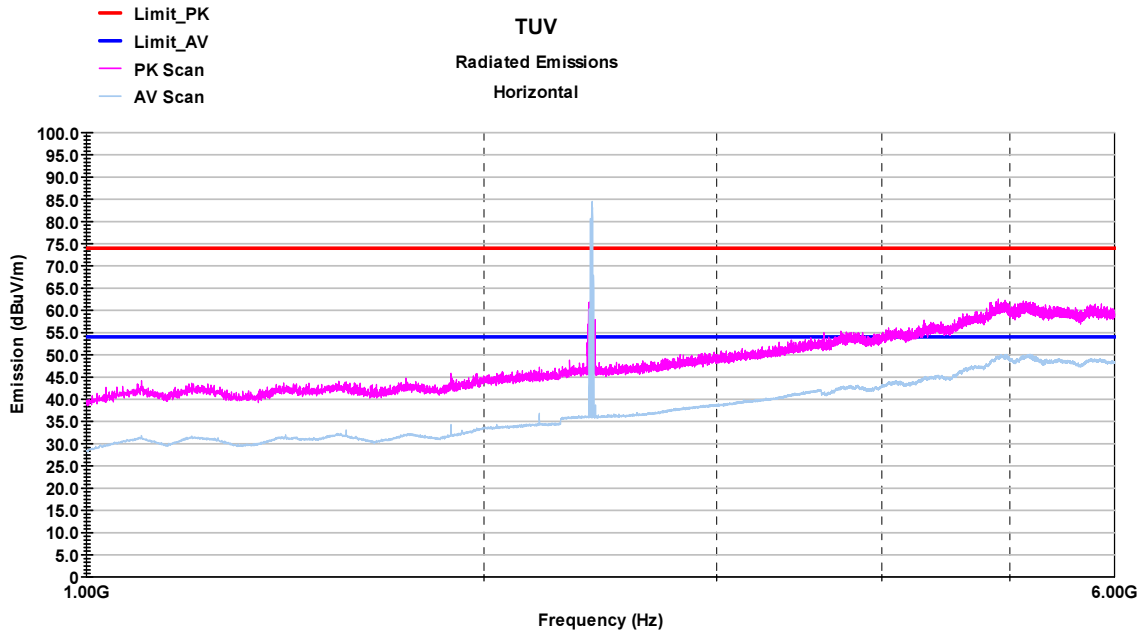
Tabulated results of Radiated Emission Measurement
Operation Mode: #1
Frequency: 30MHz – 1GHz

Frequency (MHz)	QP (dBuV/m)	Margin (dB)	TT (deg)	Tower (cm)	Polarization (H or V)	Correction (dB)
68.470 MHz	36.057	-3.943	90.000	108.000	V	6.897
72.910 MHz	38.756	-1.244	21.000	116.000	V	6.983
78.370 MHz	38.718	-1.282	164.000	104.000	V	7.027
287.980 MHz	33.105	-12.915	360.000	120.000	H	13.132

Graphical representation of Radiated Emission Measurement
Operation Mode: #1
Frequency: 1GHz – 6GHz
Antenna Polarization: Vertical
Channel: Low / Standard: IEE 802.11g (worst case)

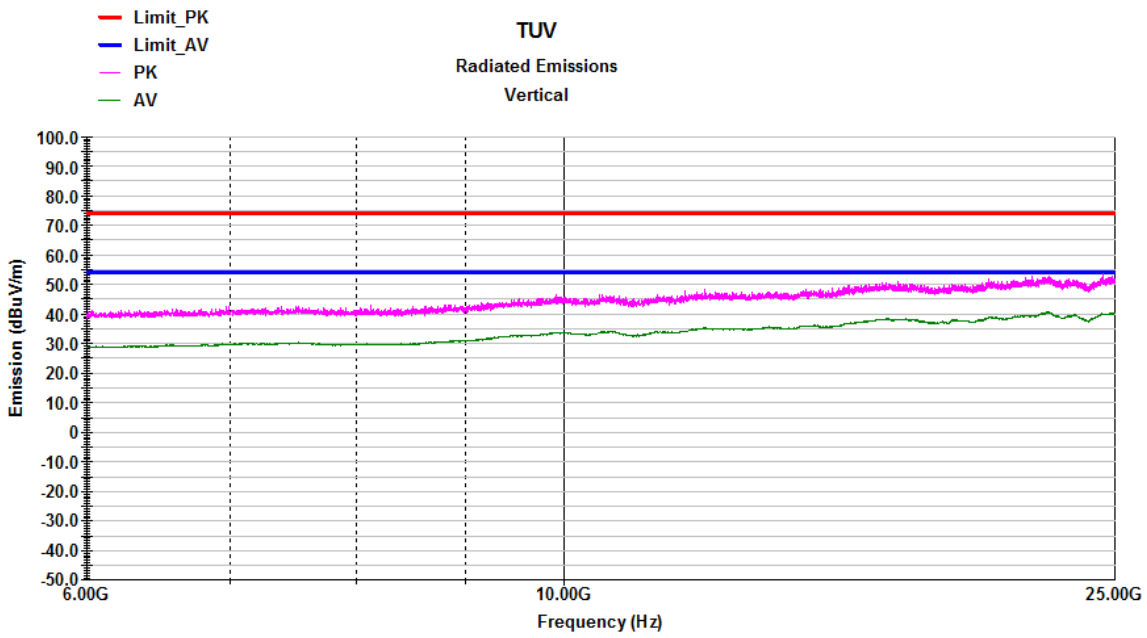


Graphical representation of Radiated Emission Measurement
Operation Mode: #1
Frequency: 1GHz – 6GHz
Antenna Polarization: Horizontal
Channel: Low / Standard: IEE 802.11g (worst case)

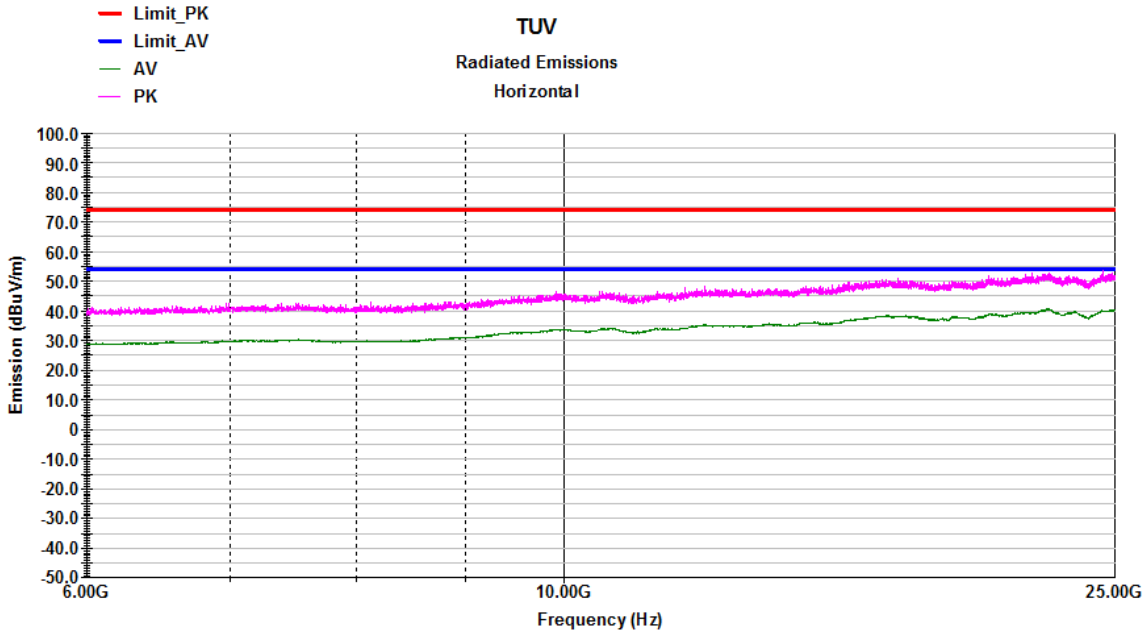


Tabulated results of Radiated Emission Measurement
Operation Mode: #1
Frequency: 1GHz - 6GHz

Graphical representation of Radiated Emission Measurement
Operation Mode: #1
Frequency: 6GHz – 25GHz
Antenna Polarization: Vertical
Channel: Low / Standard: IEE 802.11g (worst case)



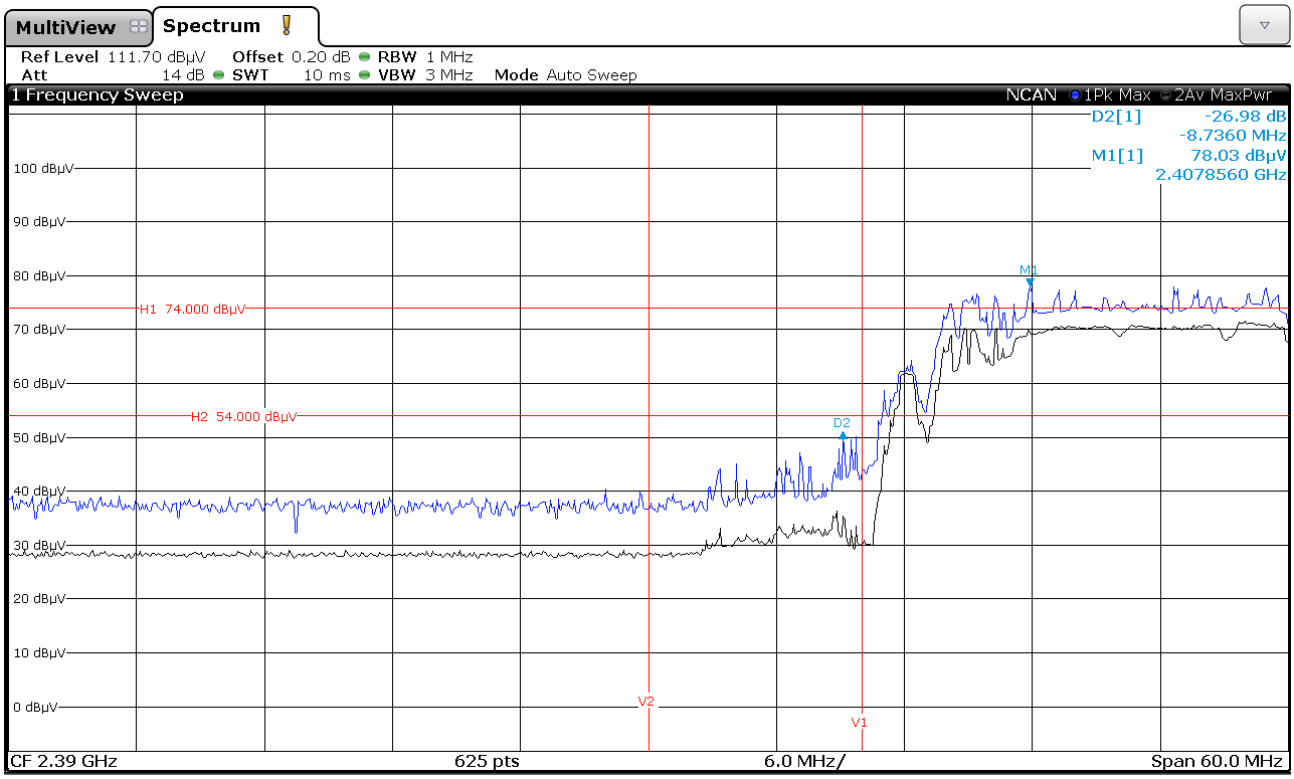
Graphical representation of Radiated Emission Measurement
Operation Mode: #1
Frequency: 6GHz – 25GHz
Antenna Polarization: Horizontal
Channel: Low / Standard: IEE 802.11g (worst case)



Tabulated results of Radiated Emission Measurement
Operation Mode: #1
Frequency: 6GHz - 25GHz

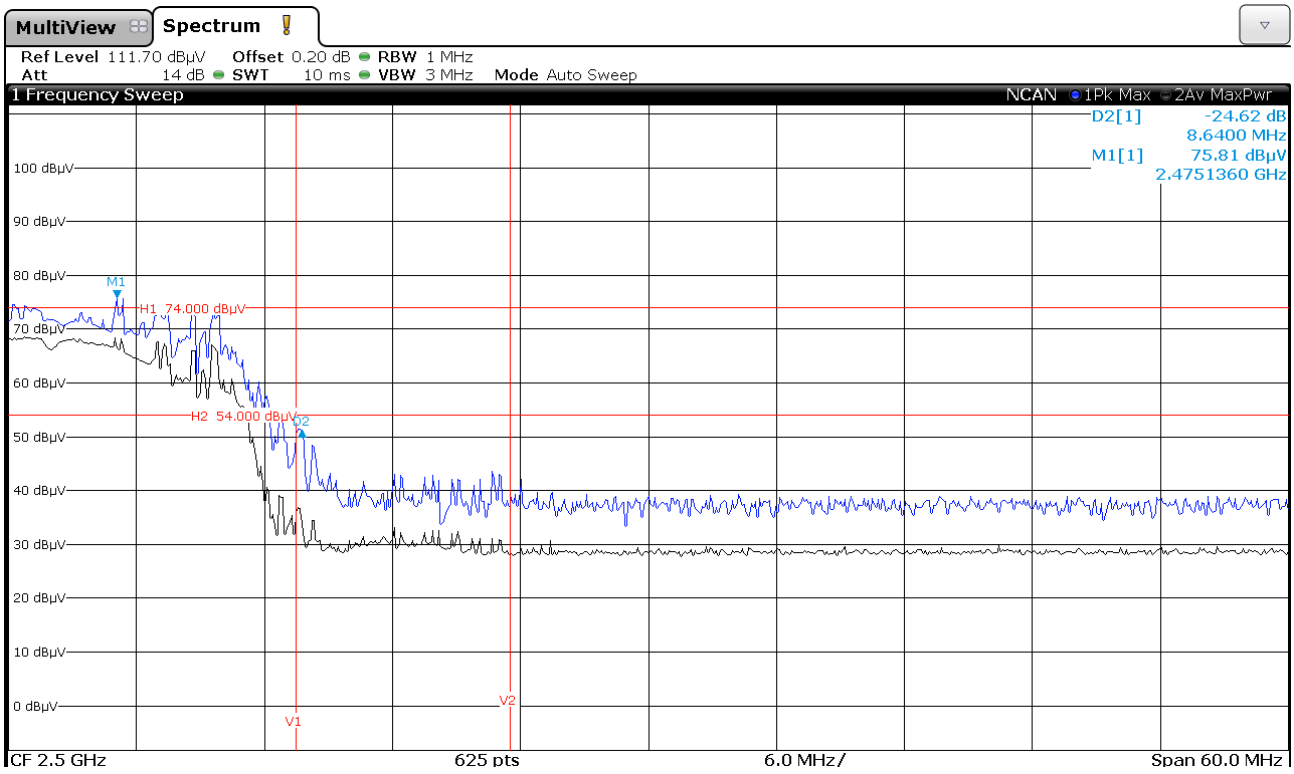
Graphical representation of Antenna Port Spurious Emission - Radiated
Operation Mode: #1
Standard: IEE 802.11g (worst case)
Channel: Low

BAND EDGE

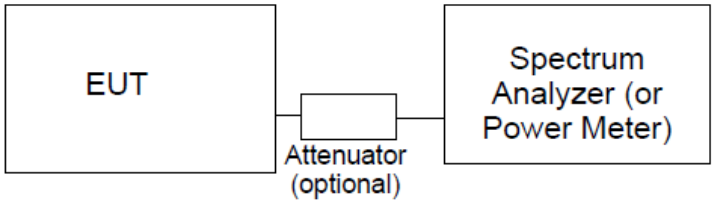


Graphical representation of Antenna Port Spurious Emission - Radiated
Operation Mode: #1
Standard: IEE 802.11g (worst case)
Channel: High

BAND EDGE



13. Test Conditions and Results – 6dB BANDWIDTH

14	TEST: Radiated Emission	PASS
Parameters required prior to the test	Laboratory Ambient Temperature (°C)	15 to 35 °C
	Relative Humidity (%)	30 to 60 %
Parameters recorded during the test	Laboratory Ambient Temperature (°C)	24°C
	Relative Humidity (%)	48%
	Air pressure (hPa)	1020
—	Frequency	Application Point
Fully configured sample tested at the power line frequency	24Vdc	SMA Connector
Equipment mode:	Operation mode	#1
FCC Standard	§15.247	
Systems using digital modulation techniques may operate in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.		
Further information to test setup		

Test Equipment Used					
Description	Manufacturer	Model	Identifier	Calibration date	Calibration due
EMI Test Receiver	R&S	ESW44	87020967	06/2017	06/2018
20dB Attenuator	RS Components	Huber & Suhner	87020534	10/2017	10/2018

Test Results – Protocol b			
Channel	Frequency (MHz)	6dB Bandwidth (MHz)	Minimum Limit (MHz)
1	2412	14.585	0,5
6	2437	14.505	0,5
11	2462	14.585	0,5

Test Results – Protocol g			
Channel	Frequency (MHz)	6dB Bandwidth (MHz)	Minimum Limit (MHz)
1	2412	16.343	0,5
6	2437	16.343	0,5
11	2462	16.303	0,5

Test Results – Protocol n 20MHz			
Channel	Frequency (MHz)	6dB Bandwidth (MHz)	Minimum Limit (MHz)
1	2412	17.462	0,5
6	2437	17.462	0,5
11	2462	17.462	0,5

Test Results – Protocol n 40MHz			
Channel	Frequency (MHz)	6dB Bandwidth (MHz)	Minimum Limit (MHz)
3	2422	35.804	0,5
6	2437	35.724	0,5
9	2452	35.724	0,5

14. Test Conditions and Results – OUTPUT POWER

15	TEST: Output Power (conducted)	PASS
Parameters required prior to the test	Laboratory Ambient Temperature (°C)	15 to 35 °C
	Relative Humidity (%)	30 to 60 %
Parameters recorded during the test	Laboratory Ambient Temperature (°C)	22,5°C
	Relative Humidity (%)	51%
	Air pressure (hPa)	1020
—	Frequency	Application Point
Fully configured sample tested at the power line frequency	24Vdc	SMA Connector
Equipment mode:	Operation mode	#1
FCC Standard	§15.247	

(b) The maximum peak conducted output power of the intentional radiator shall not exceed the following:

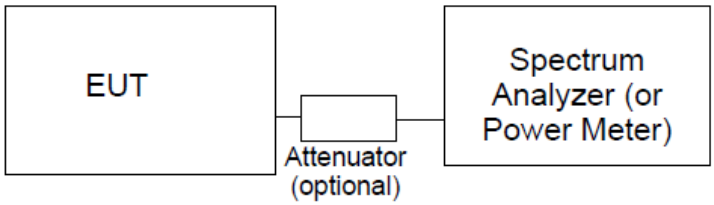
(1) For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

(2) For frequency hopping systems operating in the 902-928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.

(3) For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

(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.

Further information to test setup



Test Equipment Used					
Description	Manufacturer	Model	Identifier	Calibration date	Calibration due
Fast Power Sensor USB SENSOR HUB	R&S	NRP-Z81 NRP-Z5	87020796	08/2017	08/2018
20dB Attenuator	RS Components	Huber & Suhner	87020534	10/2017	10/2018

Test result of Peak Output Power (802.11b)

Channel	Channel Frequency (MHz)	Output Power			Limit
		Output power conducted (dBm)	Antenna gain (dBi)	Total Power (W)	(W)
1	2412	16.603	3.11	0,093	1
6	2437	15.843	2.95	0,075	1
11	2462	16.382	2.95	0,086	1

Test result of Peak Output Power (802.11g)

Channel	Channel Frequency (MHz)	Output Power			Limit
		Output power conducted (dBm)	Antenna gain (dBi)	Total Power (W)	(W)
1	2412	15.966	3.11	0,079	1
6	2437	15.967	2.95	0,079	1
11	2462	15.957	2.95	0,077	1

Test result of Peak Output Power (802.11n 20MHz)

Channel	Channel Frequency (MHz)	Output Power			Limit
		Output power conducted (dBm)	Antenna gain (dBi)	Total Power (W)	(W)
1	2412	9.065	3.11	0,017	1
6	2437	8.974	2.95	0,016	1
11	2462	9.033	2.95	0,016	1

Test result of Peak Output Power (802.11n 40MHz)

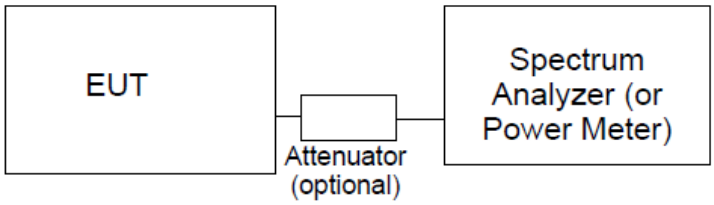
Channel	Channel Frequency (MHz)	Output Power			Limit
		Output power conducted (dBm)	Antenna gain (dB)	Total Power (W)	(W)
3	2422	5.162	3.11	0,006	1
6	2437	6.049	2.95	0,008	1
9	2452	4.987	2.95	0,006	1

15. Test Conditions and Results – CONDUCTED ANTENNA PORT SPURIOUS EMISSIONS

17	TEST: Conducted Antenna Port Spurious Emission (external antenna)	PASS
Parameters required prior to the test	Laboratory Ambient Temperature (°C)	15 to 35 °C
	Relative Humidity (%)	30 to 60 %
Parameters recorded during the test	Laboratory Ambient Temperature (°C)	22°C
	Relative Humidity (%)	50%
	Air pressure (hPa)	1020
—	Frequency	Application Point
Fully configured sample tested at the power line frequency	24Vdc	SMA Connector
Equipment mode:	Operation mode	#1
FCC Standard	§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. 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) (see §15.205(c)).

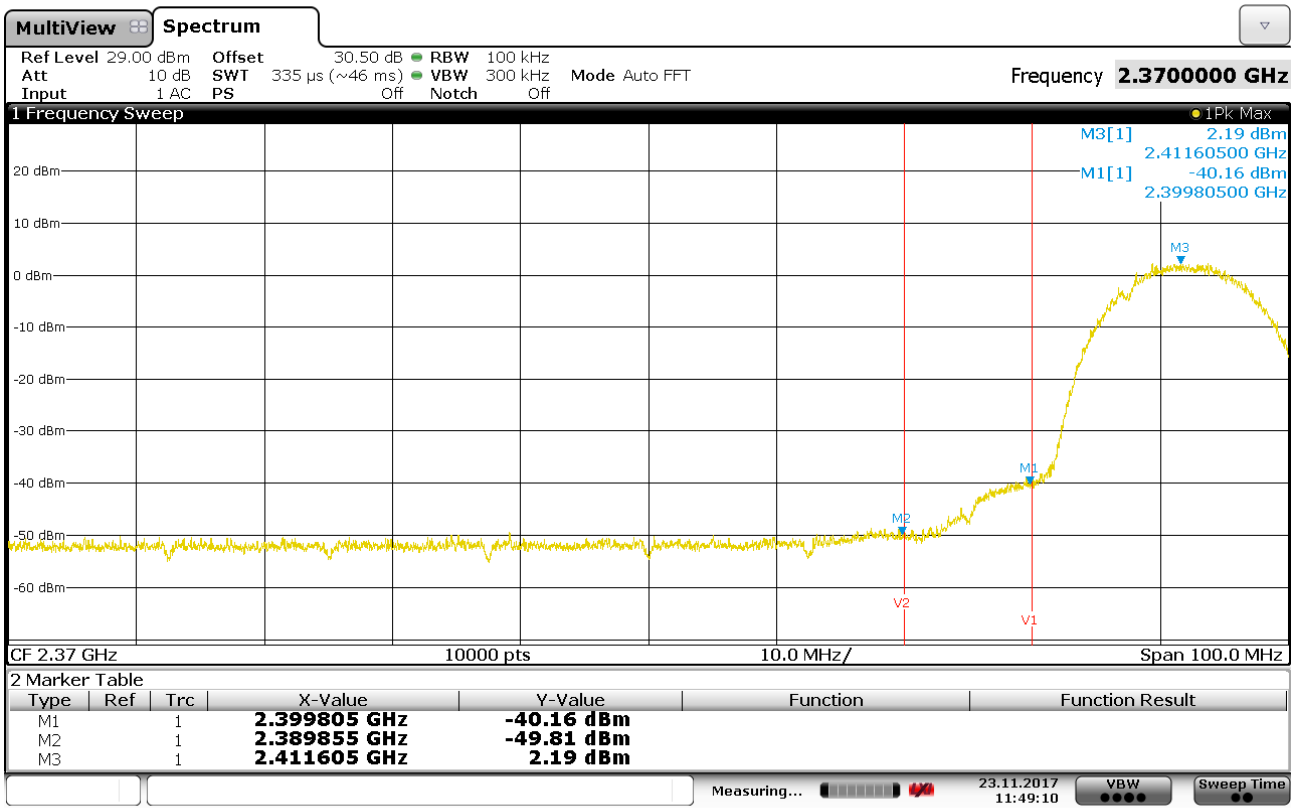
Further information to test setup



Test Equipment Used					
Description	Manufacturer	Model	Identifier	Calibration date	Calibration due
EMI Test Receiver	R&S	ESW44	87020967	06/2017	06/2018
20dB Attenuator	RS Components	Huber & Suhner	87020534	10/2017	10/2018

Graphical representation of Antenna Port Spurious Emission - Conducted
Operation Mode: #1
Standard: IEE 802.11b
Channel: #1
BAND EDGE

001

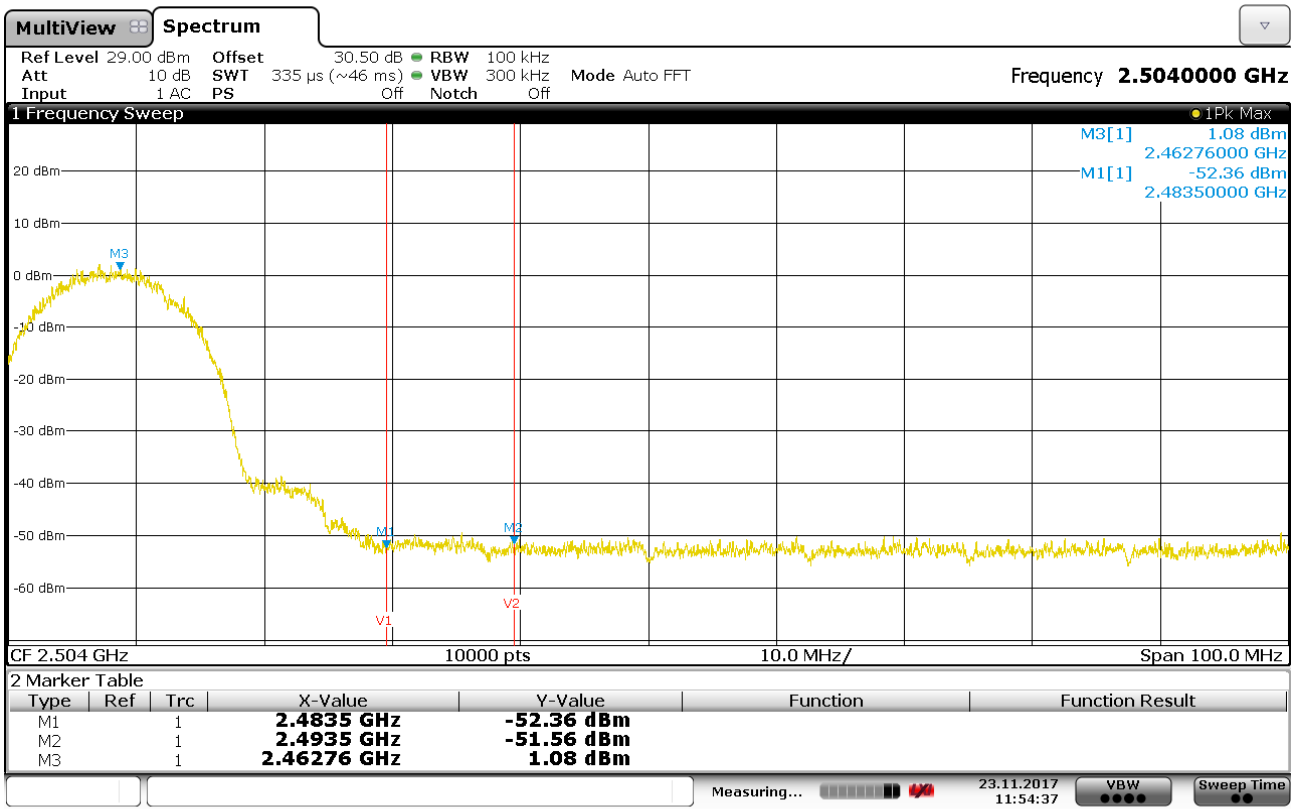


11:49:11 23.11.2017

Graphical representation of Antenna Port Spurious Emission - Conducted
Operation Mode: #1
Standard: IEE 802.11b
Channel: #11

BAND EDGE

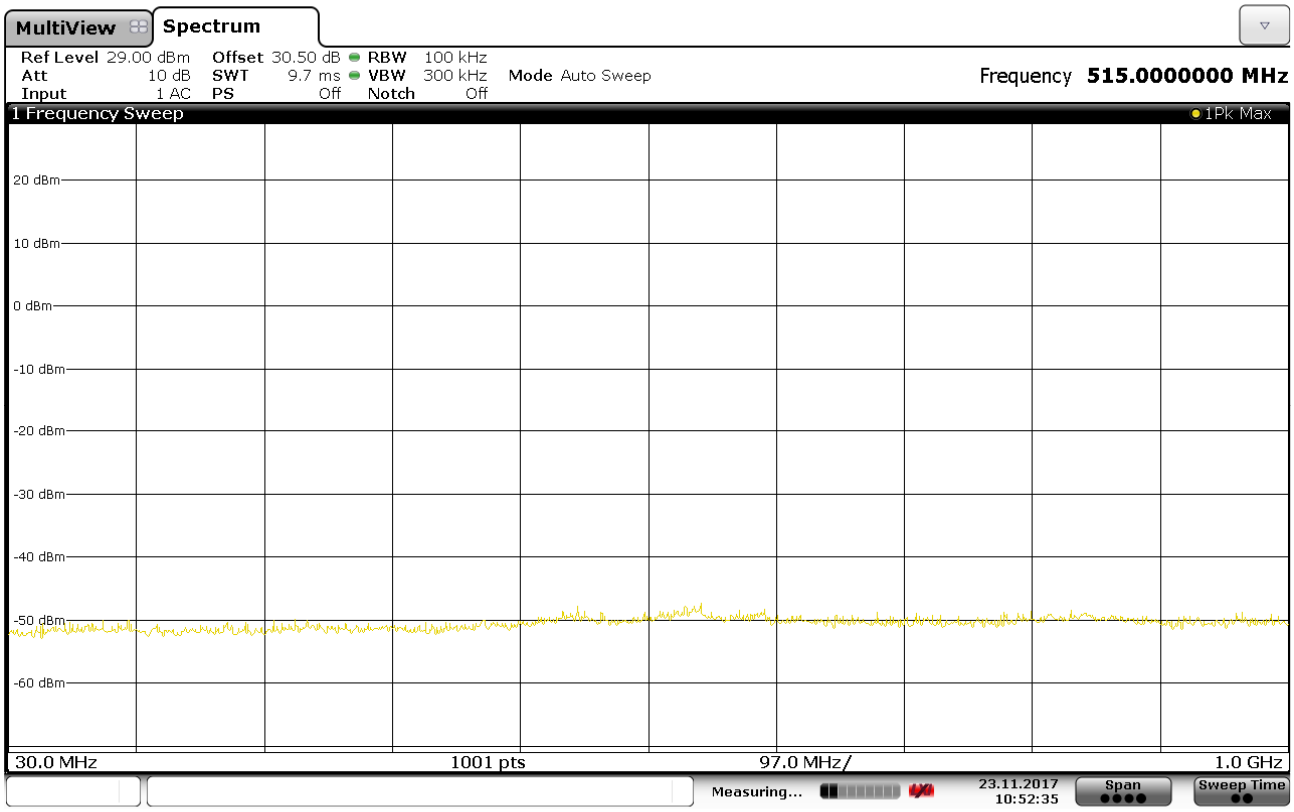
001



11:54:37 23.11.2017

Antenna Port Spurious Emission - Conducted
Operation Mode: #1
Standard: IEE 802.11b
Channel: #1

001



10:52:35 23.11.2017

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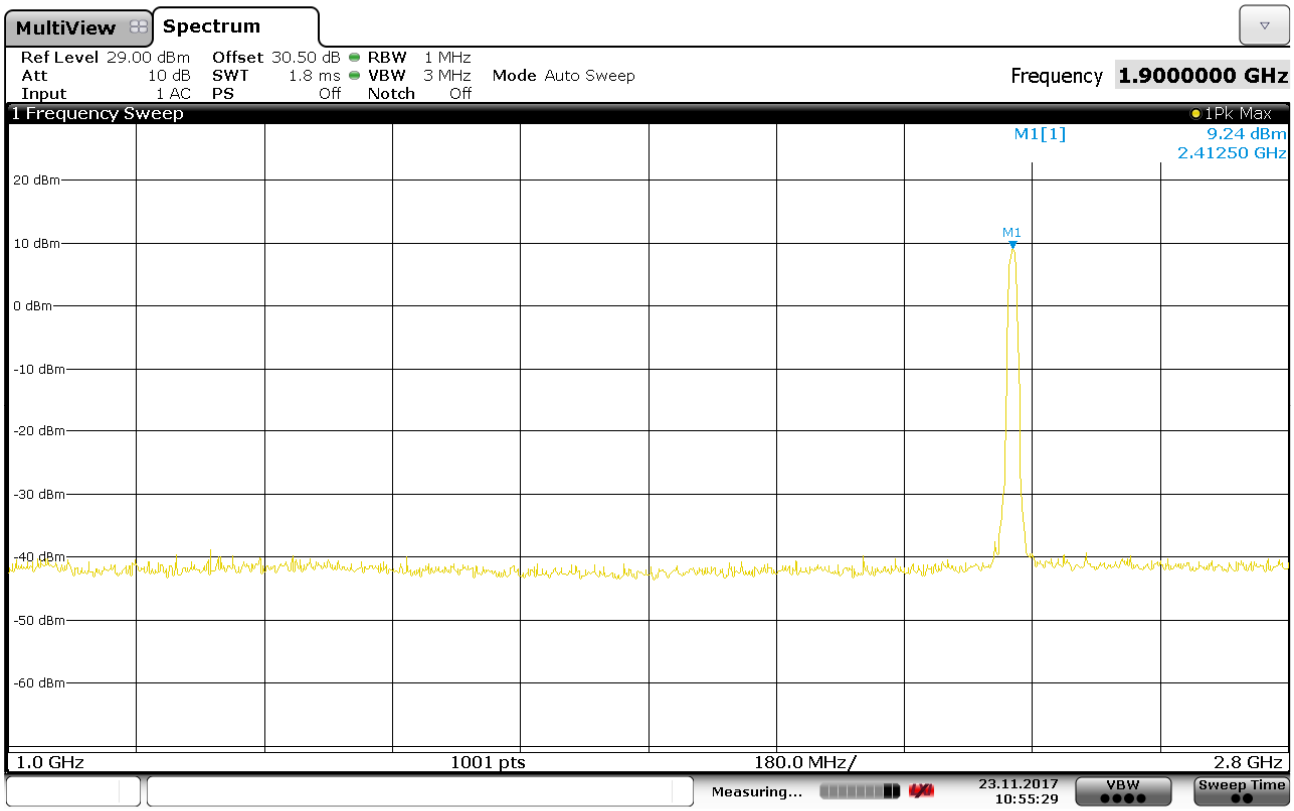

10:55:29 23.11.2017

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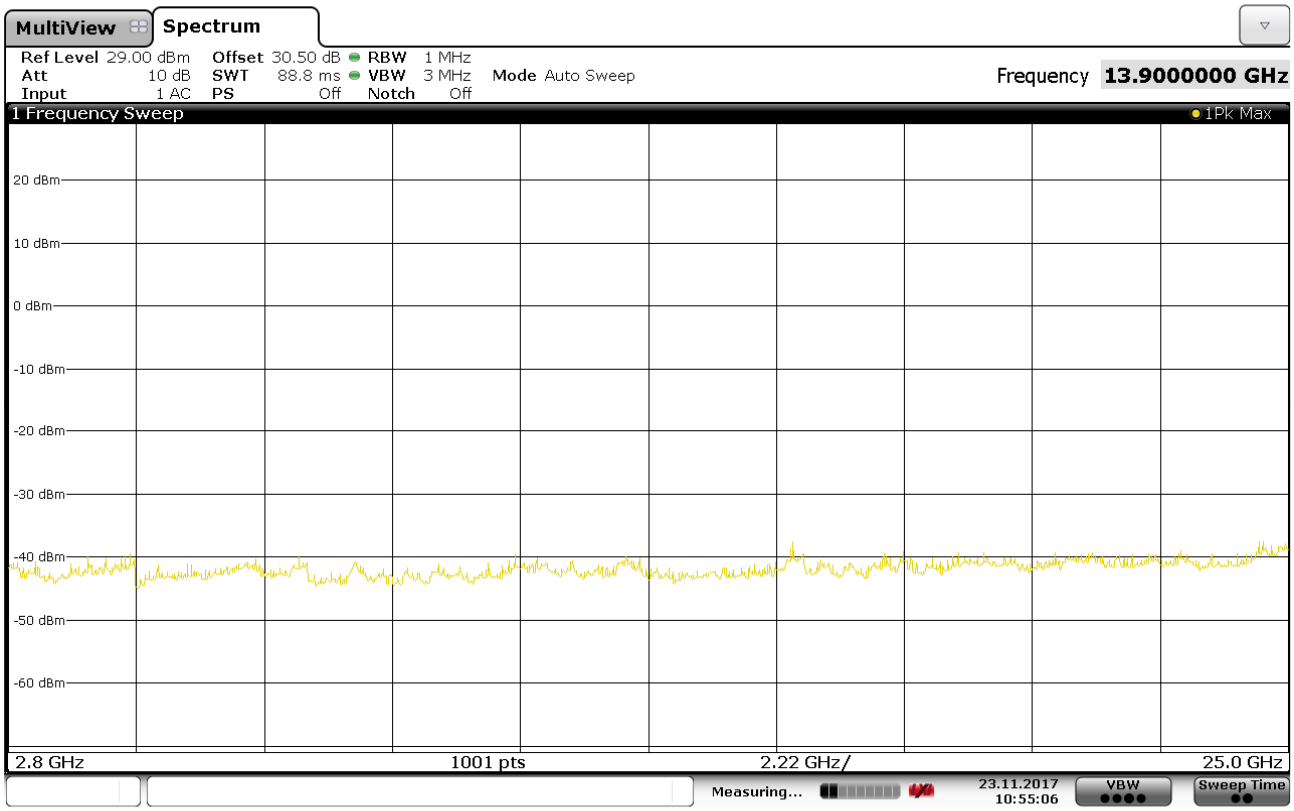

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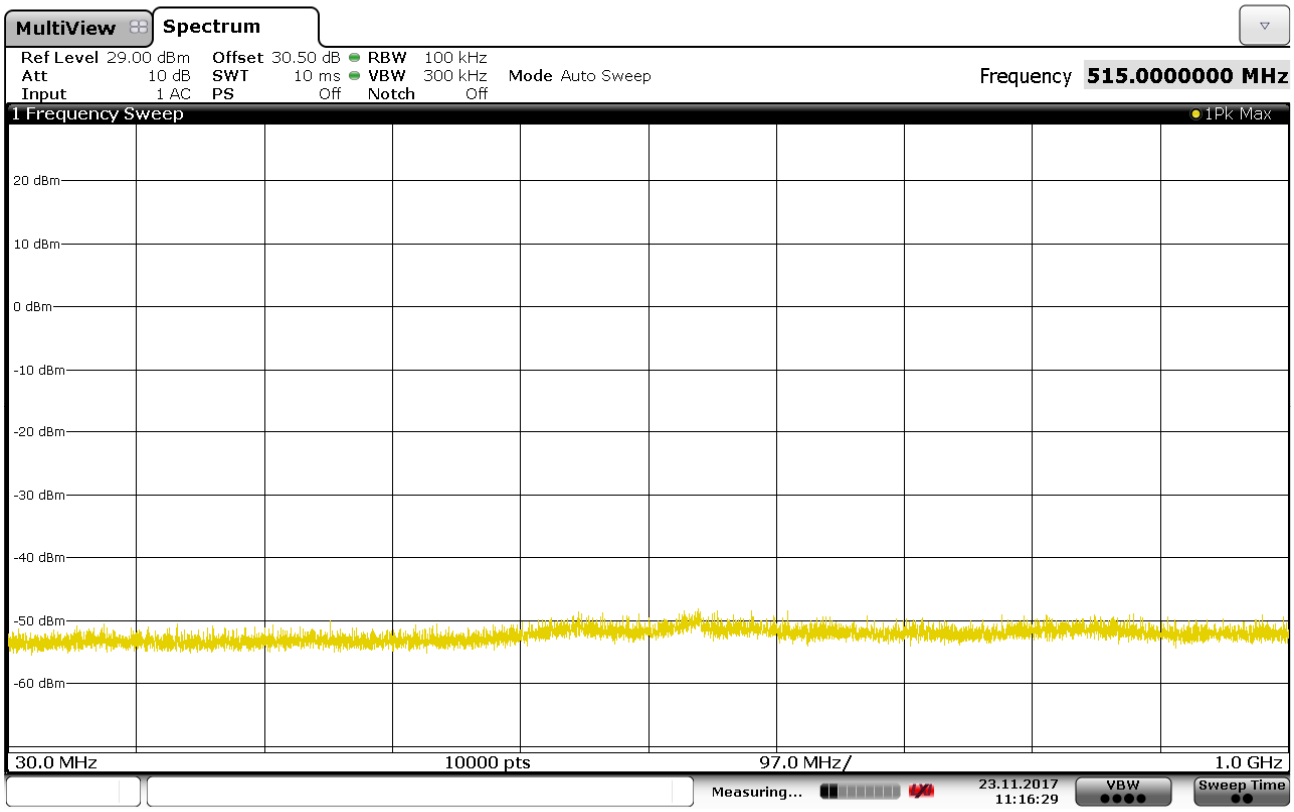
Antenna Port Spurious Emission - Conducted
Operation Mode: #1
Standard: IEE 802.11b
Channel: #6

001



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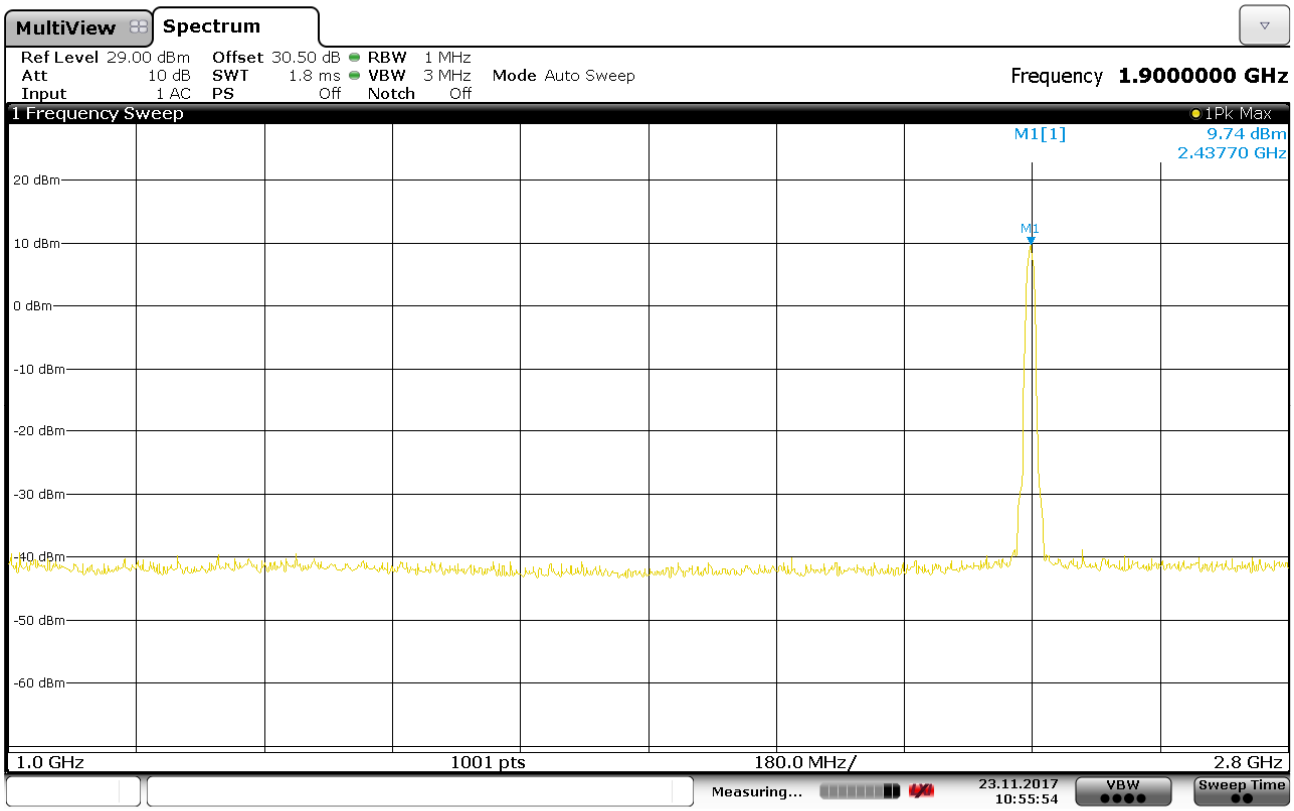

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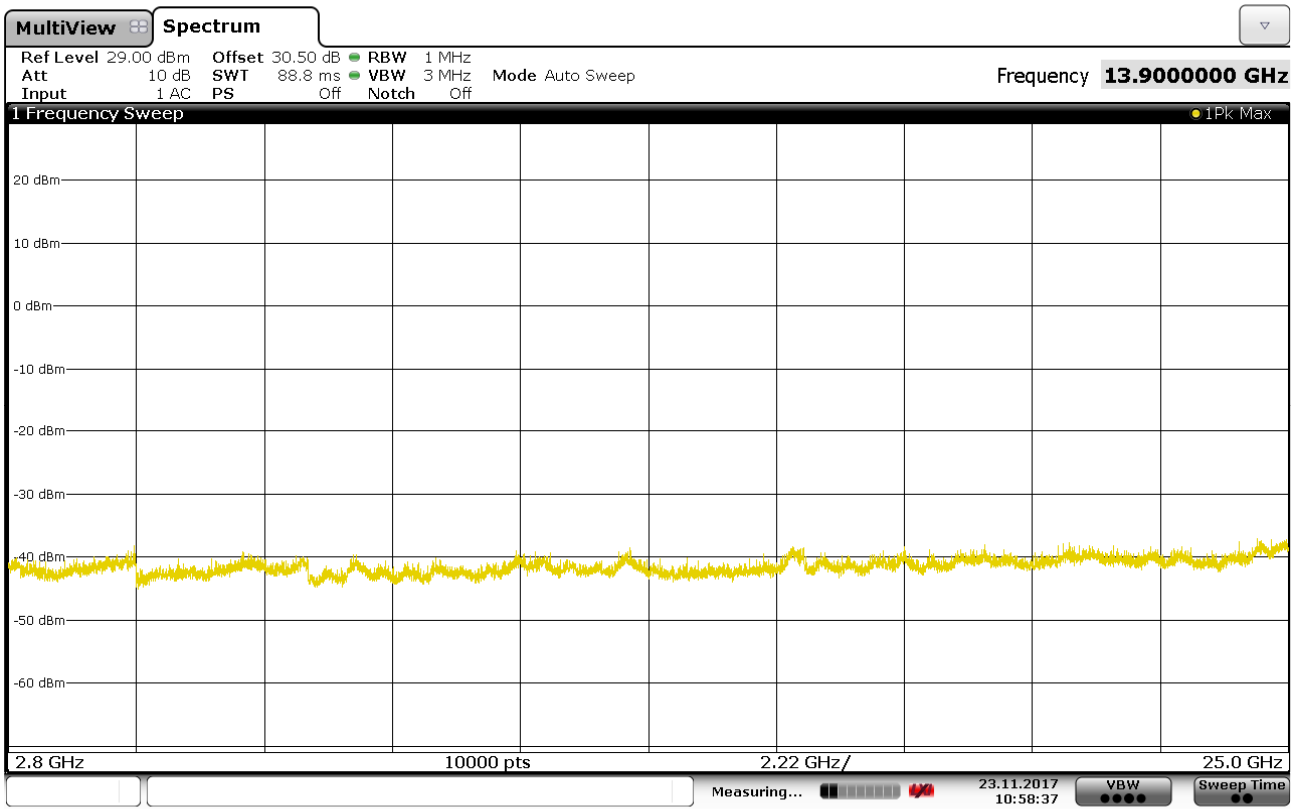

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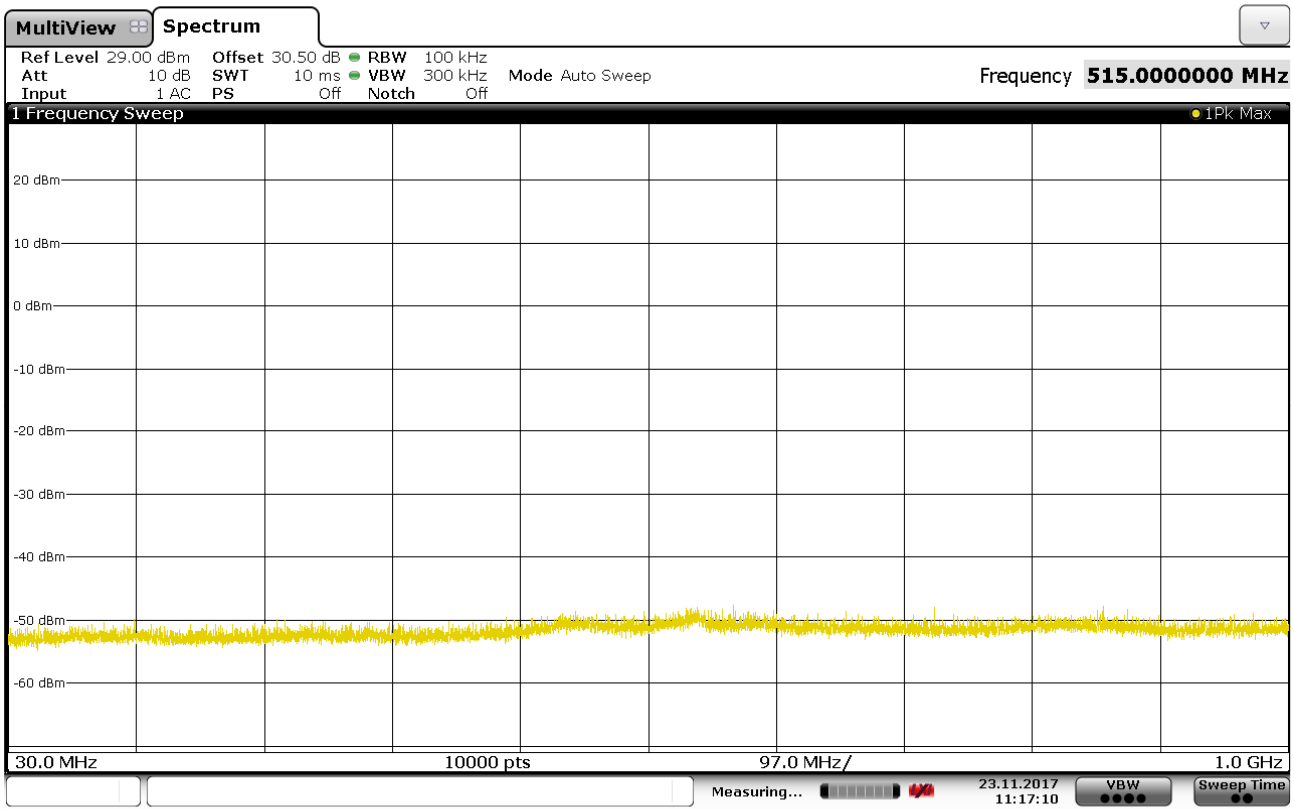
Antenna Port Spurious Emission - Conducted
Operation Mode: #1
Standard: IEE 802.11b
Channel: #11

001



11:17:11 23.11.2017

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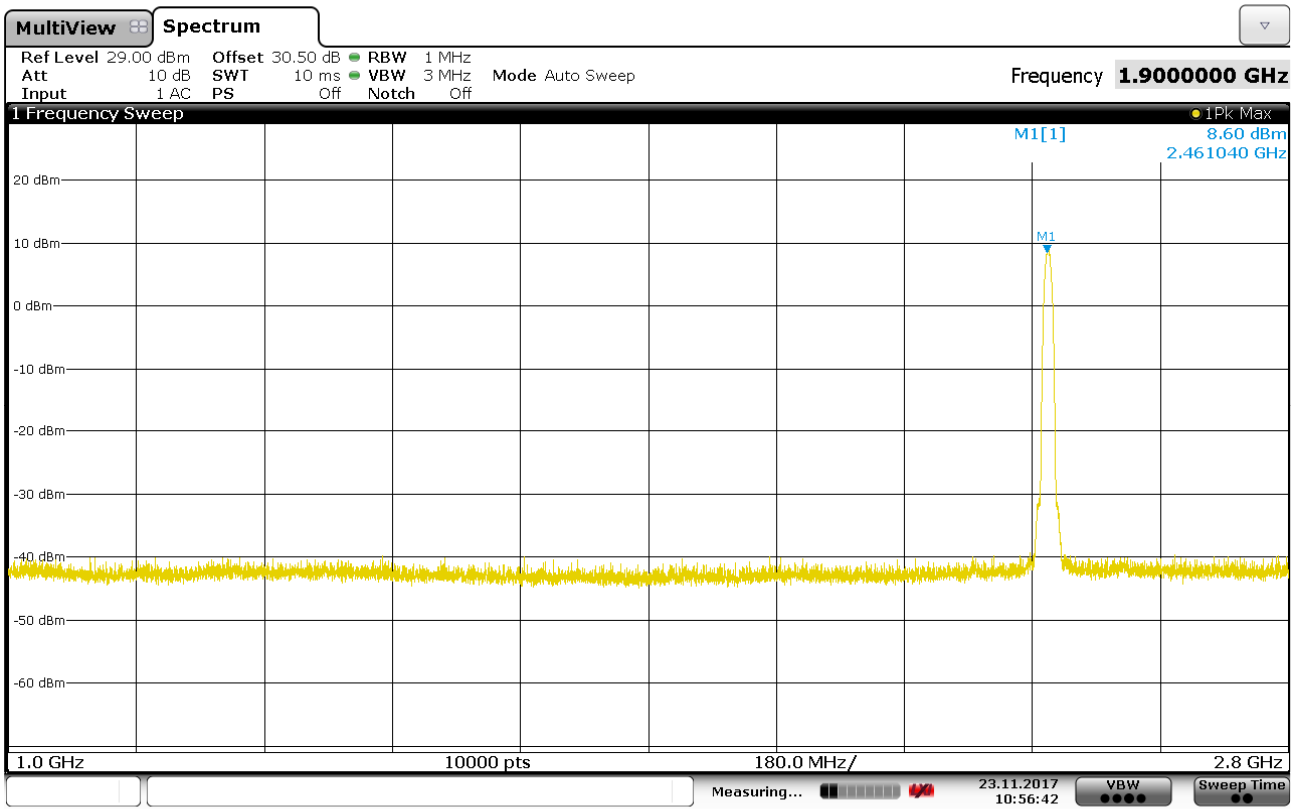

10:56:42 23.11.2017

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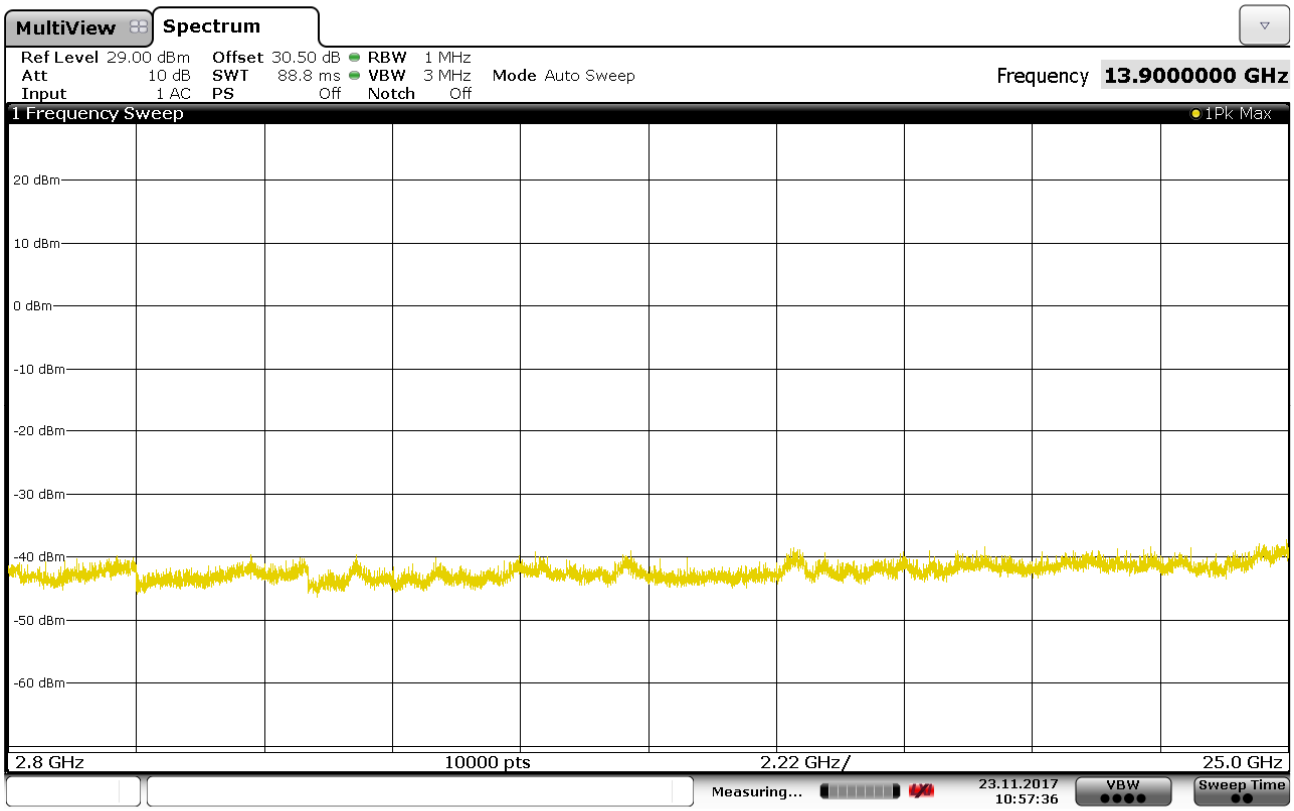
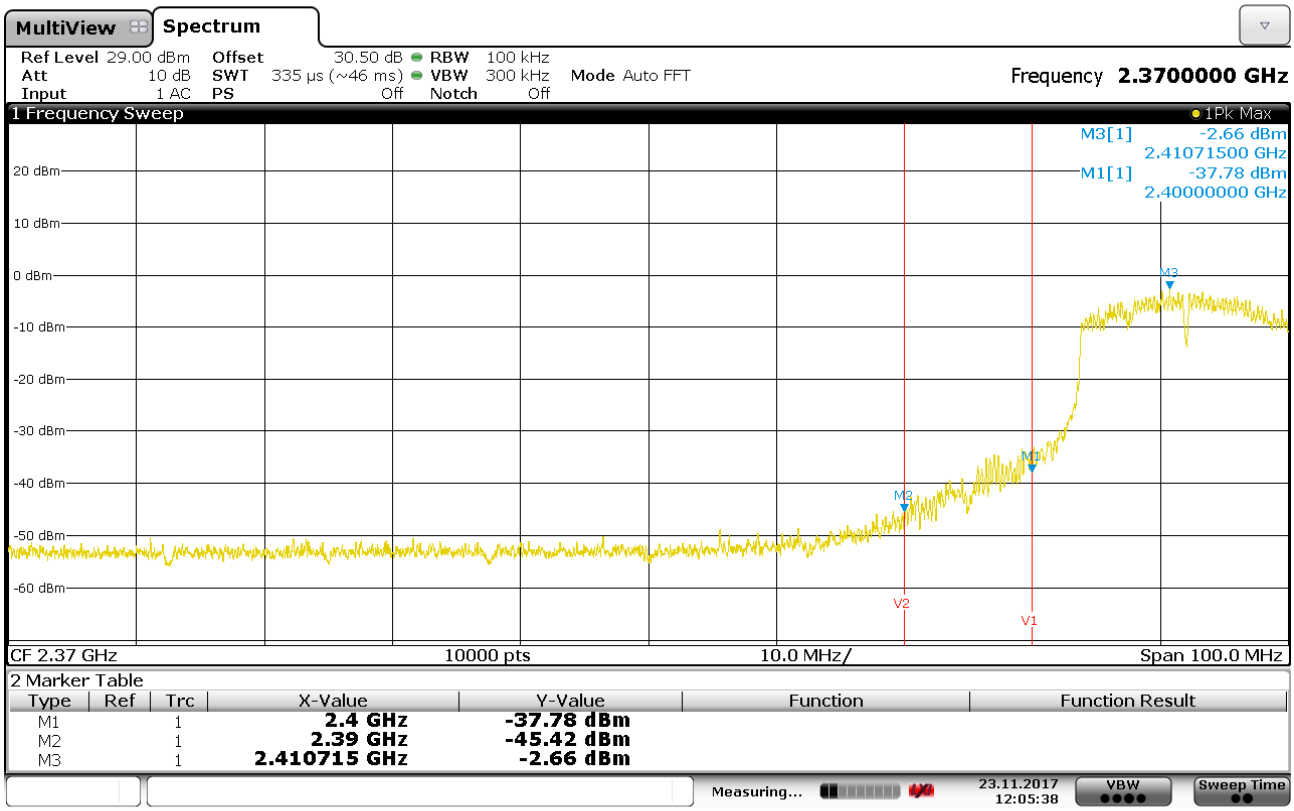


10:57:36 23.11.2017

Graphical representation of Antenna Port Spurious Emission - Conducted
Operation Mode: #1
Standard: IEE 802.11g
Channel: #1

BAND EDGE

001

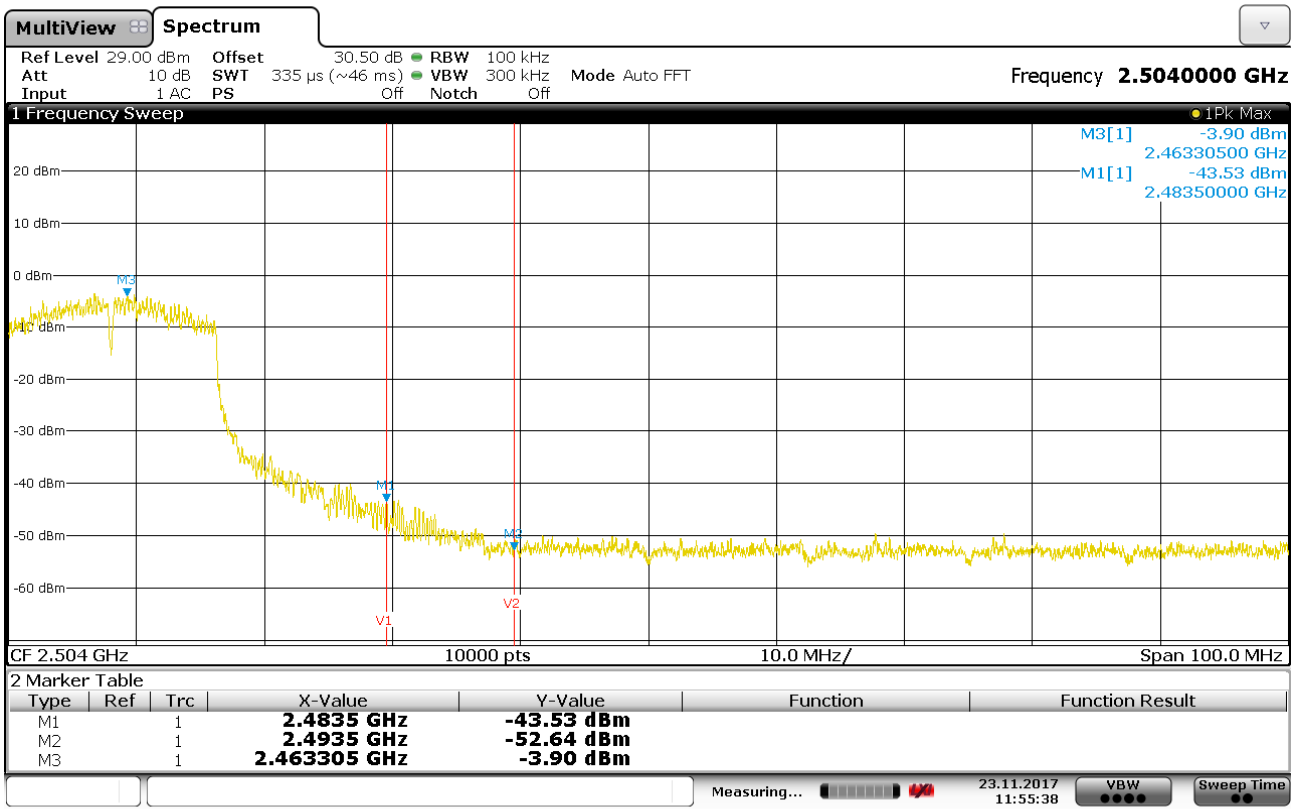


12:05:39 23.11.2017

Graphical representation of Antenna Port Spurious Emission - Conducted
Operation Mode: #1
Standard: IEE 802.11g
Channel: #11

BAND EDGE

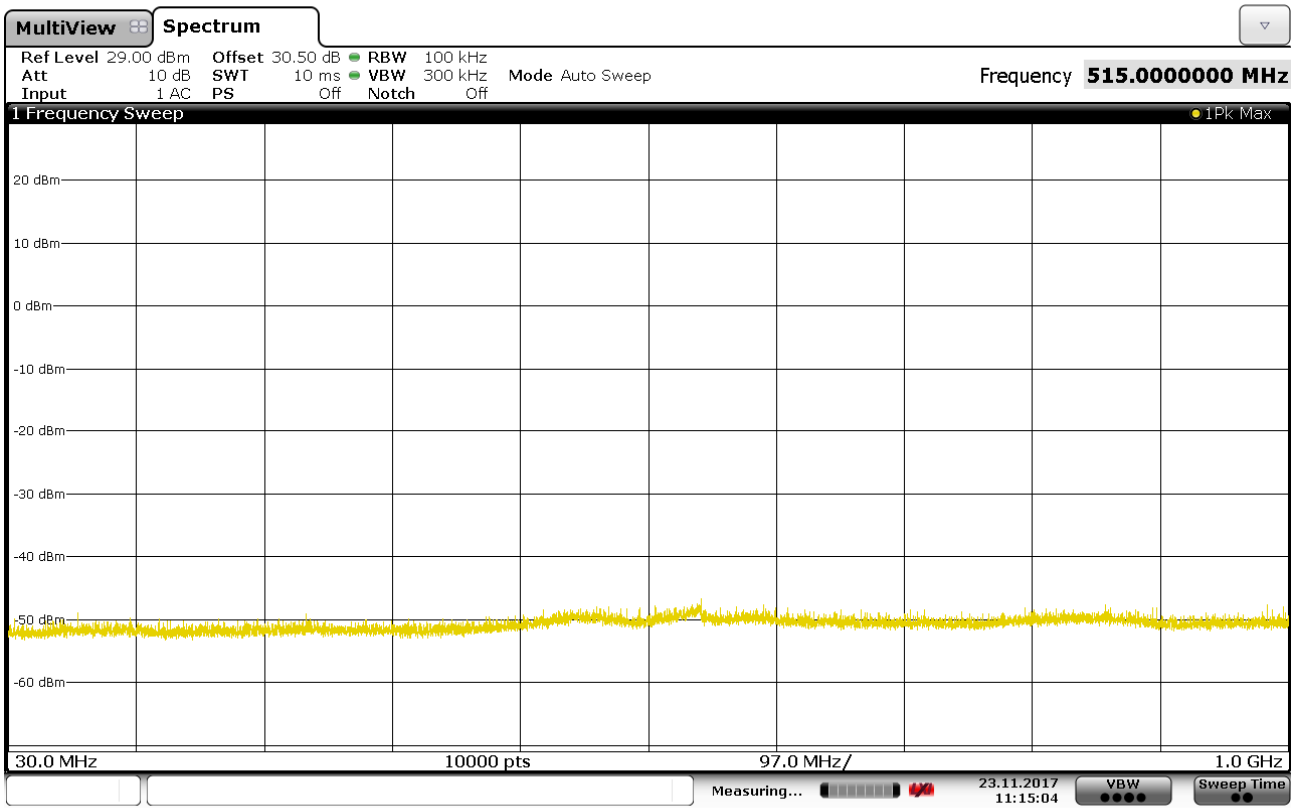
001



11:55:39 23.11.2017

Antenna Port Spurious Emission - Conducted
Operation Mode: #1
Standard: IEE 802.11g
Channel: #1

001



11:15:05 23.11.2017

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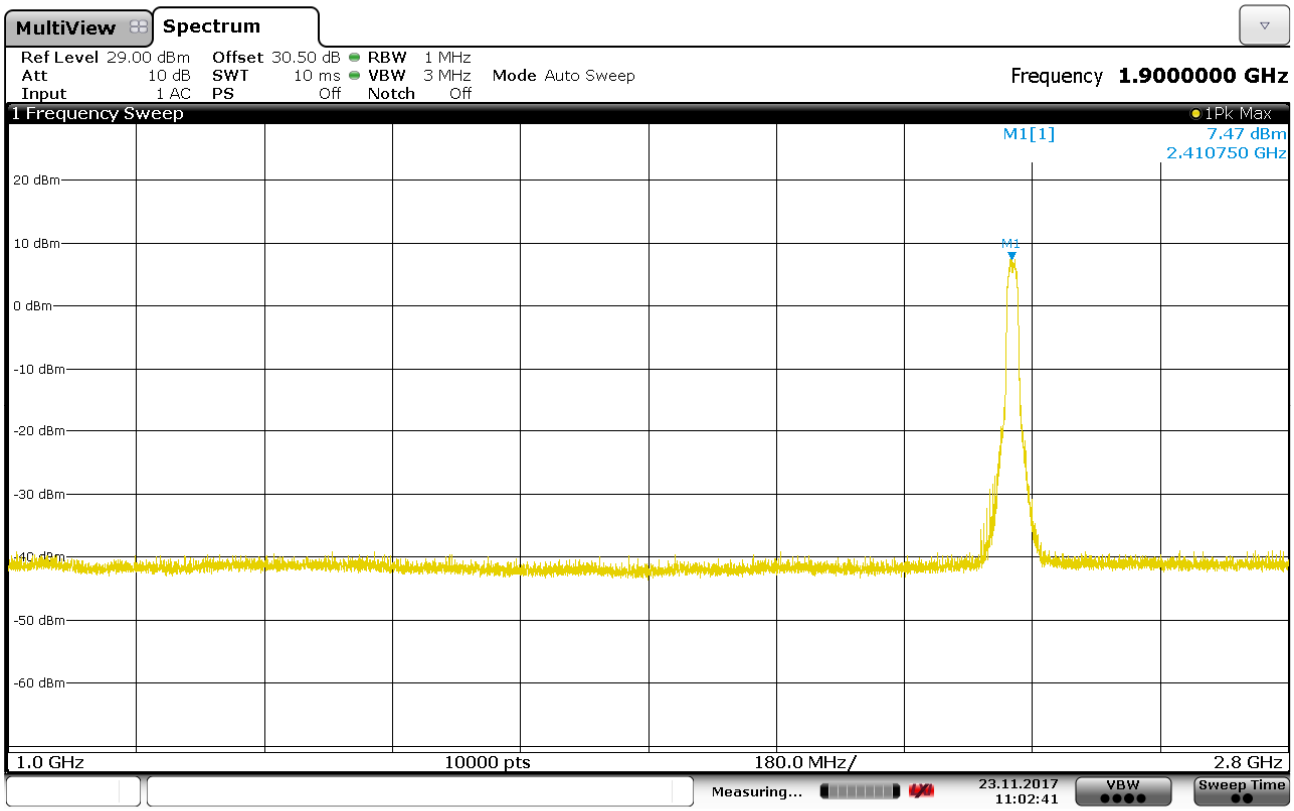

11:02:41 23.11.2017

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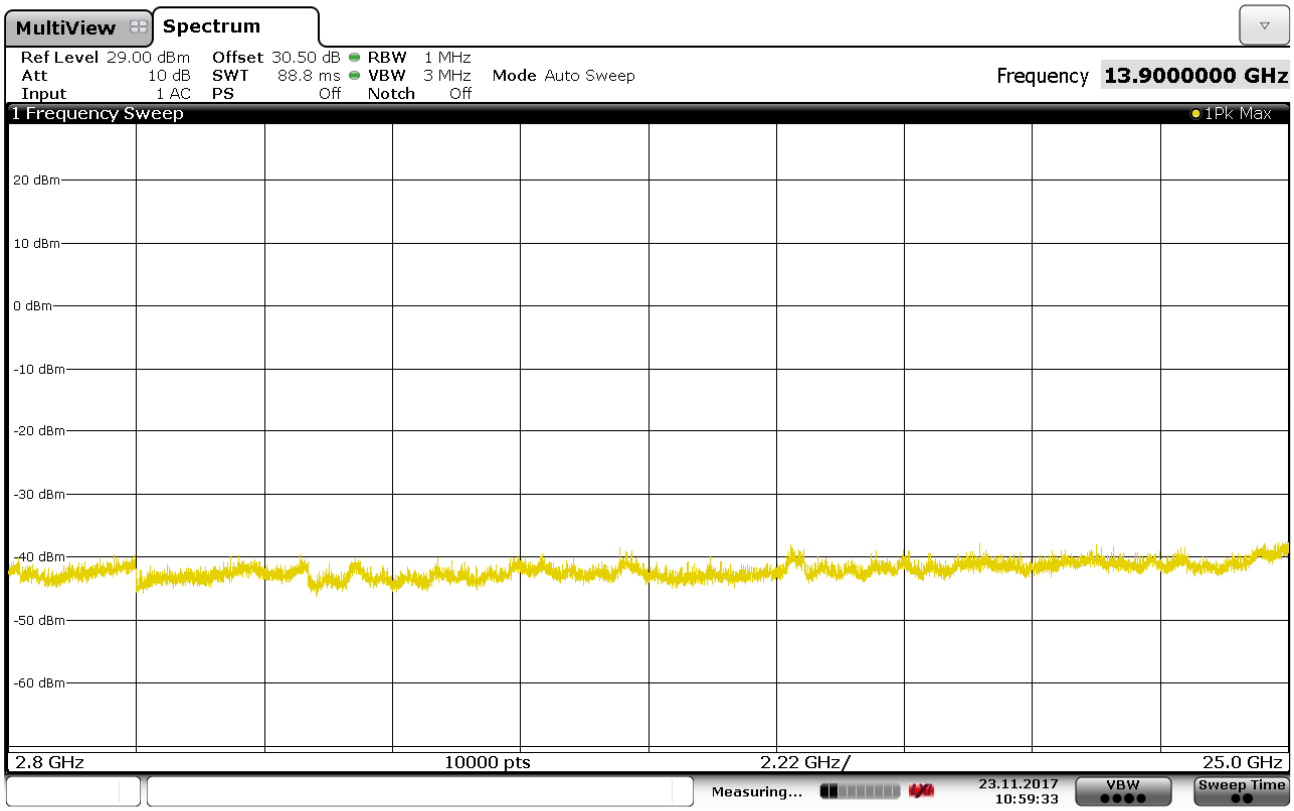
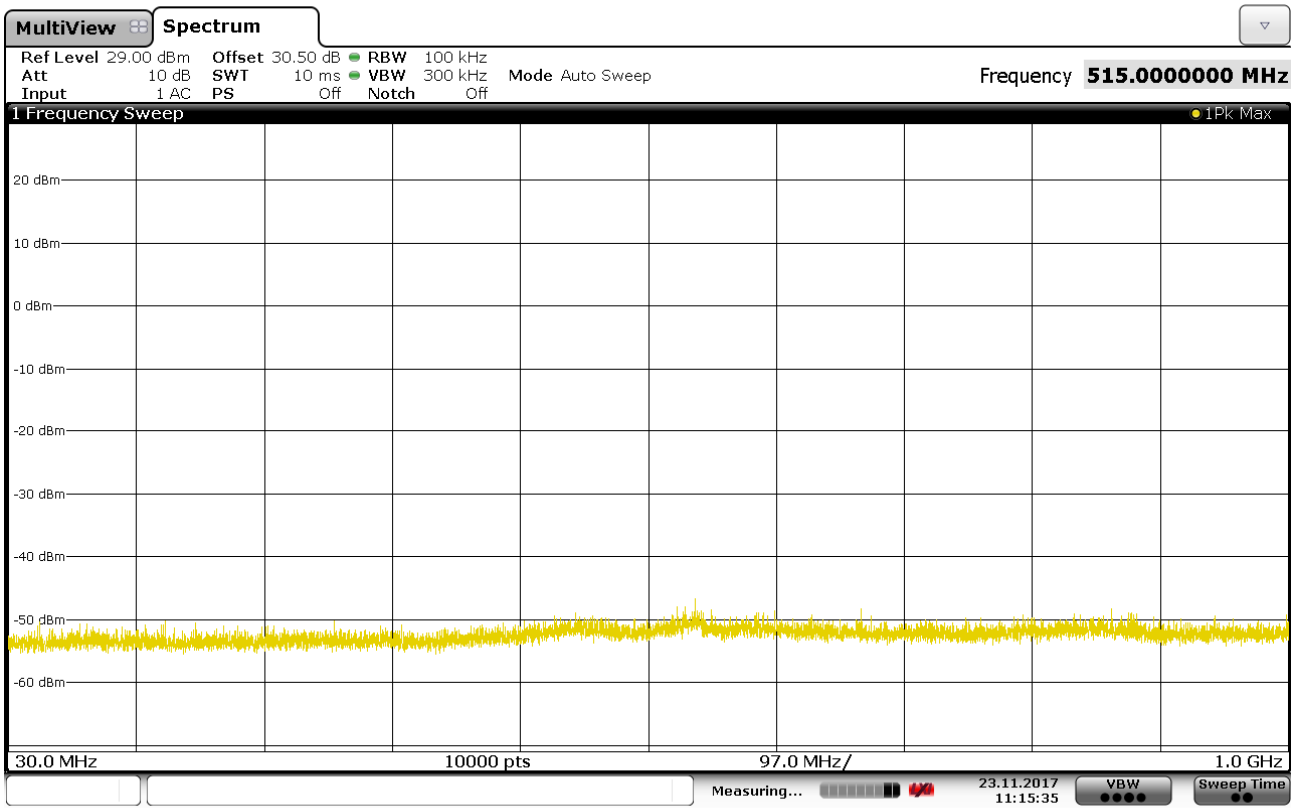


10:59:34 23.11.2017

Antenna Port Spurious Emission - Conducted
Operation Mode: #1
Standard: IEE 802.11g
Channel: #6

001



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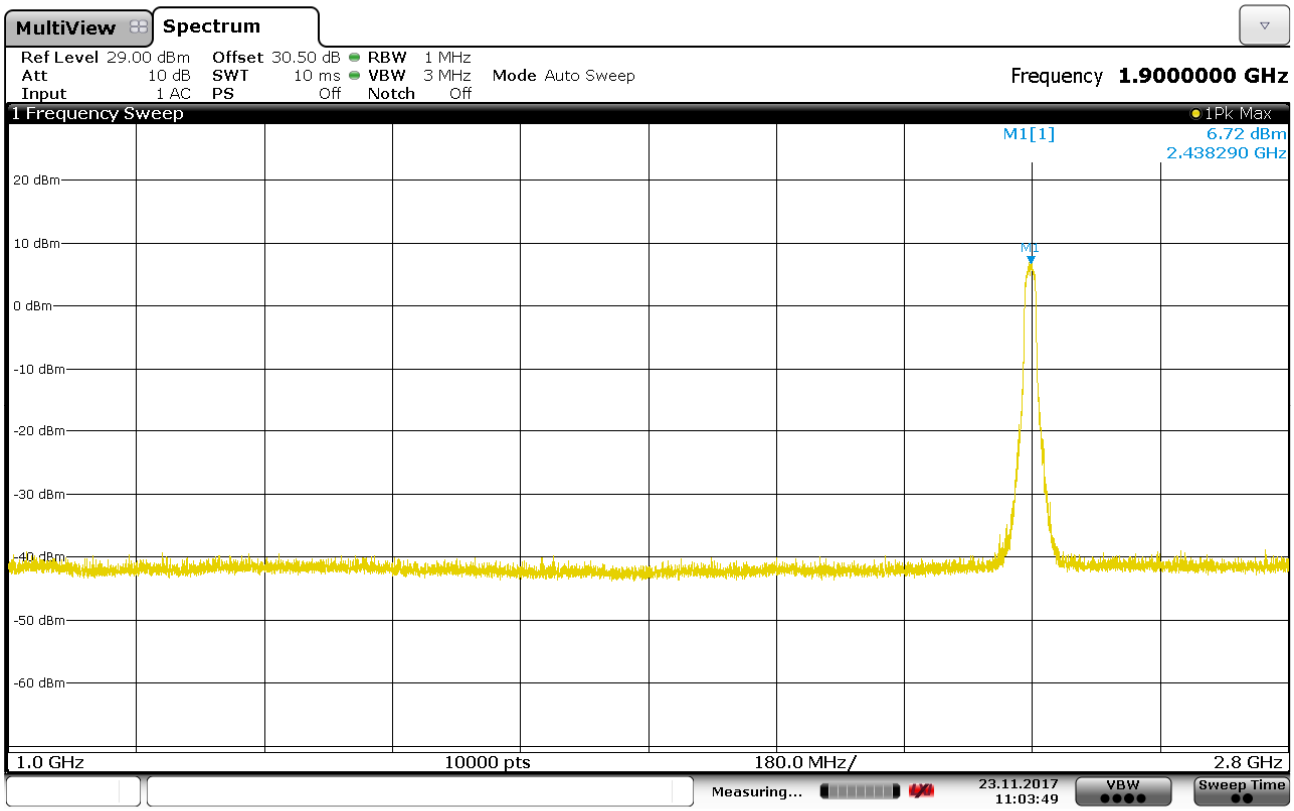

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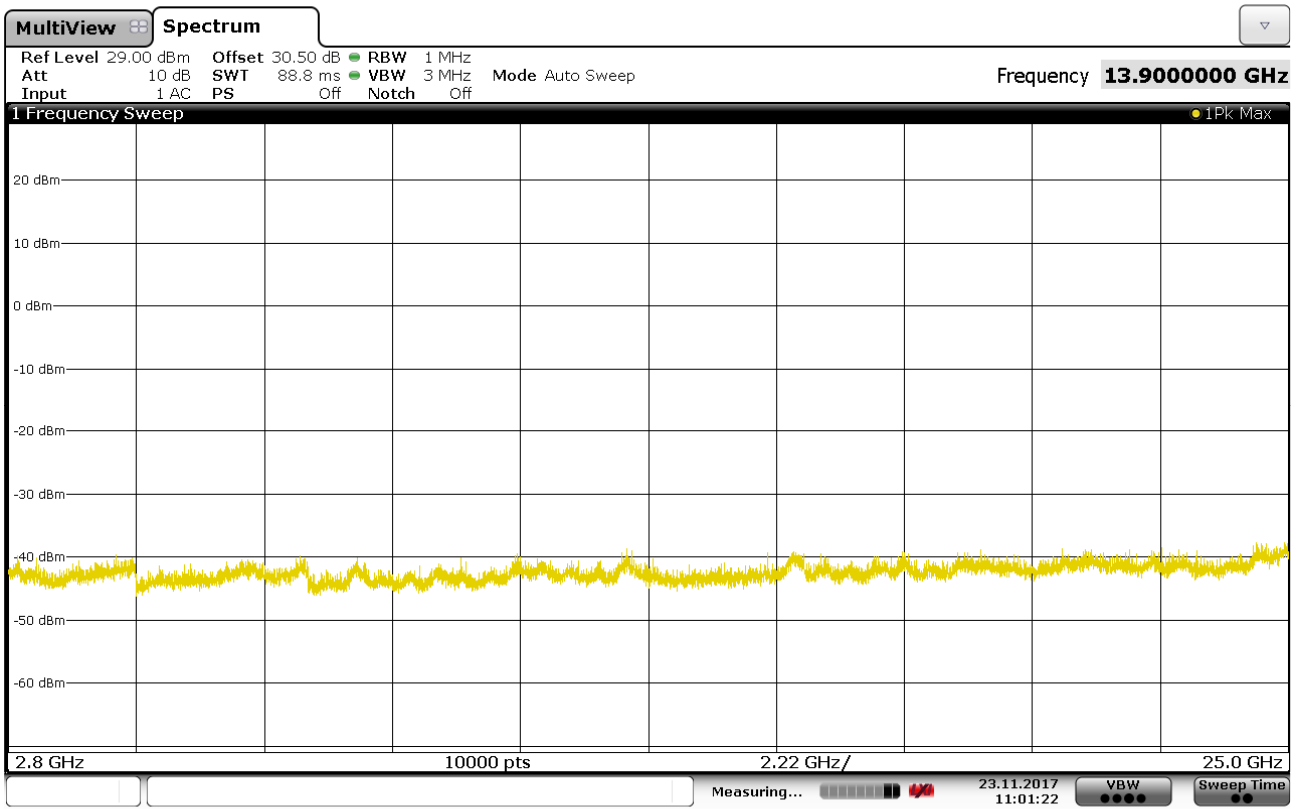

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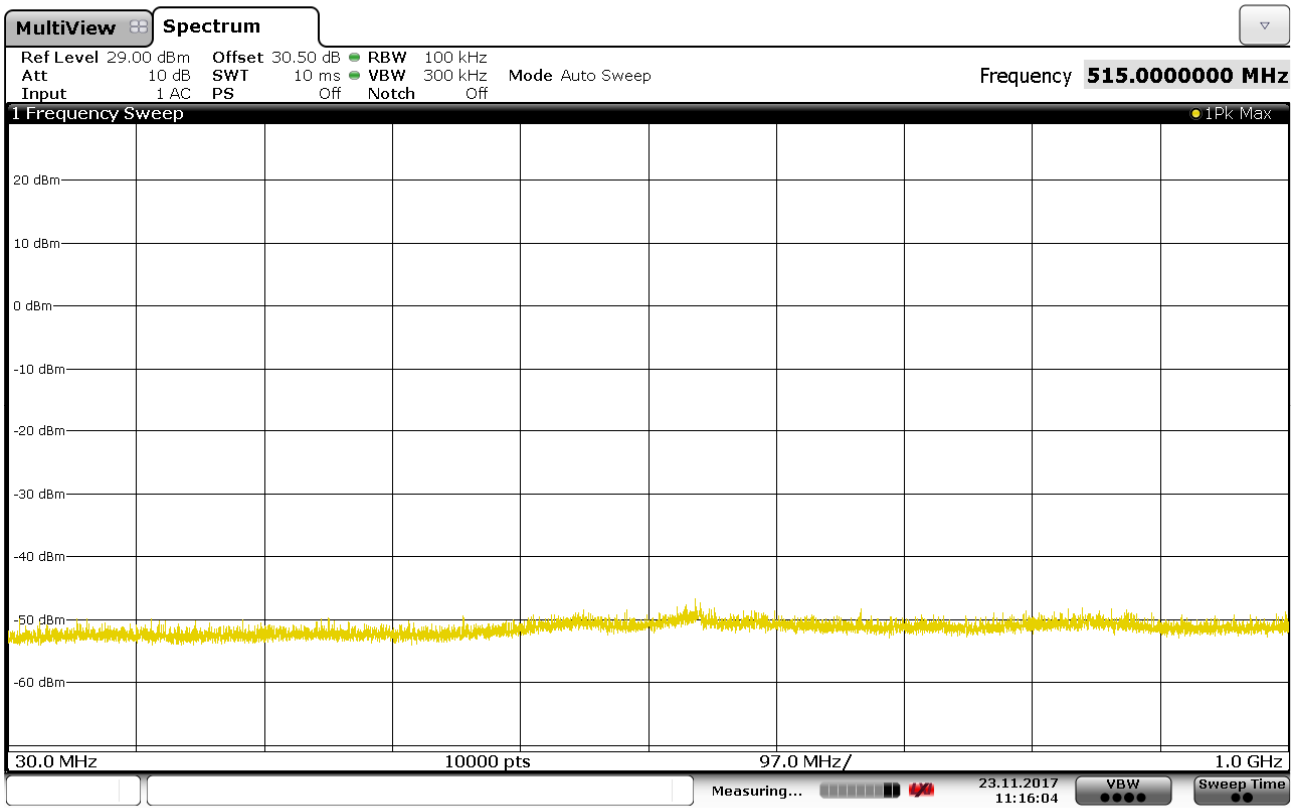
Antenna Port Spurious Emission - Conducted
Operation Mode: #1
Standard: IEE 802.11g
Channel: #11

001



11:16:05 23.11.2017

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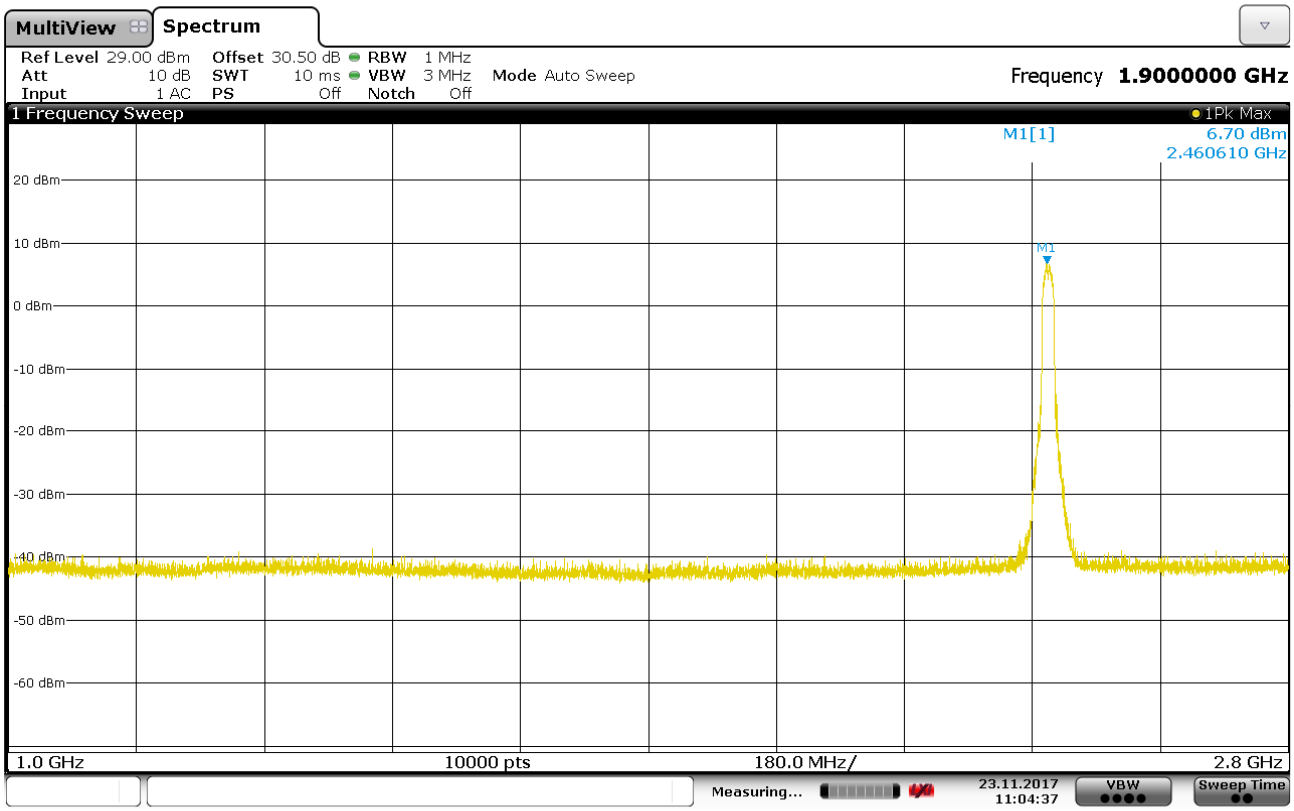

11:04:37 23.11.2017

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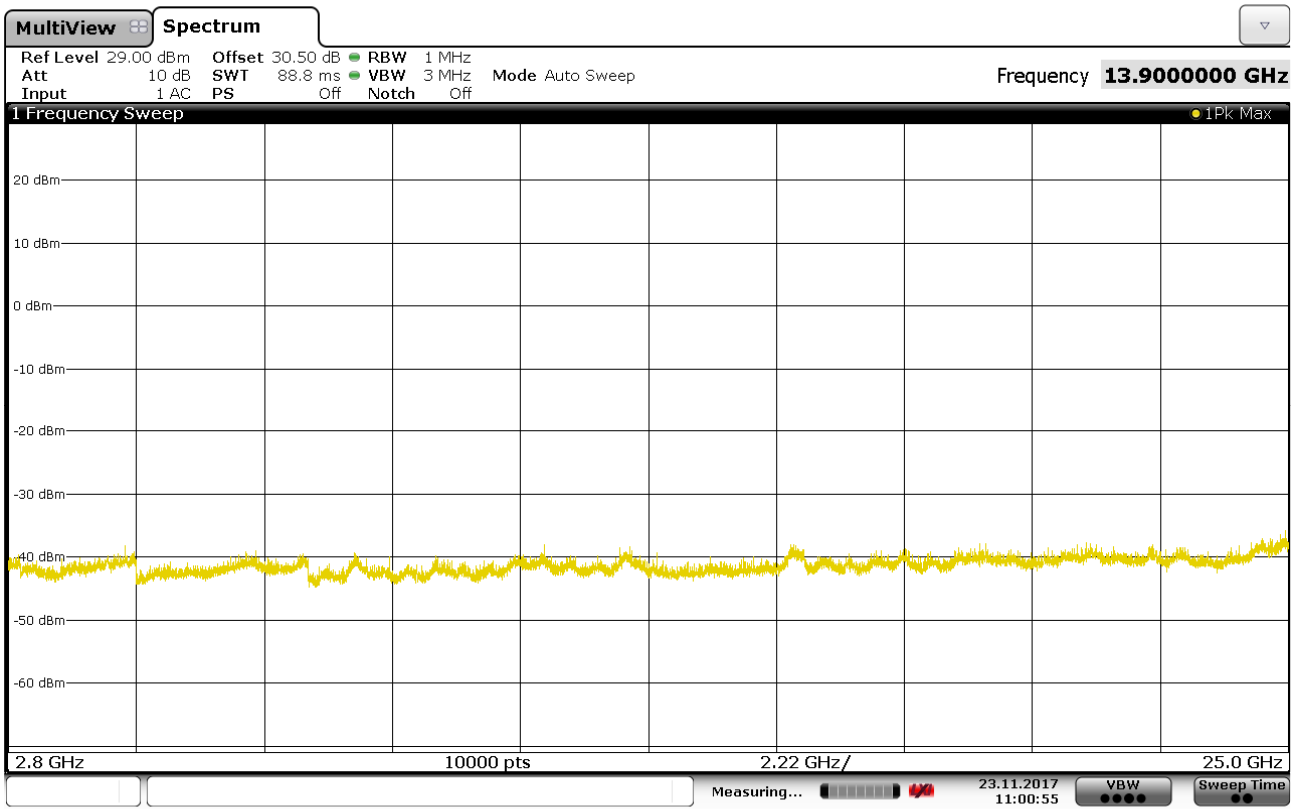
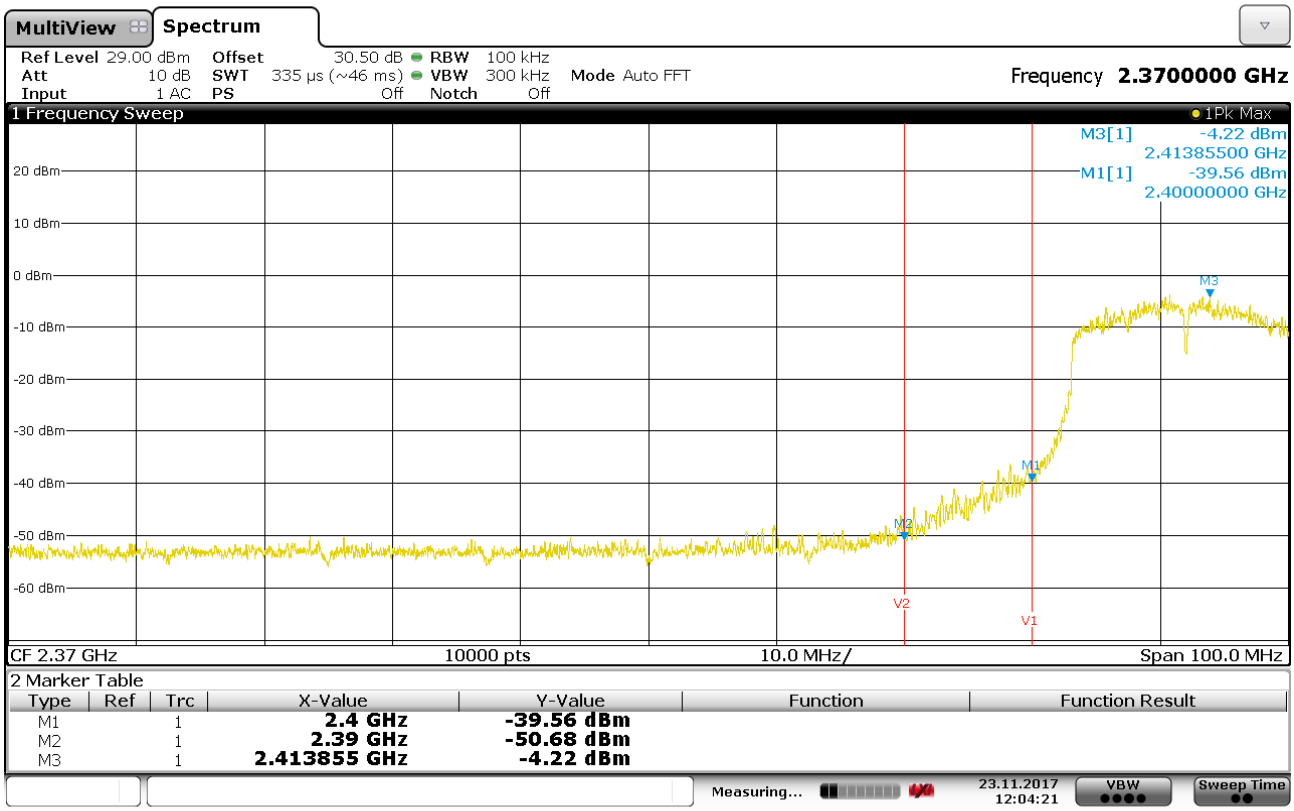


11:00:56 23.11.2017

Graphical representation of Antenna Port Spurious Emission - Conducted
Operation Mode: #1
Standard: IEE 802.11n 20MHz
Channel: #1

BAND EDGE

001

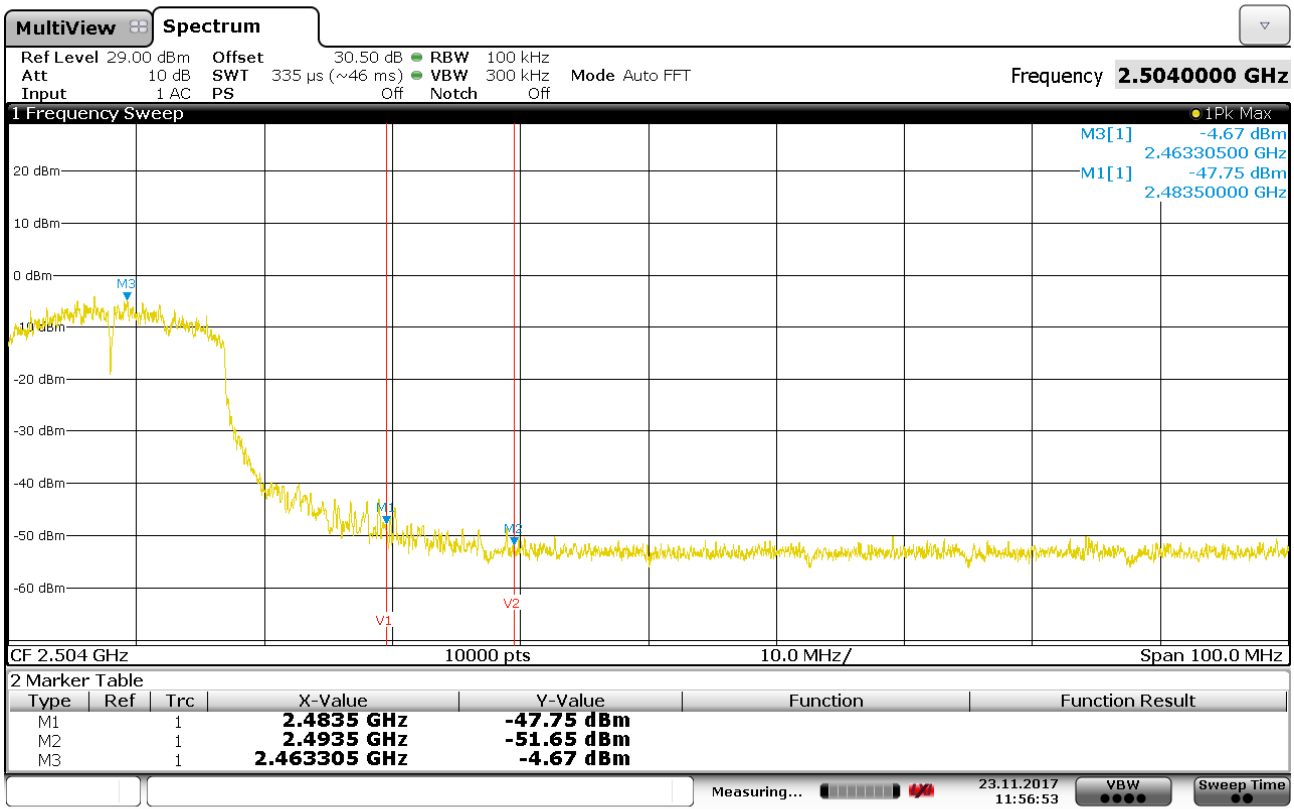


12:04:21 23.11.2017

Graphical representation of Antenna Port Spurious Emission - Conducted
Operation Mode: #1
Standard: IEE 802.11n 20MHz
Channel: #11

BAND EDGE

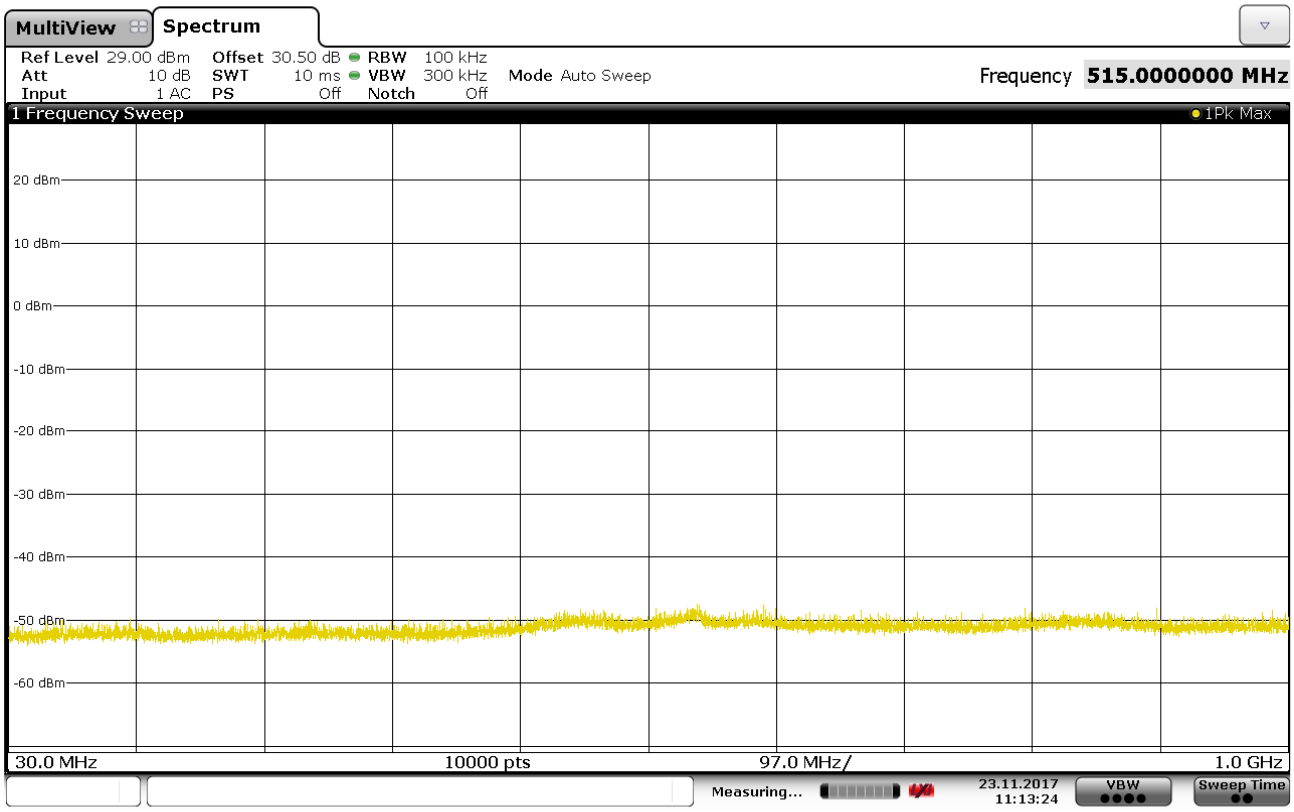
001



11:56:54 23.11.2017

Graphical representation of Antenna Port Spurious Emission - Conducted
Operation Mode: #1
Standard: IEE 802.11n 20MHz
Channel: #1

001



11:13:24 23.11.2017

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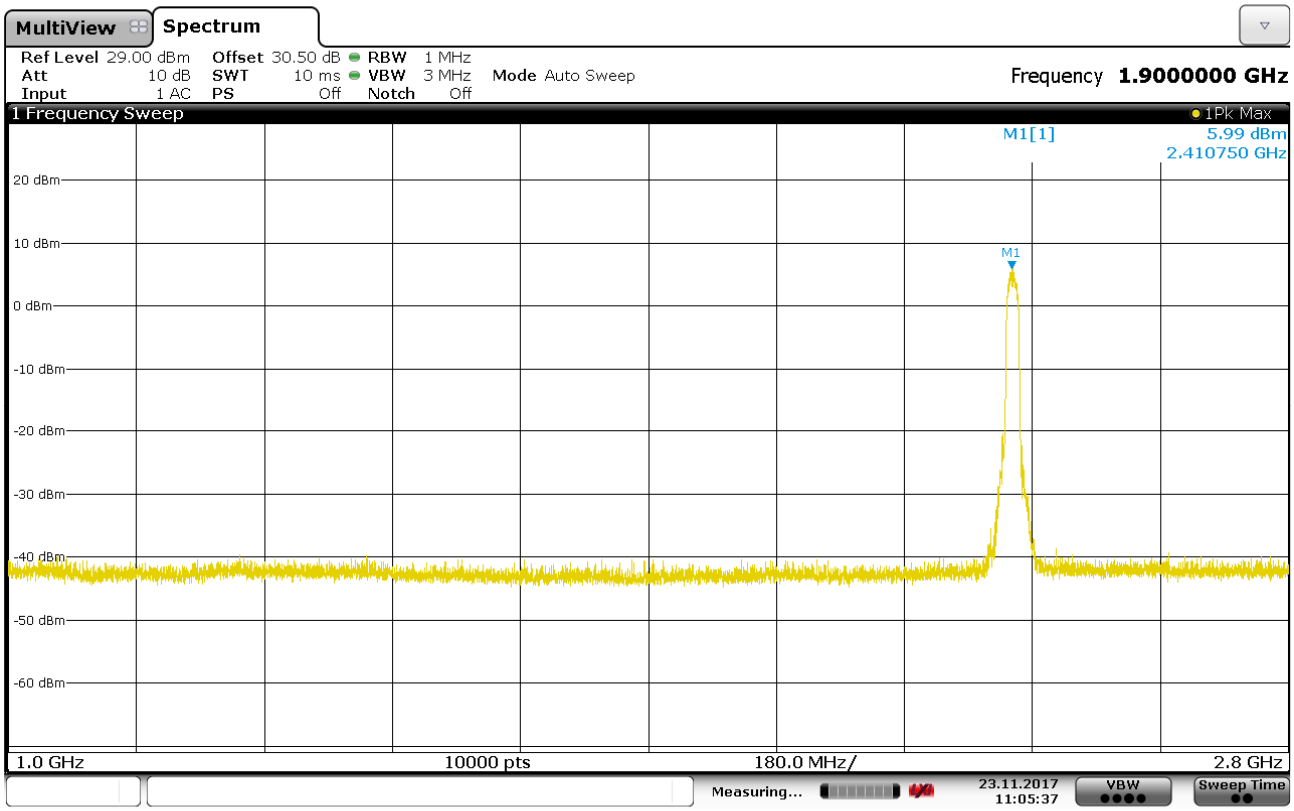

11:05:38 23.11.2017

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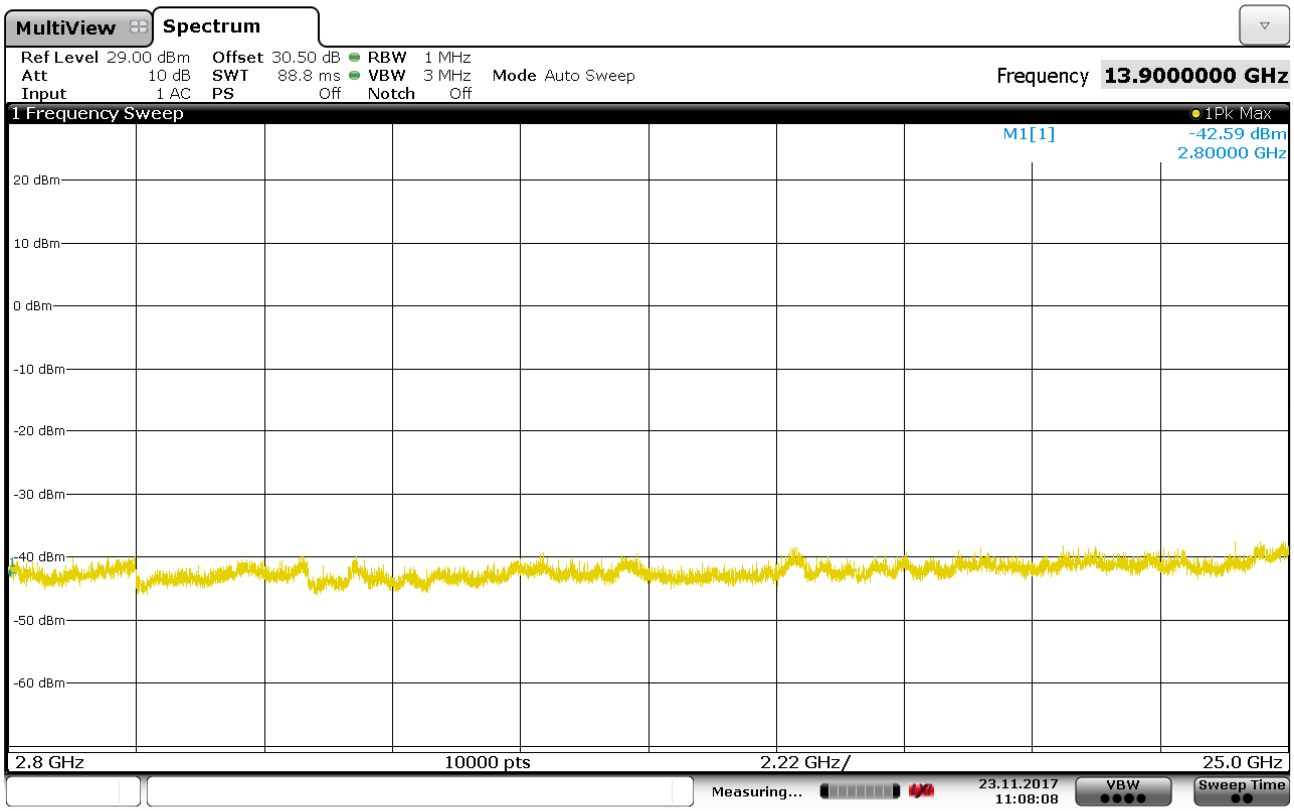
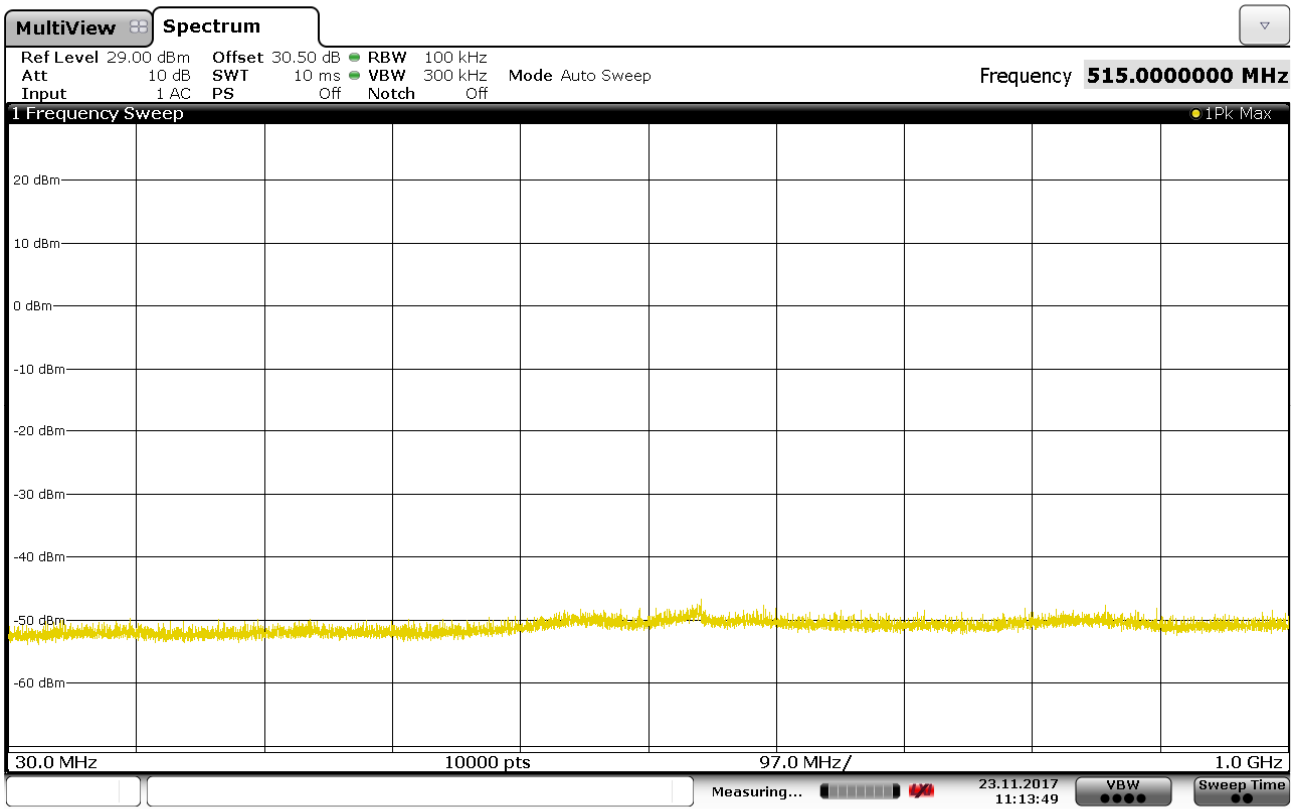


11:08:09 23.11.2017

Antenna Port Spurious Emission - Conducted
Operation Mode: #1
Standard: IEE 802.11n 20MHz
Channel: #6

001



11:13:50 23.11.2017

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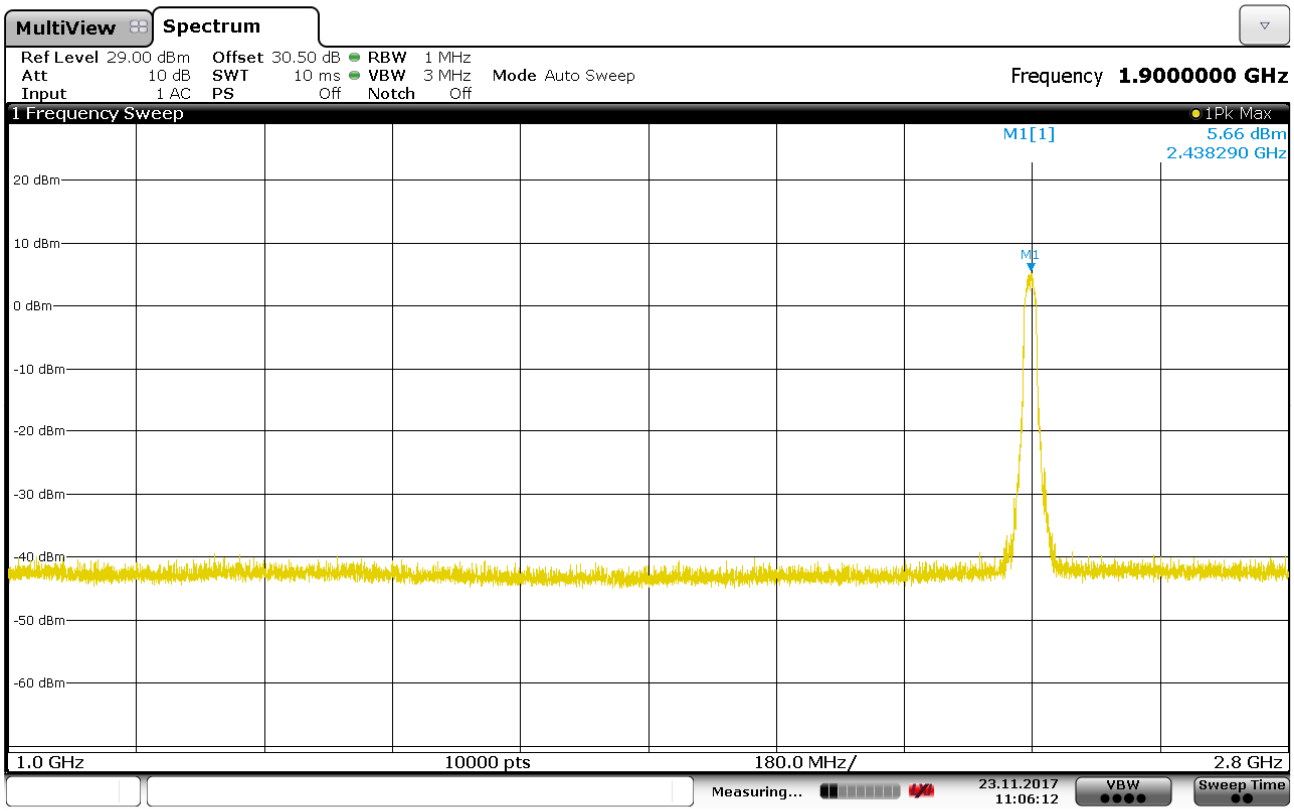

11:06:12 23.11.2017

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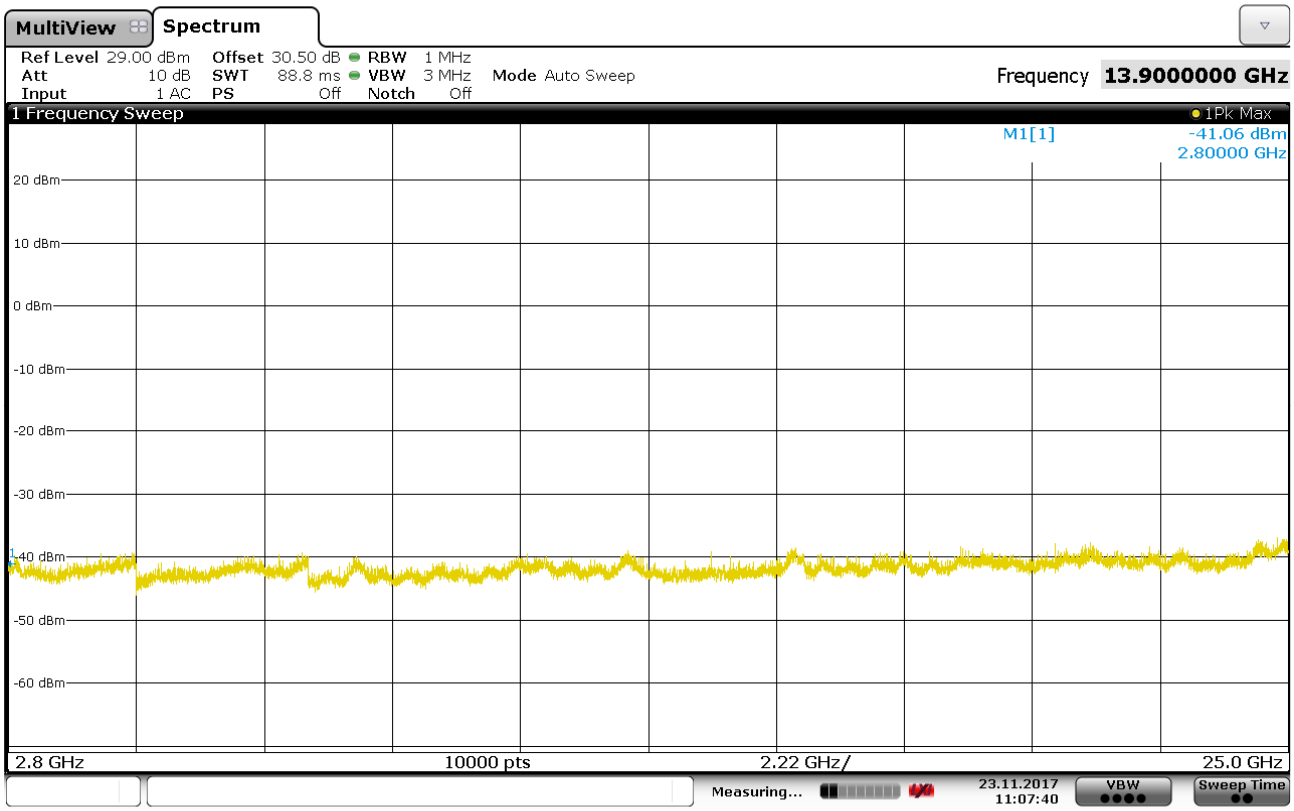
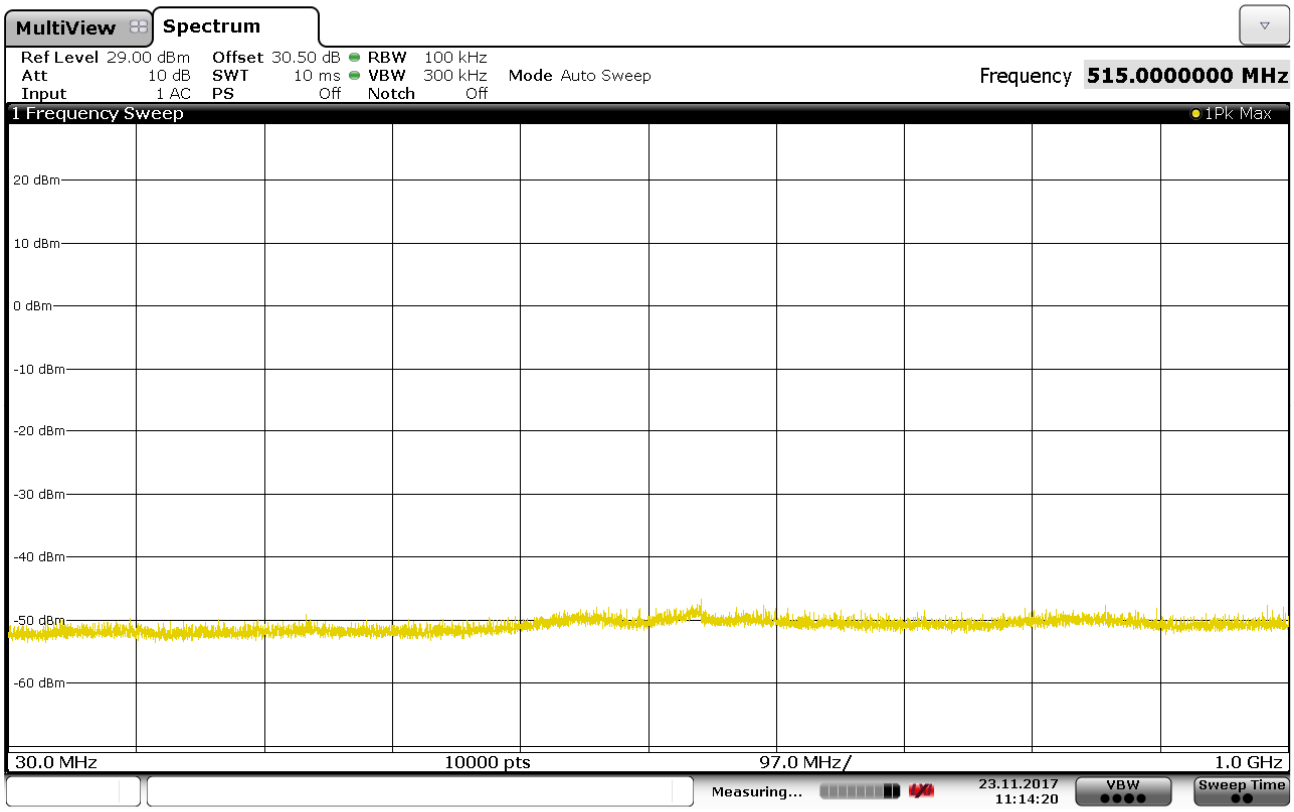


11:07:40 23.11.2017

Graphical representation of Antenna Port Spurious Emission - Conducted
Operation Mode: #1
Standard: IEE 802.11n 20MHz
Channel: #11

001



11:14:20 23.11.2017

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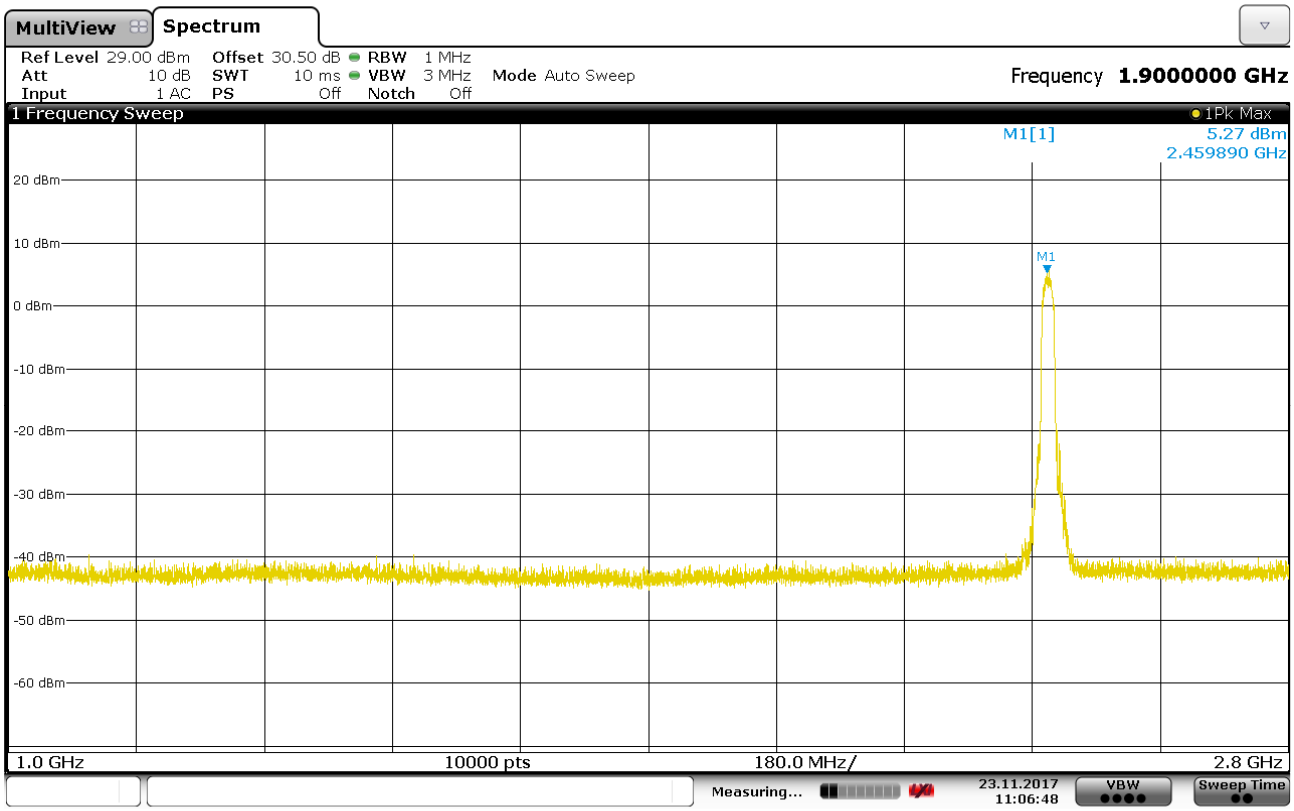

11:06:48 23.11.2017

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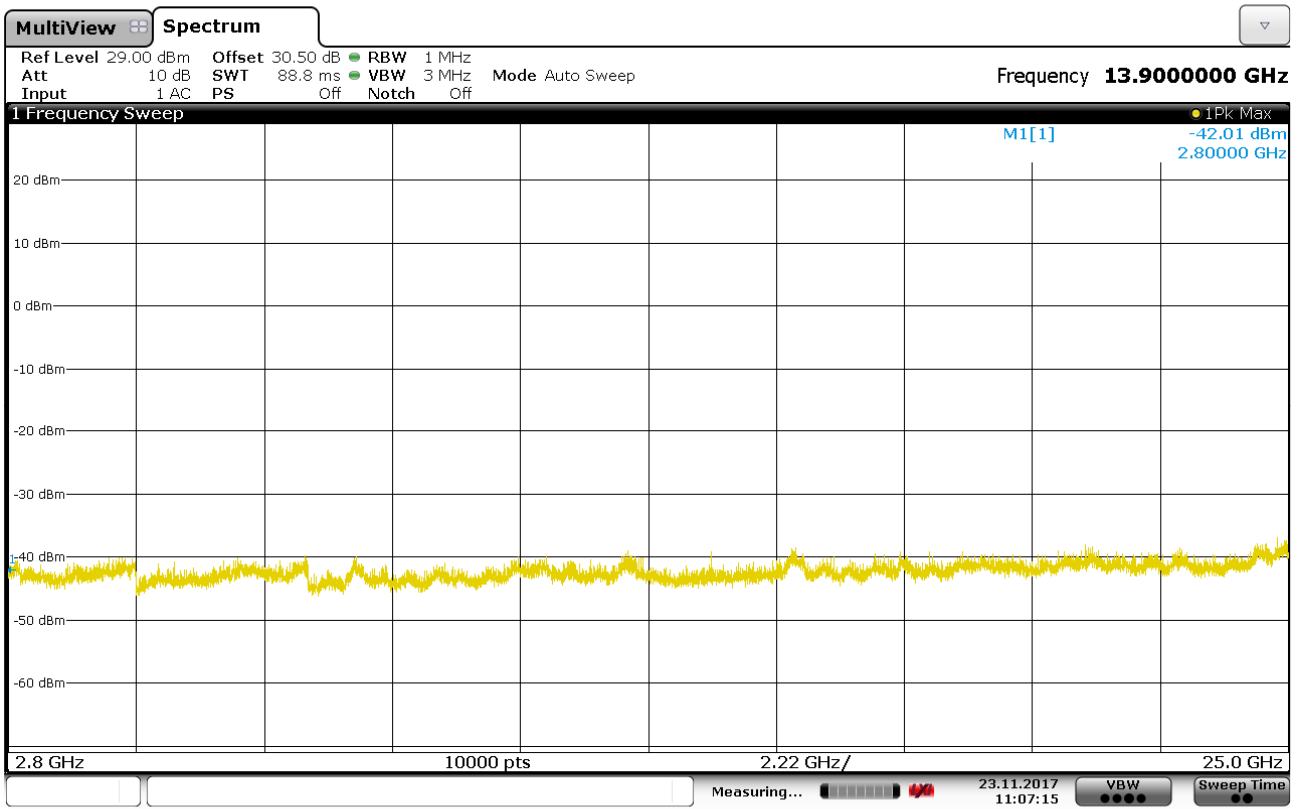
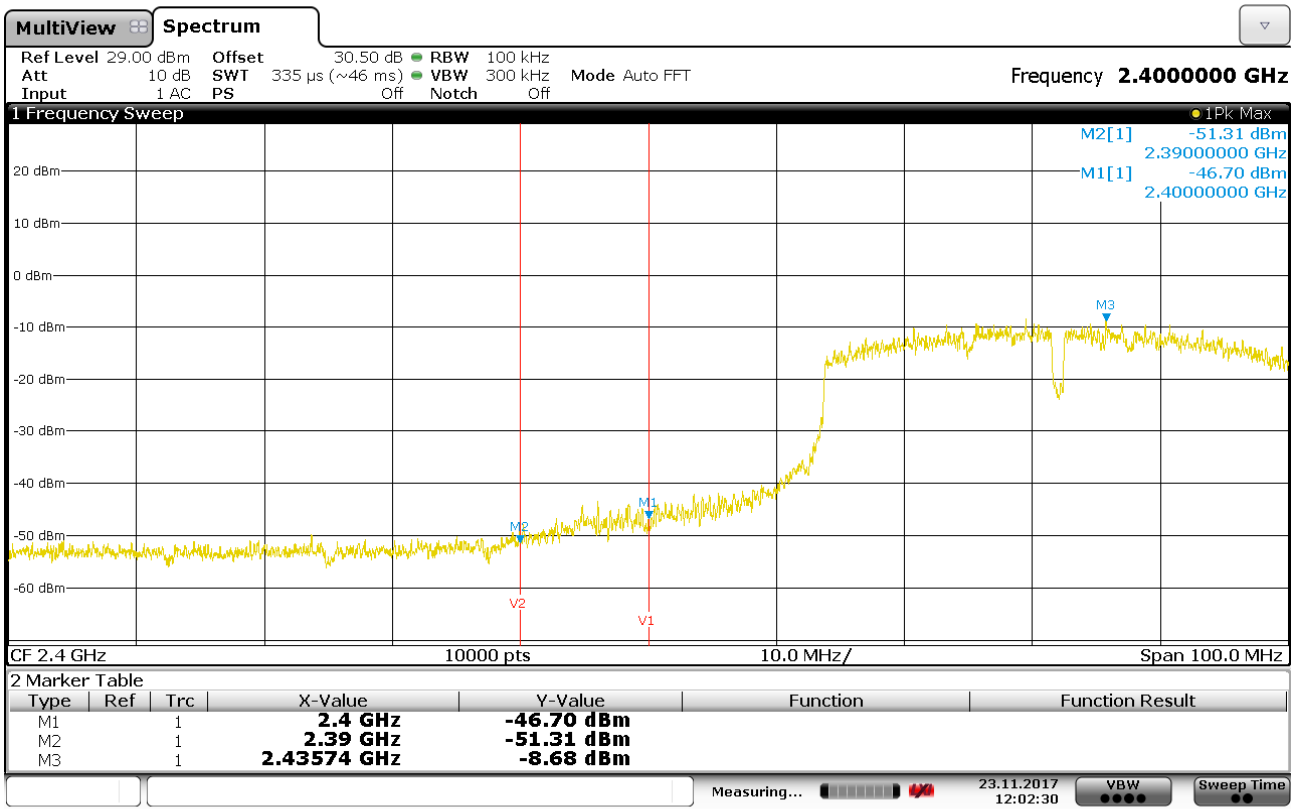


11:07:15 23.11.2017

Graphical representation of Antenna Port Spurious Emission - Conducted
Operation Mode: #1
Standard: IEE 802.11n 40MHz
Channel: #3

BAND EDGE

001

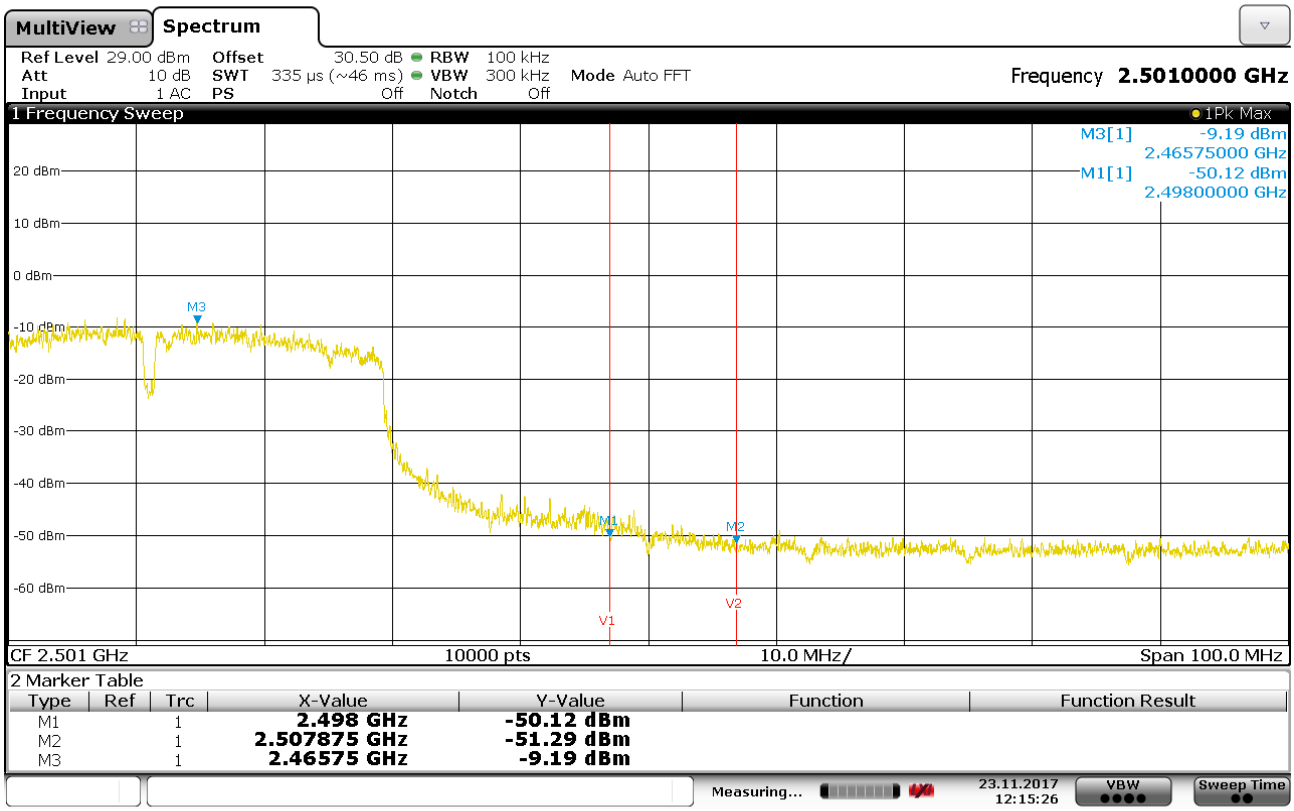


12:02:31 23.11.2017

Graphical representation of Antenna Port Spurious Emission - Conducted
Operation Mode: #1
Standard: IEE 802.11n 40MHz
Channel: #9

BAND EDGE

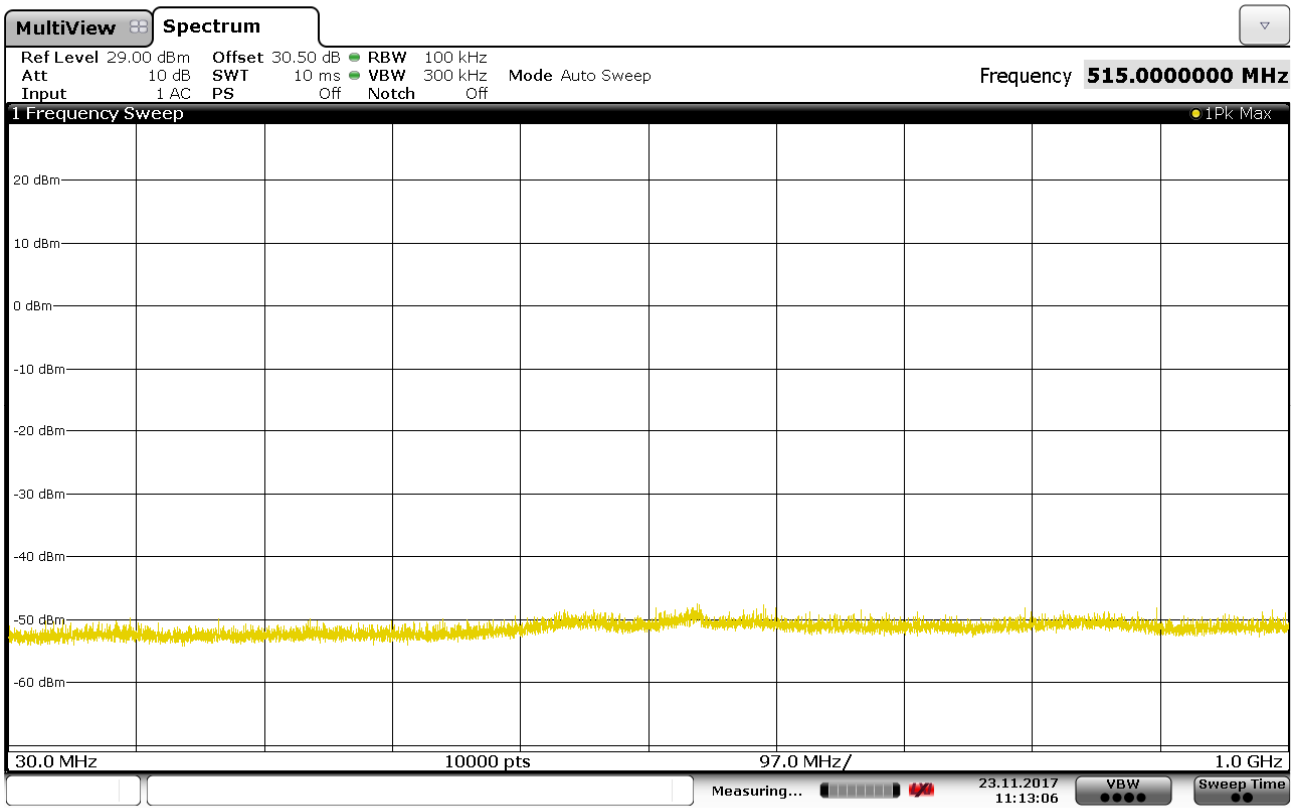
001



12:15:27 23.11.2017

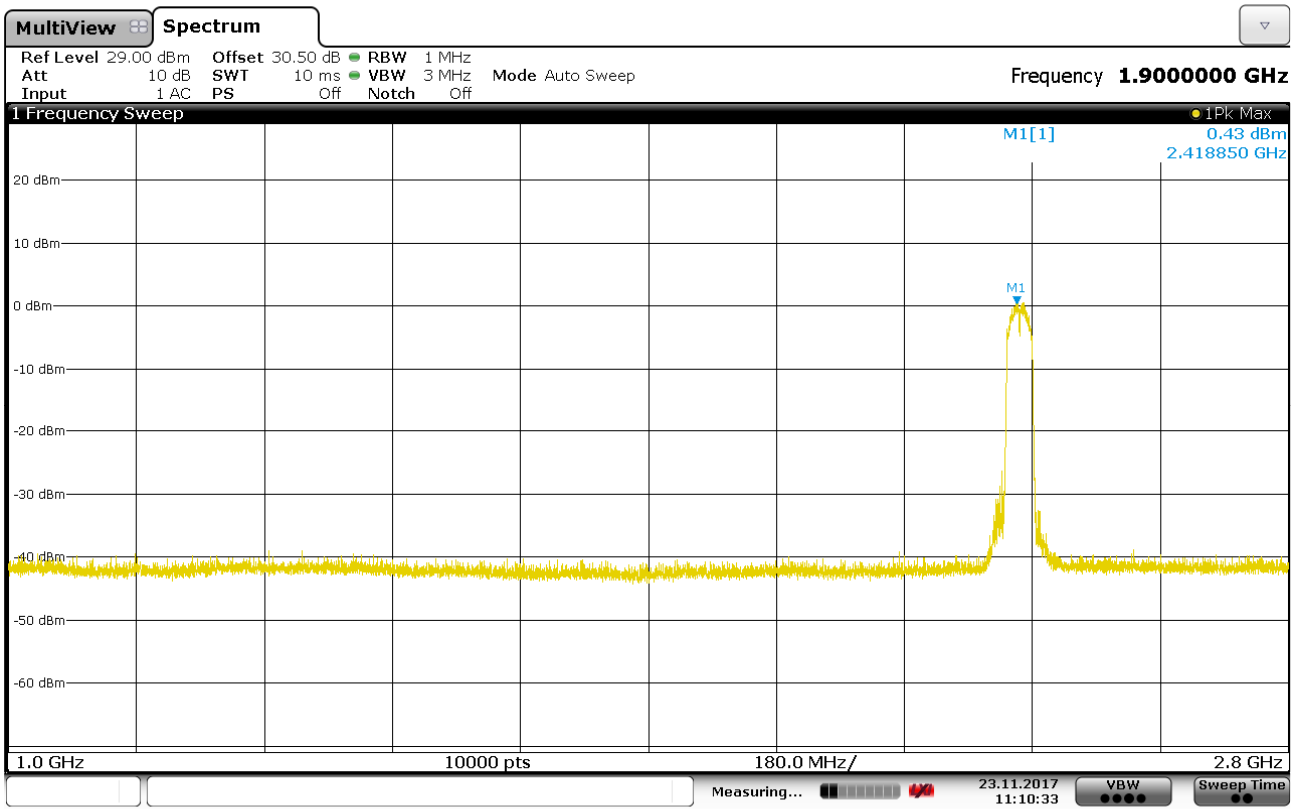
Antenna Port Spurious Emission - Conducted
Operation Mode: #1
Standard: IEE 802.11n 40MHz
Channel: #3

001



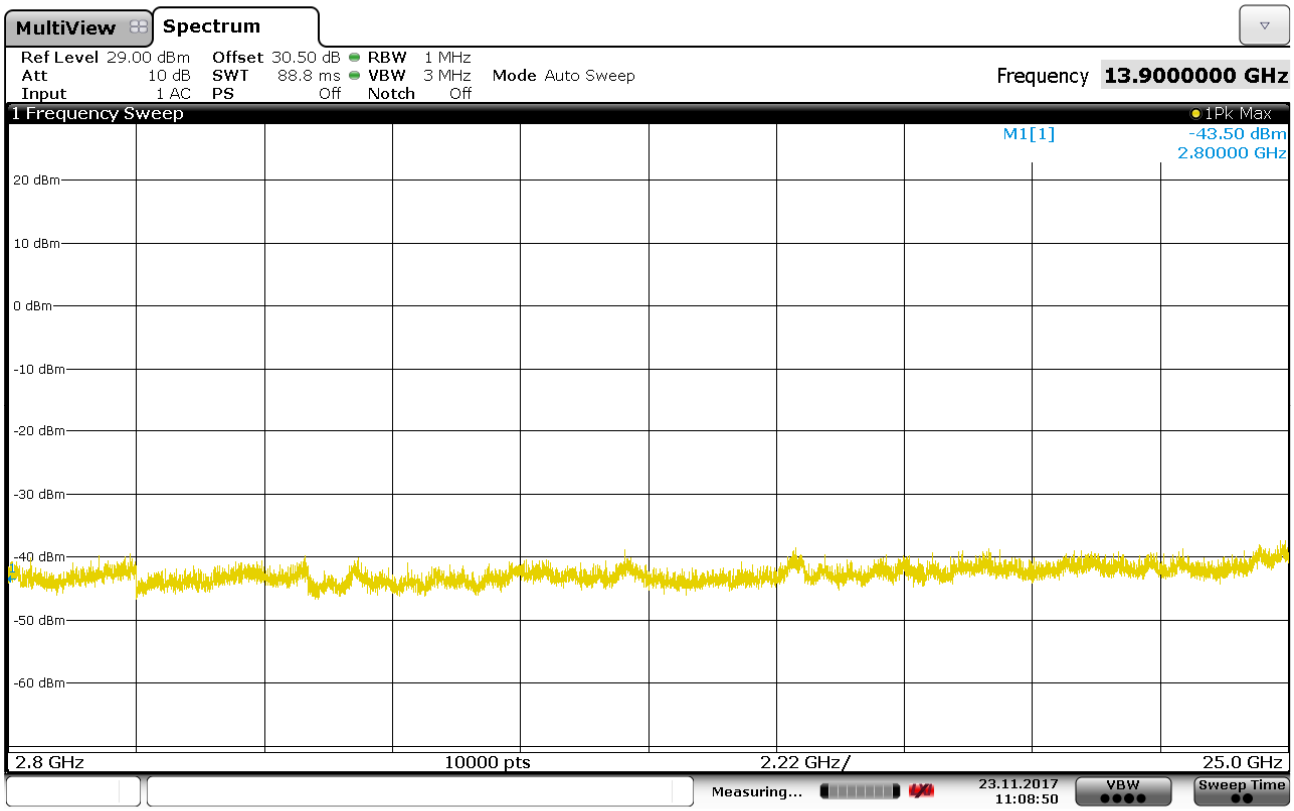
11:13:06 23.11.2017

001



11:10:34 23.11.2017

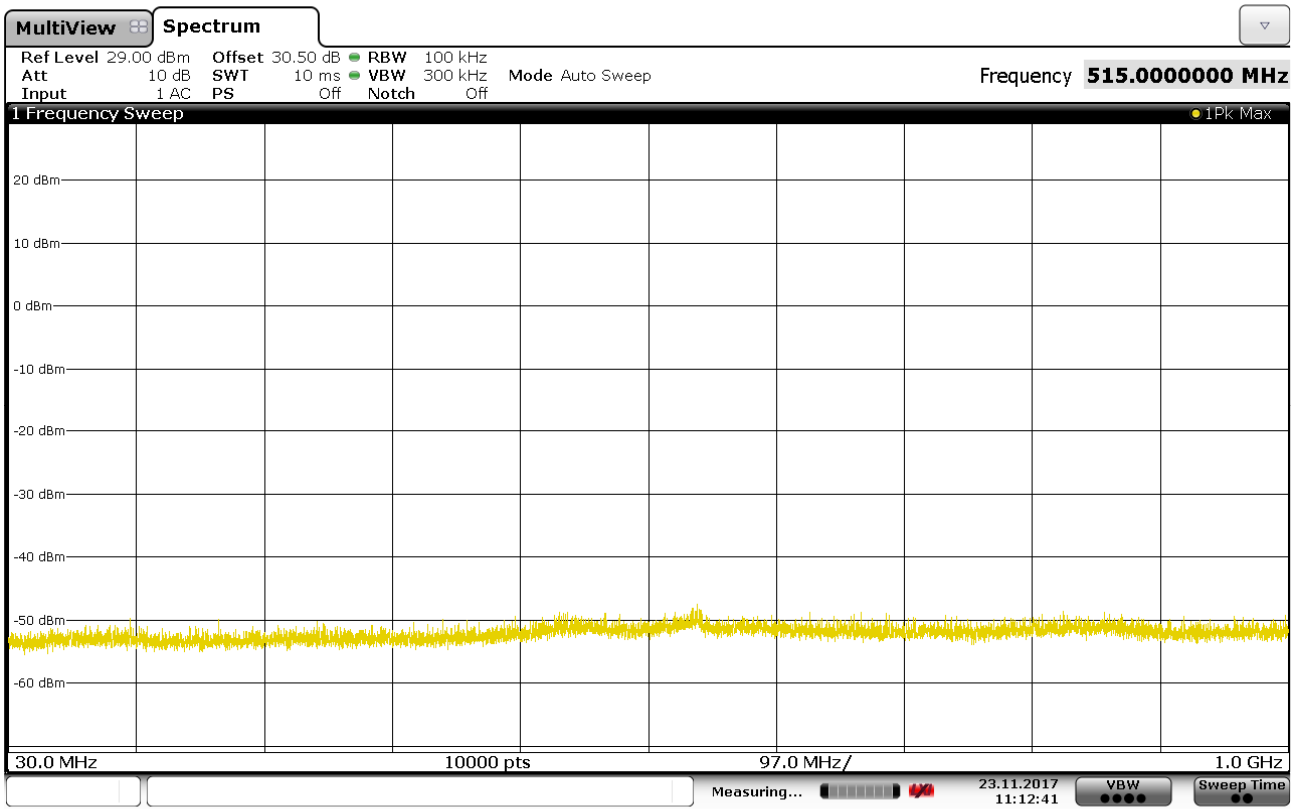
001



11:08:51 23.11.2017

Antenna Port Spurious Emission - Conducted
Operation Mode: #1
Standard: IEE 802.11n 40MHz
Channel: #6

001



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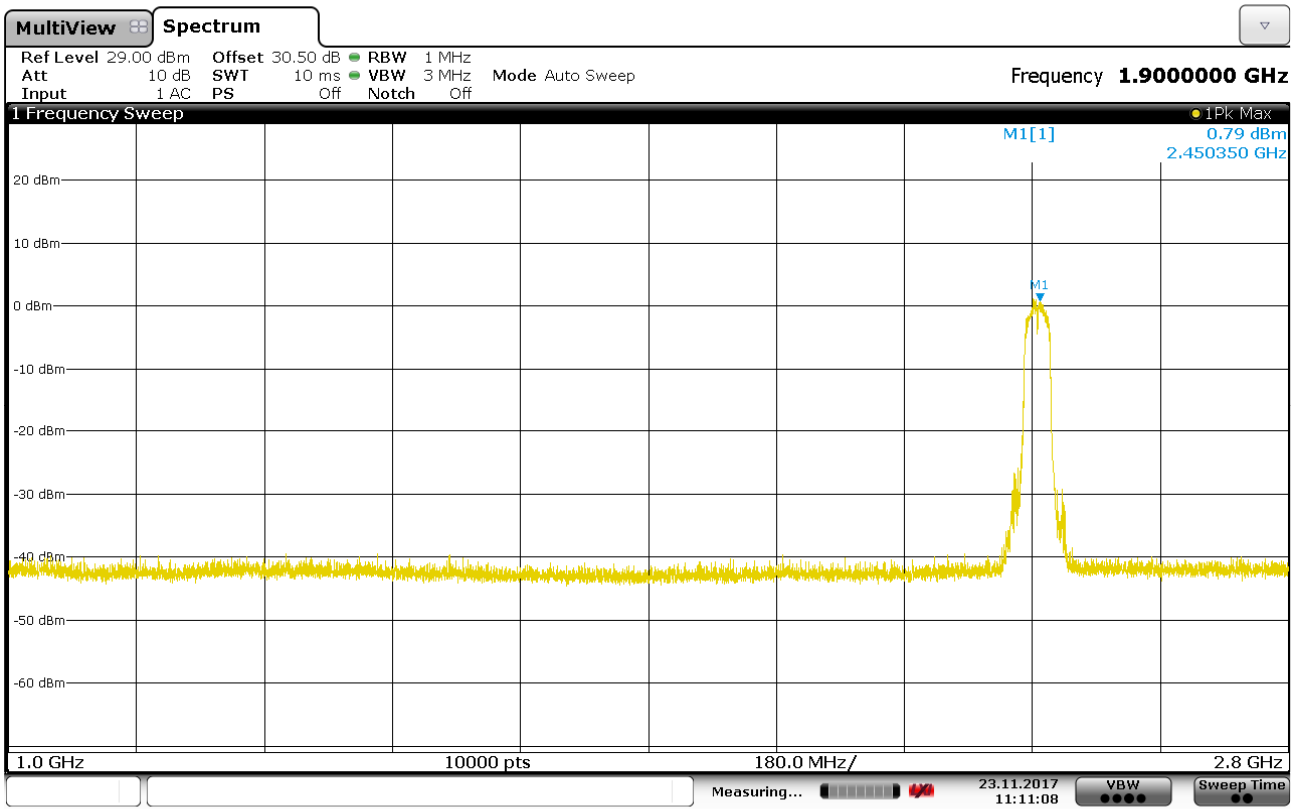
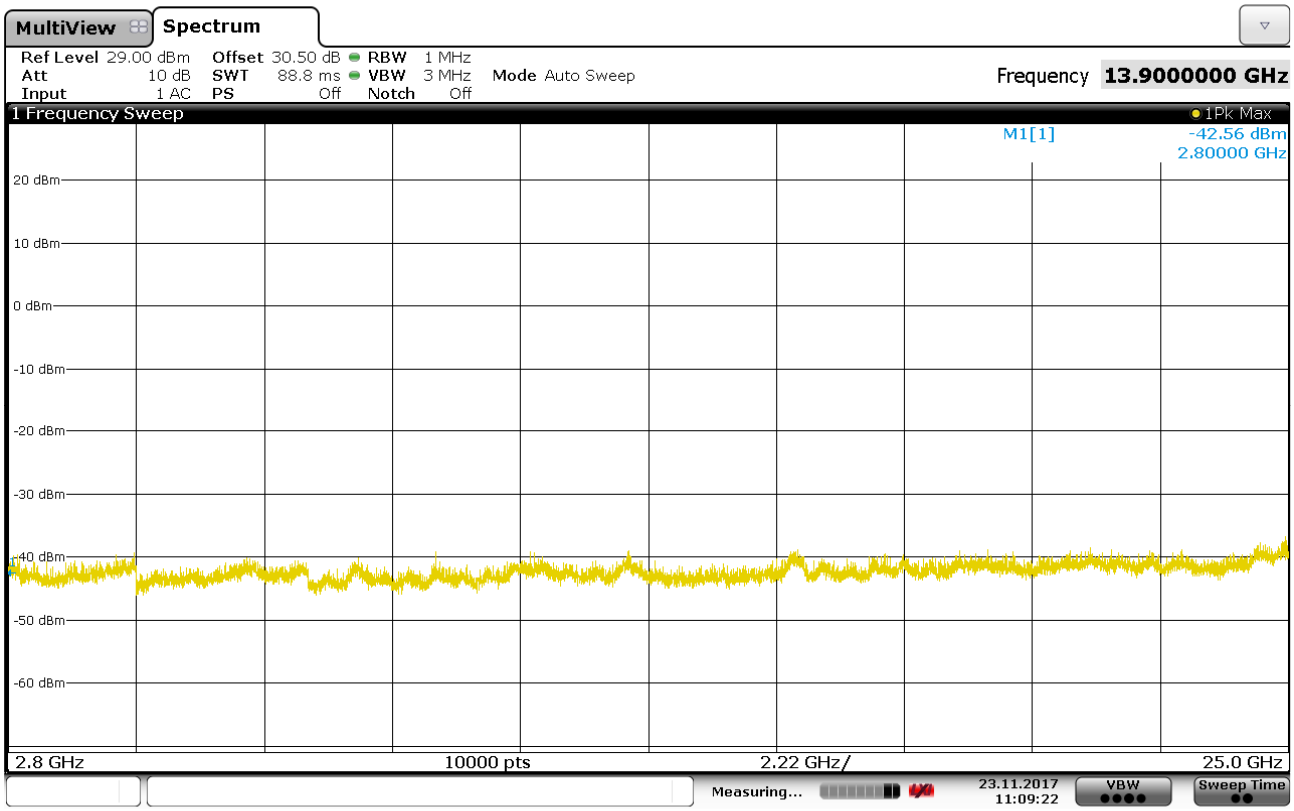


11:11:09 23.11.2017

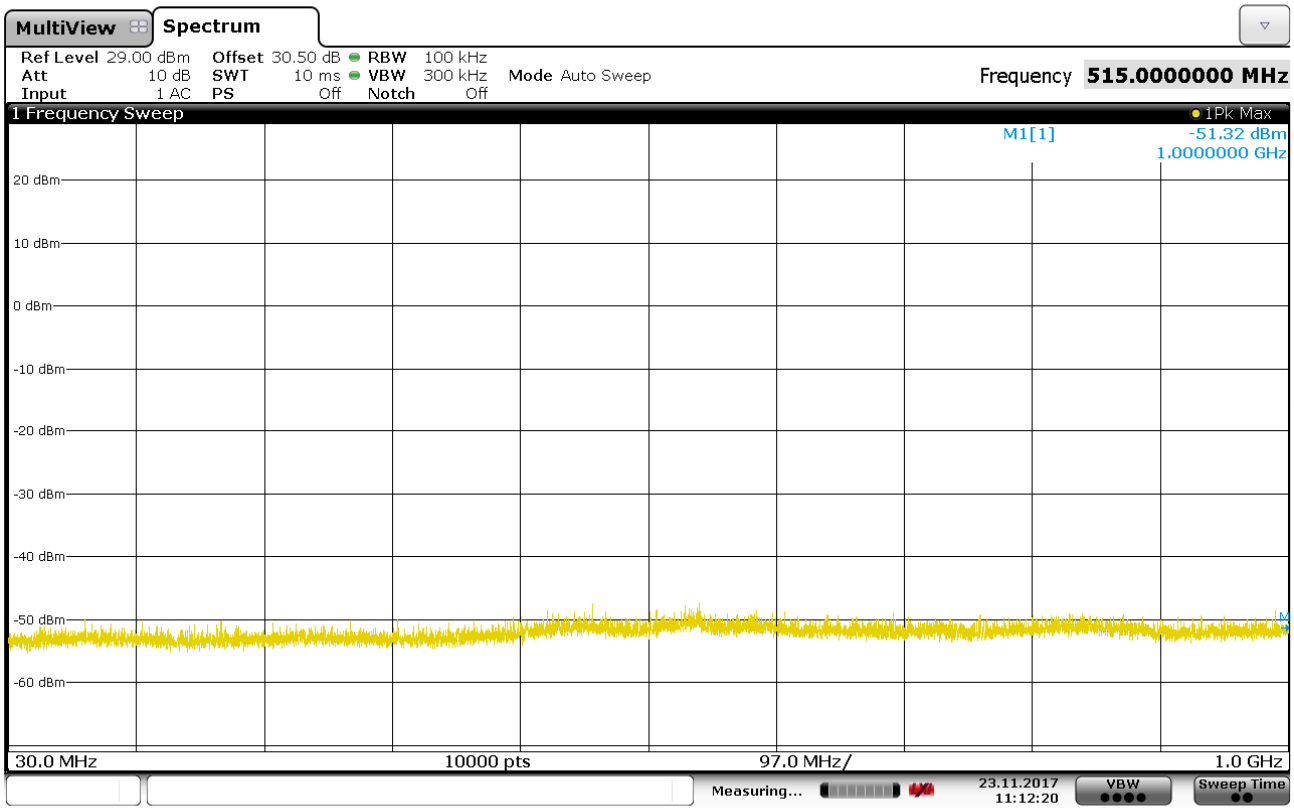
001



11:09:23 23.11.2017

Antenna Port Spurious Emission - Conducted
Operation Mode: #1
Standard: IEE 802.11n 40MHz
Channel: #9

001



11:12:20 23.11.2017

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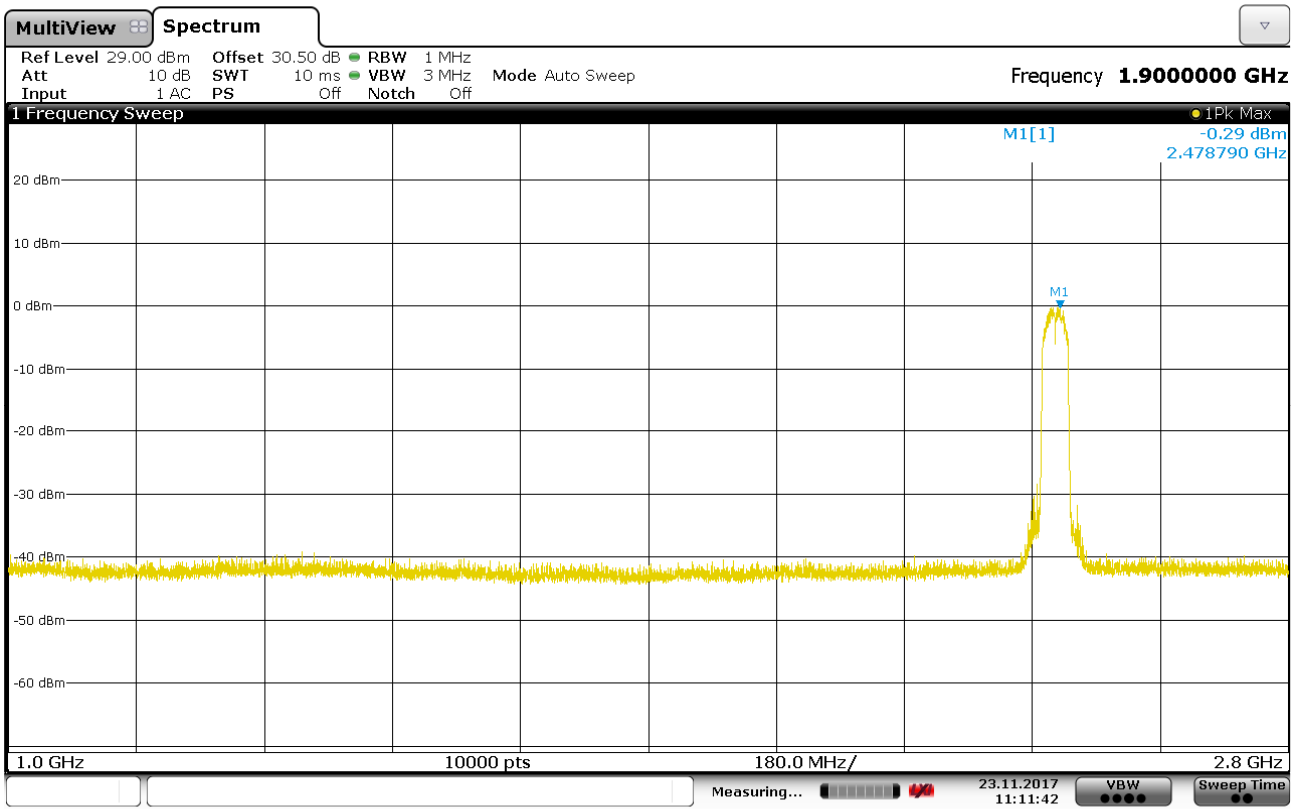
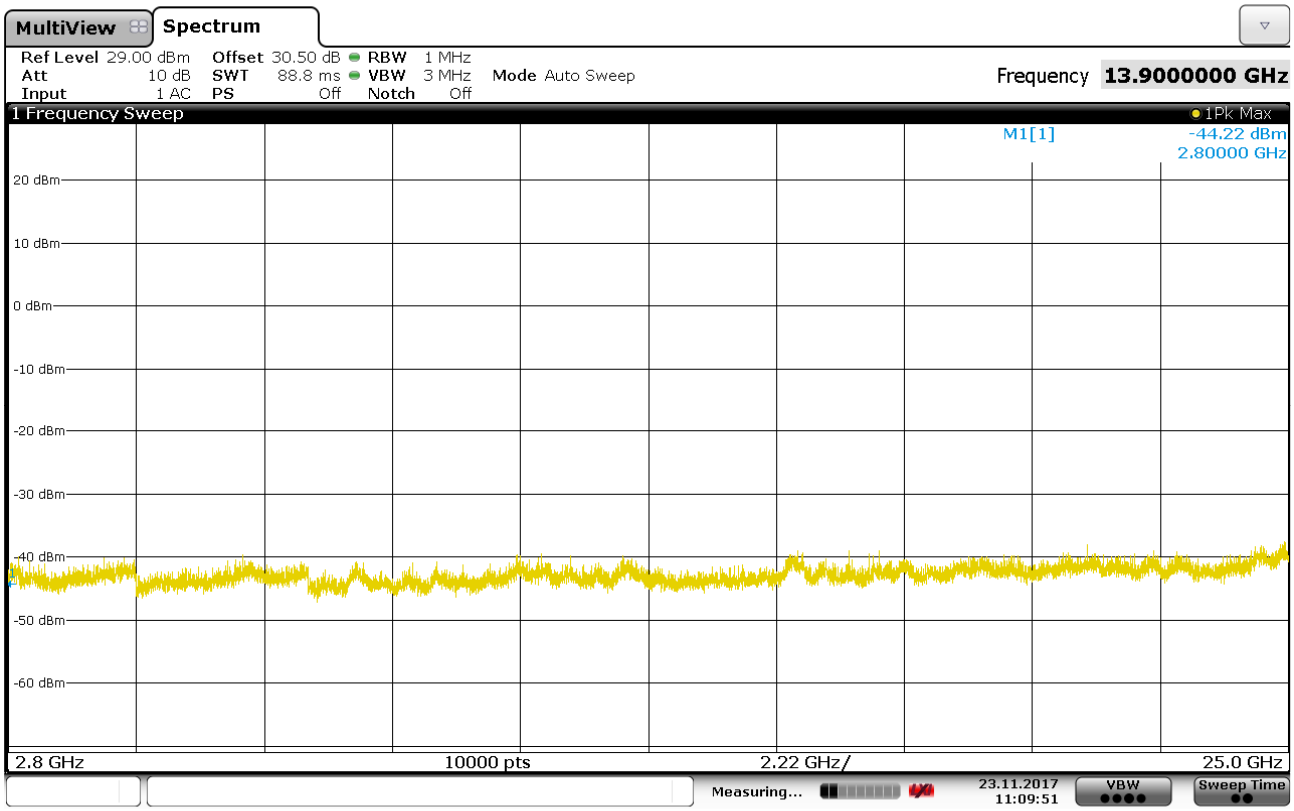


11:11:43 23.11.2017

001



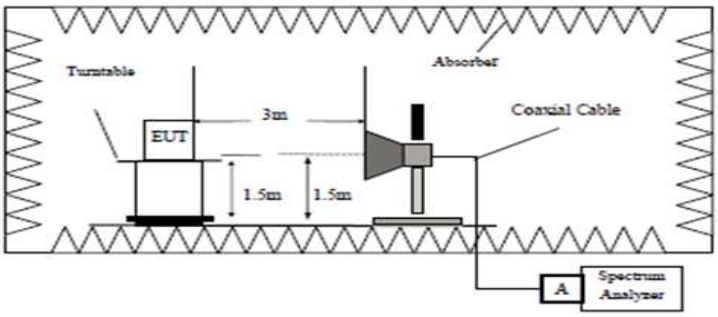
11:09:52 23.11.2017

Test Conditions and Results – RADIATED ANTENNA PORT SPURIOUS EMISSION

18	TEST: Radiated Antenna Port Spurious Emission (external antenna)	PASS
Parameters required prior to the test	Laboratory Ambient Temperature (°C)	15 to 35 °C
	Relative Humidity (%)	30 to 60 %
Parameters recorded during the test	Laboratory Ambient Temperature (°C)	21°C
	Relative Humidity (%)	52%
	Air pressure (hPa)	1020
—	Frequency	Application Point
Fully configured sample tested at the power line frequency	24Vdc	Enclosure
Equipment mode:	Operation mode	#1
FCC Standard	§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. 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) (see §15.205(c)).

Further information to test setup



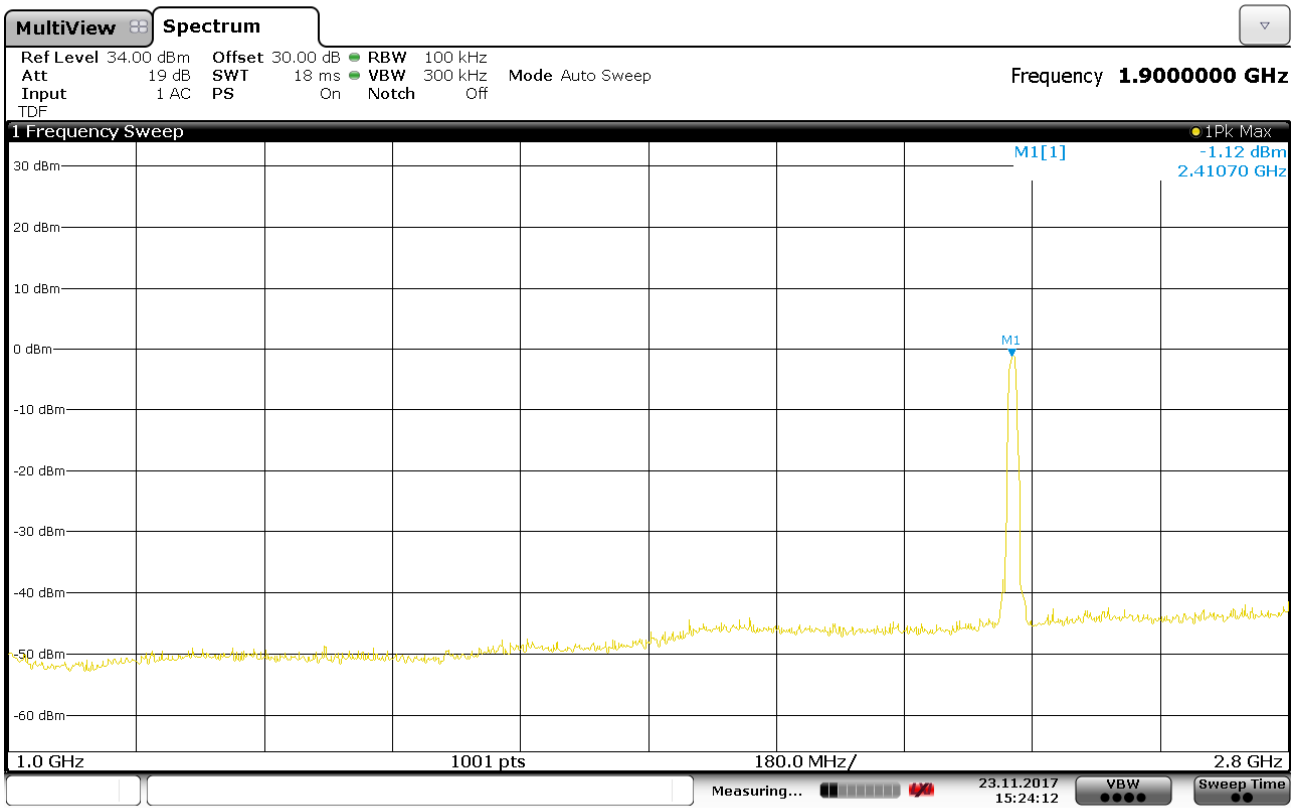
For frequency >1GHz only explorative test has been execuded. No spurious or hamonics are detected.

Test Equipment Used					
Description	Manufacturer	Model	Identifier	Calibration date	Calibration due
CSSA	ETS Lindgren	FACT3	87020484	10/2016	10/2018
EMI Test Receiver	R&S	ESW44	87020967	06/2017	06/2018
Antenna BiConiLog	ETS Lindgren	3124E	87020457	05/2017	05/2020
Antenna Horn with Preamplifier	ETS Lindgren	3117-PA	87020458	05/2017	05/2020
Antenna Horn with Preamplifier	ETS Lindgren	114514	87020459	05/2017	05/2020
Antenna Horn with Preamplifier	ETS Lindgren	120722	87020460	05/2017	05/2020

Antenna Port Spurious Emission - Radiated
Operation Mode: #1
Standard: IEE 802.11b
Channel: #1

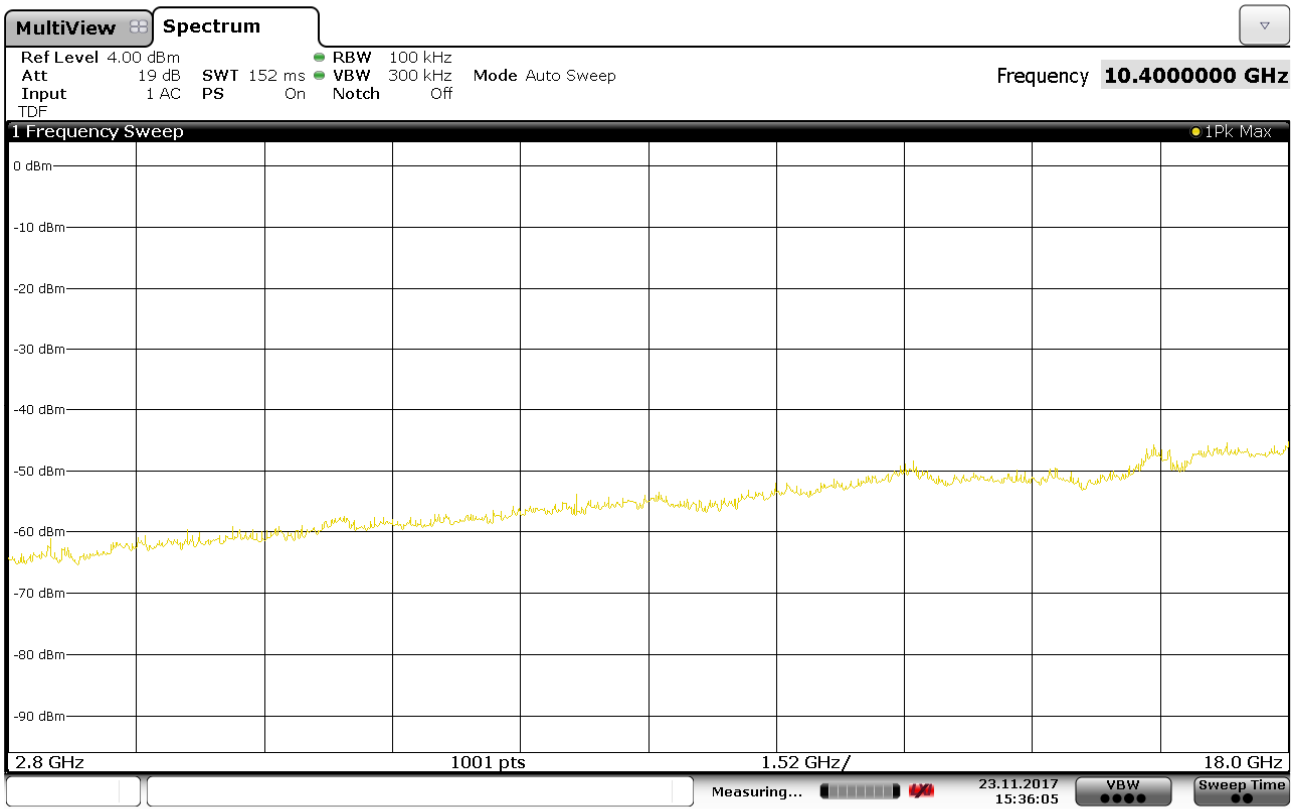
9KHz-1000MHz								
Frequency	Reading value	Antenna Factor	Cable Loss	Pre-Amp. Gain	Correcting reading	PK Limit (AV + 20dB)	PK Limit (AV + 20dB)	Margin
(MHz)	(dBµV)	(dB3/m)	(dB)	(dB)	(dBµV/m)	(µV/m)	(dBµV/m)	(dB)
F<1000	not significant	---	---	---	---	5000	74.00	---

001



15:24:12 23.11.2017

001



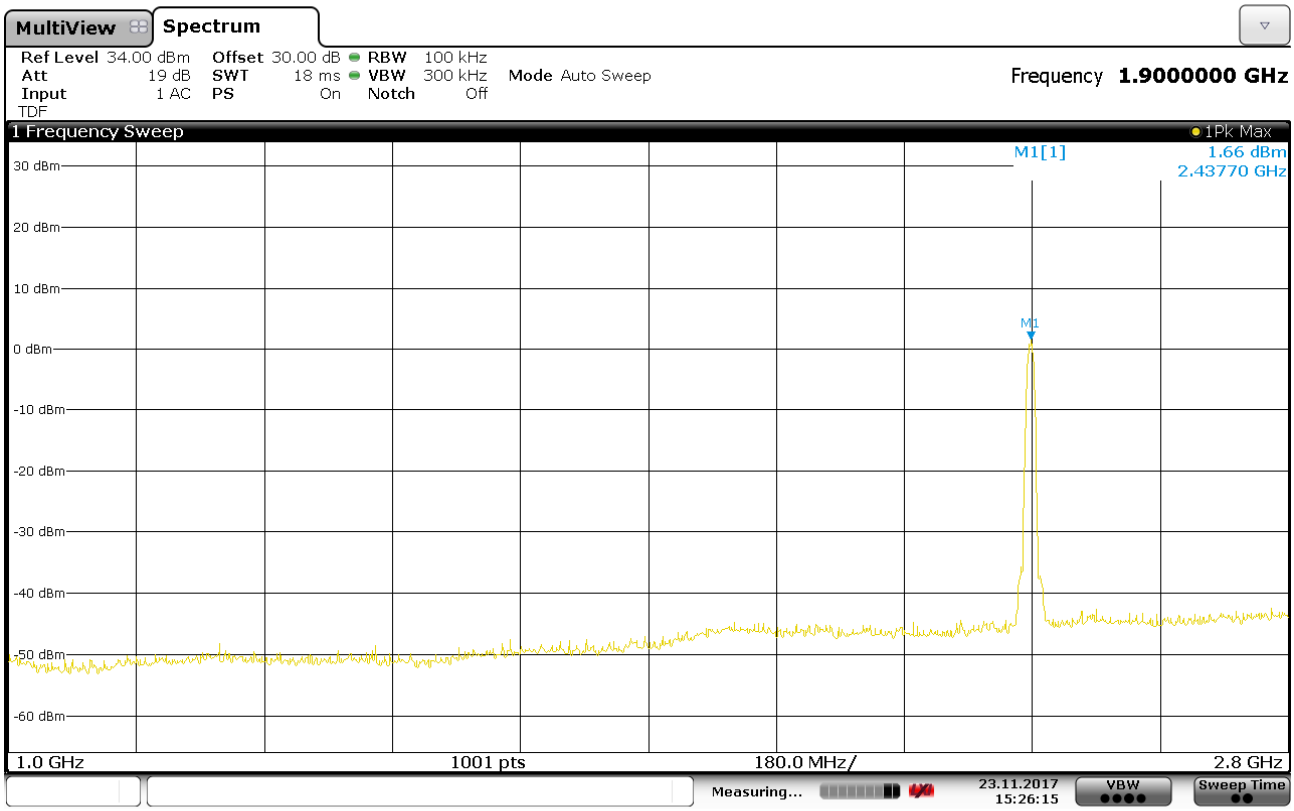
15:36:06 23.11.2017

18÷26 GHz								
Frequency	Reading value	Antenna Factor	Cable Loss	Pre-Amp. Gain	Correcting reading	PK Limit (AV + 20dB)	PK Limit (AV + 20dB)	Margin
(MHz)	(dBµV)	(dB3/m)	(dB)	(dB)	(dBµV/m)	(µV/m)	(dBµV/m)	(dB)
f>18000	not significant	---	---	---	---	5000	74.00	---

Antenna Port Spurious Emission - Radiated
Operation Mode: #1
Standard: IEE 802.11b
Channel: #6

9KHz-1000MHz								
Frequency	Reading value	Antenna Factor	Cable Loss	Pre-Amp. Gain	Correcting reading	PK Limit (AV + 20dB)	PK Limit (AV + 20dB)	Margin
(MHz)	(dBµV)	(dB3/m)	(dB)	(dB)	(dBµV/m)	(µV/m)	(dBµV/m)	(dB)
F<1000	not significant	---	---	---	---	5000	74.00	---

001



15:26:16 23.11.2017

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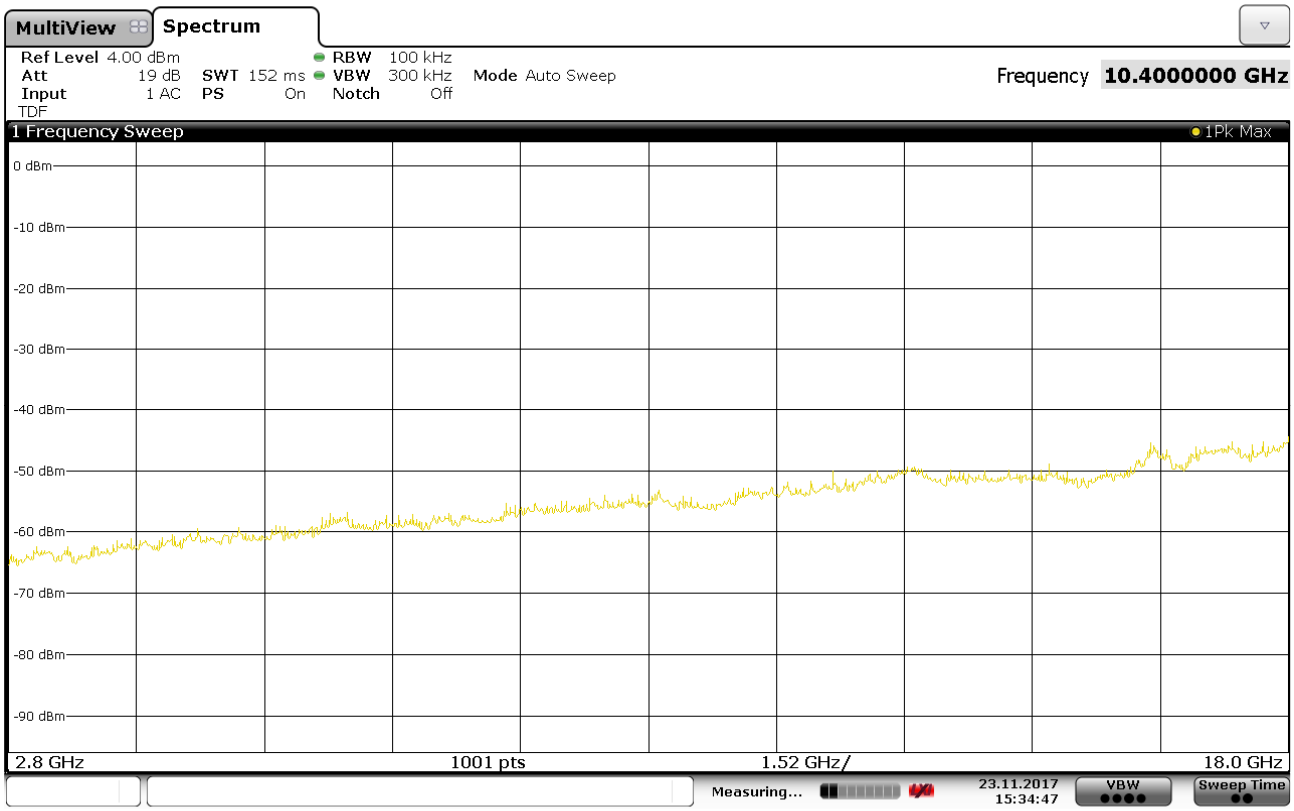


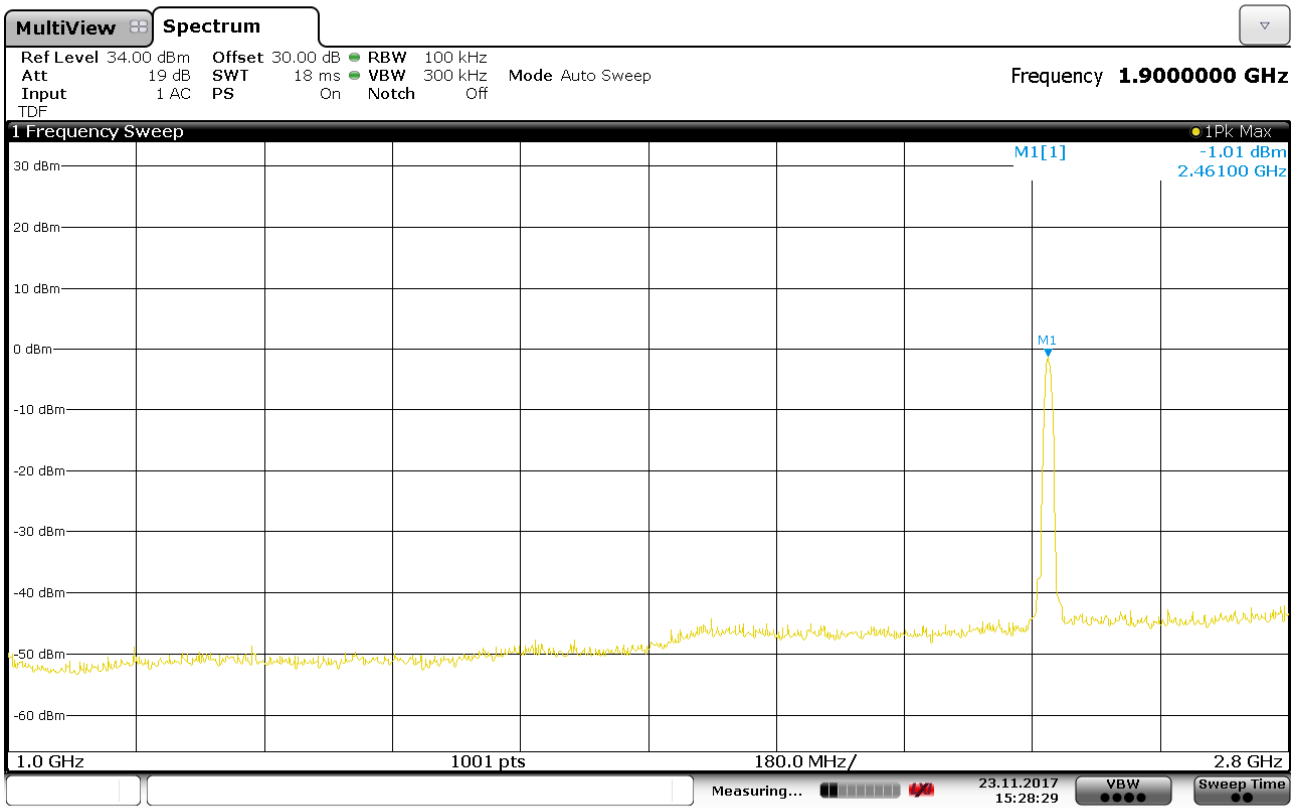
15:34:48 23.11.2017

18÷26 GHz								
Frequency	Reading value	Antenna Factor	Cable Loss	Pre-Amp. Gain	Correcting reading	PK Limit (AV + 20dB)	PK Limit (AV + 20dB)	Margin
(MHz)	(dBµV)	(dB3/m)	(dB)	(dB)	(dBµV/m)	(µV/m)	(dBµV/m)	(dB)
f>18000	not significant	---	---	---	---	5000	74.00	---

Antenna Port Spurious Emission - Radiated
Operation Mode: #1
Standard: IEE 802.11b
Channel: #11

9KHz-1000MHz								
Frequency	Reading value	Antenna Factor	Cable Loss	Pre-Amp. Gain	Correcting reading	PK Limit (AV + 20dB)	PK Limit (AV + 20dB)	Margin
(MHz)	(dBµV)	(dB3/m)	(dB)	(dB)	(dBµV/m)	(µV/m)	(dBµV/m)	(dB)
F<1000	not significant	---	---	---	---	5000	74.00	---

001



15:28:30 23.11.2017

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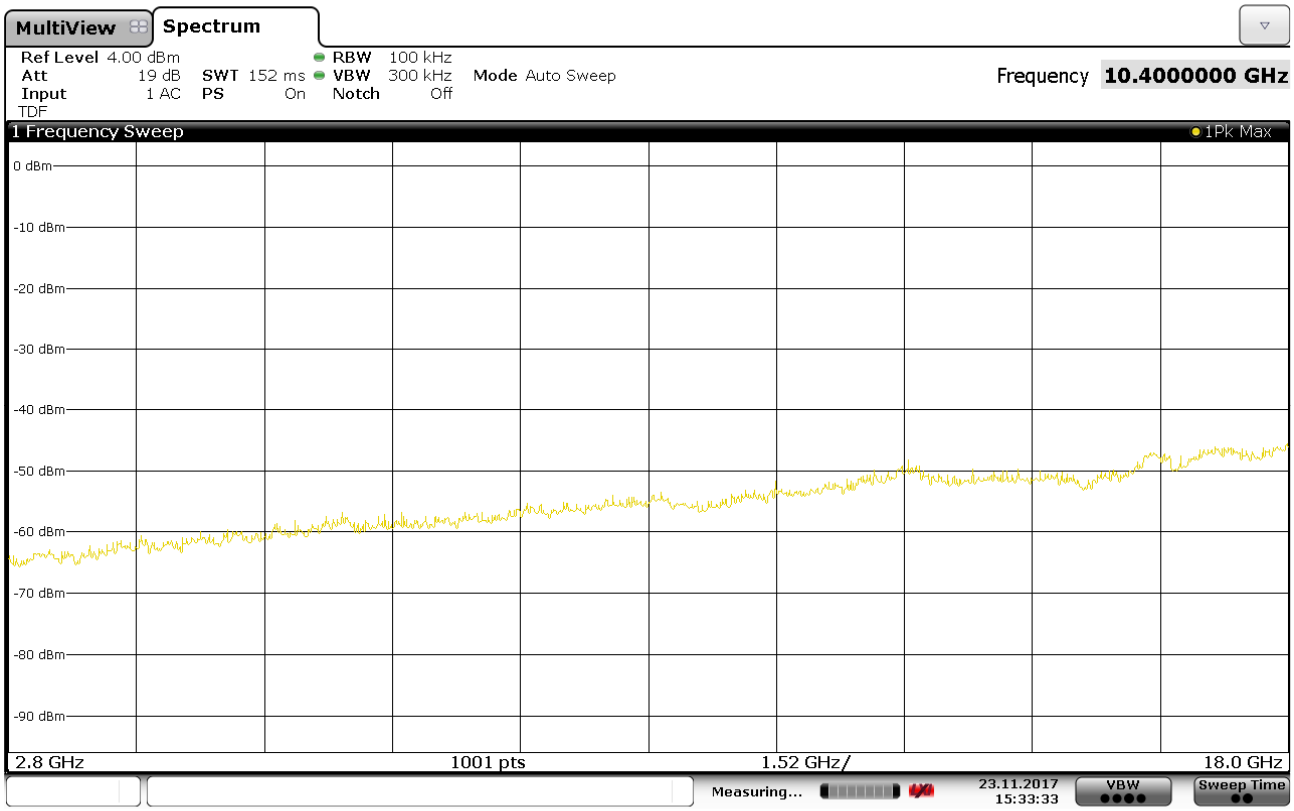


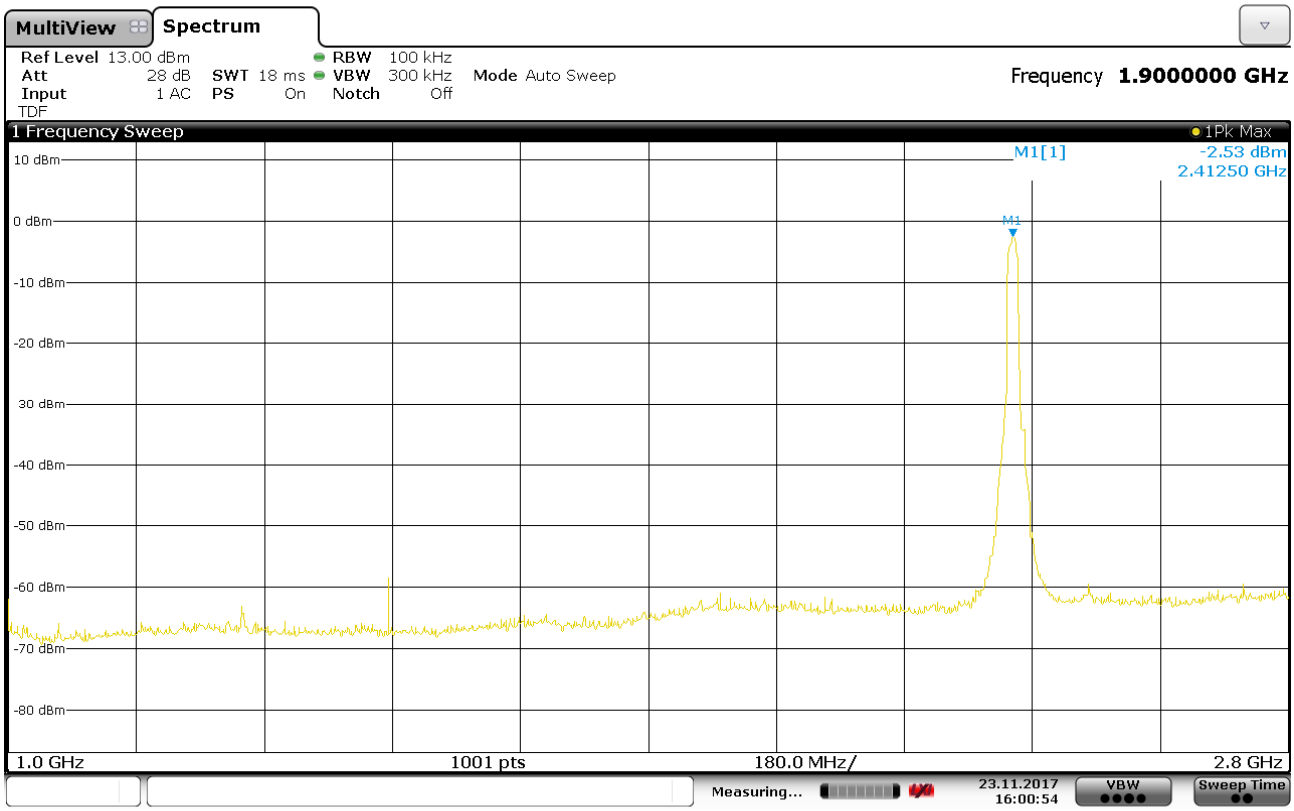
15:33:34 23.11.2017

18÷26 GHz								
PEAK RESULT (RBW=1MHz; VBW=3MHz)								
Frequency	Reading value	Antenna Factor	Cable Loss	Pre-Amp. Gain	Correcting reading	PK Limit (AV + 20dB)	PK Limit (AV + 20dB)	Margin
(MHz)	(dBµV)	(dB3/m)	(dB)	(dB)	(dBµV/m)	(µV/m)	(dBµV/m)	(dB)
f>18000	not significant	---	---	---	---	5000	74.00	---

Antenna Port Spurious Emission - Radiated
Operation Mode: #1
Standard: IEE 802.11g
Channel: #1

9KHz-1000MHz								
Frequency	Reading value	Antenna Factor	Cable Loss	Pre-Amp. Gain	Correcting reading	PK Limit (AV + 20dB)	PK Limit (AV + 20dB)	Margin
(MHz)	(dBµV)	(dB3/m)	(dB)	(dB)	(dBµV/m)	(µV/m)	(dBµV/m)	(dB)
F<1000	not significant	---	---	---	---	5000	74.00	---

001



16:00:54 23.11.2017

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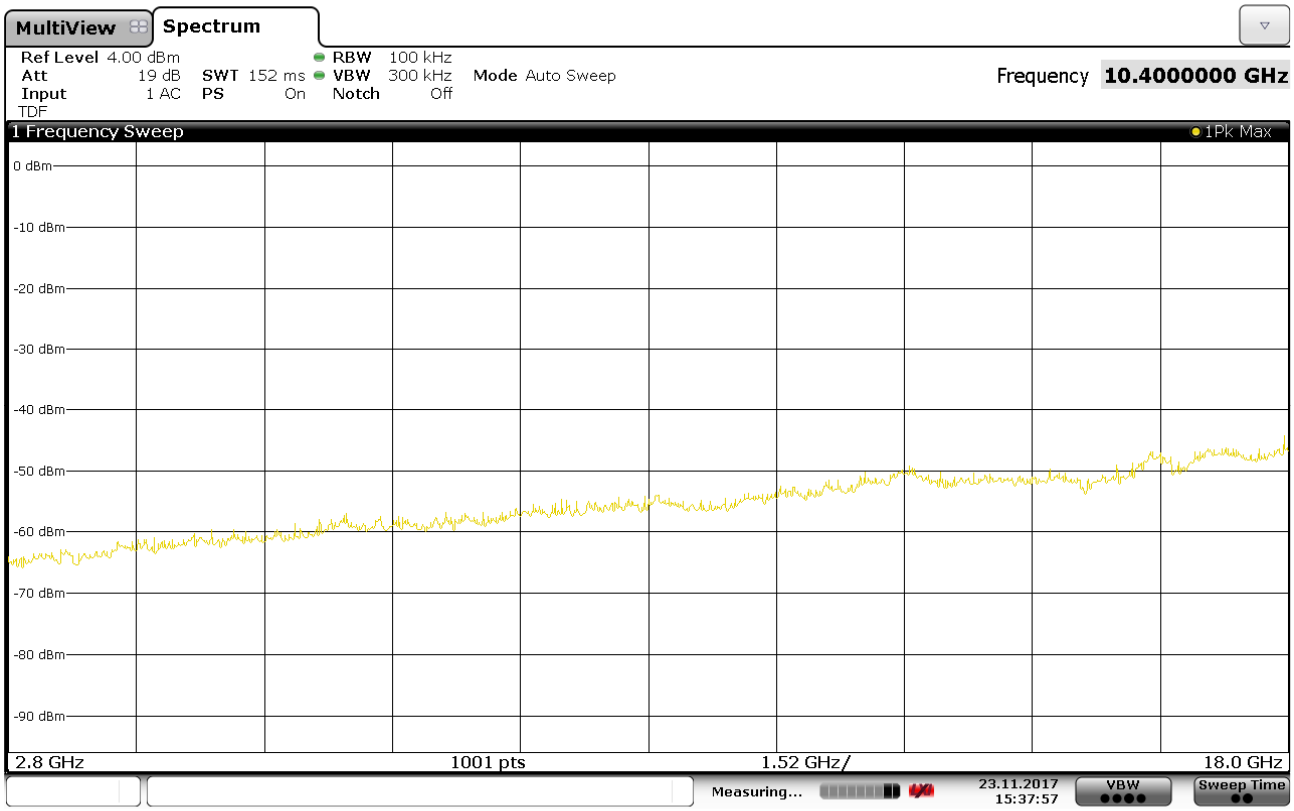


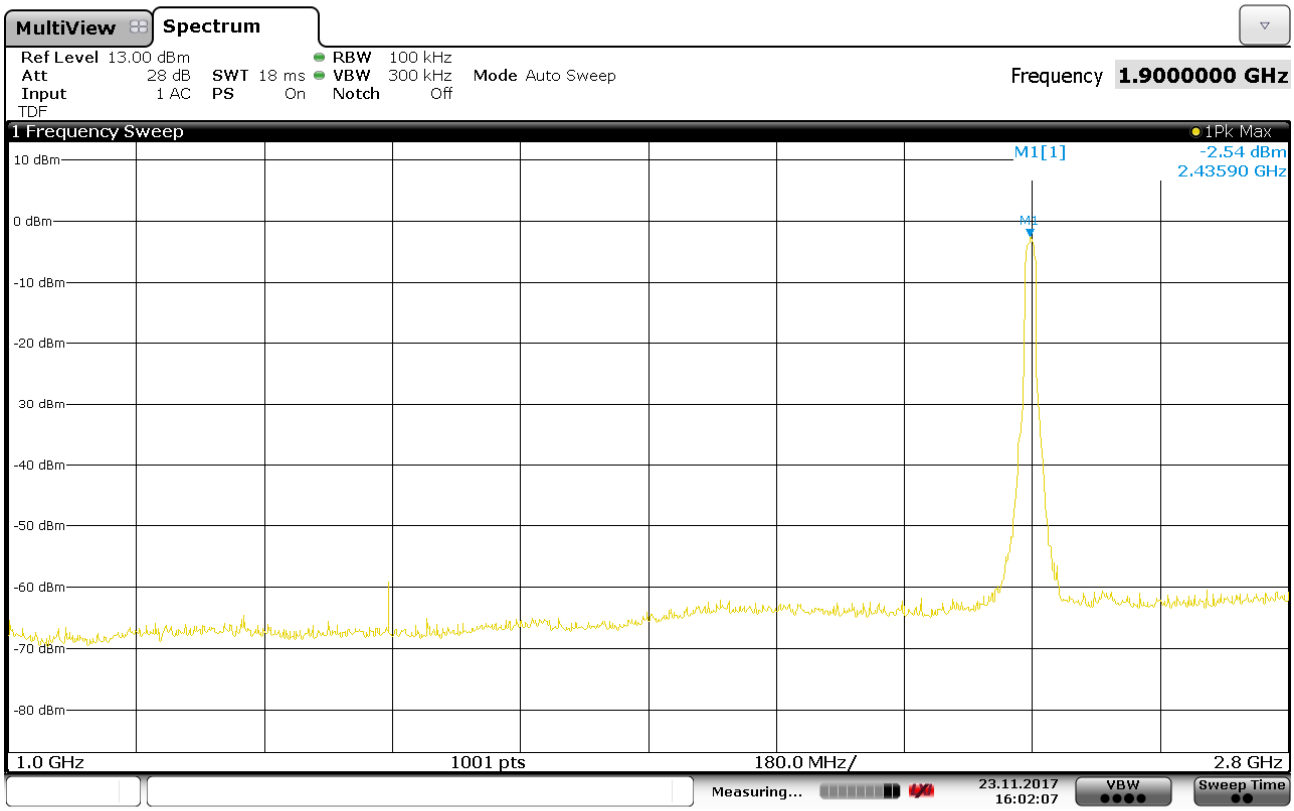
15:37:57 23.11.2017

18÷26 GHz								
PEAK RESULT (RBW=1MHz; VBW=3MHz)								
Frequency	Reading value	Antenna Factor	Cable Loss	Pre-Amp. Gain	Correcting reading	PK Limit (AV + 20dB)	PK Limit (AV + 20dB)	Margin
(MHz)	(dBµV)	(dB3/m)	(dB)	(dB)	(dBµV/m)	(µV/m)	(dBµV/m)	(dB)
f>18000	not significant	---	---	---	---	5000	74.00	---

Antenna Port Spurious Emission - Radiated
Operation Mode: #1
Standard: IEE 802.11b
Channel: #6

9KHz-1000MHz								
Frequency	Reading value	Antenna Factor	Cable Loss	Pre-Amp. Gain	Correcting reading	PK Limit (AV + 20dB)	PK Limit (AV + 20dB)	Margin
(MHz)	(dBµV)	(dB3/m)	(dB)	(dB)	(dBµV/m)	(µV/m)	(dBµV/m)	(dB)
F<1000	not significant	---	---	---	---	5000	74.00	---

001



16:02:08 23.11.2017

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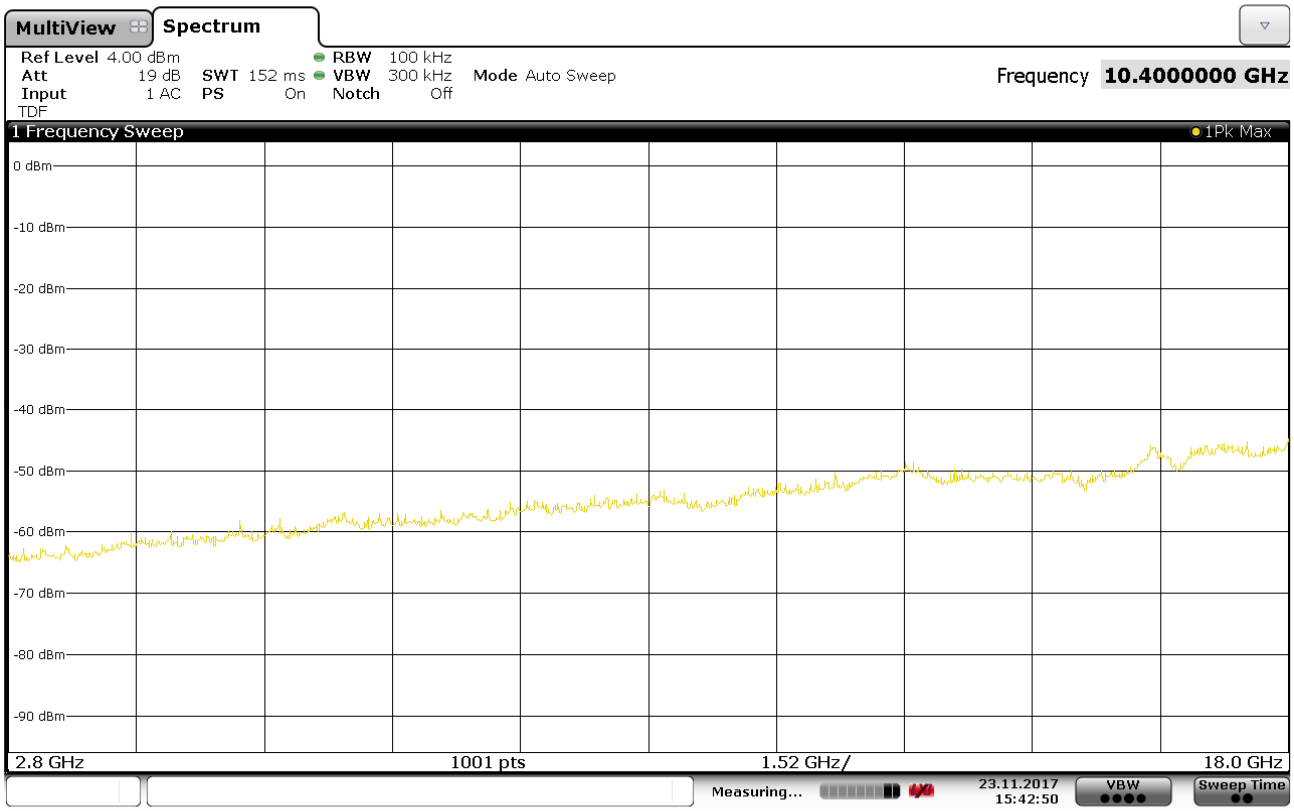


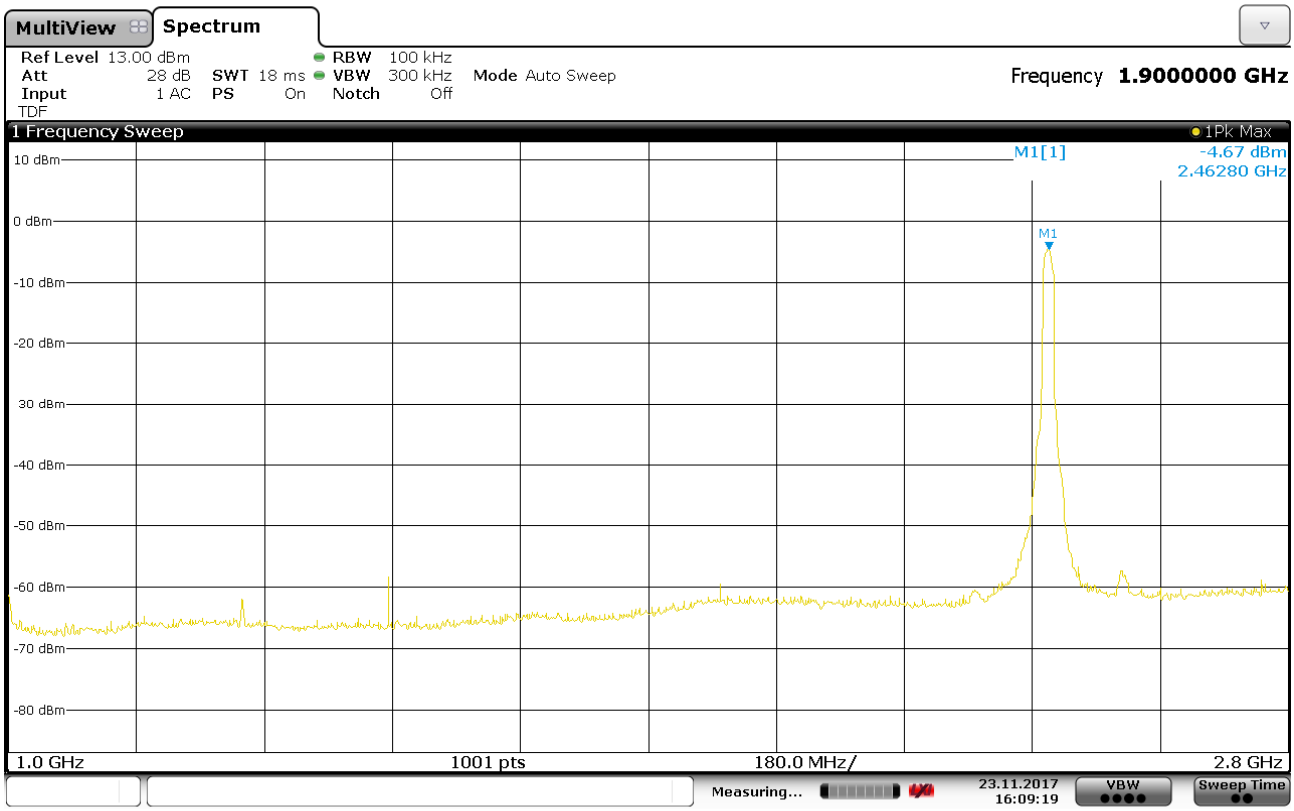
15:42:50 23.11.2017

18÷26 GHz								
Frequency	Reading value	Antenna Factor	Cable Loss	Pre-Amp. Gain	Correcting reading	PK Limit (AV + 20dB)	PK Limit (AV + 20dB)	Margin
(MHz)	(dBµV)	(dB3/m)	(dB)	(dB)	(dBµV/m)	(µV/m)	(dBµV/m)	(dB)
f>18000	not significant	---	---	---	---	5000	74.00	---

Antenna Port Spurious Emission - Radiated
Operation Mode: #1
Standard: IEE 802.11g
Channel: #11

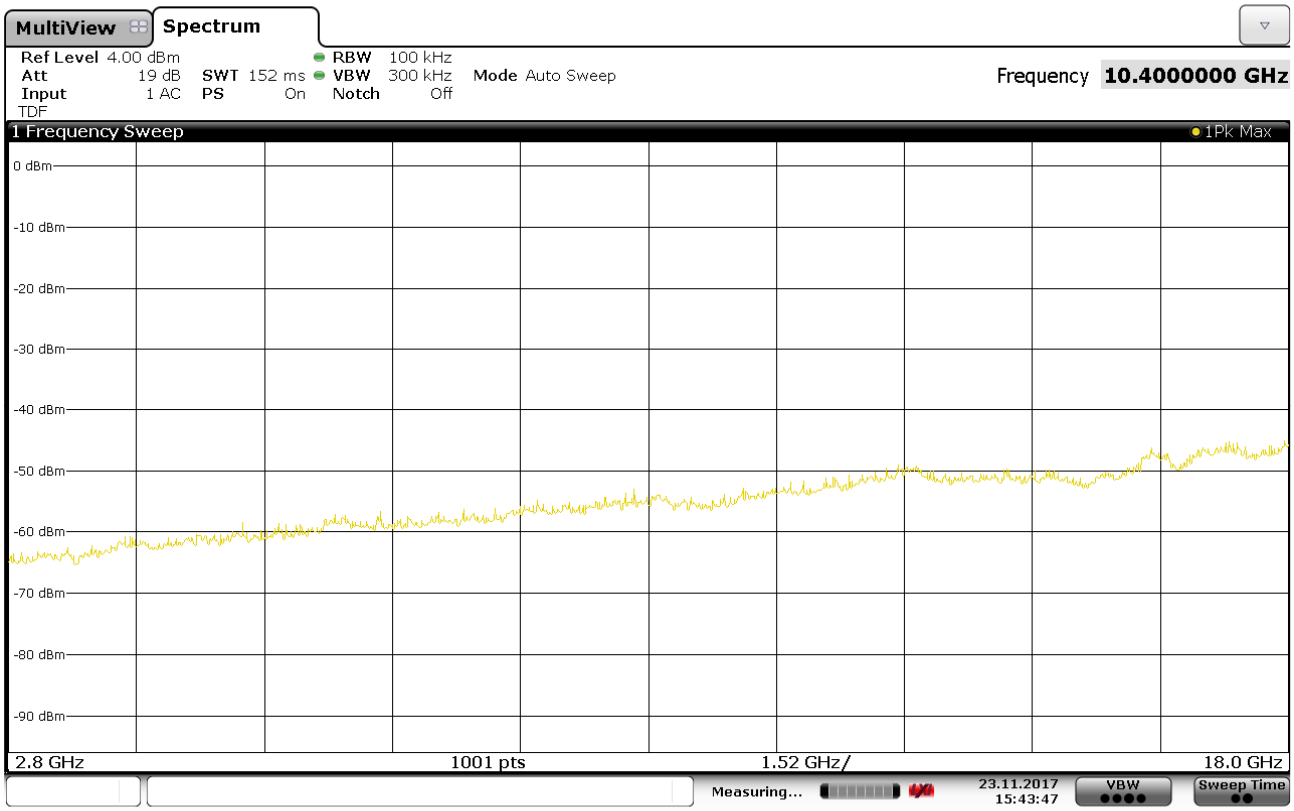
9KHz-1000MHz								
Frequency	Reading value	Antenna Factor	Cable Loss	Pre-Amp. Gain	Correcting reading	PK Limit (AV + 20dB)	PK Limit (AV + 20dB)	Margin
(MHz)	(dBµV)	(dB3/m)	(dB)	(dB)	(dBµV/m)	(µV/m)	(dBµV/m)	(dB)
F<1000	not significant	---	---	---	---	5000	74.00	---

001



16:09:20 23.11.2017

001



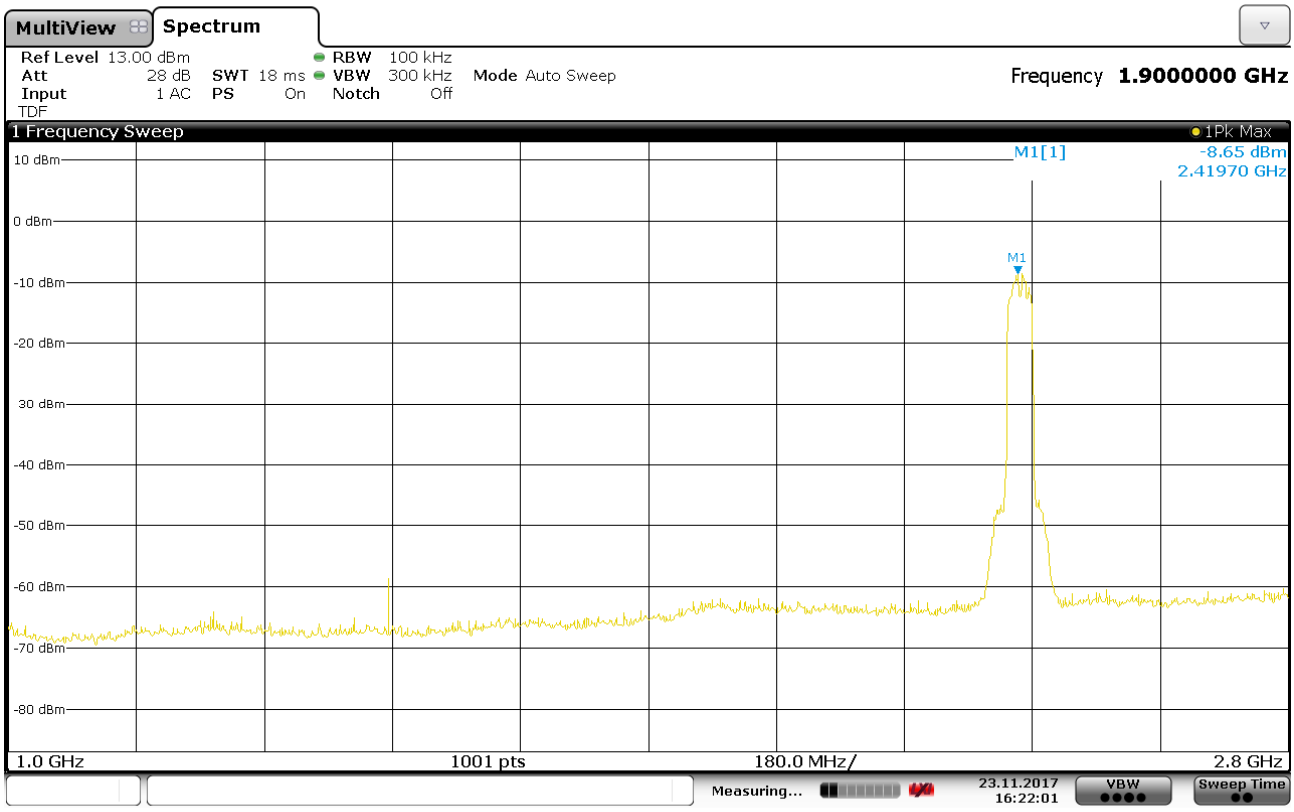
15:43:47 23.11.2017

18÷26 GHz								
PEAK RESULT (RBW=1MHz; VBW=3MHz)								
Frequency	Reading value	Antenna Factor	Cable Loss	Pre-Amp. Gain	Correcting reading	PK Limit (AV + 20dB)	PK Limit (AV + 20dB)	Margin
(MHz)	(dBµV)	(dB3/m)	(dB)	(dB)	(dBµV/m)	(µV/m)	(dBµV/m)	(dB)
f>18000	not significant	---	---	---	---	5000	74.00	---

Antenna Port Spurious Emission - Radiated
Operation Mode: #1
Standard: IEE 802.11n 20MHz
Channel: #1

9KHz-1000MHz								
Frequency	Reading value	Antenna Factor	Cable Loss	Pre-Amp. Gain	Correcting reading	PK Limit (AV + 20dB)	PK Limit (AV + 20dB)	Margin
(MHz)	(dBµV)	(dB3/m)	(dB)	(dB)	(dBµV/m)	(µV/m)	(dBµV/m)	(dB)
F<1000	not significant	---	---	---	---	5000	74.00	---

001



16:22:01 23.11.2017

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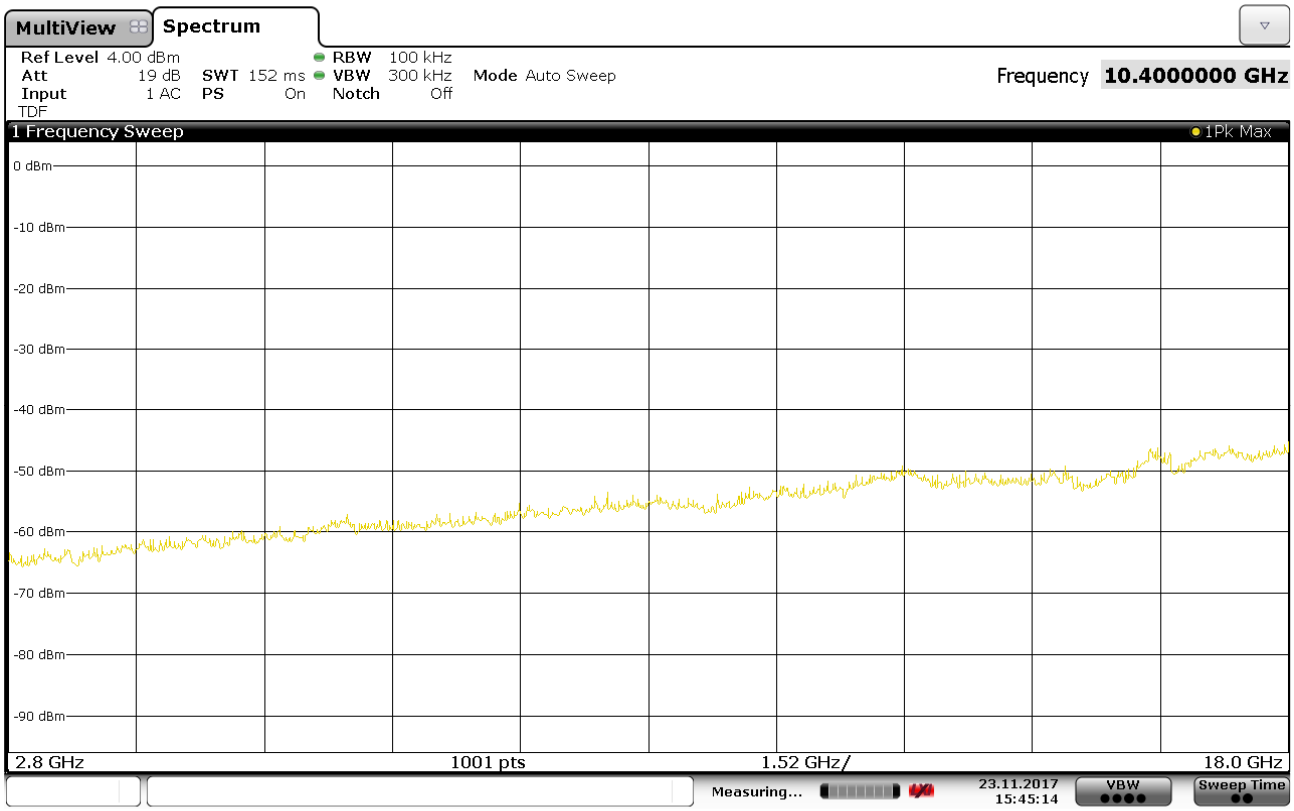


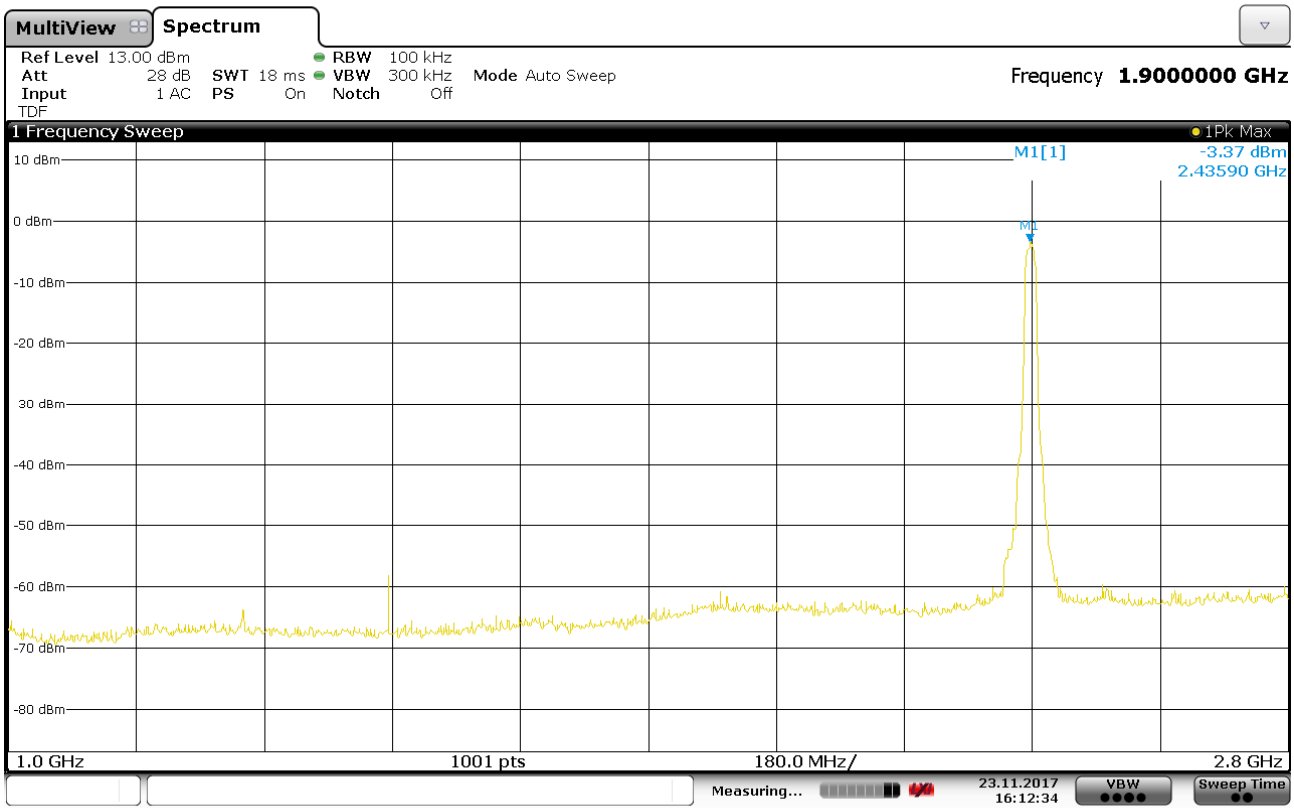
15:45:14 23.11.2017

18÷26 GHz								
PEAK RESULT (RBW=1MHz; VBW=3MHz)								
Frequency	Reading value	Antenna Factor	Cable Loss	Pre-Amp. Gain	Correcting reading	PK Limit (AV + 20dB)	PK Limit (AV + 20dB)	Margin
(MHz)	(dBµV)	(dB3/m)	(dB)	(dB)	(dBµV/m)	(µV/m)	(dBµV/m)	(dB)
f>18000	not significant	---	---	---	---	5000	74.00	---

Antenna Port Spurious Emission - Radiated
Operation Mode: #1
Standard: IEE 802.11b
Channel: #6

9KHz-1000MHz								
Frequency	Reading value	Antenna Factor	Cable Loss	Pre-Amp. Gain	Correcting reading	PK Limit (AV + 20dB)	PK Limit (AV + 20dB)	Margin
(MHz)	(dBµV)	(dB3/m)	(dB)	(dB)	(dBµV/m)	(µV/m)	(dBµV/m)	(dB)
F<1000	not significant	---	---	---	---	5000	74.00	---

001



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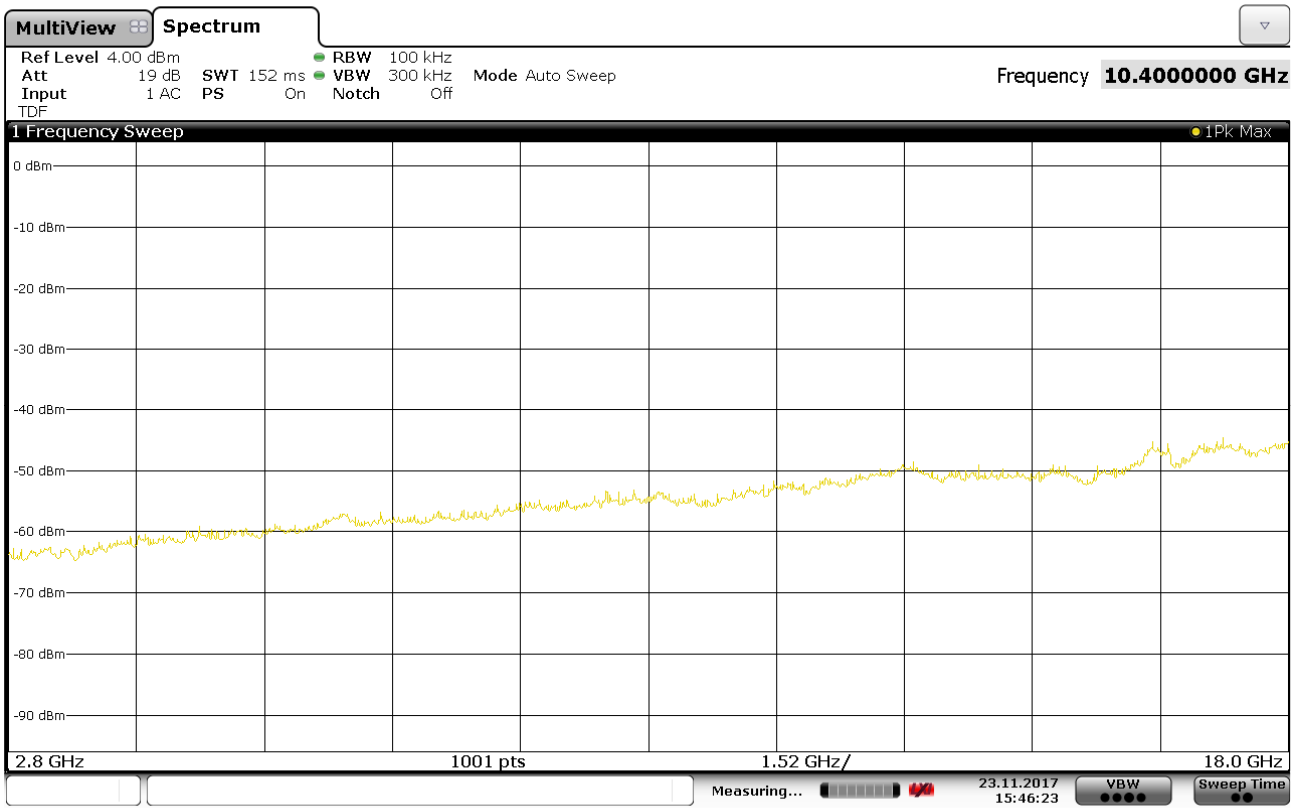


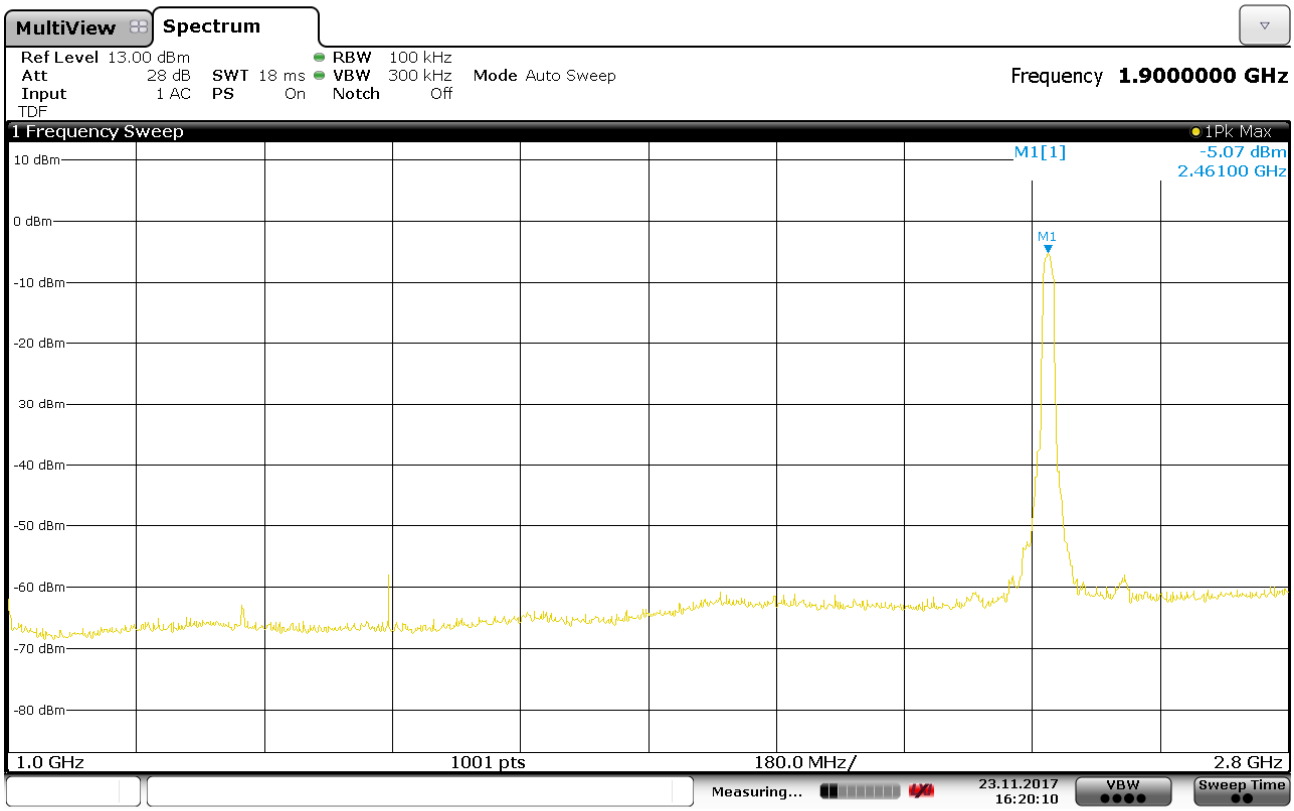
15:46:23 23.11.2017

18÷26 GHz								
Frequency	Reading value	Antenna Factor	Cable Loss	Pre-Amp. Gain	Correcting reading	PK Limit (AV + 20dB)	PK Limit (AV + 20dB)	Margin
(MHz)	(dBµV)	(dB3/m)	(dB)	(dB)	(dBµV/m)	(µV/m)	(dBµV/m)	(dB)
f>18000	not significant	---	---	---	---	5000	74.00	---

Antenna Port Spurious Emission - Radiated
Operation Mode: #1
Standard: IEE 802.11n 20MHz
Channel: #11

9KHz-1000MHz								
Frequency	Reading value	Antenna Factor	Cable Loss	Pre-Amp. Gain	Correcting reading	PK Limit (AV + 20dB)	PK Limit (AV + 20dB)	Margin
(MHz)	(dBµV)	(dB3/m)	(dB)	(dB)	(dBµV/m)	(µV/m)	(dBµV/m)	(dB)
F<1000	not significant	---	---	---	---	5000	74.00	---

001



16:20:11 23.11.2017

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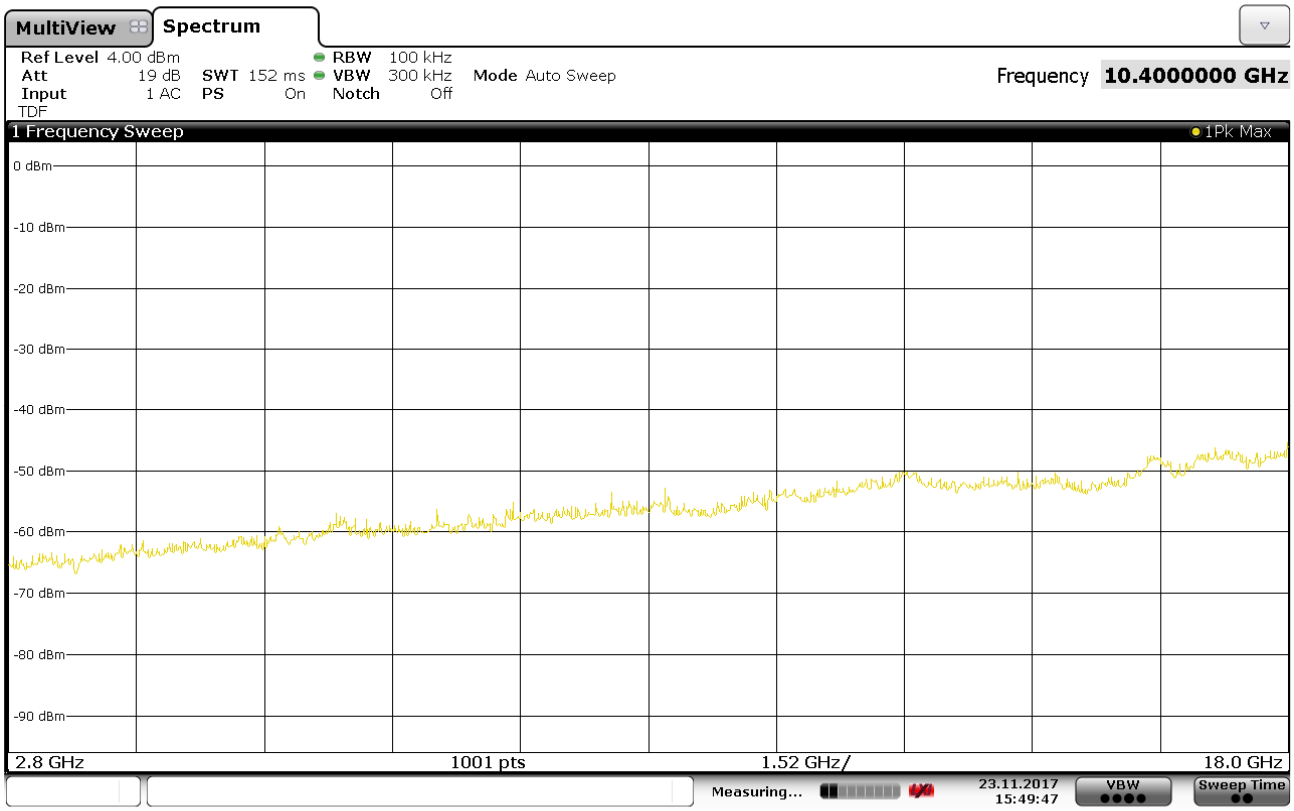


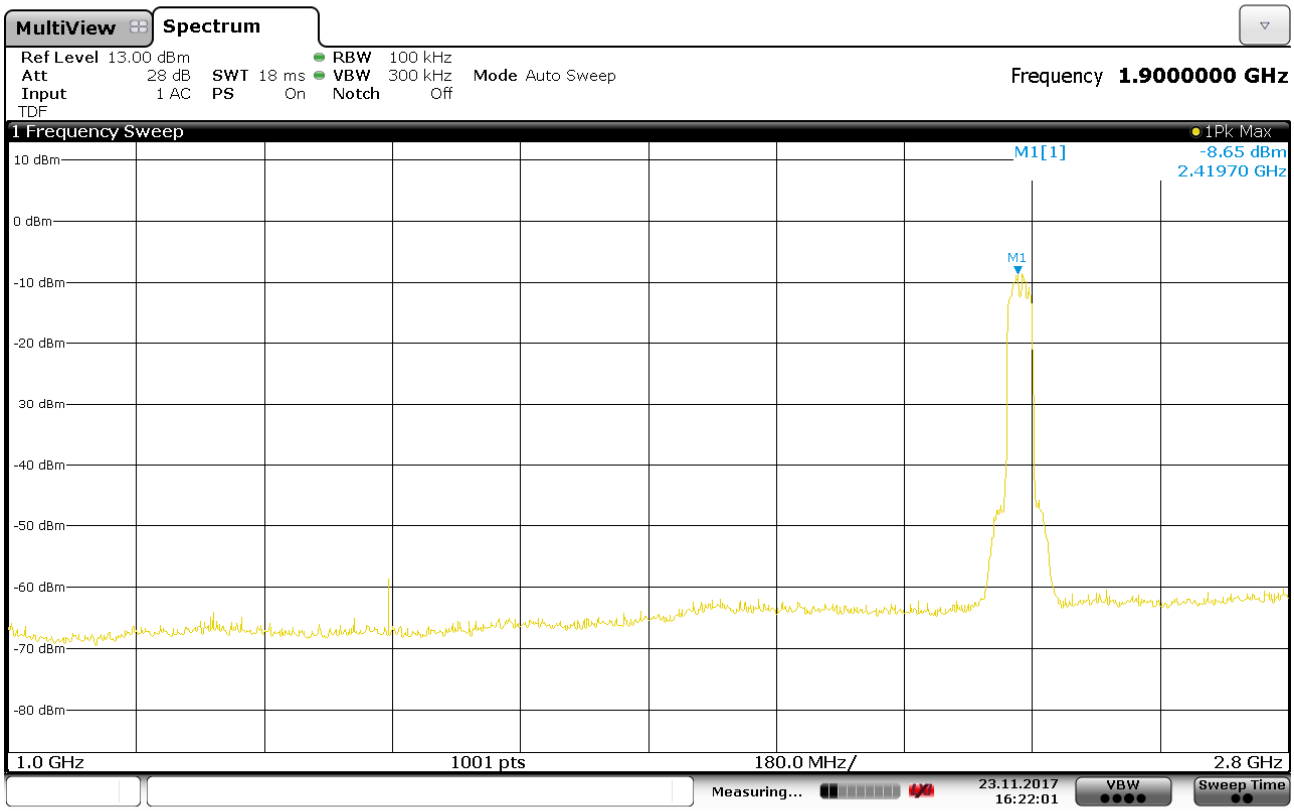
15:49:47 23.11.2017

18÷26 GHz								
PEAK RESULT (RBW=1MHz; VBW=3MHz)								
Frequency	Reading value	Antenna Factor	Cable Loss	Pre-Amp. Gain	Correcting reading	PK Limit (AV + 20dB)	PK Limit (AV + 20dB)	Margin
(MHz)	(dBµV)	(dB3/m)	(dB)	(dB)	(dBµV/m)	(µV/m)	(dBµV/m)	(dB)
f>18000	not significant	---	---	---	---	5000	74.00	---

Antenna Port Spurious Emission - Radiated
Operation Mode: #1
Standard: IEE 802.11n 40MHz
Channel: #3

9KHz-1000MHz								
Frequency	Reading value	Antenna Factor	Cable Loss	Pre-Amp. Gain	Correcting reading	PK Limit (AV + 20dB)	PK Limit (AV + 20dB)	Margin
(MHz)	(dBµV)	(dB3/m)	(dB)	(dB)	(dBµV/m)	(µV/m)	(dBµV/m)	(dB)
F<1000	not significant	---	---	---	---	5000	74.00	---

001



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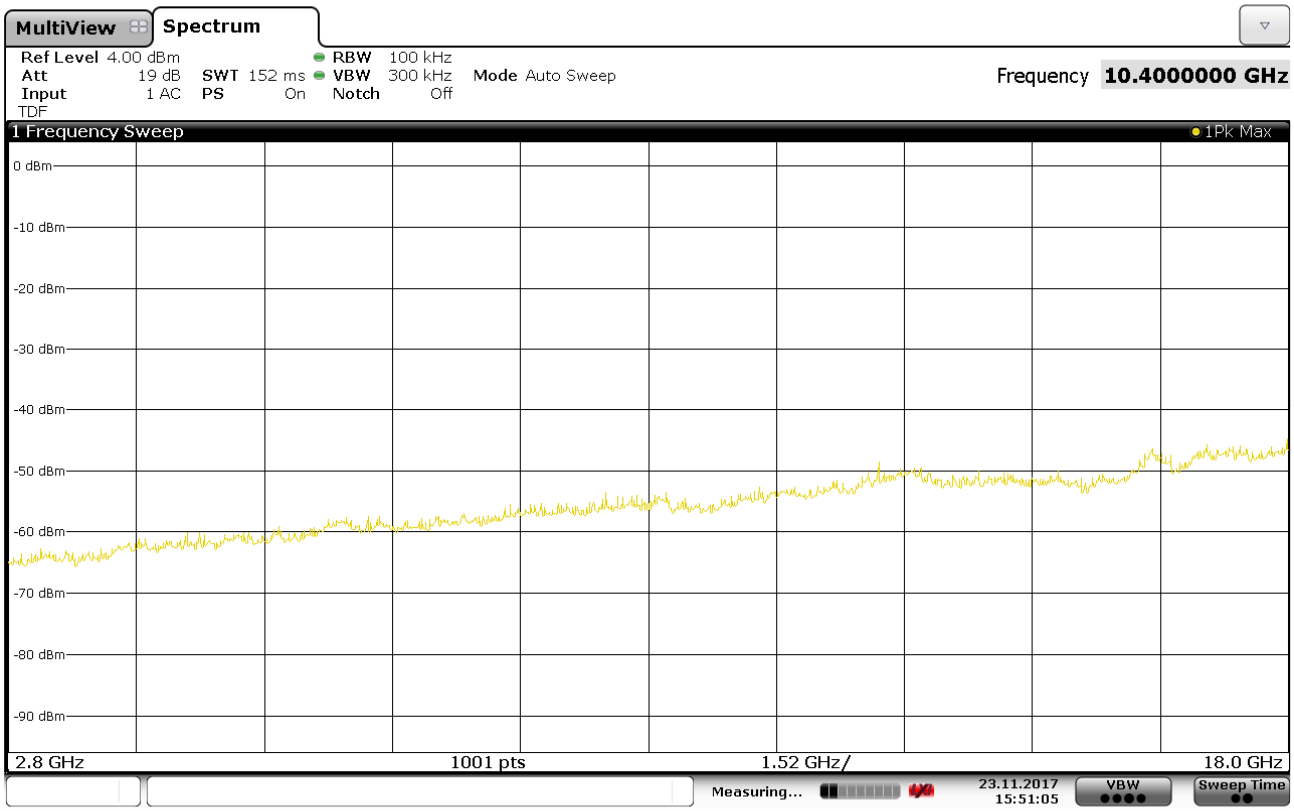


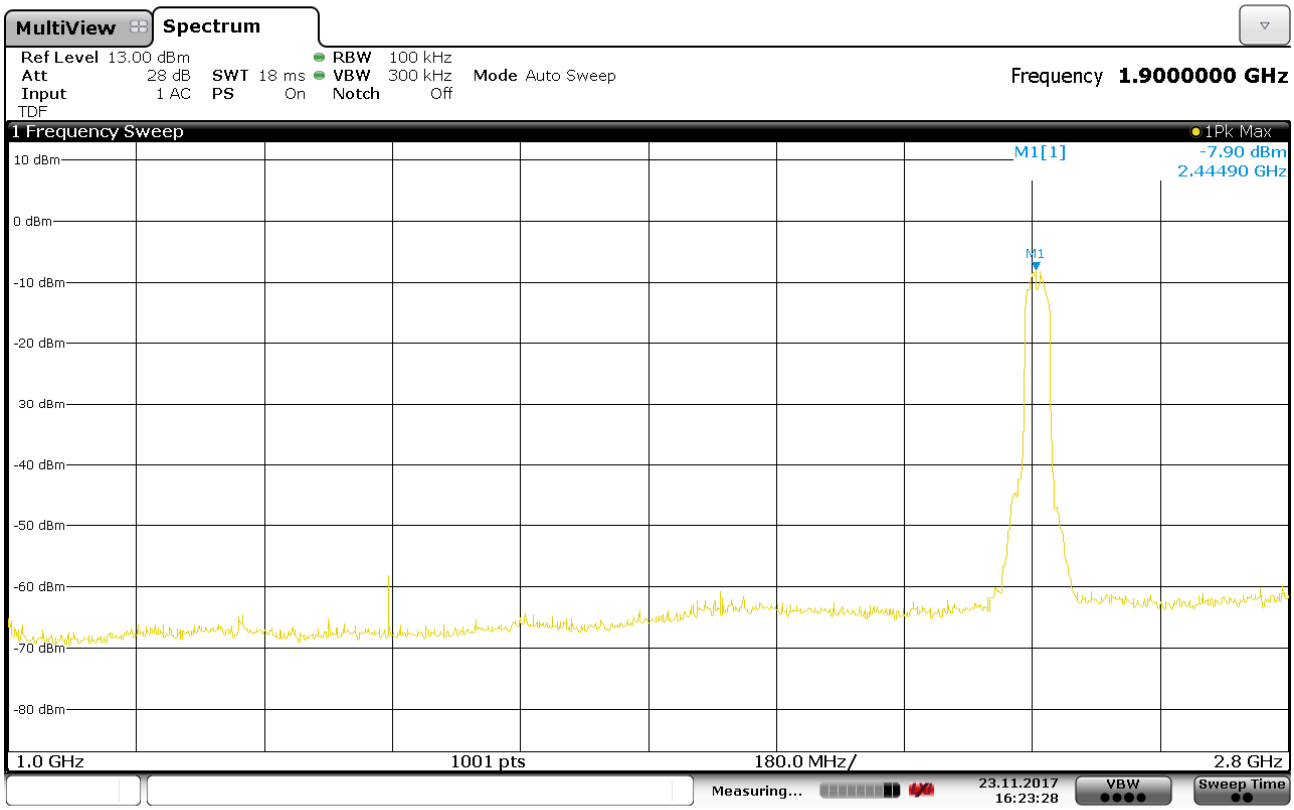
15:51:05 23.11.2017

18÷26 GHz								
PEAK RESULT (RBW=1MHz; VBW=3MHz)								
Frequency	Reading value	Antenna Factor	Cable Loss	Pre-Amp. Gain	Correcting reading	PK Limit (AV + 20dB)	PK Limit (AV + 20dB)	Margin
(MHz)	(dBµV)	(dB3/m)	(dB)	(dB)	(dBµV/m)	(µV/m)	(dBµV/m)	(dB)
f>18000	not significant	---	---	---	---	5000	74.00	---

Antenna Port Spurious Emission - Radiated
Operation Mode: #1
Standard: IEE 802.11n 40MHz
Channel: #6

9KHz-1000MHz								
Frequency	Reading value	Antenna Factor	Cable Loss	Pre-Amp. Gain	Correcting reading	PK Limit (AV + 20dB)	PK Limit (AV + 20dB)	Margin
(MHz)	(dBµV)	(dB3/m)	(dB)	(dB)	(dBµV/m)	(µV/m)	(dBµV/m)	(dB)
F<1000	not significant	---	---	---	---	5000	74.00	---

001



16:23:28 23.11.2017

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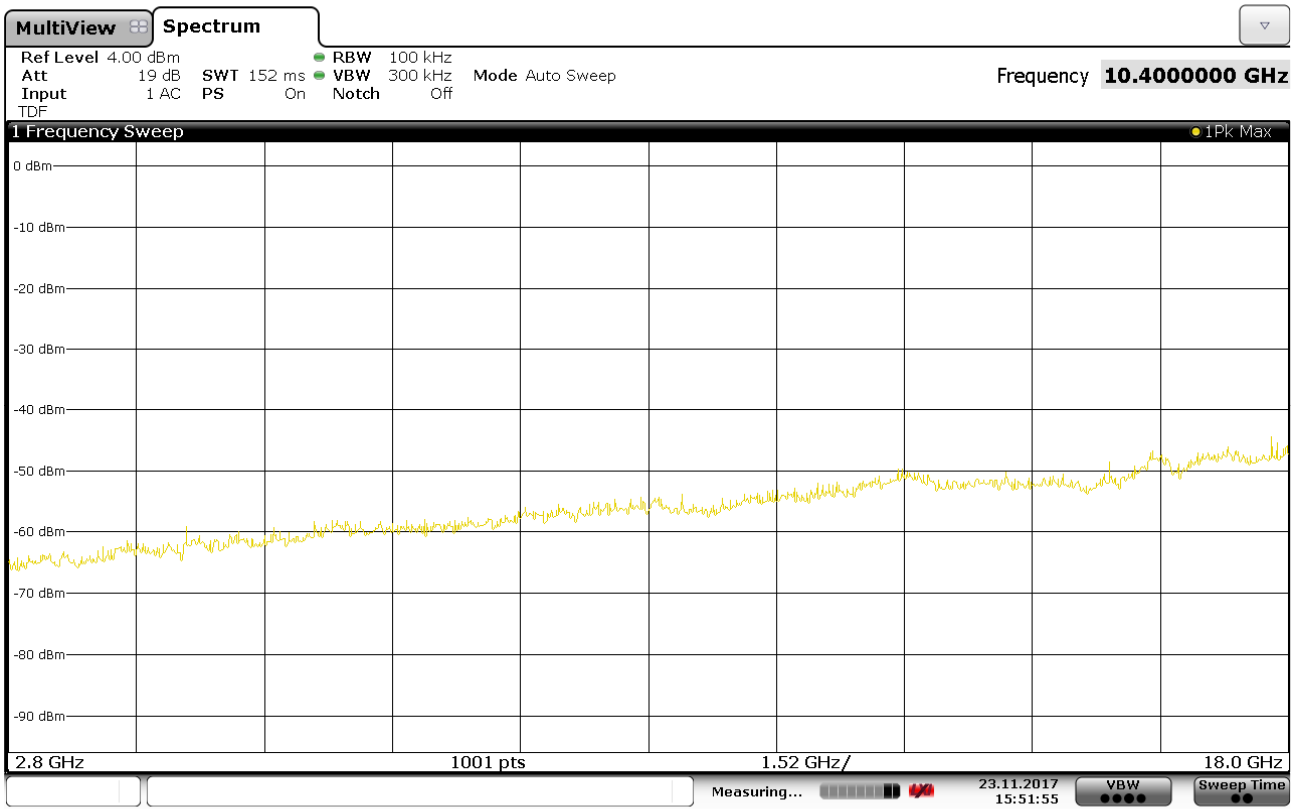


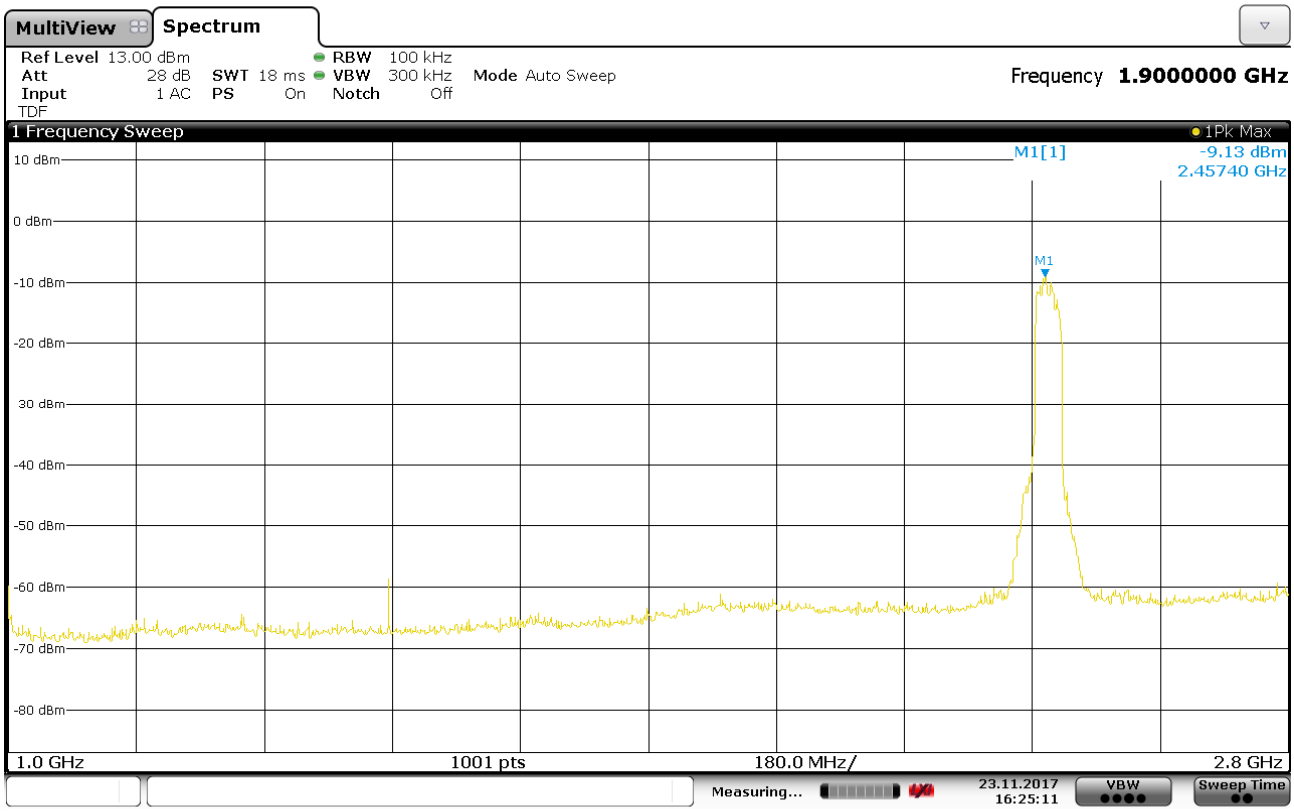
15:51:55 23.11.2017

18÷26 GHz								
Frequency	Reading value	Antenna Factor	Cable Loss	Pre-Amp. Gain	Correcting reading	PK Limit (AV + 20dB)	PK Limit (AV + 20dB)	Margin
(MHz)	(dBµV)	(dB3/m)	(dB)	(dB)	(dBµV/m)	(µV/m)	(dBµV/m)	(dB)
f>18000	not significant	---	---	---	---	5000	74.00	---

Antenna Port Spurious Emission - Radiated
Operation Mode: #1
Standard: IEE 802.11n 40MHz
Channel: #9

9KHz-1000MHz								
Frequency	Reading value	Antenna Factor	Cable Loss	Pre-Amp. Gain	Correcting reading	PK Limit (AV + 20dB)	PK Limit (AV + 20dB)	Margin
(MHz)	(dBµV)	(dB3/m)	(dB)	(dB)	(dBµV/m)	(µV/m)	(dBµV/m)	(dB)
F<1000	not significant	---	---	---	---	5000	74.00	---

001



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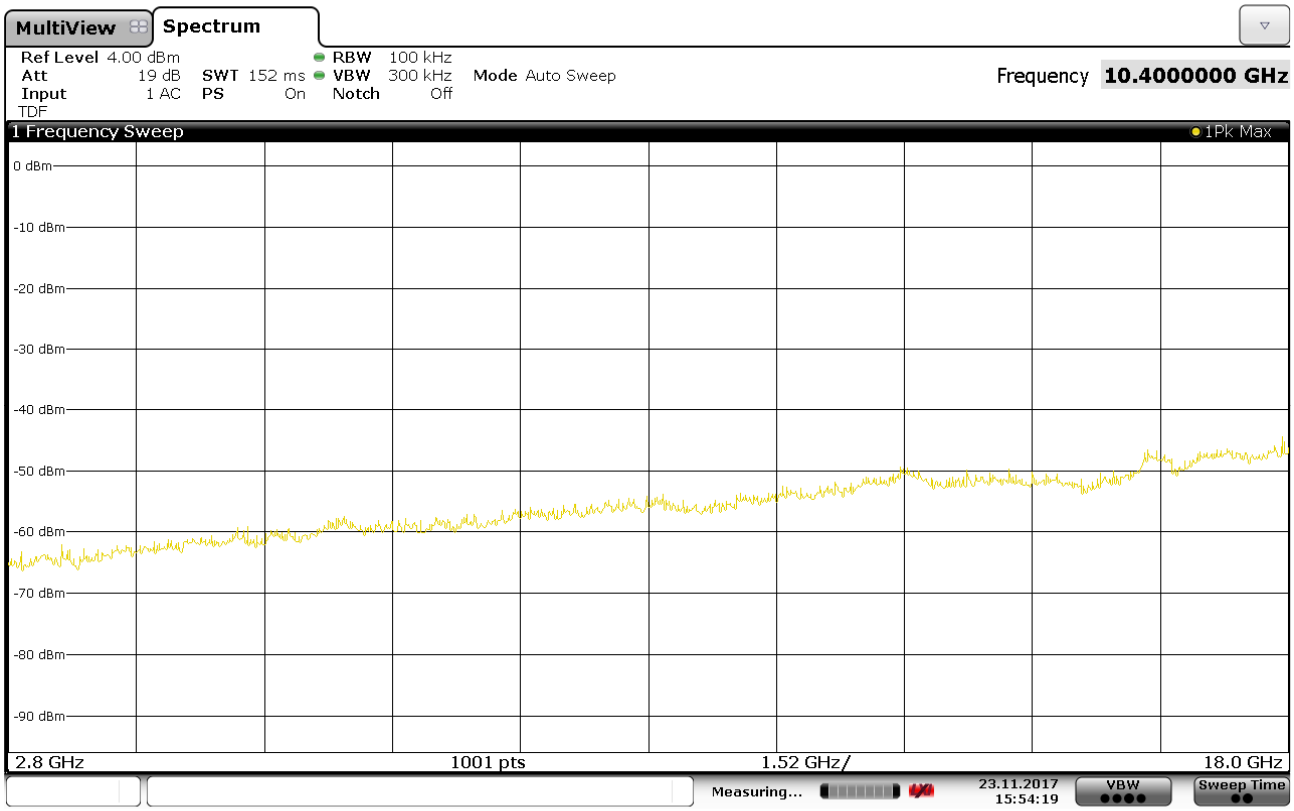
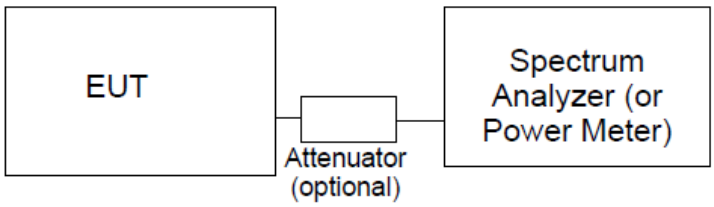


15:54:20 23.11.2017

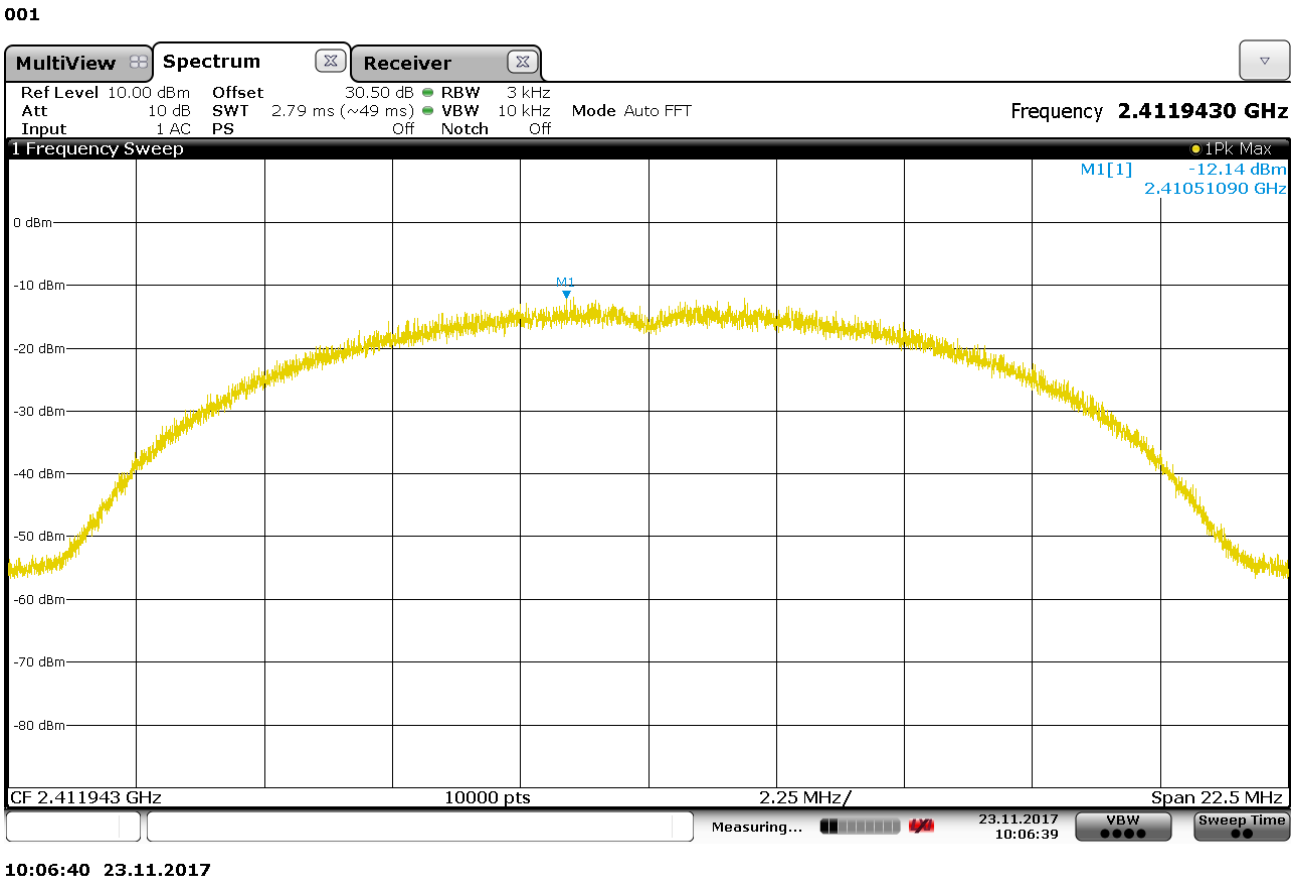
18÷26 GHz								
PEAK RESULT (RBW=1MHz; VBW=3MHz)								
Frequency	Reading value	Antenna Factor	Cable Loss	Pre-Amp. Gain	Correcting reading	PK Limit (AV + 20dB)	PK Limit (AV + 20dB)	Margin
(MHz)	(dBµV)	(dB3/m)	(dB)	(dB)	(dBµV/m)	(µV/m)	(dBµV/m)	(dB)
f>18000	not significant	---	---	---	---	5000	74.00	---

16. Test Conditions and Results – POWER SPECTRAL DENSITY

20	TEST: Power Spectral Density	PASS
Parameters required prior to the test	Laboratory Ambient Temperature (°C)	15 to 35 °C
	Relative Humidity (%)	30 to 60 %
Parameters recorded during the test	Laboratory Ambient Temperature (°C)	24°C
	Relative Humidity (%)	37%
	Air pressure (hPa)	1020
—	Frequency	Application Point
Fully configured sample tested at the power line frequency	24Vdc	SMA Connector
Equipment mode:	Operation mode	#1
FCC Standard	§15.247	
(e) For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.		
Further information to test setup		

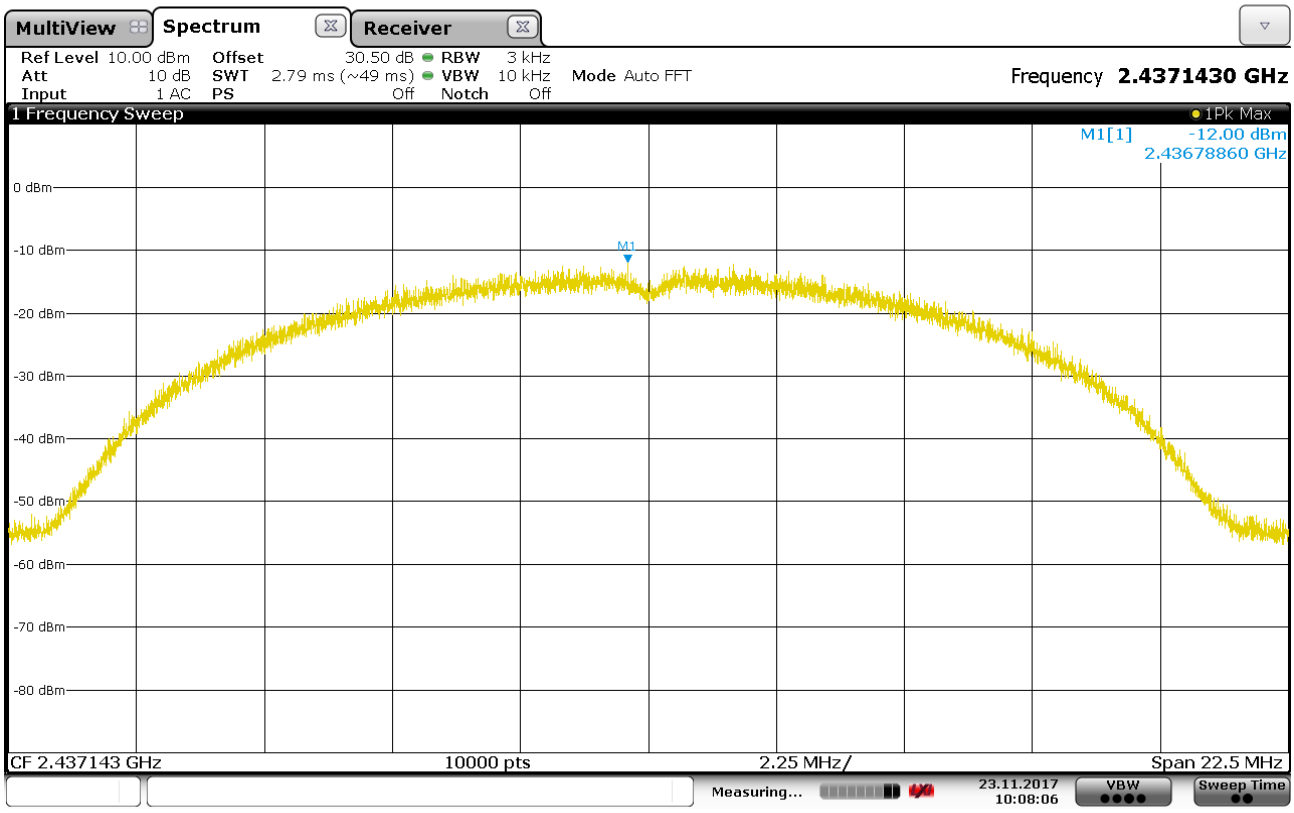
Test Equipment Used					
Description	Manufacturer	Model	Identifier	Calibration date	Calibration due
EMI Test Receiver	R&S	ESW44	87020967	06/2017	06/2018
20dB Attenuator	RS Components	Huber & Suhner	87020534	10/2017	10/2018

Graphical representation of Power Spectral Density
Operation Mode: #1
Standard: IEE 802.11b
Channel: #1



Graphical representation of Power Spectral Density
Operation Mode: #1
Standard: IEE 802.11b
Channel: #6

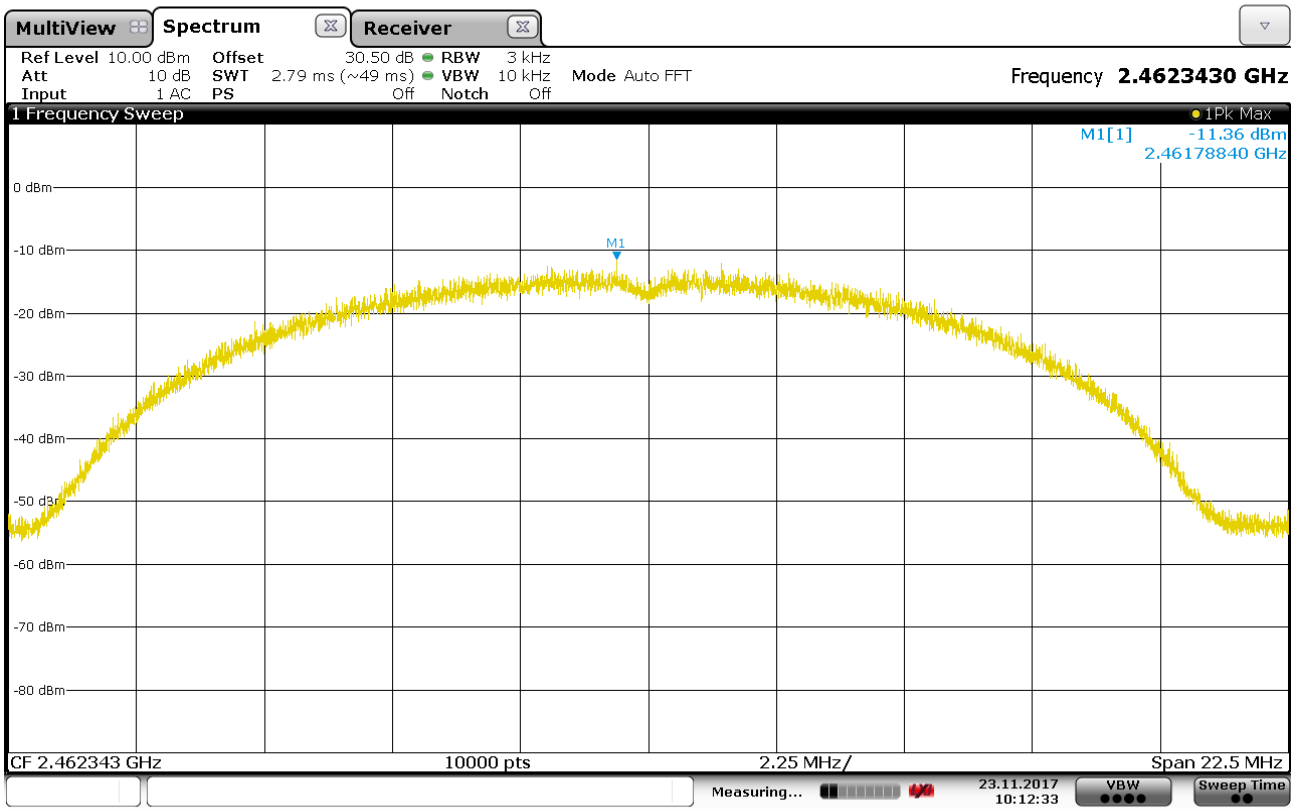
001



10:08:06 23.11.2017

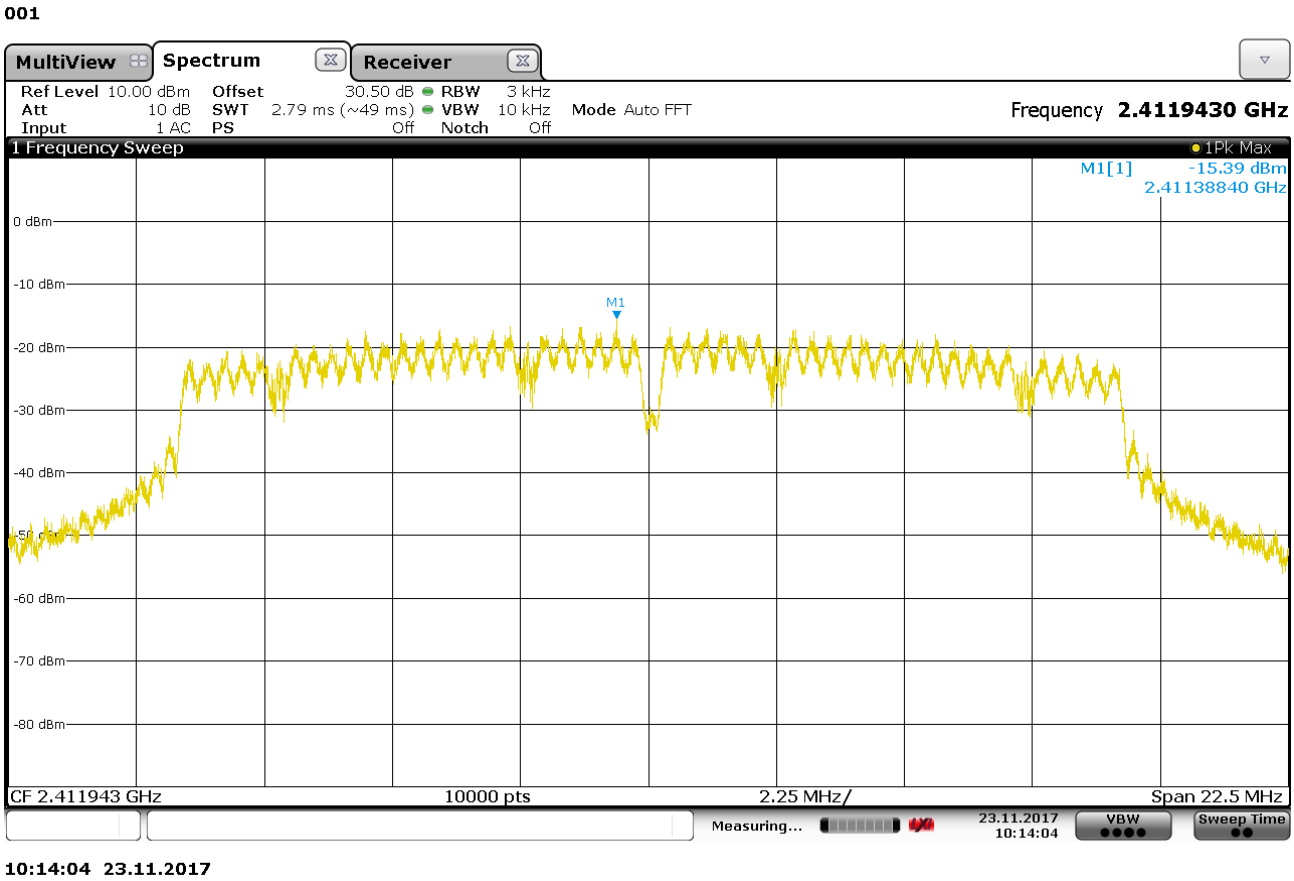
Graphical representation of Power Spectral Density
Operation Mode: #1
Standard: IEE 802.11b
Channel: #11

001

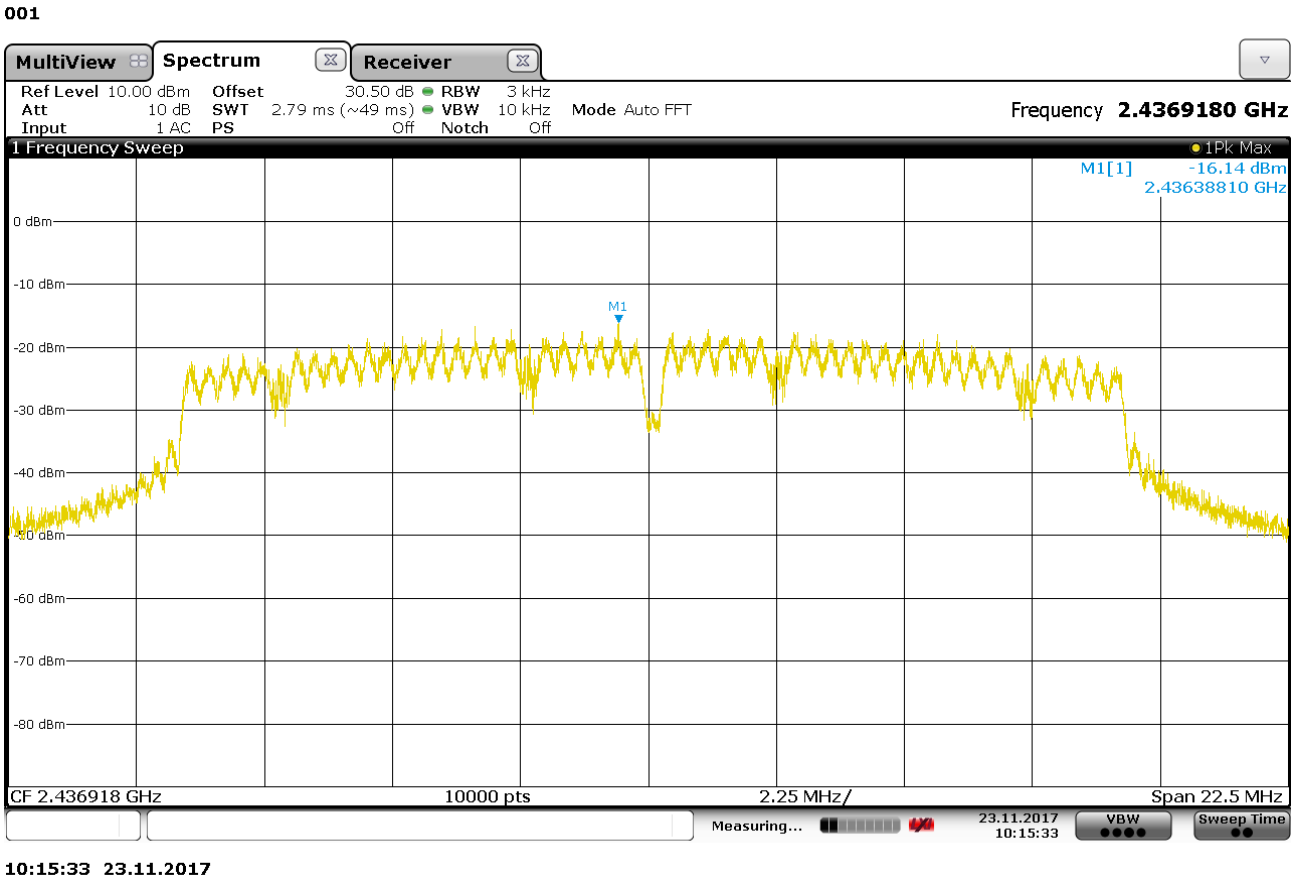


10:12:34 23.11.2017

Graphical representation of Power Spectral Density
Operation Mode: #1
Standard: IEE 802.11g
Channel: #1

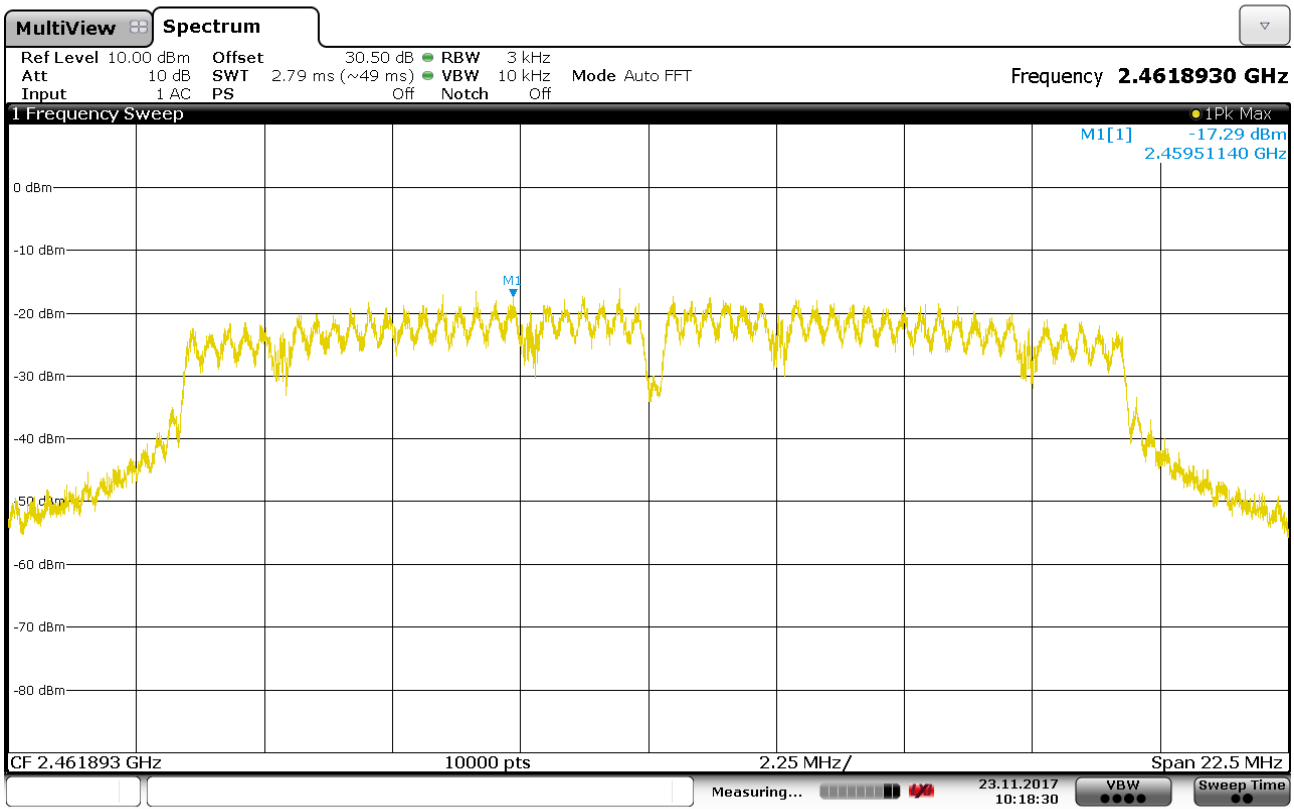


Graphical representation of Power Spectral Density
Operation Mode: #1
Standard: IEE 802.11g
Channel: #6



Graphical representation of Power Spectral Density
Operation Mode: #1
Standard: IEE 802.11g
Channel: #11

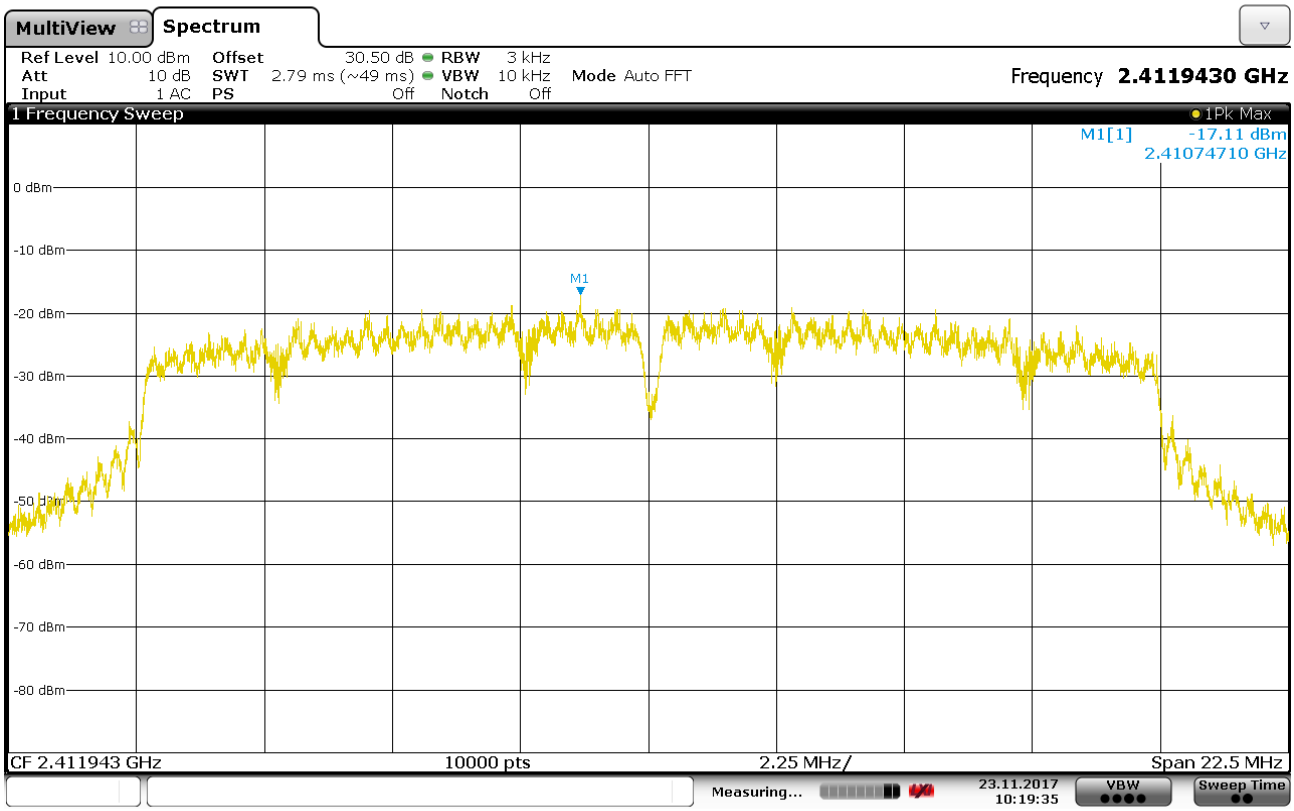
001



10:18:30 23.11.2017

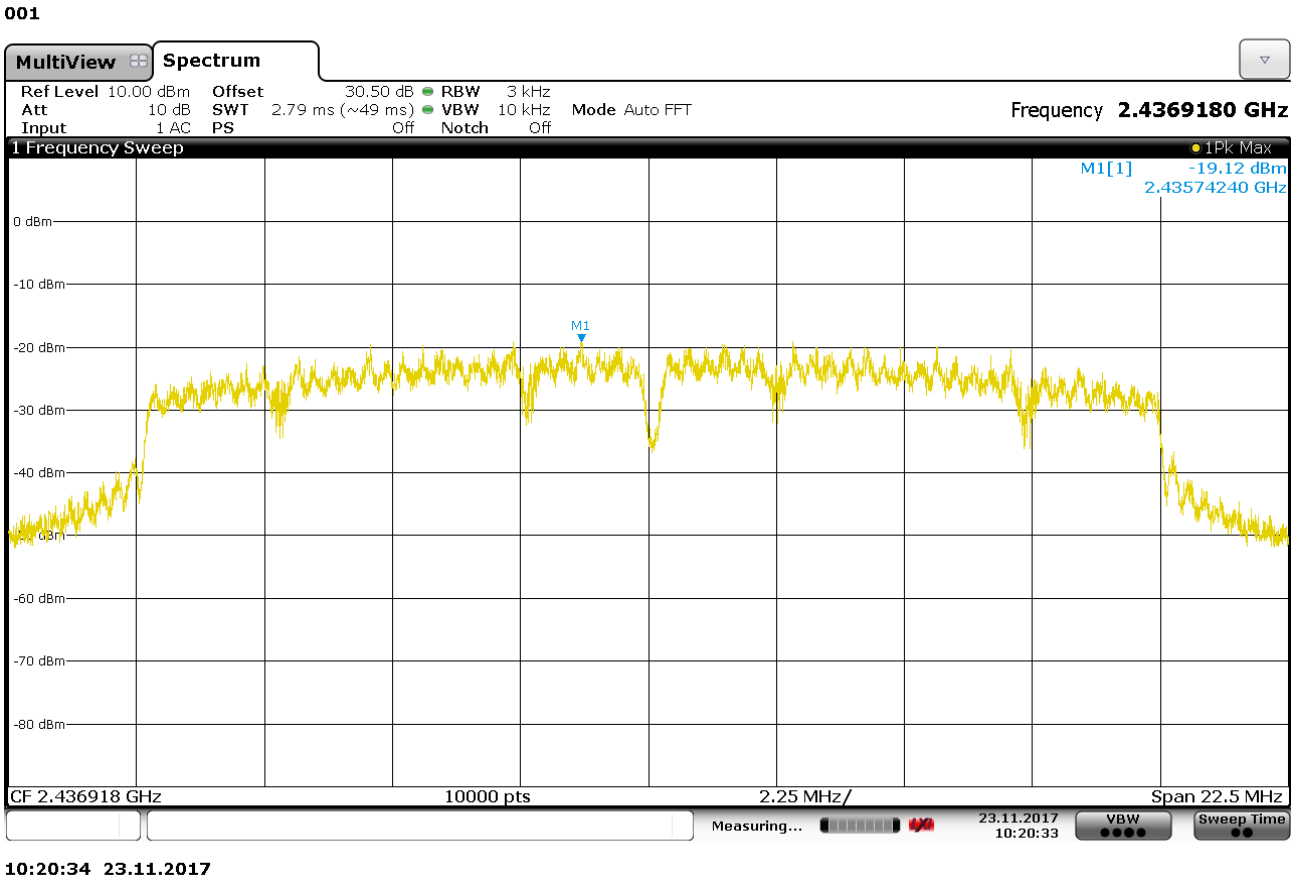
Graphical representation of Power Spectral Density
Operation Mode: #1
Standard: IEE 802.11n 20MHz
Channel: #1

001



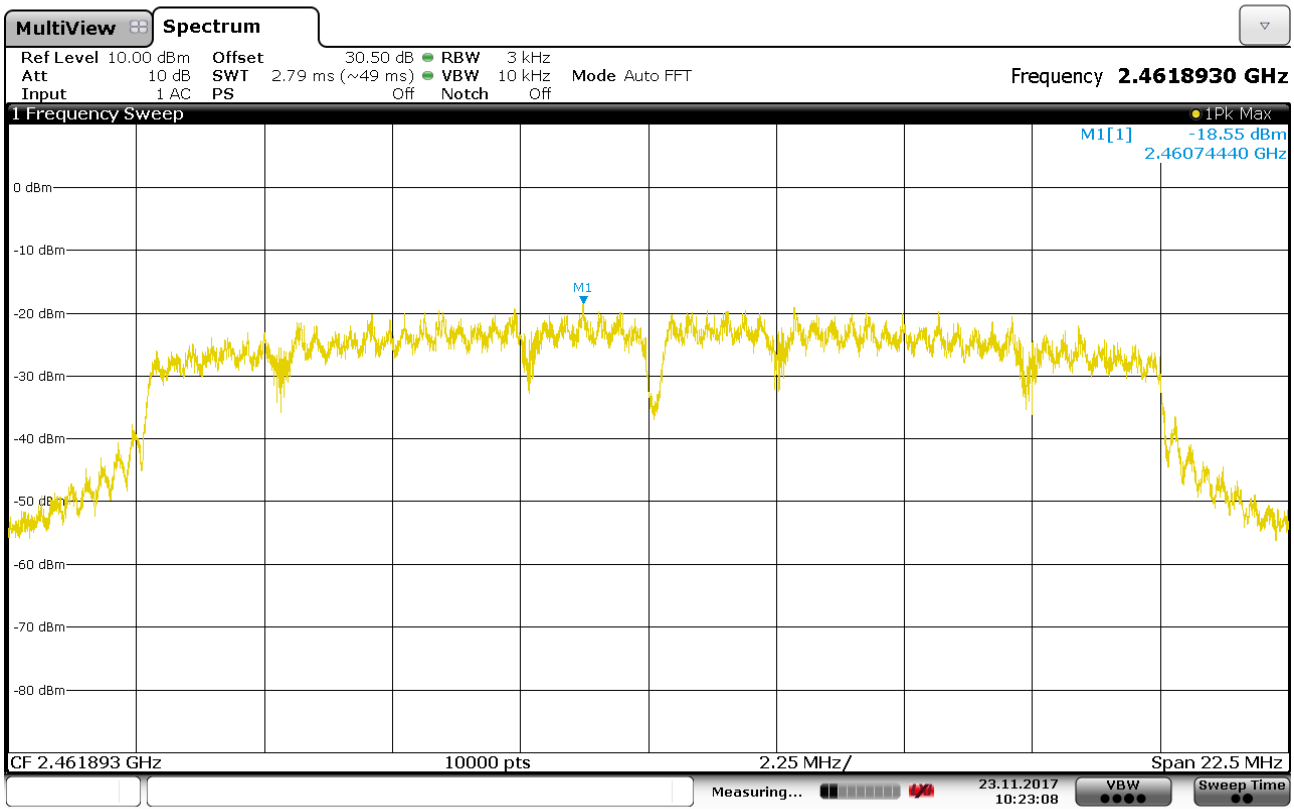
10:19:36 23.11.2017

Graphical representation of Power Spectral Density
Operation Mode: #1
Standard: IEE 802.11n 20MHz
Channel: #6



Graphical representation of Power Spectral Density
Operation Mode: #1
Standard: IEE 802.11g 20MHz
Channel: #11

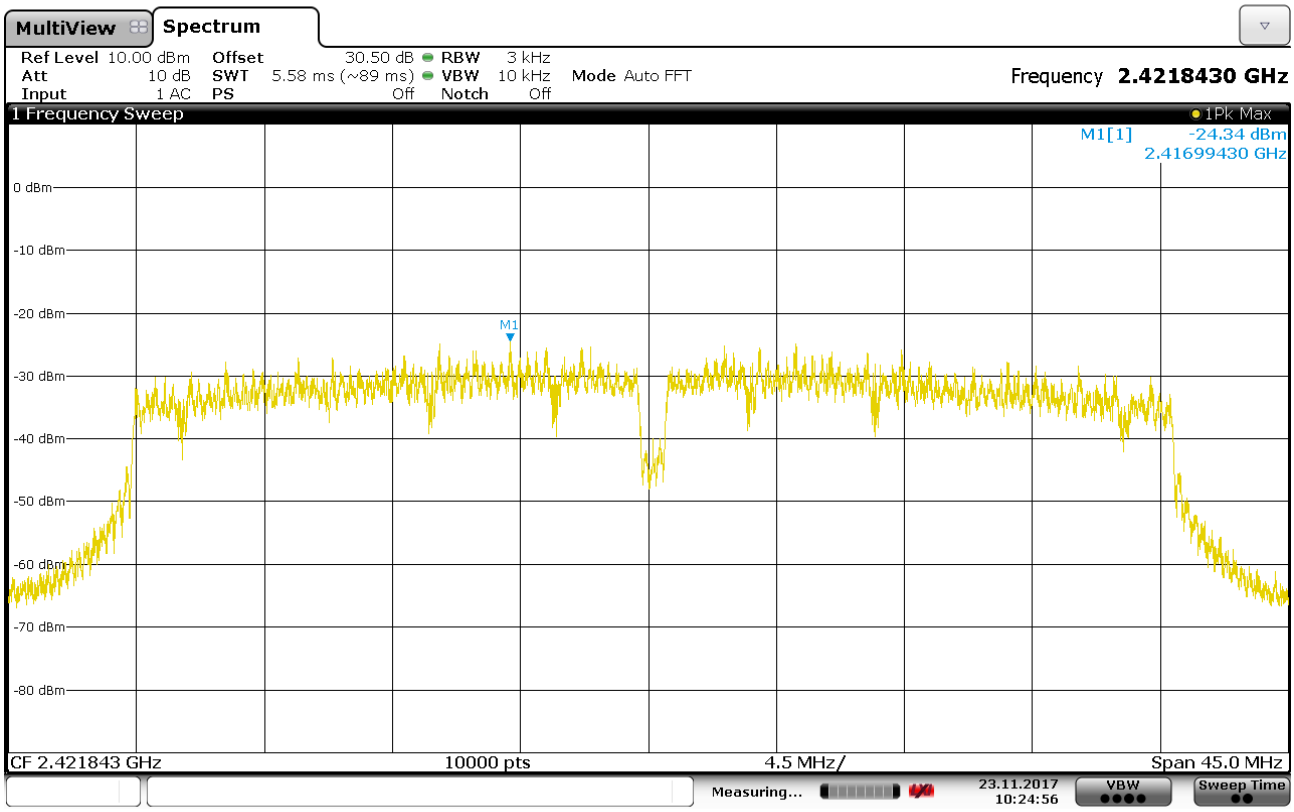
001



10:23:09 23.11.2017

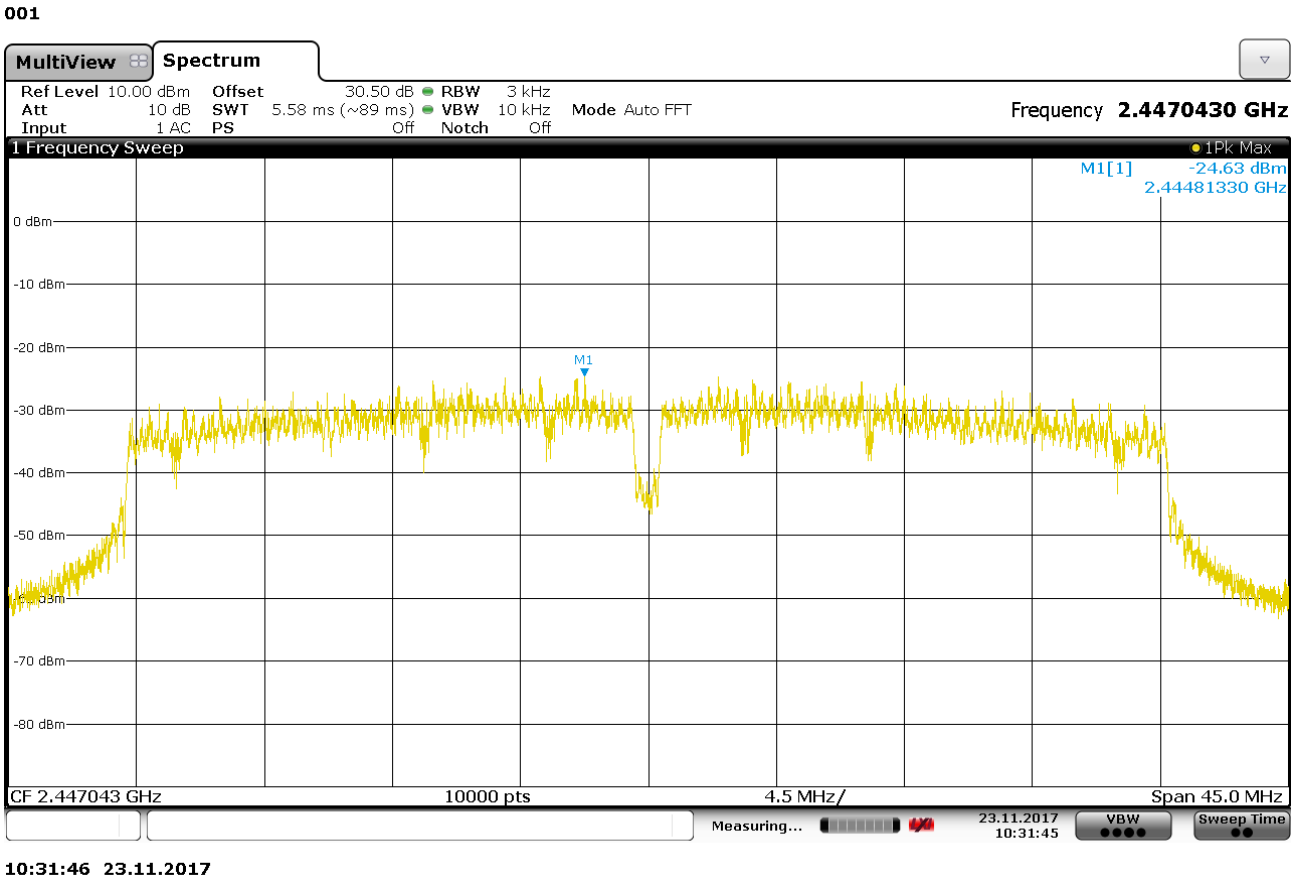
Graphical representation of Power Spectral Density
Operation Mode: #1
Standard: IEE 802.11n 40MHz
Channel: #1

001

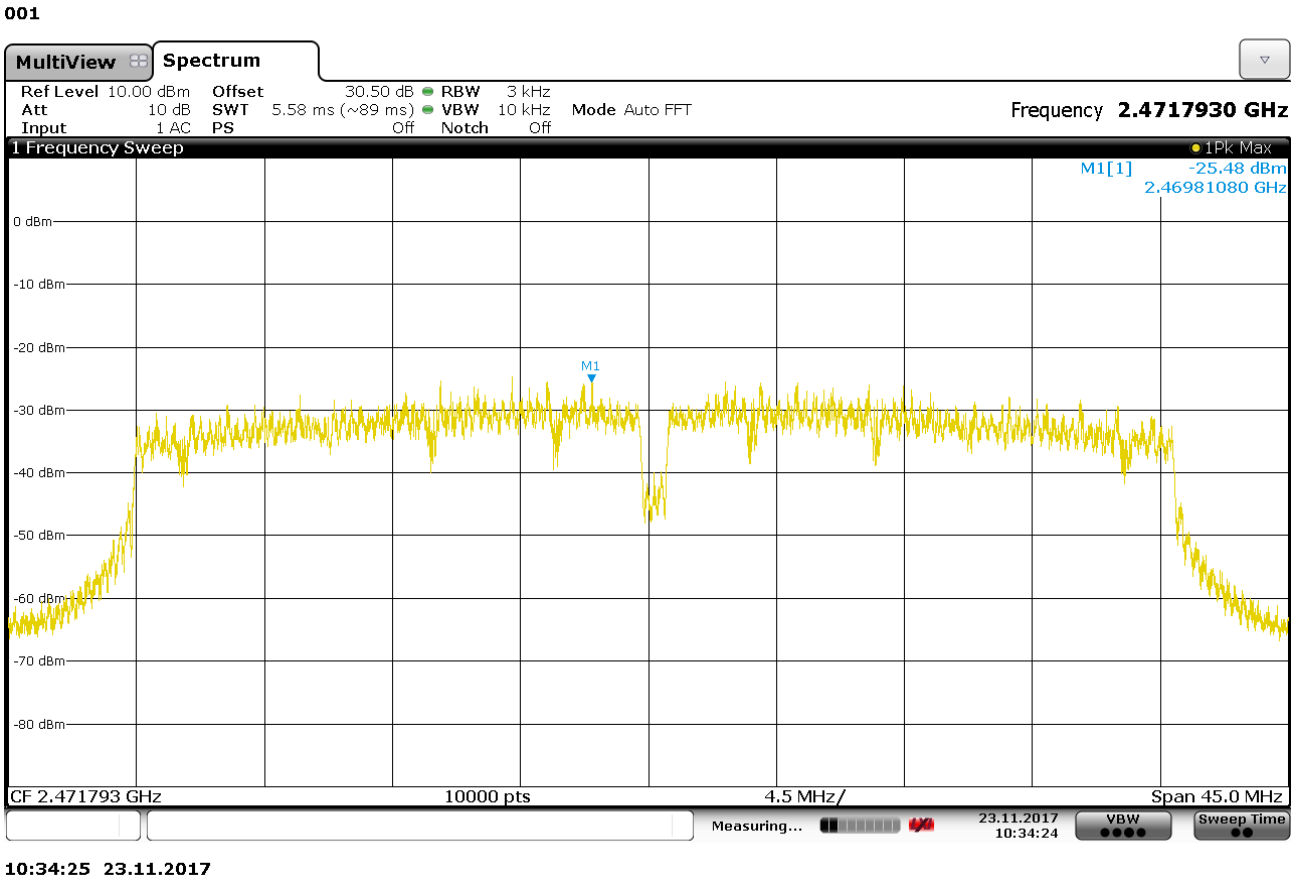


10:24:57 23.11.2017

Graphical representation of Power Spectral Density
Operation Mode: #1
Standard: IEE 802.11n 40MHz
Channel: #6



Graphical representation of Power Spectral Density
Operation Mode: #1
Standard: IEE 802.11g 20MHz
Channel: #11



17. Test Conditions and Results – RF EXPOSURE REQUIREMENTS

21	TEST: RF Exposure Requirements	PASS
Parameters required prior to the test	Laboratory Ambient Temperature (°C)	15 to 35 °C
	Relative Humidity (%)	30 to 60 %
Parameters recorded during the test	Laboratory Ambient Temperature (°C)	---
	Relative Humidity (%)	---
	Air pressure (hPa)	1020
—	Frequency	Application Point
Fully configured sample tested at the power line frequency	24Vdc	Enclosure
Equipment mode:	Operation mode	#1 #2 #3
FCC Standard	§15.247	

General Test Configuration

Calculation uses the free space transmission formula:

$$S = \frac{PG}{4\pi r^2} \quad \text{or equivalent} \quad S = \frac{EIRP}{4\pi r^2}$$

where
P = input power of the antenna
G = antenna gain relative to an isotropic antenna
r = distance from the antenna to the point of investigation.
EIRP = Effective Isotropic Radiated Power

Summary of Results

Device COMPLIES with Power Density requirements at 20cm separation

Directional Gain Calculation

Antenna: 3.11dBi (see pag.8)

SAR Test Exclusion Thresholds for 100 MHz – 6 GHz and ≥ 50 mm **447498 D01 General RF Exposure Guidance v06 – Appendix A**						
MHz	**50**	60	70	80	90	mm
100	474	481	487	494	501	SAR Test Exclusion Threshold (mW)
150	387	397	407	417	427	
300	274	294	314	334	354	
450	224	254	284	314	344	
835	164	220	275	331	387	
900	158	218	278	338	398	
1500	122	222	322	422	522	
1900	108	209	309	409	509	
2450	96	196	296	**396**	496	
3600	79	179	279	379	479	
5200	66	166	266	366	466	
5400	65	165	265	365	465	
5800	62	162	262	362	462	

The *test separation distances* ≥ *80 mm* is applied to determine SAR test exclusion.

Protocol b (worst case)

RESULTS			
CH	TX Frequency (MHz)	Measured Power at Antenna Connector (dBm)	Antenna Gain (dBi)
1	2412	16.603	3.11

CH	TX Frequency (MHz)	Radiated power (dBm)	E.I.R.P. (mW)	Distance (mm)	{[Power allowed at numeric threshold for 80 mm in step a)] + [(test separation distance – 80 mm)·10]} mW, for > 1500 MHz and ≤ 6 GHz	Limits
1	2412	19.713	94	80	94mW	328mW

Average Power at the Antenna	0.046 watts
Antenna Gain in dBi	3.11 dBi
Distance to the Area of Interest	2.62 feet 0.7986 metres
Frequency of Operation	2412 MHz
Are Ground Reflections Calculated?	No
Estimated RF Power Density	0.0012 mW/cm^2

	Controlled Environment	Uncontrolled Environment
Maximum Permissible Exposure (MPE)	5.005 mW/cm^2	1.005 mW/cm^2
Distance to Compliance From Centre of Antenna	0.0902 feet 0.0275 metres	0.1398 feet 0.0426 metres
Does the Area of Interest Appear to be in Compliance?	yes	yes

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marks the last page of this test report