Report No. 2-320258

Test Report

Product	Bluetooth Low Energy (BLE) module
Name and address of the applicant	ASSA ABLOY Hospitality AS Anolitveien 1-3, 1400 Ski, Norway
Name and address of the manufacturer	ASSA ABLOY Hospitality AS Anolitveien 1-3, 1400 Ski, Norway
Model	7001CC1
Rating	4.5Vdc
Trademark	ASSA ABLOY
Serial number	/
Additional information	2.4GHz, Bluetooth Low Energy (BLE).
Tested according to	**FCC Part 15.247** Frequency Hopping Transmitters / Digital Transmission Systems **Industry Canada RSS-247, Issue 2** Digital Transmission Systems (DTSs),Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices
Order number	320258
Tested in period	2016.11.23 - 2017.03.01
Issue date	2017.06.01
Name and address of the testing laboratory	Nemko Instituttveien 6 Kjeller, Norway FCC No: 994405 IC OATS: 2040D-1 TEL: +47 22 96 03 30 FAX: +47 22 96 05 50

Prepared by [G.Suhanthakumar]	Approved by [Frode Sveinsen]

Template version: B

CONTENTS

1 INFORMATION

1.1 Test Item

Name :	ASSA ABLOY
FCC ID :	Y7V-7001CC1
Industry Canada ID :	9514A-7001CC1
Model/version :	7001CC1
Serial number :	/
Hardware identity and/or version:	Rev-C
Software identity and/or version :	11.12
Frequency Range :	2402 - 2480MHz
Tunable Bands :	None
Number of Channels :	39
Operating Modes :	Transceiver
Type of Modulation :	GFSK, 250kHz deviation
User Frequency Adjustment :	None
Rated Output Power :	2.96 mW
Type of Power Supply :	4.5Vdc (3x LR6 batteries)
Antenna Connector :	None (PCB antenna)
Antenna Diversity Supported :	No
Desktop Charger :	No

Description of Test Item

The Bluetooth Low Energy Module is located.

Theory of Operation

The module follows the Bluetooth specification 4-0, operating in the 2.4GHz band. The module is designed using the nRF51822 system on chip from Nordic Semiconductor.

This system on chip contains a microcontroller, memory and embedded 2.4GHz transceiver supporting BLE. The transceiver's main oscillator is controlled by a 32MHz crystal. The transceiver's Real Time Clock is controlled by a 32.768kHz crystal.

1.2 Normal test conditions

Temperature:	20 - 24 °C
Relative humidity:	20 - 50 %
Normal test voltage:	4.5 V dc(3x1.5Vdc AA batteries)

The values are the limit registered during the test period. All tests were performed with fully charged batteries.

1.3 Test Engineer(s)

G.Suhanthakumar

1.4 Description of modification for Modification Filing

Not applicable.

1.5 Family List Rational

Not Applicable.

1.6 Comments

And the output level is set to maximum in the software.
The radiated measurements are tested on three axis.
Three fully charged primary batteries are used.
All ports were populated during spurious emission measurements.

2 TEST REPORT SUMMARY

2.1 General

All measurements are tracable to national standards.

The tests were conducted for the purpose of demonstrating compliance with FCC CFR 47 Part 15, paragraph 15.247 and Industry Canada RSS-247 Issue 2.

Tests were performed in accordance with ANSI C63.4-2014 and and ANSI C63.10-2013.

Radiated tests were made in a semi-anechoic chamber at measuring distances of 3m and 10m.

A description of the test facility is on file with the FCC and Industry Canada.

☒ New Submission	☒ Production Unit
☐ Class II Permissive Change	☐ Pre-production Unit
DTS Equipment Code	☐ Family Listing

2.2 Test Summary

Name of test	FCC Part 15 reference	RSS-247 Issue 2, RSS-GEN Issue 4 reference	Result
Supply Voltage Variations	15.31(e)	6.11 (RSS-GEN)	NA [2]
Number of Operating Frequencies	15.31(m)	5.1 (6) (RSS-247)	N/A
Antenna Requirement	15.203	8.3 (RSS-GEN)	Complies[1]
Power Line Conducted Emission	15.107(a) 15.207(a)	8.8 (RSS-GEN)	NA [2]
Channel Separation	15.247(a)(1)	5.1 (4) (RSS-247)	N/A
Pseudorandom Hopping Algorithm	15.247(a)(1)	5.1 (3) (RSS-247)	N/A
Time of Occupancy	15.247(a)(1)(iii)	5.1 (5) (RSS-247)	N/A
Occupied Bandwidth	15.247(a)(1)	5.1 (7) (RSS-247)	Complies
Occupied Bandwidth	N/A	6.6 (RSS-GEN)	
Minimum 6 dB Bandwidth	15.247(a)(2)	5.2 (1) (RSS-247)	Complies
Peak Power Output	15.247(b)	5.4 (RSS-247)	Complies
Power Spectral Density	15.247(d)	5.2 (2) (RSS-247)	Complies
Spurious Emissions (Antenna Conducted)	15.247(c)	5.5 (RSS-247)	Complies[1]
Spurious Emissions (Radiated)	15.247(c) 15.109(a) 15.209(a)	5.5 (RSS-247) 6.13 (RSS-GEN) 8.9 (RSS-GEN)	Complies

[1] The tested equipment has integrated antennas only

[2] EUT is battery powered

3 TEST RESULTS

3.1 Occupied Bandwidth

Para. No.: RSS-Gen

Test Performed By: G.Suhanthakumar	Date of Test: 2016.11.23

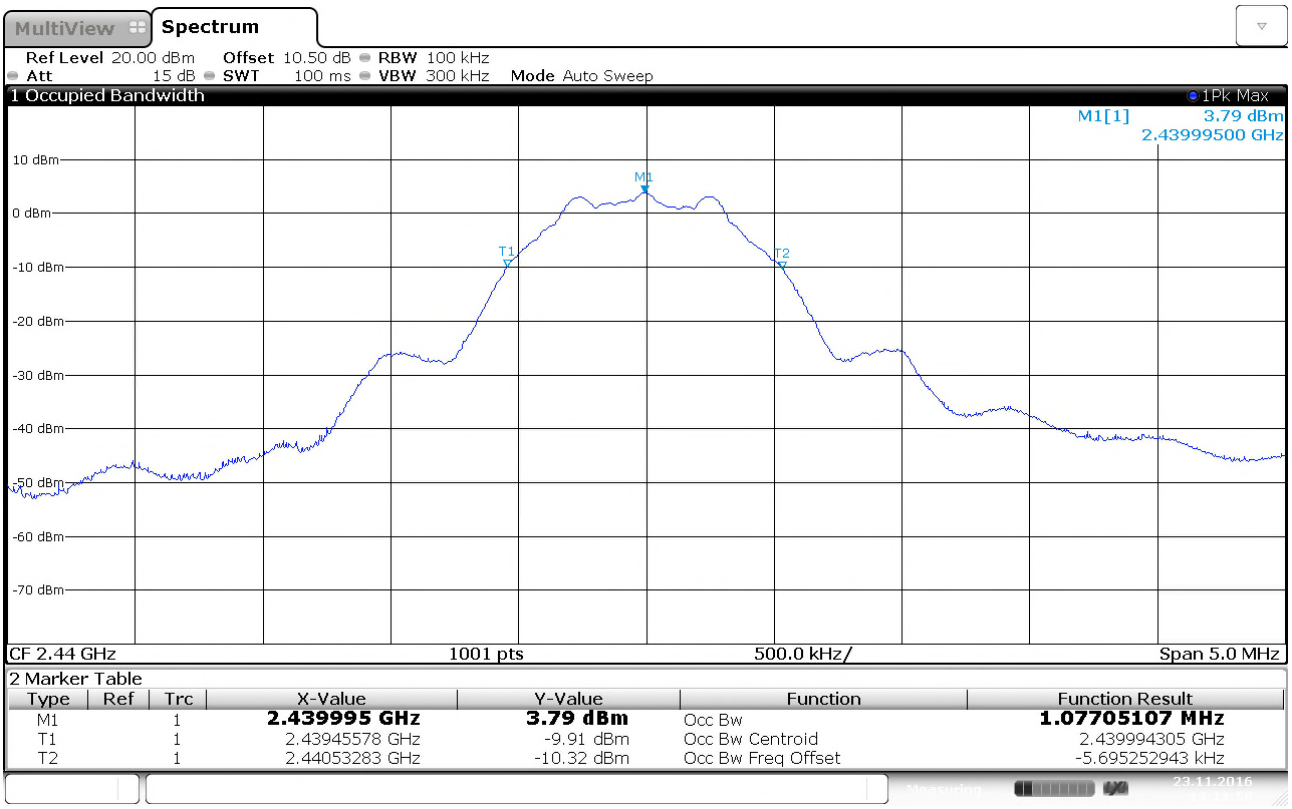
Test Results: Complies

Measurement Data:

OBW (MHz)
2440MHz
1.08

Requirements:

For information only



OBW- ch2440MHz

3.3 Minimum 6 dB Bandwidth

Para. No.: 15.247 (a)(2)

Test Performed By: G.Suhanthakuar	**Date of Test: 2016.11.23 & 2017.02.08**

Test Results: Complies

Measurement Data:

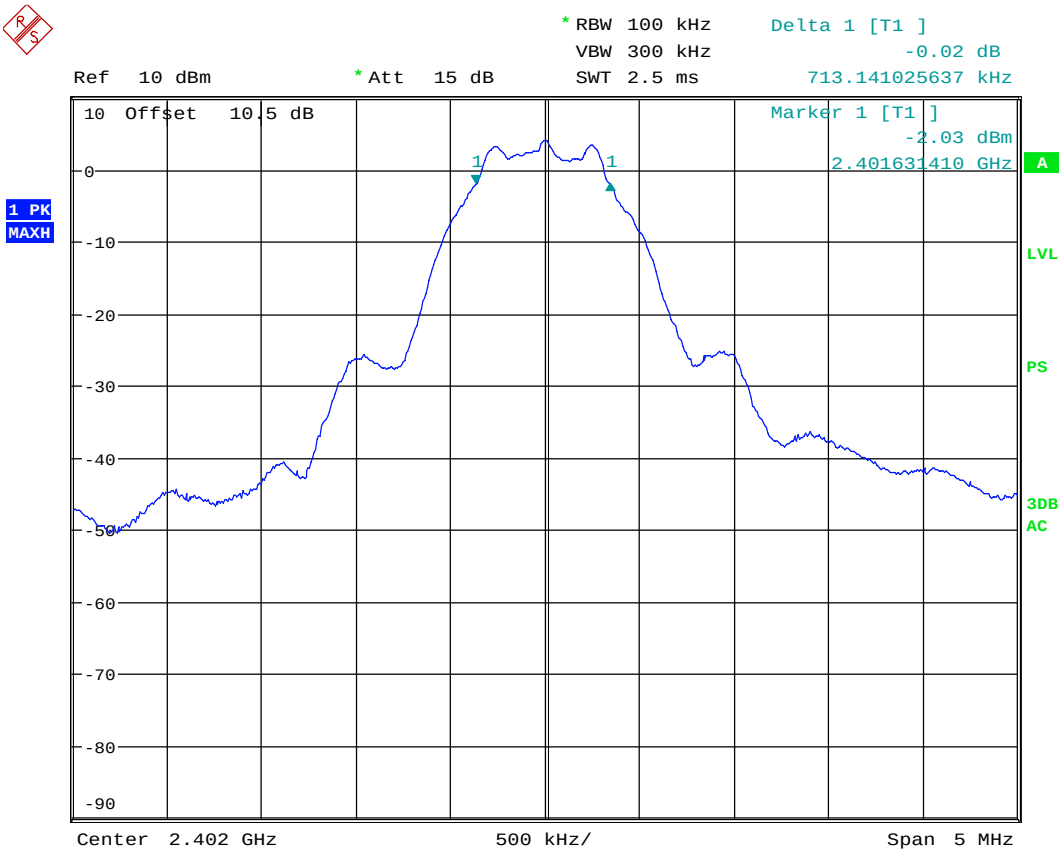
Measured 6 dB Bandwidth (kHz)		
2402 MHz, Ch 1	**2440 MHz, Ch 19**	**2480 MHz, Ch 39**
713.14	719.3	7729.3

Fully charged battery is used

Requirements:

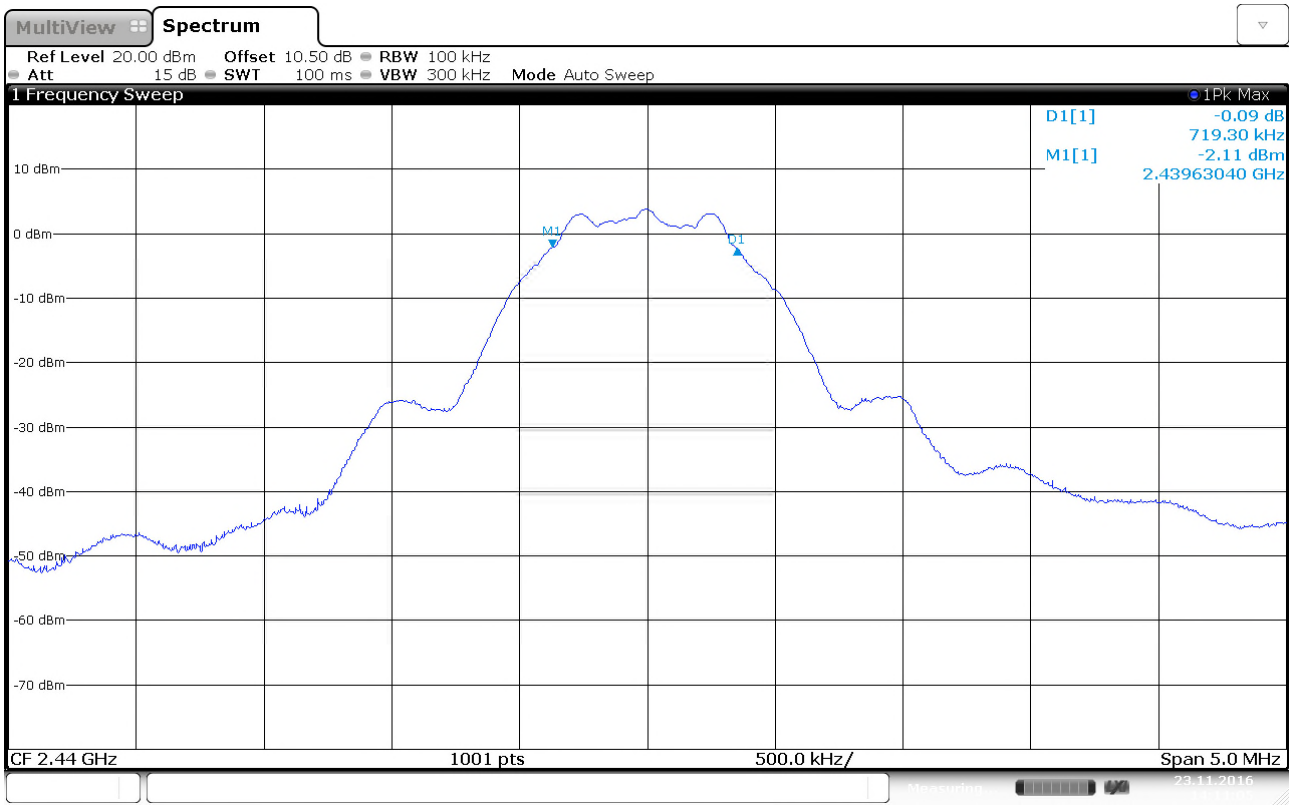
For Digital Transmission Systems in the 2400-2483.5 MHz band the minimum 6 dB bandwidth shall be at least 500 KHz.

No requirements for Frequency Hopping Systems.

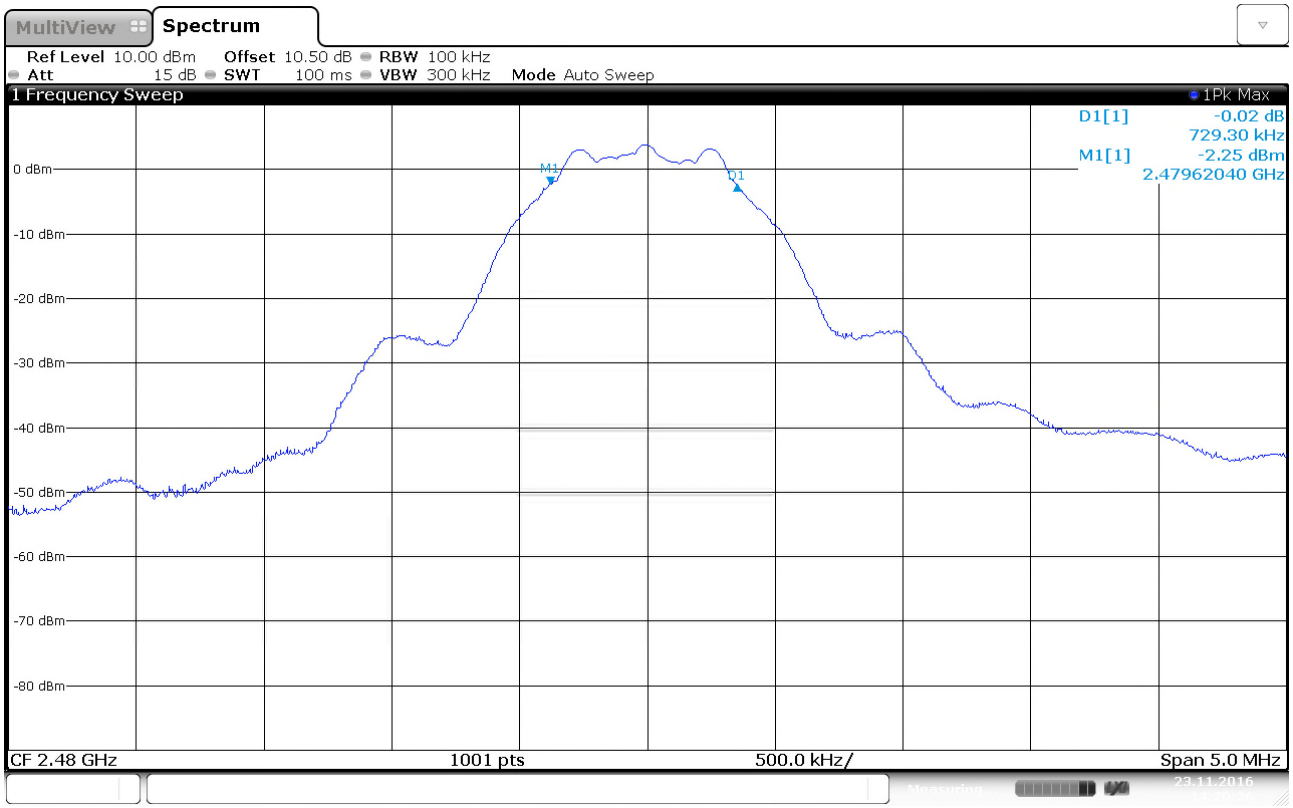


Date: 8.FEB.2017 09:19:18

Ch2402MHz, 6 dB BW



Ch2440MHz, 6 dB BW



Ch2480MHz, 6 dB BW

3.4 Peak Power Output

Para. No.: 15.247 (b)

Test Performed By: G.Suhanthakuar	Date of Test: 2016.11.23 & 2017.02.08

Test Results: Complies

Measurement Data:

RF channel	2402 MHz	2440 MHz	2480 MHz
Measured Maxium Field strength (dBµV/m) –VP	100.44	100.05	100.15
Calc. Radiated Power (dBm)	5.21	4.82	4.92
Calc. Radiated Power (mW)	3.32	3.03	3.11
Measured Conducted Power (dBm)	4.71	3.85	3.90
Measured Conducted Power (mW)	2.96	2.43	2.45
Calculated Antenna Gain (dBi)	0.5	1.0	1.0

Antenna gain = 10*log (EIRP/Conducted power) dBi

EIRP is calculated from measured field strength by the formulas in KDB 412172 D01 Determining ERP and EIRP v01.

The maximum field strength is obtained in YZ plane and Vertical polarization

See attached graph.

Detachable antenna? ☐ Yes ☒ No

If detachable, is the antenna connector non-standard? ☐ Yes ☐ No

Type of antenna connector: N/A

Requirements:

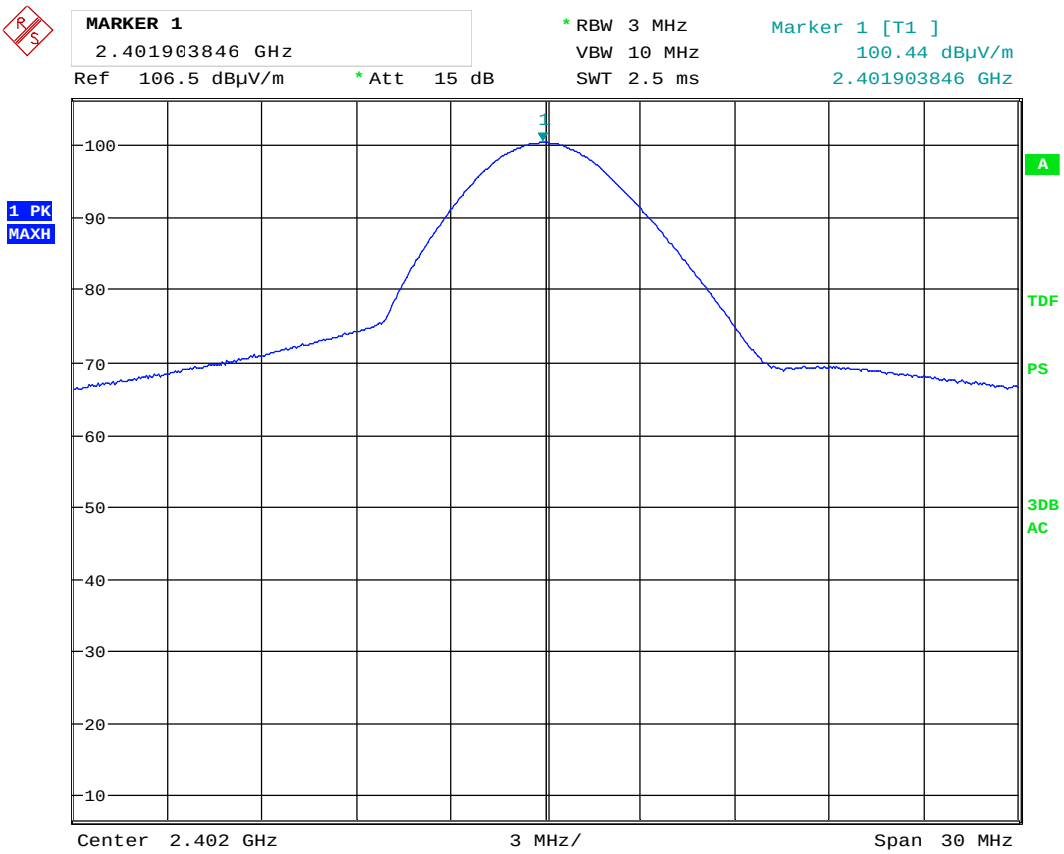
The maximum peak output power shall not exceed the following limits:

For frequency hopping systems employing at least 75 hopping channels: 1 Watt

For all other frequency hopping systems in the 2400 - 2483.5 MHz band: 0.125 Watts

For Digital Transmission Systems in the 2400 - 2483.5 MHz band: 1 Watt

If transmitting antennas of directional gain greater than 6 dBi are used, the peak output power from the intentional radiator shall be reduced below the stated value above by the amount in dB that the directional gain of the antenna exceeds 6 dBi.



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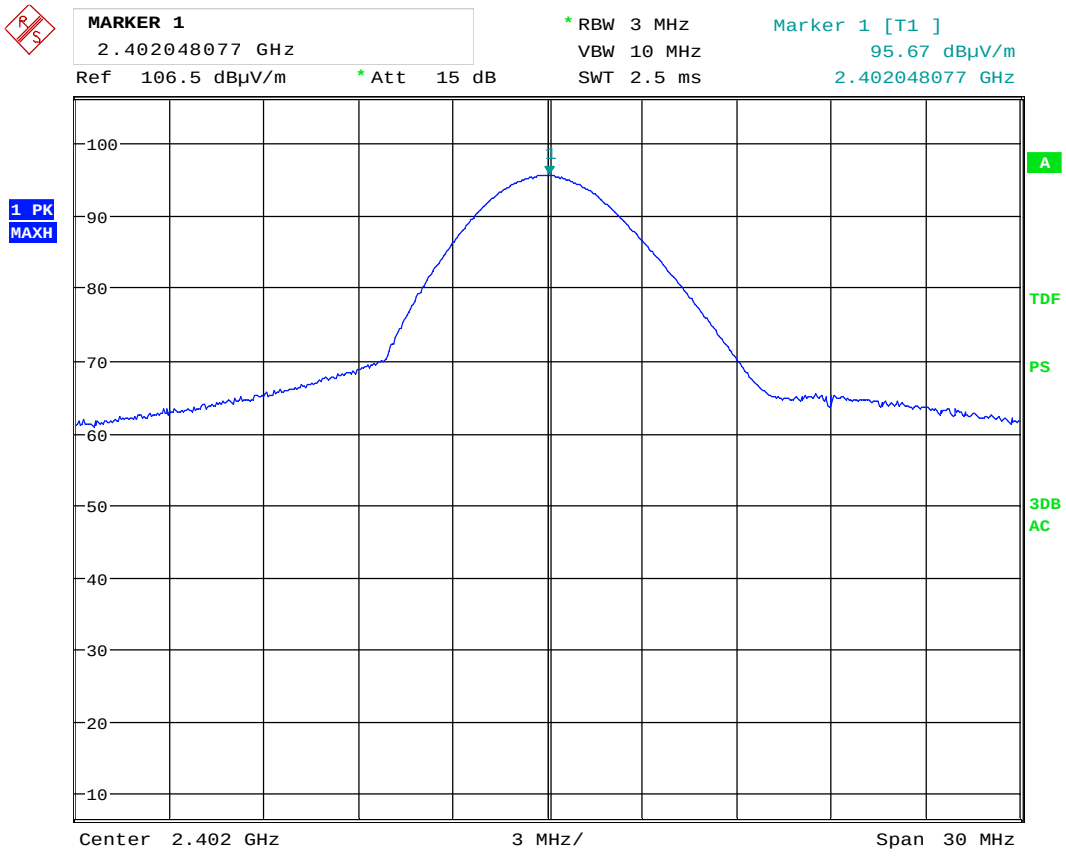
Radiated Field strength, VP , 2402 MHz



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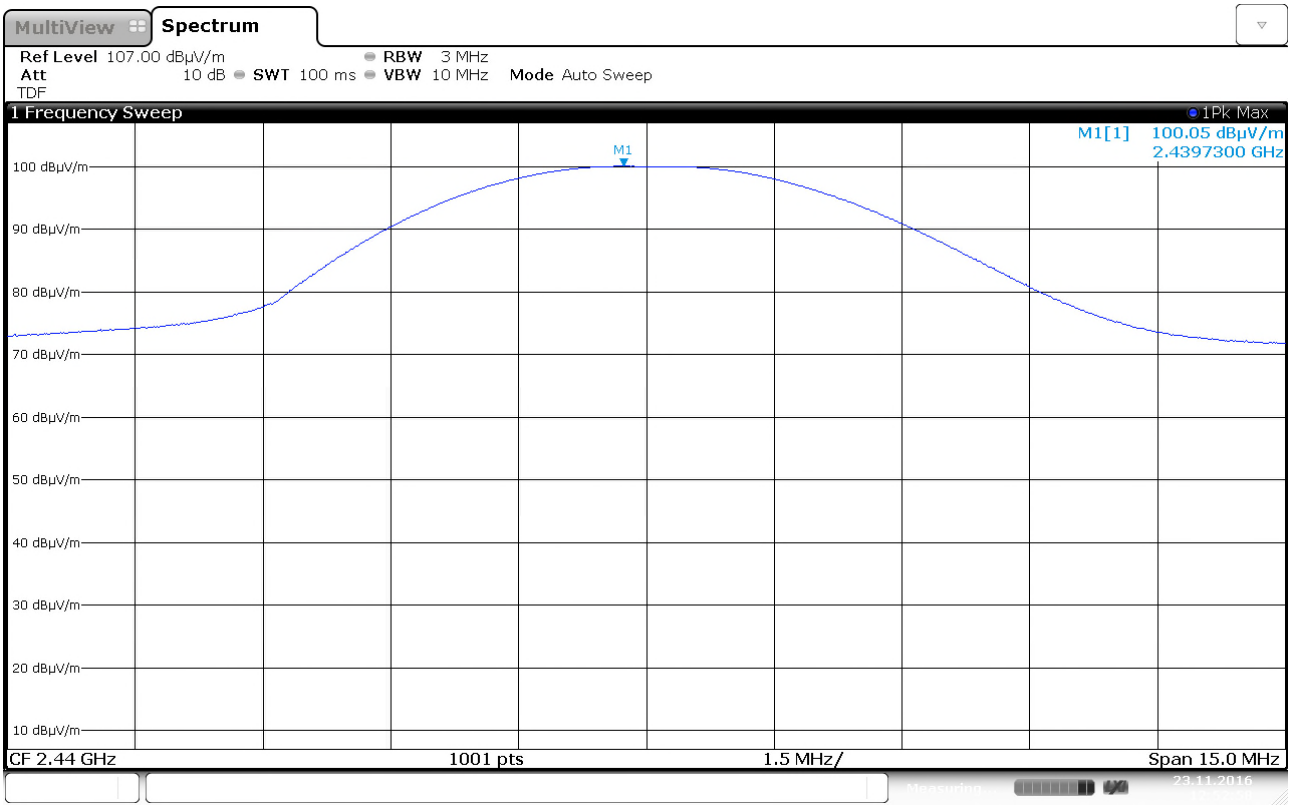
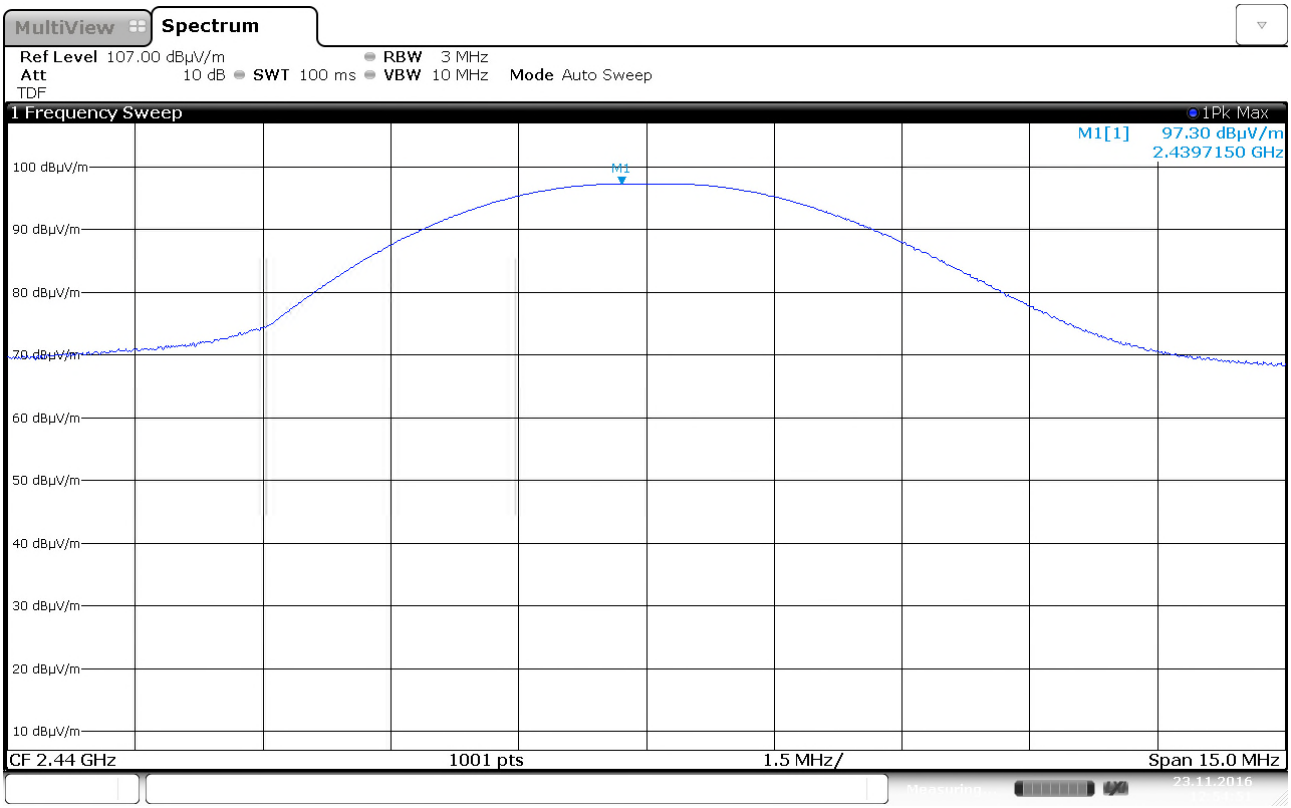
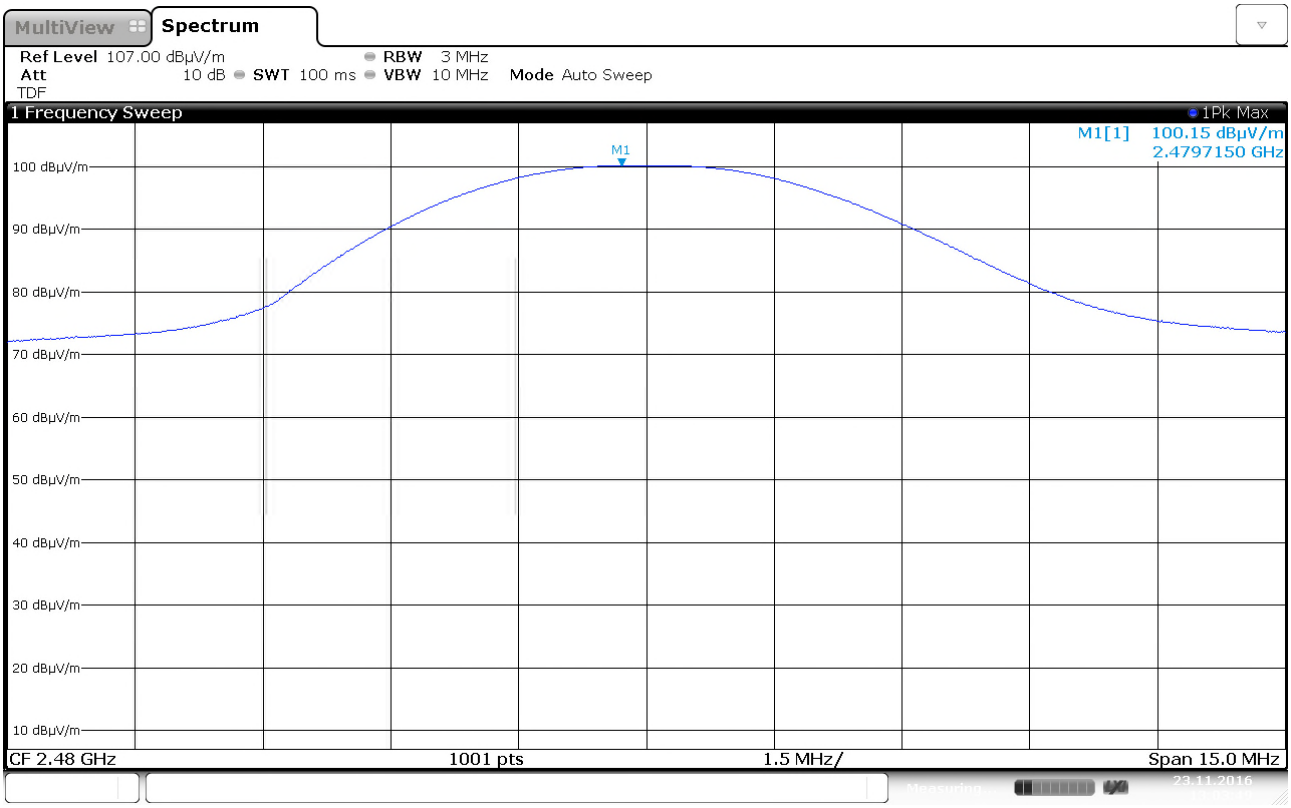
Radiated field strength, HP, 2402 MHz



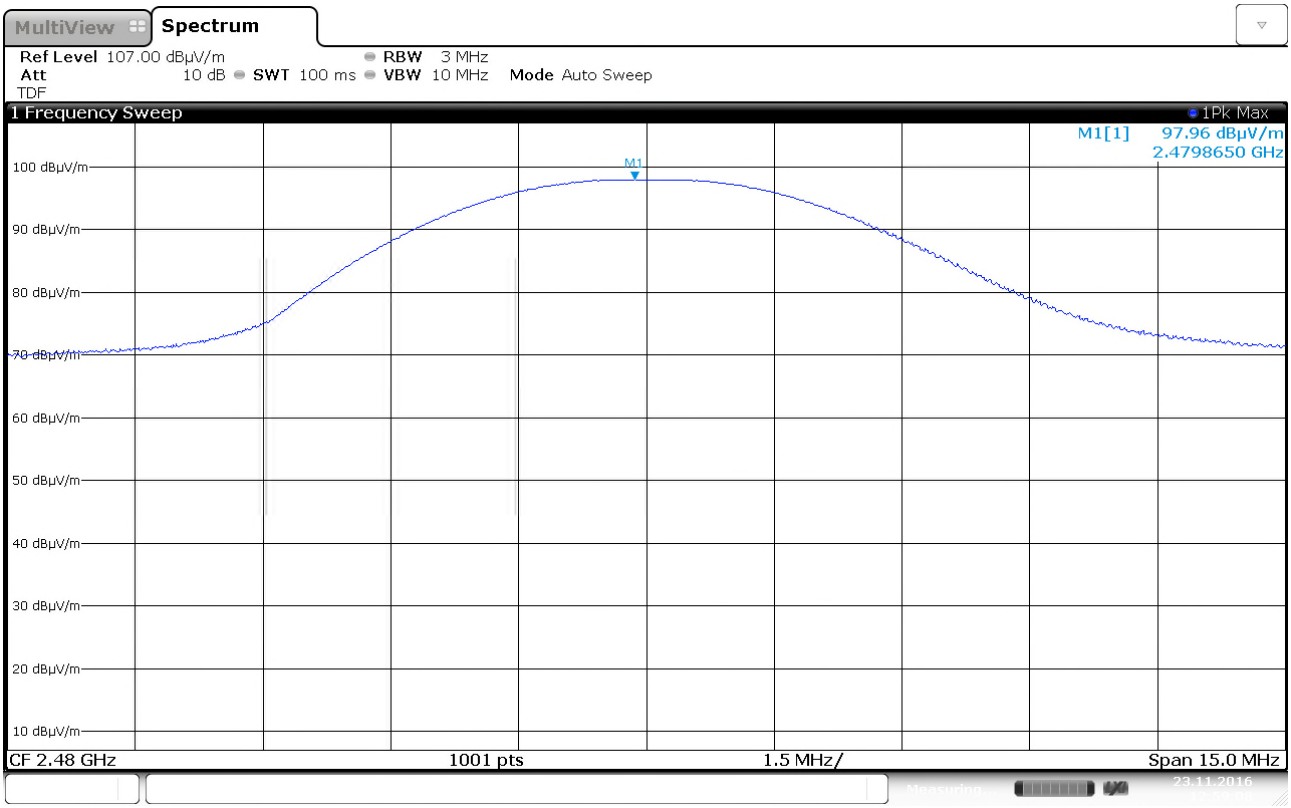
Radiated field strength, VP, 2440 MHz



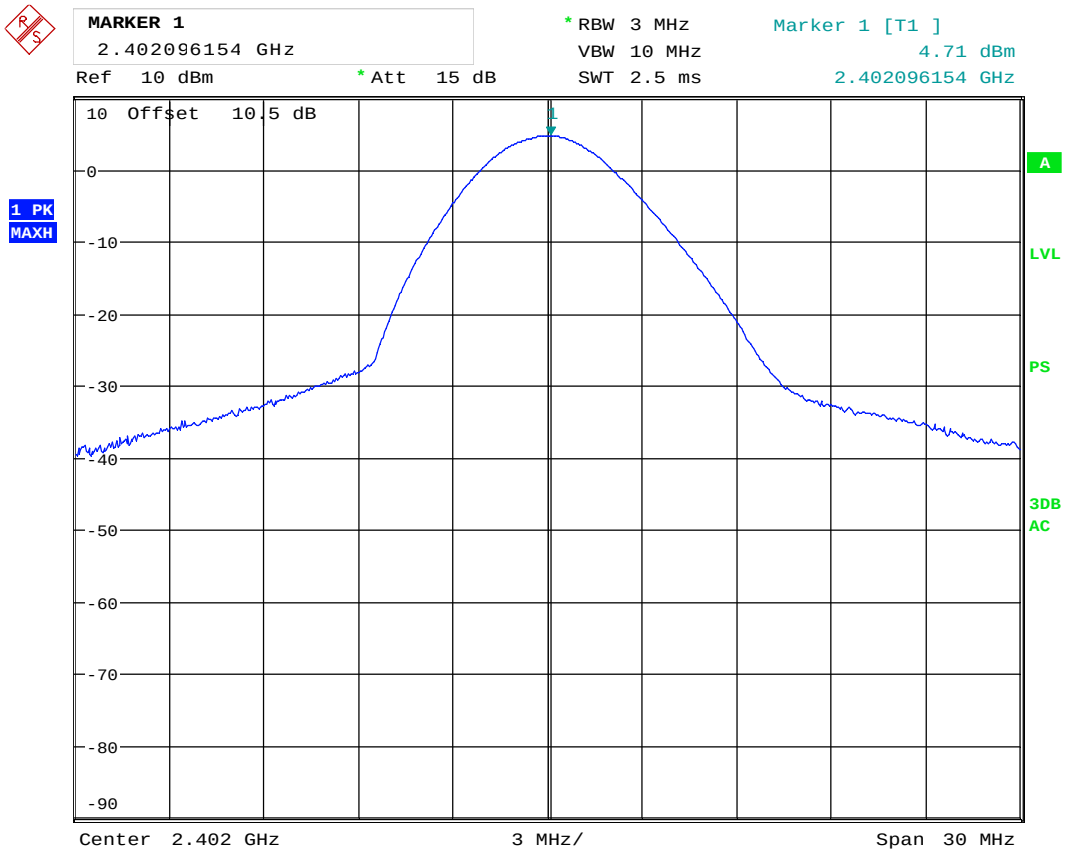
Radiated field strength, HP, 2440 MHz



Radiated field strength, VP, 2480 MHz



Radiated field strength, HP, 2480 MHz



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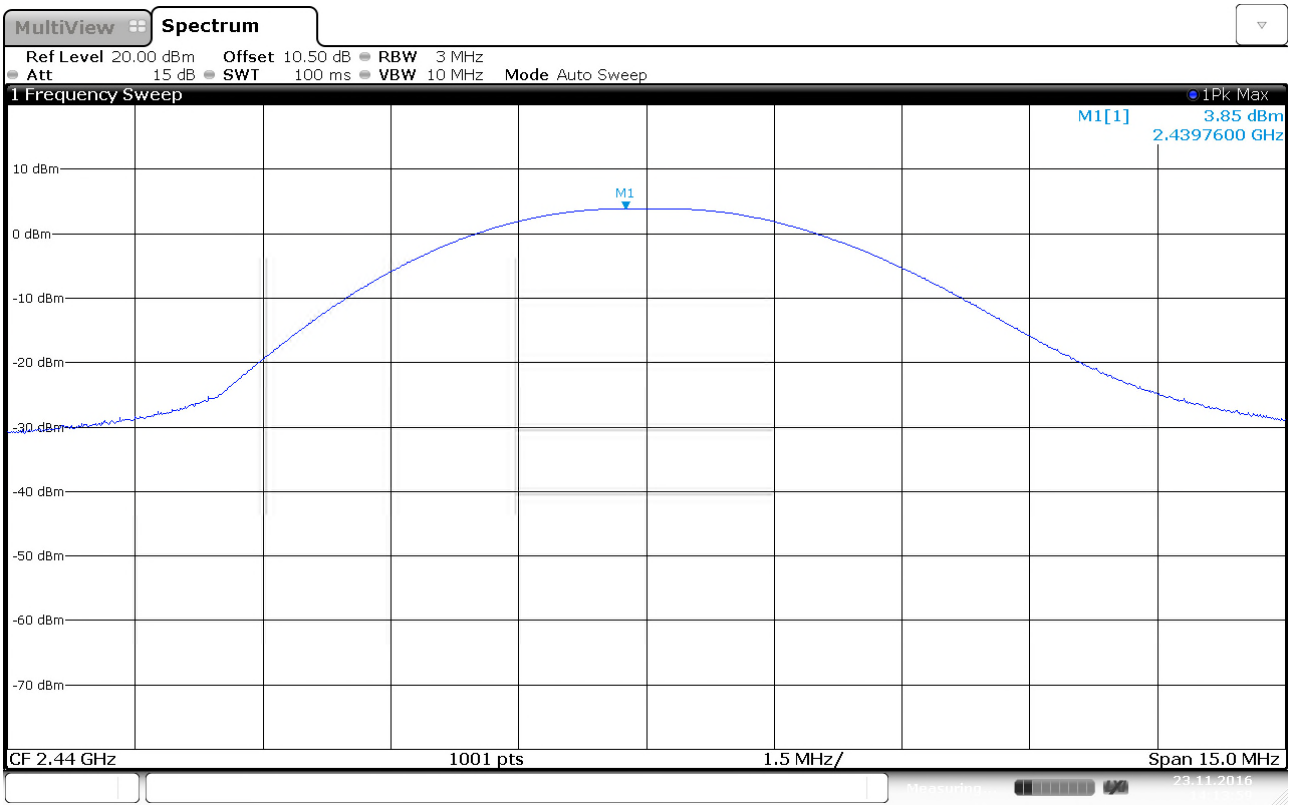
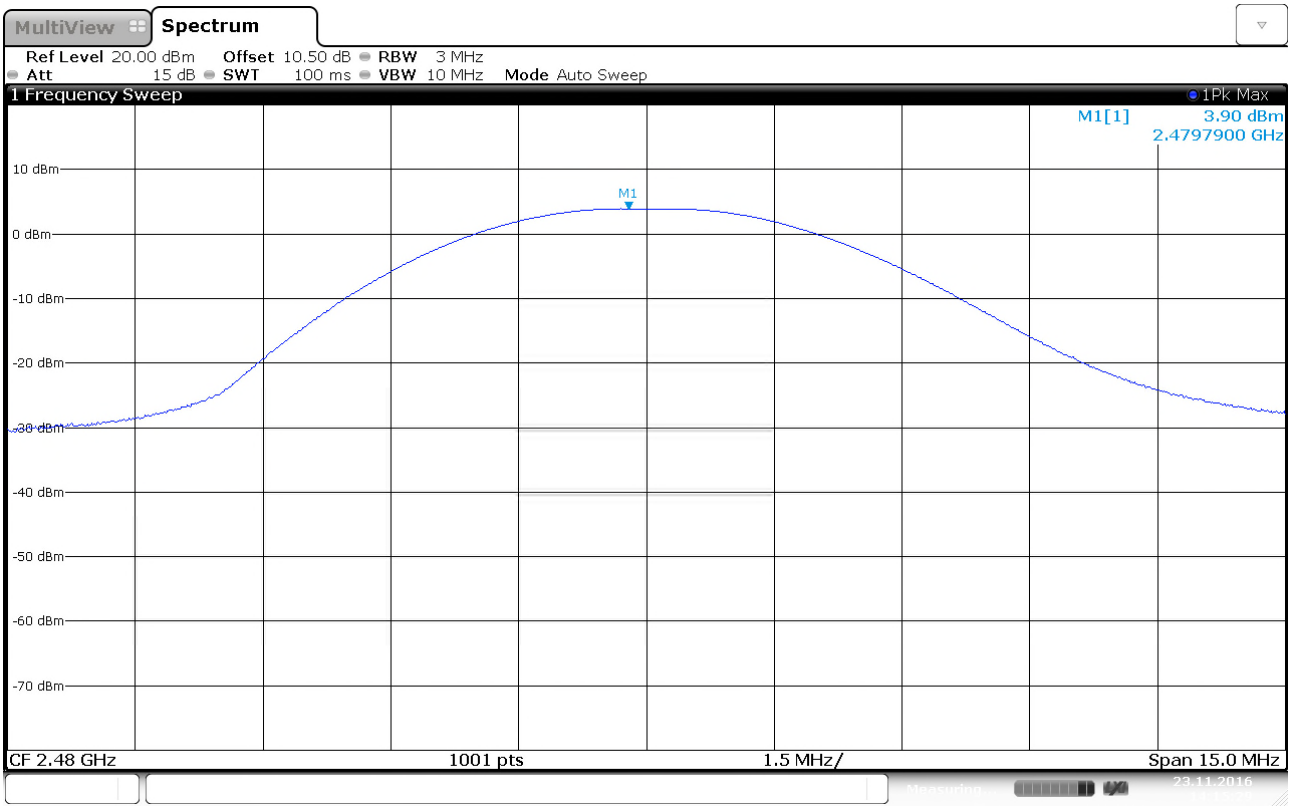
Conducted power – 2402MHz



Conducted power – 2440MHz



Conducted power – 2480MHz

3.5 Spurious Emissions (Radiated)

Para. No.: 15.247 (c)

Test Performed By: G.Suhanthakuar	Date of Test: 2016.11.23 & 2017.02.08

Test Results: Complies

Band-edge, @3m

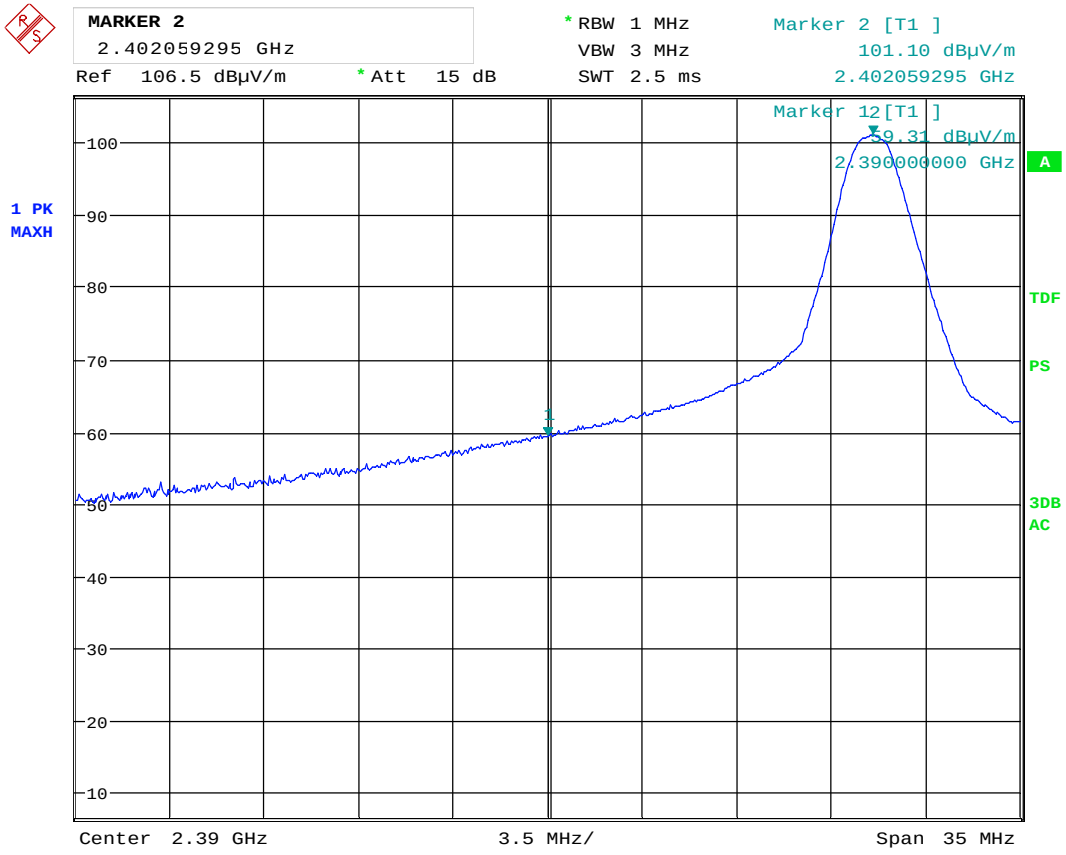
Frequency	Measured Field Strength @3m, dBµV/m	Detector	Limit dBµV/m	Margin dB
2.39 GHz	59.31	PK	74	14.69
	39.31	AV	54	14.69
2.4835 GHz	68.64	PK	74	5.36
	48.64	AV	54	5.36

Average values are measured with Peak Detector and corrected for Duty Cycle.
See attached plots.

Duty Cycle Correction Factor Calculation:
Duty Cycle = On Time / (Period * Number of Channels) = 213 µs / (628 µs * 39) = 0.0087
Duty Cycle Correction factor = -20 x log (Duty Cycle) = 41.2 dB
Maximum allowed Duty Cycle Correction: 20 dB

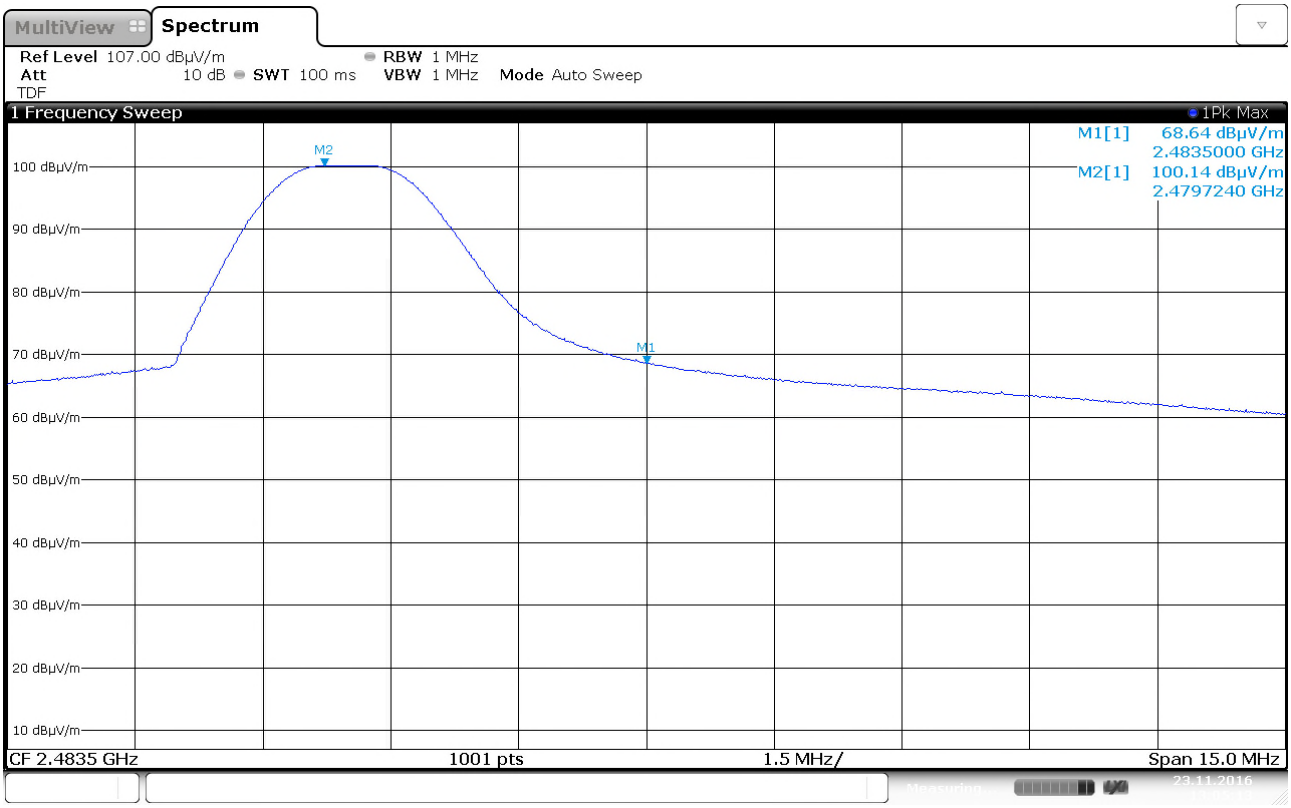
RF conducted power to 25 GHz see attached graph.
Maximum RF level outside operating band:

RF ch 01: 50 dB/C, margin >30 dB
RF ch 19: 53 dB/C, margin >30 dB
RF ch 39: 55 dB/C, margin >30 dB

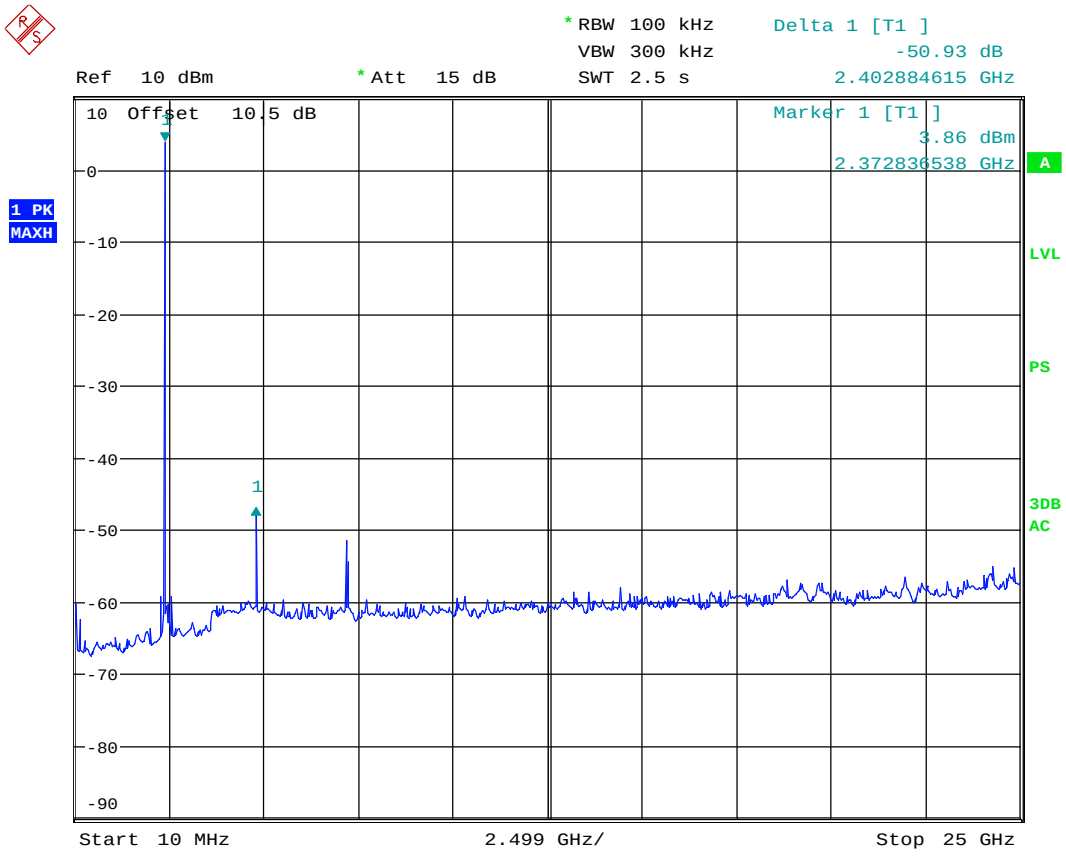


Date: 8.FEB.2017 09:53:44

Band Edge, 2390 MHz, Peak Detector

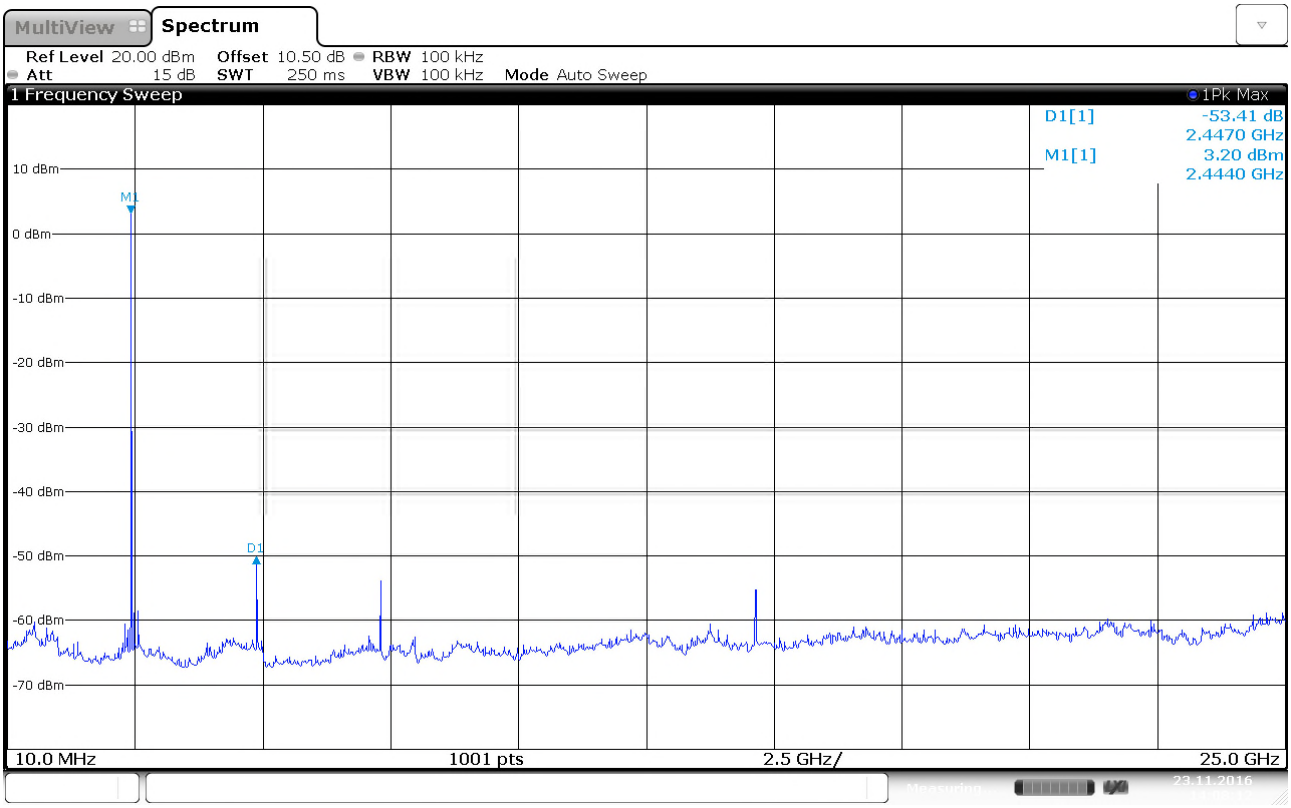


Band Edge, 2483.5 MHz, Peak Detector

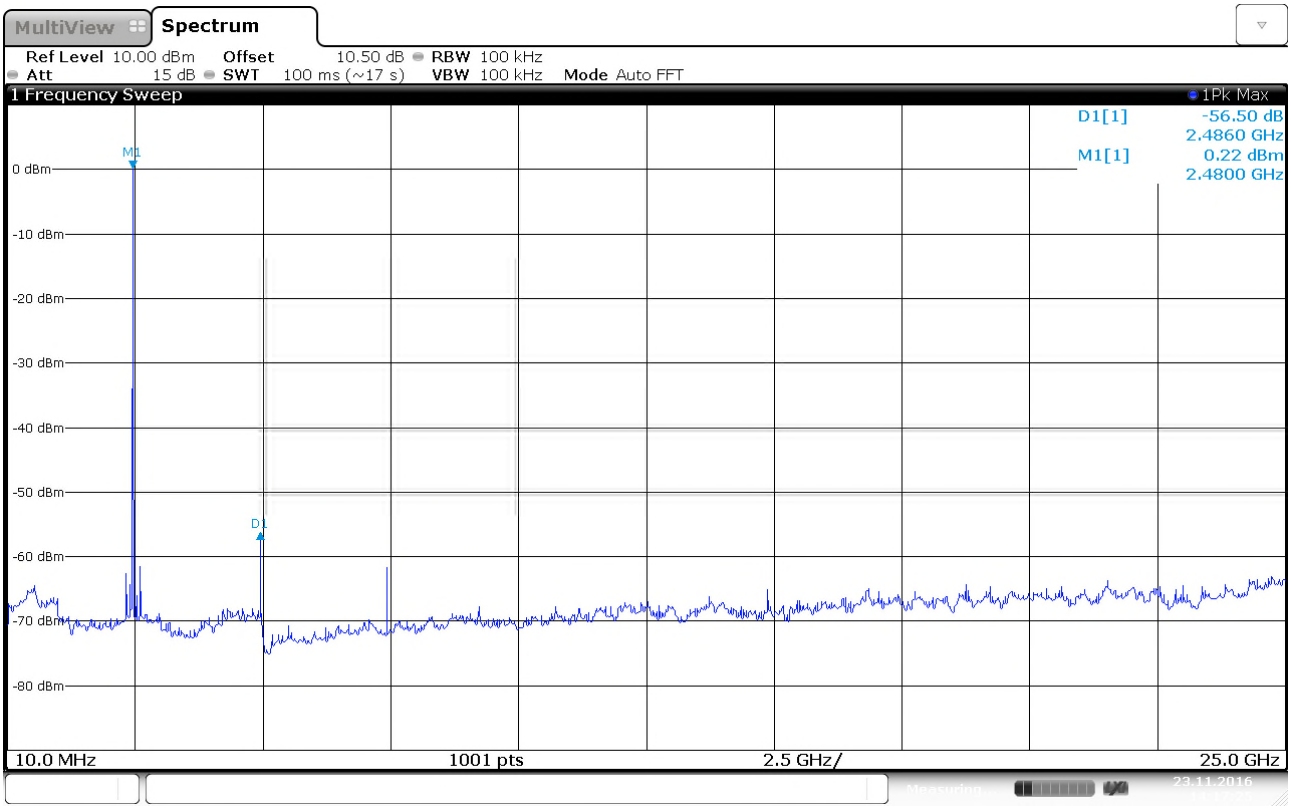


Date: 8.FEB.2017 09:20:19

Conductd spurious emission 10MHz – 25GHz - ch2402MHz



Conductd spurious emission 10MHz – 25GHz - ch2440MHz



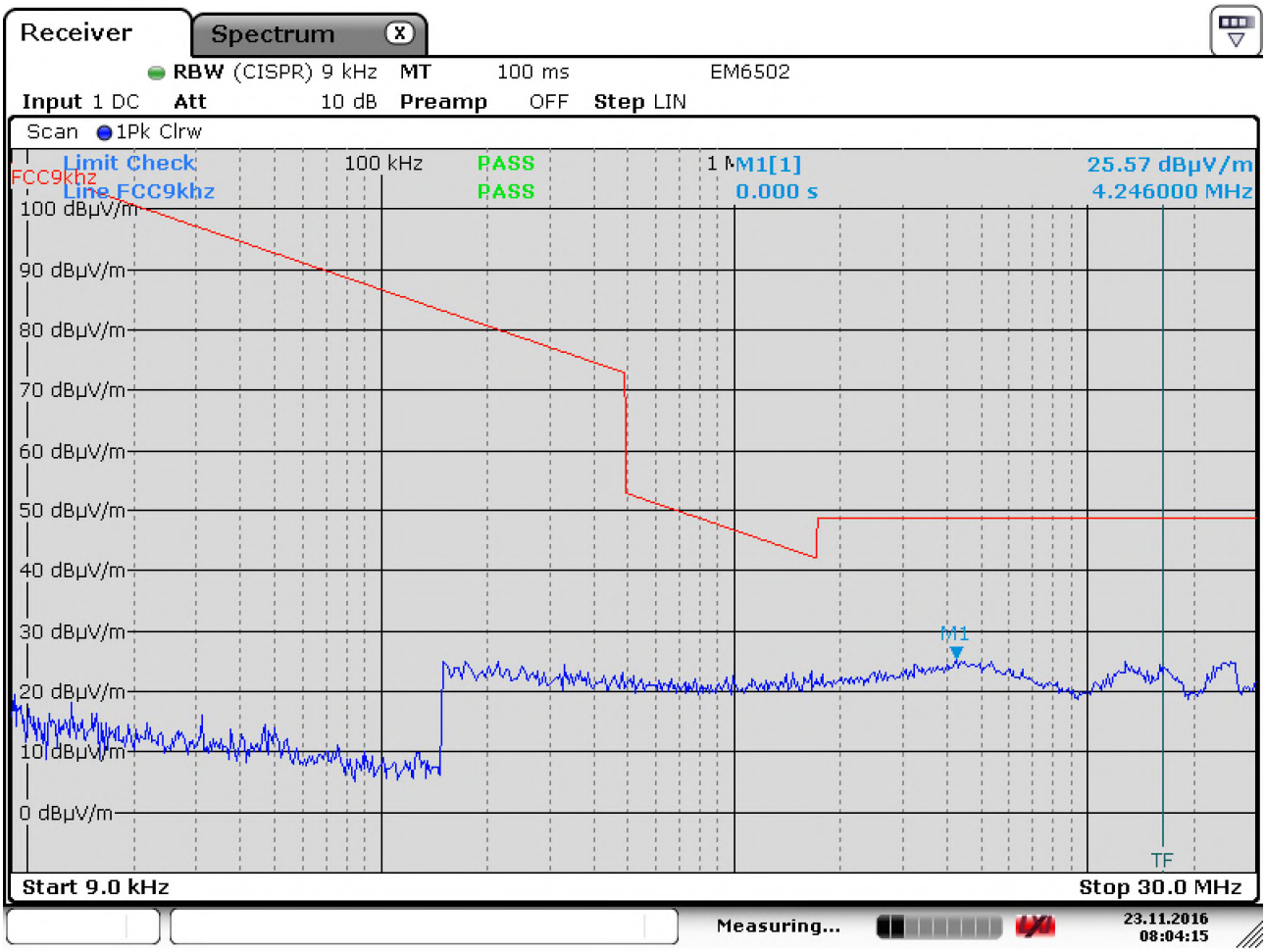
Conducted spurious emission 10MHz – 25GHz - ch2480MHz

Radiated emissions 10 kHz-30 MHz.

Measuring distance 10 m, measured with Peak detector.

No component detected, see attached graph.

Limit is converted to 10 m using 40 dB/decade according to 15.31 (f) (2).



Radiated Emissions, 9 kHz – 30 MHz @10m

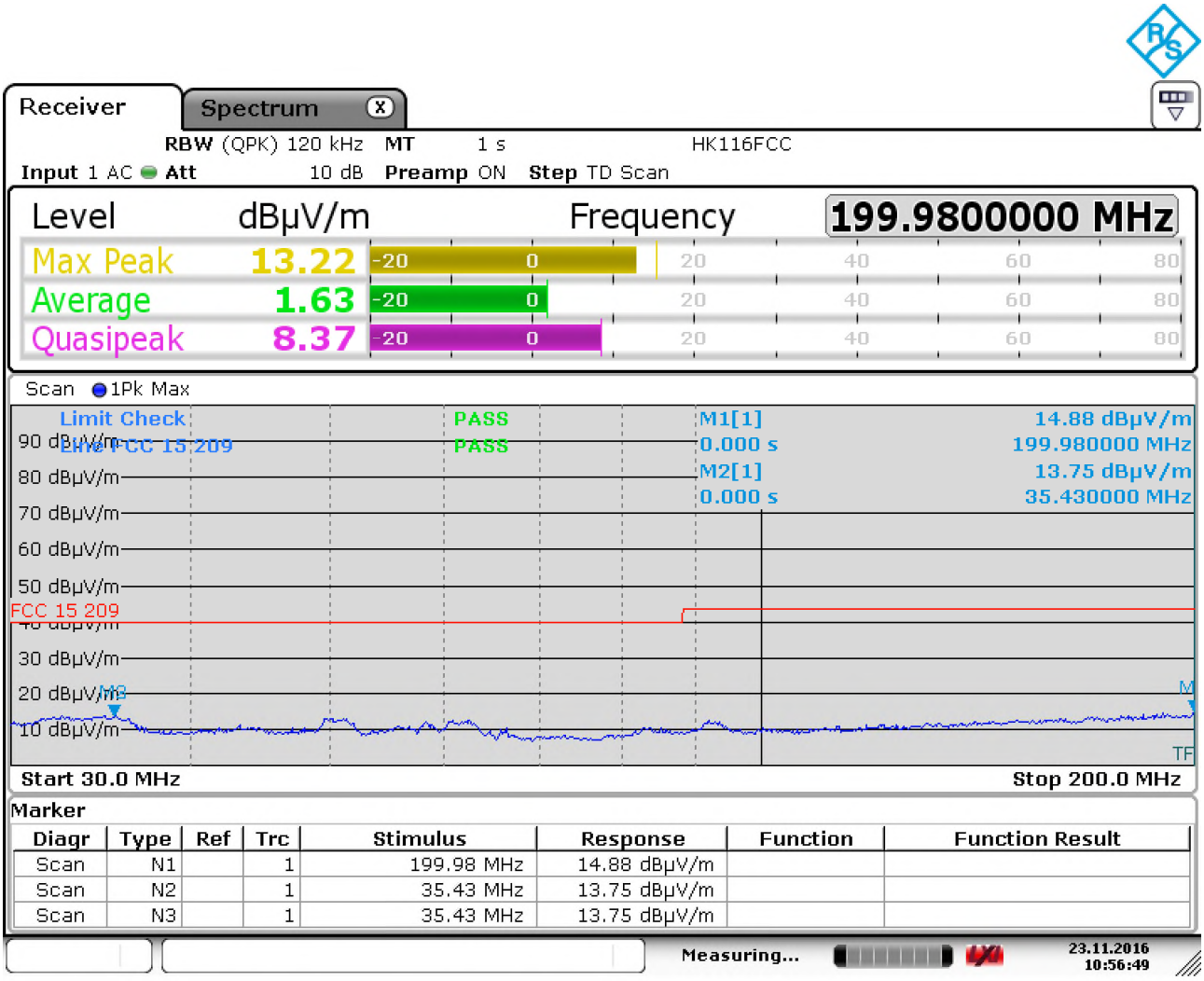
Radiated emission 30 – 1000 MHz.

Detector: Quasi-Peak

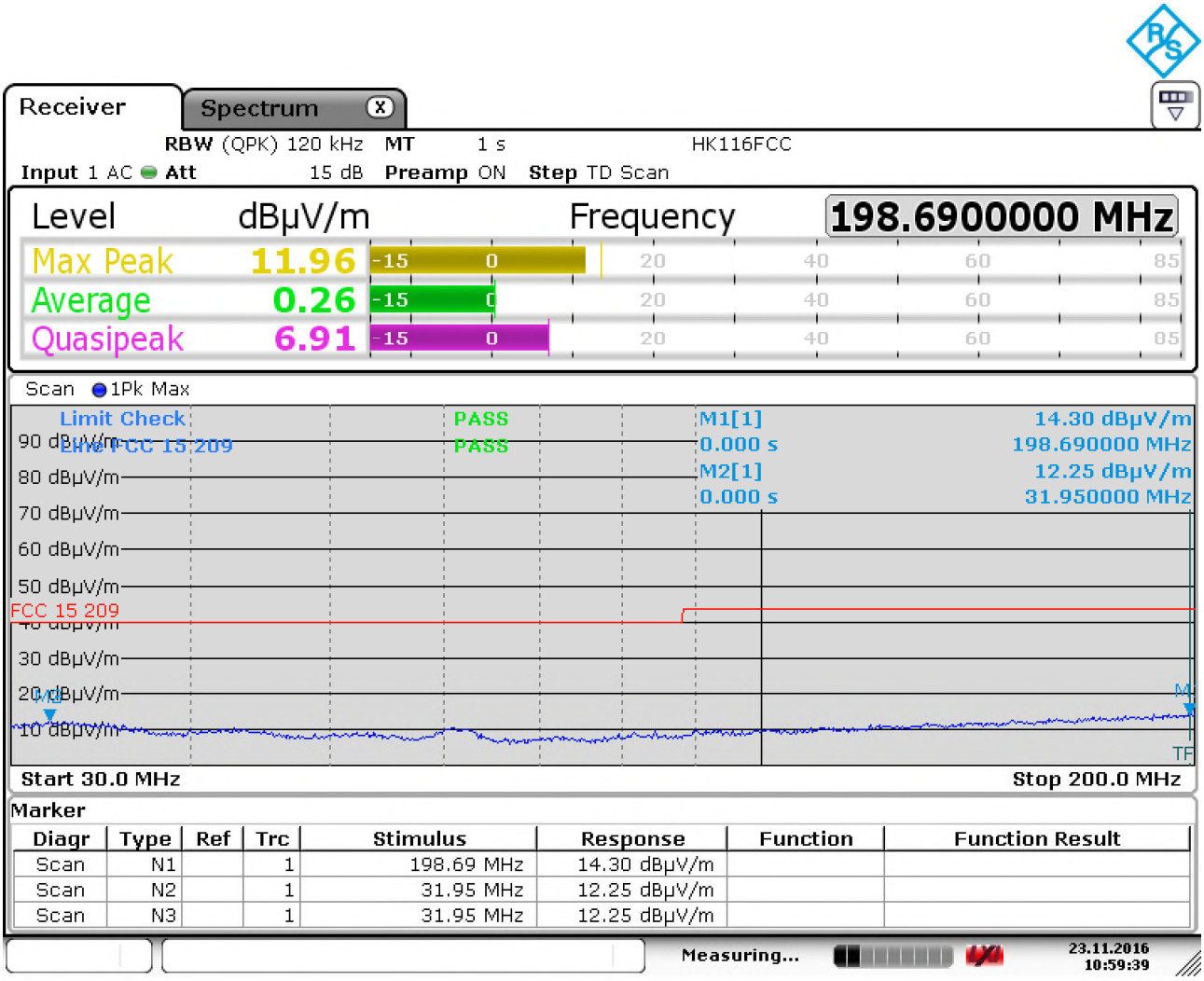
Measuring distance 3 .

Frequency	Operational condition	Detector	Field strength	Measuring distance	Limit FCC15.209	Margin
MHz			dBµV/m	metres	dBµV/m	dB
/	TX on	PK	/	3	40.0	/

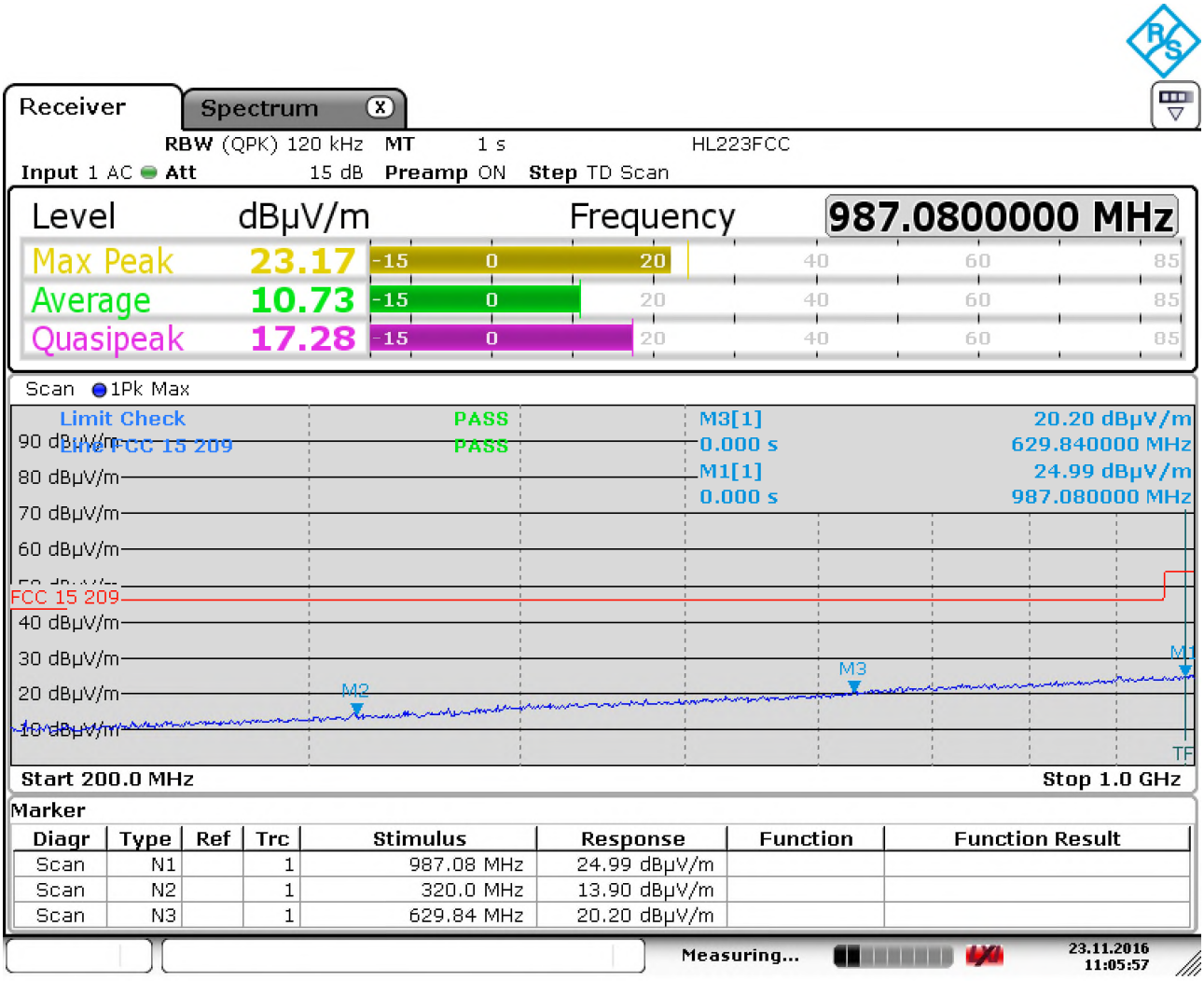
See attached graphs.



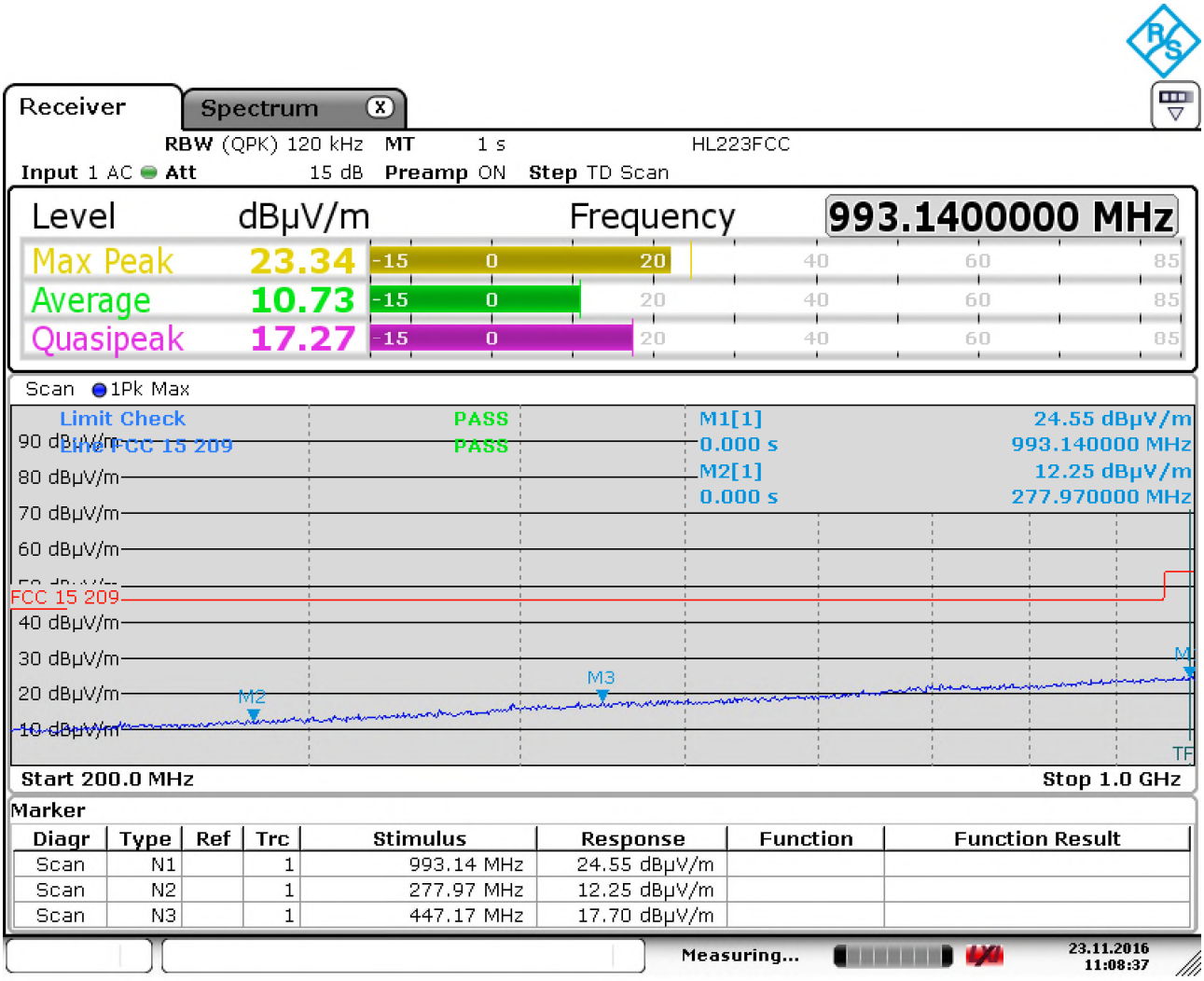
Radiated Emissions, 30 – 200 MHz, VP, @3m, PK scan



Radiated Emissions, 30 – 200 MHz, HP, @3m, PK scan



Radiated Emissions, 200 - 1000 MHz, VP , @3m, PK scan



Radiated Emissions, 200 - 1000MHz, HP , @3m, PK scan

Radiated Emissions, 1-25 GHz

Measuring distance: 3m (1 – 8 GHz)
1m (8 – 18 GHz)

A pre-scan was performed above 18 GHz and no spurious emissions were detected.

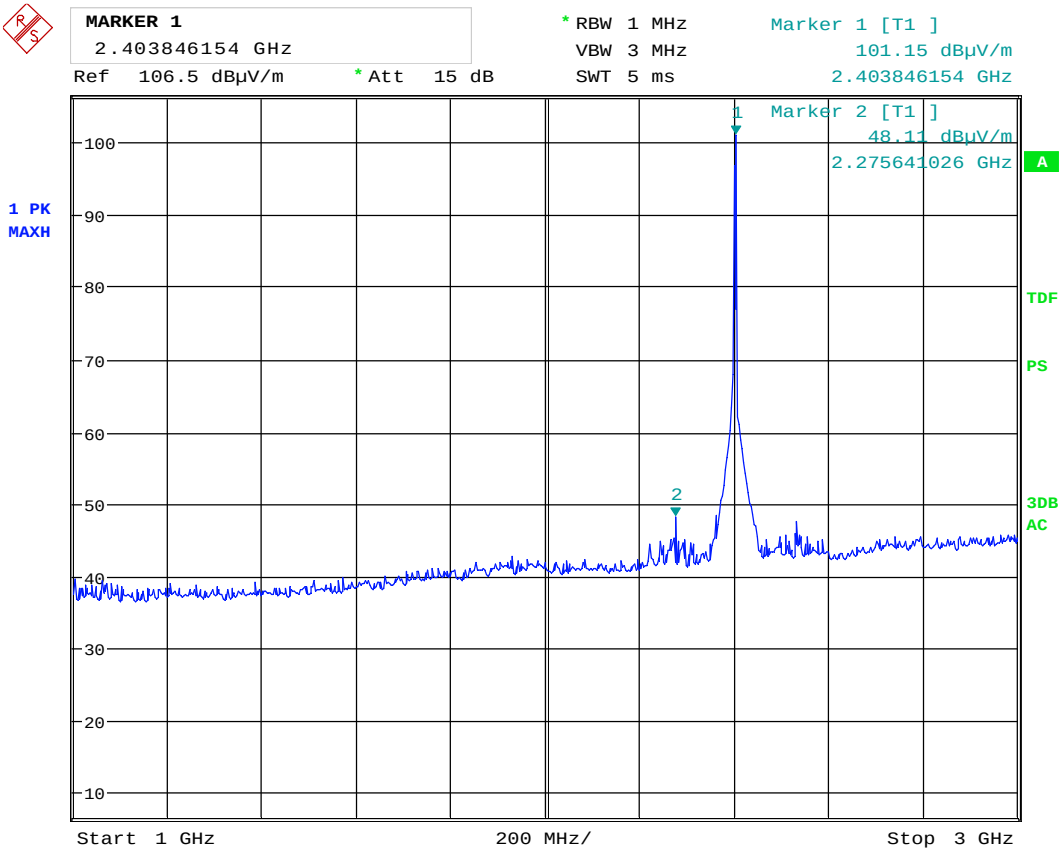
Peak Detector:

Frequency	RF channel	Dist. corr. factor	Field strength, Peak Detector	Duty cycle corr. factor	Limit	Margin
GHz	L,M,H	dB	dBµV/m	dB	dBµV/m	dB
4.81	L	0	< 54	0	74	>20
4.88	M	0	< 54	0	74	>20
4.96	H	0	< 54	0	74	>20
7.206	L	0	58.94	0	74	15.06
7.320	M	0	< 54	0	74	>20
7.440	H	0	< 54	0	74	>20
Other freqs	L,M,H	/	< 54	0	74	>20

Average Detector:

Frequency	RF channel	Dist. corr. factor	Field strength, Average Detector	Duty cycle corr. factor	Limit	Margin
GHz	L,M,H	dB	dBµV/m	dB	dBµV/m	dB
4.81	L	0	/	0	54	/
4.88	M	0	/	0	54	/
4.96	H	0	/	0	54	/
7.206	L	0	38.94	20	54	15.06
7.320	M	0	/	0	54	/
7.440	H	0	/	4.7	54	/
Other freqs	L,M,H	/	/	0	54	/

Tested according to KDB 558074 D01 DTS Meas Guidance v03r05, Section 12.2.5.2
Antenna factor, amplifier gain and cable loss are included in spectrum analyzer “Transducer factor”.
See plots.



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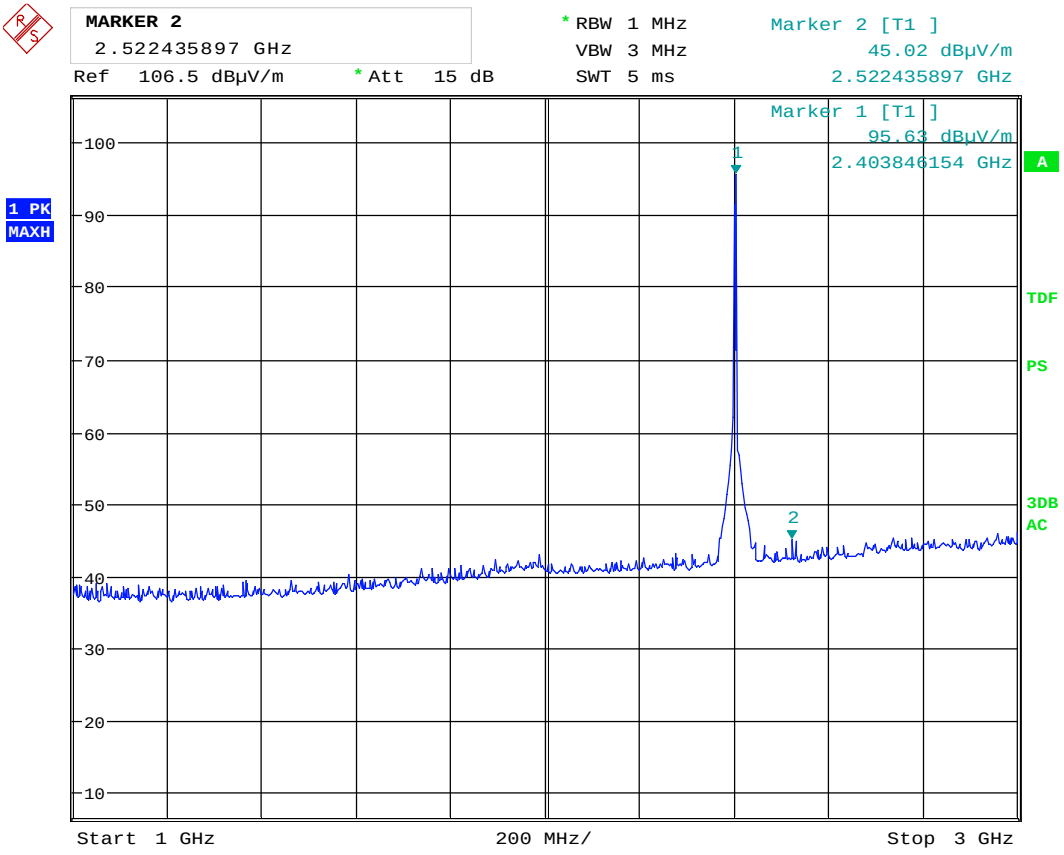
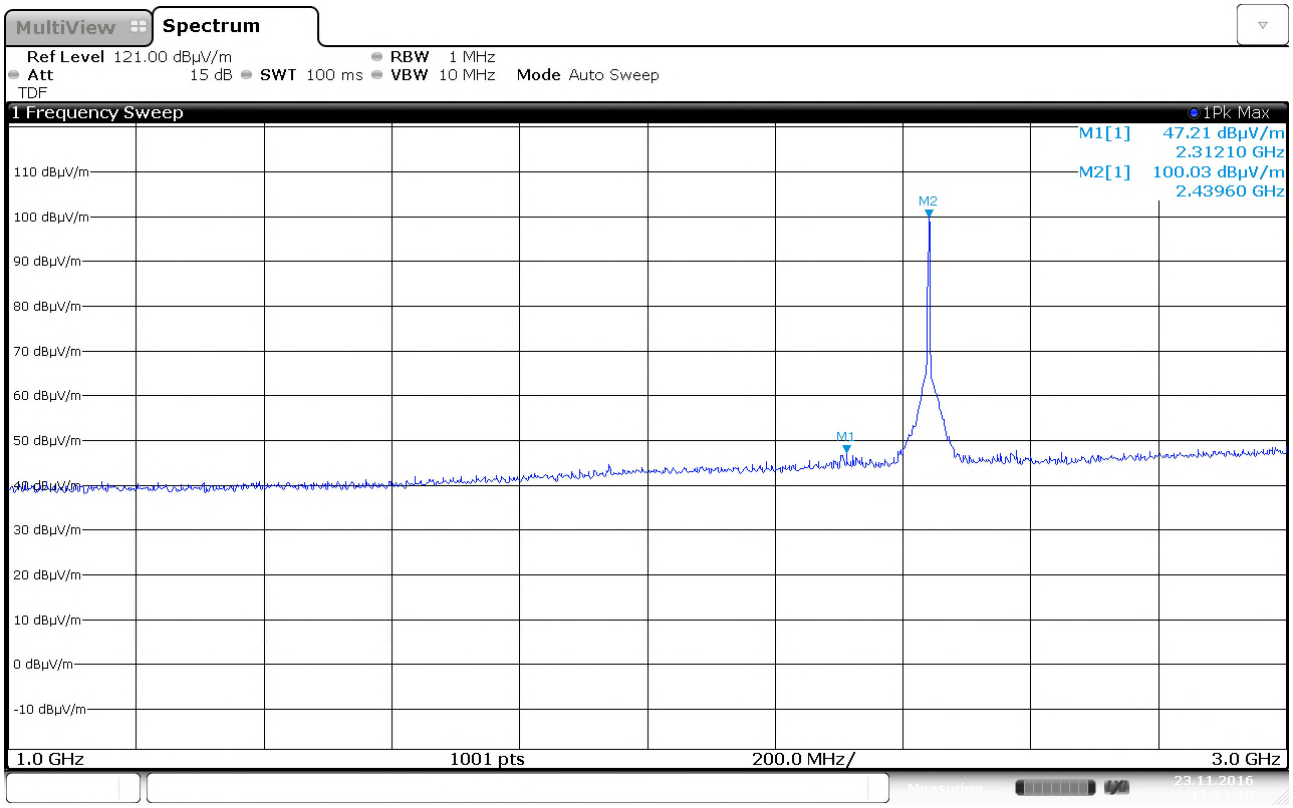
Radiated Emissions, 2402MHz, 1 – 3 GHz, VP, @3m – Pre-scan

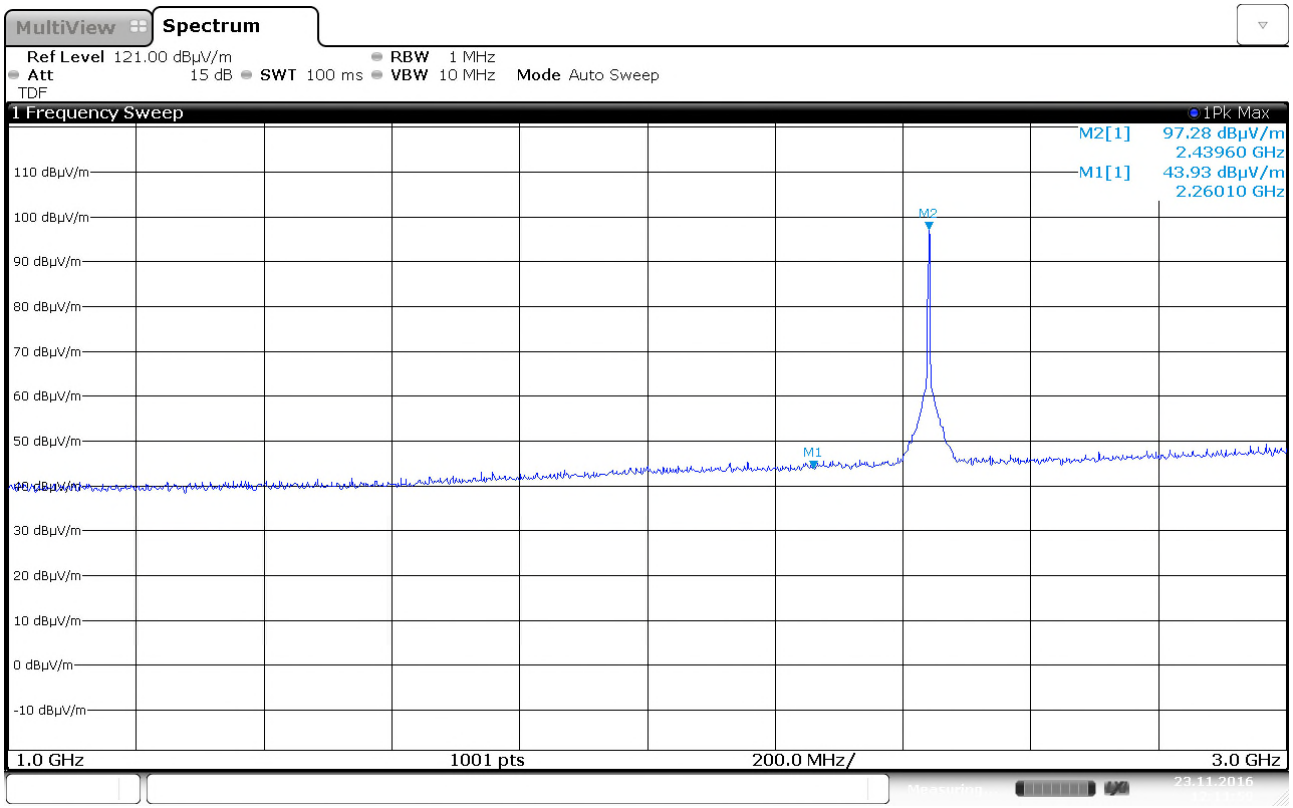


Date: 8.FEB.2017 09:48:15

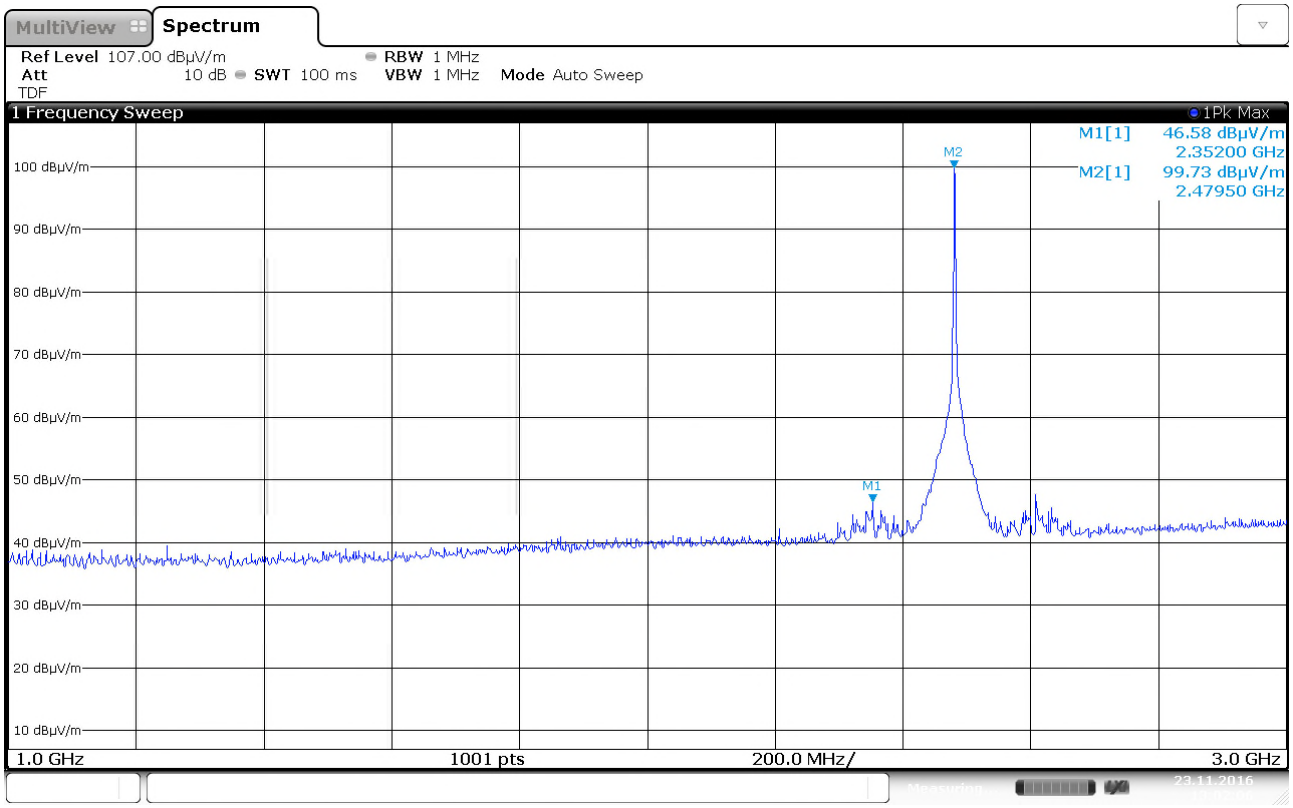
Radiated Emissions, 2404 MHz, 1 – 3 GHz, HP, @3m – Pre-scan



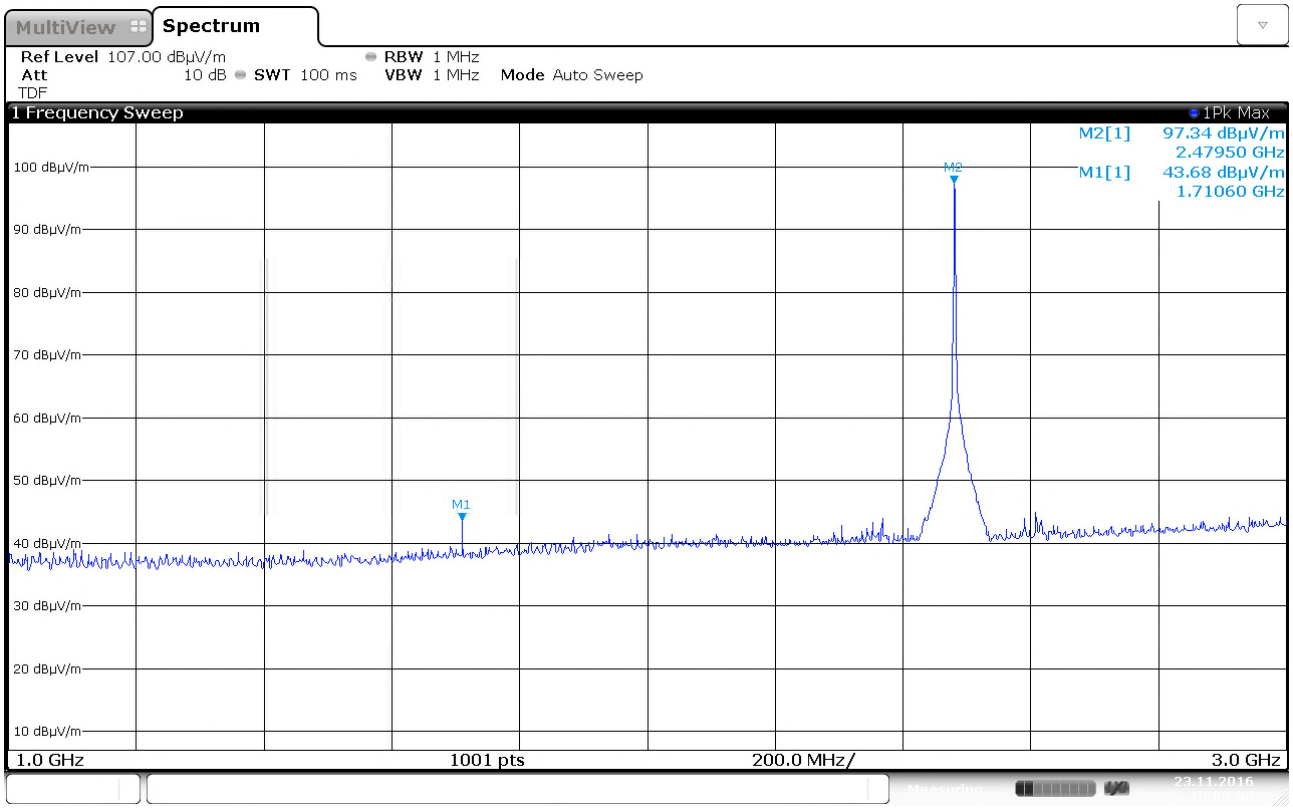
Radiated Emissions ch. 2440 MHz, 1 – 3 GHz, VP, @3m – Pre-scan



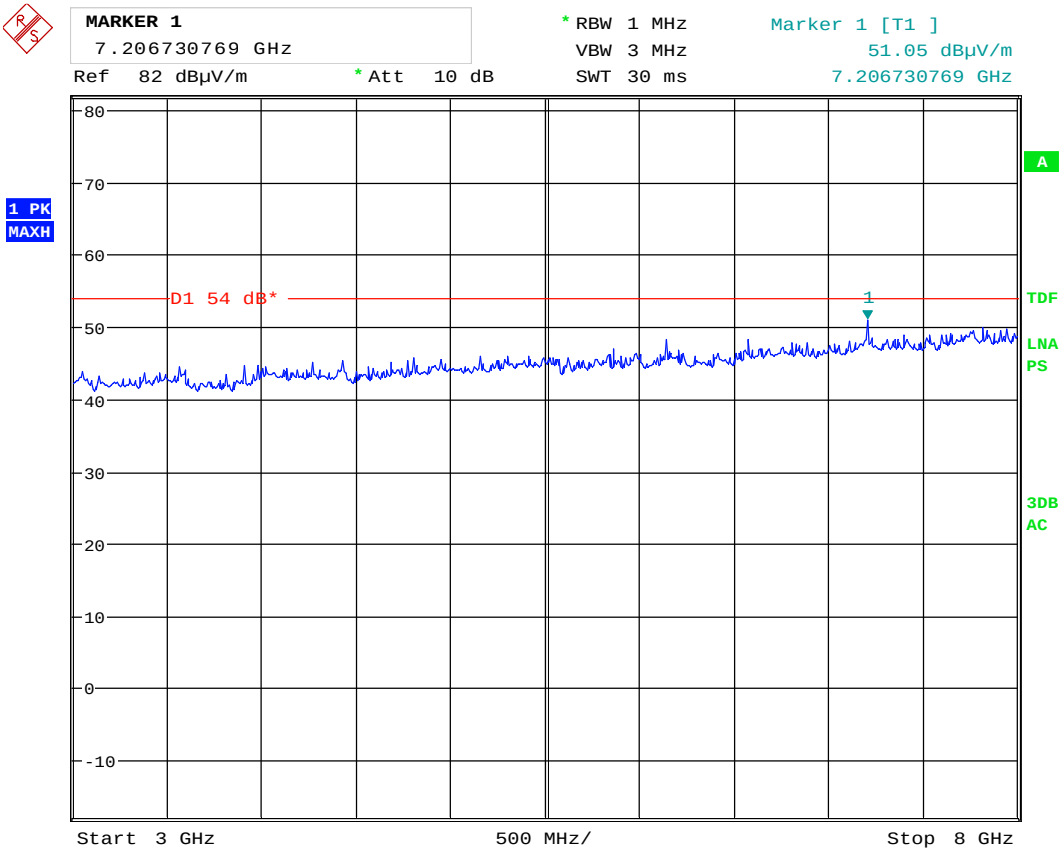
Radiated Emissions ch. 2440 MHz, 1 – 3 GHz, HP, @3m – Pre-scan



Radiated Emissions ch. 2480 MHz, 1 – 3 GHz, VP, @3m – Pre-scan



Radiated Emissions ch. 2480 MHz, 1 – 3 GHz, HP, @3m – Pre-scan



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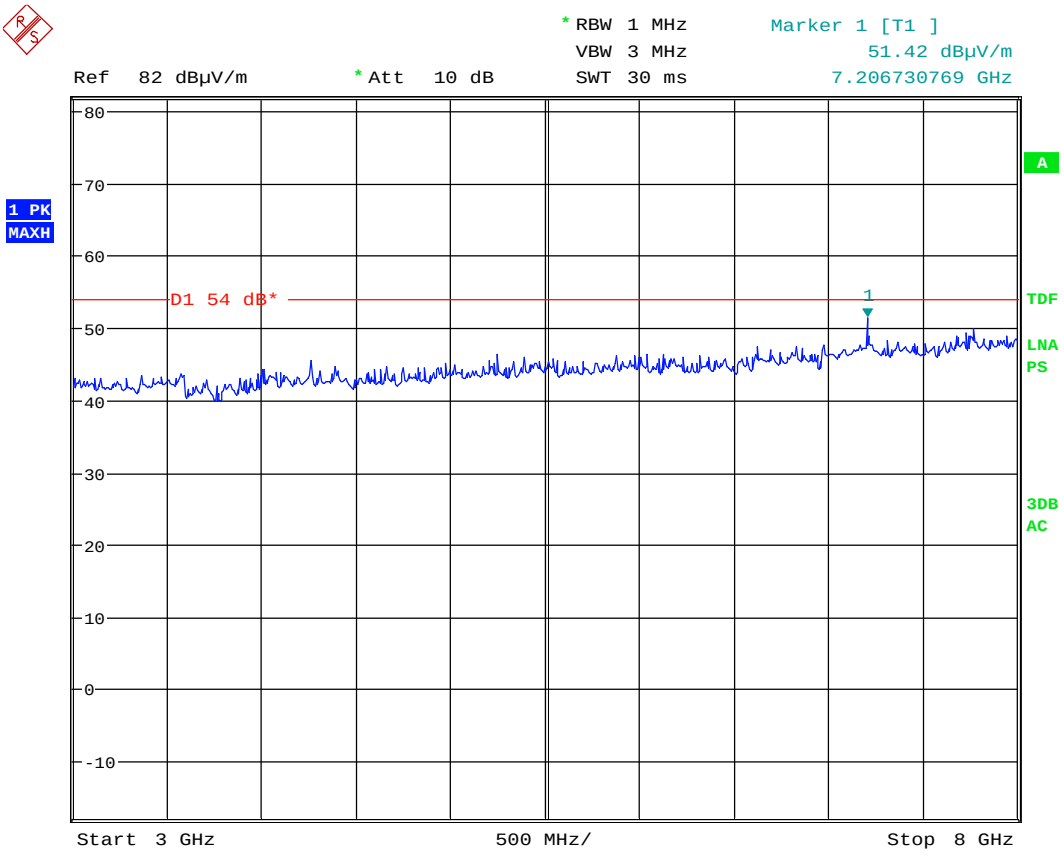
Radiated Emissions ch. 2402 MHz, 3 – 8 GHz, VP, @3m – Pre-scan



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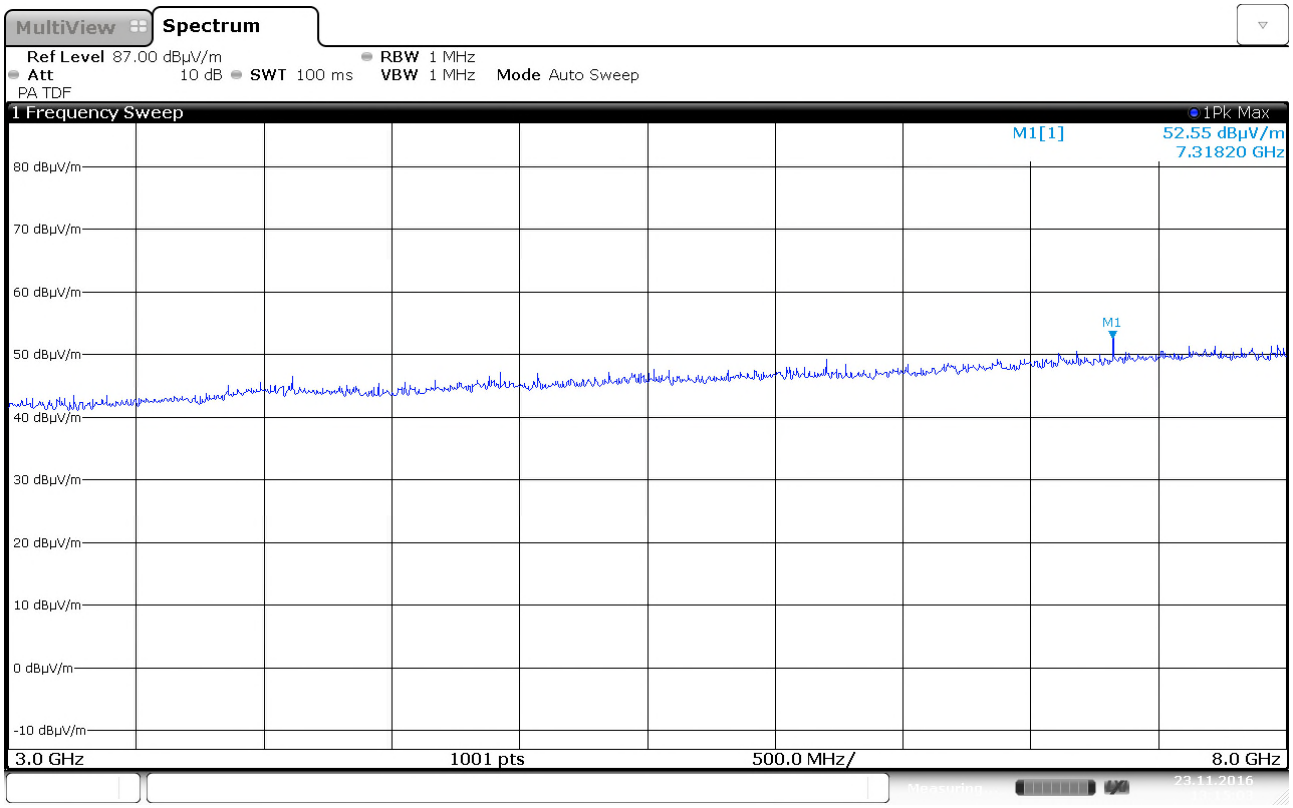
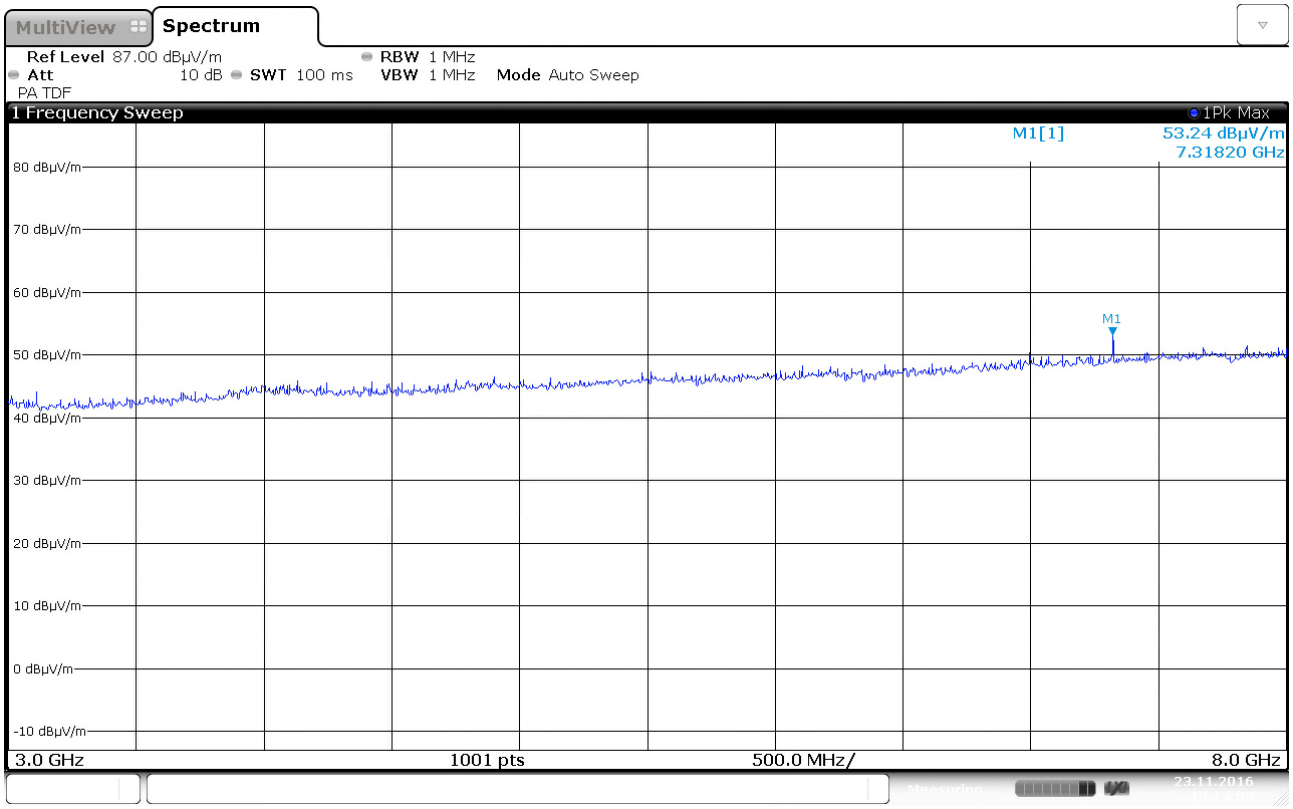
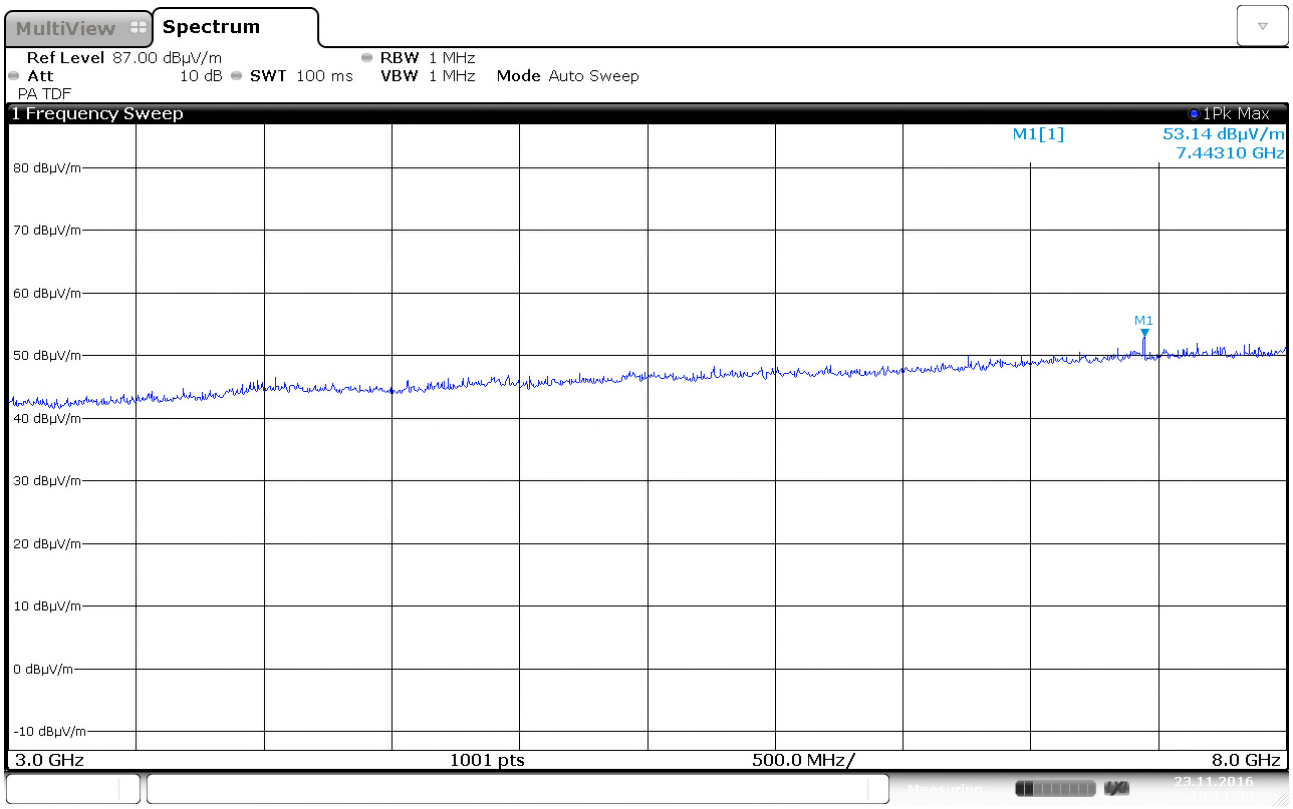
Radiated Emissions ch. 2402 MHz, 3 – 8 GHz, HP, @3m – Pre-scan



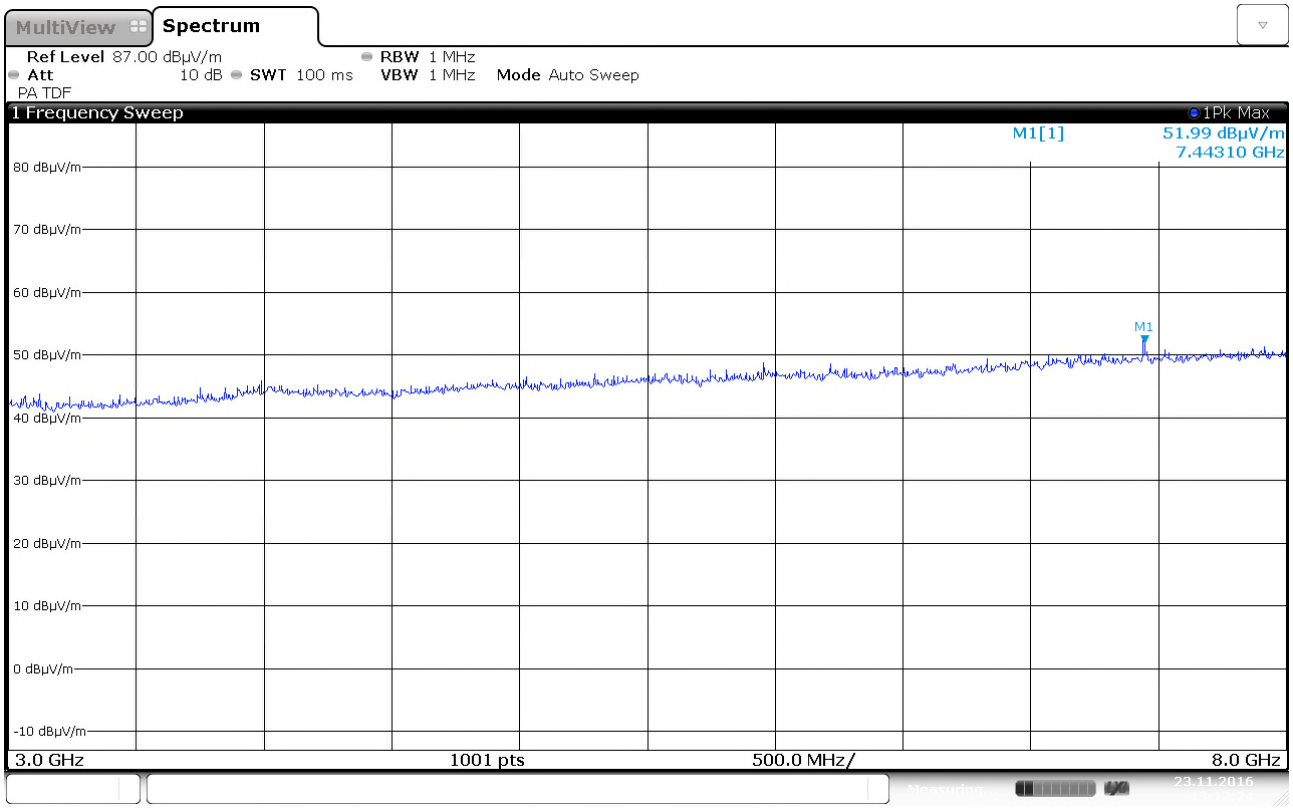
Radiated Emissions ch. 2440 MHz, 3 – 8 GHz, VP, @3m – Pre-scan



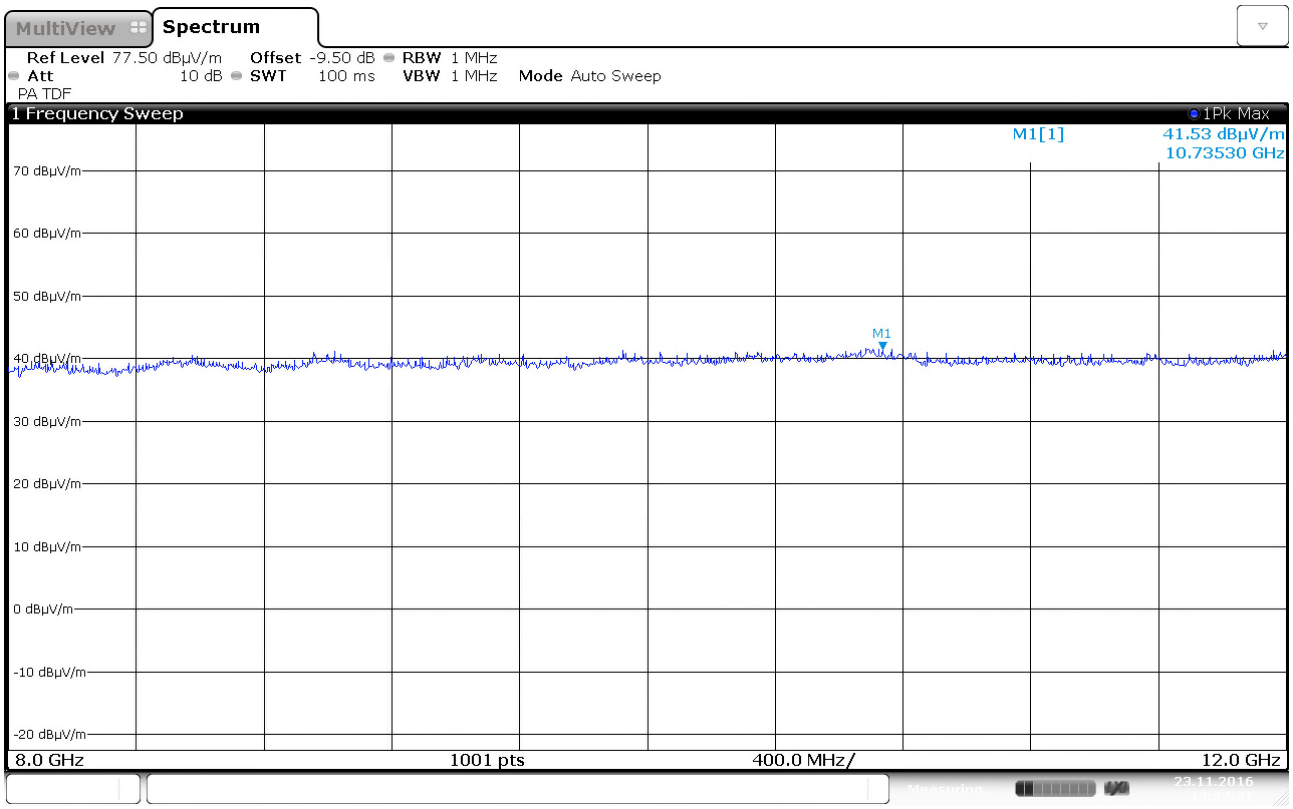
Radiated Emissions ch. 2440 MHz, 3 – 8 GHz, HP, @3m – Pre-scan



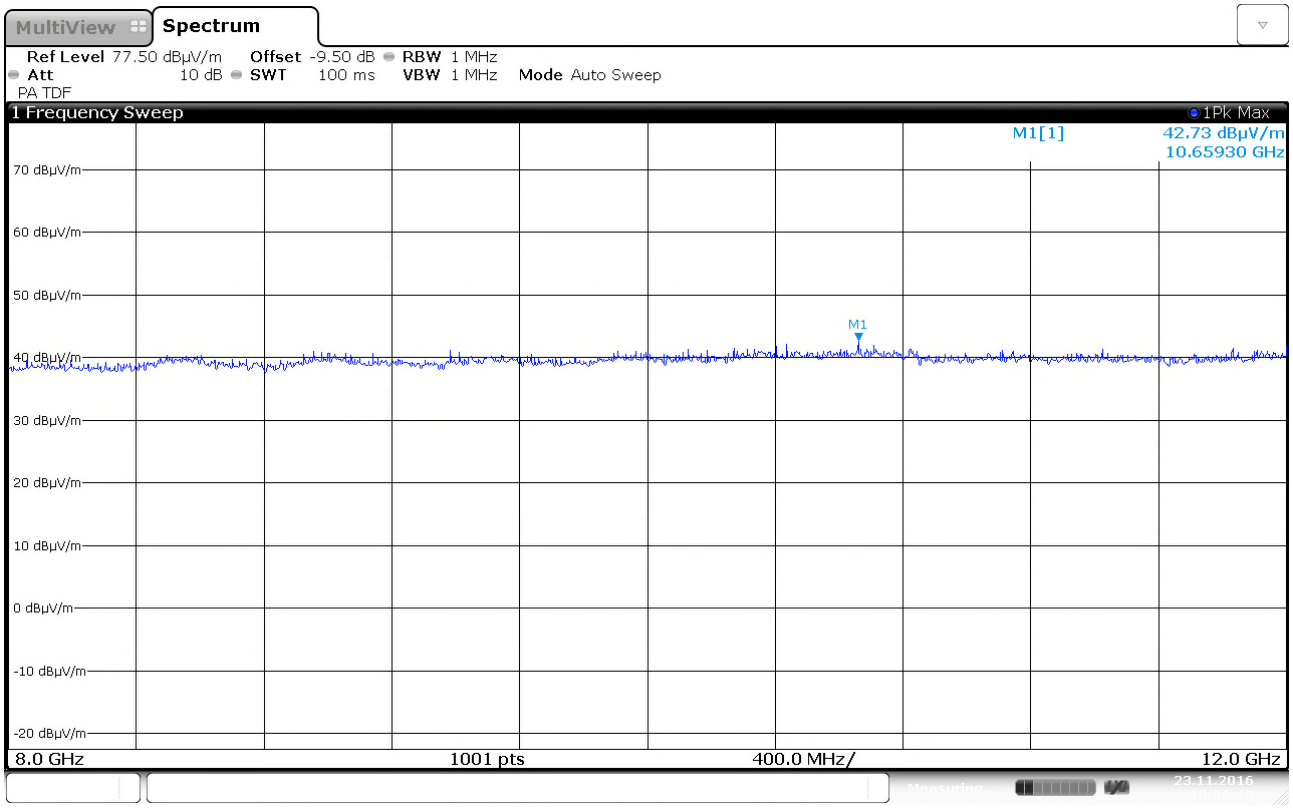
Radiated Emissions ch. 2480 MHz, 3 – 8 GHz, VP, @3m – Pre-scan



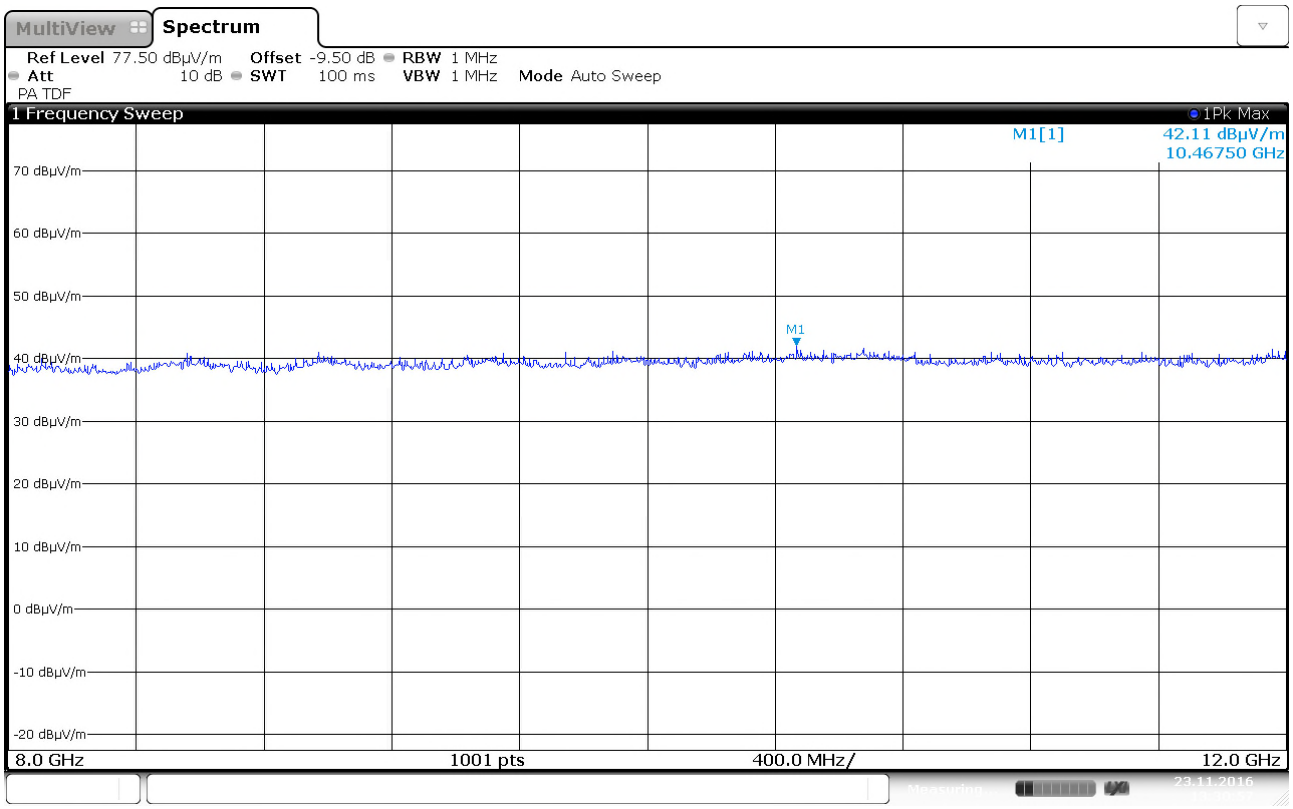
Radiated Emissions ch. 2480 MHz, 3 – 8 GHz, HP, @3m – Pre-scan



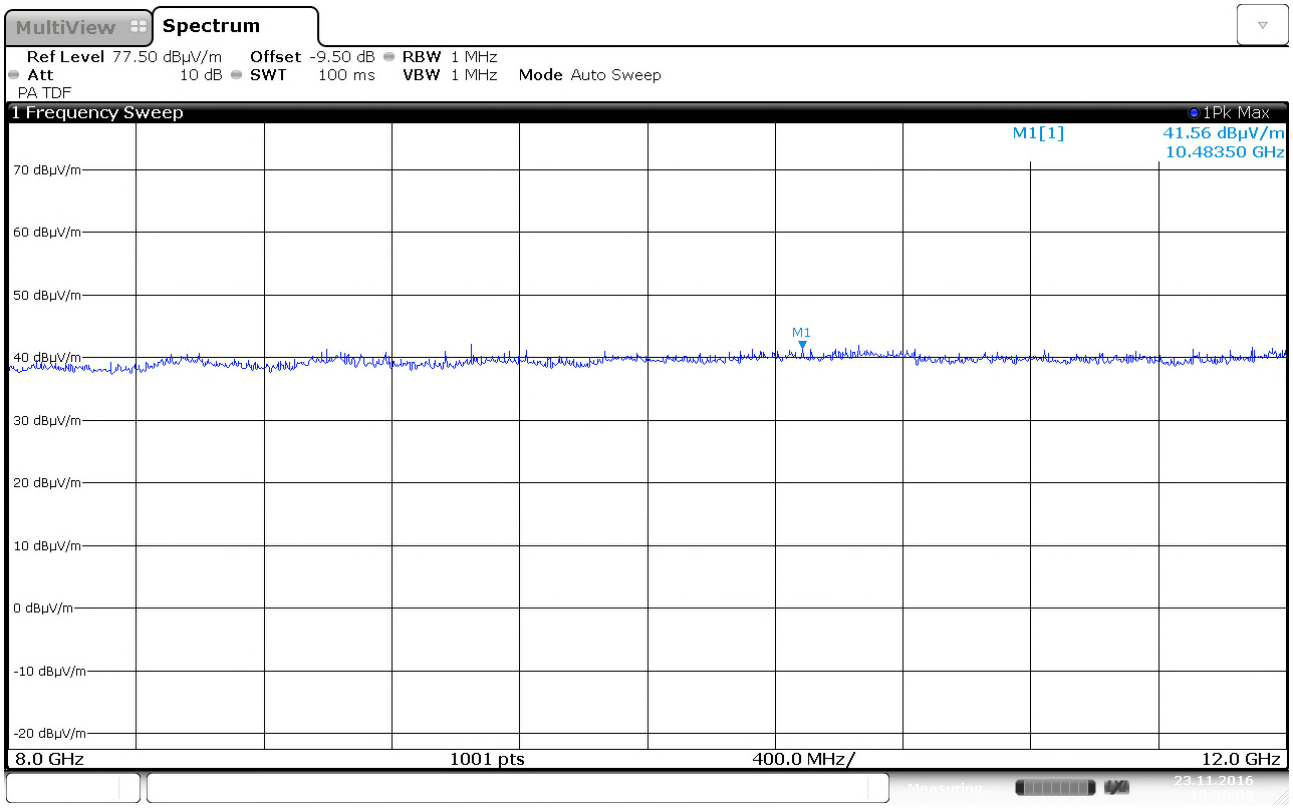
Radiated Emissions ch. 2402 MHz, 8 – 12 GHz, VP, @1m – Pre-scan



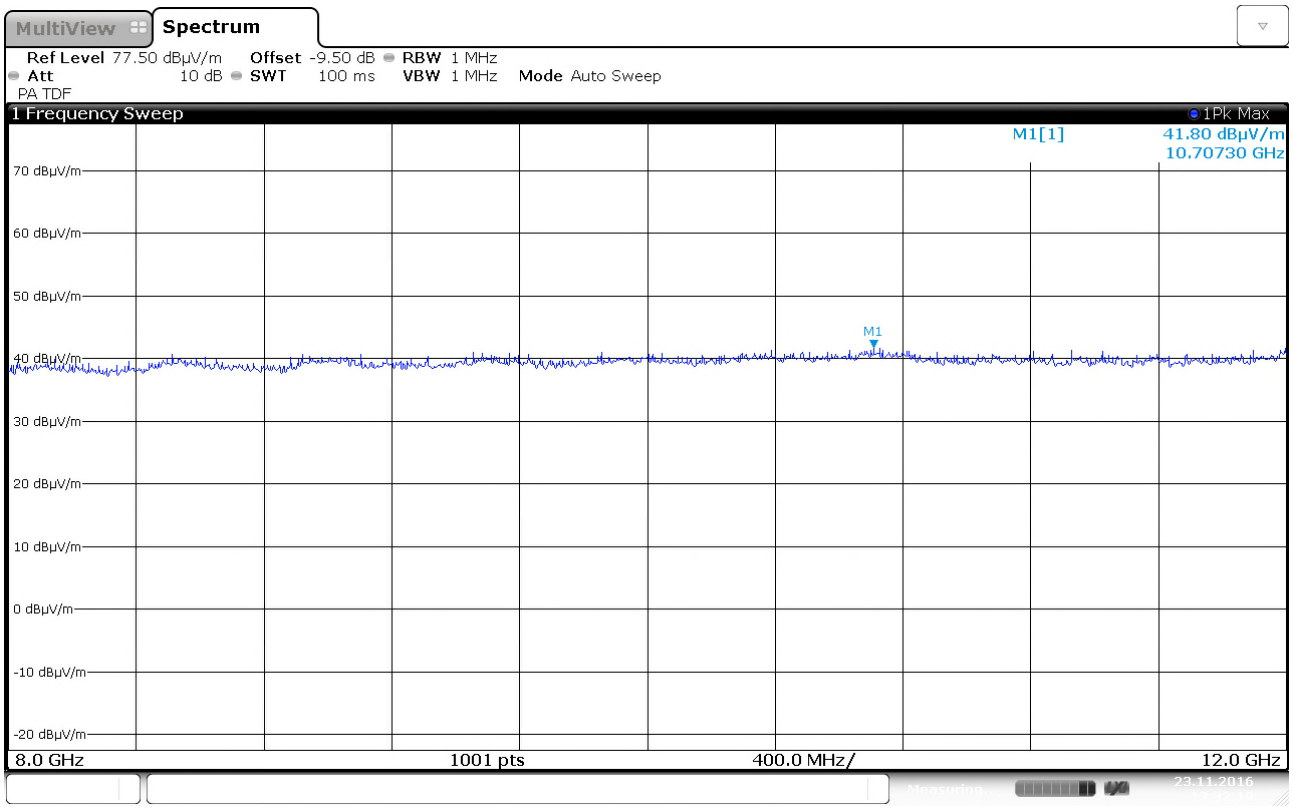
Radiated Emissions ch. 2402 MHz, 8 – 12 GHz, HP, @1m – Pre-scan



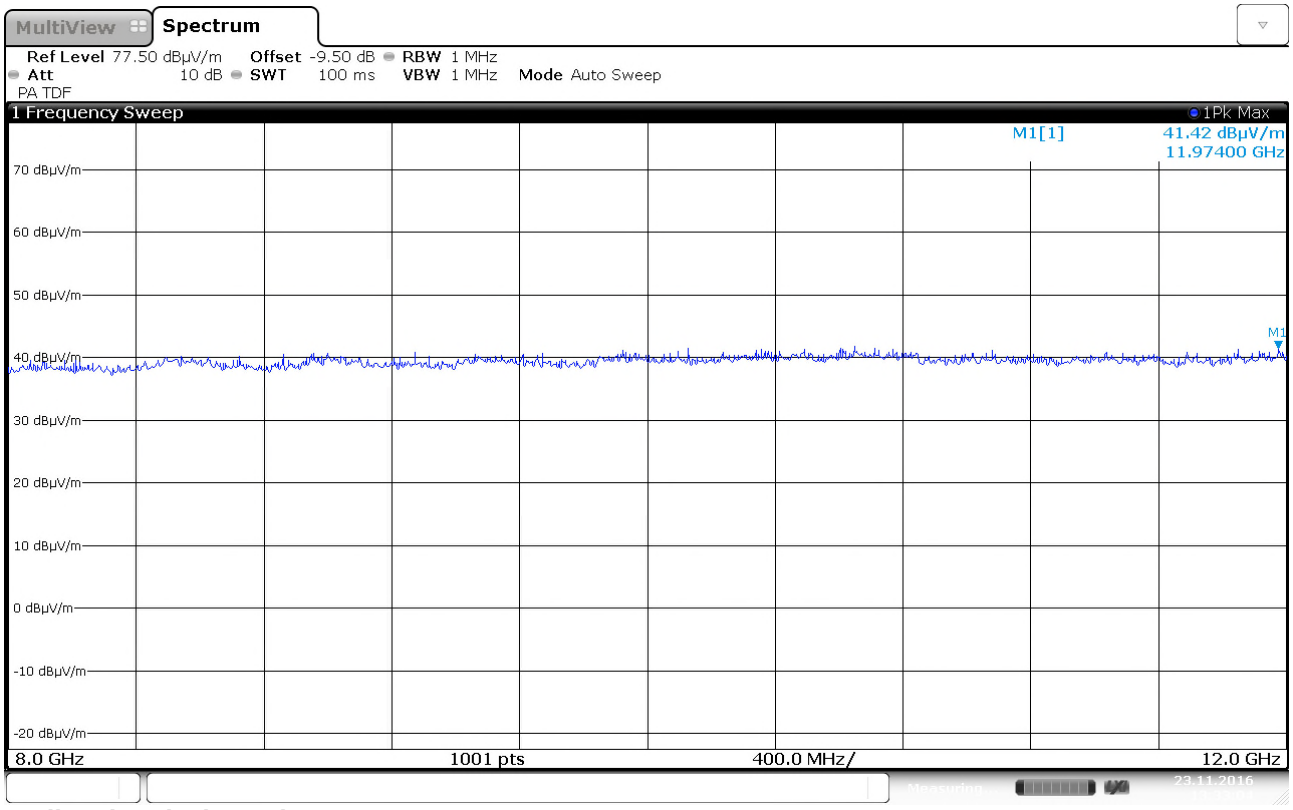
Radiated Emissions ch. 2440 MHz, 8 – 12 GHz, VP, @1m – Pre-scan



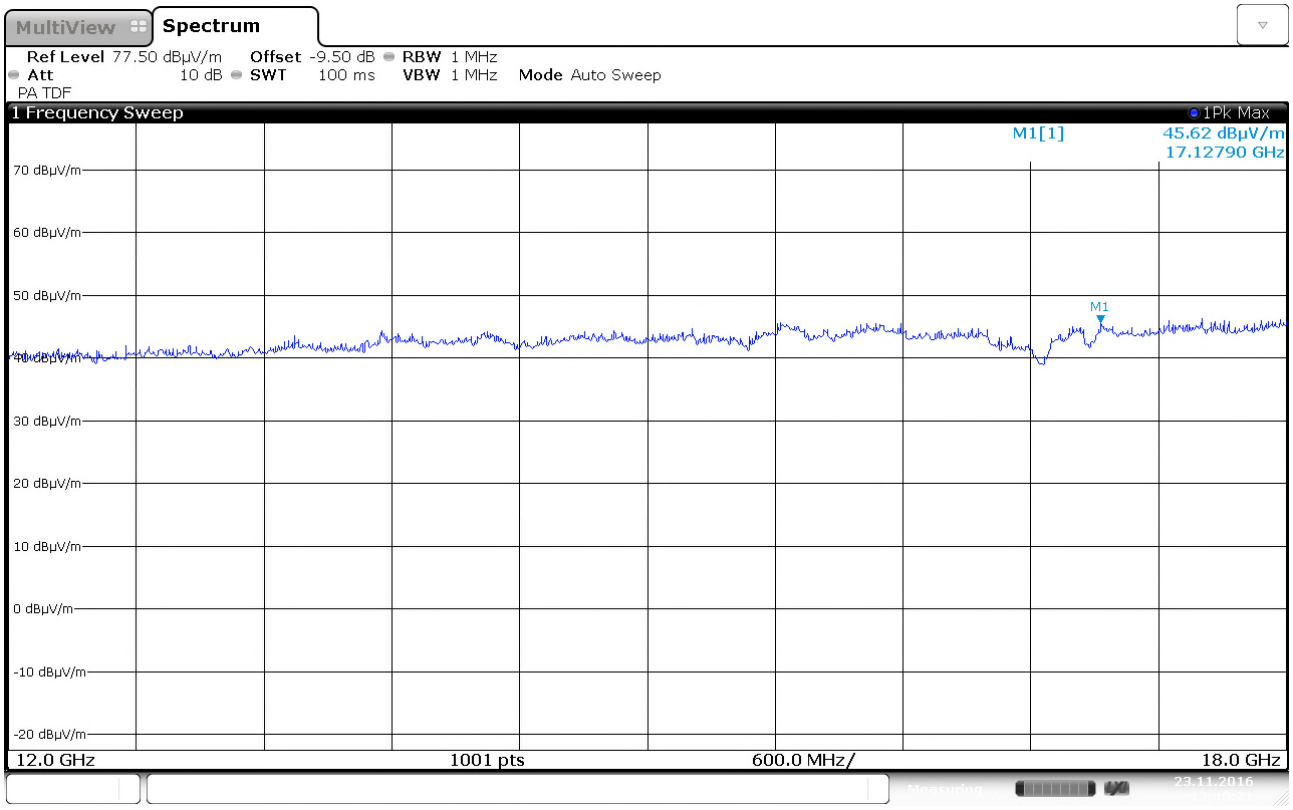
Radiated Emissions ch. 2440 MHz, 8 – 12 GHz, HP, @1m – Pre-scan



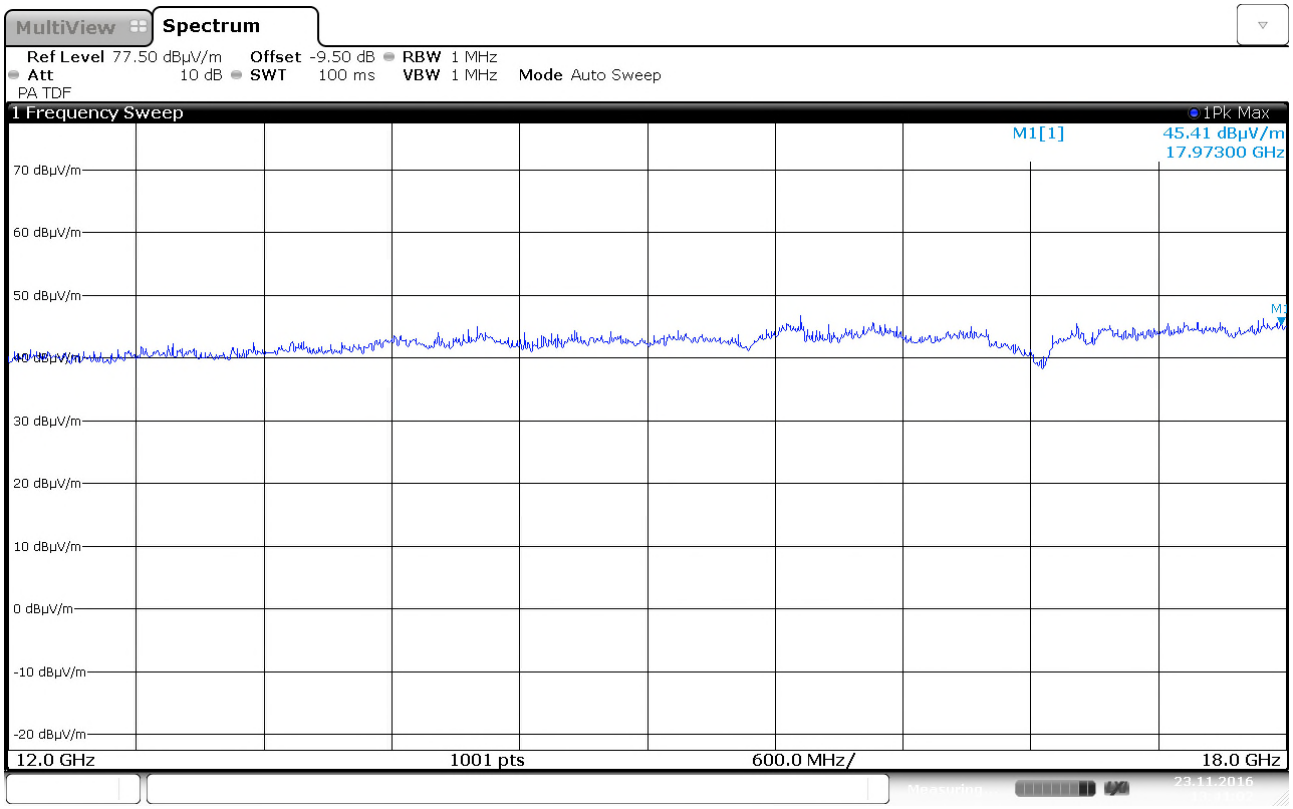
Radiated Emissions ch. 2480 MHz, 8 – 12 GHz, VP, @1m – Pre-scan



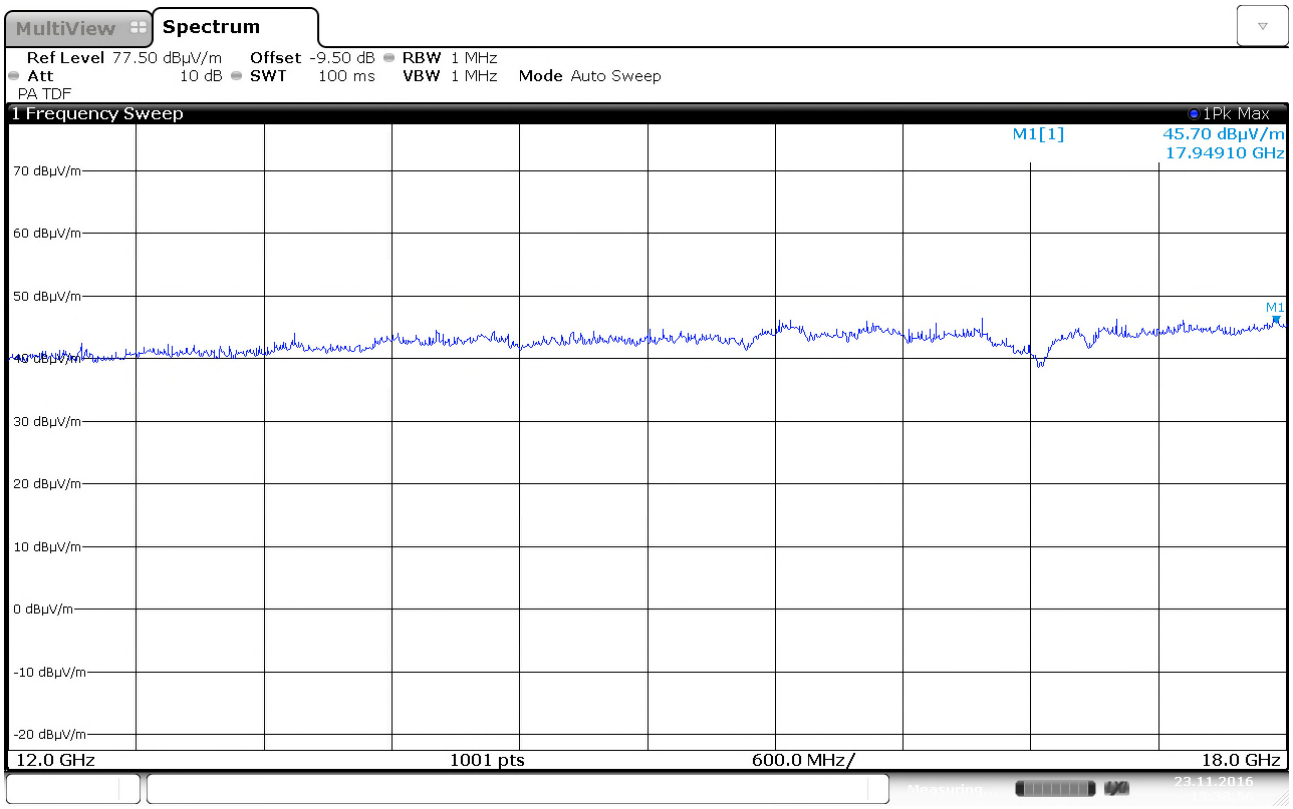
Radiated Emissions ch. 2480 MHz, 8 – 12 GHz, HP, @1m – Pre-scan



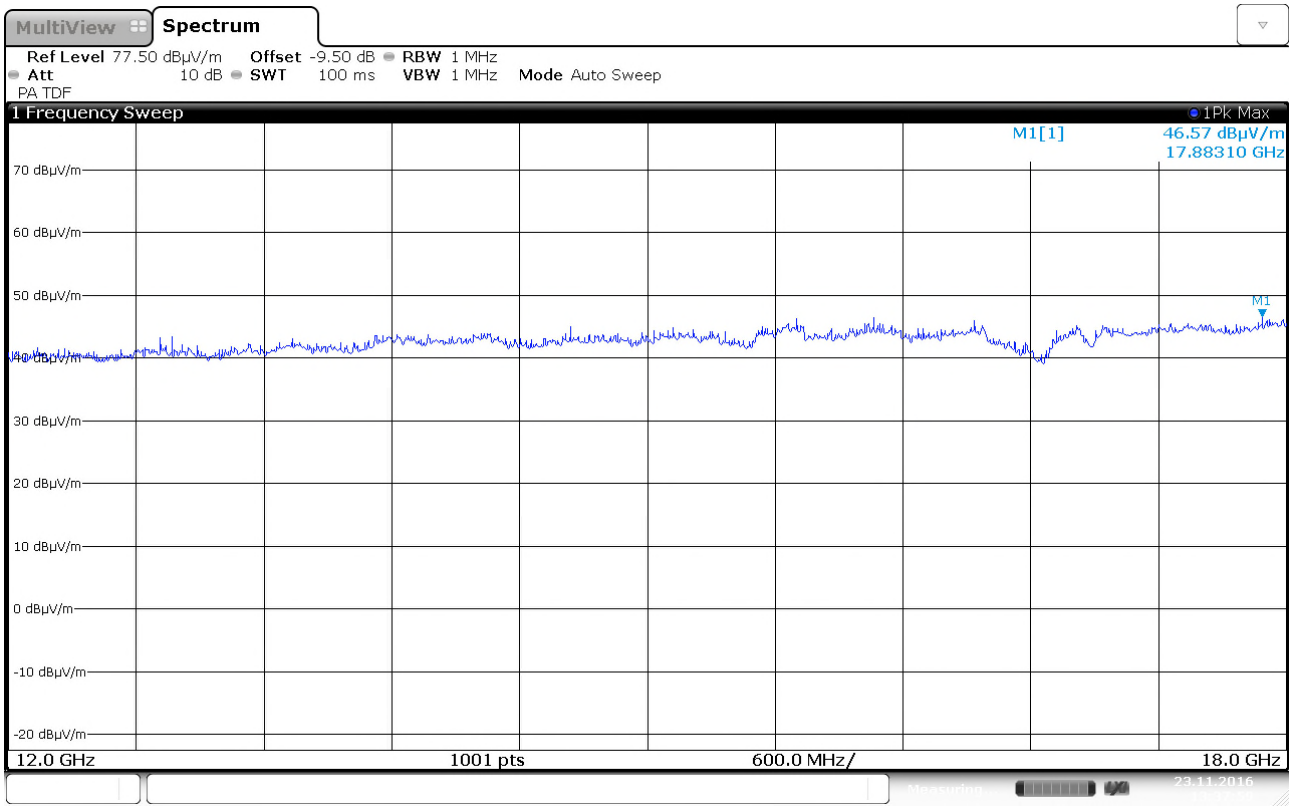
Radiated Emissions ch. 2404 MHz, 12 – 18 GHz, VP, @1m – Pre-scan



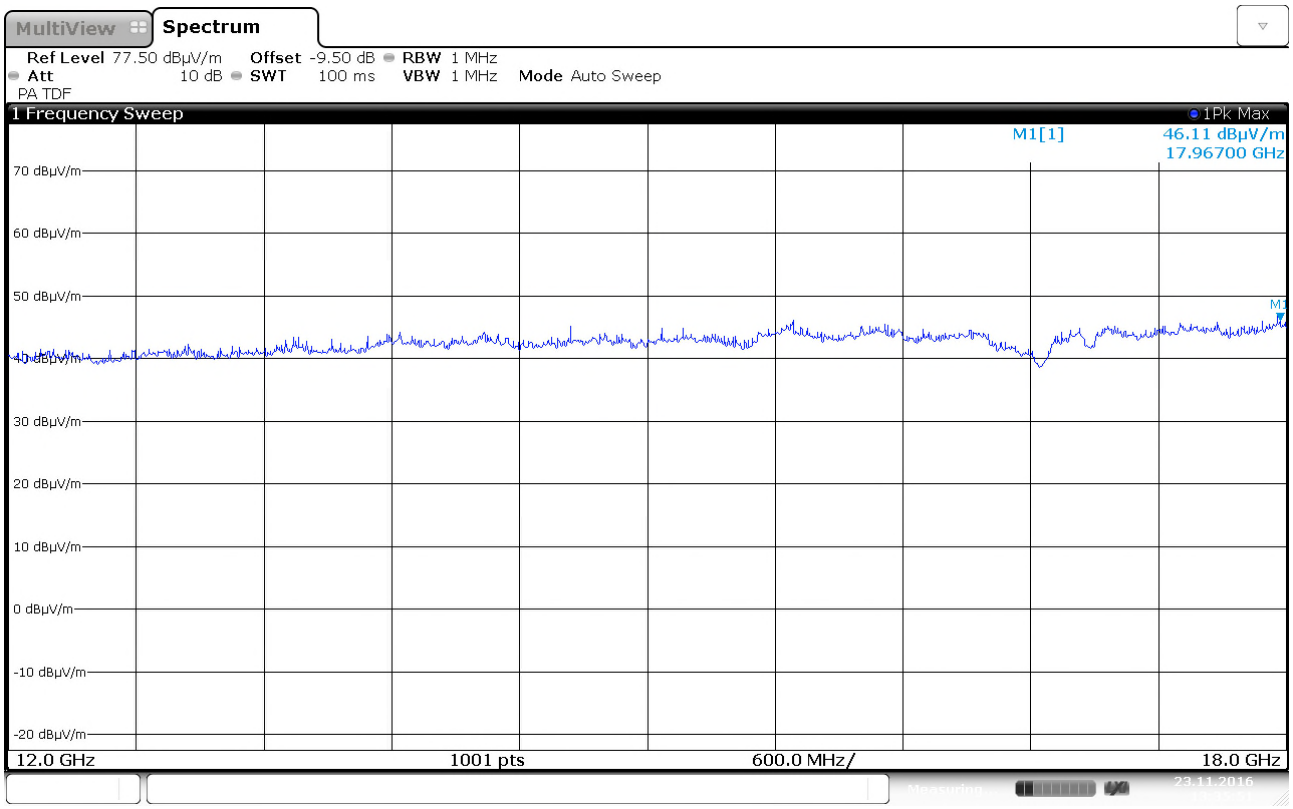
Radiated Emissions ch. 2404 MHz, 12 – 18 GHz, HP, @1m – Pre-scan



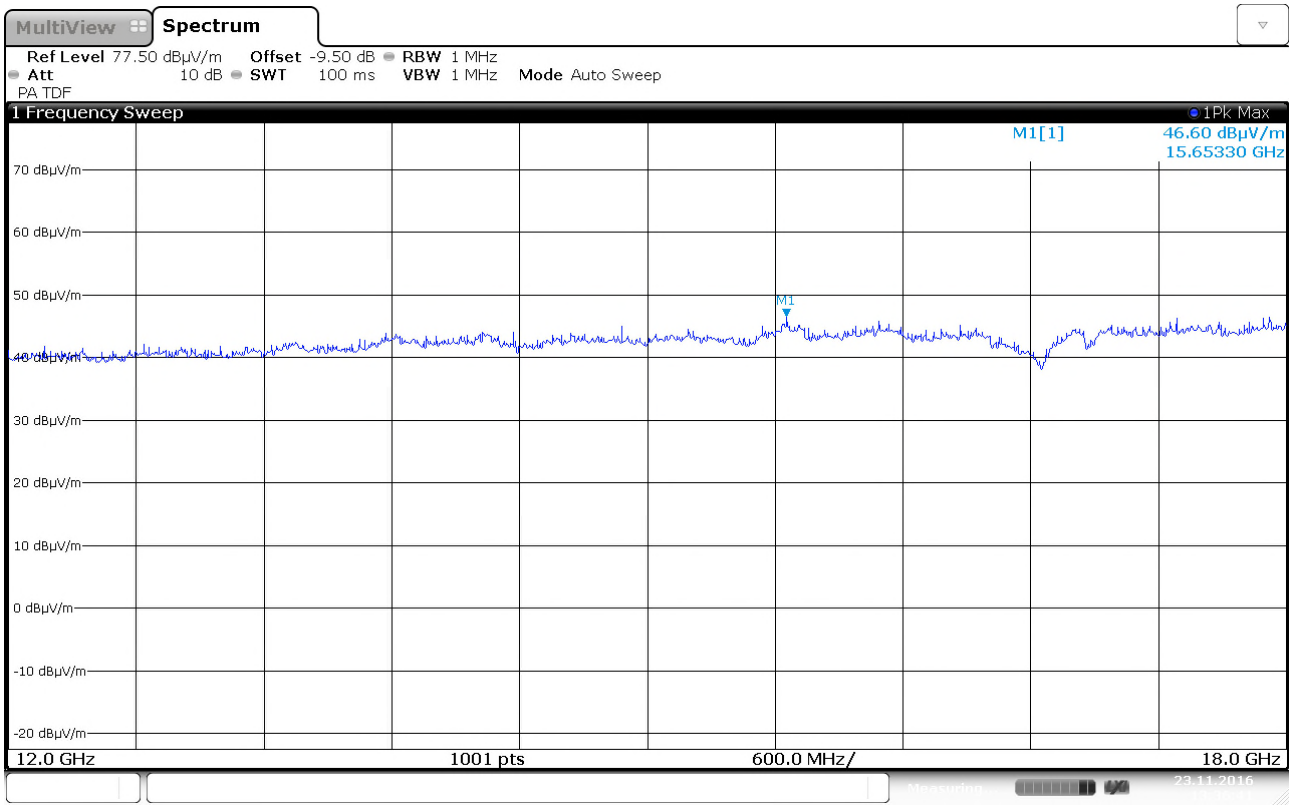
Radiated Emissions ch. 2440 MHz, 12 – 18 GHz, VP, @1m – Pre-scan



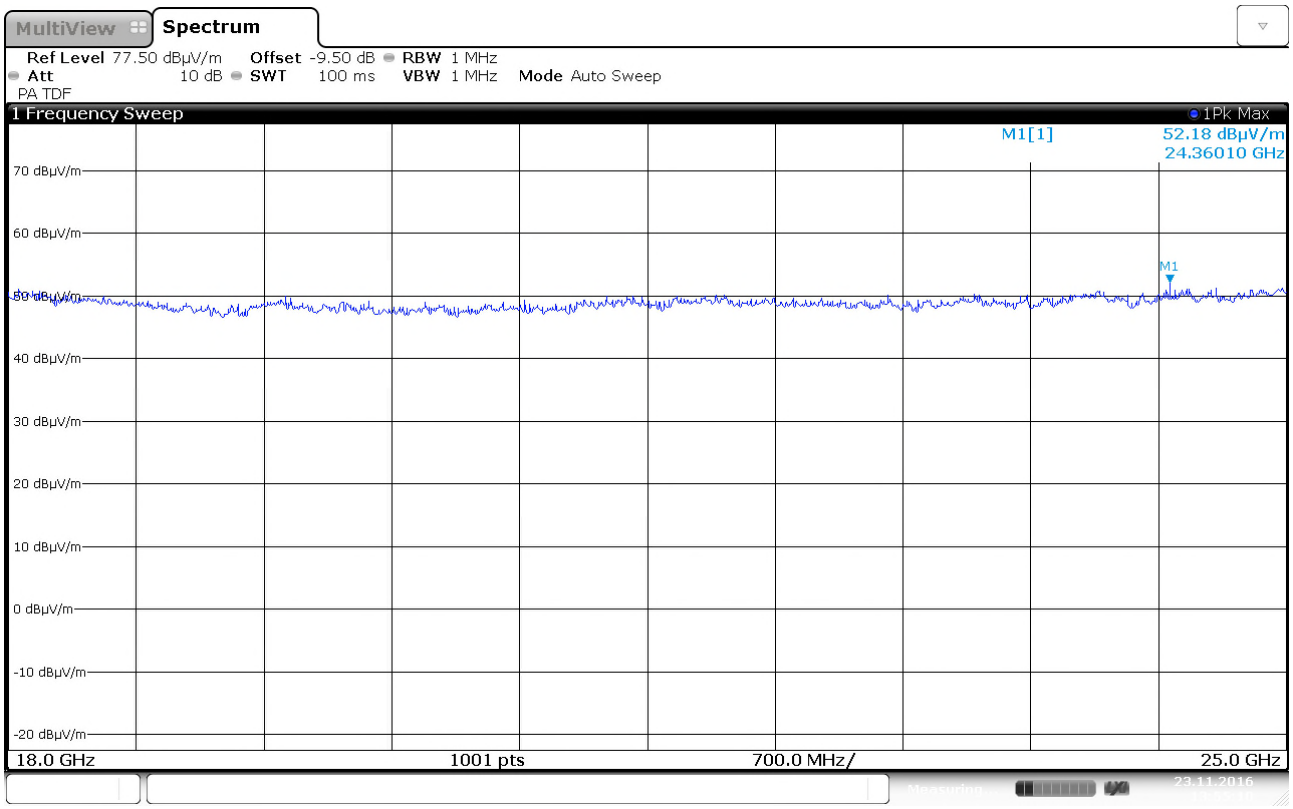
Radiated Emissions ch. 2440 MHz, 12 – 18 GHz, HP, @1m – Pre-scan



Radiated Emissions ch. 2480 MHz, 12 – 18 GHz, VP, @1m – Pre-scan



Radiated Emissions ch. 2480 MHz, 12 – 18 GHz, HP, @1m – Pre-scan



Radiated Emissions ch. 2440 MHz, 18 – 25 GHz, VP/HP, Pre-scan

3.6 Power Spectral Density (PSD)

Para. No.: 15.247 (d)

Test Performed By: G.Suhanthakumar	**Date of Test: 2016.11.23 & 2017.02.08**

Test Results: Passed

Measured and Calculated Data:

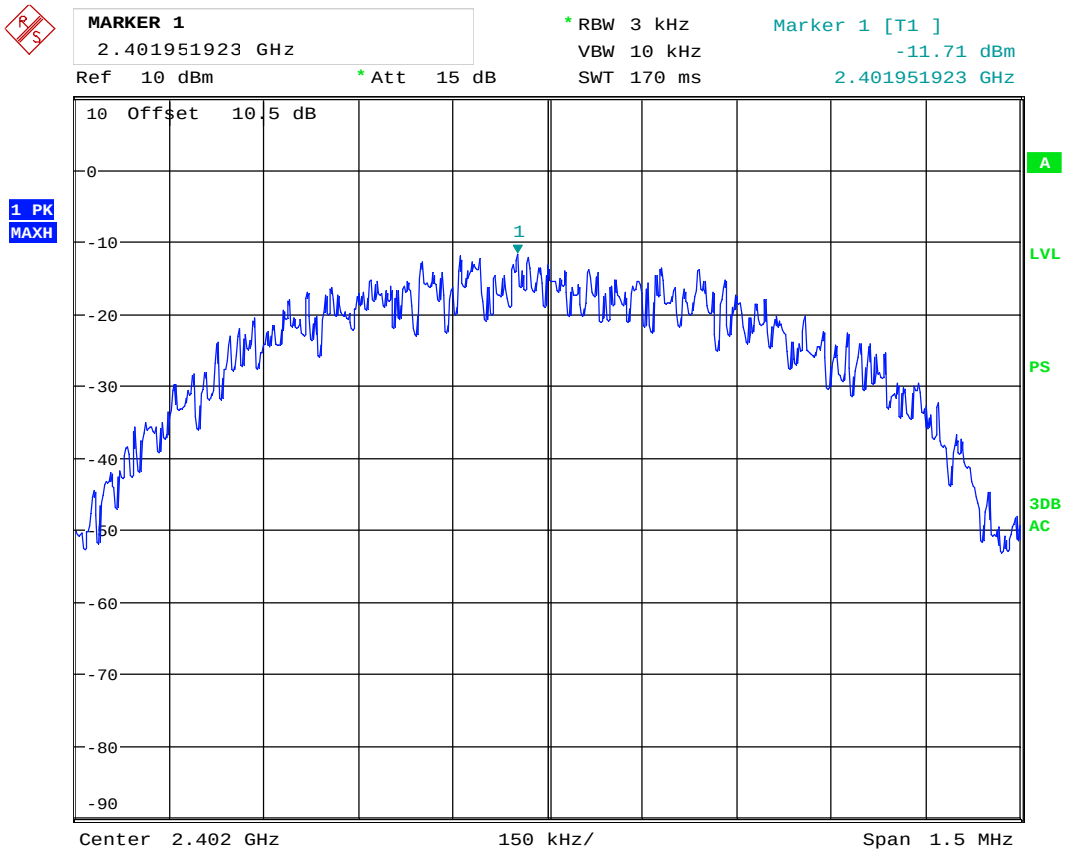
The measurement procedures PKPSD described in KDB 558074 D01 v03r05 was used.

	calculated peak PSD dBm
Power Spectral Density @2402 MHz	-11.71
Power Spectral Density @2440 MHz	-12.09
Power Spectral Density @2480 MHz	-11.83

Requirements:

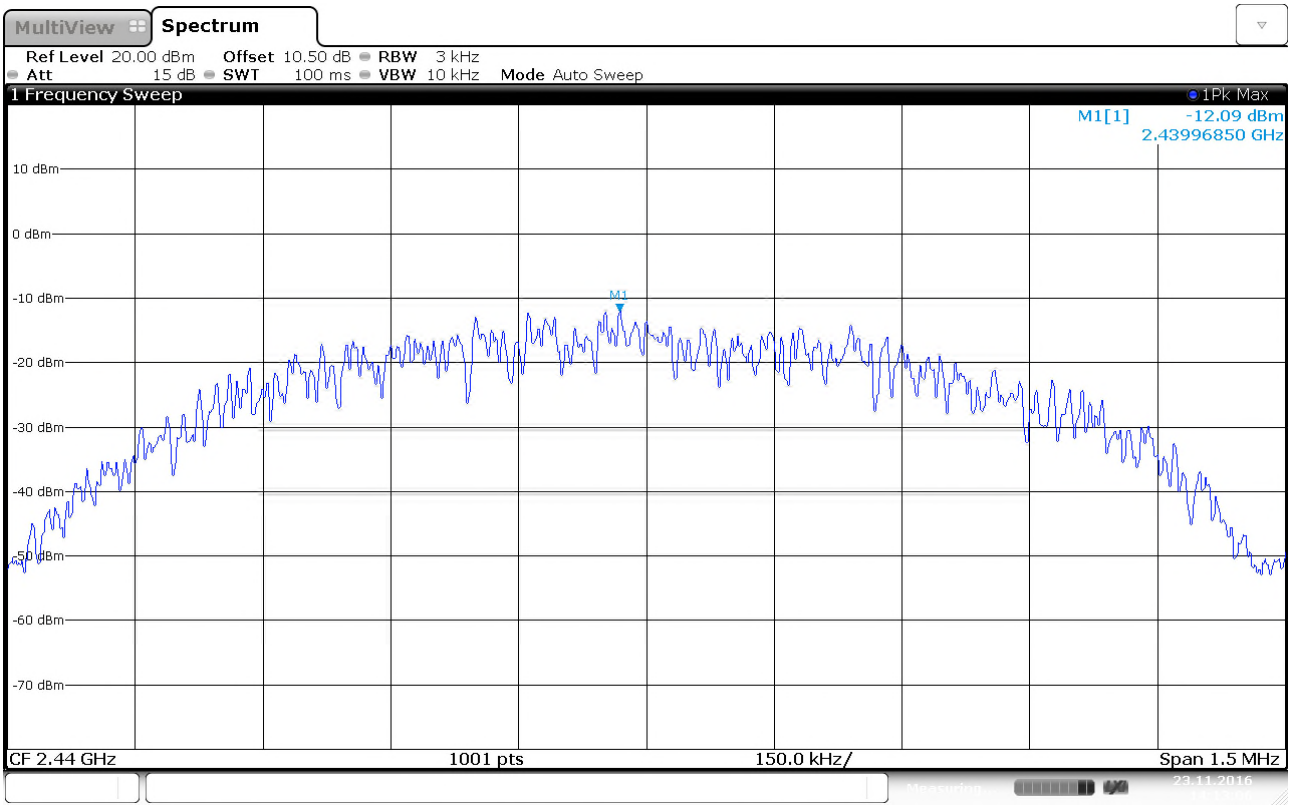
The Power Spectral Density of a Digital Transmission System shall be no greater than +8 dBm in any 3 kHz band

No requirements for Frequency Hopping Systems.

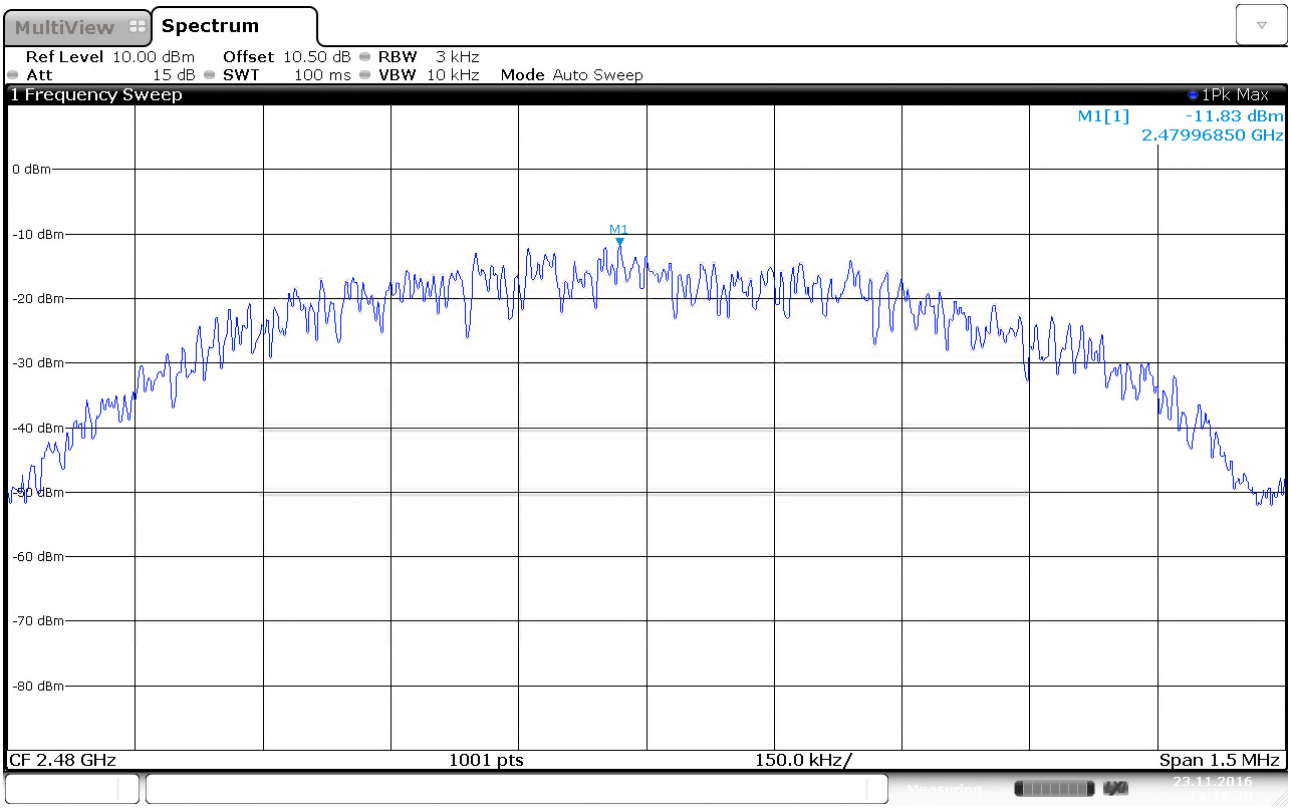


Date: 8.FEB.2017 09:17:45

PSD Measurement - 2402MHz



PSD Measurement – 2440MHz



PSD Measurement - 2480MHz

4 Measurement Uncertainty

Measurement Uncertainty Values		
Test Item		**Uncertainty**
Output Power		±0.5 dB
Power Spectral Density		±0.5 dB
Out of Band Emissions, Conducted	**< 3.6 GHz**	±0.6 dB
	> 3.6 GHz	±0.9 dB
Spurious Emissions, Radiated	**< 1 GHz**	±2.5 dB
	> 1 GHz	±2.2 dB
Emission Bandwidth		±4 %
Power Line Conducted Emissions		+2.9 / -4.1 dB
Spectrum Mask Measurements	**Frequency**	±5 %
	Amplitude	±1.0 dB
Frequency Error		±0.6 ppm
Temperature Uncertainty		±1 °C

All uncertainty values are expanded standard uncertainty to give a confidence level of 95%, based on coverage factor k=2

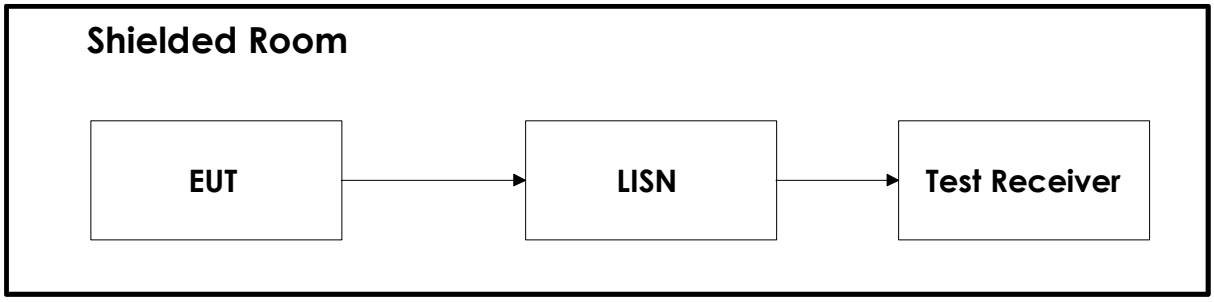
5 LIST OF TEST EQUIPMENT

To facilitate inclusion on each page of the test equipment used for related tests, each item of test equipment and ancillaries are identified (numbered) by the Test Laboratory.

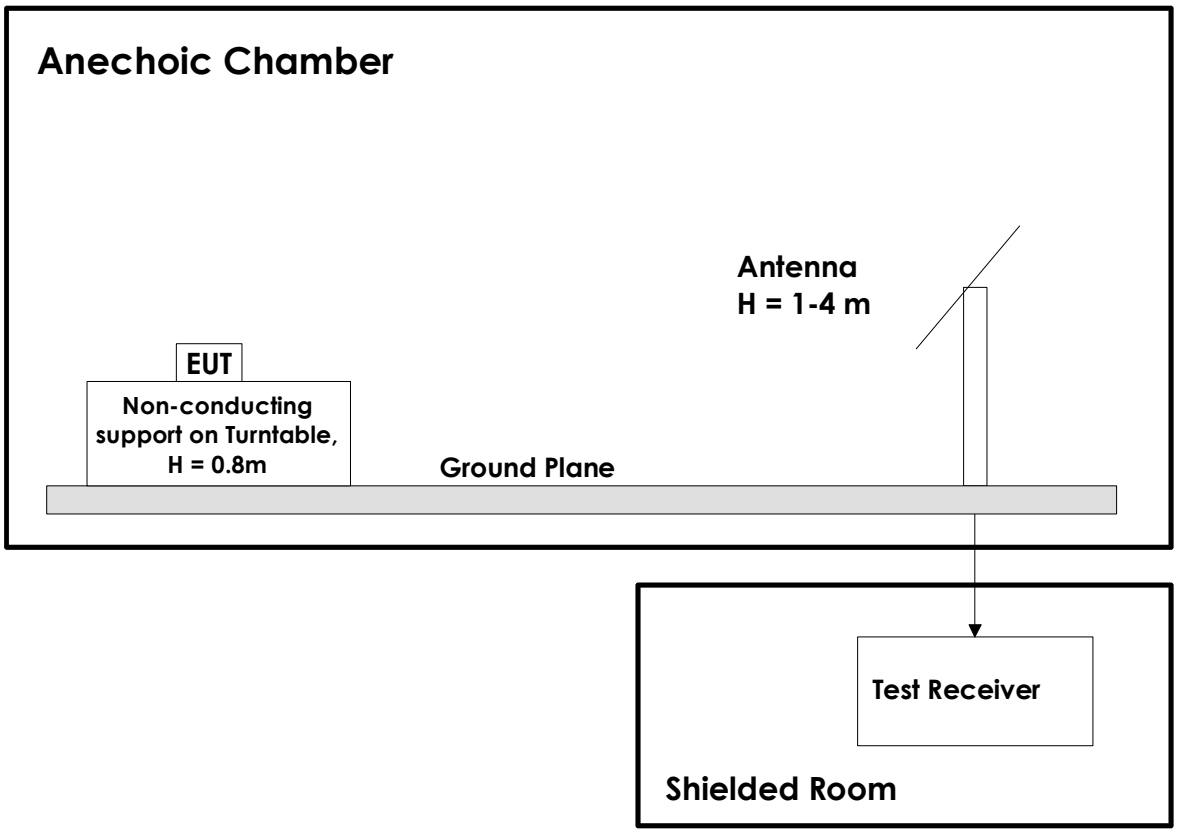
No.	Instrument/ ancillary	Type of instrument/ ancillary	Manufacturer	Ref. no.	Cal. Date	Cal. Due
1.	ESR	EMI Receiver	Rohde & Schwarz	LR1639	2016.11	2017.11
2.	FSW43	Spectrum Analyzer	Rohde & Schwarz	LR 1640	2016.11	2018.11
3.	HFH2-Z2	Active Loop antenna	Rohde & Schwarz	LR1660	2014.10	2017.10
4.	3115	Antenna horn	EMCO	LR 1330	2010.08	2017.08
5.	HK116	Biconical Antenna	Rohde & Schwarz	LR 1260	2013.12	2017.12
6.	HL223	Log Periodic antenna	Rohde & Schwarz	LR 1261	2013.12	2017.12
7.	643	Antenna Horn	Narda	LR 093	2009.10	2019.10
8.	PM7320X	Antenna Horn	Sivers Lab	LR 102	2009.10	2019.10
9.	DBF-520-20	Antenna Horn	Systron Donner	LR 100	2009.10	2019.10
10.	638	Antenna Horn	Narda	LR 1480	2009.10	2019.10
11.	4768-10	Attenuator	Narda	LR 1356	Cal b4 use	
12.	6HC3000/18000	Highpass Filter	Trilithic	LR 1614	Cal b4 use	
13.	8449B	Pre-amplifier	Hewlett Packard	LR 1322	2016.09	2017.09
14.	310N	Pre-amplifier	Sonoma	LR 1686	2016.05	2017.05
15.	Model 87 V	Multimeter	Fluke	LR 1597	2016.10	2018.10
16.	6812B	Power source	Agilent	LR 1515	2015.12.02	2017.12.02
17.	D001	DC power supply	Farnell	LT 5150	Cal b4 use	

6 BLOCK DIAGRAM

6.1 Power Line Conducted Emission



6.2 Test Site Radiated Emission



Revision history

Version	Date	Comment	Sign
00	2017.06.01	First version	gns