



Report No. 347031-01-002

FCC TEST REPORT / IC TEST REPORT

Product	Remote control	
Name and address of the applicant	Multiplex Modellsport GmbH & Co. KG Westliche Gewerbestr. 1 D – 75015 Bretten-Gölshausen (Germany)	
Name and address of the manufacturer	Multiplex Modellsport GmbH & Co. KG Westliche Gewerbestr. 1 D – 75015 Bretten-Gölshausen (Germany)	
Model	Cockpit SX9 Trinity	
Rating	3.3Vdc	
Trademark	MULTIPLEX	
Serial number	/	
Additional information	2.4 GHz FHSS Transceiver.	
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	
Report number	347031-01-002	
Tested in period	2018-02-08 - 2018-05-30	
Issue date	2018-11-16	
Name and address of the testing laboratory	Nemko GmbH & Co. KG Reetzstraße 58 D-76327 Pfinztal Tel.: + 49 (0) 7240 – 63 – 0 Fax: + 49 (0) 7240 – 63 – 11	 Bundesnetzagentur FCC No: 973501 IC OATS: 10921A-1
 Prepared by [Dipl.-Ing. M. Korný]  Approved by [Dipl.-Ing. P. Lukas]		

Template version: B

CONTENTS

1	INFORMATION	3
1.1	Test Item.....	3
1.2	Normal test conditions	4
1.3	Test Engineer(s)	4
1.4	Description of modification for Modification Filing	4
1.5	Family List Rational	4
1.6	Antenna Requirement.....	4
1.7	Worst-Case Configuration and Mode.....	4
1.8	Comments	4
2	TEST REPORT SUMMARY	5
2.1	General.....	5
2.2	Test Summary	6
3	TEST RESULTS.....	7
3.1	Power Line Conducted Emissions	7
3.2	Occupied Bandwidth.....	10
3.4	Minimum 6 dB Bandwidth	12
3.5	Peak Power Output.....	15
3.6	Conducted Emissions at Antenna Connector	19
3.7	Restricted Bands of operation	22
3.8	Spurious Emissions (Radiated)	23
3.9	Power Spectral Density (PSD).....	62
4	Measurement Uncertainty.....	65
5	LIST OF TEST EQUIPMENT	66
6	BLOCK DIAGRAM.....	67
6.1	Power Line Conducted Emission	67
6.2	Test Site Radiated Emission.....	67

1 INFORMATION

1.1 Test Item

Name :	Multiplex
FCC ID :	2APABCOCKPITSX
Industry Canada ID :	23810-COCKPITSX
Model/version :	Cockpit SX9 Trinity
Frequency Range :	2402 - 2479 MHz
Tunable Bands :	None
Number of Channels :	39
Operating Modes :	Transceiver
Type of Modulation :	FHSS
User Frequency Adjustment :	None
Output Power (radiated) :	91.2 mW
Type of Power Supply :	3.3 Vdc (LiFePo-Battery)
Antenna Connector :	None (PCB antenna)
Antenna Diversity Supported :	No
Desktop Charger :	Yes

Description of Test Item

The EUT is a remote-control transmitter for model planes. The transmitter is controlled by the main microcontroller. A pcb antenna is utilized. The device will communicate with a receiver in the model. Communication is bi-directional.

Theory of Operation

Operational description of the M-LINK „Spectrum Sharing Mechanism“.

M-LINK is a bidirectional FHSS-system hopping over 39 channels. The hopping sequence is generated during production by a random generator, so in every sequence each hopping frequency appears uniquely. The hopping channel separation is 2MHz.

1.2 Normal test conditions

Temperature: 20 - 26 °C
Relative humidity: 45 - 55 %
Normal test voltage: 3.3 Vdc (LiFePo-Battery)

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

1.3 Test Engineer(s)

Markus Korny

1.4 Description of modification for Modification Filing

Not applicable.

1.5 Family List Rational

Not Applicable.

1.6 Antenna Requirement

Is the antenna detachable?

☐ Yes ☒ No

If detachable, is the antenna connector non-standard?

☐ Yes ☐ No

Type of antenna connector: N/A

Ref. FCC §15.203

1.7 Worst-Case Configuration and Mode

Radiated Emissions was performed with the EUT set to transmit at the channel with the highest output power as worst-case scenario.

1.8 Comments

And the output level is set to maximum in the software.

The radiated measurements are tested on three axes.

Three fully charged batteries are used.

All ports were populated during spurious emission measurements.

2 TEST REPORT SUMMARY

2.1 General

All measurements are traceable 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 ANSI C63.10-2013.

Radiated tests were performed in a semi-anechoic shielded room ($f < 1$ GHz) and a fully-anechoic shielded room ($f > 1$ GHz) at a measuring distance of 3m.

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



THIS TEST REPORT APPLIES ONLY TO THE ITEM(S) AND CONFIGURATIONS TESTED.

Deviations from, additions to, or exclusions from the test specifications are described in "Summary of Test Data".

Nemko Group authorizes the above named company to reproduce this report provided it is reproduced in its entirety and for use by the company's employees only. Any reproduction of parts of this report requires approval in writing from Nemko Group.

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. Nemko Group accepts no responsibility for damages suffered by any third party as a result of decisions made or actions based on this report.

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)	N/A 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)	Complies ³
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)	N/A
Occupied Bandwidth / 99% OCC-BW	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 EUT charging via wall-plug adapter

- Only for information

3 TEST RESULTS

3.1 Power Line Conducted Emissions

Para. No.: 15.207 (a)/8.8

Test Performed By: Thomas Stein	Date of Test: 2018-02-08
---------------------------------	--------------------------

Measurement procedure: ANSI C63.4-2014 using 50 μ H/50 ohms LISN.

Test Results: Complies.

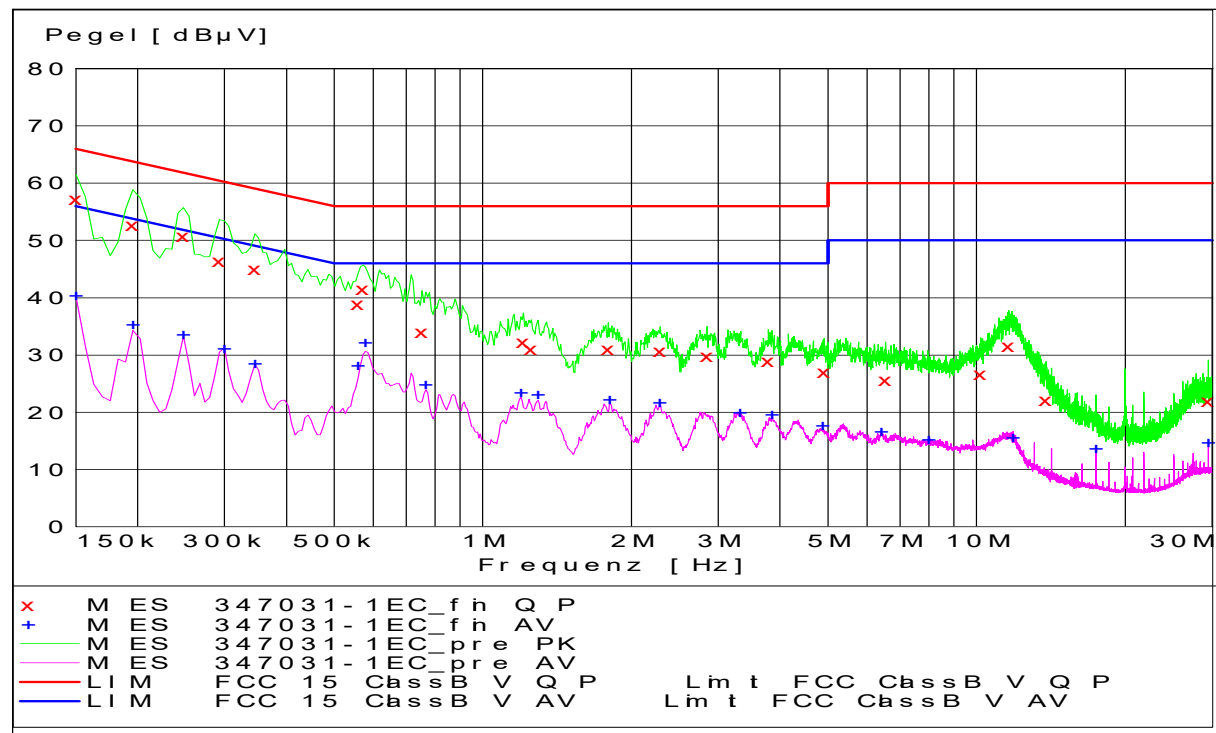
Measurement Data: See attached graph.

AC/DC adapter type: Peak Tech 6010D

Input voltage to AC/DC adapter: 115V/60Hz

Highest measured value (L1 and N):

Diagram



Final measurements QP with Quasi-Peak-Detector

Frequenz MHz	Pegel dBµV	Transd dB	Limit dBµV	Margin dB	Line	PE
0.150000	57.30	10.00	66.00	8.70	N	FLO
0.195500	52.80	10.00	63.80	11.00	N	FLO
0.247500	50.80	10.00	61.80	11.00	N	FLO
0.293000	46.40	10.00	60.40	14.10	N	FLO
0.345000	45.00	10.00	59.10	14.00	N	FLO
0.559500	38.90	10.00	56.00	17.10	N	FLO
0.572500	41.60	10.00	56.00	14.40	N	FLO
0.754500	34.00	10.00	56.00	22.00	N	FLO
1.209500	32.30	10.00	56.00	23.70	N	FLO
1.255000	31.10	10.00	56.00	24.90	N	FLO
1.794500	31.00	10.10	56.00	25.00	N	FLO
2.288500	30.80	10.10	56.00	25.20	N	FLO
2.847500	29.90	10.10	56.00	26.10	N	FLO
3.790000	29.00	10.20	56.00	27.00	N	FLO
4.914500	27.10	10.20	56.00	28.90	N	FLO
6.546000	25.70	10.30	60.00	34.30	N	FLO
10.192500	26.60	10.50	60.00	33.40	L1	FLO
11.635500	31.60	10.60	60.00	28.40	L1	FLO
13.832500	22.10	10.80	60.00	37.90	N	FLO
29.478000	22.00	10.90	60.00	38.00	N	FLO

Final measurements AV with Average-Detector

Frequenz MHz	Pegel dBµV	Transd dB	Limit dBµV	Margin dB	Line	PE
0.150000	40.30	10.00	56.00	15.70	N	FLO
0.195500	35.20	10.00	53.80	18.60	N	FLO
0.247500	33.50	10.00	51.80	18.40	N	FLO
0.299500	31.10	10.00	50.30	19.20	N	FLO
0.345000	28.50	10.00	49.10	20.50	N	FLO
0.559500	28.00	10.00	46.00	18.00	N	FLO
0.579000	32.10	10.00	46.00	13.90	N	FLO
0.767500	24.90	10.00	46.00	21.10	N	FLO
1.196500	23.50	10.00	46.00	22.50	N	FLO
1.294000	23.00	10.00	46.00	23.00	N	FLO
1.807500	22.10	10.10	46.00	23.90	N	FLO
2.282000	21.70	10.10	46.00	24.30	N	FLO
3.322000	19.90	10.20	46.00	26.10	N	FLO
3.855000	19.60	10.20	46.00	26.40	N	FLO
4.882000	17.70	10.20	46.00	28.30	N	FLO
6.403000	16.60	10.30	50.00	33.40	N	FLO
7.995500	15.20	10.40	50.00	34.80	N	FLO
11.863000	15.60	10.60	50.00	34.40	N	FLO
17.466000	13.70	11.00	50.00	36.30	N	FLO
29.471500	14.60	10.90	50.00	35.40	N	FLO

3.2 Occupied Bandwidth

Para. No.: 15.247 (a)(1)(iii)

Para. No.: 6.6 RSS-Gen

Test Performed By: Markus Korny

Date of Test: 2018-05-30

Test Results: Complies

Measurement Data:

Number of RF Channels in use:	39
Channel Center Frequencies:	The channels are centered at each full MHz from 2402 to 2479 MHz
99 % Bandwidth (OBW)	1165 kHz

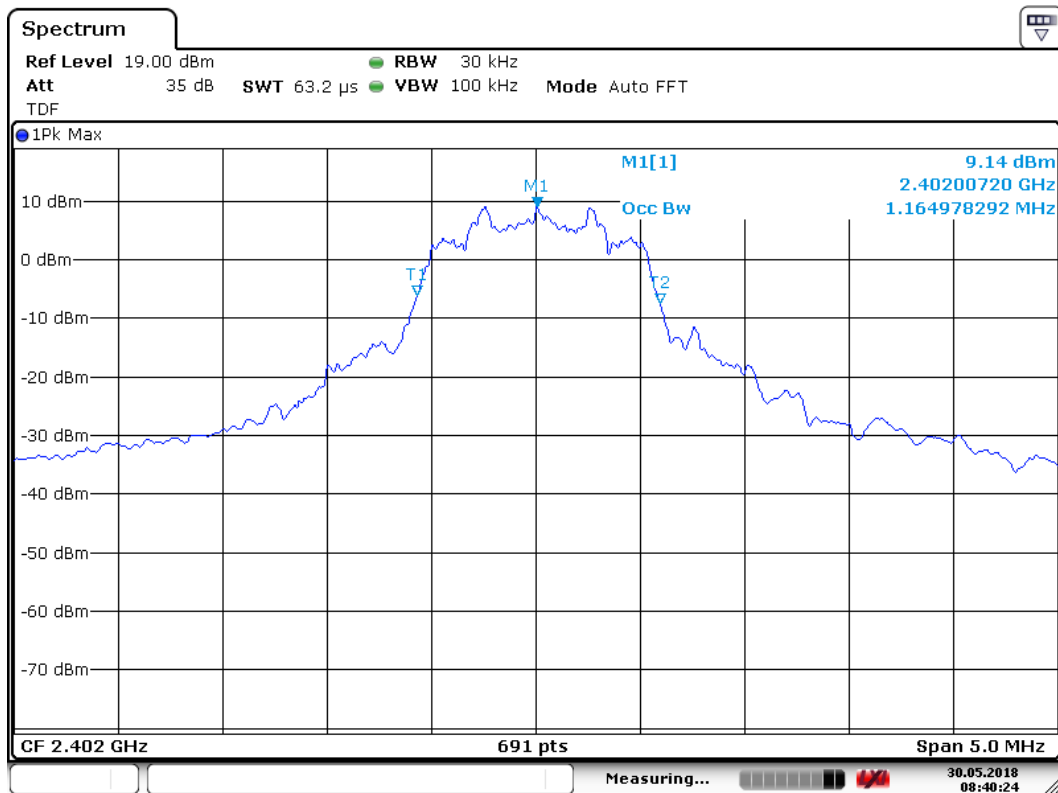
Fully charged battery is used

Requirements:

Frequency hopping systems in the 2400 – 2483.5 MHz band shall use at least 15 non-overlapping channels.
No requirements for bandwidth for this frequency band.

No requirements for Digital Transmission Systems.

Reported for information only



Date: 30.MAY.2018 08:40:25

2402 MHz – 99% OCC BW

3.4 Minimum 6 dB Bandwidth

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

Test Performed By: Markus Korny	Date of Test: 2018-05-30
---------------------------------	--------------------------

Test Results: Complies

Measurement Data:

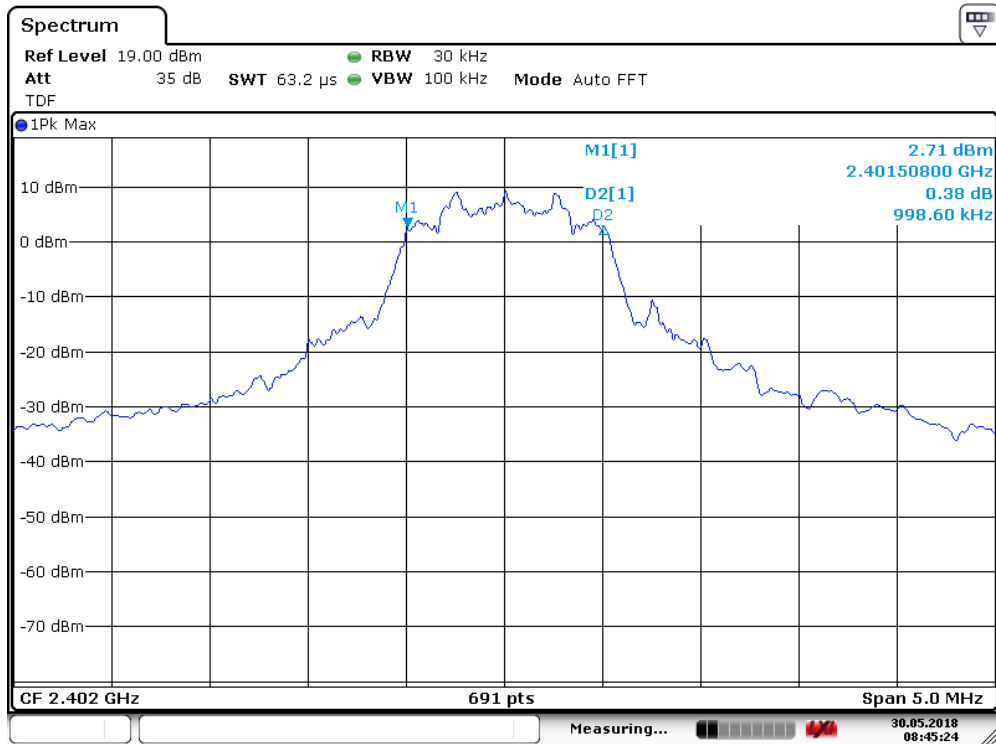
Measured 6 dB Bandwidth (kHz)		
2402 MHz, Ch 2	2440 MHz, Ch 40	2479 MHz, Ch 79
998.6	962.4	933.4

Fully charged battery is used

Requirements:

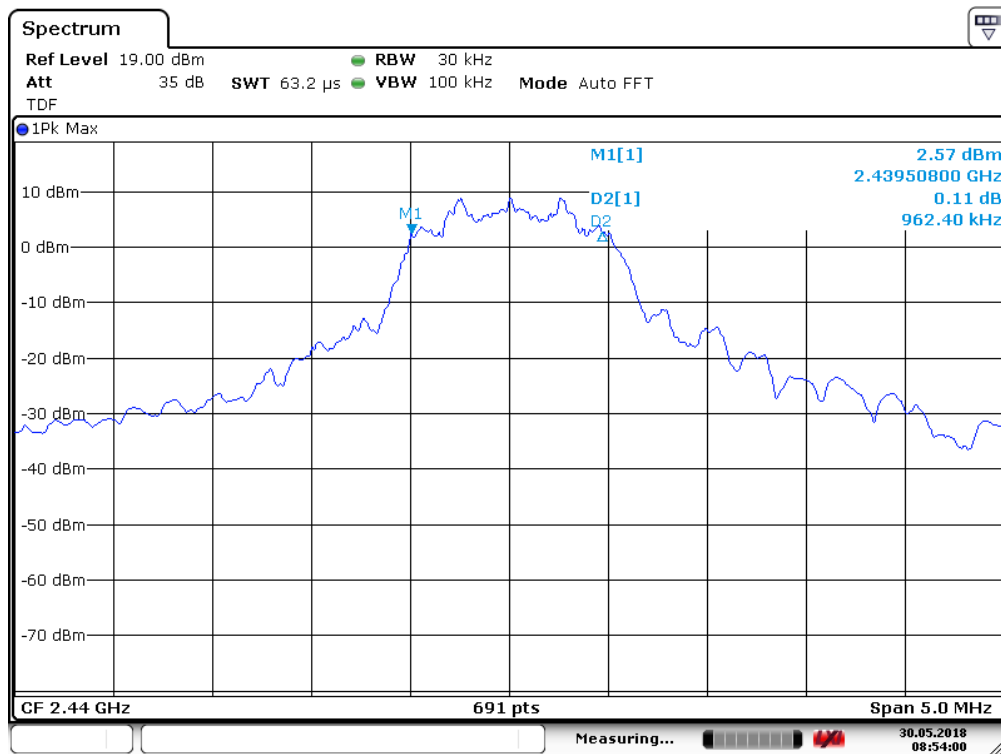
For Digital Transmission Systems in the 2400-2483.5 MHz band the minimum 6 dB bandwidth shall be at least 500 KHz.

No requirements for Frequency Hopping Systems.



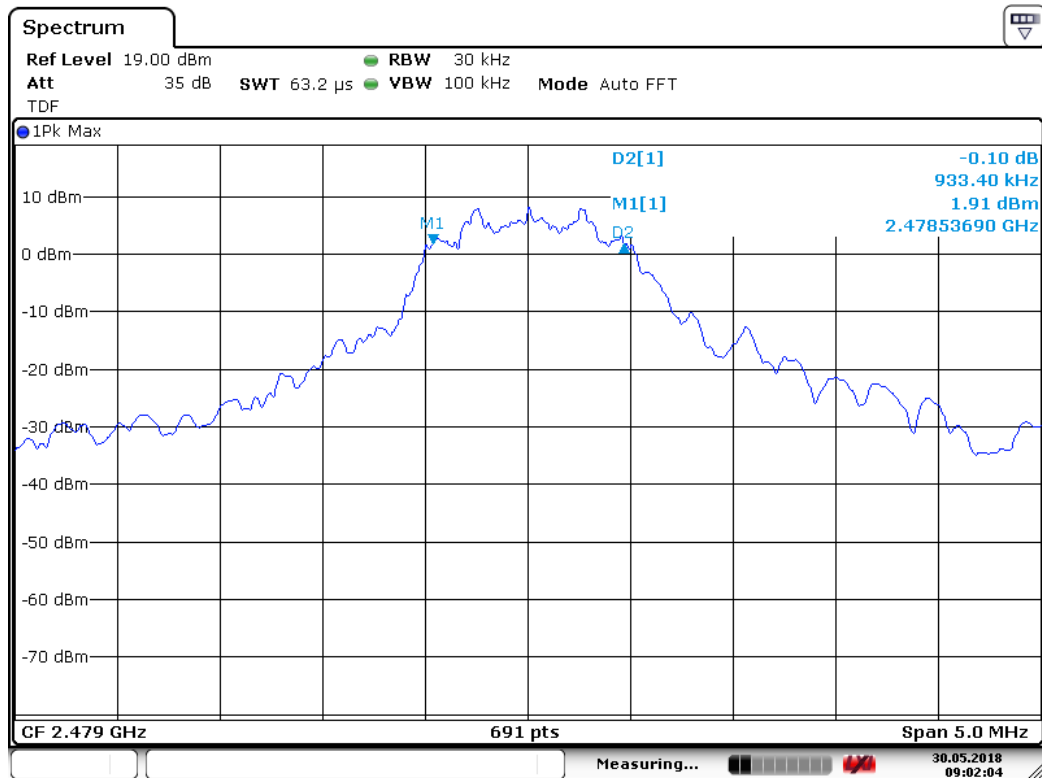
Date: 30.MAY.2018 08:45:24

Ch2402MHz, 6 dB BW



Date: 30.MAY.2018 08:54:00

Ch2440MHz, 6 dB BW



Date: 30.MAY.2018 09:02:04

Ch2479MHz, 6 dB BW

3.5 Peak Power Output

Para. No.: 15.247 (b)

Test Performed By: Markus Korny	Date of Test: 2018-03-21, 2018-05-30
---------------------------------	--------------------------------------

Test Results: Complies

Measurement Data:

RF channel	2402 MHz	2440 MHz	2479 MHz
Measured Maxium Field strength (dBµV/m) – HP	114.83	112.71	111.28
Calc. Radiated Power (dBm)	19.60	17.48	16.05
Calc. Radiated Power (mW)	91.23	55.99	40.28
Measured Conducted Power (dBm)	14.49	14.24	13.55
Measured Conducted Power (mW)	28.12	26.55	22.65
Calculated Antenna Gain (dBi)	3.0	1.1	0.4

Antenna gain = $10 \cdot \log(\text{EIRP} / \text{Conducted power})$ 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 XY 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:

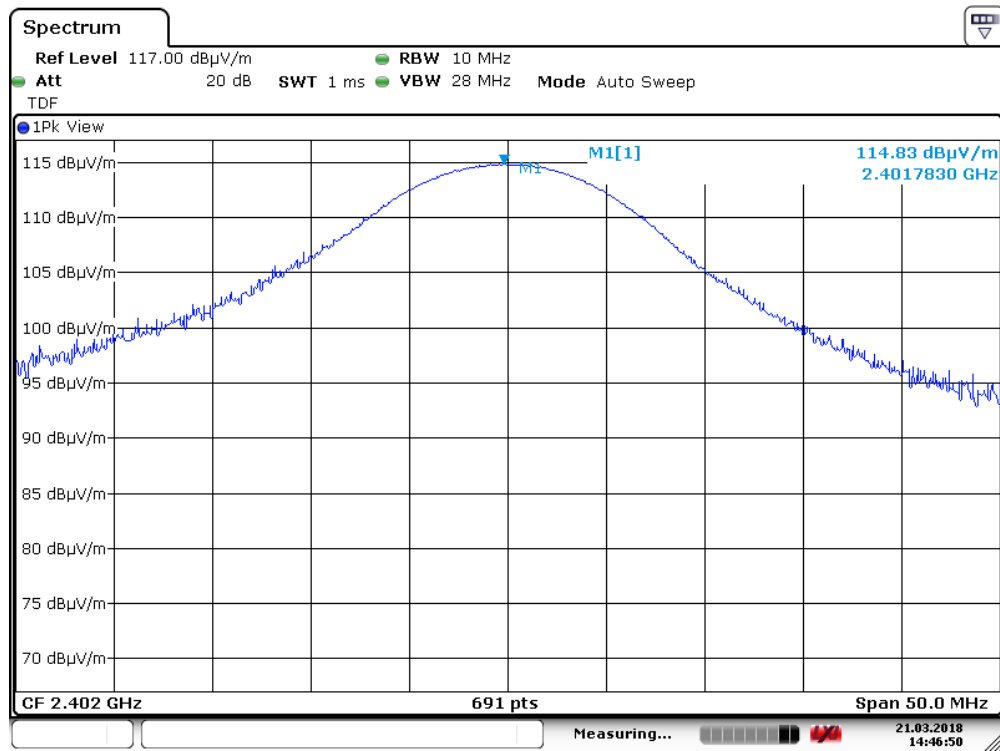
The maximum peak output power shall not exceed the following limits:

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

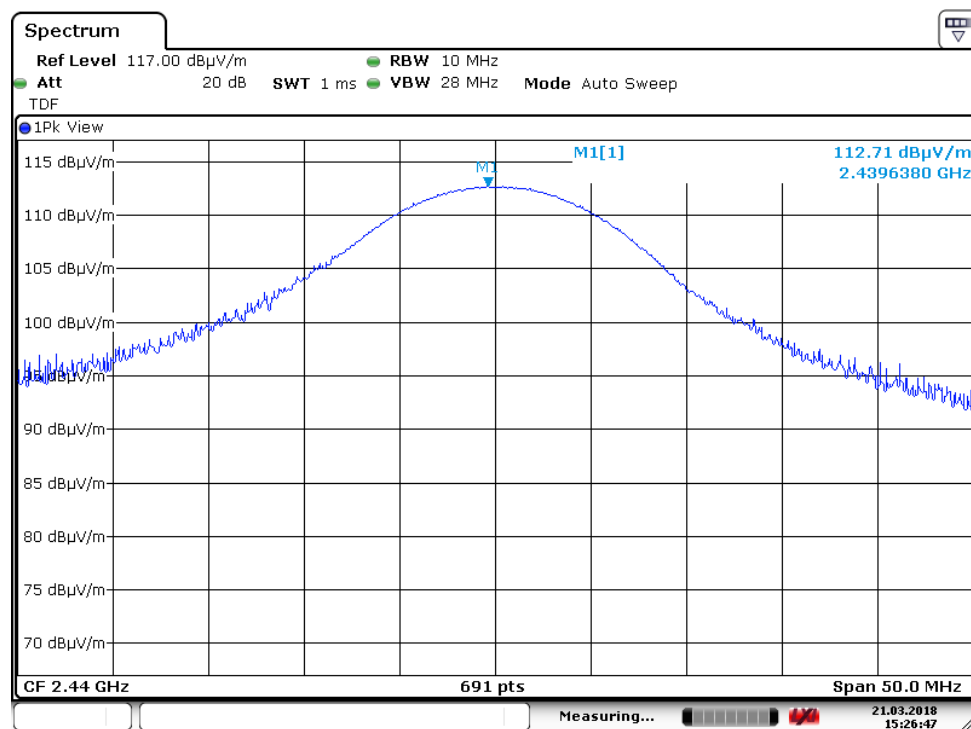
For Digital Transmission Systems in the 2400 - 2483.5 MHz band: 1 Watt

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.



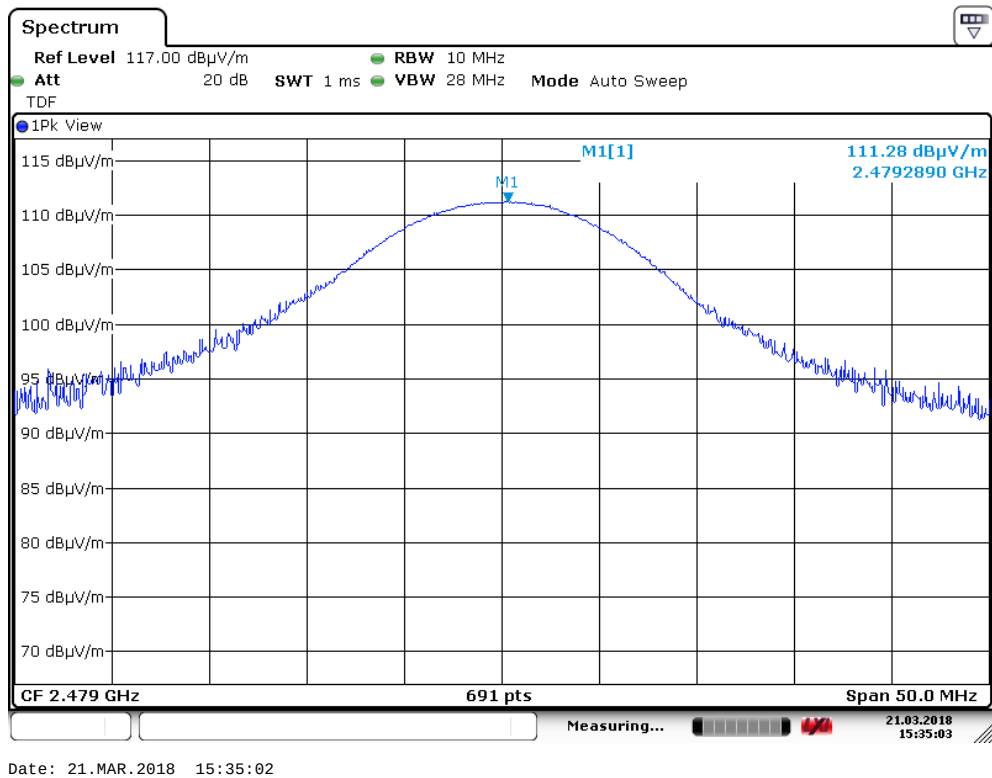
Date: 21.MAR.2018 14:46:49

Radiated field strength, HP, 2402 MHz

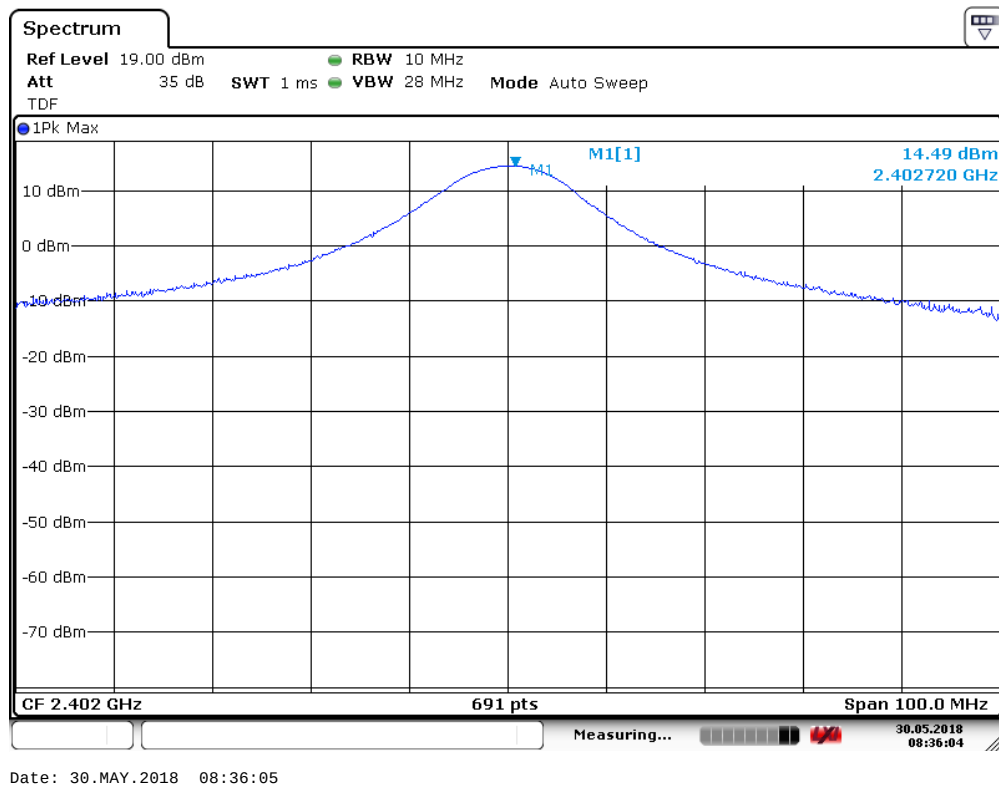


Date: 21.MAR.2018 15:26:47

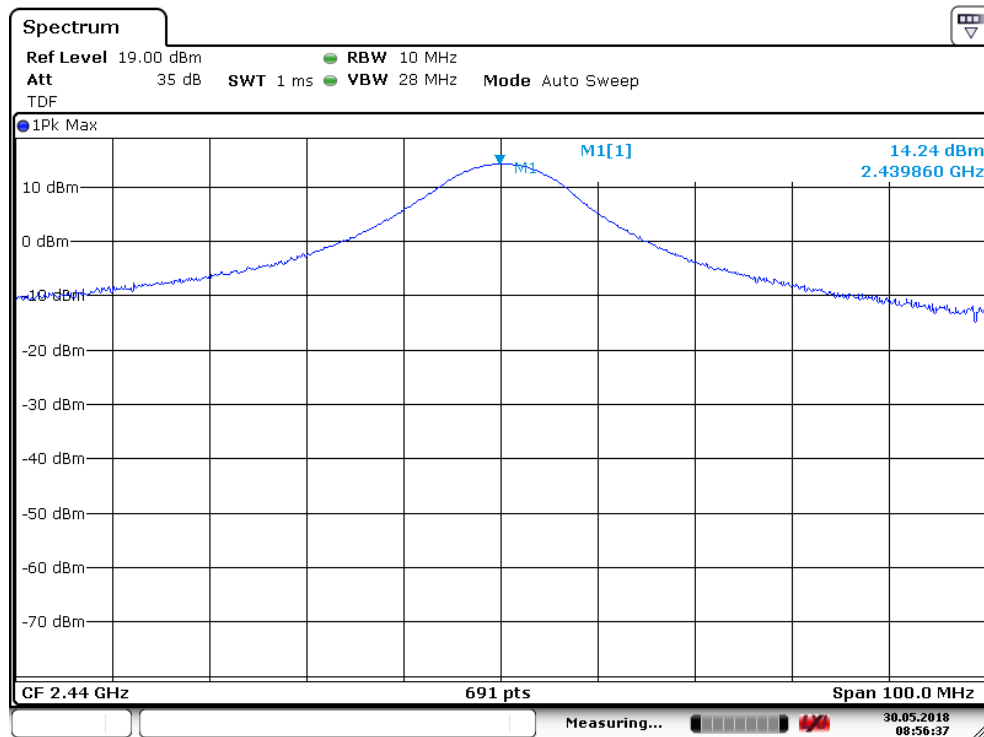
Radiated field strength, HP, 2440 MHz



Radiated field strength, HP, 2479 MHz

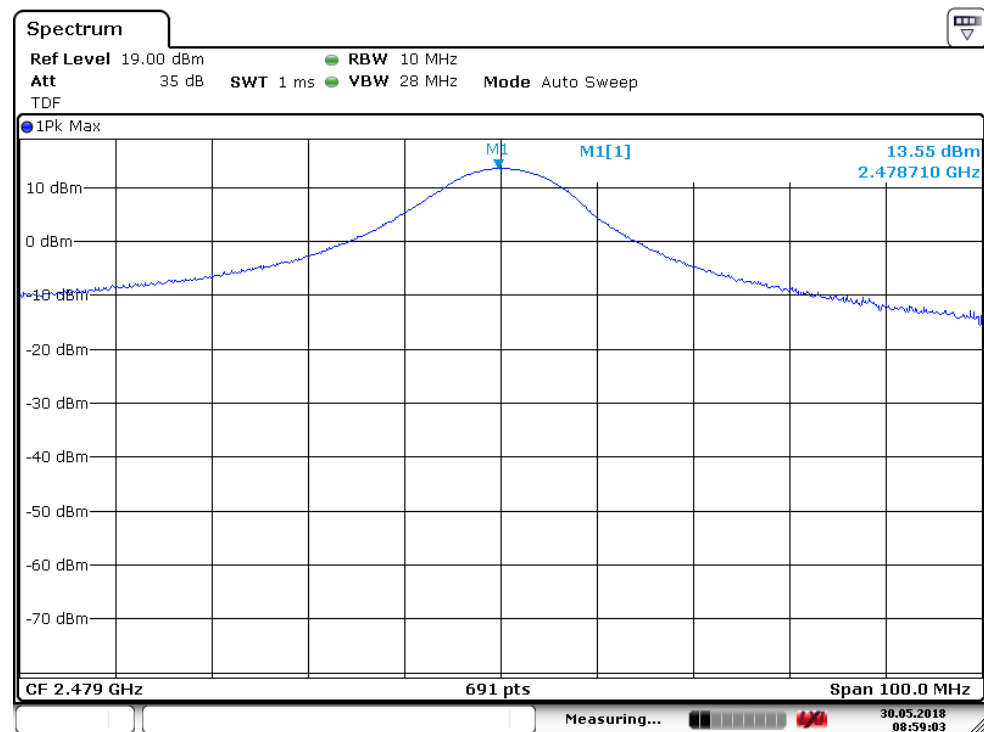


Conducted power – 2402MHz



Date: 30.MAY.2018 08:56:38

Conducted power – 2440MHz



Date: 30.MAY.2018 08:59:04

Conducted power – 2479MHz

3.6 Conducted Emissions at Antenna Connector

Para. No.: 15.247 (d)

Test Performed By: Markus Korny	Date of Test: 2018-05-30
---------------------------------	--------------------------

Test Results: Complies

RF conducted power to 25 GHz see attached plots.

Maximum RF level outside operating band:

RF ch 2402MHz: 60 dB/C, margin >30 dB

RF ch 2440MHz: 61 dB/C, margin >30 dB

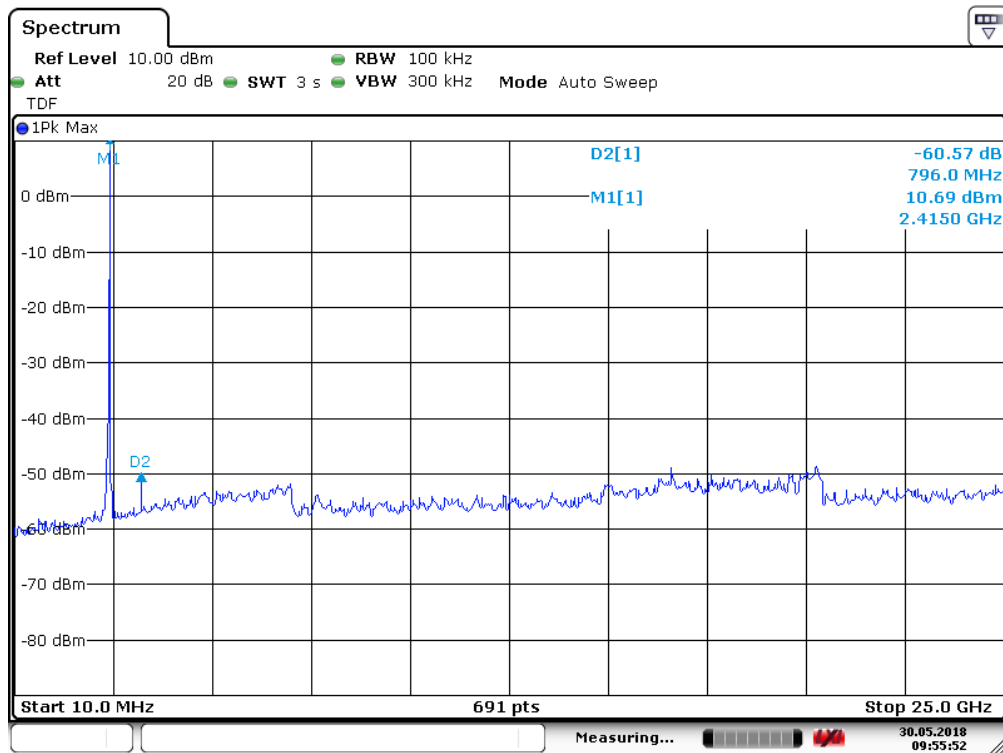
RF ch 2479MHz: 60 dB/C, margin >30 dB

Limit

Peak measurement	RMS averaging
20 dBc or more in 100 kHz bandwidth	30 dBc or more in 100 kHz bandwidth

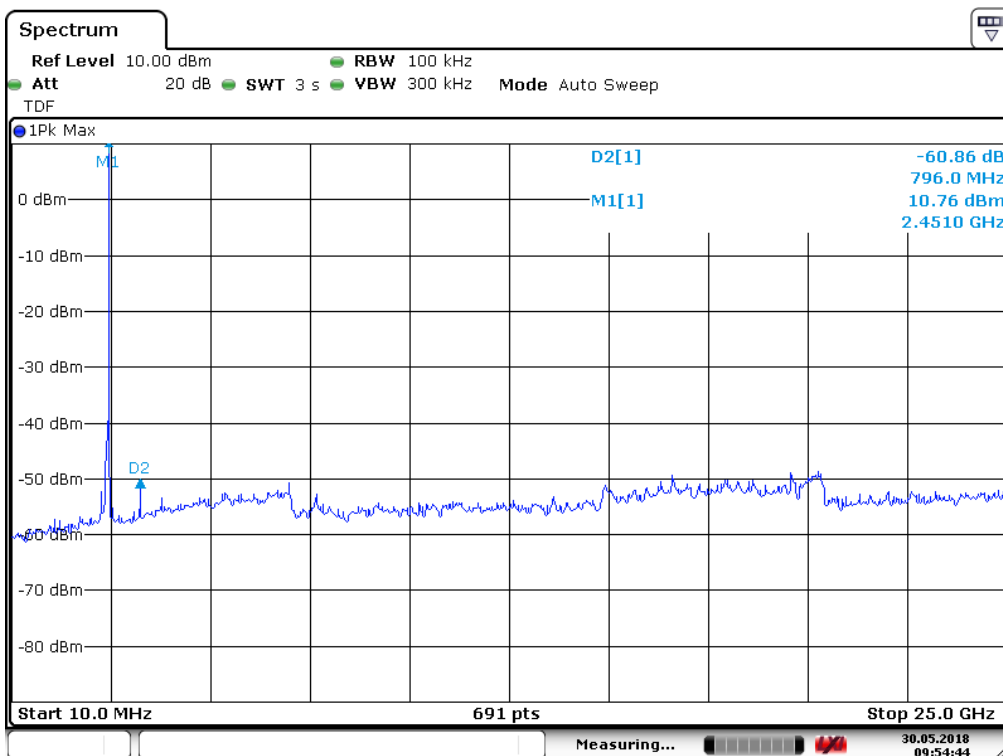
Detector type shall be the same as used for measuring Output Power.

Attenuation below the general limits specified in part 15.209(a) is not required.



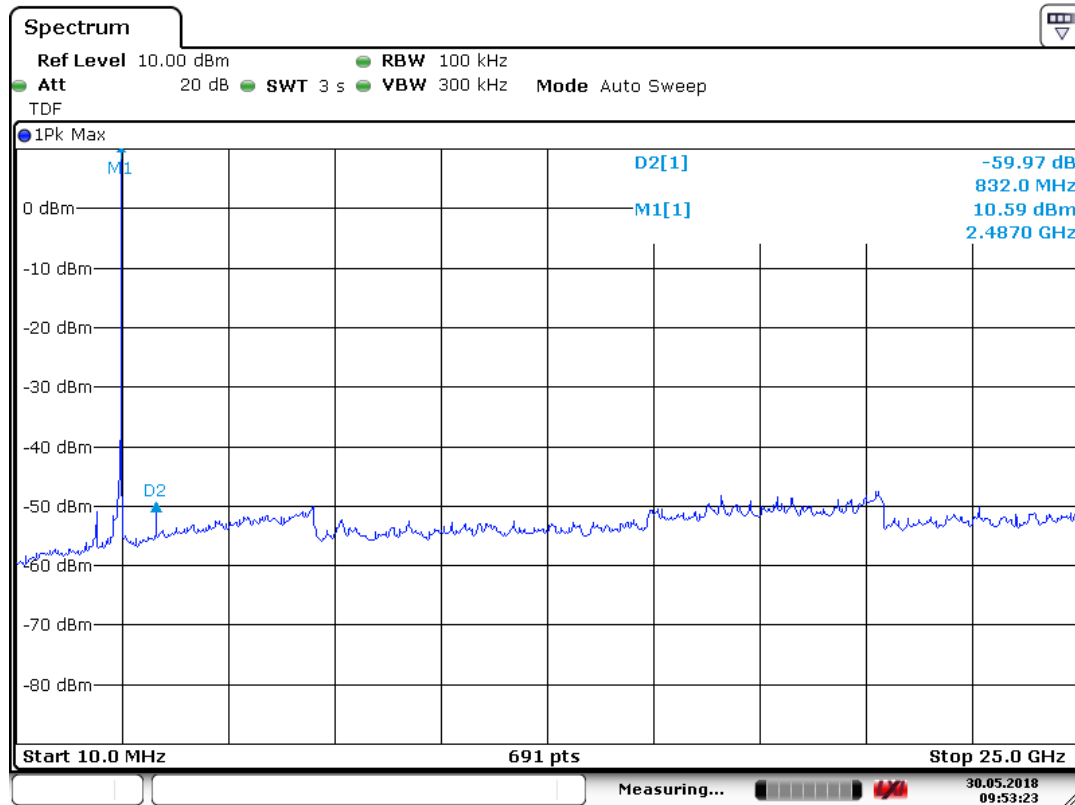
Date: 30.MAY.2018 09:55:53

Conductd spurious emission 10MHz – 25GHz - ch2402MHz



Date: 30.MAY.2018 09:54:45

Conductd spurious emission 10MHz – 25GHz - ch2440MHz



Date: 30.MAY.2018 09:53:23

Conducted spurious emission 10MHz – 25GHz - ch2479MHz

3.7 Restricted Bands of operation

Restricted Bands of operation for FCC and ISSED are defined in FCC Part 15.205 and ISSED RSS-GEN, Issue 4 clause 8.10.

Generally, no fundamentals are allowed in the restricted bands and all emissions must comply with the limits in FCC 15.209 or RSS-GEN, Issue 4, clause 8.9.

FCC (MHz)	ISED (MHz)	FCC (GHz)	ISED (GHz)
0.090-0.110		0.96-1.24 1.3-1.427	0.96-1.427
0.495-0.505		1.435-1.6265	
2.1735-2.1905		1.6455-1.6465	
	3.020-3.026	1.660-1.710	
4.125-4.128		1.7188-1.7222	
4.17725-4.17775		2.2-2.3	
4.20725-4.20775		2.31-2.39	
	5.677-5.683	2.4835-2.5	
6.215-6.218		2.69-2.9	2.655-2.9
6.26775-6.26825		3.26-3.267	
6.31175-6.31225		3.332-3.339	
8.291-8.294		3.3458-3.358	
8.362-8.366		3.6-4.4	3.5-4.4
8.37625-8.38675		4.5-5.15	
8.41425-8.41475		5.35-5.46	
12.29-12.293		7.25-7.75	
12.51975-12.52025		8.025-8.5	
12.57675-12.57725		9.0-9.2	
13.36-13.41		9.3-9.5	
16.42-16.423		10.6-12.7	
16.69475-16.69525		13.25-13.4	
16.80425-16.80475		14.47-14.5	
25.5-25.67		15.35-16.2	
37.5-38.25		17.7-21.4	
73-74.6		22.01-23.12	
74.8-75.2		23.6-24.0	
108-121.94 123-138	108-138	31.2-31.8	
149.9-150.05		36.43-36.5	
156.52475-156.52525		Above 38.6	
156.7-156.9			
162.0125-167.17			
167.72-173.2			
240-285			
322-335.4			
399.9-410			
608-614			

Frequencies in **Bold** text are specific for FCC or ISSED, all other frequencies are common.

3.8 Spurious Emissions (Radiated)

Para. No.: 15.247 (c)

Test Performed By: Markus Korny	Date of Test: 2018-03-21
---------------------------------	--------------------------

Test Results: Complies

Band-edge, @3m

Frequency	Measured Field Strength @3m, dBμV/m	Detector	Limit dBμV/m	Margin dB
2.39 GHz	55.68	PK	74	18.32
	35.68 *)	AV	54	18.32
2.4835 GHz	61.78	PK	74	12.22
	41.78 **)	AV	54	12.22

*) Ch 2.390GHz: 55.68dBμV/m – 20 dB=35.68 dBμV/m

**) Ch 2.4835GHz: 61.78dBμV/m – 20 dB=41.78 dBμV/m

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

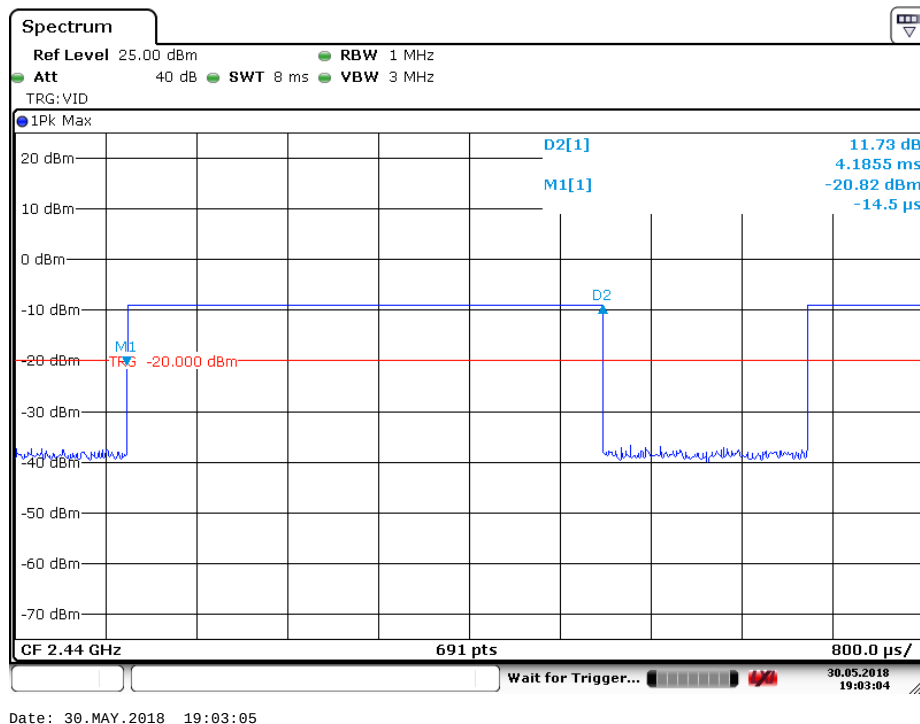
See attached plots.

Duty Cycle Correction Factor Calculation:

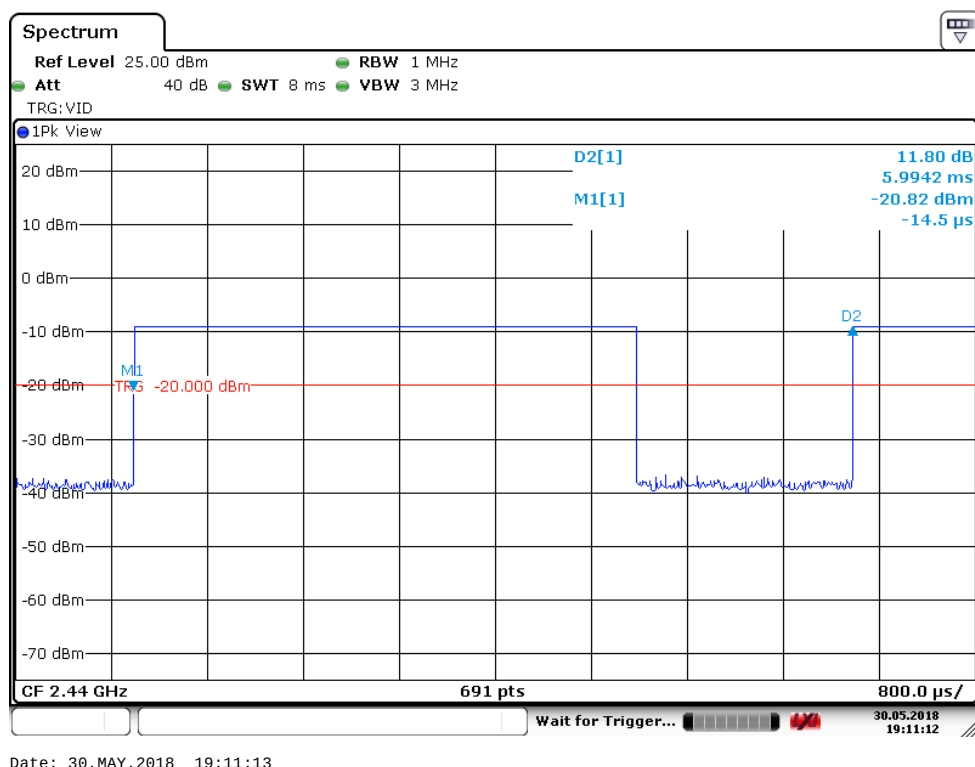
Duty Cycle = On Time / (Period * Number of Channels) = 4.18 ms / (6 ms * 39) = 0.0179

Duty Cycle Correction factor = -20 x log (Duty Cycle) = 34.9 dB

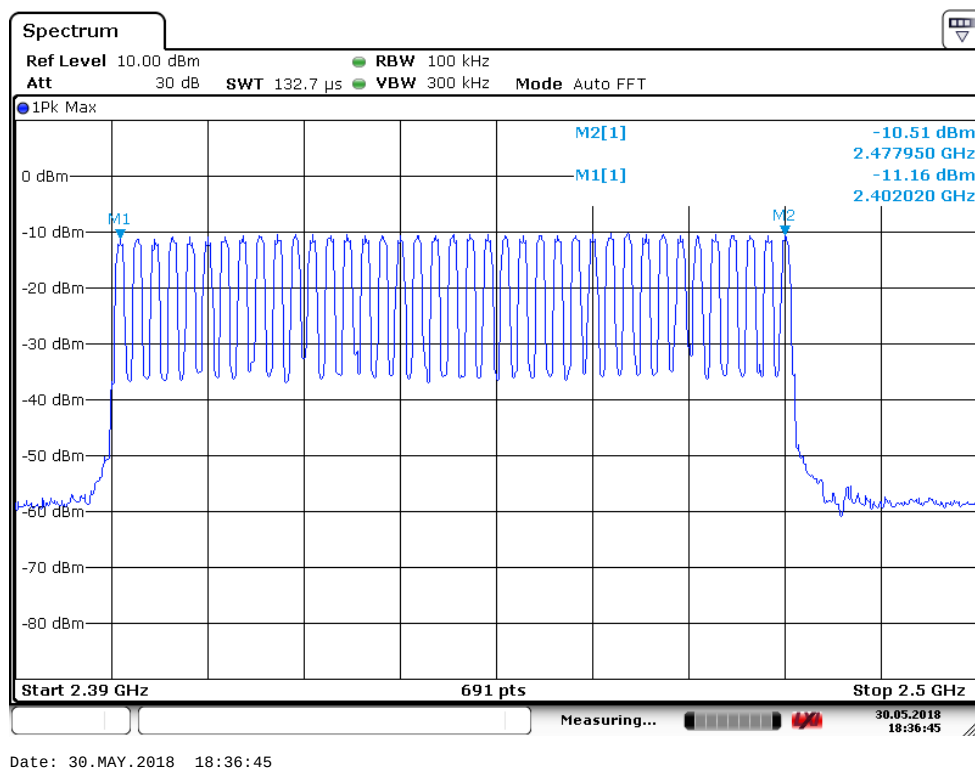
Maximum allowed Duty Cycle Correction: 20 dB



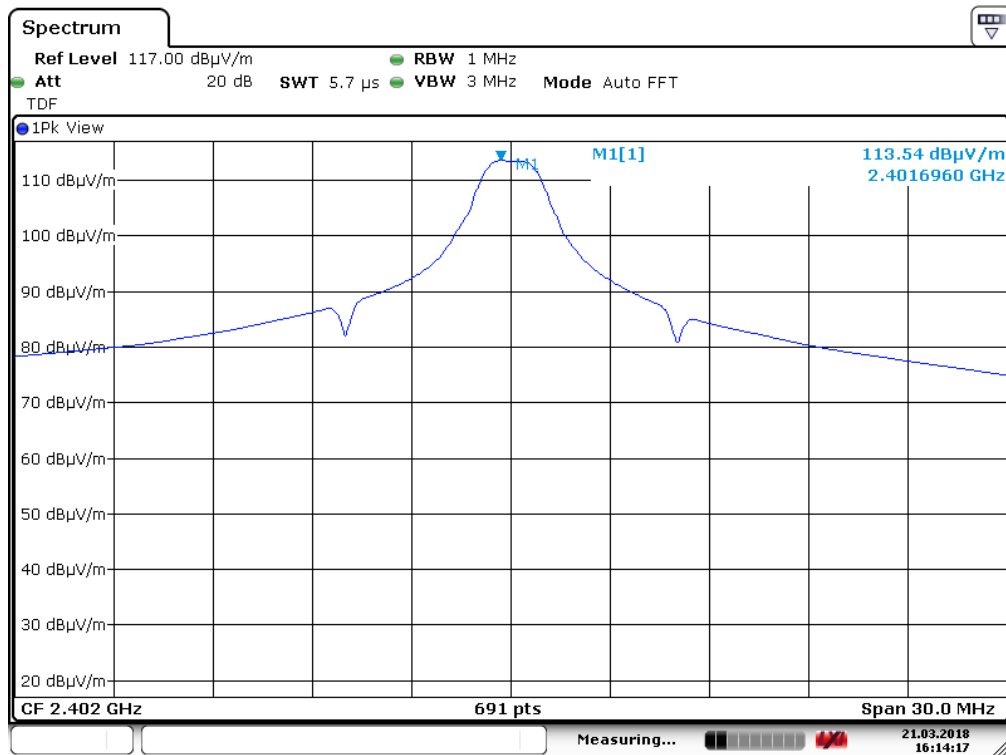
Burst length



Sequence time

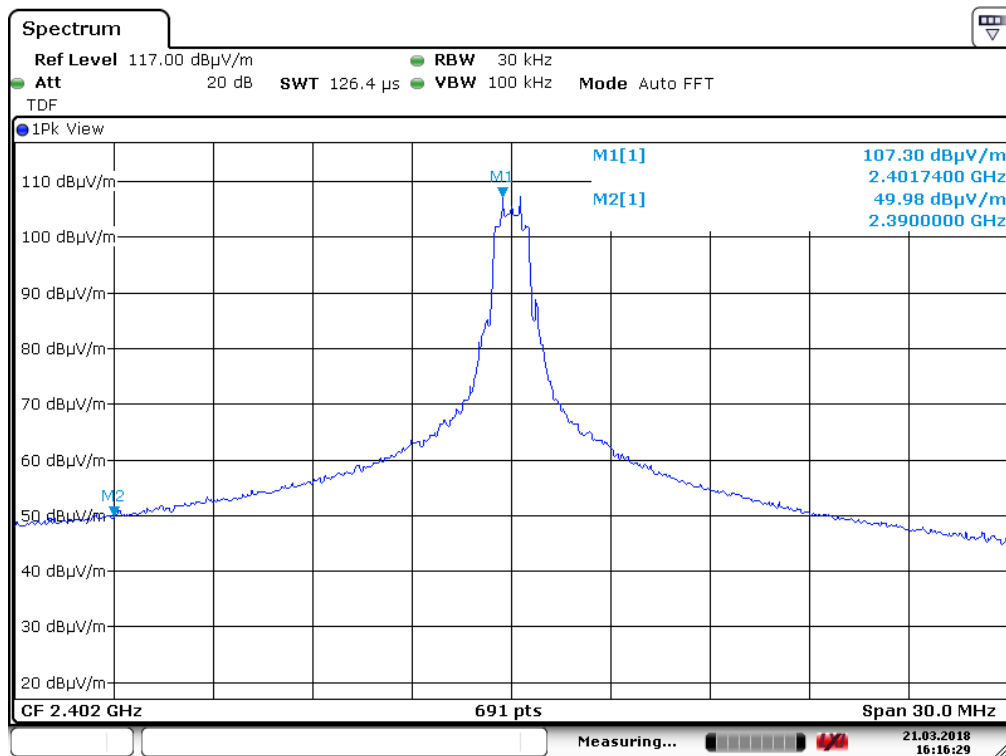


Hopping channels



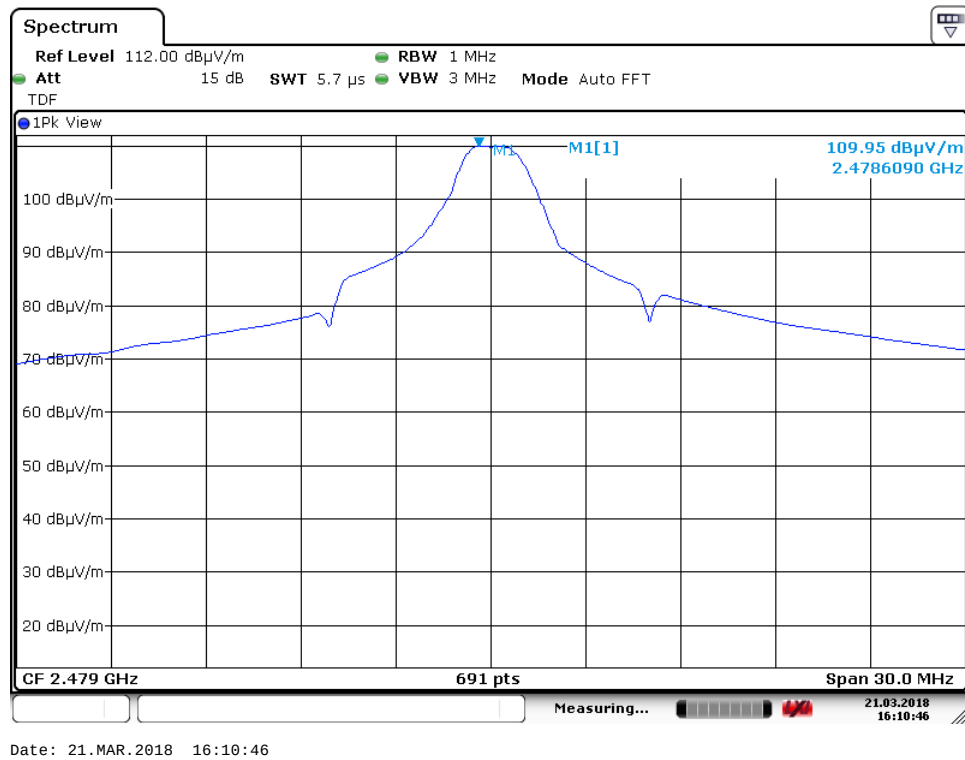
Date: 21.MAR.2018 16:14:17

Max field strength 2390 MHz

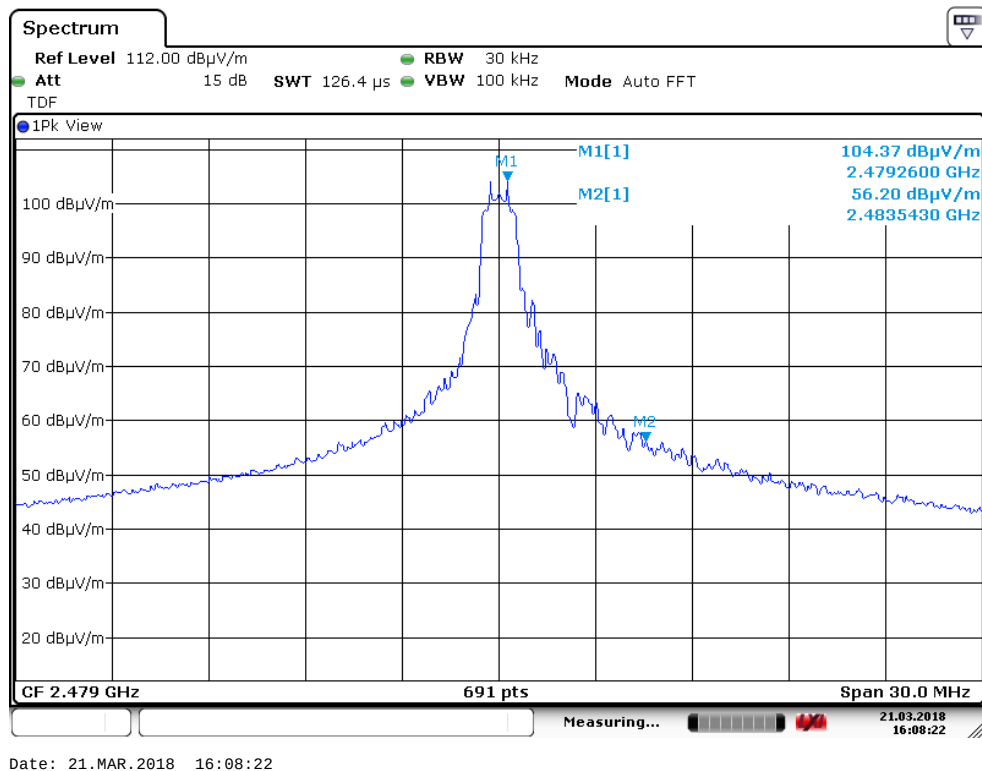


Date: 21.MAR.2018 16:16:29

Marker Delta, 2390 MHz, Peak Detector



Max field strength 2483.5 MHz



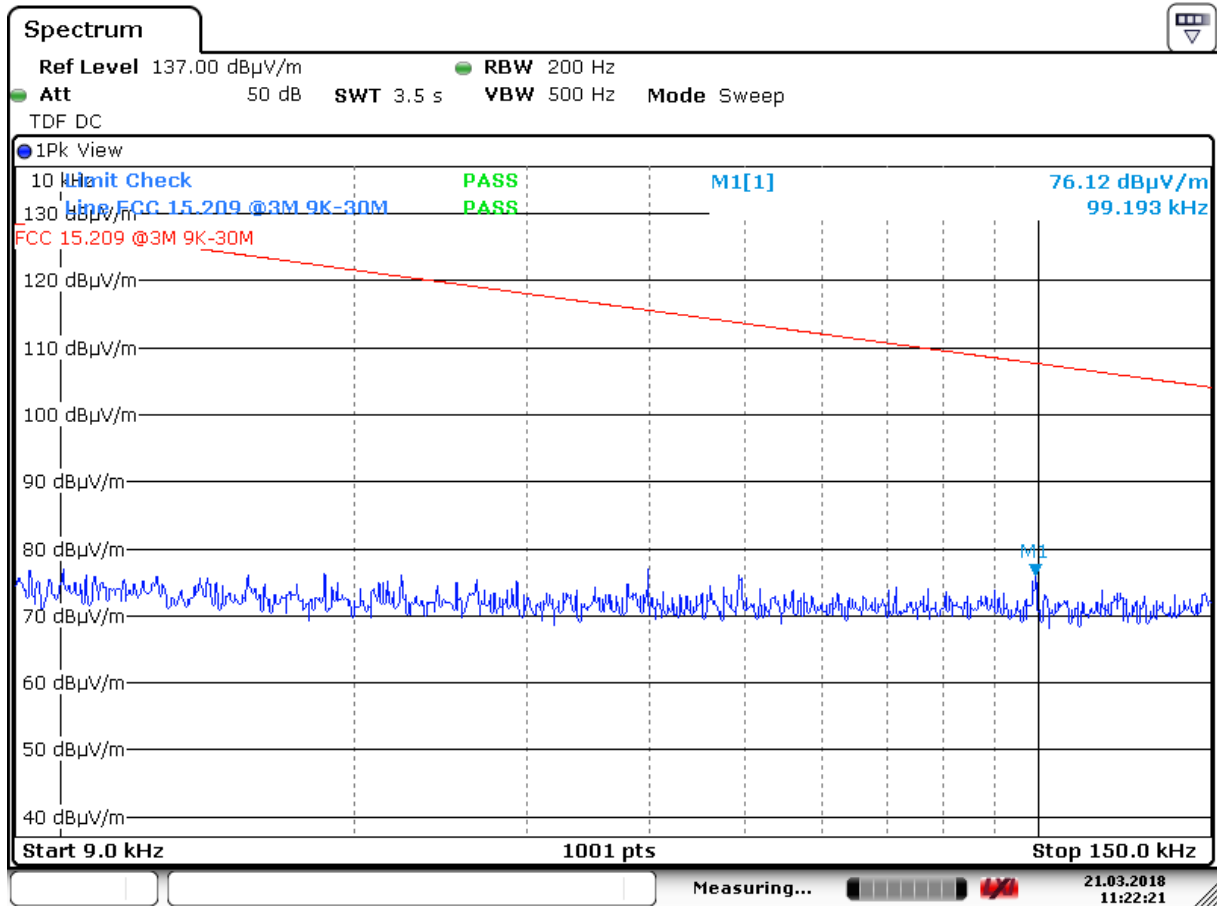
Marker Delta, 2483.5 MHz, Peak Detector

Radiated emissions 10 kHz-30 MHz.

Measuring distance 3 m, measured with Peak detector.

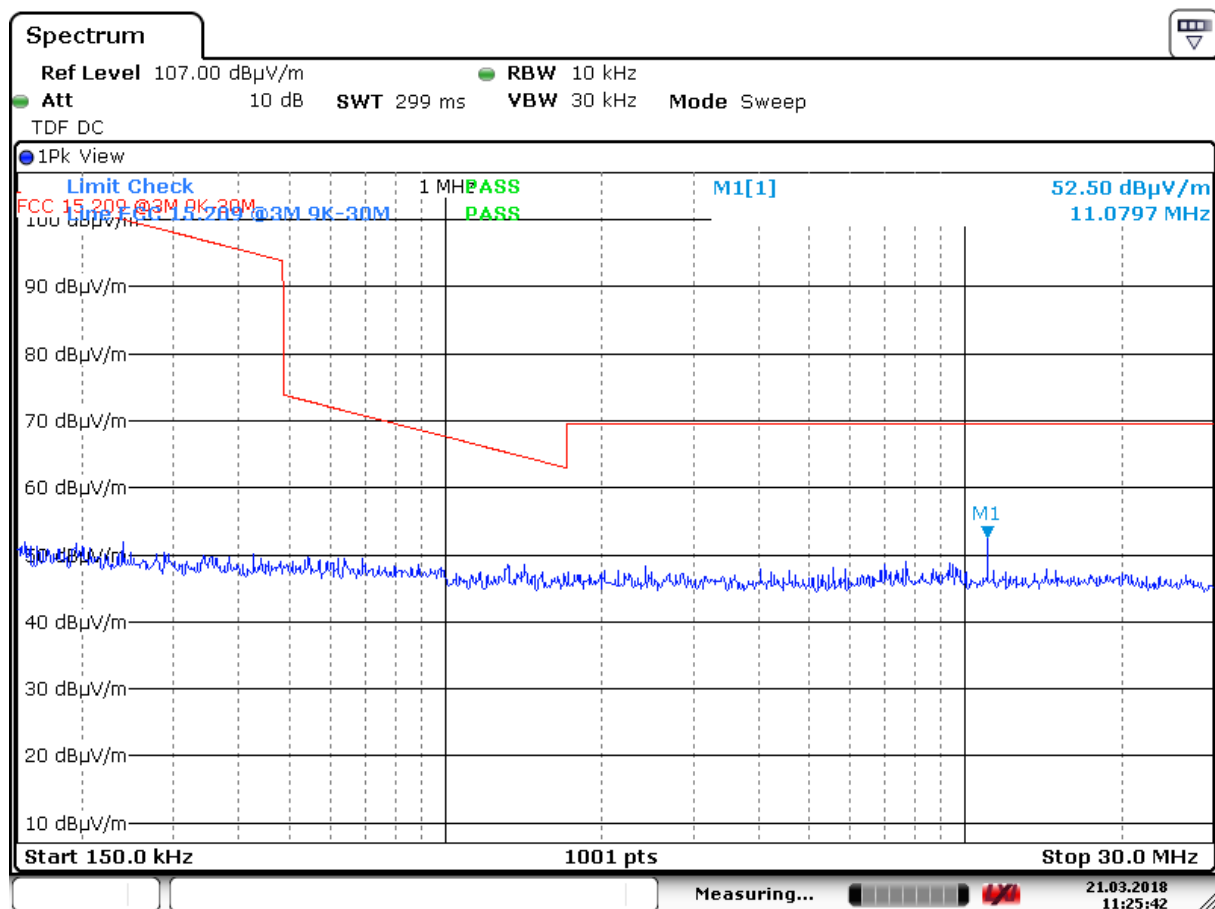
No component detected, see attached graph.

Limit is converted to 3 m using 40 dB/decade according to 15.31 (f) (2).



Date: 21.MAR.2018 11:22:21

Radiated Emissions, 9 kHz – 150 kHz @3m



Date: 21.MAR.2018 11:25:42

Radiated Emissions, 150 kHz - 30MHz @3m

Radiated emission 30 – 1000 MHz.

Detector: Quasi-Peak

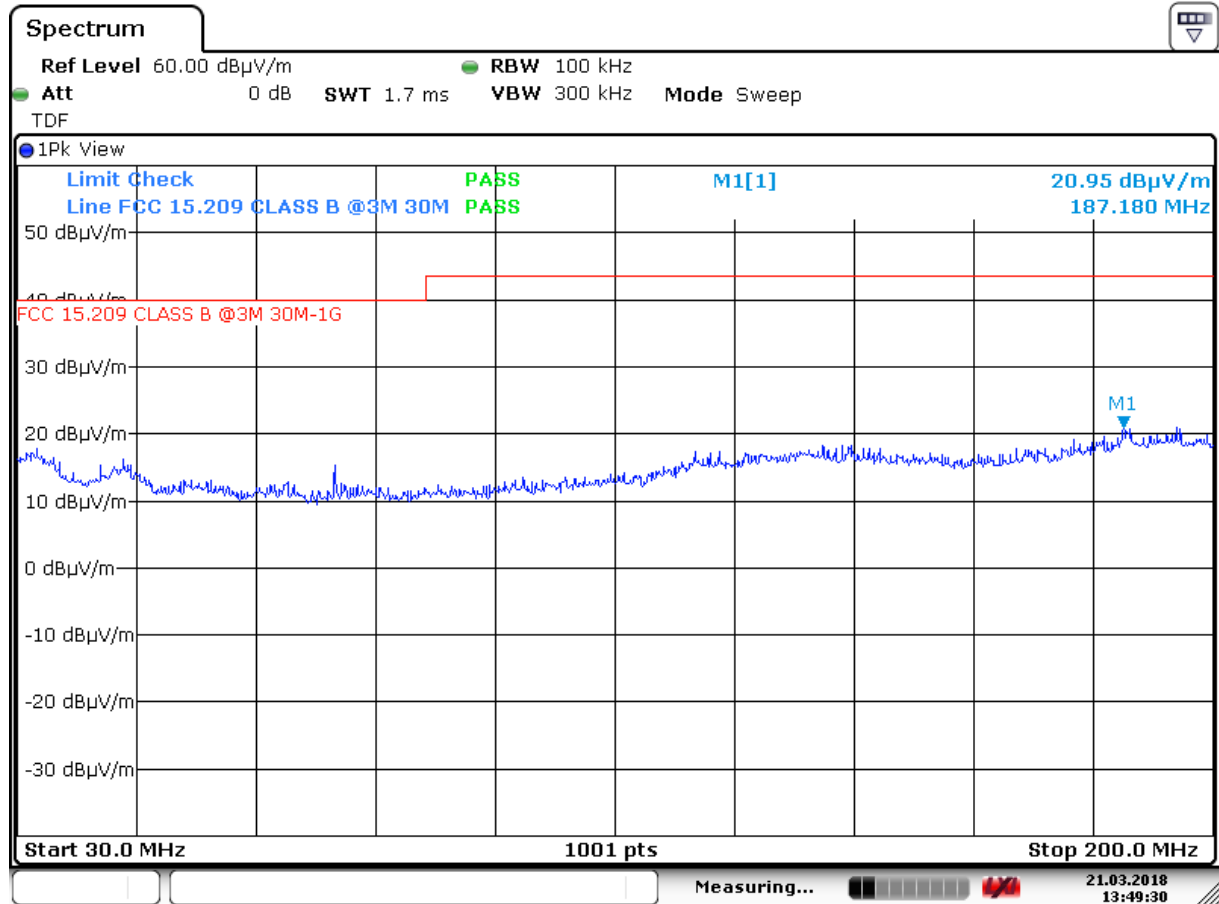
Measuring distance 3 m.

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

See attached graphs.

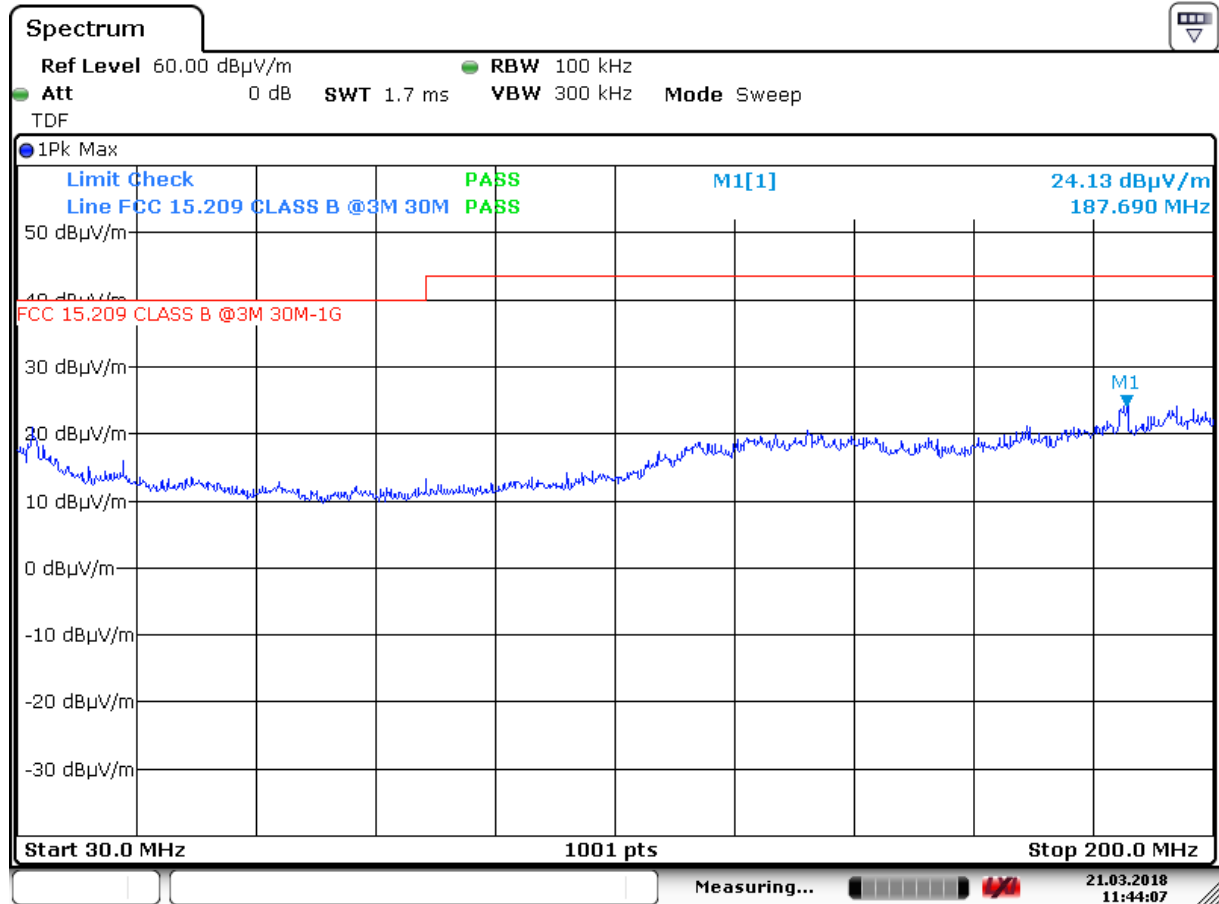
Requirements/Limit

FCC	Part 15.209 @ frequencies defined in §15.205	
ISED	RSS-GEN Issue 4, Clause 8.9 @ frequencies defined in clause 8.10	
	Radiated emission limit @3 meters	
Frequency (MHz)	Quasi Peak (μV/m)	Quasi Peak (dBμV/m)
30 – 88	100	40.0
88 – 216	150	43.5
216 – 960	200	46.0
Above 960	500	54.0



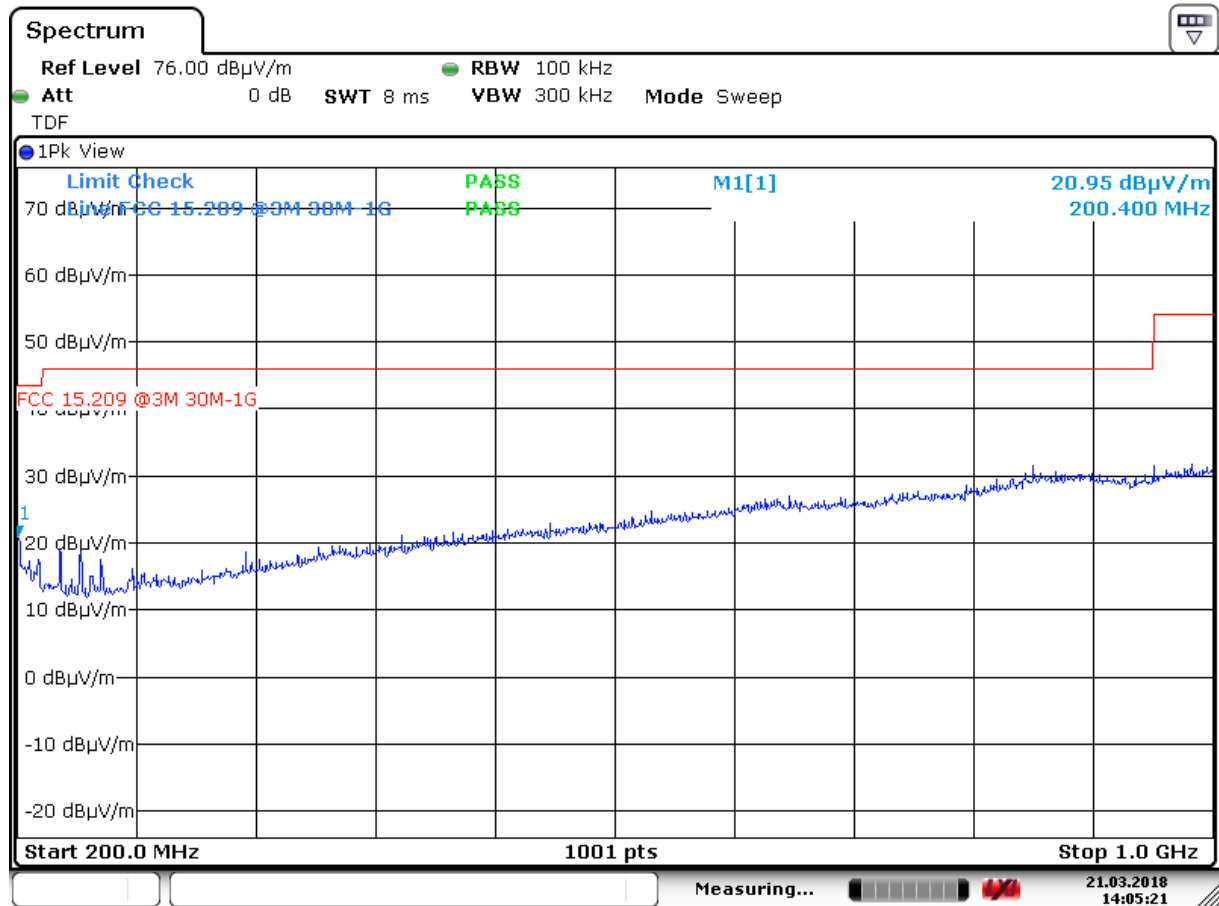
Date: 21.MAR.2018 13:49:30

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



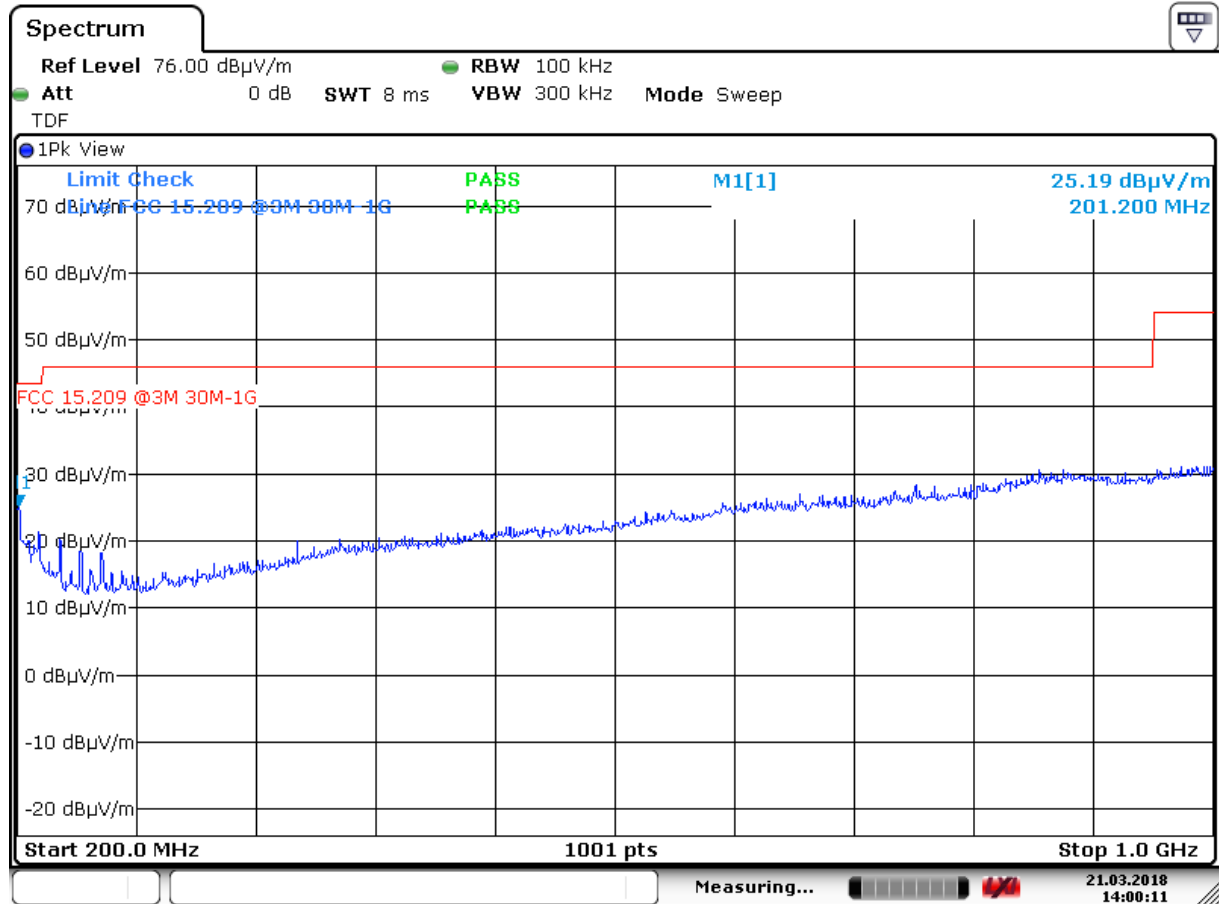
Date: 21.MAR.2018 11:44:07

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



Date: 21.MAR.2018 14:05:21

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



Date: 21.MAR.2018 14:00:10

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

Radiated Emissions, 1-25 GHz

Measuring distance: 3m (1 – 25 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	dB μ V/m	dB	dB μ V/m	dB
4.80	L	0	55.56	0	74	18.44
4.88	M	0	56.79	0	74	17.21
4.96	H	0	56.64	0	74	17.36
7.207	L	0	56.57	0	74	17.43
7.319	M	0	59.62	0	74	14.38
7.438	H	0	61.27	0	74	12.73
9.609	L	0	52.85	0	74	>20
9.759	M	0	54.21	0	74	19.79
9.917	H	0	54.22	0	74	19.78
12.008	L	0	59.48	0	74	14.52
12.201	M	0	60.37	0	74	13.63
12.397	H	0	57.51	0	74	16.49
14.414	L	0	62.14	0	74	11.86
14.642	M	0	63.04	0	74	10.96
14.876	H	0	57.65	0	74	16.35
17.990	L,M,H	0	60.71	0	74	13.29
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	dB μ V/m	dB	dB μ V/m	dB
4.80	L	0	35.56 *)	20	54	18.44
4.88	M	0	36.79 *)	20	54	17.21
4.96	H	0	36.64 *)	20	54	17.36
7.207	L	0	36.57 *)	20	54	17.43
7.319	M	0	39.62 *)	20	54	14.38
7.438	H	0	41.27 *)	20	54	12.73
9.609	L	0	/	0	54	/
9.759	M	0	34.21 *)	20	54	19.79
9.917	H	0	34.22 *)	20	54	19.78
12.008	L	0	39.48 *)	20	54	14.52
12.201	M	0	40.37 *)	20	54	13.63
12.397	H	0	37.51 *)	20	54	16.49
14.414	L	0	42.14 *)	20	54	11.86
14.642	M	0	43.04 *)	20	54	10.96
14.876	H	0	37.65 *)	20	54	16.35
17.990	L,M,H	0	49.69	0	54	4.31
Other freqs	L,M,H	/	/	0	54	/

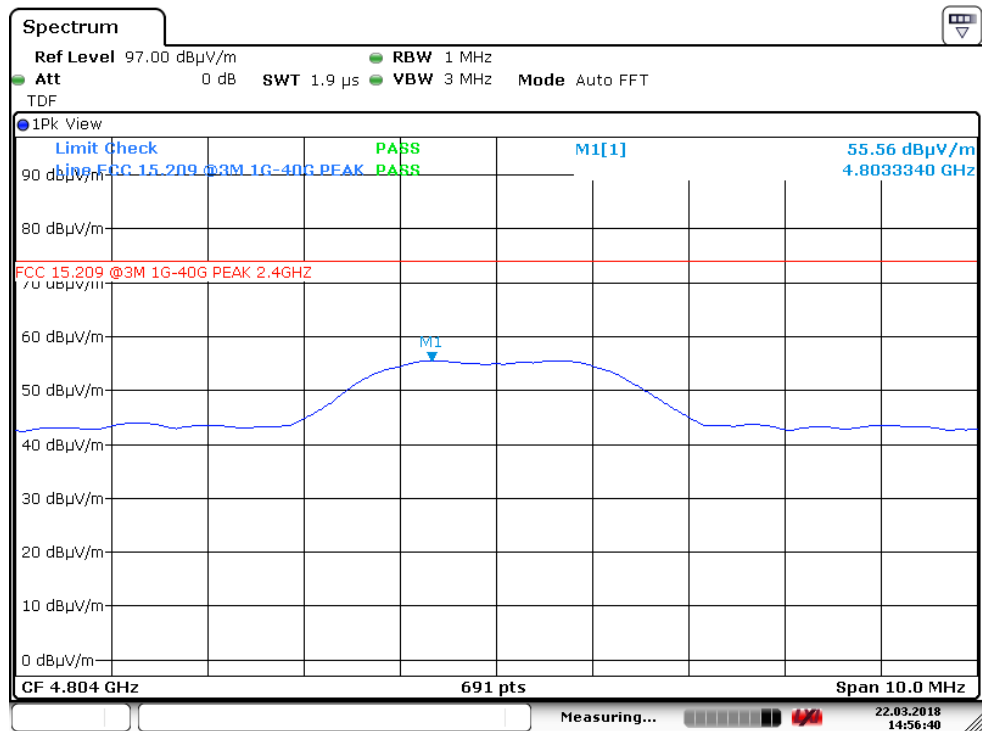
*) Average Values are calculated from Peak Values by Duty Cycle Correction Factor.

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".

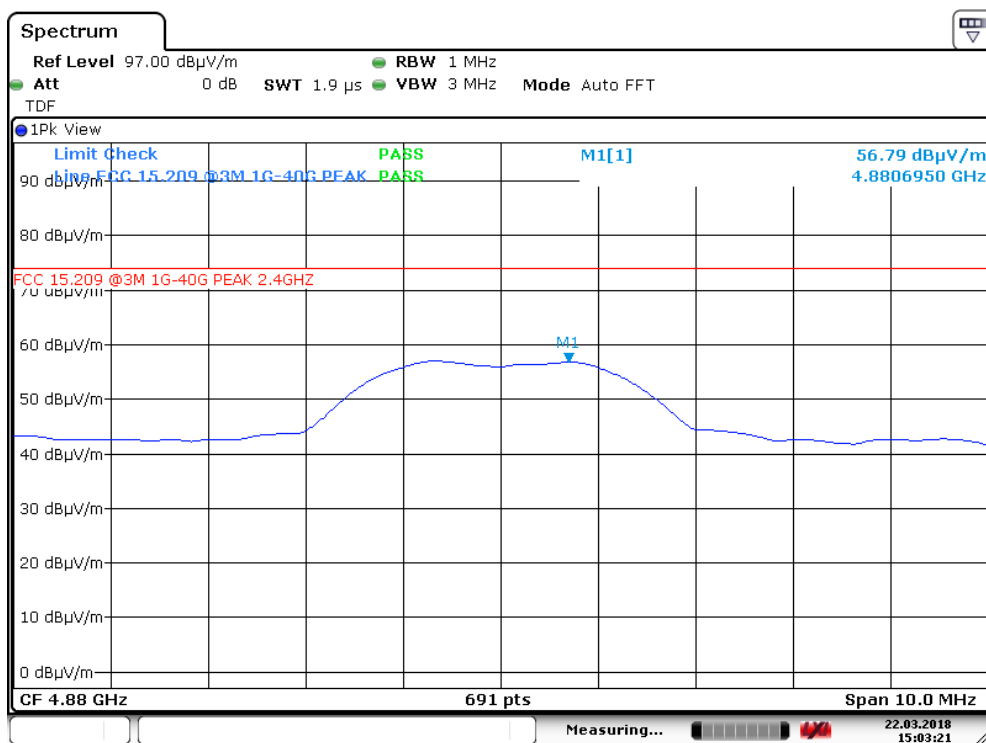
See plots.

No harmonics detected in the frequency range 18 – 25 GHz



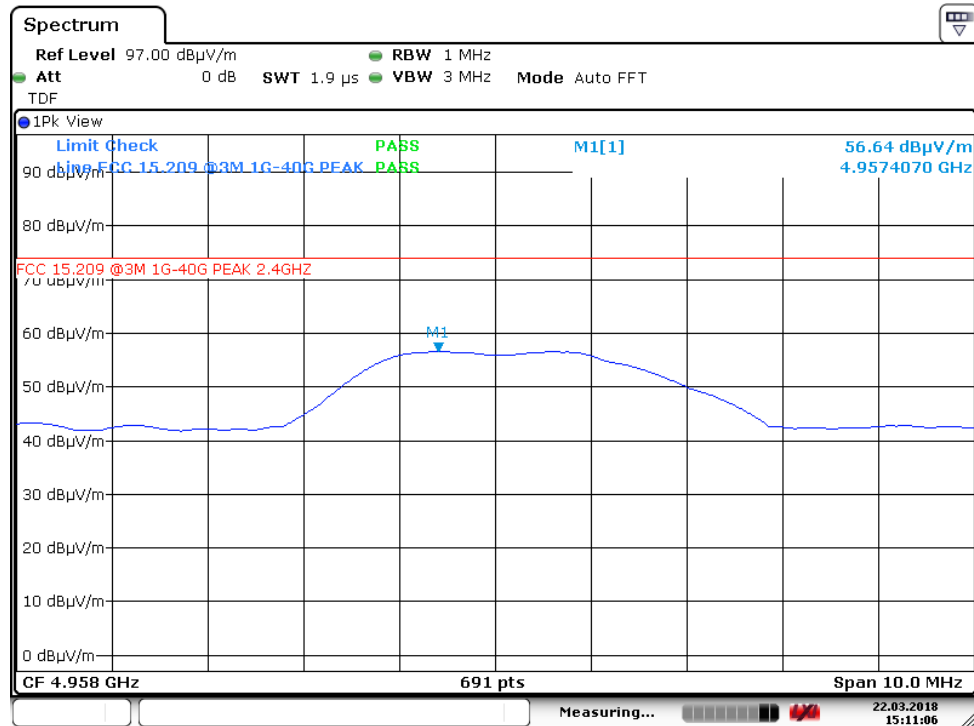
Date: 22.MAR.2018 14:56:41

2nd harmonic – ch2402MHz, HP – PK



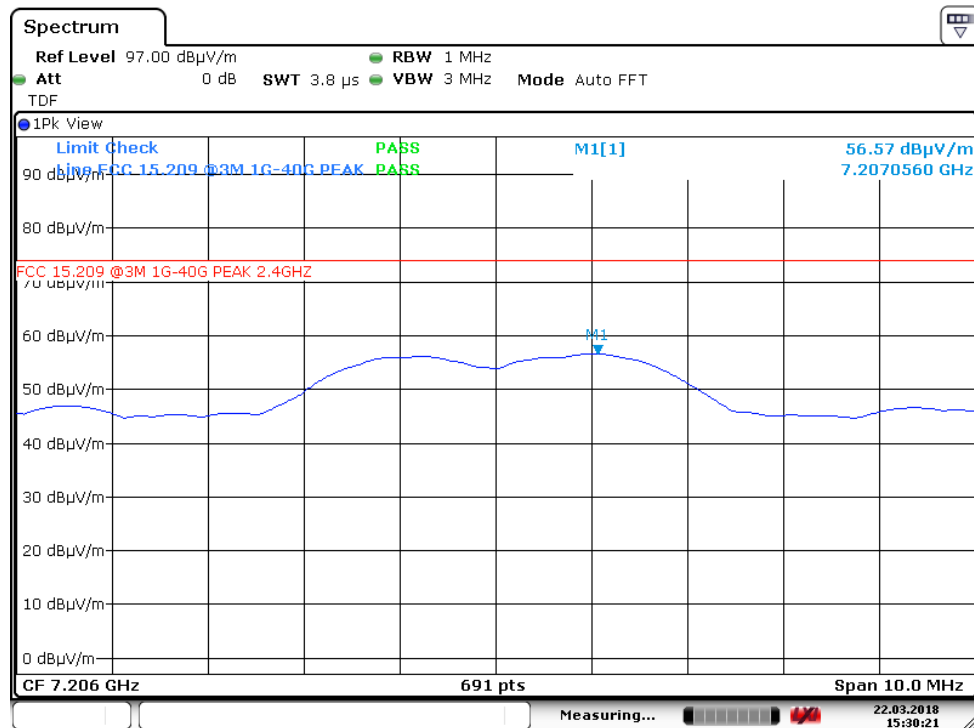
Date: 22.MAR.2018 15:03:22

2nd harmonic – ch2440MHz, HP – PK



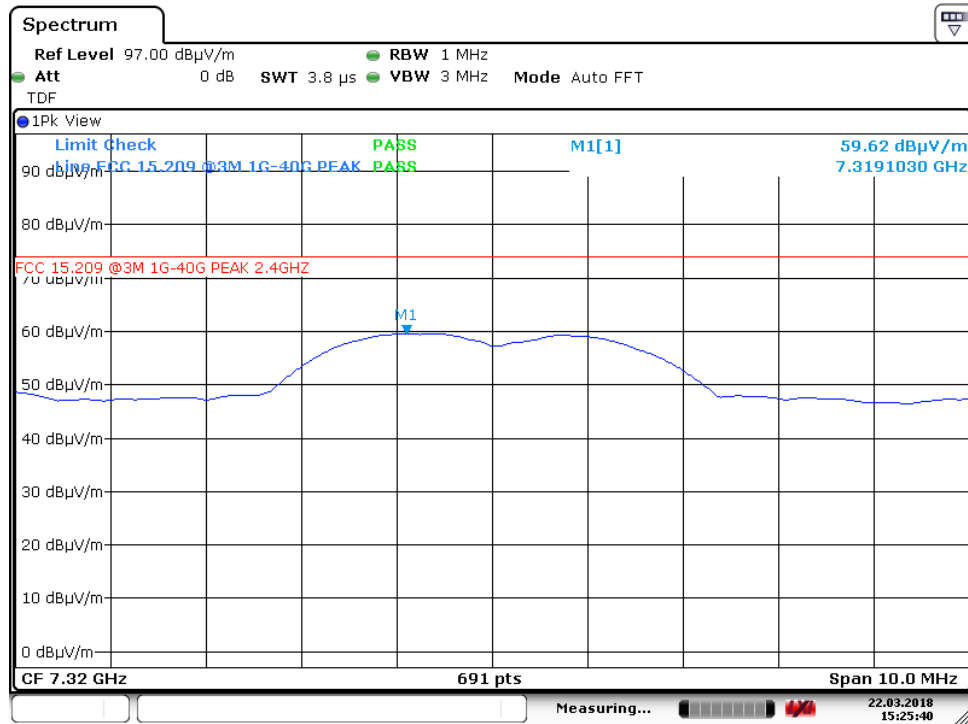
Date: 22.MAR.2018 15:11:06

2nd harmonic – ch2479MHz, HP – PK



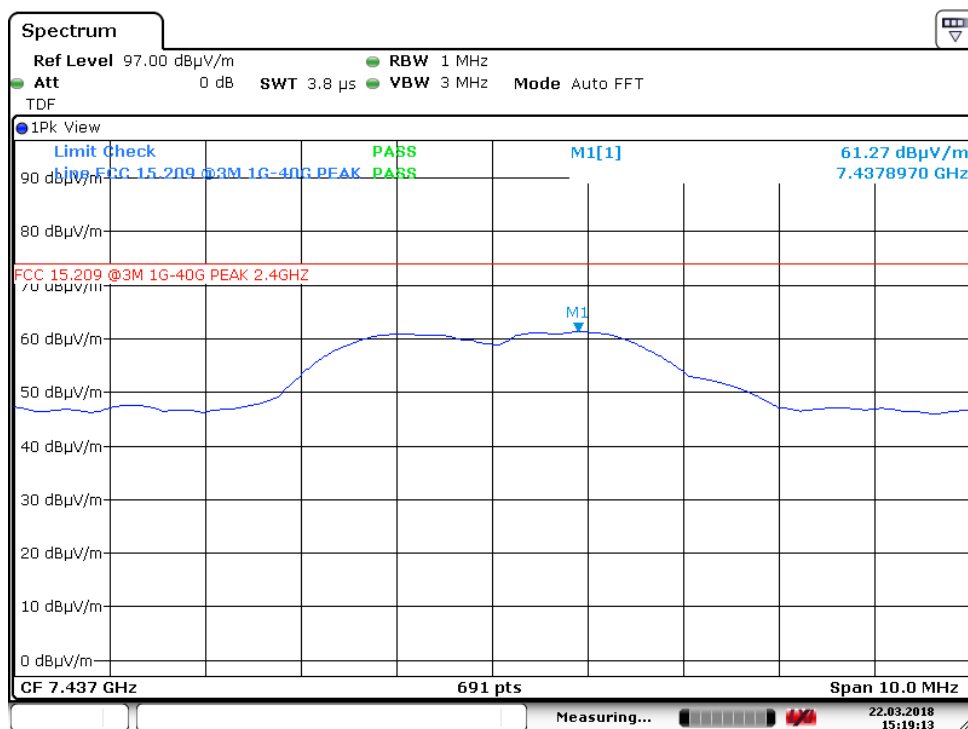
Date: 22.MAR.2018 15:30:22

3rd harmonic – ch2402MHz, HP – PK



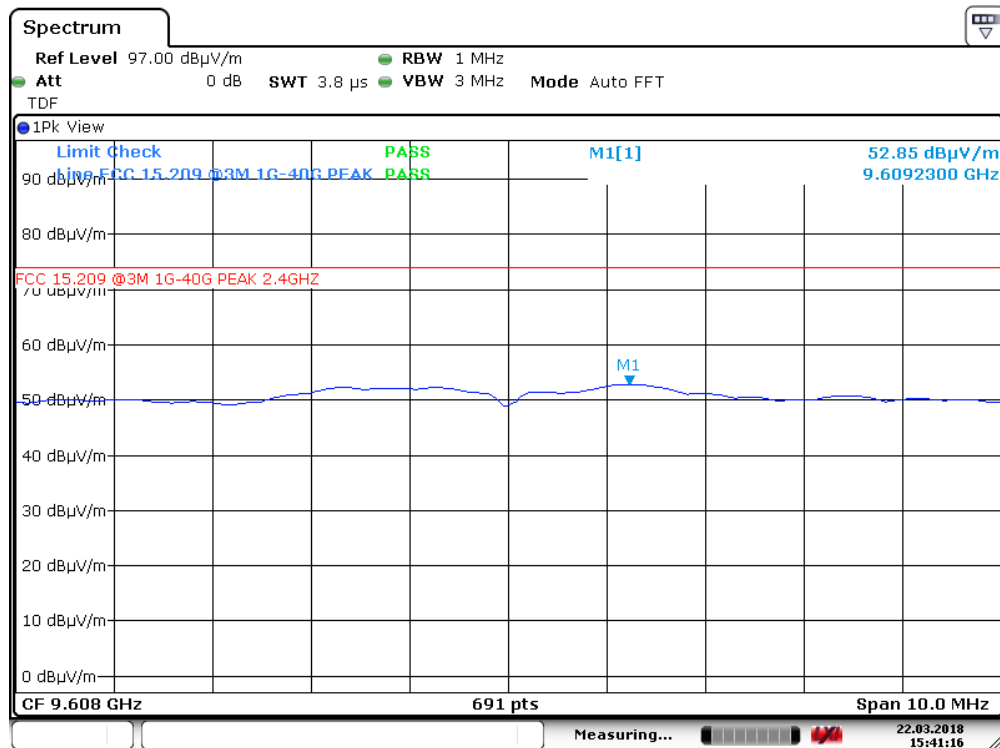
Date: 22.MAR.2018 15:25:40

3rd harmonic – ch2440MHz, HP – PK



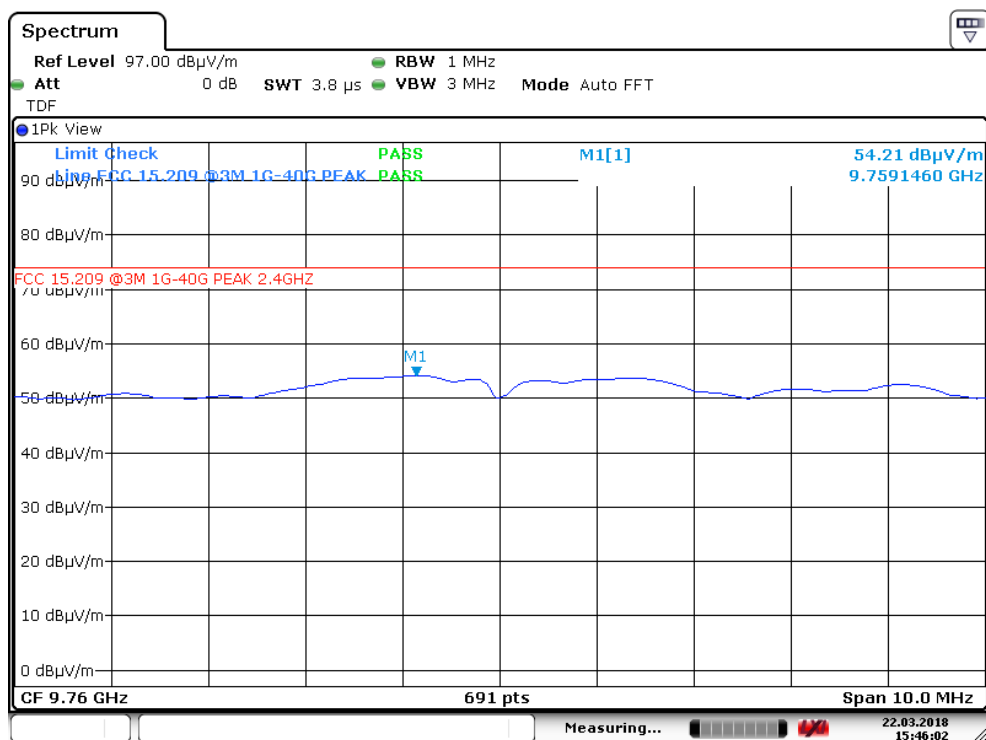
Date: 22.MAR.2018 15:19:13

3rd harmonic – ch2479MHz, HP – PK



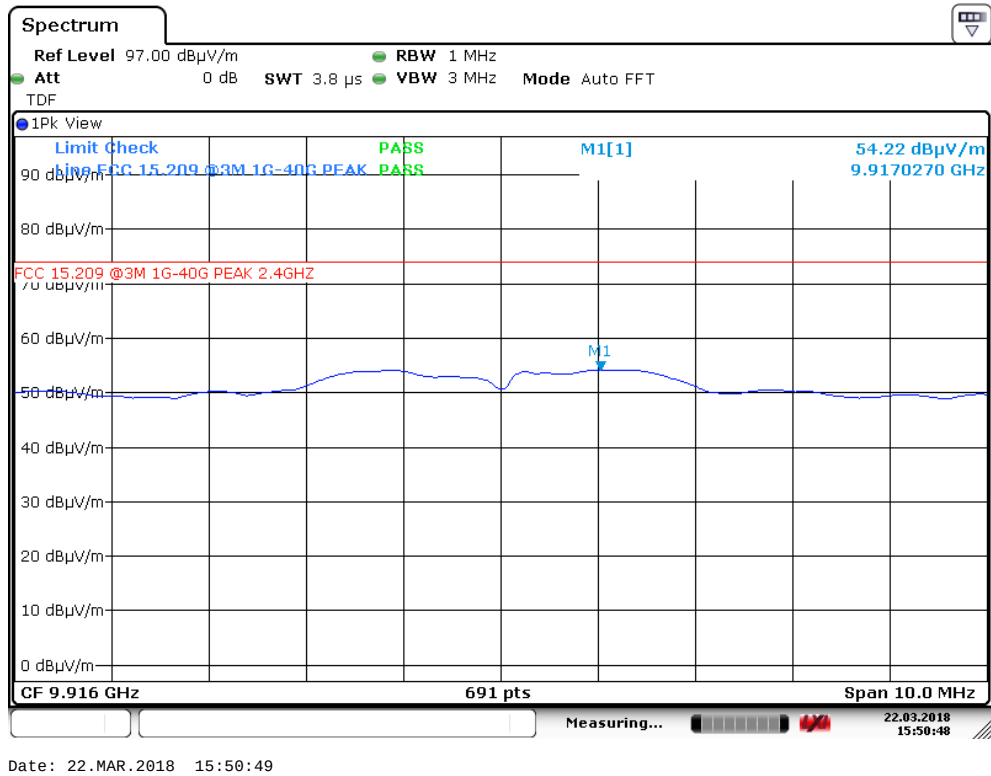
Date: 22. MAR. 2018 15:41:17

4th harmonic – ch2402MHz, HP – PK

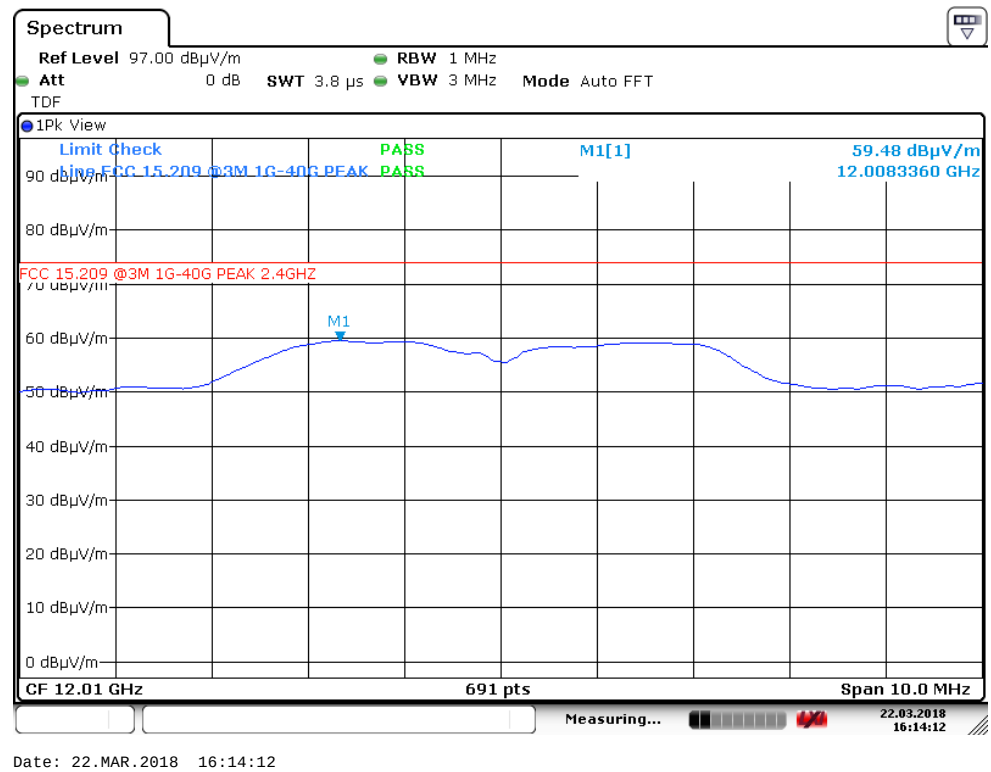


Date: 22. MAR. 2018 15:46:02

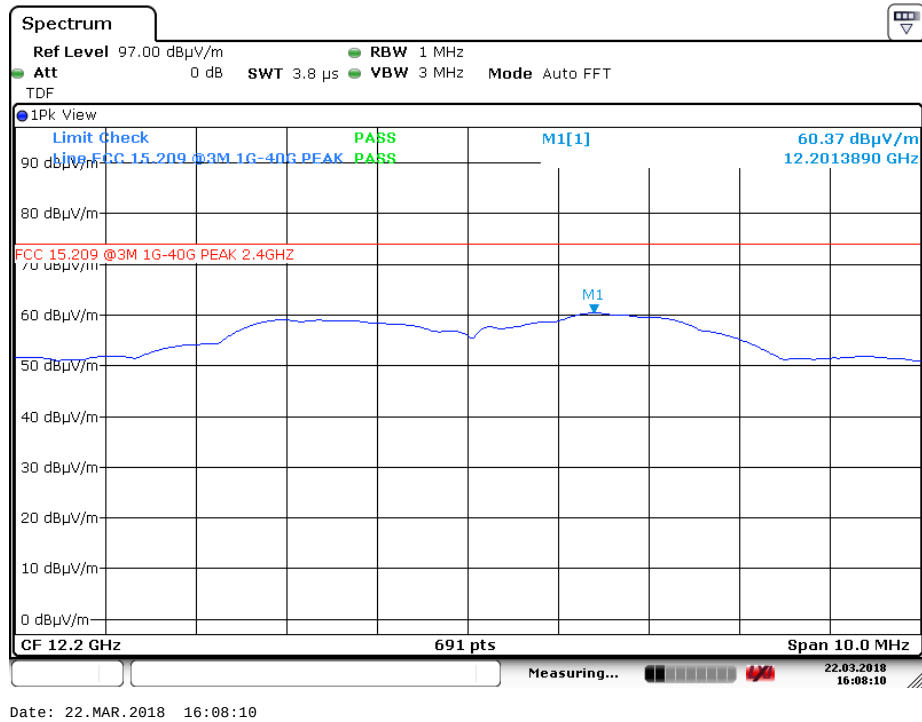
4th harmonic – ch2440MHz, HP – PK



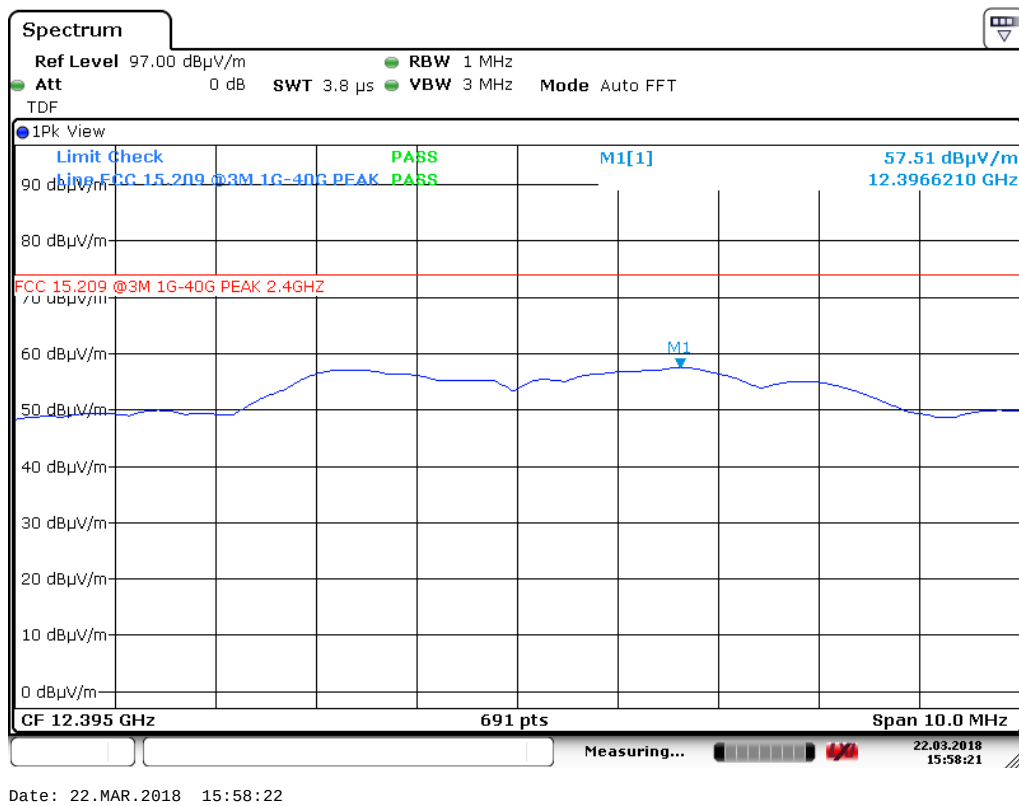
4th harmonic – ch2479MHz, HP – PK



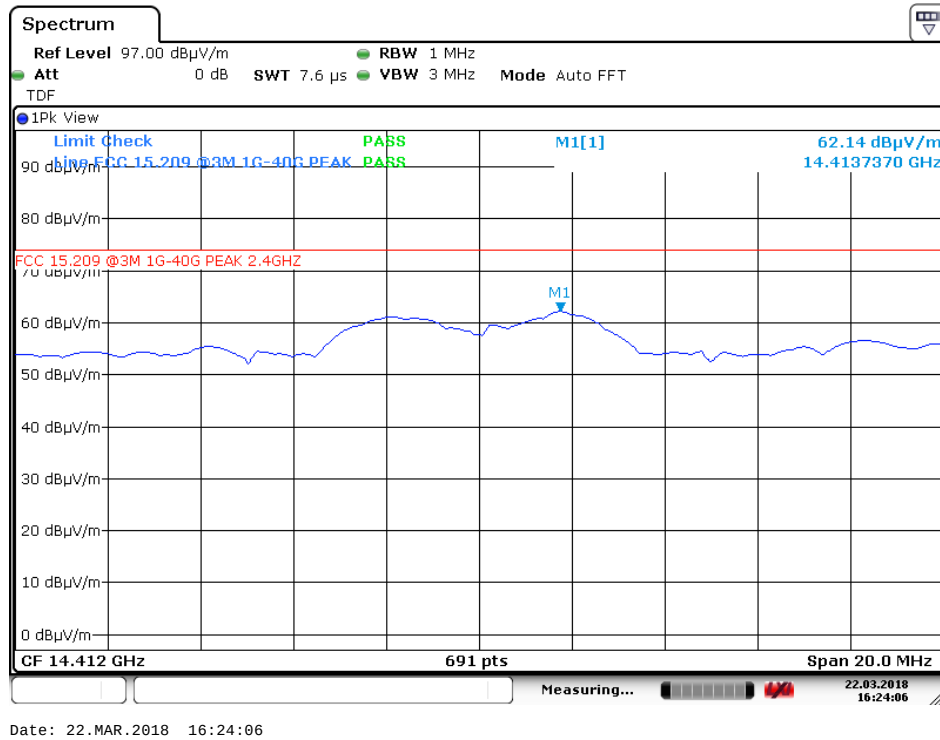
5th harmonic – ch2402MHz, HP – PK



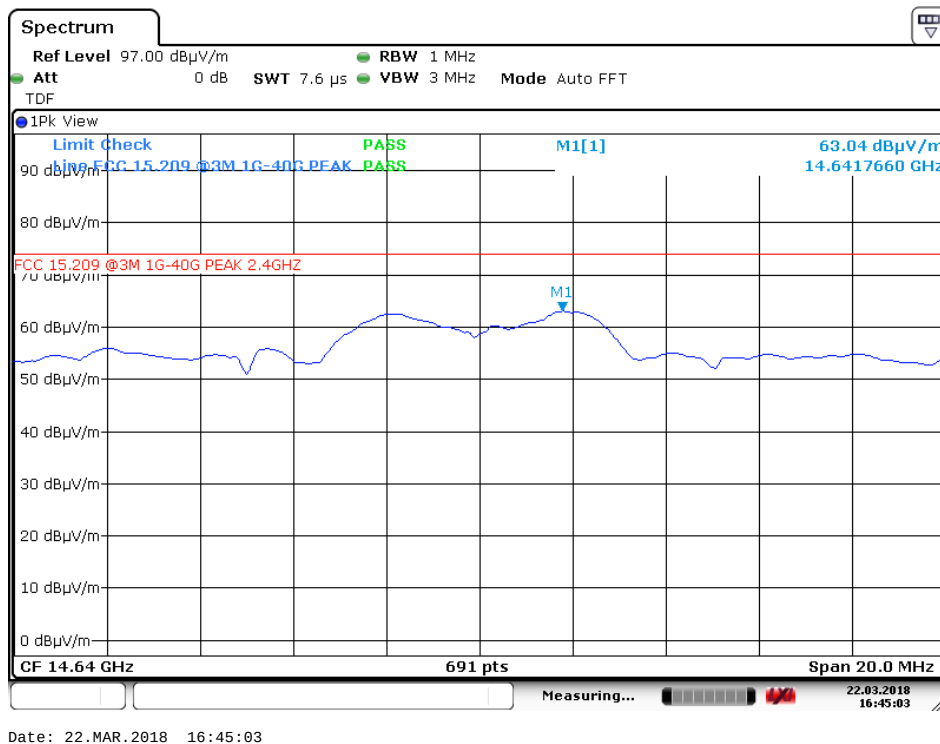
5th harmonic – ch2440MHz, HP – PK



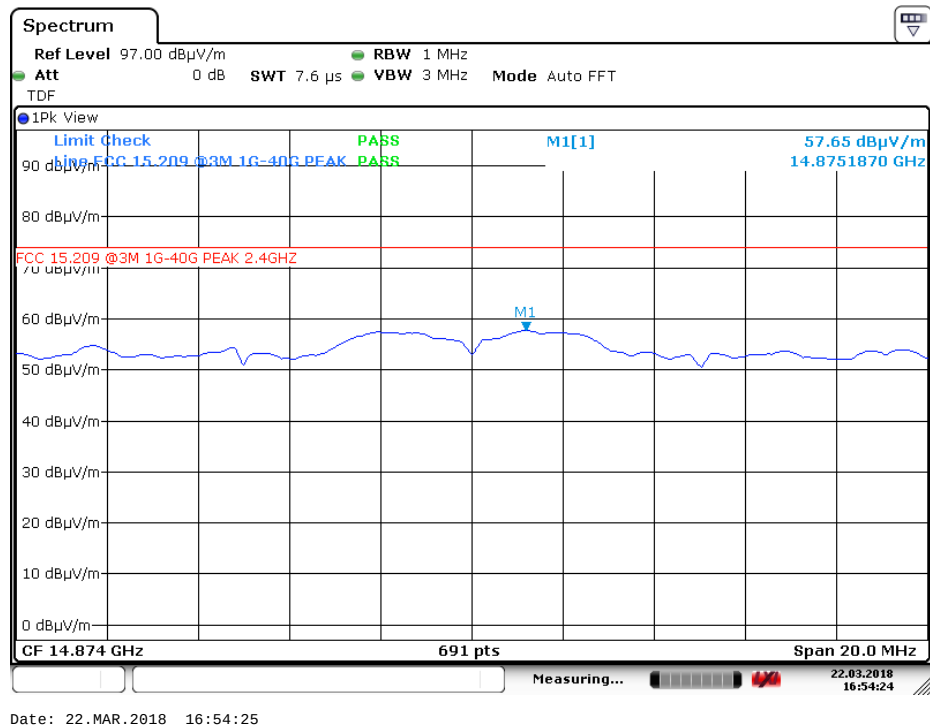
5th harmonic – ch2479MHz, HP – PK



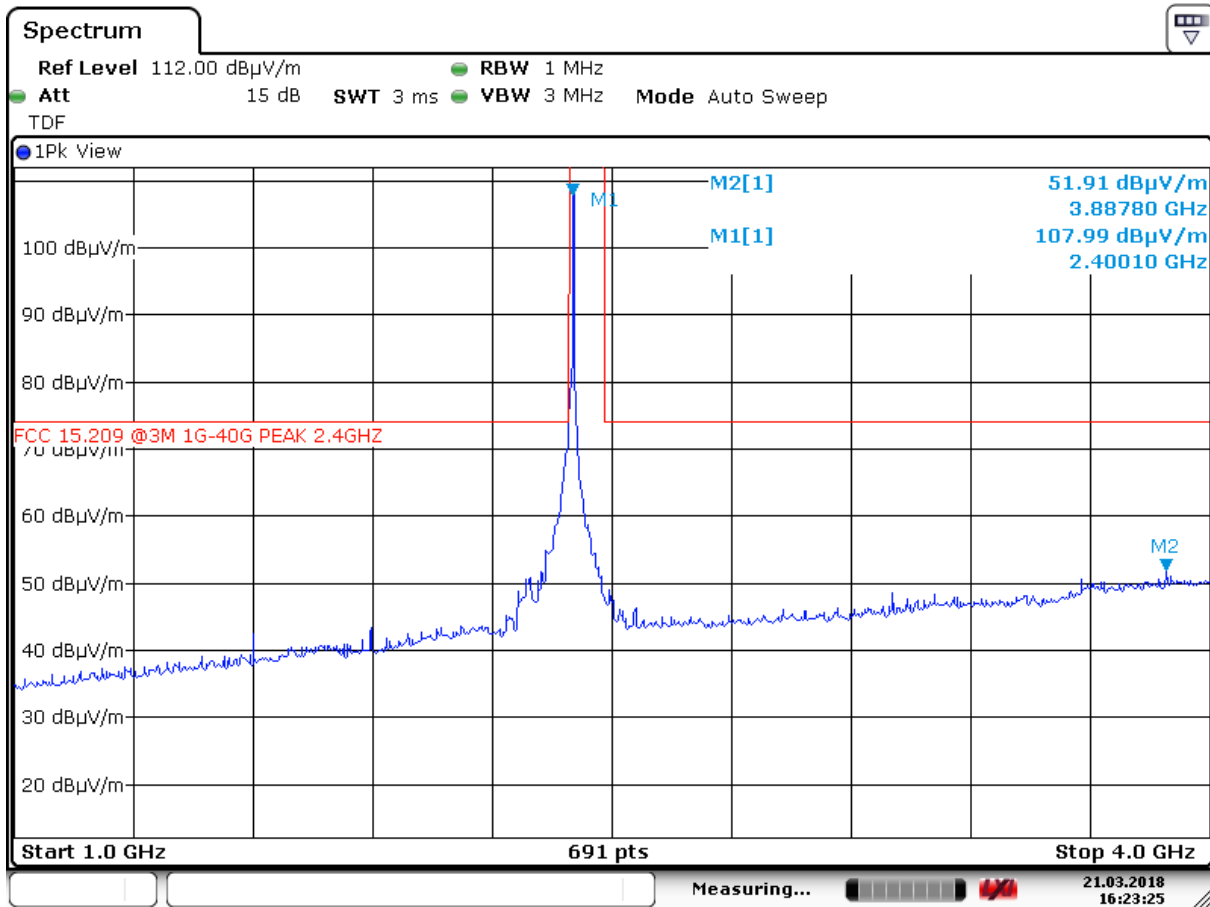
6th harmonic – ch2402MHz, HP – PK



6th harmonic – ch2440MHz, HP – PK

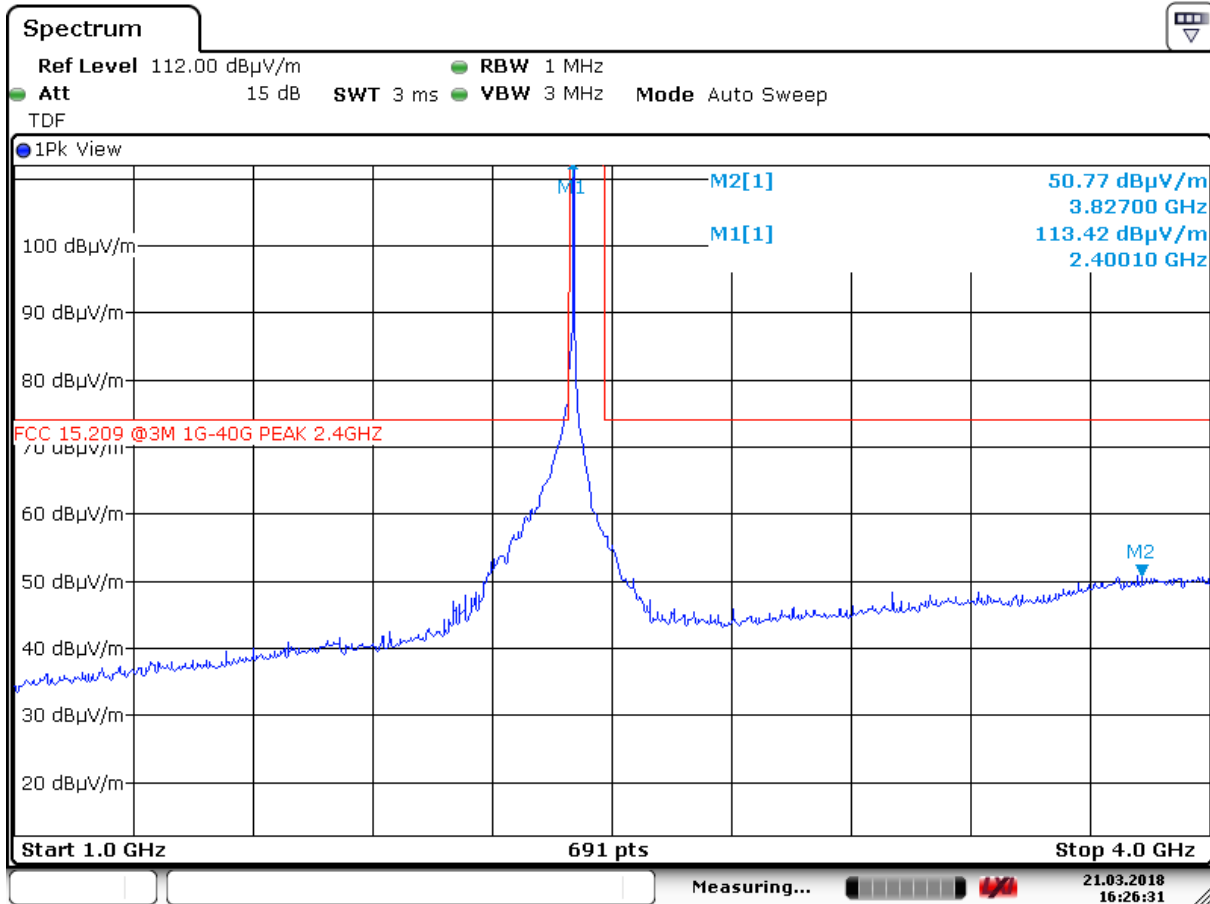


6th harmonic – ch2479MHz, HP – PK



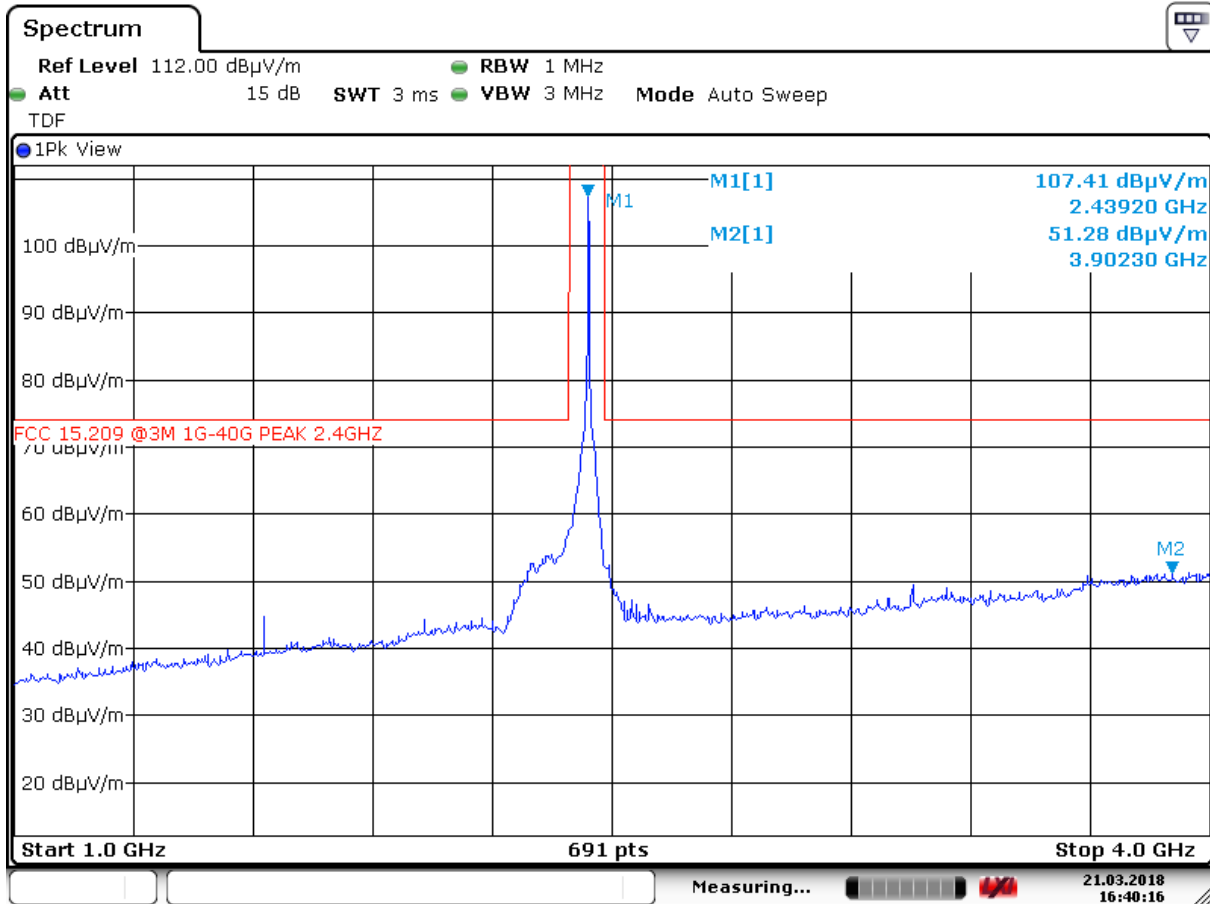
Date: 21.MAR.2018 16:23:25

Radiated Emissions, 2402 MHz, 1 – 4 GHz, VP, @3m – Pre-scan



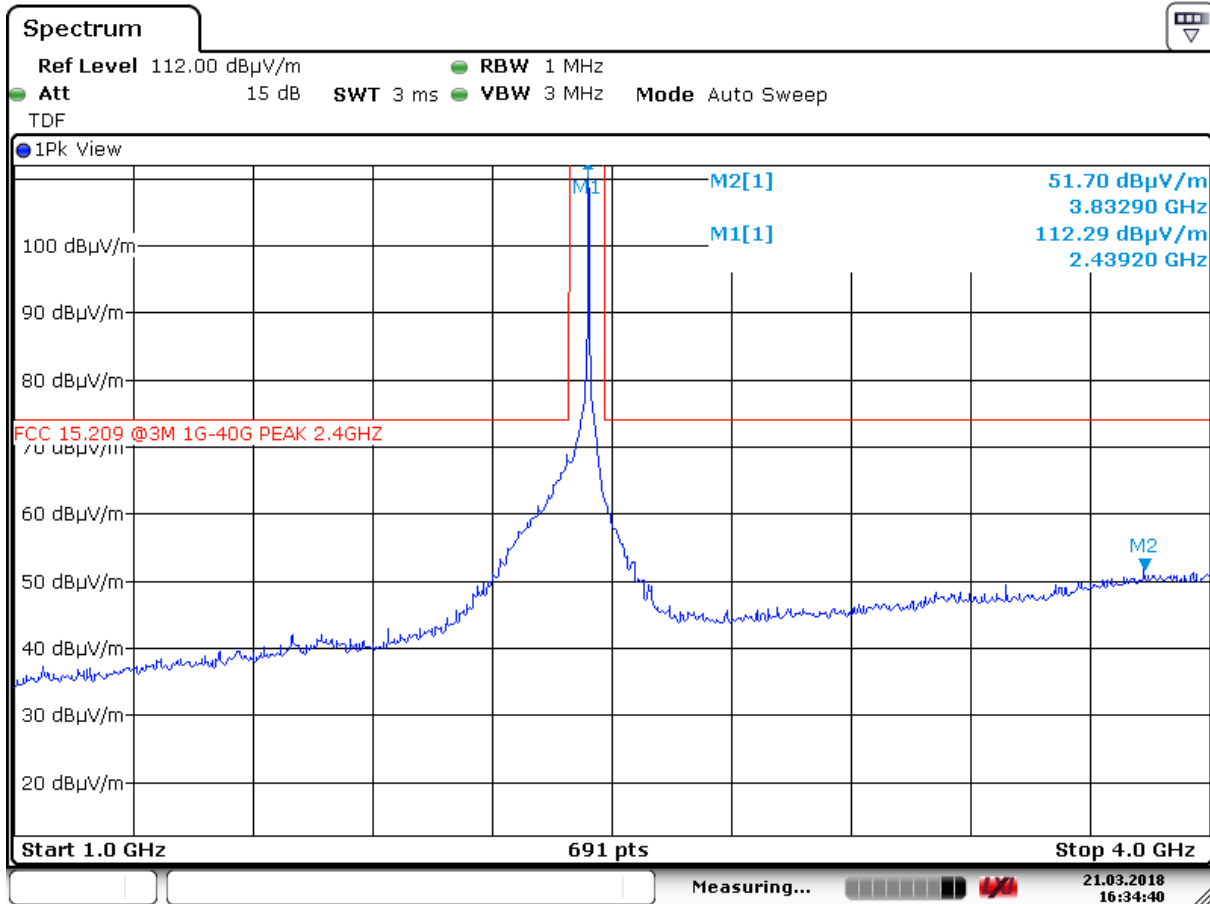
Date: 21.MAR.2018 16:26:31

Radiated Emissions, 2402 MHz, 1 – 4 GHz, HP, @3m – Pre-scan



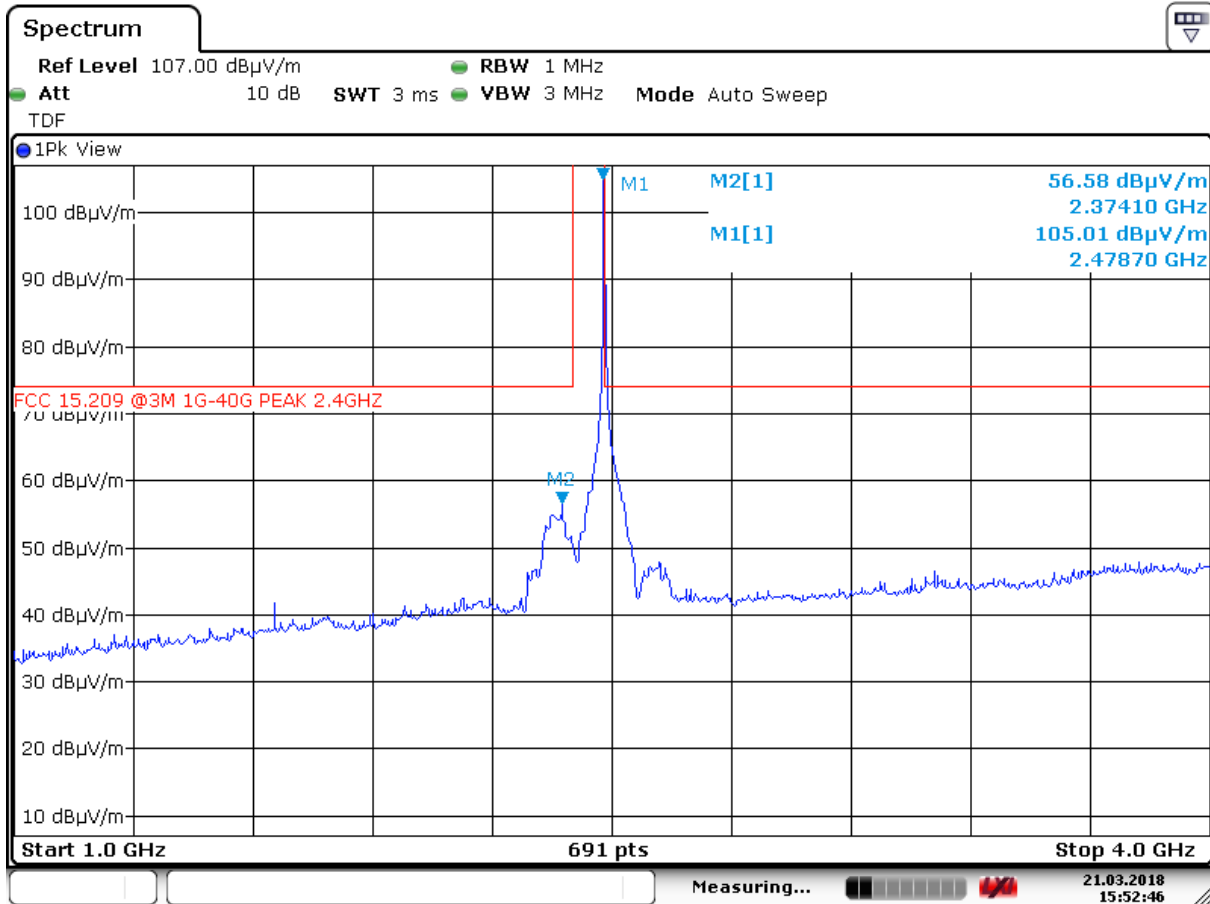
Date: 21.MAR.2018 16:40:16

Radiated Emissions ch. 2440 MHz, 1 – 4 GHz, VP, @3m – Pre-scan



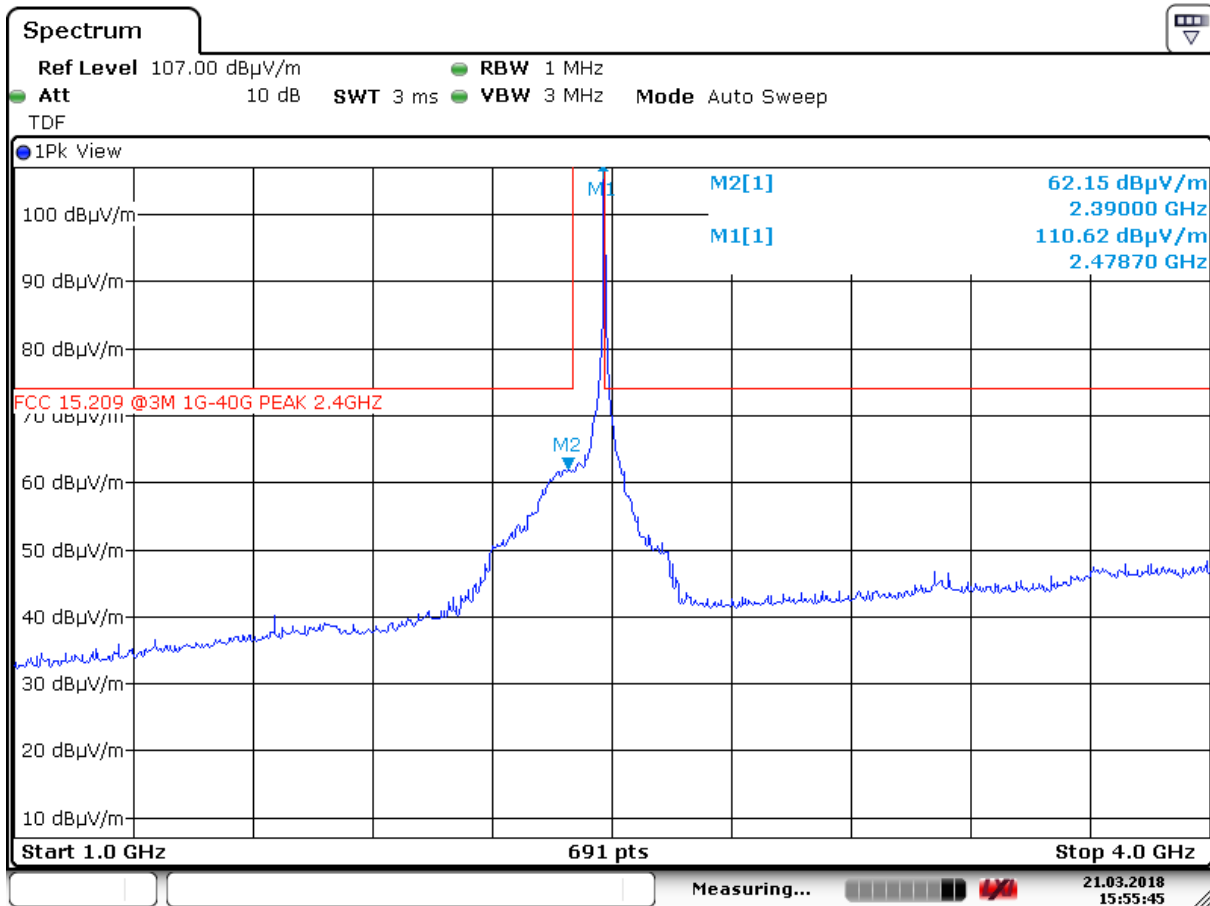
Date: 21.MAR.2018 16:34:40

Radiated Emissions ch. 2440 MHz, 1 – 4 GHz, HP, @3m – Pre-scan



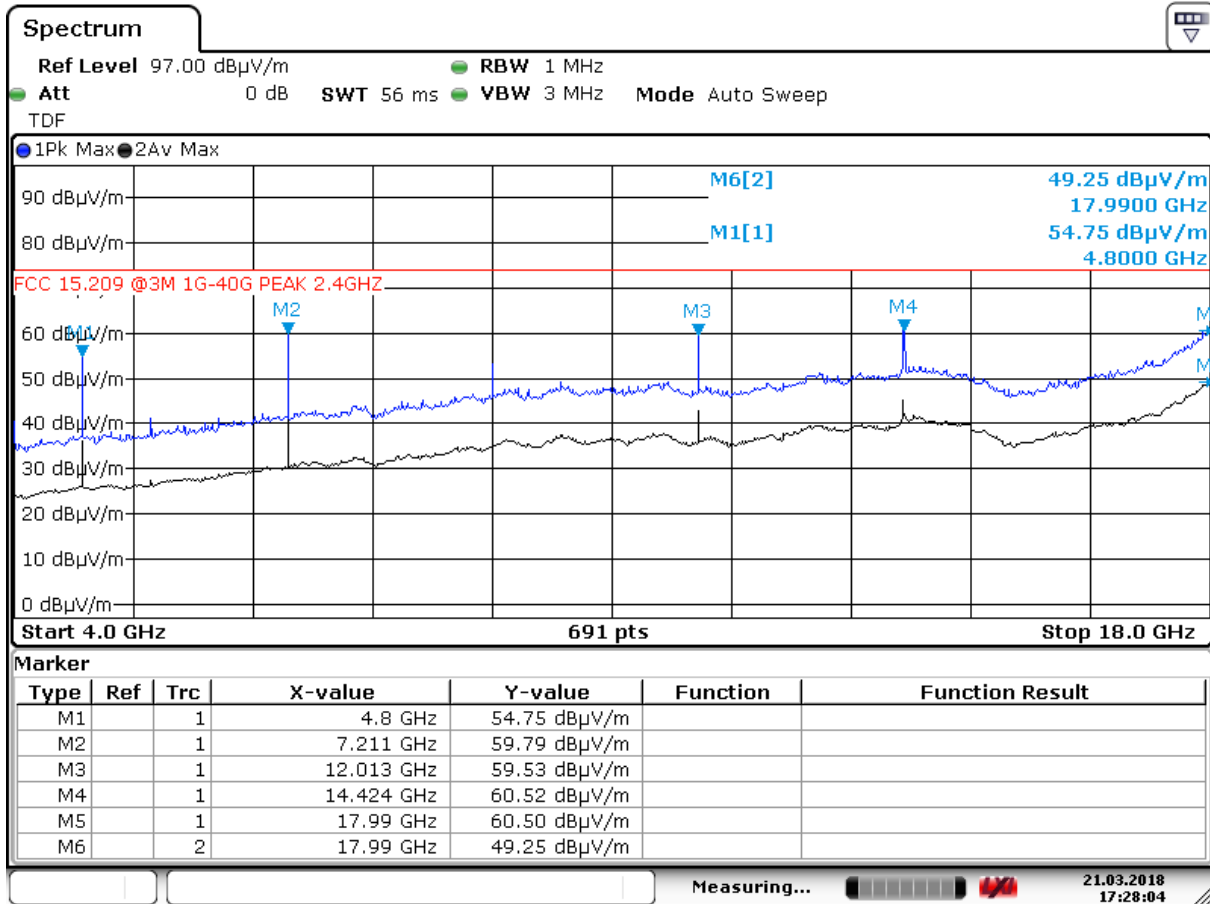
Date: 21.MAR.2018 15:52:46

Radiated Emissions ch. 2479 MHz, 1 – 4 GHz, VP, @3m – Pre-scan



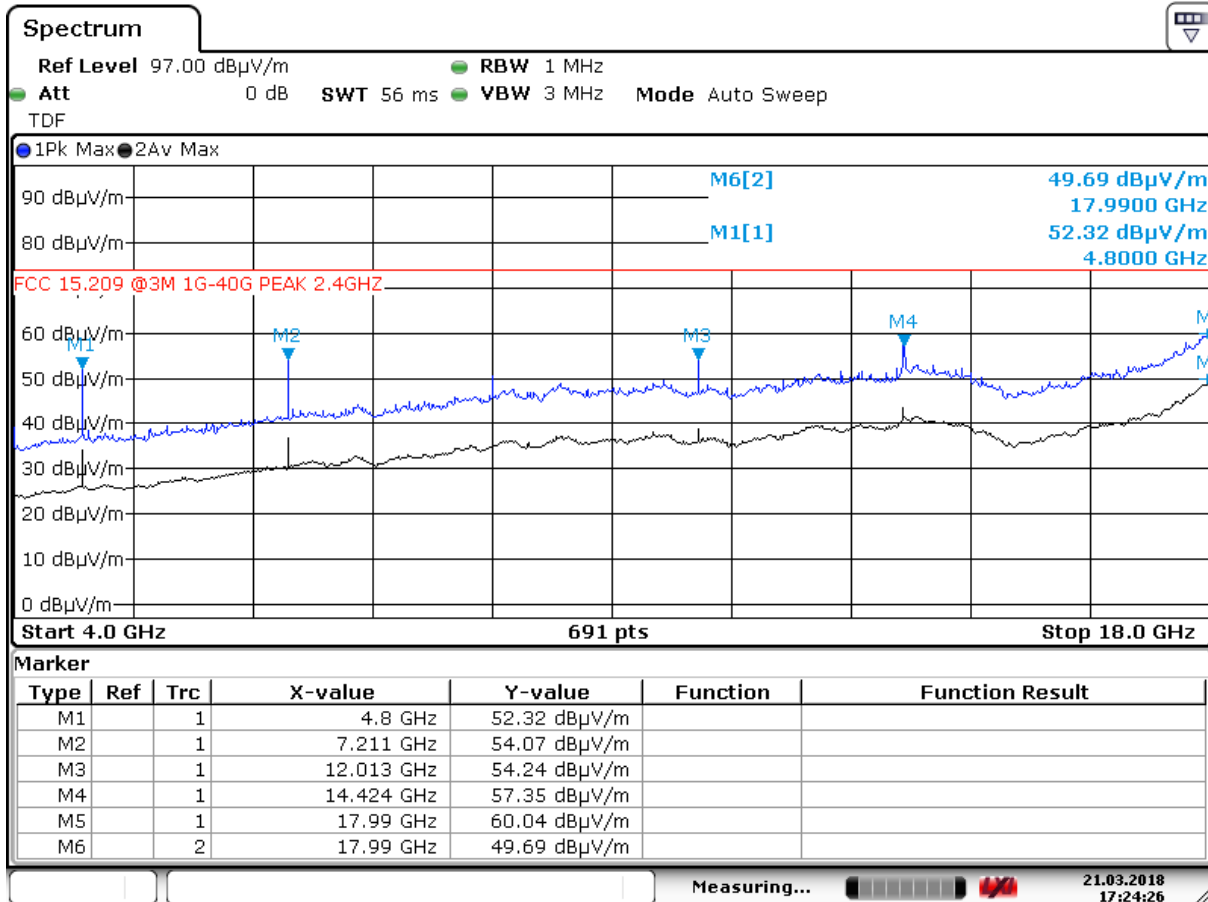
Date: 21.MAR.2018 15:55:45

Radiated Emissions ch. 2479 MHz, 1 – 4 GHz, HP, @3m – Pre-scan



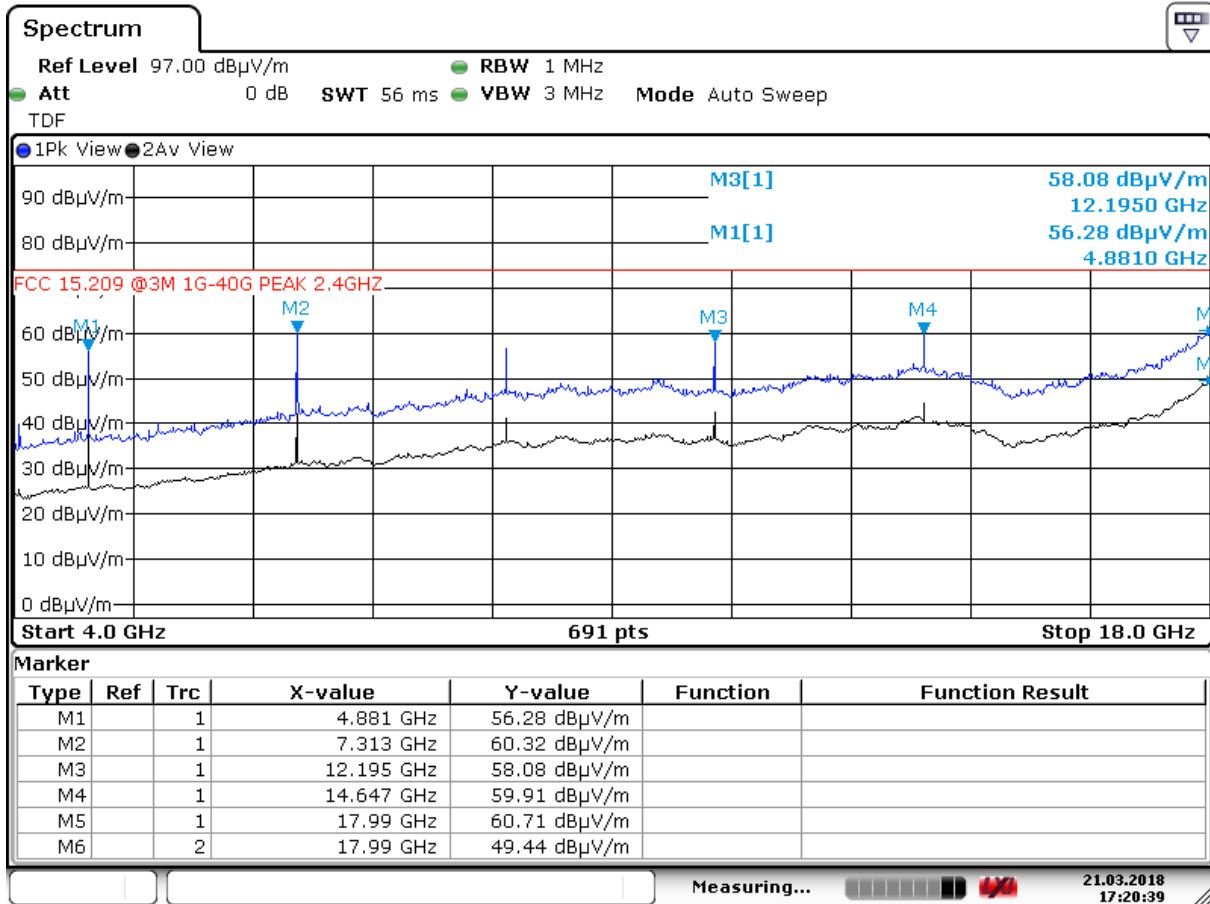
Date: 21.MAR.2018 17:28:04

Radiated Emissions ch. 2402 MHz, 4 – 18 GHz, VP, @3m – Pre-scan



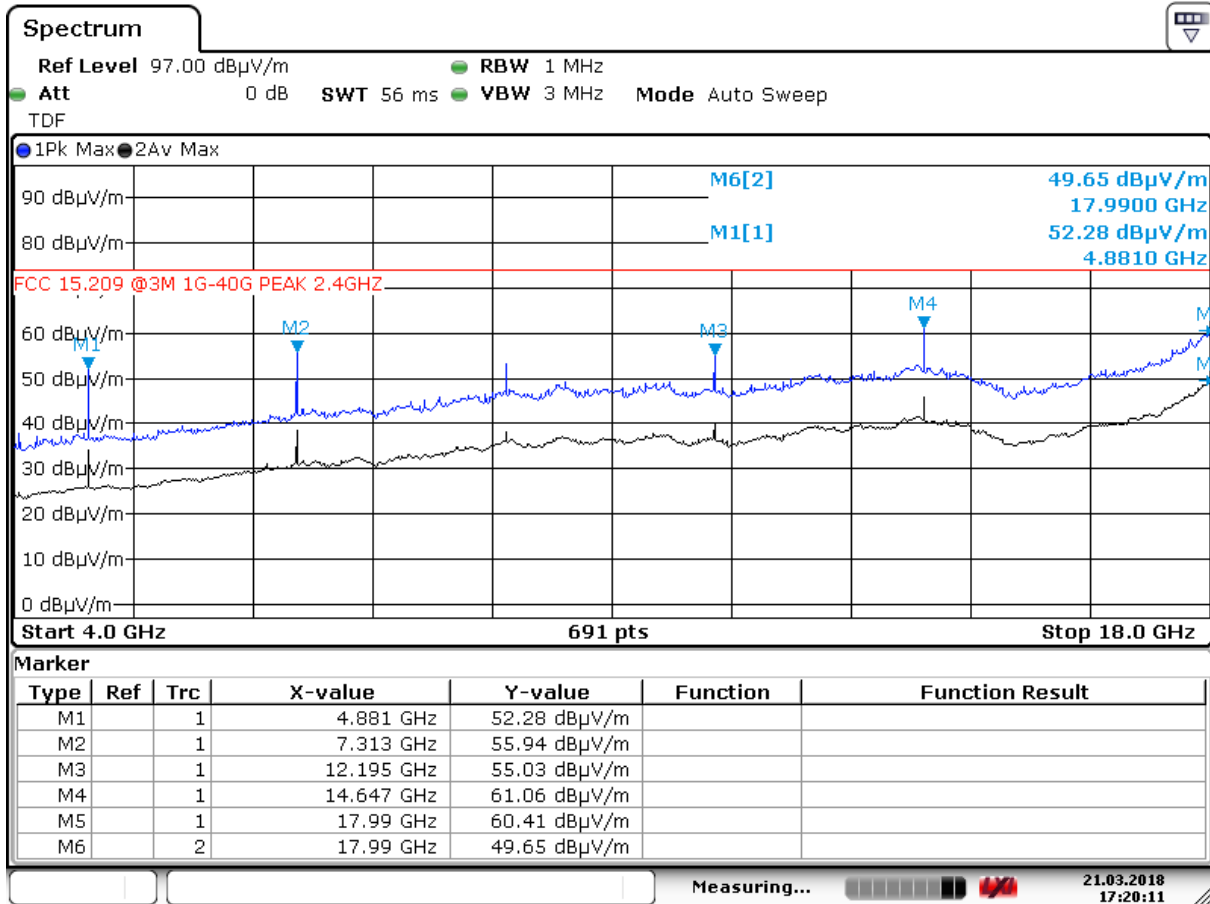
Date: 21.MAR.2018 17:24:25

Radiated Emissions ch. 2402 MHz, 4 – 18 GHz, HP, @3m – Pre-scan



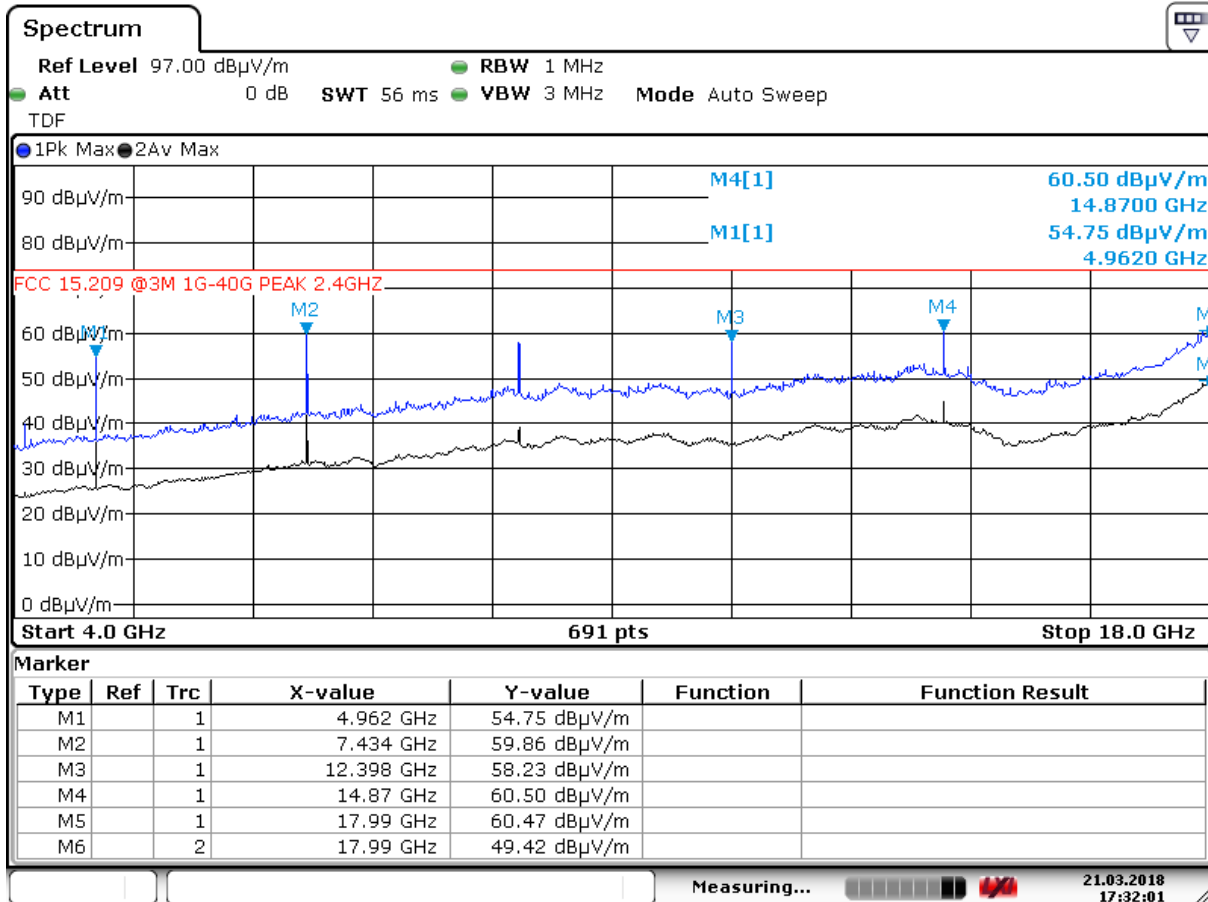
Date: 21.MAR.2018 17:20:39

Radiated Emissions ch. 2440 MHz, 4 – 18 GHz, VP, @3m – Pre-scan



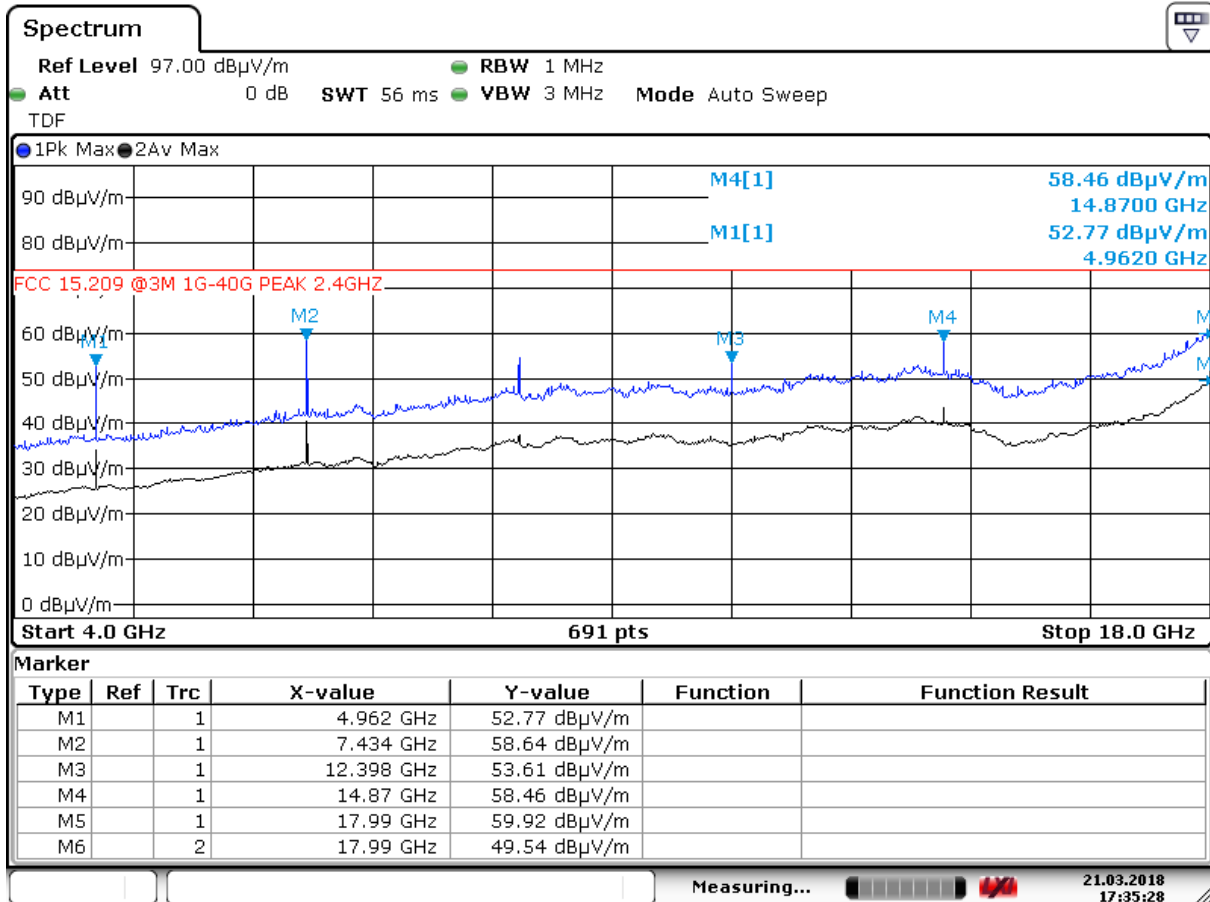
Date: 21.MAR.2018 17:20:11

Radiated Emissions ch. 2440 MHz, 4 – 18 GHz, HP, @3m – Pre-scan



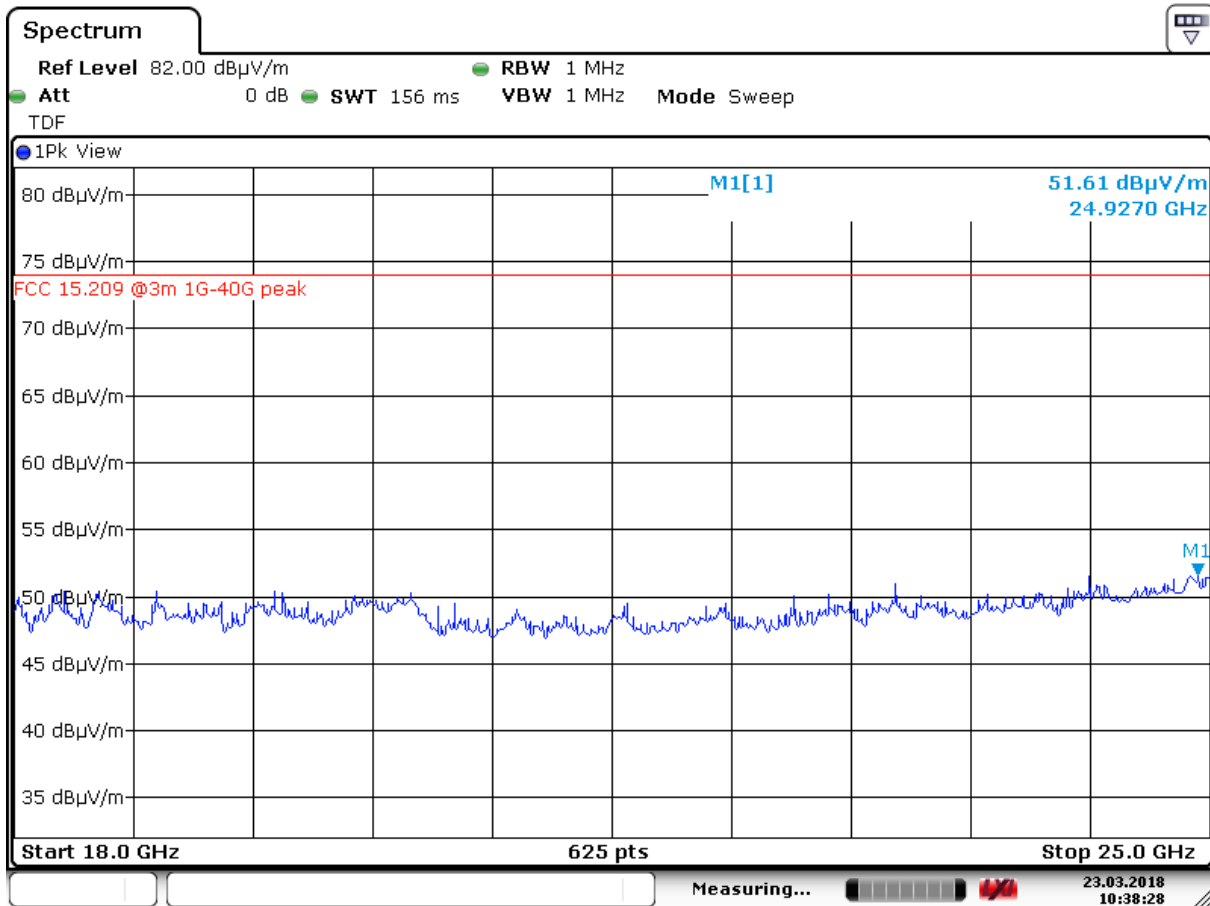
Date: 21.MAR.2018 17:32:01

Radiated Emissions ch. 2479 MHz, 4 – 18 GHz, VP, @3m – Pre-scan



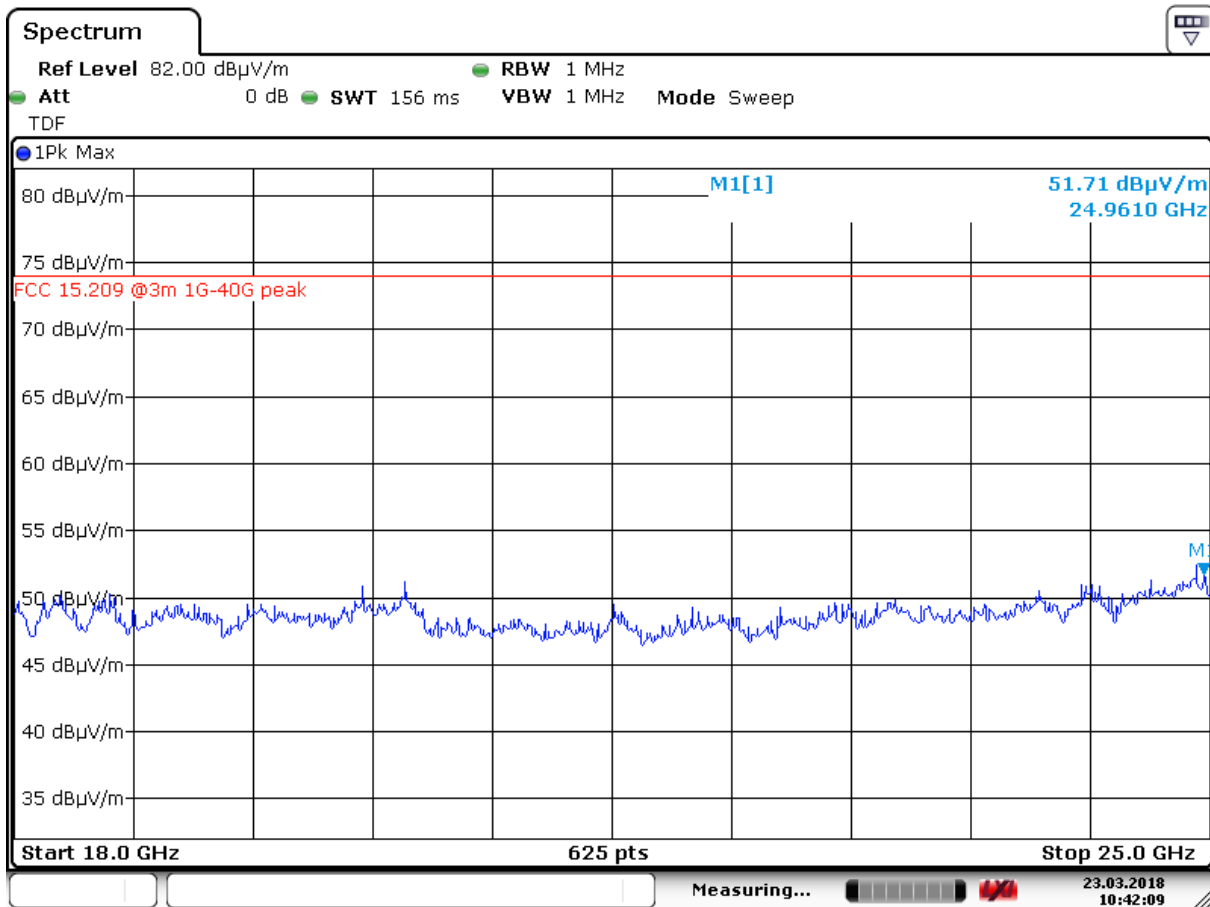
Date: 21.MAR.2018 17:35:27

Radiated Emissions ch. 2479 MHz, 4 – 18 GHz, HP, @3m – Pre-scan



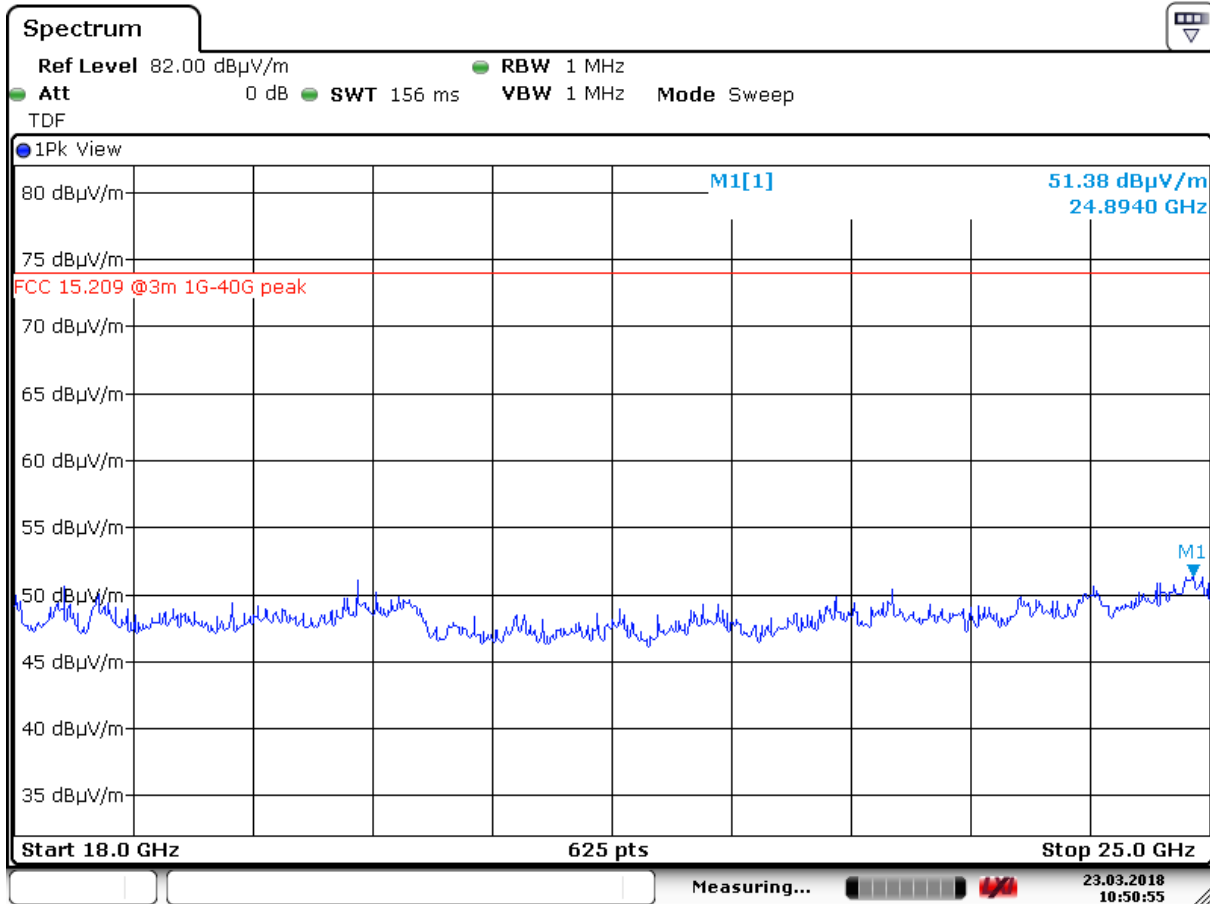
Date: 23.MAR.2018 10:38:29

Radiated Emissions ch. 2402 MHz, 18 – 25 GHz, VP, @3m – Pre-scan



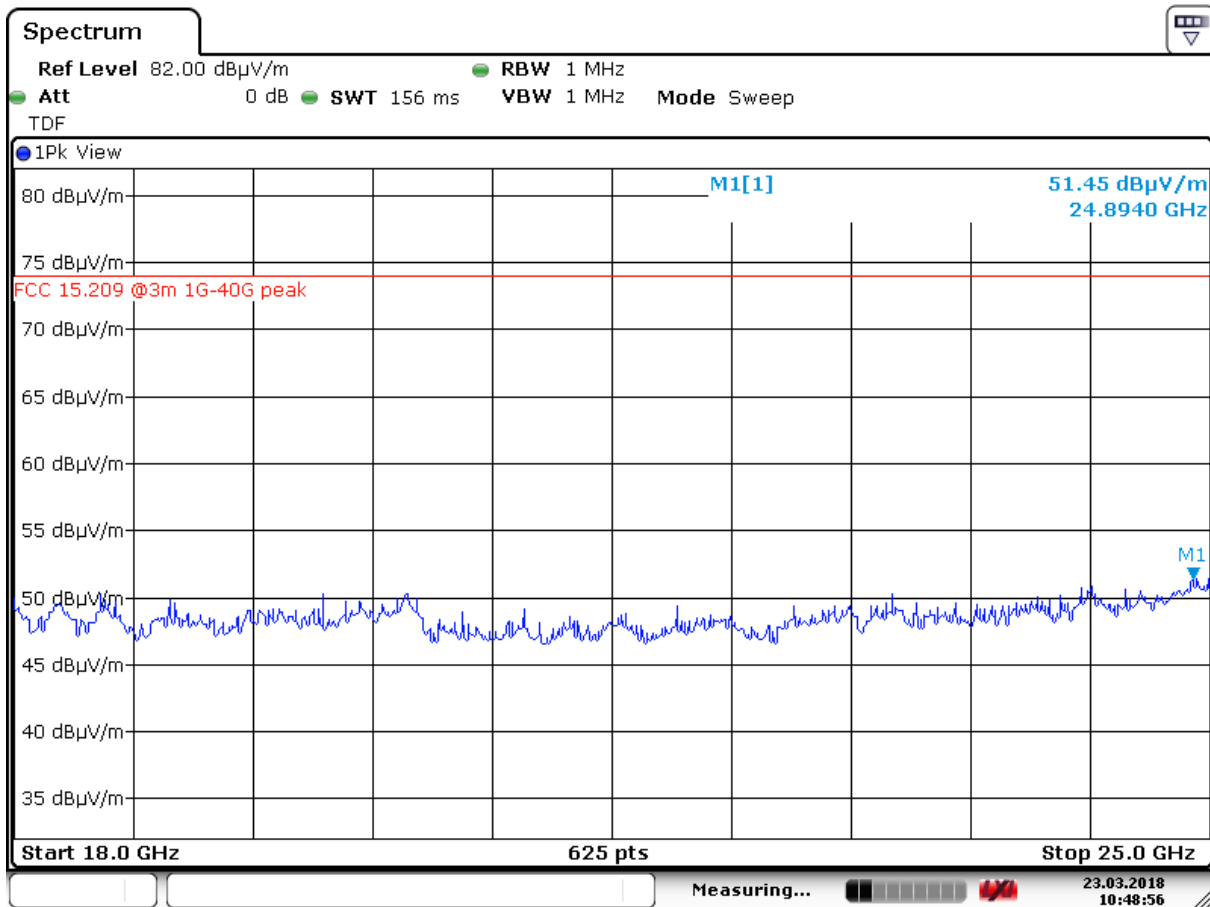
Date: 23.MAR.2018 10:42:10

Radiated Emissions ch. 2402 MHz, 18 – 25 GHz, HP, @3m – Pre-scan



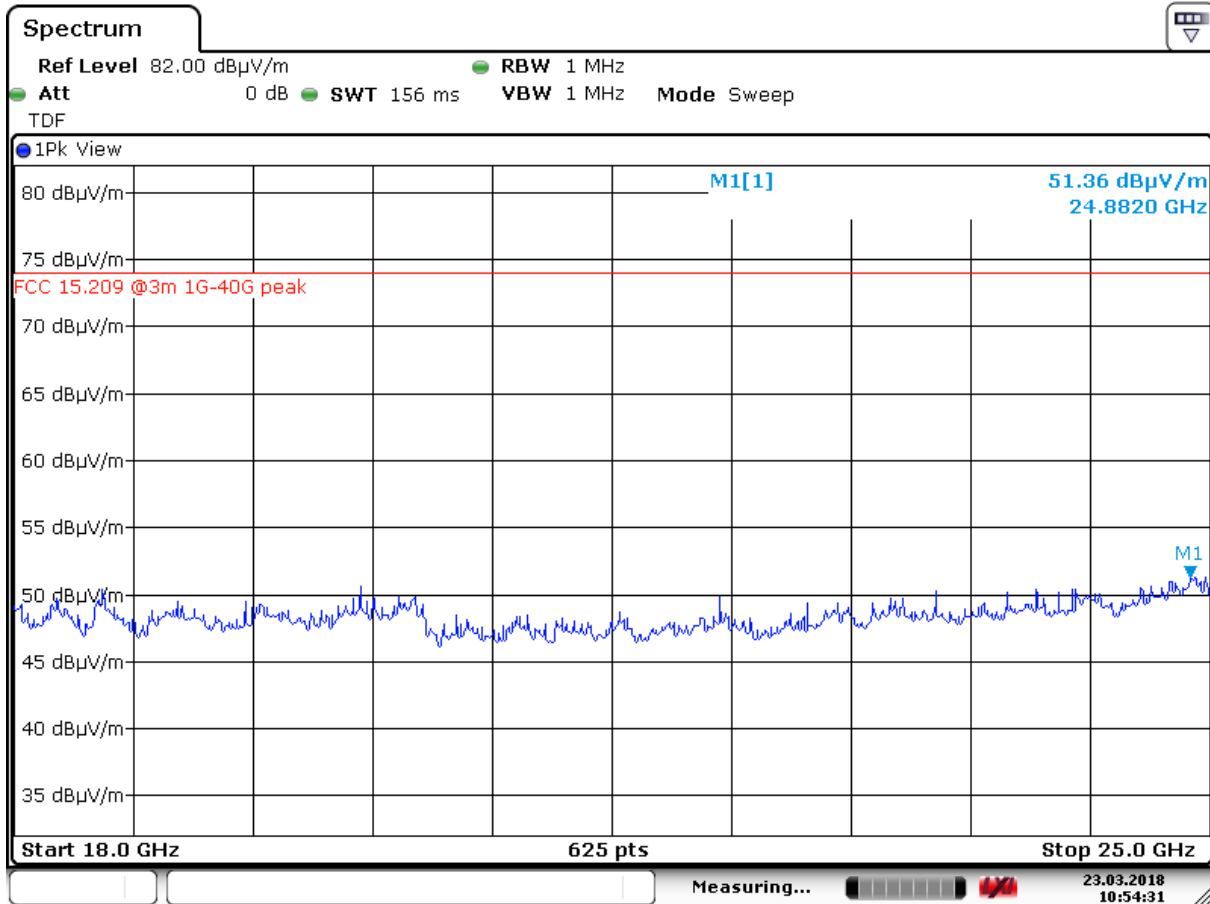
Date: 23.MAR.2018 10:50:55

Radiated Emissions ch. 2440 MHz, 18 – 25 GHz, VP, @3m – Pre-scan



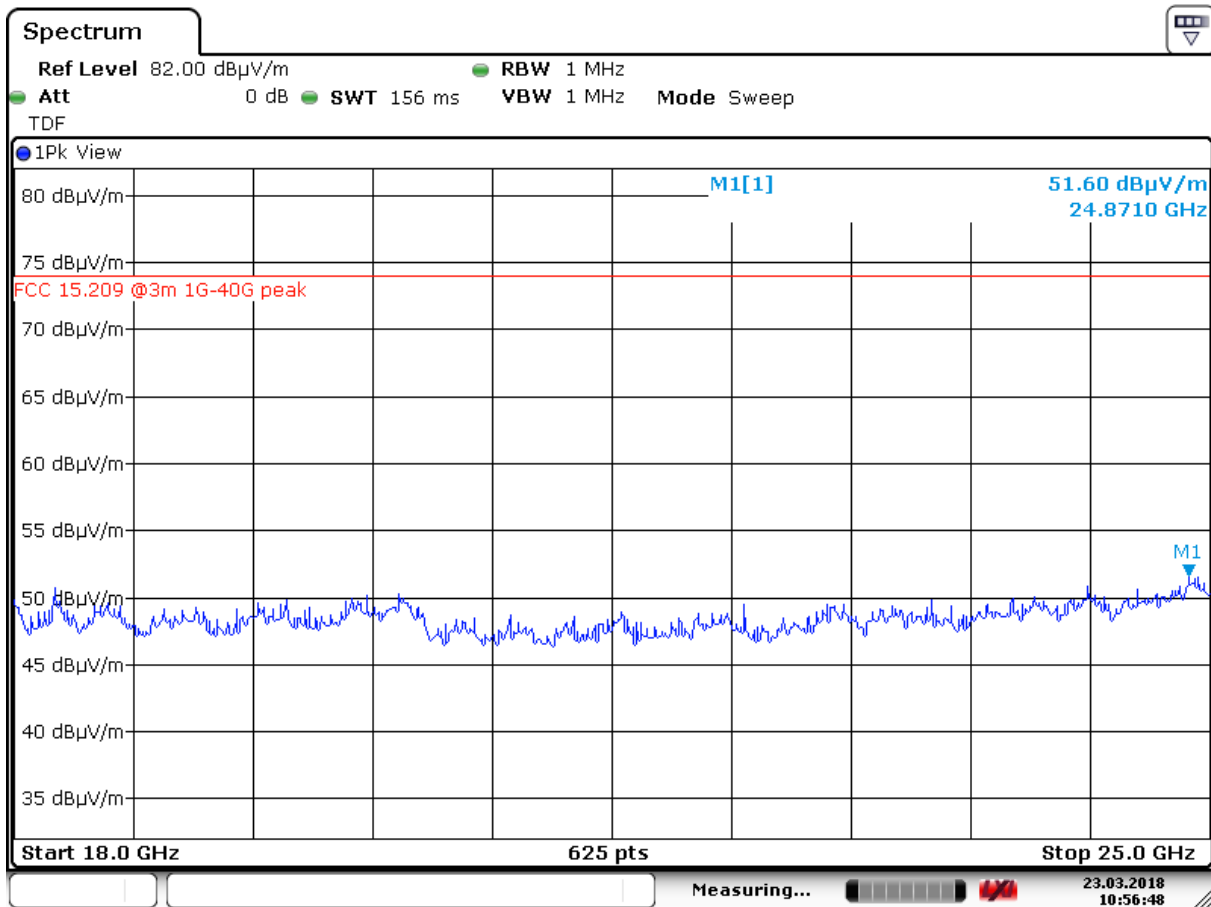
Date: 23.MAR.2018 10:48:57

Radiated Emissions ch. 2440 MHz, 18 – 25 GHz, HP, @3m – Pre-scan



Date: 23.MAR.2018 10:54:32

Radiated Emissions ch. 2479 MHz, 18 – 25 GHz, VP, @3m – Pre-scan



Date: 23.MAR.2018 10:56:49

Radiated Emissions ch. 2479 MHz, 18 – 25 GHz, HP, @3m – Pre-scan

3.9 Power Spectral Density (PSD)

Para. No.: 15.247 (d)

Test Performed By: Markus Korny

Date of Test: 2018-05-30

Test Results: Passed

Measured and Calculated Data:

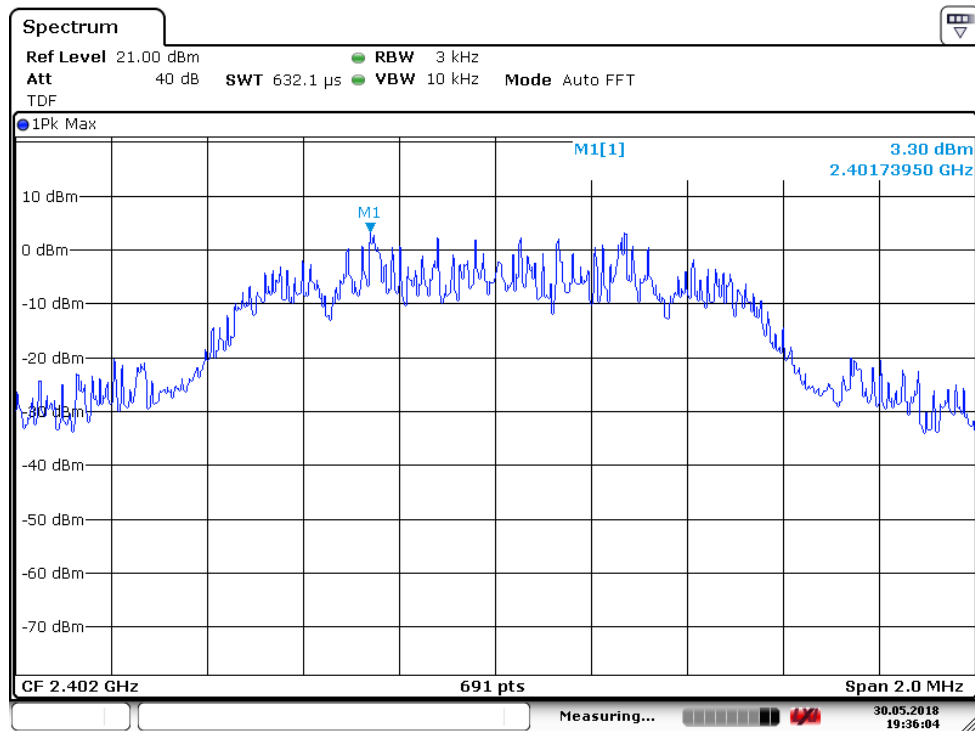
The measurement procedures PKPSD described in KDB 558074 D01 v03r05 was used.

	calculated peak PSD dBm
Power Spectral Density @2402 MHz	3.30
Power Spectral Density @2440 MHz	3.25
Power Spectral Density @2479 MHz	2.61

Requirements:

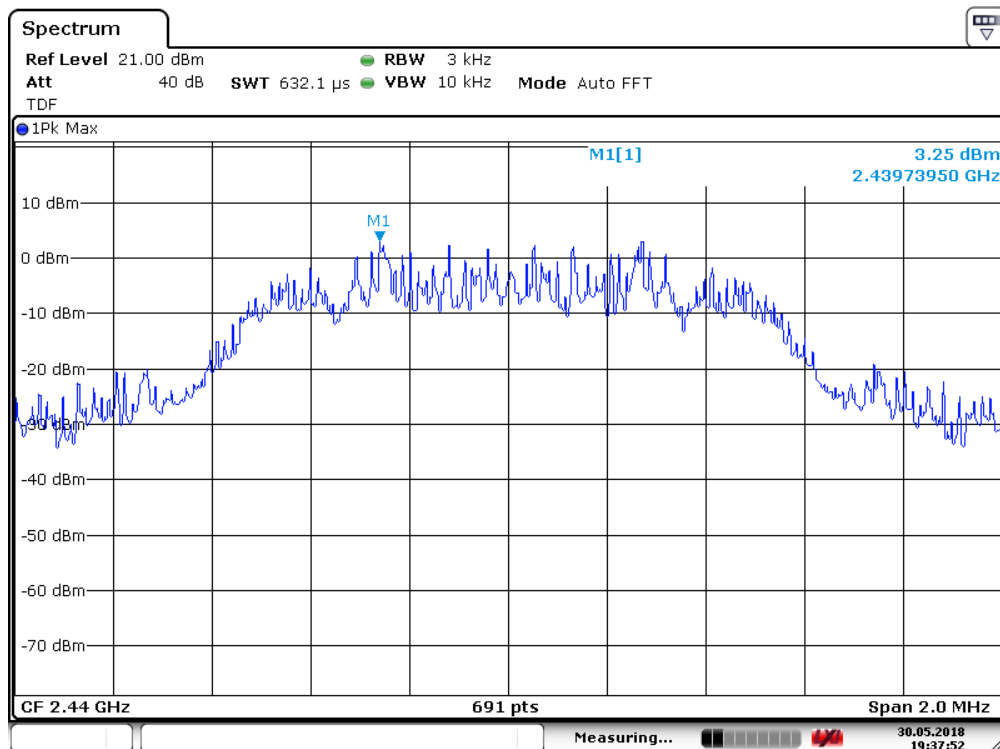
The Power Spectral Density of a Digital Transmission System shall be no greater than +8 dBm in any 3 kHz band

No requirements for Frequency Hopping Systems.



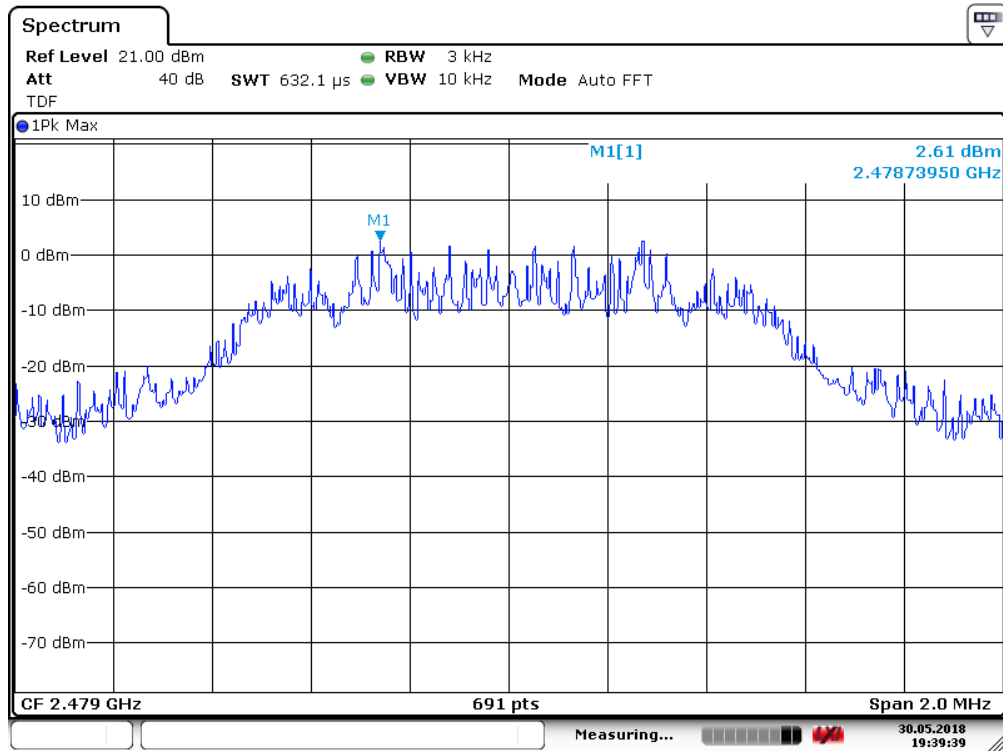
Date: 30.MAY.2018 19:36:04

PSD Measurement - 2402MHz



Date: 30.MAY.2018 19:37:52

PSD Measurement – 2440MHz



Date: 30.MAY.2018 19:39:39

PSD Measurement - 2479MHz

4 Measurement Uncertainty

Measurement Uncertainty Values		
Test Item		Uncertainty
Output Power		±0.8 dB
Power Spectral Density		±0.8 dB
Out of Band Emissions, Conducted	< 3.6 GHz	±0.8 dB
	> 3.6 GHz	±1.2 dB
Spurious Emissions, Radiated	< 200 MHz	±4.77 dB
	200 MHz - 1 GHz	±5.02 dB
	1 GHz – 18 GHz	±4.94 dB
	> 18 GHz	±5.91 dB
Emission Bandwidth		±4 %
Power Line Conducted Emissions		±3.58 %
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

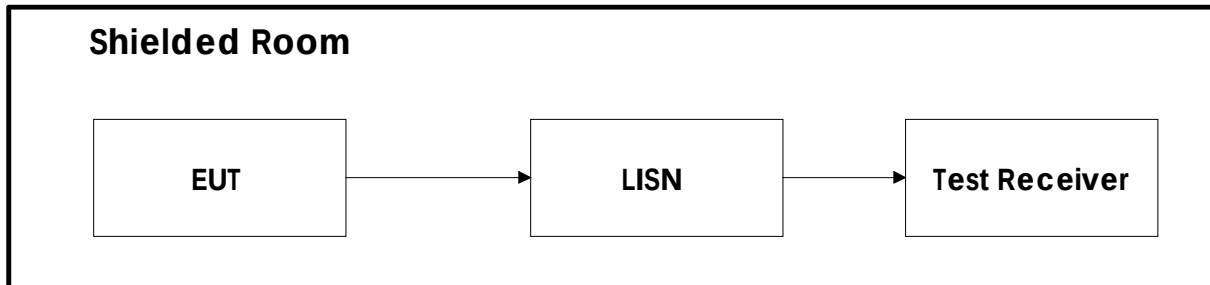
5 LIST OF TEST EQUIPMENT

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.

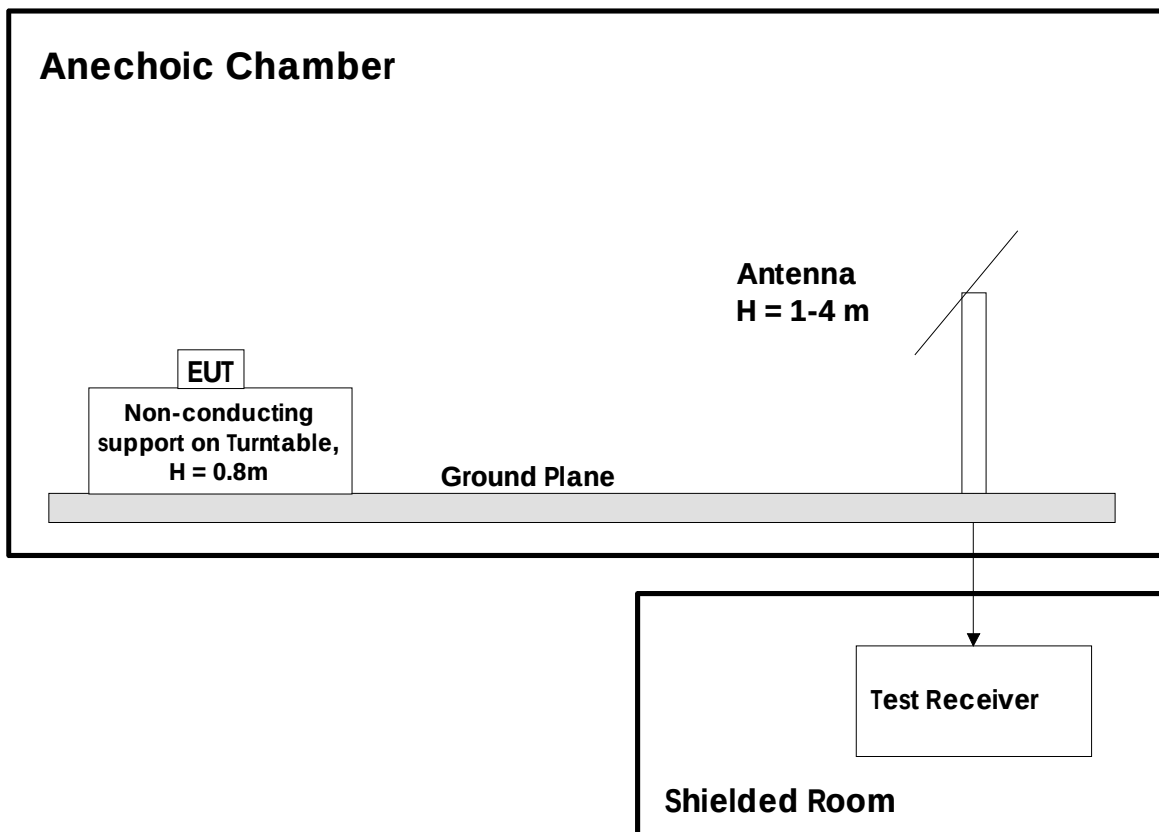
Ref No	Instrument/ ancillary	Manufacturer	Type of instrument/ ancillary	Cal. Date	Cal. Due
1-0039	Loop antenna	Rohde & Schwarz	HFH2-Z2	2017-09	2018-09
1-0040	Biconical antenna	Rohde & Schwarz	HK116	2015-08	2018-08
1-0055	LopPer antenna	Rohde & Schwarz	HL223	2015-08	2018-08
1-0080	Turntable	H. Deisel	DS 420	--	--
1-0256	Horn antenna	Schwarzbeck Mess-Elektronik	BBHA 9120	--	--
1-0361	Semi anechoic chamber	Reinhold & Mahla	3m	2017-06	2020-06
1-0364	Antenna cable 2	Kabelwerk Eupen	RF/Cord CMS / RG 214-N/7	2016-09	2019-09
1-0604	EMI test receiver	Rohde & Schwarz	ESU8	2017-09	2018-09
1-0611	Signal analyzer	Rohde & Schwarz	FSV 40	2017-09	2018-09
1-0614	Log.-per. antenna	Schwarzbeck Mess-Elektronik	STLP 9148 Stacked Log.-Per. Antenne	2016-11	2019-11
1-0615	Pre amplifier	Schwarzbeck Mess-Elektronik	BBV-9718 Broadband Preamplifier	2017-09	2018-09
1-0619	Coaxial cable (to SAC)	Huber+Suhner	SF106/2x11N-651/2m	2016-09	2019-09
1-0620	Antenna cable 3	Huber+Suhner	SF106/2x11N-651/3m	2016-09	2019-09
1-0771	Broadband Horn antenna	Schwarzbeck Mess-Elektronik	SHF-EHF Horn, 15-40GHz	2018-03	2021-03
1-0781	Pre amplifier	Schwarzbeck Mess-Elektronik	BBV 9721	2017-09	2018-09
1-0782	Antenna cable	Huber & Suhner	FB142A	2015-07	2018-07
1-0789	High Pass Filter	Mini Circuits	VHF-1320+ 1700-3800 MHz	2016-09	2019-09
1-0790	High Pass Filter	Mini Circuits	VHF-3100+ 3400-9900MHz	2016-09	2019-09
1-0791	High Pass Filter	Mini Circuits	VHF-740+ 900-2200MHz	2016-09	2019-09
1-0870	10 dB Attenuator	Mini Circuits	BW-N10W5+	2016-09	2019-09
1-0924	Cable 1m	---	SMA	2016-09	2019-09
1-0925	Cable 1m	---	SMA	2016-09	2019-09
1-0926	Cable 1m	Harbour Industries	SMA	2016-09	2019-09
1-0927	Cable 1m	Harbour Industries	SMA	2016-09	2019-09
1-0966	RF power meter	DARE	RPR3006W	2017-07	2018-07

6 BLOCK DIAGRAM

6.1 Power Line Conducted Emission



6.2 Test Site Radiated Emission



Measurements at 1GHz and above were performed with turntable height 1.5m and with the ground plane covered by absorbers.

Revision history

Version	Date	Comment	Sign
002	2018-11-16	Plots implemented to support duty cycle calculation	mk
001	2018-07-26	Report according equipment class DTS	mk
000	2018-05-31	First version	mk