

Test Report

Product	Radio Module with Lora Transceiver
Name and address of the applicant	Nordic Light AB Servicegatan 13 93124 Skellefteå, Sweden
Name and address of the manufacturer	Nordic Light AB Servicegatan 13 93124 Skellefteå, Sweden
Model	2096
Rating	5.0V _{DC} (30mA, microUSB)
Trademark	Piri
Serial number	1
Additional information	Lora, CSS
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	383761
Tested in period	2020-03-24 to 2020-03-25
Issue date	2020-11-25
Name and address of the testing laboratory	 Instituttveien 6 Kjeller, Norway www.nemko.com CAB Number: FCC: NO0001 ISED: NO0470 TEL: +47 22 96 03 30 FAX: +47 22 96 05 50   An accredited technical test executed under the Norwegian accreditation scheme
 Prepared by [Frode Sveinsen]  Approved by [G.Suhanthakumar]	
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1 INFORMATION

1.1 Test Item

Name	Piri
FCC ID	2AX9P-2096
ISED ID	/
Model/version	2096
Serial number	1
Hardware identity and/or version	2096-103
Software identity and/or version	1.5
Frequency Range	2402 – 2480 MHz
Channel Separation	2 MHz
Number of Channels	40
Type of Modulation	Lora Transceiver with Chirp Spread Spectrum Modulation (CSS)
Operating Modes	Selectable Bandwidth 400 kHz, 800 kHz, 1600 kHz
Rated Output Power	2.8 mW
Type of Power Supply	microUSB
Antenna Connector	None (Integral Antenna)
Number of Antennas	1
Diversity or Smart Antennas	N/A
Desktop Charger	N/A

Description of Test Item

The EUT is a radio module with Lora Transceiver.

1.2 Normal test condition

Temperature: 20 - 24 °C
Relative humidity: 20 - 50 %
Normal test voltage: 5.0 V DC

The values are the limit registered during the test period.

1.3 Test Engineer(s)

Frode Sveinsen / G. Suhantakumar

1.4 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

1.5 Duty Cycle Correction

Operating Mode	Spreading Factor (Worst Case)	Transmission Time (ms)	Transmission Window (ms)	Maximum Duty Cycle (%)	Duty Cycle Correction Factor (dB)	Maximum Allowed DC Corr Factor
bw400kHz	SF6	33	125*2	33	9.6	20 dB
bw800kHz	SF7	29	125*2	29	10.8	20 dB
bw1600kHz	SF7	14	125*2	14	17.1	20 dB

Maximum 4 transmissions per second
Maximum allowed Duty Cycle Correction Factor is 20 dB

1.6 Worst-Case Configuration and Mode

All RF tests were performed with the EUT transmitting at Power Level 5. During RF measurements the EUT was powered and controlled from a computer connected by USB.

Most measurements were performed at all bandwidths, some tests were performed only on 800 kHz. It was checked that the output power was similar for all bandwidths.

Power Line Conducted Emissions were performed by the EUT powered from the supplied USB Power Adaptor. The EUT transmits bursts on 3 channels when connected to the adaptor.

1.7 Comments

The measurements were done with the EUT powered from the microUSB connector.

2 TEST REPORT SUMMARY

2.1 General

All measurements are traceable to national standards.

The tests were conducted for demonstrating compliance with FCC CFR 47 Part 15, paragraph 15.247 and Industry Canada RSS-247 Issue 2 and RSS-GEN Issue 5.

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

Radiated tests were made in a semi-anechoic chamber at measuring distances of 1m, 3m and 10m.

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

☒ 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".

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2.2 Test Summary

Name of test	FCC Part 15 reference	RSS-247 Issue 2, RSS-GEN Issue 5 reference	ANSI C63.10-2013 Reference	Result
Supply Voltage Variations	15.31(e)	6.11 (RSS-GEN)	5.13	Complied
Antenna Requirement	15.203	6.8 (RSS-GEN)	5.8	Complies
Power Line Conducted Emission	15.107(a) 15.207(a)	7.2 / 8.8 (RSS-GEN)	6.2	Complied
Occupied Bandwidth (99% BW)	N/A	6.7 (RSS-GEN)	6.9.3	Complied
DTS Bandwidth	15.247(a)(2)	5.2 (1) (RSS-247)	11.8 Option 2	Complies
Peak Power Output	15.247(b)	5.4 (RSS-247)	11.9.1.1	Complied
Power Spectral Density	15.247(d)	5.2 (2) (RSS-247)	11.10.2 PKPSD (DTS)	Complies
Spurious Emissions (Antenna Conducted)	15.247(c)	5.5 (RSS-247)	6.7 11.11 (DTS)	Complied
Spurious Emissions (Radiated)	15.247(c) 15.109(a) 15.209(a)	5.5 (RSS-247) 7.3 (RSS-GEN) 8.9 (RSS-GEN)	6.3, 6.5, 6.6, 6.10 11.12, 11.13 (DTS)	Complies

Revision history

Revision	Date	Comment	Sign
00	2020.11.25	First edition	FS

3 TEST RESULTS

3.1 Power Line Conducted Emissions

FCC Part 15.107 (a)

ISED RSS-GEN Issue 5, Clause 7.2/8.8

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

Test Results: Complies

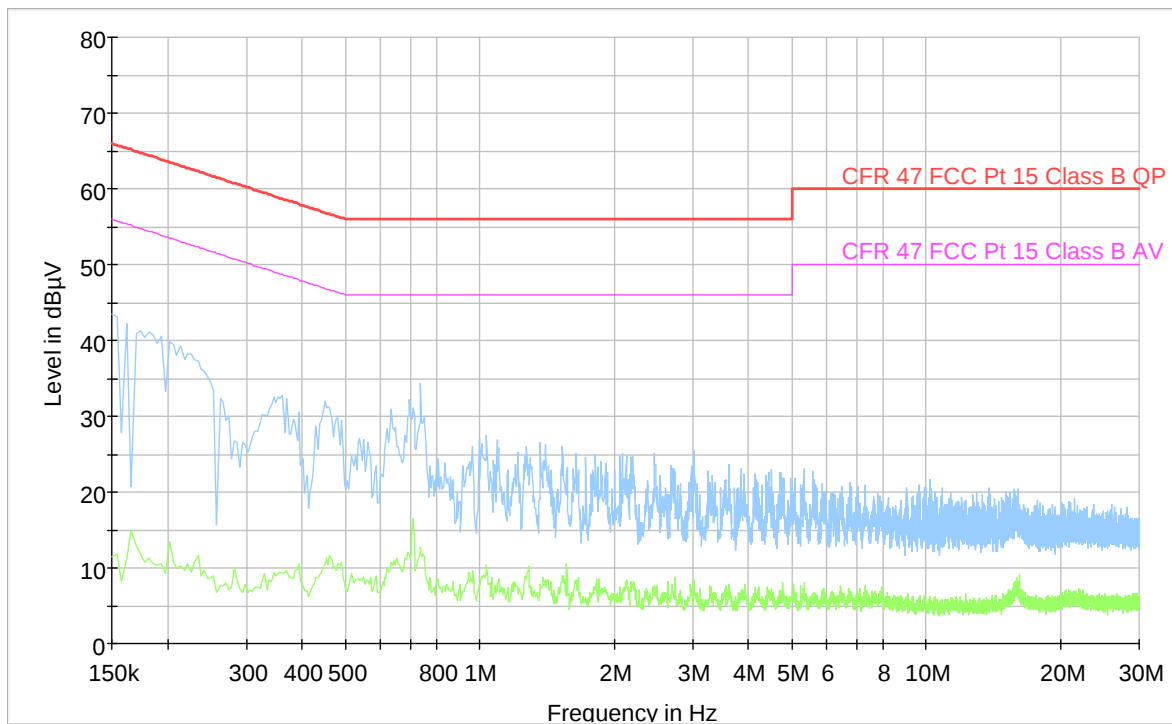
Measurement Data: See attached plots.

Highest measured value (L1 and N):

120V 60Hz

Frequency (MHz)	QuasiPeak (dB μ V)	Average (dB μ V)	Limit (dB μ V)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Filter
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Full Spectrum



Tested with USB Adaptor DELTACO Model: USB-AC158

3.2 Occupied Bandwidth (99% BW)

FCC Part 15.247 (a)(1)(iii)

ISED Canada RSS-247 Issue 2, Clause 5.1

ISED Canada RSS-GEN Issue 5, Clause 6.7

Measurement procedure: ANSI C63.10-2013 Clause 6.9.3 / 7.8.3

Test Results: Complies

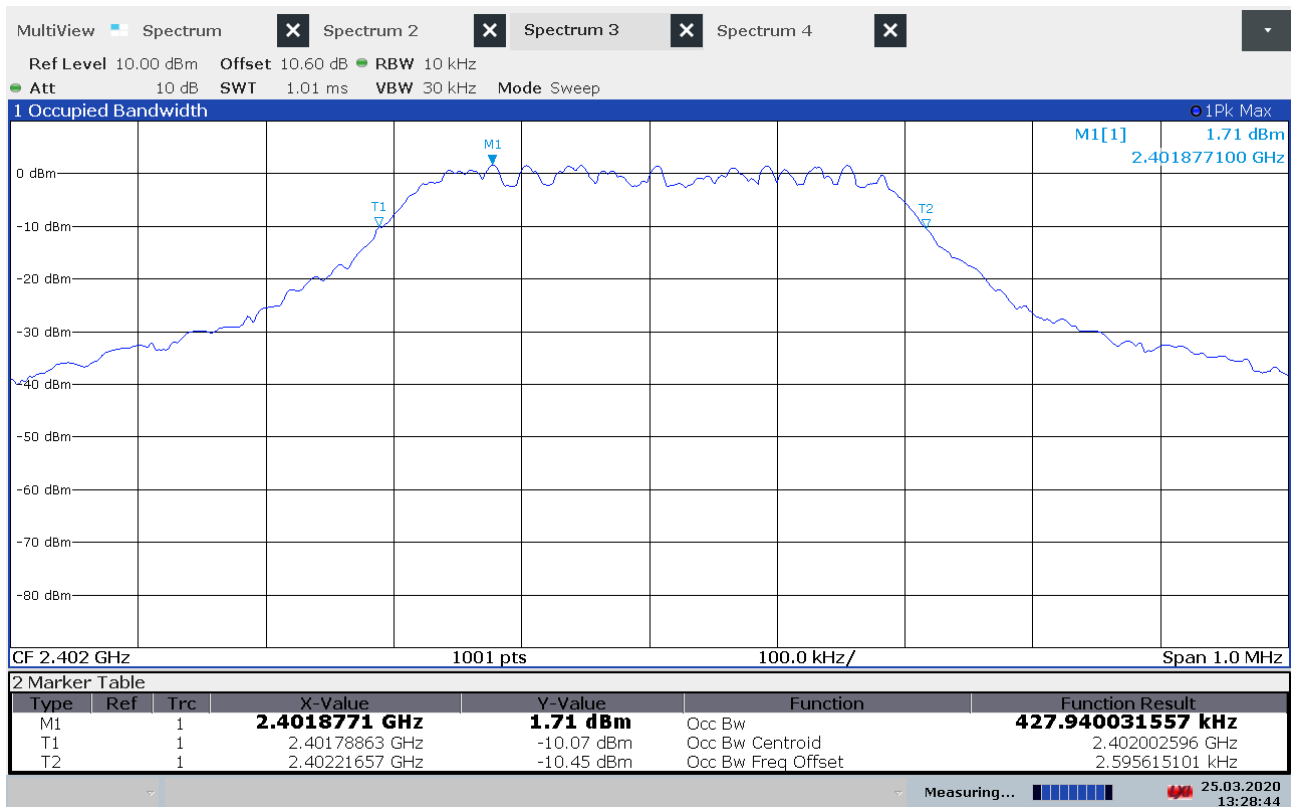
Measurement Data:

Carrier Frequency	Occupied Bandwidth (99% BW)		
	bw400kHz	Bw800kHz	Bw1600kHz
2402 MHz	428 kHz	875 kHz	1.67 MHz
2440 MHz	429 kHz	873 kHz	1.67 MHz
2480 MHz	427 kHz	871 kHz	1.68 MHz

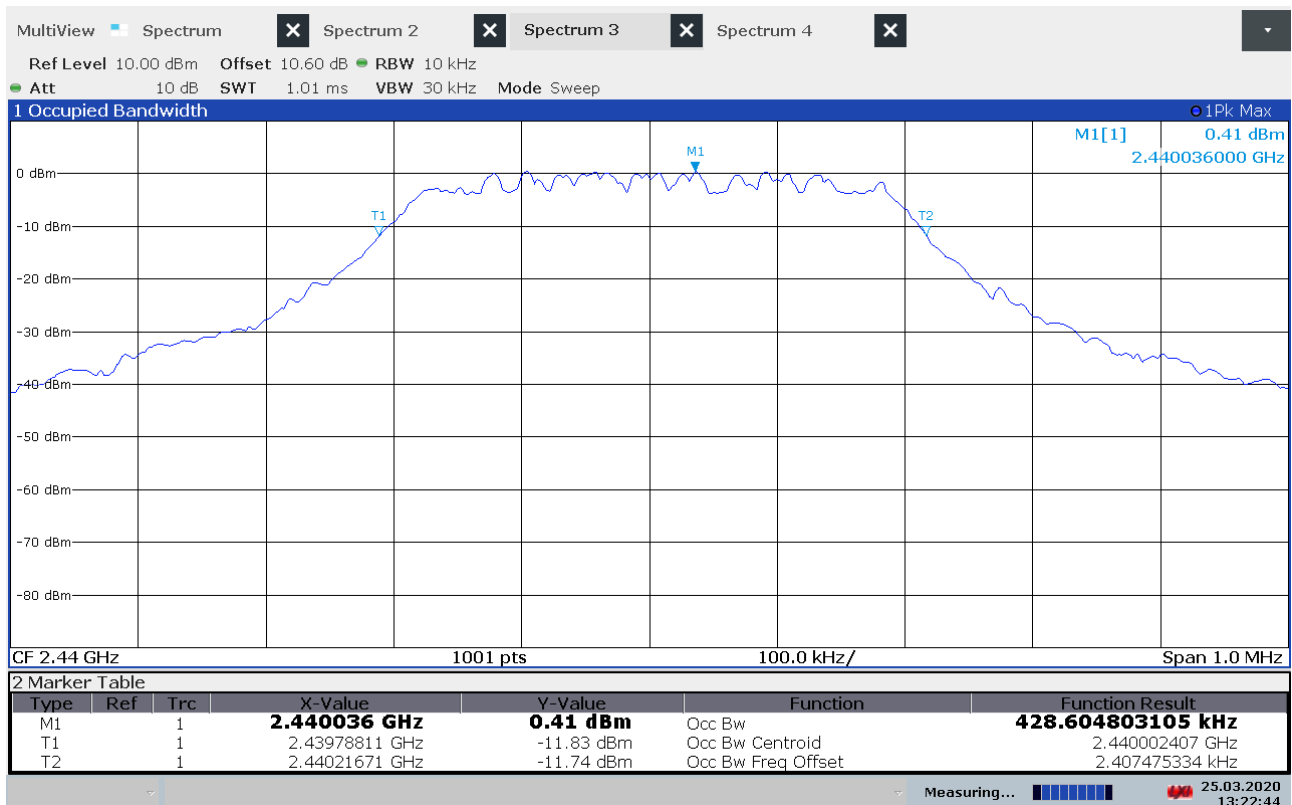
See attached plots.

Requirements:

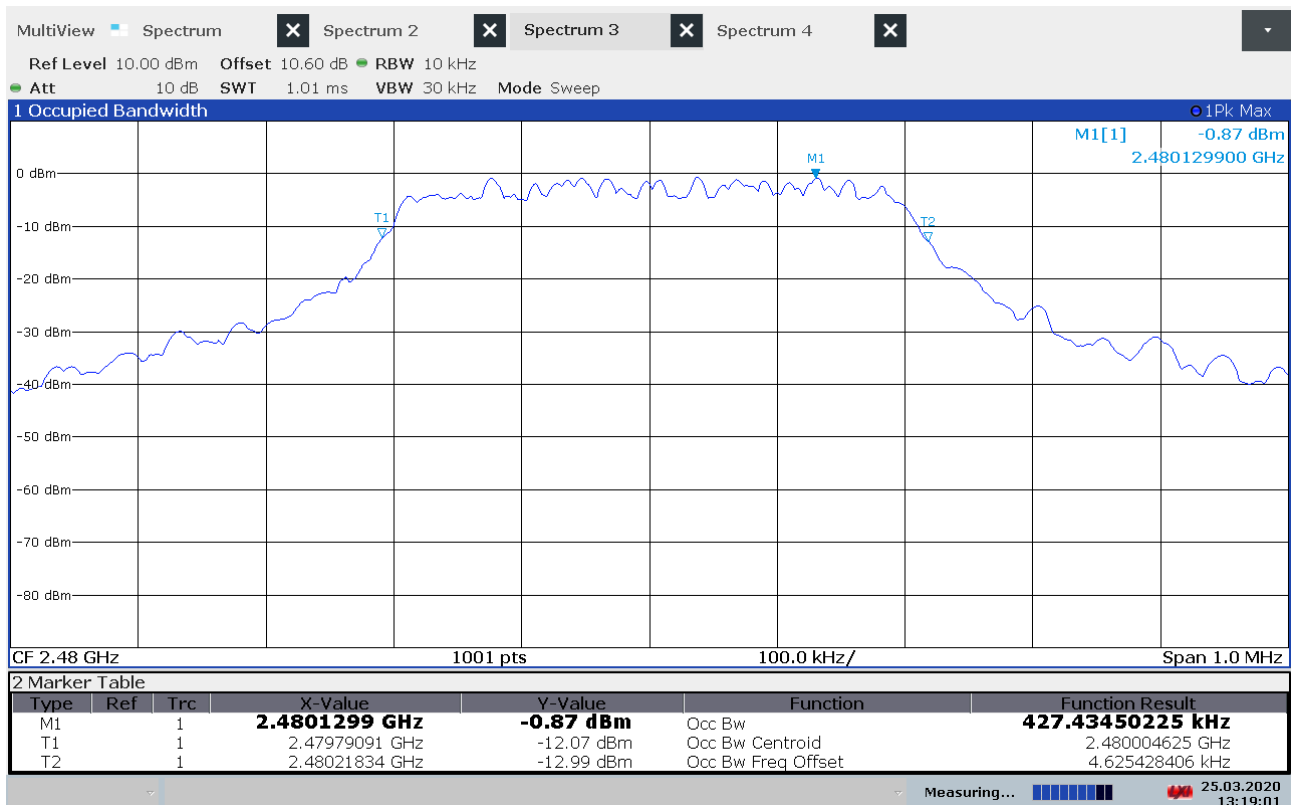
No requirement for 99% BW, reported for information only.



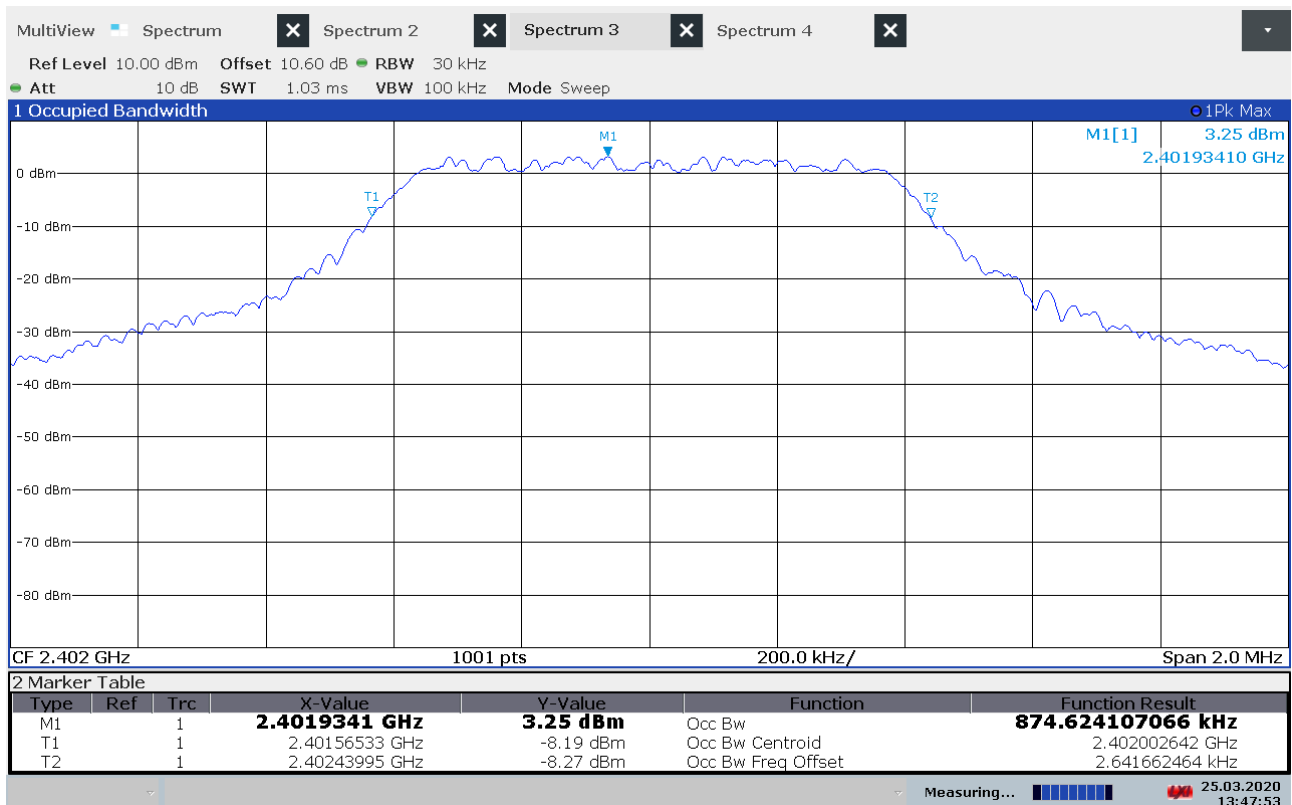
99% Bandwidth, 2402 MHz, bw400kHz



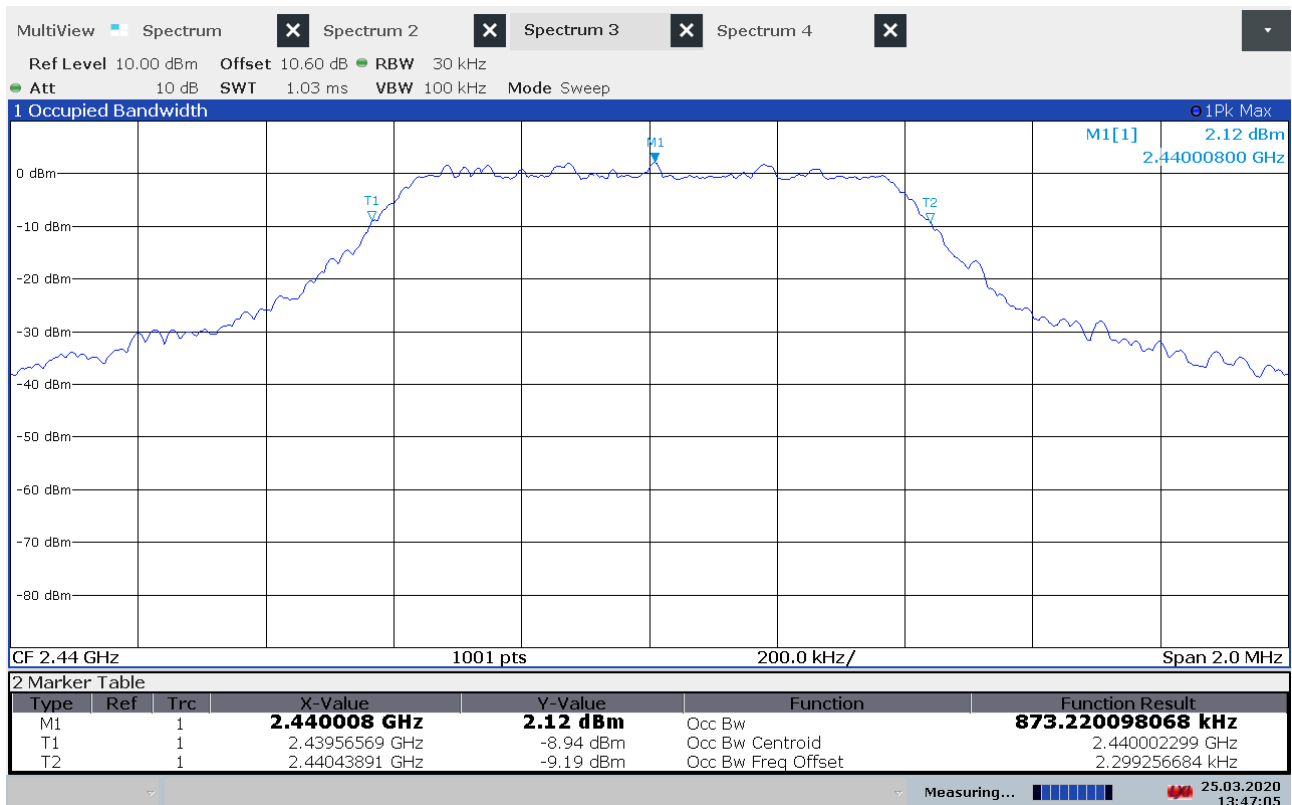
99% Bandwidth, 2440 MHz, bw400kHz



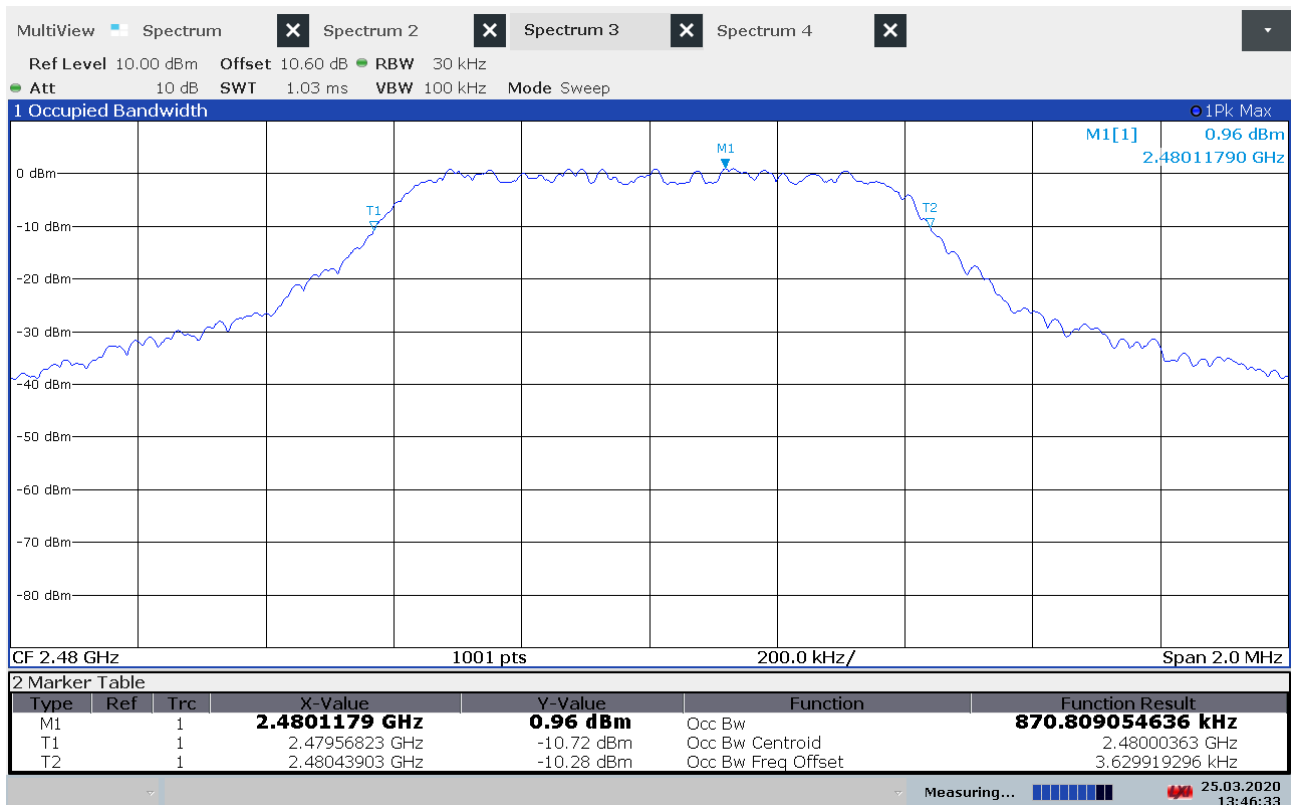
99% Bandwidth, 2480 MHz, bw400kHz



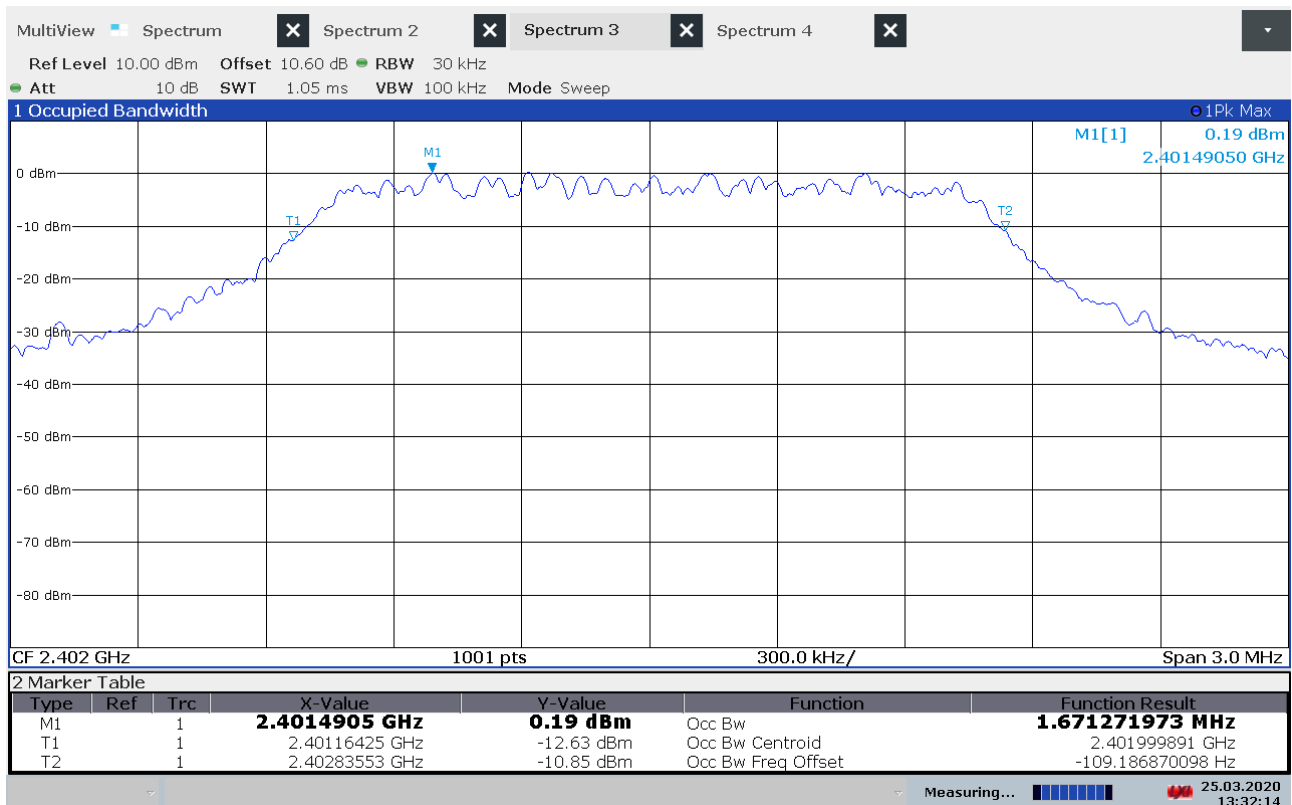
99% Bandwidth, 2402 MHz, bw800kHz



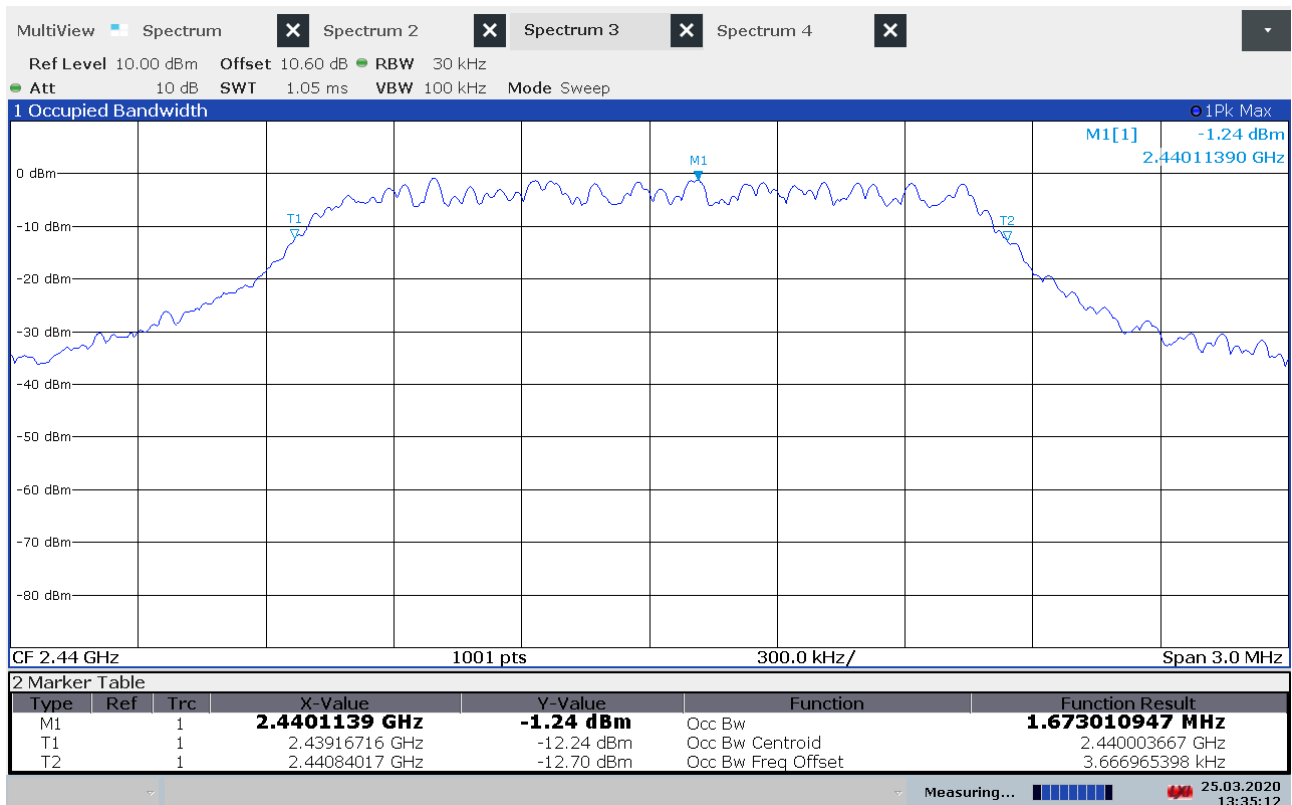
99% Bandwidth, 2440 MHz, bw800kHz



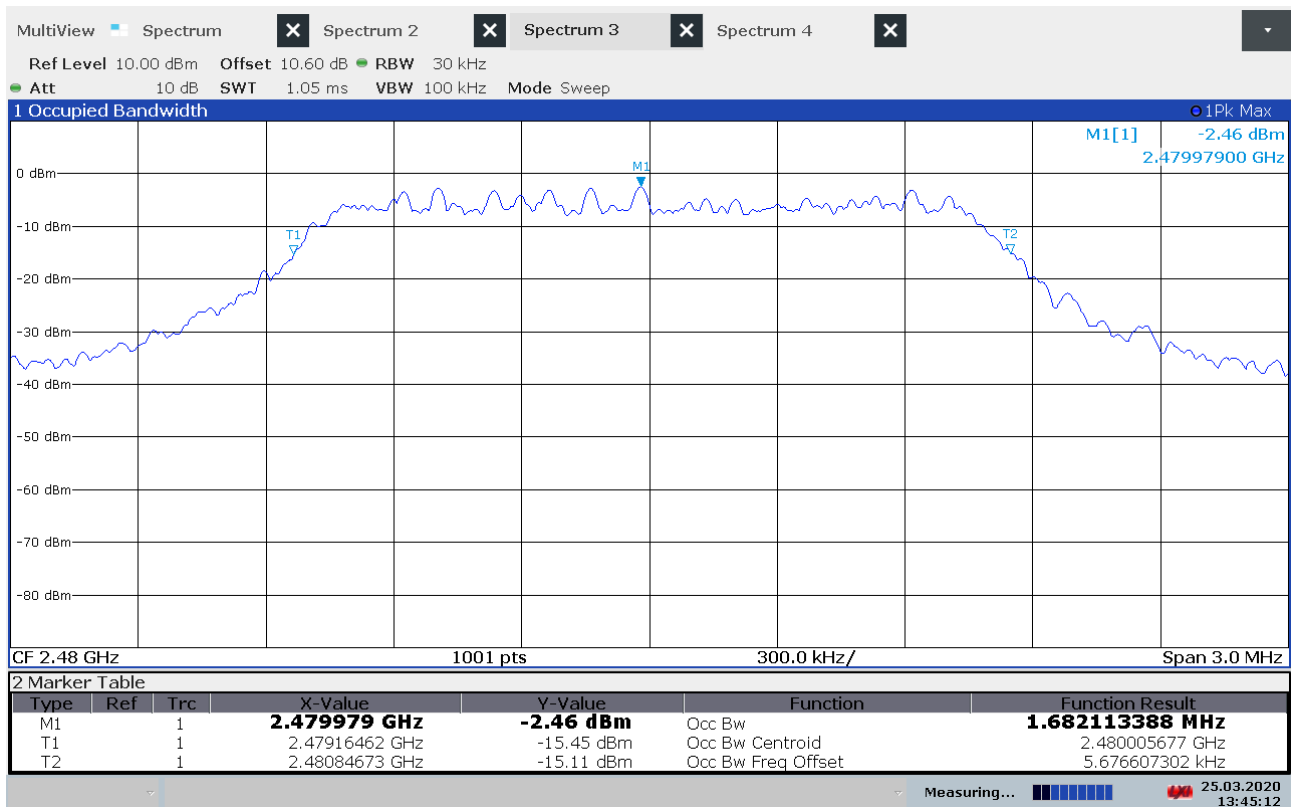
99% Bandwidth, 2480 MHz, bw800kHz



99% Bandwidth, 2402 MHz, bw1600kHz



99% Bandwidth, 2440 MHz, bw1600kHz



99% Bandwidth, 2480 MHz, bw1600kHz

3.3 DTS Bandwidth

FCC Part 15.247 (a)(2)

ISED Canada RSS-247 Issue 2, Clause 5.2 (a)

Measurement procedure: ANSI C63.10-2013 Clause 11.8

Test Results: Complies

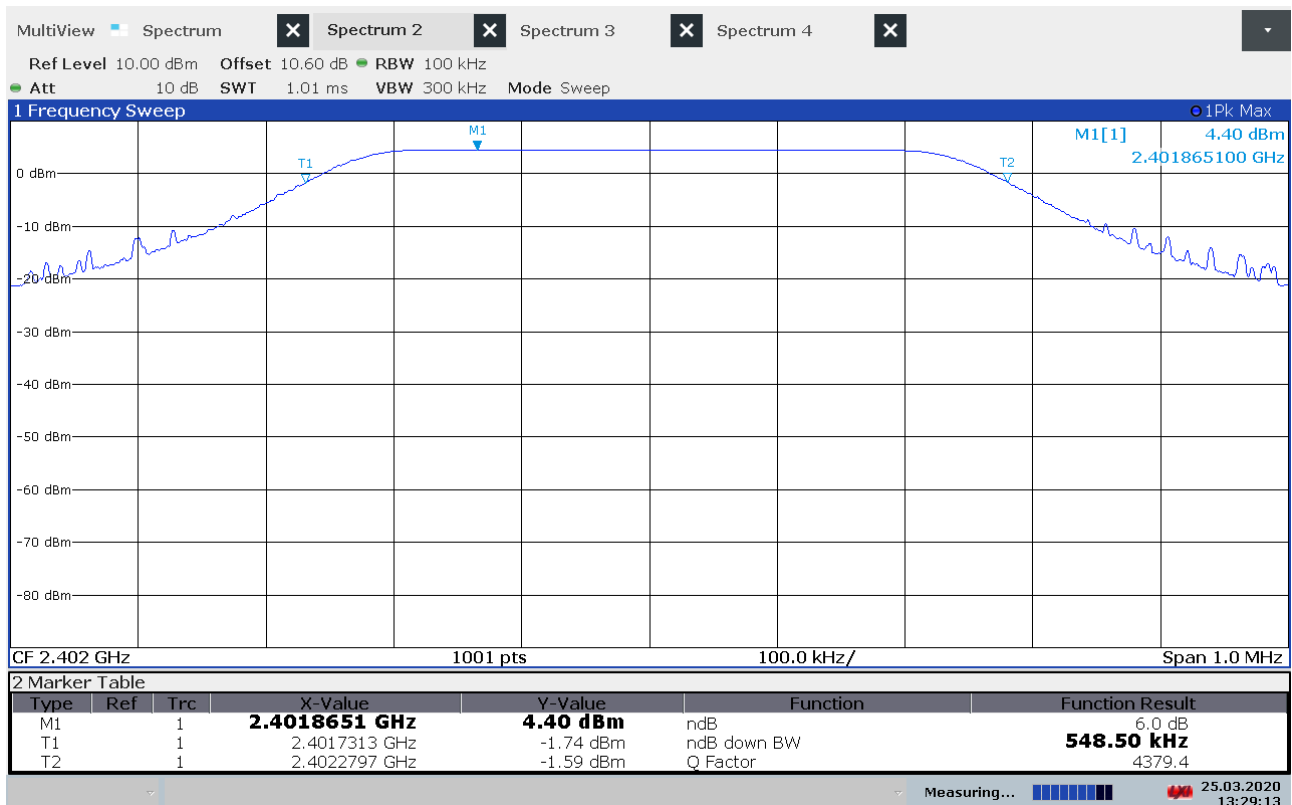
Measurement Data:

Carrier Frequency	DTS Bandwidth (6dB BW)		
	bw400kHz	Bw800kHz	Bw1600kHz
2402 MHz	549 kHz	931 kHz	1.66 MHz
2440 MHz	548 kHz	935 kHz	1.68 MHz
2480 MHz	552 kHz	939 kHz	1.69 MHz

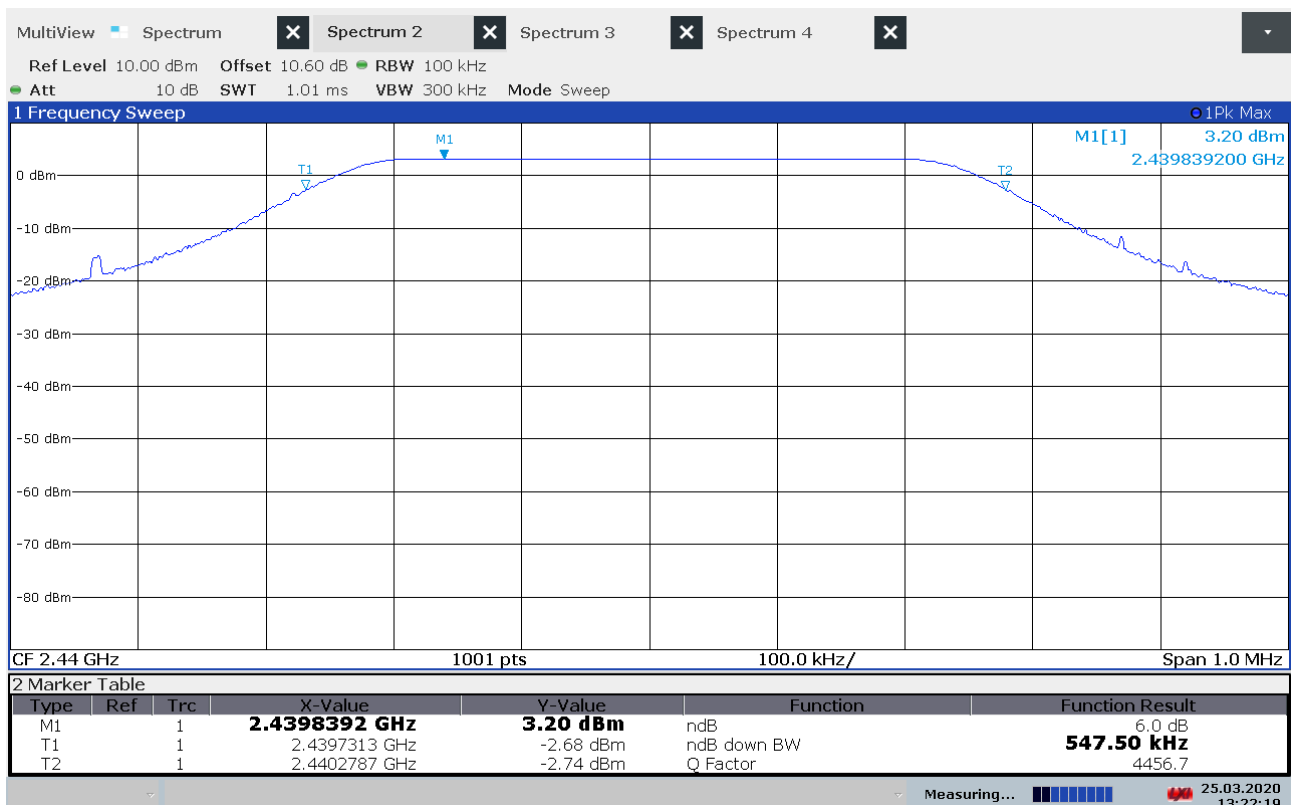
Requirements:

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

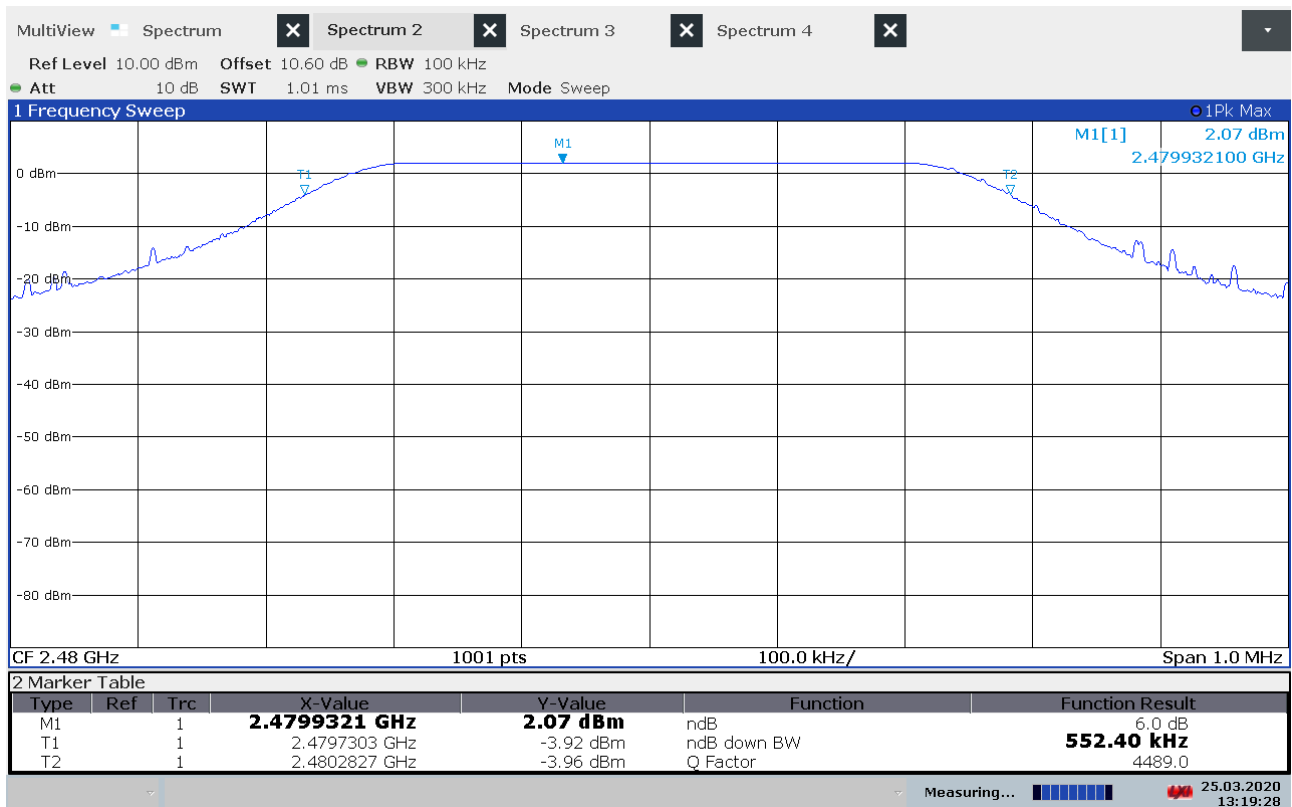
No requirements for Frequency Hopping Systems.



DTS Bandwidth, 2402 MHz, bw400kHz



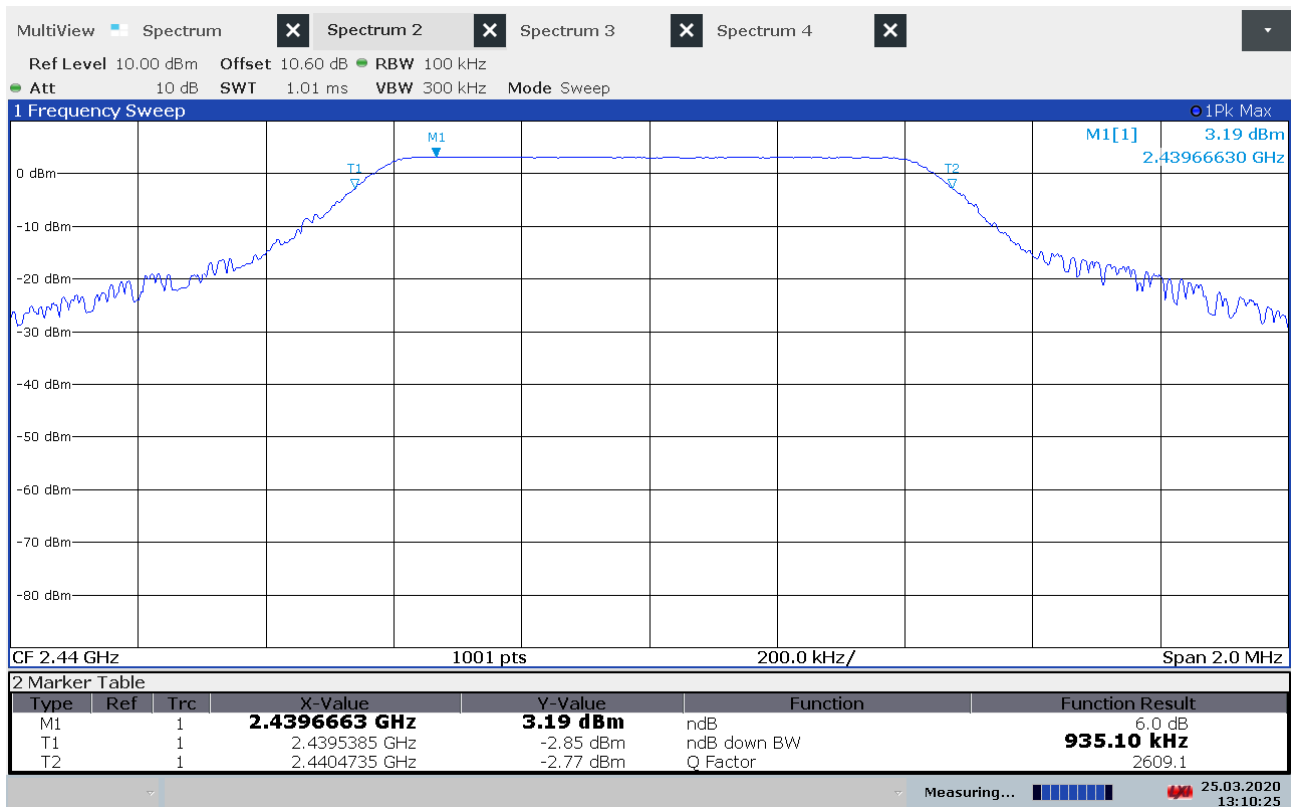
DTS Bandwidth, 2440 MHz, bw400kHz



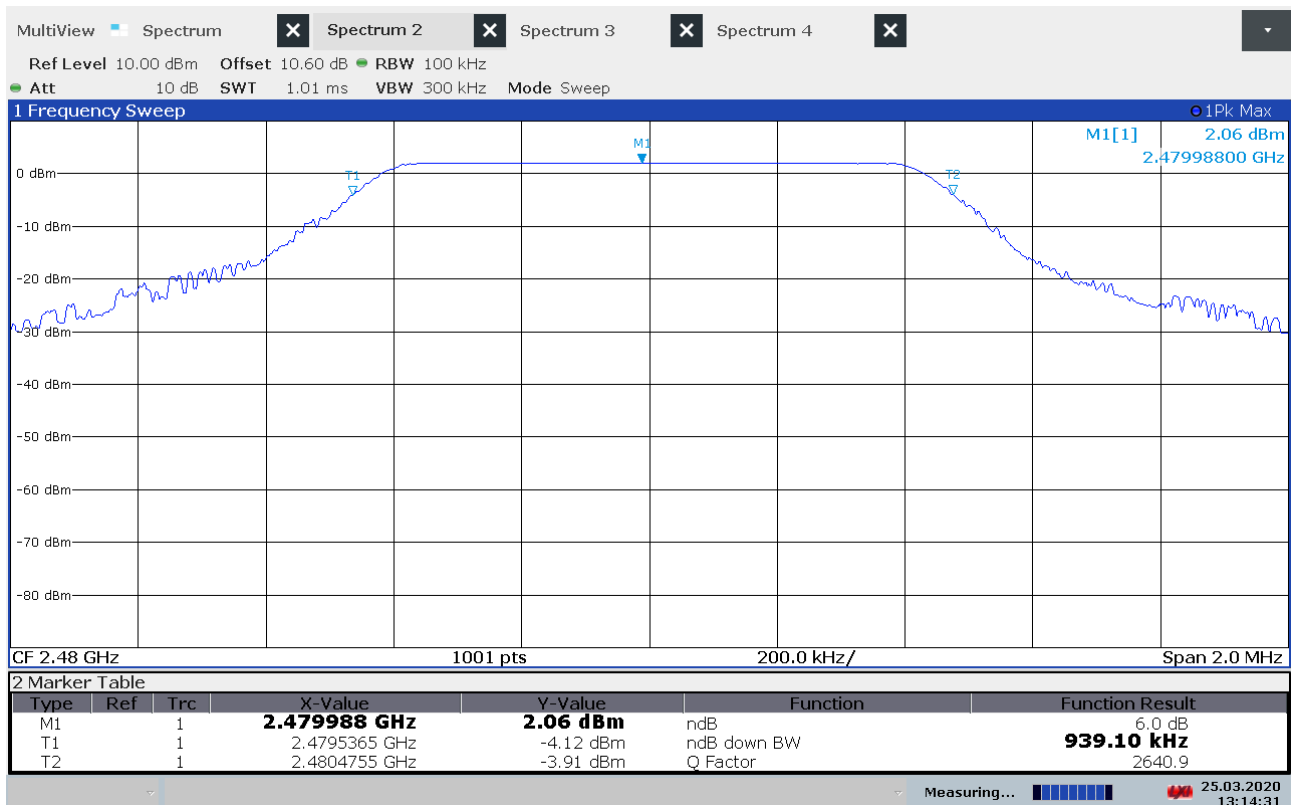
DTS Bandwidth, 2480 MHz, bw400kHz



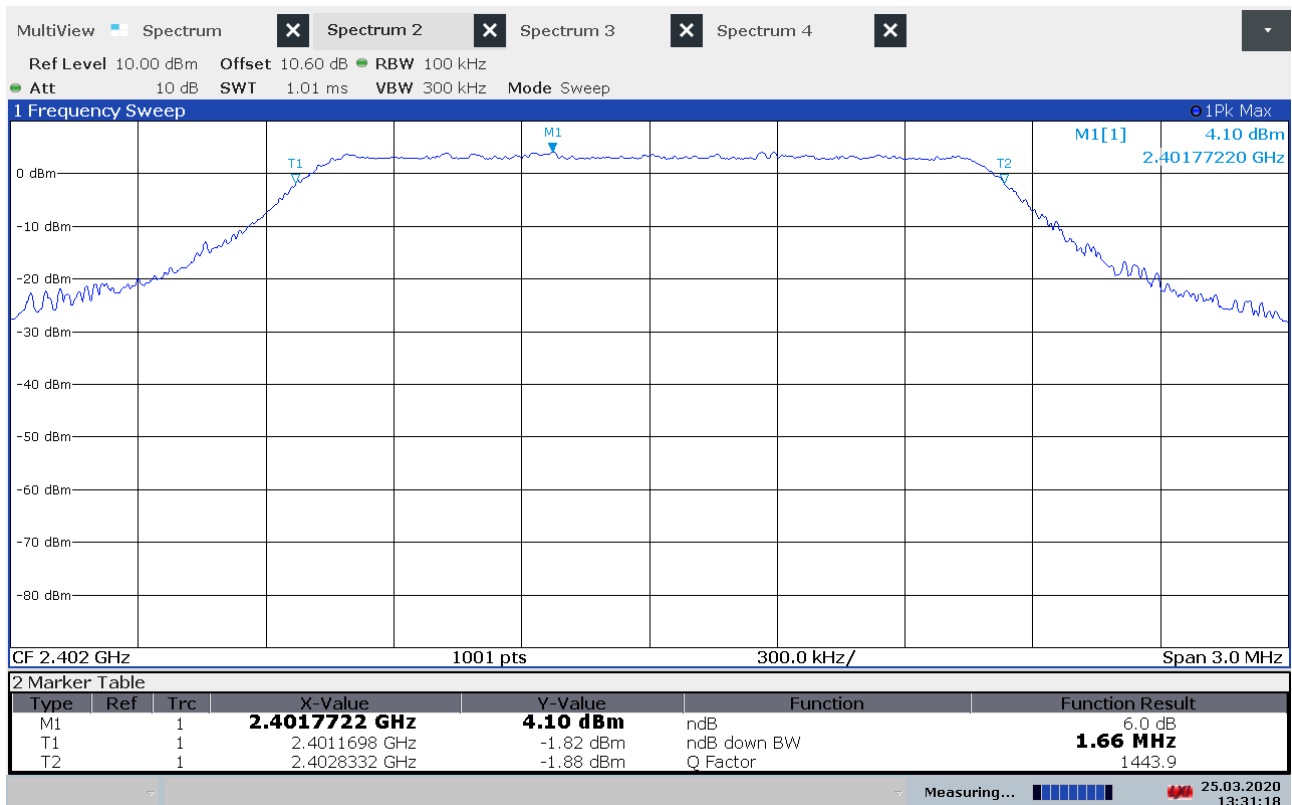
DTS Bandwidth, 2402 MHz, bw800kHz



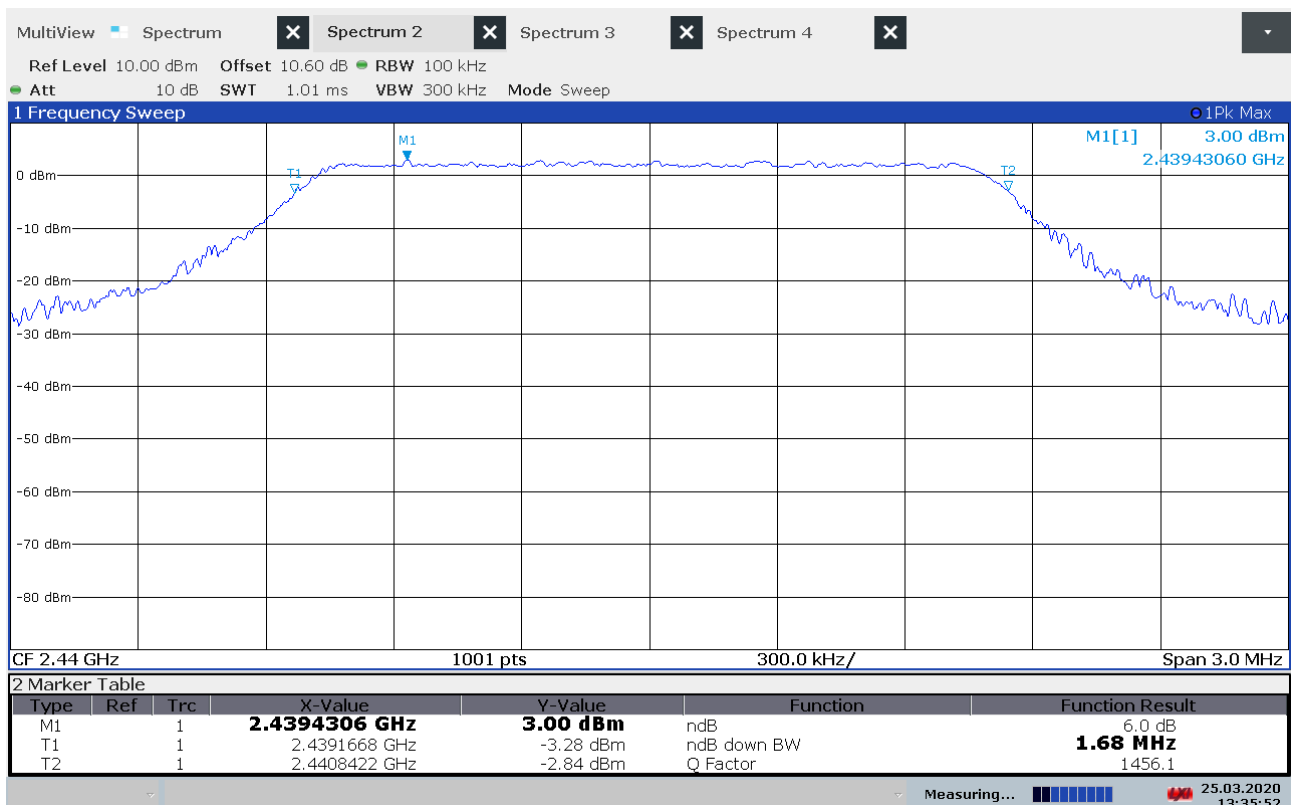
DTS Bandwidth, 2440 MHz, bw800kHz



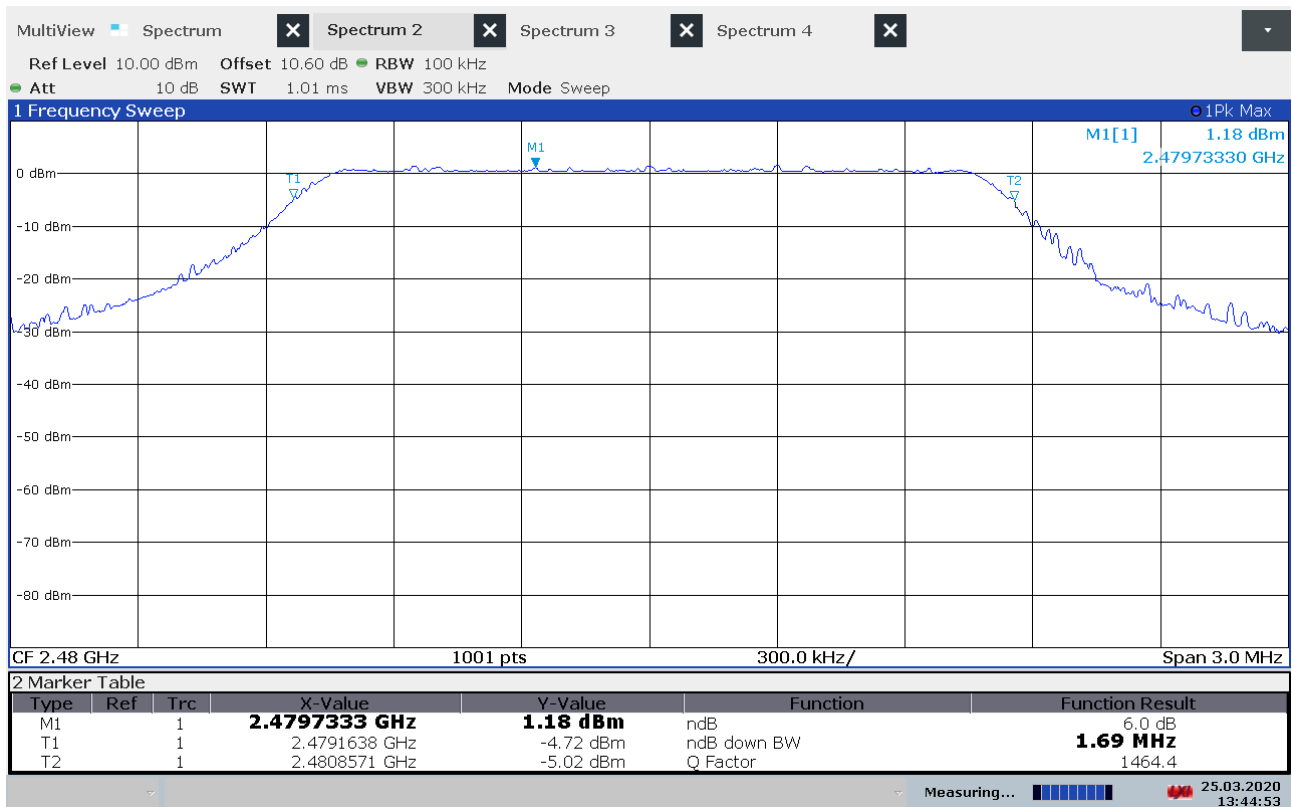
DTS Bandwidth, 2480 MHz, bw800kHz



DTS Bandwidth, 2402 MHz, bw1600kHz



DTS Bandwidth, 2440 MHz, bw1600kHz



DTS Bandwidth, 2480 MHz, bw1600kHz

3.4 Peak Power Output

FCC Part 15.247 (b)

ISED Canada RSS-247 Issue 2, Clause 5.4

Measurement procedure: ANSI C63.10-2013 Clause 11.9.1.2

Test Results: Complies

Measurement Data:

	Operating Mode	2402 MHz	2440 MHz	2480 MHz
Conducted Power (dBm)	bw400kHz	4.4	3.3	2.2
	bw800kHz	4.5	3.2	2.2
	bw1600kHz	4.4	3.3	2.0
Conducted Power (mW)	bw400kHz	2.8	2.1	1.7
	bw800kHz	2.8	2.1	1.6
	bw1600kHz	2.8	2.1	1.6
Field Strength (dBμV/m)	bw800kHz	100.84	102.22	102.09
EIRP, Calculated (mW)	bw800kHz	3.6	5.0	4.9
Antenna gain (dBi)	bw800kHz	1.2	3.7	4.7

Output Power reported is Maximum Peak Power.

Radiated Power was calculated from measured Field Strength using the method described in FCC KDB 412172 D01.

Antenna Gain is less than 6 dBi.

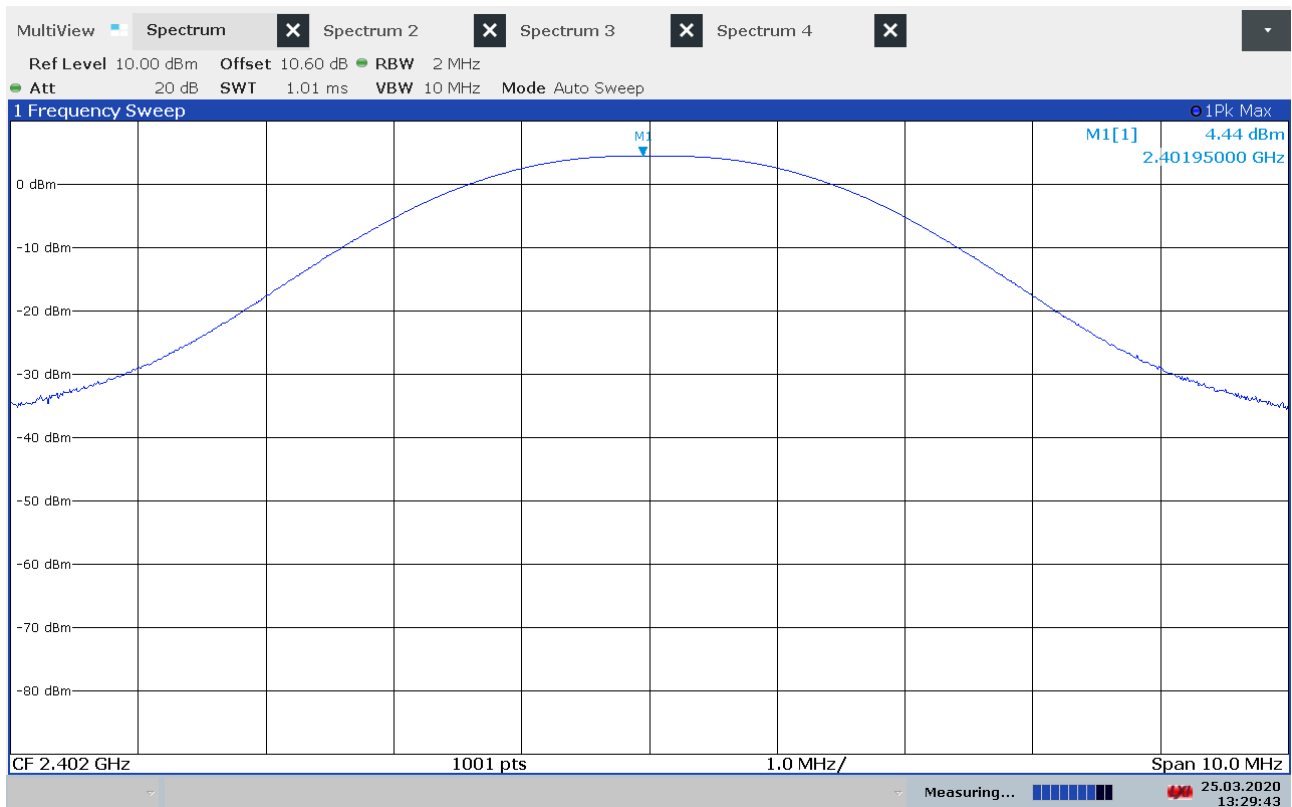
See attached plots.

Requirements:

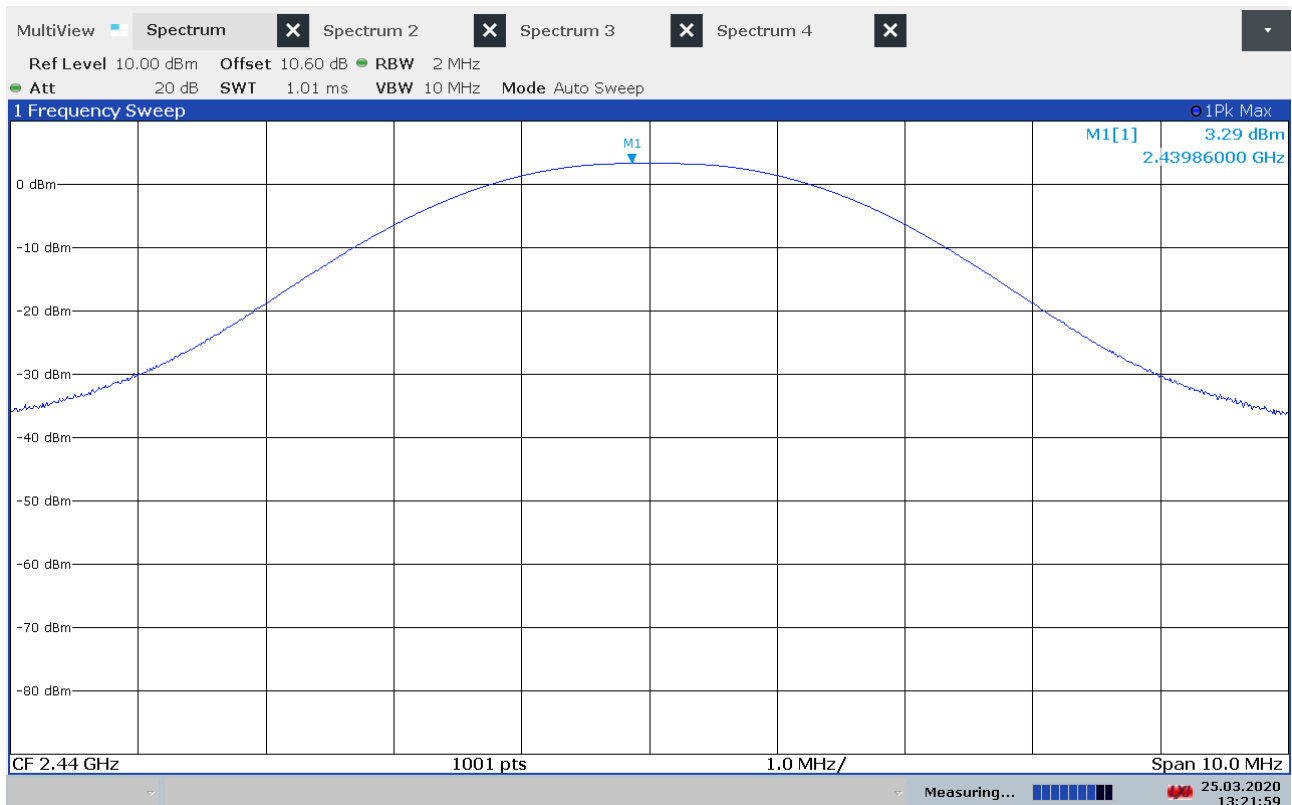
The maximum peak output power shall not exceed the following limits:

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

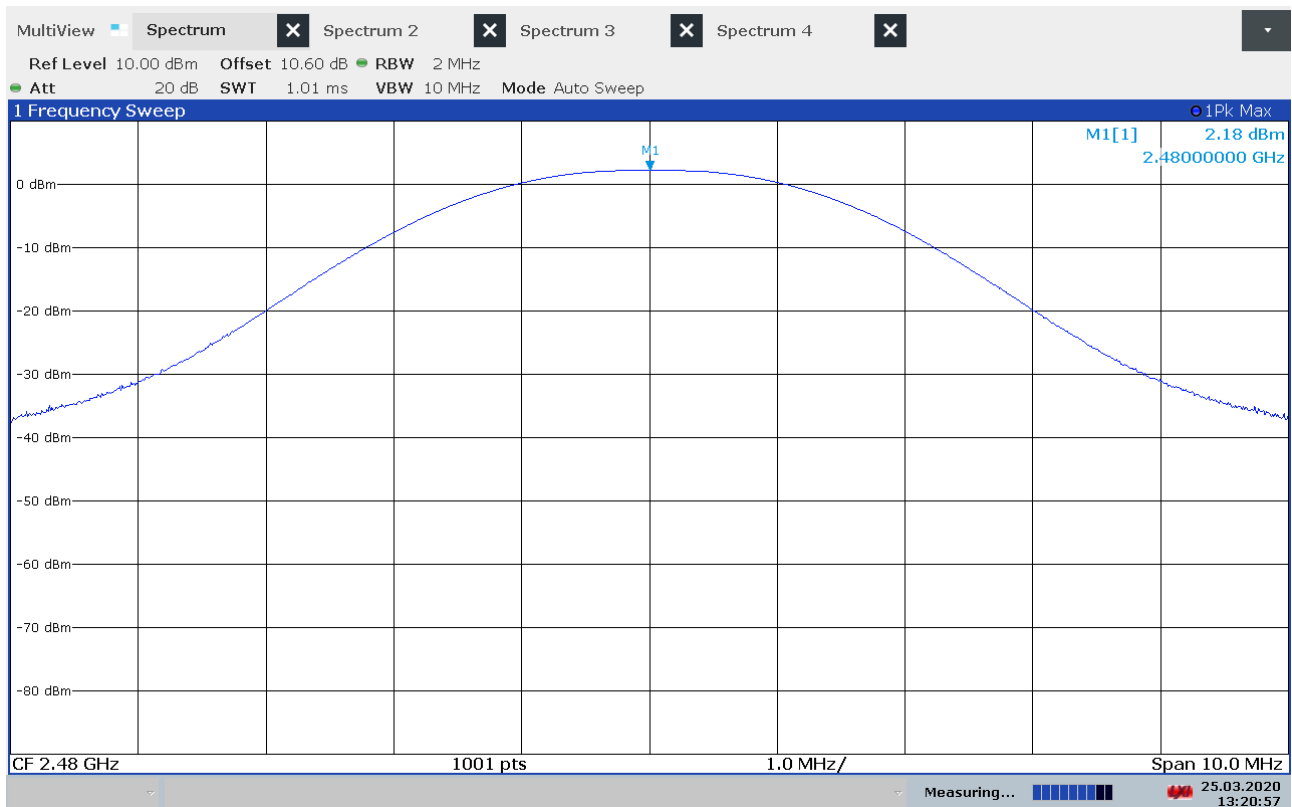
If transmitting antennas of directional gain greater than 6 dBi are used, the peak output power from the intentional radiator shall be reduced below the stated value above by the amount in dB that the directional gain of the antenna exceeds 6 dBi.



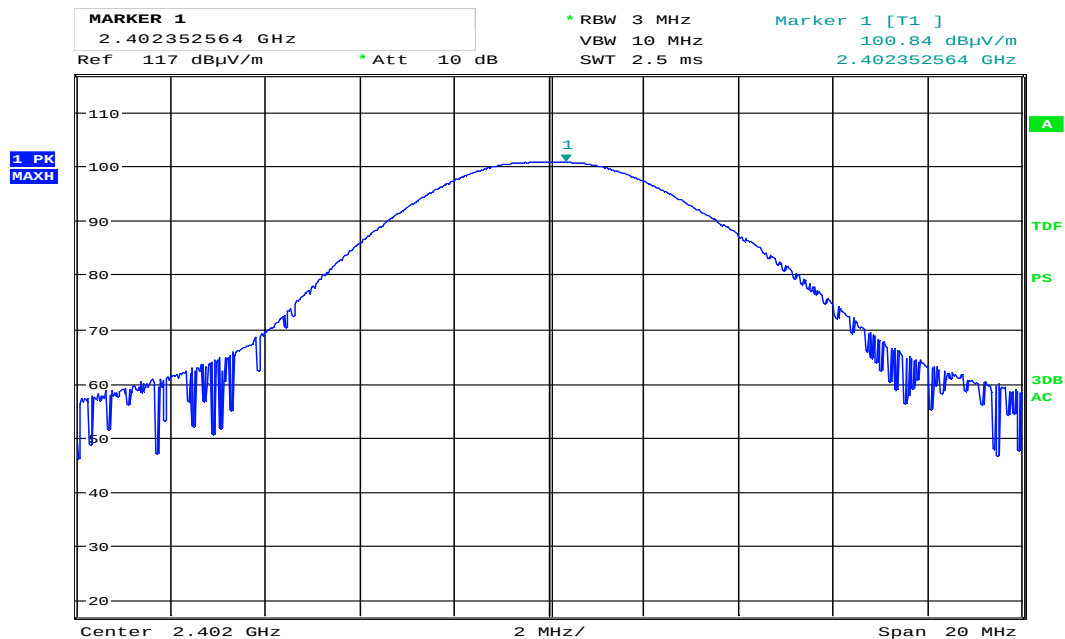
Output Power 2402 MHz, bw400kHz



Output Power 2440 MHz, bw400kHz

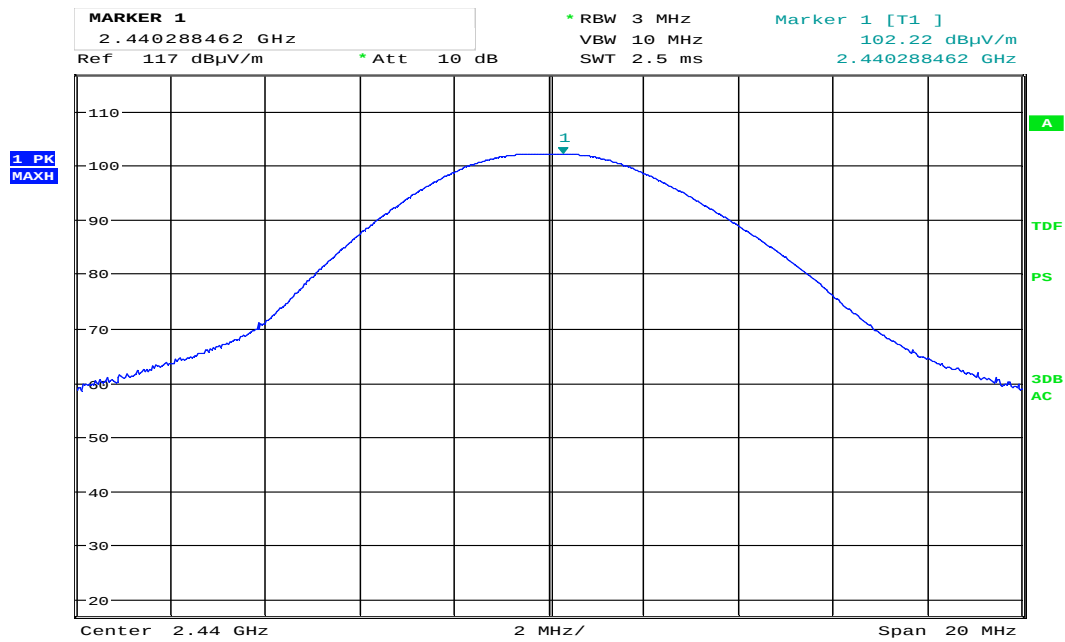


Output Power 2480 MHz, bw400kHz



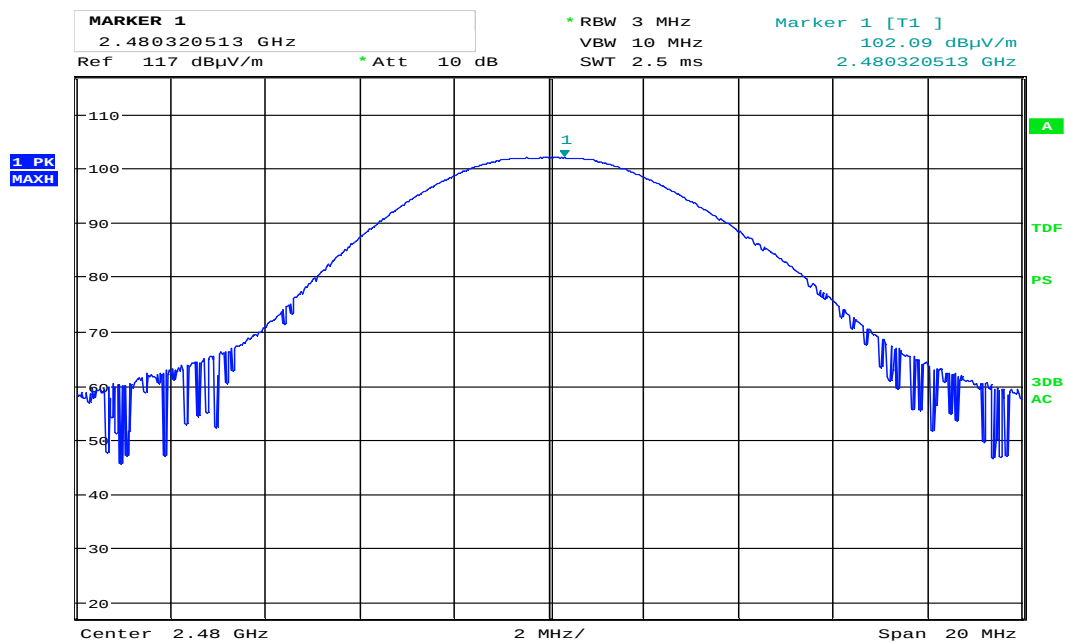
Date: 24.MAR.2020 12:32:22

Maximum Field Strength 2402 MHz, bw800kHz



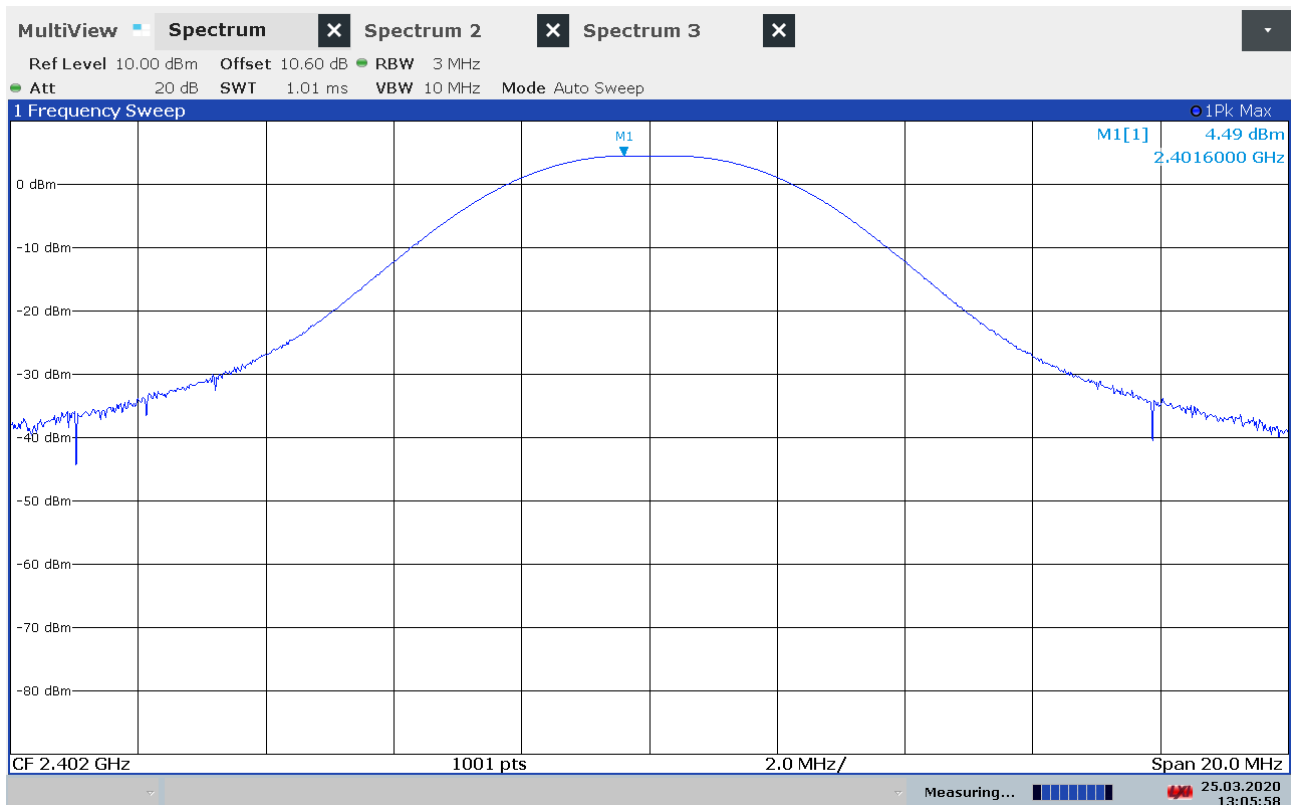
Date: 24.MAR.2020 12:31:43

Maximum Field Strength 2440 MHz, bw800kHz

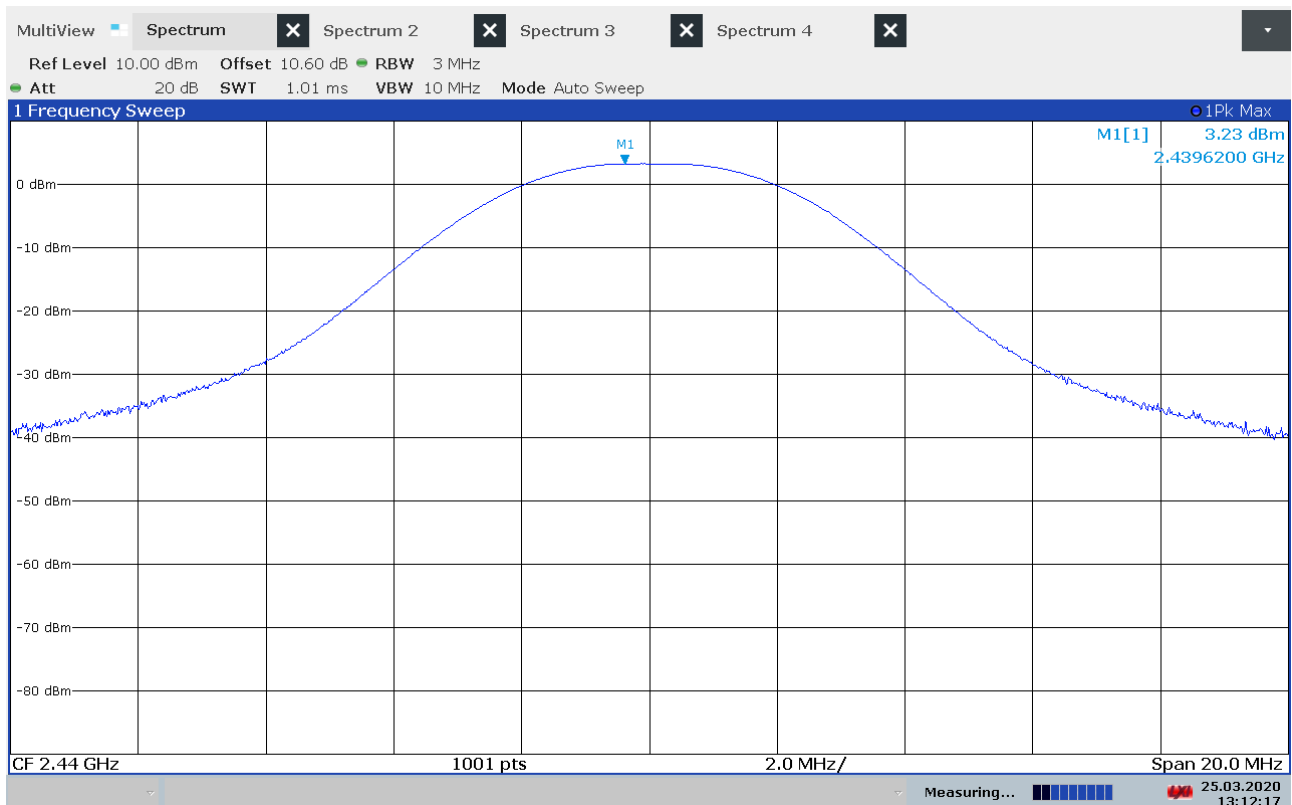


Date: 24.MAR.2020 12:13:59

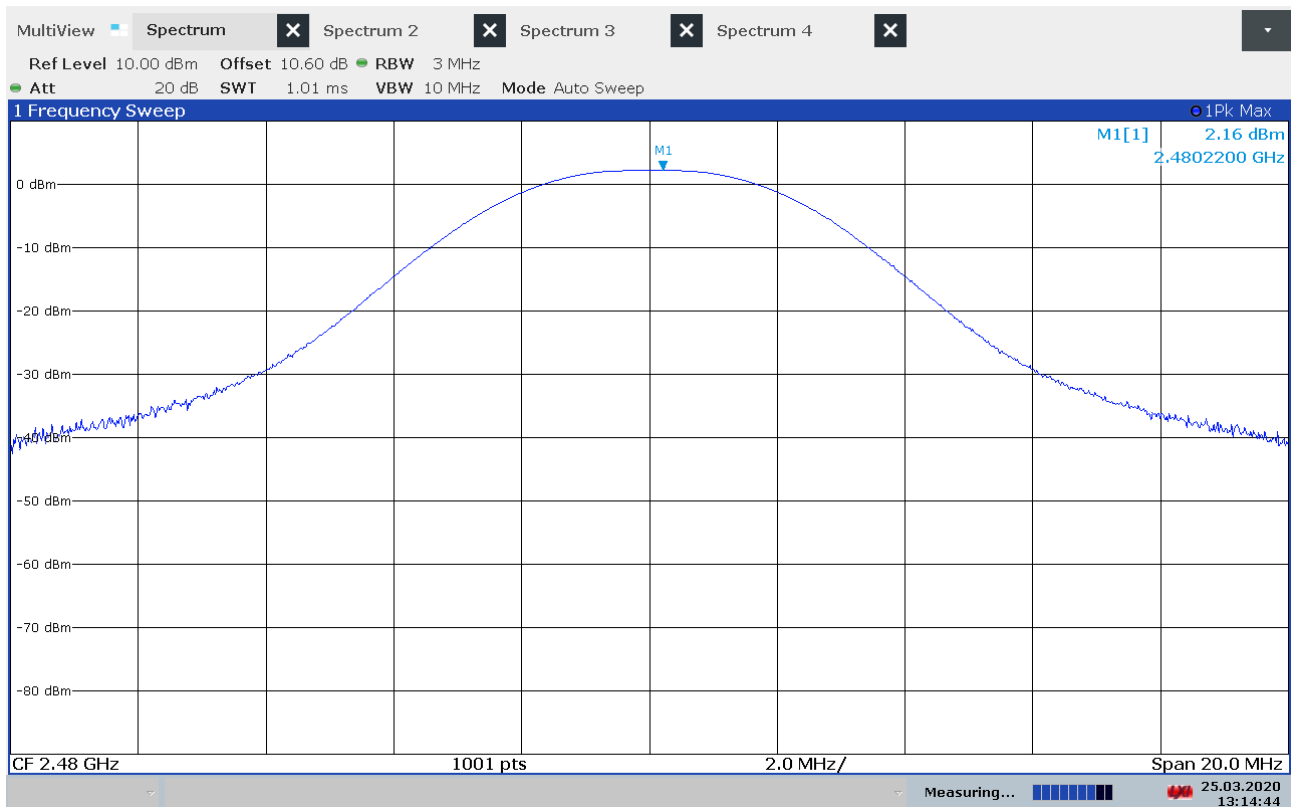
Maximum Field Strength 2480 MHz, bw800kHz



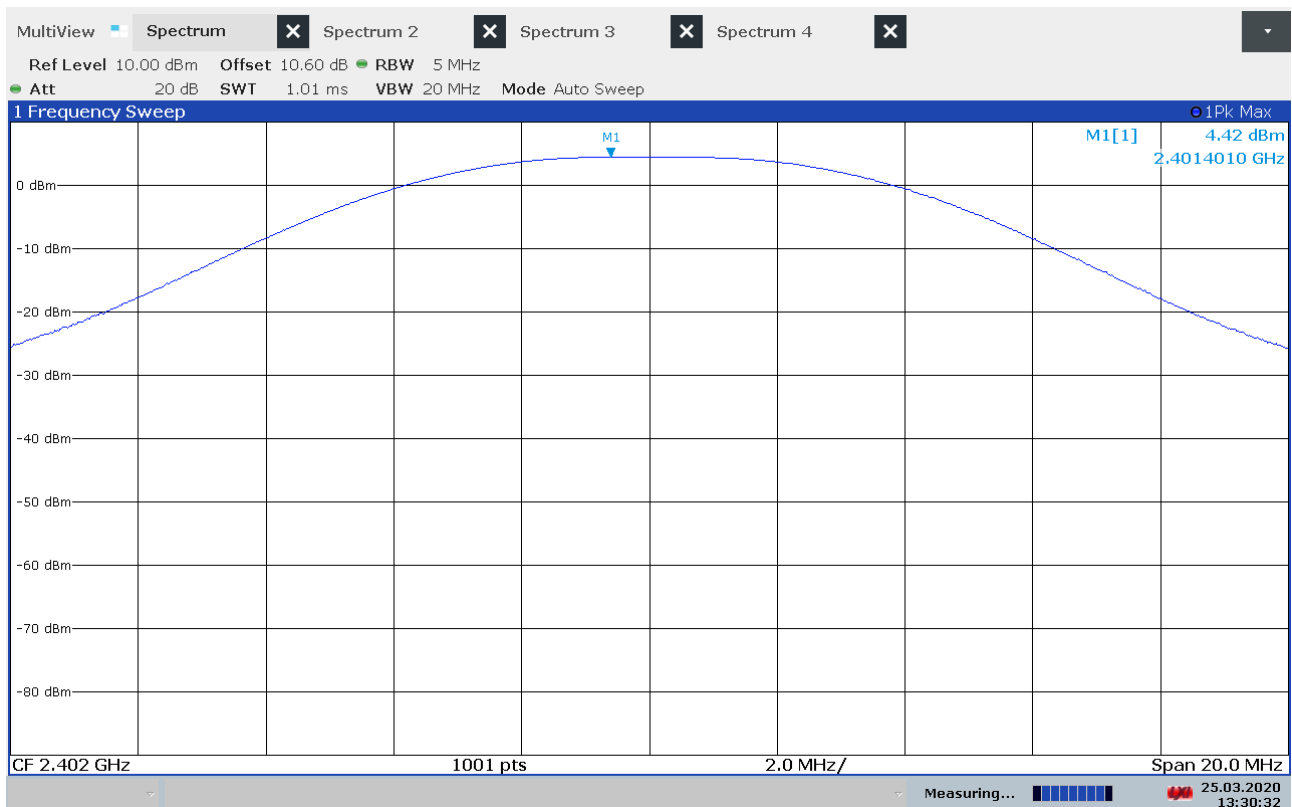
Output Power 2402 MHz, bw800kHz



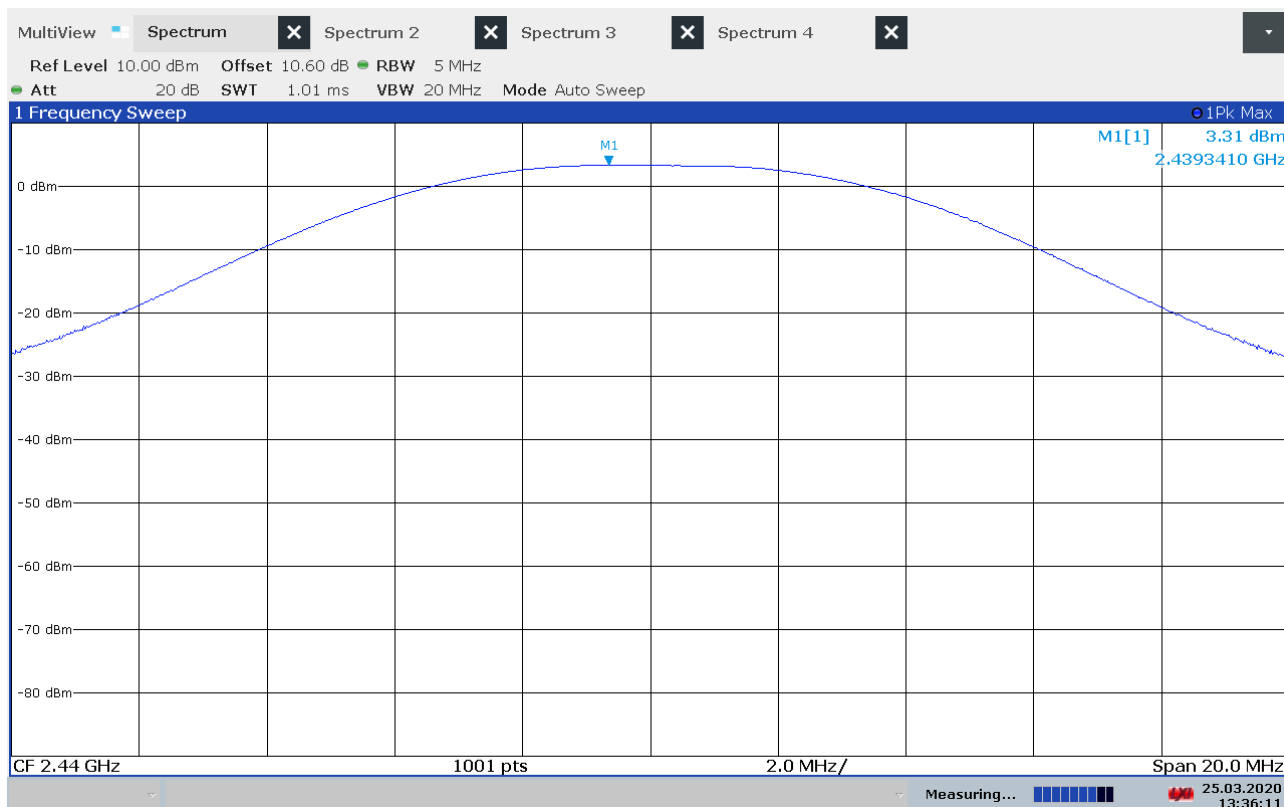
Output Power 2440 MHz, bw800kHz



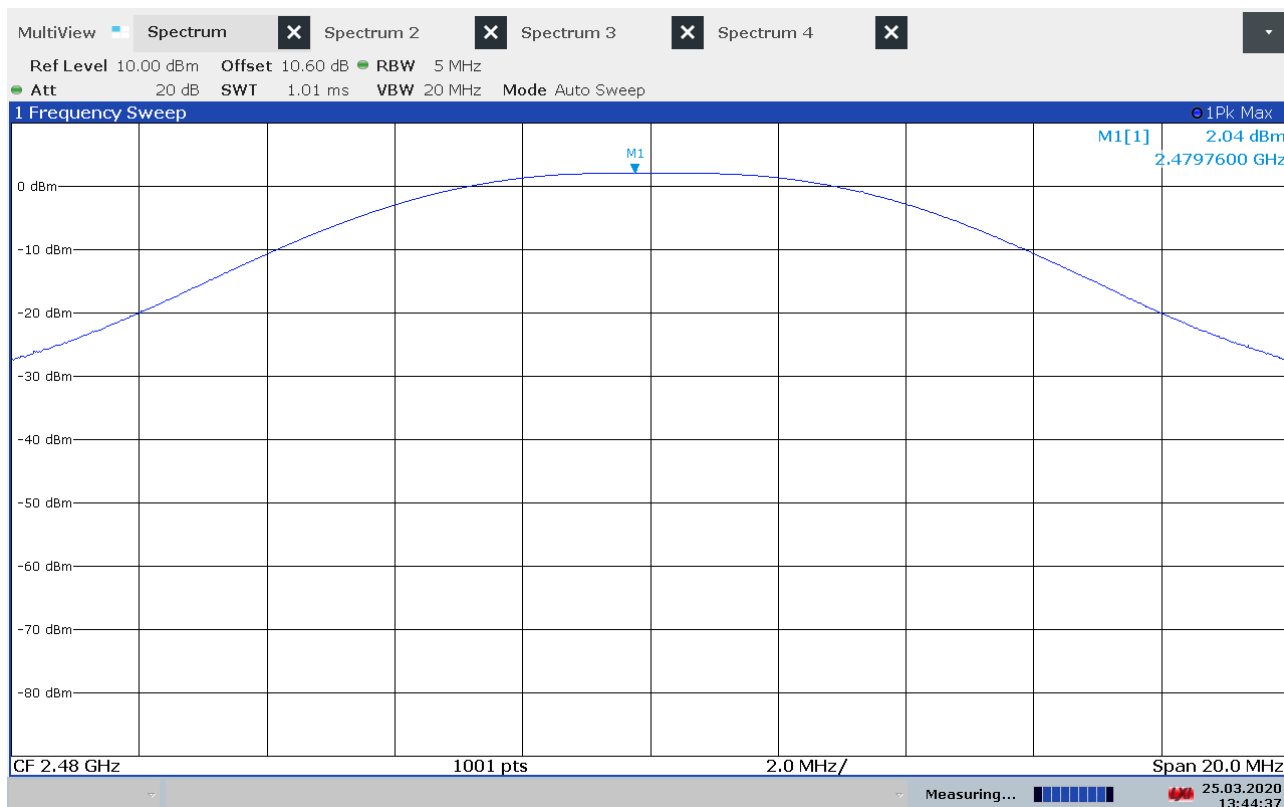
Output Power 2480 MHz, bw800kHz



Output Power 2402 MHz, bw1600kHz



Output Power 2440 MHz, bw1600kHz



Output Power 2480 MHz, bw1600kHz

3.5 Conducted Emissions at Antenna Connector

FCC Part 15.247 (d)

ISED Canada RSS-247 Issue 2, Clause 5.5

Measurement procedure: ANSI C63.10-2013 Clause 11.11

Test Results: Complies

Measurement Data:

Carrier Frequency	Highest Value (dBc)	Margin (dB)	Verdict
2402 MHz	> 40	> 20	Pass
2440 MHz	> 40	> 20	Pass
2480 MHz	> 40	> 20	Pass

Measured with Peak Detector

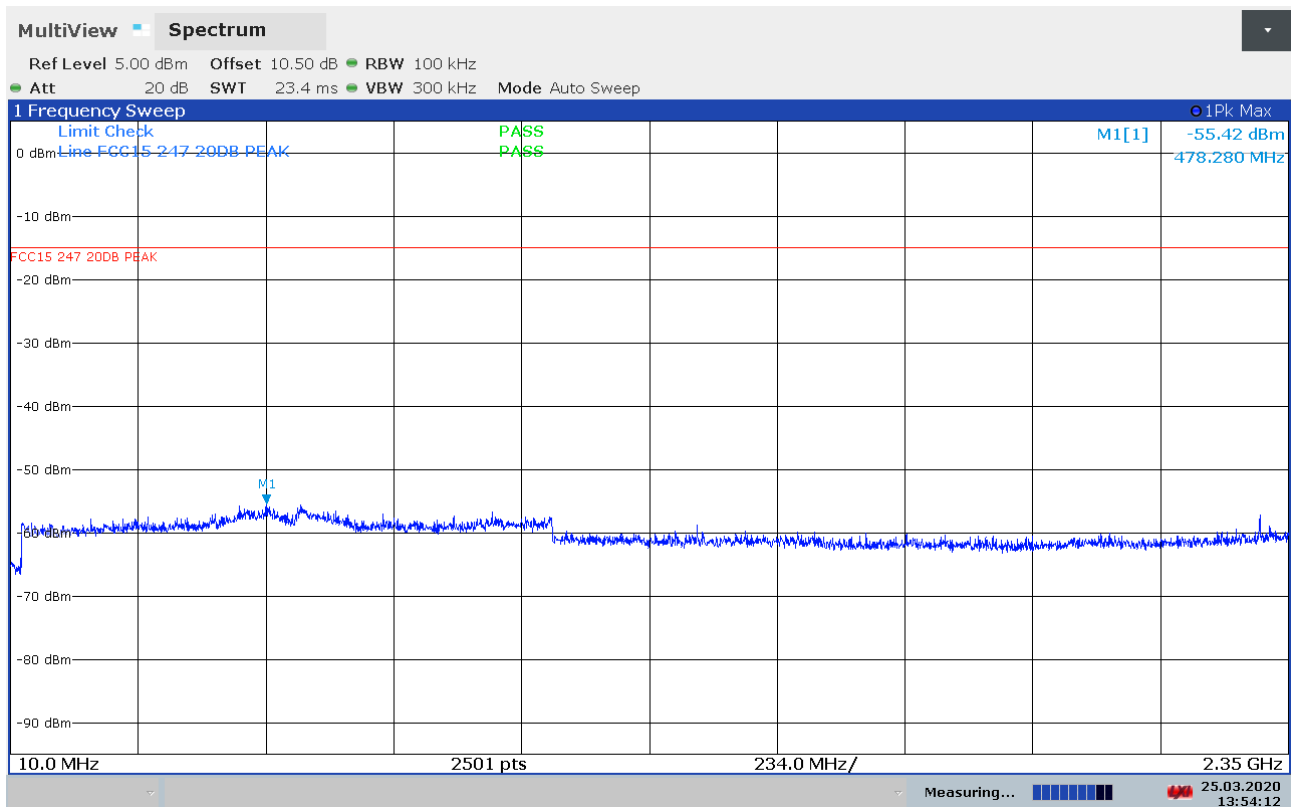
RF conducted power to 25 GHz: see attached plots.

Limit

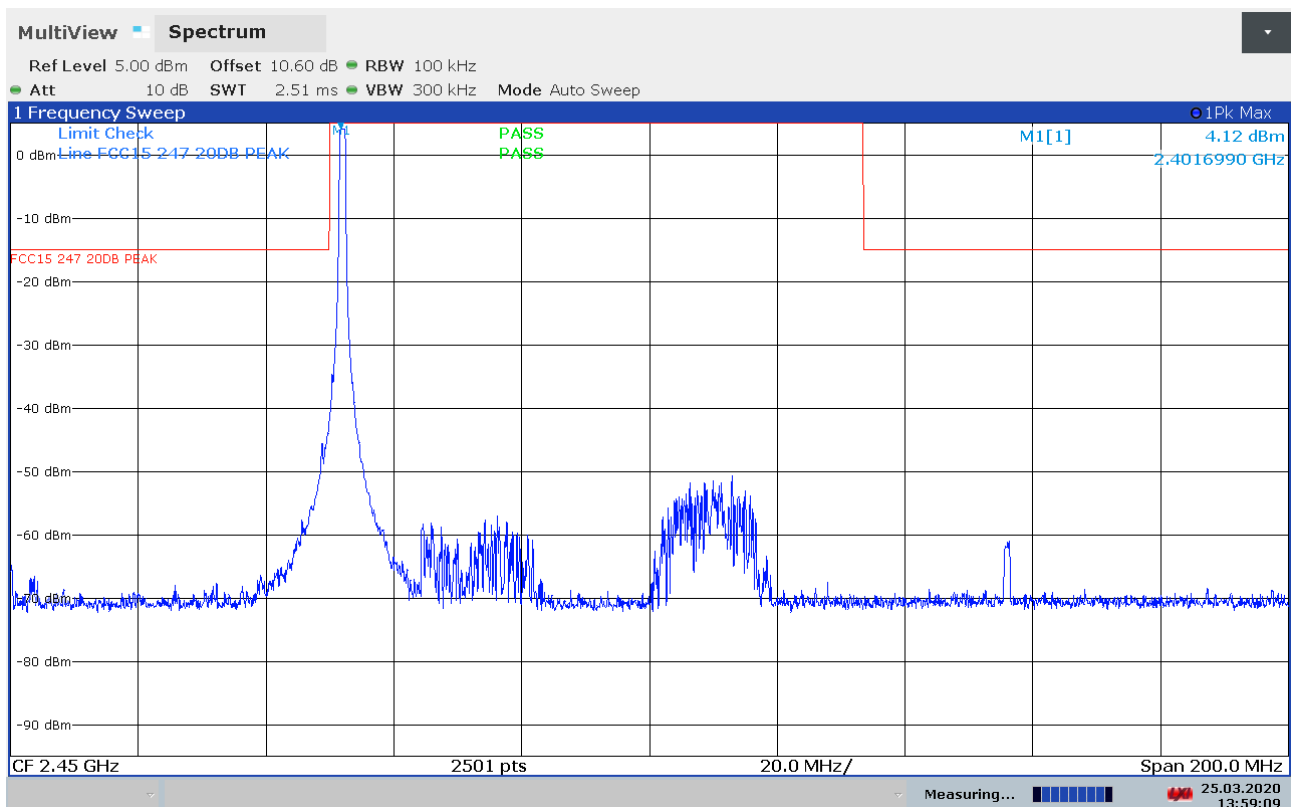
Peak measurement	RMS averaging
20 dBc or more in 100 kHz bandwidth	30 dBc or more in 100 kHz bandwidth

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

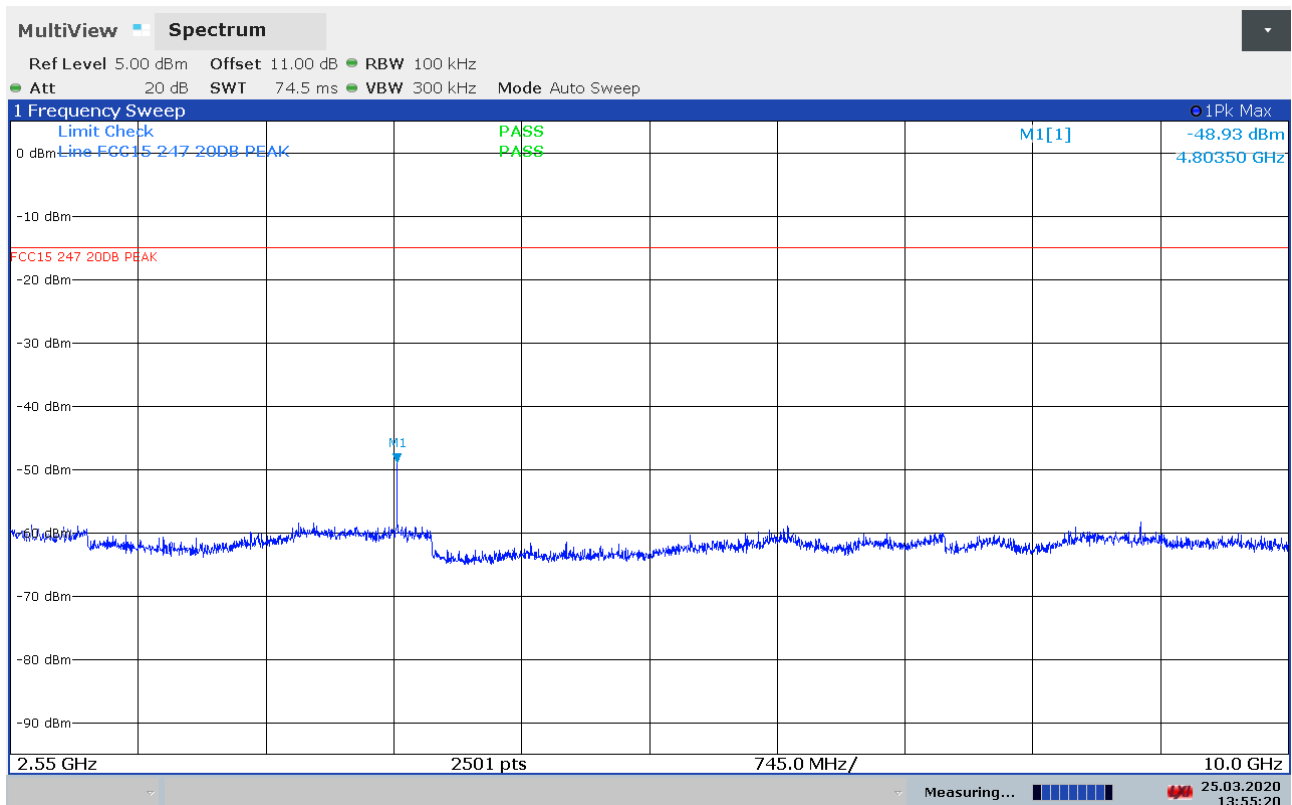
Attenuation below the general limits specified in part 15.209(a) is not required.



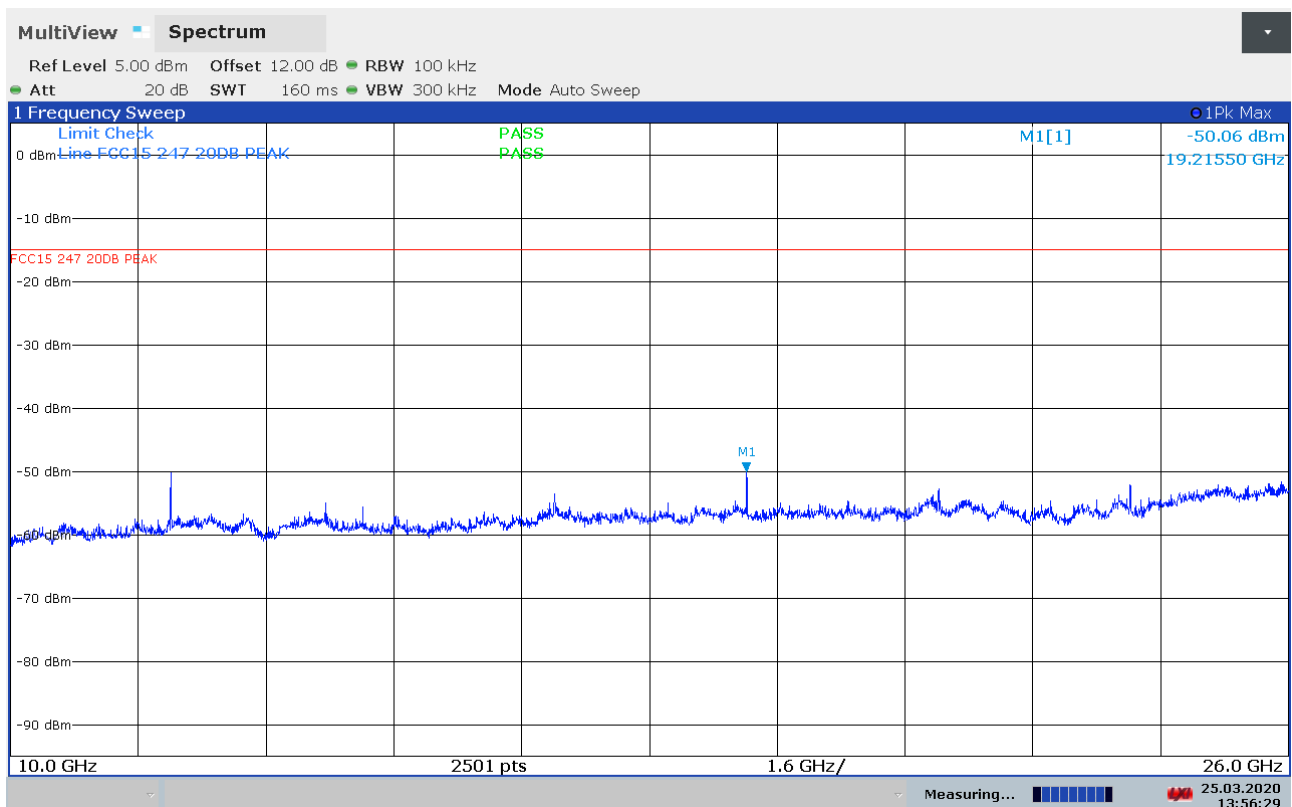
Emissions at Antenna Connector, 10 – 2350 MHz, 2402 MHz, bw800kHz



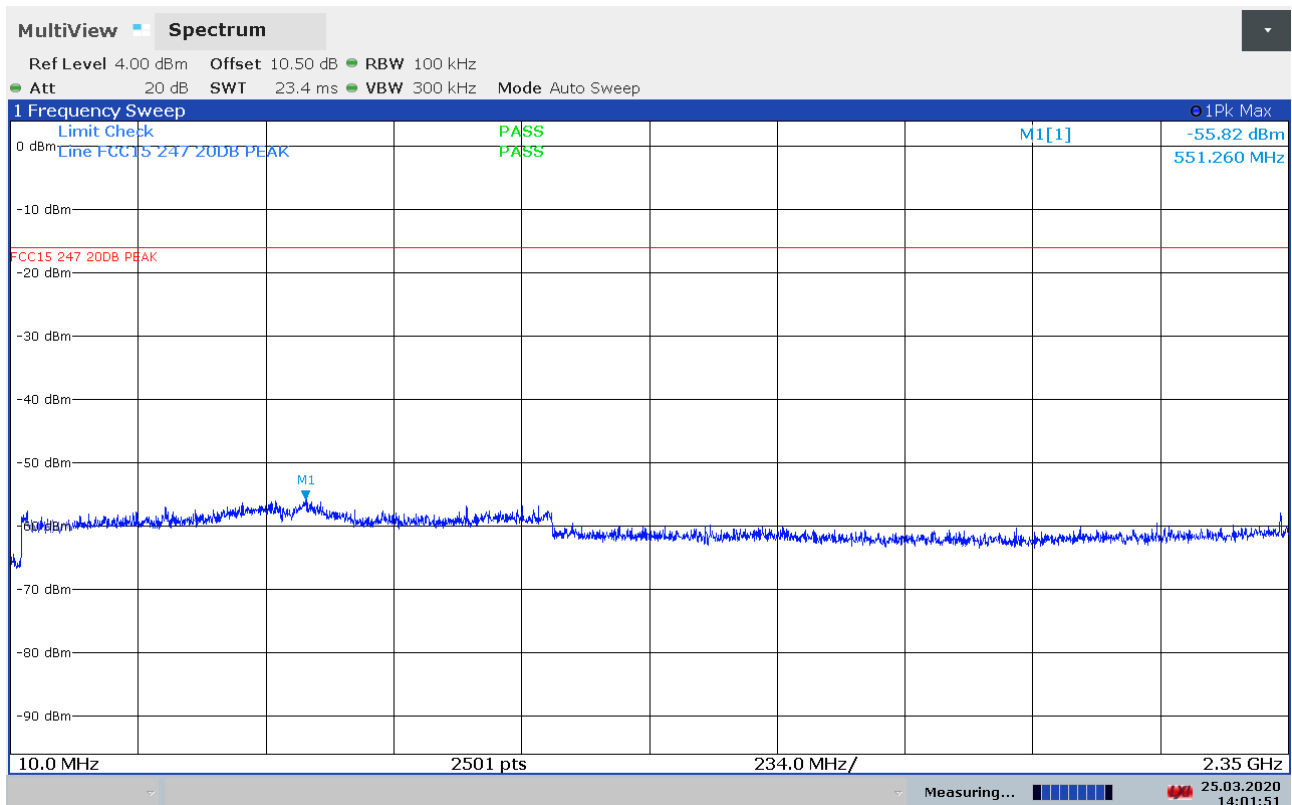
Emissions at Antenna Connector, 2350 – 2550 MHz, 2402 MHz, bw800kHz



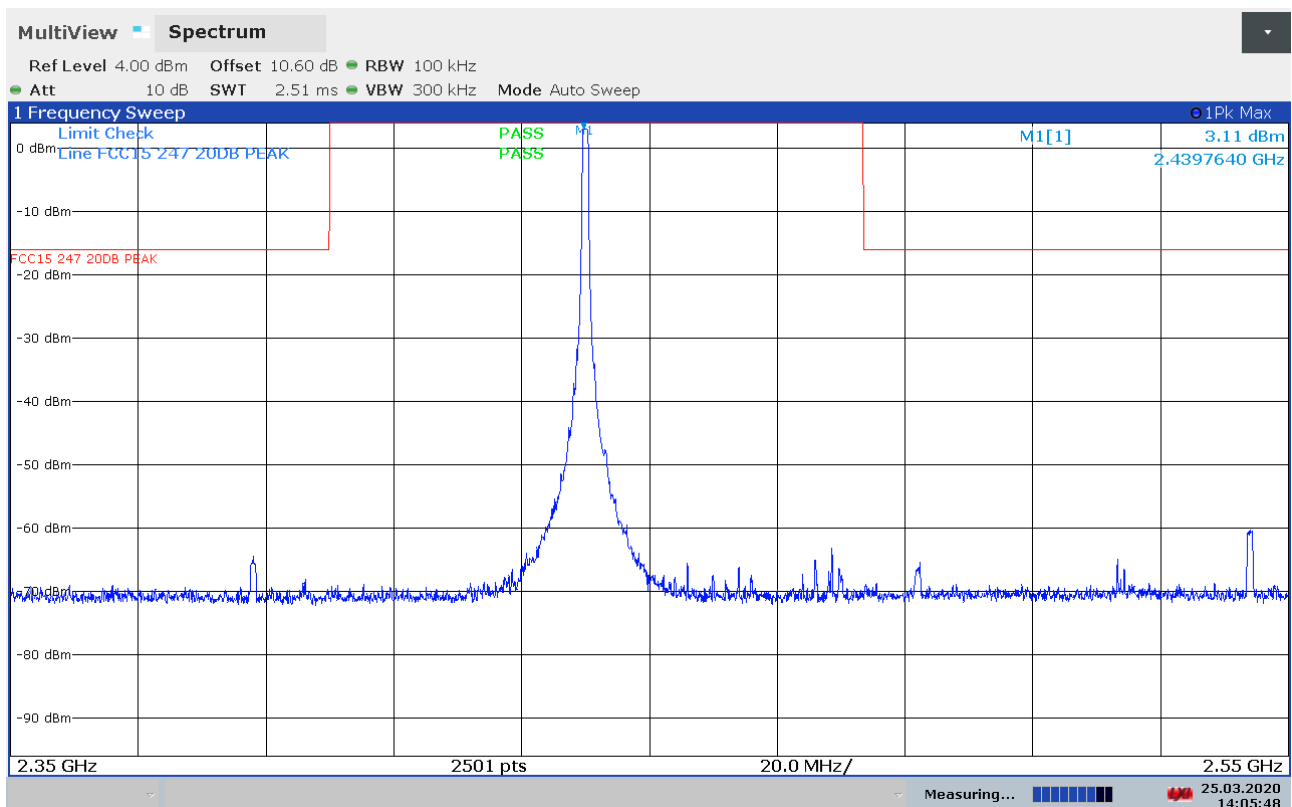
Emissions at Antenna Connector, 2550 – 10000 MHz, 2402 MHz, bw800kHz



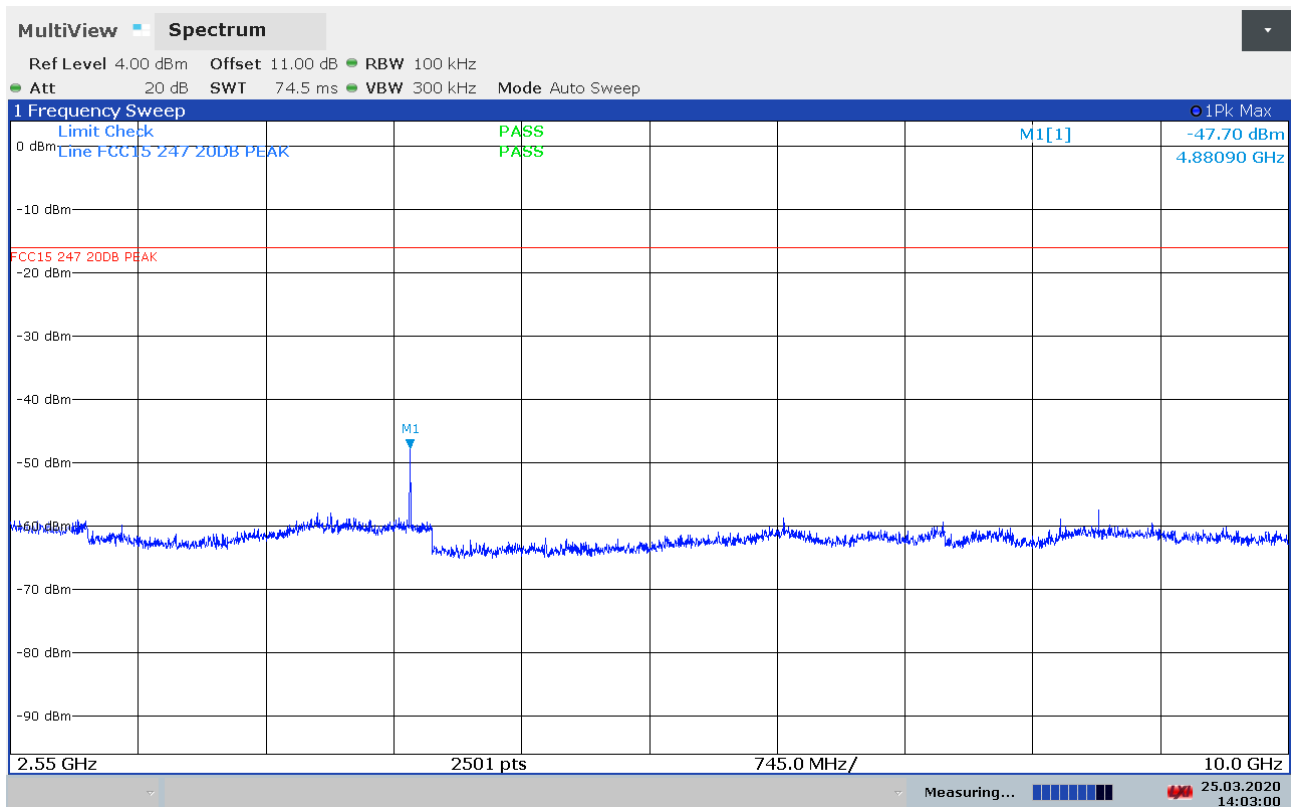
Emissions at Antenna Connector, 10000 – 26000 MHz, 2402 MHz, bw800kHz



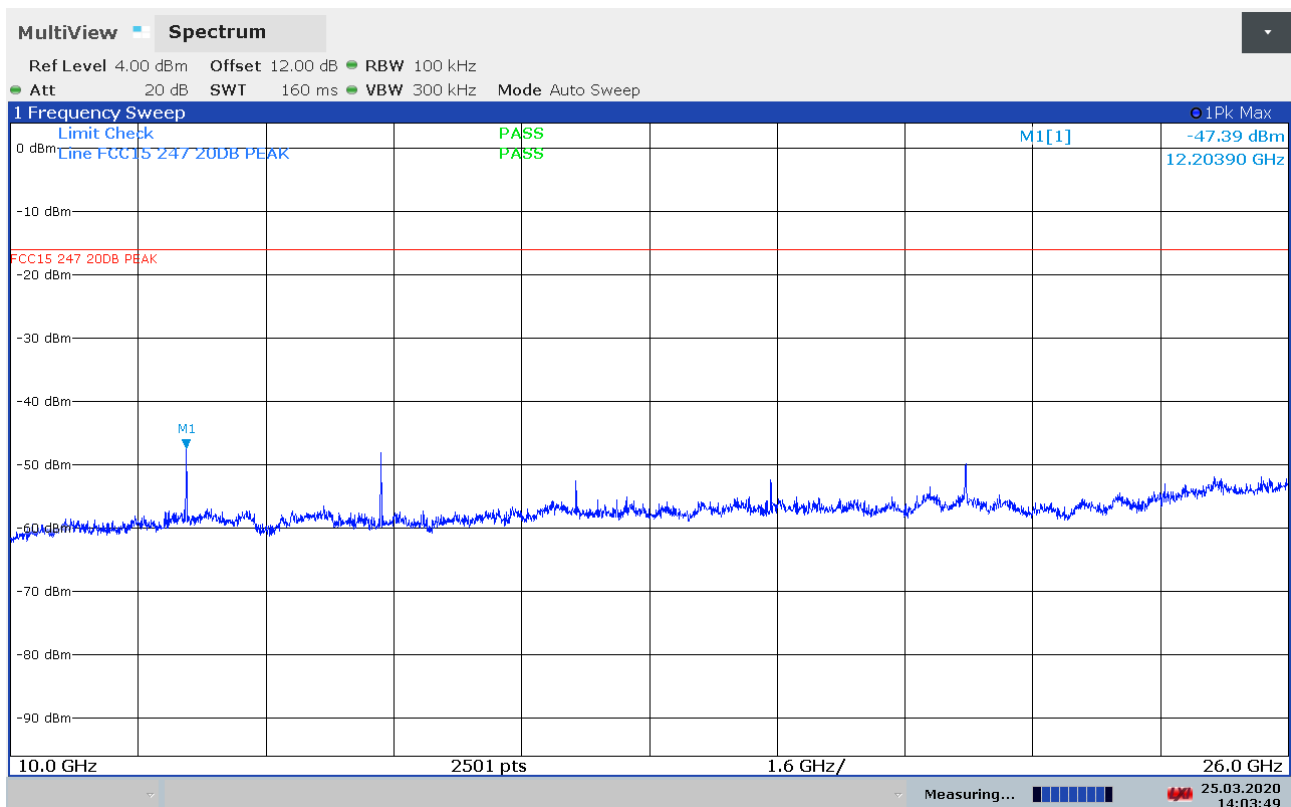
Emissions at Antenna Connector, 10 – 2350 MHz, 2440 MHz, bw800kHz



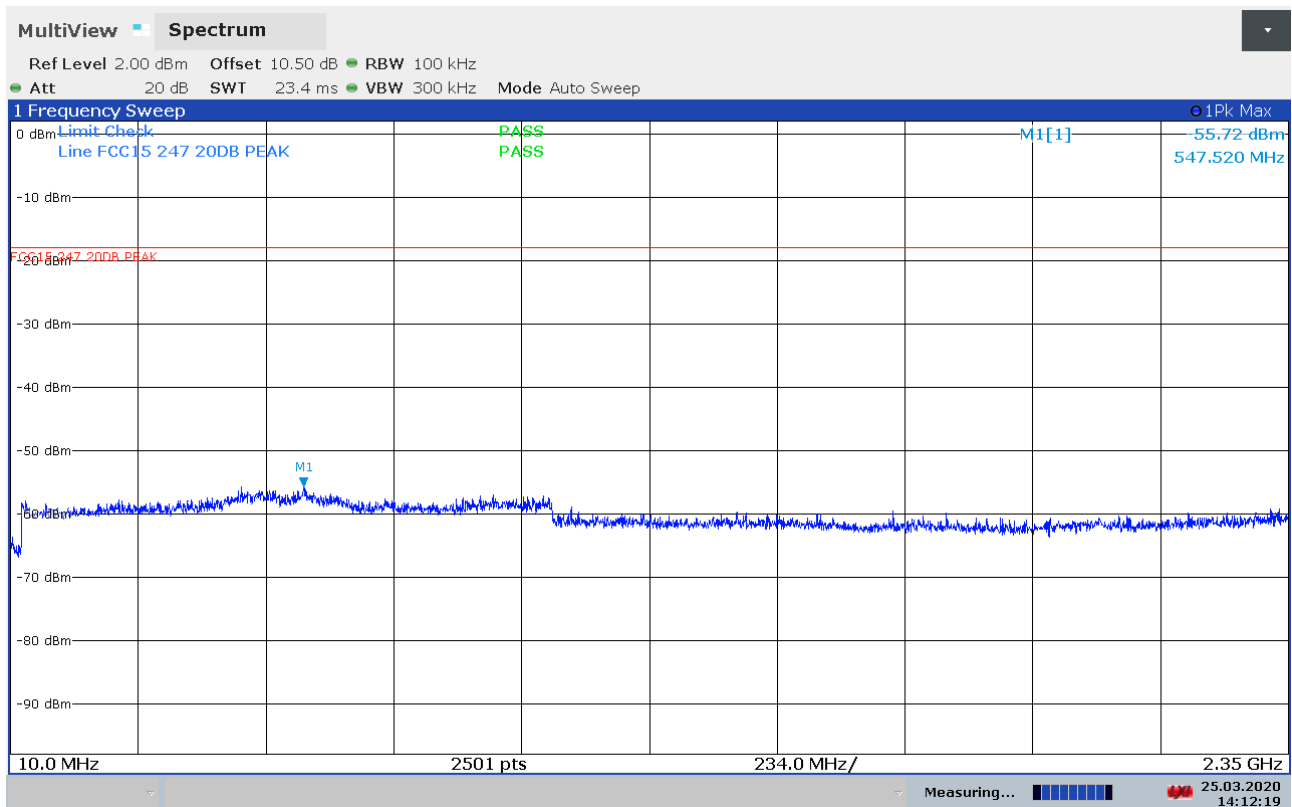
Emissions at Antenna Connector, 2350 – 2550 MHz, 2440 MHz, bw800kHz



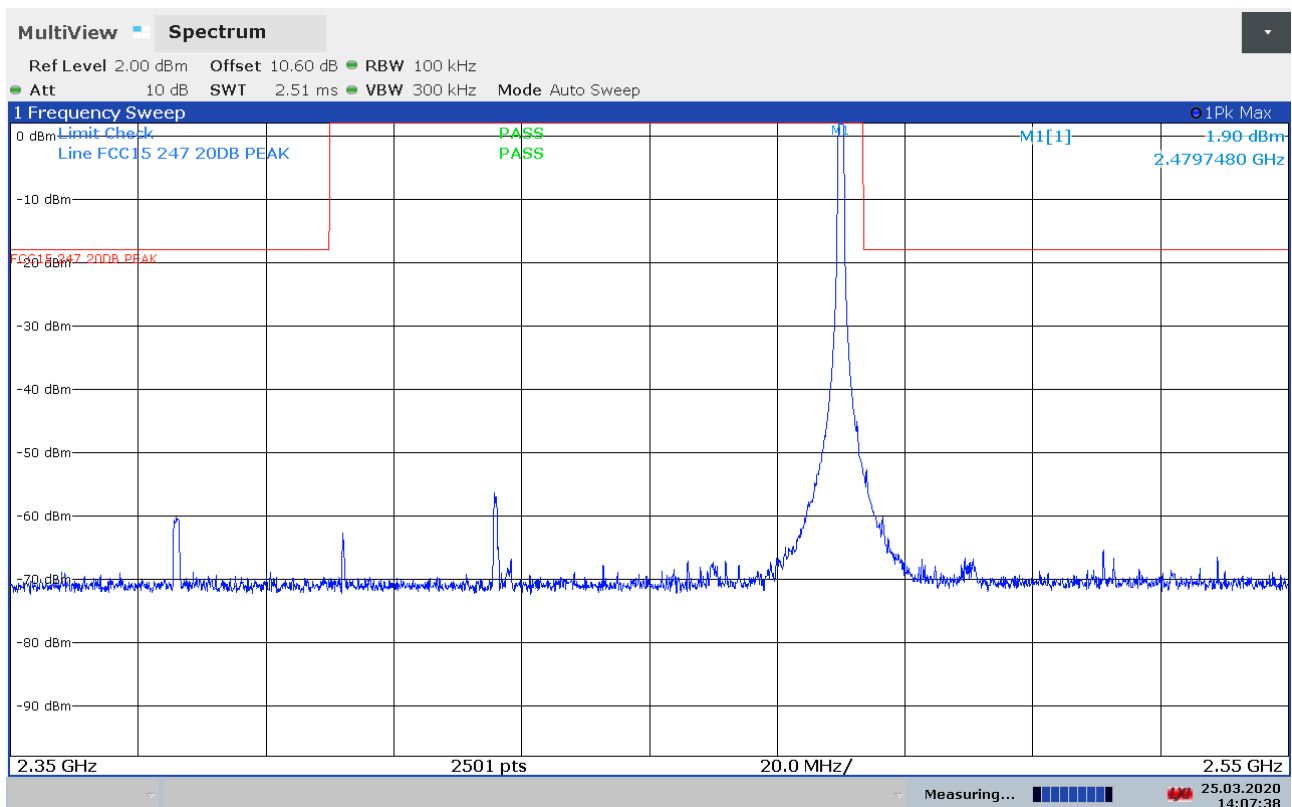
Emissions at Antenna Connector, 2550 – 10000 MHz, 2440 MHz, bw800kHz



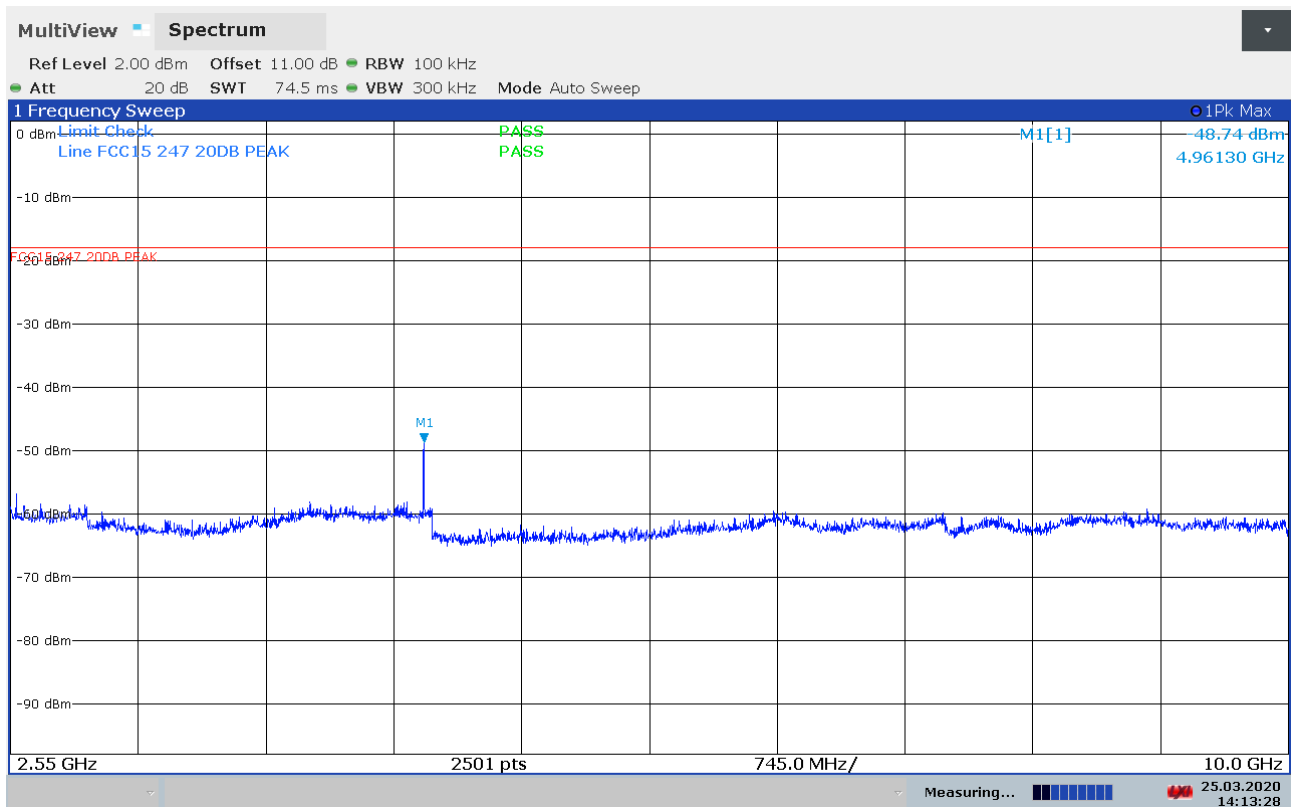
Emissions at Antenna Connector, 10000 – 26000 MHz, 2440 MHz, bw800kHz



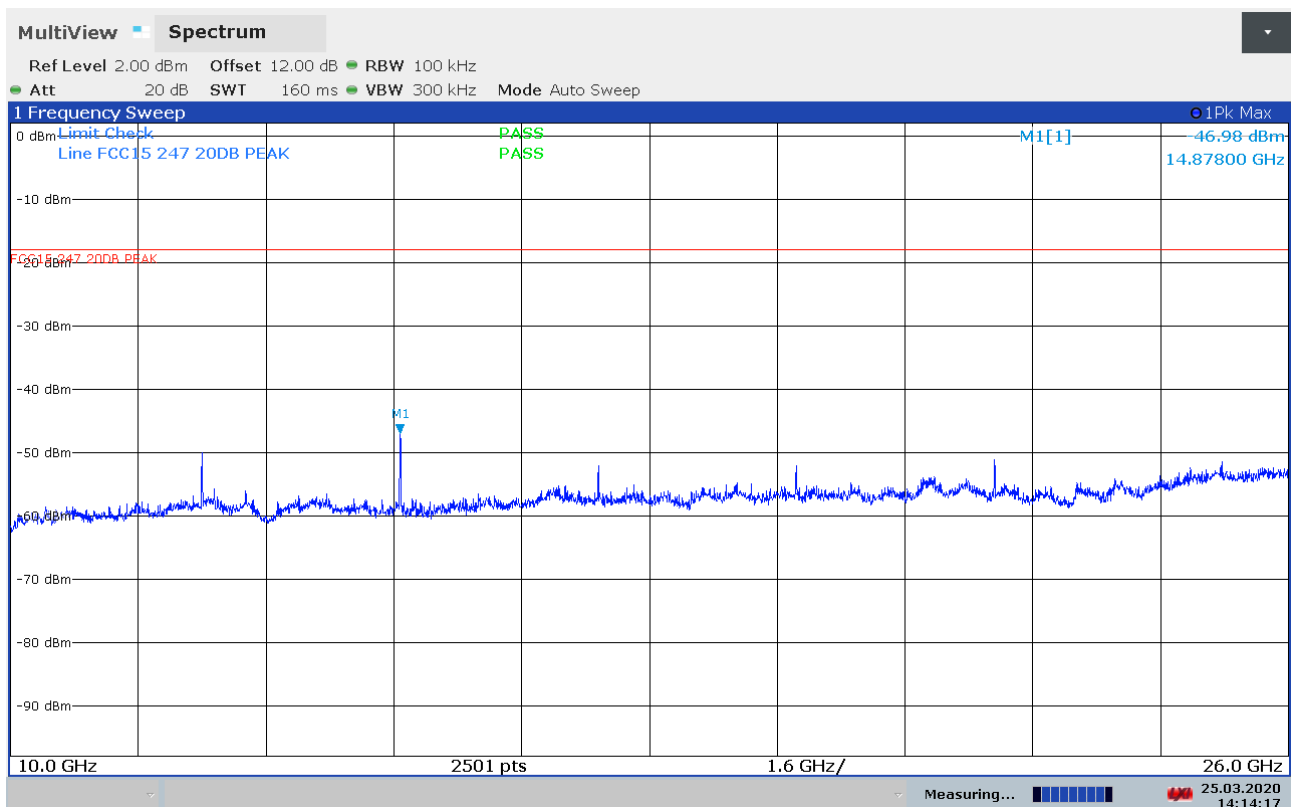
Emissions at Antenna Connector, 10 – 2350 MHz, 2480 MHz, bw800kHz



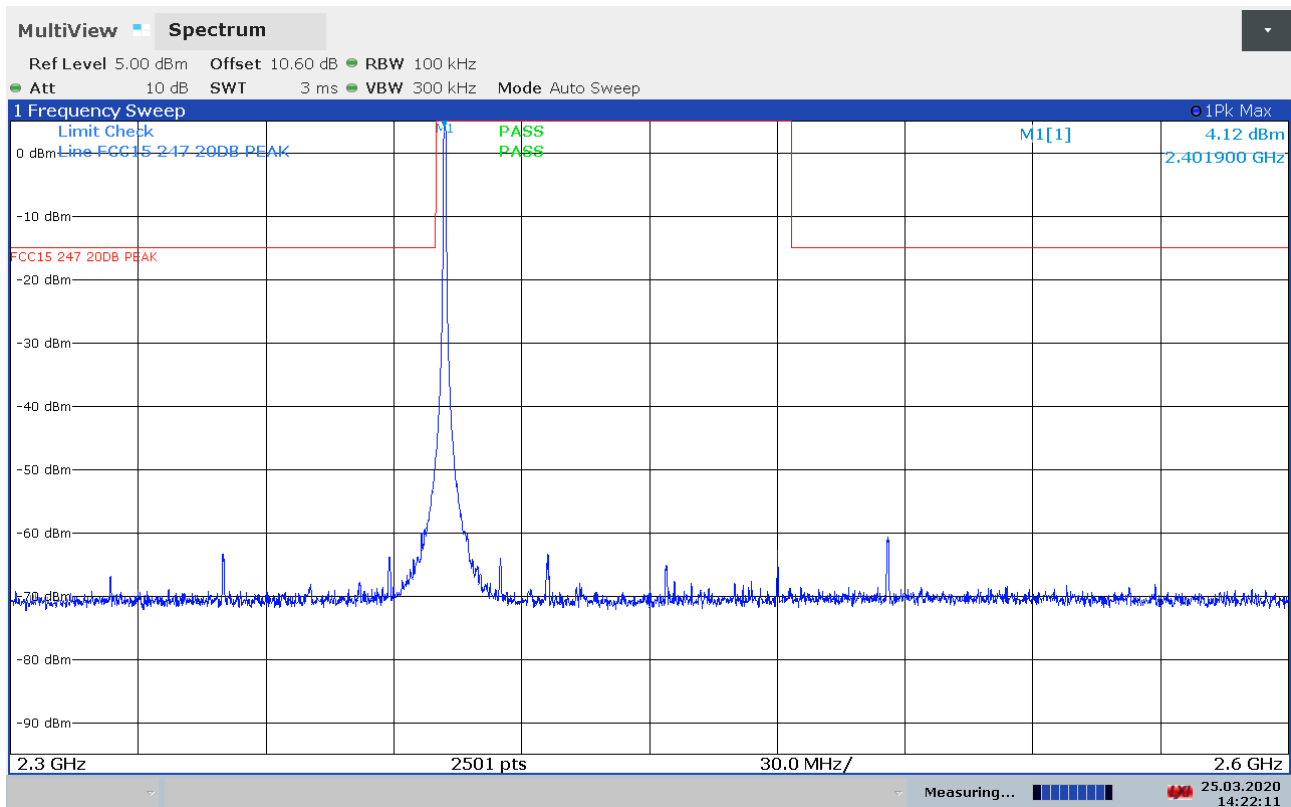
Emissions at Antenna Connector, 2350 – 2550 MHz, 2480 MHz, bw800kHz



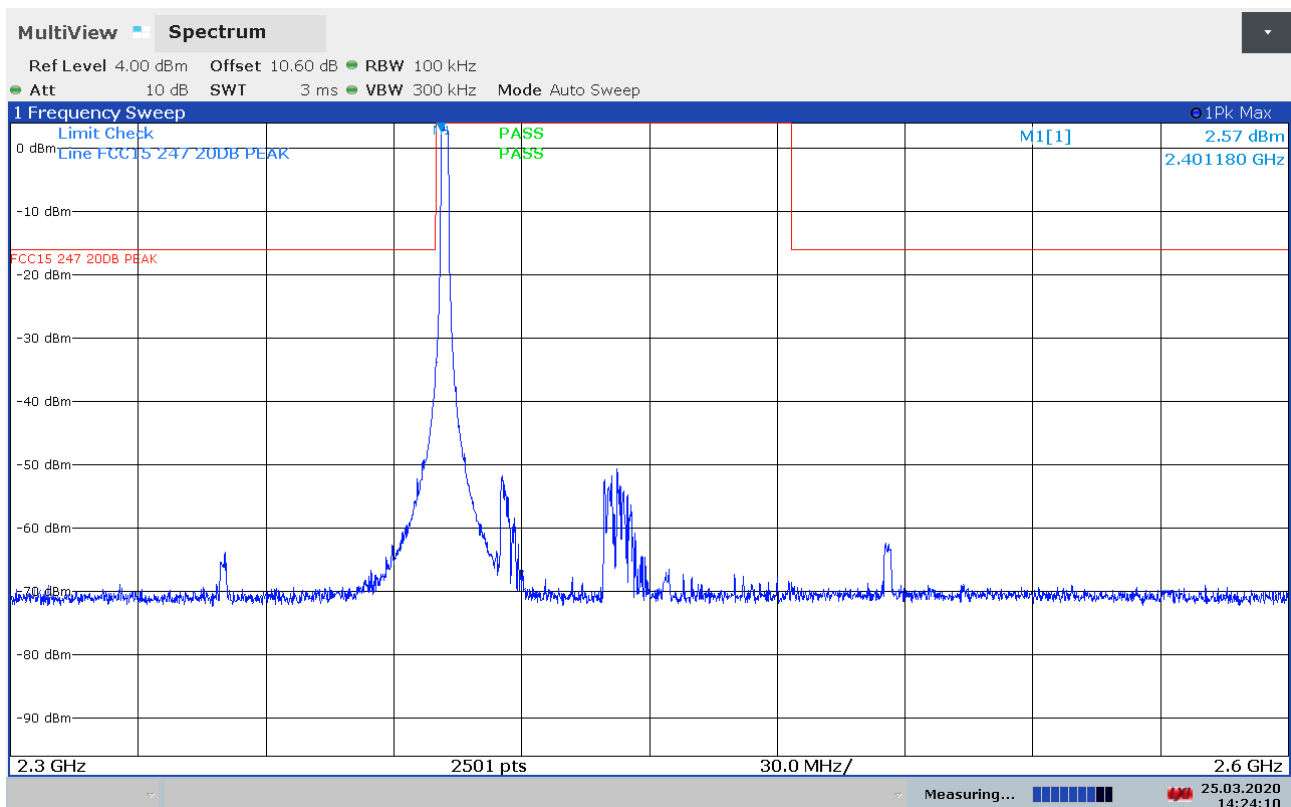
Emissions at Antenna Connector, 2550 – 10000 MHz, 2480 MHz, bw800kHz



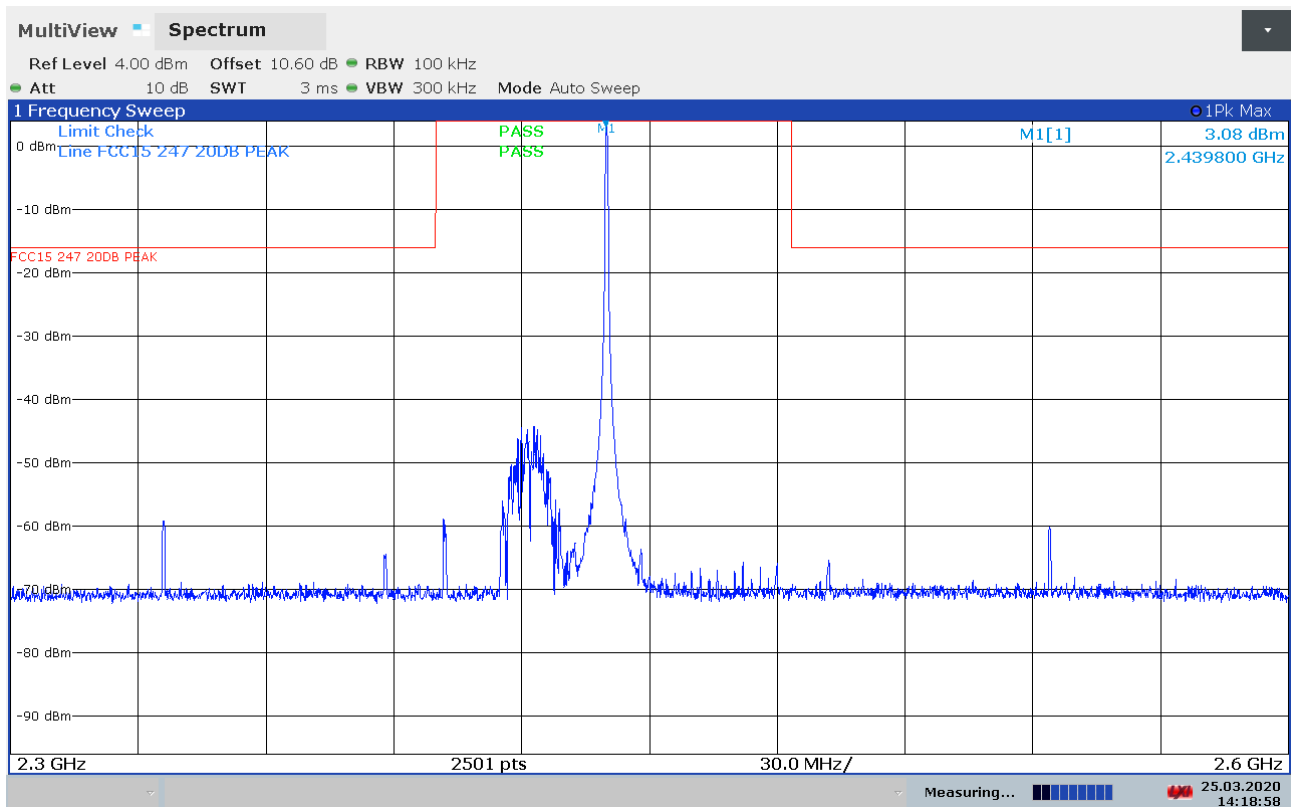
Emissions at Antenna Connector, 10000 – 26000 MHz, 2480 MHz, bw800kHz



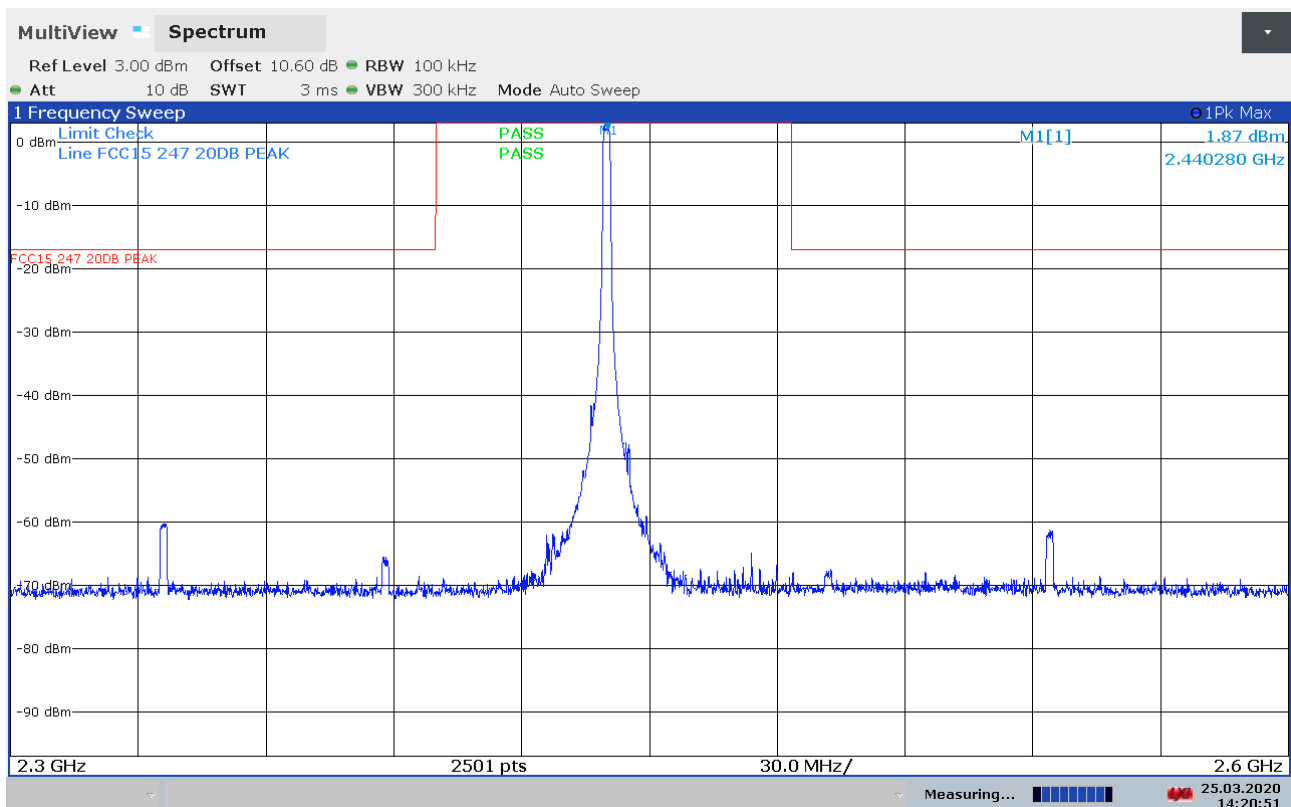
Emissions at Antenna Connector, 2300 – 2600 MHz, 2402 MHz, bw400kHz



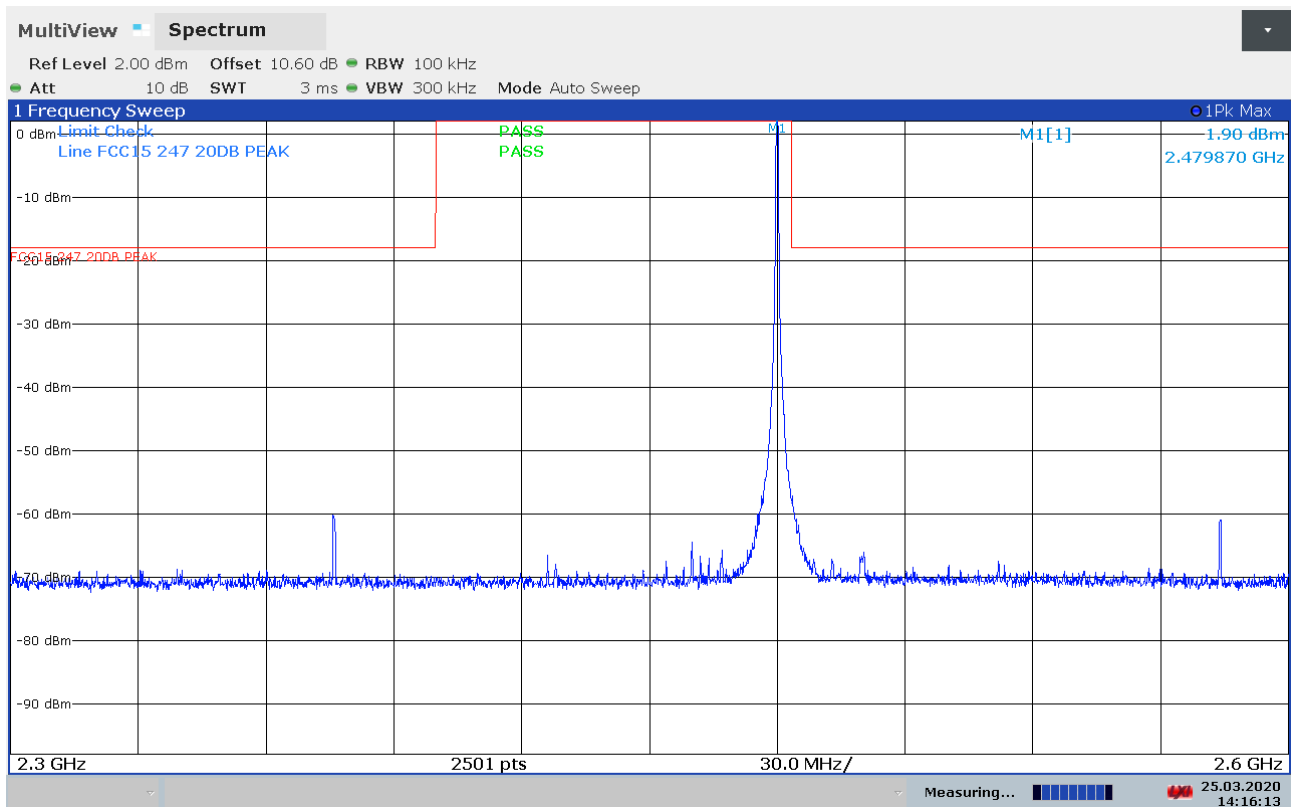
Emissions at Antenna Connector, 2300 – 2600 MHz, 2402 MHz, bw1600kHz



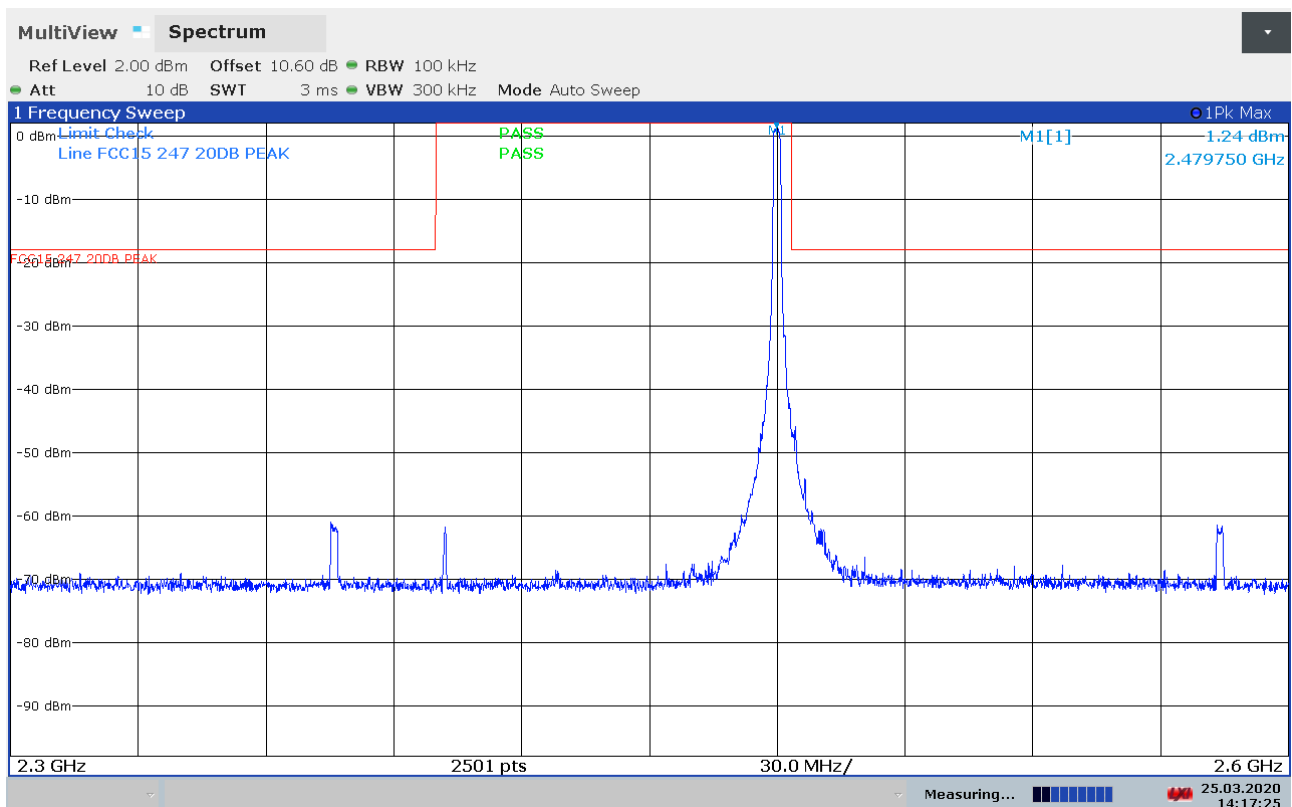
Emissions at Antenna Connector, 2300 – 2600 MHz, 2440 MHz, bw400kHz



Emissions at Antenna Connector, 2300 – 2600 MHz, 2440 MHz, bw1600kHz



Emissions at Antenna Connector, 2300 – 2600 MHz, 2480 MHz, bw400kHz



Emissions at Antenna Connector, 2300 – 2600 MHz, 2480 MHz, bw1600kHz

3.6 Restricted Bands of operation

Restricted Bands of operation for FCC and ISSED are defined in FCC Part 15.205 and ISSED RSS-GEN, Issue 5 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 5, clause 8.9.

FCC (MHz)	ISSED (MHz)	FCC (GHz)	ISSED (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.

3.7 Radiated Emissions, Band Edge

FCC Part 15.209 (a)

ISED Canada RSS-GEN Issue 5, Clause 7.3 / 8.9

Measurement procedure: ANSI C63.10-2013 Clause 11.12

Test Results: Complies

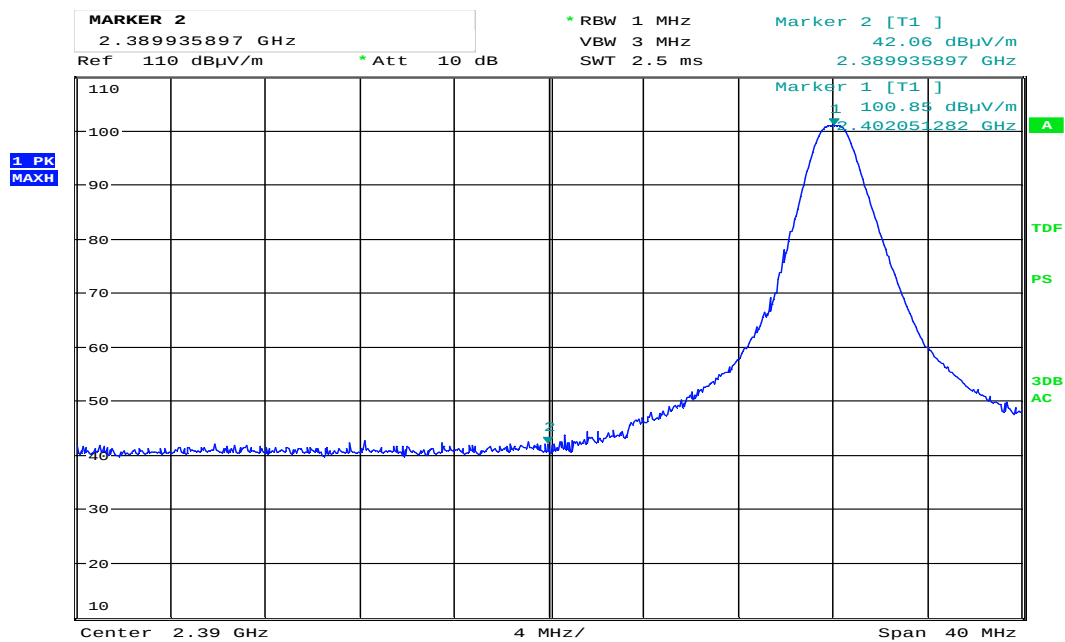
Measurement Data:

Detector	bw	Measured field strength (dB μ V/m)		Limit	Margin	
		2390 MHz	2483.5 MHz	dB μ V/m	dB	
Peak Detector	400 kHz	42.1	53.7	74	31.9	20.3
	800 kHz	46.4	57.0	74	27.6	17.0
	1600 kHz	50.7	63.9	74	23.3	10.1
Average Detector	400 kHz	/	/	54	>20	>20
	800 kHz	/	46.2	54	>20	17.0
	1600 kHz	/	46.8	54	>20	10.1

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

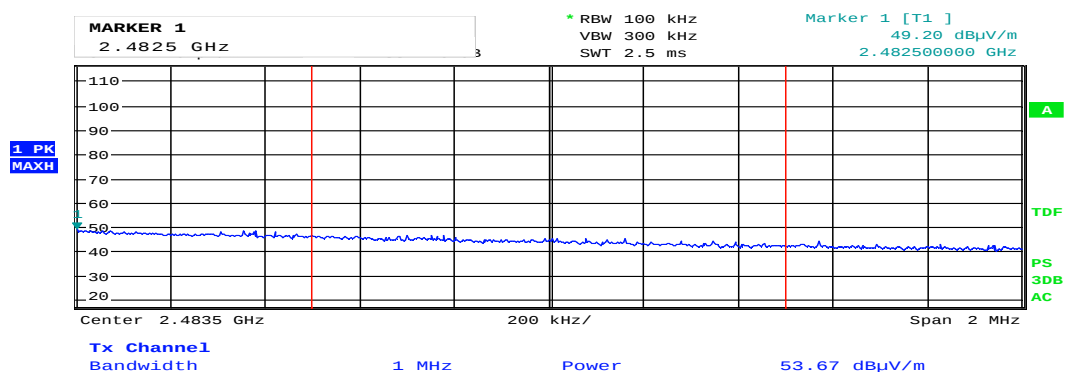
Average value is not reported where Peak Value is below Average Limit.

See attached plots.



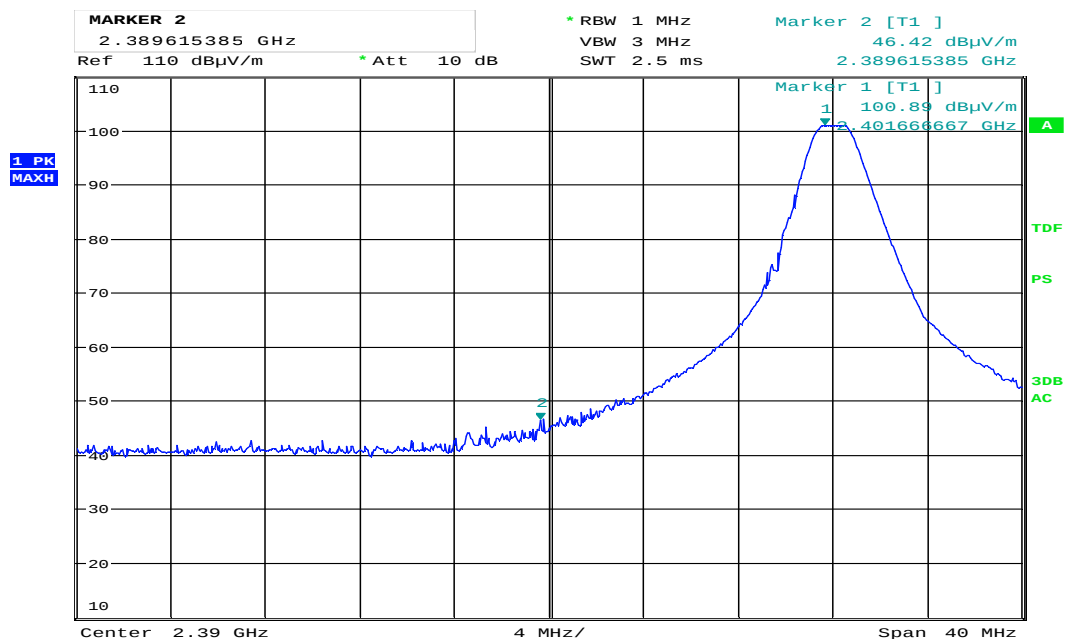
Date: 24.MAR.2020 12:34:25

Lower Band Edge, 2402 MHz, bw400kHz Peak



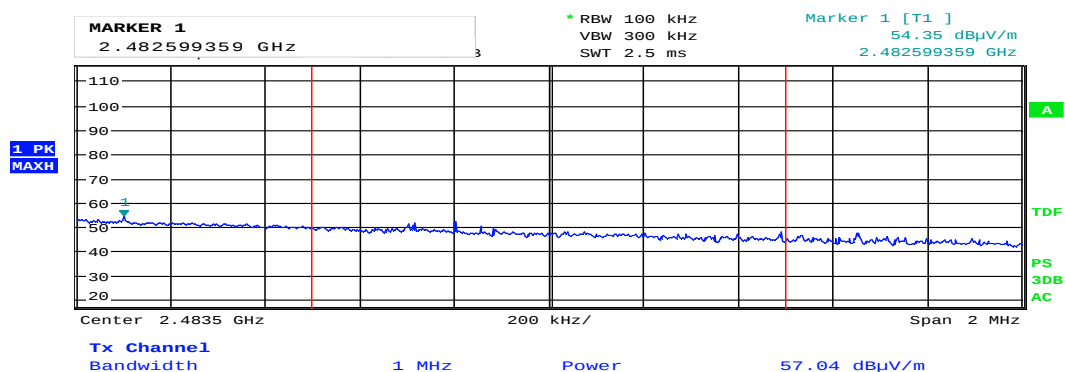
Date: 24.MAR.2020 12:26:37

Upper Band Edge, 2480 MHz, bw400kHz Peak



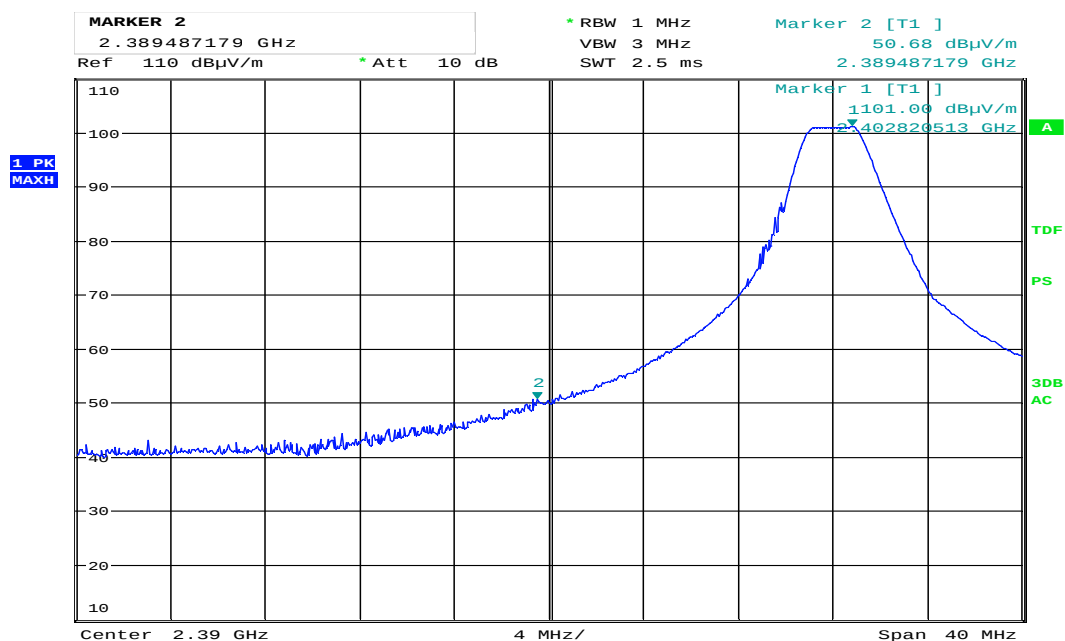
Date: 24.MAR.2020 12:33:34

Lower Band Edge, 2402 MHz, bw800kHz Peak



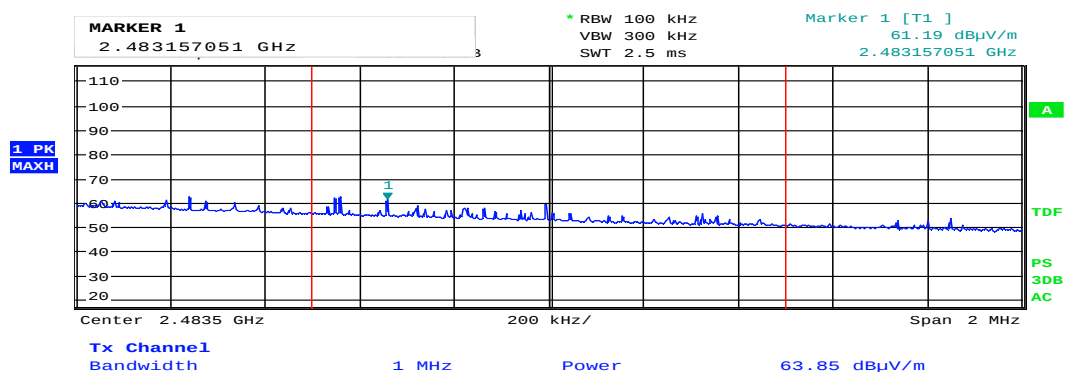
Date: 24.MAR.2020 12:17:38

Upper Band Edge, 2480 MHz, bw800kHz Peak



Date: 24.MAR.2020 12:35:26

Lower Band Edge, 2402 MHz, bw1600kHz Peak



Date: 24.MAR.2020 12:16:46

Upper Band Edge, 2480 MHz, bw1600kHz Peak

Radiated Emission, 30 – 1000 MHz

FCC Part 15.209 (a)

ISED Canada RSS-GEN Issue 5, Clause 7.3/8.9

Measurement procedure: ANSI C63.10-2013 Clause 11.12

Test Results: Complies

Measurement Data:

Detector: Peak (found frequencies were measured with Quasi-Peak Detector)

Measuring distance 3 m

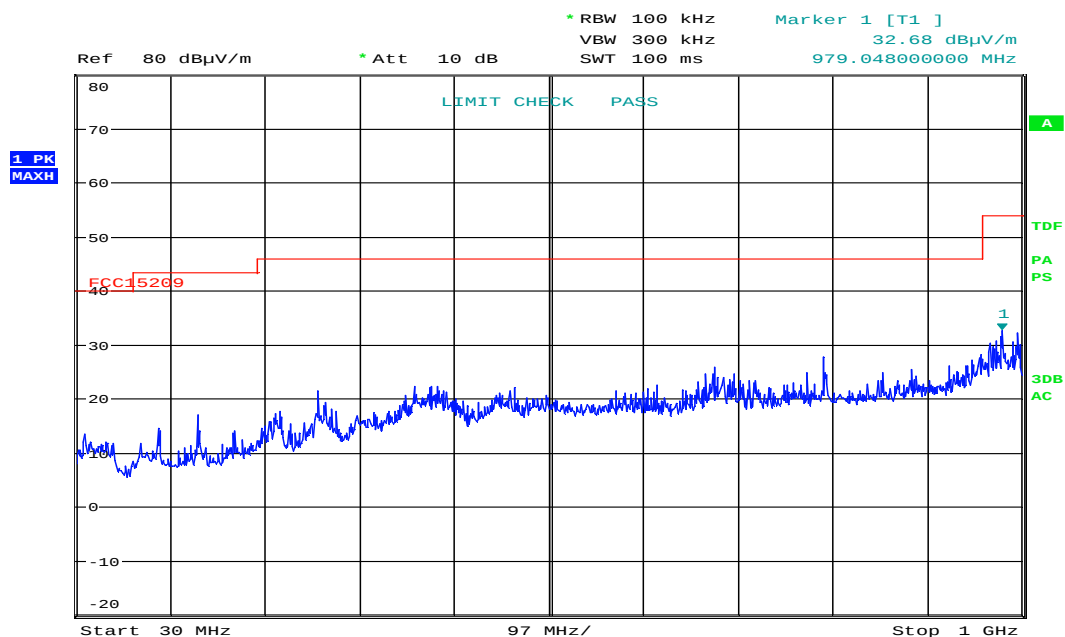
Tested with EUT transmitting on 2440 MHz with bw800kHz.

Frequency MHz	Dist. corr. Factor dB	Field strength @3m QP Det., dBμV/m	Limit dBμV/m	Margin dB
30 – 88 MHz	0	< 30	40.0	> 10
88 – 216 MHz	0	< 30	43.5	> 13.5
216 – 960 MHz	0	< 30	46.0	> 16
960 – 1000 MHz	0	< 34	54.0	> 20

See attached plots

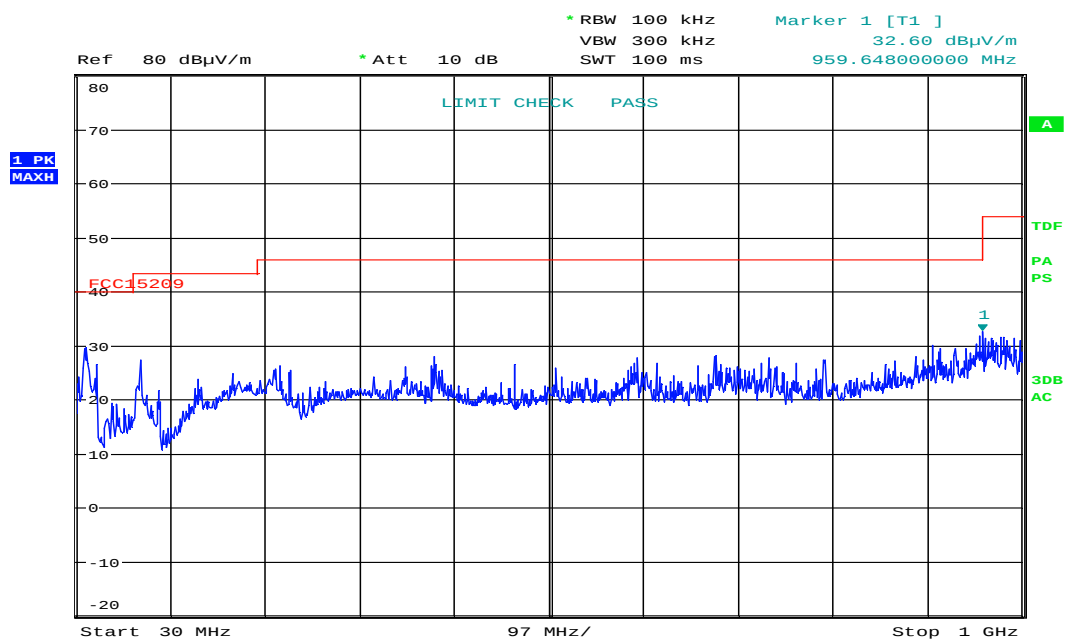
Requirements/Limit

FCC	Part 15.209 @ frequencies defined in §15.205	
ISED	RSS-GEN Issue 5, Clause 8.9 @ frequencies defined in clause 8.10	
Frequency	Radiated emission limit @3 meters	
30 – 88 MHz	100 μV/m	40.0 dBμV/m
88 – 216 MHz	150 μV/m	43.5 dBμV/m
216 – 960 MHz	200 μV/m	46.0 dBμV/m
960 – 1000 MHz	500 μV/m	54.0 dBμV/m
	Limits above are with Quasi Peak Detector	



Date: 24.MAR.2020 17:09:00

30 – 1000 MHz, 2440MHz, bw800kHz, HP



Date: 24.MAR.2020 17:06:48

30 – 1000 MHz, 2440MHz, bw800kHz, VP

3.8 Radiated Emissions, 1-26 GHz

FCC Part 15.209 (a)

ISED Canada RSS-GEN Issue 5, Clause 7.3/8.9

Measurement procedure: ANSI C63.10-2013 Clause 11.12

Test Results: Complies

Measurement Data:

Measuring distance: 3m (1 – 18 GHz)
1m (18 – 26 GHz)

Peak Detector:

Carrier Frequency (MHz)	Frequency (MHz)	Peak Field Strength, @3m (dBμV/m)	Average Field Strength, @3m (dBμV/m)	Peak Limit (dBμV/m)	Average Limit (dBμV/m)	Peak Margin (dB)	Average Margin (dB)
2402	4804	54.9	45.3	74	54	19.1	8.7
	7206	52.0	/	74	54	22.0	/
	19216	59.7	50.1	74	54	14.3	3.9
2440	4880	57.1	47.5	74	54	16.9	6.5
	7320	53.6	/	74	54	20.4	/
	14640	62.8	53.2	74	54	11.2	0.8
	19520	58.9	49.3	74	54	15.1	4.7
2480	4960	56.5	46.9	74	54	17.5	7.1
	7440	54.6	45.0	74	54	19.4	9.0
	19840	56.0	46.4	74	54	18.0	7.6
	22320	55.4	45.8	74	54	18.6	8.2

All frequencies above are harmonics of the carrier.

Average Detector values are calculated from Peak values by Duty Cycle Correction Factor.

A Band Reject Filter was used for all measurements from 1 GHz to 18 GHz.

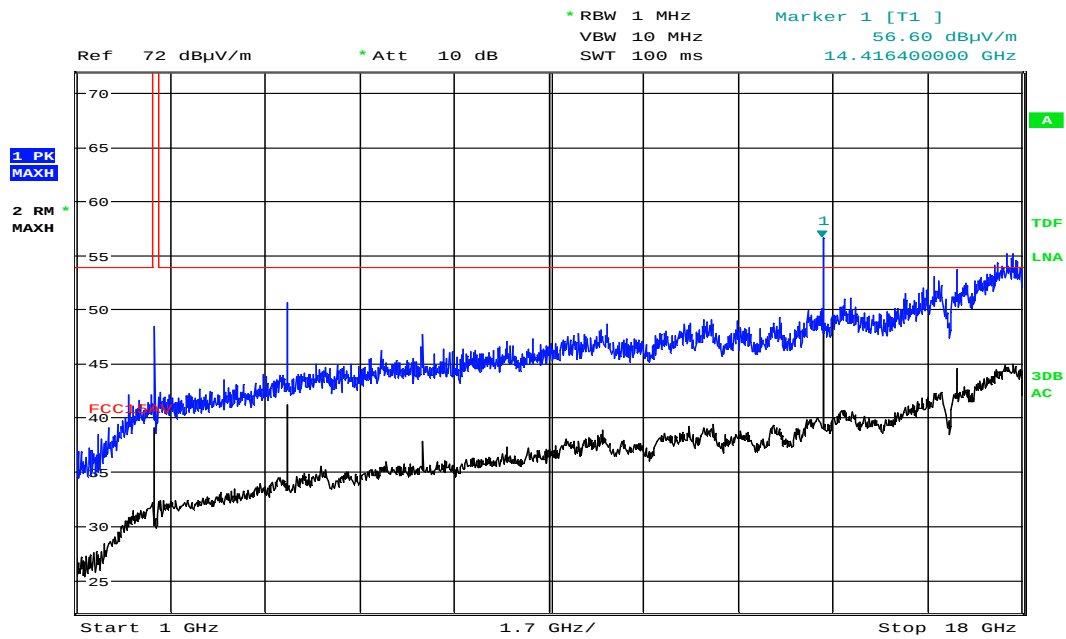
Measurements at 1m are converted to 3m using the distance correction factor (20 dB/octave).

Antenna factor, amplifier gain and cable loss are included in spectrum analyzer "Transducer factor".

See plots.

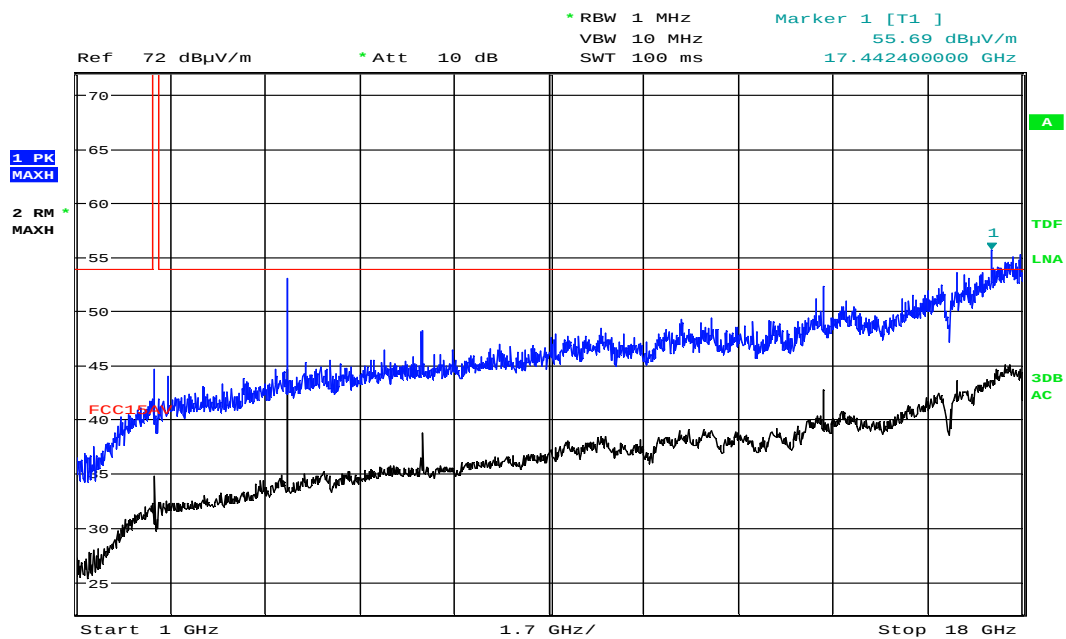
Requirements/Limit

FCC	Part 15.209 @ frequencies defined in §15.205	
ISED	RSS-GEN Issue 5, clause 8.9 @ frequencies defined in clause 8.10	
	Radiated emission limit @3 meters	
Frequency	Average Detector	Peak Detector
1 – 26 GHz	54.0 dBμV/m	74.0 dBμV/m



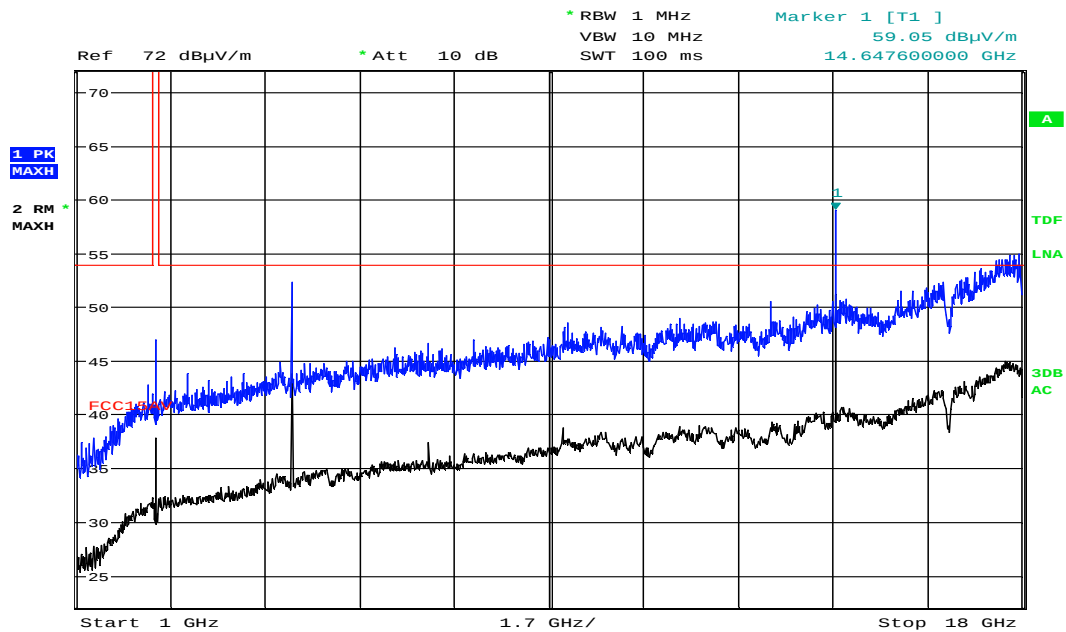
Date: 24.MAR.2020 13:50:50

Radiated Emissions 1000 – 18000 MHz, 2402 MHz, HP



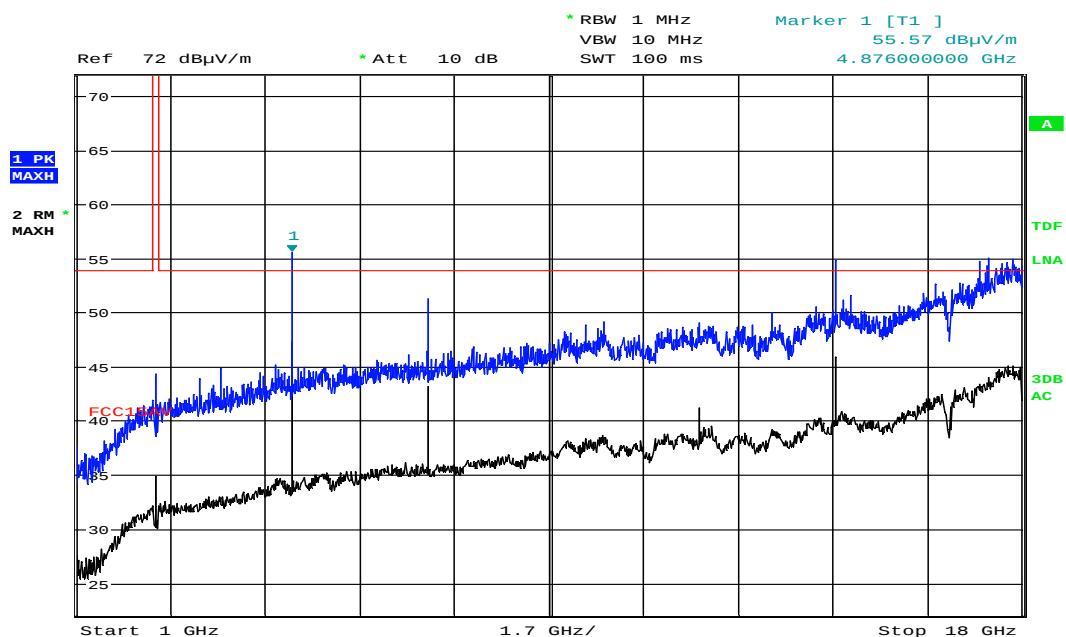
Date: 24.MAR.2020 13:48:44

Radiated Emissions 1000 – 18000 MHz, 2402 MHz, VP



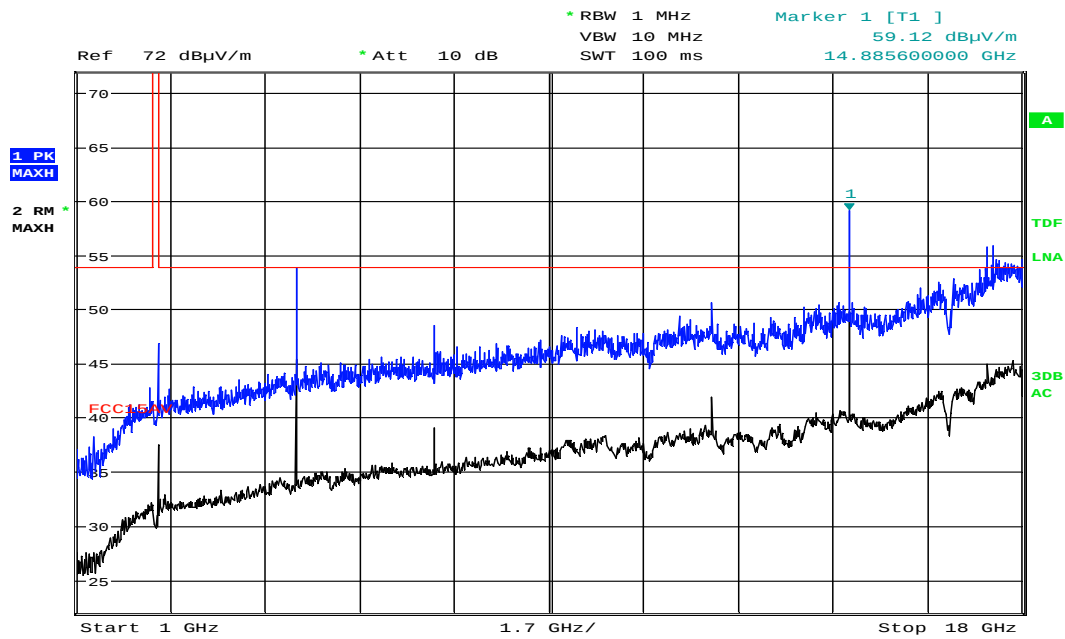
Date: 24.MAR.2020 14:54:31

Radiated Emissions 1000 – 18000 MHz, 2440 MHz, HP



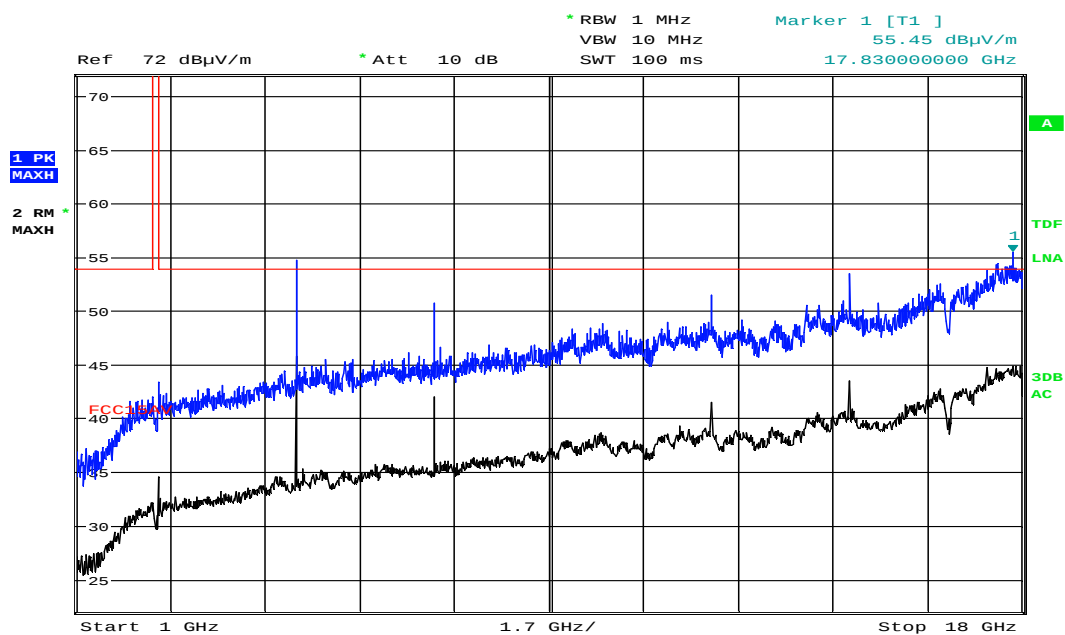
Date: 24.MAR.2020 14:46:53

Radiated Emissions 1000 – 18000 MHz, 2440 MHz, VP



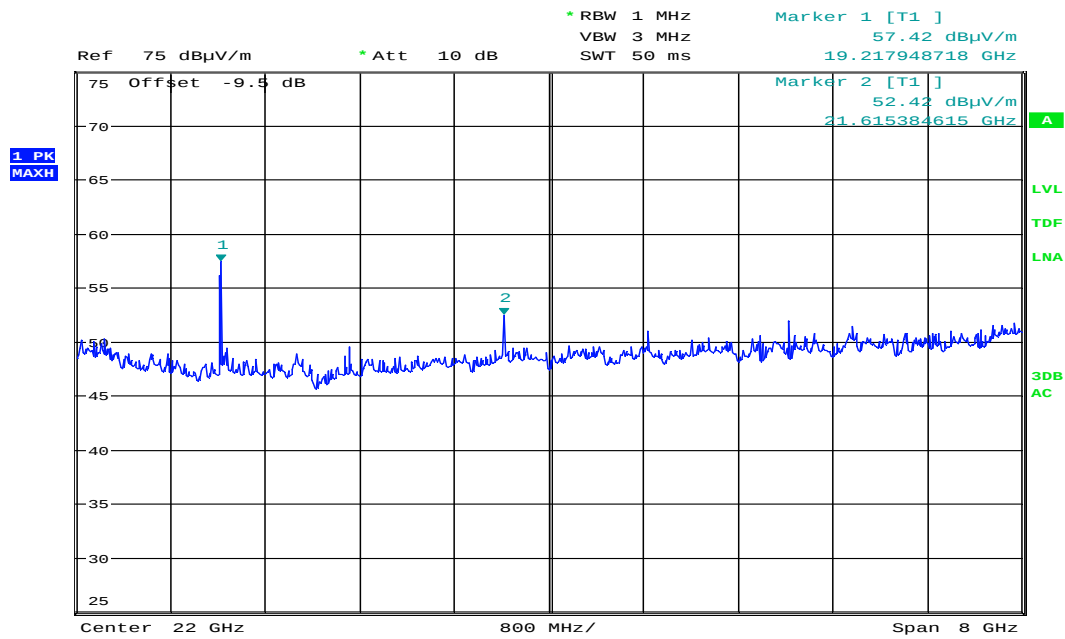
Date: 24.MAR.2020 13:43:39

Radiated Emissions 1000 – 18000 MHz, 2480 MHz, HP



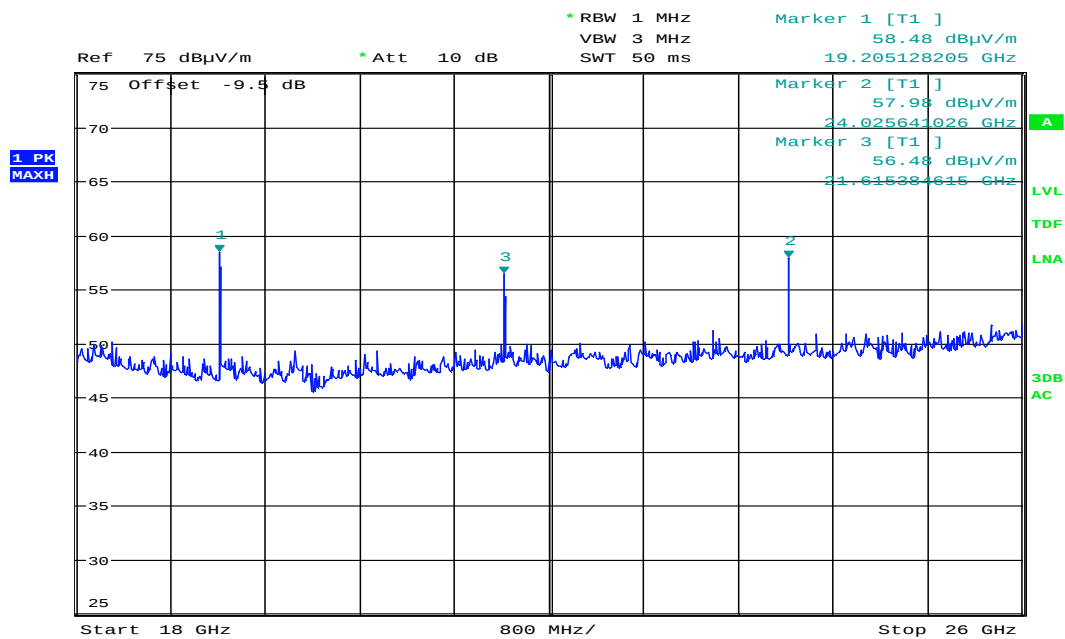
Date: 24.MAR.2020 13:41:33

Radiated Emissions 1000 – 18000 MHz, 2480 MHz, VP



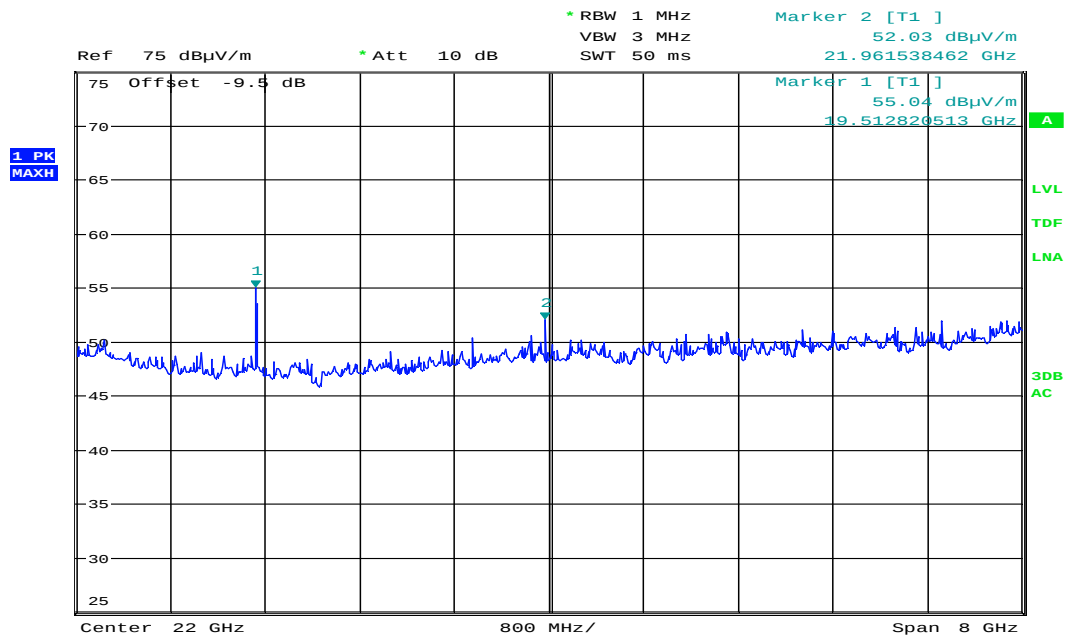
Date: 24.MAR.2020 15:55:43

Radiated Emissions 18000 – 26000 MHz, 2402 MHz, HP, @1m



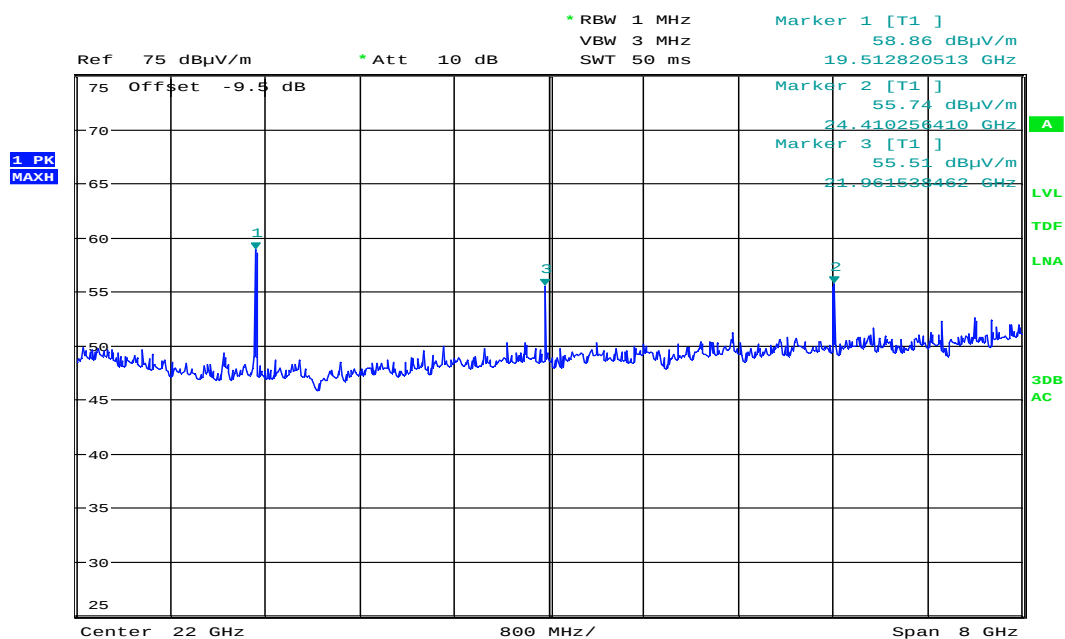
Date: 24.MAR.2020 15:54:22

Radiated Emissions 18000 – 26000 MHz, 2402 MHz, VP, @1m



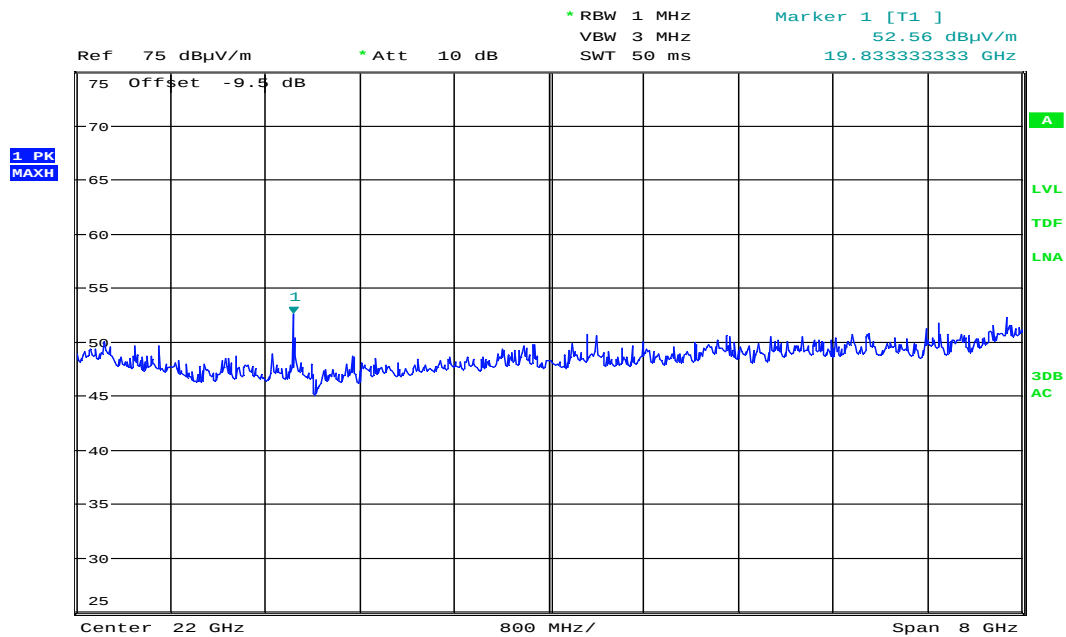
Date: 24.MAR.2020 15:43:52

Radiated Emissions 18000 – 26000 MHz, 2440 MHz, HP, @1m



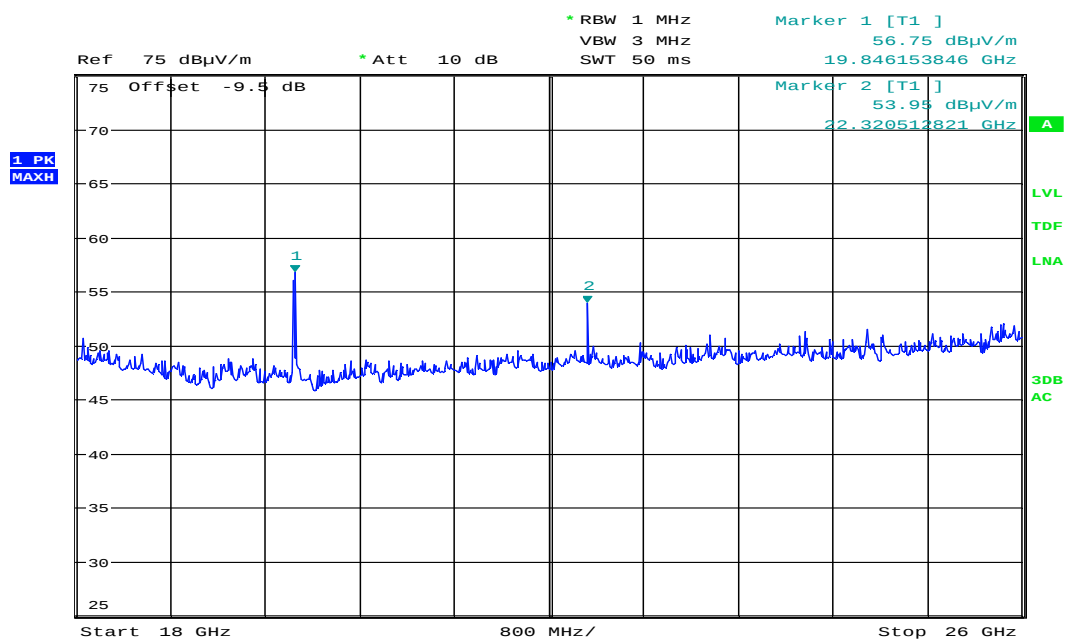
Date: 24.MAR.2020 15:42:26

Radiated Emissions 18000 – 26000 MHz, 2440 MHz, VP, @1m



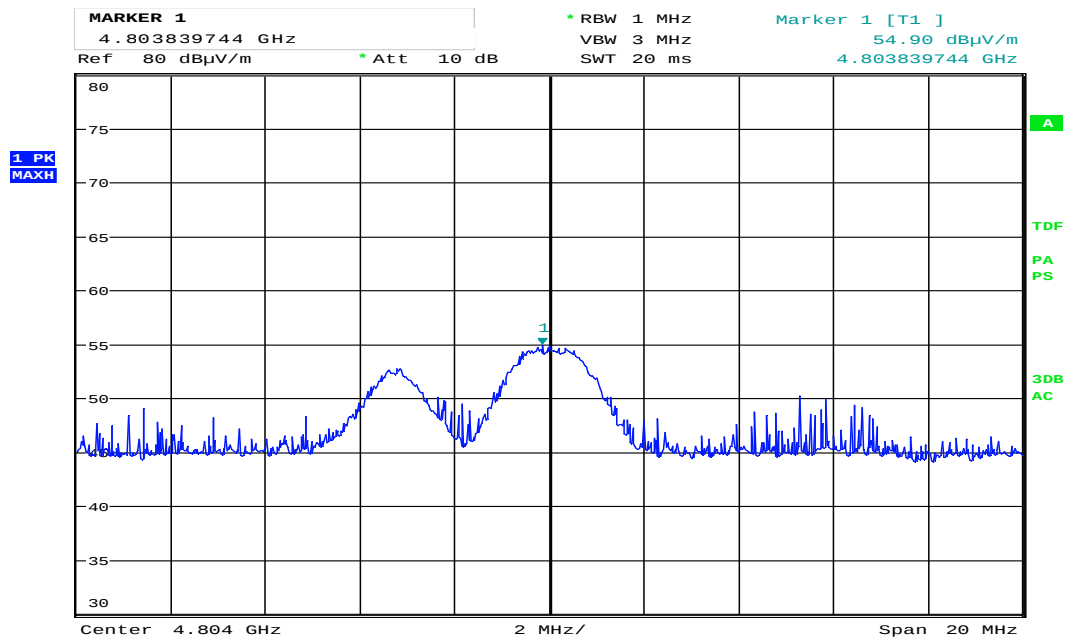
Date: 24.MAR.2020 16:07:08

Radiated Emissions 18000 – 26000 MHz, 2480 MHz, HP, @1m



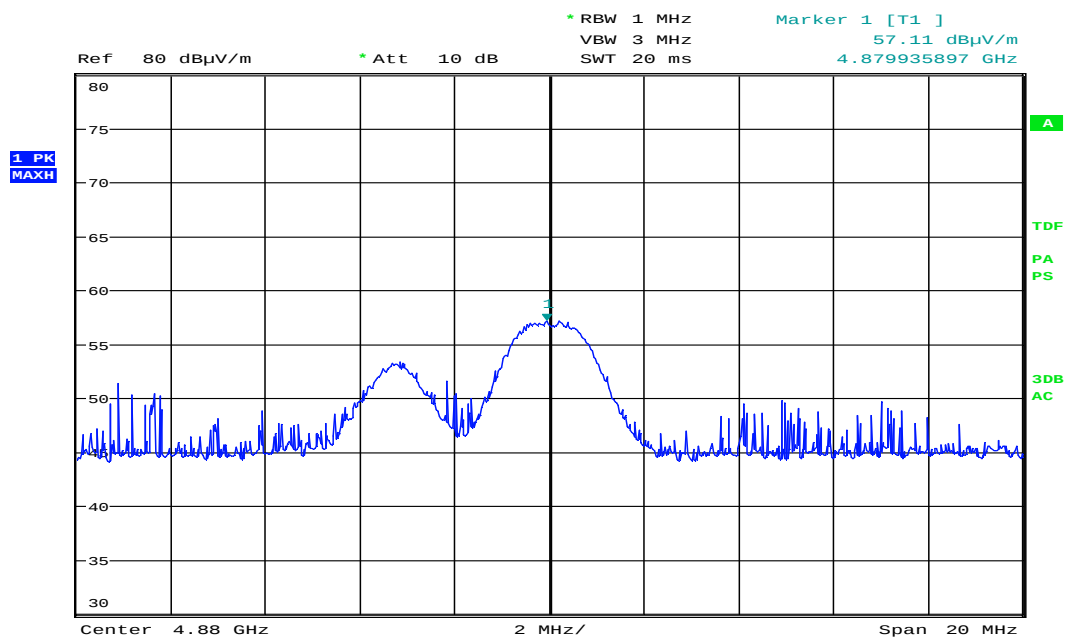
Date: 24.MAR.2020 16:05:51

Radiated Emissions 18000 – 26000 MHz, 2480 MHz, VP, @1m



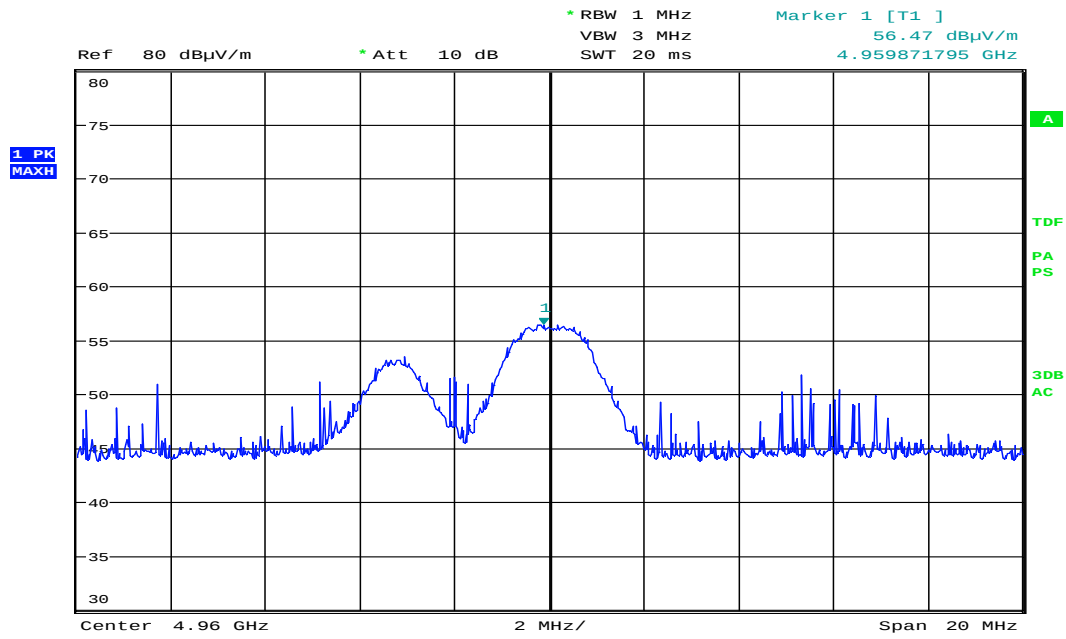
Date: 24.MAR.2020 12:03:18

Radiated Emissions 4804 MHz, 2402 MHz, HP



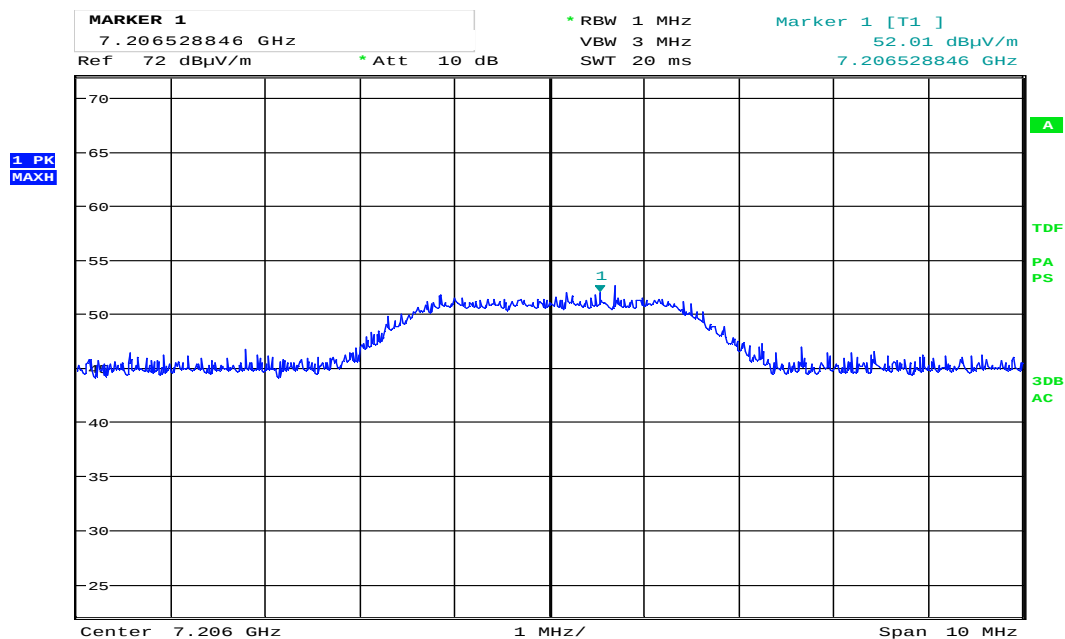
Date: 24.MAR.2020 12:02:13

Radiated Emissions 4880 MHz, 2440 MHz, HP



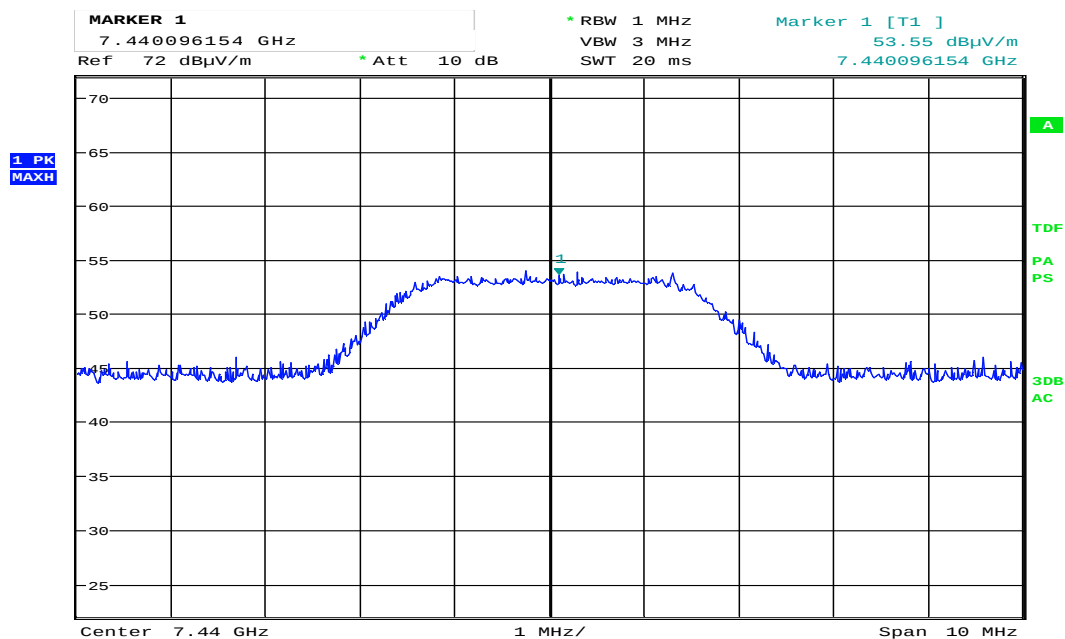
Date: 24.MAR.2020 12:04:44

Radiated Emissions 4960 MHz, 2480 MHz, HP



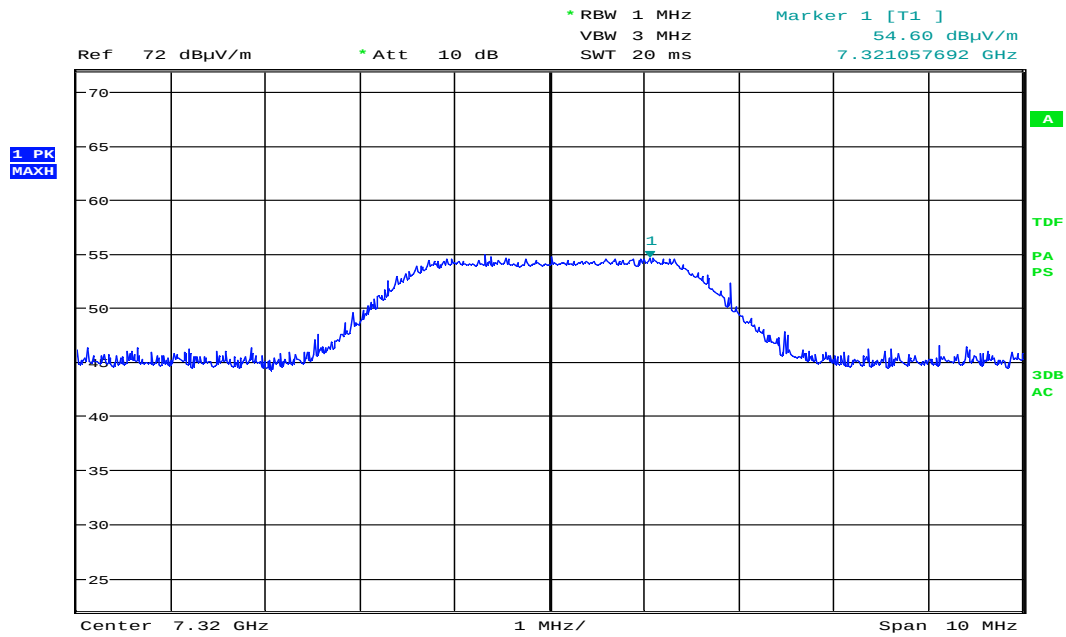
Date: 24.MAR.2020 14:25:28

Radiated Emissions 7206 MHz, 2402 MHz, VP



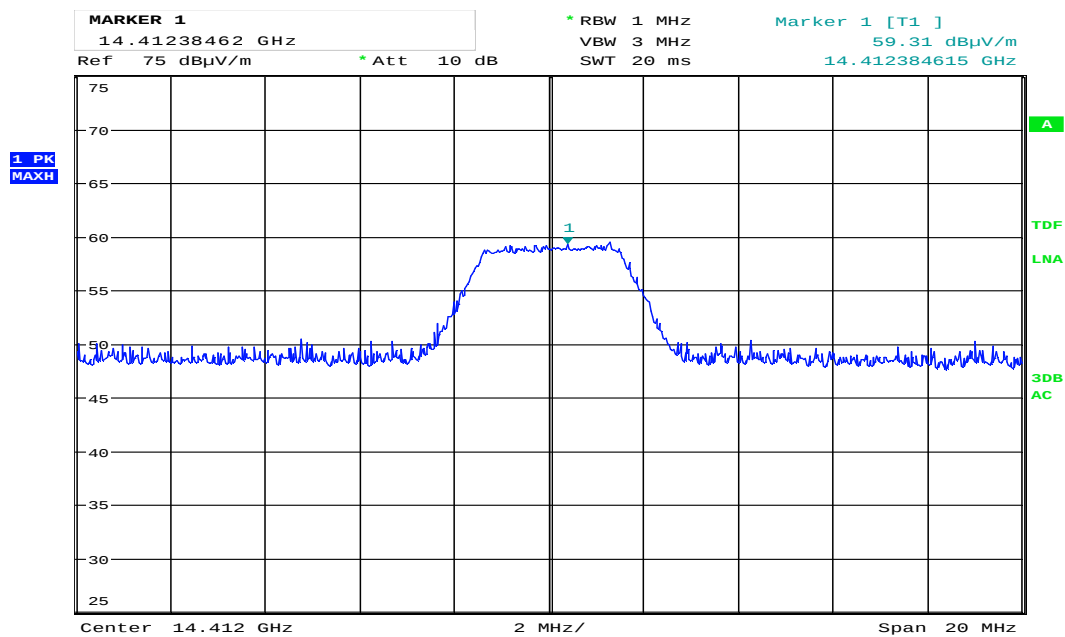
Date: 24.MAR.2020 14:27:06

Radiated Emissions 7440 MHz, 2440 MHz, VP



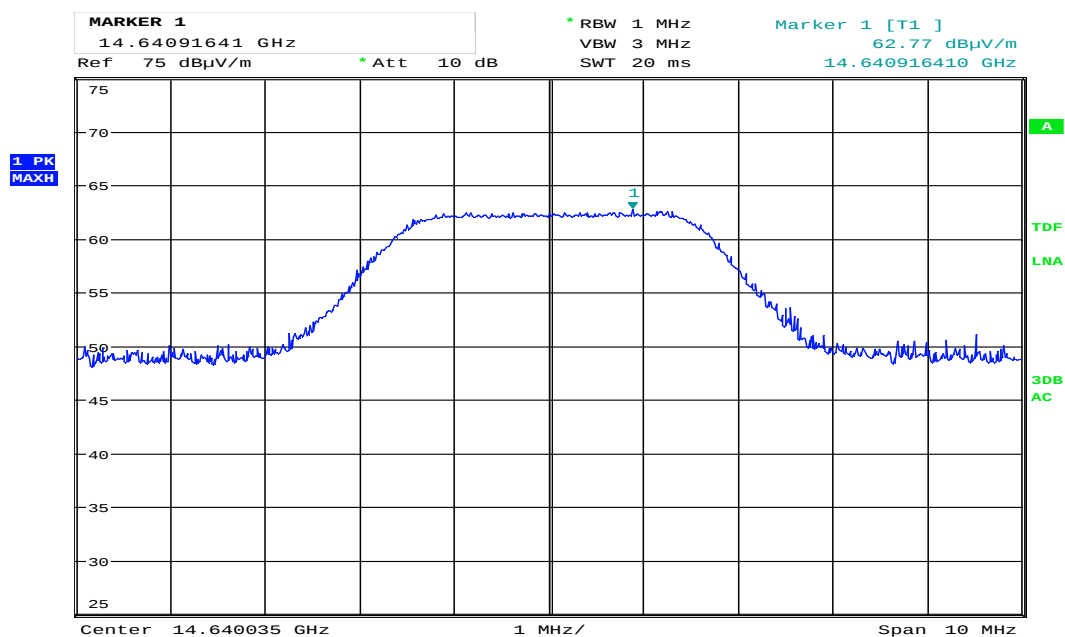
Date: 24.MAR.2020 14:24:34

Radiated Emissions 7320 MHz, 2480 MHz, VP



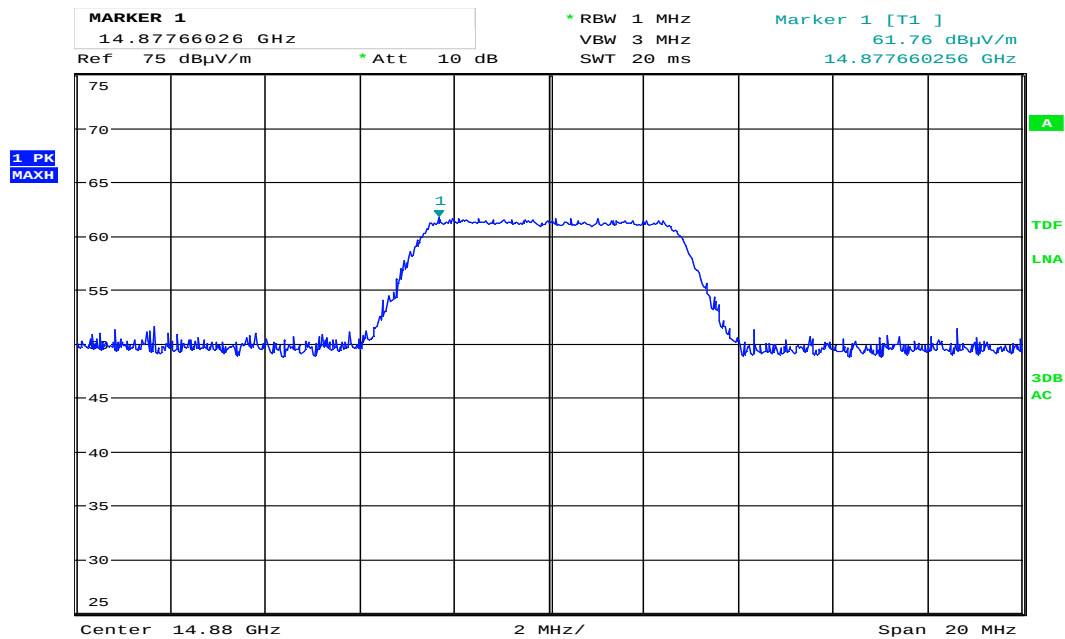
Date: 24.MAR.2020 13:35:40

Radiated Emissions 14412 MHz, 2402 MHz, HP (Not in Restricted Band)



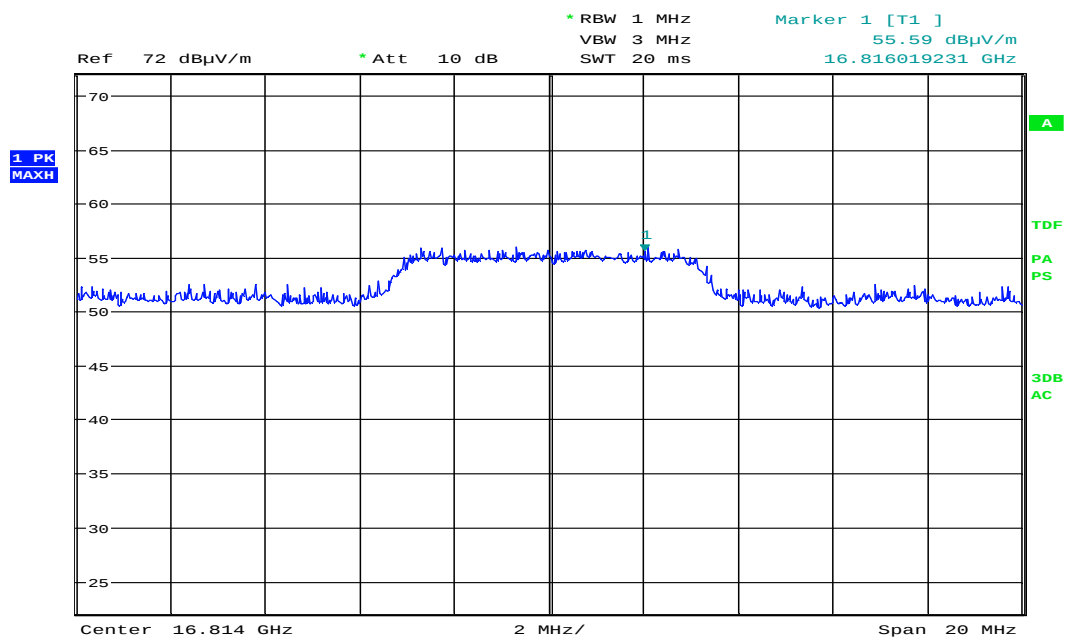
Date: 24.MAR.2020 13:11:27

Radiated Emissions 14640 MHz, 2440 MHz, VP



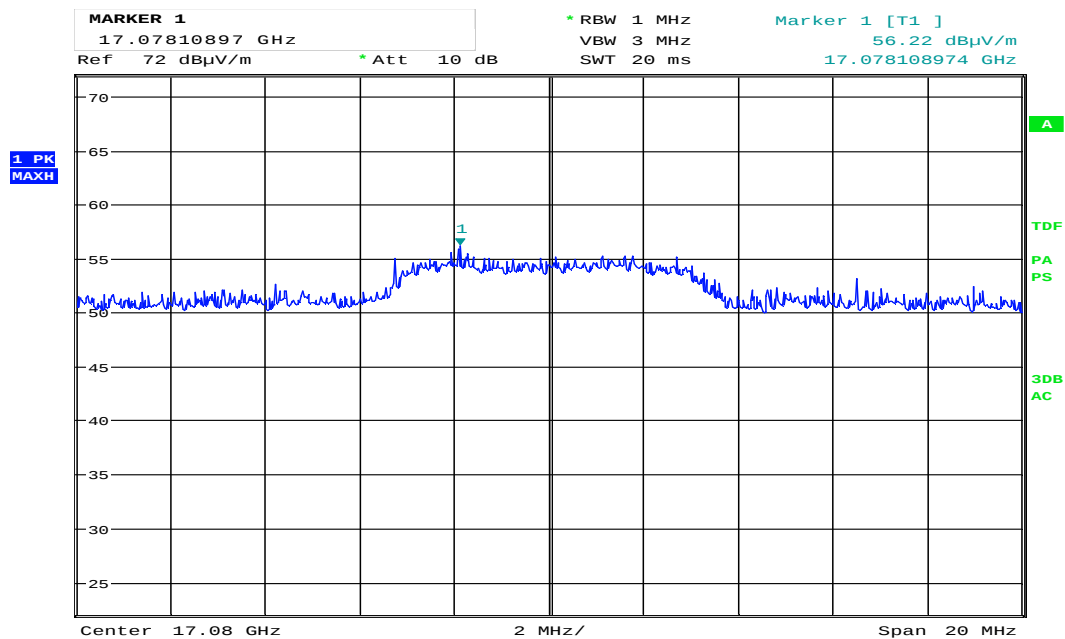
Date: 24.MAR.2020 13:37:16

Radiated Emissions 14880 MHz, 2480 MHz, HP (Not in Restricted Band)



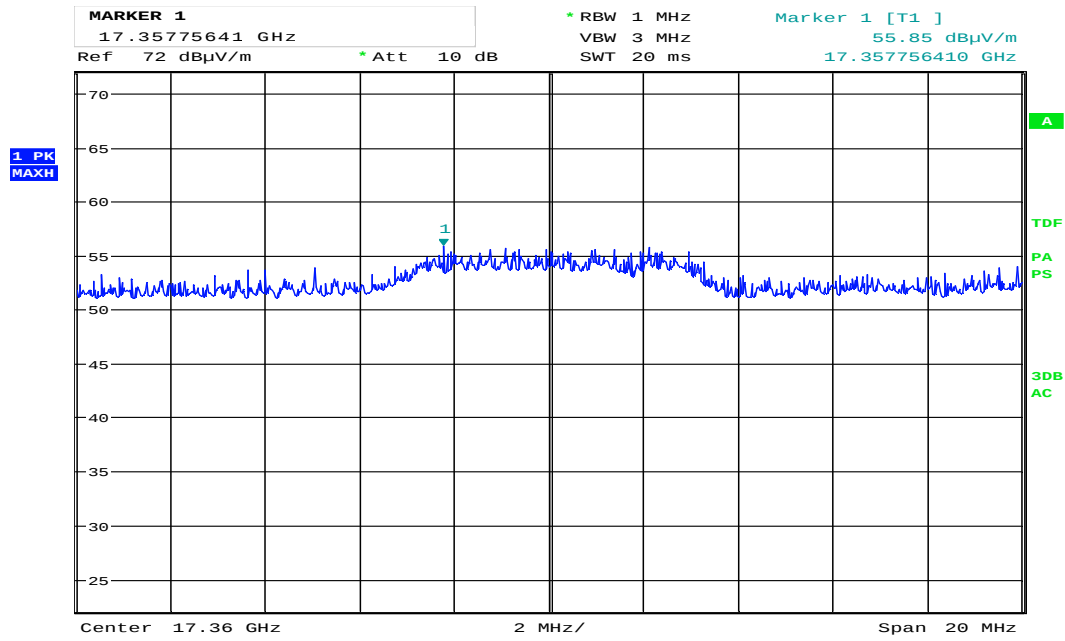
Date: 24.MAR.2020 14:08:06

Radiated Emissions 16814 MHz, 2402 MHz, HP (Not in Restricted Band)



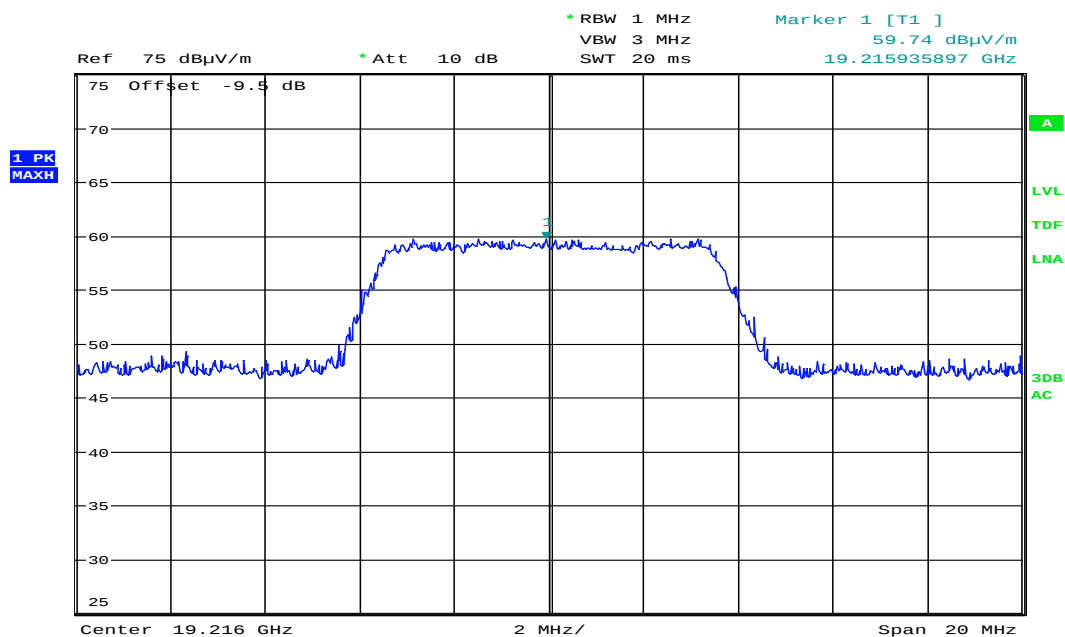
Date: 24.MAR.2020 14:09:30

Radiated Emissions 17080 MHz, 2440 MHz, HP (Not in Restricted Band)



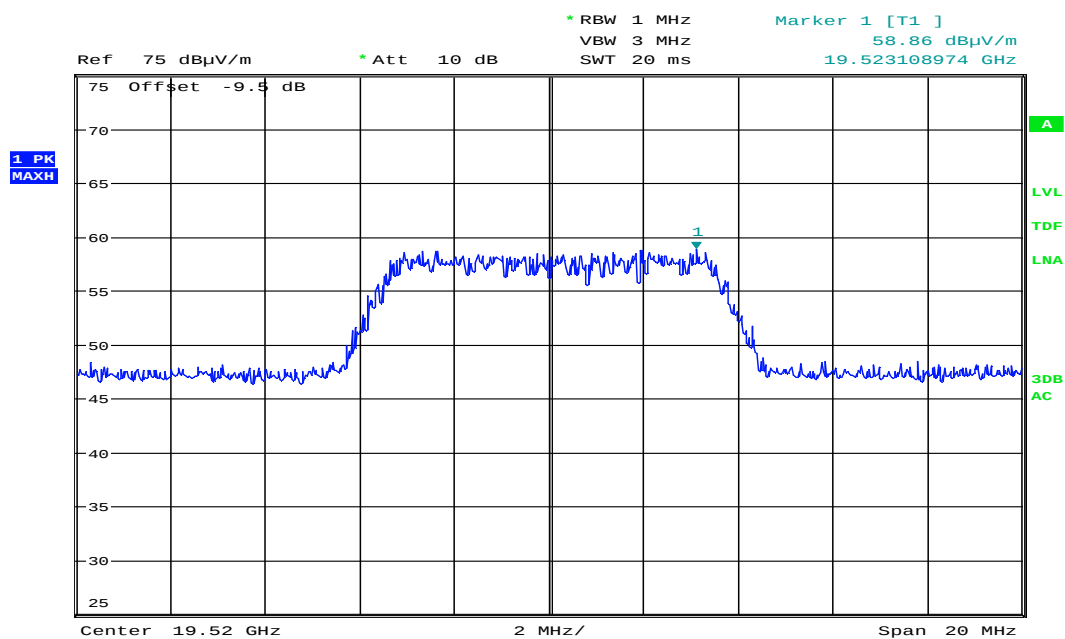
Date: 24.MAR.2020 14:10:27

Radiated Emissions 17360 MHz, 2480 MHz, HP (Not in Restricted Band)



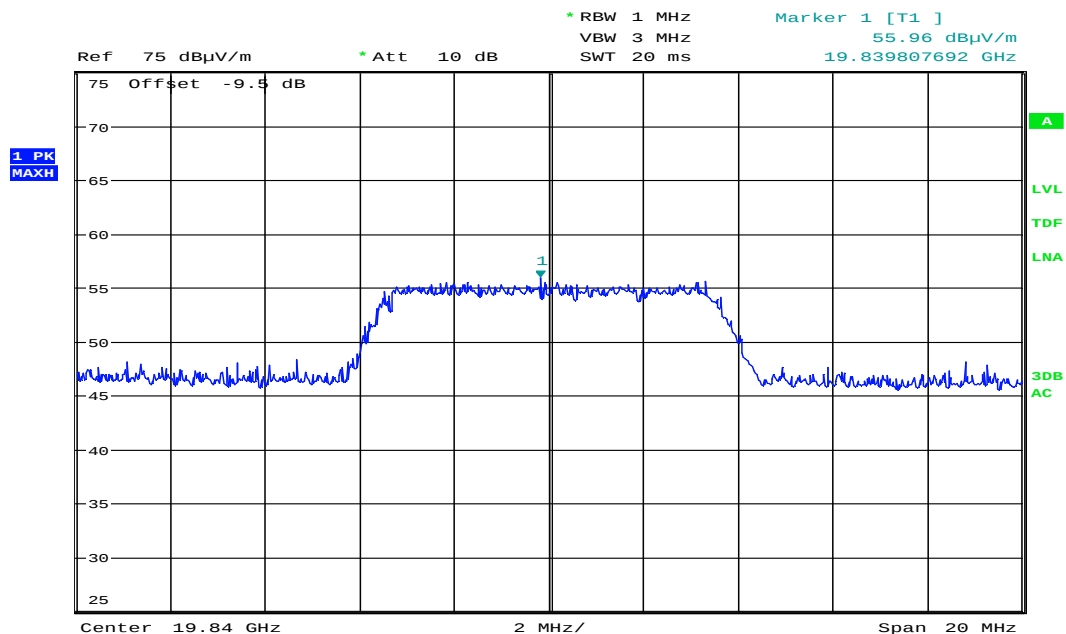
Date: 24.MAR.2020 15:58:53

Radiated Emissions 19216 MHz, 2402 MHz, VP



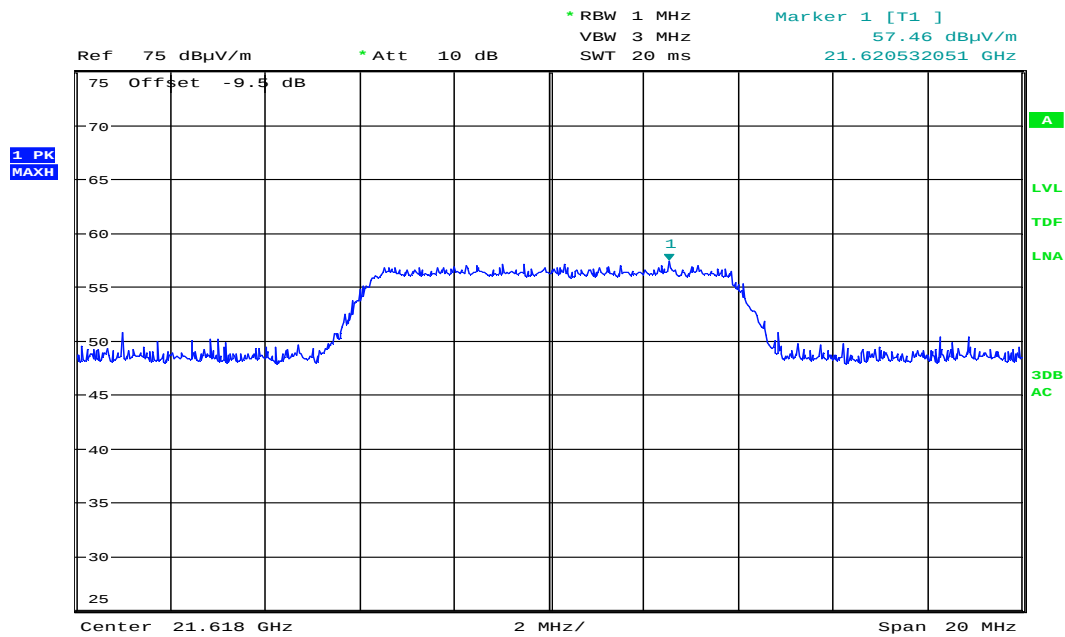
Date: 24.MAR.2020 15:46:47

Radiated Emissions 19520 MHz, 2440 MHz, VP



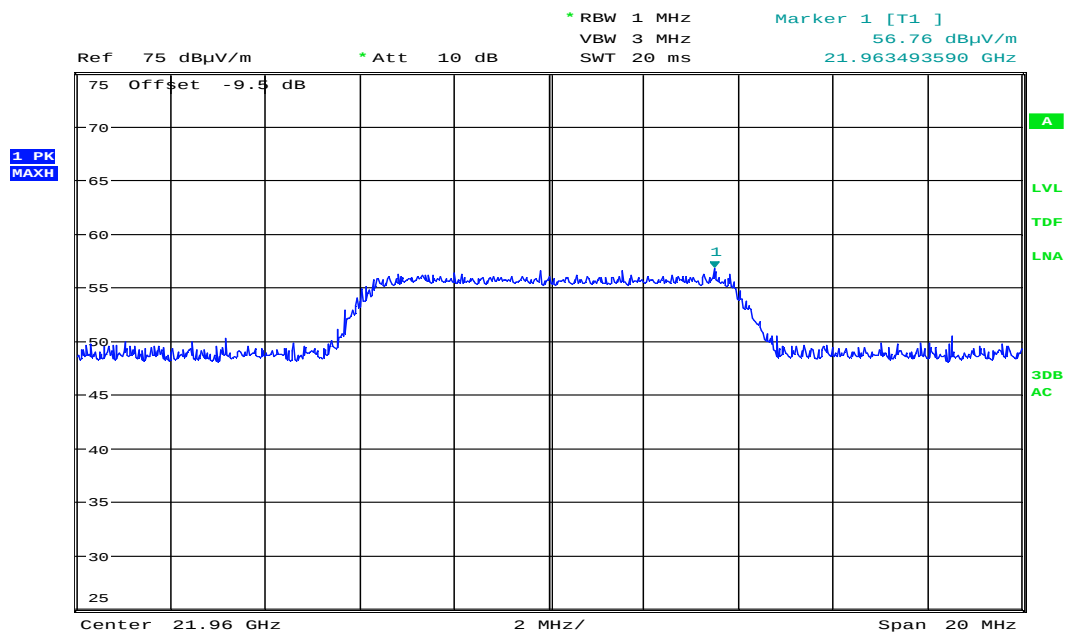
Date: 24.MAR.2020 16:10:43

Radiated Emissions 19840 MHz, 2480 MHz, VP



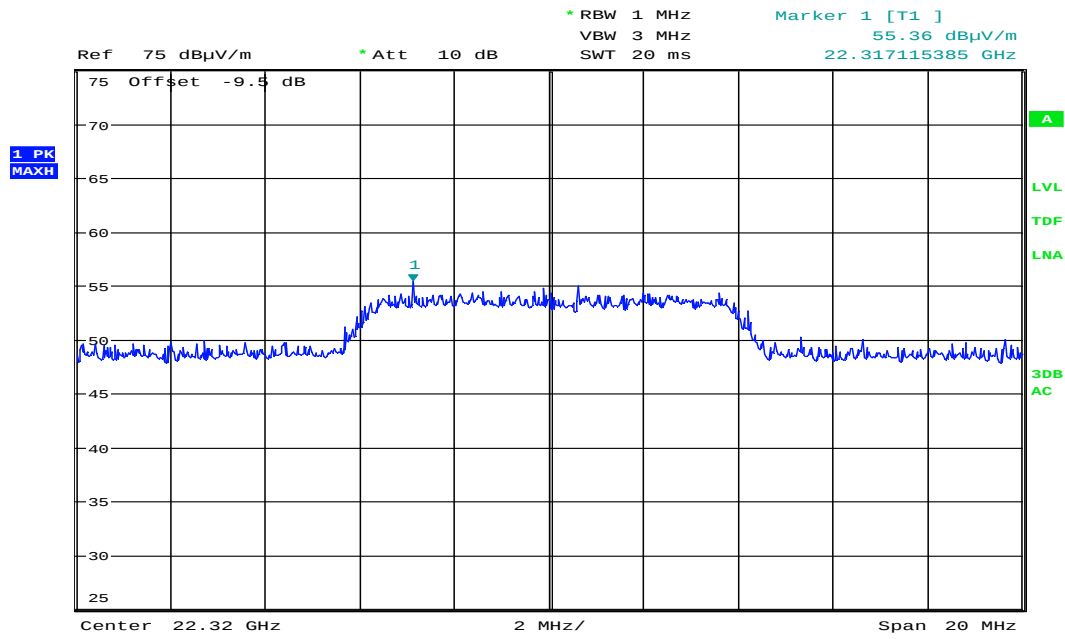
Date: 24.MAR.2020 16:00:44

Radiated Emissions 21618 MHz, 2402 MHz, VP (Not in Restricted Band)



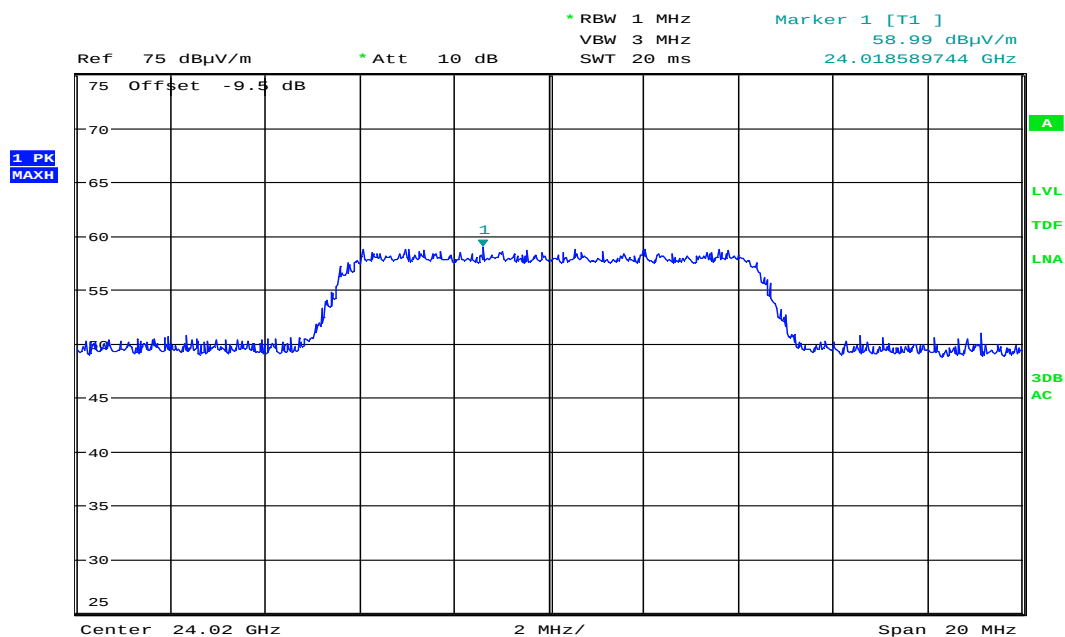
Date: 24.MAR.2020 15:48:31

Radiated Emissions 21960 MHz, 2440 MHz, VP (Not in Restricted Band)



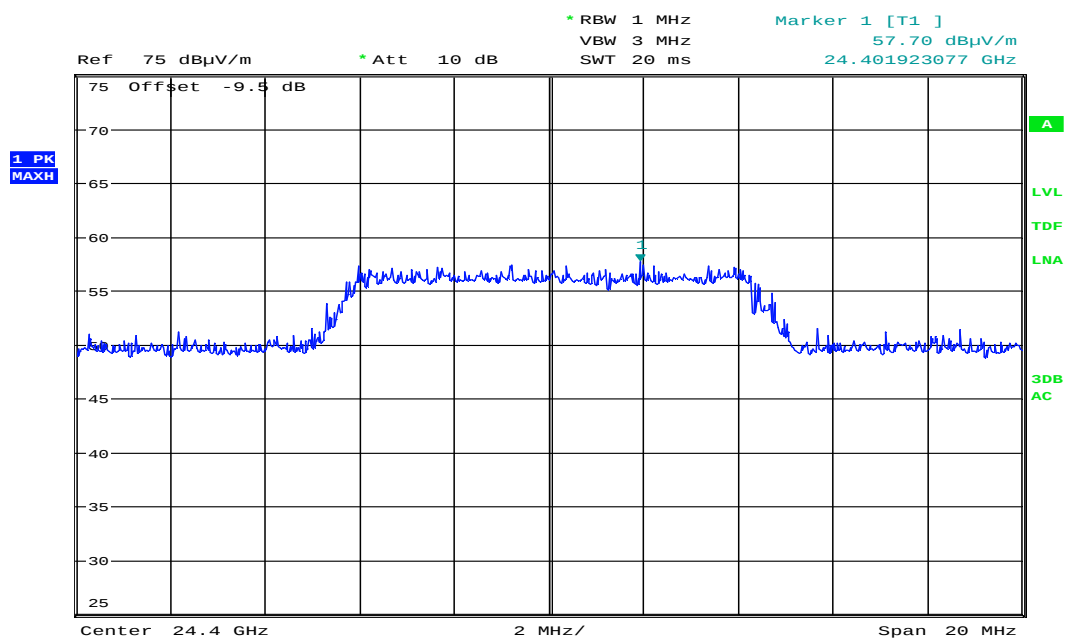
Date: 24.MAR.2020 16:11:59

Radiated Emissions 22320 MHz, 2480 MHz, VP



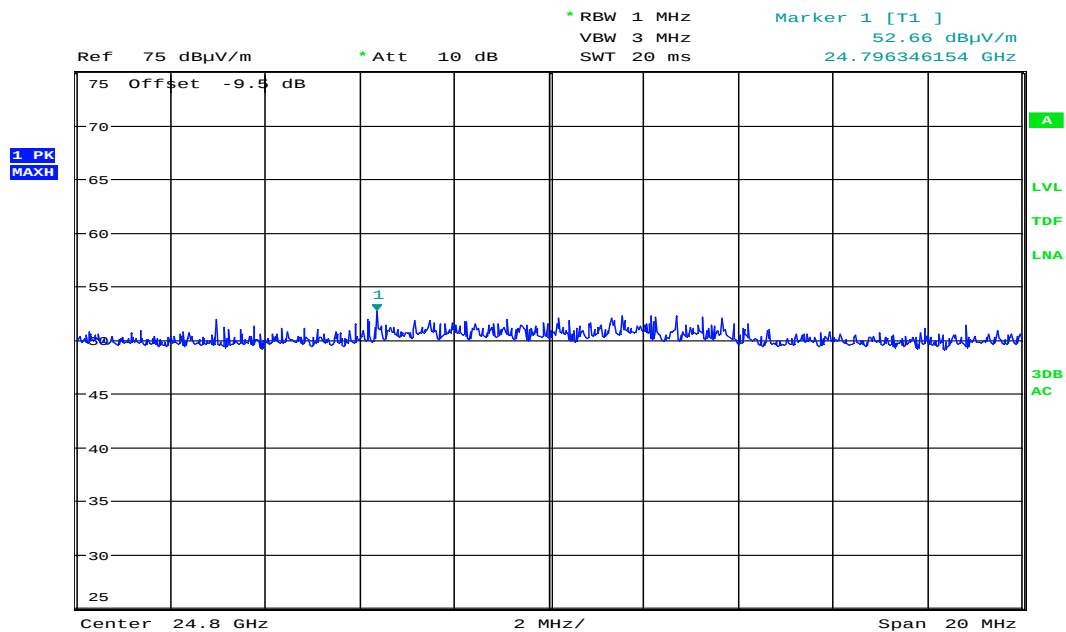
Date: 24.MAR.2020 16:02:36

Radiated Emissions 24020 MHz, 2402 MHz, VP (Not in Restricted Band)



Date: 24.MAR.2020 15:51:57

Radiated Emissions 24400 MHz, 2440 MHz, VP (Not in Restricted Band)



Date: 24.MAR.2020 16:13:16

Radiated Emissions 24800 MHz, 2480 MHz, VP (Not in Restricted Band)

3.9 Power Spectral Density (PSD)

FCC part 15.247(d)

ISED Canada RSS-247 Issue 2, Clause 5.2 (2)

Measurement procedure: ANSI C63.10-2013 Clause 11.10

Test Results: Complies

Measurement Data:

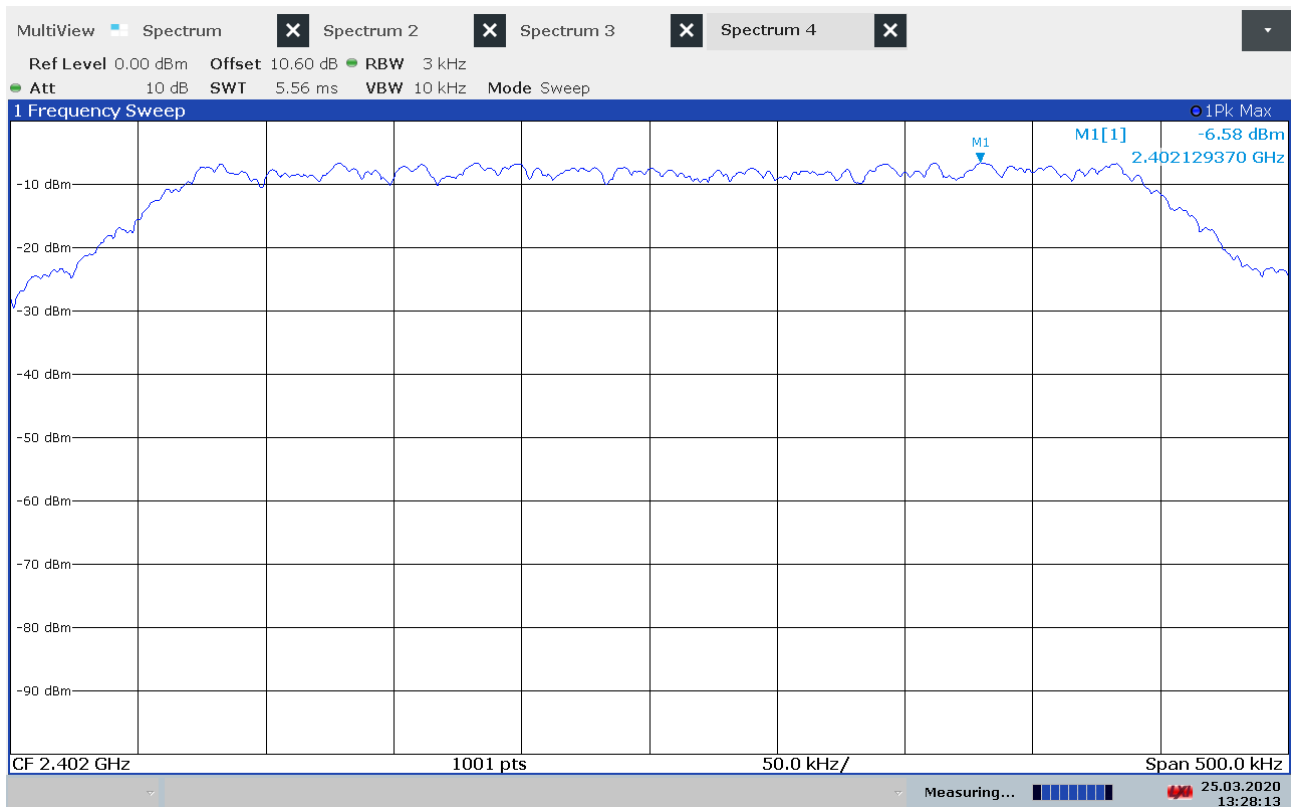
The measurement procedure PKPSD described in ANSI C63.10-2013 was used.

Carrier Frequency	Measured Power Spectral Density (dBm/3kHz)		
	bw400kHz	Bw800kHz	Bw1600kHz
2402 MHz	-6.6	-11.7	-14.6
2440 MHz	-7.9	-12.9	-15.8
2480 MHz	-8.8	-14.0	-16.9

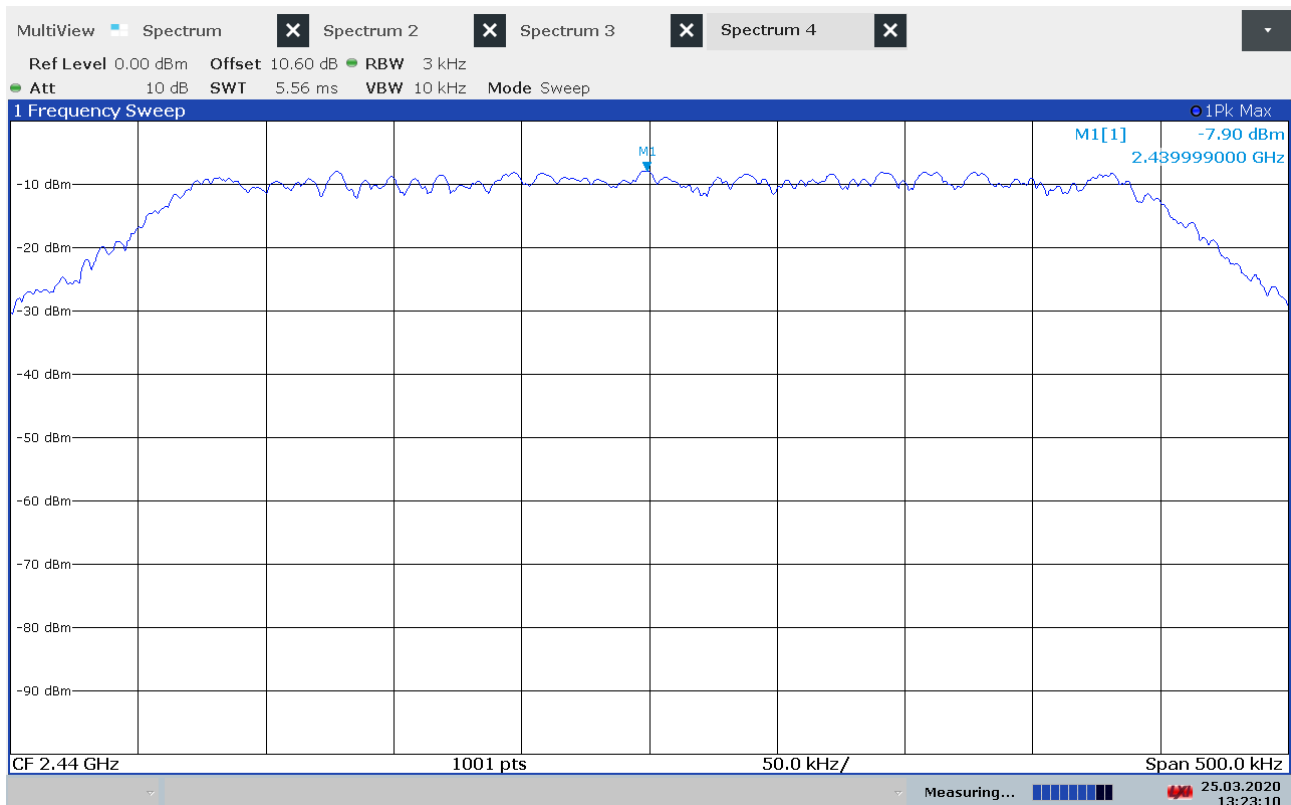
Requirements:

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

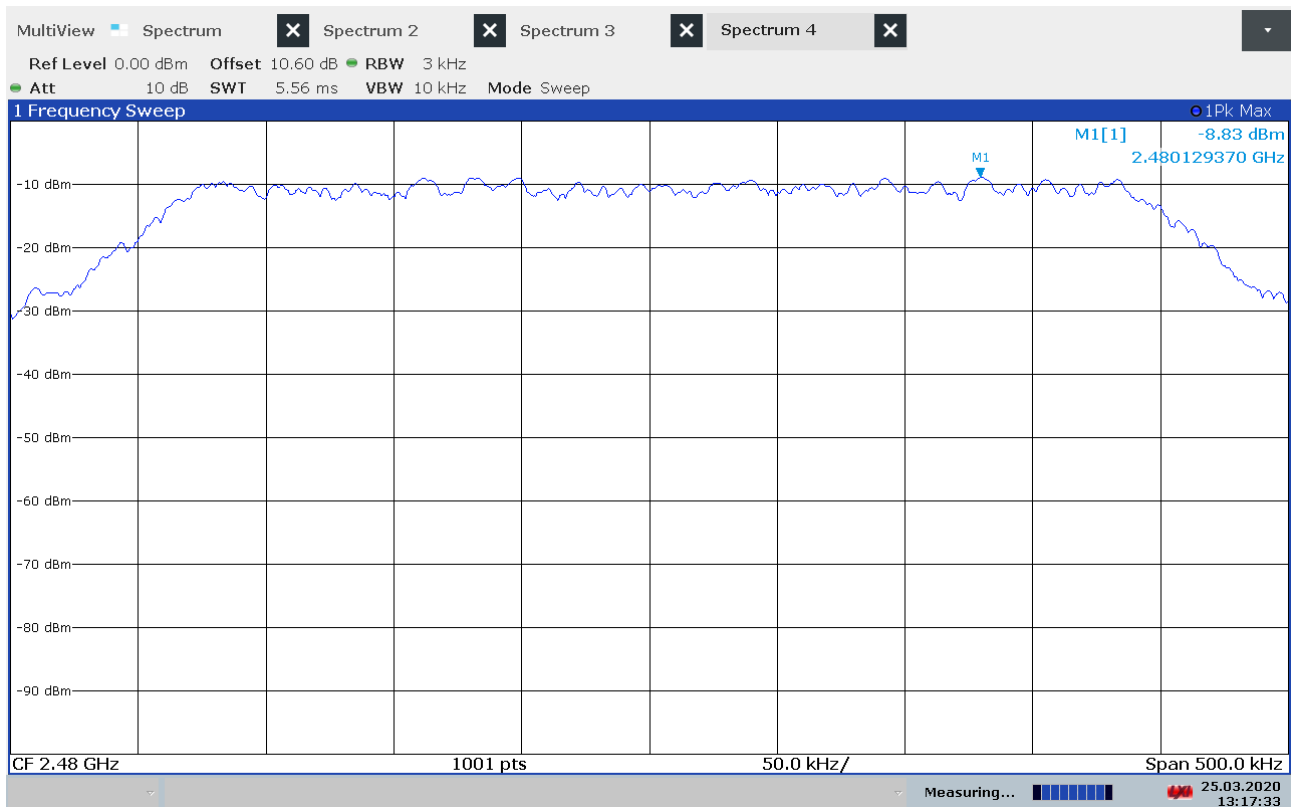
No requirements for Frequency Hopping Systems.



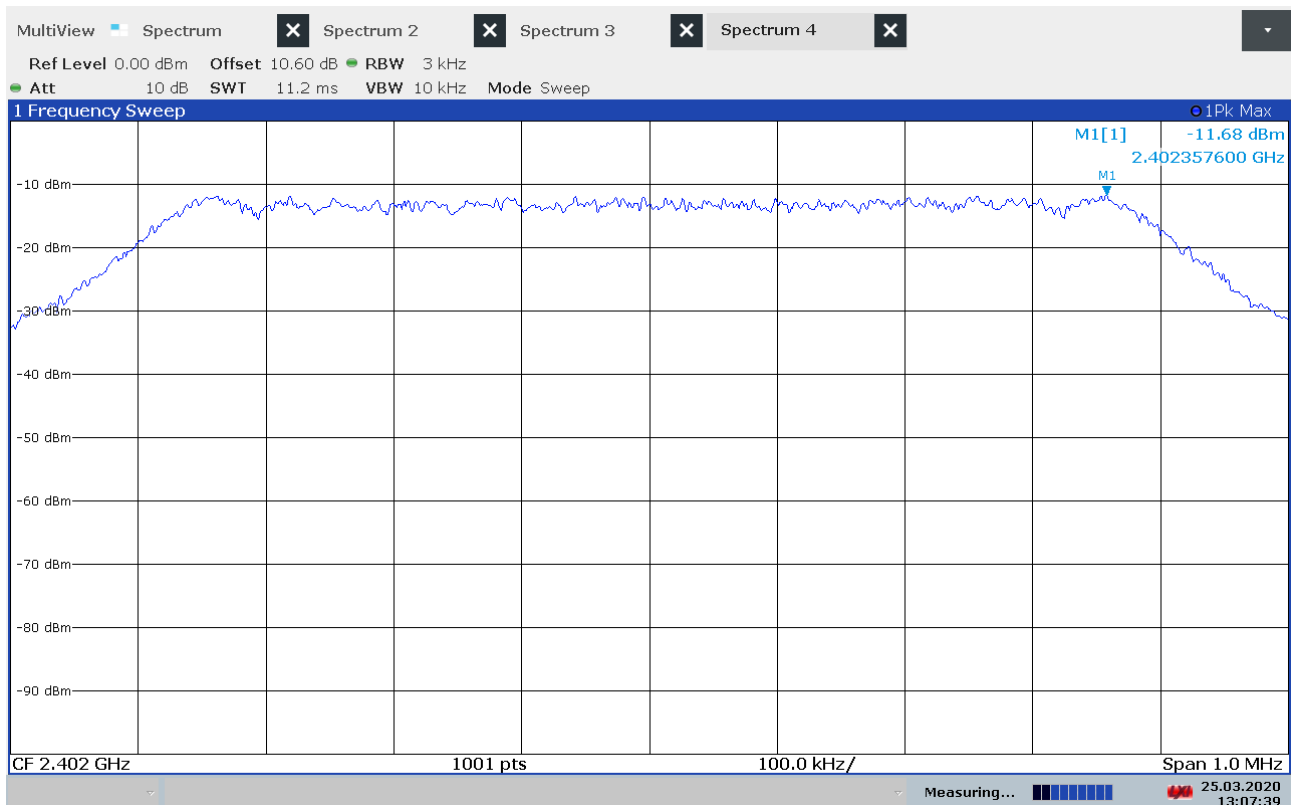
Power Spectral Density, 2402MHz, bw400kHz



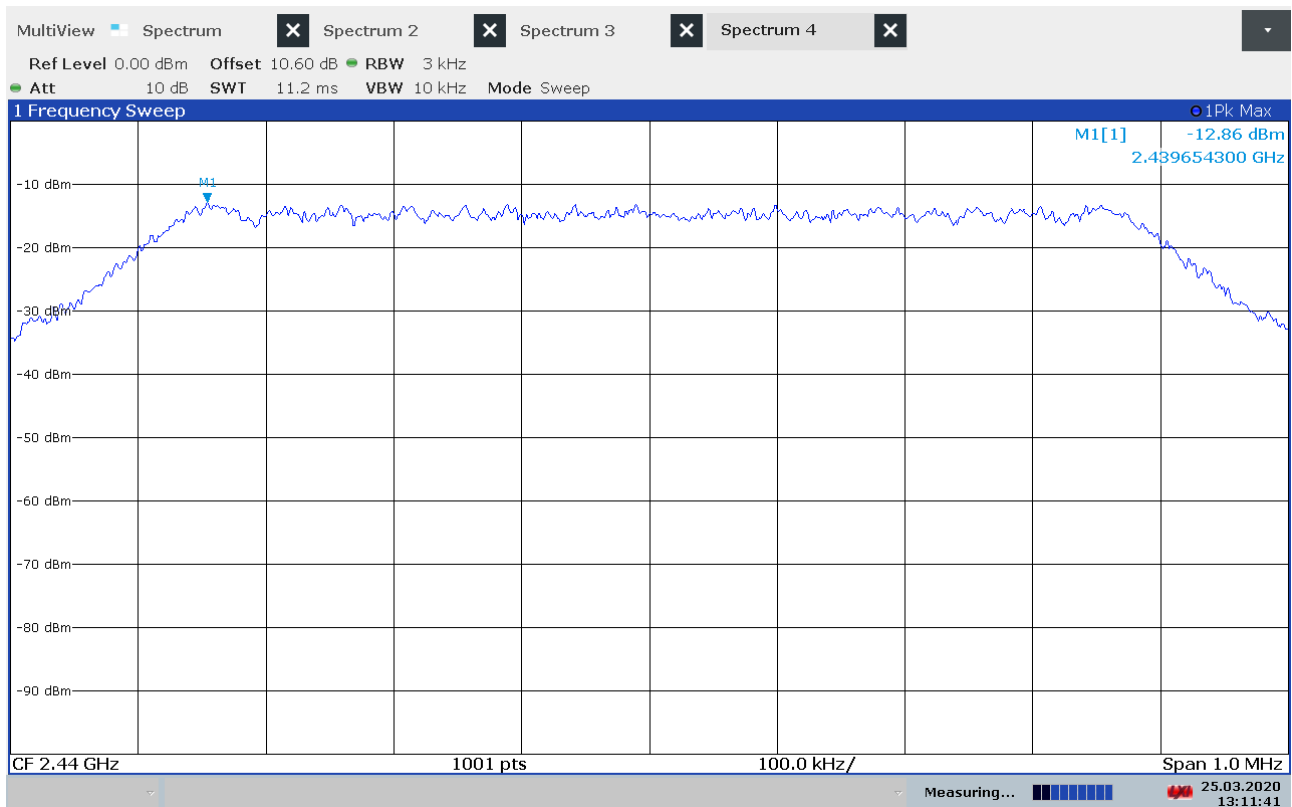
Power Spectral Density, 2440MHz, bw400kHz



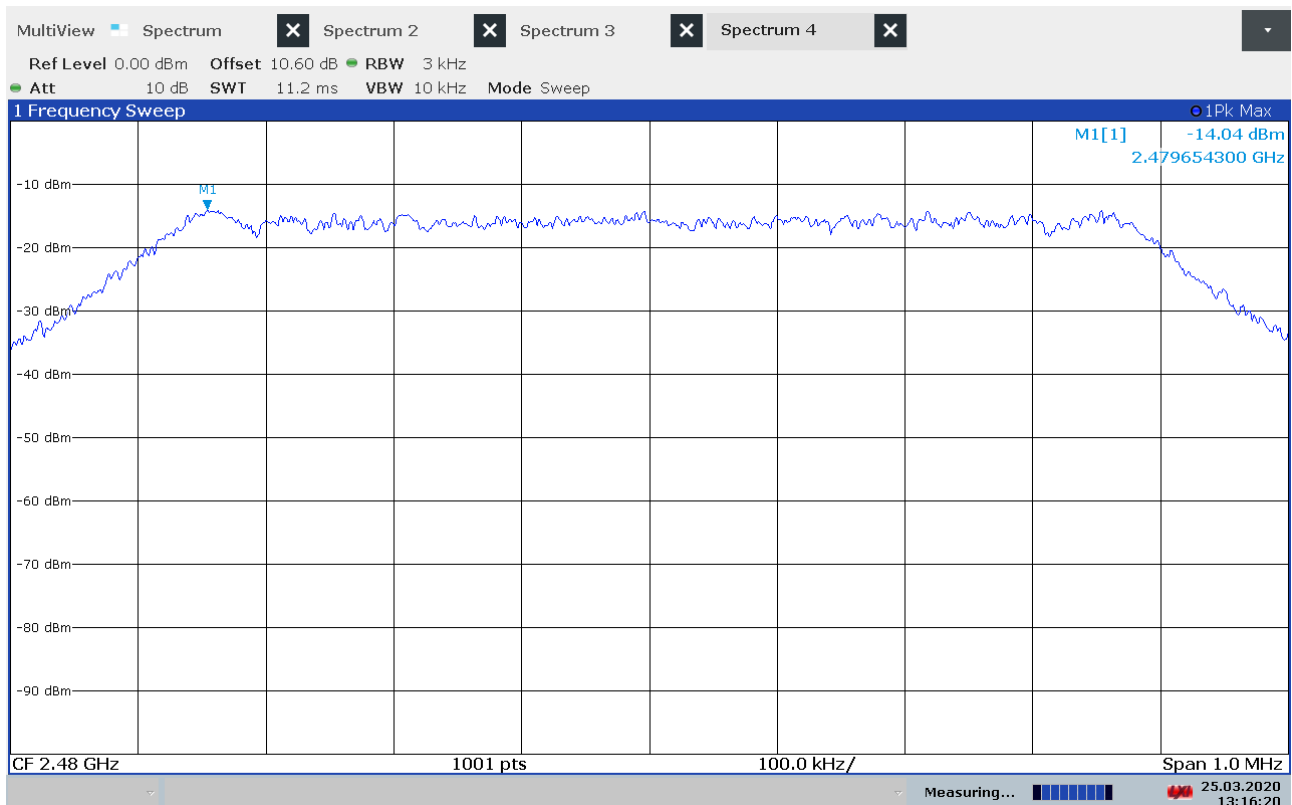
Power Spectral Density, 2480MHz, bw400kHz



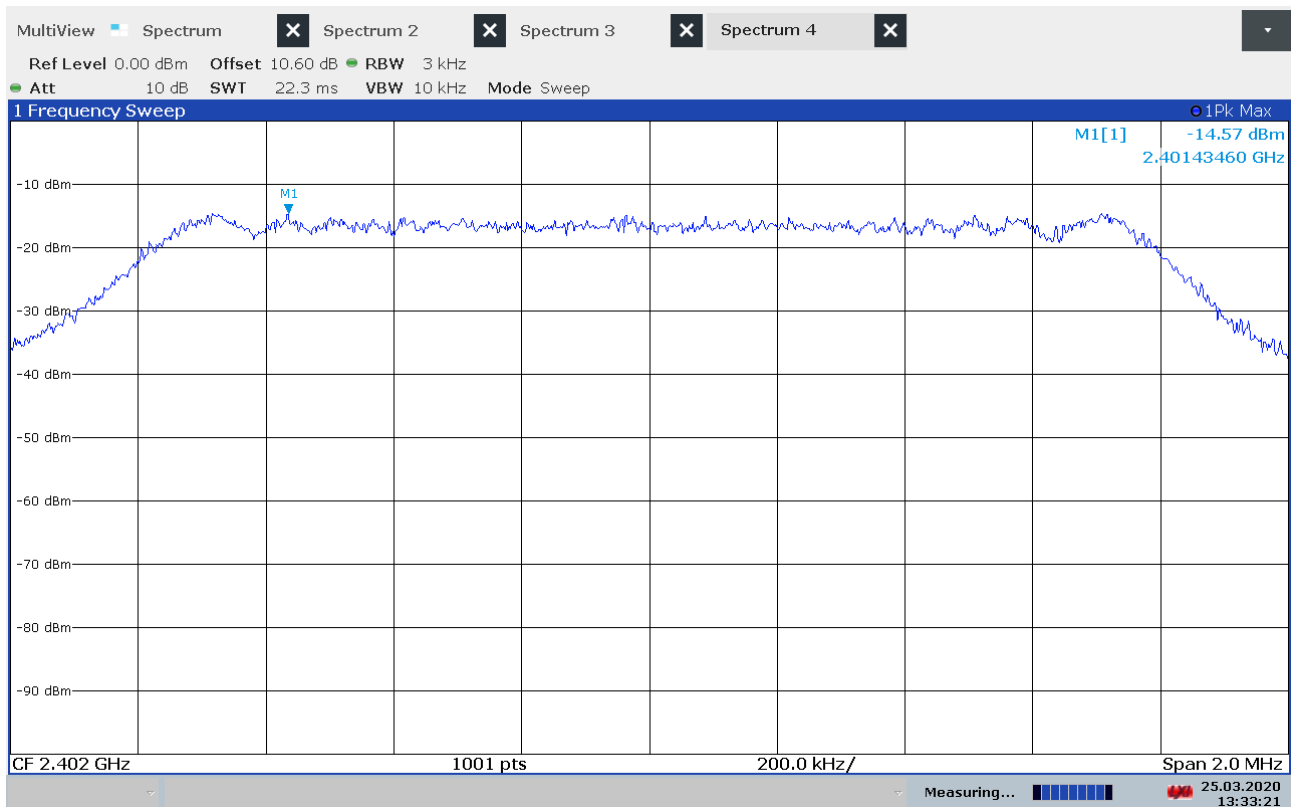
Power Spectral Density, 2402MHz, bw800kHz



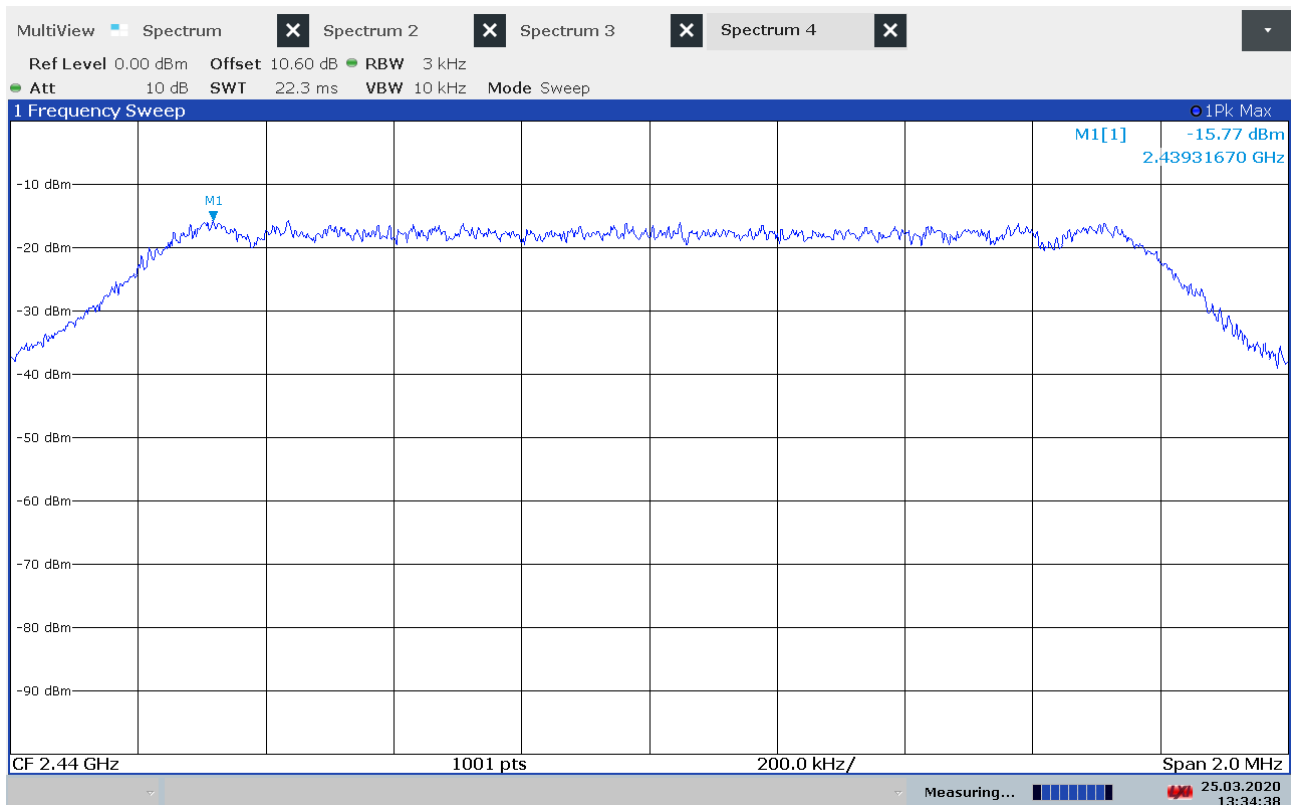
Power Spectral Density, 2440MHz, bw800kHz



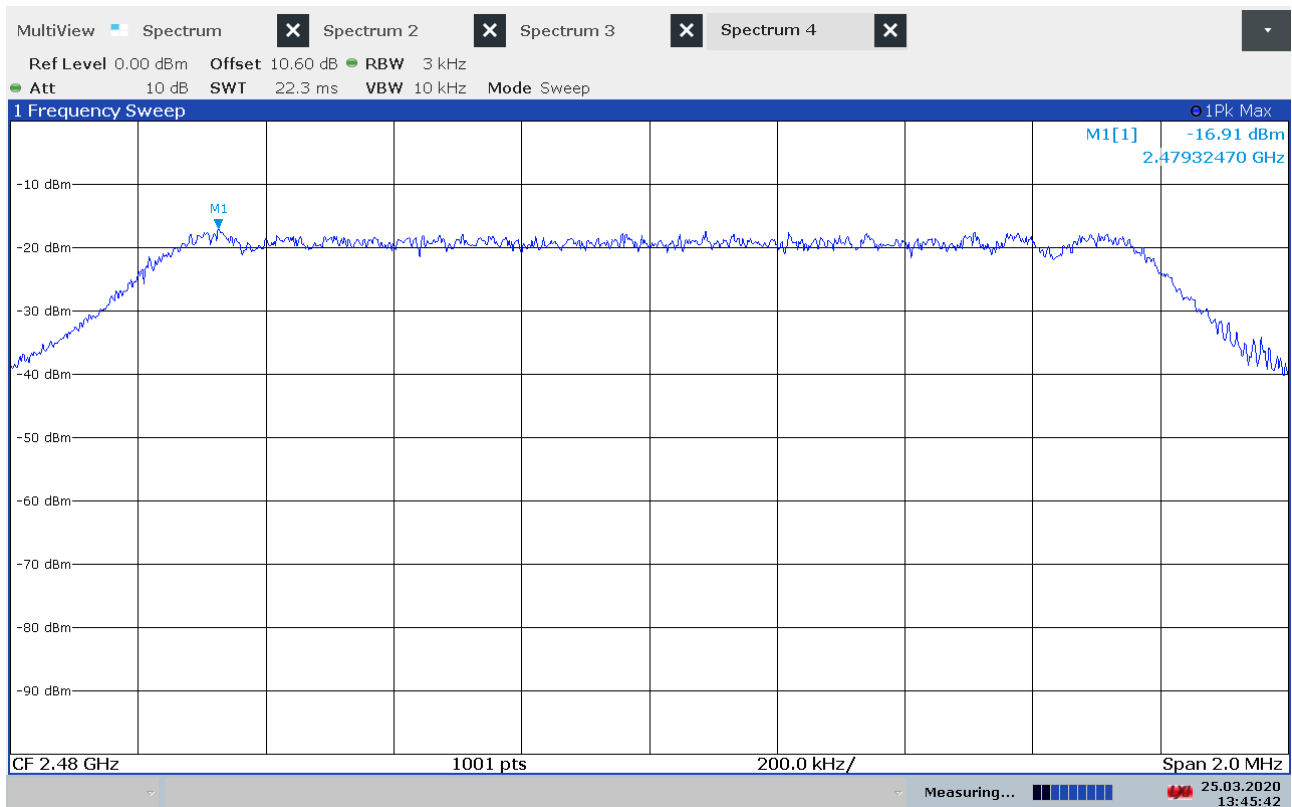
Power Spectral Density, 2480MHz, bw800kHz



Power Spectral Density, 2402MHz, bw1600kHz



Power Spectral Density, 2440MHz, bw1600kHz



Power Spectral Density, 2480MHz, bw1600kHz

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.	Model number	Description	Manufacturer	Ref. no.	Cal. date	Cal. Due
1	ESU40	Measuring Receiver	Rohde & Schwarz	LR 1639	2020-01	2021-01
2	FSW43	Spectrum Analyzer	Rohde & Schwarz	LR 1690	2020-01	2021-01
3	6810.17B	Attenuator	Suhner	LR 1669	2019-07	2020-07
4	N0324415	BandStop Filter	Microwave Circ.	LR 1760	2020-03	2021-03
5	WLK5-1100-1485-7000-40SS	LowPass Filter	Wainwright Inst.	LR 1761	COU	
6	VULB 9163	BiLog Antenna	Schwarzbech	LR 1616	2020-01	2023-01
7	Model 317	PreAmplifier	Sonoma	LR 1687	2019-07	2020-07
8	3117-PA	Horn Antenna with PreAmp	EMCO	LR 1717	2017-12	2020-12
9	3115	Horn Antenna	EMCO	LR 1330	2016-10	2021-10
10	8449A	Pre-amplifier	Hewlett Packard	LR 1322	2019-07	2020-07
11	638	Antenna Horn	Narda	LR 1480	2010-06	2020-06
12	ESCI3	Measuring Receiver	Rohde & Schwarz	N-4259	2019.10	2020.10
13	ENV216	Two Line V-Network	Rohde & Schwarz	LR 1665	2019-11	2021-11
14	6812B	AC Power Source	Agilent	LR 1515	COU	
12	ST8/SMAm/Nm/36	RF Cable	Suhner	LR 1630	COU	

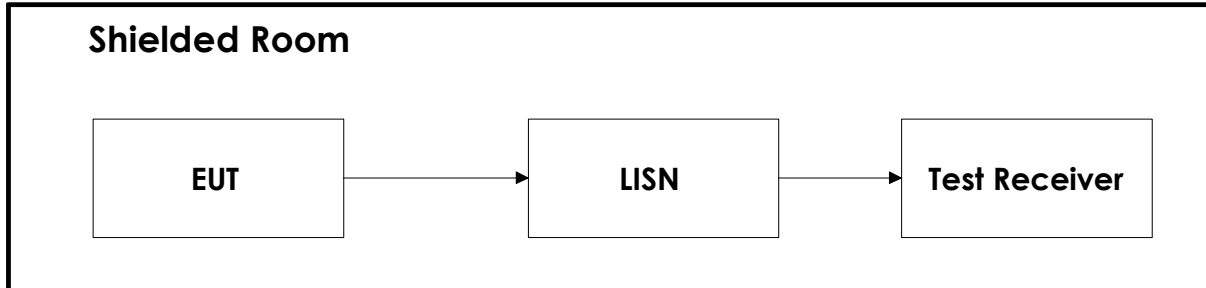
COU = Calibrate on Use

The software listed below has been used for one or more tests.

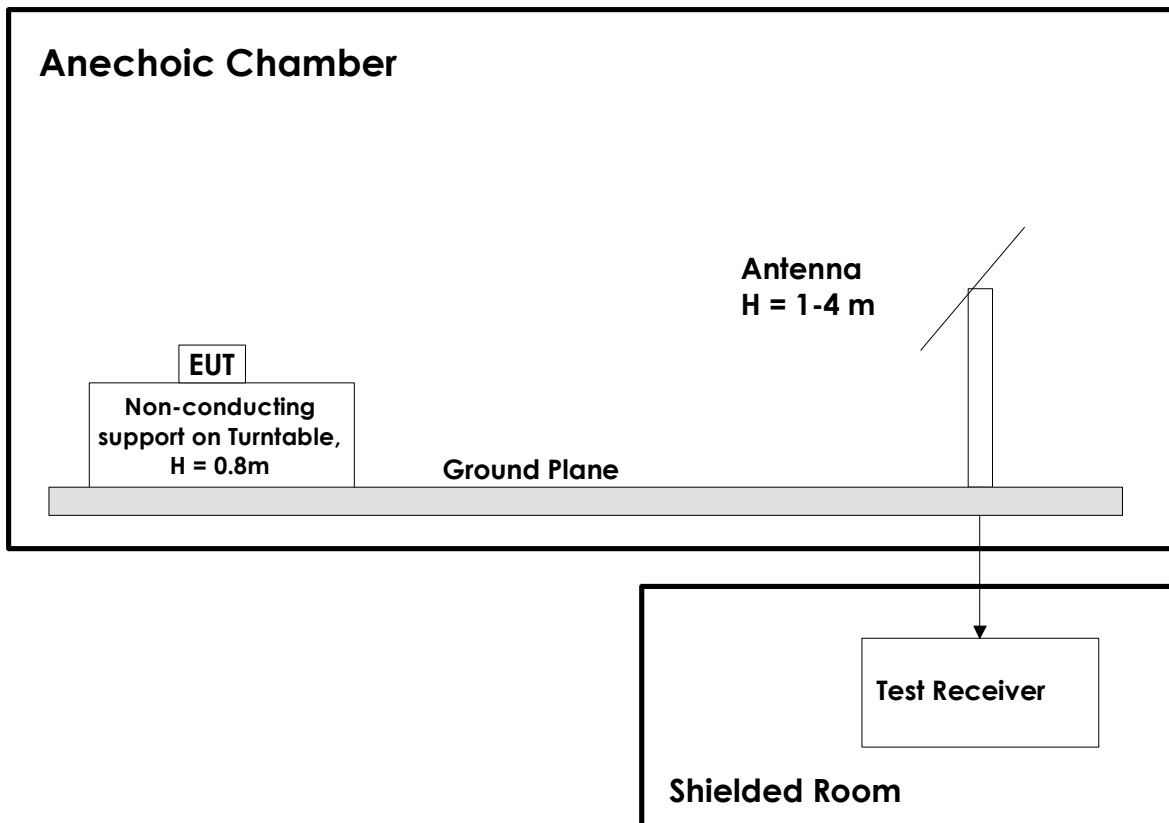
No.	Manufacturer	Name	Version	Comment
1	Rohde & Schwarz	EMC32	10.40.10	Power Line Conducted test software
2	Rohde & Schwarz	EMC32	10.50.50	Radiated Emissions test software
3	Rohde & Schwarz	GPBShot	2.7	Screenshots from R&S Spectrum Analyzers

6 BLOCK DIAGRAM

6.1 Power Line Conducted Emission



6.2 Test Site Radiated Emission



This test setup is used for all radiated emissions tests. For frequencies below 30 MHz the measuring distance is 10m, for all other frequencies it is 3m or 1m. Emissions above 1 GHz are measured with a Spectrum Analyzer and Horn Antenna. For measurements above 18 GHz the test receiver is moved inside the anechoic chamber and located next to the antenna to minimize the cable loss. All measurements at 1GHz and above were performed with turntable height 1.5m and with the ground plane covered by absorbers. A pre-amplifier is used for all measurements above 30 MHz, and High-Pass or Band-Pass filter is used for all harmonics.