Report No. 397015-01-R01

Test Report

Product	Headset with Bluetooth Classic and FM receiver
Name and address of the applicant	Hellberg Safety AS Stakebergsvägen 2 SE-44361 Stenkullen, Sweden
Name and address of the manufacturer	Hellberg Safety AS Stakebergsvägen 2 SE-44361 Stenkullen, Sweden
Model	412RDB, 412RDBH, 412DB, 412DBH
Rating	3.0V_{DC} (2x AA cells)
Trademark	Zekler
Serial number	See clause 1.1
Additional information	Bluetooth Basic Rate and EDR, FM Receiver
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	397015
Tested in period	2020-05-06 to 2020-05-08
Issue date	2020-06-24
Name and address of the testing laboratory	Nemko 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 ilac-MRA NORWEGIAN ACCREDITATION TEST 033 **An accredited technical test executed under the Norwegian accreditation scheme**

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

Nemko Norway
Nemko AS, Instituttveien 6, P.O. Box 96 Kjeller, 2027 Kjeller, Norway
TEL +47 22 96 03 30 FAX +47 22 96 05 50 EMAIL info@nemko.com
ENTERPRISE NUMBER NO974404532

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1 INFORMATION

1.1 Test Item

Name	**Zekler**
Model/version	**412RDB, 412RDBH, 412DB, 412DBH**
FCC ID	**QF9-ZEKLER412**
ISED ID	**5808A-ZEKLER412**
Serial number	**Conducted Sample: 3970150002** **Radiated Sample: 3970150003**
Hardware identity and/or version	**49002-801-K, 48001-801-K**
Software identity and/or version	**1.01**
Frequency Range	**2402 – 2480 MHz**
Number of Channels	**79**
Operating Modes	**Bluetooth FHSS**
Type of Modulation	**GFSK, π/4-DQPSK, 8-DPSK**
Rated Output Power	**0.83 mW**
Type of Power Supply	**Primary or Secondary Batteries (2x AA Alkaline or NiMH cells)**
Antenna Connector	**None (Integral Antenna)**
Number of Antennas	**1**
Interfaces	**Charger and 3.5mm audio jack**
AC Adaptor	**BESTGK Adapter, Model: K-T50501000E1** **(Input: 100-240V ~50-60Hz, 0.15A; Output: 5V_{DC}, 1000mA)**

Description of Test Item

The EUT is a headset with Bluetooth Transceiver and FM Receiver.

1.2 Normal test condition

Temperature:	**20 - 24 °C**
Relative humidity:	**20 - 50 %**
Normal test voltage:	**3.0 V DC (nominal voltage, primary batteries)**

The values are the limit registered during the test period.

All tests were performed with new alkaline cells, except the power line conducted test that was performed with NiMH cells.

1.3 Test Engineer(s)

Frode Sveinsen

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 Worst-Case Configuration and Mode

All tests were performed with the EUT programmed via a USB-to-Serial converter using the test software BlueTest3 from the software package CSR BlueSuite version 2.6.8.

Radiated Emissions was performed with the EUT set to transmit at the selected modulation type and channel. Band Edge and any found harmonics was checked with all 3 modulation schemes. The default power level was used for all tests, i.e. the power level programmed in the device. All tests were performed with packet type DH1, 2-DH1 or 3-DH1, except where noted.

1.6 Comments

All measurements were done with the EUT powered by new batteries.

Power line Conducted Tests were performed with Rechargable NiMH cells.

2 TEST REPORT SUMMARY

2.1 General

All measurements are tracable 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 and ANSI C63.10-2013.

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

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

☒ New Submission ☒ Production Unit

☐ Class II Permissive Change ☐ Pre-production Unit

DSS 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”.

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	N/A
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	Complies
Channel Separation and 20 dB BW	15.247(a)(1)	5.1 (4) (RSS-247)	7.8.2 (FHSS)	Complies
Number of Hopping Frequencies	15.31(m)	5.1 (6) (RSS-247)	7.8.3 (FHSS)	Complies
Pseudorandom Hopping Algorithm	15.247(a)(1)	5.1 (3) (RSS-247)	N/A (FHSS)	Complies
Time of Occupancy (dwell time)	15.247(a)(1)(iii)	5.1 (5) (RSS-247)	7.8.4 (FHSS)	Complies
Occupied Bandwidth	15.247(a)(1)	5.1 (7) (RSS-247)	6.9.2 FHSS)	Complies
Occupied Bandwidth (99% BW)	N/A	6.7 (RSS-GEN)	6.9.3	Complies
Peak Power Output	15.247(b)	5.4 (RSS-247)	11.9.1.1	Complies
Spurious Emissions (Antenna Conducted)	15.247(c)	5.5 (RSS-247)	6.7 7.8.6 (FHSS) 7.8.8 (FHSS)	Complies
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	Complies

3 TEST RESULTS

3.1 Power Line Conducted Emissions

FCC Part 15.207

ISED RSS-GEN Issue 5, Clause 7.2 / 8.8

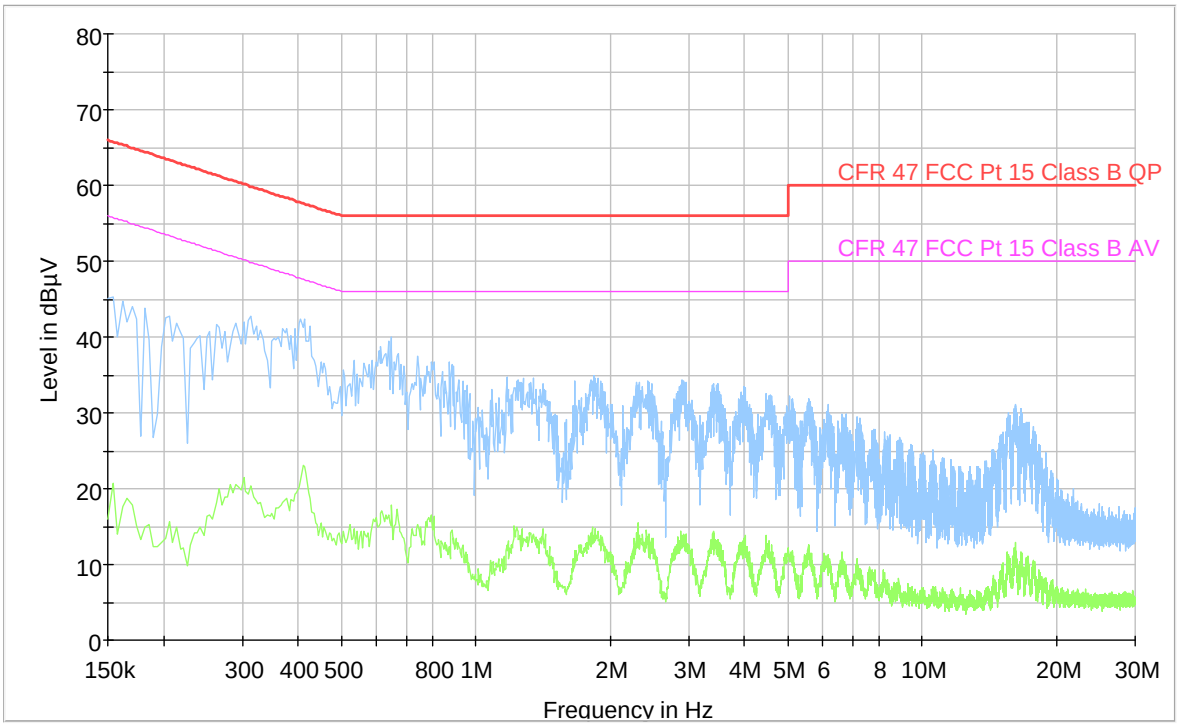
Measurement procedure: **ANSI C63.4-2014 using 50 µH/50 ohms LISN**

Test Results: **Complies**

Measurement Data: **See attached plots**

EUT Charging, 120V 60Hz

Full Spectrum



Measured with NiMH cells in EUT and charging from the supplied AC adaptor.

3.2 Channel Separation and 20dB Bandwidth

FCC Part 15.247(a)(1)

ISED RSS-247 Issue 2, Clause 5.1 (b)

Measurement procedure: **ANSI C63.10-2013 Clause 7.8.2**

Test Results: **Complies**

Measurement Data:

Modulation	Channel Separation	Verdict
Basic Rate (GFSK)	1.0 MHz	Complies
2-EDR (π/4-DPSK)	1.0 MHz	Complies
3-EDR (8-DPSK)	1.0 MHz	Complies

Modulation	20 dB Bandwidth		
	2402MHz	2440MHz	2480MHz
Basic Rate (GFSK)	766 kHz	764 kHz	766 kHz
2-EDR (π/4-DPSK)	1.22 MHz	1.22 MHz	1.25 MHz
3-EDR (8-DPSK)	1.20 MHz	1.20 MHz	1.21 MHz

See attached plots

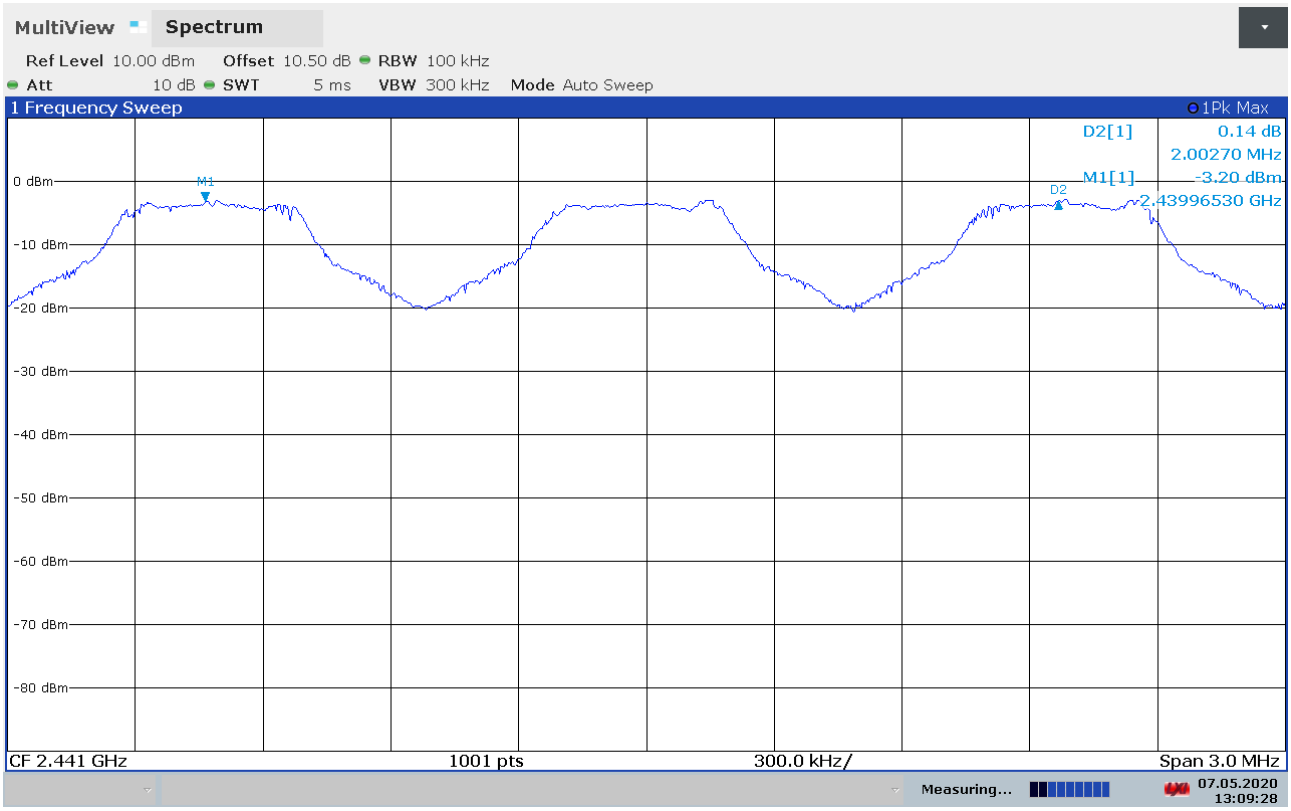
Requirement:

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

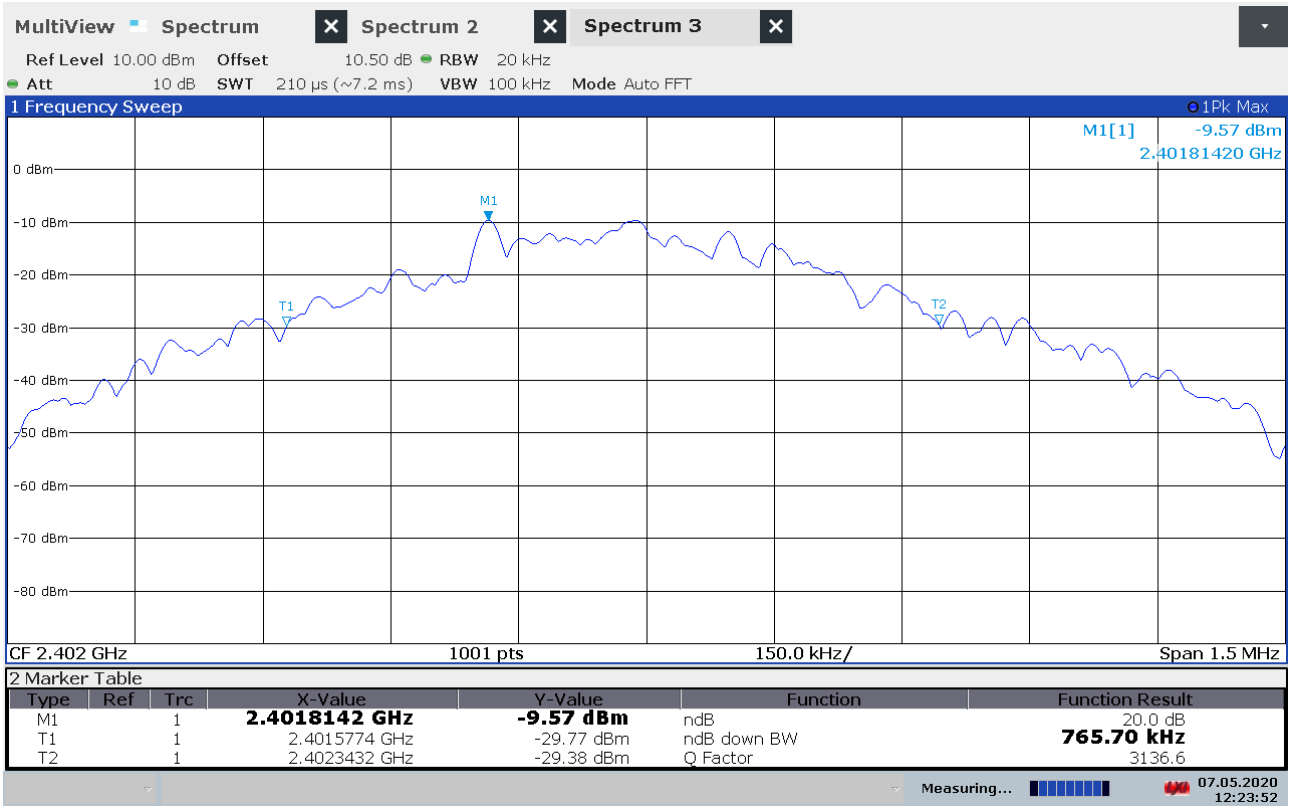
or:

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the system operates with an output power no greater than 125 mW.

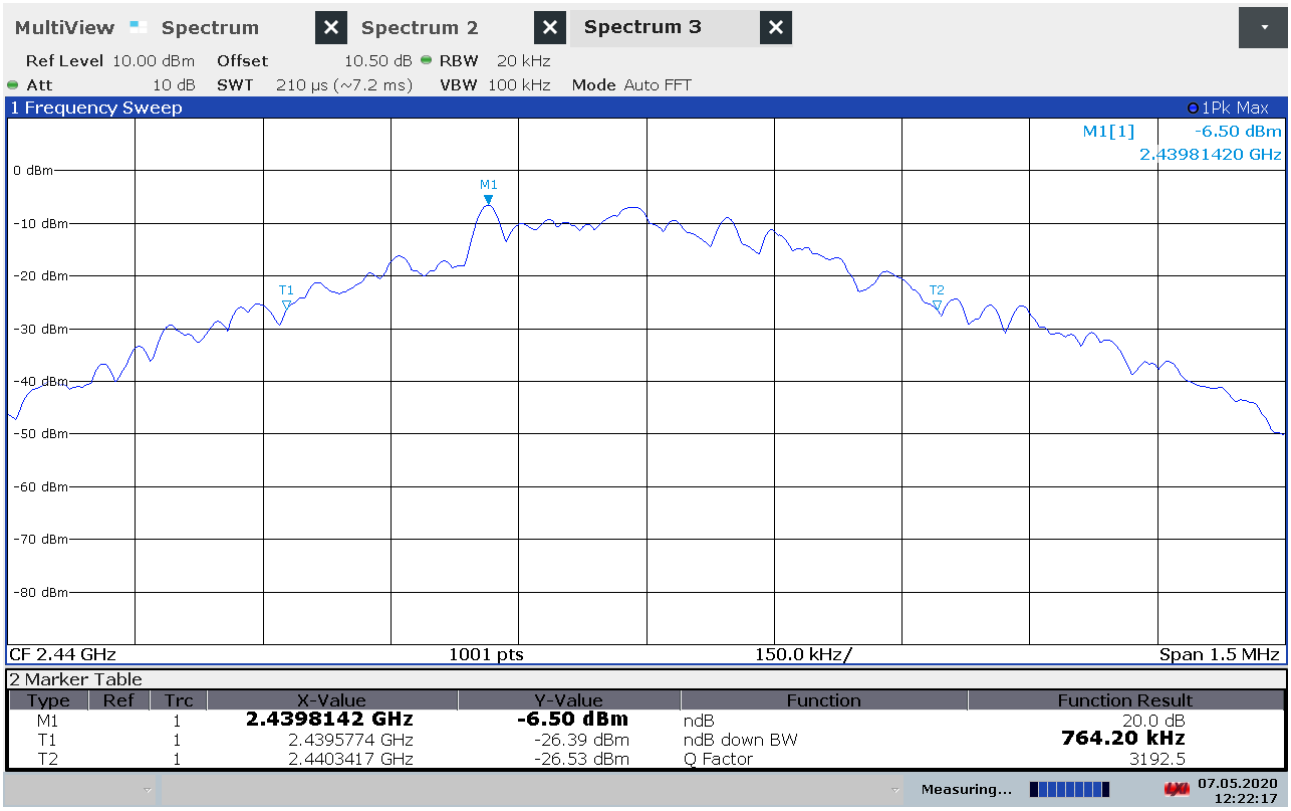
No requirements for Digital Transmission Systems.



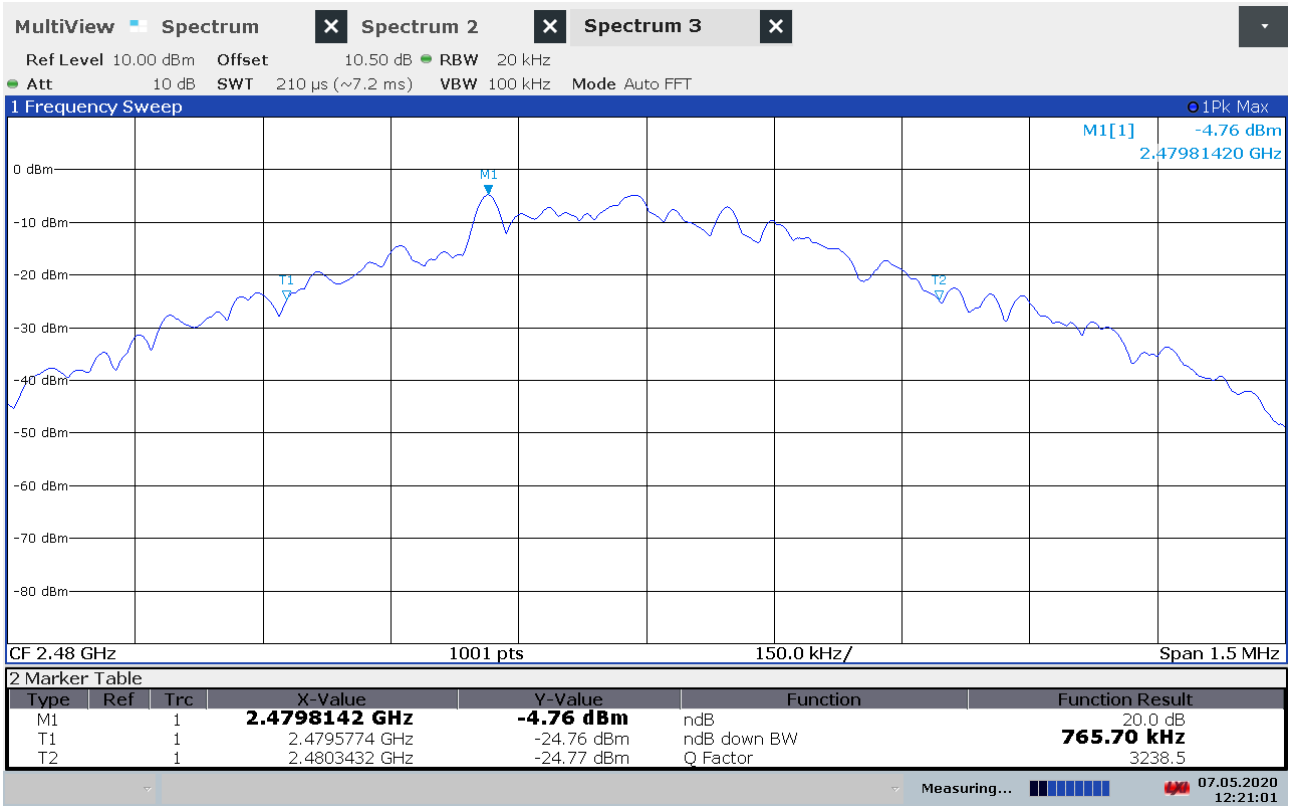
Channel Separation



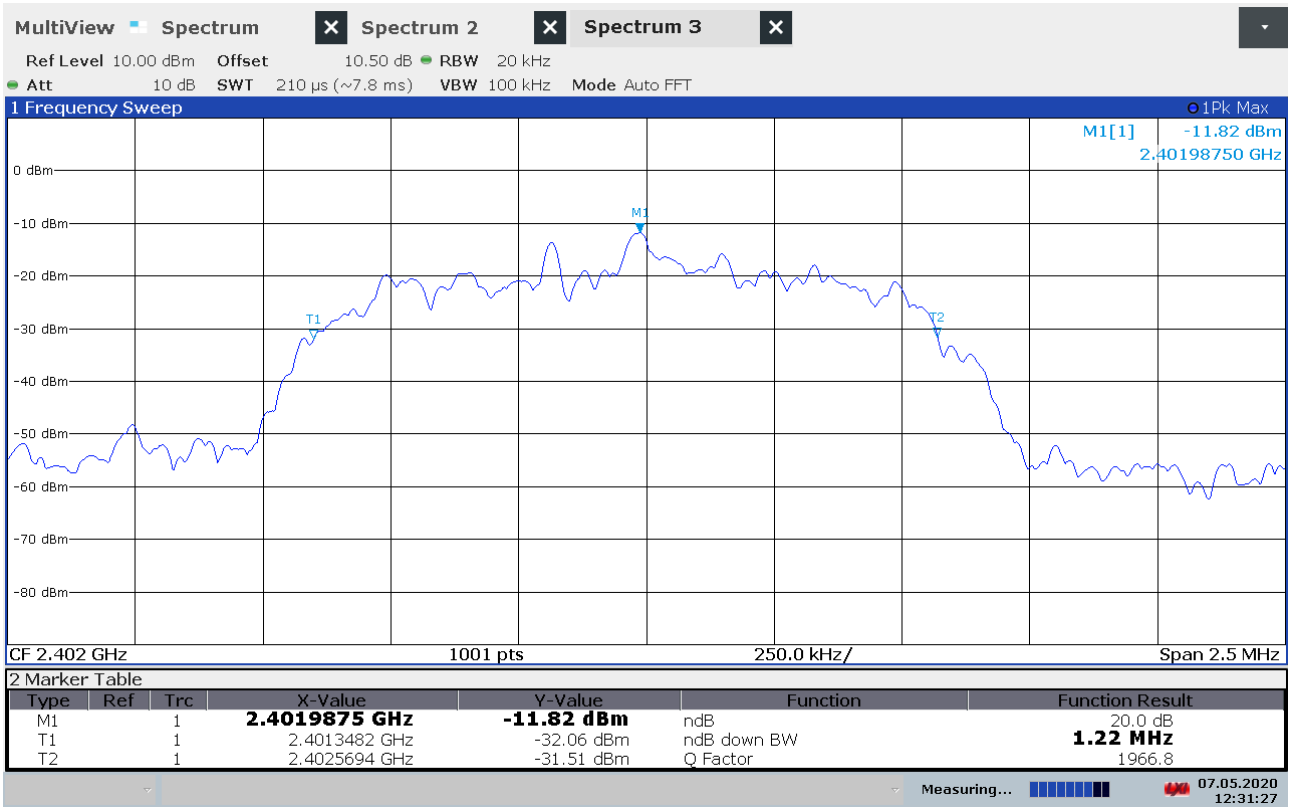
20dB Bandwidth, GFSK, 2402MHz



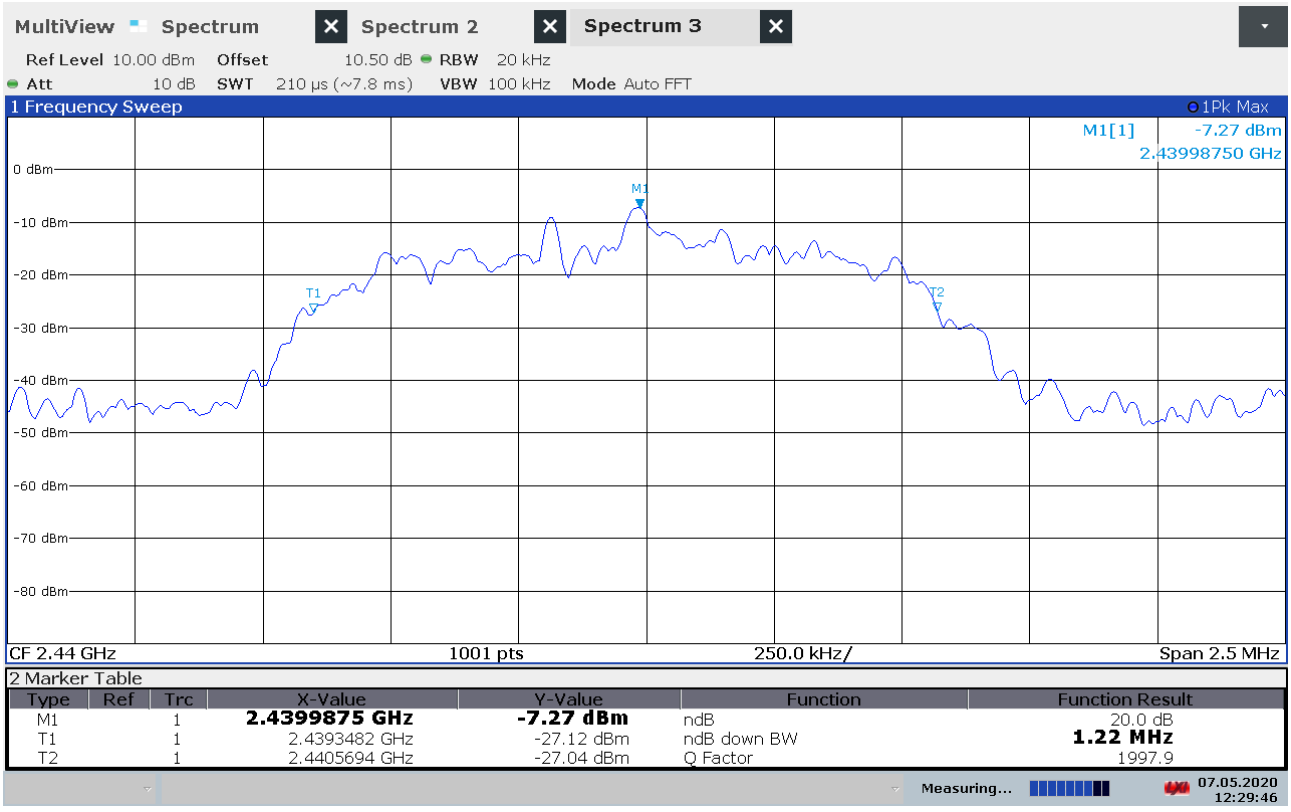
20dB Bandwidth, GFSK, 2440MHz



20dB Bandwidth, GFSK, 2480MHz

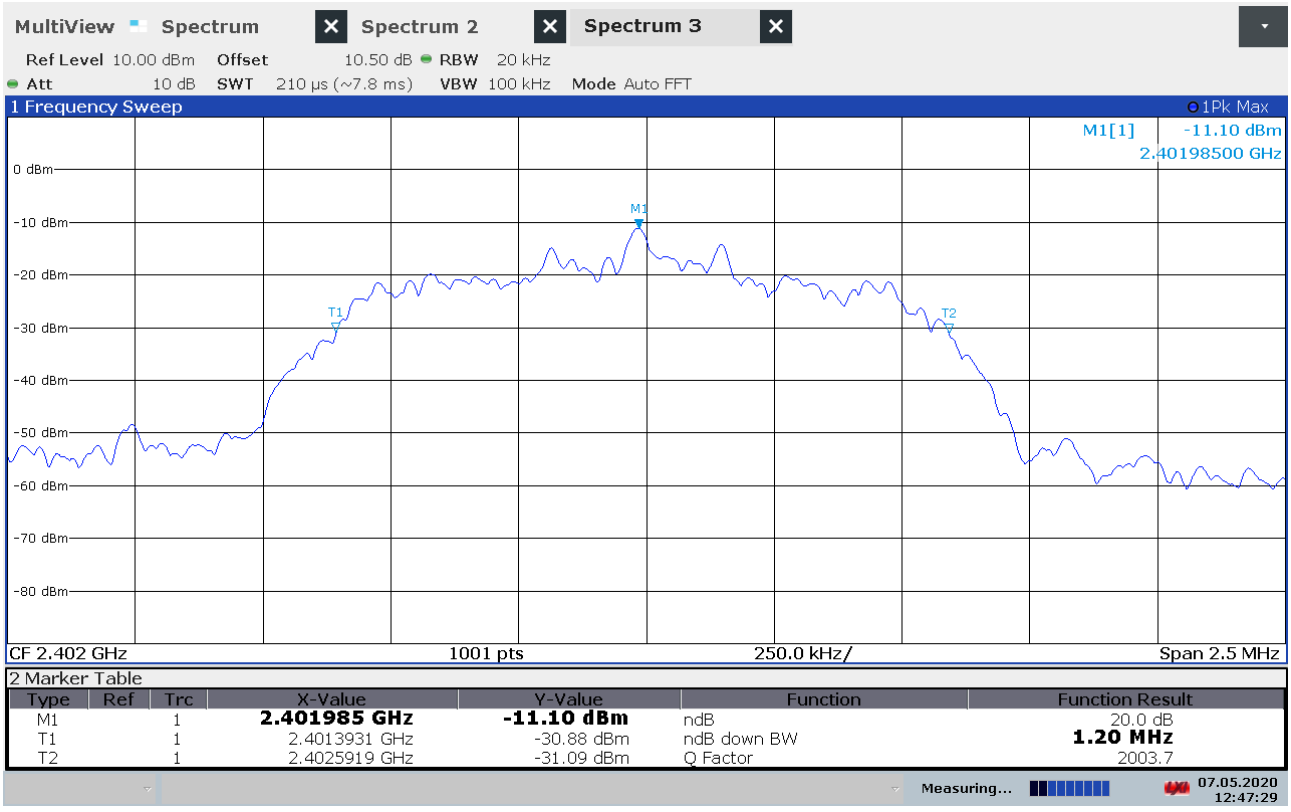


20dB Bandwidth, π/4-DQPSK, 2402MHz

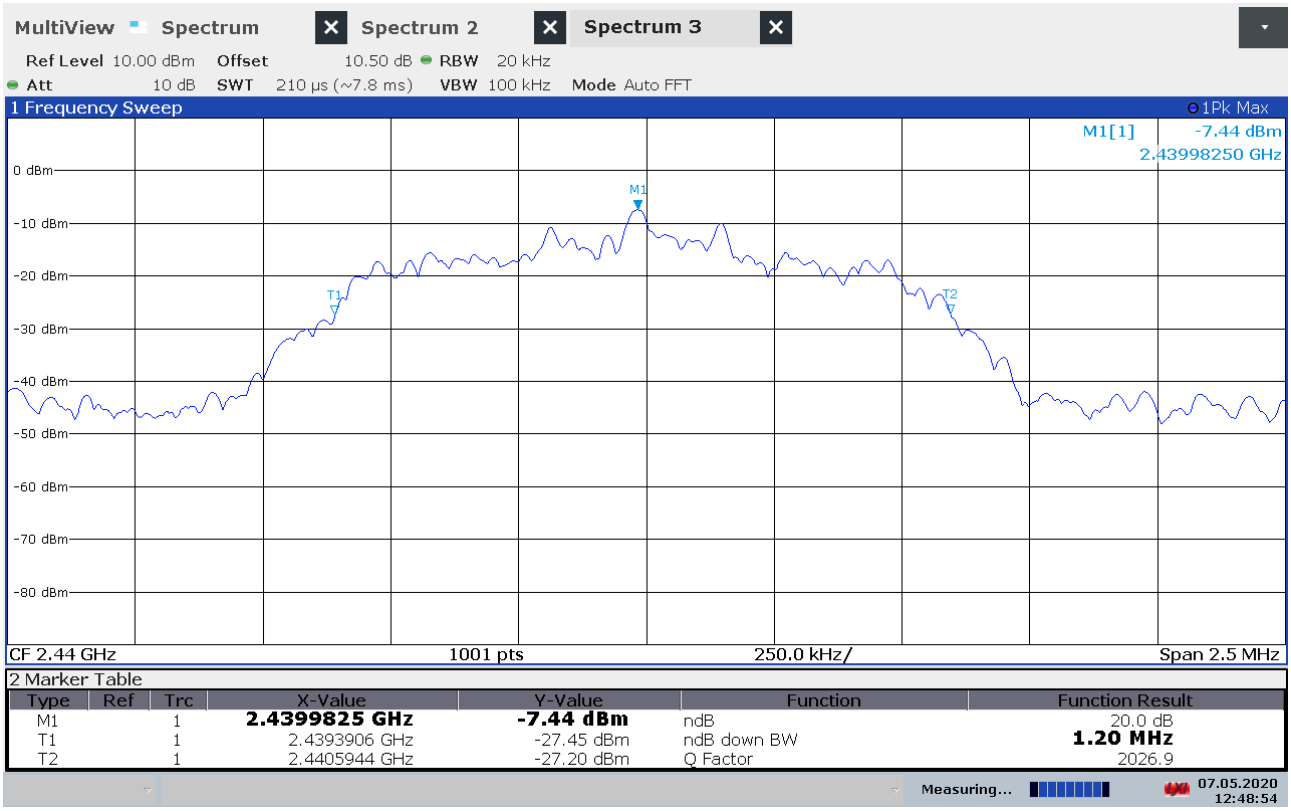


20dB Bandwidth, π/4-DQPSK, 2440MHz

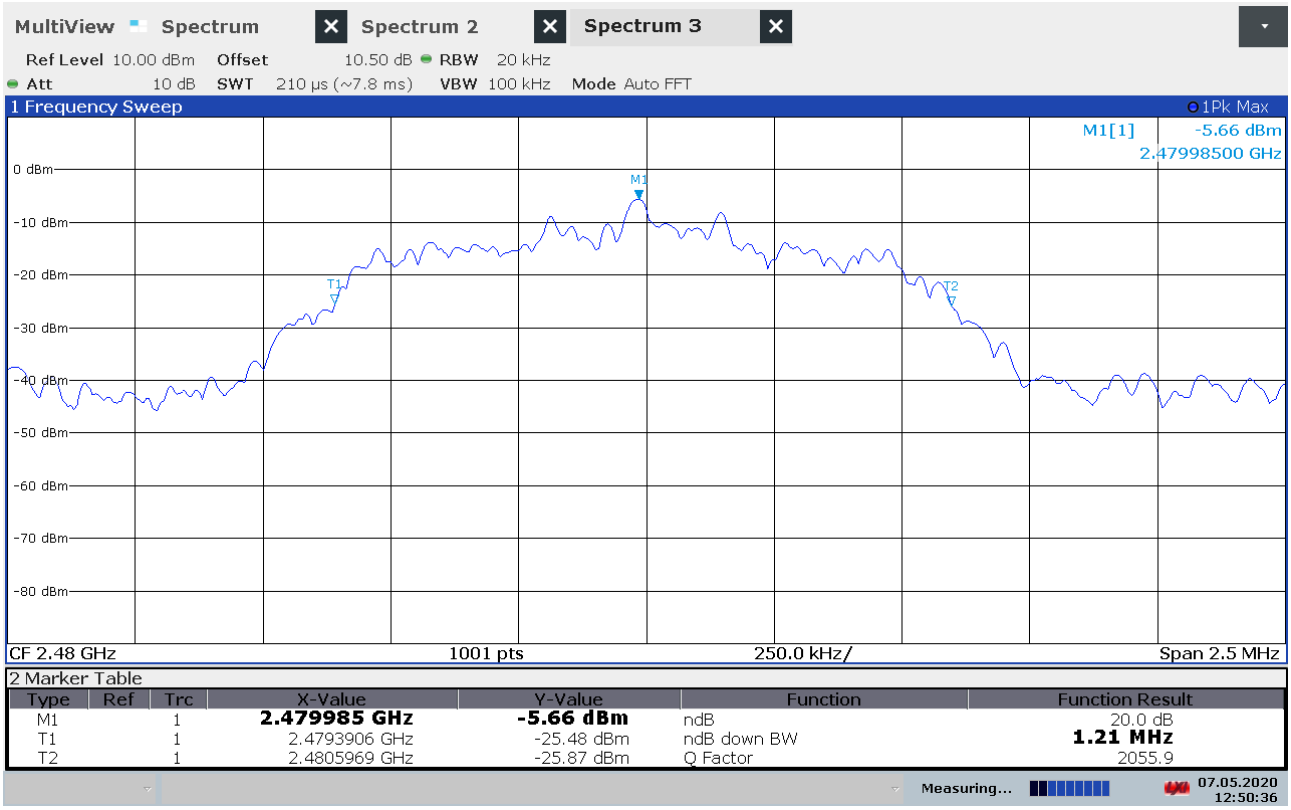
20dB Bandwidth, π/4-DQPSK, 2480MHz



20dB Bandwidth, 8-DPSK, 2402MHz



20dB Bandwidth, 8-DPSK, 2440MHz



20dB Bandwidth, 8-DPSK, 2480MHz

3.3 Occupancy Time

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

ISED Canada RSS-247 Issue 2, Clause 5.1 (c)

Measurement procedure: **ANSI C63.10-2013 Clause 7.8.4**

Test Results: **Complies**

Measurement Data:

Frame Type and Data Rate	Burst Length (ms)	Frame Length (ms)	Time of Occupancy (ms)	Verdict
DH1 – Basic Rate	0.40	1.25	128.00	Complies
DH3 – Basic Rate	1.66	2.50	265.60	Complies
DH5 – Basic Rate	2.91	3.75	310.40	Complies
2-DH1 – 2-EDR	0.41	1.25	131.20	Complies
2-DH3 – 2-EDR	1.67	2.50	267.20	Complies
2-DH5 – 2-EDR	2.92	3.75	311.47	Complies
3-DH1 – 3-EDR	0.41	1.25	131.20	Complies
3-DH3 – 3-EDR	1.67	2.50	267.20	Complies
3-DH5 – 3-EDR	2.92	3.75	311.47	Complies

Time between RF burst on same channel = Frame Length * Number of Channels

Time of occupancy = (Burst Length * Number of Channels * 400 ms) / Time Between Burst on Same Channel
= (Burst Length * 400 ms) / Frame Length

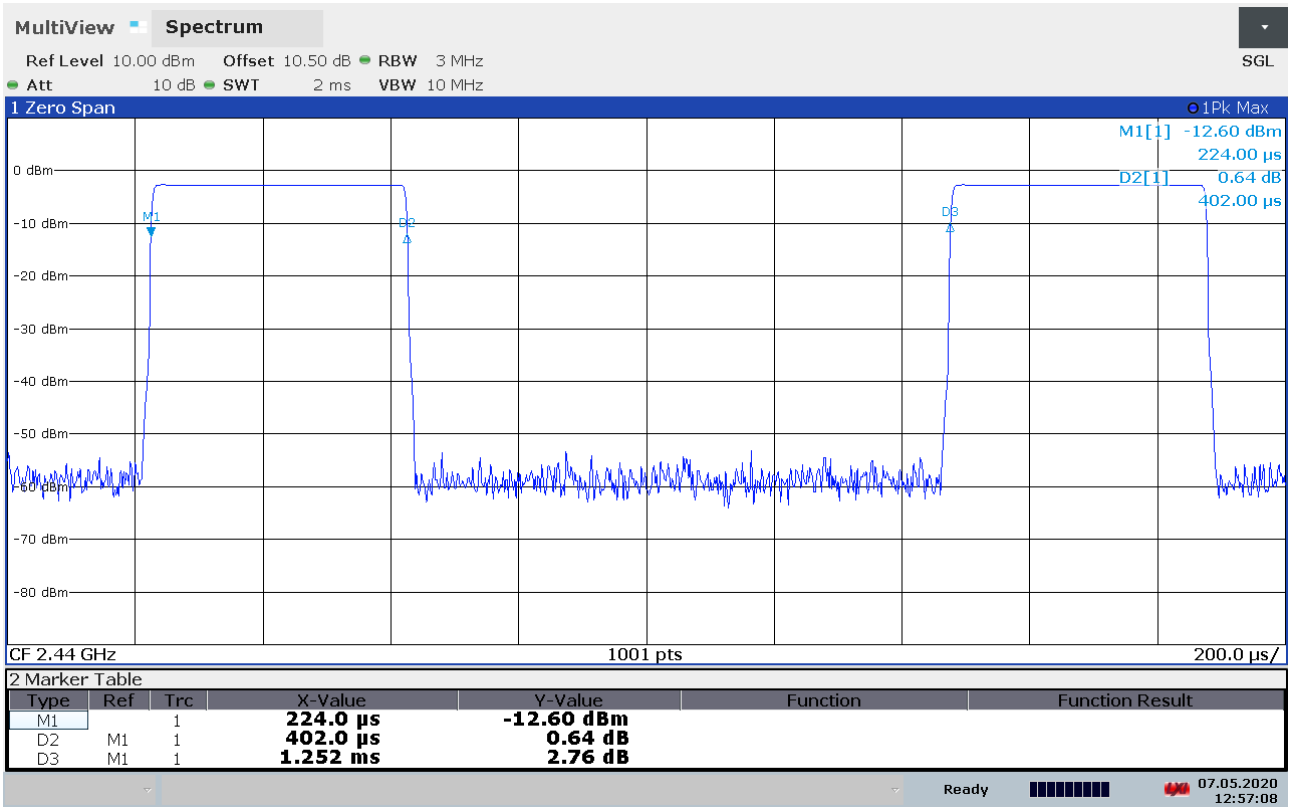
Number of RF channels is minimum 20 and maximum 78

See attached plots

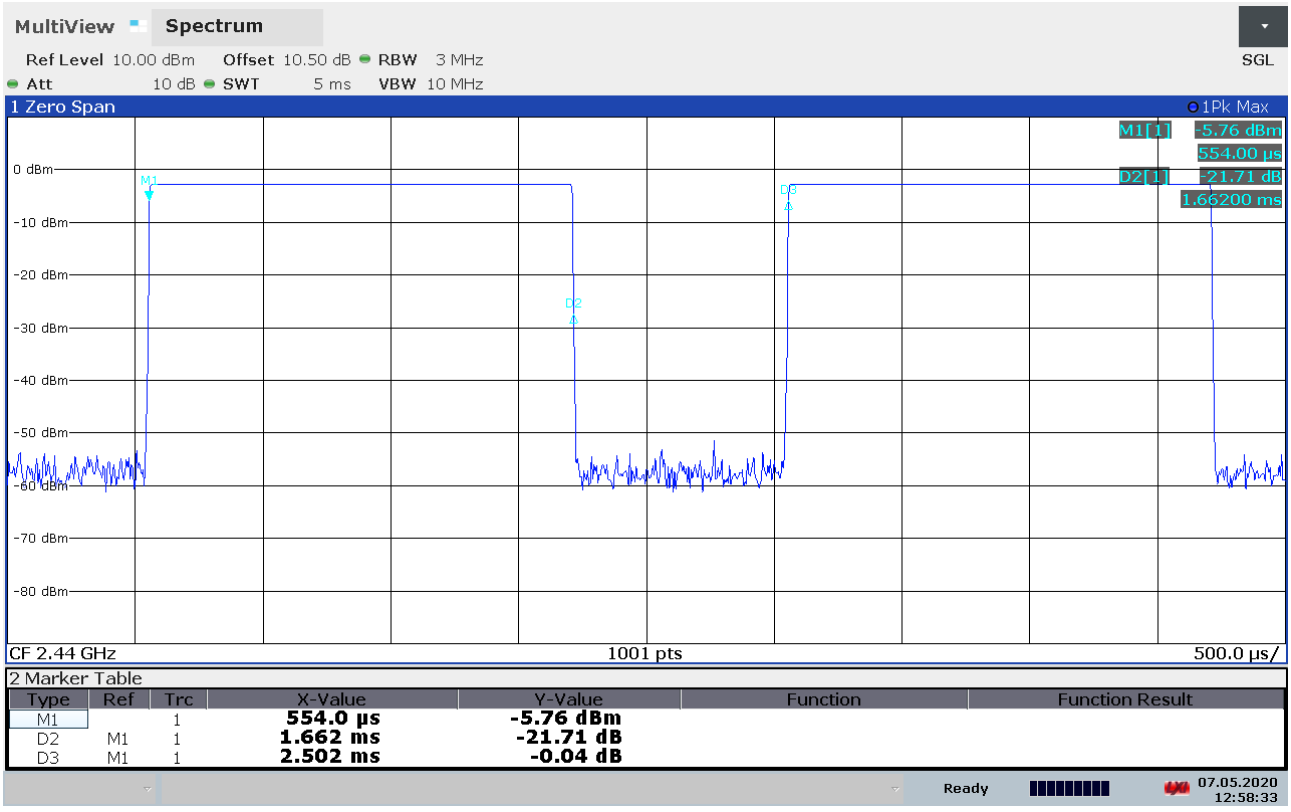
Requirements:

The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

No requirements for Digital Transmission Systems.

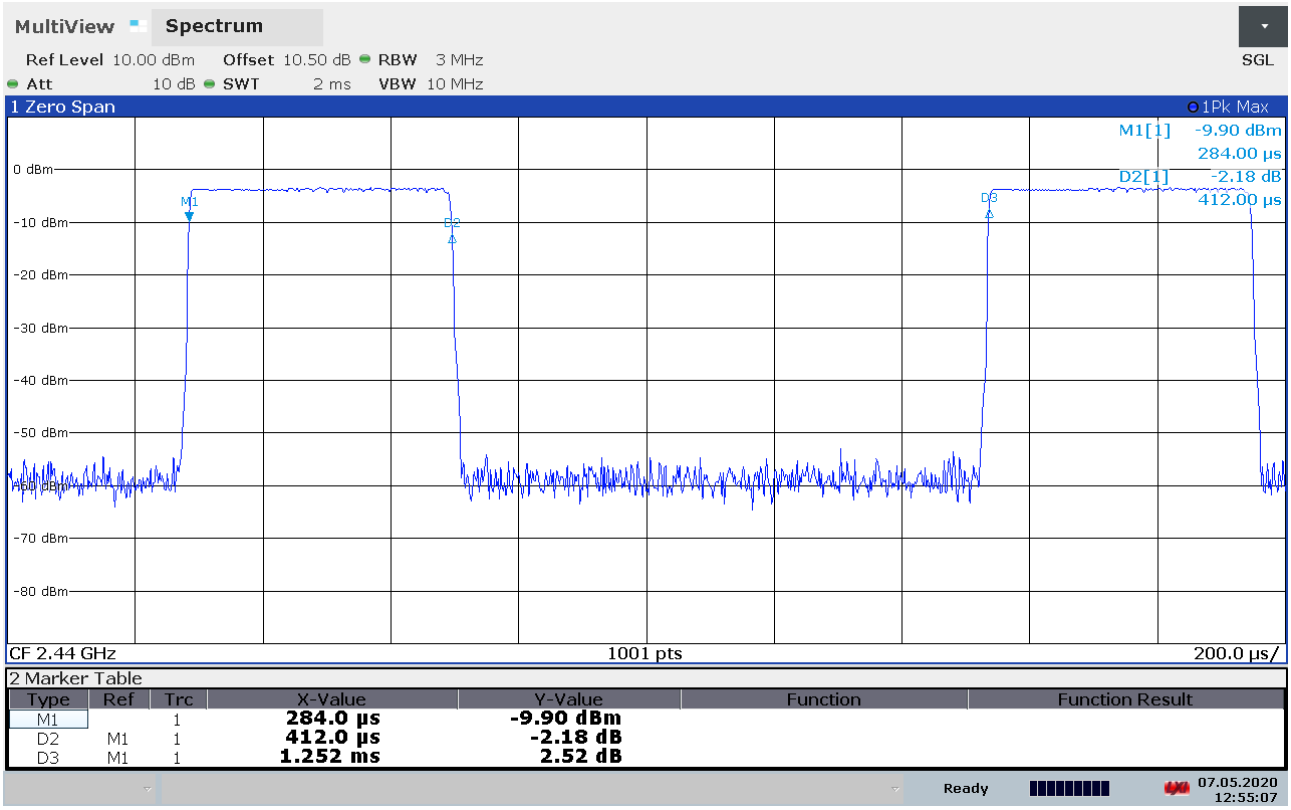


Burst Length, DH1

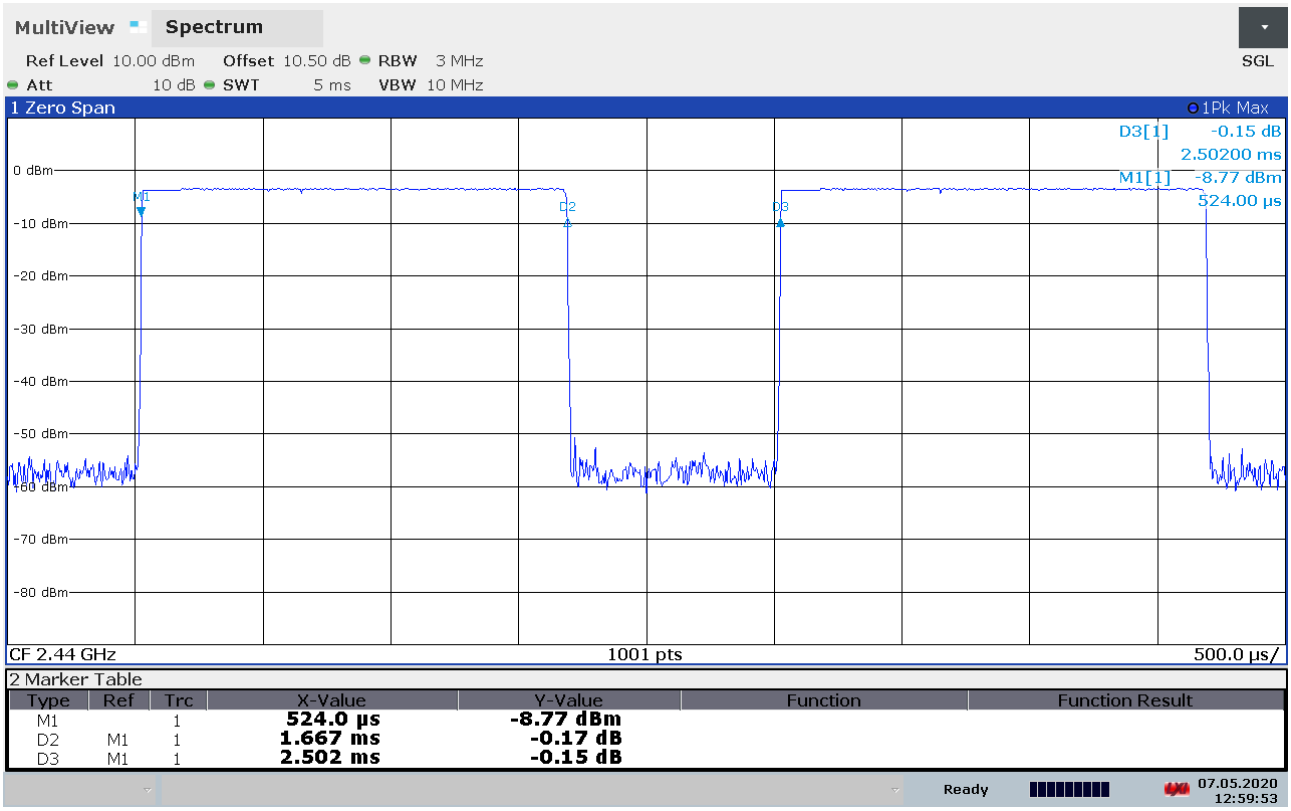


Burst Length, DH3

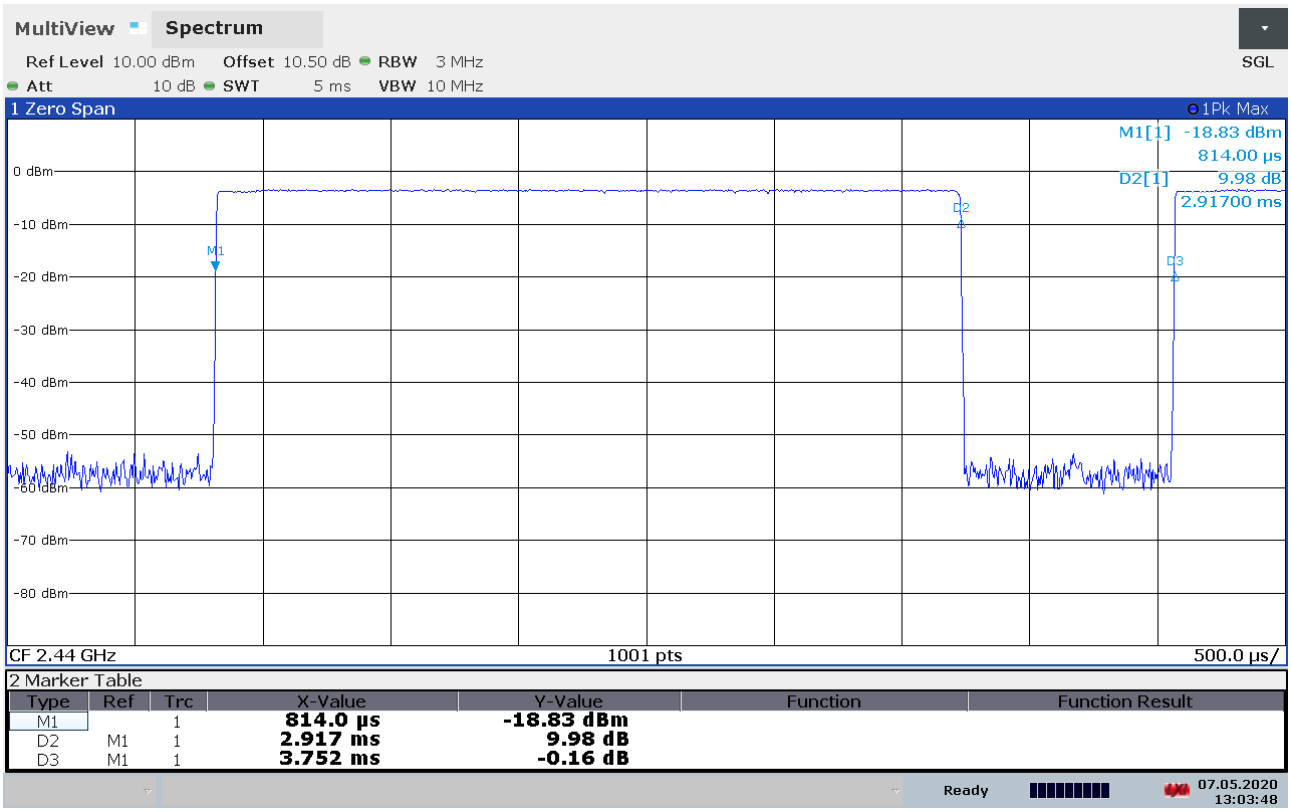
Burst Length, DH5



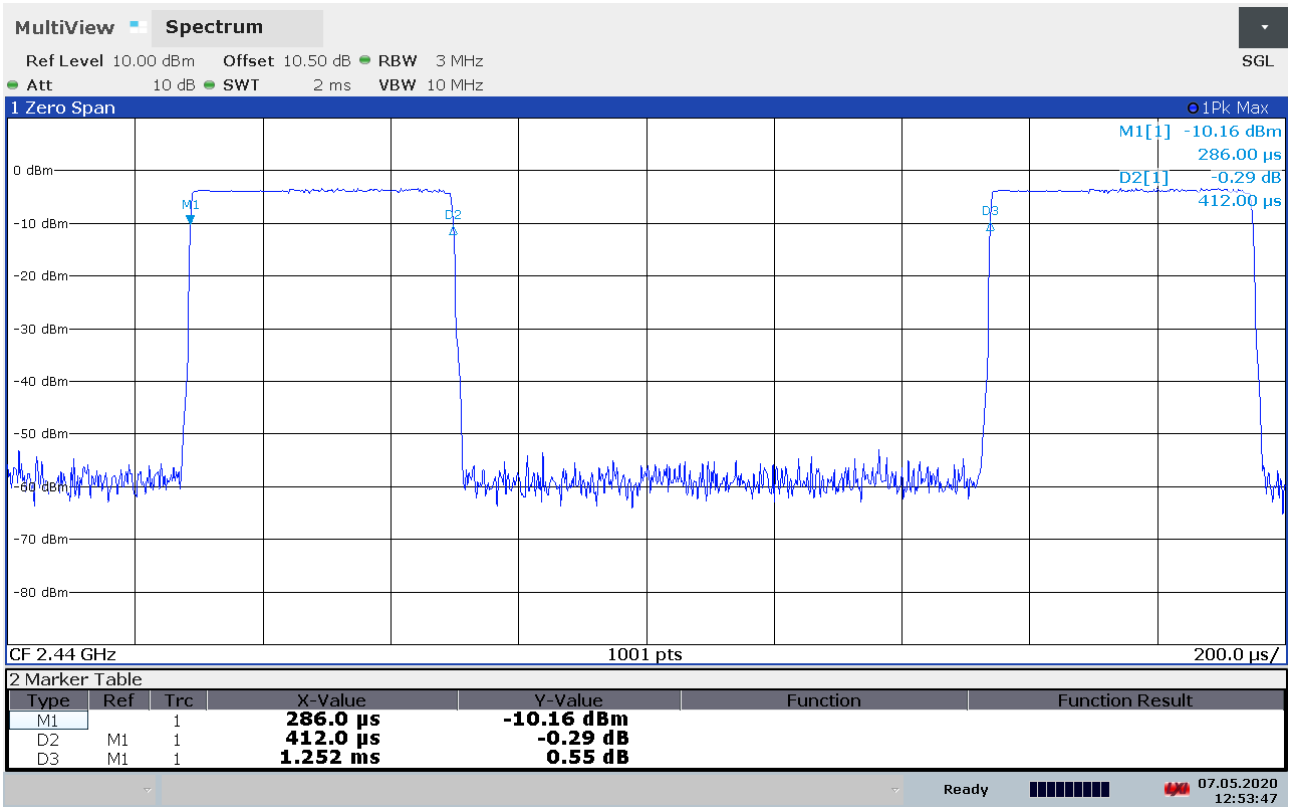
Burst Length, 2-DH1



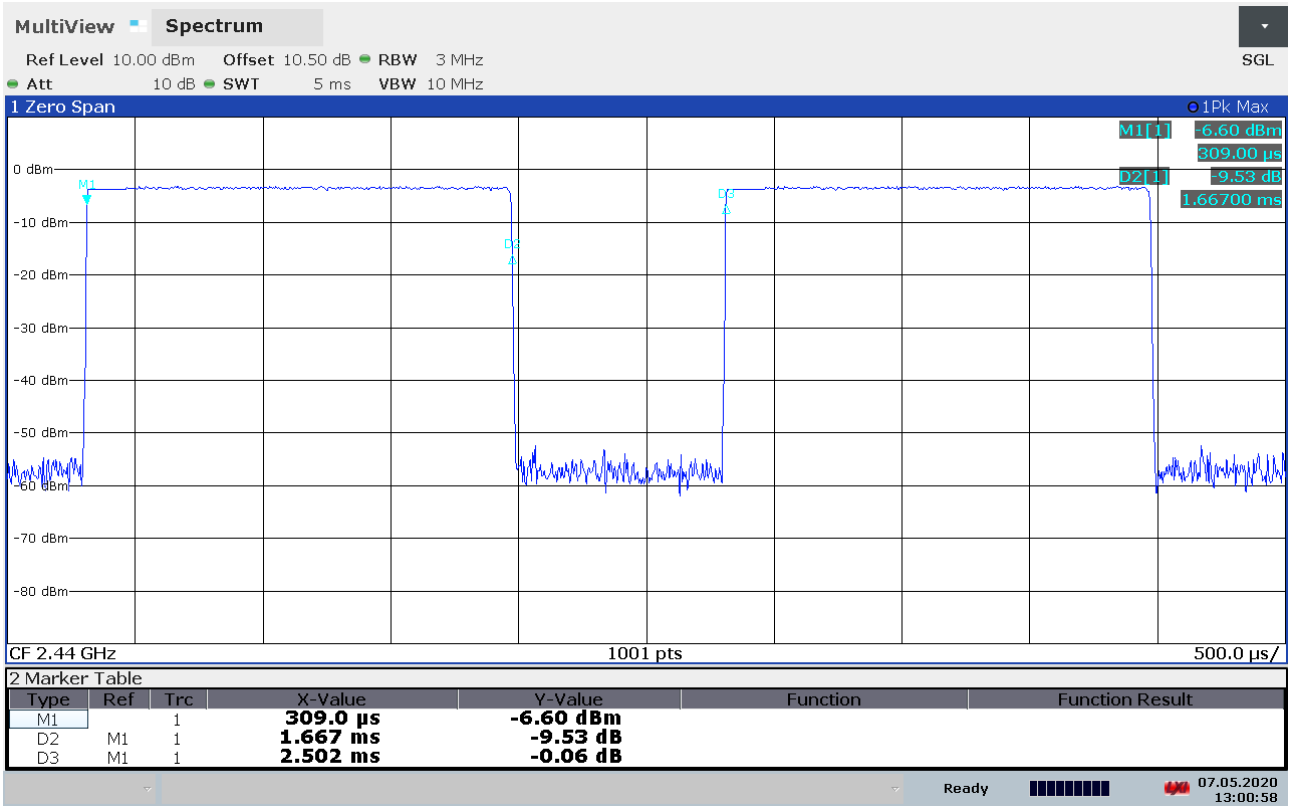
Burst Length, 2-DH3



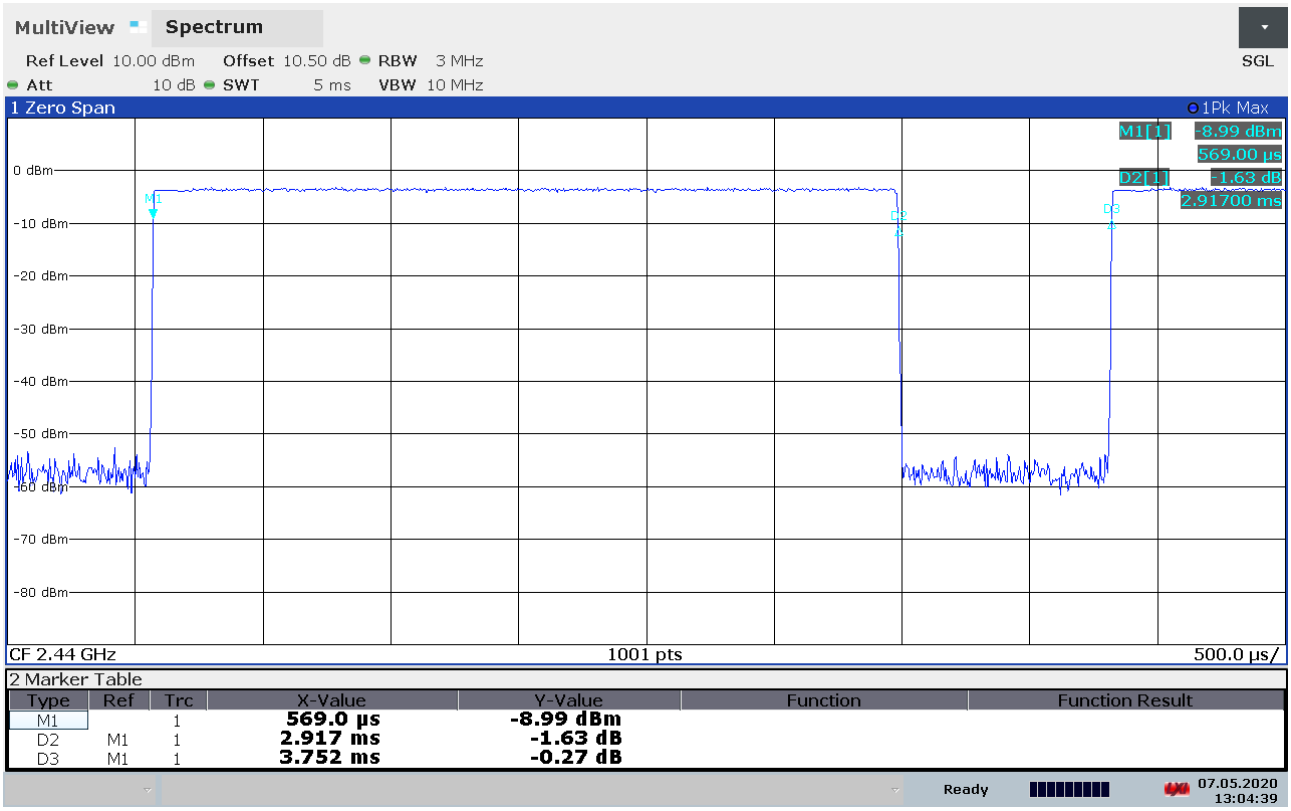
Burst Length, 2-DH5



Burst Length, 3-DH1



Burst Length, 3-DH3



Burst Length, 3-DH5

3.4 Occupied Bandwidth (99% BW) and Hopping Bandwidth

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:

Number of RF Channels in use:	**79**
Channel Centre Frequencies:	**2402 to 2480 with 1 MHz Channel Separation**

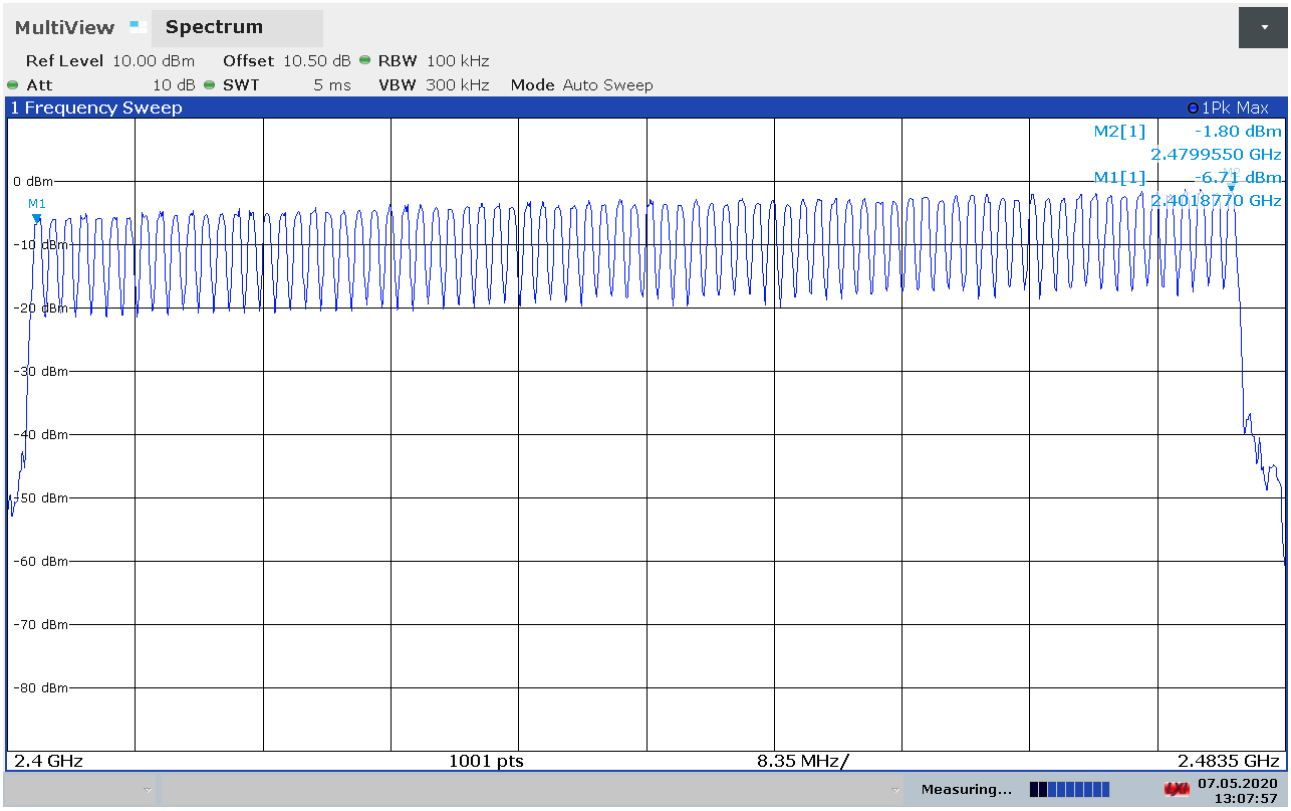
Modulation	Occupied Bandwidth (99% BW)		
	2402MHz	2440MHz	2480MHz
Basic Rate (GFSK)	865 kHz	863 kHz	857 kHz
2-EDR (π/4-DPSK)	1.17 MHz	1.19 MHz	1.21 MHz
3-EDR (8-DPSK)	1.15 MHz	1.18 MHz	1.19 MHz

See attached plots.

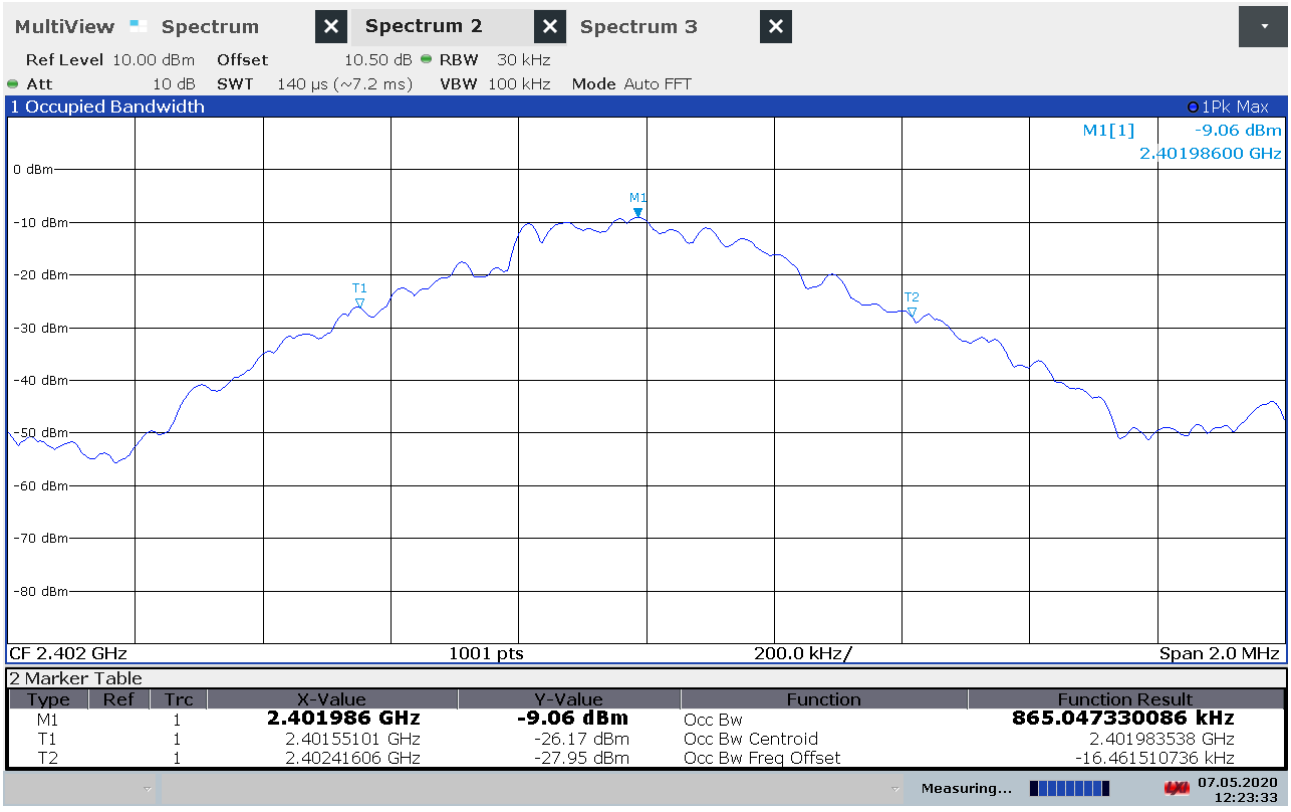
Requirements:

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 requirement for 99% BW.

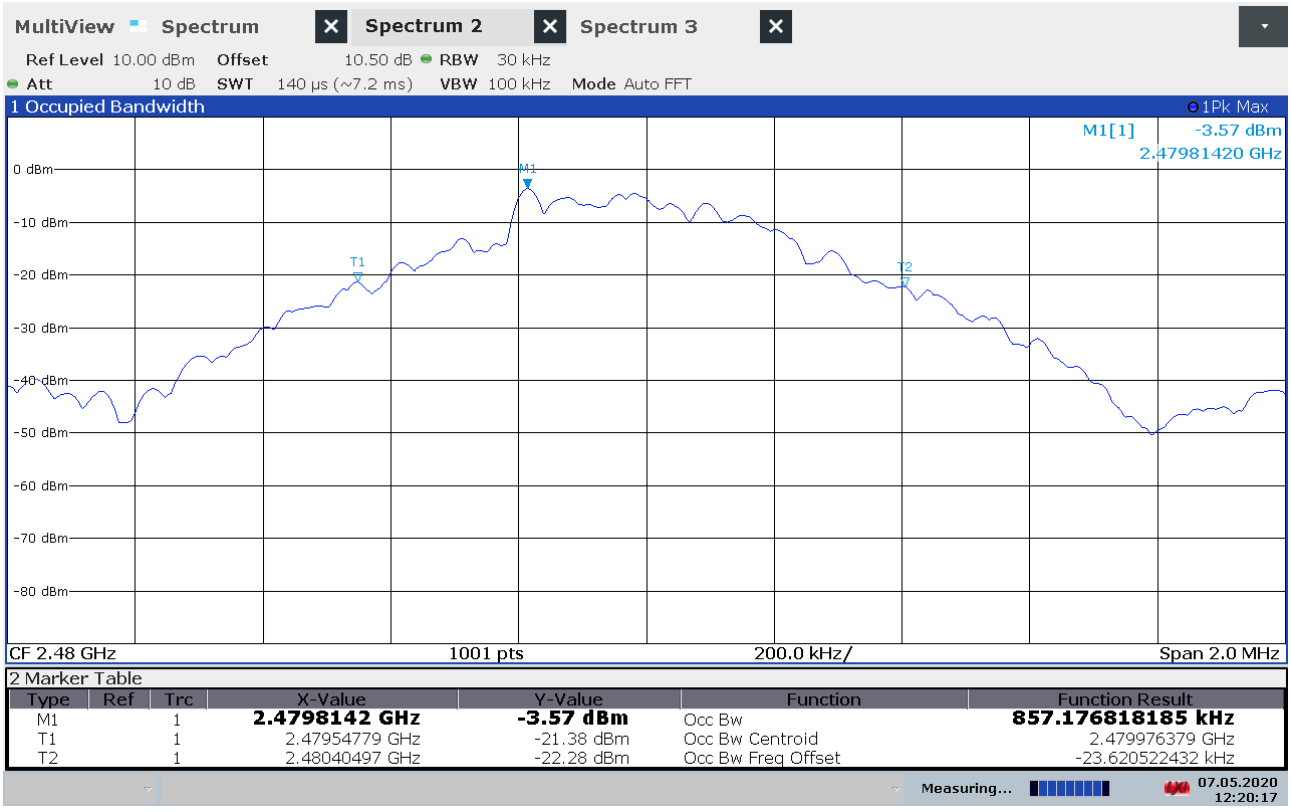


RF Channels in Use

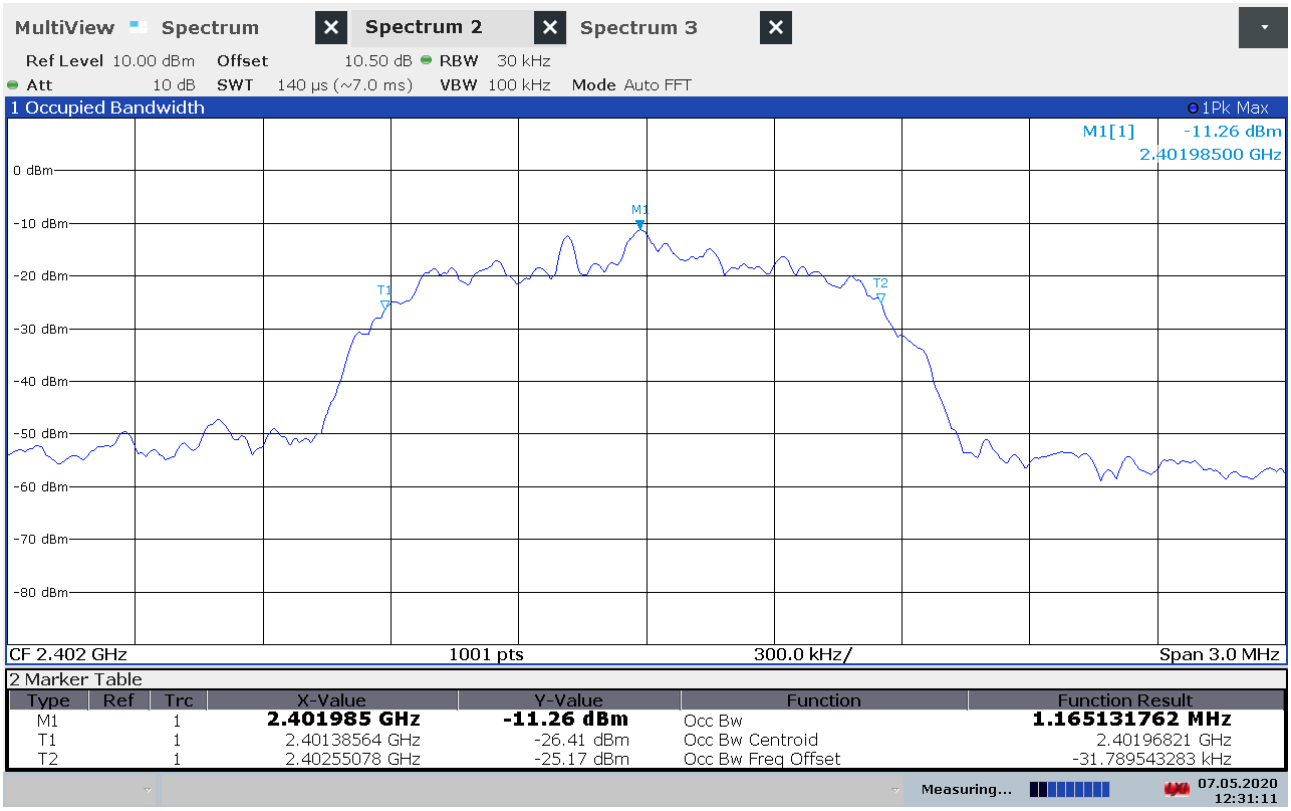


99% Bandwidth, GFSK, 2402MHz

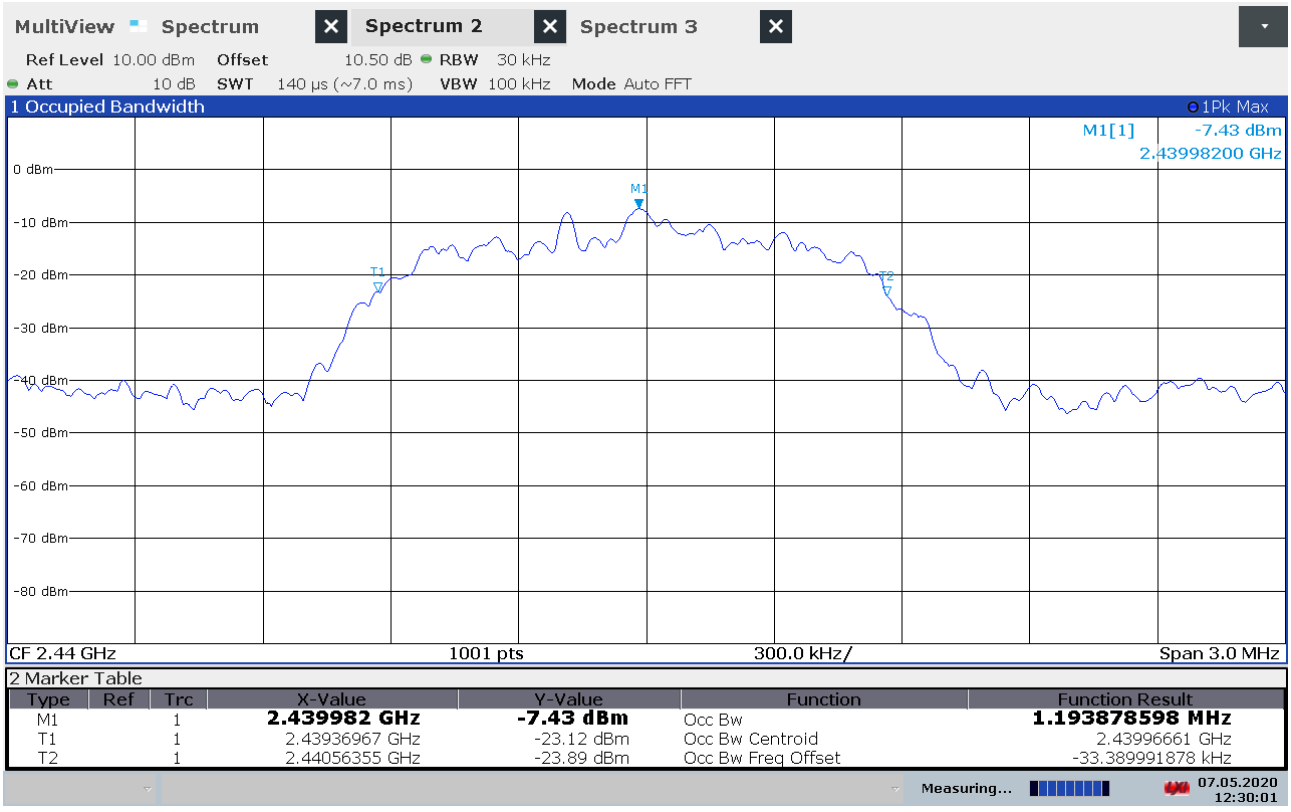
99% Bandwidth, GFSK, 2440MHz



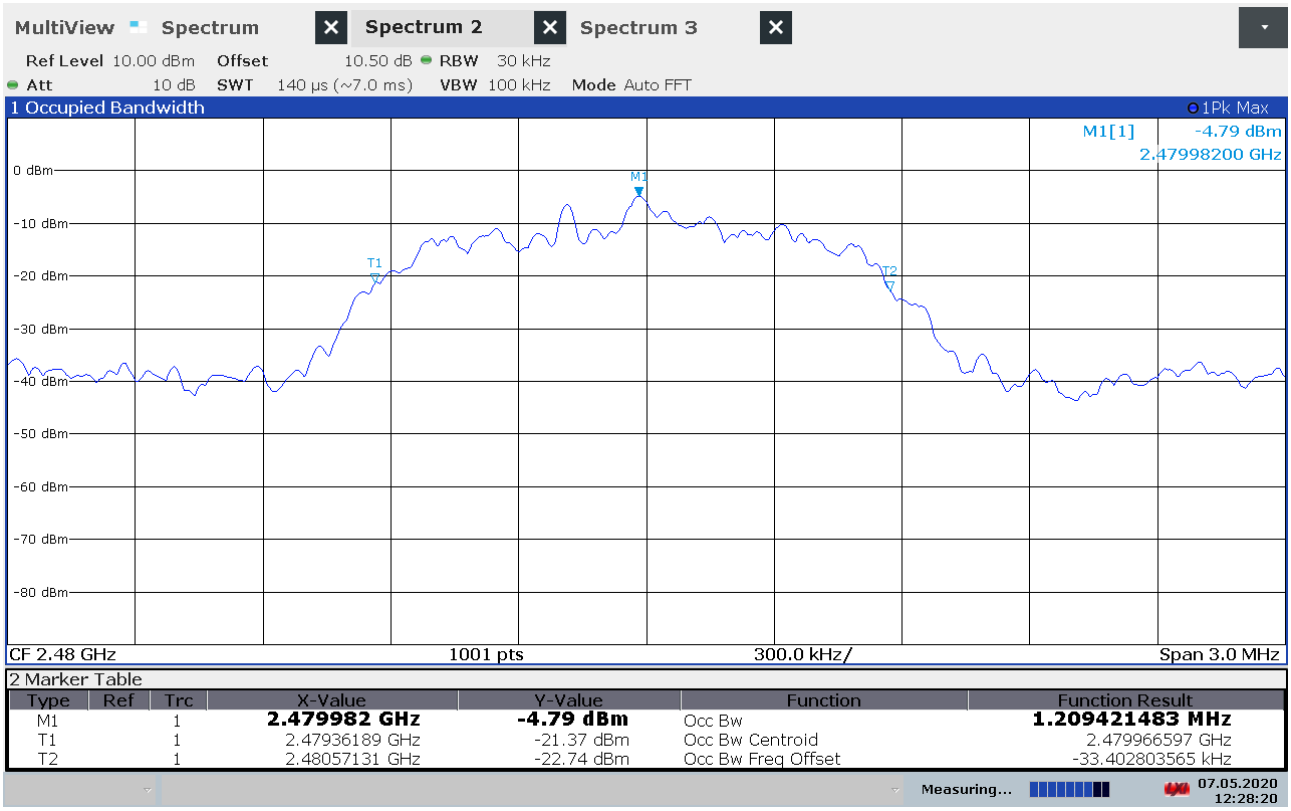
99% Bandwidth, GFSK, 2480MHz



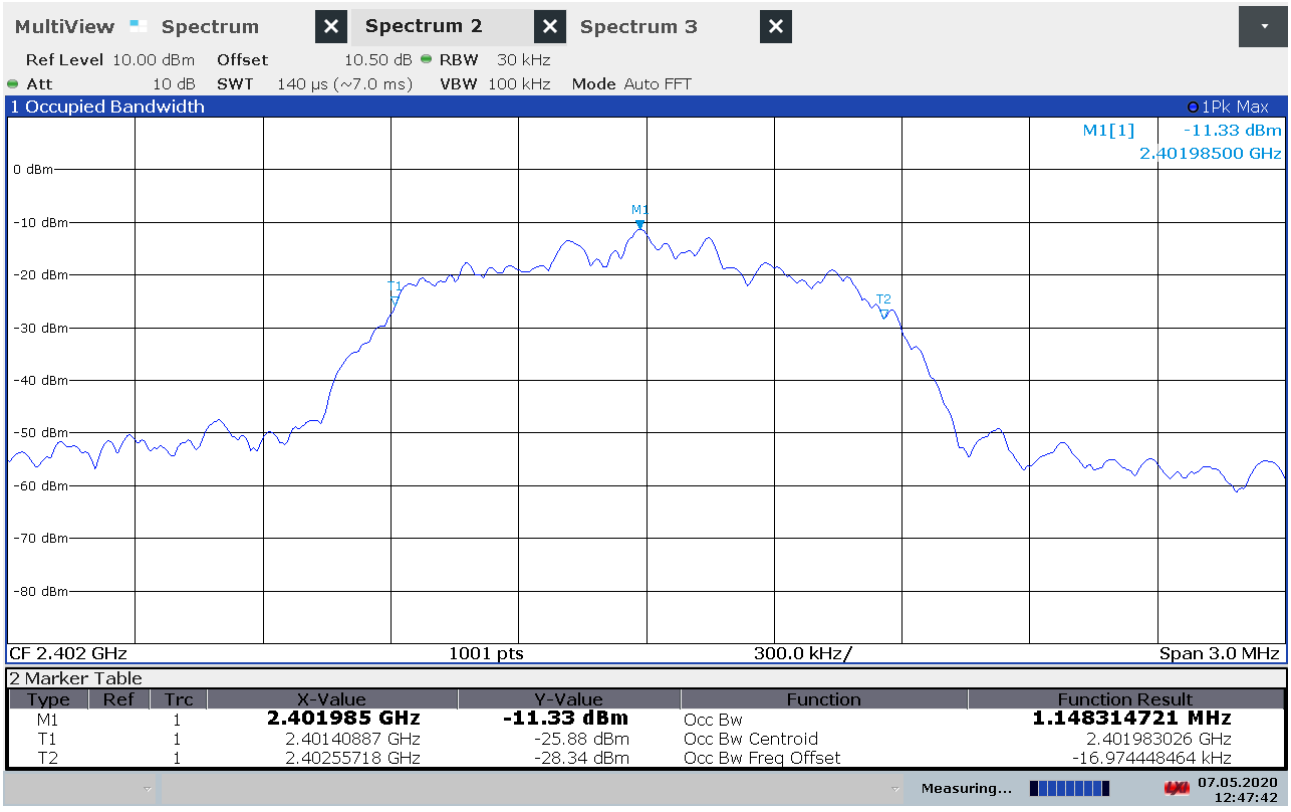
99% Bandwidth, π/4-DQPSK, 2402MHz



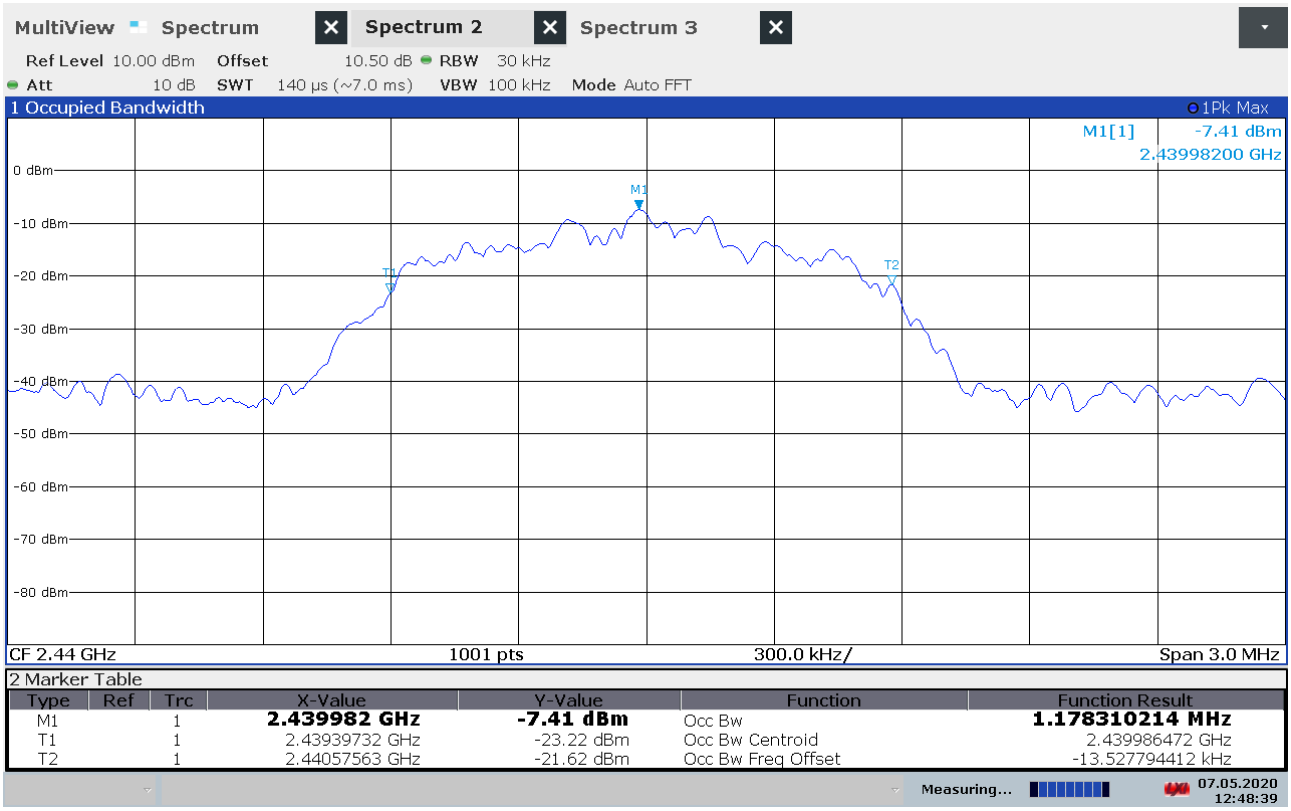
99% Bandwidth, π/4-DQPSK, 2440MHz



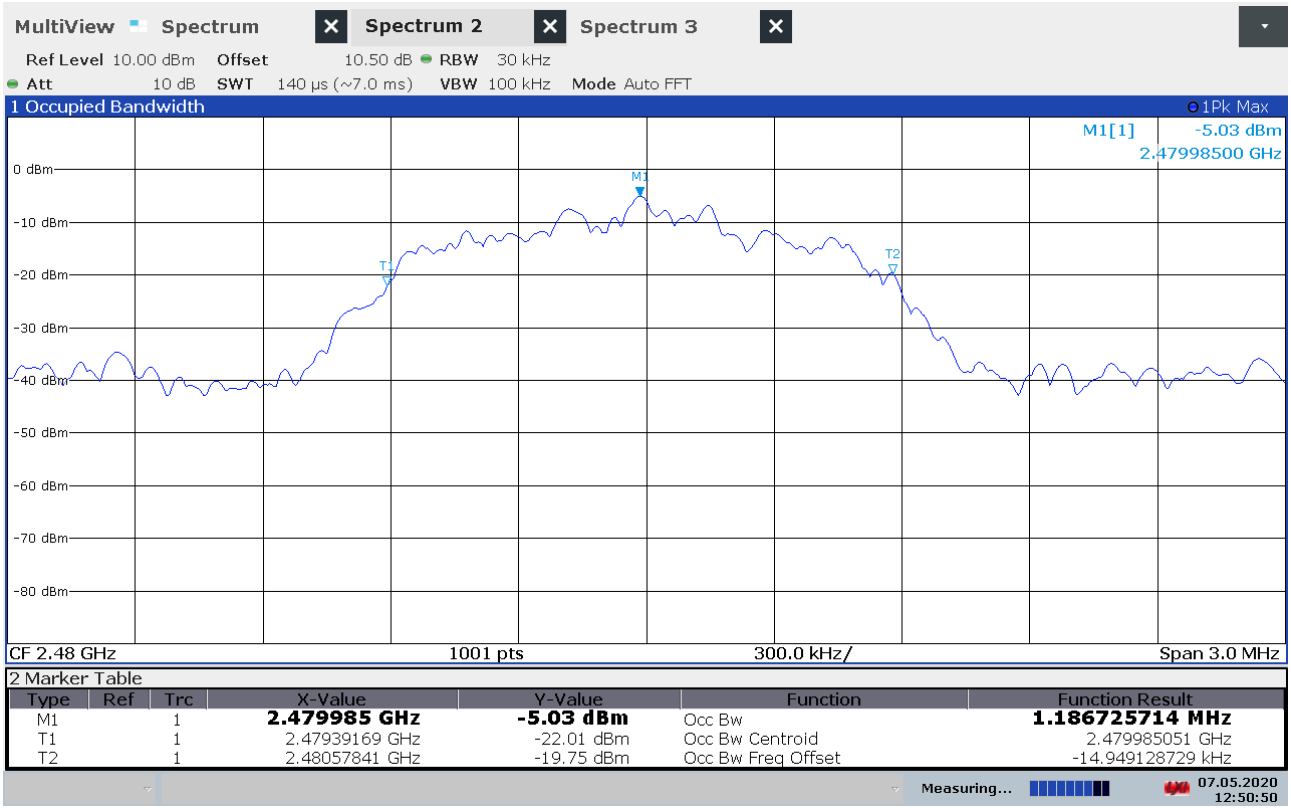
99% Bandwidth, π/4-DQPSK, 2480MHz



99% Bandwidth, 8-DPSK, 2402MHz



99% Bandwidth, 8-DPSK, 2440MHz



99% Bandwidth, 8-DPSK, 2480MHz

3.5 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:

Peak Power				
	Modulation	2402 MHz	2440 MHz	2480 MHz
Conducted Power (dBm)	GFSK	-5.26	-2.39	-0.81
Conducted Power (dBm)	π/4-DQPSK	-6.71	-3.00	-1.40
Conducted Power (dBm)	8-DPSK	-6.52	-3.21	-1.43
Conducted Power (mW)	GFSK	0.30	0.58	0.83
Conducted Power (mW)	π/4-DQPSK	0.21	0.50	0.72
Conducted Power (mW)	8-DPSK	0.22	0.48	0.72

Output Power reported is Maximum Peak Power.

See attached plots.

Requirements:

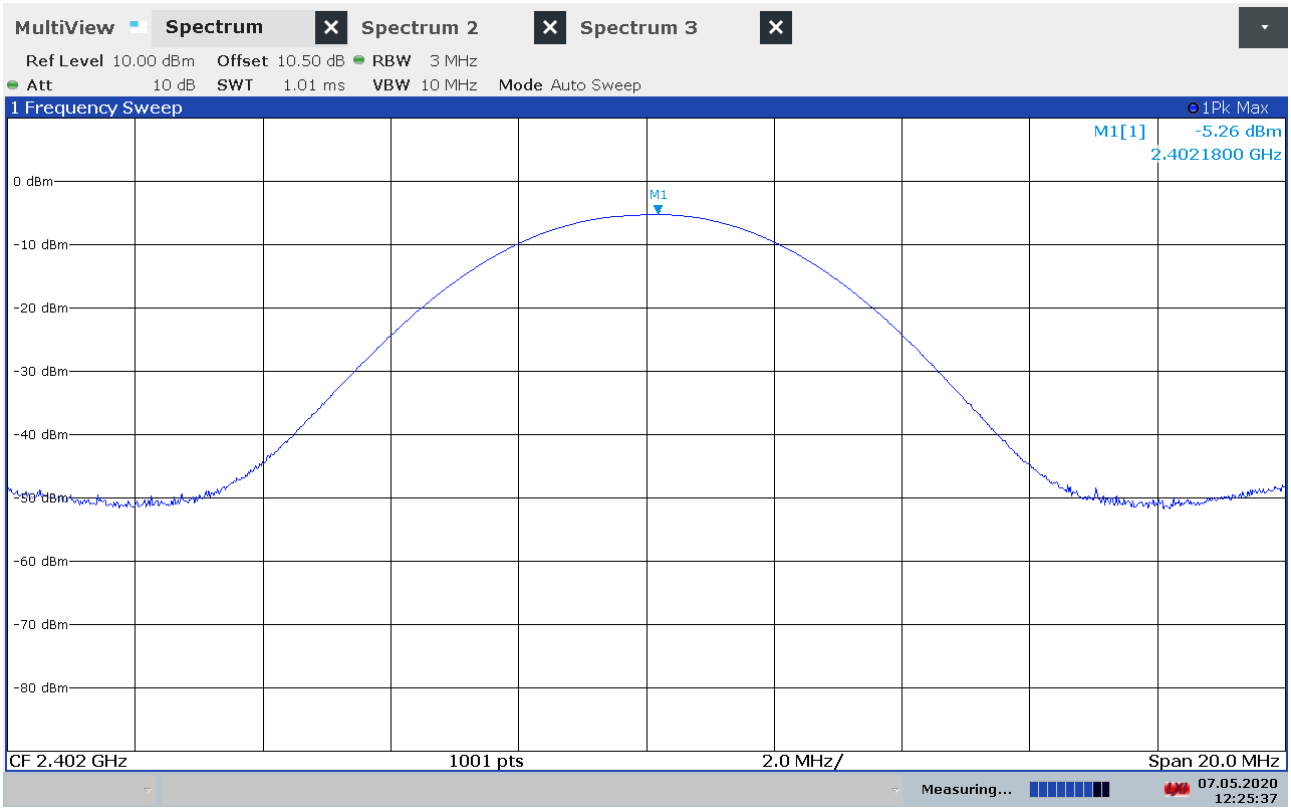
The maximum peak output power shall not exceed the following limits:

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

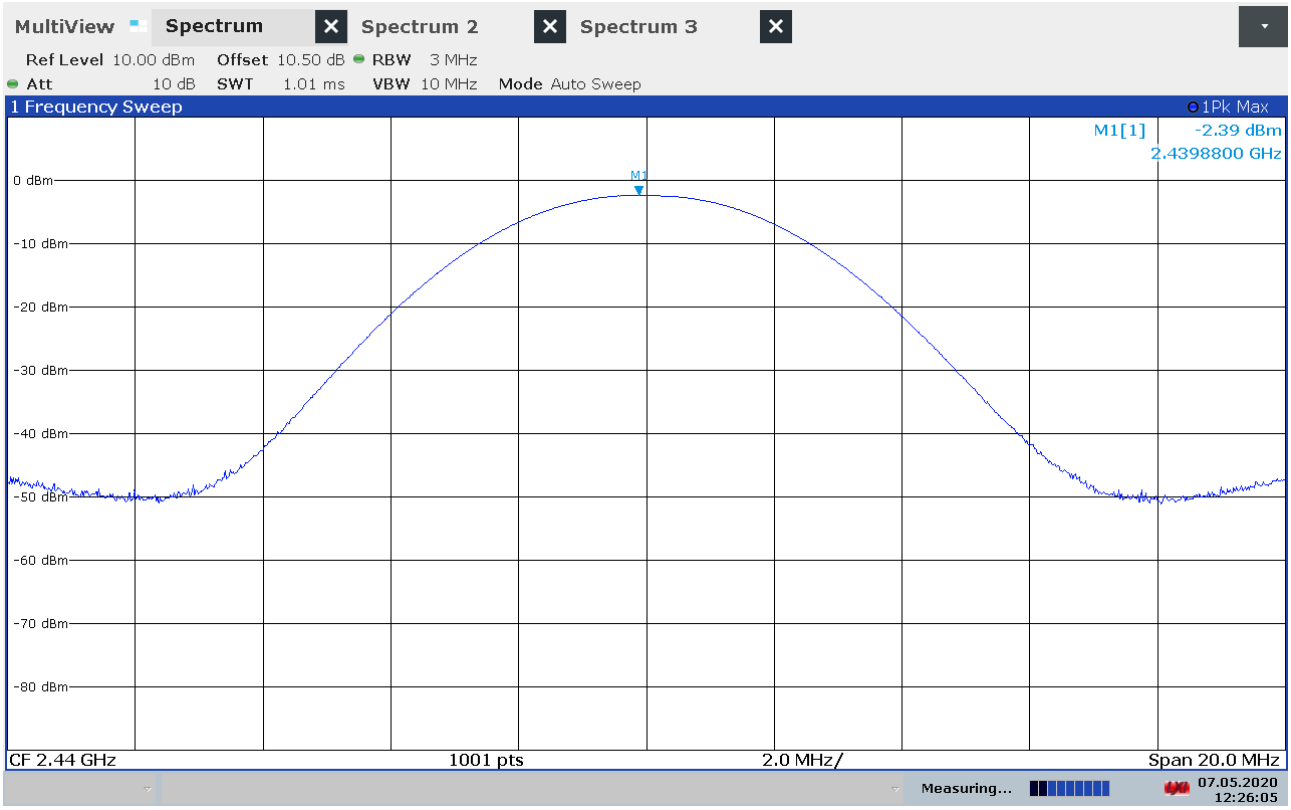
For all other frequency hopping systems in the 2400 - 2483.5 MHz band: 0.125 Watts

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

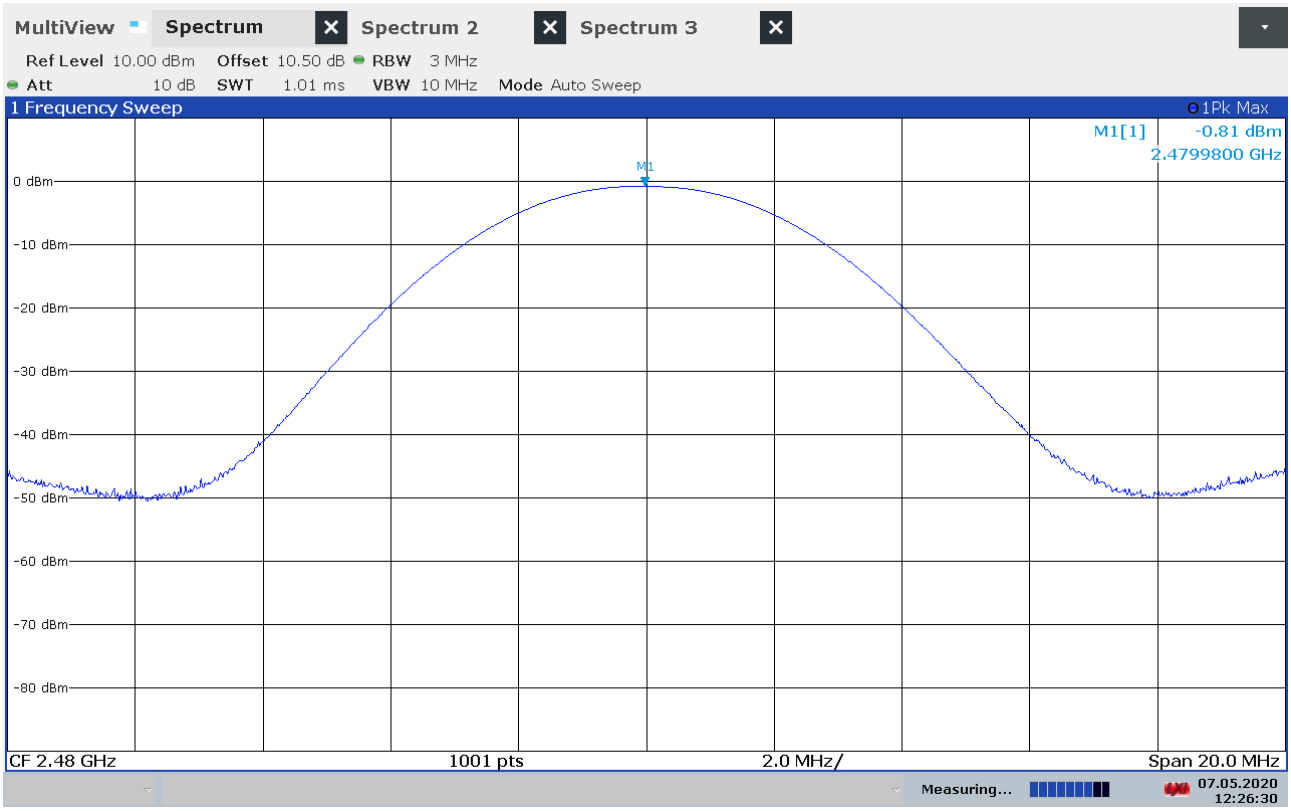
If transmitting antennas of directional gain greater than 6 dBi are used, the peak output power from the intentional radiator shall be reduced below the stated value above by the amount in dB that the directional gain of the antenna exceeds 6 dBi.



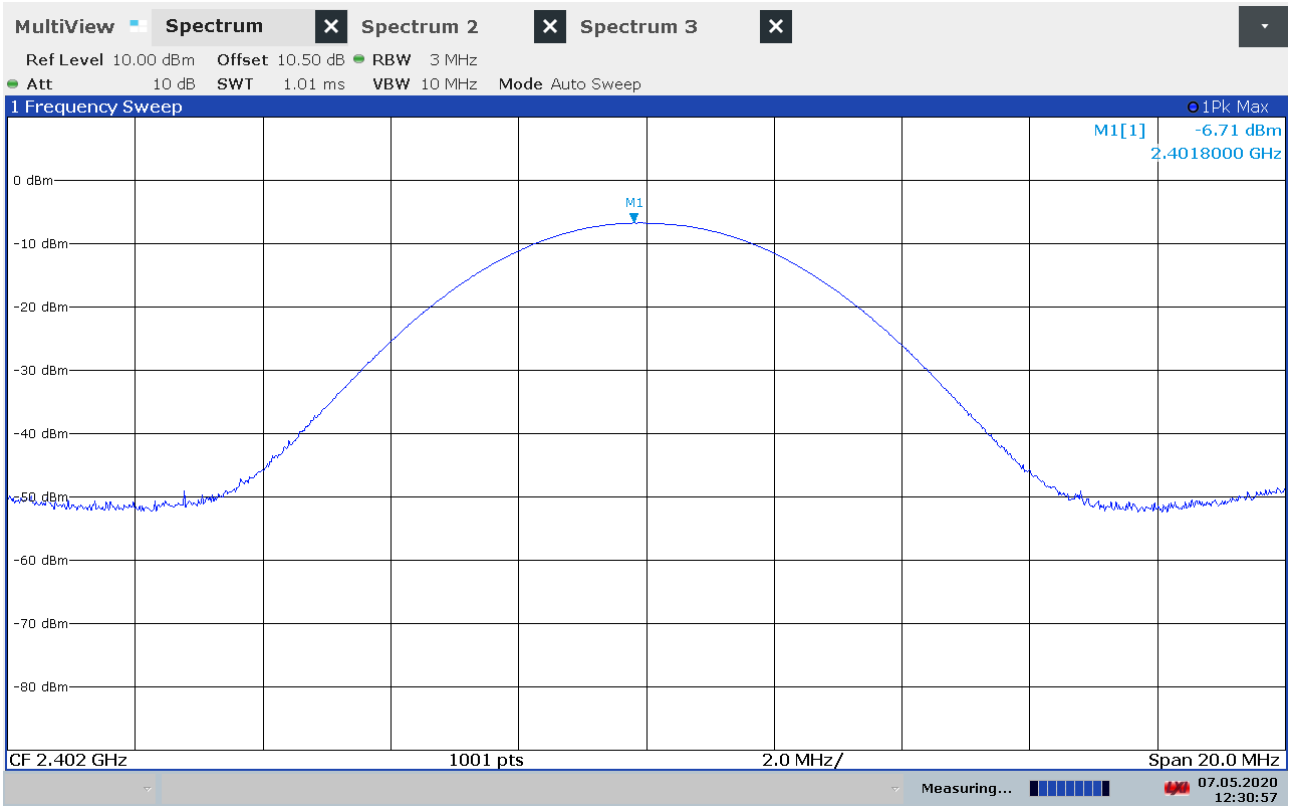
Output Power, 2402 MHz, GFSK



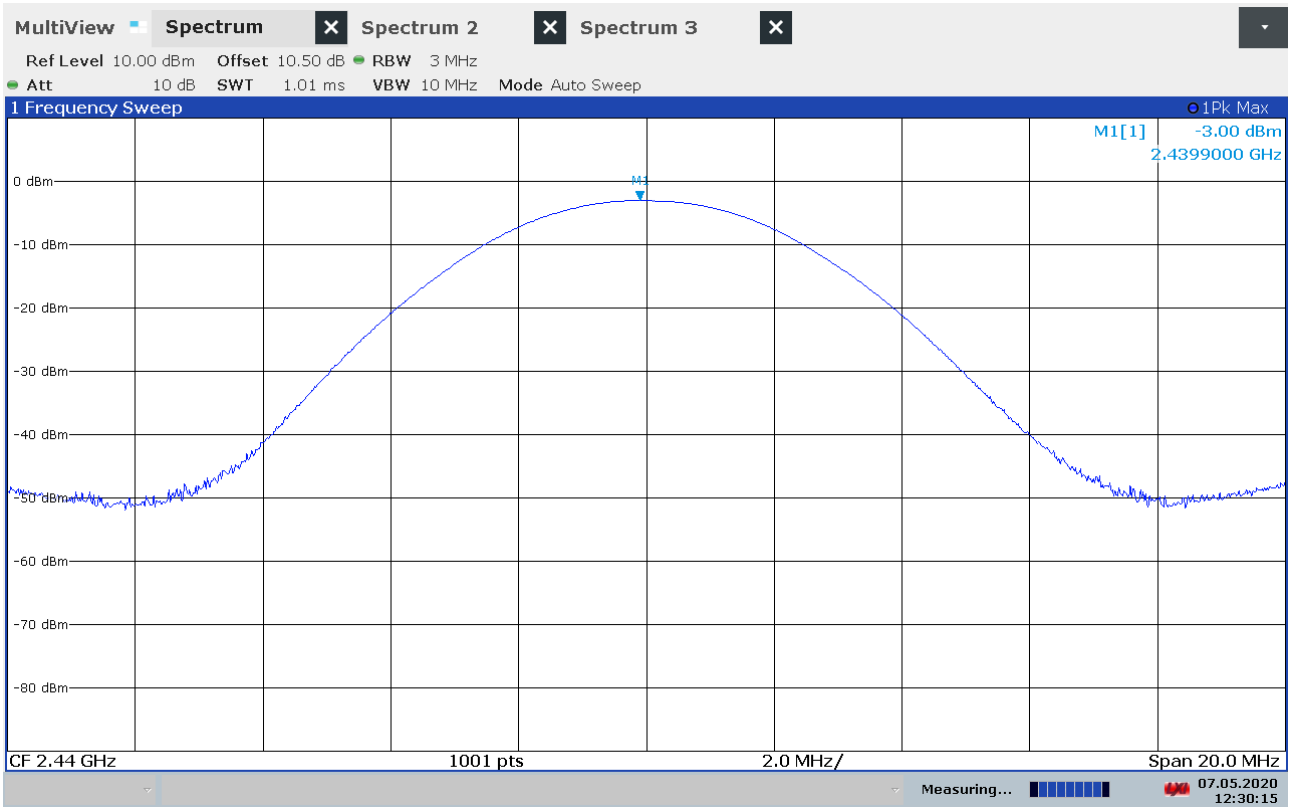
Output Power, 2440 MHz, GFSK



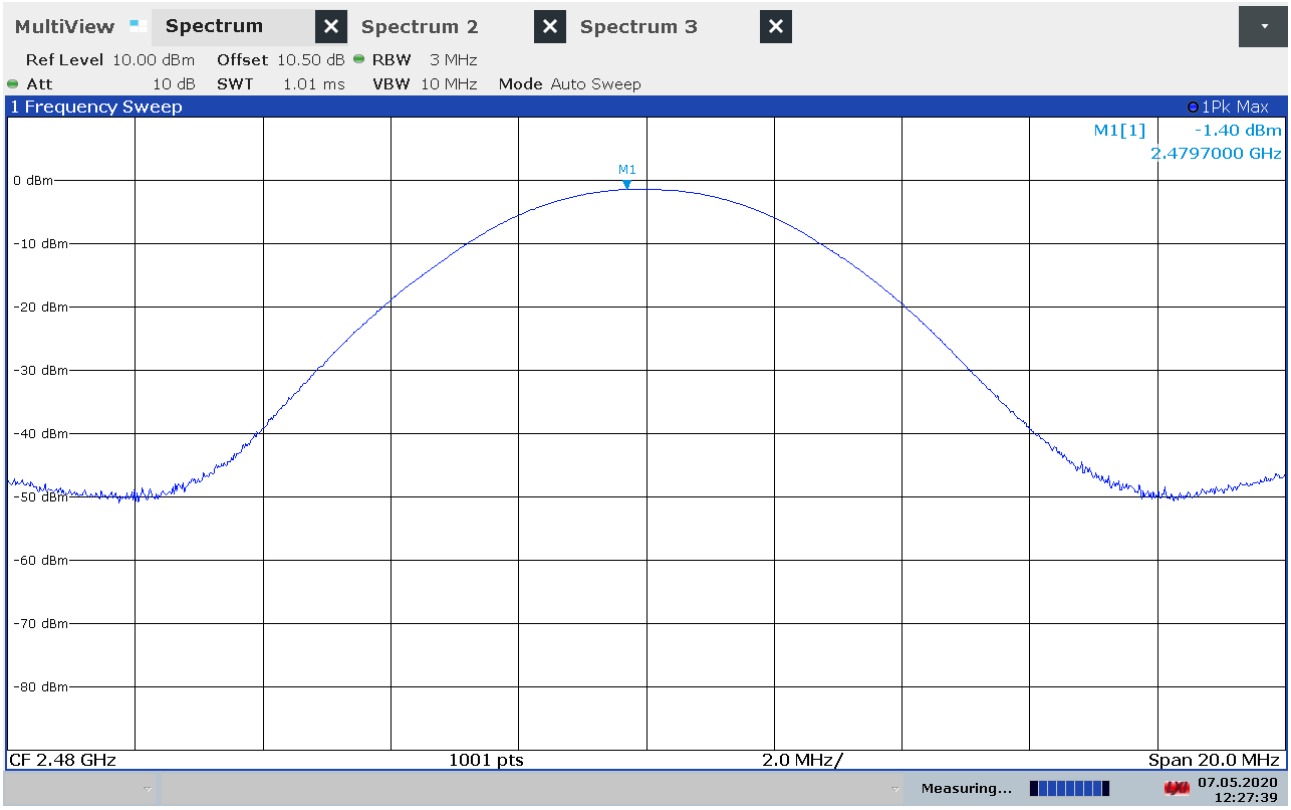
Output Power, 2480 MHz, GFSK



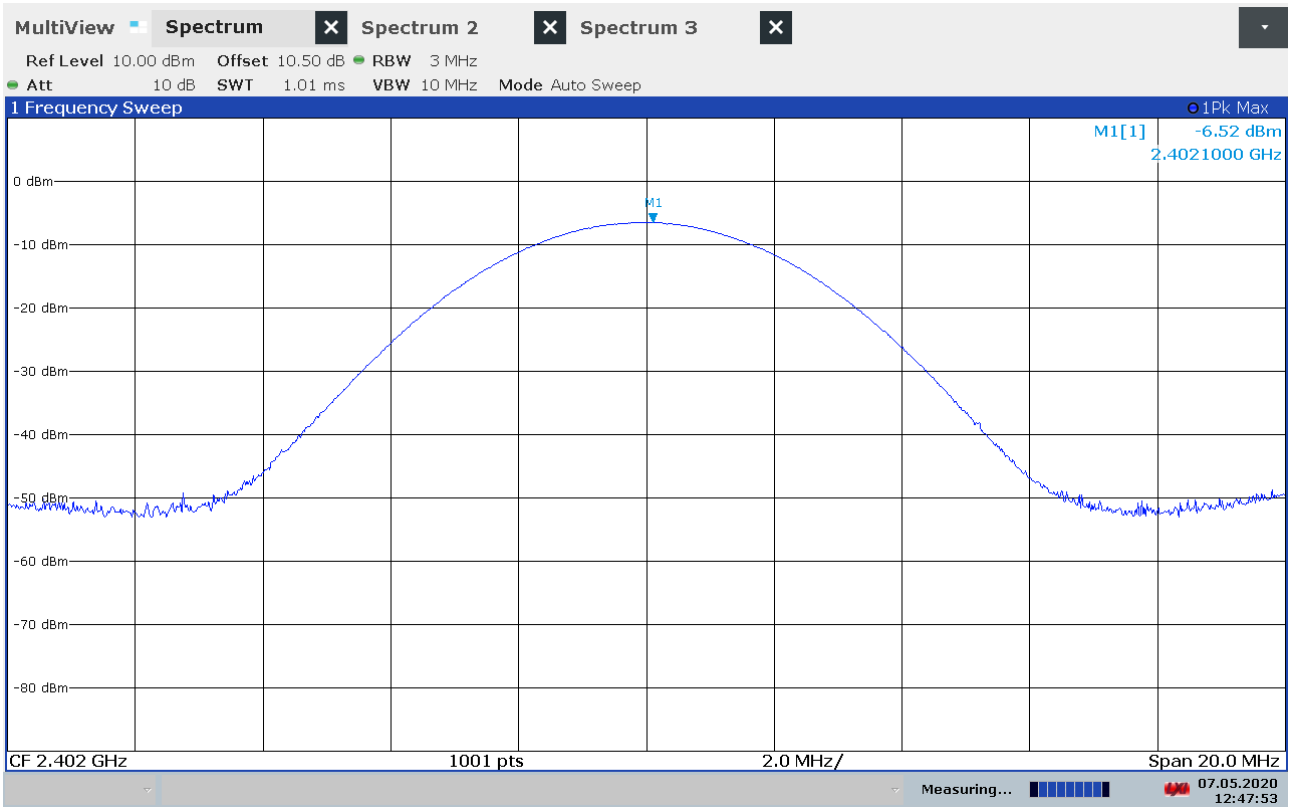
Output Power, 2402 MHz, π/4-DQPSK



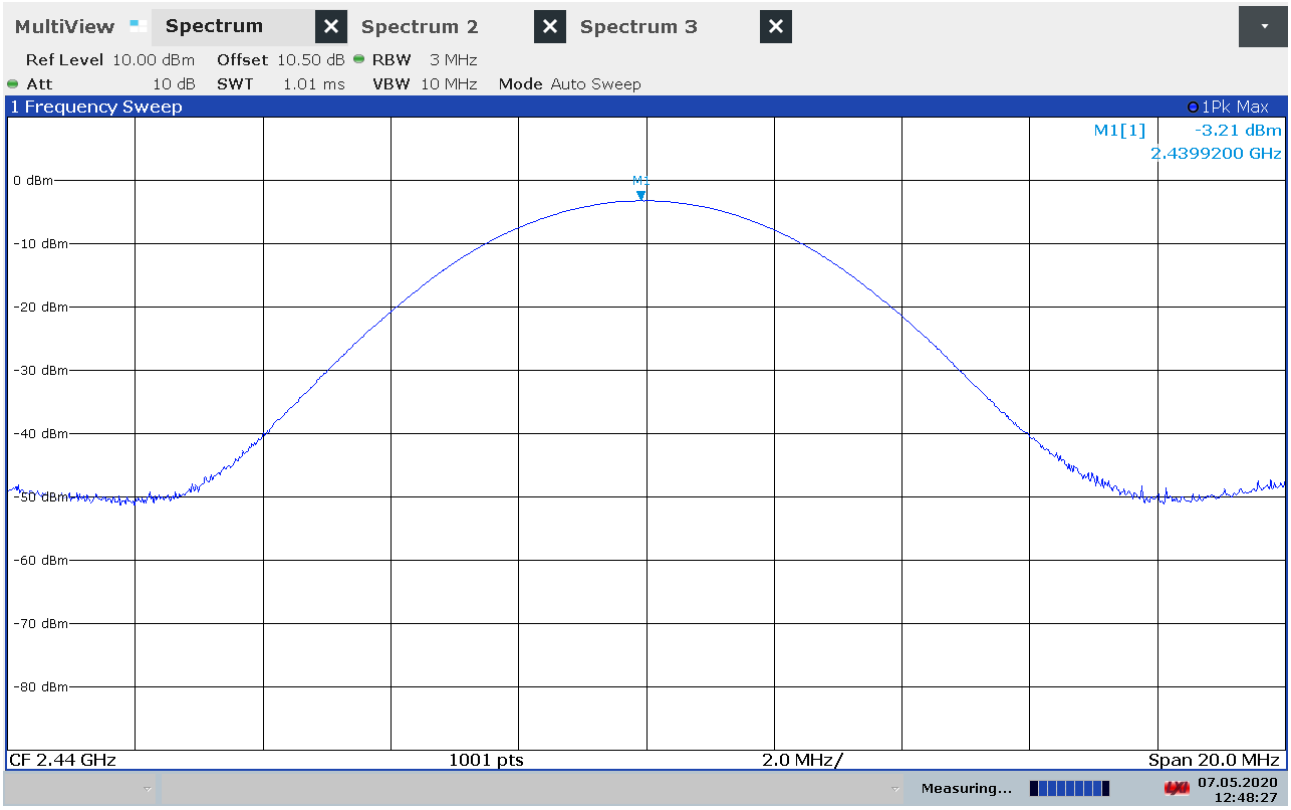
Output Power, 2440 MHz, π/4-DQPSK



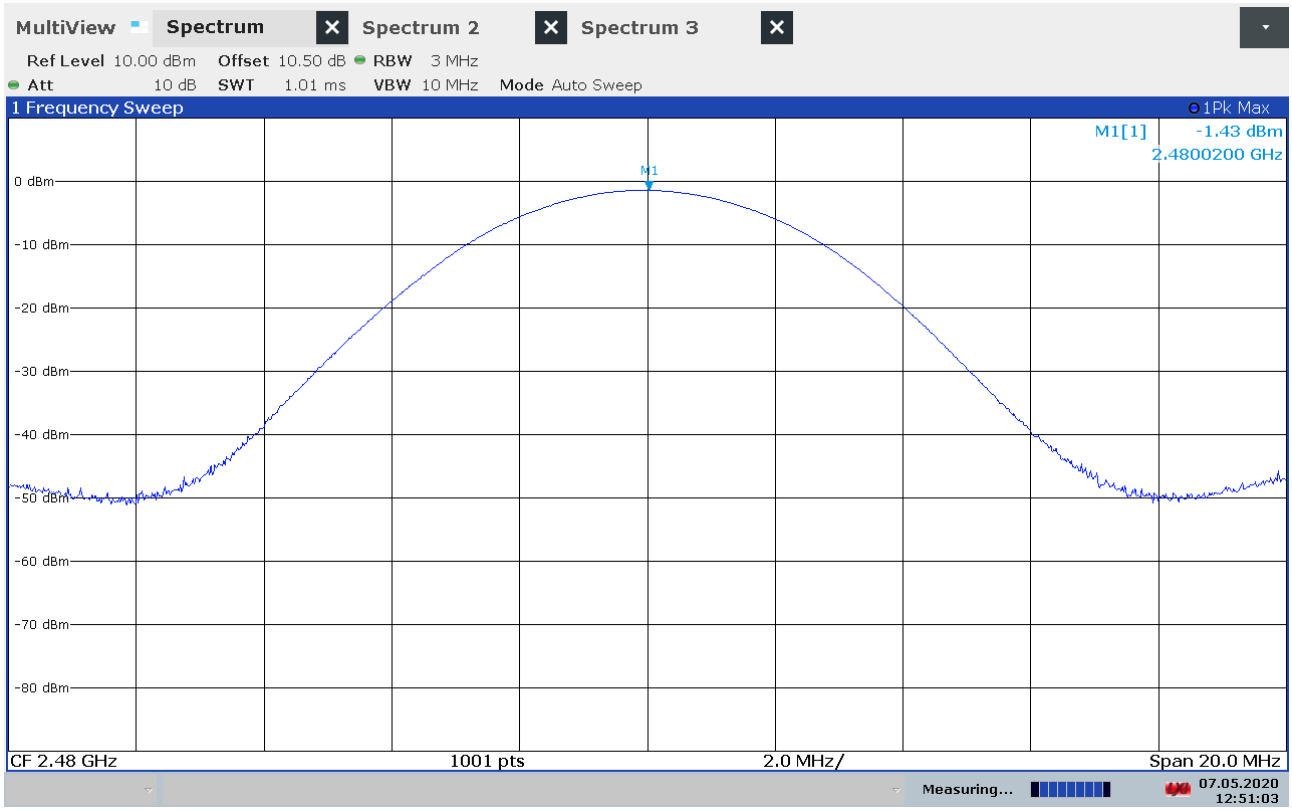
Output Power, 2480 MHz, π/4-DQPSK



Output Power, 2402 MHz, 8-DPSK



Output Power, 2440 MHz, 8-DPSK



Output Power, 2480 MHz, 8-DPSK

3.6 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	> 30	> 10	Pass
2440 MHz	> 30	> 10	Pass
2480 MHz	> 30	> 10	Pass
Hopping	> 30	> 10	Pass

Measured with Peak Detector

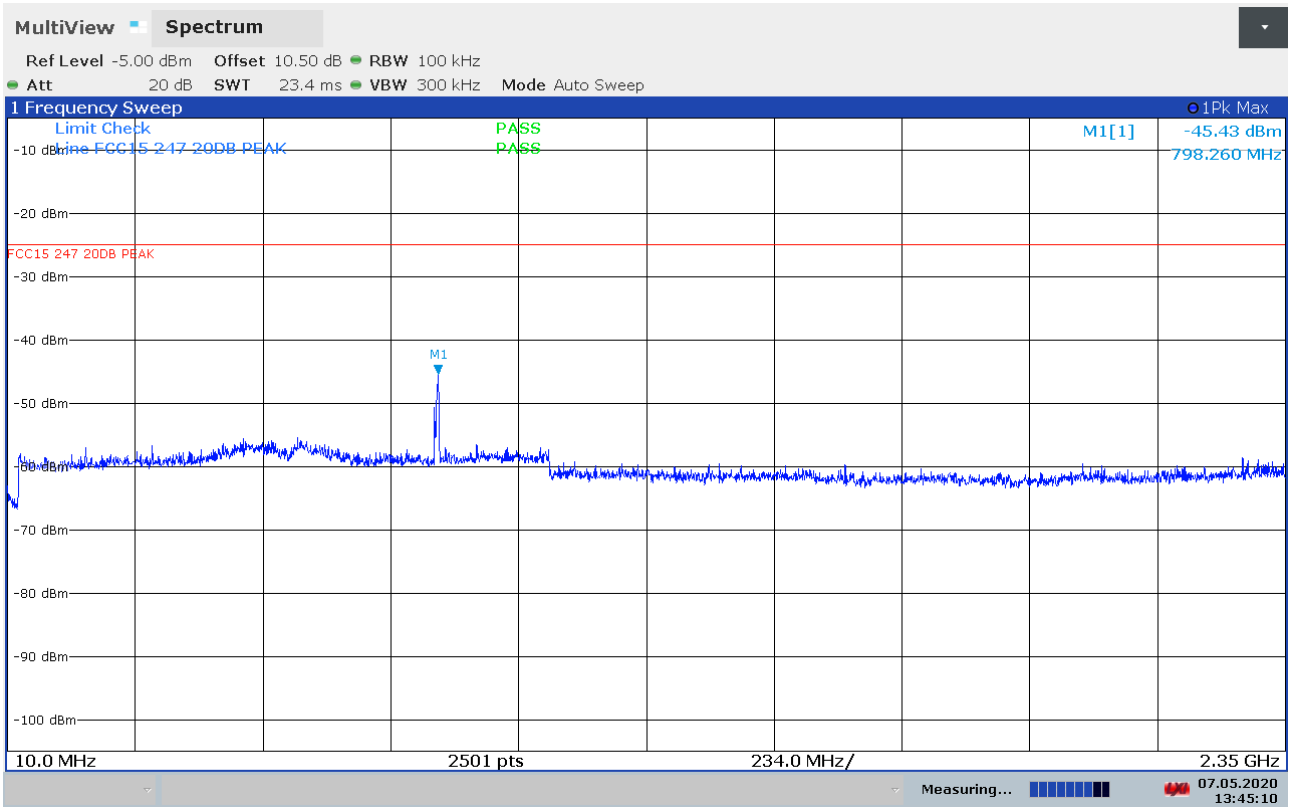
RF conducted power to 25 GHz: see attached plots.

Limit

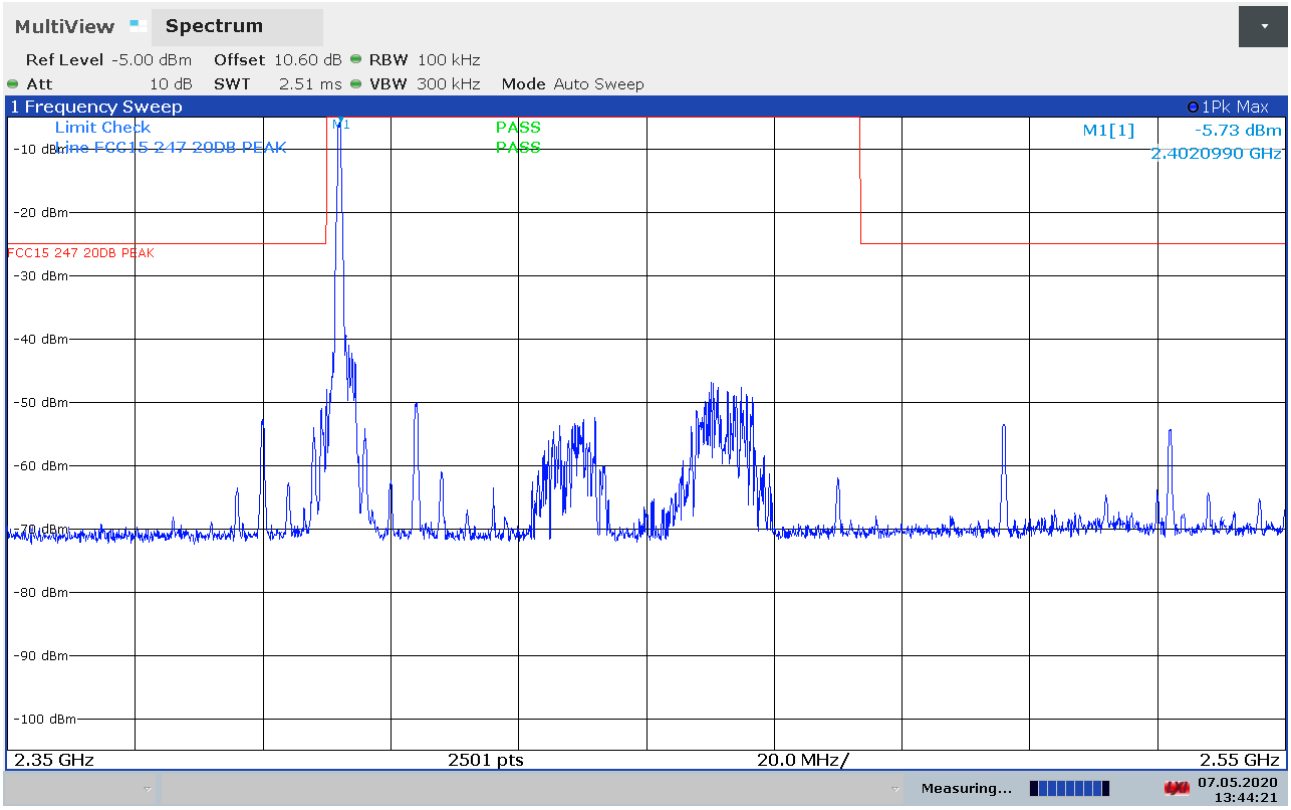
Peak measurement	RMS averaging
20 dBc or more in 100 kHz bandwidth	30 dBc or more in 100 kHz bandwidth

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

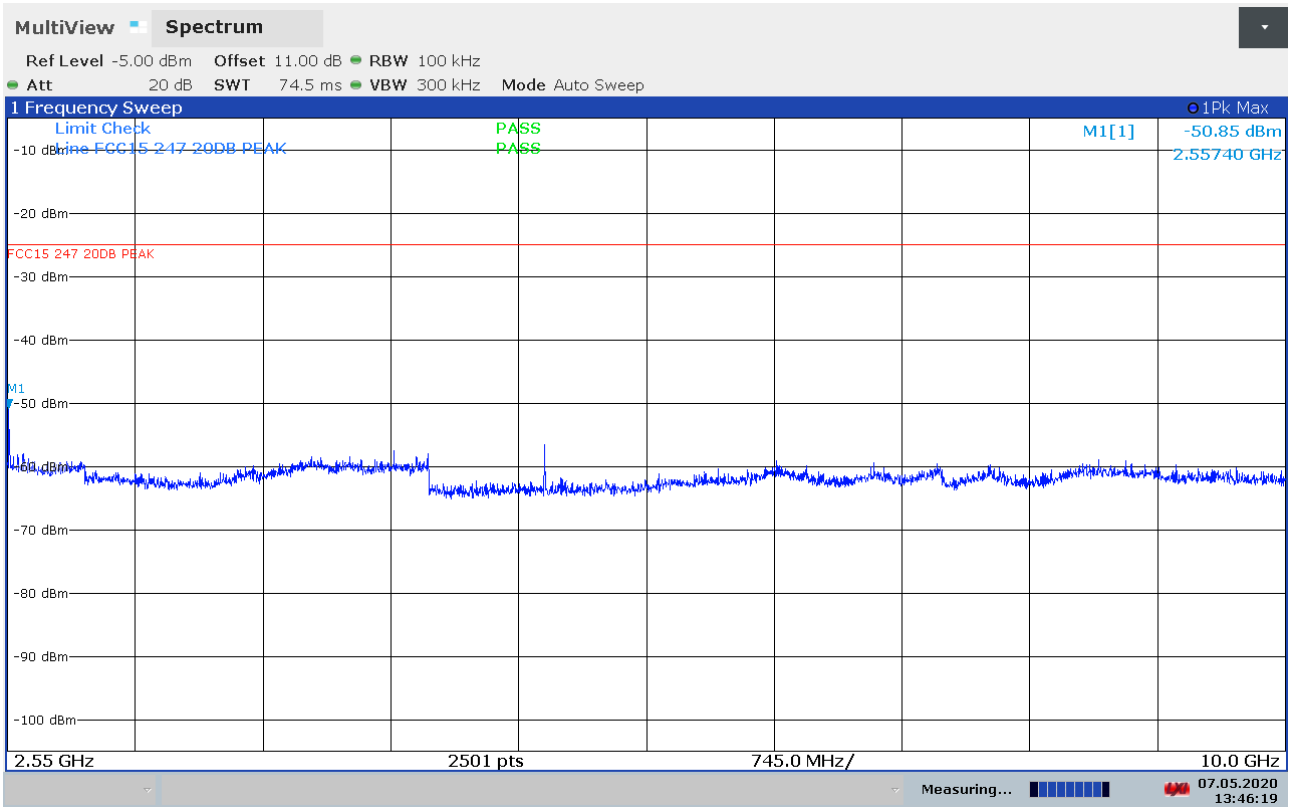
Attenuation below the general limits specified in part 15.209(a) is not required.



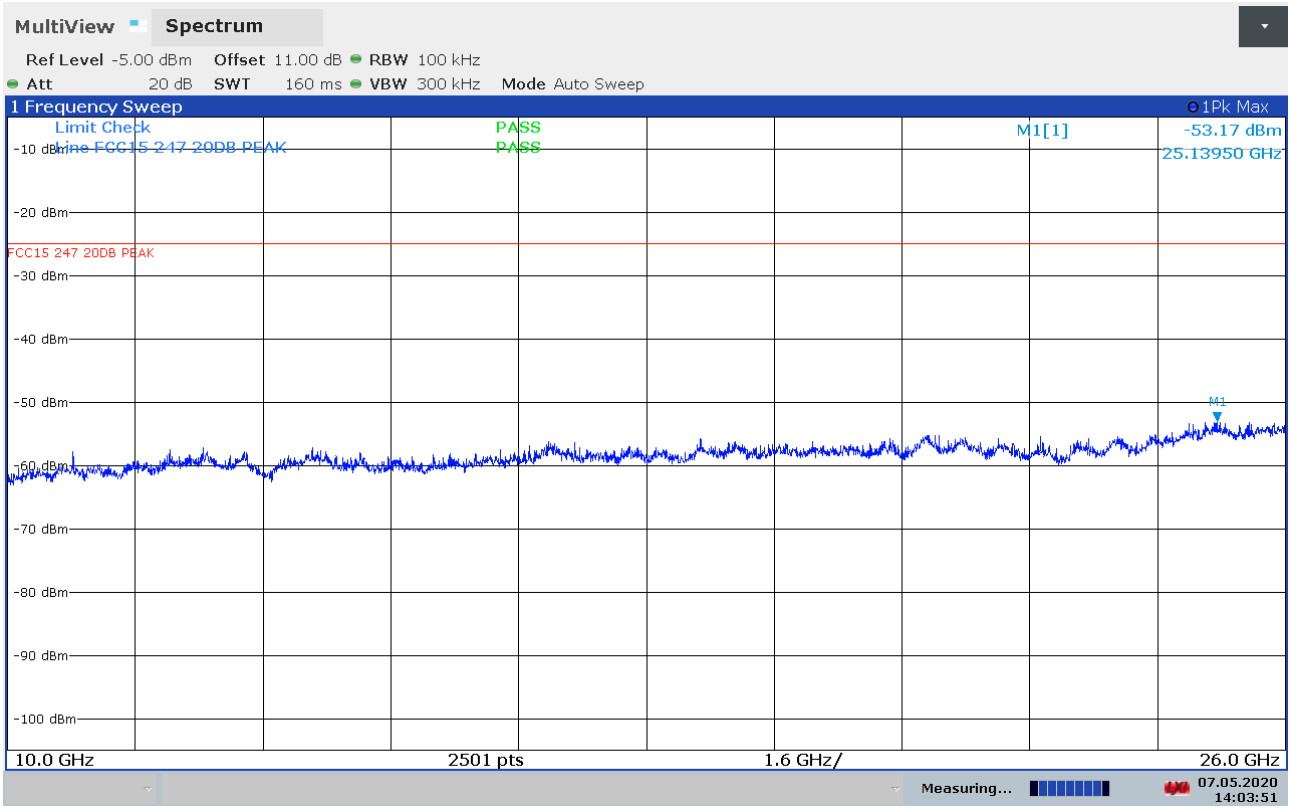
Conducted Emissions, 10 -2350 MHz, 2402 MHz, GFSK



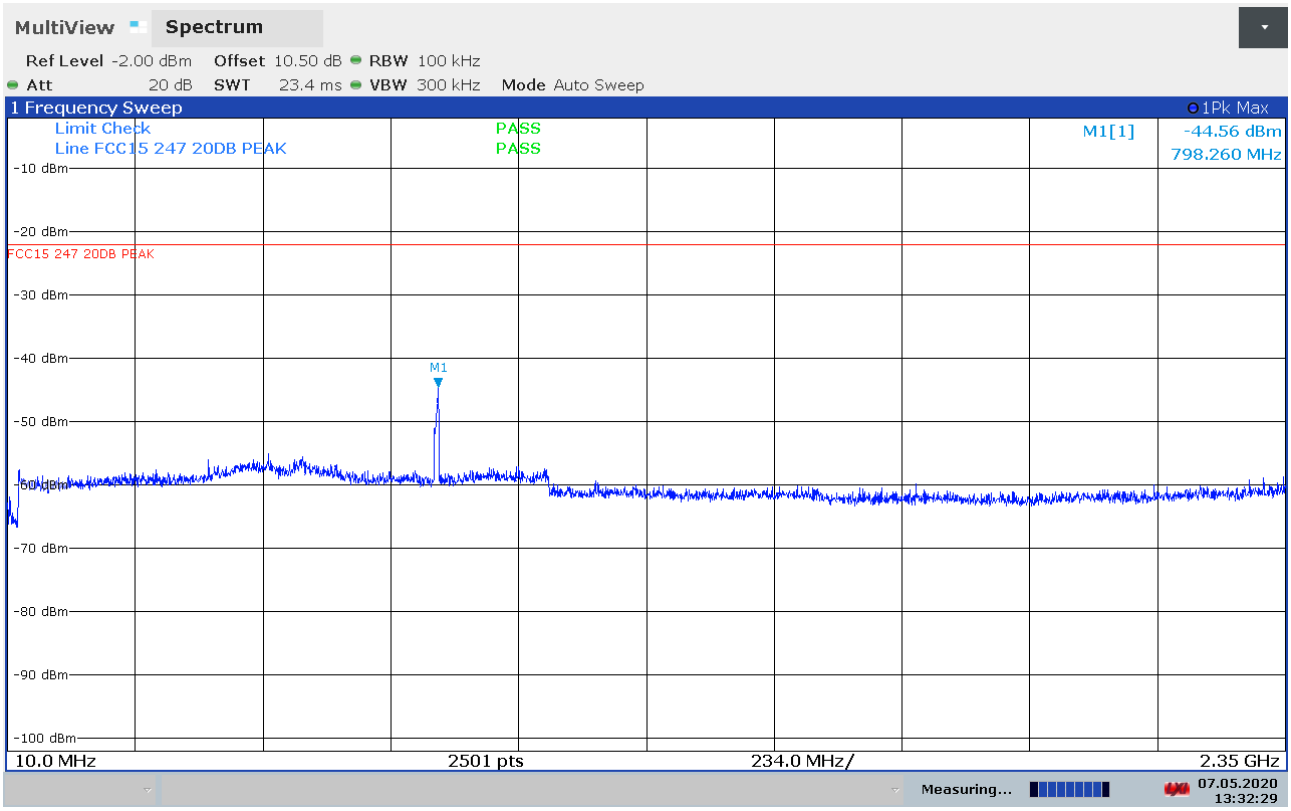
Conducted Emissions, 2350 -2550 MHz, 2402 MHz, GFSK



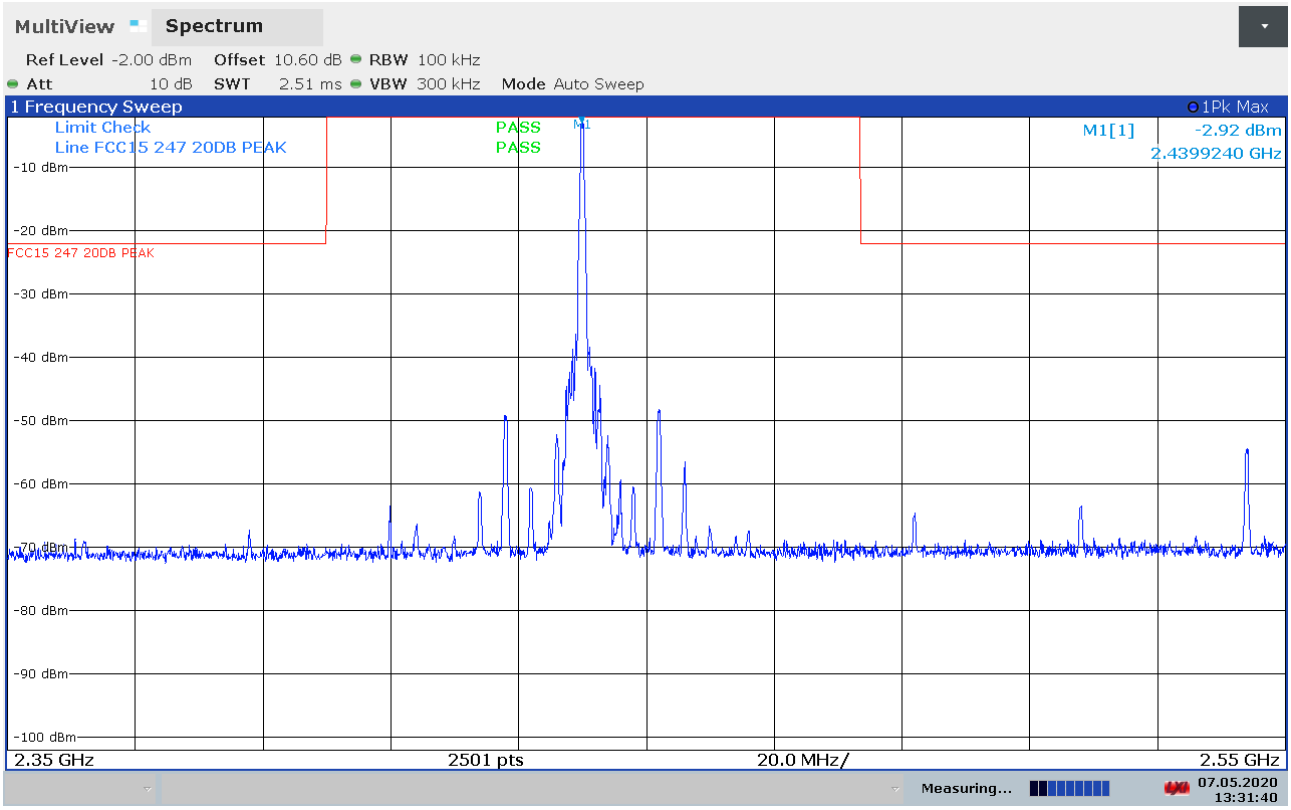
Conducted Emissions, 2550 -10000 MHz, 2402 MHz, GFSK



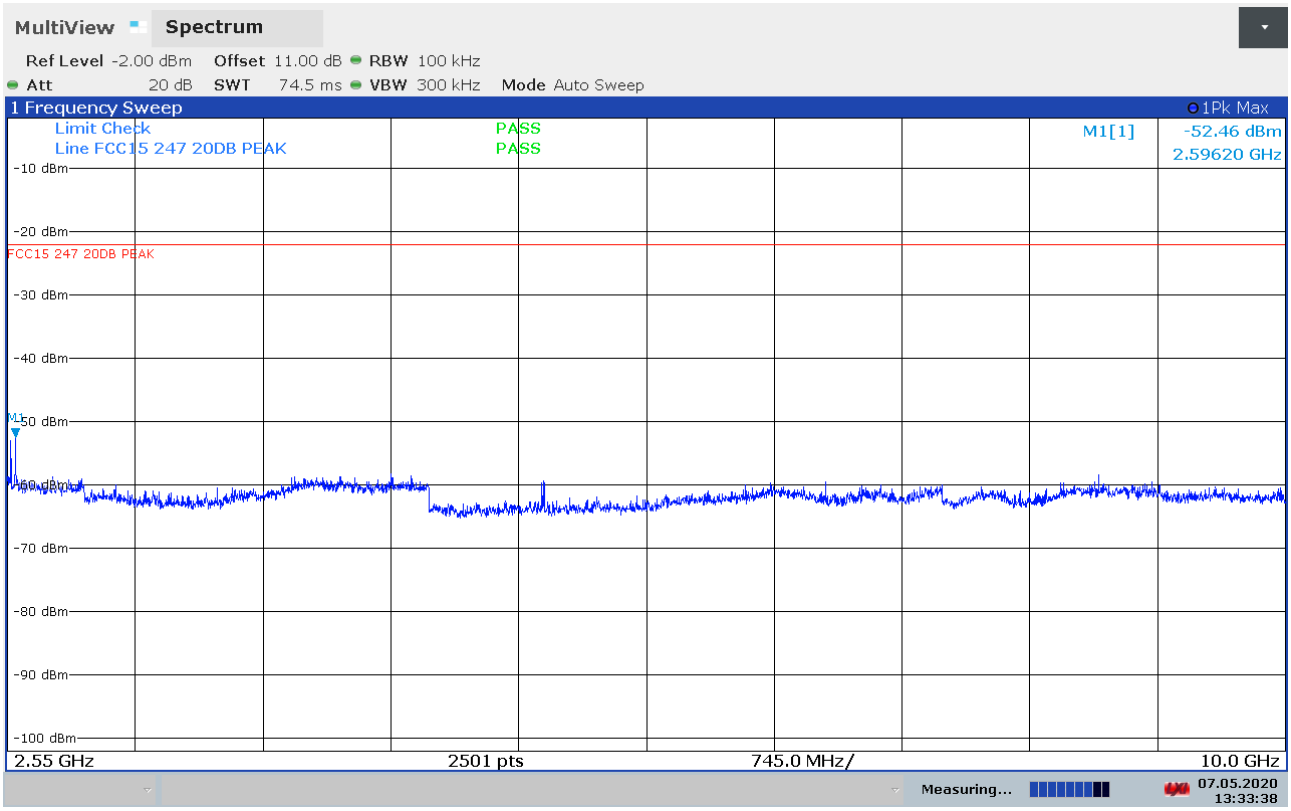
Conducted Emissions, 10000 -26000 MHz, 2402 MHz, GFSK



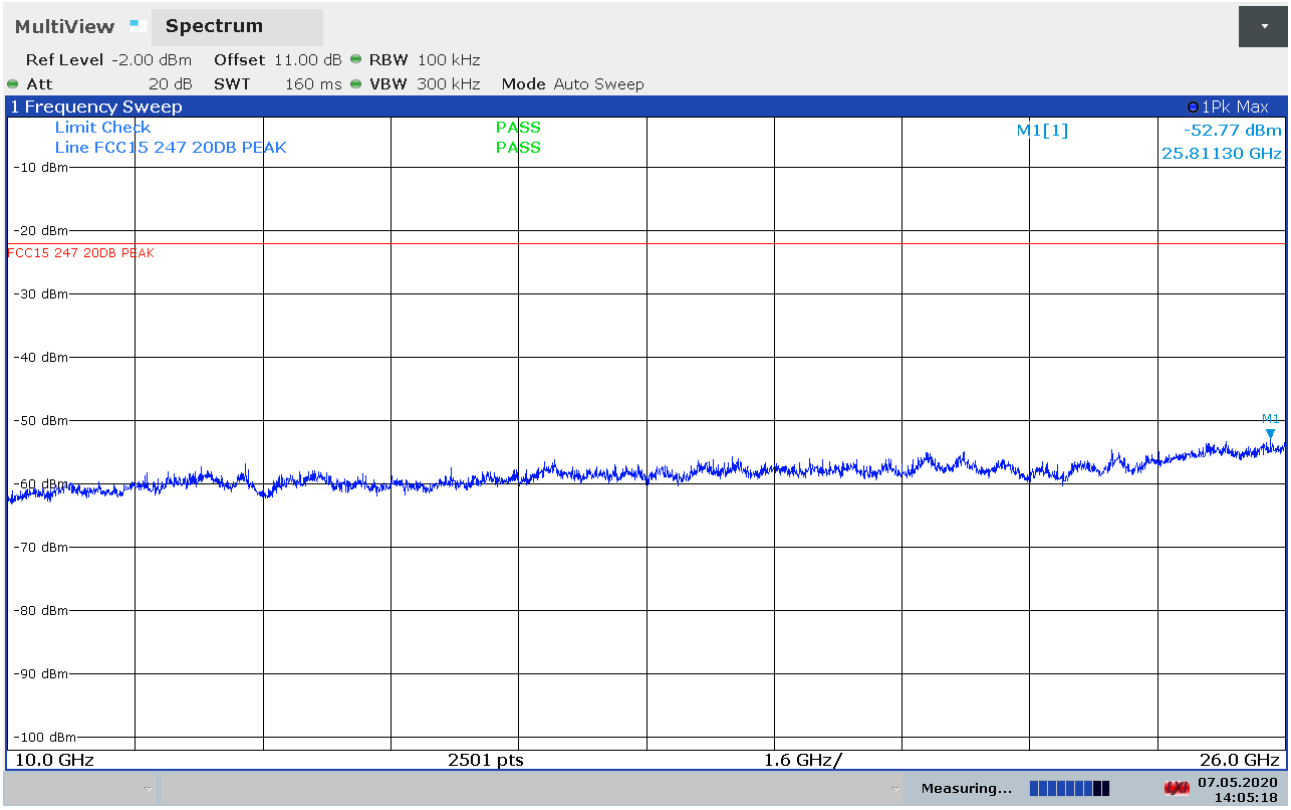
Conducted Emissions, 10 -2350 MHz, 2440 MHz, GFSK



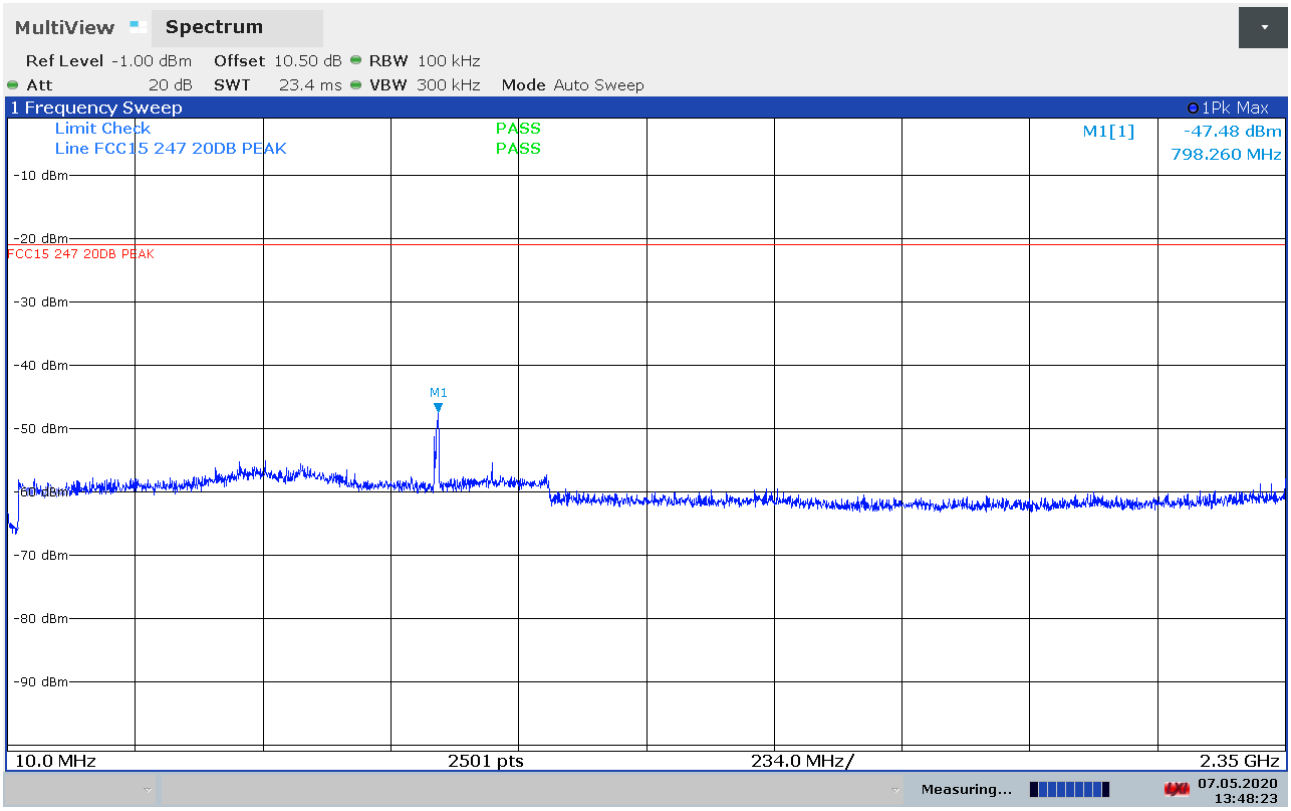
Conducted Emissions, 2350 -2550 MHz, 2440 MHz, GFSK



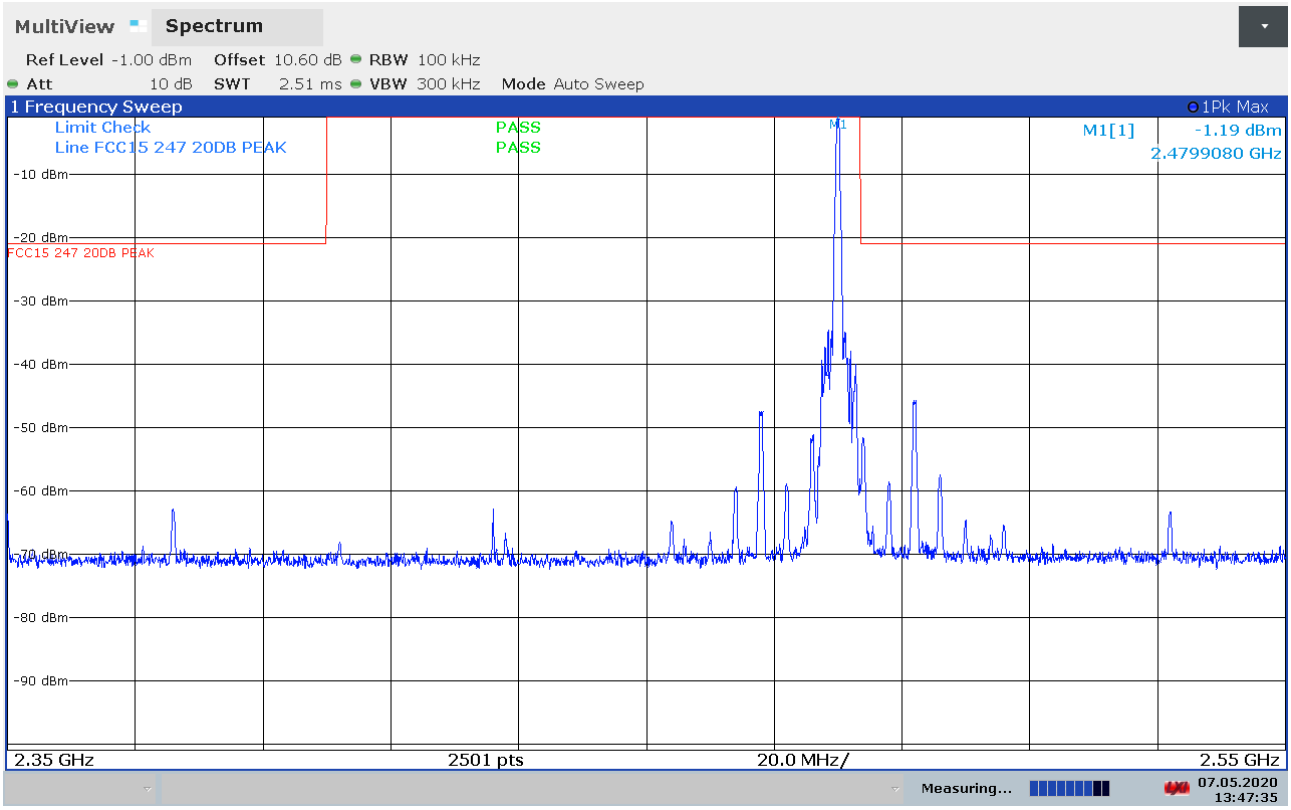
Conducted Emissions, 2550 -10000 MHz, 2440 MHz, GFSK



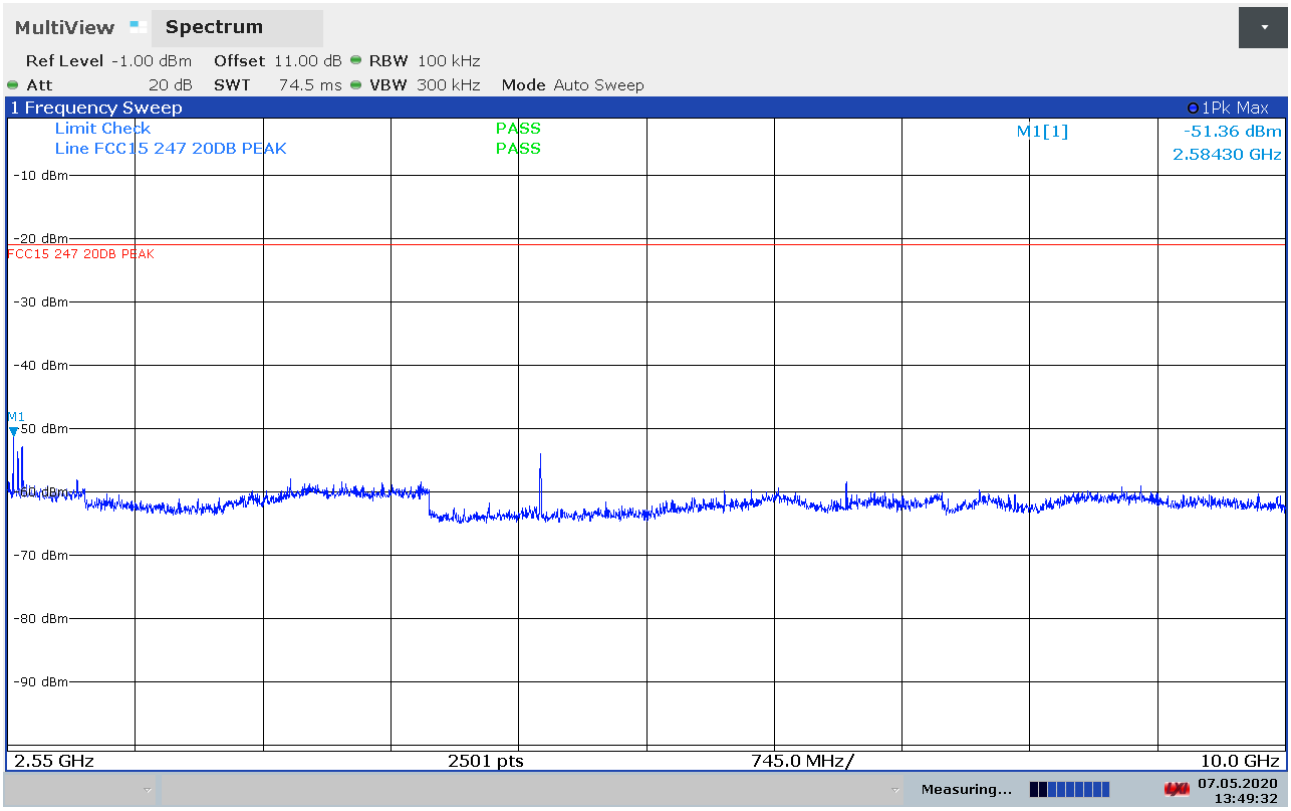
Conducted Emissions, 10000 -26000 MHz, 2440 MHz, GFSK



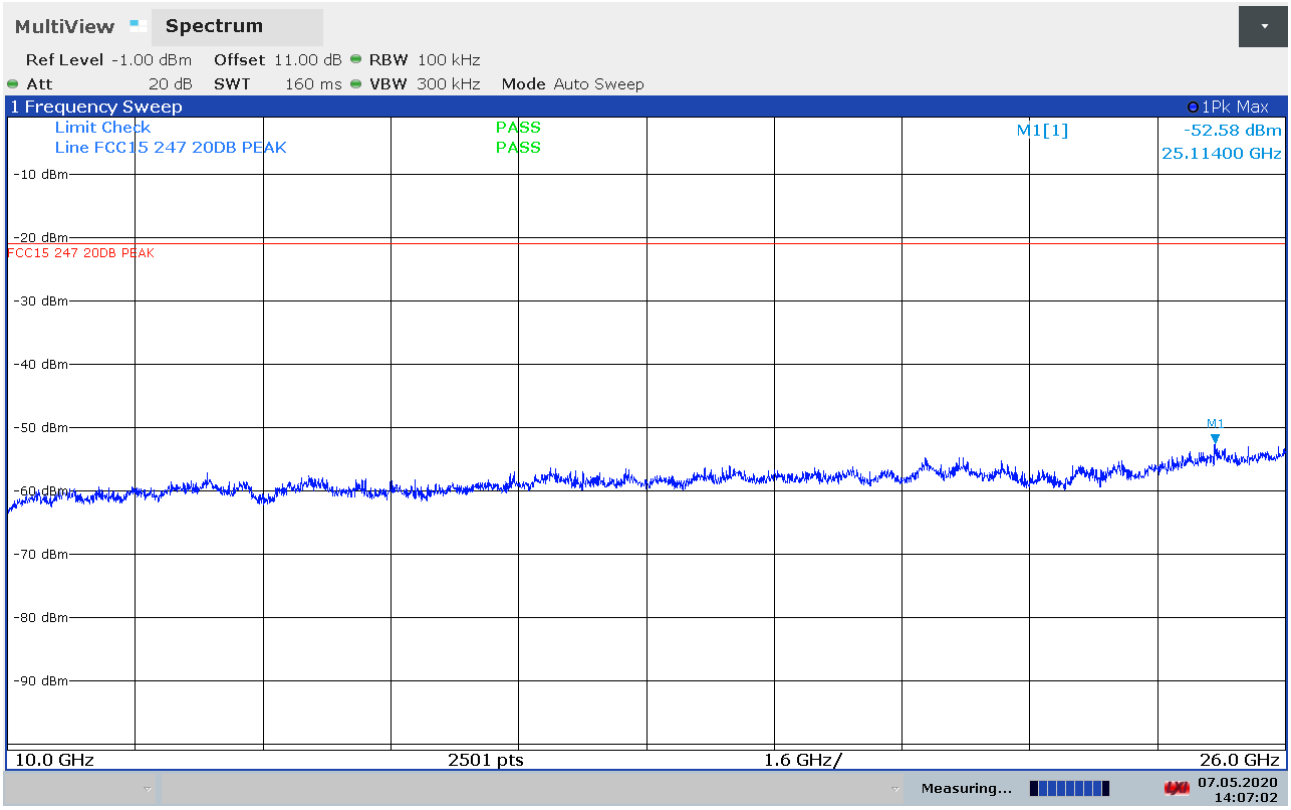
Conducted Emissions, 10 -2300 MHz, 2480 MHz, GFSK



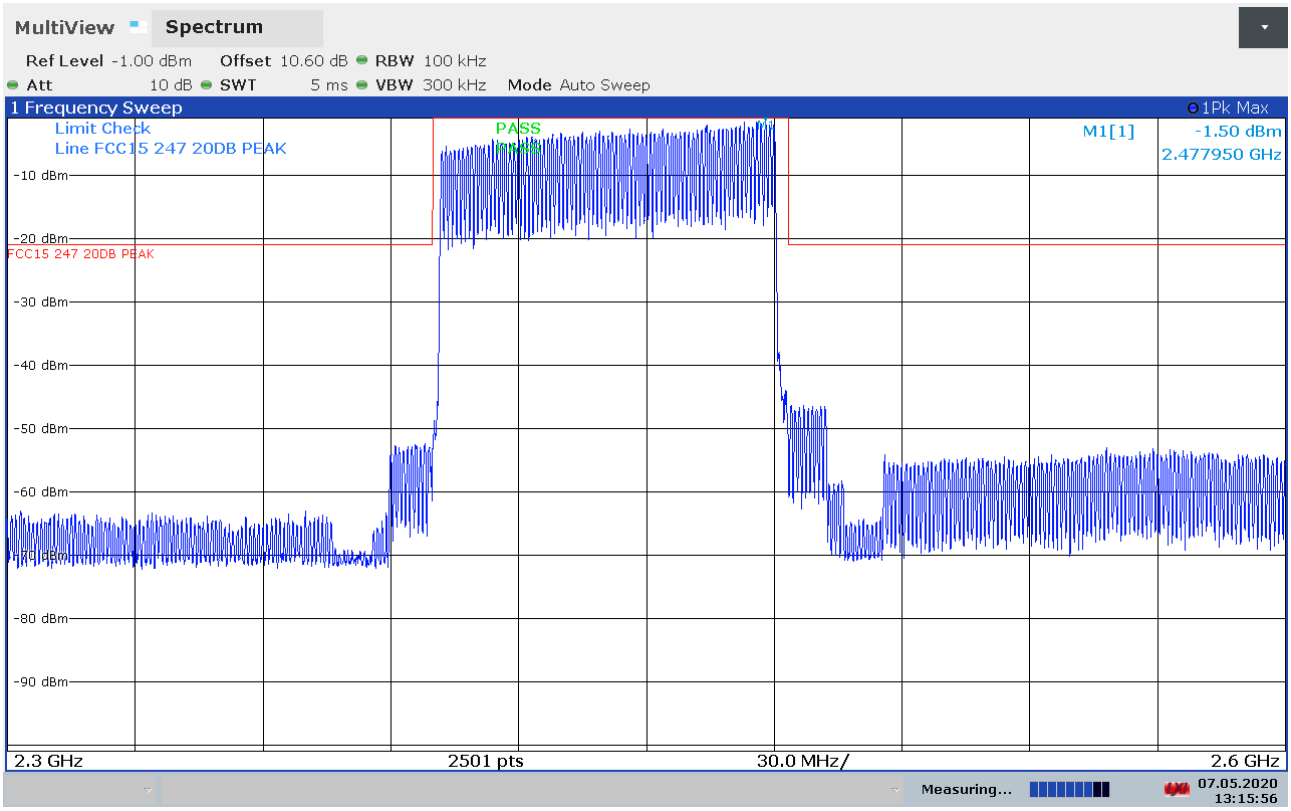
Conducted Emissions, 2350 -2550 MHz, 2480 MHz, GFSK



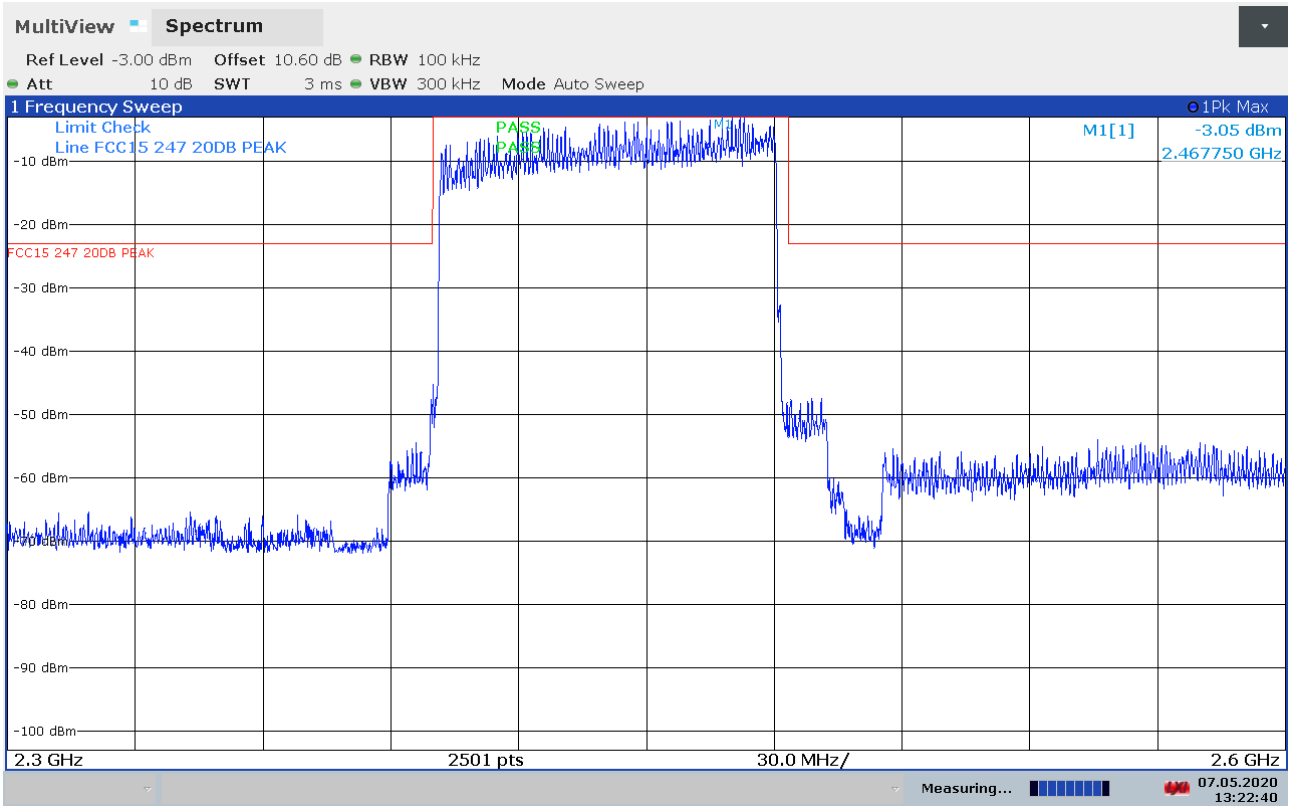
Conducted Emissions, 2550 -10000 MHz, 2480 MHz, GFSK



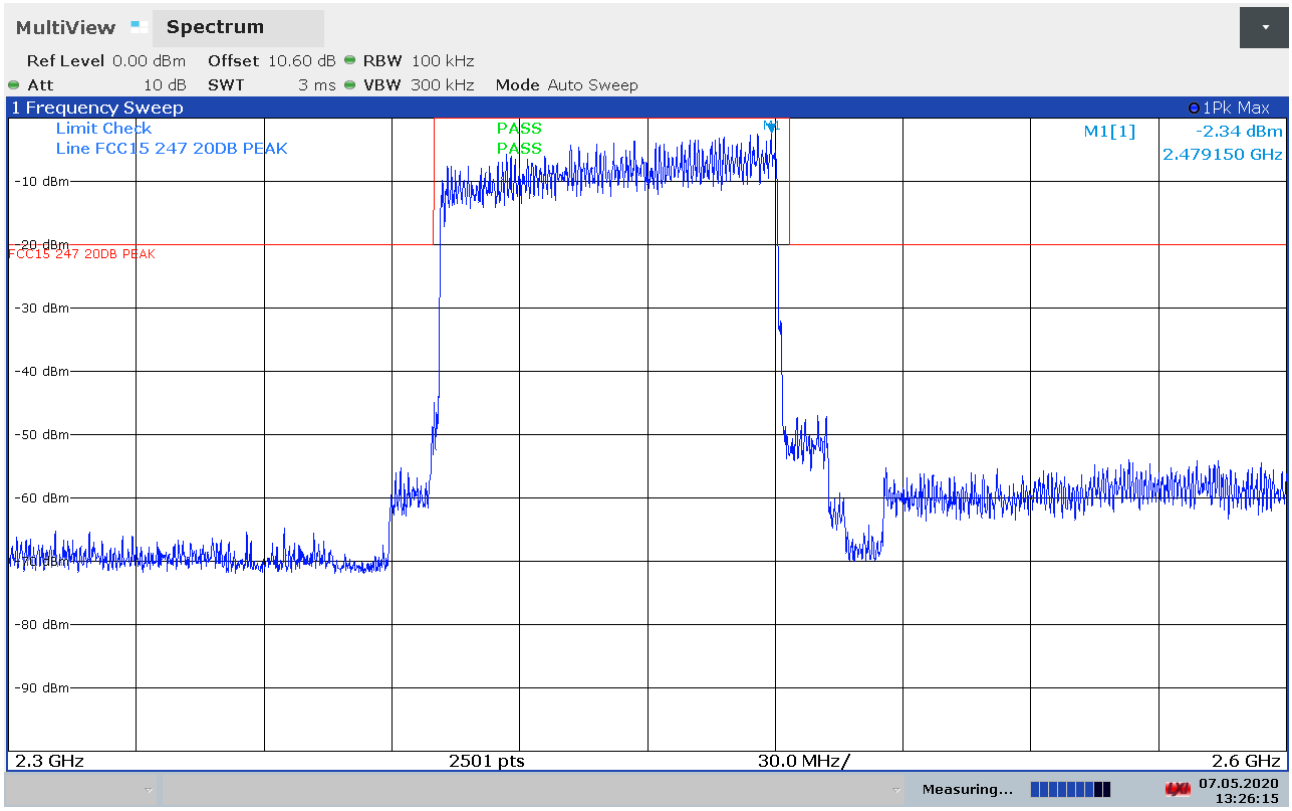
Conducted Emissions, 10000 -26000 MHz, 2480 MHz, GFSK



Conducted Emissions, 2300 -2600 MHz, Hopping, GFSK



Conducted Emissions, 2300 -2600 MHz, Hopping, π/4-DQPSK



Conducted Emissions, 2300 -2600 MHz, Hopping, 8-DPSK

3.7 Restricted Bands of operation

Restricted Bands of operation for FCC and ISED are defined in FCC Part 15.205 and ISED 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)	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 ISED, all other frequencies are common.

3.8 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	Modulation	Measured field strength (dBµV/m)		Limit	Margin	
		2390 MHz	2483.5 MHz	dBµV/m	dB	
Peak	GFSK	56.9	61.7	74	17.1	12.3
	π/-DQPSK	55.1	58.7	74	18.9	15.3
	8-DPSK	55.7	59.6	74	18.3	14.4
Average	GFSK	36.9	41.7	54	17.1	12.3
	π/-DQPSK	35.1	38.7	54	18.9	15.3
	8-DPSK	35.7	39.6	54	18.3	14.4

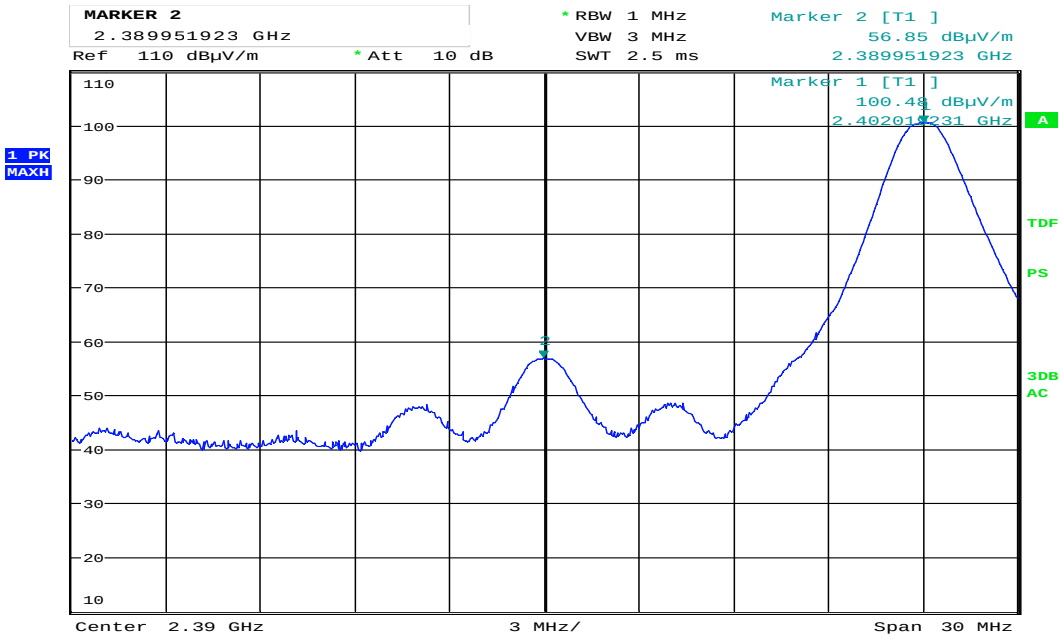
Average Detector values are measured with Peak Detector and corrected for Duty Cycle.

See attached plots.

Duty Cycle Correction Factor Calculation:

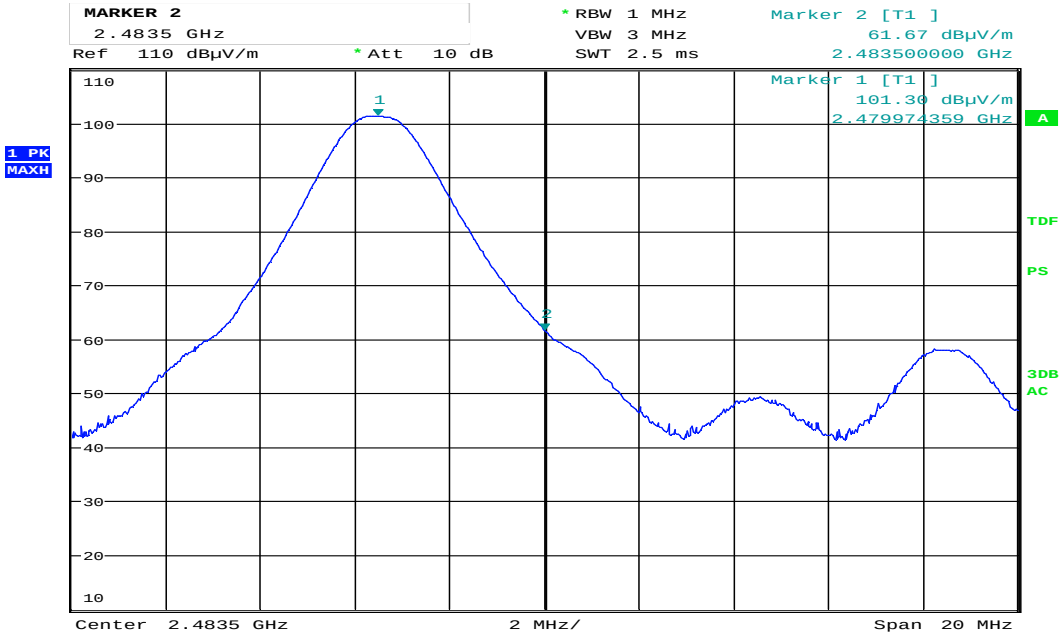
Duty Cycle = slot length / (frame length * number of hopping channels)

Maximum Duty Cycle Correction Factor according to Para 15.35 (b): 20 dB



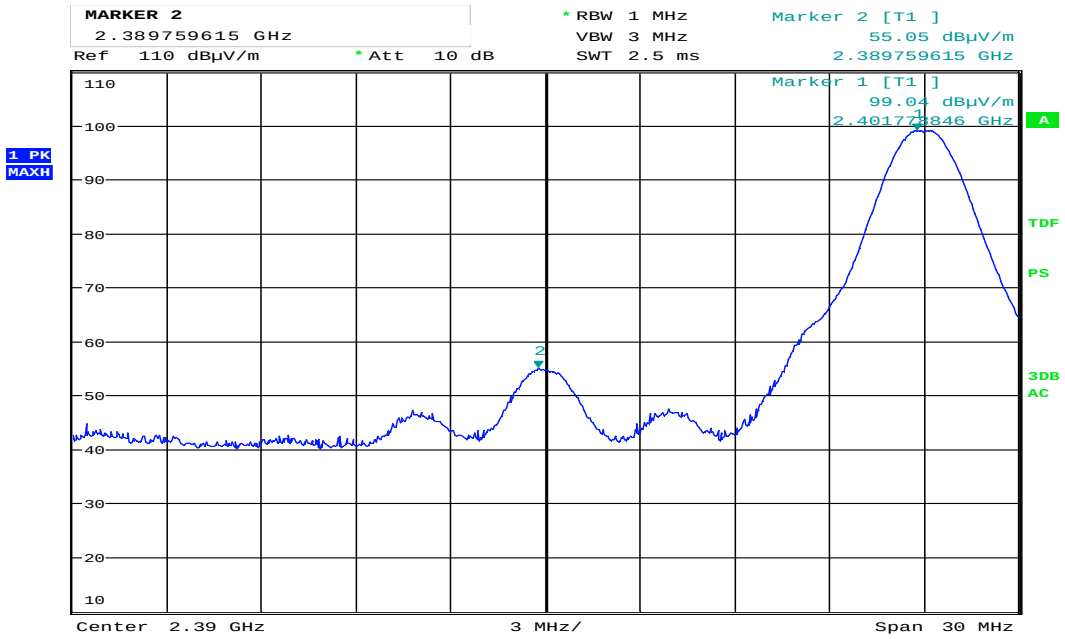
Date: 6.MAY.2020 09:16:40

Band Edge, 2402MHz, GFSK



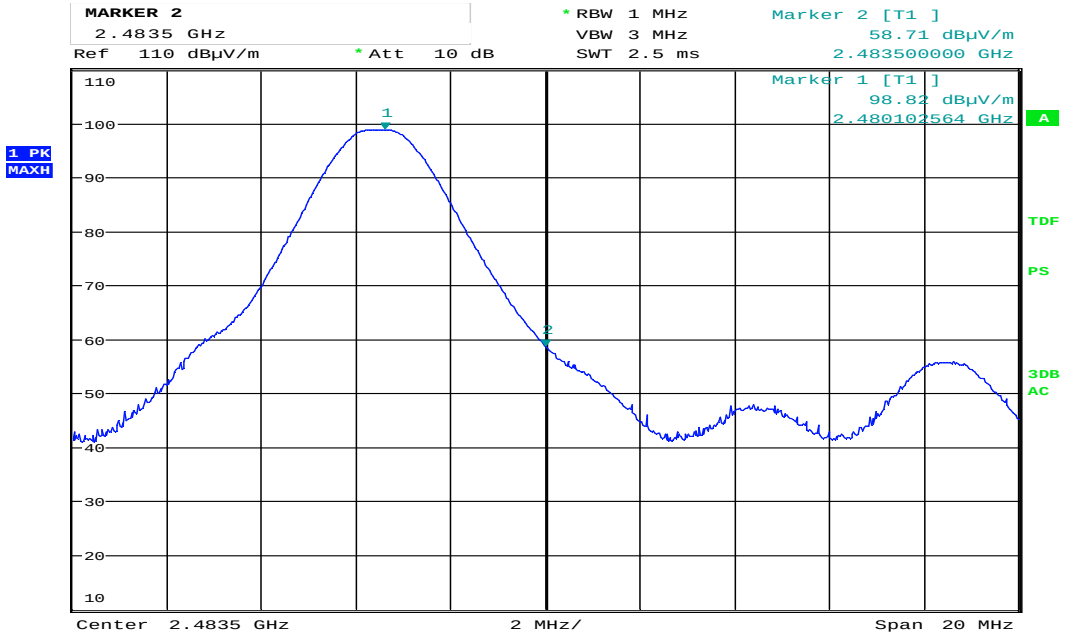
Date: 6.MAY.2020 09:13:55

Band Edge, 2480MHz, GFSK



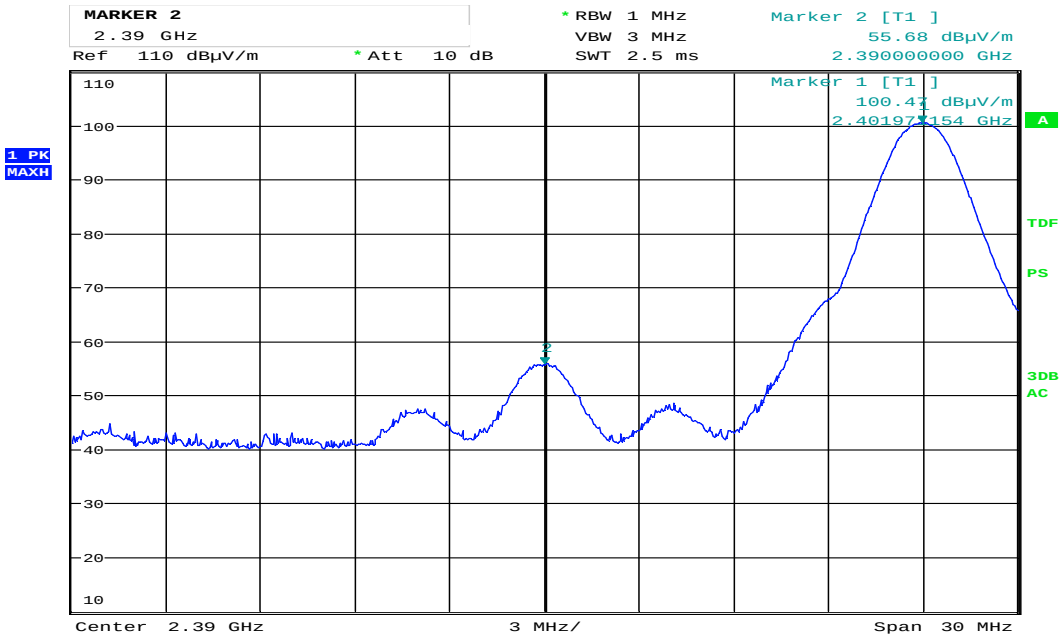
Date: 6.MAY.2020 09:37:06

Band Edge, 2402MHz, π/4-DQPSK



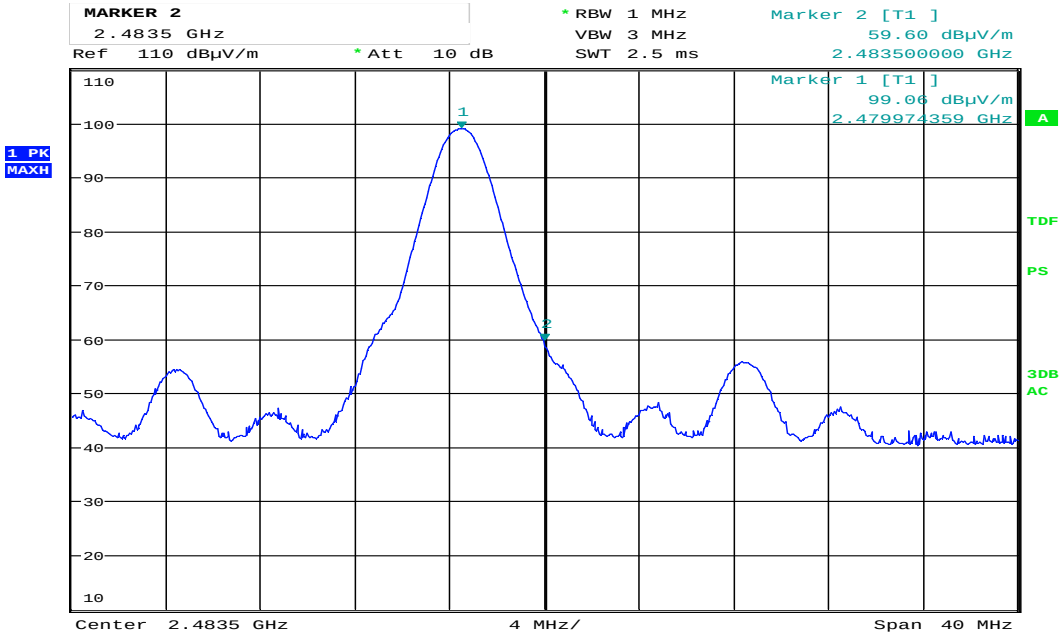
Date: 6.MAY.2020 09:32:10

Band Edge, 2480MHz, π/4-DQPSK



Date: 6.MAY.2020 09:39:33

Band Edge, 2402MHz, 8-DPSK



Date: 6.MAY.2020 09:29:03

Band Edge, 2480MHz, 8-DPSK

3.9 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 3m

Tested in hopping mode mode with GFSK modulation

Frequency (MHz)	Dist. corr. Factor (dB)	Field strength @3m QP Detector (dBµV/m)	Limit (dBµV/m)	Margin (dB)
155.999	0	35.4	43.5	8.1
158.000	0	25.7	43.5	17.8
159.997	0	32.9	43.5	10.6
359.997	0	45.8	46.0	0.2

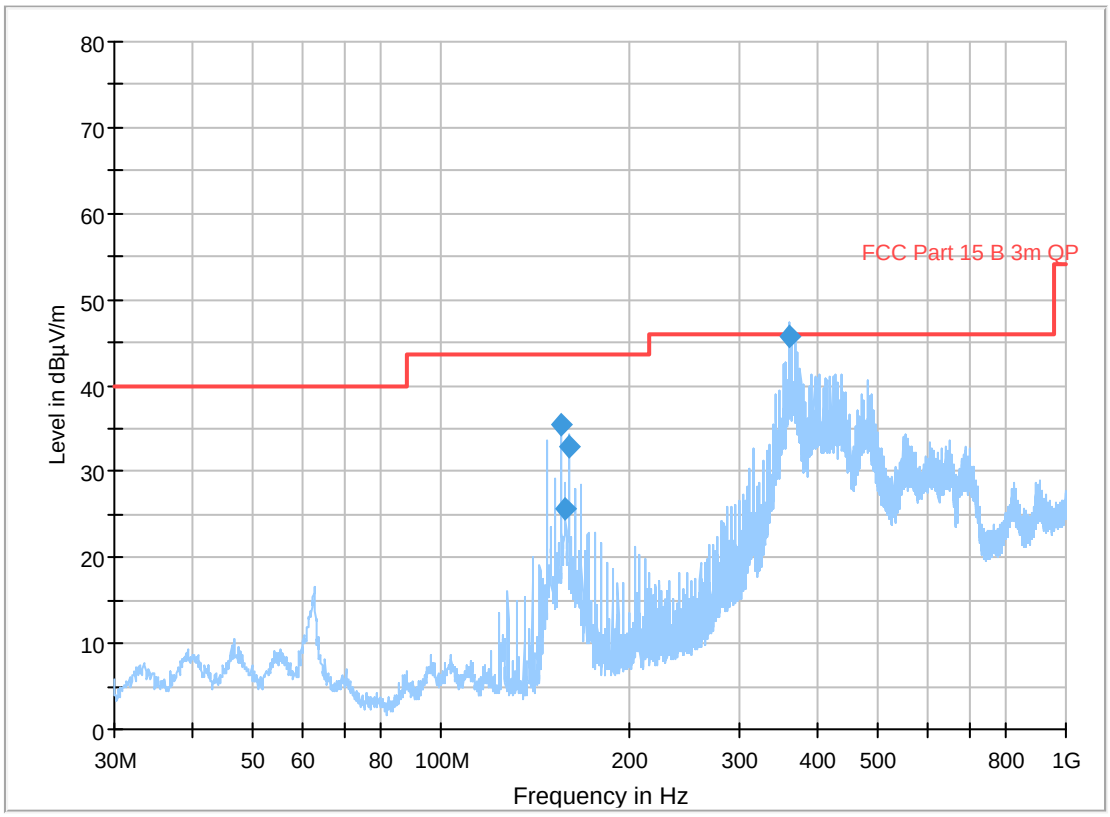
A low pass filter was used for measurements below 1 GHz

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	

Full Spectrum



Radiated Emissions, 30 -1000MHz, Hopping, GFSK

3.10 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)

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

Peak Detector:

Frequency (MHz)	RF channel (L/M/H)	Field strength, Peak Detector, @3m (dBµV/m)	Limit (dBµV/m)	Margin (dB)
4804	L	57.7	74	16.3
7206		53.0	74	21.0
4880	M	57.3	74	16.7
7320		53.9	74	20.1
4960	H	56.8	74	17.2
7440		52.9	74	21.1
Other freqs	L / M / H	None detected	74	>20

Average Detector:

Frequency (MHz)	RF channel (L/M/H)	Field strength, Average Detector, @3m (dBµV/m)	Duty cycle corr. Factor (dB)	Limit (dBµV/m)	Margin (dB)
4804	L	37.7	20	54	16.3
7206		33.0	20	54	21.0
4880	M	37.3	20	54	16.7
7320		33.9	20	54	20.1
4960	H	36.8	20	54	17.2
7440		32.9	20	54	21.1
Other freqs	L / M / H	None detected	20	54	>20

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

Average Value is not required when Peak Value is below Average Limit.

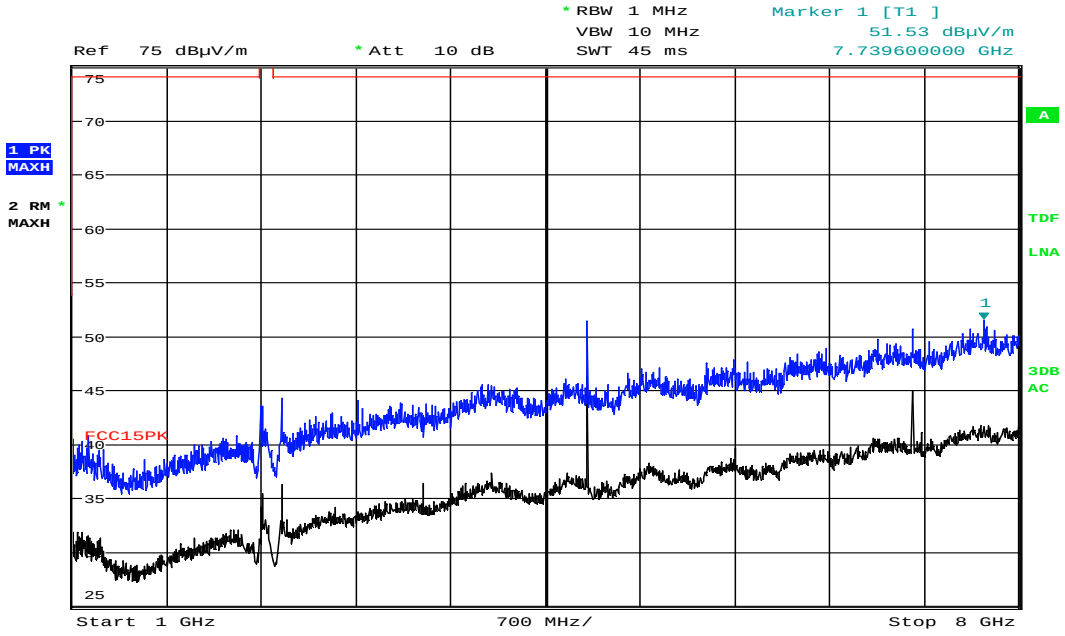
A Band Reject Filter was used for measurements from 1 GHz to 18 GHz.

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

See plots.

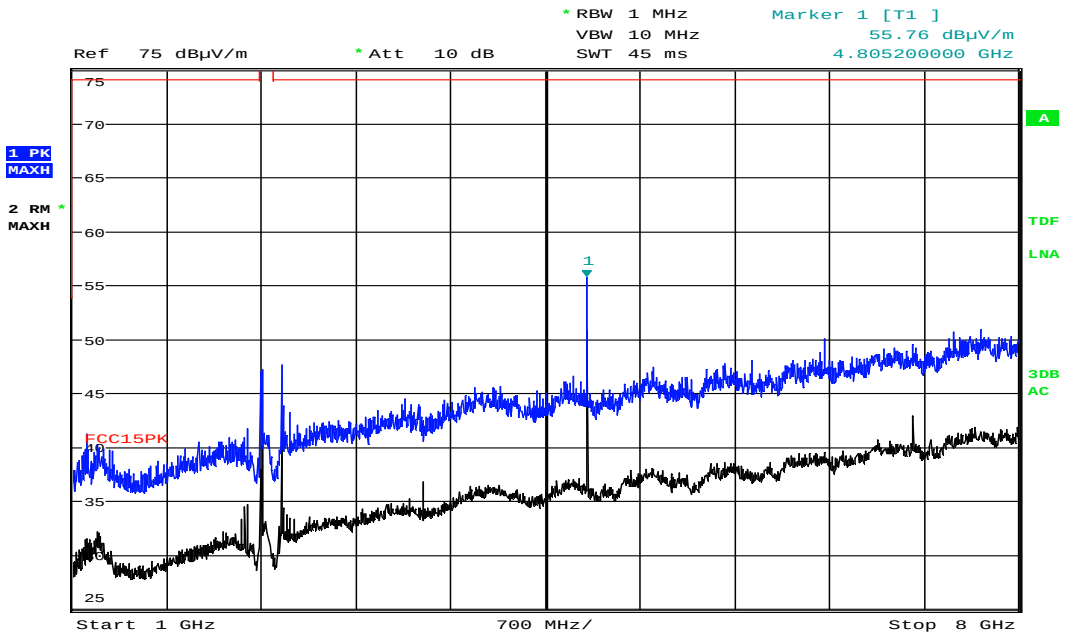
Requirements/Limit

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



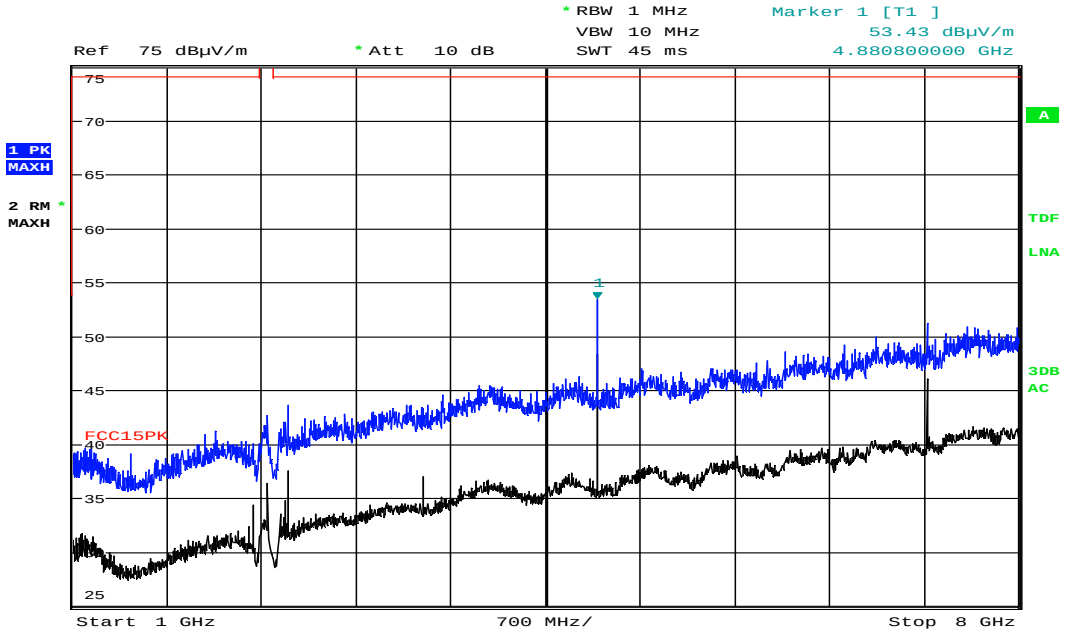
Date: 6.MAY.2020 10:17:03

Radiated Emissions, 1000 -8000MHz, 2402MHz, GFSK, HP



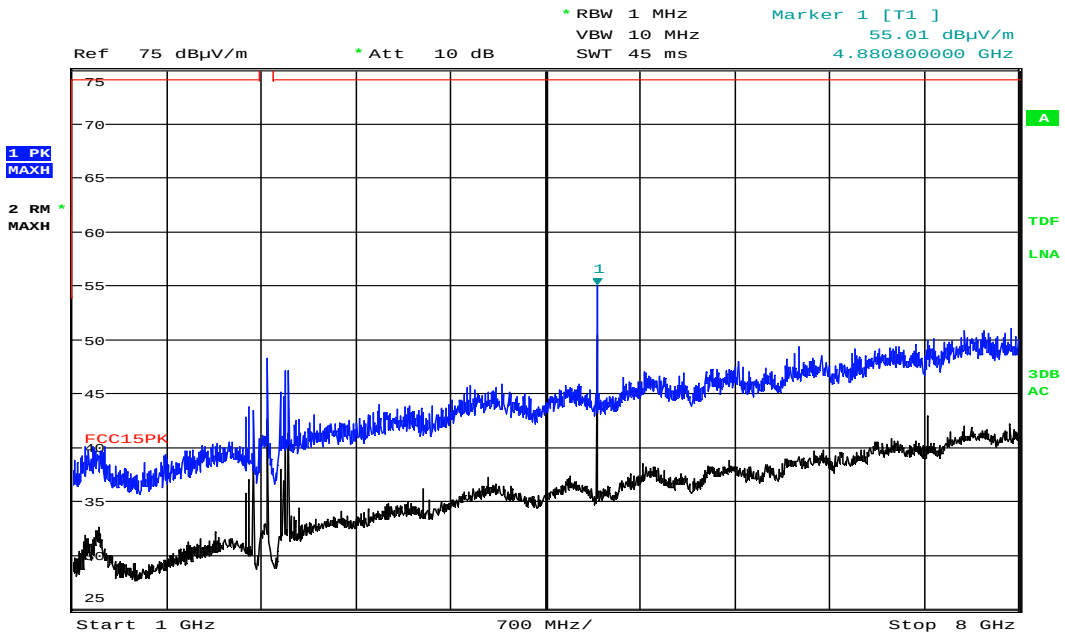
Date: 6.MAY.2020 10:15:07

Radiated Emissions, 1000 -8000MHz, 2402MHz, GFSK, VP



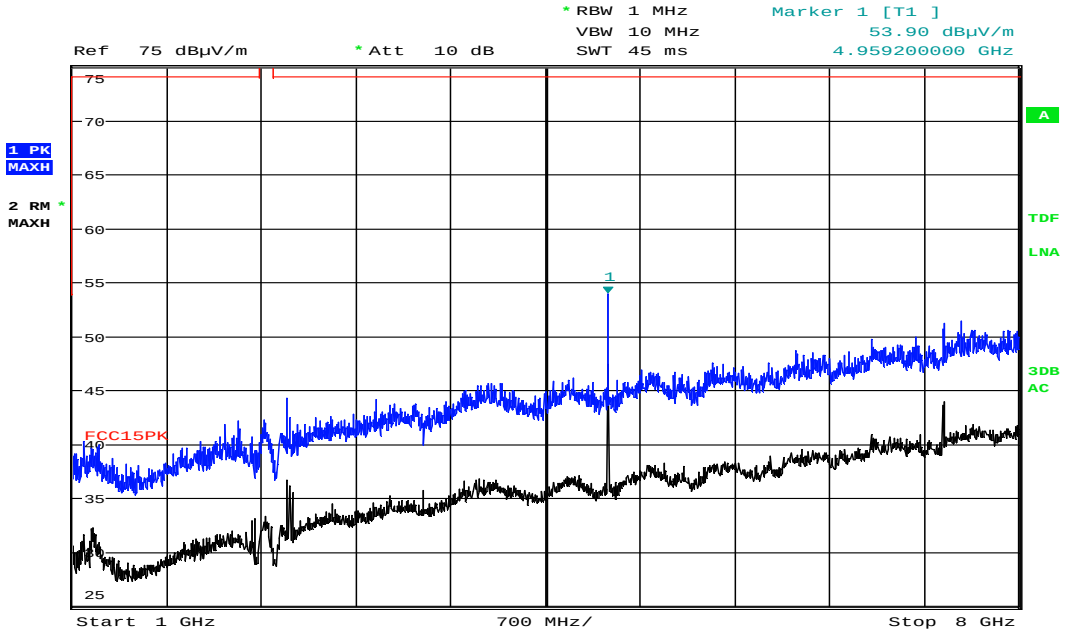
Date: 6.MAY.2020 09:50:02

Radiated Emissions, 1000 -8000MHz, 2440MHz, GFSK, HP



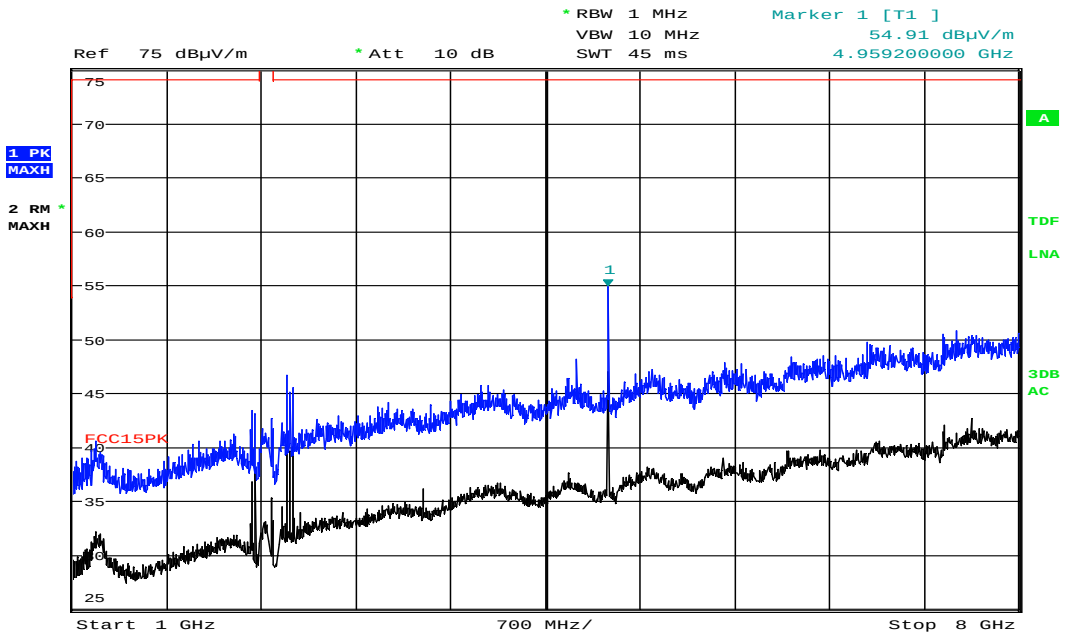
Date: 6.MAY.2020 09:48:05

Radiated Emissions, 1000 -8000MHz, 2440MHz, GFSK, VP



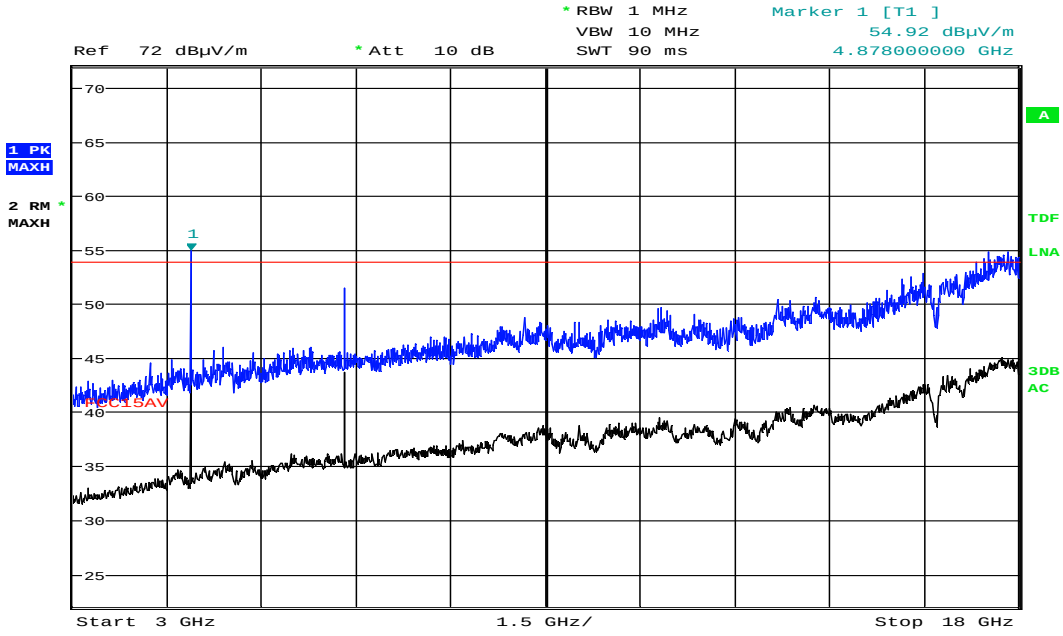
Date: 6.MAY.2020 10:47:10

Radiated Emissions, 1000 -8000MHz, 2480MHz, GFSK, HP



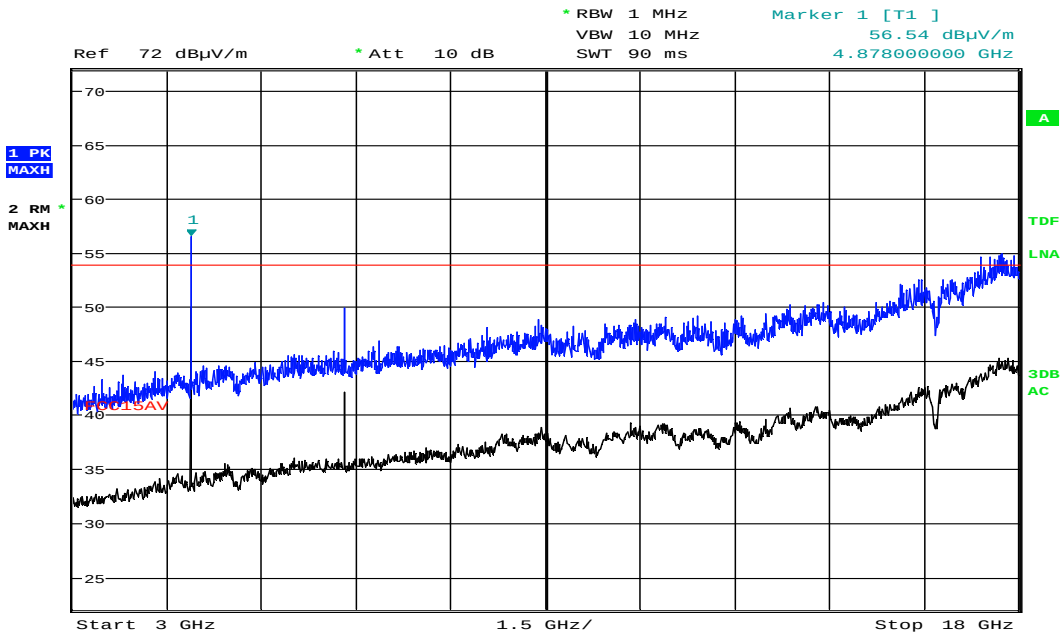
Date: 6.MAY.2020 10:45:14

Radiated Emissions, 1000 -8000MHz, 2480MHz, GFSK, VP



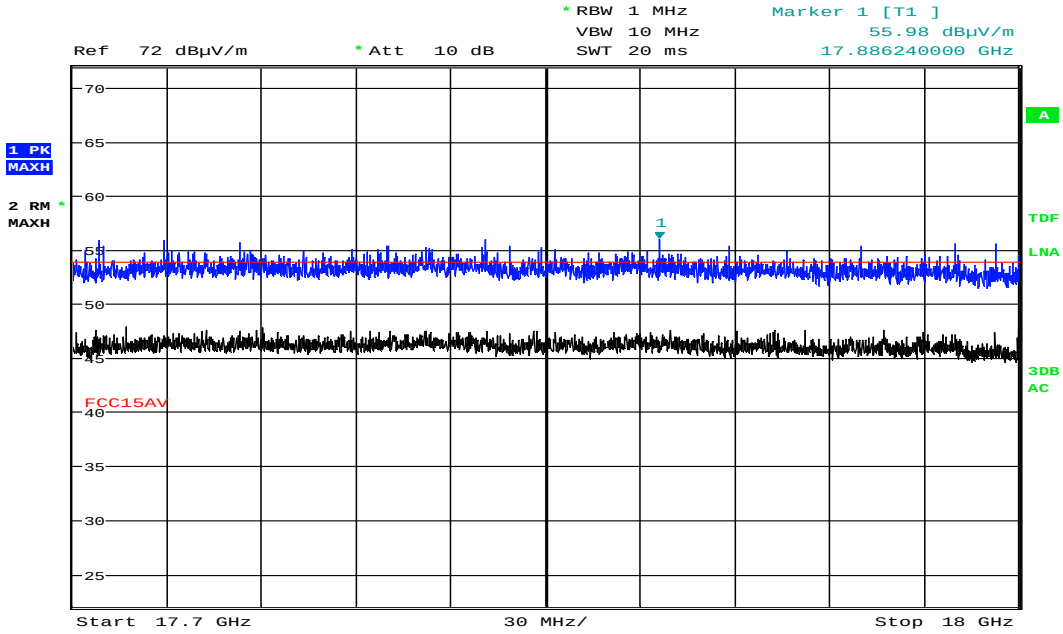
Date: 6.MAY.2020 11:49:10

Radiated Emissions, 3000 -18000MHz, 2440MHz, GFSK, HP



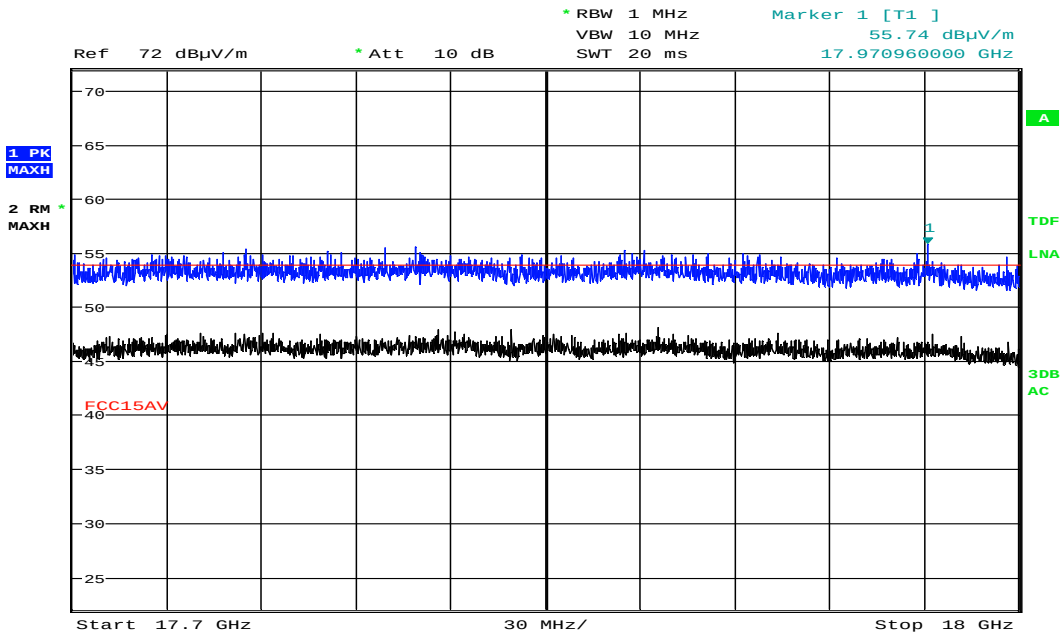
Date: 6.MAY.2020 11:47:14

Radiated Emissions, 3000 -18000MHz, 2440MHz, GFSK, VP



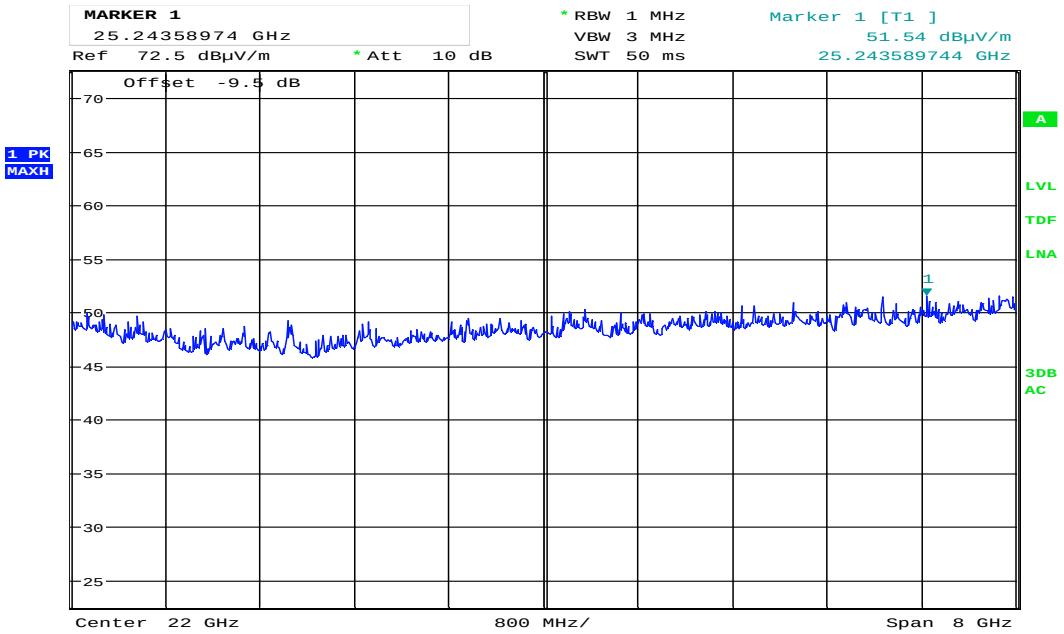
Date: 6.MAY.2020 12:33:10

Radiated Emissions, 17700 -18000MHz, 2440MHz, GFSK, HP

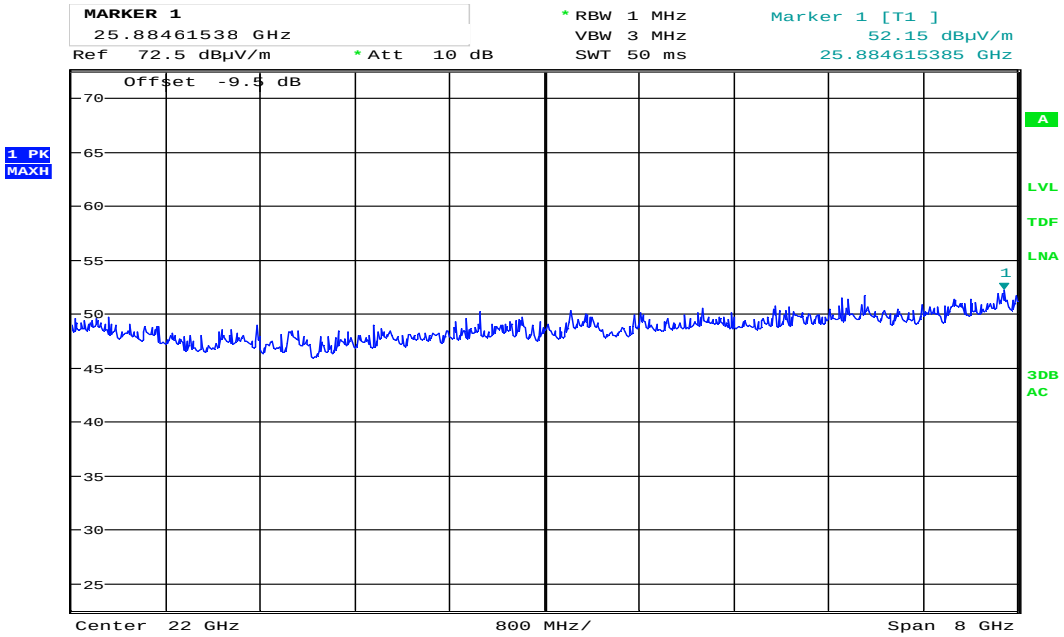


Date: 6.MAY.2020 12:31:13

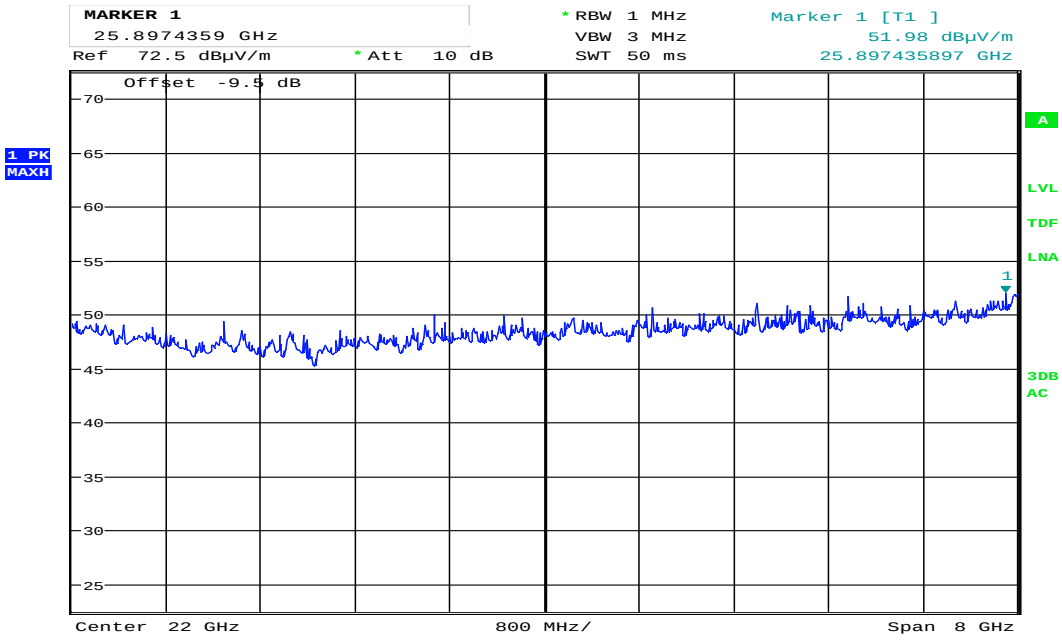
Radiated Emissions, 17700 -18000MHz, 2440MHz, GFSK, VP



Pre-scan, 18 -26 GHz, 2402MHz @1m

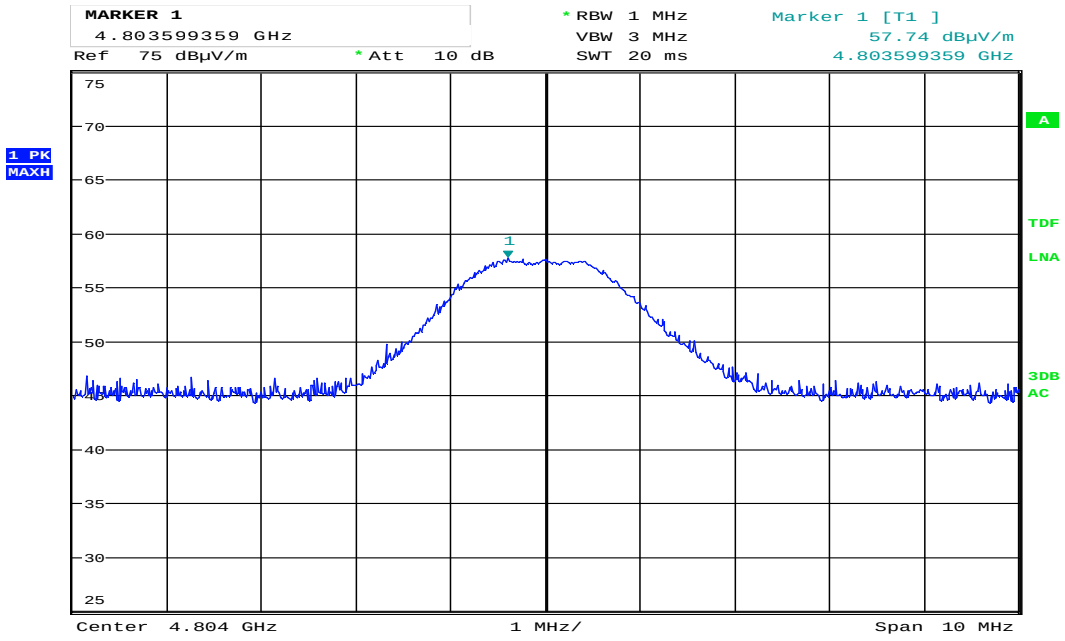


Pre-scan, 18 -26 GHz, 2440MHz @1m



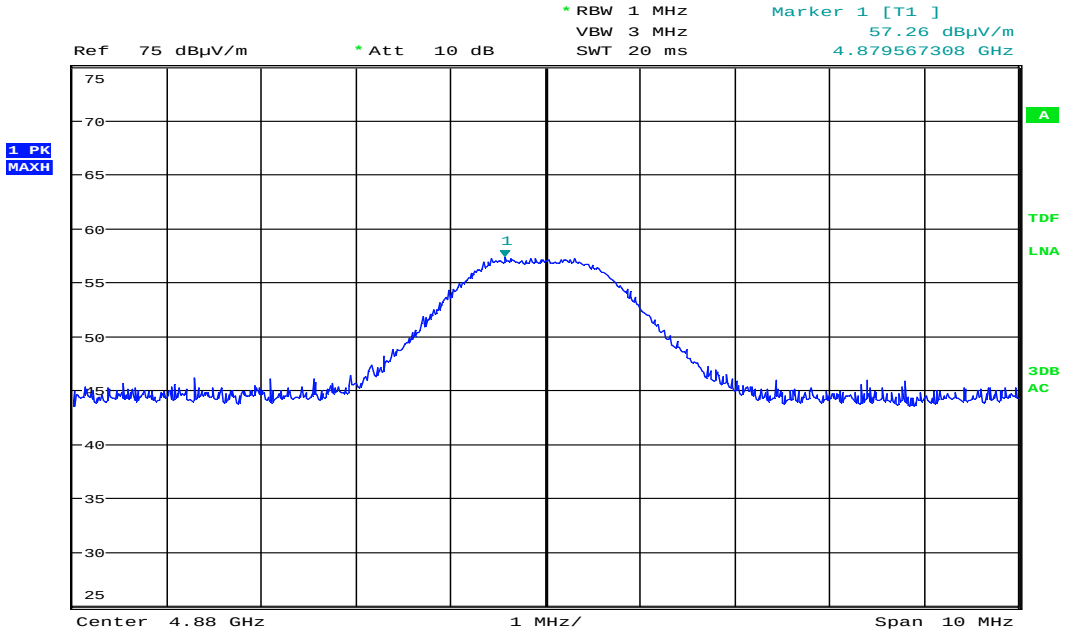
Date: 6.MAY.2020 13:32:27

Pre-scan, 18 -26 GHz, 2480MHz @1m



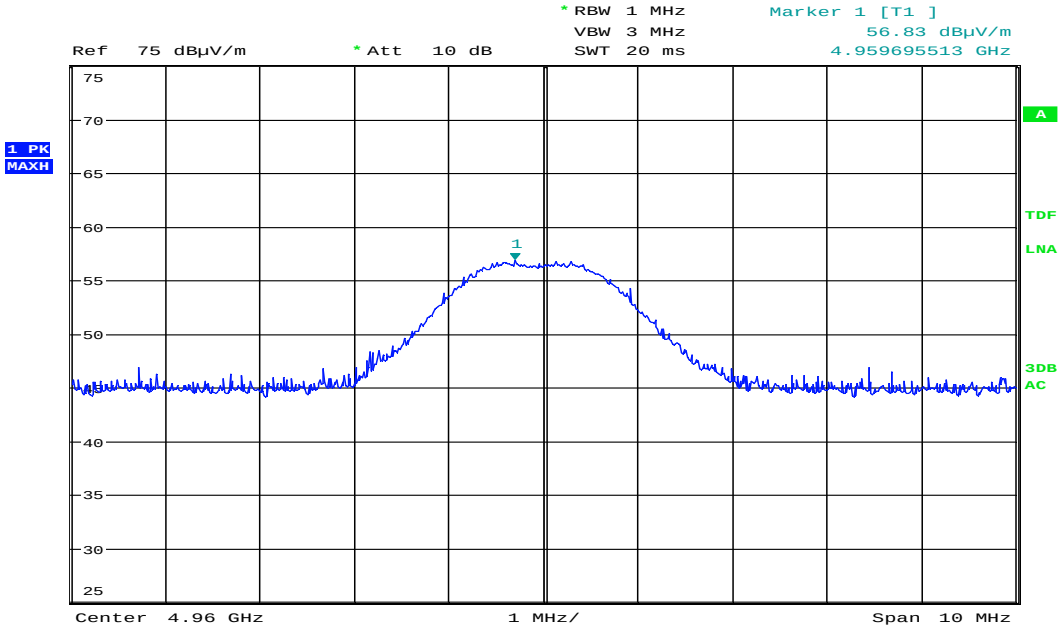
Date: 6.MAY.2020 10:34:05

Maximum Radiated Emissions, 4804MHz, 2402MHz, GFSK



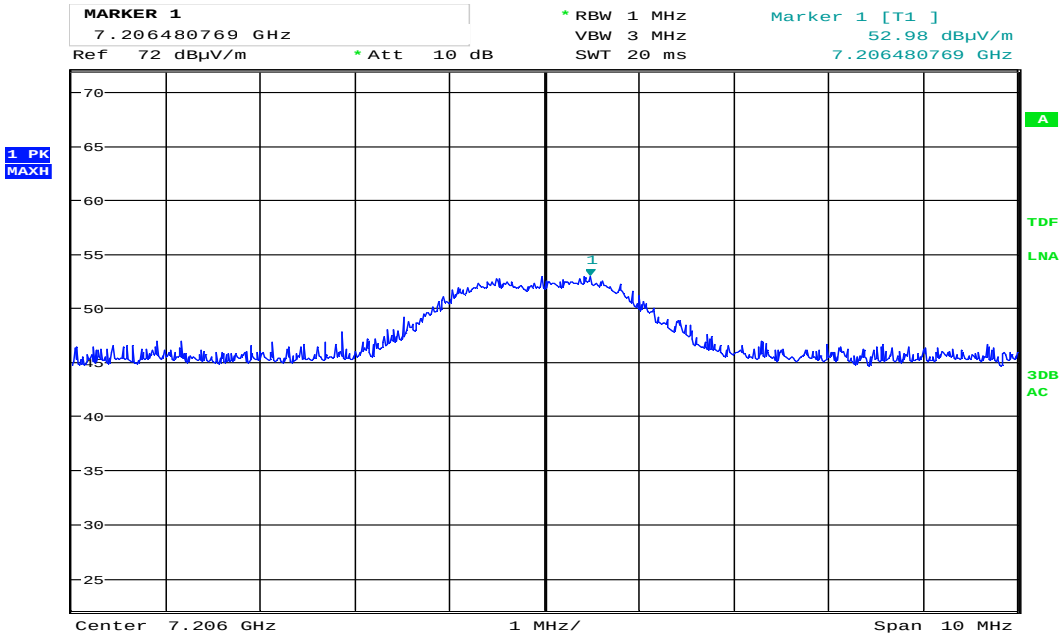
Date: 6.MAY.2020 10:05:49

Maximum Radiated Emissions, 4880MHz, 2440MHz, GFSK



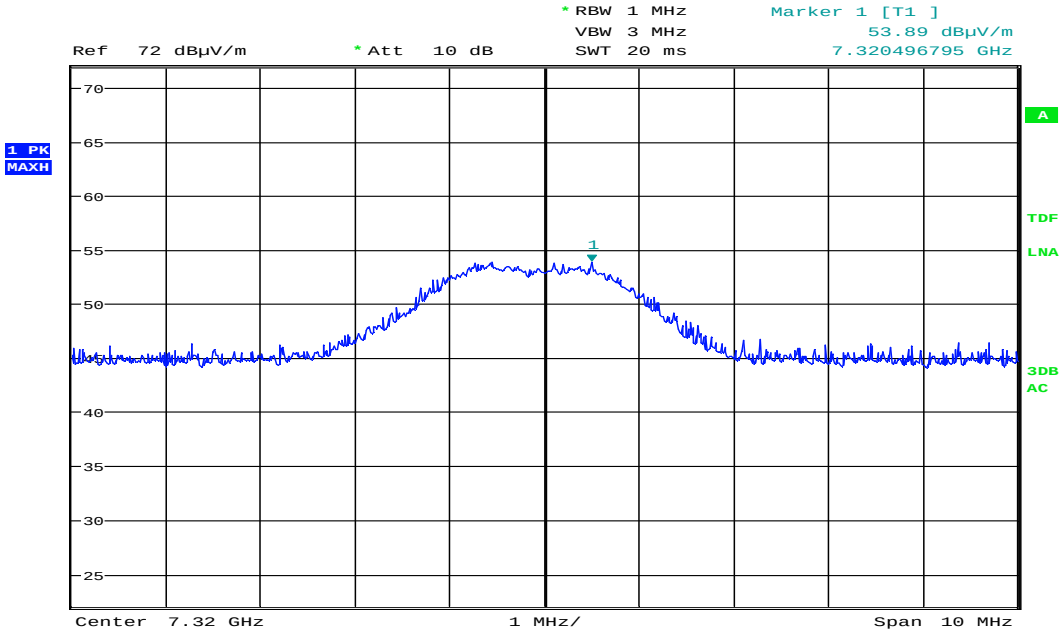
Date: 6.MAY.2020 11:09:04

Maximum Radiated Emissions, 4960MHz, 2480MHz, GFSK



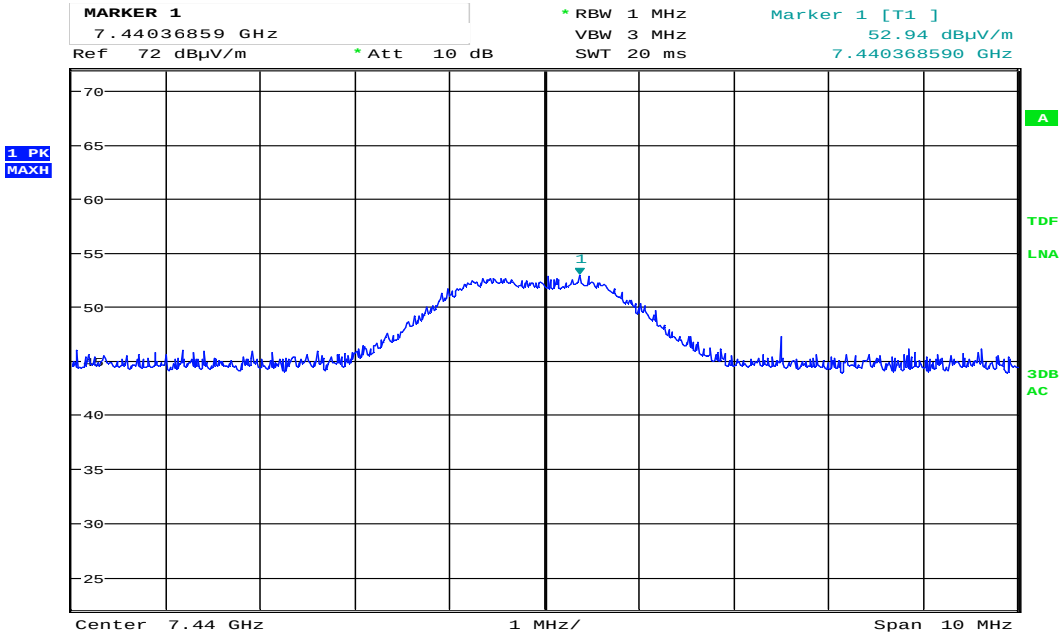
Date: 6.MAY.2020 12:13:42

Maximum Radiated Emissions, 7206MHz, 2402MHz, GFSK



Date: 6.MAY.2020 12:11:17

Maximum Radiated Emissions, 7320MHz, 2440MHz, GFSK



Date: 6.MAY.2020 12:18:31

Maximum Radiated Emissions, 7440MHz, 2480MHz, GFSK

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	FSW43	Spectrum Analyzer	Rohde & Schwarz	LR 1690	2020.01	2021.01
2	6810.17B	Attenuator	Suhner	LR 1669	2019-07	2020-07
3	NO324415	Band Reject Filter	Microwave Circuits	LR 1760	COU	
4	WLK5-1100-1485-7000-40SS	LowPass Filter	Wainwright Inst.	LR 1761	COU	
5	VULB 9163	BiLog Antenna	Schwarzbech	LR 1616	2020-01	2023-01
6	Model 310	PreAmplifier	Sonoma	LR 1686	2019-07	2020-07
7	3117-PA	Horn Antenna with PreAmp	EMCO	LR 1717	2017-12	2020-12
8	3115	Horn Antenna	EMCO	LR 1330	2016-10	2021-10
9	8449A	Pre-amplifier	Hewlett Packard	LR 1322	2019-07	2020-07
10	638	Antenna Horn	Narda	LR 1480	2010-06	2020-06
11	ST 8/SMAm/Nm/36	RF Cable	Suhner	LR 1630	COU	

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

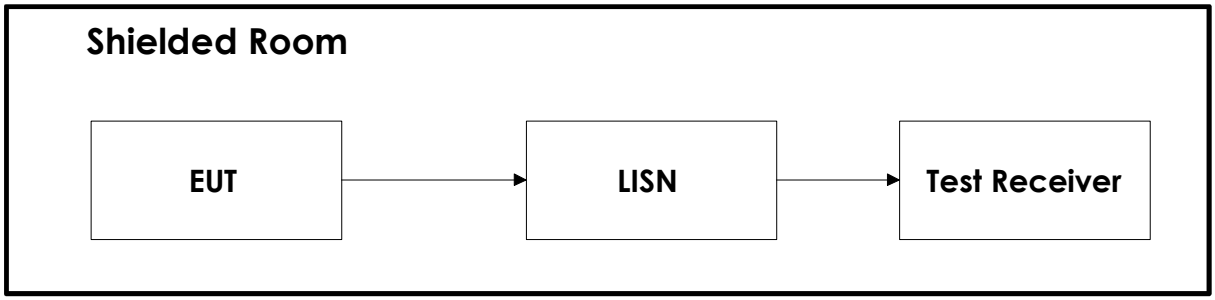
No.	Manufacturer	Name	Version	Comment
1	Rohde & Schwarz	EMC32	10.50.40	Conducted Emissions test software
2	Rohde & Schwarz	EMC32	10.50.40	Radiated Emissions test software
3	Rohde & Schwarz	GPIBShot	2.7	Screenshots from R&S Spectrum Analyzers

Revision history

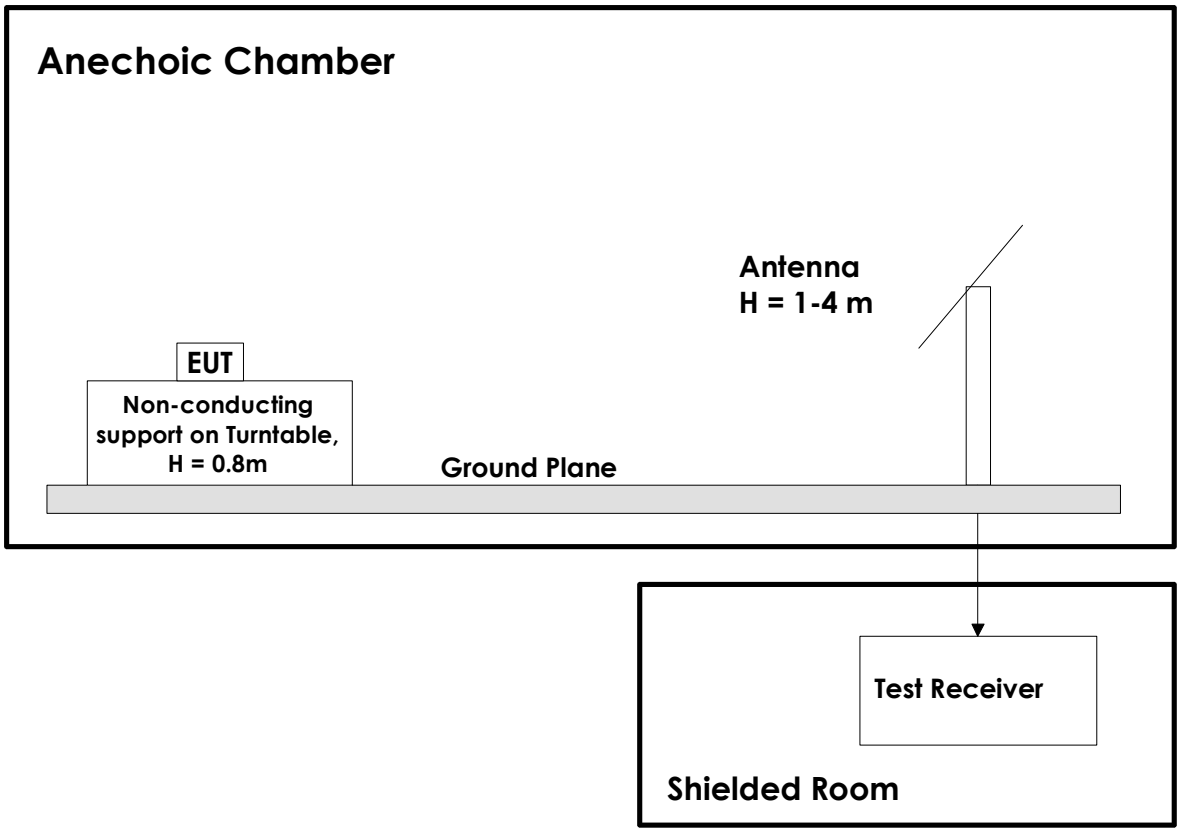
Revision	Date	Comment	Sign
00	2020-06-14	First edition	FS
01	2020-06-24	Updated Configuration Description	FS

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.