

Test Report

Product	Transceiver Module
Name and address of the applicant	Scanreco AB Stensättravägen 13, SE-127 39 Skärholmen Box 90304, SE-120 25 Stockholm, SWEDEN
Name and address of the manufacturer	Scanreco AB Stensättravägen 13, SE-127 39 Skärholmen Box 90304, SE-120 25 Stockholm, SWEDEN
Model	TR06-001
Rating	3.4Vdc and 4.0Vdc, Battery
Trademark	Scanreco
Serial number	See page 3
Additional information	2.4GHz, FHSS, Radio Module
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	400635
Tested in period	2020.06.24 – 2020.09.08
Issue date	2021.01.18
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   NORWEGIAN ACCREDITATION TEST 033 An accredited technical test executed under the Norwegian accreditation scheme
 Prepared by [G.Suhanthakumar]  Approved by [Frode Sveinsen]	
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1 INFORMATION

1.1 Test Item

Name	Transceiver Module
FCC ID	N5OTR061
ISED ID	6476A-TR061
Model/version	TR06-001
Serial number	Marked as "FHSS"
Hardware identity and/or version	102112
Software identity and/or version	G6COMM_PROD
Frequency Range	2405 - 2480 MHz
Channel Separation	5 MHz
Number of Channels	16
Operating Modes	TX/RX
Type of Modulation	O-QPSK
User Frequency Adjustment	None
Rated Output Power	116.95mW
Type of Power Supply	Battery, 3.4Vdc and 4Vdc
Antenna Connector	Yes, RP-SMA for external antennas (for both TX and RX)
Number of Antennas	2 (one TX and one for RX) 1 at a time (either Monopole antenna or dipole antenna) The two antennas are never used simultaneously.
Diversity or Smart Antennas	Yes, Diversity
Desktop Charger	N/A

Tested with Dipole antenna type S151AH-2450 and monopole antenna type M70XCR

Description of Test Item

2.4GHz band transceiver module

1.2 Normal test condition

Temperature:	20 - 24 °C
Relative humidity:	20 - 50 %
Normal test voltage:	3.4 Vdc and 4Vdc

The values are the limit registered during the test period.

1.3 Test Engineer(s)

G.Suwanthakumar

1.4 Model Variants

The same printed circuit board is used for the different radio module models. Different frequencies (f. ex. 915Mhz and 2.4GHz) can not be transmitted simultaneously, only one at a time.

Model/type	Comment	Tested
TR06 004	Components belonging to the 2.4GHz, 915MHz and additional sub-GHz radio parts are assembled on the board.	☒
TR06 001	Components belonging just to the 2.4GHz radio part are assembled on the board.	☐
TR06 002	Components belonging to the 2.4GHz and 915MHz parts are assembled on the board.	☐

1.5 Antenna Requirement

Is the antenna detachable?

☒ Yes ☐ No

If detachable, is the antenna connector non-standard?

☒ Yes ☐ No

Type of antenna connector: RP-SMA

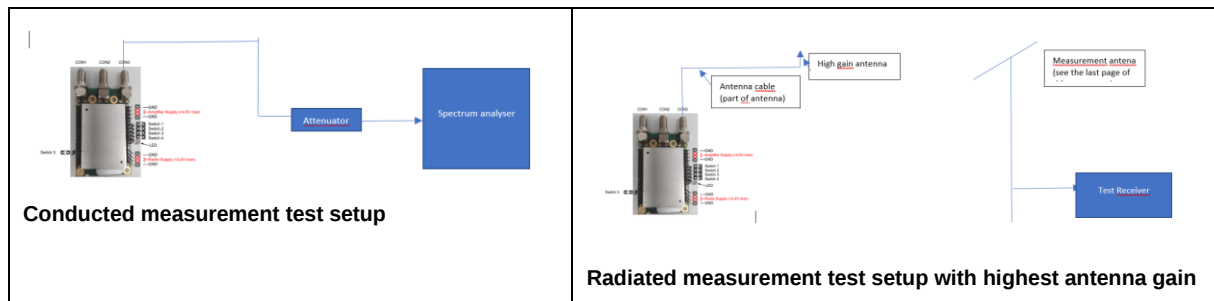
Ref. FCC §15.203

1.6 Worst-Case Configuration and Mode

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

Channel no.	Frequency (MHz)	Modulation	SW Name	Power setting (dBm)
1	2405	O-QPSK	G6COMM_TEST	21
8	2440	O-QPSK	G6COMM_TEST	21
16	2480	O-QPSK	G6COMM_TEST	21

Output power was set and pre-determined in the SW and adjusted by moving the jumpers. It is described document "TR06 Output power adjusting."



1.7 Comments

All measurements were done with the EUT powered with external dc power supply instead of battery.

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 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 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".

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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	N/A ¹
Antenna Requirement	15.203	6.8 (RSS-GEN)	5.8	Complies ²
Power Line Conducted Emission	15.107(a) 15.207(a)	7.2 / 8.8 (RSS-GEN)	6.2	N/A ¹
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 (20dB BW)	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	
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 11.12, 11.13 (DTS)	Complies

¹ The tested equipment operates only with battery.

² External antenna with RP-SMA connector

3 TEST RESULTS

3.1 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:

Channel Separation:	5 MHz
20 dB Bandwidth of hopping channel:	2.81 MHz
Nominal value for Channel Separation	5 MHz

Channel bandwidth for 4 channels is 20.07MHz,

Channel separation is $20.07\text{MHz}/4 = 5\text{MHz}$

RF channel has no influence on 20 dB bandwidth.

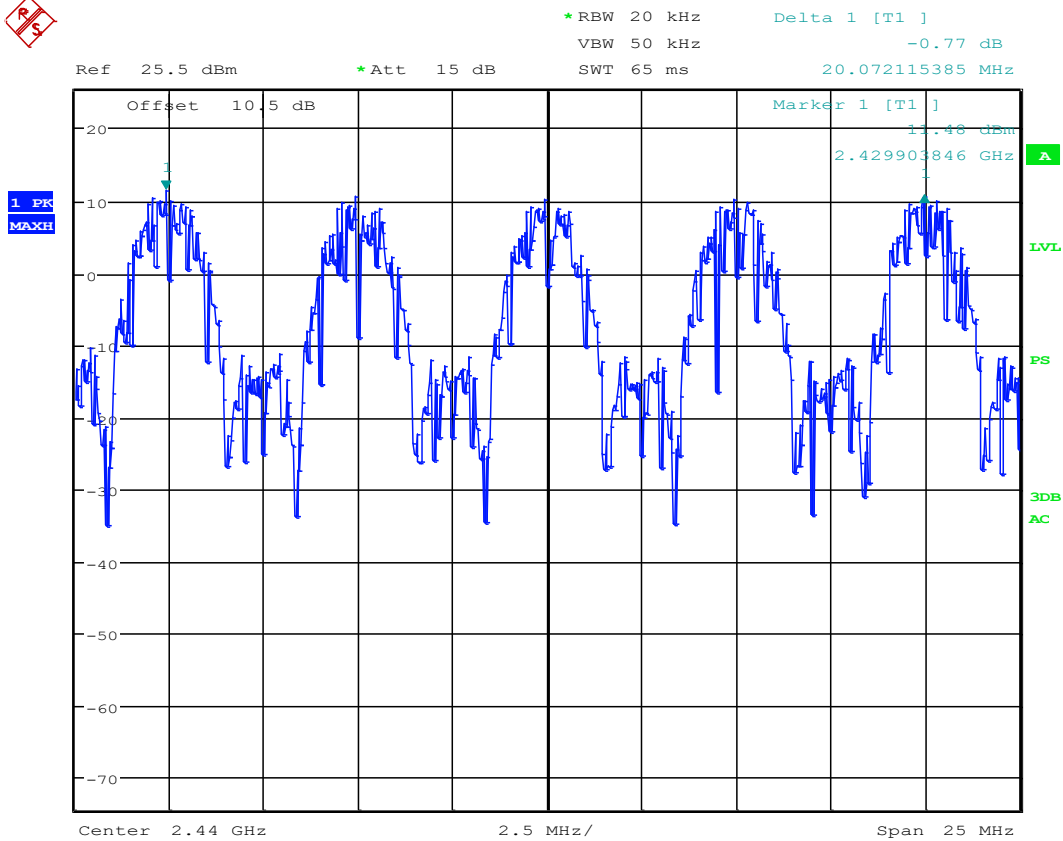
See attached plots

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.

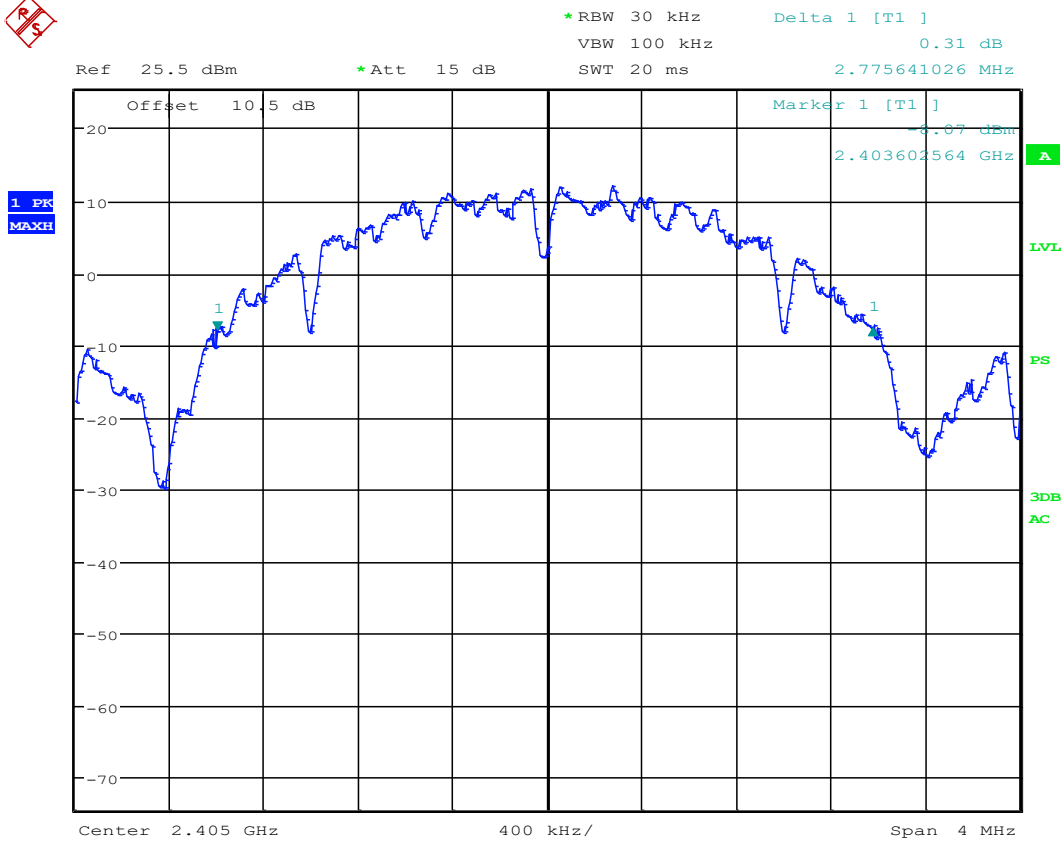
or:

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.



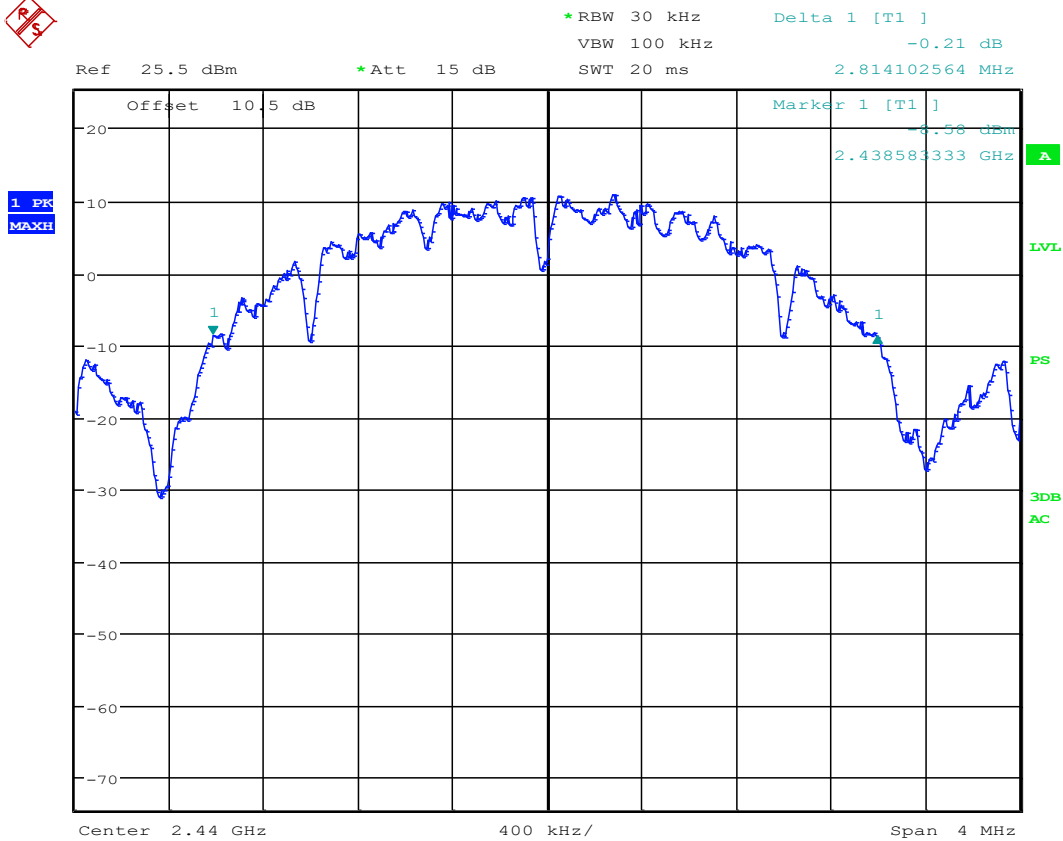
Date: 13.AUG.2020 13:14:10

Channel Separation



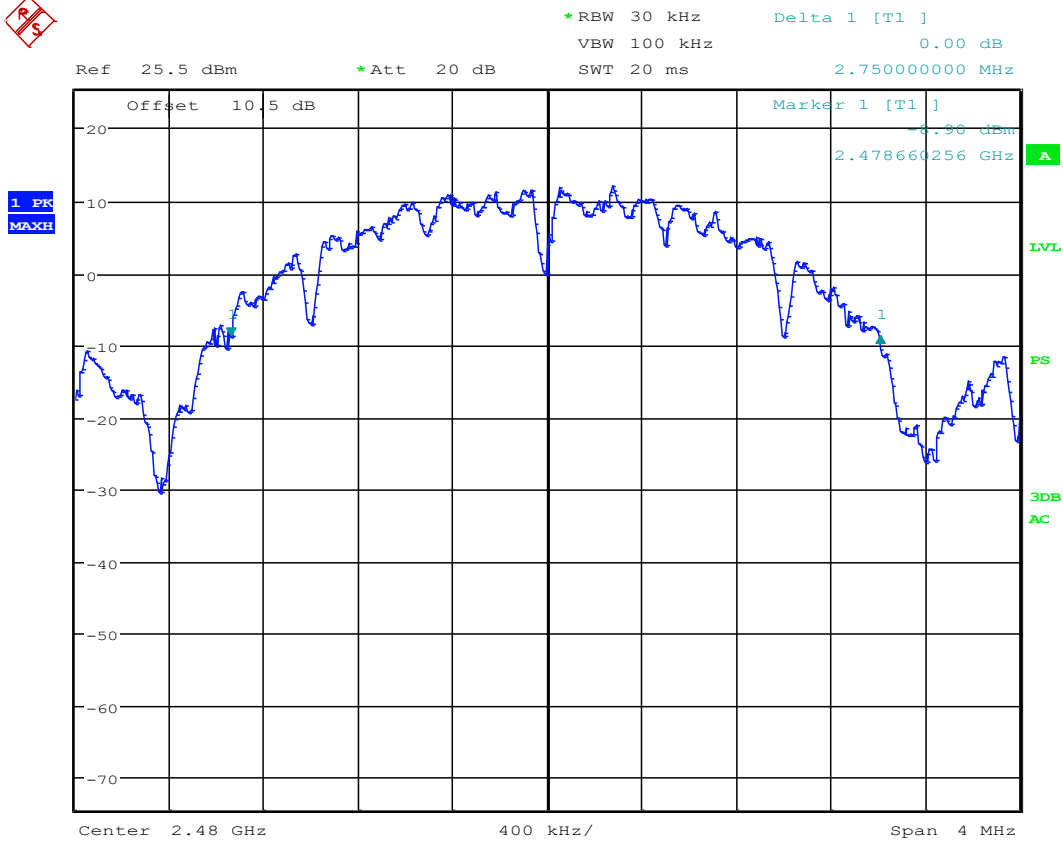
Date: 13.AUG.2020 13:03:18

20dB Bandwidth, ch2405 MHz



Date: 13.AUG.2020 13:07:40

20dB Bandwidth, ch2440 MHz



Date: 13.AUG.2020 12:50:20

20dB Bandwidth, ch2480 MHz

3.2 Pseudorandom Hopping Algorithm

FCC Part 15.247 (a)(1)

ISED Canada RSS-247 Issue 2, Clause 5.1

Test Results: Complies

Measurement Data: /

Requirements:

The channel frequencies shall be selected from a pseudorandom ordered list of hopping frequencies. Each frequency must be used equally by the transmitter.

No requirements for Digital Transmission Systems.

Base Table Hopping Sequence

The hopping sequence is described in the document: "Scanreco Frequency Hopping Algorithm"..

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:

	Ch 2405MHz	Ch 2440MHz	Ch 2480MHz
Number of RF Channels:	16	16	16
Maximum Length of RF Burst pr. channel	2.27 ms	2.27 ms	2.27 ms
Time between RF Burst on same RF Channel	0.801 s	0.801 s	0.801 s
Time of Occupancy	0.018 s	0.018 s	0.018 s

Ch2405MHz; Time of occupancy: $(0.00227 \times 0.4 \times 16) / 0.801 = 0.018s$

Ch2440MHz; Time of occupancy: $(0.00227 \times 0.4 \times 16) / 0.801 = 0.018s$

Ch2480MHz; Time of occupancy: $(0.00227 \times 0.4 \times 16) / 0.801 = 0.018s$

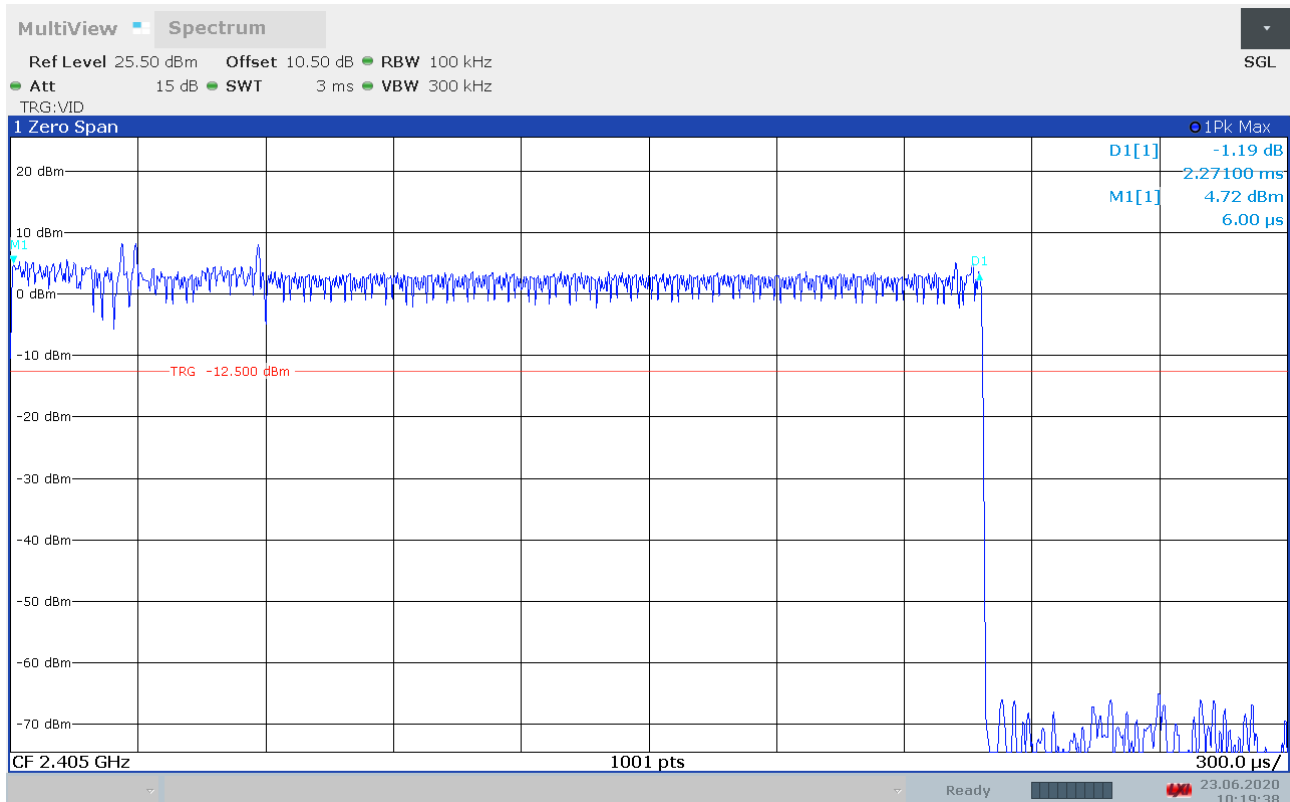
Number of RF channels maximum 16

See attached plots

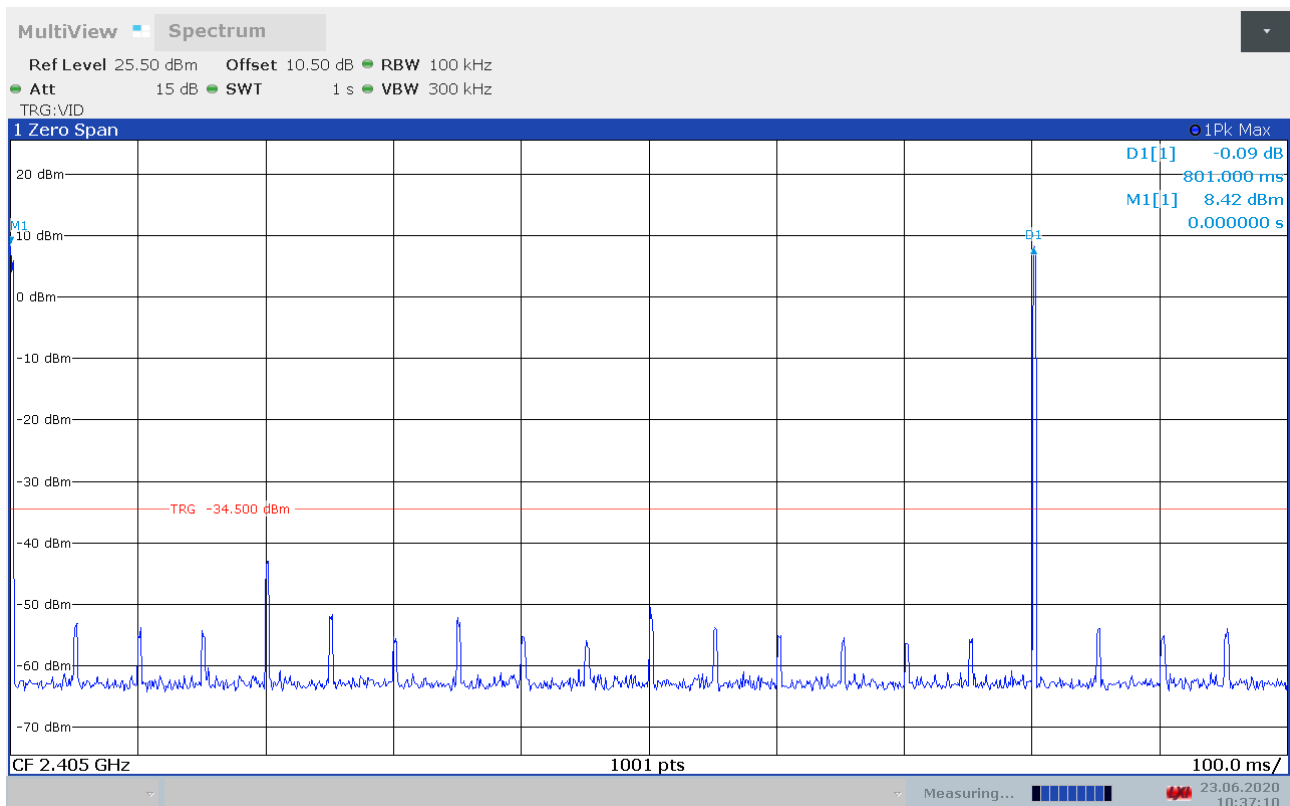
Requirements:

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



Dwell Time

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:	16
Channel Centre Frequencies:	2405 - 2480 MHz
99% BW Measured on Centre Channel (2440 MHz)	2.47 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 requirements for Digital Transmission Systems.

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





MARKER 1

2.405275641 GHz

*RBW 30 kHz

VBW 100 kHz

SWT 20 ms

Marker 1 [T1]

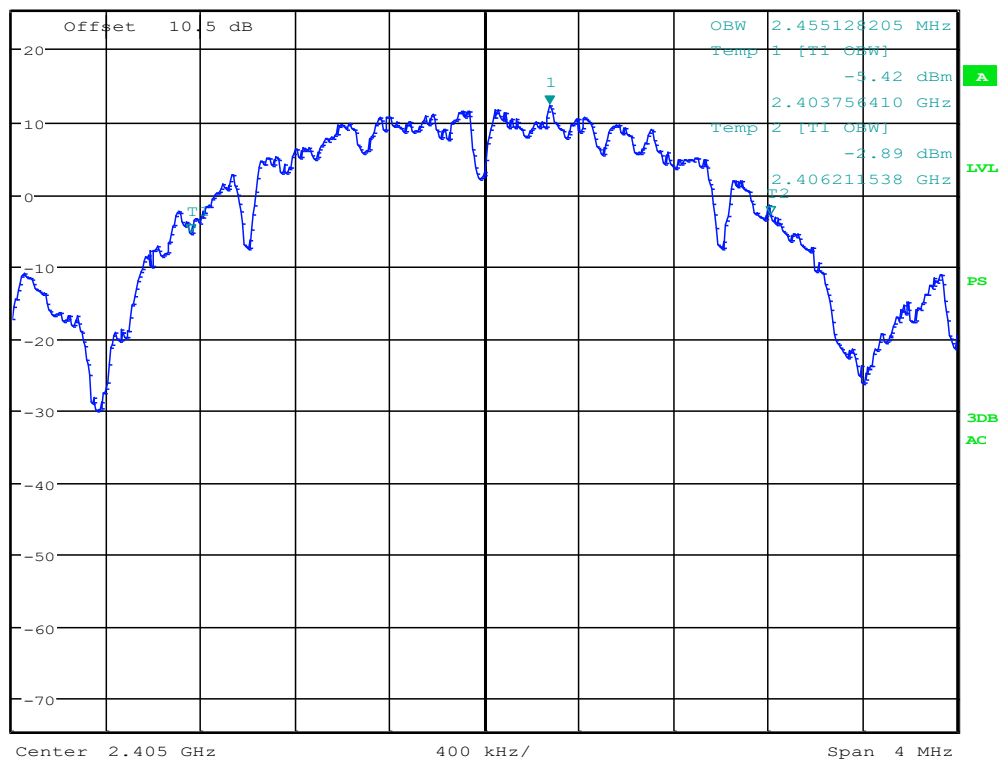
12.29 dBm

2.405275641 GHz

Ref 25.5 dBm

*Att 15 dB

1 PK
MAXH



Date: 13.AUG.2020 13:04:39

99% Bandwidth, ch2405MHz



MARKER 1

2.439897436 GHz

Ref 25.5 dBm

*Att 15 dB

*RBW 30 kHz

VBW 100 kHz

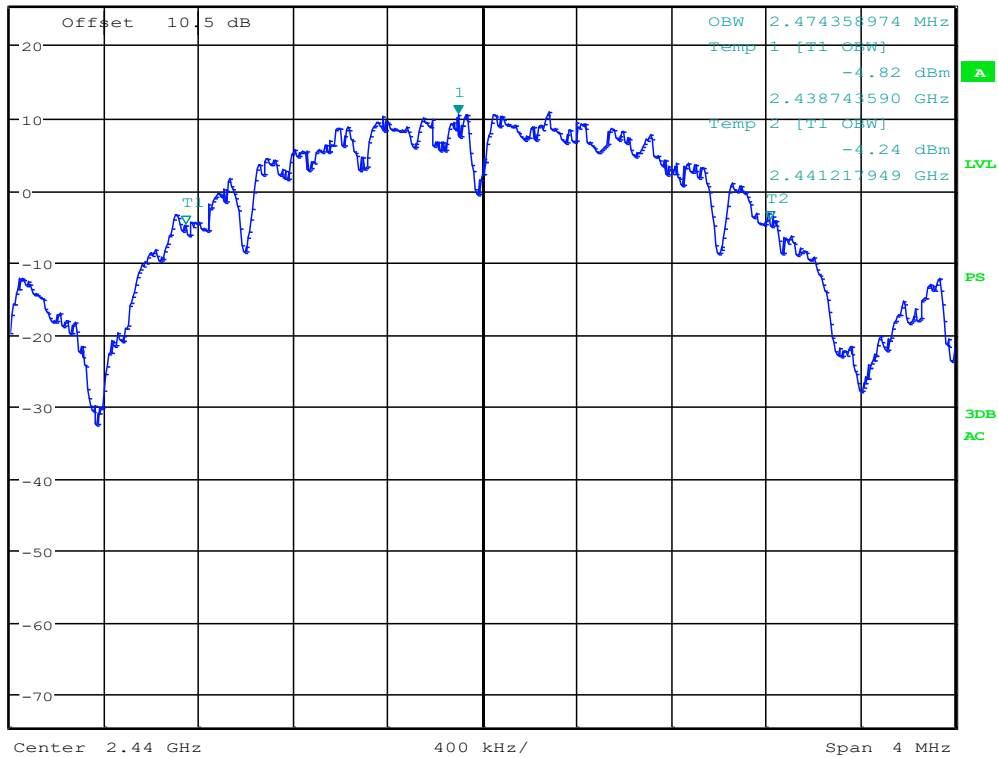
SWT 20 ms

Marker 1 [T1]

10.51 dBm

2.439897436 GHz

1 PK
MAXH



Date: 13.AUG.2020 13:06:24

99% Bandwidth, ch2440MHz



MARKER 1

2.480275641 GHz

Ref 25.5 dBm

*Att 20 dB

*RBW 30 kHz

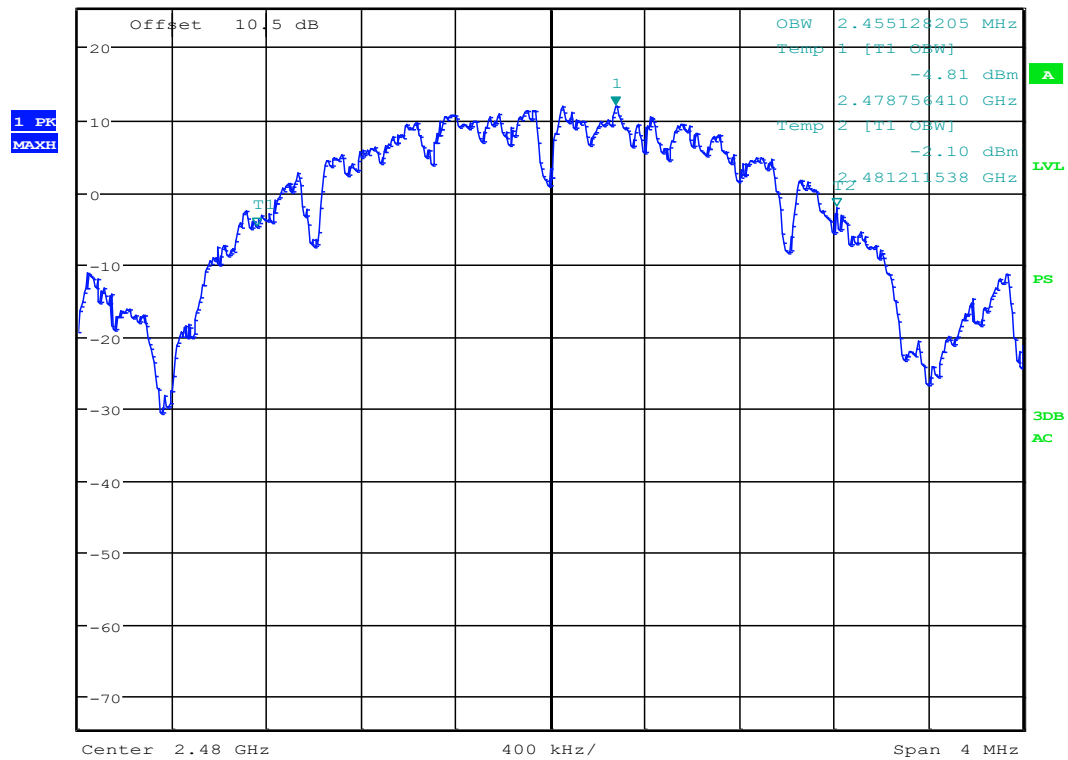
VBW 100 kHz

SWT 20 ms

Marker 1 [T1]

12.02 dBm

2.480275641 GHz



Date: 13.AUG.2020 12:48:18

99% Bandwidth, ch2480MHz

3.6 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:

	2405 MHz	2440 MHz	2480 MHz
Conducted Power (dBm)	20.11	18.64	20.68
Conducted Power (mWatts)	102.57	73.11	116.95
Monopole antenna: Field Strength (dBμV/m), VP	114.0	113.6	115.4
Monopole antenna EIRP, Calculated (mW)	76.4	68.9	115.2
Monopole antenna: Antenna gain (dBi)	-1.3	-0.3	-0.5
Dipole antenna: Field Strength (dBμV/m), VP	112.3	117.9	117.9
Dipole antenna EIRP, Calculated (mW)	50.7	187.9	187.9
Dipole antenna: Antenna gain (dBi)	-3.1	4.1	2.1

Output Power reported is Maximum Peak Power.

The Integrated Band Power Method was used to measure Output Power

Radiated Power was calculated from measured Field Strength using the method described in ANSI C63.10-2013 Eq. 39.

Antenna Gain is less than 6 dBi.

See attached plots.

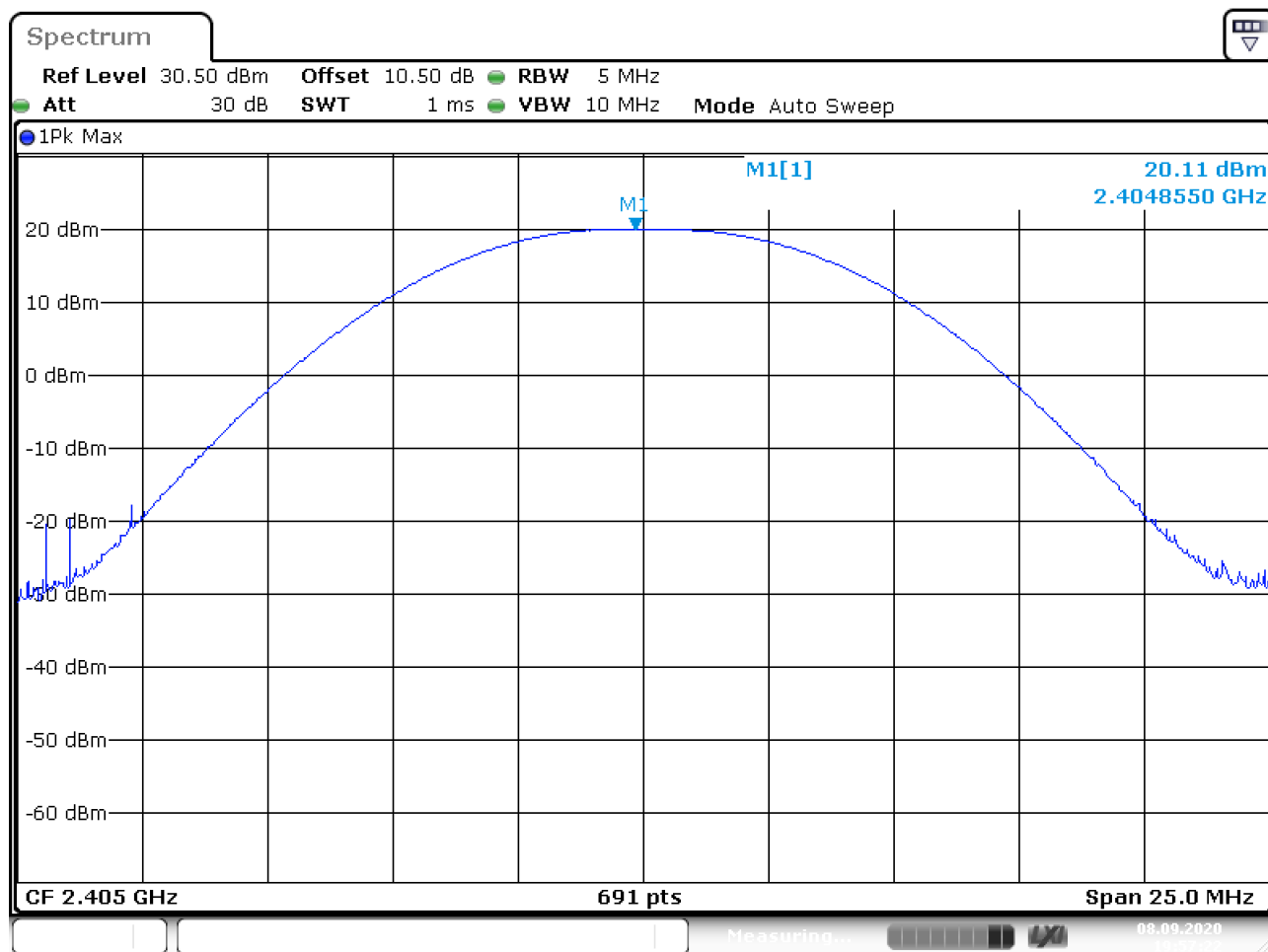
Requirements:

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

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

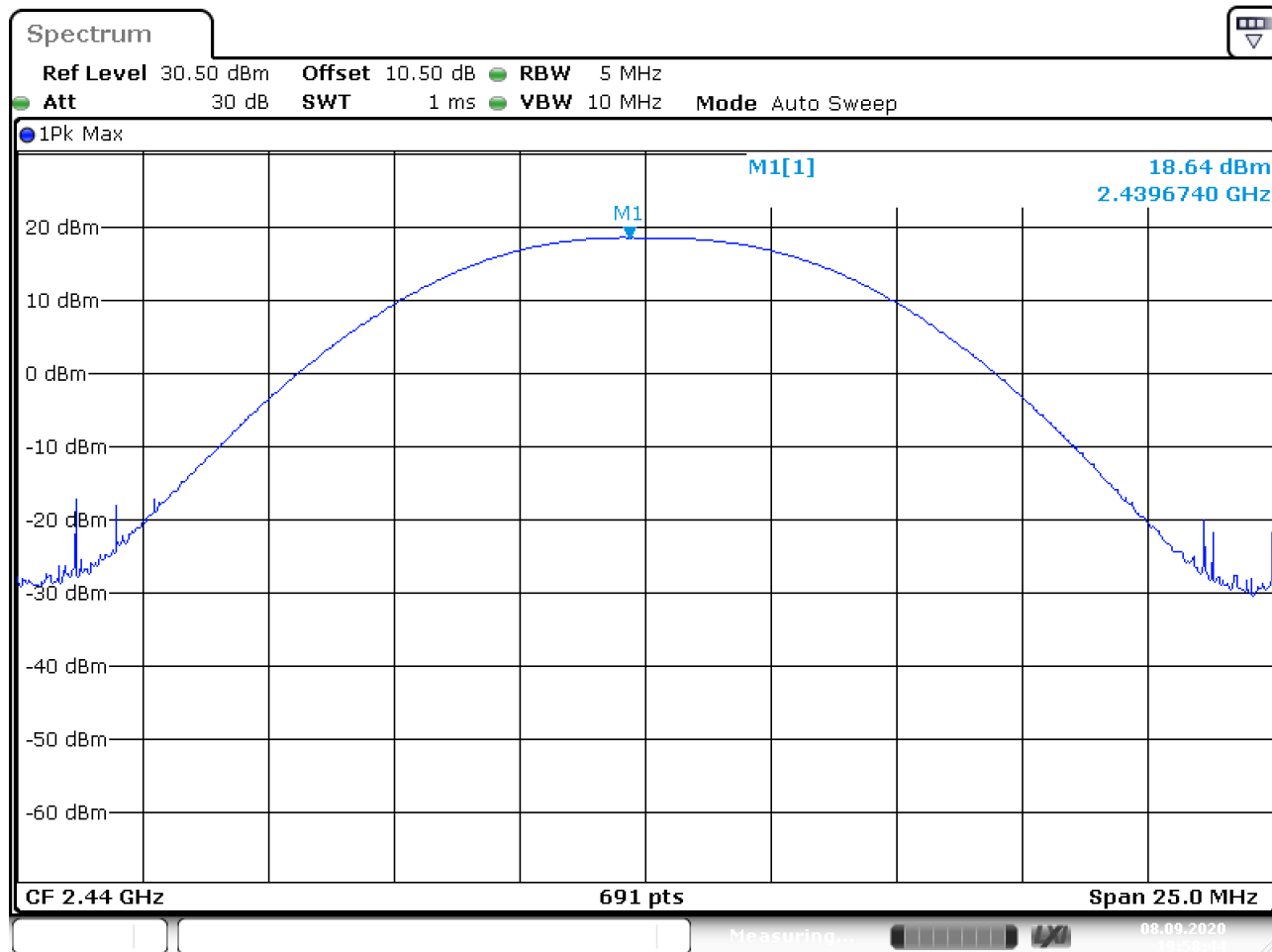
For all other frequency hopping systems in the 2400 - 2483.5 MHz band: 0.125 Watts

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.



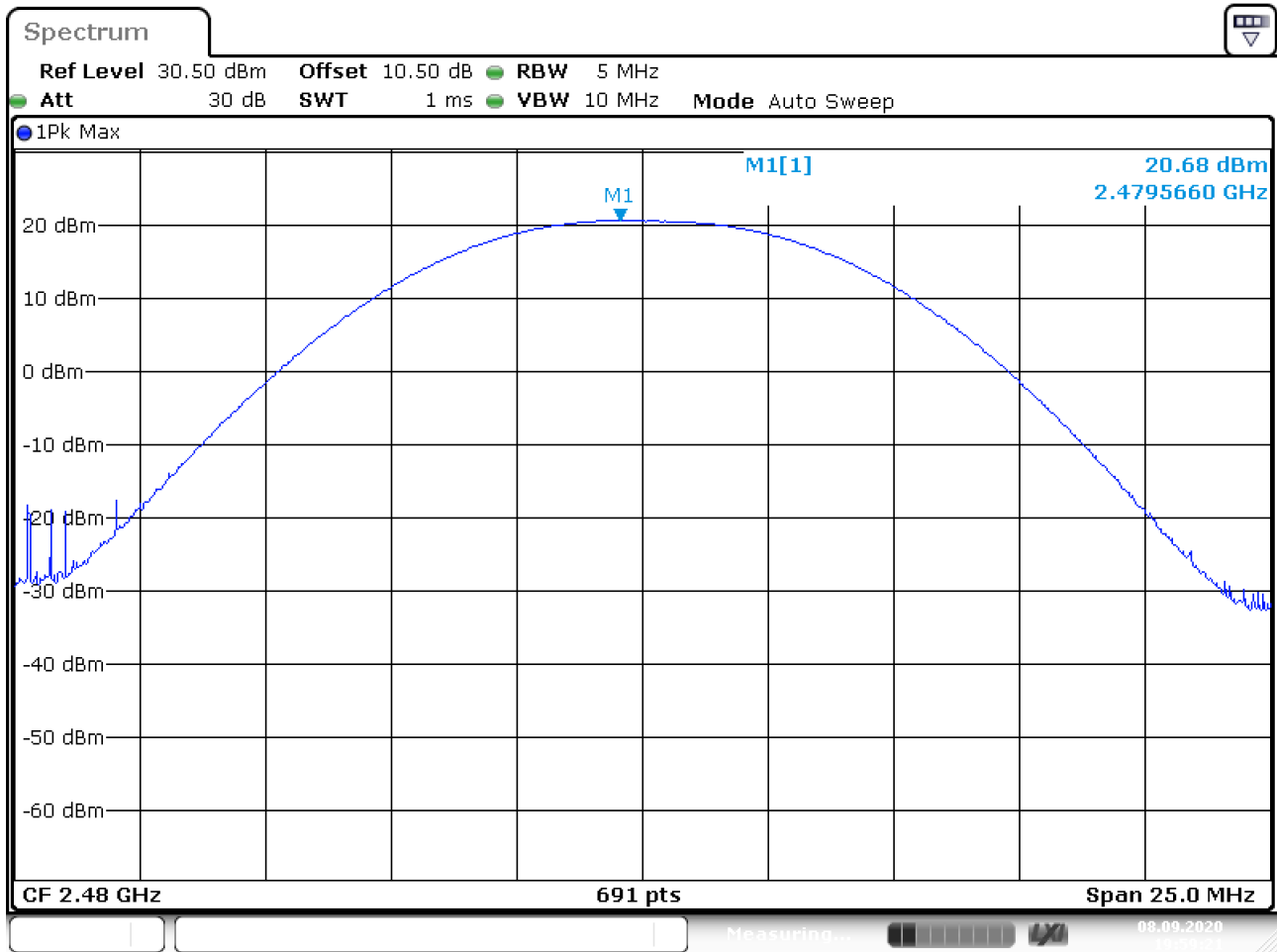
Date: 8.SEP.2020 19:57:23

Conducted Power, Ch2405MHz



Date: 8.SEP.2020 19:58:45

Conducted Power, Ch2440MHz



Date: 8.SEP.2020 19:59:21

Conducted Power, Ch2480MHz



MARKER 1

13.125 μ s

Ref 125 dB μ V/m

*Att 10 dB

RBW 5 MHz

VBW 10 MHz

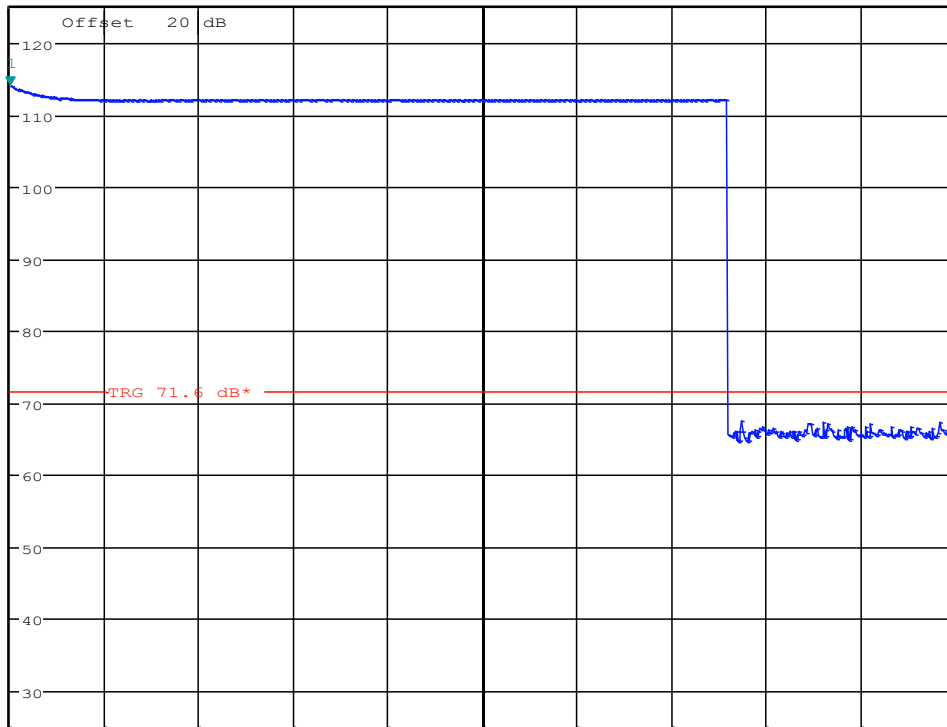
SWT 3 ms

Marker 1 [T1]

114.03 dB μ V/m

13.125000 μ s

1 PK
MAXH



Date: 17.AUG.2020 15:33:48

Monopole antenna: Measured Field Strength, VP, ch2405MHz



MARKER 1

13.125 μ s

Ref 125 dB μ V/m

*Att 10 dB

RBW 5 MHz

VBW 10 MHz

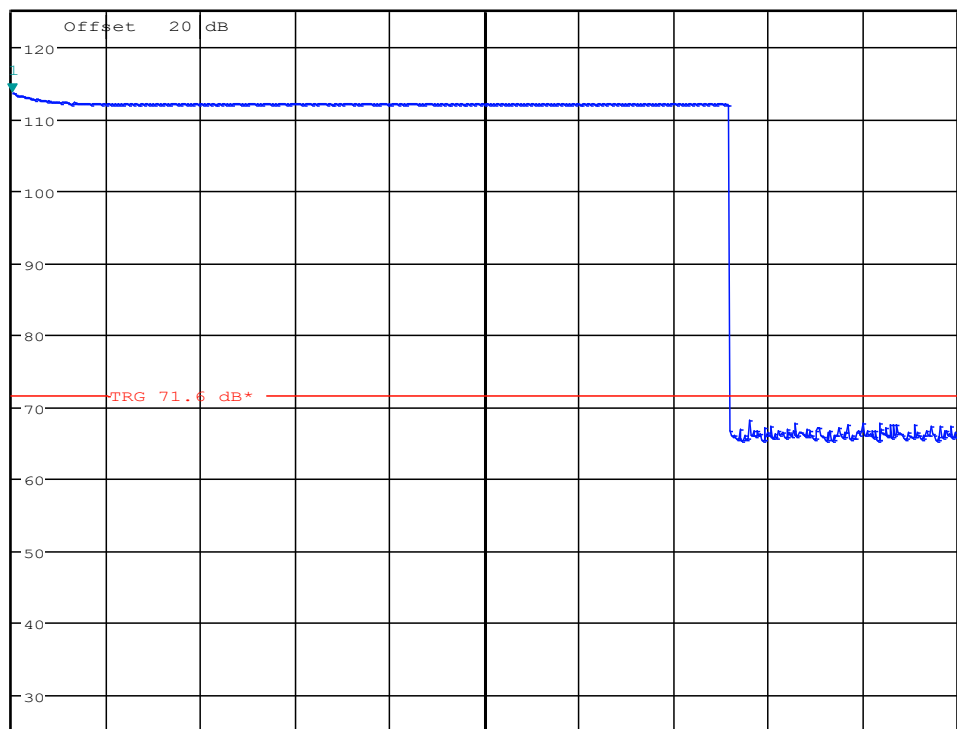
SWT 3 ms

Marker 1 [T1]

113.58 dB μ V/m

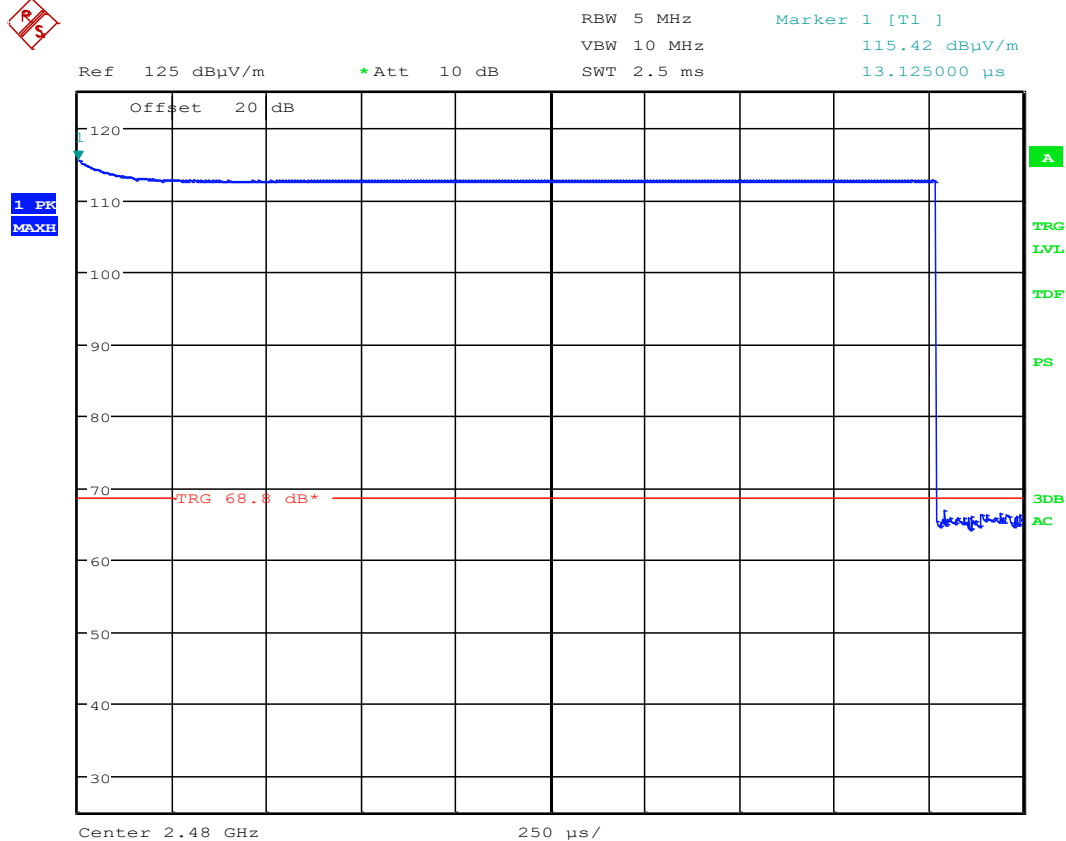
13.125000 μ s

1 PK
MAXH



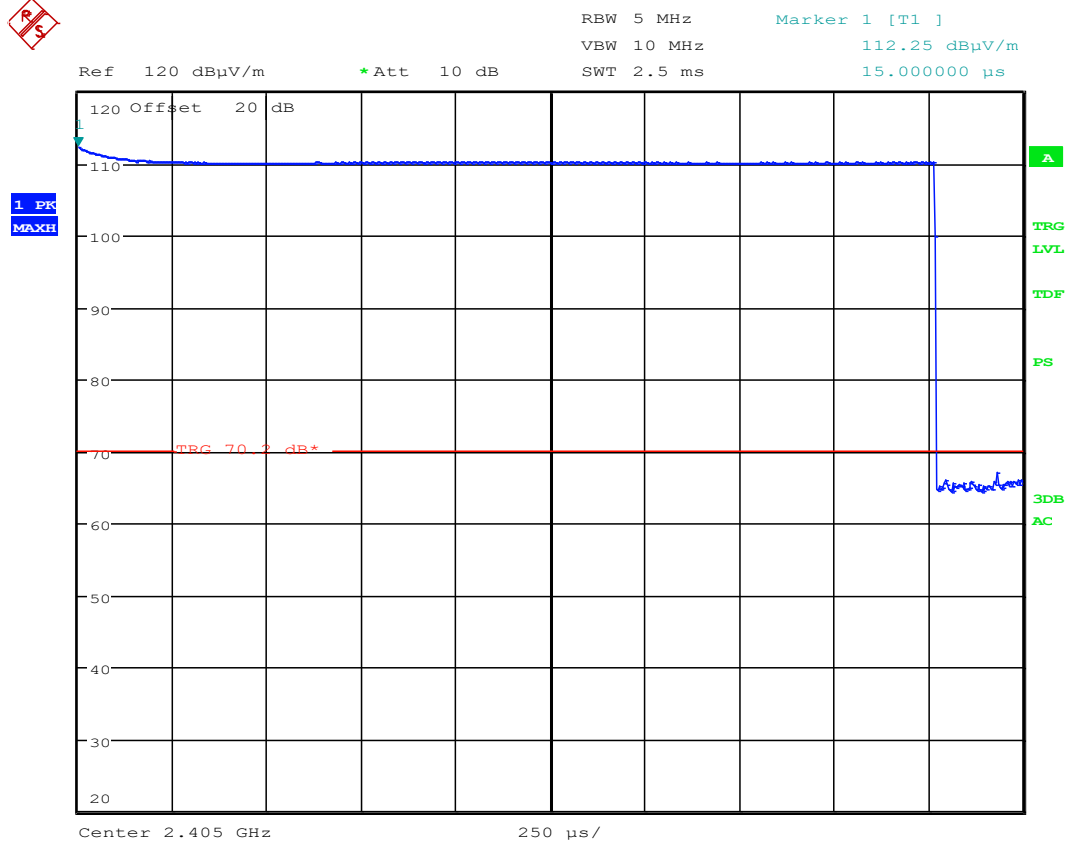
Date: 17.AUG.2020 15:34:32

Monopole antenna: Measured Field Strength, VP, ch2440MHz



Date: 17.AUG.2020 15:00:54

Monopole antenna: Measured Field Strength, VP, ch2480MHz



Date: 13.AUG.2020 14:02:04

Dipole antenna: Measured Field Strength, VP, ch2405MHz



MARKER 1

0 s

Ref 137 dBμV/m

*Att 10 dB

RBW 5 MHz

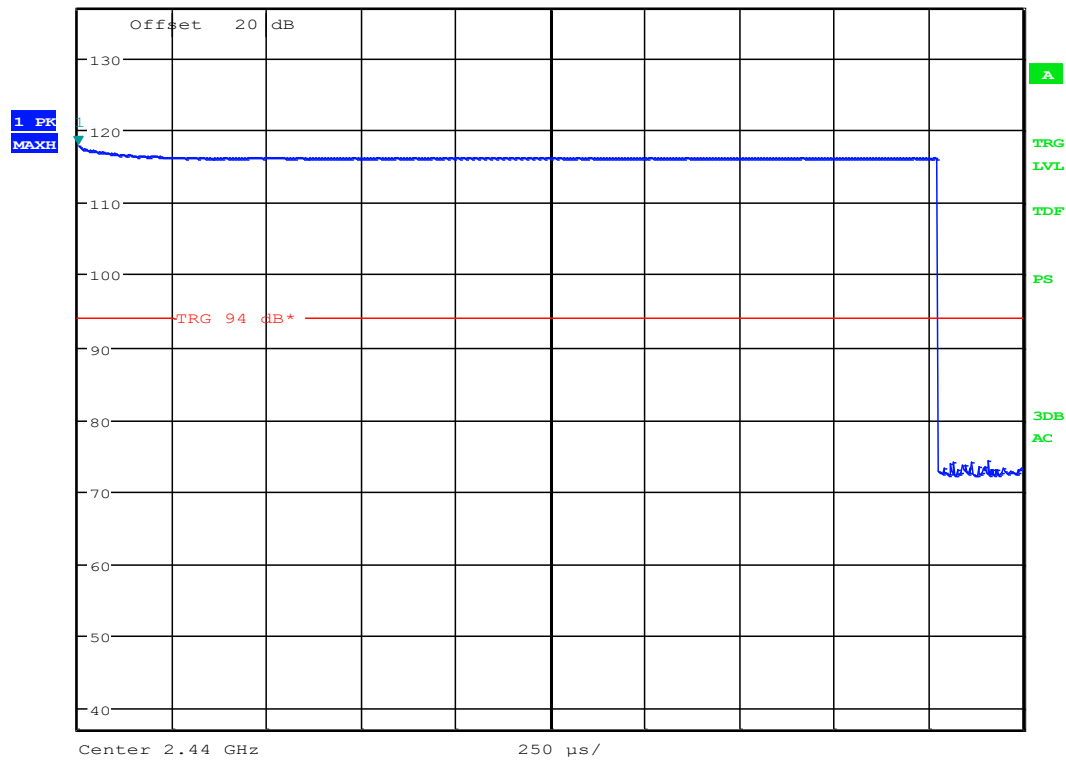
VBW 10 MHz

SWT 2.5 ms

Marker 1 [T1]

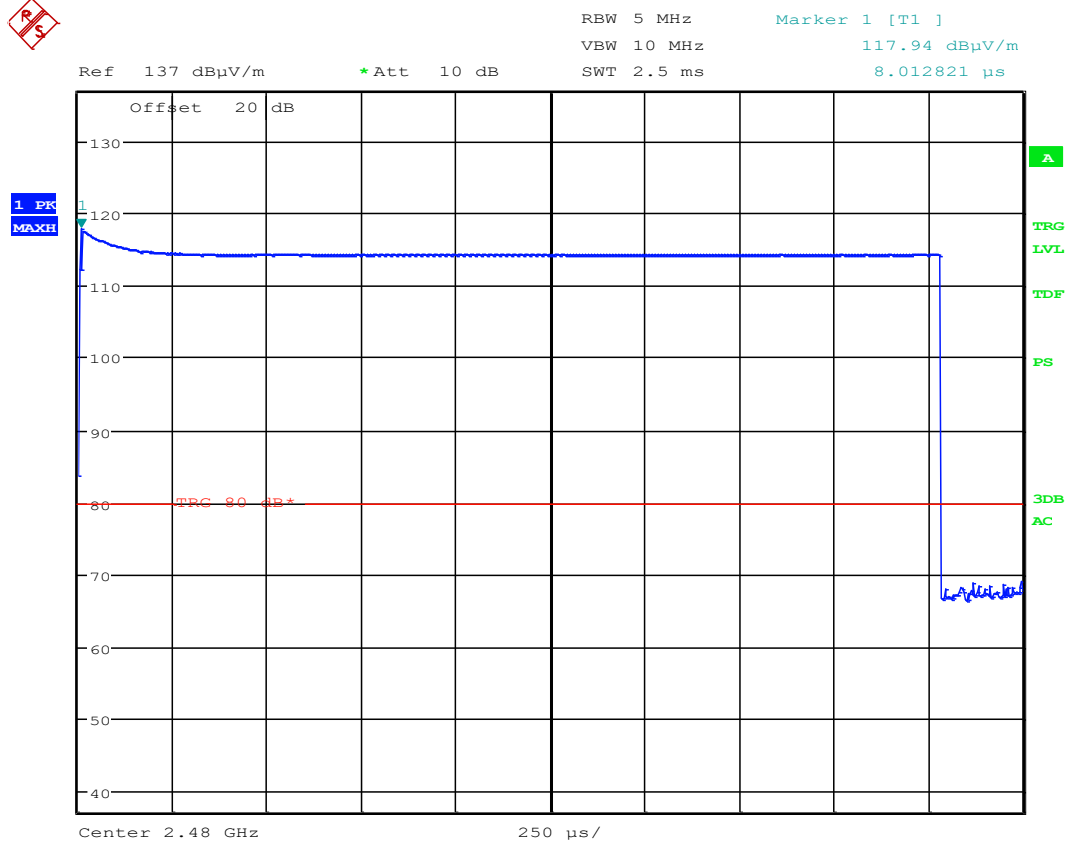
117.94 dBμV/m

0.000000 s



Date: 17.AUG.2020 12:33:44

Dipole antenna: Measured Field Strength, VP, ch2440MHz



Date: 13.AUG.2020 13:39:26

Dipole antenna: Measured Field Strength, VP, ch2480MHz

3.7 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
In hopping mode	39.9	> 30	Pass
2405 MHz	55.0	> 30	Pass
2440 MHz	43.9	> 30	Pass
2480 MHz	40.5	> 30	Pass

Measured with Peak Detector

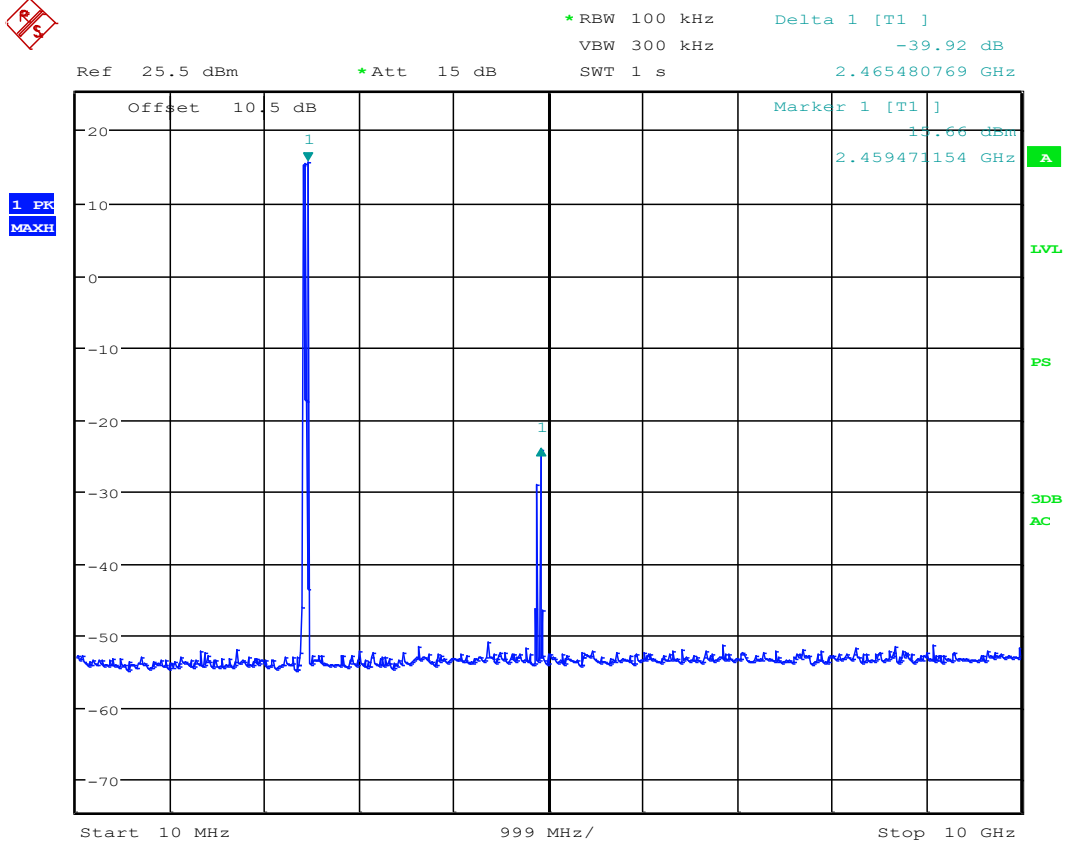
RF conducted power to 25 GHz: see attached plots.

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.



Date: 13.AUG.2020 13:18:31

Conducted spurious emissions, 10MHz - 10GHz, In hopping mode



MARKER 1

14.0625 GHz

*RBW 100 kHz

Marker 1 [T1]

VBW 300 kHz

-49.94 dBm

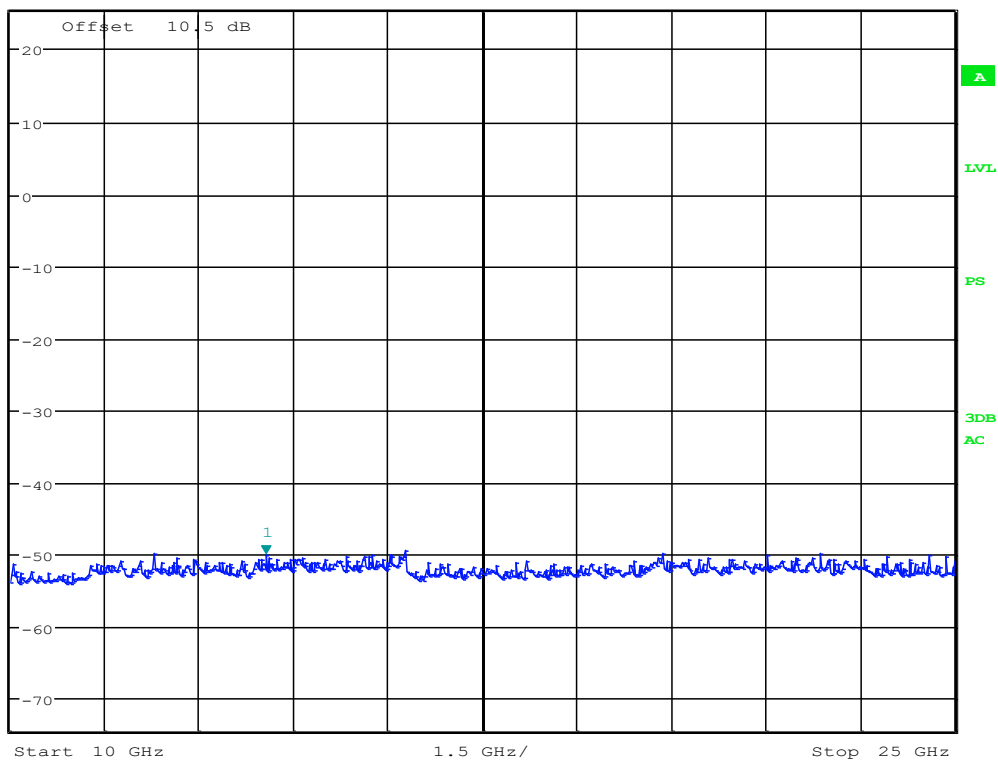
Ref 25.5 dBm

*Att 15 dB

SWT 1.5 s

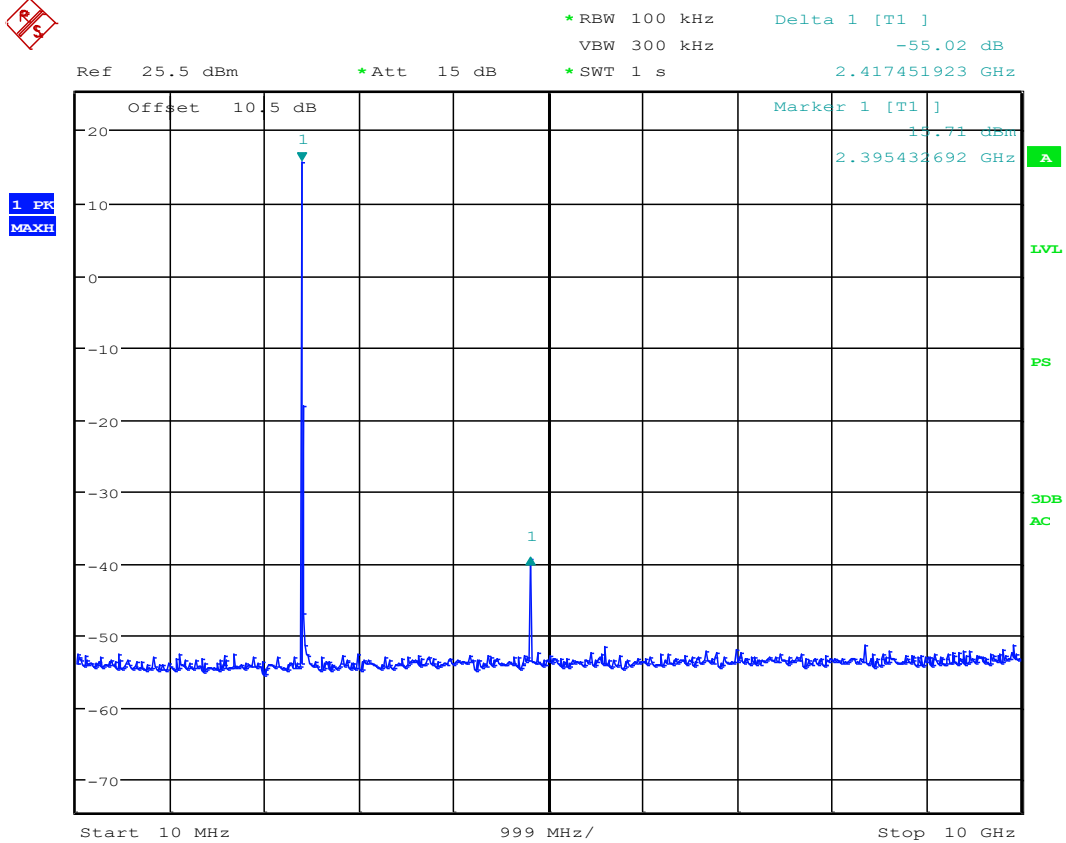
14.06250000 GHz

1 PK
MAXH



Date: 13.AUG.2020 13:19:19

Conducted spurious emissions, 10GHz - 25GHz, in hopping mode



Date: 13.AUG.2020 12:58:41

Conducted spurious emissions, 10MHz - 10GHz, ch2405MHz



MARKER 1

22.40384615 GHz

*RBW 100 kHz

Marker 1 [T1]

VBW 300 kHz

-50.21 dBm

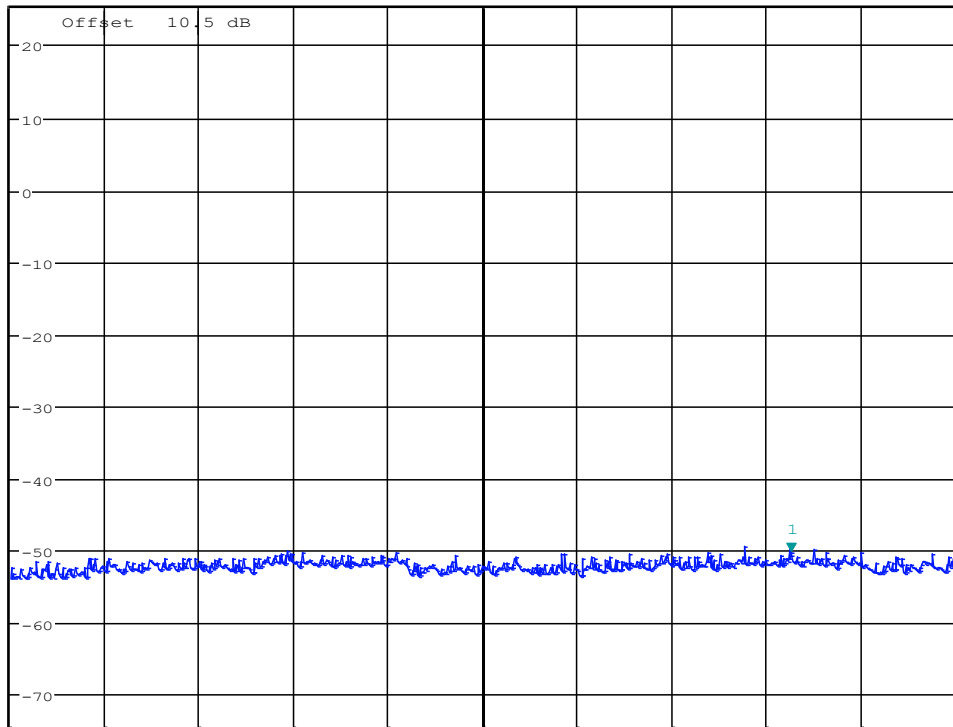
Ref 25.5 dBm

*Att 15 dB

SWT 1.5 s

22.403846154 GHz

1 PK
MAXH



Center 17.5 GHz

1.5 GHz/

Span 15 GHz

Date: 13.AUG.2020 12:54:14

Conducted spurious emissions, 10GHz - 25GHz, ch2405MHz



Conducted spurious emissions, 10MHz - 10GHz, ch2440MHz



MARKER 1

15.72115385 GHz

*RBW 100 kHz

Marker 1 [T1]

VBW 300 kHz

-49.58 dBm

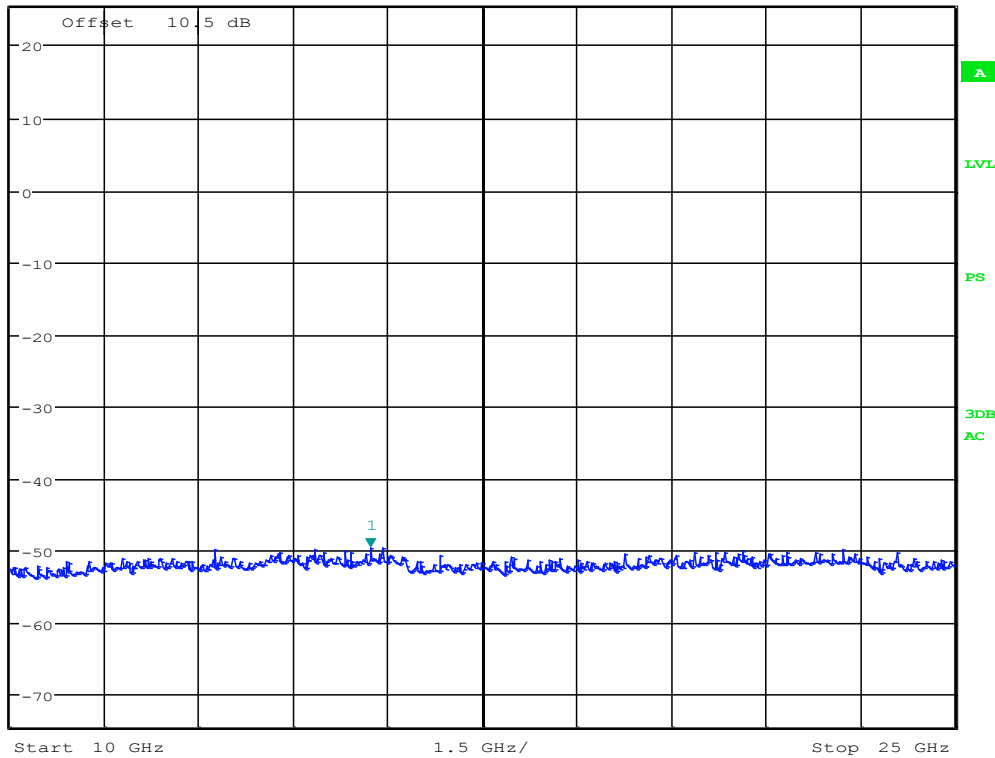
Ref 25.5 dBm

*Att 15 dB

SWT 1.5 s

15.721153846 GHz

1 PK
MAXH



Date: 13.AUG.2020 13:10:04

Conducted spurious emissions, 10GHz - 25GHz, ch2440MHz



DELTA MARKER 2

4.959801282 GHz

Ref 25.5 dBm

*Att 15 dB

*RBW 100 kHz

VBW 300 kHz

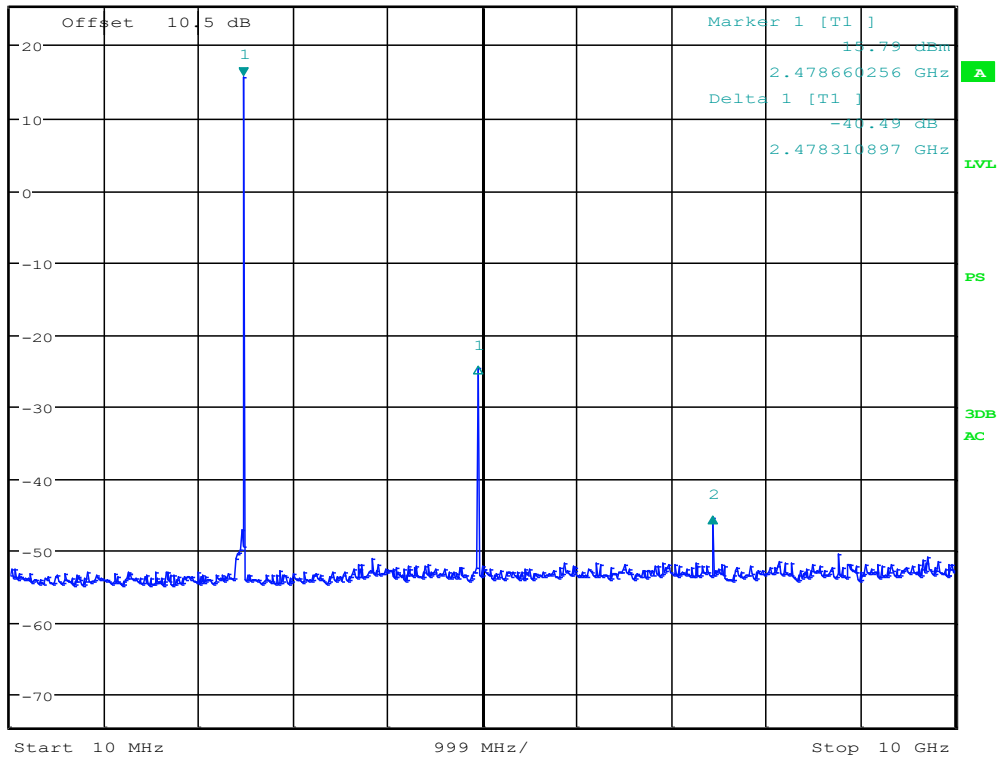
SWT 1 s

Delta 2 [T1]

-61.13 dB

4.959801282 GHz

1 PK
MAXH



Date: 13.AUG.2020 12:52:42

Conducted spurious emissions, 10MHz - 10GHz, ch2480MHz



MARKER 1

10 GHz

*RBW 100 kHz

Marker 1 [T1]

VBW 300 kHz

-53.18 dBm

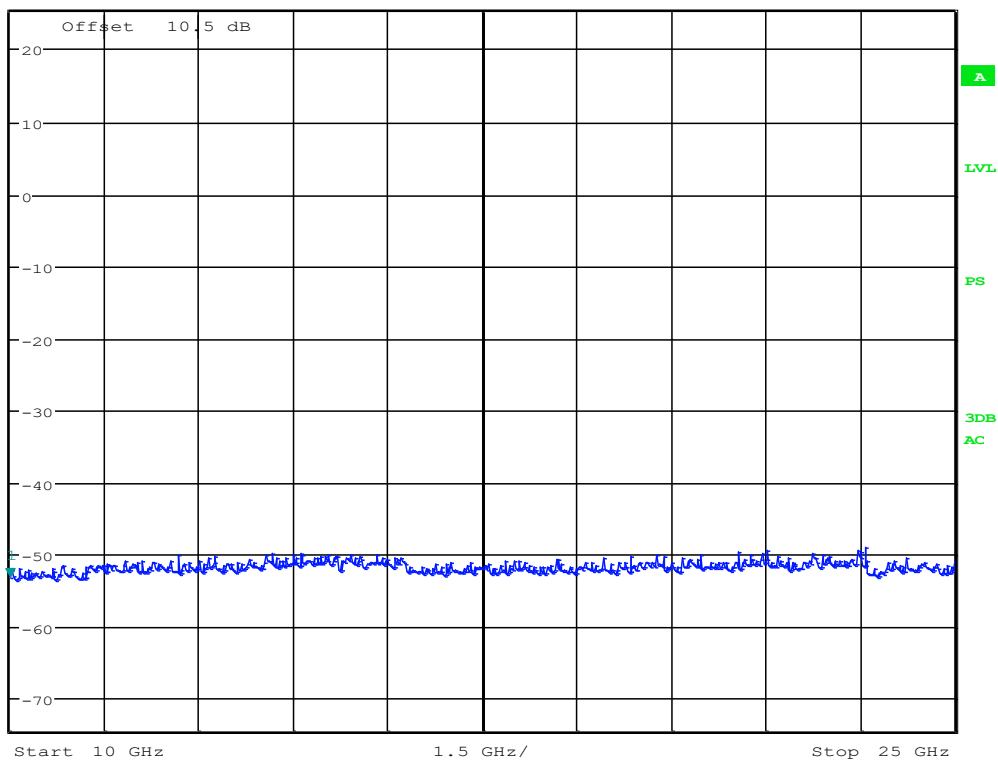
Ref 25.5 dBm

*Att 15 dB

SWT 1.5 s

10.000000000 GHz

1 PK
MAXH



Date: 13.AUG.2020 12:53:35

Conducted spurious emissions, 10GHz - 25GHz, ch2480MHz

3.8 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)	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.

3.9 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:

Band-Edge: Monopole antenna

	Measured field strength (dBμV/m)		Limit	Margin	
	2390 MHz	2483.5 MHz	dBμV/m	dB	
Peak Detector	59.86	67.56	74	14.14	6.44
Average Detector	/	/	54	/	/
Average with Duty Cycle correction	39.86	47.56	54	14.14	6.44

Band-Edge: Dipole antenna

	Measured field strength (dBμV/m)		Limit	Margin	
	2390 MHz	2483.5 MHz	dBμV/m	dB	
Peak Detector	58.03	72.63	74	15.97	1.37
Average Detector	/	/	54	/	/
Average with Duty Cycle correction	38.03	52.63	54	15.97	1.37

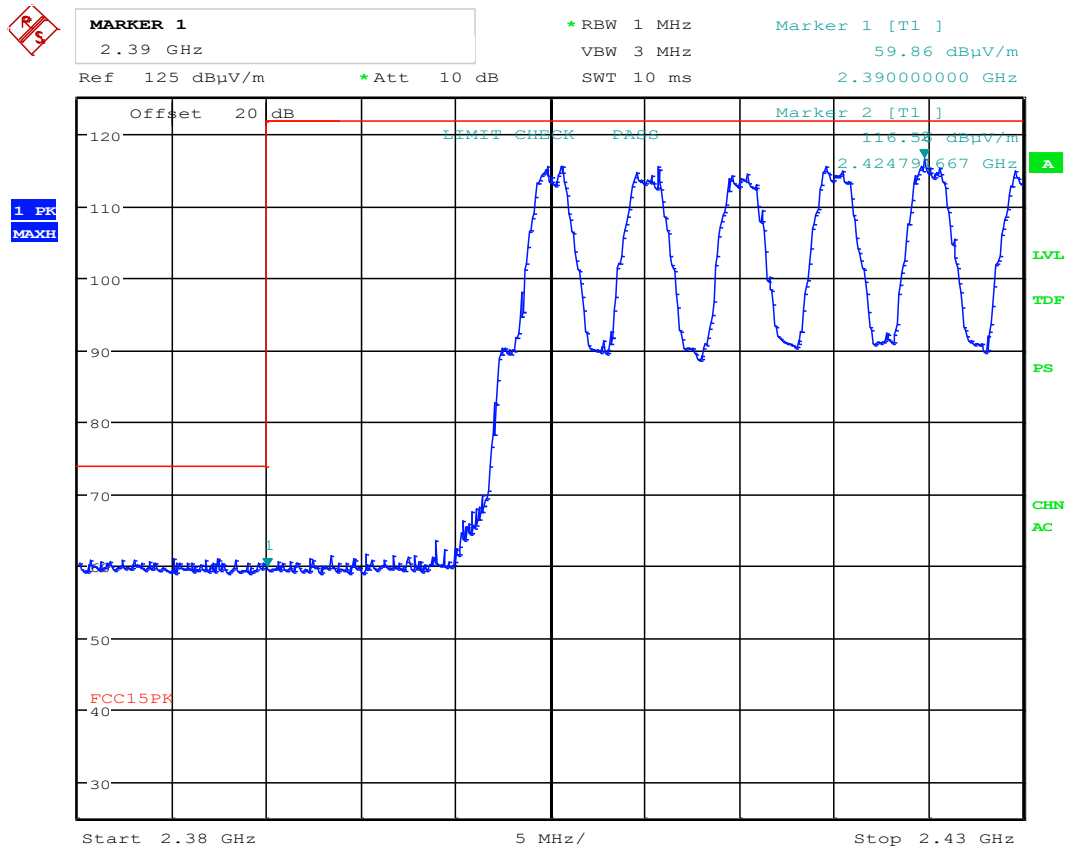
See attached plots.

Duty Cycle Correction Factor Calculation:

The maximum duty cycle calculation is given by manufacturer in the operational description is 4.3%

Duty Cycle Correction factor = $-20 \times \log(0.043) = -27.3$ dB

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

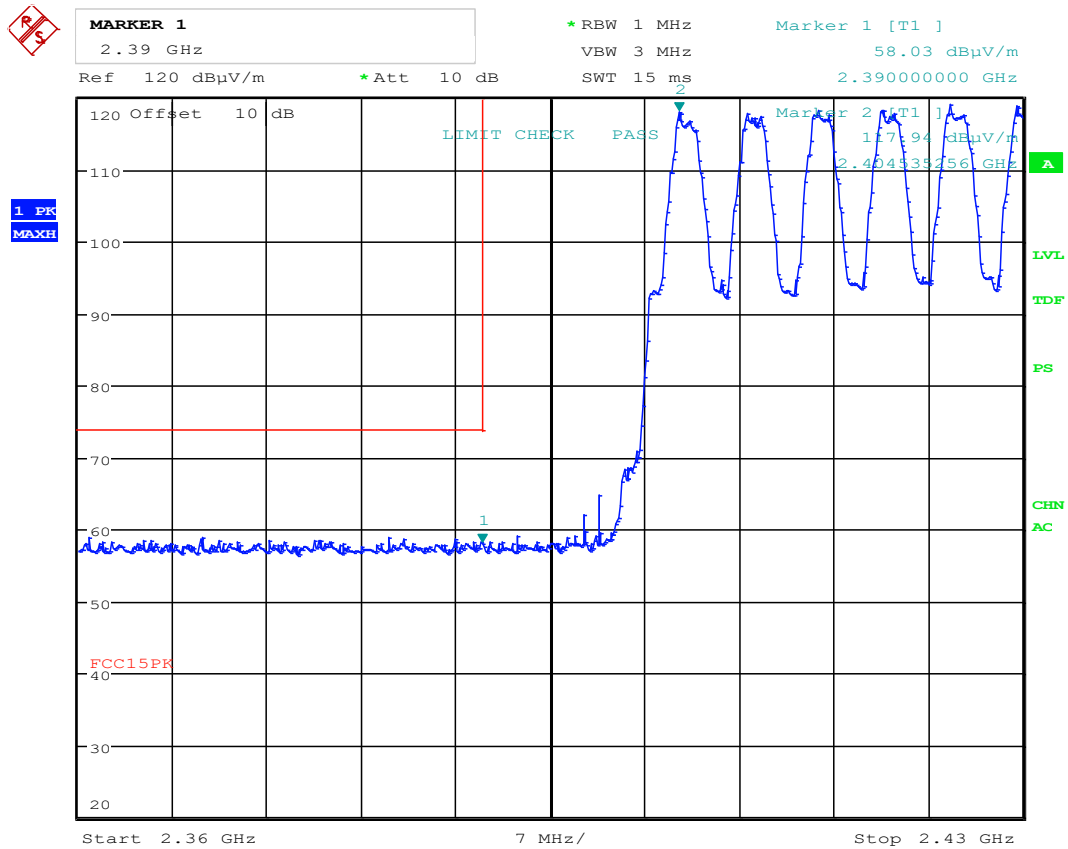


Date: 17.AUG.2020 15:30:09

Monopole antenna: Lower Band Edge, PK , ch2405MHz



Monopole antenna: Upper band Edge, PK, ch2480MHz



Date: 17.AUG.2020 12:49:26

Dipole antenna: Lower Band Edge, PK , ch2405MHz



MARKER 1

2.4835 GHz

Ref 130 dBμV/m

*Att 10 dB

*RBW 1 MHz

VBW 3 MHz

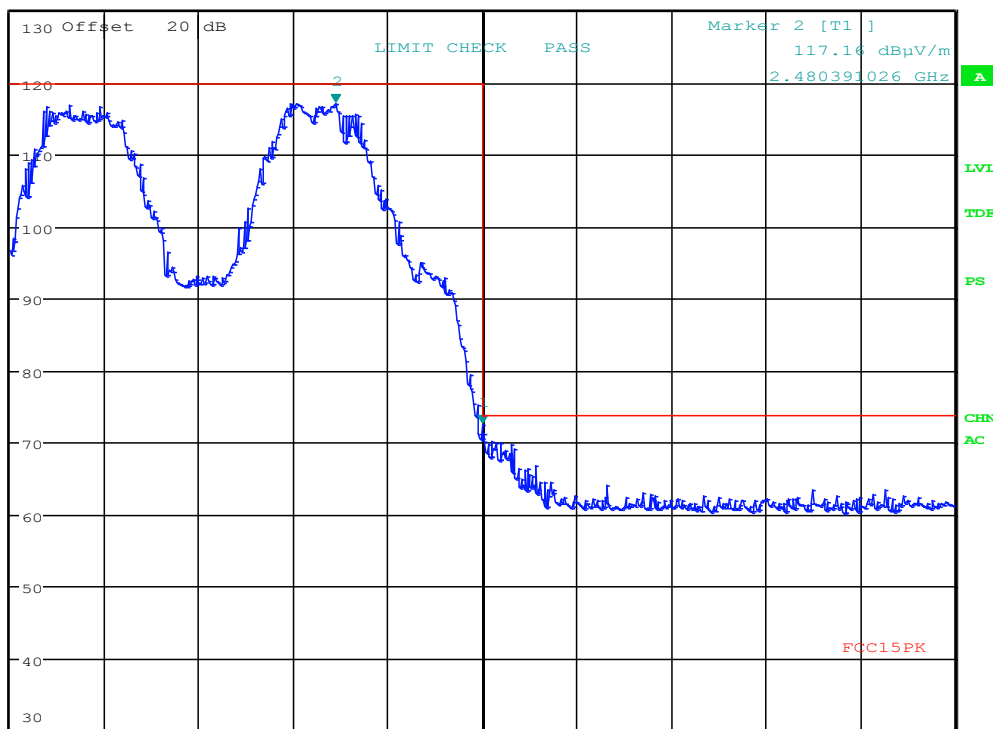
SWT 5 ms

Marker 1 [T1]

72.63 dBμV/m

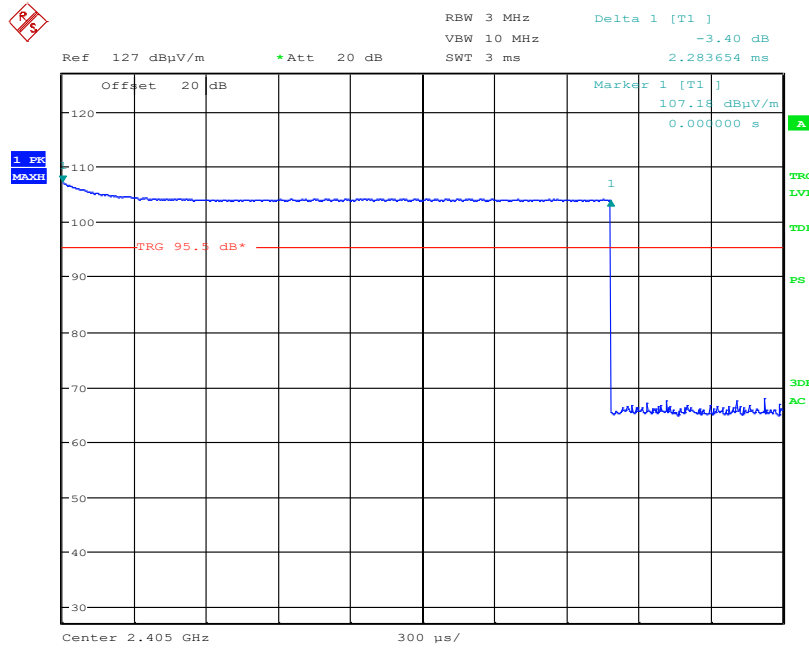
2.483500000 GHz

1 PK
MAXH



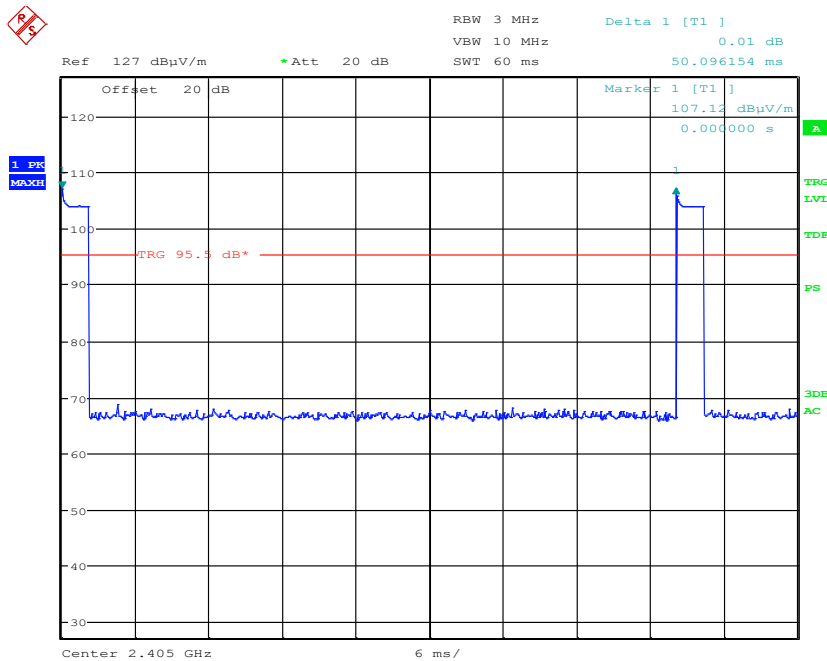
Date: 13.AUG.2020 14:20:31

Dipole antenna: Upper Band Edge, PK, ch2480MHz



Date: 18.JUN.2020 12:46:36

Duty Cycle ON time



Date: 18.JUN.2020 12:45:26

Duty Cycle ON time+OFF time

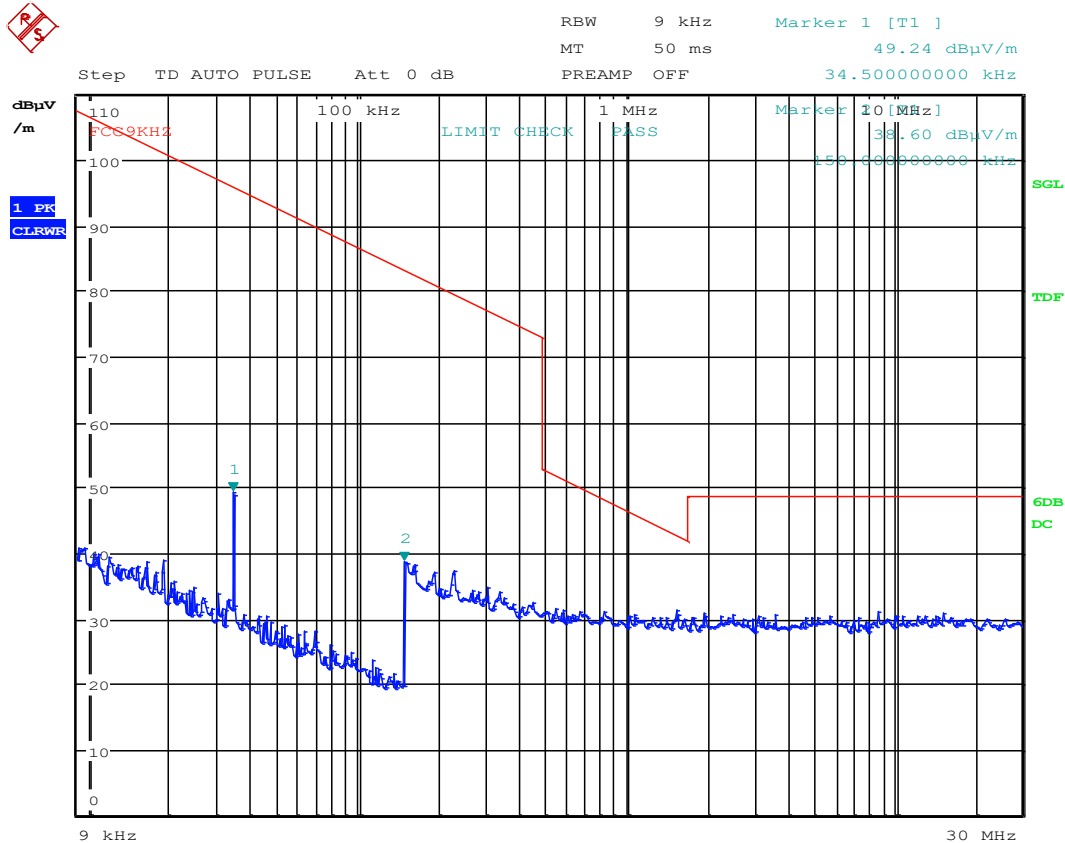
3.10 Radiated Emissions, 10 kHz – 30 MHz.

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



Date: 20.JUN.2020 08:52:42

Measuring distance 10 m, Peak detector.

No component detected, (The 34.5kHz is part of the test setup and not from the EUT)

see attached graph.

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

3.11 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 in TX mode

With monopole antenna:

Frequency (MHz)	QuasiPeak (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
35.300650	26.52	40.00	13.48	1000.0	120.000	107.0	V	328.0

With dipole antenna:

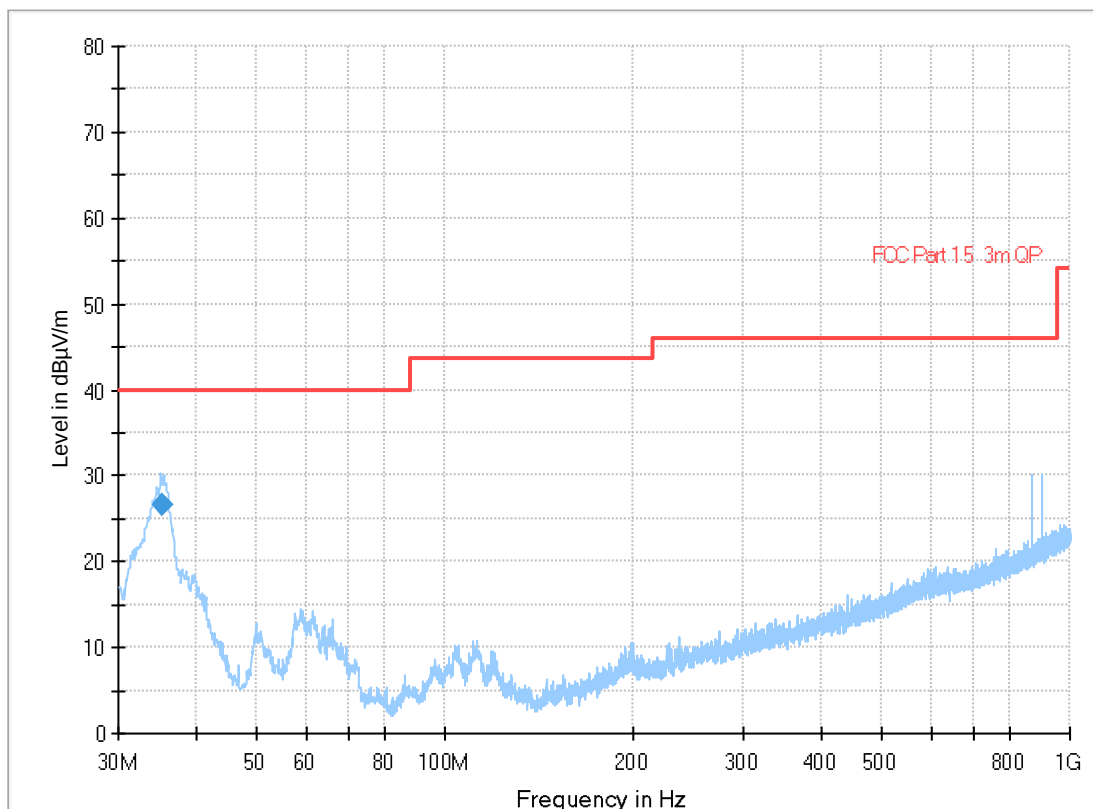
Frequency (MHz)	QuasiPeak (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
869.535600	27.29	46.00	18.71	1000.0	120.000	116.0	V	311.0

See attached plots

Requirements/Limit

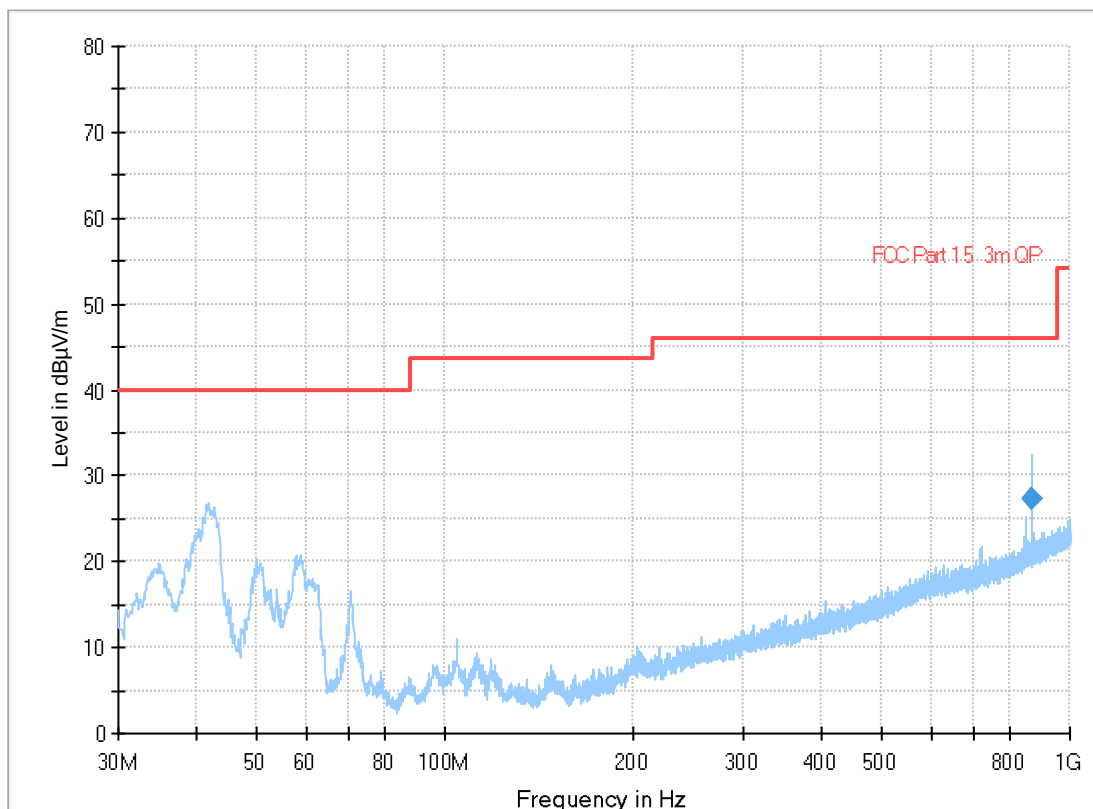
FCC	Part 15.209 @ frequencies defined in §15.205	
ISED	RSS-GEN Issue 5, Clause 8.9 @ frequencies defined in clause 8.10	
Frequency	Radiated emission limit @3 meters	
30 – 88 MHz	100 μV/m	40.0 dBμV/m
88 – 216 MHz	150 μV/m	43.5 dBμV/m
216 – 960 MHz	200 μV/m	46.0 dBμV/m
960 – 1000 MHz	500 μV/m	54.0 dBμV/m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

Full Spectrum



With Mnpole Antenna

Full Spectrum



With dipole antenna

3.12 Radiated Emissions, 1-25 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.

Monopole Antenna:

Restricted band:

Peak Detector:

Frequency	RF channel	Dist. corr. factor	Field strength, Peak Detector, 3m	Duty cycle corr. factor	Limit	Margin
GHz		dB	dB μ V/m	dB	dB μ V/m	dB
4.81	L	0	52.44	/	74	21.56
4.88	M	0	52.36	/	74	21.64
4.96	H	0	52.82	/	74	21.18
7.32	M	0	52.80	/	74	21.20
7.44	H	0	54.79	/	74	19.21
Other freqs	/	0	Below AV limit	/	74	>20

Restricted band:

Average Detector:

Frequency	RF channel	Dist. corr. factor	Field strength, Peak Detector, 3m	Duty cycle corr. factor	Limit	Margin
GHz		dB	dB μ V/m	dB	dB μ V/m	dB
4.81	L	0	/	20	54	/
4.88	M	0	/	20	54	/
4.96	H	0	/	20	54	/
7.32	M	0	/	20	54	/
7.44	H	0	34.79	20	54	19.21
Other freqs	Hopping	0	Below AV limit	/	54	>20

Maximum for 2nd harmonic is obtained in Horizontal polarization and Maximum for all other harmonics is obtained in vertical polarization.

Duty Cycle Correction factor = $-20 \times \log(0.043) = -27$ dB (Duty cycle: 4.3%), For single channel

Hopping channels 16.

Maximum allowed Duty Cycle Correction: 20 dB

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

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

Non- Restricted band:

Peak Detector:

Frequency	RF channel	Dist. corr. factor	Field strength of emission Peak Detector, 3m	Field strength of Fundamental frequency Peak Detector, 3m	Limit	Margin
MHz	MHz	dB	dB μ V/m	dB μ V/m	dBc	dB
7.21	L	0	55.06	112.6	20	57.54
9.62	L	0	55.84	112.6	20	56.76
9.76	M	0	55.12	109.4	20	54.28
9.92	H	0	62.41	112.2	20	49.79
Other freqs	/	0	None detected	112.6	20	/

Maximum is obtained in vertical polarization.

Duty Cycle Correction factor = $-20 \times \log(0.043) = -27$ dB (Duty cycle: 4.3%)

Maximum allowed Duty Cycle Correction: 20 dB

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

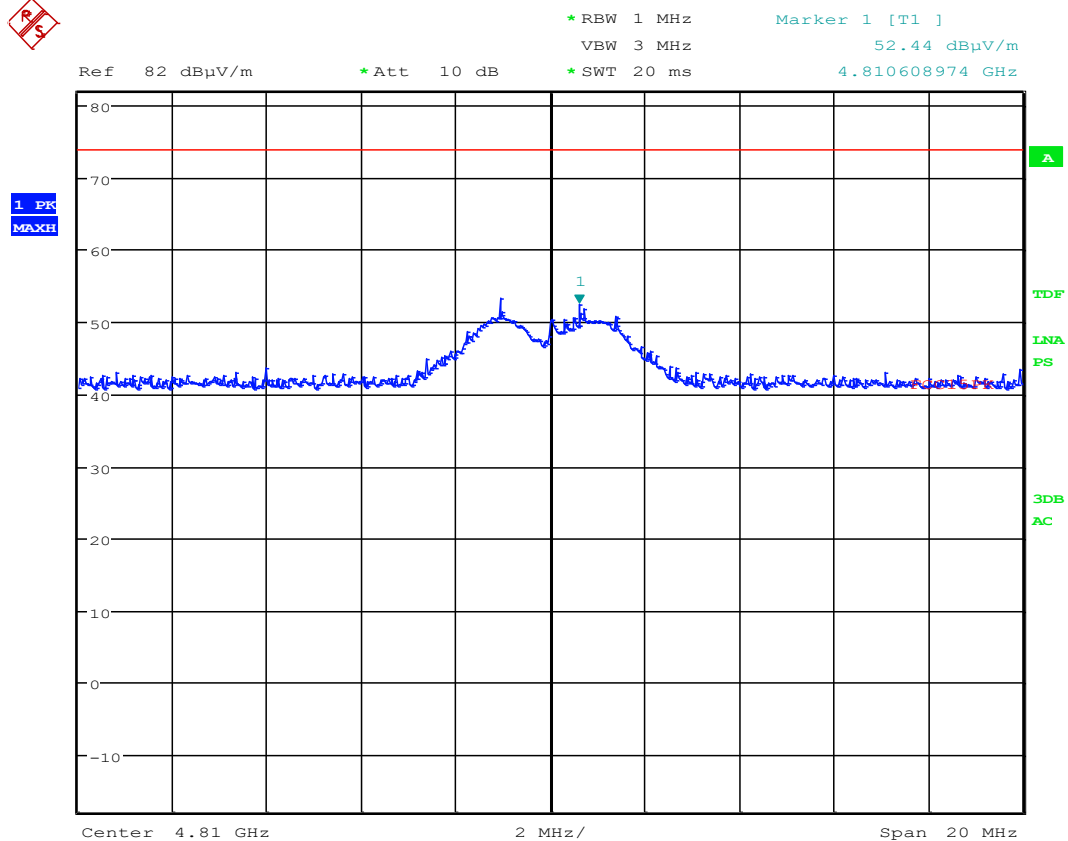
A Notch Filter was used for measurements from 1 GHz to 18 GHz .

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 dB μ V/m	74.0 dB μ V/m



Date: 17.AUG.2020 15:50:52

Monopole antenna: 2nd Harmonic, HP, ch2405MHz



MARKER 1

4.880865385 GHz

* RBW 1 MHz

VBW 3 MHz

SWT 20 ms

Marker 1 [T1]

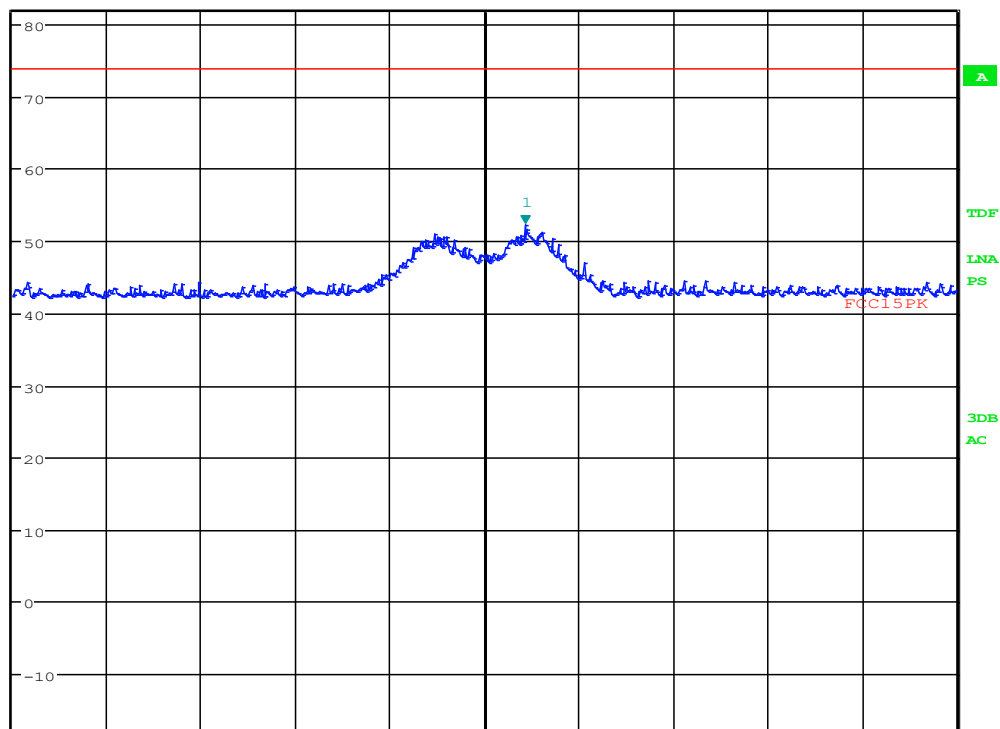
52.36 dBμV/m

4.880865385 GHz

Ref 82 dBμV/m

* Att 10 dB

1 PK
MAXH



Center 4.88 GHz

2 MHz/

Span 20 MHz

Date: 17.AUG.2020 16:41:29

Monopole antenna: 2nd Harmonic, VP, ch2440MHz



MARKER 1

4.959358974 GHz

* RBW 1 MHz

Marker 1 [T1]

VBW 3 MHz

52.82 dBμV/m

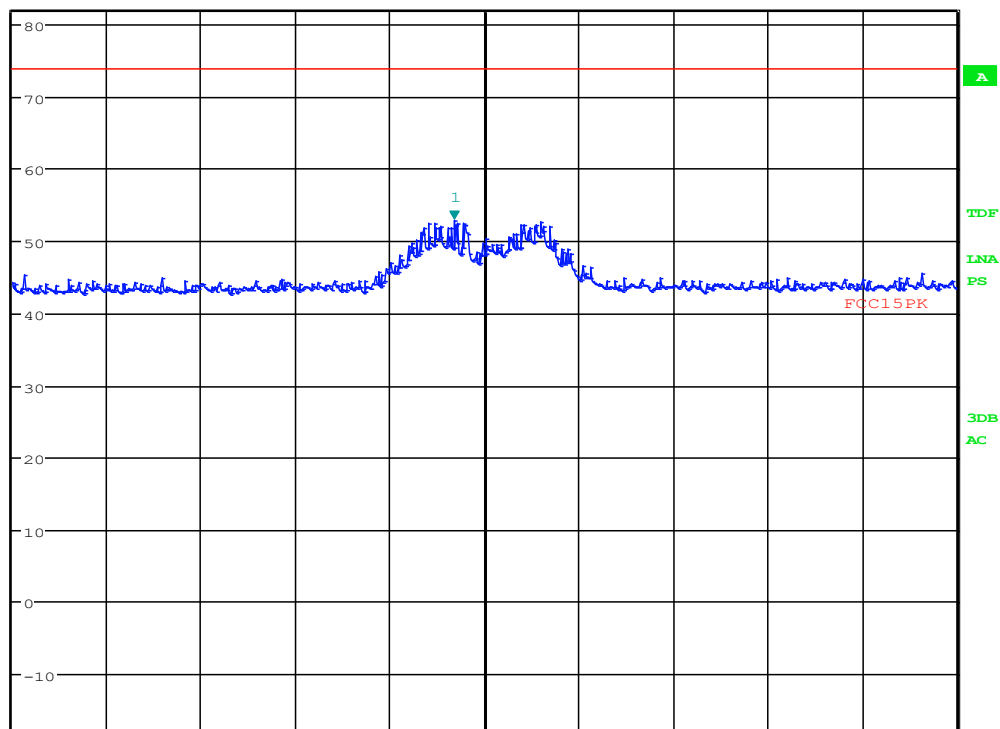
Ref 82 dBμV/m

* Att 10 dB

SWT 20 ms

4.959358974 GHz

1 PK
MAXH



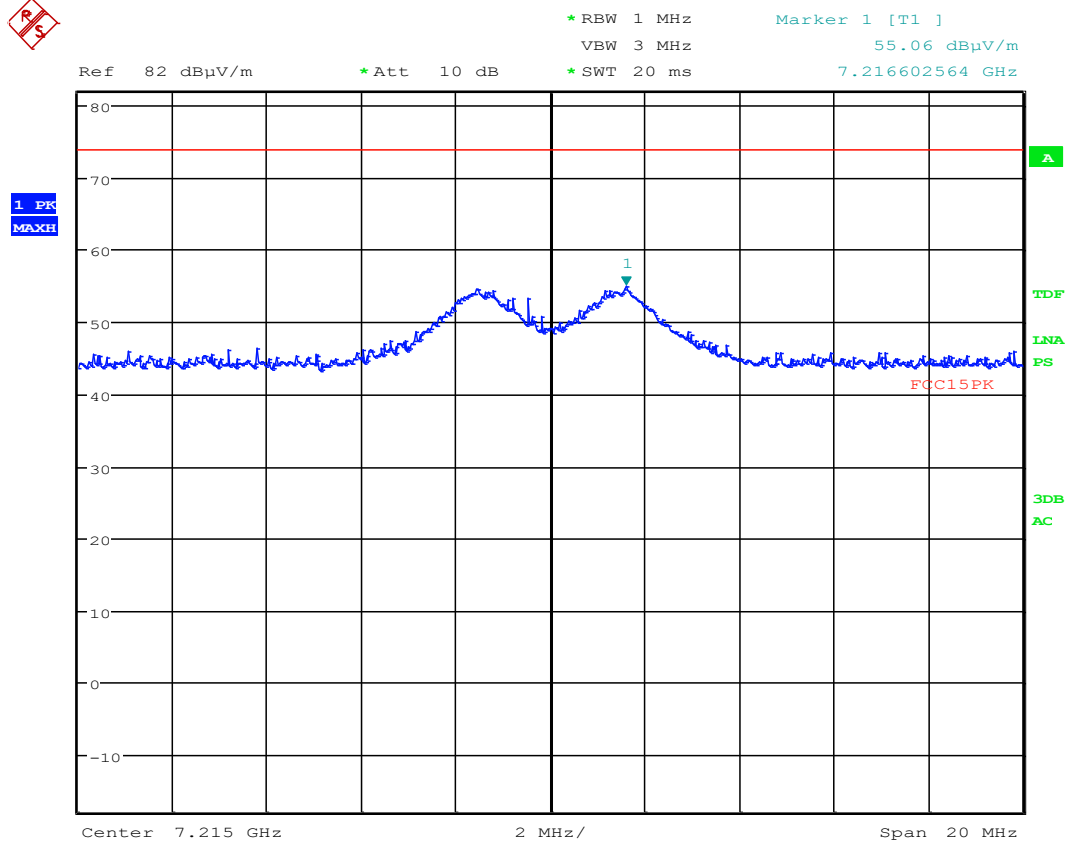
Center 4.96 GHz

2 MHz/

Span 20 MHz

Date: 17.AUG.2020 16:49:35

Monopole antenna: 2nd Harmonic, VP, ch2480MHz



Date: 17.AUG.2020 16:03:35

Monopole antenna:3rd Harmonic, VP, ch2405MHz



MARKER 1

7.31849359 GHz

* RBW 1 MHz

VBW 3 MHz

SWT 20 ms

Marker 1 [T1]

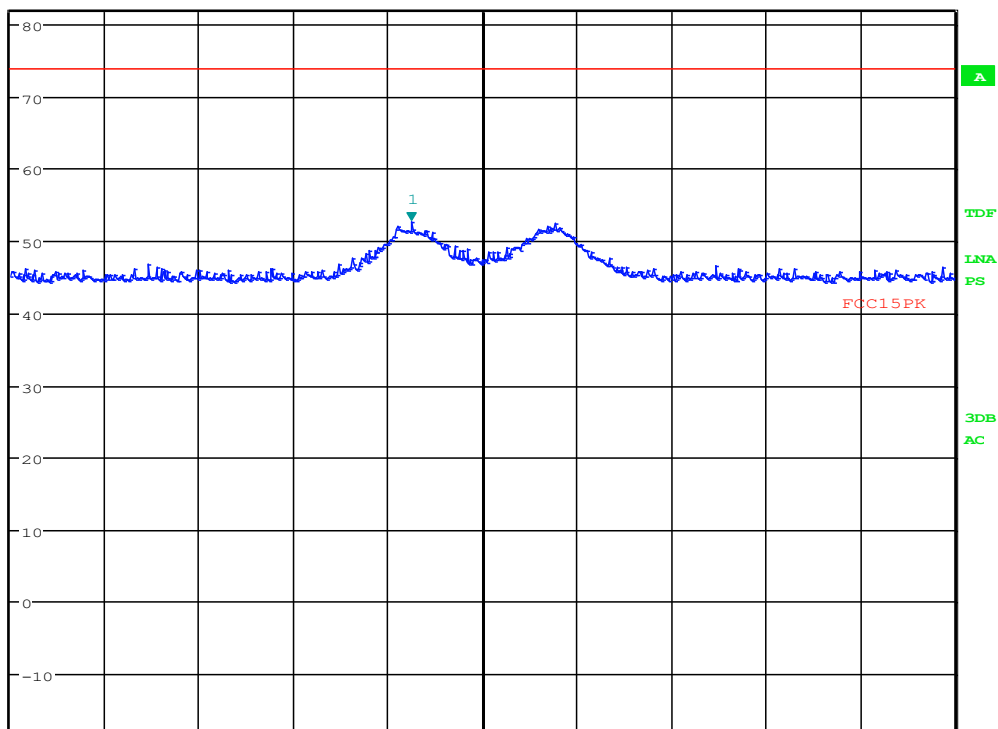
52.80 dBμV/m

7.318493590 GHz

Ref 82 dBμV/m

* Att 10 dB

1 PK
MAXH



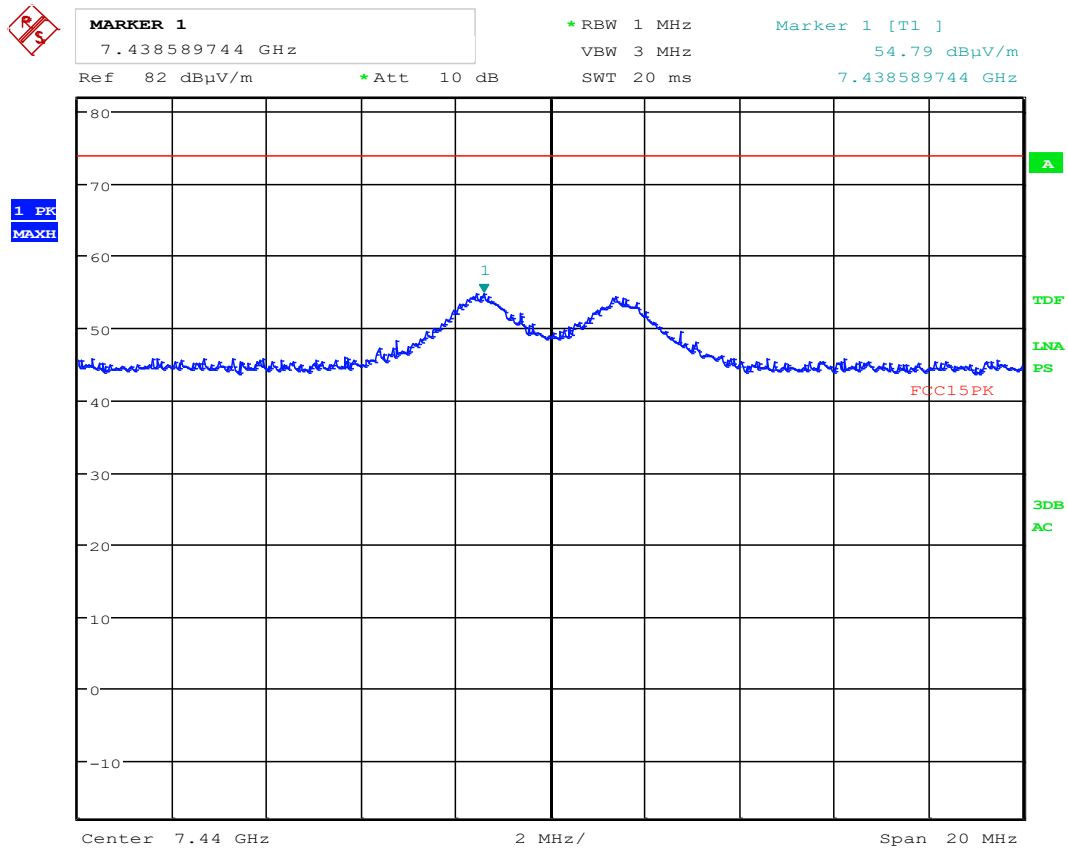
Center 7.32 GHz

2 MHz/

Span 20 MHz

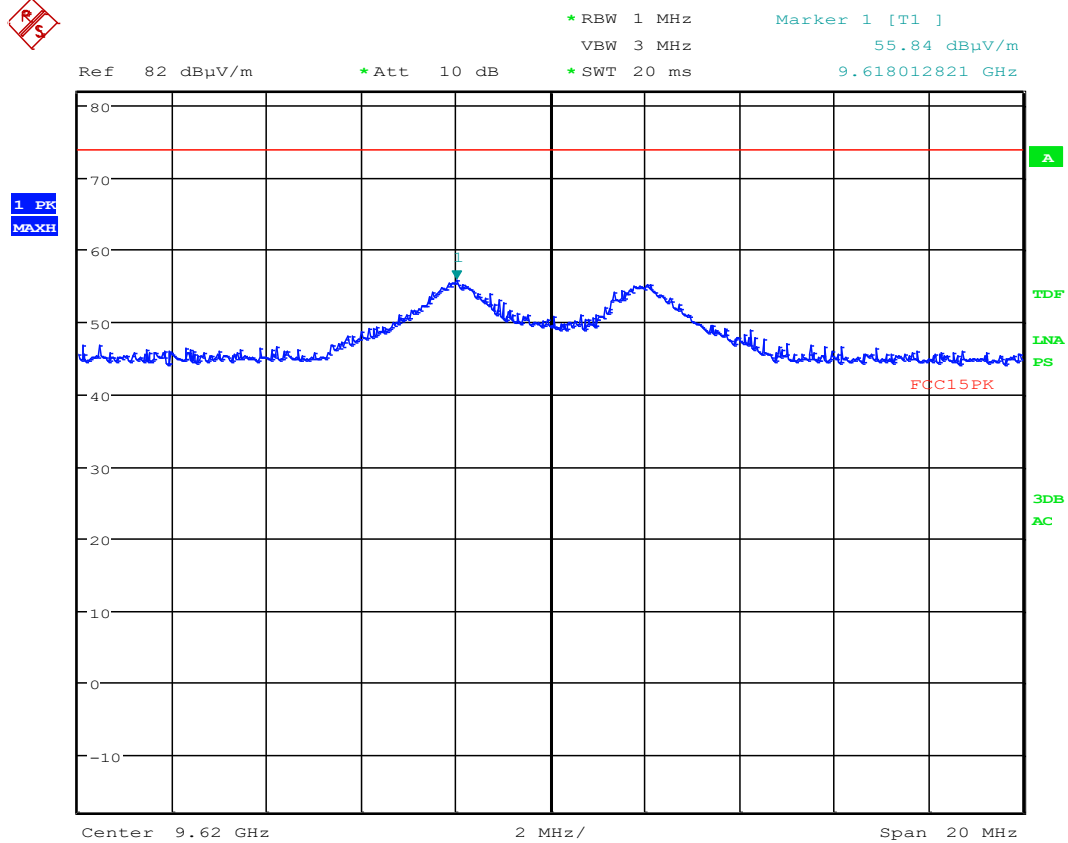
Date: 17.AUG.2020 16:43:17

Monopole antenna:3rd Harmonic, VP, ch2440MHz



Date: 17.AUG.2020 16:47:53

Monopole antenna:3rd Harmonic, VP, ch2480MHz



Date: 17.AUG.2020 16:14:13

Monopole antenna:4th Harmonic, VP, ch2405MHz



MARKER 1

9.757948718 GHz

* RBW 1 MHz

Marker 1 [T1]

VBW 3 MHz

55.12 dBμV/m

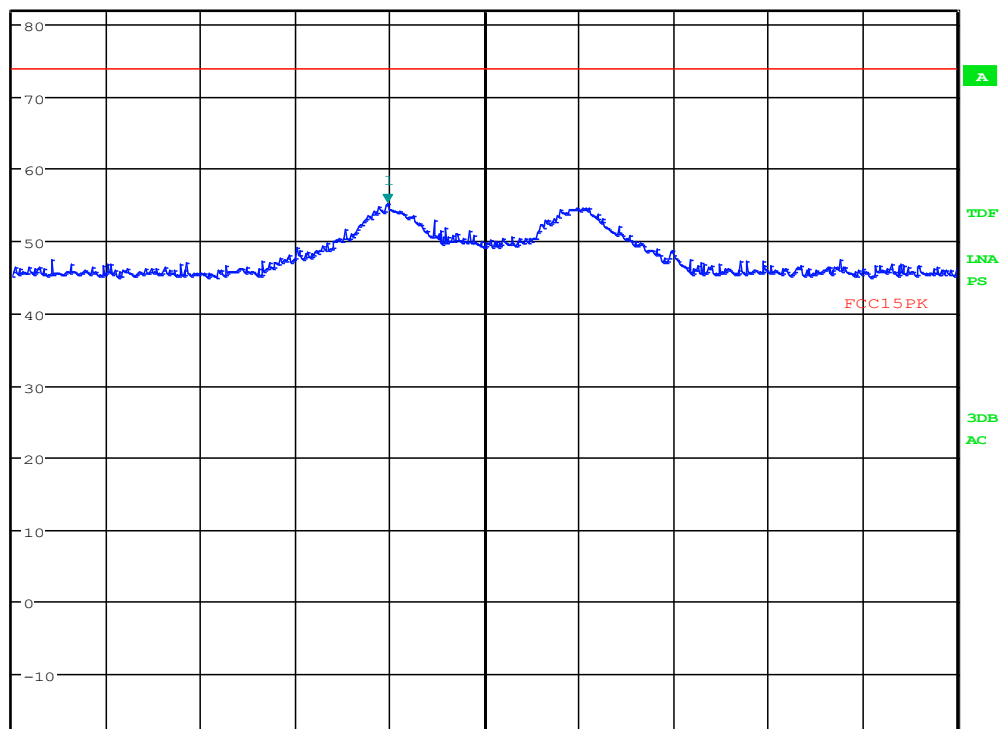
Ref 82 dBμV/m

* Att 10 dB

SWT 20 ms

9.757948718 GHz

1 PK
MAXH



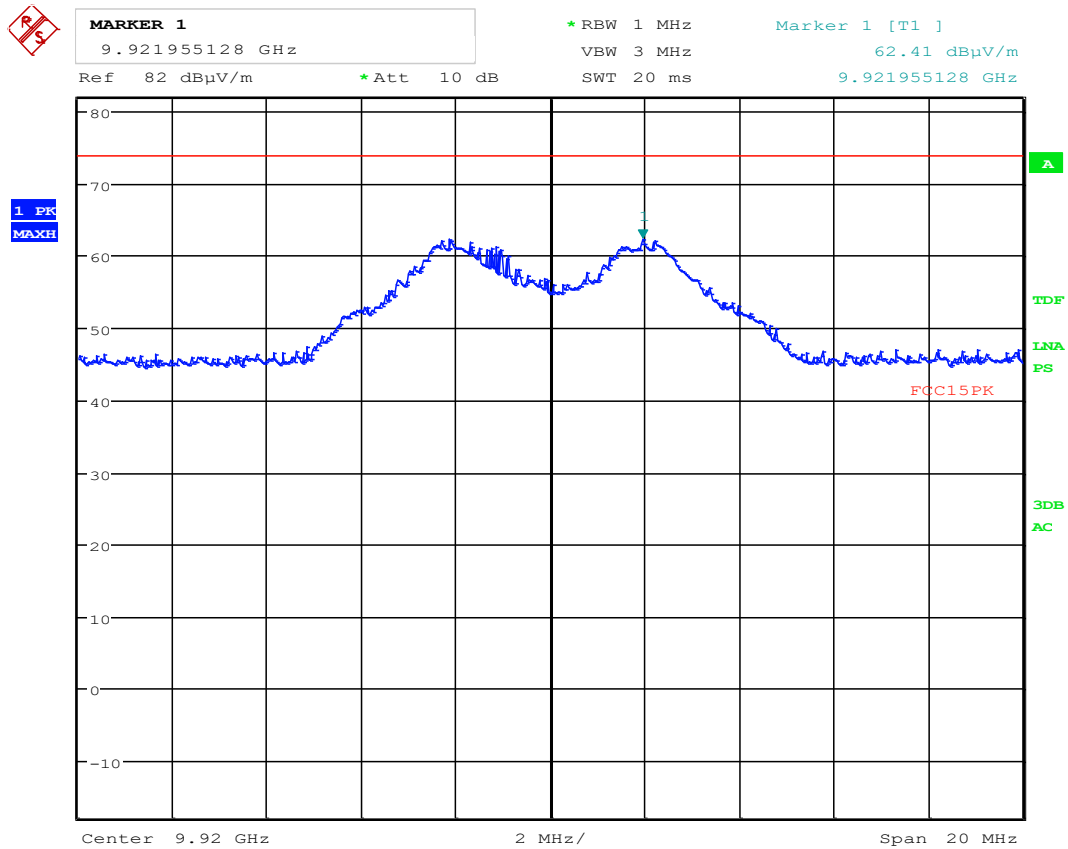
Center 9.76 GHz

2 MHz/

Span 20 MHz

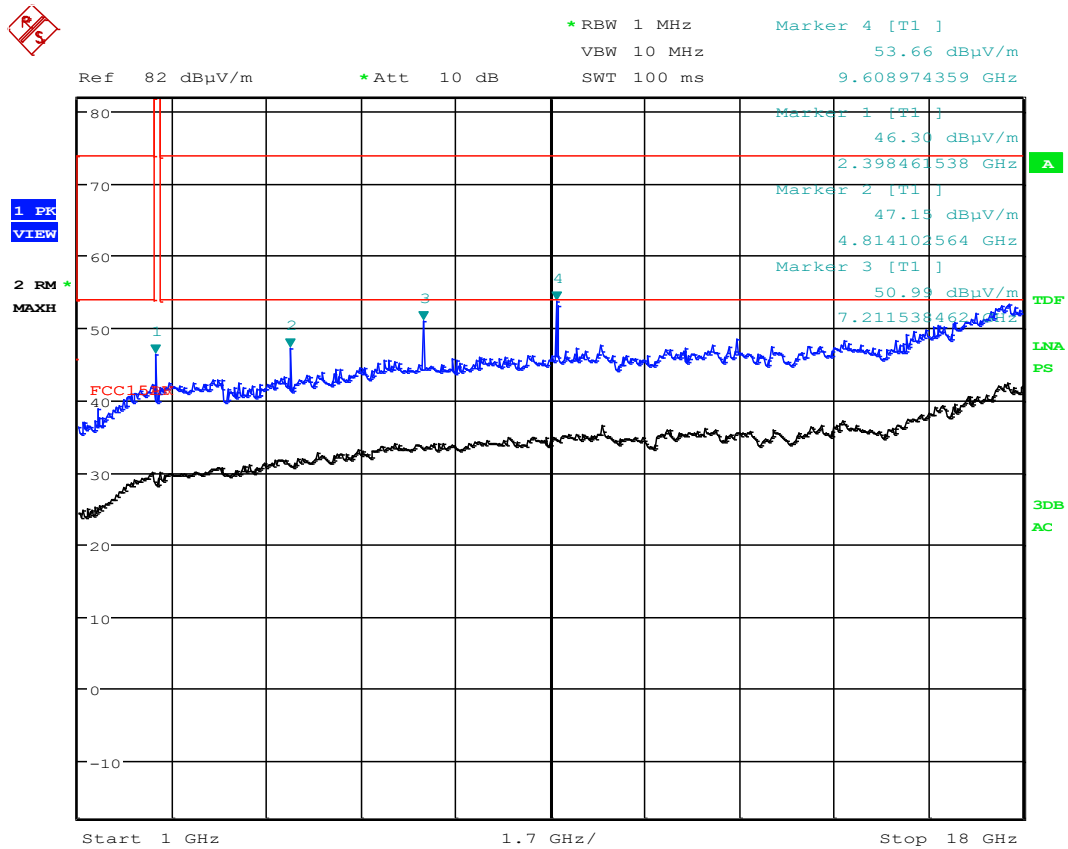
Date: 17.AUG.2020 16:44:21

Monopole antenna:4th Harmonic, VP, ch2440MHz



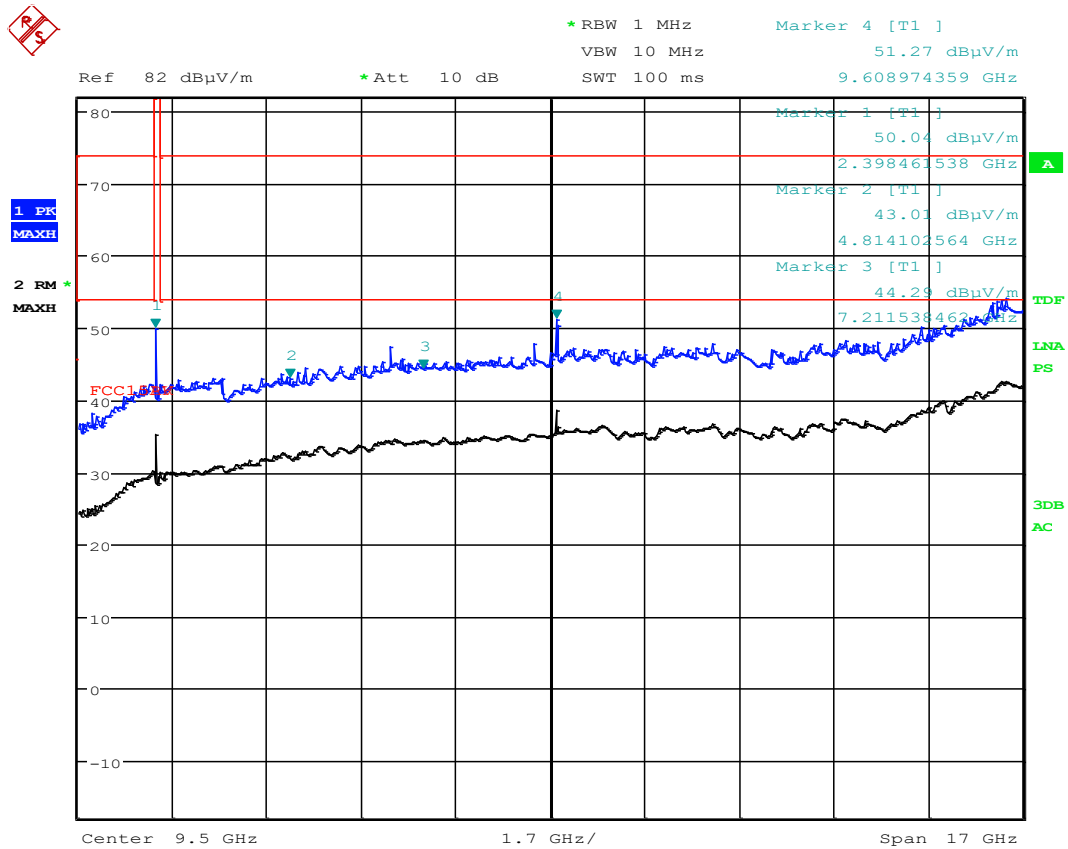
Date: 17.AUG.2020 16:46:48

Monopole antenna:4th Harmonic, VP



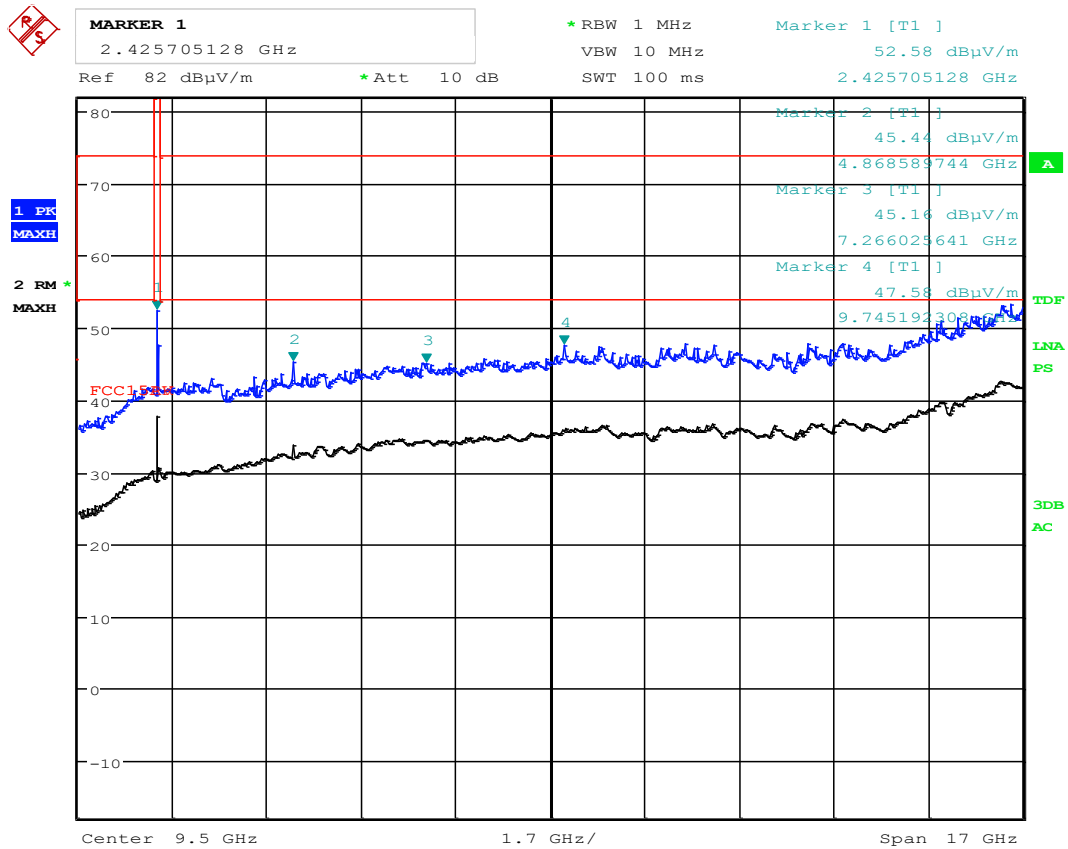
Date: 17.AUG.2020 16:28:33

Monopole antenna: Radiated spurious emissions, VP, 1 - 18GHz, ch2405MHz, PK scan



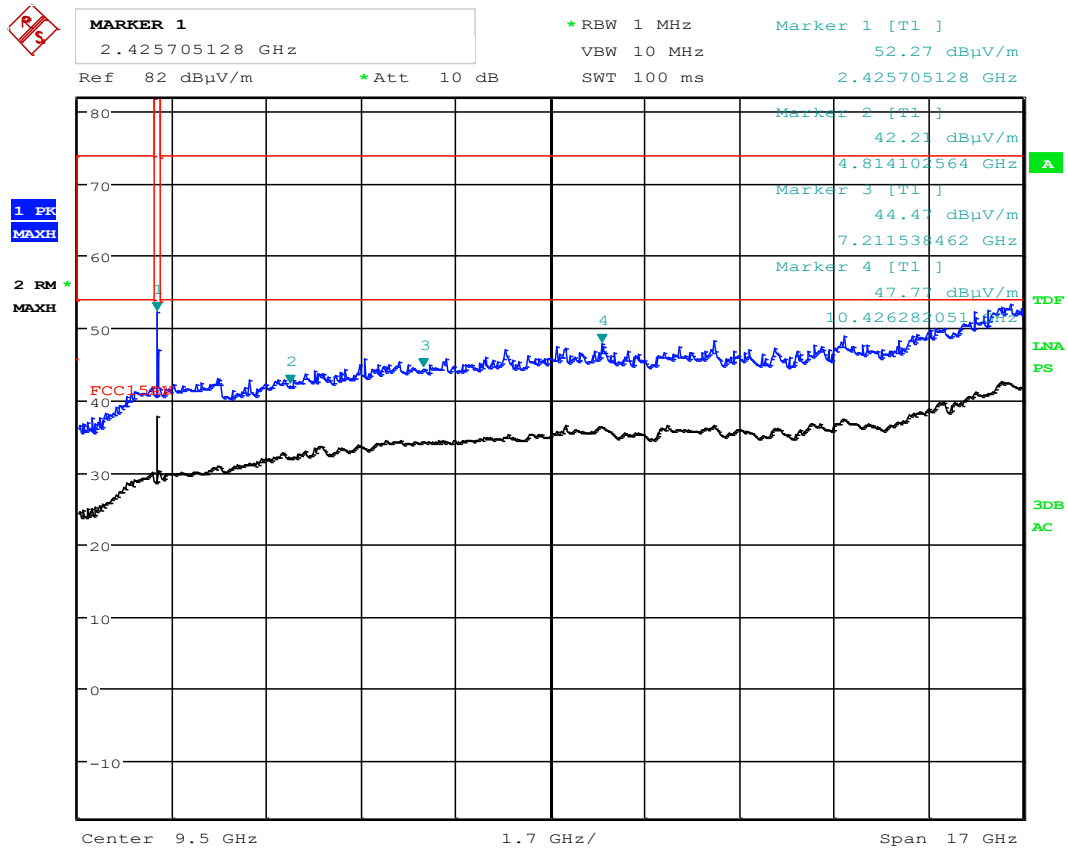
Date: 17.AUG.2020 16:31:38

Monopole antenna: Radiated spurious emissions, HP, 1 - 18GHz, ch2405MHz, PK scan



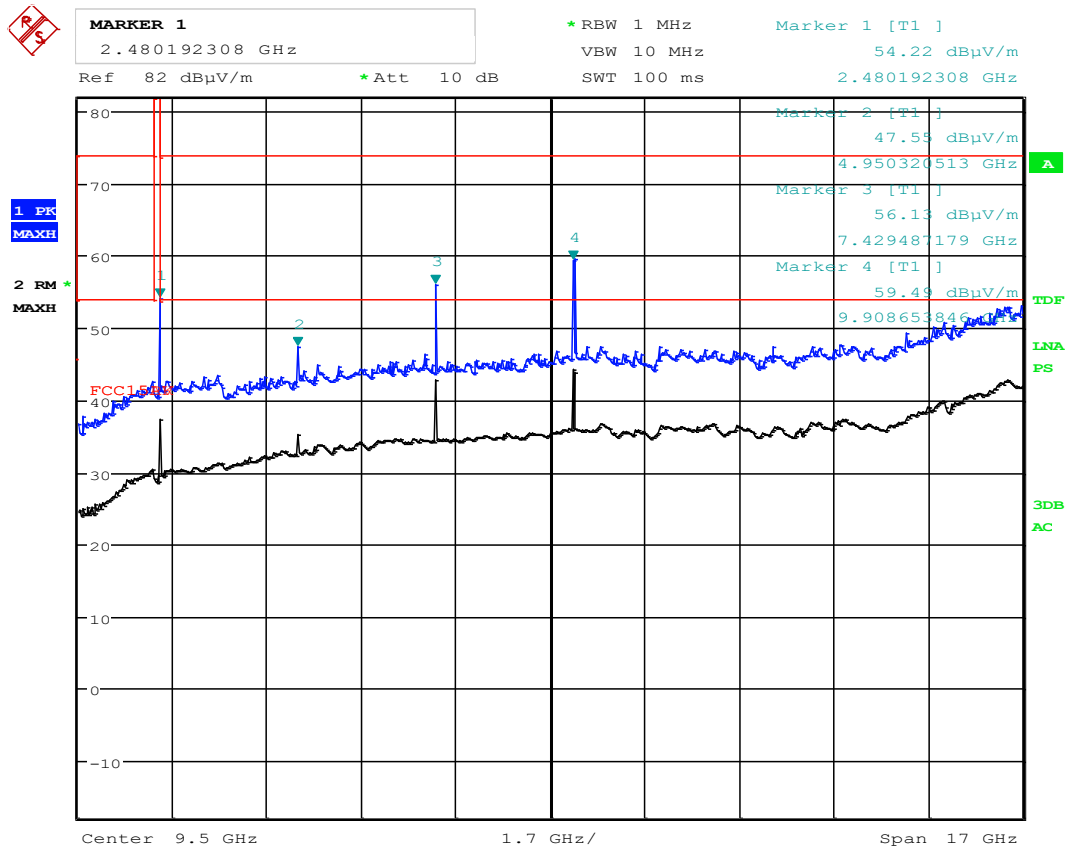
Date: 17.AUG.2020 16:38:58

Monopole antenna: Radiated spurious emissions, VP, 1 - 18GHz, ch2440MHz, PK scan



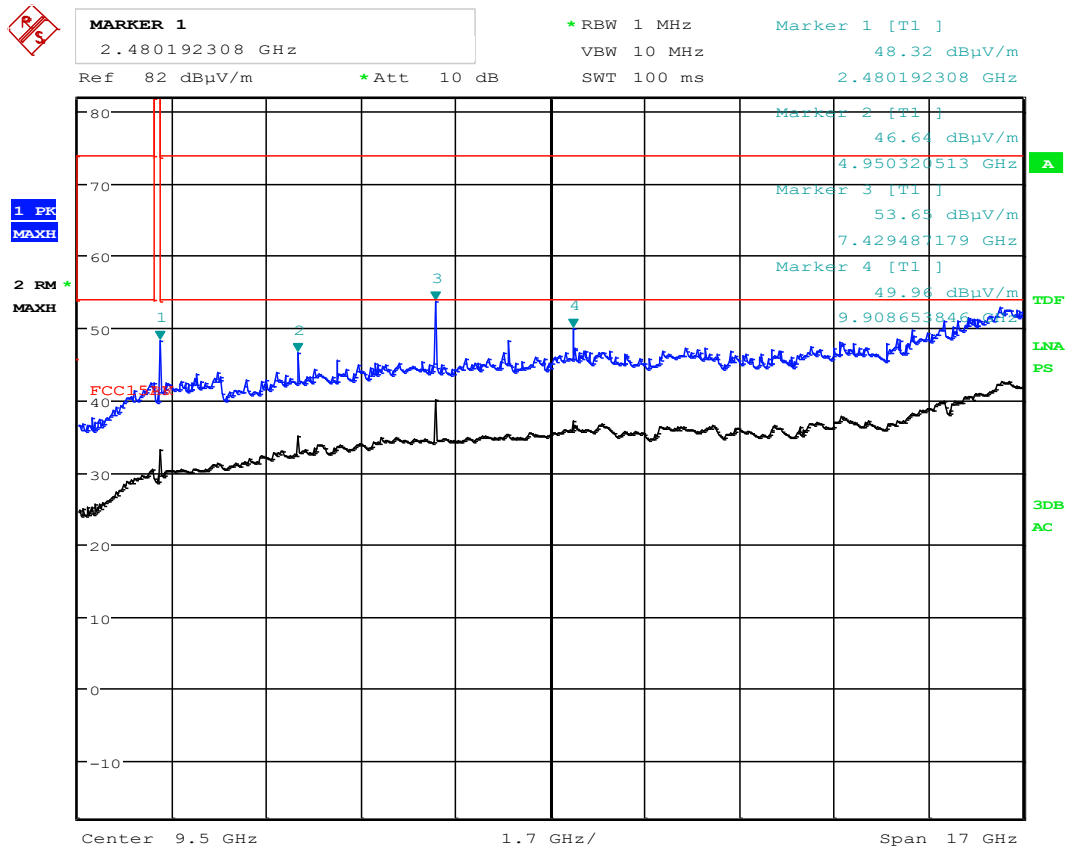
Date: 17.AUG.2020 16:37:38

Monopole antenna: Radiated spurious emissions, HP, 1 - 18GHz, ch2440MHz, PK scan



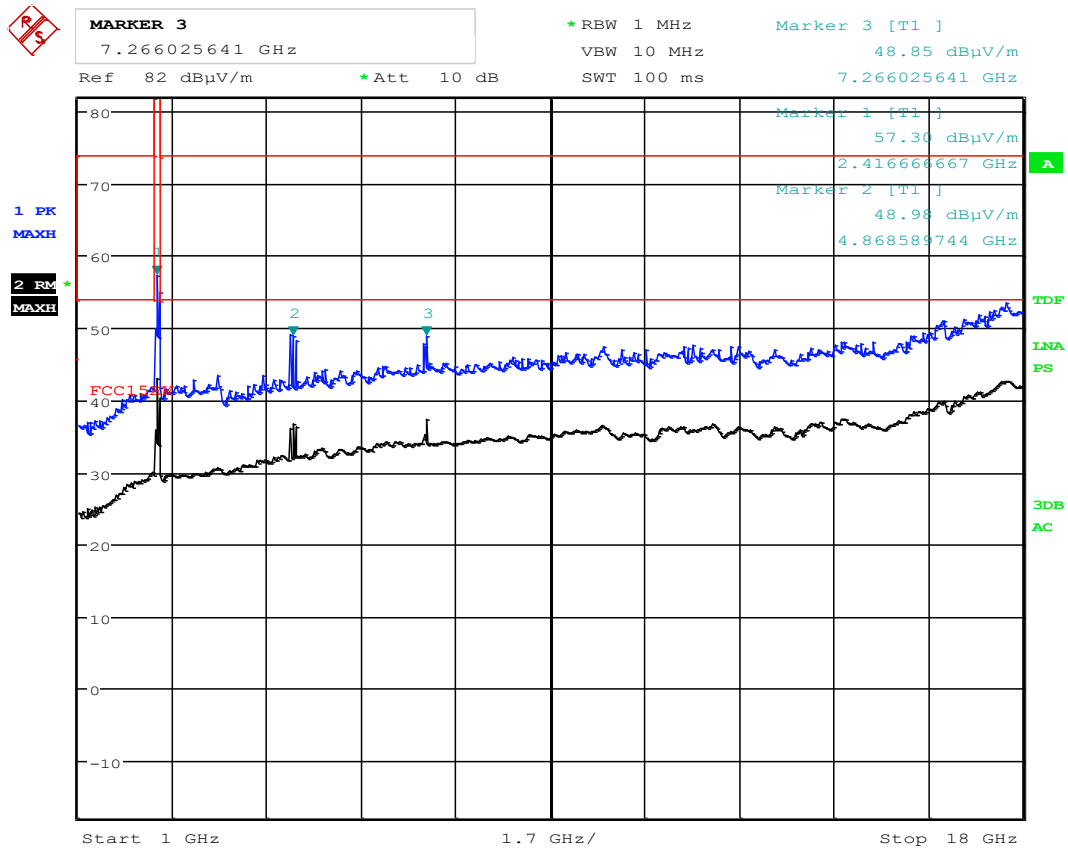
Date: 17.AUG.2020 16:52:15

Monopole antenna: Radiated spurious emissions, VP, 1 - 18GHz, ch2480MHz, PK scan



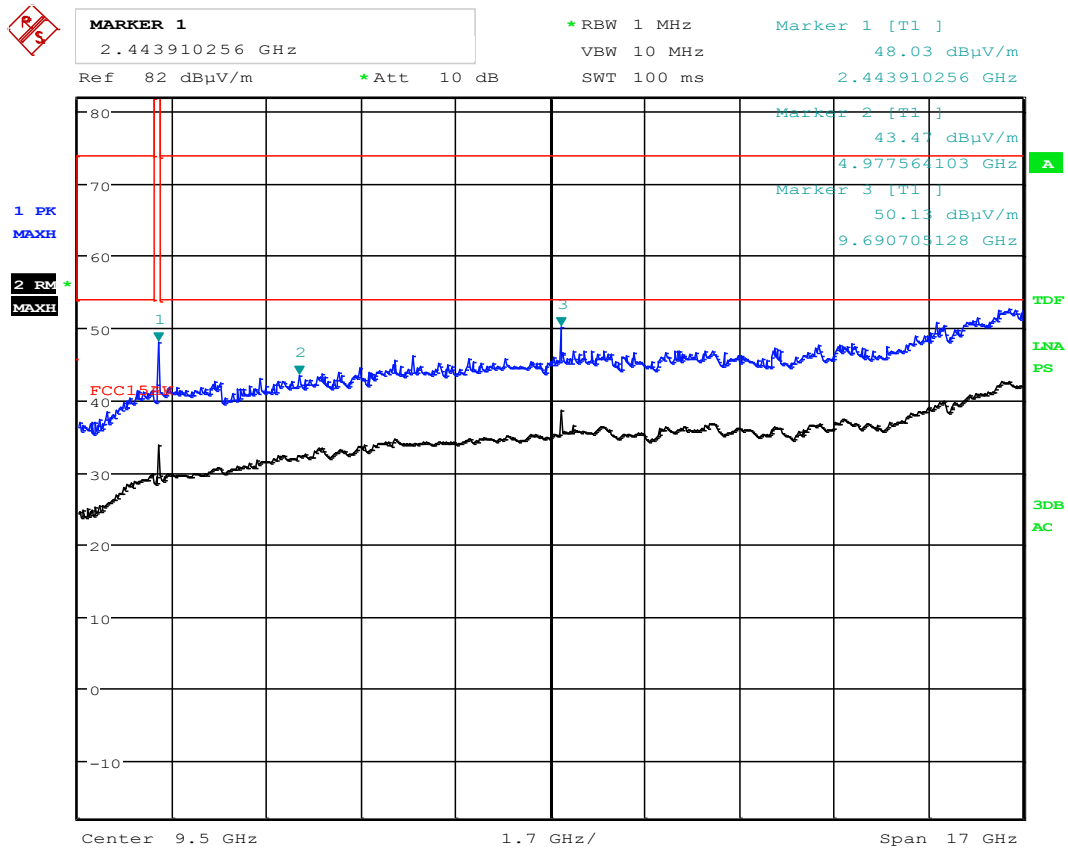
Date: 17.AUG.2020 16:51:04

Monopole antenna: Radiated spurious emissions, HP, 1 - 18GHz, ch2480MHz, PK scan



Date: 17.AUG.2020 15:39:04

Monopole antenna: Radiated spurious emissions, VP, 1 - 18GHz, In hopping mode, PK scan



Date: 17.AUG.2020 15:40:15

Monopole antenna: Radiated spurious emissions, HP, 1 - 18GHz, In hopping mode, PK scan



MARKER 1

24.5625 GHz

*RBW 1 MHz

VBW 3 MHz

SWT 45 ms

Marker 1 [T1]

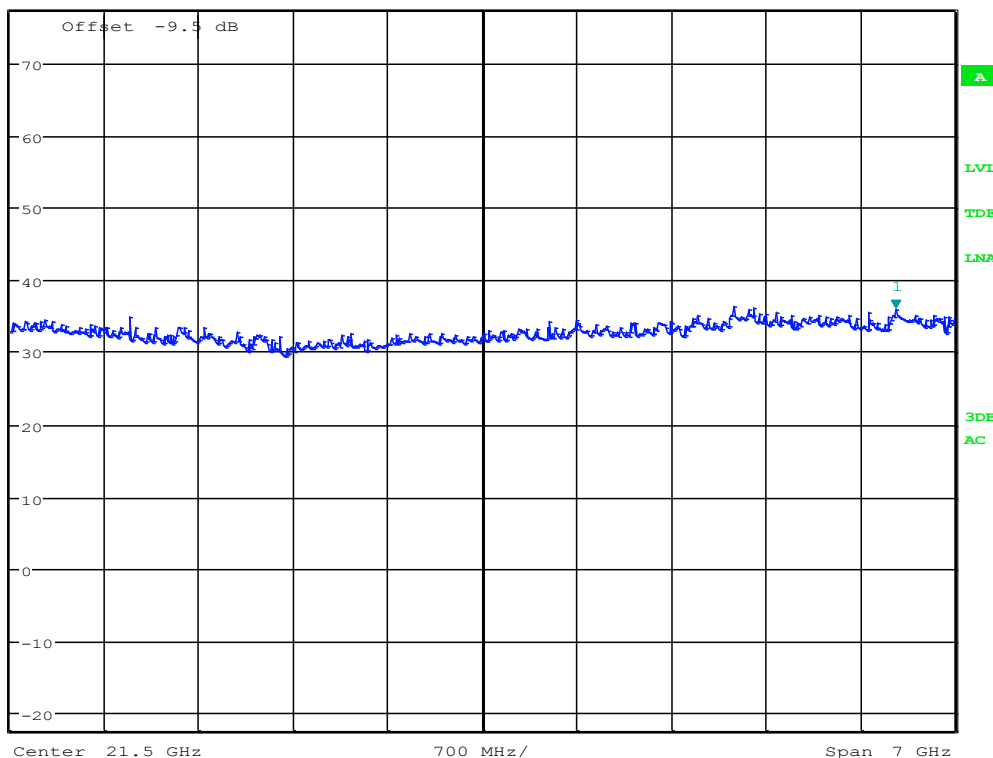
35.91 dBμV/m

24.562500000 GHz

Step 77.5 dBμV/m

*Att 10 dB

1 PK
MAXH



Date: 20.JUN.2020 09:17:40

Monopole antenna, Pre-scan, Radiated spurious emissions, VP, 18 - 25GHz



MARKER 1

24.73076923 GHz

*RBW 1 MHz

VBW 3 MHz

SWT 45 ms

Marker 1 [T1]

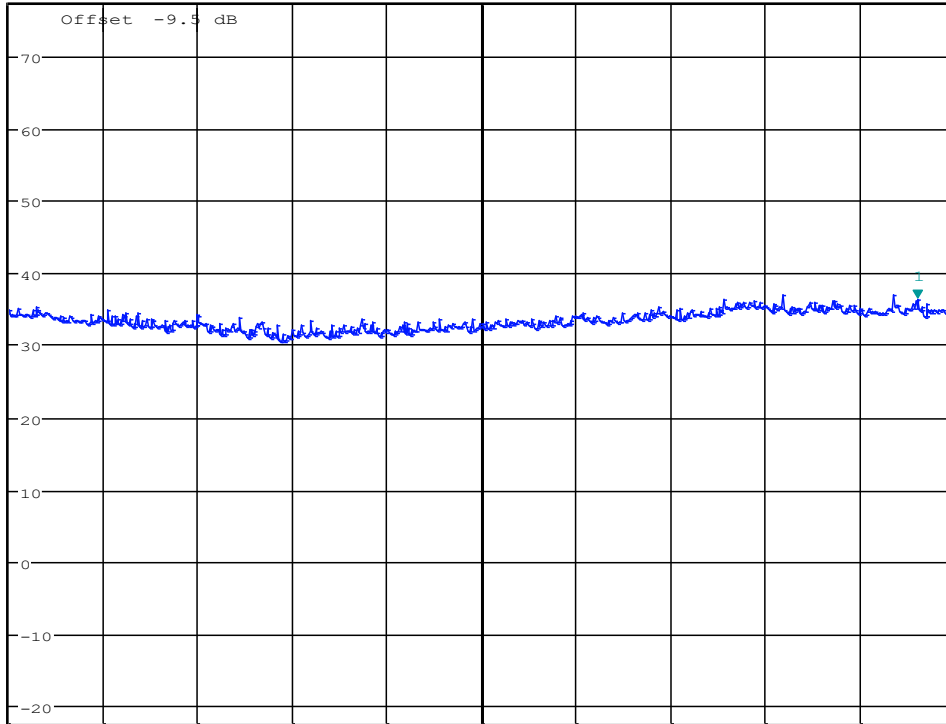
36.53 dBμV/m

24.730769231 GHz

Step 77.5 dBμV/m

*Att 10 dB

1 PK
MAXH



Center 21.5 GHz

700 MHz/

Span 7 GHz

Date: 20.JUN.2020 09:15:30

Monopole antenna, Pre-scan, Radiated spurious emissions, HP, 18 - 25GHz

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.

Dipole Antenna:

Restricted band:

Peak Detector:

Frequency	RF channel	Dist. corr. factor	Field strength, Peak Detector, 3m	Duty cycle corr. factor	Limit	Margin
GHz		dB	dB μ V/m	dB	dB μ V/m	dB
4.81	L	0	44.91	/	74	29.09
4.88	M	0	51.52	/	74	22.48
4.96	H	0	54.06	/	74	19.94
7.32	M	0	54.37	/	74	19.63
7.44	H	0	59.13	/	74	14.87
Other freqs	/	0	Below AV limit	/	74	>20

Restricted band:

Average Detector:

Frequency	RF channel	Dist. corr. factor	Field strength, Peak Detector, 3m	Duty cycle corr. factor	Limit	Margin
GHz		dB	dB μ V/m	dB	dB μ V/m	dB
4.81	L	0	/	20	54	/
4.88	M	0	/	20	54	/
4.96	H	0	34.06	20	54	19.94
7.32	M	0	34.37	20	54	19.63
7.44	H	0	39.13	20	54	14.87
Other freqs	/	0	Below AV limit	/	54	>20

Maximum is obtained in vertical polarization.

Duty Cycle Correction factor = $-20 \times \log(0.043) = -27$ dB (Duty cycle: 4.3%) , For single channel

Hopping channels 16.

Maximum allowed Duty Cycle Correction: 20 dB

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

A High Pass Filter was used for measurements from 3 GHz to 18 GHz.

Non- Restricted band:

Peak Detector:

Frequency	RF channel	Dist. corr. factor	Field strength of emission Peak Detector, 3m	Field strength of Fundamental frequency Peak Detector, 3m	Limit	Margin
MHz	MHz	dB	dB μ V/m	dB μ V/m	dBc	dB
7.21	L	0	53.88	112.3	20	58.42
9.62	L	0	59.90	112.3	20	52.40
9.76	M	0	52.53	117.9	20	65.37
9.92	H	0	50.01	117.9	20	67.89
Other freqs	hopping	0	None detected	112	20	/

Maximum is obtained in vertical polarization.

Duty Cycle Correction factor = $-20 \times \log(0.043) = -27$ dB (Duty cycle: 4.3%)

Maximum allowed Duty Cycle Correction: 20 dB

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

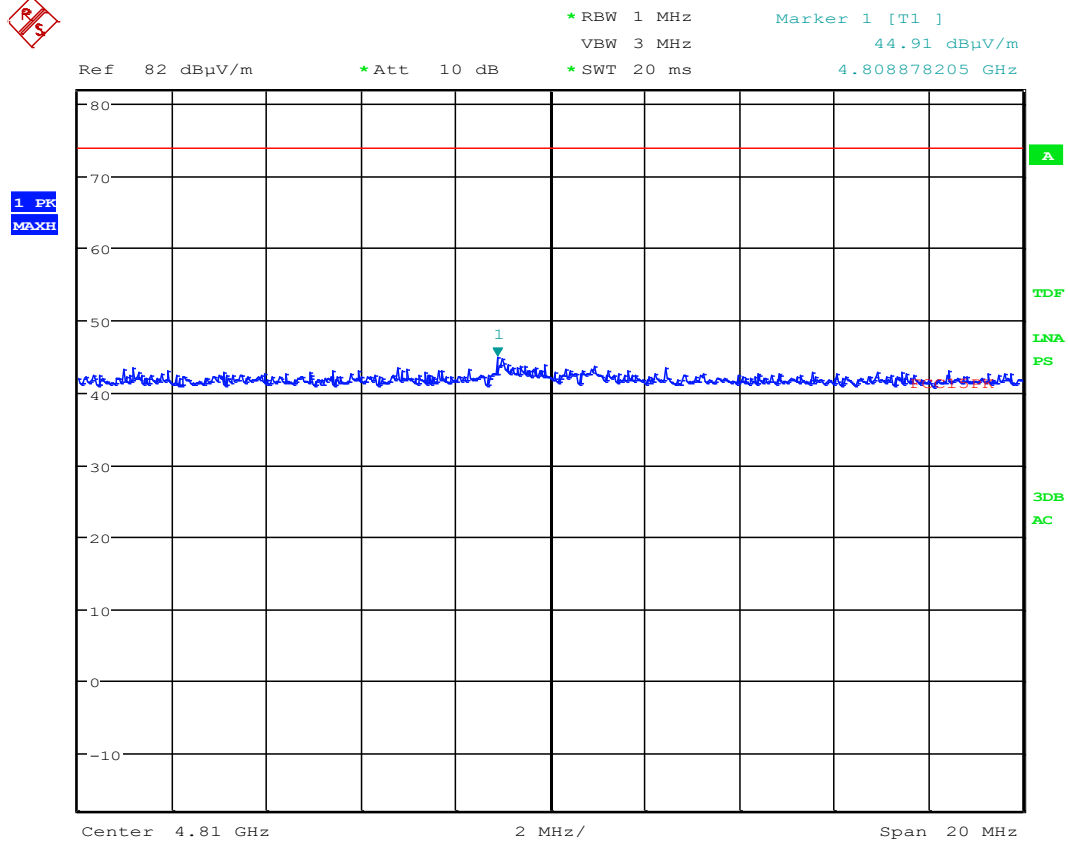
A Notch Filter was used for measurements from 1 GHz to 18 GHz .

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

See plots.

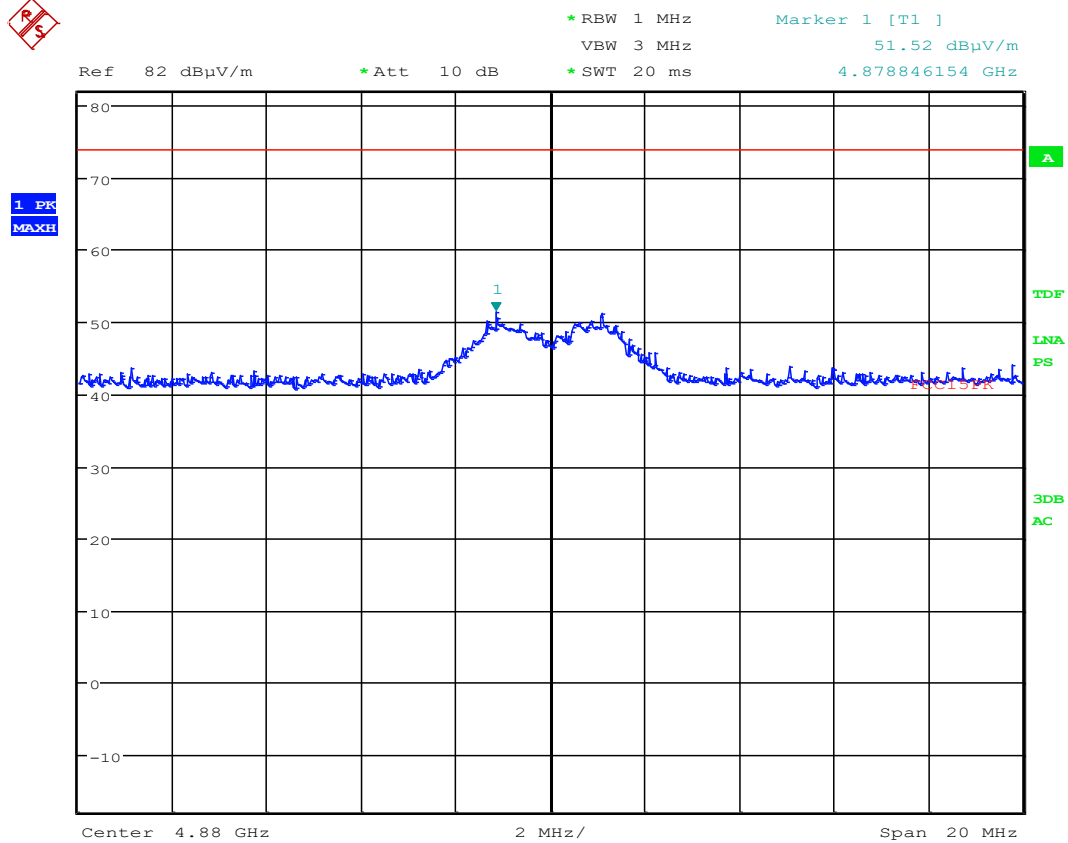
Requirements/Limit

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: 17.AUG.2020 13:42:55

Dipole antenna:2nd Harmonic, HP, ch2405MHz



Date: 17.AUG.2020 14:00:11

Dipole antenna:2nd Harmonic, HP, ch2440MHz



MARKER 1

4.959423077 GHz

* RBW 1 MHz

VBW 3 MHz

* SWT 20 ms

Marker 1 [T1]

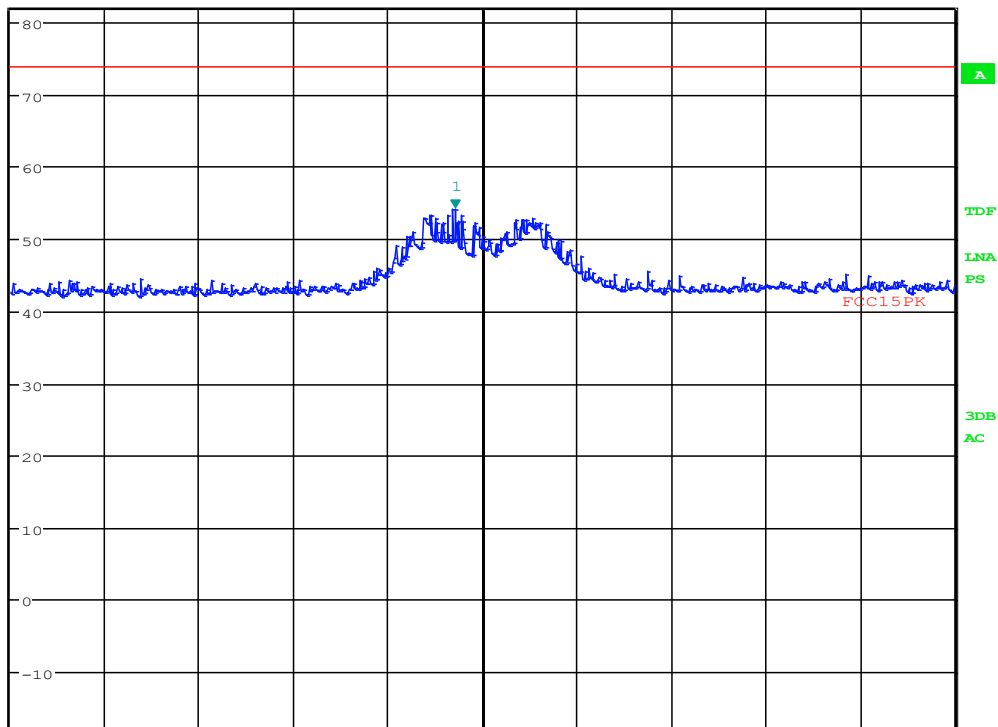
54.06 dBμV/m

4.959423077 GHz

Ref 82 dBμV/m

* Att 10 dB

1 PK
MAXH



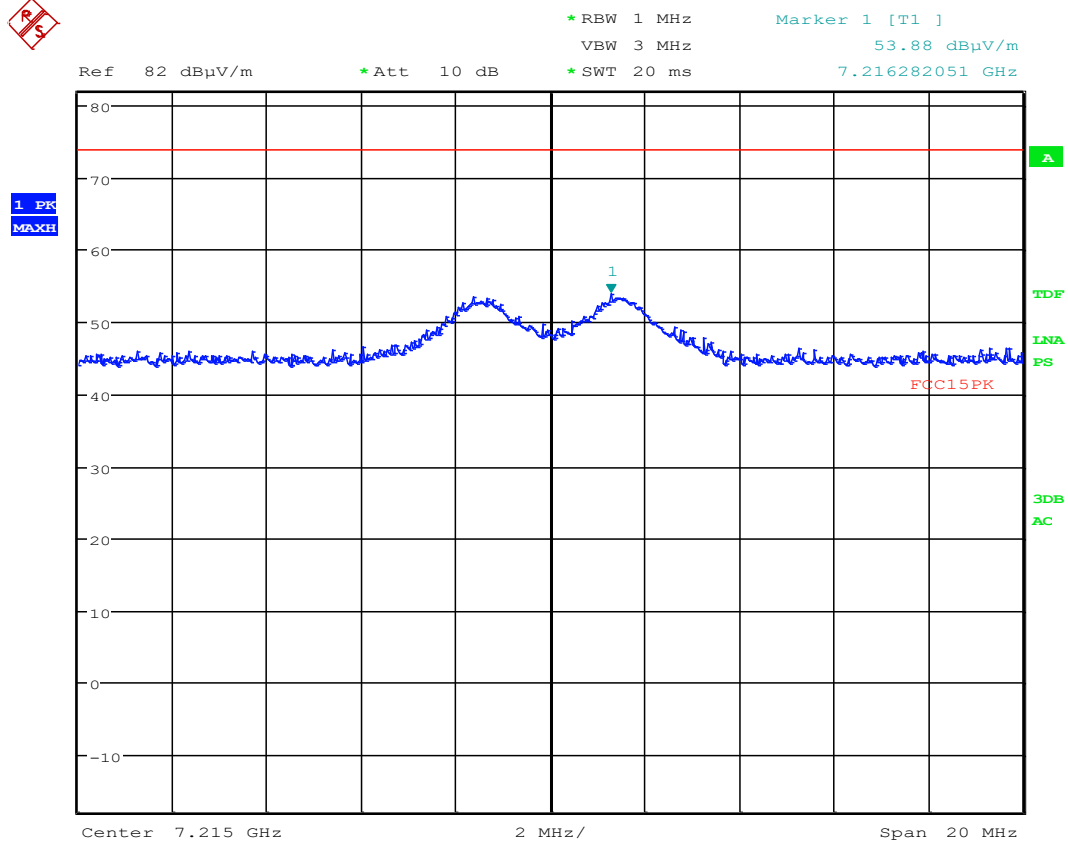
Center 4.96 GHz

2 MHz/

Span 20 MHz

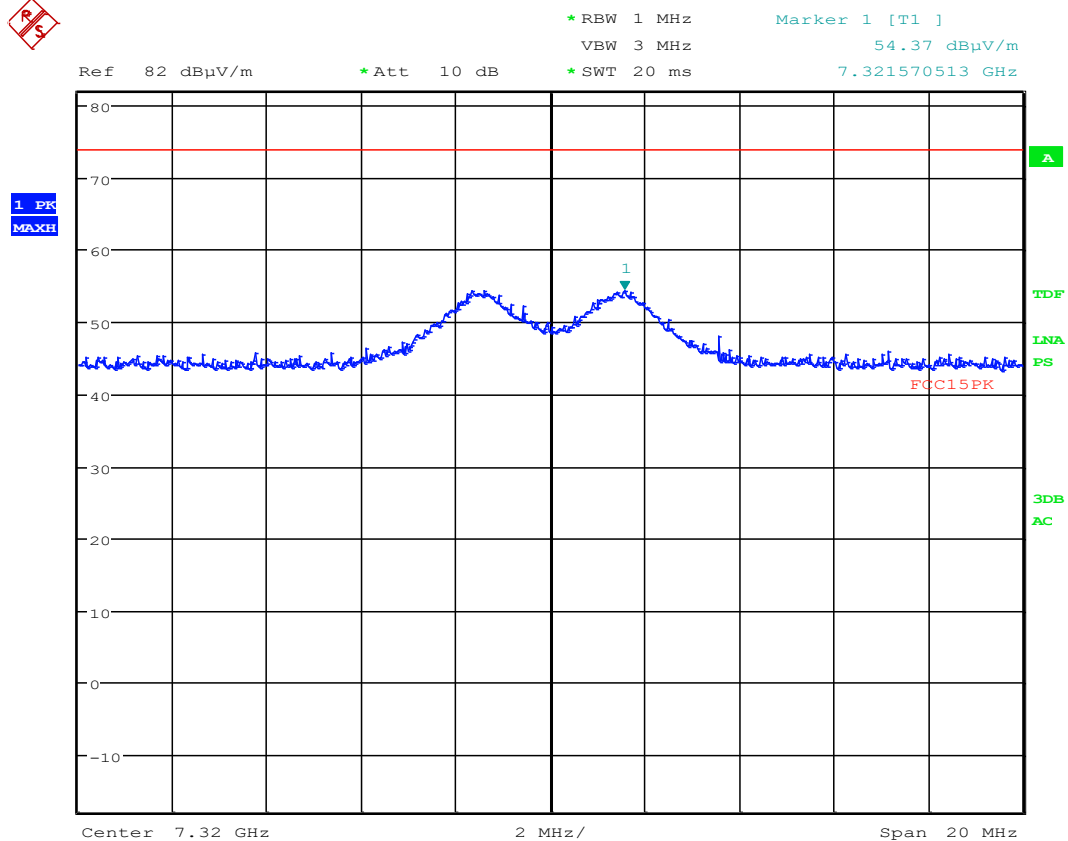
Date: 17.AUG.2020 14:42:36

Dipole antenna:2nd Harmonic, HP, ch2480MHz



Date: 17.AUG.2020 13:19:09

Dipole antenna:3rd Harmonic, VP, ch2405MHz



Date: 17.AUG.2020 14:28:31

Dipole antenna:3rd Harmonic, VP, ch2440MHz



MARKER 1

7.438333333 GHz

* RBW 1 MHz

VBW 3 MHz

* SWT 20 ms

Marker 1 [T1]

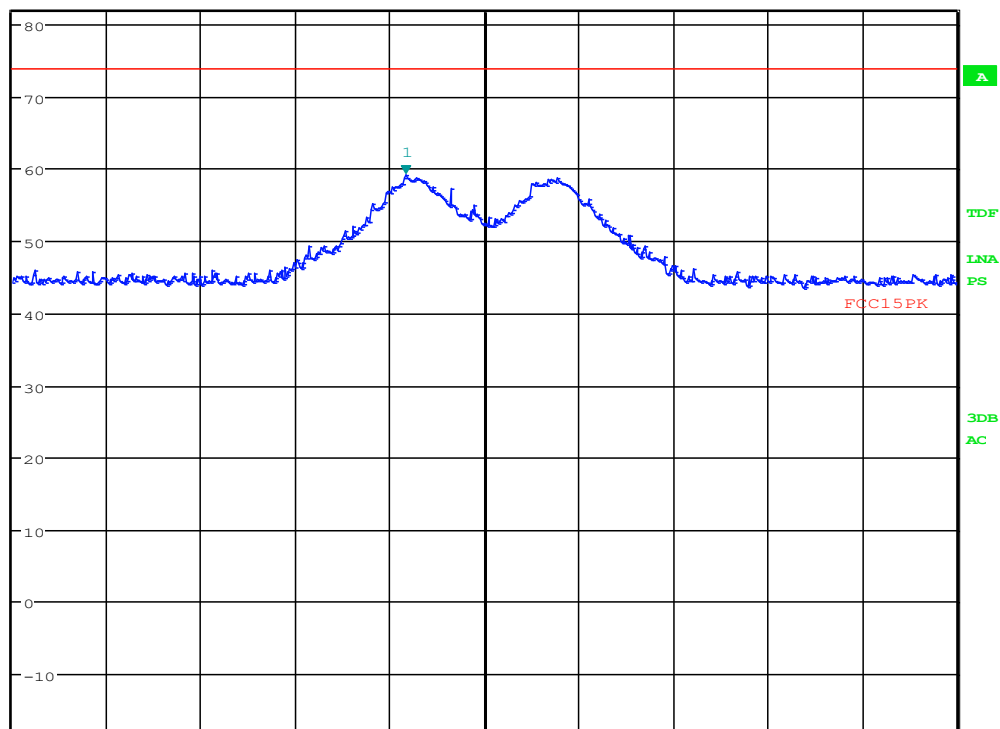
59.13 dBμV/m

7.438333333 GHz

Ref 82 dBμV/m

* Att 10 dB

1 PK
MAXH



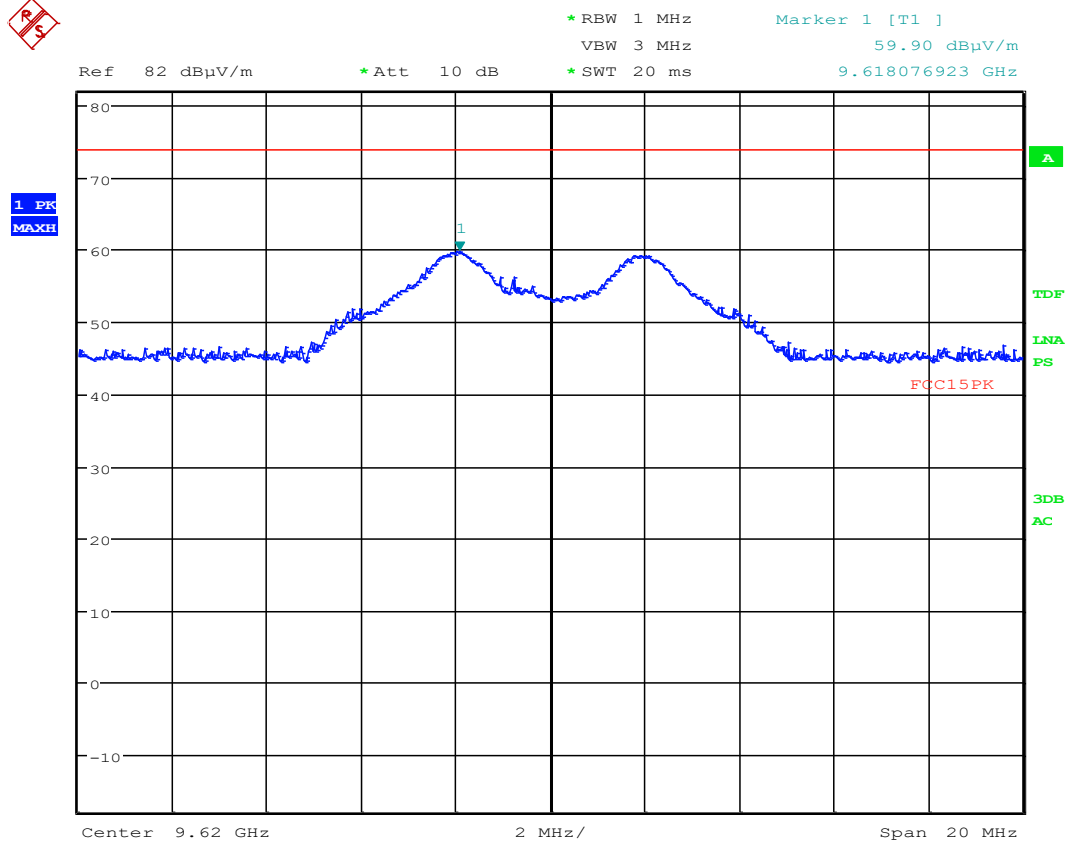
Center 7.44 GHz

2 MHz/

Span 20 MHz

Date: 17.AUG.2020 14:39:30

Dipole antenna:3rd Harmonic, VP, ch2480MHz



Date: 17.AUG.2020 13:33:57

Dipole antenna:4th Harmonic, VP, ch2405MHz



MARKER 1

9.761955128 GHz

* RBW 1 MHz

VBW 3 MHz

* SWT 20 ms

Marker 1 [T1]

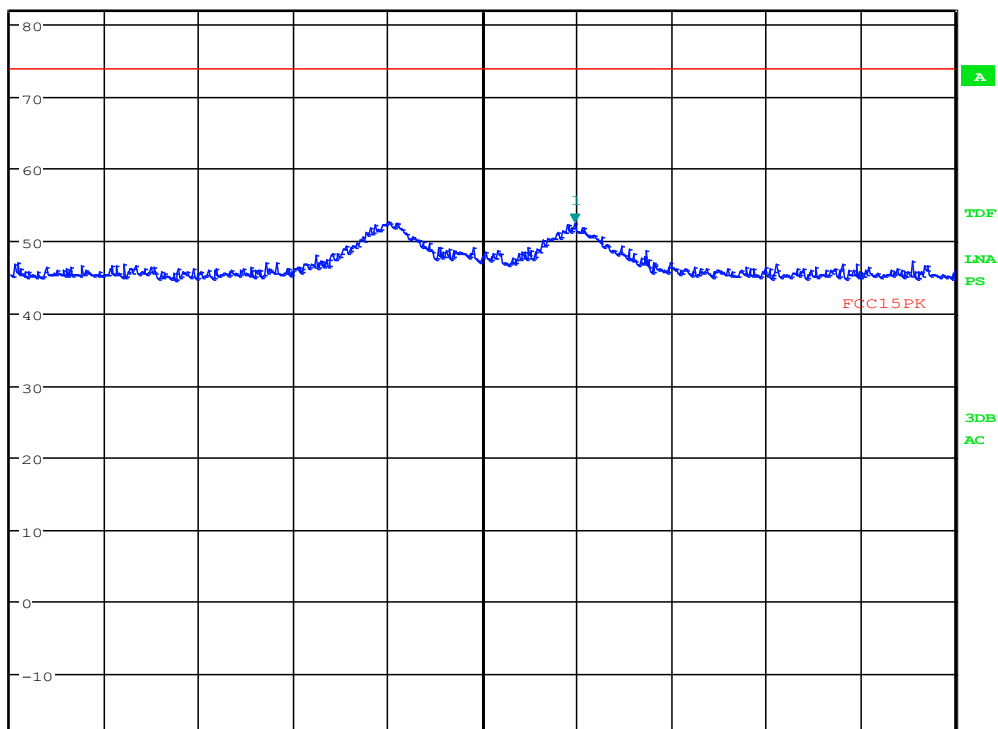
52.53 dBμV/m

9.761955128 GHz

Ref 82 dBμV/m

* Att 10 dB

1 PK
MAXH



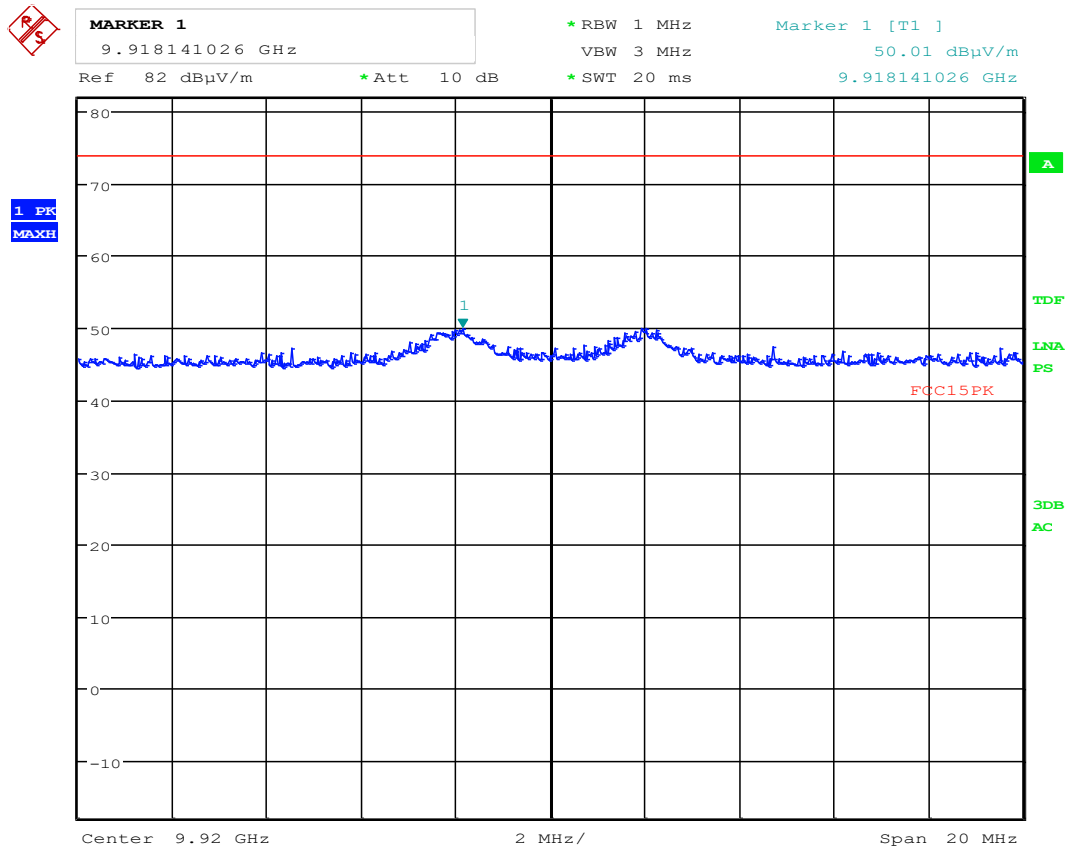
Center 9.76 GHz

2 MHz/

Span 20 MHz

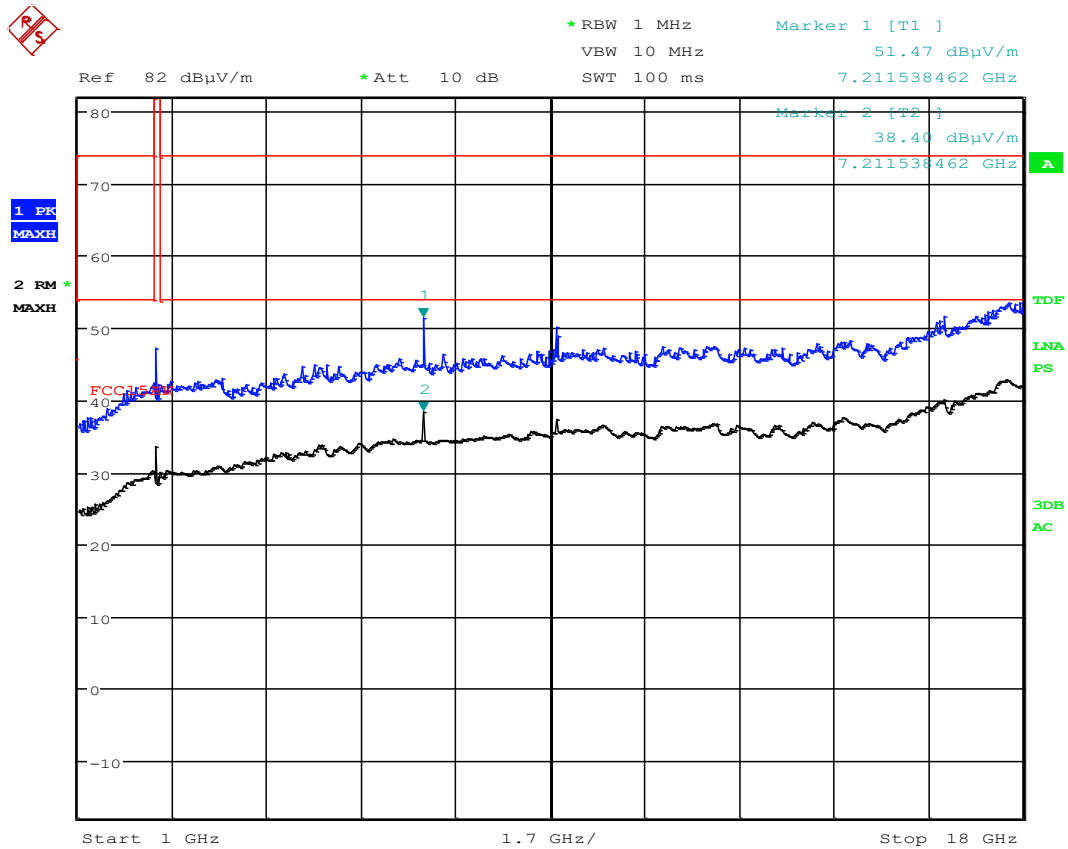
Date: 17.AUG.2020 14:34:59

Dipole antenna:4th Harmonic, VP, ch2440MHz



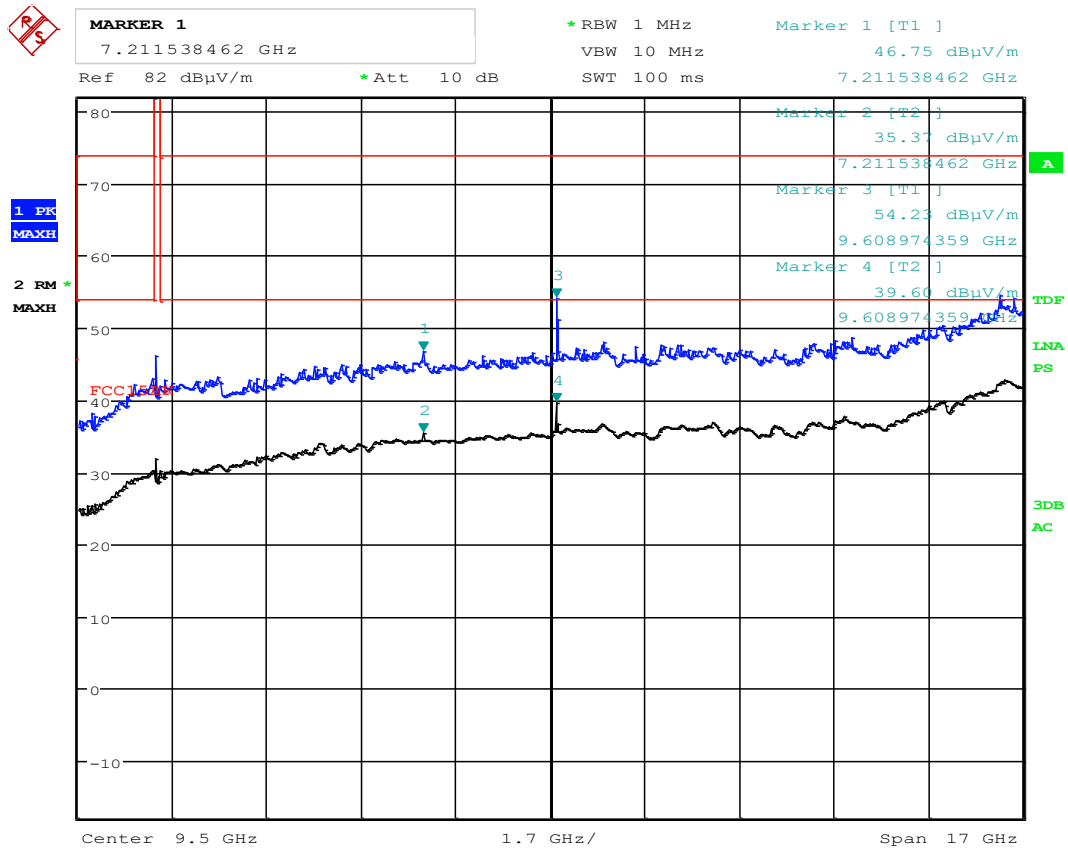
Date: 17.AUG.2020 14:37:13

Dipole antenna:4th Harmonic, VP, ch2480MHz



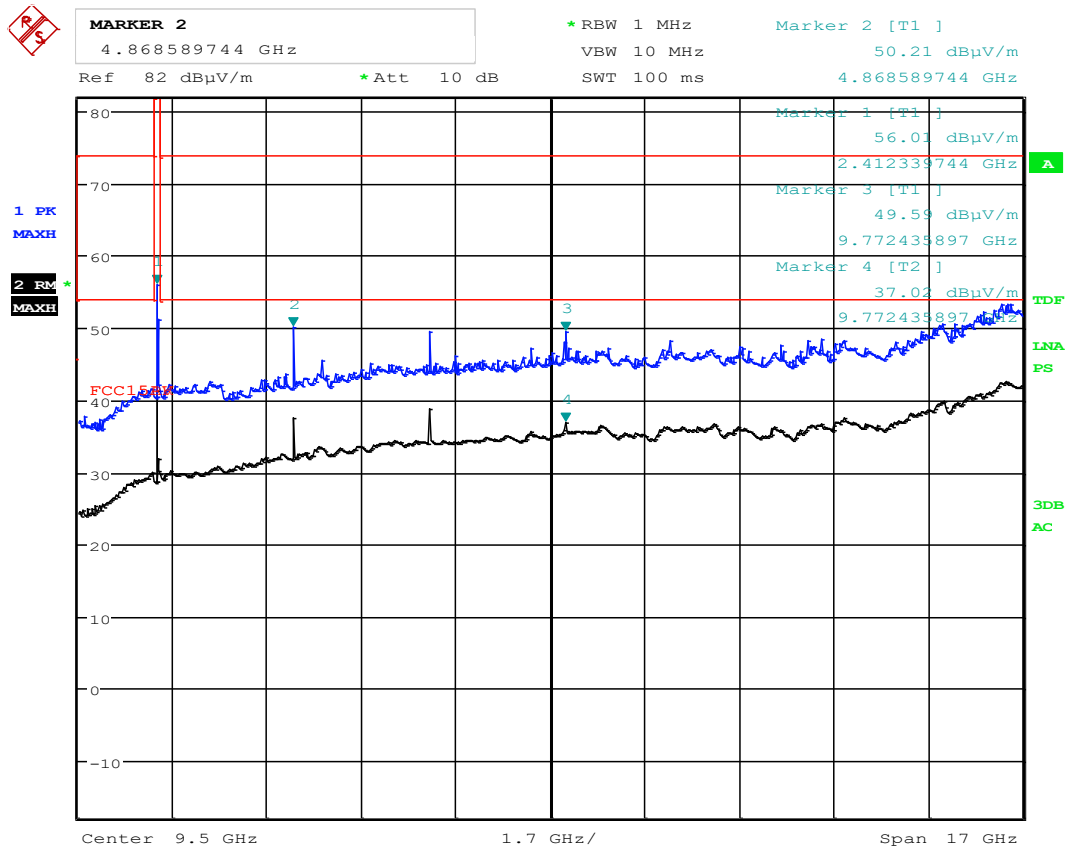
Date: 17.AUG.2020 13:06:46

Dipole Antenna: Radiated spurious emissions, VP, 1 - 18GHz, ch2405MHz, PK scan



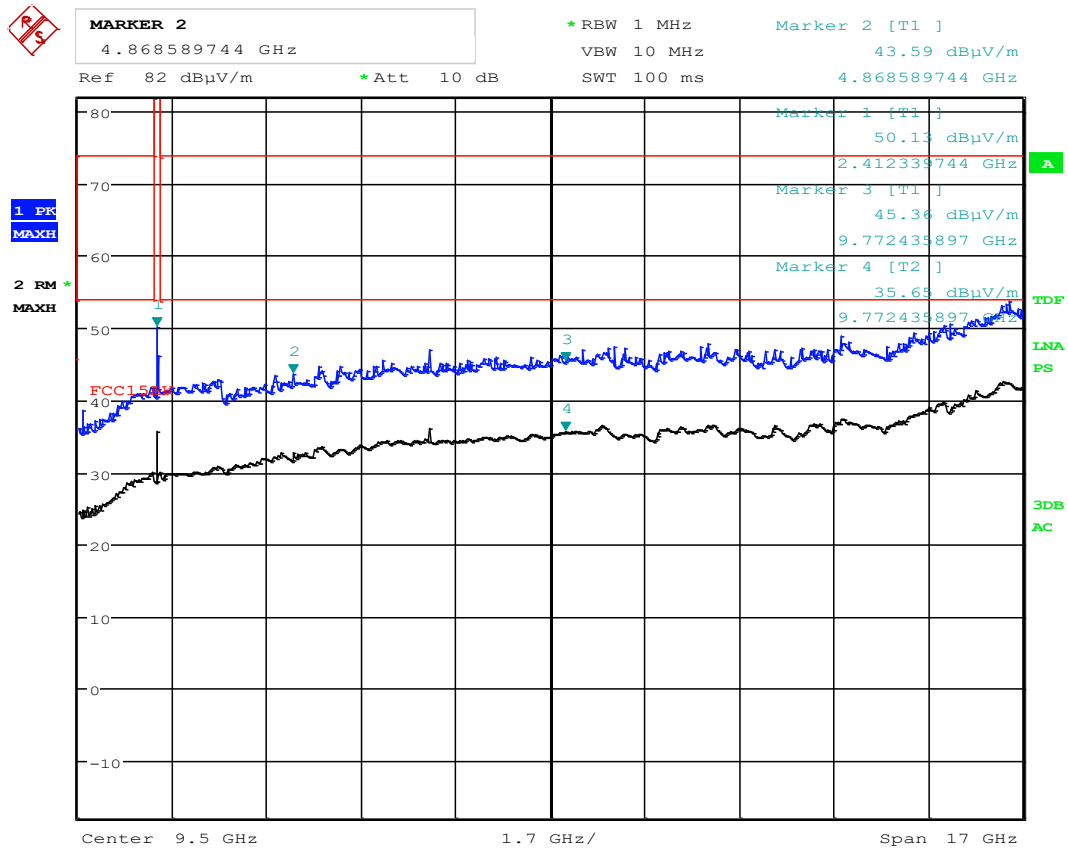
Date: 17.AUG.2020 13:09:07

Dipole Antenna: Radiated spurious emissions, HP, 1 - 18GHz, ch2405MHz, PK scan



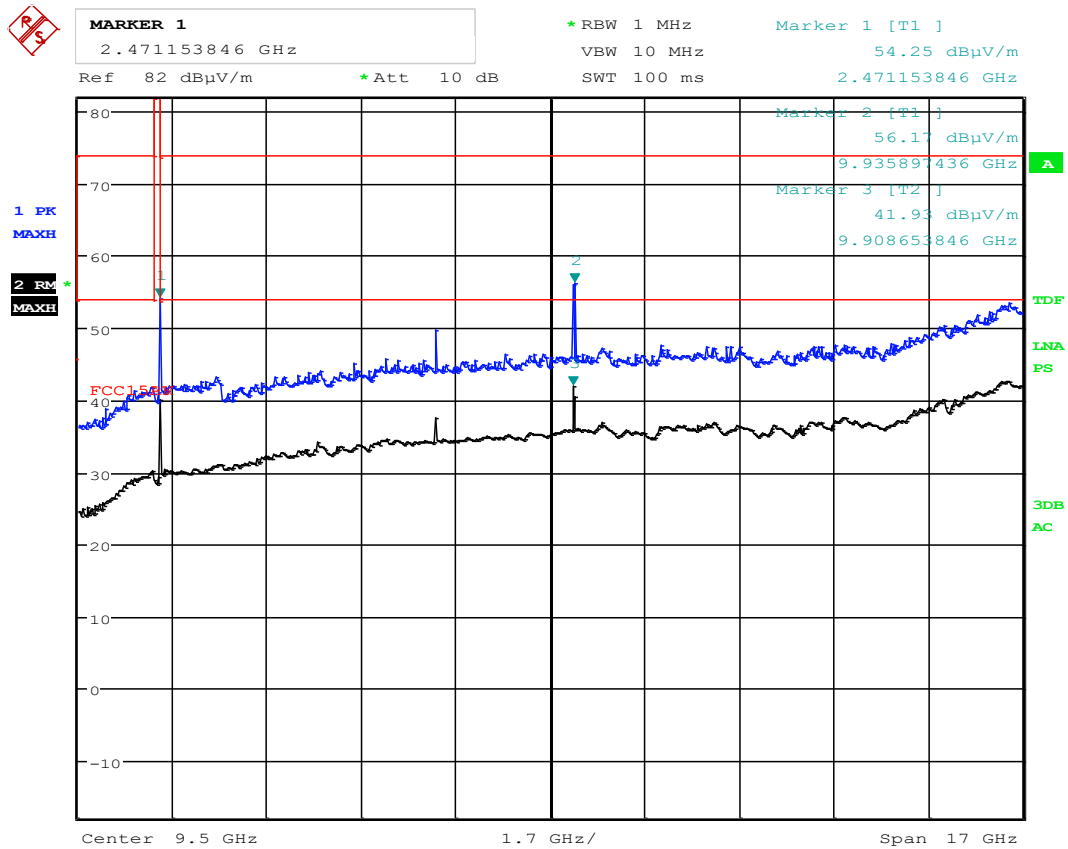
Date: 17.AUG.2020 13:50:07

Dipole Antenna: Radiated spurious emissions, VP, 1 - 18GHz, ch2440MHz, PK scan



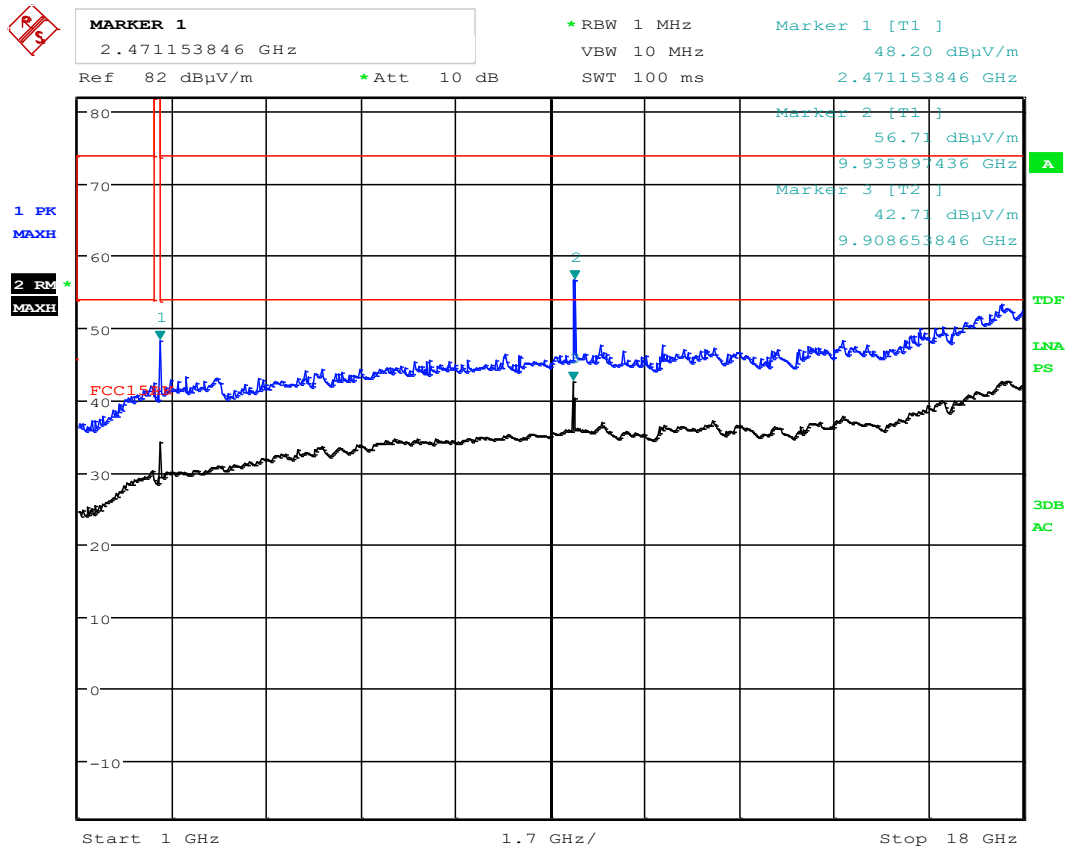
Date: 17.AUG.2020 13:51:25

Dipole Antenna: Radiated spurious emissions, HP, 1 - 18GHz, ch2440MHz, PK scan



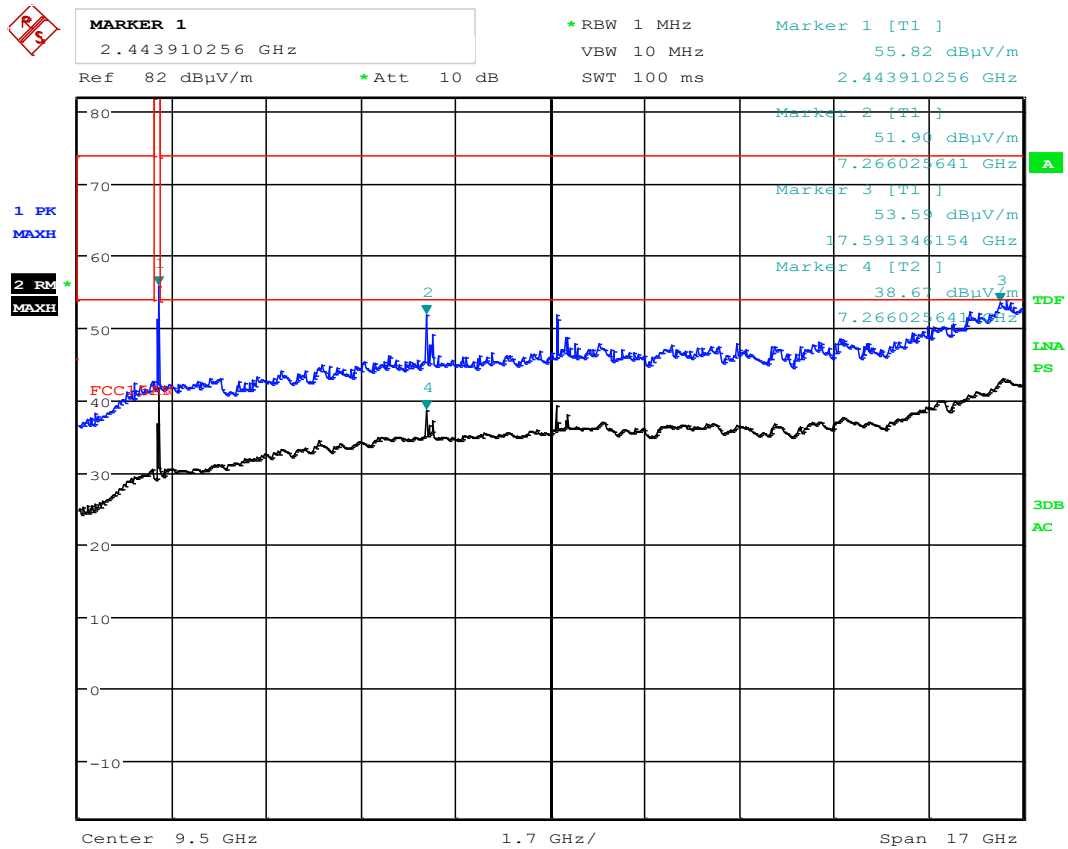
Date: 17.AUG.2020 14:45:54

Dipole Antenna: Radiated spurious emissions, VP, 1 - 18GHz, ch2480MHz, PK scan



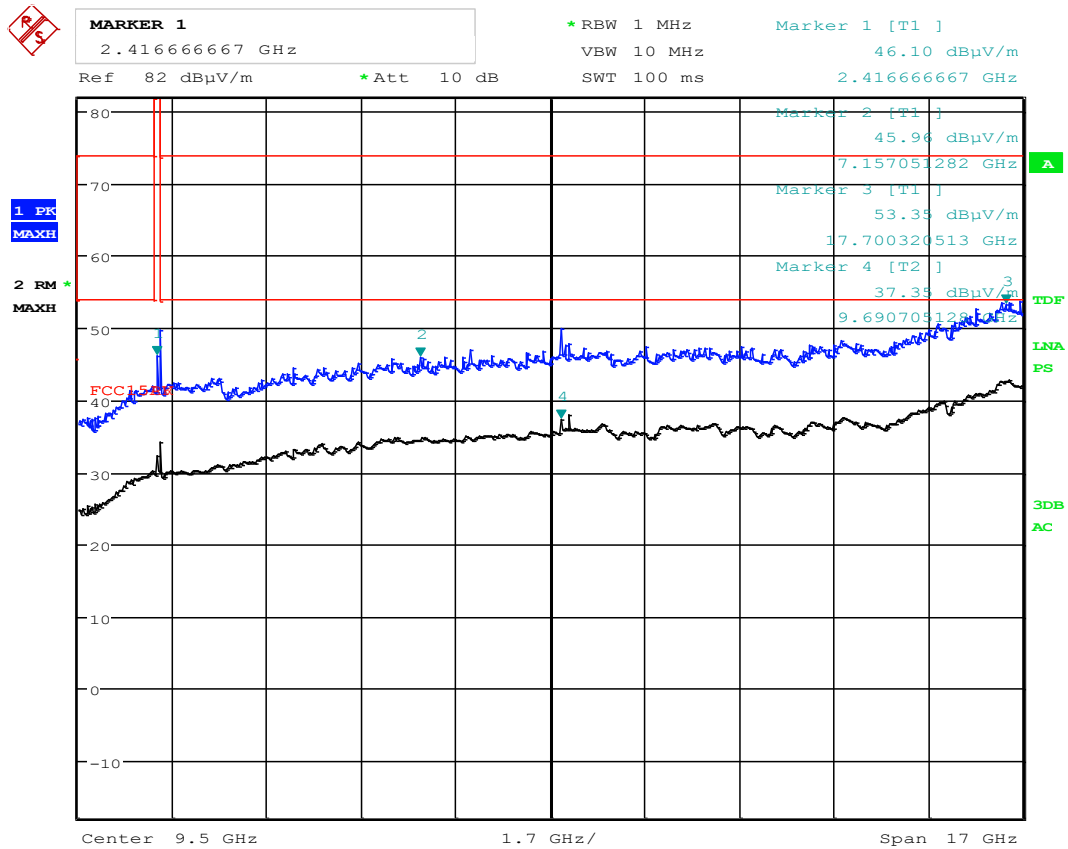
Date: 17.AUG.2020 14:47:05

Dipole Antenna: Radiated spurious emissions, HP, 1 - 18GHz, ch2480MHz, PK scan



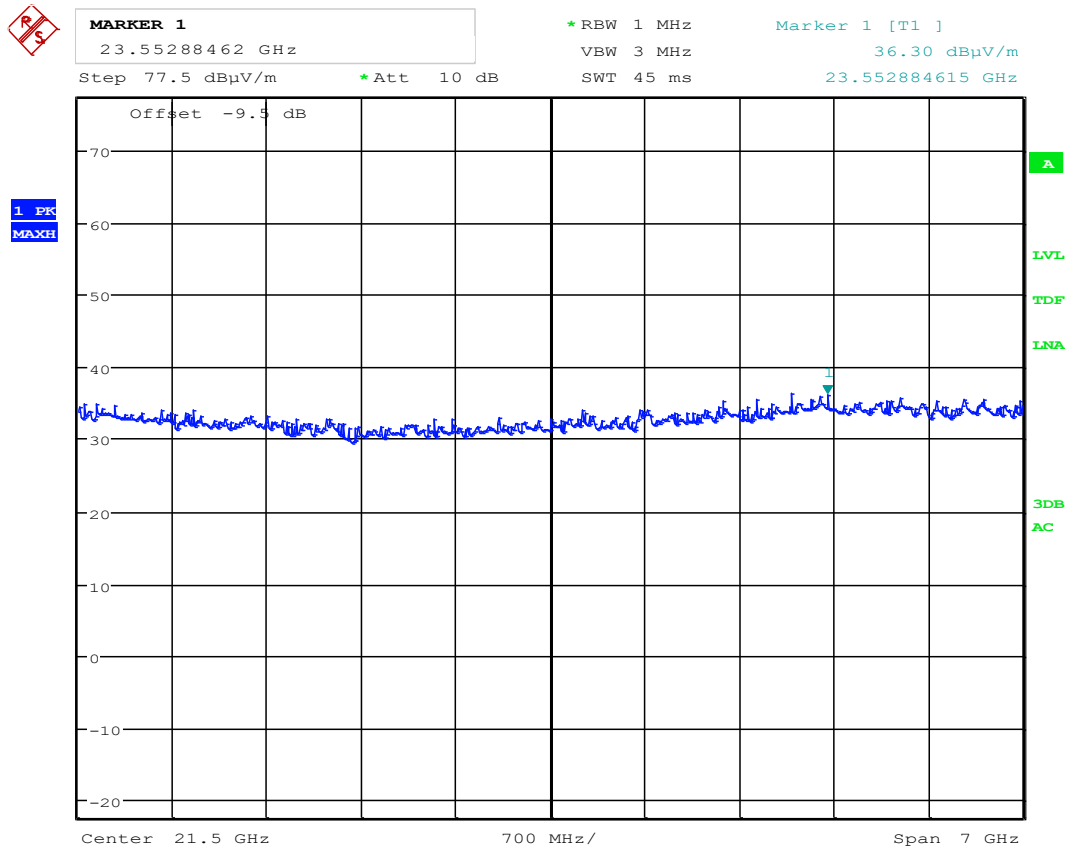
Date: 17.AUG.2020 13:00:23

Dipole Antenna: Radiated spurious emissions, VP, 1 - 18GHz,in hopping mode, PK scan



Date: 17.AUG.2020 13:02:40

Dipole Antenna: Radiated spurious emissions, HP, 1 - 18GHz,in hopping mode, PK scan



Date: 20.JUN.2020 09:18:51

Dipole Antenna, Pre-scan, Radiated spurious emissions, VP, 18 - 25GHz



MARKER 1

23.47435897 GHz

Step 77.5 dBμV/m

*Att 10 dB

*RBW 1 MHz

VBW 3 MHz

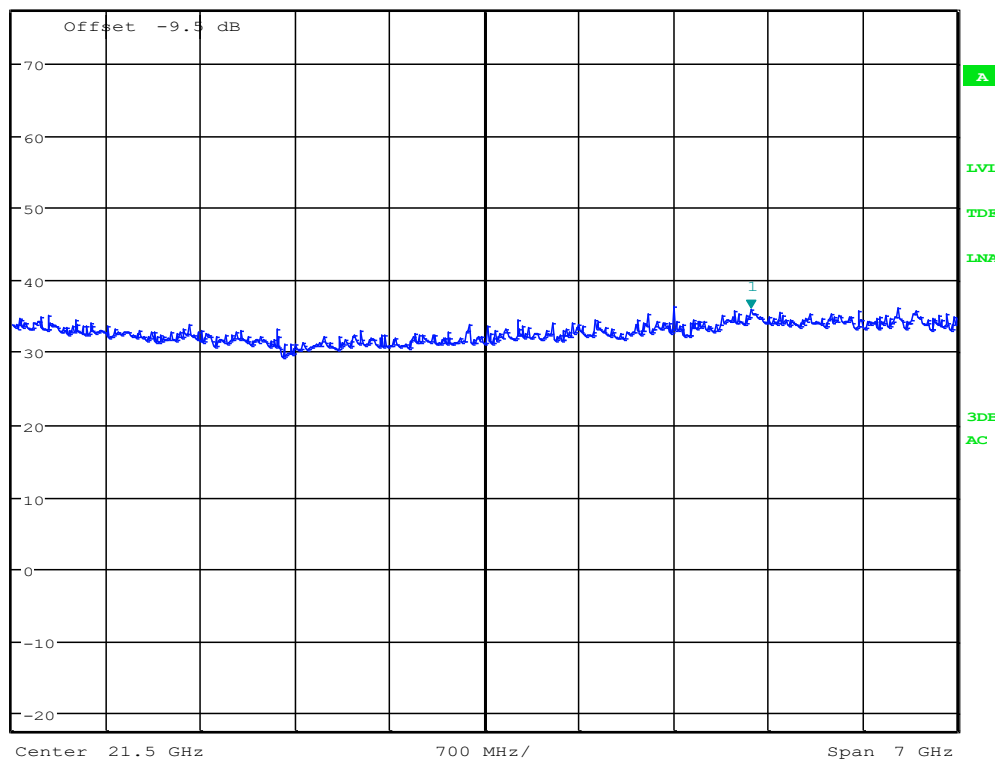
SWT 45 ms

Marker 1 [T1]

36.04 dBμV/m

23.474358974 GHz

1 PK
MAXH



Date: 20.JUN.2020 09:18:37

Dipole Antenna, Pre-scan, Radiated spurious emissions, HP, 18 - 25GHz

3.13 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

4 LIST OF TEST EQUIPMENT

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

No.	Instrument/ ancillary	Type of instrument/ ancillary	Manufacturer	Ref. no.	Cal. Date	Cal. Due
1.	ESU40	EMI Receiver	Rohde & Schwarz	LR1639	2020.01	2021.01
2.	FSW43	Spectrum analyser	Rohde & Schwarz	LR1690	2020.01	2021.01
3.	HFH2-Z2	Active Loop antenna	Rohde & Schwarz	LR1660	2019.06	2021.06
4.	3117-PA	Antenna horn	EMCO	LR 1717	2017.12	2020.12
5.	3115	Antenna horn	EMCO	LR 1330	2016.10	2020.10
6.	PM 320K	Antenna Horn	Sivers	LR 102	N/A	
7.	DBF-520-20	Antenna Horn	Systron-Donner corp	LR 101	N/A	
8.	638	Antenna Horn	NARDA	LR 1480	N/A	
9.	637	Antenna Horn	NARDA	LR 099	N/A	
10	VULB9163	Bi-log Hybrid Antenna	Schwarzbeck	LR 1616	2020.01	2022.01
11	4768-10	Attenuator	Narda	LR 1356	Cal b4 use	
12	6HC3000/18000	Highpass Filter	Trilithic	LR 1614	Cal b4 use	
13	8449B	Pre-amplifier	Hewlett Packard	LR 1322	2020.08	2021.08
14	310N	Pre-amplifier	Sonoma	LR 1686	2020.08	2021.08
15	Model 87	Multimeter	Fluke	N4672	2018.11	2020.11
16	6812B	AC Power source	Agilent	LR 1515	2019.03	2021.03
17	CPX400D	Power supply	TTi	LR 1744	Cal b4 use	

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

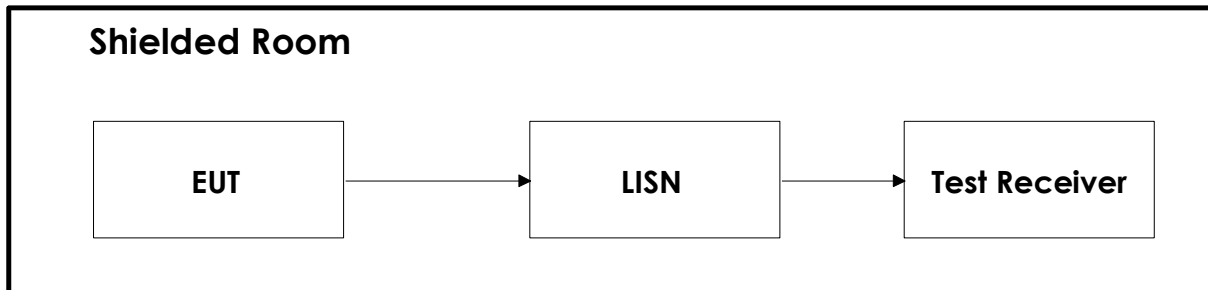
No.	Manufacturer	Name	Version	Comment
1	Rohde & Schwarz	GPBShot	2.7	Screenshots from R&S Spectrum Analyzers
2	Rohde & Schwarz	RSCOMMANDER	1.9.2 64bit	Versatile Software Tool for R&S Instruments
3	Rohde & Schwarz	EMC 32	10.40.10	Radiated Emission test software

Revision history

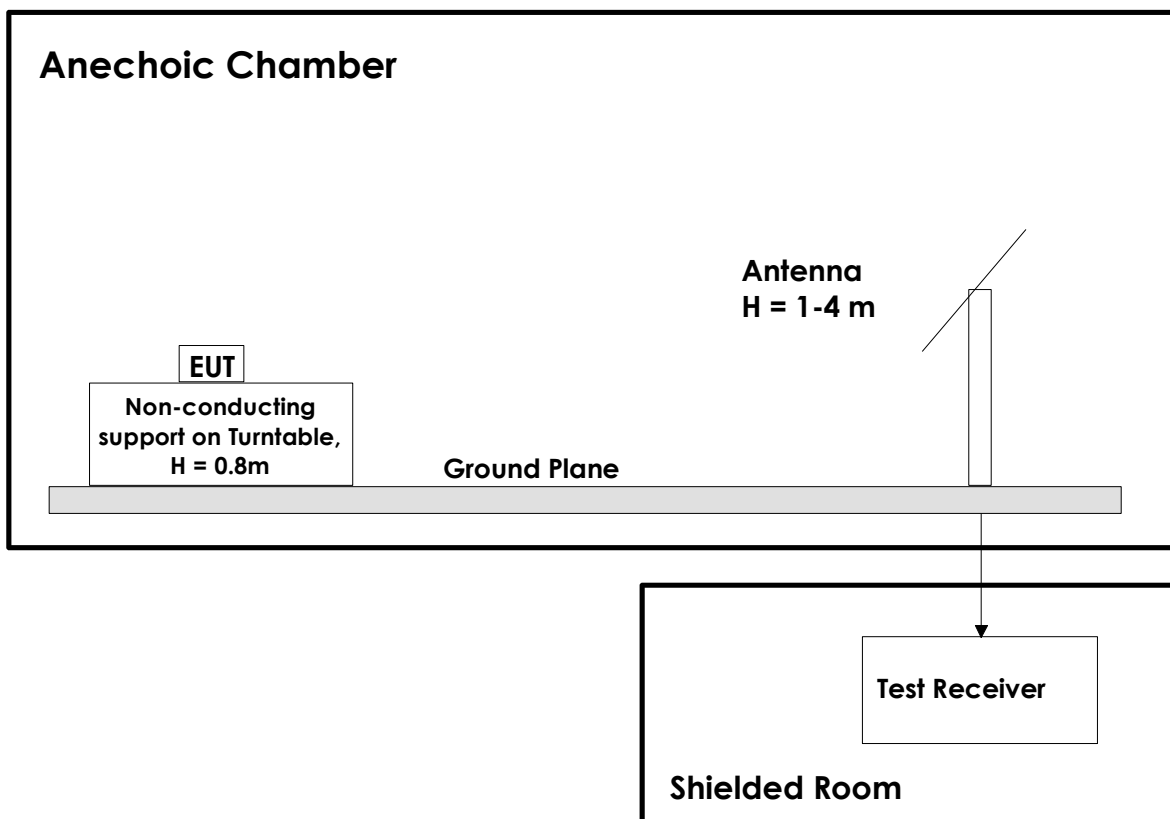
Version	Date	Comment	Sign
00	2020.09.08	First Version	gns
01	2020.12.10	In cl.1.6 detailed test information is given and power table in page 21 is corrected	gns
02	2021.01.18	FCC/ISED updated for each module and SW name is provided	gns

5 BLOCK DIAGRAM

5.1 Power Line Conducted Emission



5.2 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.