




# Test Report

<b>Product</b>	Aperio Communication Hub		
<b>Name and address of the applicant</b>	ASSA ABLOY AB Förmansvägen 11, 117 43 Stockholm, Sweden		
<b>Name and address of the manufacturer</b>	ASSA ABLOY AB Förmansvägen 11, 117 43 Stockholm, Sweden		
<b>Model</b>	AH20 and AH30		
<b>Rating</b>	2W, 8 – 24Vdc		
<b>Trademark</b>	Aperio		
<b>Serial number</b>	00124B001CAA97D2		
<b>Additional information</b>	This tested device contains IEEE802.15.4 based radio module.		
<b>Tested according to</b>	<b>FCC Part 15.247</b> Frequency Hopping Transmitters / Digital Transmission Systems <b>Industry Canada RSS-247, Issue 2</b> Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices		
<b>Order number</b>	371093		
<b>Tested in period</b>	2019.08.21 – 2019.08.23		
<b>Issue date</b>	2019.09.04		
<b>Name and address of the testing laboratory</b>	 Instituttveien 6 Kjeller, Norway	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 [G.Suhanthakumar]		 Approved by [Frode Sveinsen]	
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# 1 INFORMATION

## 1.1 Test Item

<b>Name</b>	ASSA ABLOY
<b>FCC ID</b>	Y88-AH20R03
<b>ISED ID</b>	9504A-AH20R03
<b>Model/version</b>	AH20 and AH30
<b>Serial number</b>	00124B001CAA97D2
<b>Hardware identity and/or version</b>	P001040225-001 Rev. A
<b>Software identity and/or version</b>	0.1.12
<b>Frequency Range</b>	2400 – 2483.5 MHz
<b>Tunable Bands</b>	None
<b>Number of Channels</b>	16
<b>Operating Modes</b>	TX and RX
<b>Measured BW (99%)</b>	2.57 MHz
<b>Emission classification</b>	F2D
<b>Transmitter spurious, dBμV/m@3m</b>	PK: 72.70; AV: 53.53 ((2.4835GHz)
<b>Type of Modulation</b>	O-QPSK modulation with half sine shaped pulses
<b>User Frequency Adjustment</b>	None
<b>Conducted Output Power, Max</b>	0.00384 W (5.8dBm)
<b>Type of Power Supply</b>	12Vdc
<b>Antenna Connector</b>	Yes, RP-SMA for external antenna
<b>Number of Antennas</b>	1 at a time (either internal antenna or external antenna) Internally, two crossed polarized dipoles. The two dipoles are never used simultaneously. An external antenna as an alternative.
<b>Diversity or Smart Antennas</b>	No
<b>Desktop Charger</b>	N/A

### Description of Test Item

The Aperio Hub is a Communication Hub between one or more Aperio Online Locks and an Electronic Access Control System (EAC). Towards the Aperio locks all hubs communicate wirelessly over a proprietary IEEE802.15.4 (2.4GHz) radio protocol. Towards the EAC system it communicates over wire using Wiegand (AH20), RS-485 (AH30), or Ethernet (AH40) depending on the hub model.

## 1.2 Normal test condition

Temperature: 20 - 24 °C  
 Relative humidity: 20 - 50 %  
 Normal test voltage: 12Vdc

The values are the limit registered during the test period.

## 1.3 Test Engineer(s)

G.Suhanthakumar

## 1.4 Description of modification for Modification Filing

Not applicable.

## 1.5 Family List Rational

Model/type	Similarity	Differences
AH20	Same PCB and Radio module	Four relays and one extra connector compared to AH30
AH30	Same PCB and Radio module	

## 1.6 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

## 1.7 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.

## 1.8 Comments

All measurements were done with the EUT powered with 12VDC voltage. It was checked that power variations between 85% and 115% did not have any influence on the measurements. As well 8Vdc and 24Vdc.

Following ports were populated during spurious emission measurements:

- DC, RS 485 and Wiegand

## 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 ISED 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 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

**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	Result
Supply Voltage Variations	15.31(e)	6.11 (RSS-GEN)	Complies <sup>1</sup>
Number of frequencies	15.31(m)	6.8 (RSS-GEN)	Complies
Antenna Requirement	15.203	6.8 (RSS-GEN)	Complies <sup>2</sup>
Power Line Conducted Emission	15.107(a) 15.207(a)	7.2 / 8.8 (RSS-GEN)	Complies <sup>1</sup>
99% Occupied Bandwidth	N/A	6.7 (RSS-GEN)	Complies
Minimum 6 dB Bandwidth	15.247(a)(2)	5.2 (1) (RSS-247)	Complies
Peak Power Output	15.247(b)	5.4 (RSS-247)	Complies
Power Spectral Density	15.247(e)	5.2 (2) (RSS-247)	Complies
Spurious Emissions (Antenna Conducted)	15.247(c)(d)	5.5 (RSS-247)	Complies
Spurious Emissions (Radiated)	15.247(c)(d) 15.109(a) 15.209(a)	5.5 (RSS-247) 7.3 (RSS-GEN) 8.9 (RSS-GEN)	Complies

<sup>1</sup> The tested equipment only operates with external DC power

<sup>2</sup> External antenna and internal Integral antenna

### 3 TEST RESULTS

#### 3.1 Number of Frequencies

FCC Part 15.31 (m)

RSS-Gen 6.8

Authorized Band:	2400 - 2483.5 MHz
Frequency band width:	83.5MHz
Low Channel:	2405MHz
Mid channel:	2440MHz
High Channel:	2480MHz

### 3.2 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  $\mu$ H/50 ohms LISN

Test Results: Complies

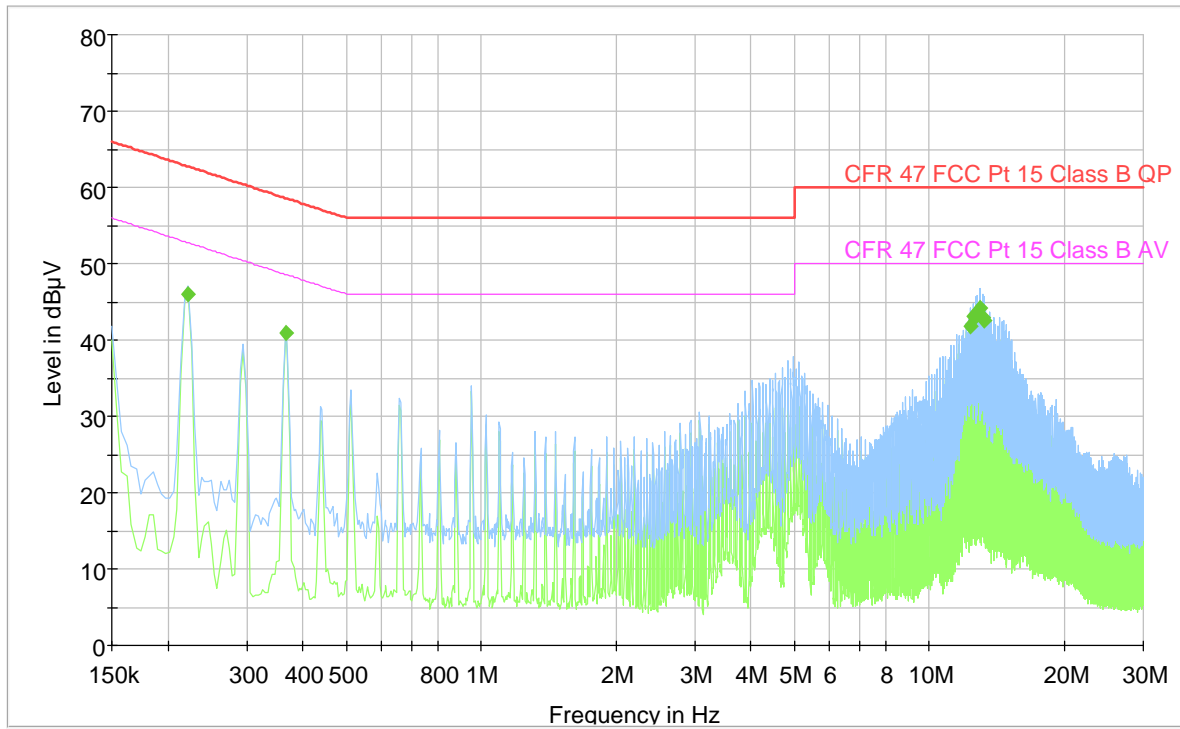
Measurement Data: See attached plots

Highest measured value (L1 and N): 120Vac, 60Hz with external DC power supply, model no: CPX400S

Frequency (MHz)	QuasiPeak (dB $\mu$ V)	Average (dB $\mu$ V)	Limit (dB $\mu$ V)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Filter
0.222	---	46.00	52.74	6.74	1000	9	L1	OFF
0.368	---	40.86	48.55	7.68	1000	9	N	OFF
12.388	---	41.78	50.00	8.22	1000	9	N	OFF
12.536	---	43.16	50.00	6.84	1000	9	N	OFF
12.684	---	43.18	50.00	6.82	1000	9	N	OFF
12.828	---	43.64	50.00	6.36	1000	9	N	OFF
12.976	---	44.16	50.00	5.84	1000	9	N	OFF
13.124	---	42.97	50.00	7.03	1000	9	N	OFF
13.268	---	42.58	50.00	7.42	1000	9	N	OFF



Full Spectrum



### 3.3 99% Occupied Bandwidth

RSS-Gen, 6.7

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 6.9.2 / 7.8.3

Test Results: Complies

Measurement Data:

Channel Frequency (MHz)	Measured 99% BW (MHz)
2405	2.56
2440	2.57
2480	2.57

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.



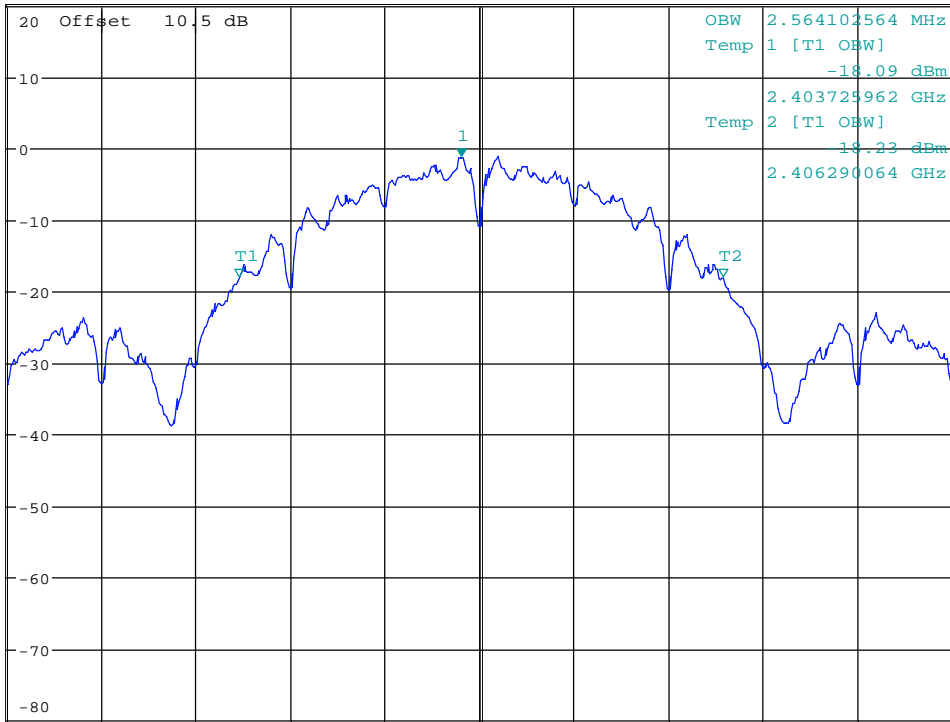
MARKER 1  
 2.404903846 GHz

\*RBW 30 kHz  
 VBW 100 kHz  
 SWT 25 ms

Marker 1 [T1 ]  
 -1.35 dBm  
 2.404903846 GHz

Ref 20 dBm \*Att 10 dB

1 PK  
 MAXH



Center 2.405 GHz 500 kHz/ Span 5 MHz

Date: 21.AUG.2019 20:04:19

**99% Bandwidth , ch2405MHz**

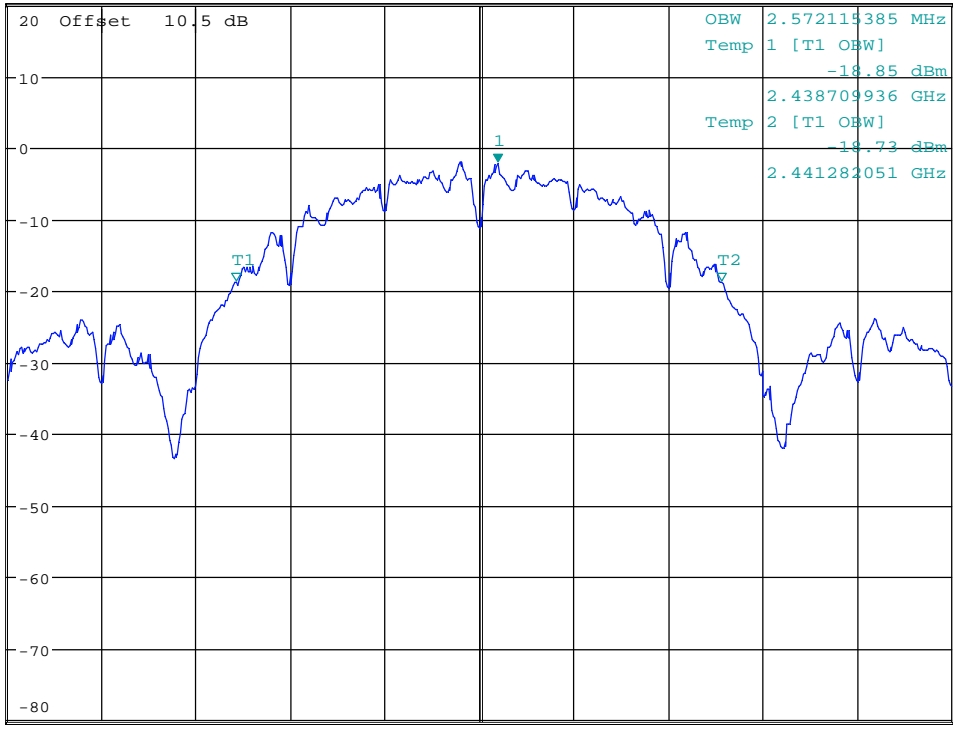


**MARKER 1**  
 2.440096154 GHz

\*RBW 30 kHz  
 VBW 100 kHz  
 SWT 25 ms  
 Marker 1 [T1 ]  
 -2.10 dBm  
 2.440096154 GHz

Ref 20 dBm \*Att 10 dB

1 PK  
 MAXH



Center 2.44 GHz 500 kHz/ Span 5 MHz

Date: 21.AUG.2019 20:12:39

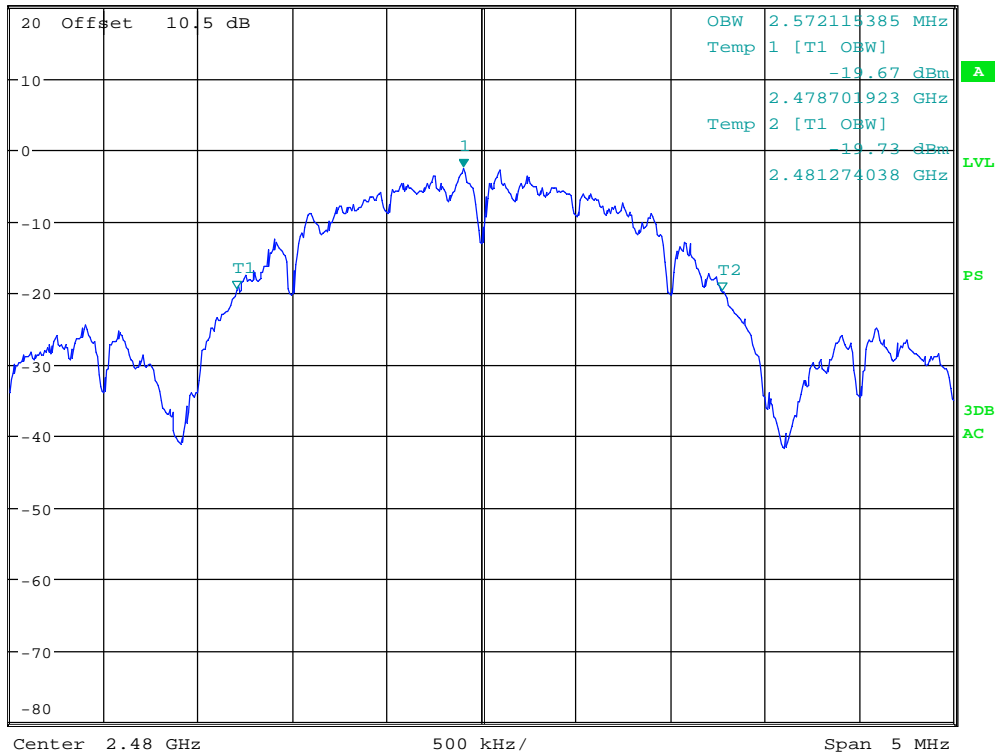
**99% Bandwidth , ch2440MHz**



**MARKER 1**  
 2.479903846 GHz

\*RBW 30 kHz      Marker 1 [T1 ]  
 VBW 100 kHz      -2.68 dBm  
 Ref 20 dBm      \*Att 10 dB      2.479903846 GHz  
 SWT 25 ms

1 PK  
 MAXH



Date: 21.AUG.2019 20:14:44

**99% Bandwidth , ch2480MHz**

### 3.4 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**

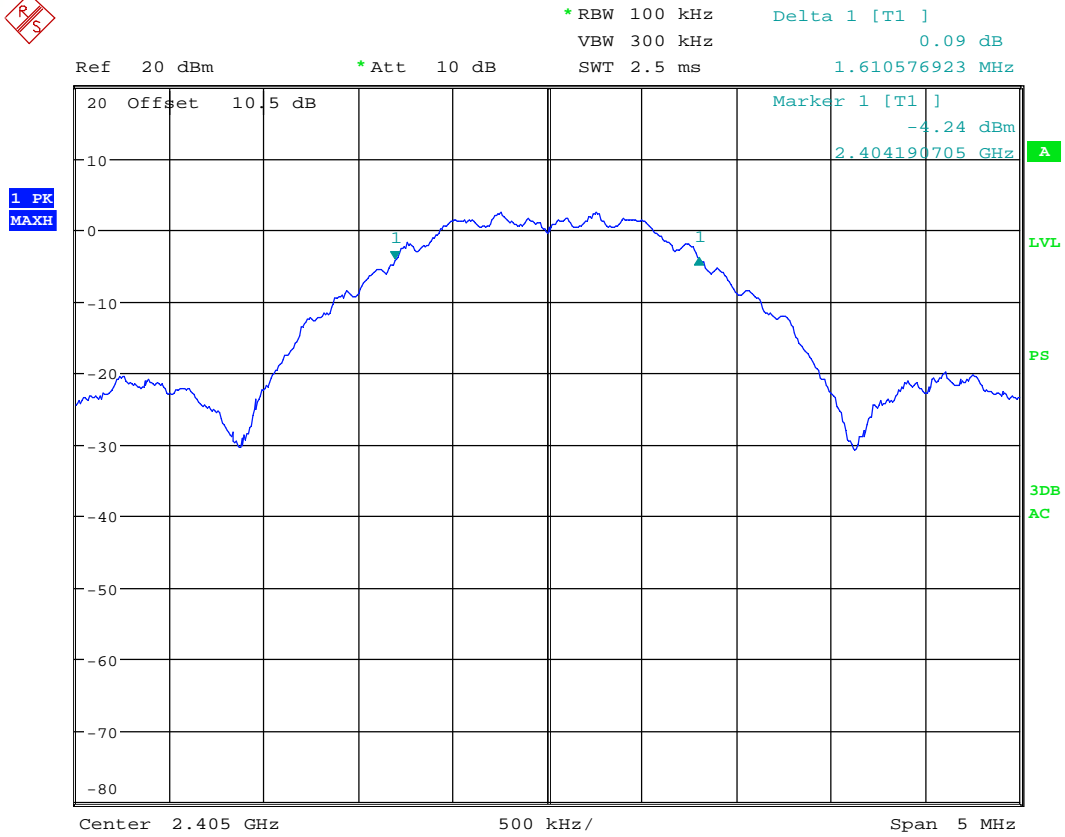
Measurement Data:

Channel Frequency (MHz)	Measured DTS BW (MHz)
2405	1.61
2440	1.64
2480	1.67

#### Requirements:

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

No requirements for Frequency Hopping Systems.



Date: 21.AUG.2019 20:03:11

DTS Bandwidth, ch2405MHz

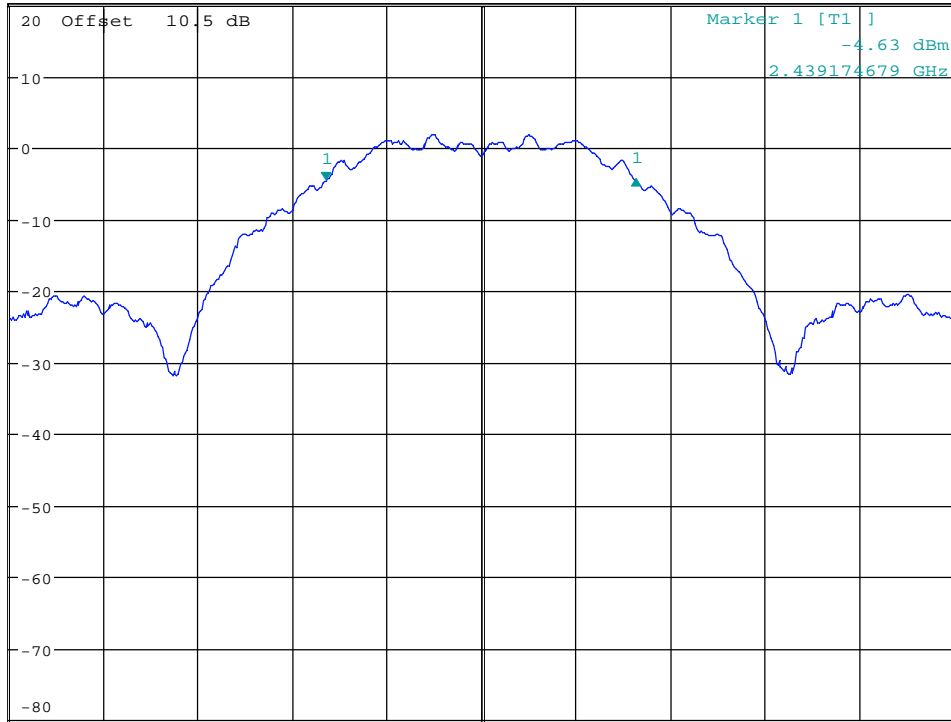


\*RBW 100 kHz      Delta 1 [T1 ]  
 VBW 300 kHz      0.17 dB  
 SWT 2.5 ms      1.642628205 MHz

Ref 20 dBm

\*Att 10 dB

1 PK  
 MAXH



Center 2.44 GHz

500 kHz/

Span 5 MHz

Date: 21.AUG.2019 20:12:09

DTS Bandwidth, ch2440MHz



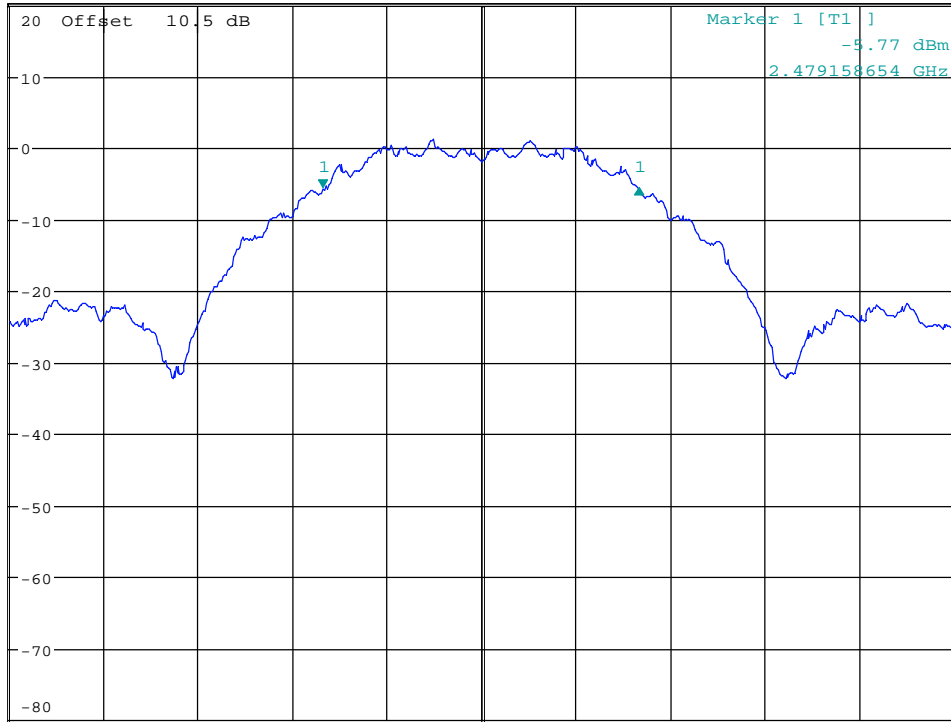


\*RBW 100 kHz      Delta 1 [T1 ]  
 VBW 300 kHz      0.02 dB  
 SWT 2.5 ms      1.674679487 MHz

Ref 20 dBm

\*Att 10 dB

1 PK  
 MAXH



Center 2.48 GHz

500 kHz/

Span 5 MHz

Date: 21.AUG.2019 20:16:00

DTS Bandwidth, ch2480MHz

### 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:

	2405 MHz	2440 MHz	2480 MHz
Conducted Power (dBm)	5.80	5.10	4.40
Conducted Power (mWatts)	3.84	3.21	2.78
Internal antenna: Field Strength (dB $\mu$ V/m), HP	104.0	105.1	104.3
Internal antenna EIRP, Calculated (mWatts)	7.54	9.71	8.07
Internal antenna: Antenna gain (dBi)	2.9	4.8	4.6
External antenna: Field Strength (dB $\mu$ V/m), VP	102.1	101.3	101.8
External antenna EIRP, Calculated (mWatts)	4.85	4.04	4.54
External antenna: Antenna gain (dBi)	1.0	1.0	2.1

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

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

See attached plots.

#### Requirements:

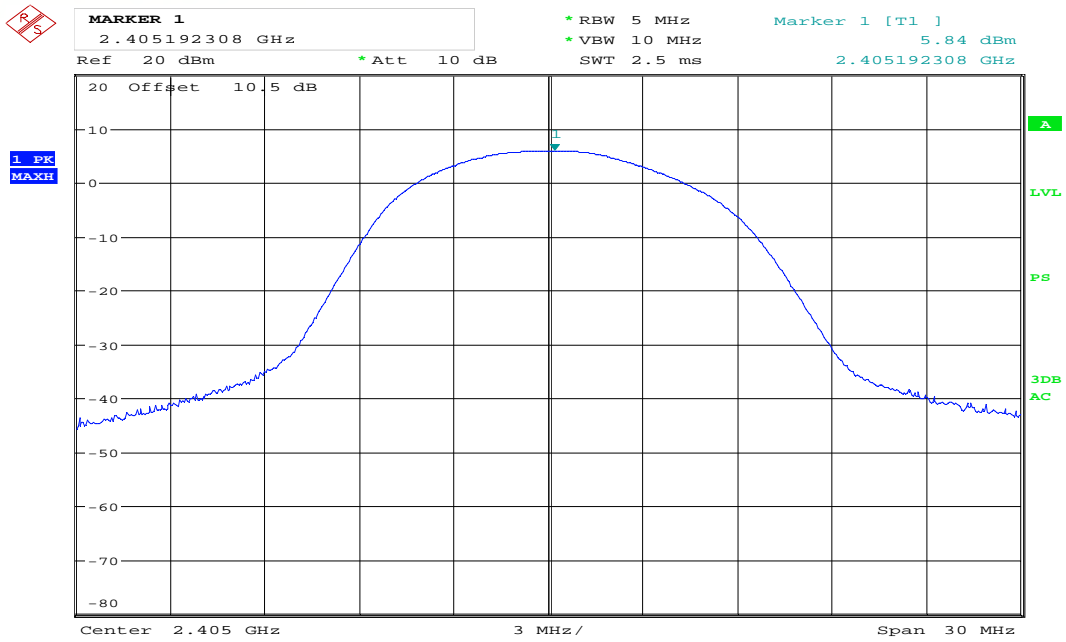
The maximum peak output power shall not exceed the following limits:

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

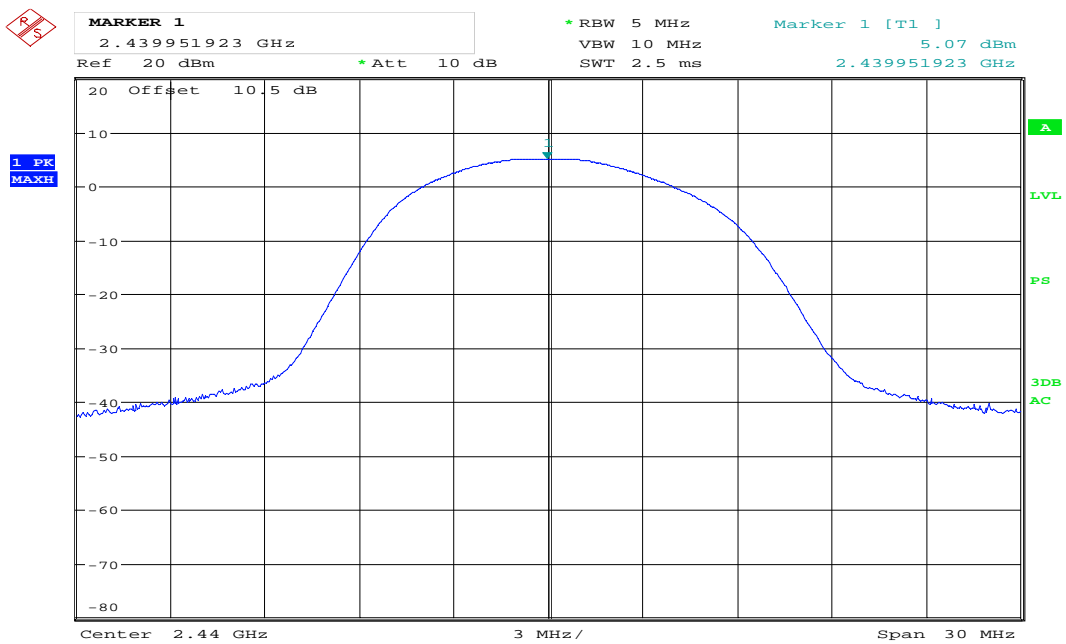
For Digital Transmission Systems in the 2400 - 2483.5 MHz band: 1 Watt

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.



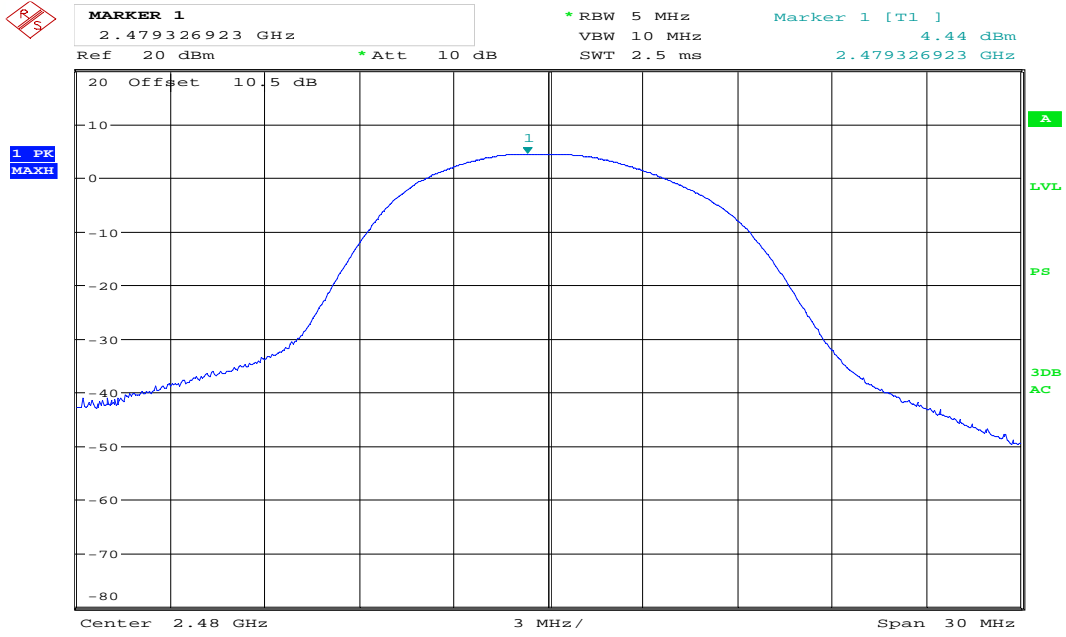
Date: 21.AUG.2019 20:01:47

Conducted Power , Ch2405MHz



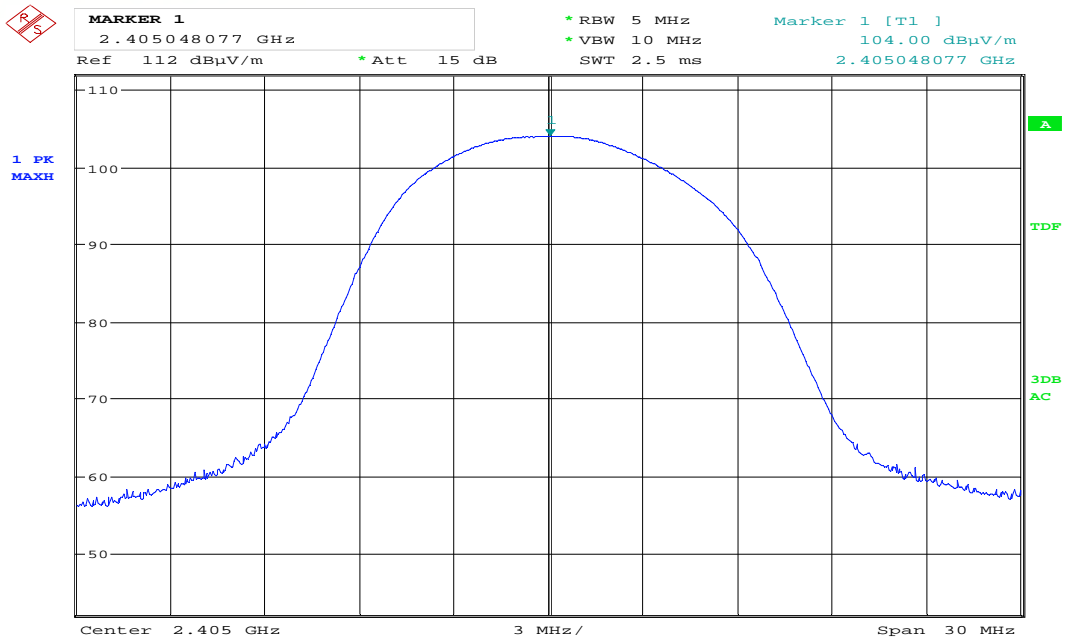
Date: 21.AUG.2019 20:10:20

Conducted Power , Ch2440MHz



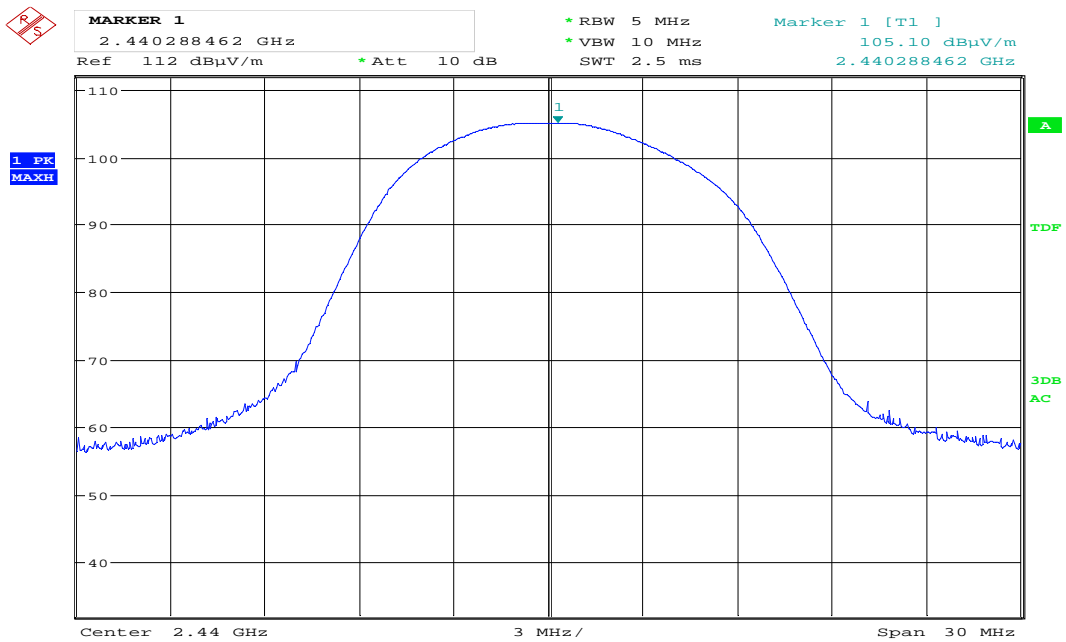
Date: 21.AUG.2019 20:16:51

Conducted Power, Ch2480MHz



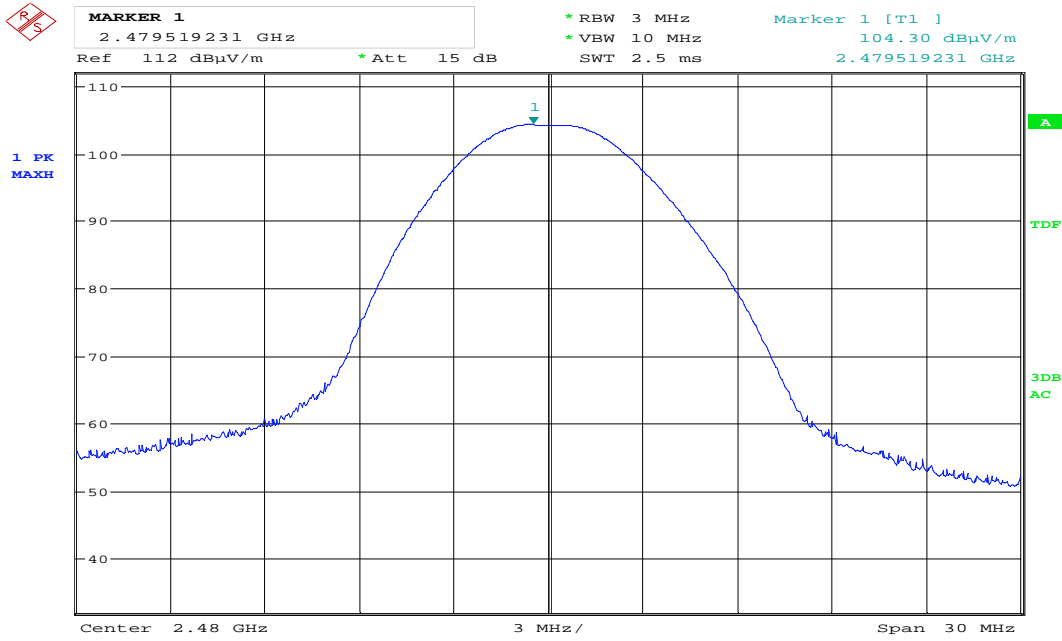
Date: 21.AUG.2019 09:32:23

Internal antenna, Measured Field Strength, HP, ch2405MHz



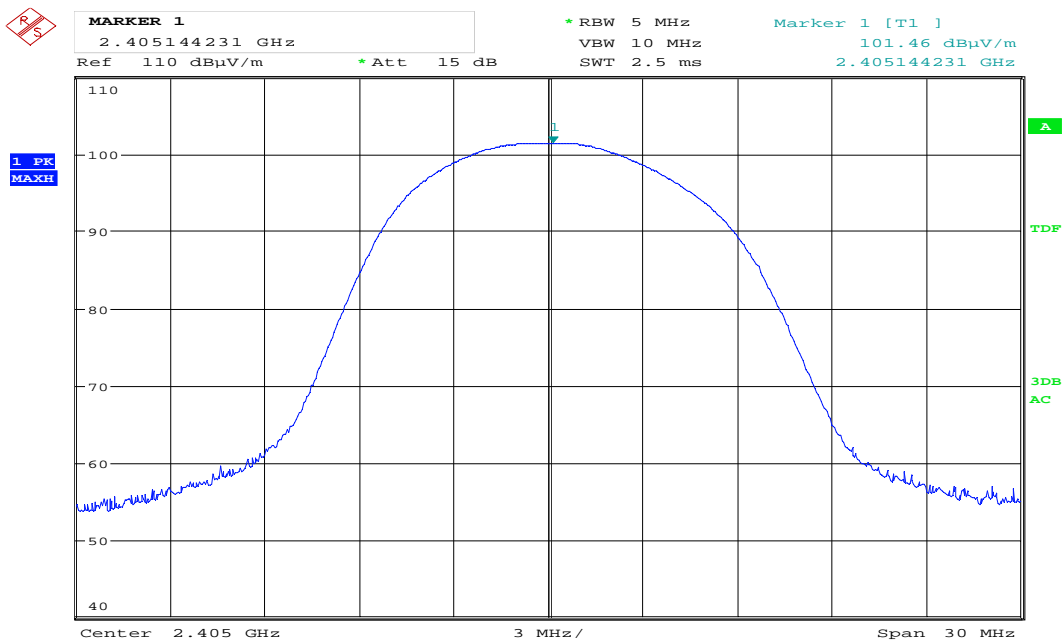
Date: 21.AUG.2019 12:20:17

Internal antenna: Measured Field Strength, HP, ch2440MHz



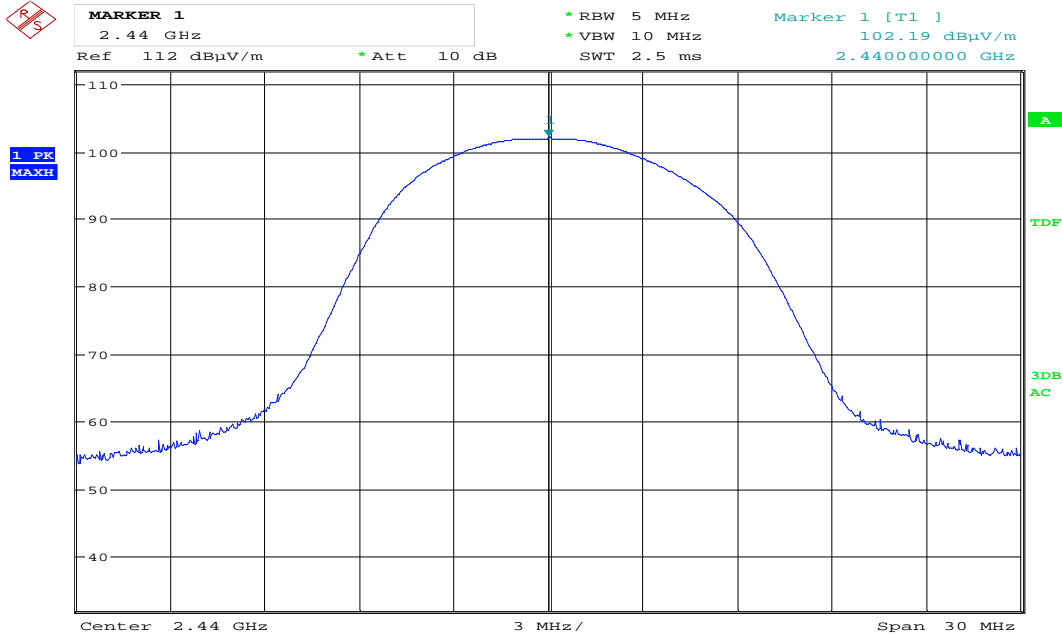
Date: 21.AUG.2019 10:07:23

Internal antenna: Measured Field Strength, HP, ch2480MHz



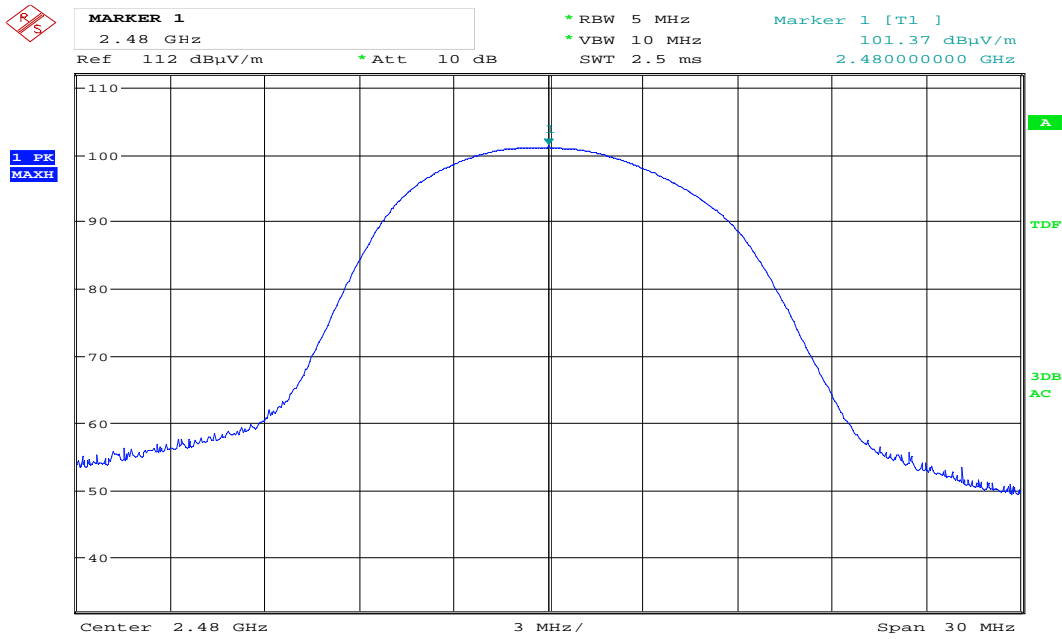
Date: 21.AUG.2019 09:20:54

Internal antenna: Measured Field Strength, VP, ch2405MHz



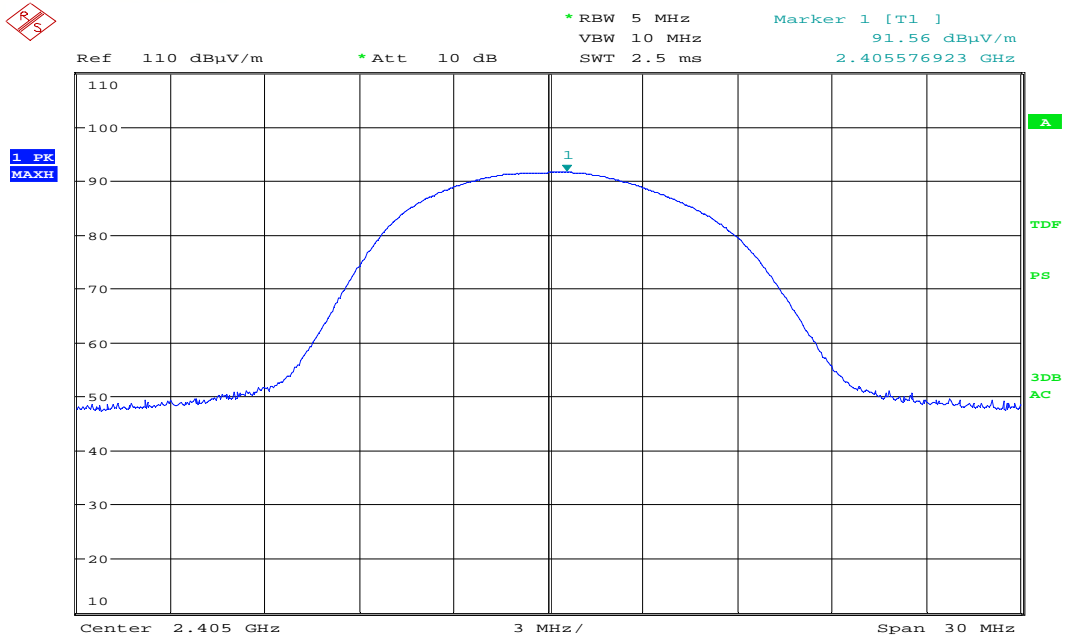
Date: 21.AUG.2019 12:19:13

Internal antenna: Measured Field Strength, VP, ch2440MHz



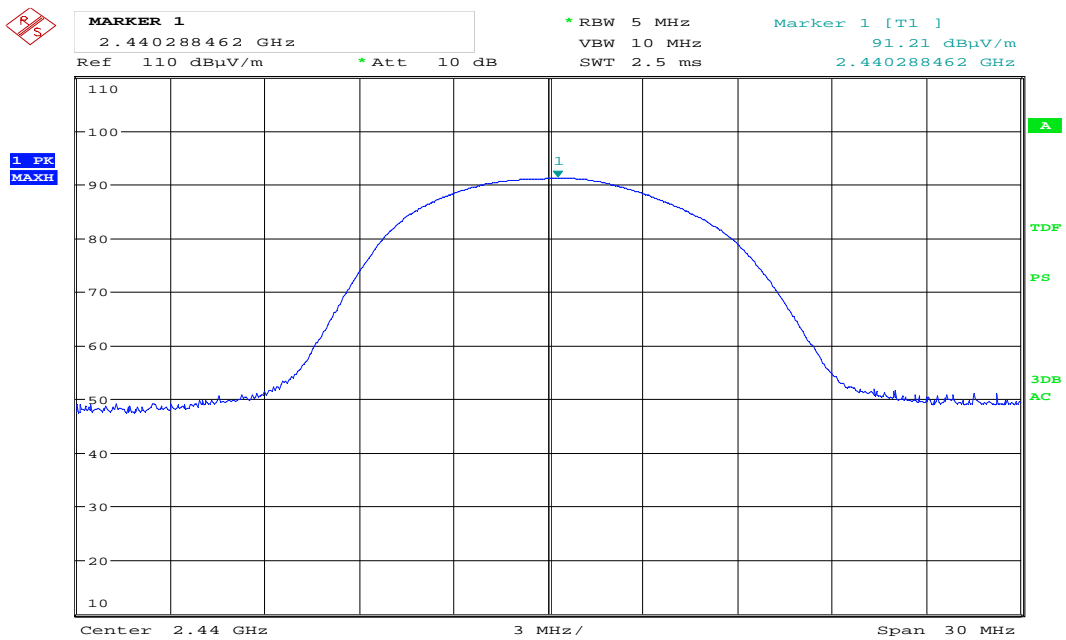
Date: 21.AUG.2019 12:07:34

Internal antenna: Measured Field Strength, VP, ch2480MHz



Date: 21.AUG.2019 18:55:45

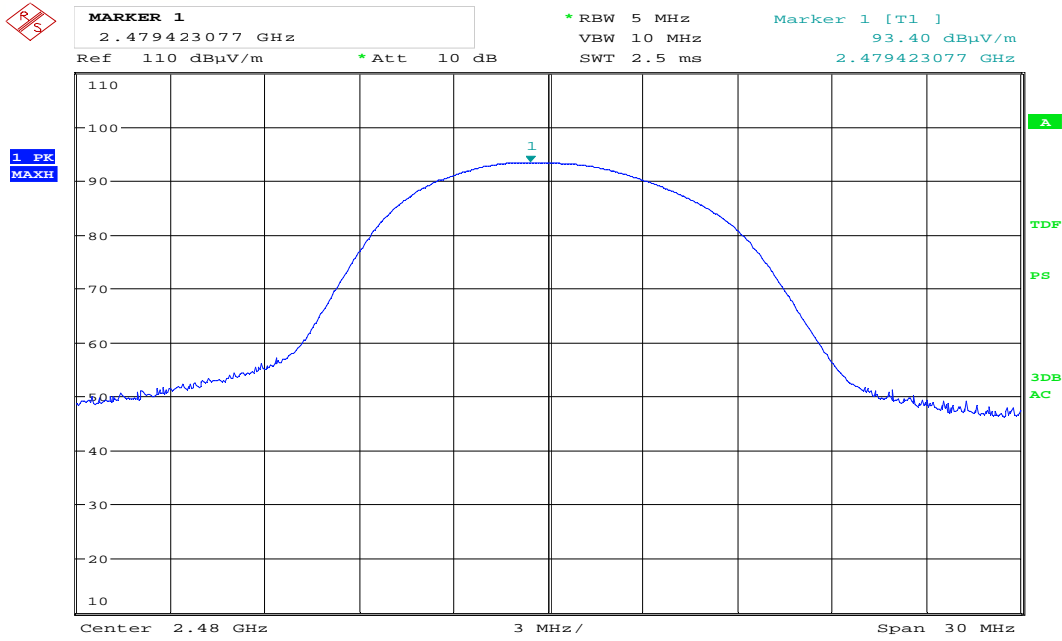
External antenna: Measured Field Strength, HP, ch2405MHz



Date: 21.AUG.2019 18:43:13

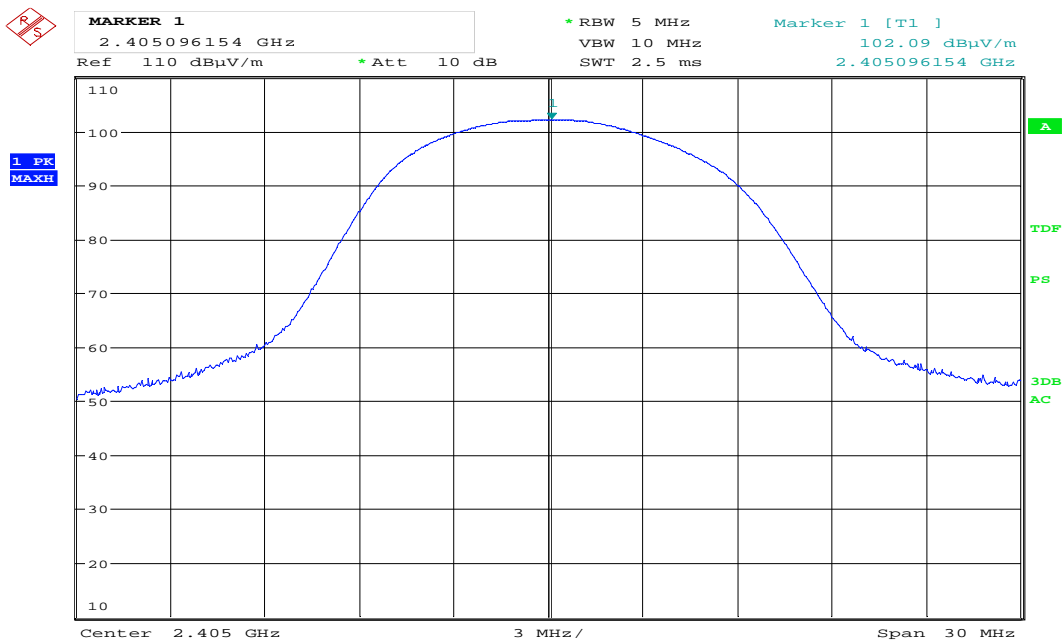
External antenna: Measured Field Strength, HP, ch2440MHz





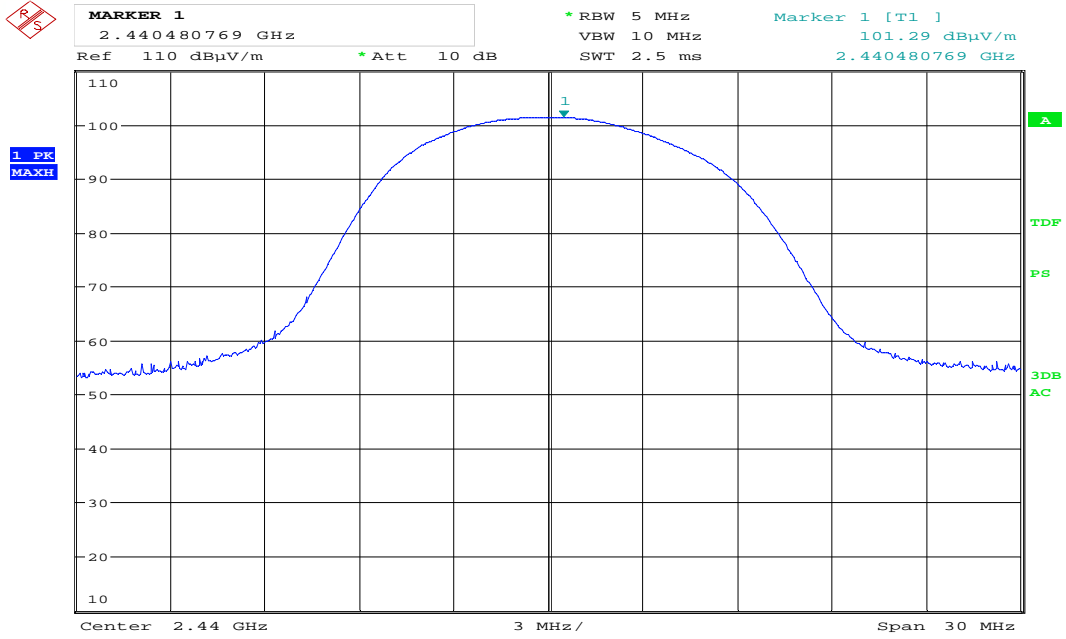
Date: 21.AUG.2019 18:40:18

External antenna: Measured Field Strength, HP, ch2480MHz



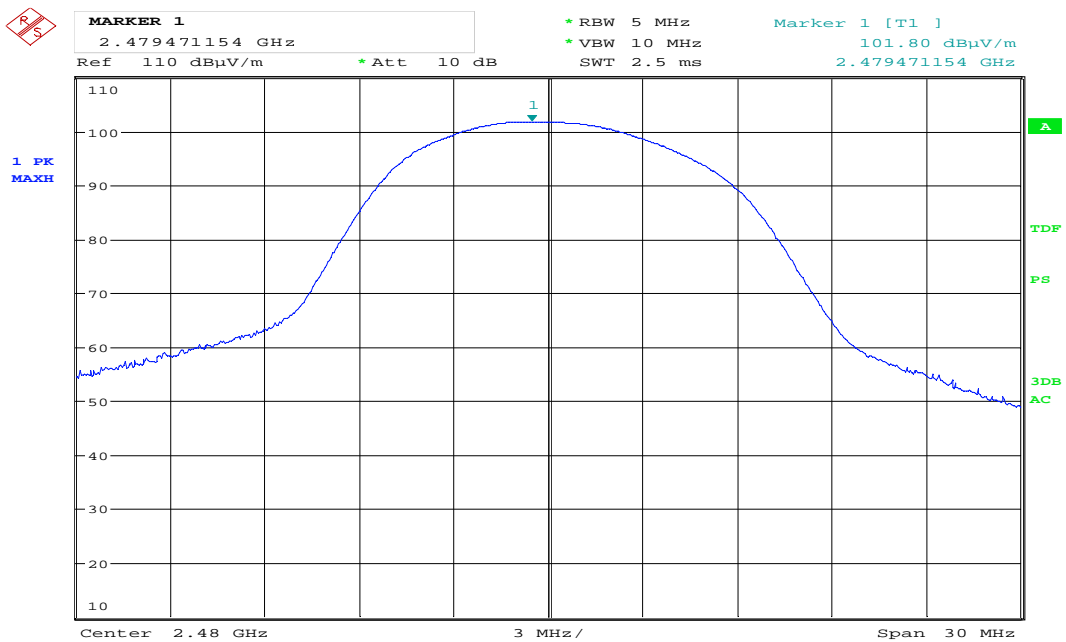
Date: 21.AUG.2019 18:49:32

External antenna: Measured Field Strength, VP, ch2405MHz



Date: 21.AUG.2019 18:46:49

External antenna: Measured Field Strength, VP, ch2440MHz



Date: 21.AUG.2019 18:26:01

External antenna: Measured Field Strength, VP, ch2480MHz

### 3.6 Conducted Emissions at Antenna Connector

Para. No.: 15.247 (d)

ISED Canada RSS-247 Issue 2, Clause 5.5

Measurement procedure: ANSI C63.10-2013 Clause 11.11

Test Results: Complies

Carrier Frequency	Highest Value (dBc)	Margin (dB)	Verdict
2405 MHz	58	>30	Pass
2440 MHz	56	>30	Pass
2480 MHz	56	>30	Pass

Measured with Peak Detector

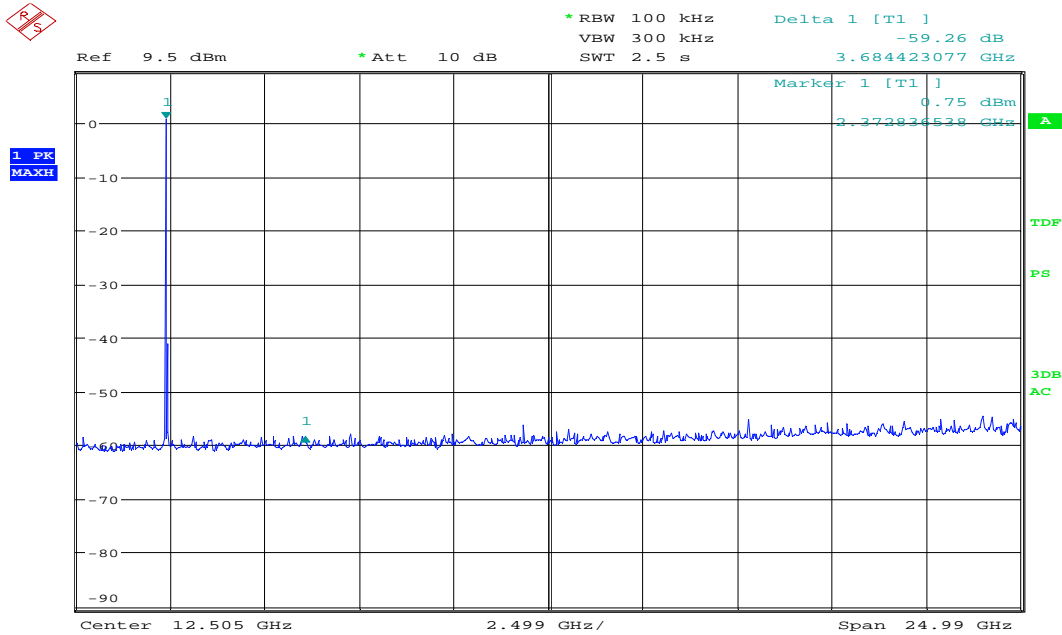
RF conducted power to 25 GHz: see attached plots.

#### Limit

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

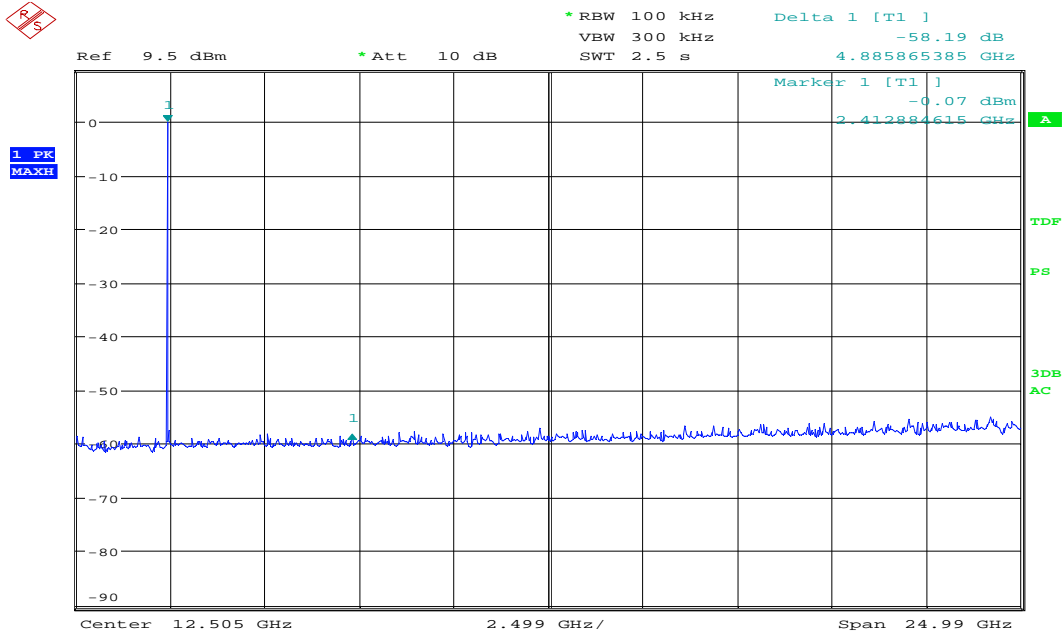
Detector type shall be the same as used for measuring Output Power.

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



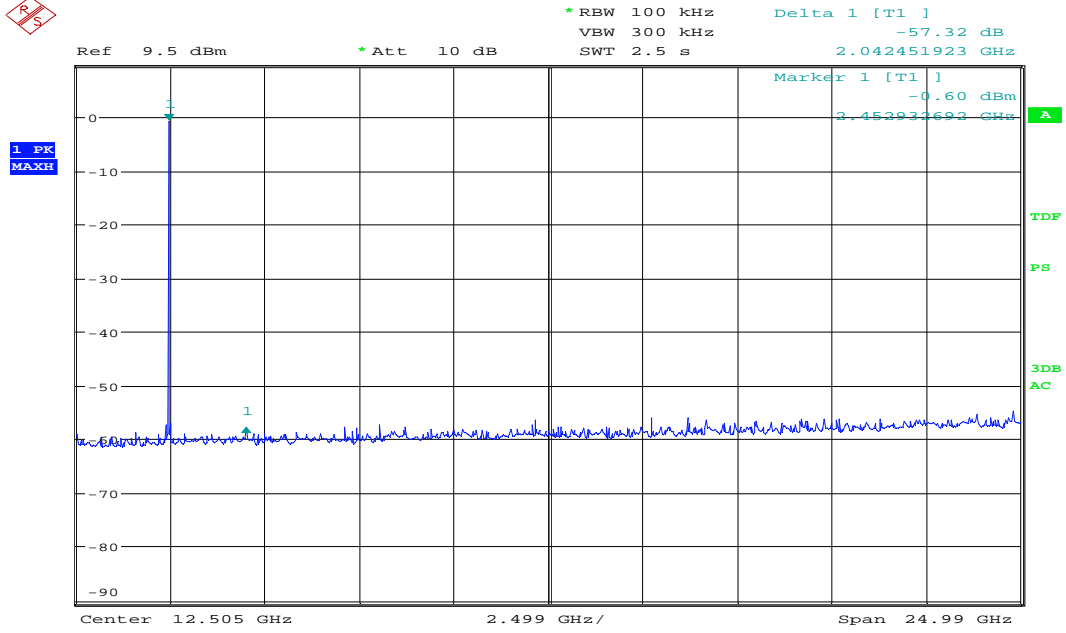
Date: 21.AUG.2019 20:08:25

Conducted spurious emissions, 10MHz - 25GHz, ch2405MHz



Date: 21.AUG.2019 20:09:26

Conducted spurious emissions, 10MHz - 5GHz, ch2440MHz



Date: 21.AUG.2019 20:17:49

Conducted spurious emissions, 10MHz - 25GHz, ch2480MHz

### 3.7 Restricted Bands of operation

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

Generally, no fundamentals are allowed in the restricted bands and all emissions must comply with the limits in FCC 15.209 or RSS-GEN, Issue 5, clause 8.9.

FCC (MHz)	ISSED (MHz)	FCC (GHz)	ISSED (GHz)
0.090-0.110		<b>0.96-1.24</b> <b>1.3-1.427</b>	<b>0.96-1.427</b>
0.495-0.505		1.435-1.6265	
2.1735-2.1905		1.6455-1.6465	
	<b>3.020-3.026</b>	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	
	<b>5.677-5.683</b>	2.4835-2.5	
6.215-6.218		<b>2.69-2.9</b>	<b>2.655-2.9</b>
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		<b>3.6-4.4</b>	<b>3.5-4.4</b>
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	
<b>108-121.94</b> <b>123-138</b>	<b>108-138</b>	31.2-31.8	
149.9-150.05		36.43-36.5	
156.52475-156.52525		Above 38.6	
156.7-156.9			
162.0125-167.17			
167.72-173.2			
240-285			
322-335.4			
399.9-410			
608-614			

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

### 3.8 Spurious Emissions (Radiated)

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: Internal antenna

	Measured field strength (dB $\mu$ V/m)		Limit dB $\mu$ V/m	Margin	
	2390 MHz	2483.5 MHz		dB	
Peak Detector	49.48	72.70	74	24.52	1.3
Average Detector	/	/	54	/	/
Average with DC correction	/	53.53	54	/	0.47

Band-Edge: External antenna

	Measured field strength (dB $\mu$ V/m)		Limit dB $\mu$ V/m	Margin	
	2390 MHz	2483.5 MHz		dB	
Peak Detector	44.61	71.15	74	29.39	2.85
Average Detector	/	/	54	/	/
Average with DC correction	/	51.98	54	/	2.02

See attached plots.

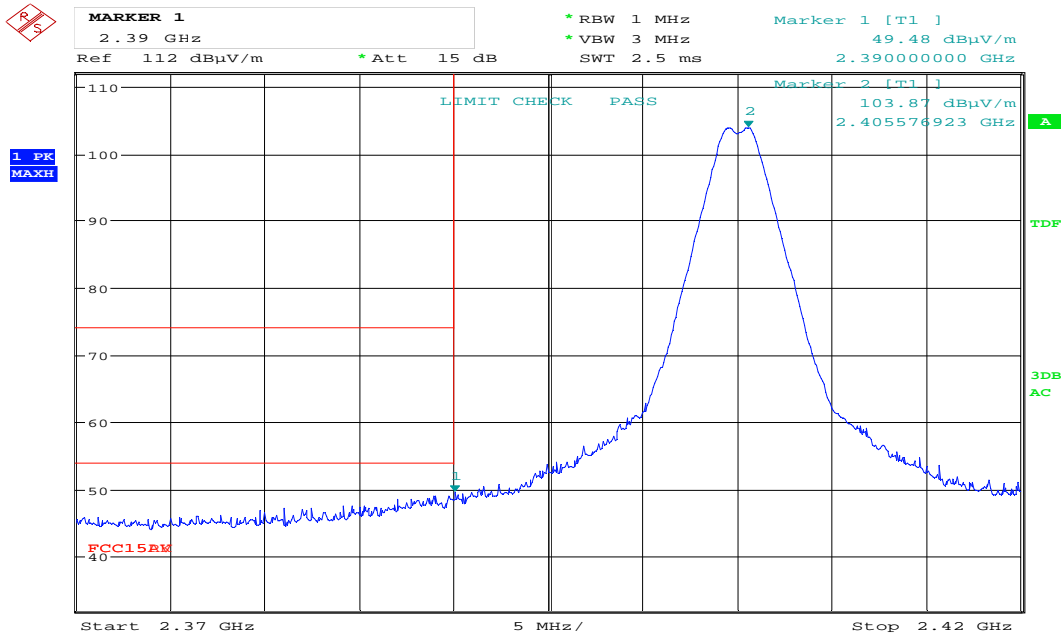
**Duty Cycle Correction Factor Calculation:**

The maximum duty cycle calculation is given by manufacturer in the operational description is 11%

Duty Cycle Correction factor =  $-20 \times \log(\text{Duty Cycle}) = -19.17 \text{ dB}$

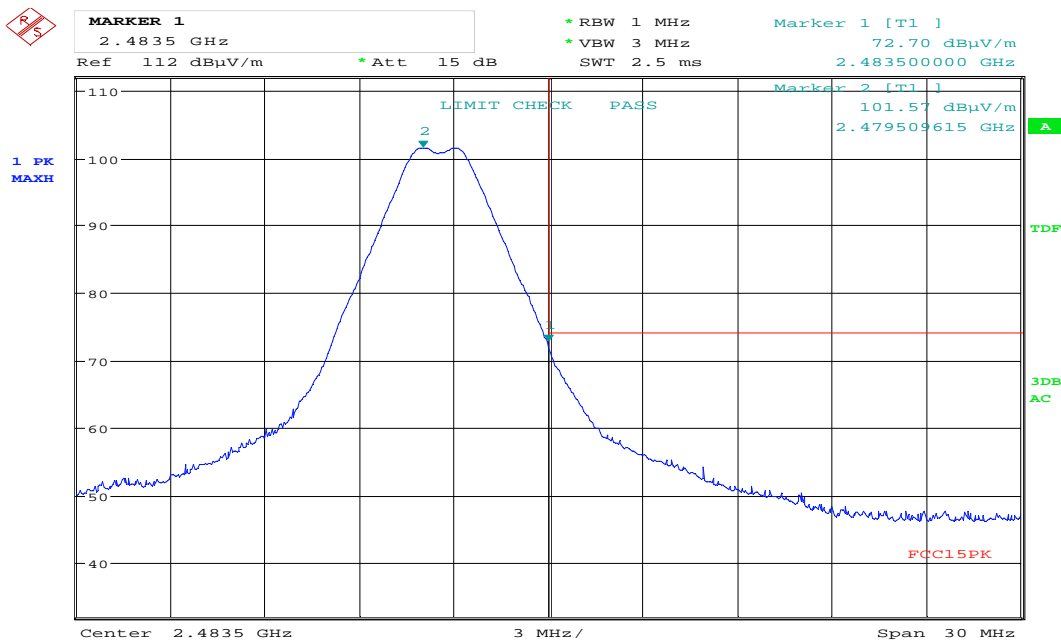
Maximum allowed Duty Cycle Correction: 20 dB

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



Date: 21.AUG.2019 09:34:50

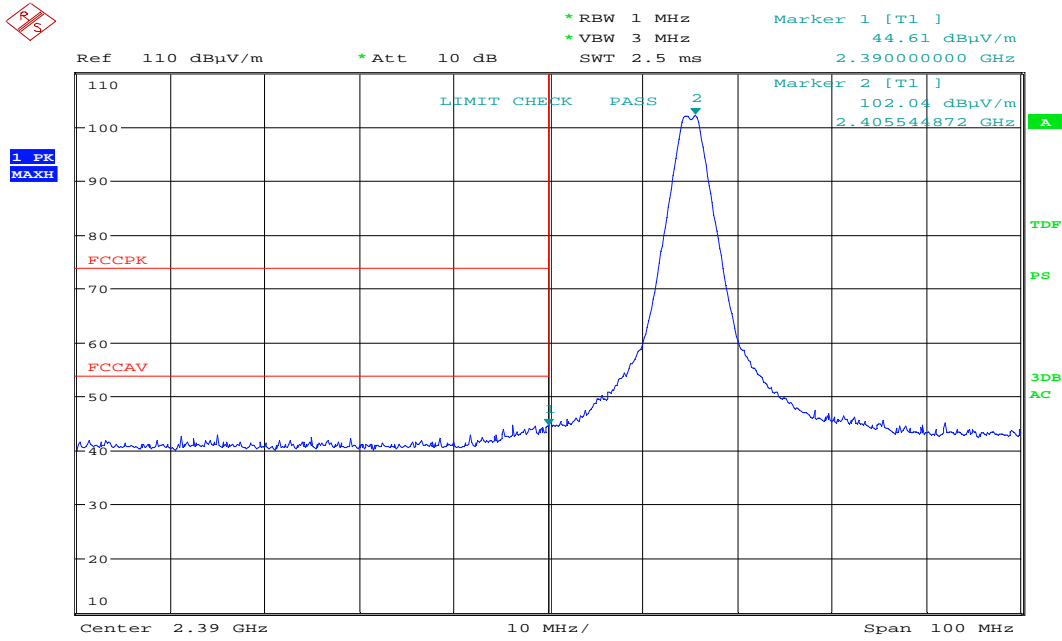
Internal antenna: Lower Band Edge, PK , ch2405MHz



Date: 21.AUG.2019 10:10:39

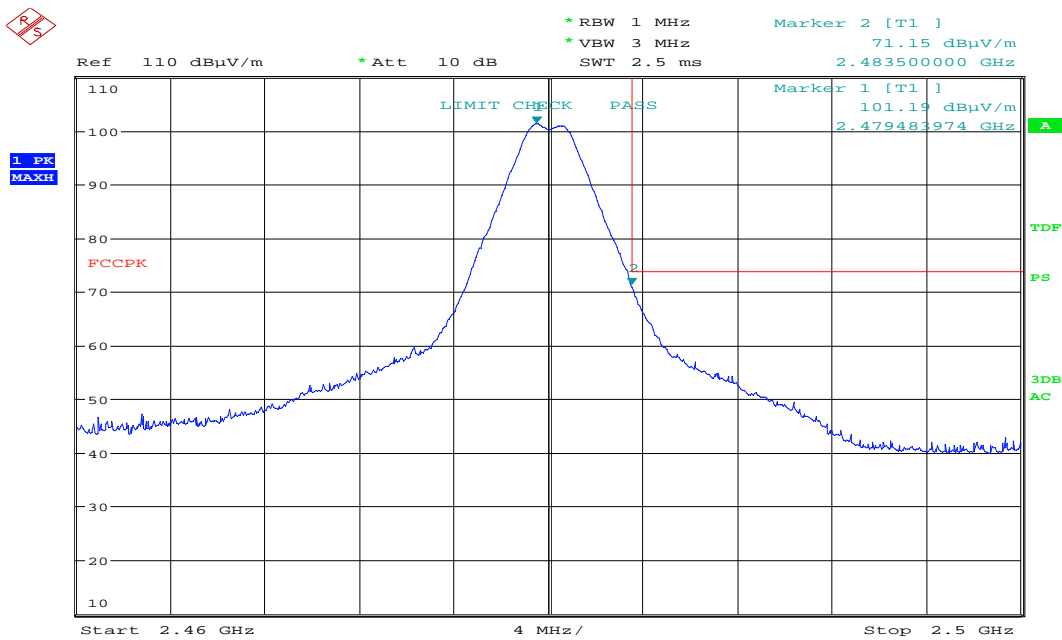
Internal antenna: Upper band Edge, PK, ch2480MHz





Date: 21.AUG.2019 18:52:09

External antenna: Lower Band Edge, PK , ch2405MHz



Date: 21.AUG.2019 18:35:37

External antenna: Upper Band Edge, PK, ch2480MHz

**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**

Detector: Quasi-Peak

Measuring distance 3 m

Tested in TX mode

Frequency (MHz)	QuasiPeak (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
38.467000	15.01	40.00	24.99	1000.0	120.000	103.0	V	315.0
42.263400	8.36	40.00	31.64	1000.0	120.000	205.0	V	265.0
56.983800	18.13	40.00	21.87	1000.0	120.000	179.0	V	200.0

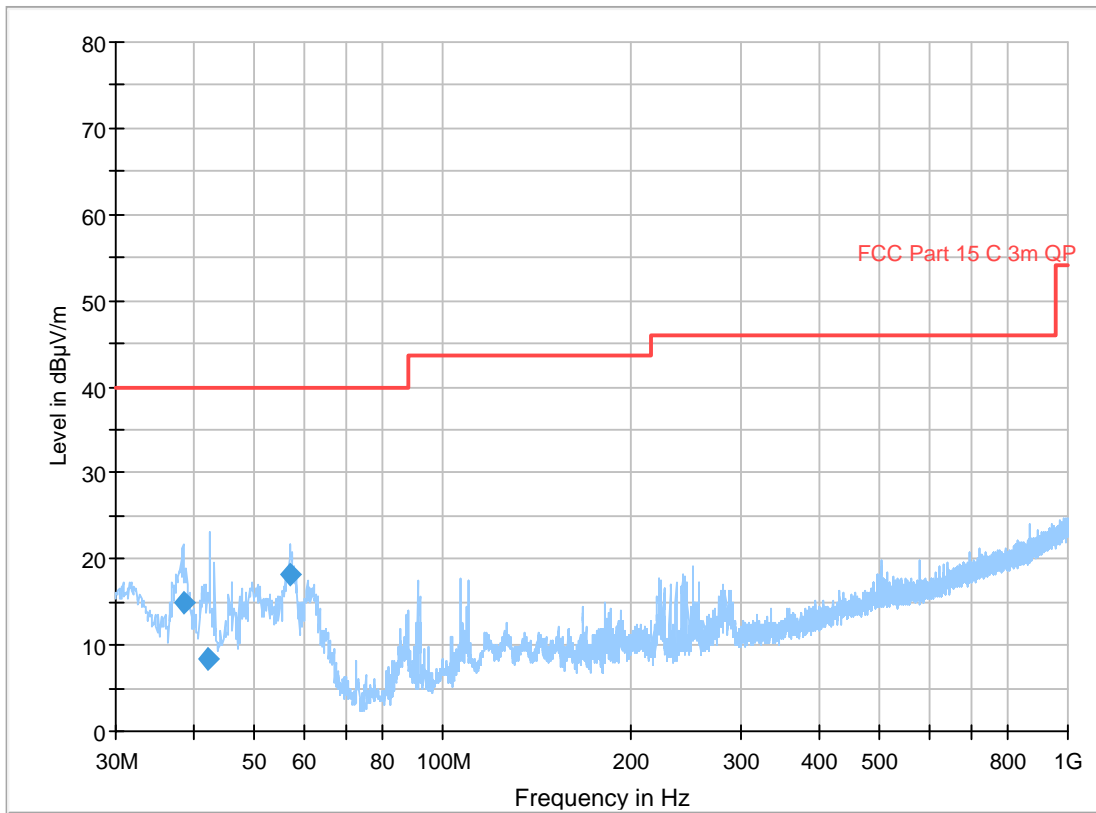
See attached plots

**Requirements/Limit**

<b>FCC</b>	Part 15.209 @ frequencies defined in §15.205	
<b>ISED</b>	RSS-GEN Issue 5, Clause 8.9 @ frequencies defined in clause 8.10	
	<b>Radiated emission limit @3 meters</b>	
<b>Frequency (MHz)</b>	<b>Quasi Peak (<math>\mu</math>V/m)</b>	<b>Quasi Peak (dB<math>\mu</math>V/m)</b>
<b>30 – 88</b>	100	40.0
<b>88 – 216</b>	150	43.5
<b>216 – 960</b>	200	46.0
<b>Above 960</b>	500	54.0

The limit above 1000 MHz is specified for Average Detector, when the measurement is performed with a Peak Detector a Duty-Cycle Correction Factor has to be calculated to find the corresponding Average Detector value.

Full Spectrum



**Internal Antenna:**

**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

Measuring distance: 3m (1 – 18 GHz), 1m (18 – 25 GHz)

**Peak Detector: (Restricted band frequencies)**

Frequency	RF channel	Dist. corr. factor	Field strength, Peak Detector, 3m	Limit	Margin
GHz	L,M,H	dB	dB $\mu$ V/m	dB $\mu$ V/m	dB
7.32	M	0	60.92	74	13.08
7.44	H	0	62.30	74	11.70
12.025	L	0	54.33	74	19.67
12.2	M	0	54.73	74	19.27
12.39	H	0	55.50	74	18.50
Other freqs	L,M,H	0	None detected	74	>20

**Average Detector: (Restricted band frequencies)**

Frequency	RF channel	Dist. corr. factor	Field strength, Average Detector, 3m	Duty cycle corr. factor	Limit	Margin
GHz	L,M,H	dB	dB $\mu$ V/m	dB	dB $\mu$ V/m	dB
7.32	M	0	41.75	19.17	54	12.25
7.44	H	0	43.13	19.17	54	10.87
12.025	L	0	35.16	19.17	54	18.84
12.2	M	0	35.56	19.17	54	18.44
12.39	H	0	36.33	19.17	54	17.67
Other freqs	L,M,H	/	None detected	/	54	>20

**Peak Detector: (Non Restricted band frequencies)**

Frequency	RF channel	Dist. corr. factor	Field strength, Peak Detector, 3m	#Limit	Margin
GHz	L,M,H	dB	dB $\mu$ V/m	dB $\mu$ V/m	dB
7.215	L	0	60.83	104.0	43.17
Other freqs	L,M,H	0	None detected		>20

# 20 dB below the highest power level of the fundamental frequency (PK).

\*distance correction is included on the plot.

Maxium is obtained in HP

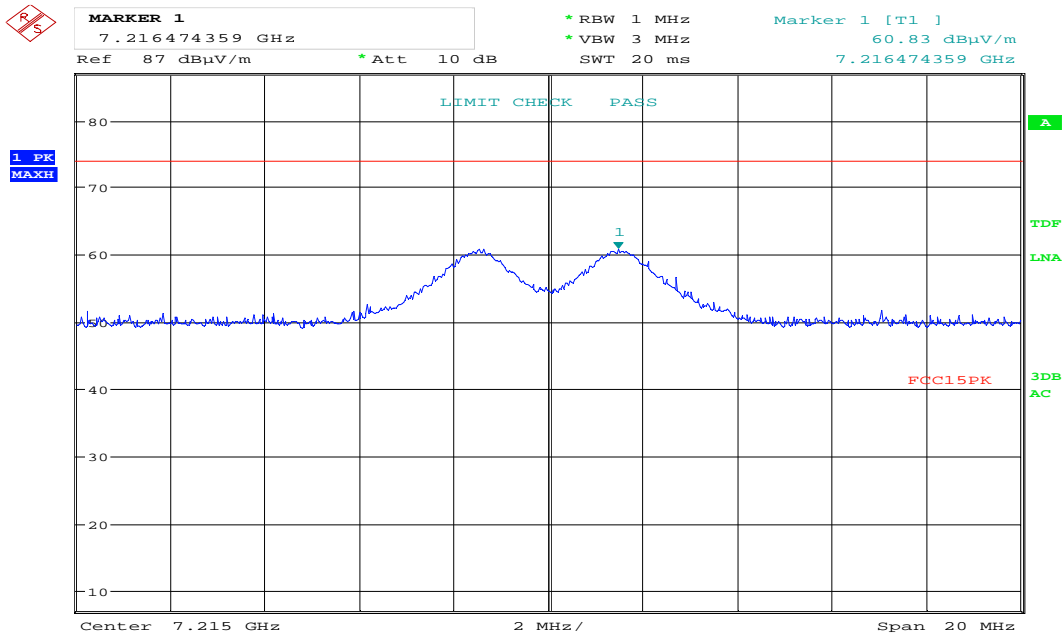
Duty Cycle Correction factor =  $-20 \times \log(0.11) = -19.17$  dB (Duty cycle : 11%)

Maximum allowed Duty Cycle Correction: 20 dB

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

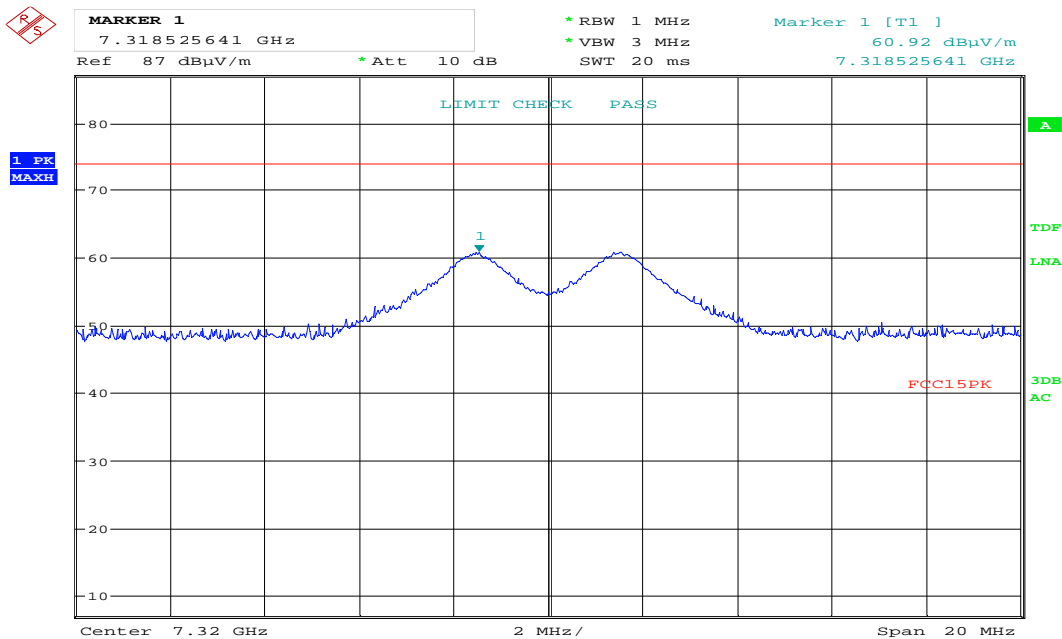
**Requirements/Limit**

<b>FCC</b>	Part 15.209 @ frequencies defined in §15.205	
<b>ISED</b>	RSS-GEN Issue 5, Clause 8.9 @ frequencies defined in clause 8.10	
	<b>Radiated emission limit @3 meters</b>	
<b>Frequency (MHz)</b>	<b>AV (dB<math>\mu</math>V/m)</b>	<b>Peak (dB<math>\mu</math>V/m)</b>
<b>Above 1 GHz</b>	54.0	74.0



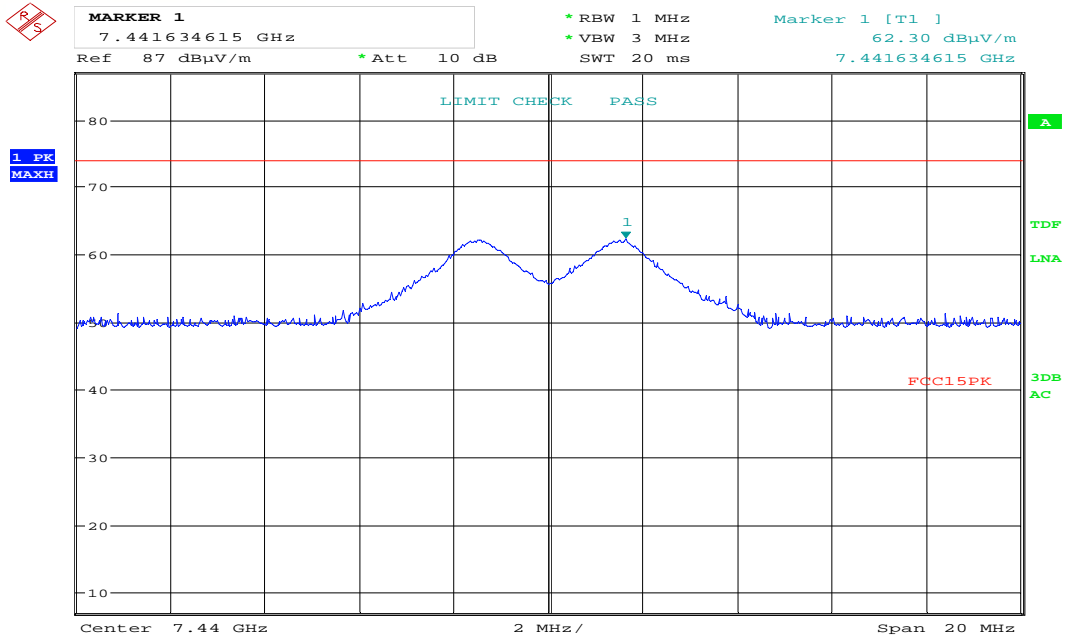
Date: 21.AUG.2019 11:16:57

Internal antenna: Radiated spurious emissions, 7,215GHz, HP, ch2405MHz



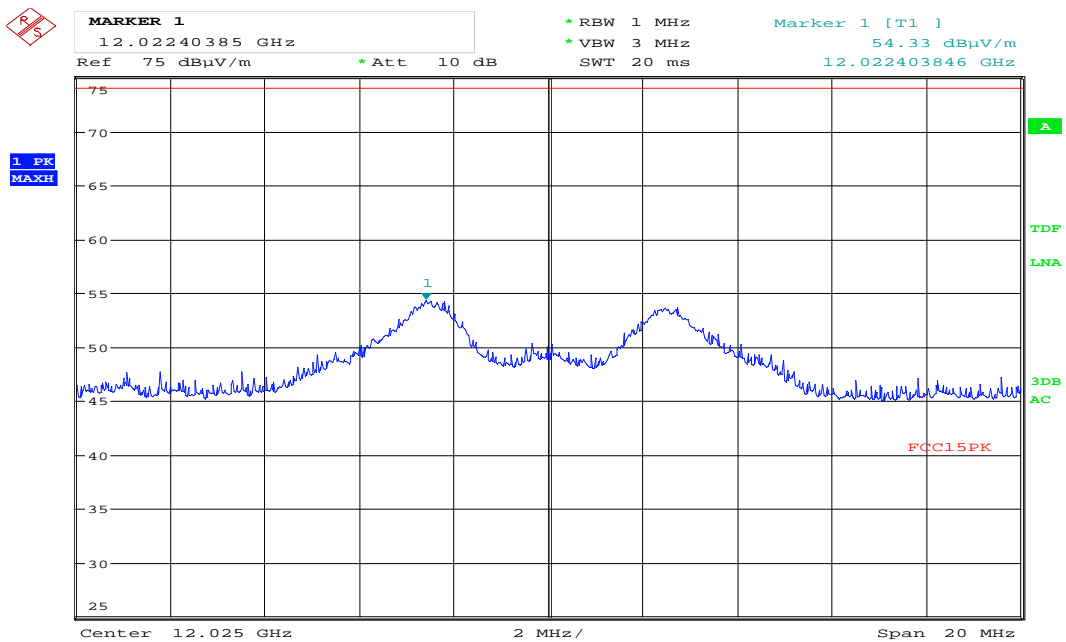
Date: 21.AUG.2019 11:23:29

Internal antenna: Radiated spurious emissions, 7,32GHz, HP, ch2440MHz



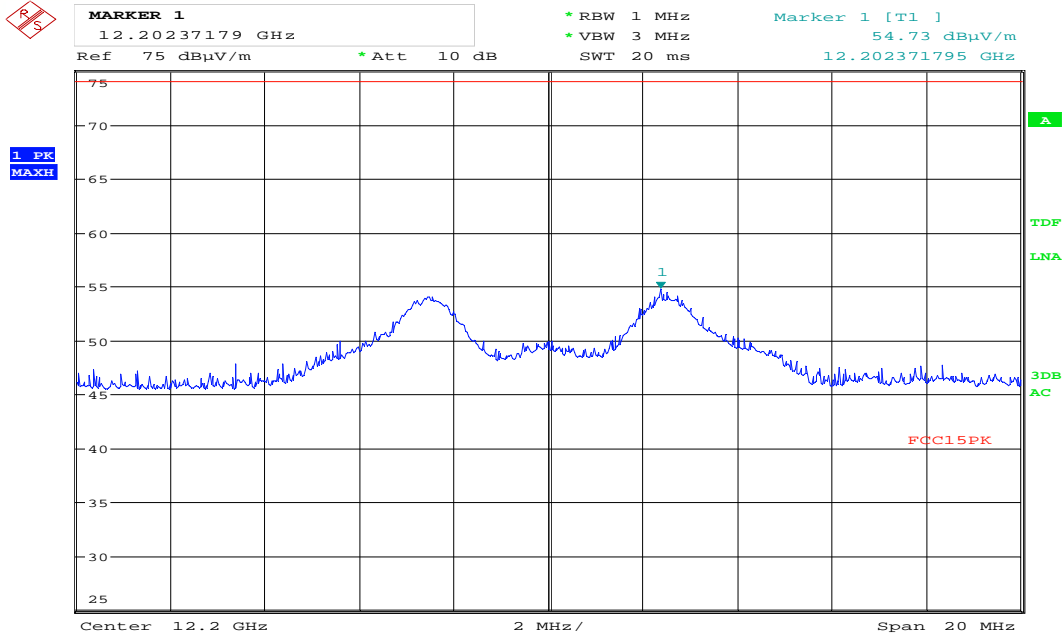
Date: 21.AUG.2019 12:13:39

Internal antenna: Radiated spurious emissions, 7,44GHz, HP, ch2480MHz



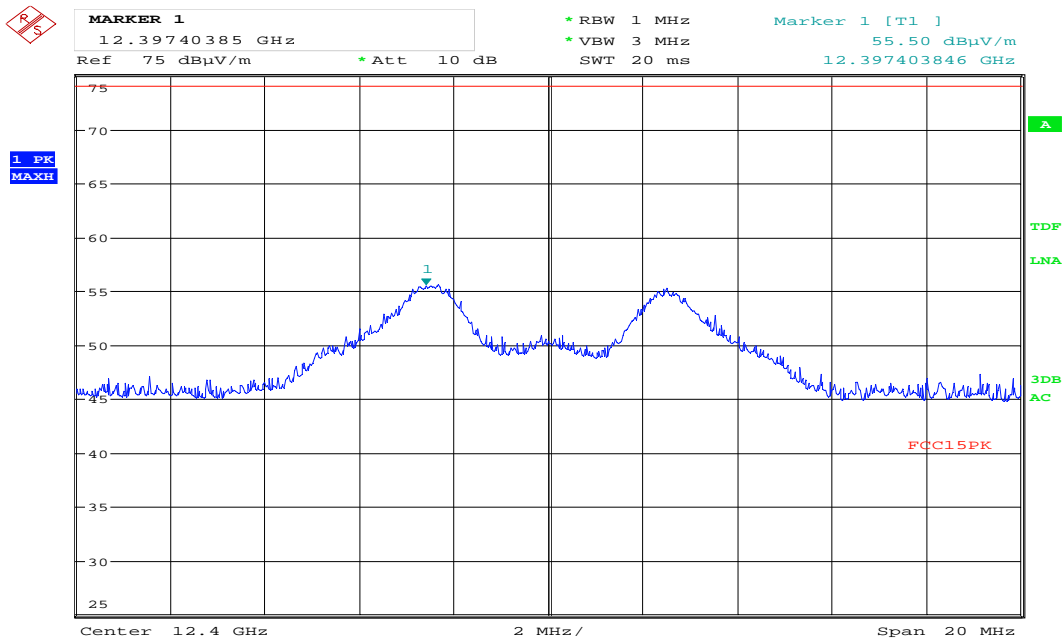
Date: 21.AUG.2019 12:59:36

Internal antenna: Radiated spurious emissions, 12.025GHz, HP, ch2405MHz



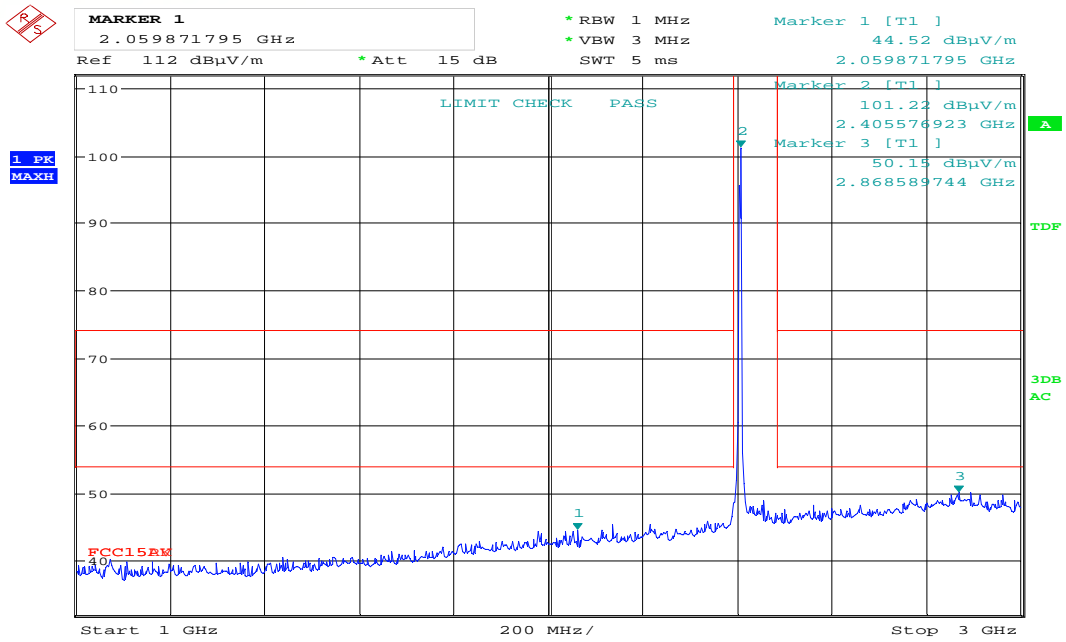
Date: 21.AUG.2019 12:52:43

Internal antenna: Radiated spurious emissions, 12.2GHz, HP, ch2440MHz



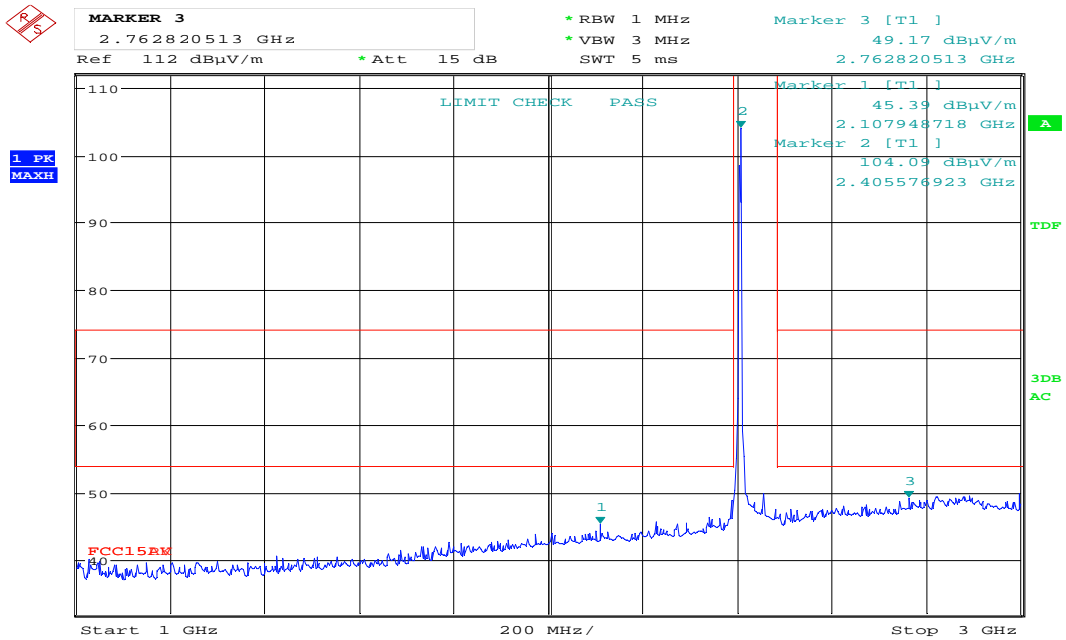
Date: 21.AUG.2019 13:06:34

Internal antenna: Radiated spurious emissions, 12.4GHz, HP, ch2480MHz



Date: 21.AUG.2019 09:37:10

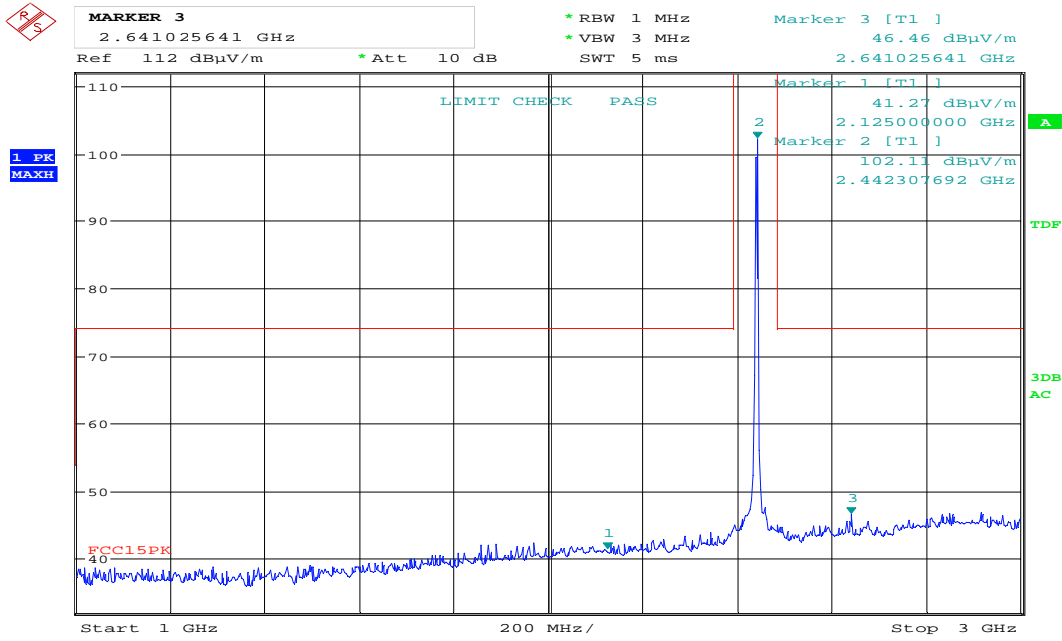
Internal antenna: Radiated spurious emissions, VP, 1 - 3GHz, ch2405MHz, PK scan



Date: 21.AUG.2019 09:35:55

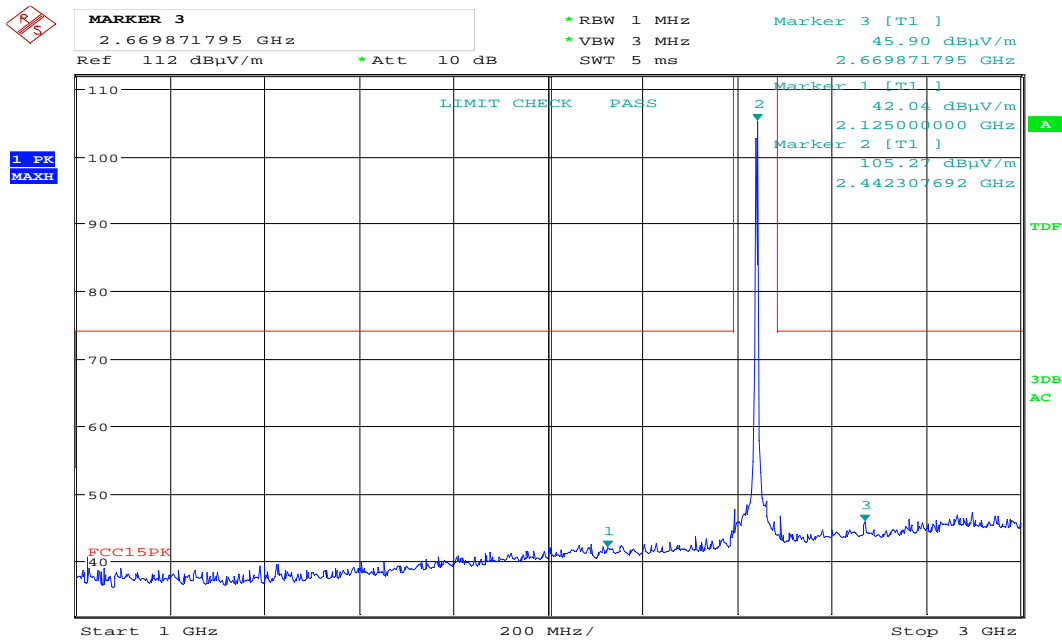
Internal antenna: Radiated spurious emissions, HP, 1 - 3GHz, ch2405MHz, PK scan





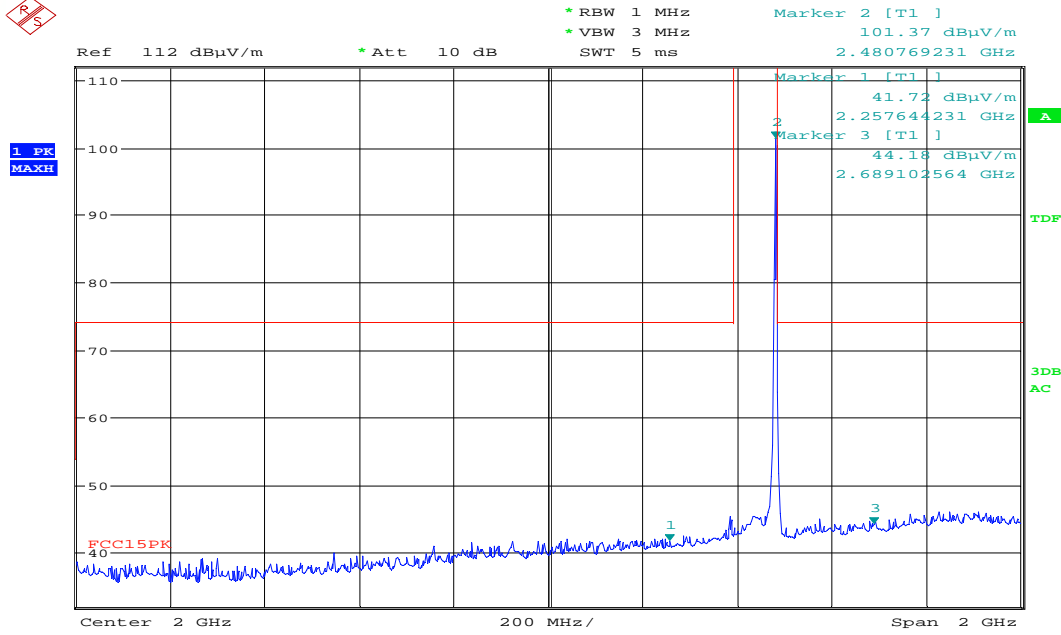
Date: 21.AUG.2019 12:18:15

Internal antenna: Radiated spurious emissions, VP, 1 - 3GHz, ch2440MHz, PK scan



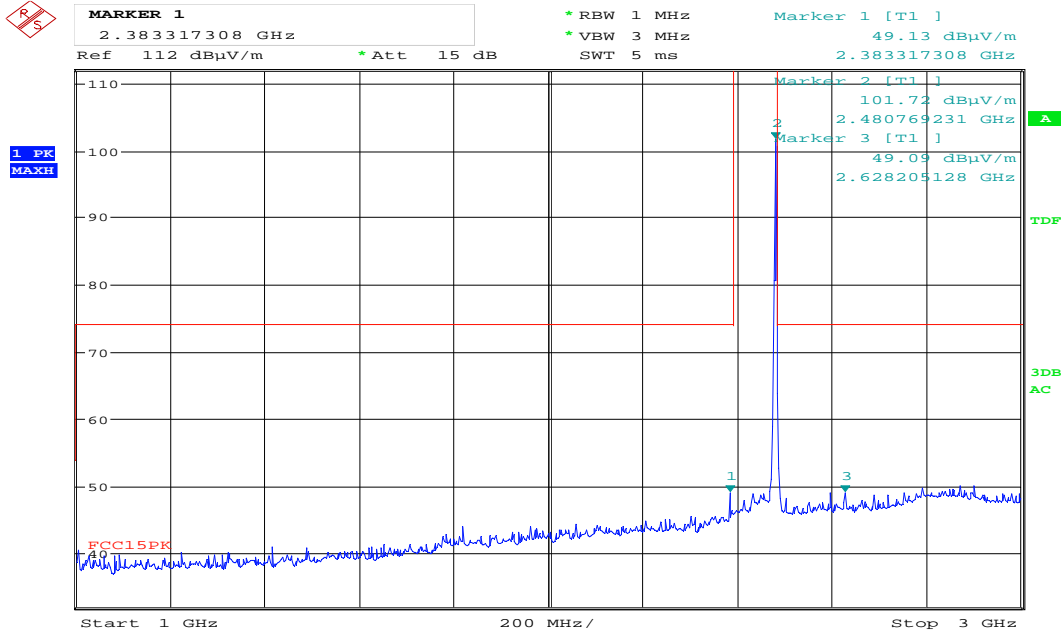
Date: 21.AUG.2019 12:16:48

Internal antenna: Radiated spurious emissions, HP, 1 - 3GHz, ch2440MHz, PK scan



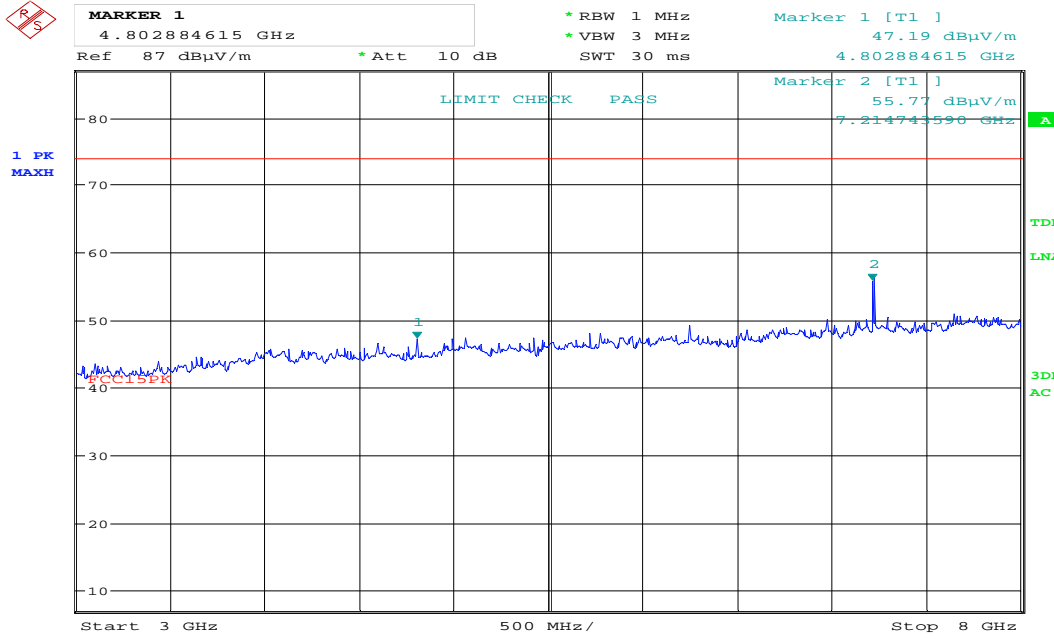
Date: 21.AUG.2019 12:06:22

Internal antenna: Radiated spurious emissions, VP, 1 - 3GHz, ch2480MHz, PK scan



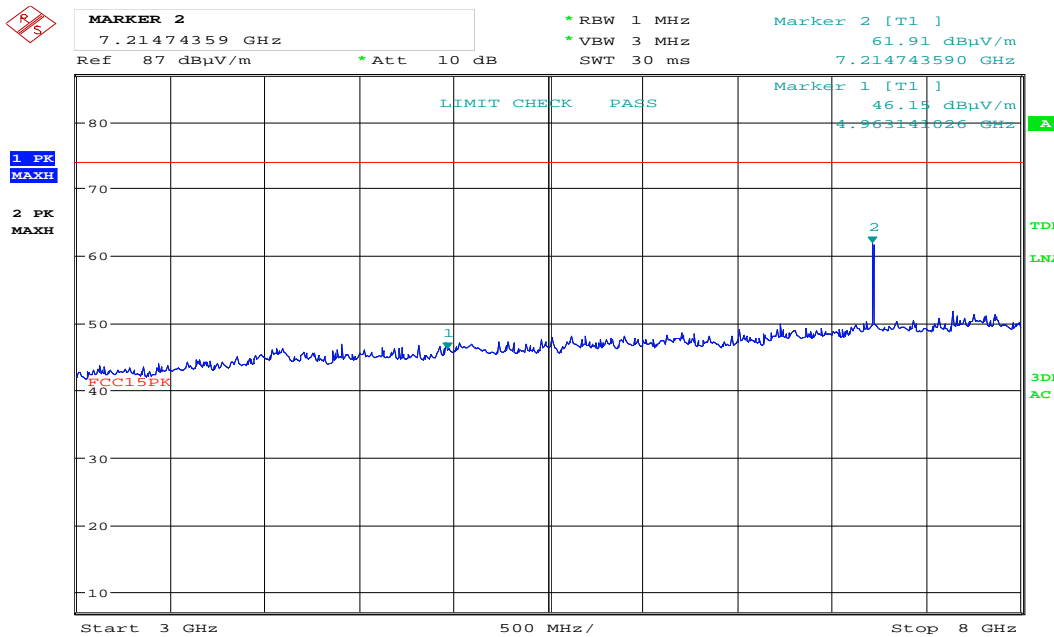
Date: 21.AUG.2019 10:05:37

Internal antenna: Radiated spurious emissions, HP, 1 - 3GHz, ch2480MHz, PK scan



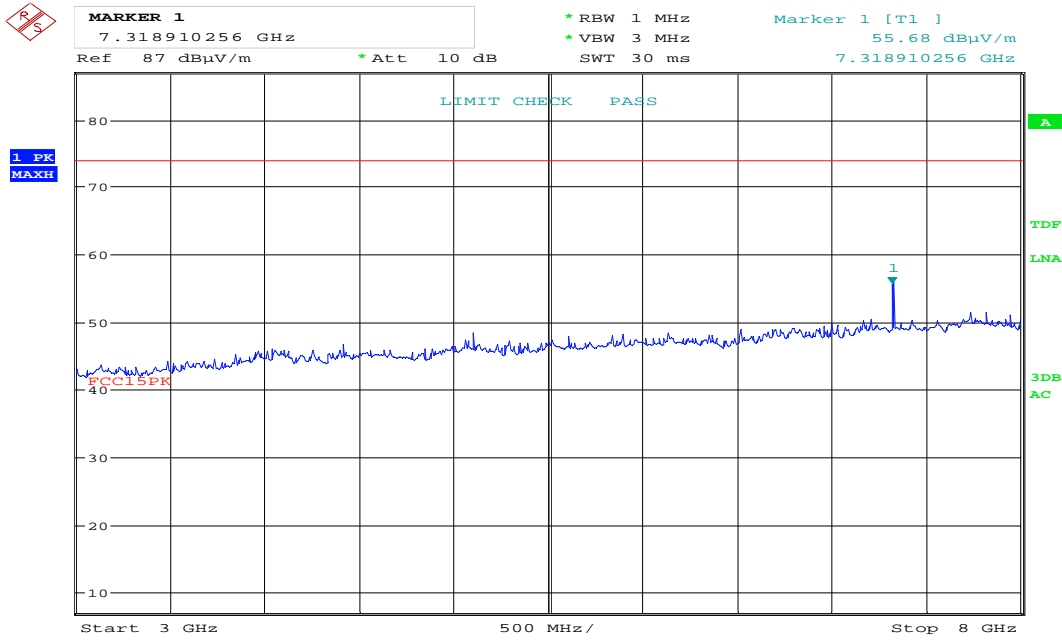
Date: 21.AUG.2019 11:12:46

Internal antenna: Radiated spurious emissions, VP, 3 - 8GHz, ch2405MHz, PK scan



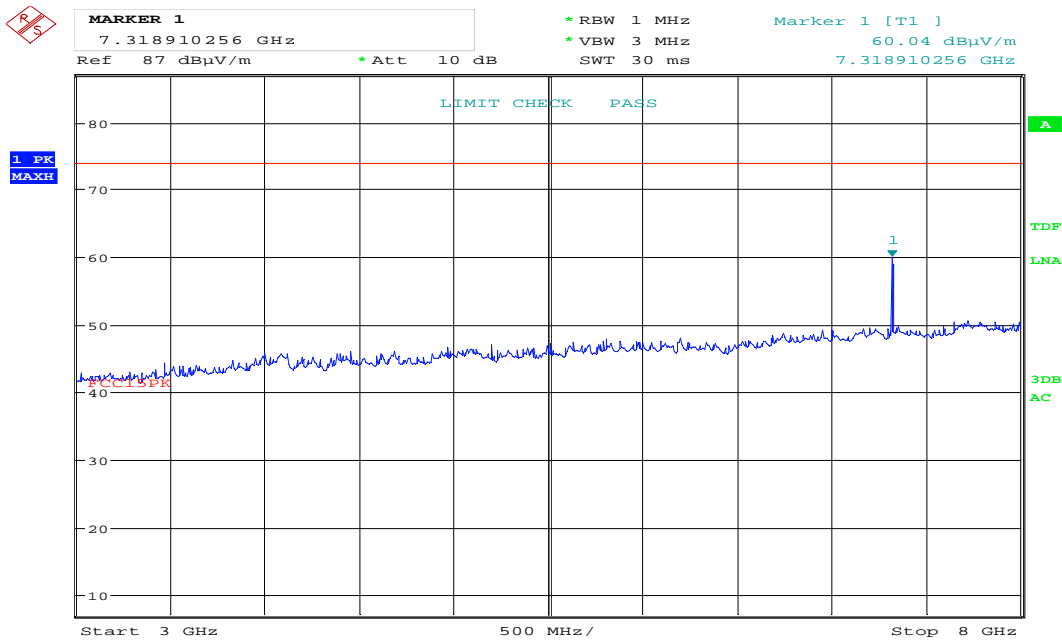
Date: 21.AUG.2019 11:09:23

Internal antenna: Radiated spurious emissions, HP, 3 - 8GHz, ch2405MHz, PK scan



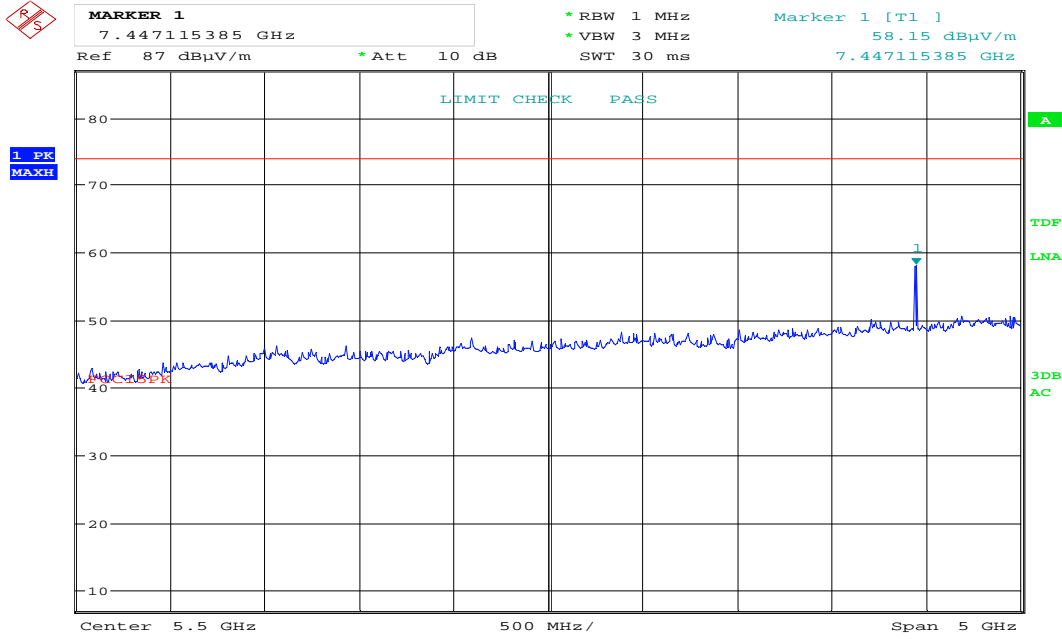
Date: 21.AUG.2019 11:28:12

Internal antenna: Radiated spurious emissions, VP, 3 - 8GHz, ch2440MHz, PK scan



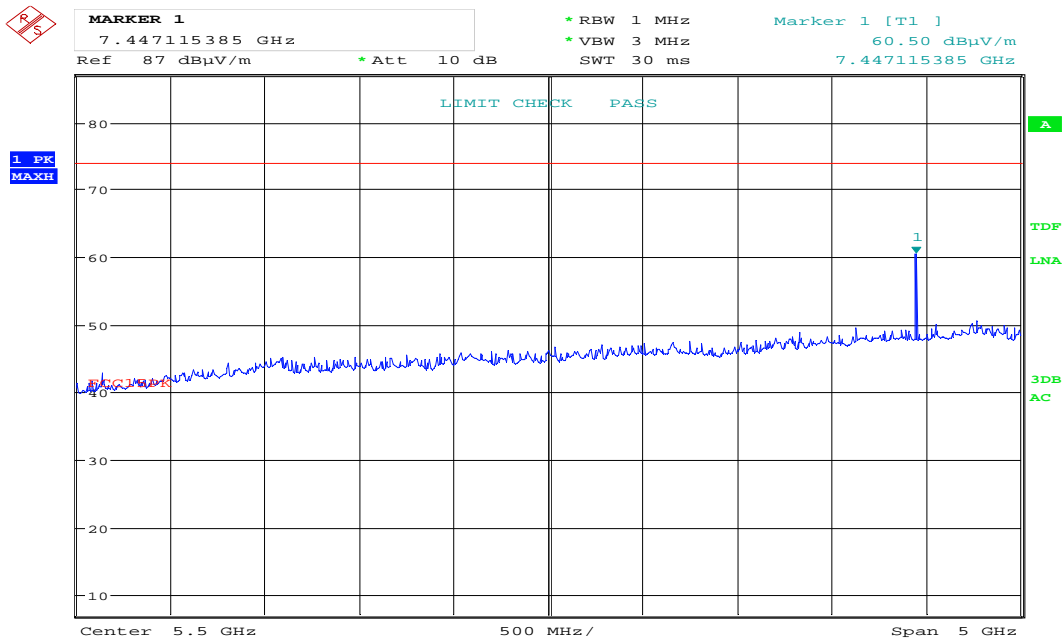
Date: 21.AUG.2019 11:22:18

Internal antenna: Radiated spurious emissions, HP, 3 - 8GHz, ch2440MHz, PK scan



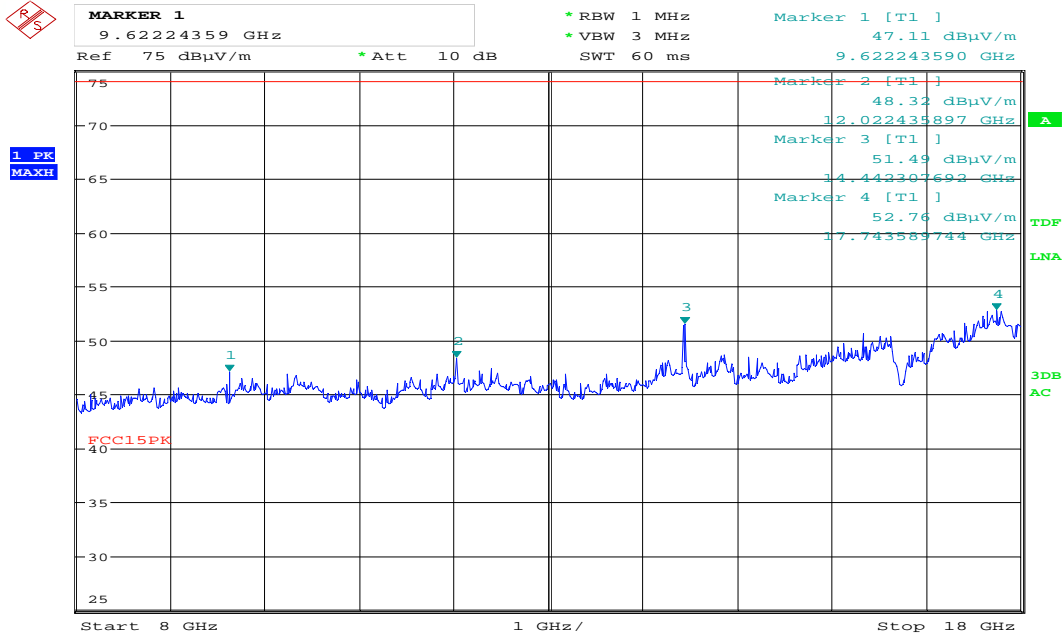
Date: 21.AUG.2019 12:11:33

Internal antenna: Radiated spurious emissions, VP, 3 - 8GHz, ch2480MHz, PK scan



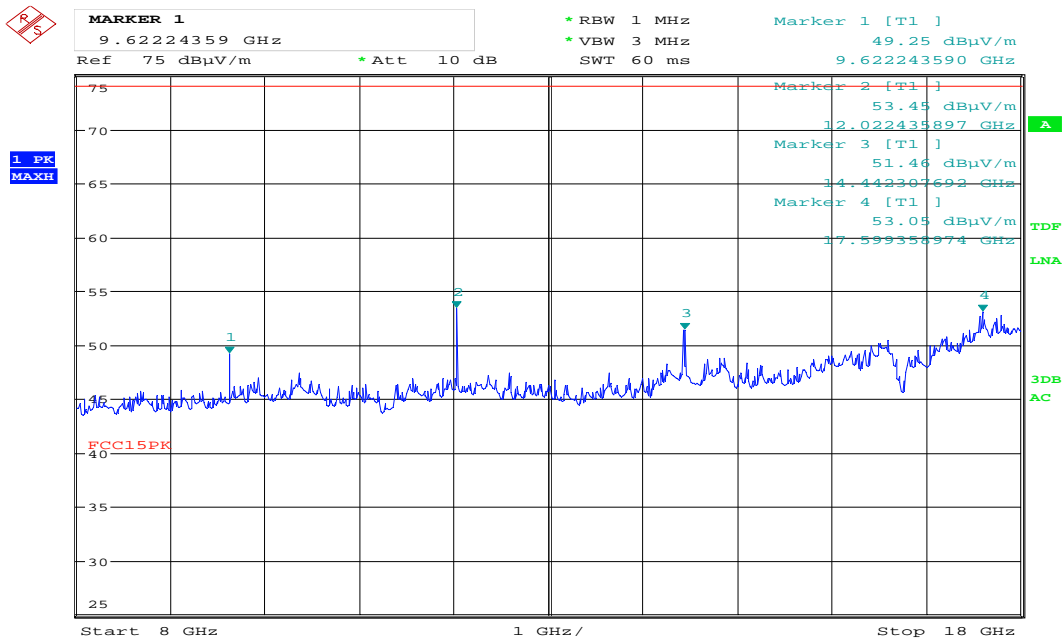
Date: 21.AUG.2019 12:12:43

Internal antenna: Radiated spurious emissions, HP, 3 - 8GHz, ch2480MHz, PK scan



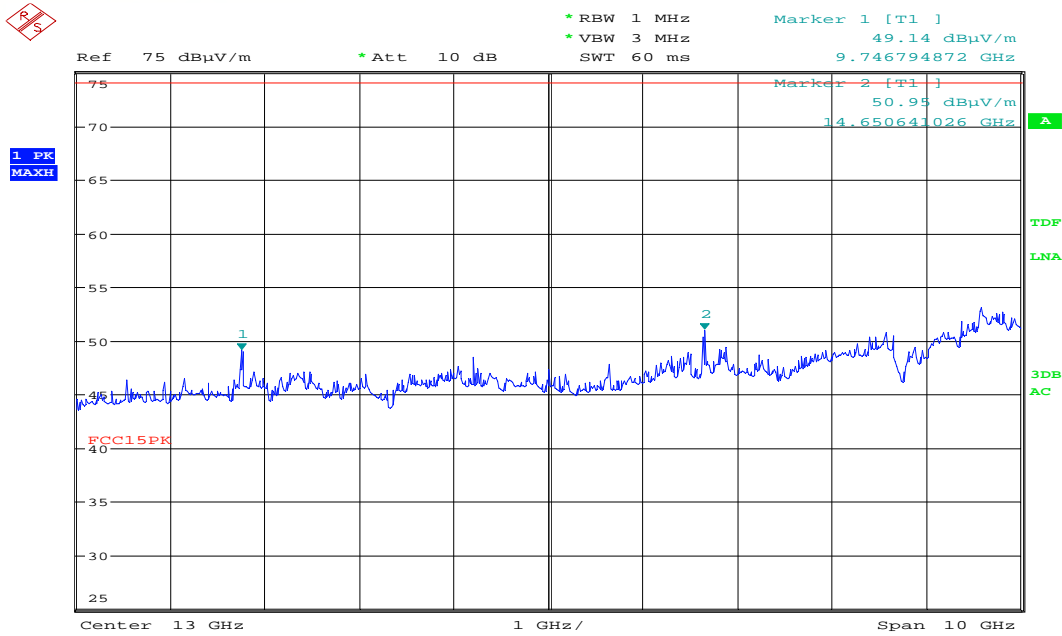
Date: 21.AUG.2019 12:58:38

Internal antenna: Radiated spurious emissions, VP, 8 - 18GHz, ch2405MHz, PK scan



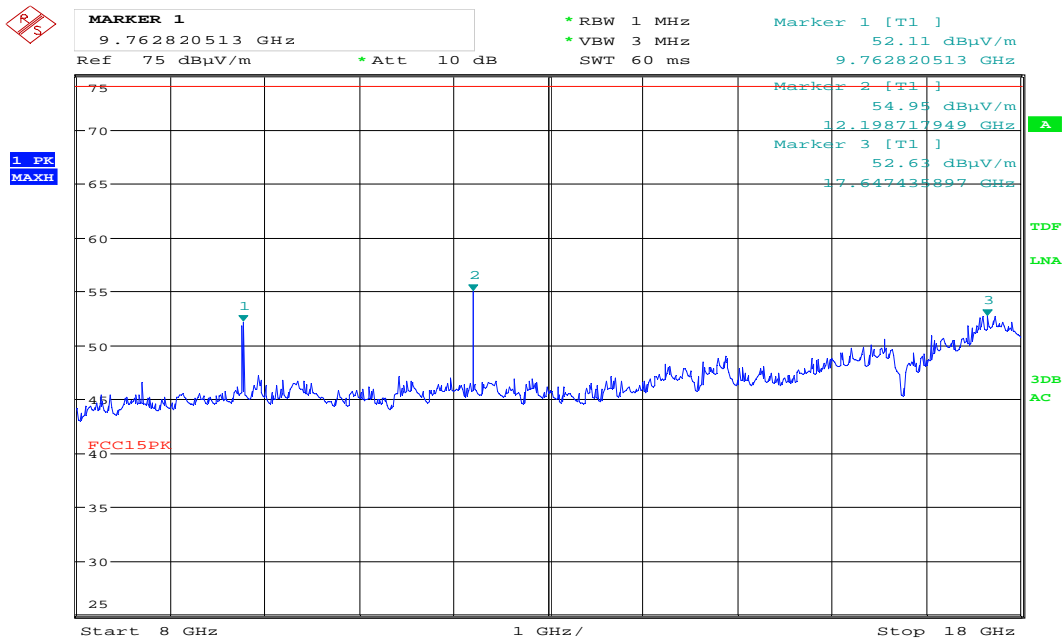
Date: 21.AUG.2019 12:56:40

Internal antenna: Radiated spurious emissions, HP, 8 - 18GHz, ch2405MHz, PK scan



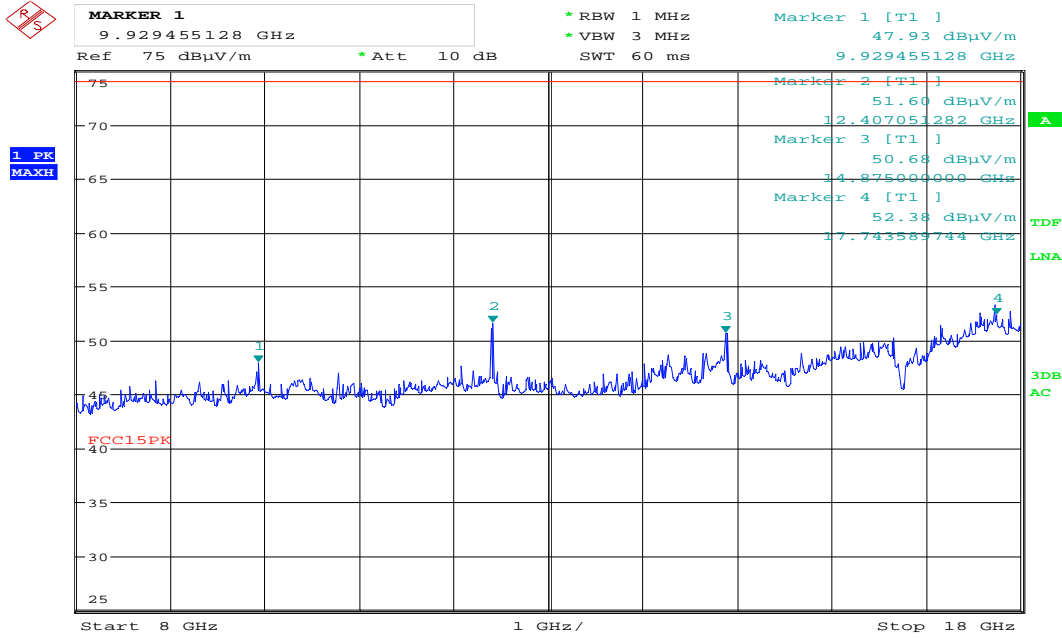
Date: 21.AUG.2019 12:45:32

Internal antenna: Radiated spurious emissions, VP, 8 - 18GHz, ch2440MHz, PK scan



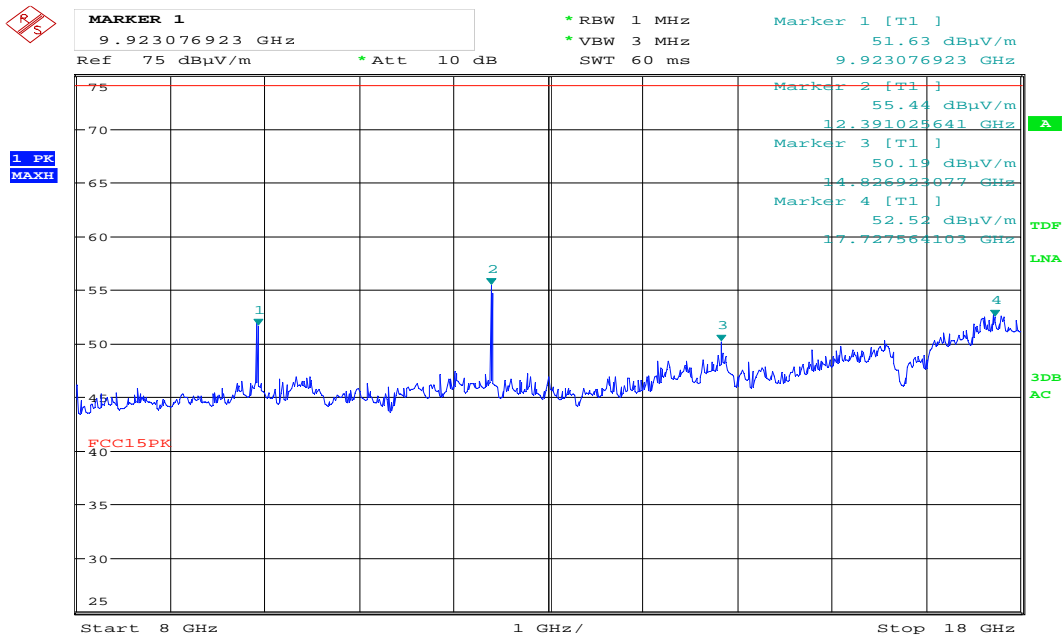
Date: 21.AUG.2019 12:47:26

Internal antenna: Radiated spurious emissions, HP, 8 - 18GHz, ch2440MHz, PK scan



Date: 21.AUG.2019 13:08:18

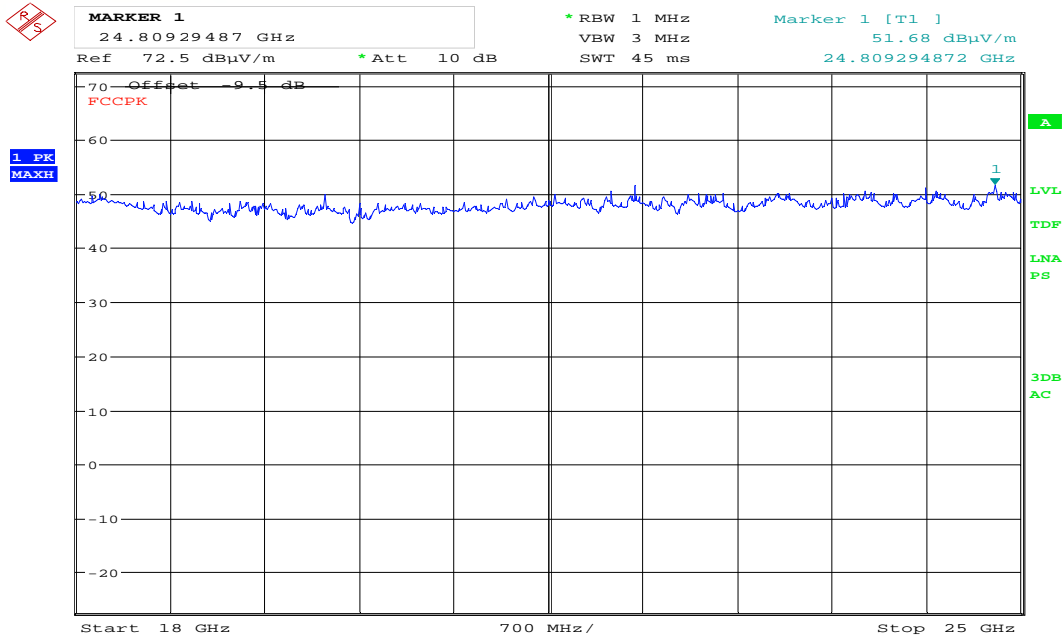
Internal antenna: Radiated spurious emissions, VP, 8 - 18GHz, ch2480MHz, PK scan



Date: 21.AUG.2019 13:05:38

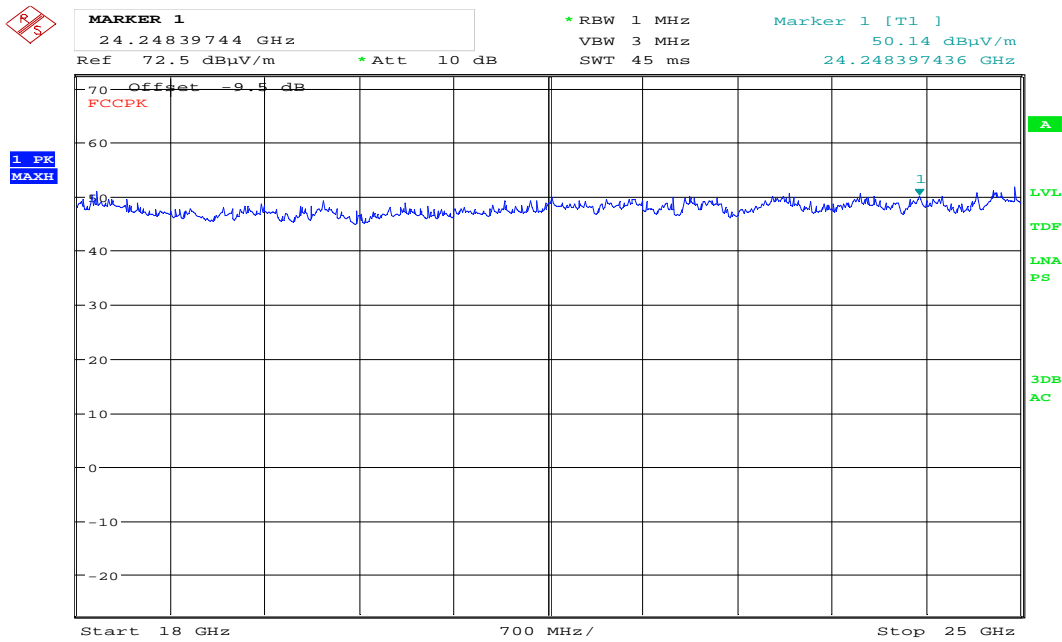
Internal antenna: Radiated spurious emissions, HP, 8 - 18GHz, ch2480MHz, PK scan





Date: 21.AUG.2019 19:47:16

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



Date: 21.AUG.2019 19:47:56

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

**External Antenna:**

**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

Measuring distance: 3m (1 – 18 GHz), 1m (18 – 25 GHz)

**Peak Detector: (Restricted band frequencies)**

Frequency	RF channel	Dist. corr. factor	Field strength, Peak Detector, 3m	Limit	Margin
GHz	L,M,H	dB	dB $\mu$ V/m	dB $\mu$ V/m	dB
7.32	M	0	59.19	74	14.81
7.44	H	0	62.08	74	11.92
12.025	L	0	54.70	74	19.30
Other freqs	L,M,H	0	None detected	74	>20

**Average Detector: (Restricted band frequencies)**

Frequency	RF channel	Dist. corr. factor	Field strength, Average Detector, 3m	Duty cycle corr. factor	Limit	Margin
GHz	L,M,H	dB	dB $\mu$ V/m	dB	dB $\mu$ V/m	dB
7.32	M	0	40.02	19.17	54	13.98
7.44	H	0	42.91	19.17	54	11.09
12.025	L	0	35.53	19.17	54	18.47
Other freqs	L,M,H	/	None detected	20	54	>20

**Peak Detector: (Non Restricted band frequencies)**

Frequency	RF channel	Dist. corr. factor	Field strength, Peak Detector, 3m	#Limit	Margin
GHz	L,M,H	dB	dB $\mu$ V/m	dB $\mu$ V/m	dB
7.215	L	0	62.55	102.1	39.55
14.44	L	0	55.61	102.1	46.49
Other freqs	L,M,H	0	None detected		>20

# 20 dB below the highest power level of the fundamental frequency (PK).

\*distance correction is included on the plot.

Maxium is obtained in HP (14.44GHz in VP)

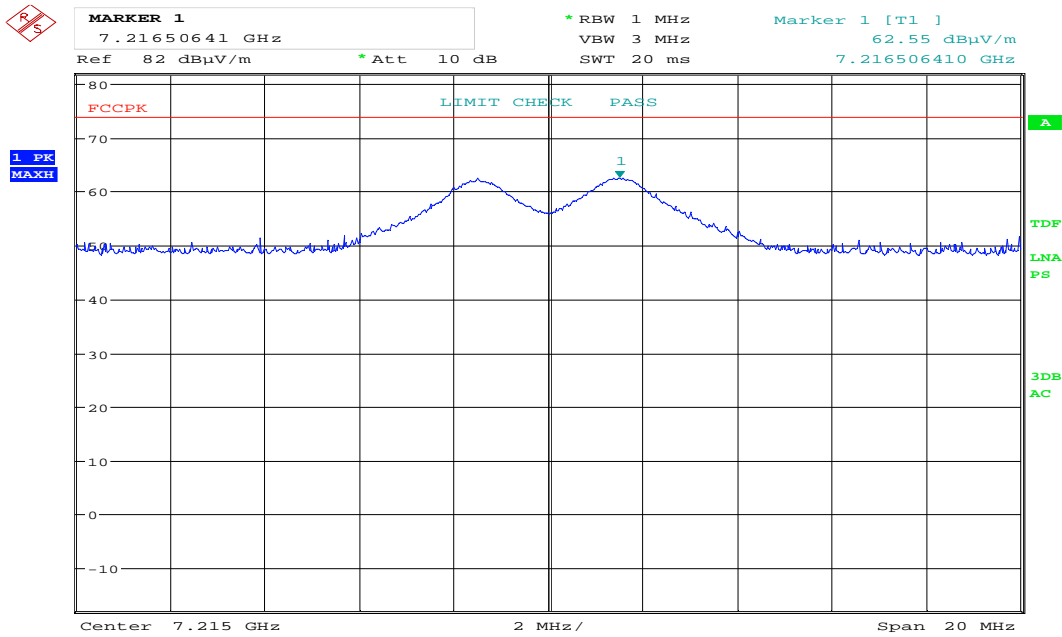
Duty Cycle Correction factor =  $-20 \times \log(0.11) = -19.17$  dB (Duty cycle: 11%)

Maximum allowed Duty Cycle Correction: 20 dB

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

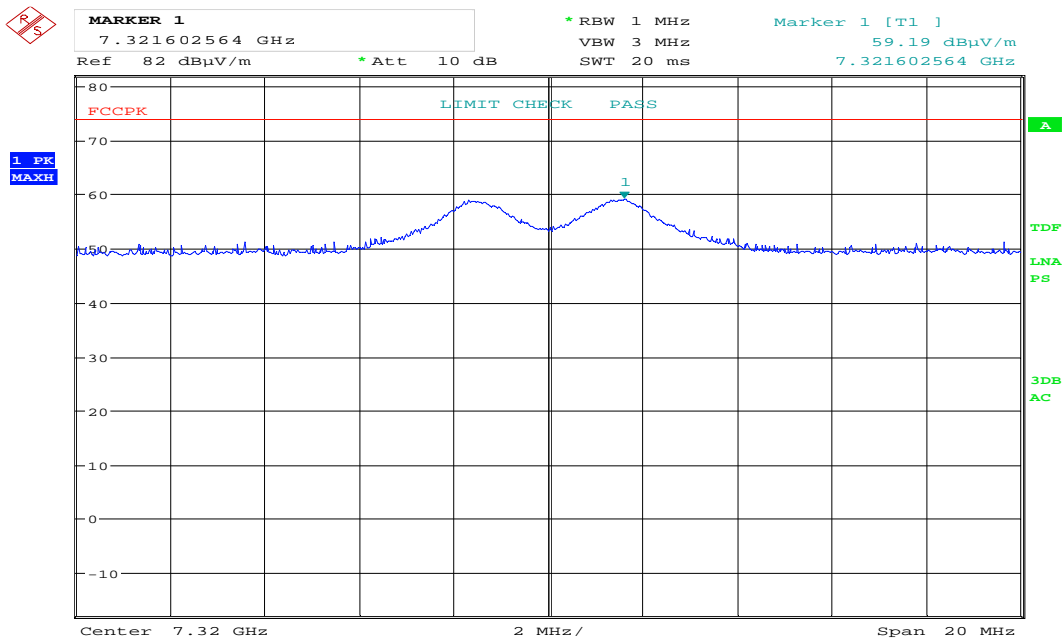
**Requirements/Limit**

<b>FCC</b>	Part 15.209 @ frequencies defined in §15.205	
<b>ISED</b>	RSS-GEN Issue 5, Clause 8.9 @ frequencies defined in clause 8.10	
	<b>Radiated emission limit @3 meters</b>	
<b>Frequency (MHz)</b>	<b>AV (dB<math>\mu</math>V/m)</b>	<b>Peak (dB<math>\mu</math>V/m)</b>
<b>Above 1 GHz</b>	54.0	74.0



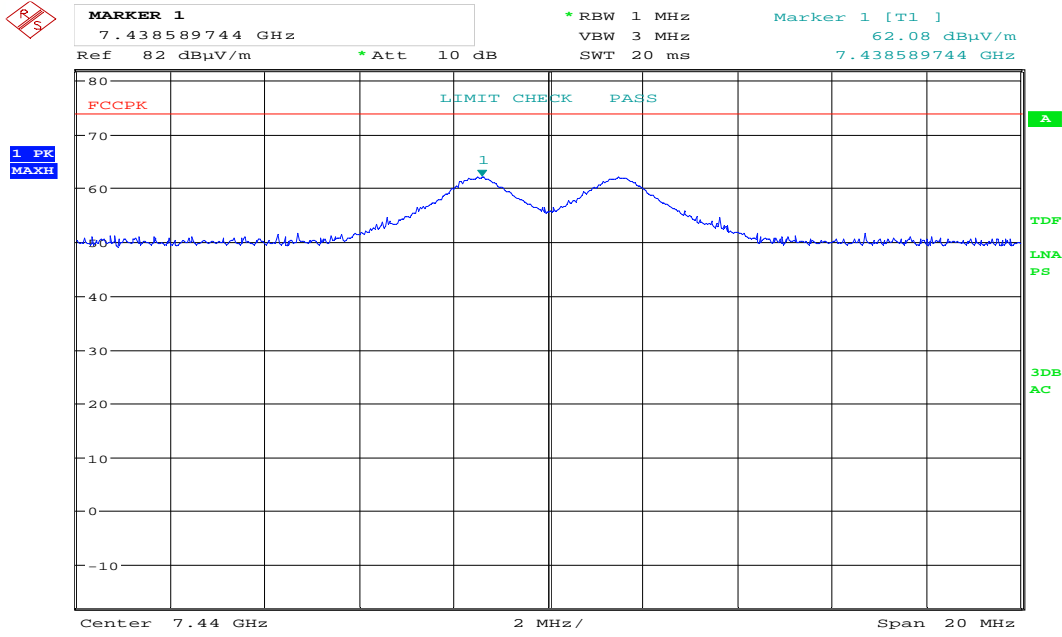
Date: 21.AUG.2019 19:02:50

External Antenna: Radiated spurious emissions, 7,215GHz, HP, ch2405MHz



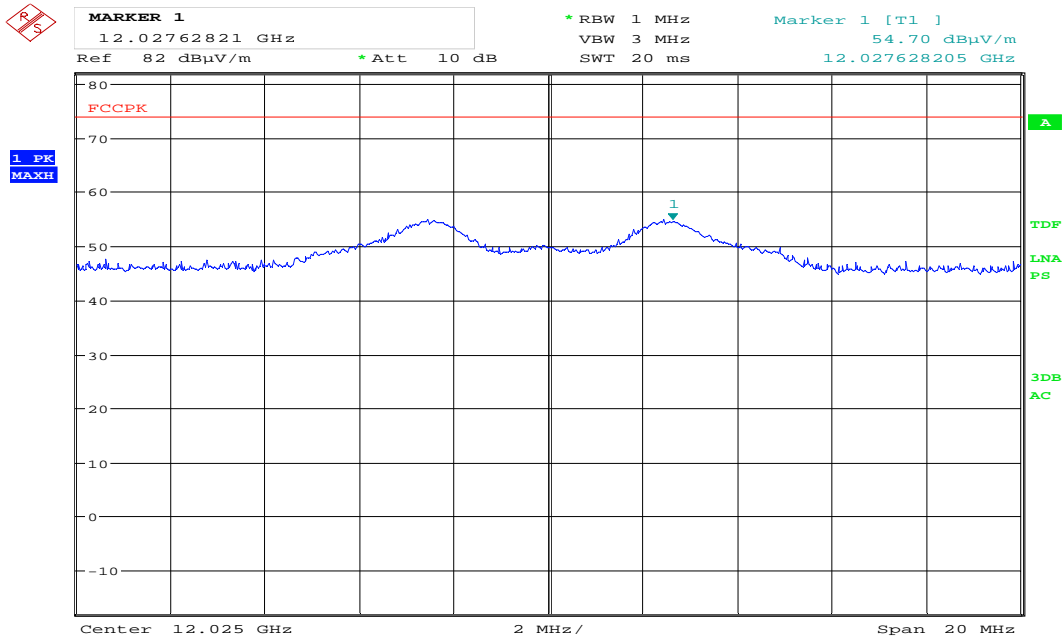
Date: 21.AUG.2019 19:06:13

External Antenna: Radiated spurious emissions, 7,32GHz, HP, ch2440MHz



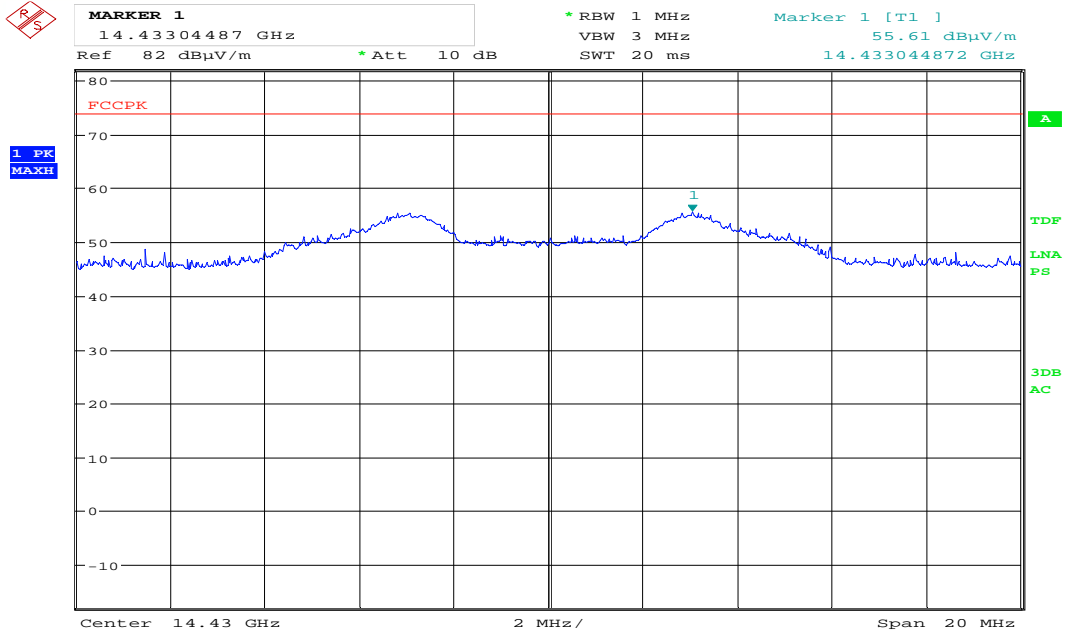
Date: 21.AUG.2019 19:12:48

External Antenna: Radiated spurious emissions, 7,44GHz, HP, ch2480MHz



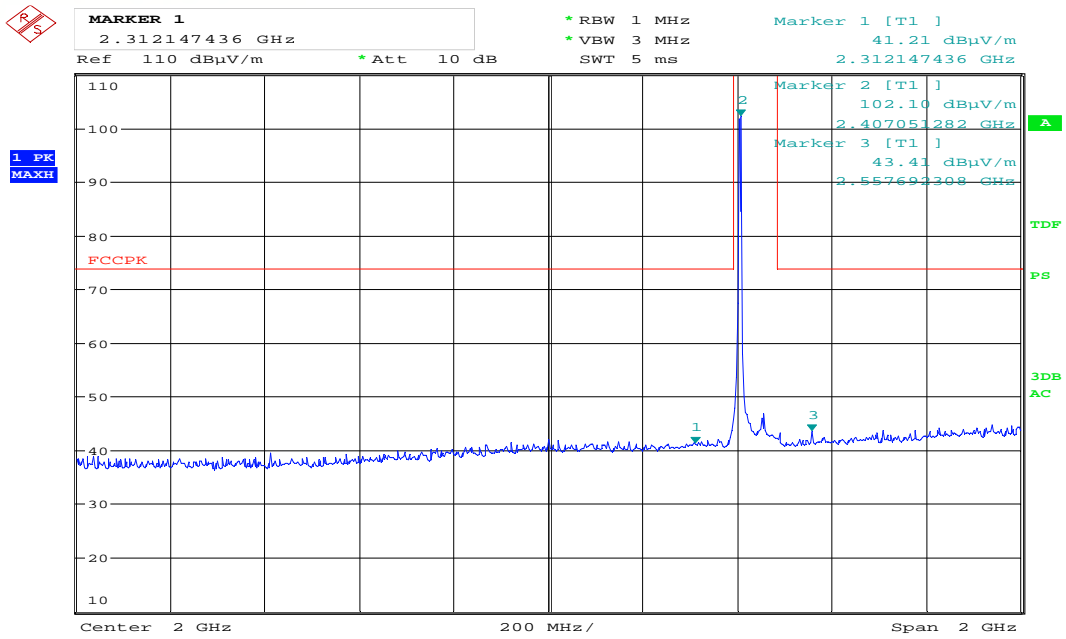
Date: 21.AUG.2019 19:37:14

External Antenna: Radiated spurious emissions, 12.2GHz, HP, ch2405MHz



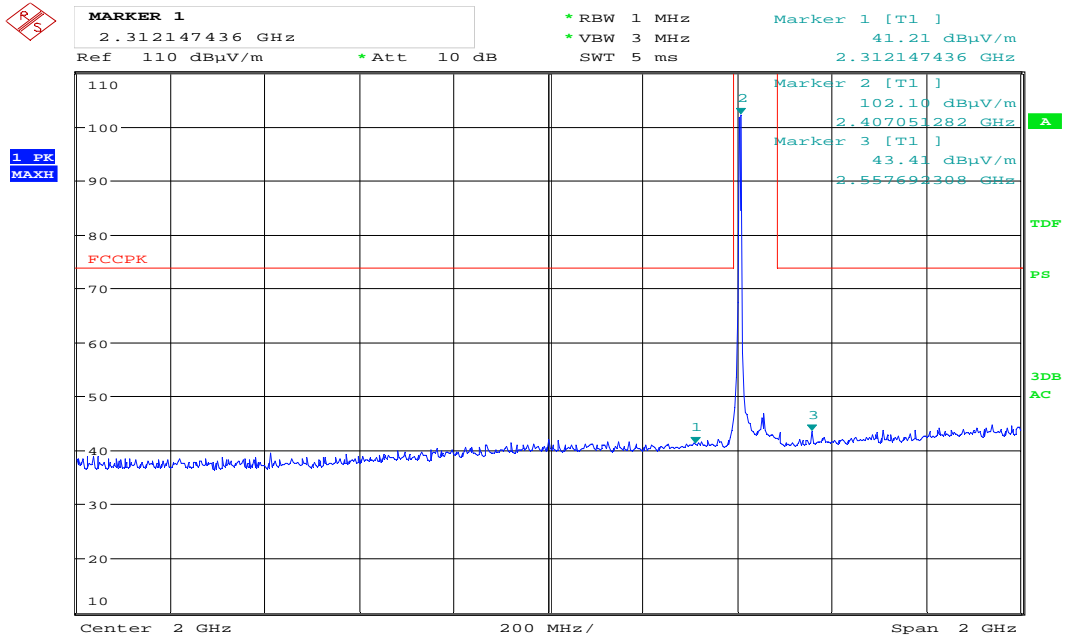
Date: 21.AUG.2019 19:37:58

External Antenna: Radiated spurious emissions, 14.42GHz, VP, ch2405MHz



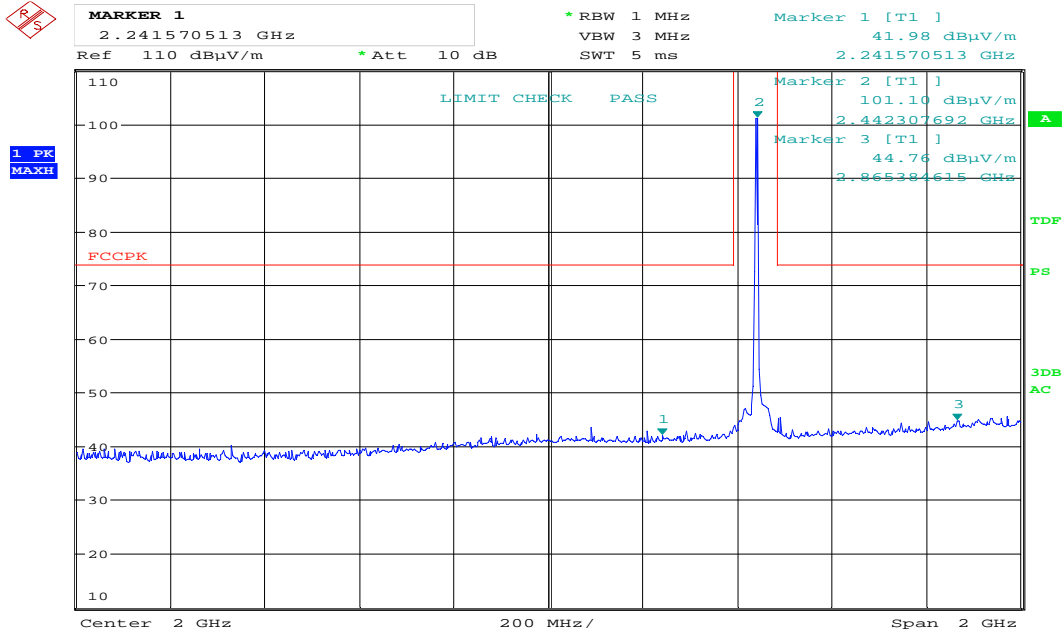
Date: 21.AUG.2019 18:50:27

External Antenna: Radiated spurious emissions, VP, 1 - 3GHz, ch2405MHz, PK scan



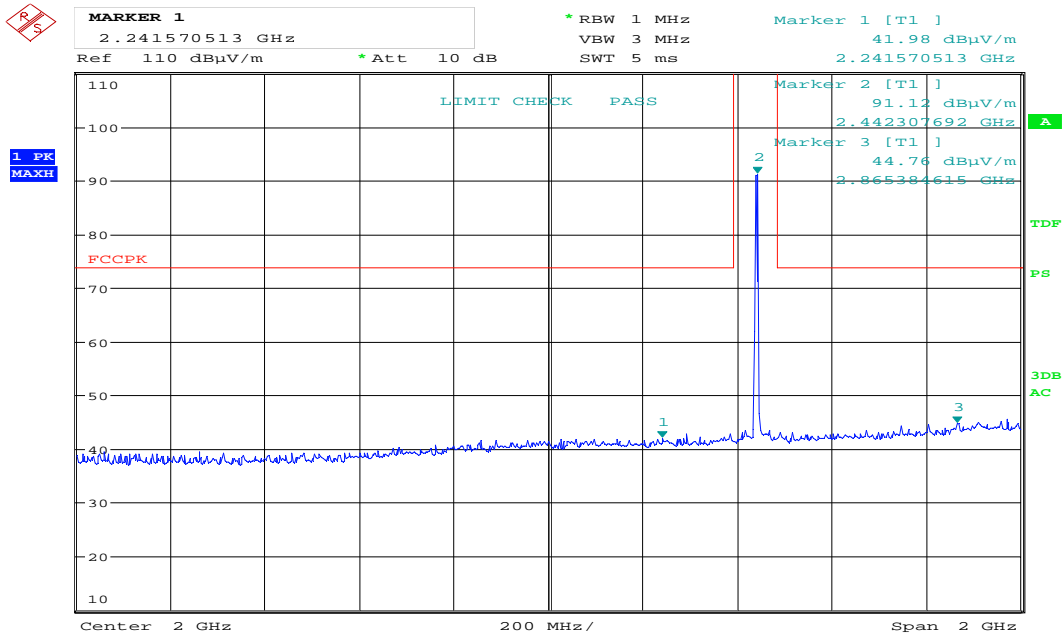
Date: 21.AUG.2019 18:50:27

External Antenna: Radiated spurious emissions, HP, 1 - 3GHz, ch2405MHz, PK scan



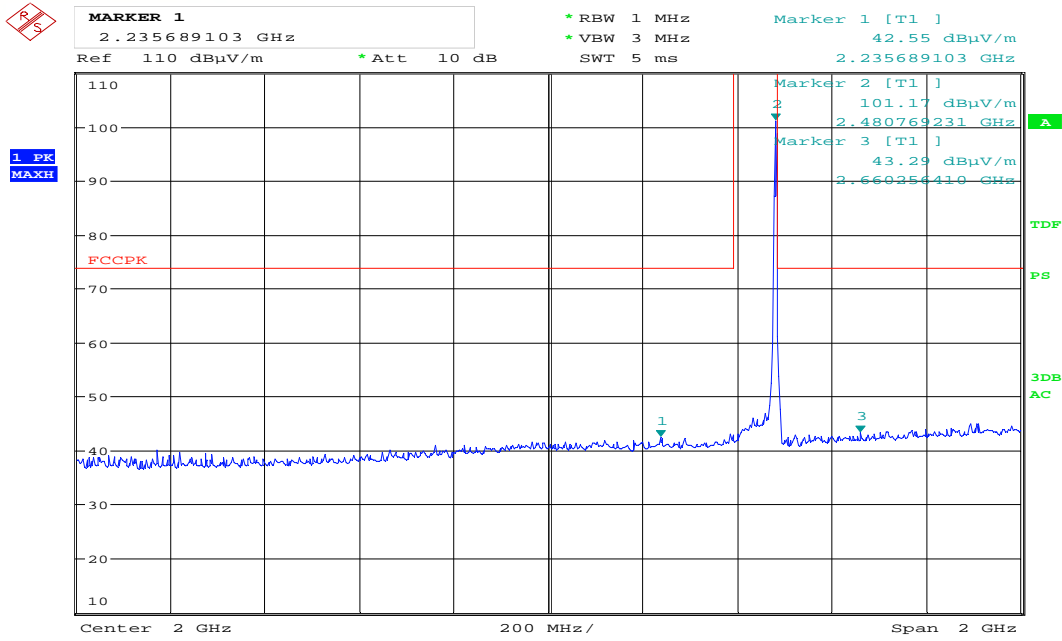
Date: 21.AUG.2019 18:46:00

External Antenna: Radiated spurious emissions, VP, 1 - 3GHz, ch2440MHz, PK scan



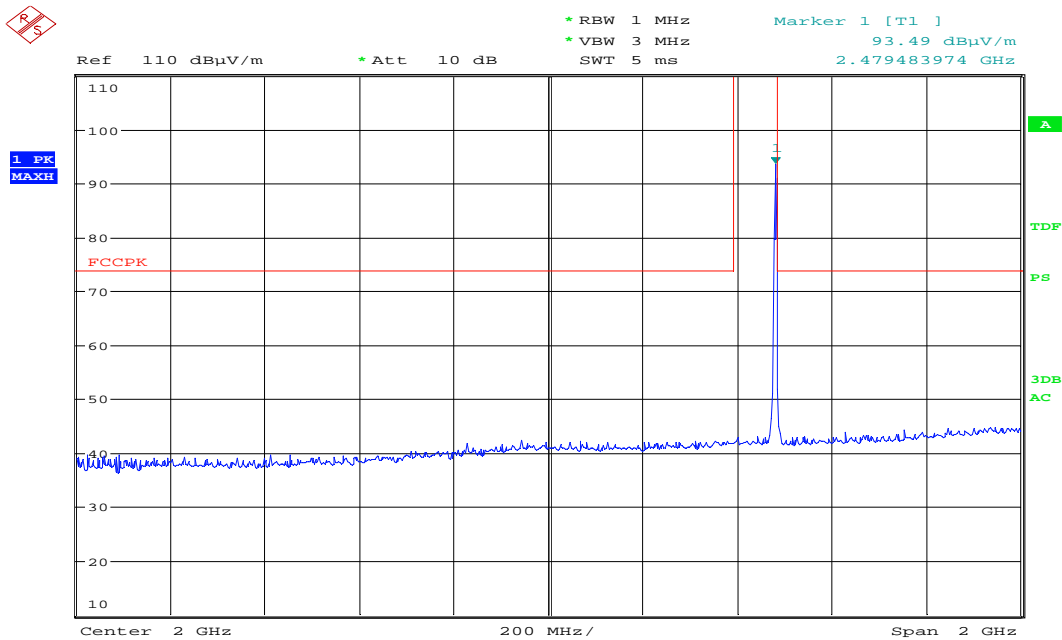
Date: 21.AUG.2019 18:44:57

External Antenna: Radiated spurious emissions, HP, 1 - 3GHz, ch2440MHz, PK scan



Date: 21.AUG.2019 18:33:20

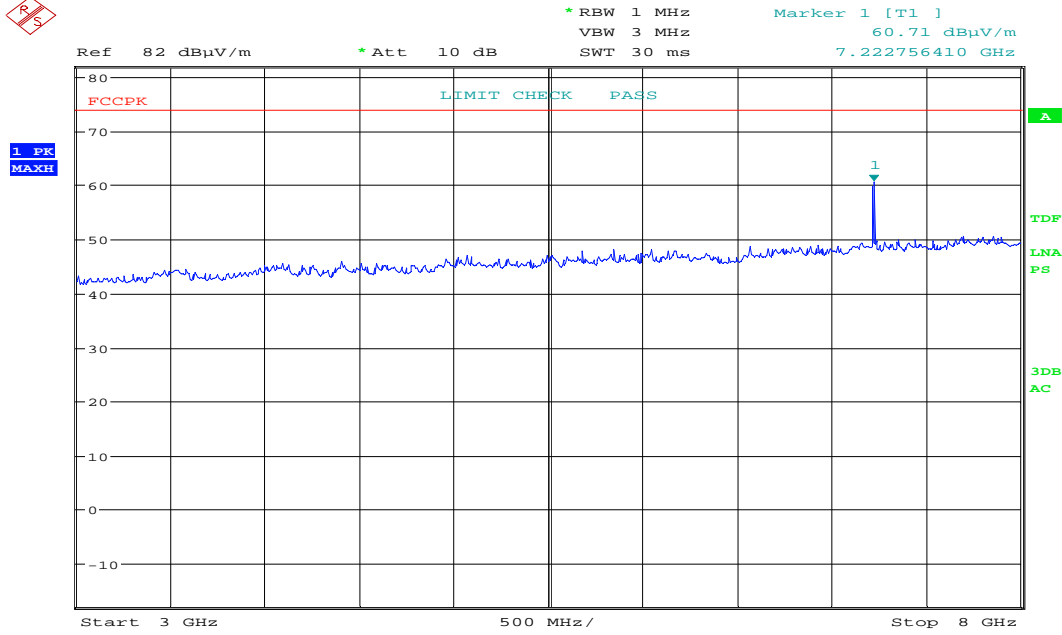
External Antenna: Radiated spurious emissions, VP, 1 - 3GHz, ch2480MHz, PK scan



Date: 21.AUG.2019 18:39:23

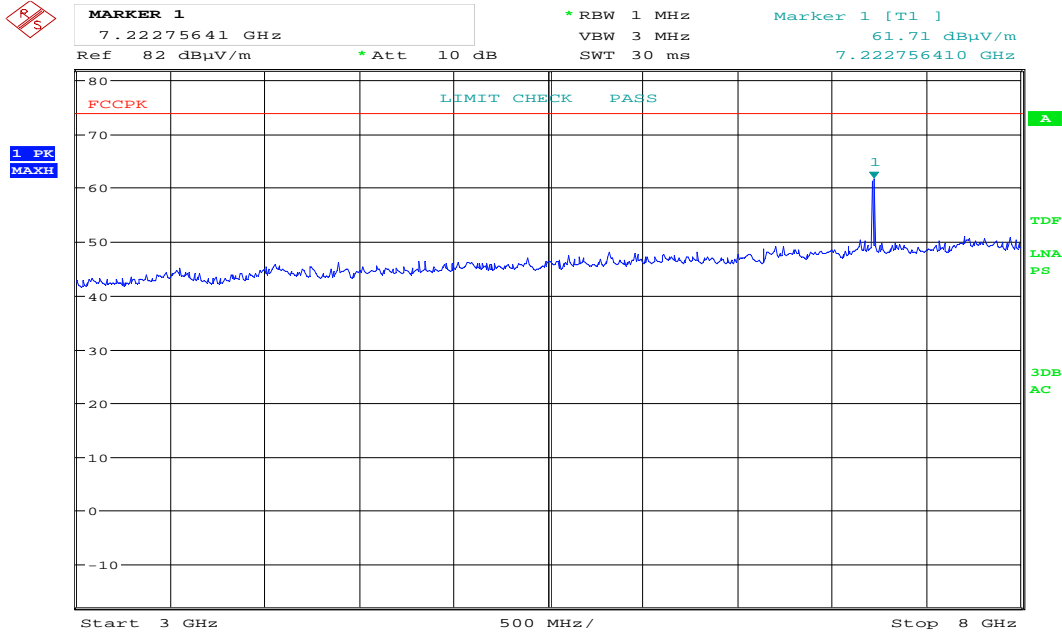
External Antenna: Radiated spurious emissions, HP, 1 - 3GHz, ch2480MHz, PK scan





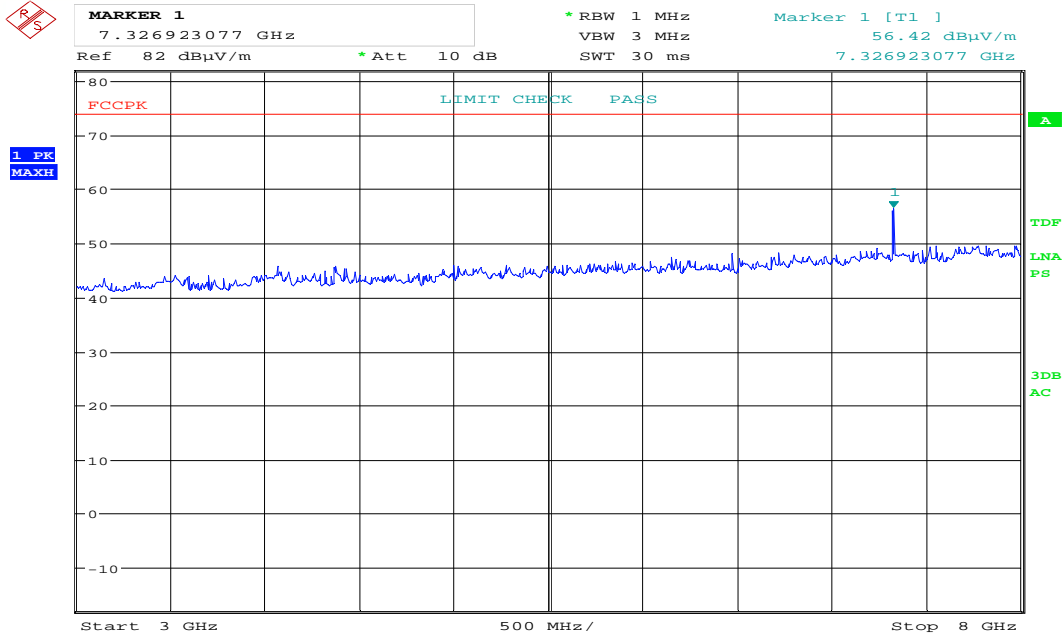
Date: 21.AUG.2019 19:01:44

External Antenna: Radiated spurious emissions, VP, 3 - 8GHz, ch2405MHz, PK scan



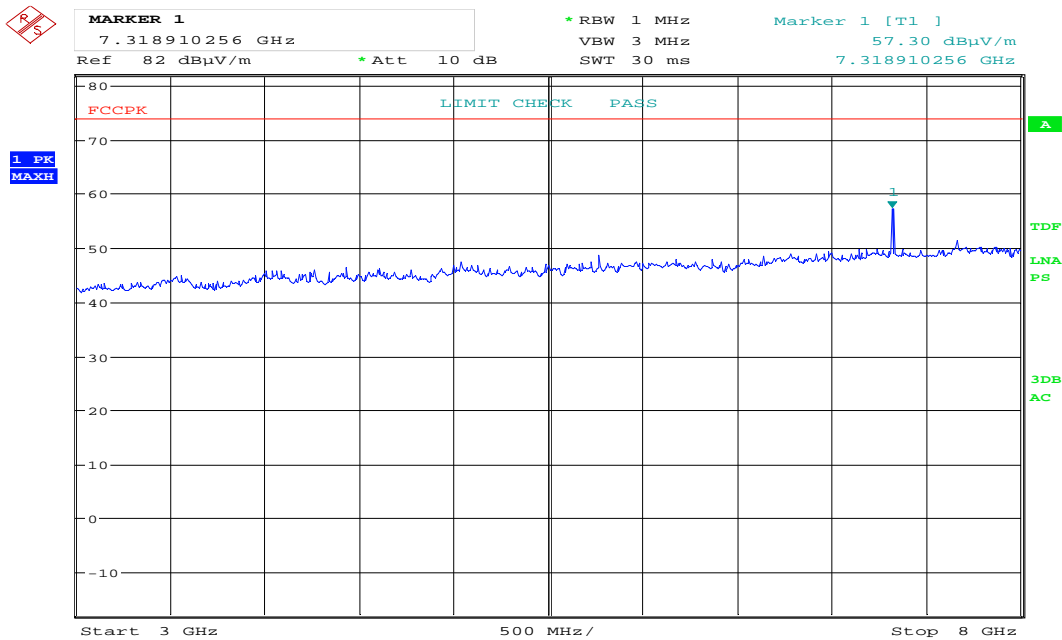
Date: 21.AUG.2019 18:59:57

External Antenna: Radiated spurious emissions, HP, 3 - 8GHz, ch2405MHz, PK scan



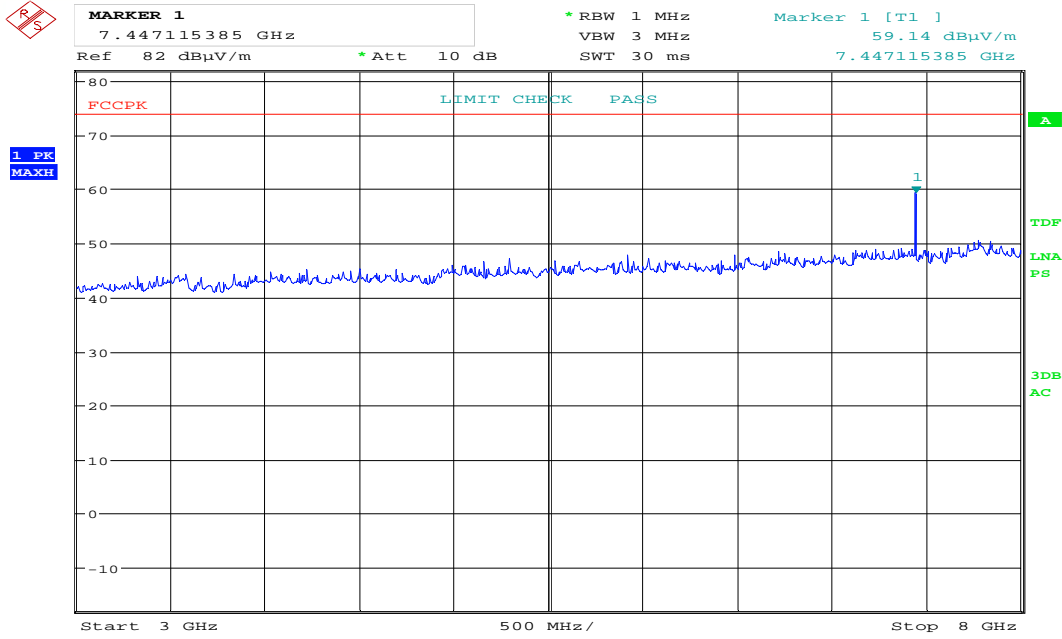
Date: 21.AUG.2019 19:08:46

External Antenna: Radiated spurious emissions, VP, 3 - 8GHz, ch2440MHz, PK scan



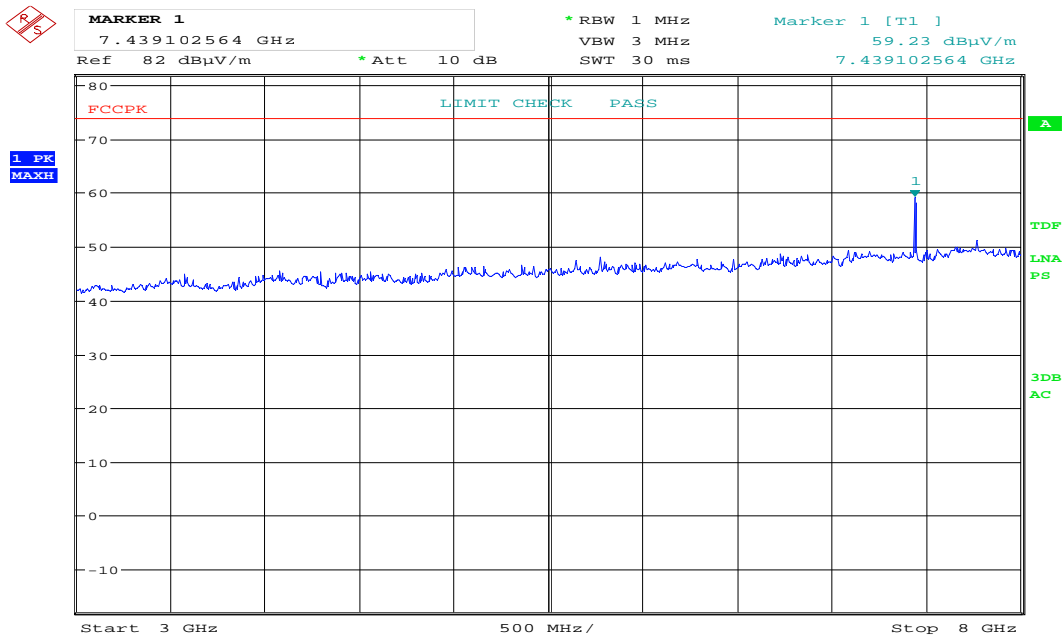
Date: 21.AUG.2019 19:08:21

External Antenna: Radiated spurious emissions, HP, 3 - 8GHz, ch2440MHz, PK scan



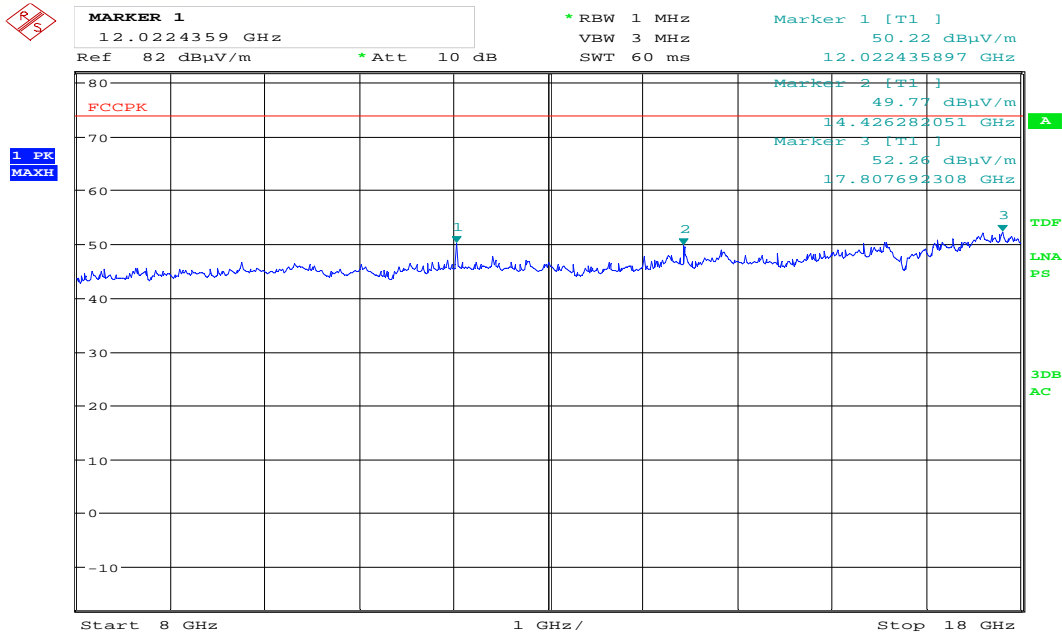
Date: 21.AUG.2019 19:10:55

External Antenna: Radiated spurious emissions, VP, 3 - 8GHz, ch2480MHz, PK scan



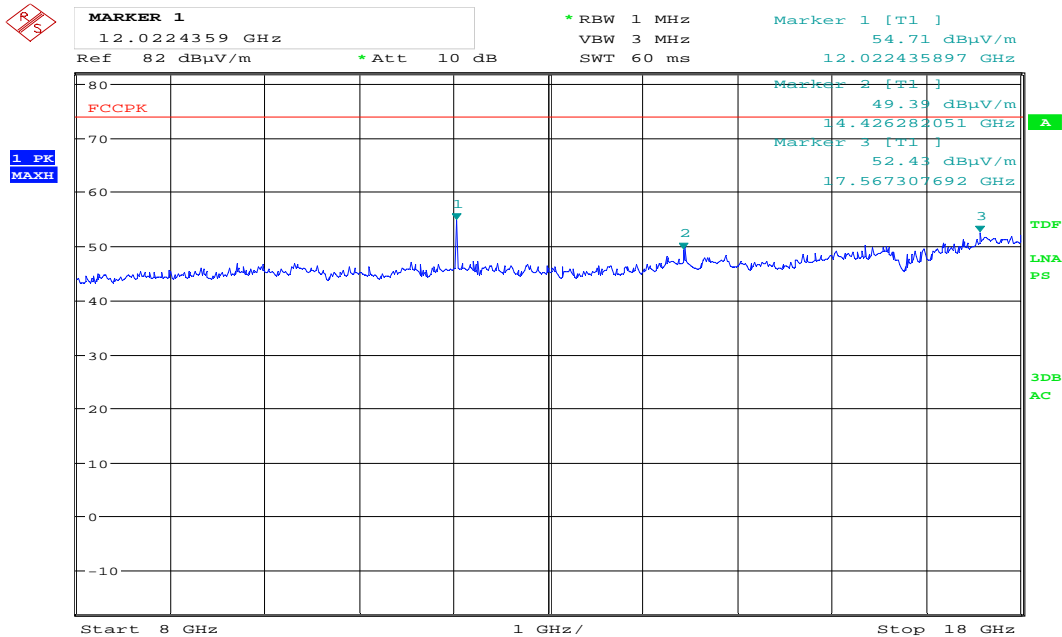
Date: 21.AUG.2019 19:11:46

External Antenna: Radiated spurious emissions, HP, 3 - 8GHz, ch2480MHz, PK scan



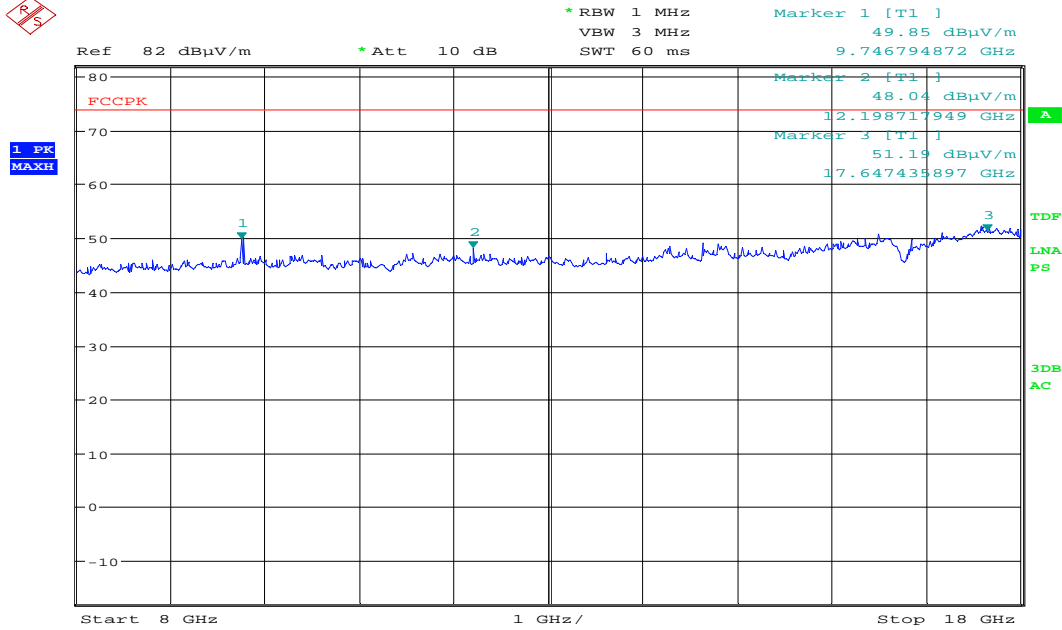
Date: 21.AUG.2019 19:35:14

External Antenna: Radiated spurious emissions, VP, 8 - 18GHz, ch2405MHz, PK scan



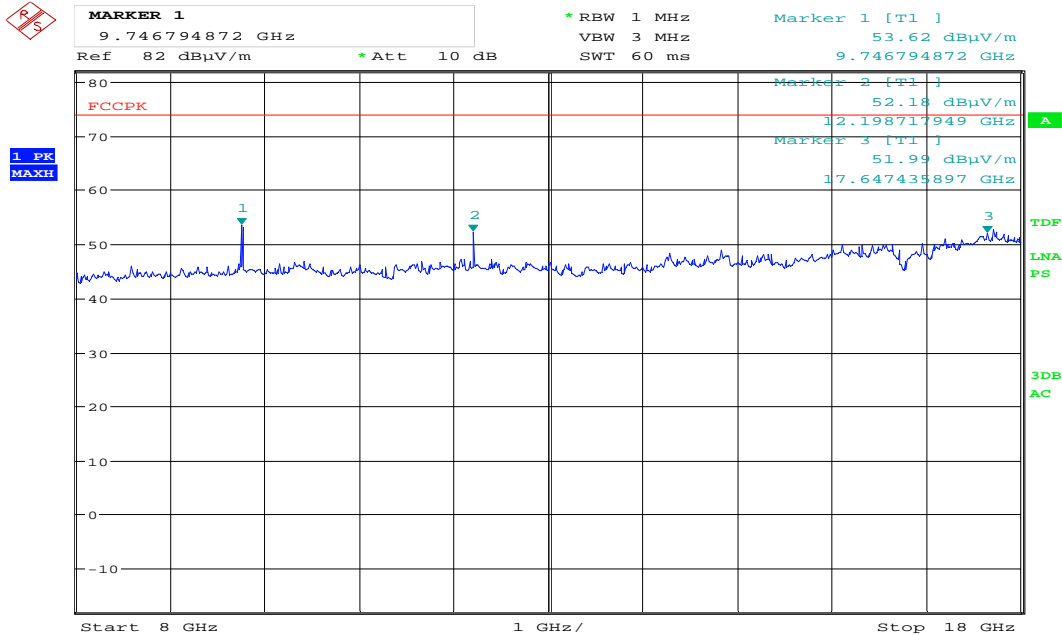
Date: 21.AUG.2019 19:36:14

External Antenna: Radiated spurious emissions, HP, 8 - 18GHz, ch2405MHz, PK scan



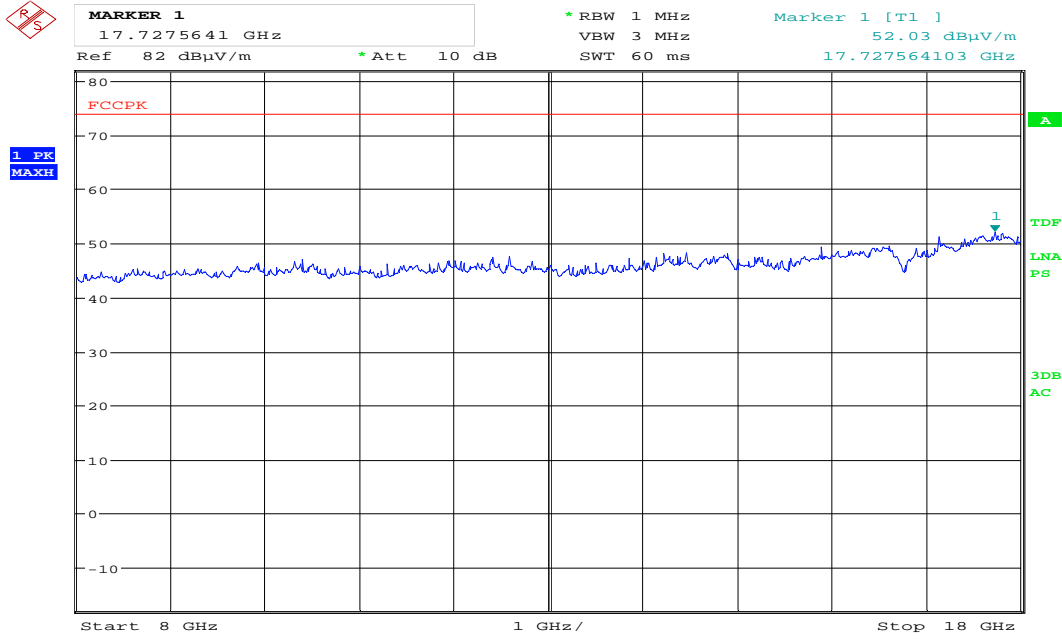
Date: 21.AUG.2019 19:31:35

External Antenna: Radiated spurious emissions, VP, 8 - 18GHz, ch2440MHz, PK scan



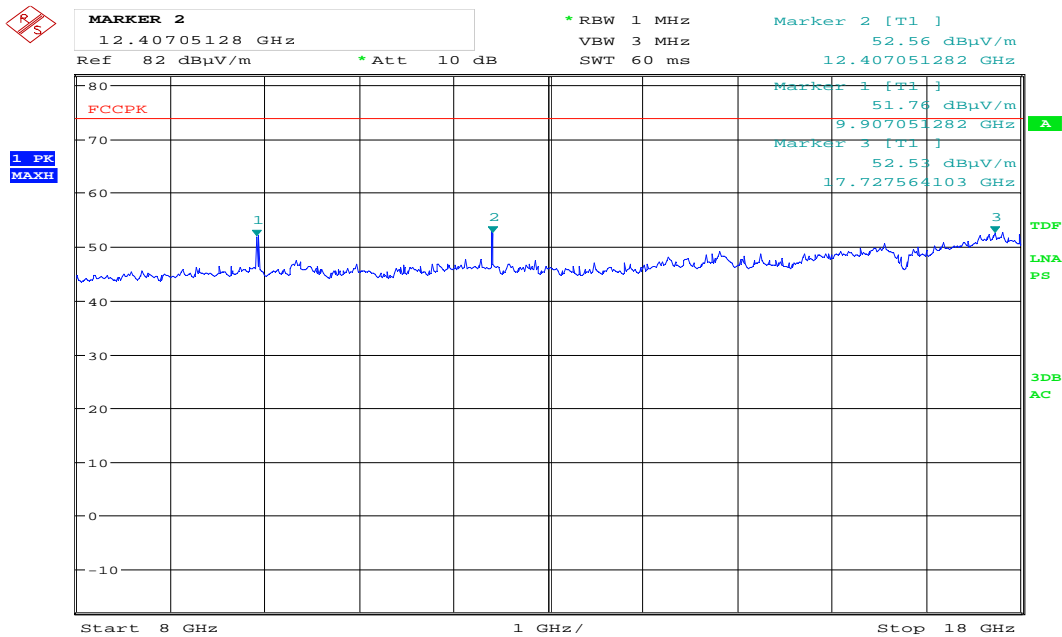
Date: 21.AUG.2019 19:29:41

External Antenna: Radiated spurious emissions, HP, 8 - 18GHz, ch2440MHz, PK scan



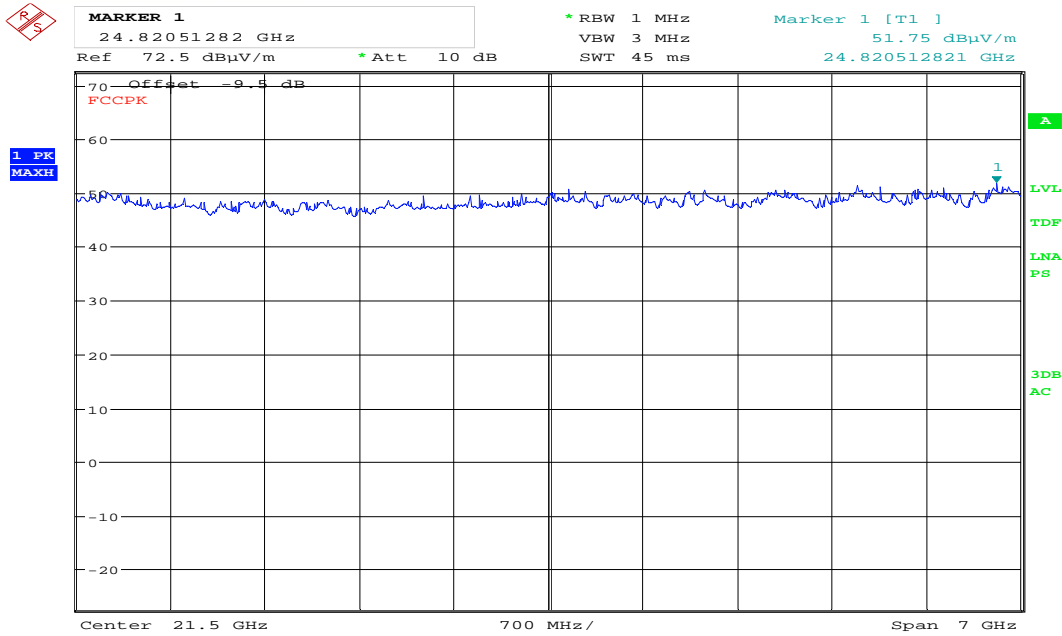
Date: 21.AUG.2019 19:24:01

External Antenna: Radiated spurious emissions, VP, 8 - 18GHz, ch2480MHz, PK scan



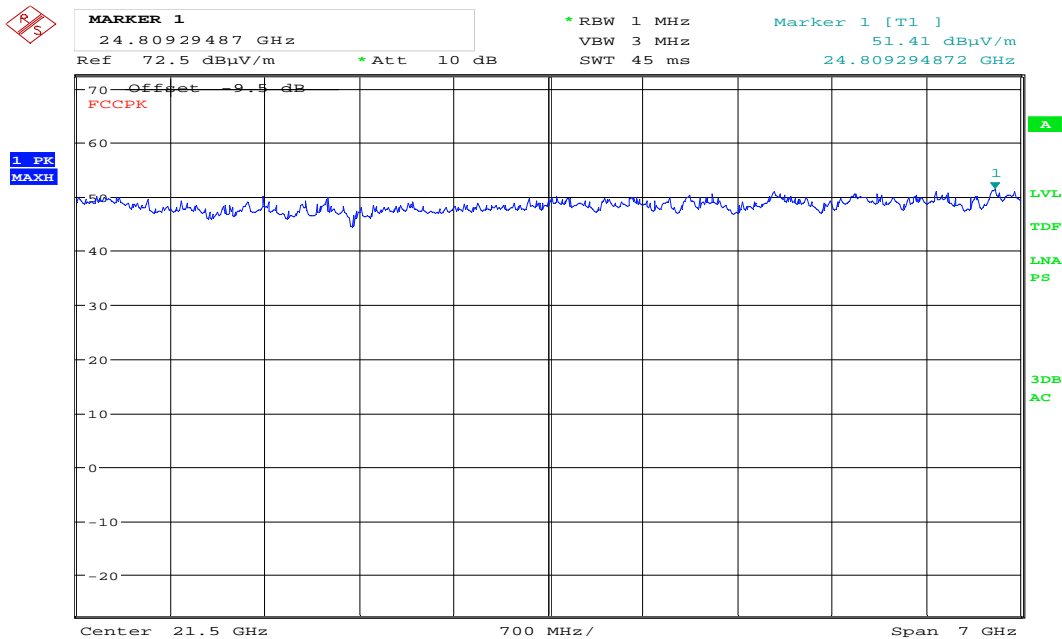
Date: 21.AUG.2019 19:26:36

External Antenna: Radiated spurious emissions, HP, 8 - 18GHz, ch2480MHz, PK scan



Date: 21.AUG.2019 19:46:13

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



Date: 21.AUG.2019 19:45:15

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

### 3.9 Power Spectral Density (PSD)

FCC part 15.247(e)

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

Measurement procedure: ANSI C63.10-2013 Clause 11.10

Test Results: Complies

#### Measured and Calculated Data:

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

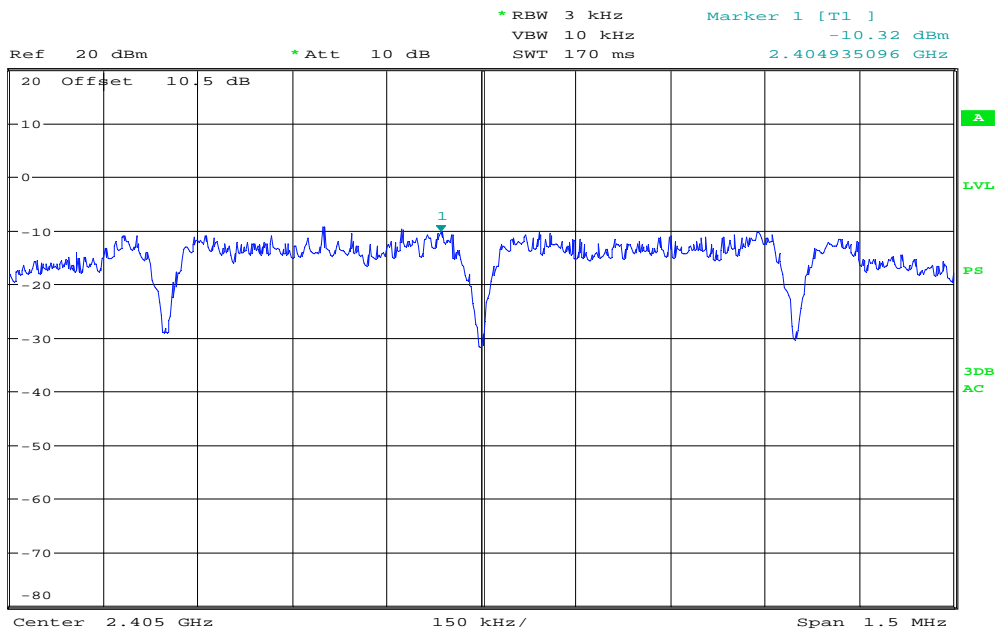
	2405 MHz	2440 MHz	2480 MHz
Measured value (dBm)	-10.32	-10.14	-10.66

#### Requirements:

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

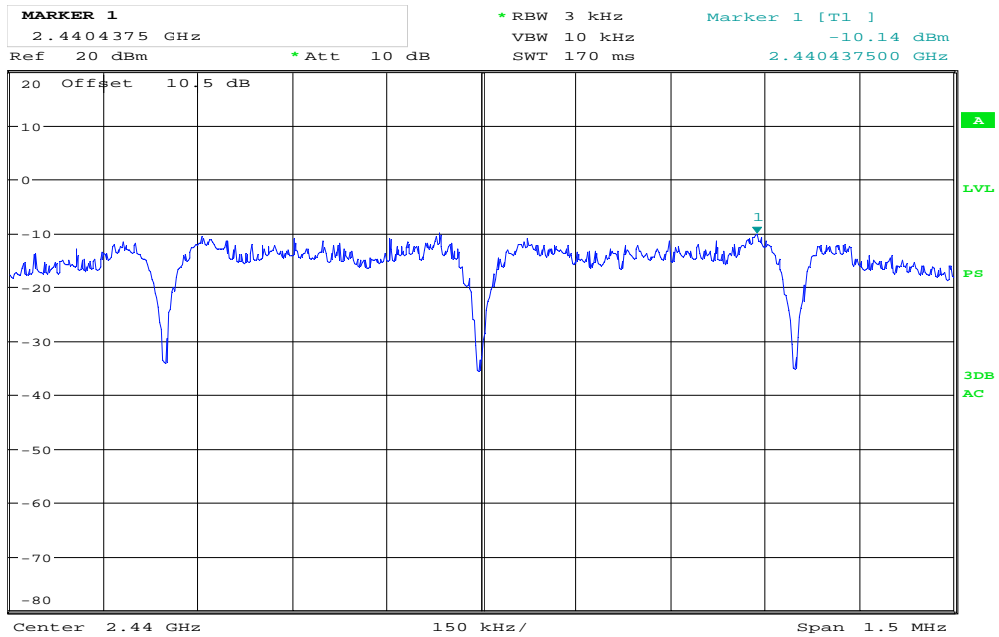
No requirements for Frequency Hopping Systems.





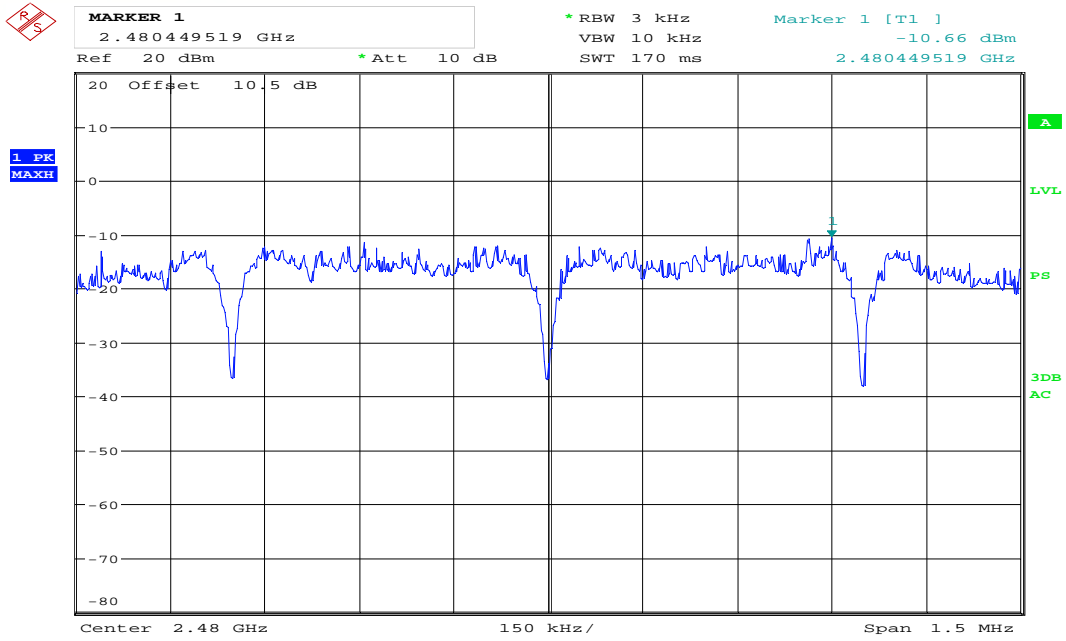
Date: 21.AUG.2019 20:05:02

Conducted PSD, ch2405MHz



Date: 21.AUG.2019 20:13:45

Conducted PSD, ch2440MHz



Date: 21.AUG.2019 20:14:15

Conducted PSD, ch2480MHz

## 4 Measurement Uncertainty

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

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

## 5 LIST OF TEST EQUIPMENT

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

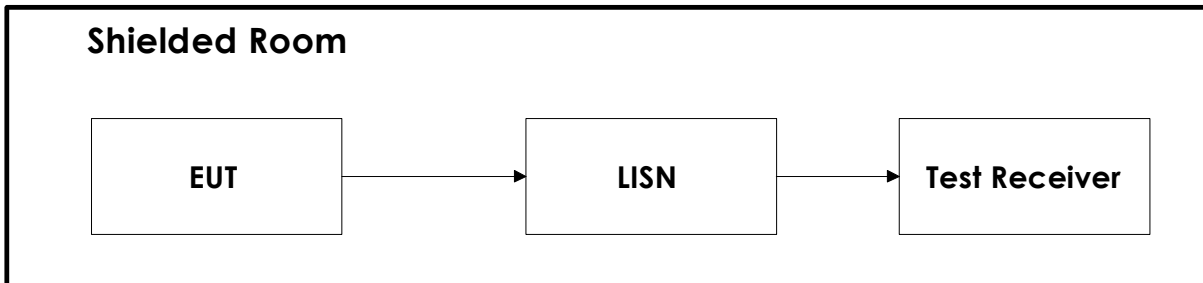
No.	Instrument/ ancillary	Type of instrument/ ancillary	Manufacturer	Ref. no.	Cal. Date	Cal. Due
1.	ESU40	EMI Receiver	Rohde & Schwarz	LR1639	2019.01	2020.01
2.	FSW43	Spectrum analyser	Rohde & Schwarz	LR1690	2019.01	2020.01
3.	HFH2-Z2	Active Loop antenna	Rohde & Schwarz	LR1660	2016.11	2019.11
4.	3117-PA	Antenna horn	EMCO	LR 1717	2017.05	2020.05
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.	ARJB1	Bi-log Hybrid Antenna	Sunol	LR 1734	2018.05	2020.05
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	2019.07	2020.07
14.	310N	Pre-amplifier	Sonoma	LR 1686	2019.07	2020.07
15.	Model 45	Multimeter	Fluke	LT 5218	2018.11	2020.11
16.	6812B	AC Power source	Agilent	LR 1515	2019.03	2021.03
17.	CPX400S	Power supply	TTi	LR 1713	Cal b4 use	

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

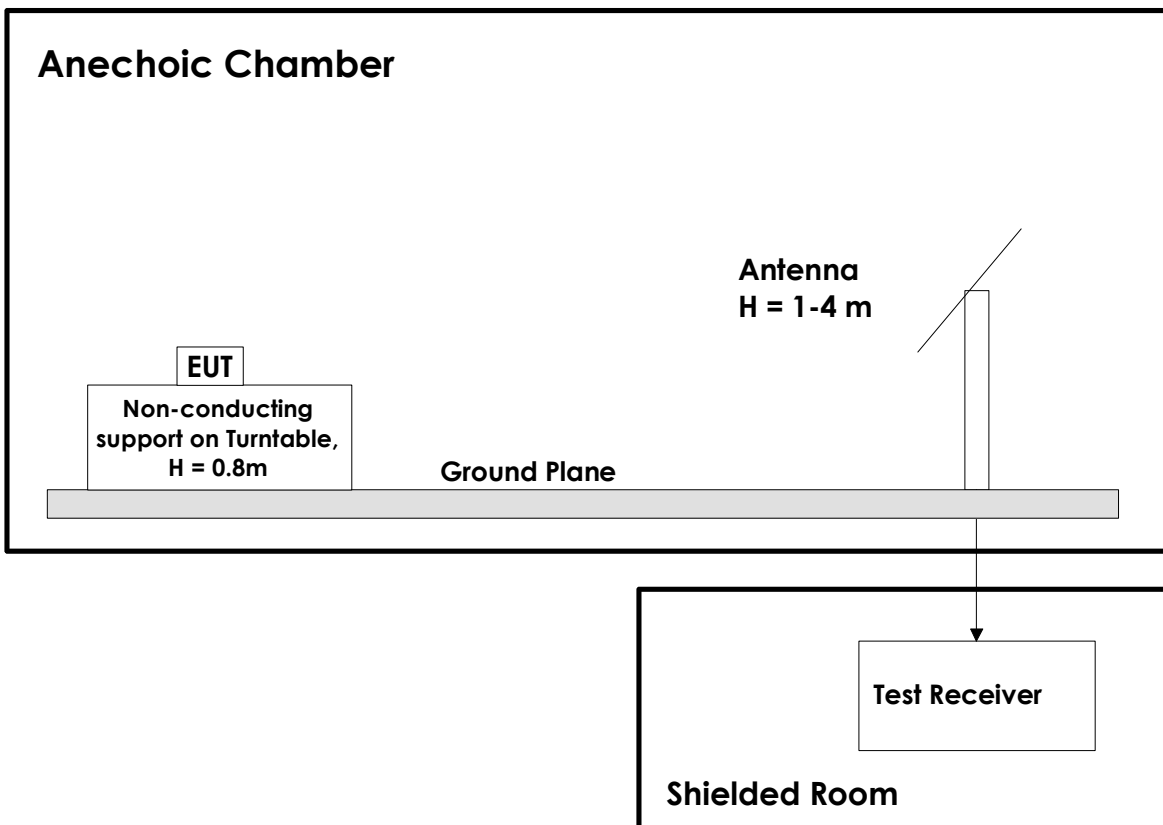
No.	Manufacturer	Name	Version	Comment
1	Rohde & Schwarz	GPIBShot	2.7	Screenshots from R&S Spectrum Analyzers
2	Rohde & Schwarz	RScommander	1.9.2 64bit	Versatile Software Tool for R&S Instruments
3	Rohde & Schwarz	EMC 32	10.40.10	Radiated Emission test software

## 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.

## Revision history

Version	Date	Comment	Sign
01	2019.09.04	First Version	gns