

# Test Report

|                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Product</b>                                                                                                                                                                                                                                                                                                                                                                                    | Bluetooth LE farm automation communication and control device                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Name and address of the applicant</b>                                                                                                                                                                                                                                                                                                                                                          | DeLaval International AB<br>P.O. Box 39<br>SE-14721 Tumba, Sweden                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Name and address of the manufacturer</b>                                                                                                                                                                                                                                                                                                                                                       | DeLaval International AB<br>P.O. Box 39<br>SE-14721 Tumba, Sweden                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Model</b>                                                                                                                                                                                                                                                                                                                                                                                      | IOM400                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Rating</b>                                                                                                                                                                                                                                                                                                                                                                                     | 24 V DC (from AC/DC power supply 100-240 VAC 50-60 Hz)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Trademark</b>                                                                                                                                                                                                                                                                                                                                                                                  | DeLaval                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Serial number</b>                                                                                                                                                                                                                                                                                                                                                                              | /                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Additional information</b>                                                                                                                                                                                                                                                                                                                                                                     | Bluetooth Low Energy                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Tested according to</b>                                                                                                                                                                                                                                                                                                                                                                        | <b>FCC Part 15.247</b><br>Frequency Hopping Transmitters / Digital Transmission Systems<br><b>Industry Canada RSS-247, Issue 2</b><br>Low Power Licence-Exempt Radiocommunications Devices                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Order number</b>                                                                                                                                                                                                                                                                                                                                                                               | 350858                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Tested in period</b>                                                                                                                                                                                                                                                                                                                                                                           | 2018.06.25 to 2018.07.09                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Issue date</b>                                                                                                                                                                                                                                                                                                                                                                                 | 2019.09.24                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Name and address of the testing laboratory</b>                                                                                                                                                                                                                                                                                                                                                 | <div style="display: flex; justify-content: space-between; align-items: flex-start;"> <div style="text-align: center;"> <br/> Instituttveien 6<br/>Kjeller, Norway<br/>www.nemko.com </div> <div style="text-align: center;"> CAB Number:<br/>FCC: NO0001<br/>ISED: NO0470<br/><br/> TEL: +47 22 96 03 30<br/>FAX: +47 22 96 05 50 </div> <div style="text-align: center;"> <br/>  </div> </div> <p style="text-align: center; color: red;">An accredited technical test executed under the Norwegian accreditation scheme</p> |
| <div style="display: flex; justify-content: space-around;"> <div style="text-align: center;"> <br/> Prepared by [Frode Sveisen] </div> <div style="text-align: center;"> <br/> Approved by [G.Suhanthakumar] </div> </div> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
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## 1 INFORMATION

### 1.1 Test Item

|                                  |                         |
|----------------------------------|-------------------------|
| Name                             | deLaval                 |
| FCC ID                           | UCSIOM400               |
| Industry Canada ID               | /                       |
| Model/version                    | IOM400                  |
| Serial number                    | /                       |
| Hardware identity and/or version | IOM400 PCBA; 89175181   |
| Software identity and/or version | Thor EMC test SW suite  |
| Frequency Range                  | 2402 – 2480 MHz         |
| Number of Channels               | 40                      |
| Type of Modulation               | Digital (GFSK)          |
| User Frequency Adjustment        | None                    |
| Rated Output Power               | 0.002 Watts (Conducted) |
| Type of Power Supply             | External DC Supply      |
| Antenna Connector                | None                    |
| Number of Antennas               | 1                       |
| Antenna Diversity Supported      | N/A                     |
| Desktop Charger                  | N/A                     |

#### Description of Test Item

The IOM400 is one of several units in a family of DeLaval modular farm automation control devices used in milking systems.

### 1.2 Normal test condition

|                      |                    |
|----------------------|--------------------|
| Temperature:         | 20 - 24 °C         |
| Relative humidity:   | 20 - 50 %          |
| Normal test voltage: | 24 V <sub>DC</sub> |

The values are the limit registered during the test period.

### 1.3 Test Engineer(s)

Frode Sveinsen

### 1.4 Antenna Requirement

Is the antenna detachable?

☐ Yes ☒ No

If detachable, is the antenna connector non-standard?

☐ Yes ☐ No

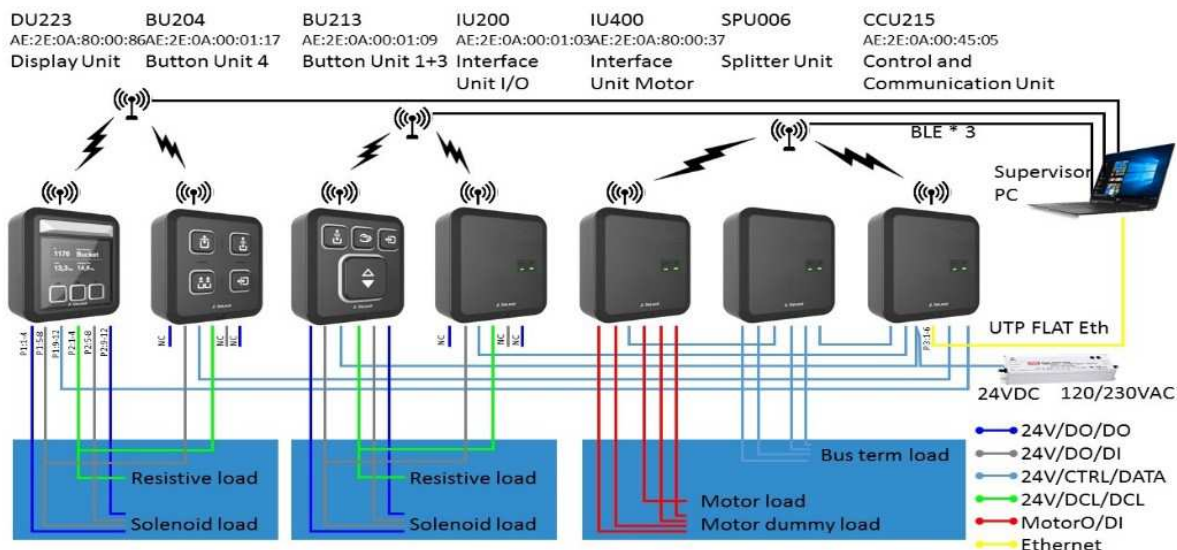
Type of antenna connector: N/A

Ref. FCC §15.203

### 1.5 Test Configuration

All tests except Power-Line Conducted tests, were performed with the EUT in stand-alone mode and with the EUT powered from a regulated external power supply. The EUT was programmed from Linux Computer that was used to send commands over the Ethernet Interface.

Power-Line Conducted tests were performed with the EUT connected to a test-wall together with other units as shown below.



### 1.6 Comments

All measurements were performed with the EUT powered by 24 V<sub>DC</sub> and it was checked that power variations between 85% and 115% did not have any influence on the 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-GEN Issue 5 and RSS-247 Issue 2.

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 the FCC and Industry Canada.

☒ New Submission

☒ Production Unit

☐ Class II Permissive Change

☐ Pre-production Unit

**DTS** Equipment Code

☐ Family Listing



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

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

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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                                | Complies |
| Antenna Requirement            | 15.203                 | 6.8 (RSS-GEN)                              | 5.8                                 | Complies |
| Power Line Conducted Emission  | 15.207(a)              | 8.8 (RSS-GEN)                              | 6.2                                 | Complies |
| Occupied Bandwidth (99% BW)    | N/A                    | 6.7 (RSS-GEN)                              | 6.9.3                               | Complies |
| DTS Bandwidth                  | 15.247(a)(2)           | 5.2 a)                                     | 11.8 Option 2                       | Complies |
| Peak Power Output              | 15.247(b)              | 5.4 b)                                     | 11.9.1.1                            | Complies |
| Power Spectral Density         | 15.247(c)              | 5.2 b)                                     | 11.10.2 PKPSD                       | Complies |
| Spurious Emissions (Conducted) | 15.247(d)              | 5.5                                        | 11.11                               | Complies |
| Spurious Emissions (Radiated)  | 15.247(c)<br>15.209(a) | 6.13 (RSS-GEN)<br>8.9 (RSS-GEN)            | 6.3, 6.5, 6.6, 6.10<br>11.12, 11.13 | Complies |

## Revision history

| Version | Date       | Comment       | Sign |
|---------|------------|---------------|------|
| 1.0     | 2018.08.08 | First Edition | FS   |
|         |            |               |      |

### 3 TEST RESULTS

#### 3.1 Power Line Conducted Emissions

FCC Part 15.207 (a)

ISED Canada RSS-Gen Issue 5, Clause 8.8

Measurement procedure: ANSI C63.4-2014 using 50  $\mu$ H/50 ohms LISN.

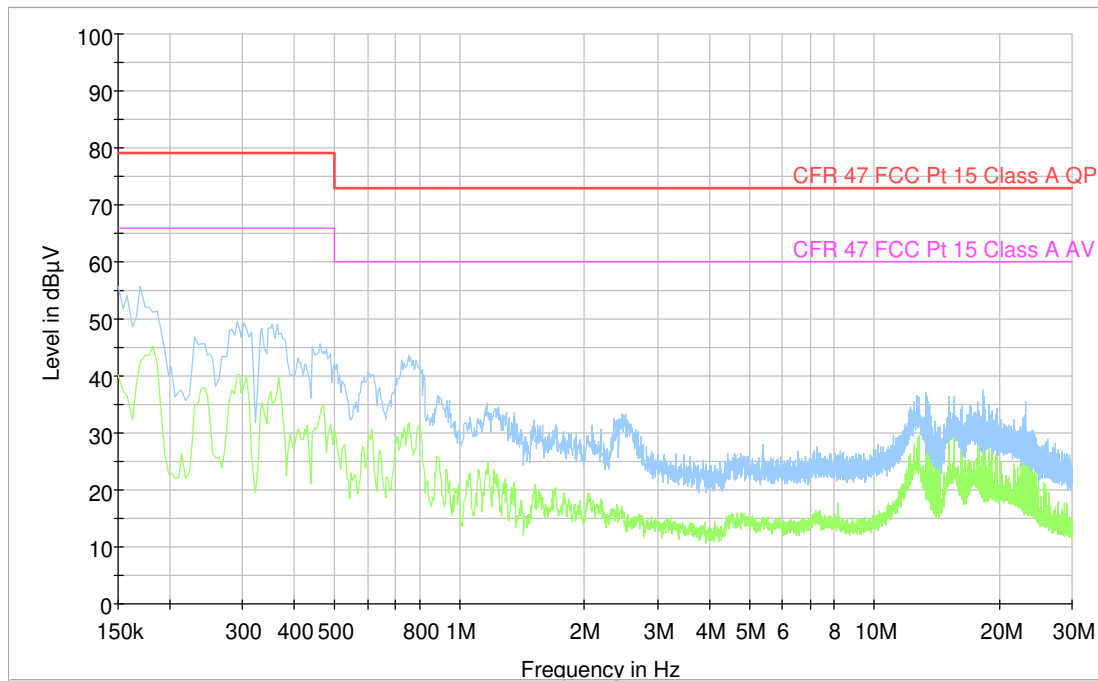
Test Results: Complies.

Measurement Data: See attached graph, (Peak detector).

Highest measured value (L1 and N): No frequencies recorded.

120V 60Hz:

Full Spectrum



## 3.2 Occupied Bandwidth

RSS-GEN Issue 5, Clause 6.7

Test Results: Complies

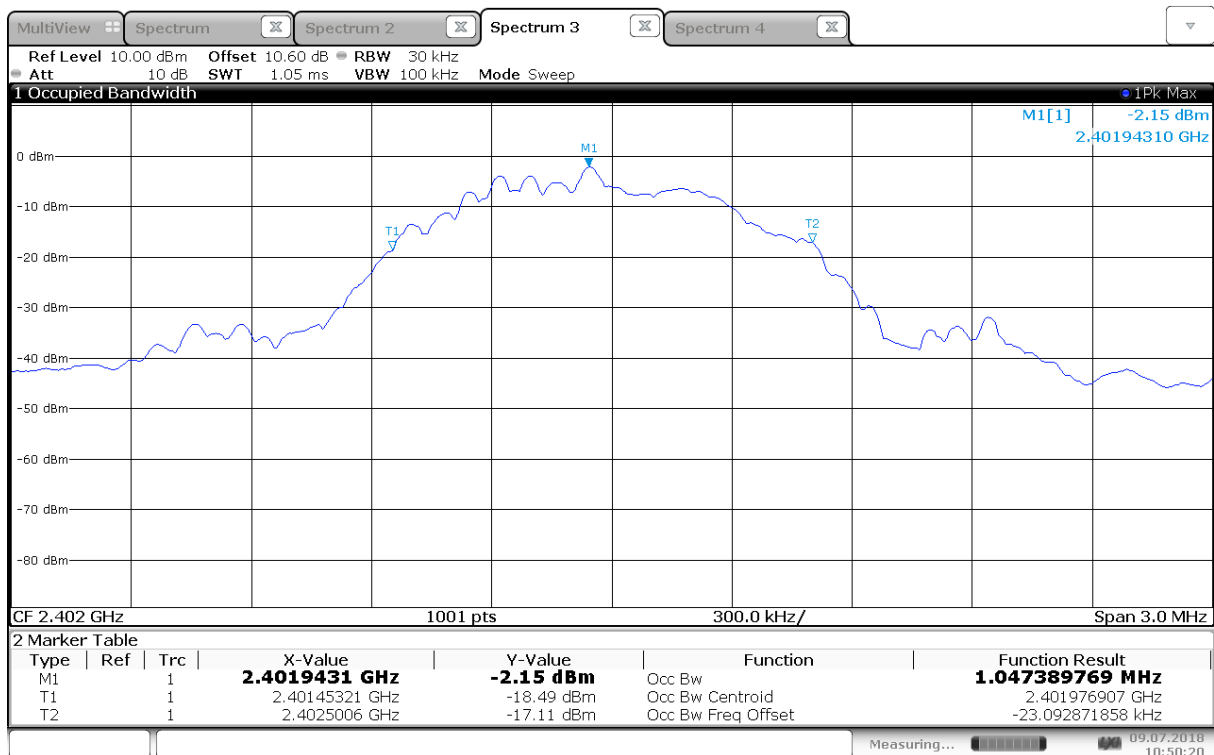
### Measurement Data:

| Carrier Frequency | Occupied Bandwidth (99% BW) |
|-------------------|-----------------------------|
| 2402 MHz          | 1.05 MHz                    |
| 2440 MHz          | 1.05 MHz                    |
| 2480 MHz          | 1.05 MHz                    |

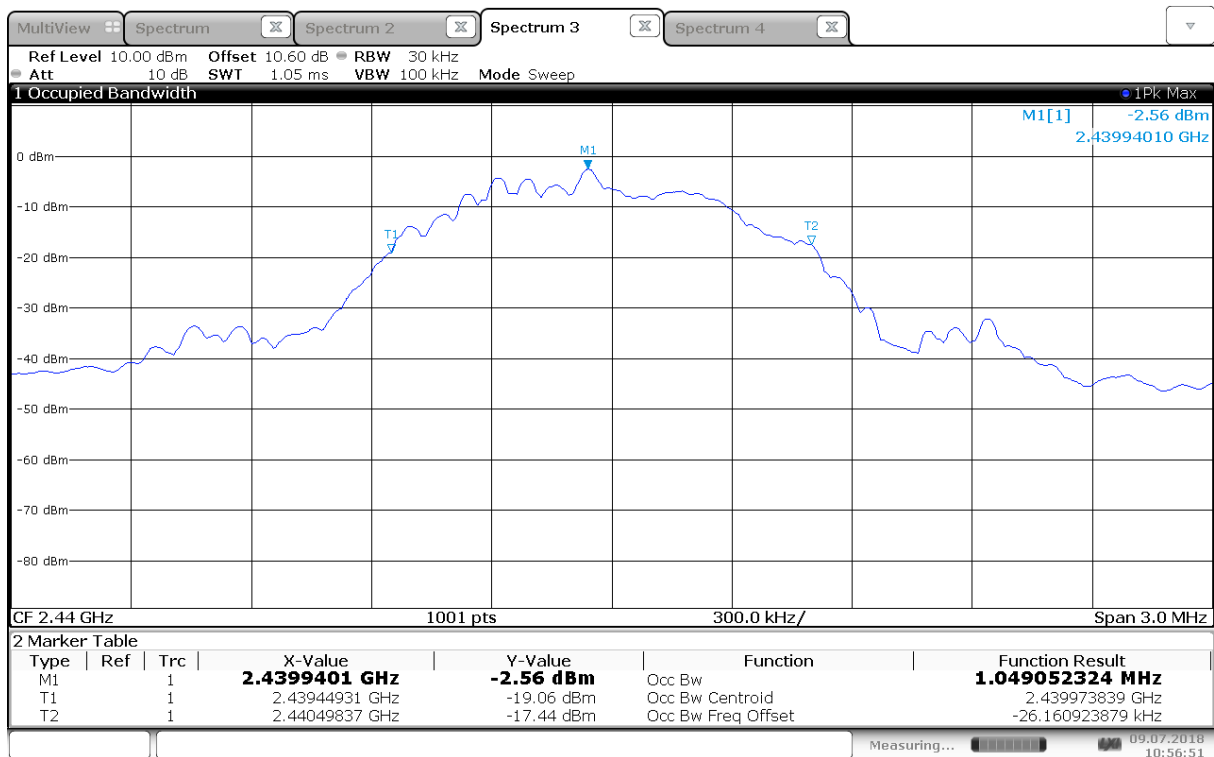
See attached plots.

### Requirements:

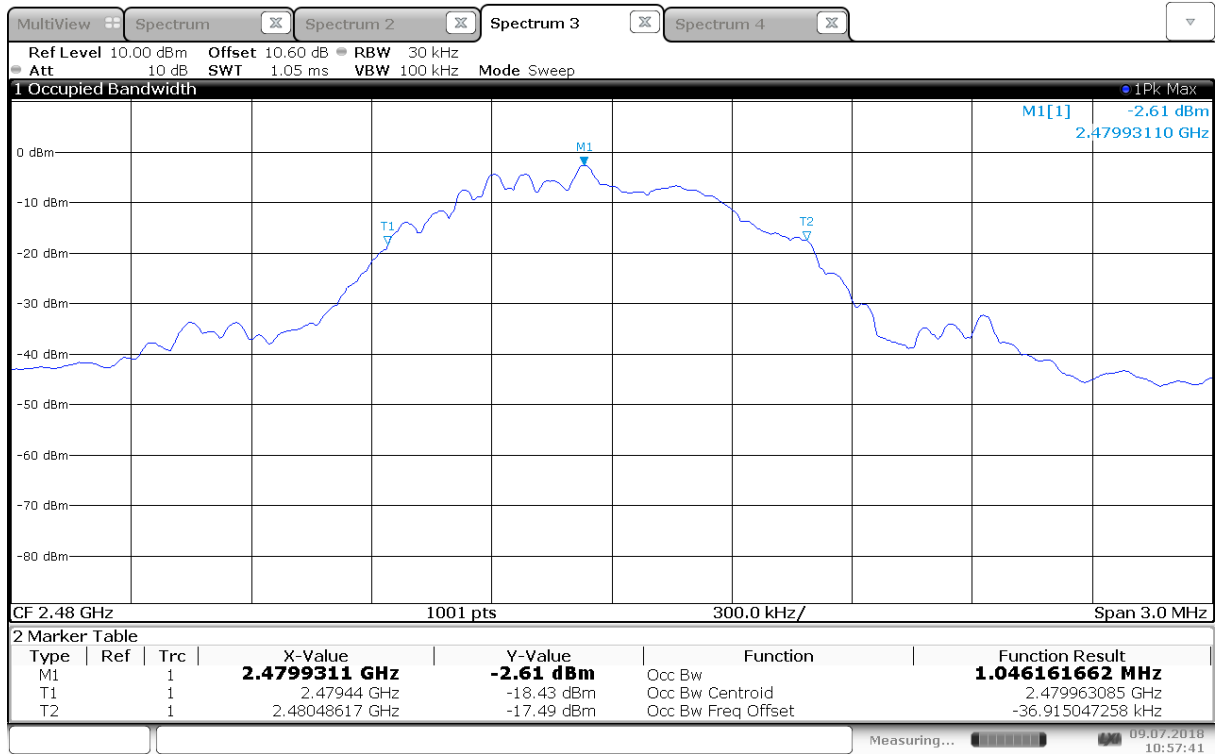
No limit specified.



Occupied Bandwidth, 99%, 2402 MHz



Occupied Bandwidth, 99%, 2440 MHz



Occupied Bandwidth, 99%, 2480 MHz

### 3.3 DTS Bandwidth

FCC Part 15.247 (a)(2)

RSS-247 Issue 2, Clause 5.2 (a)

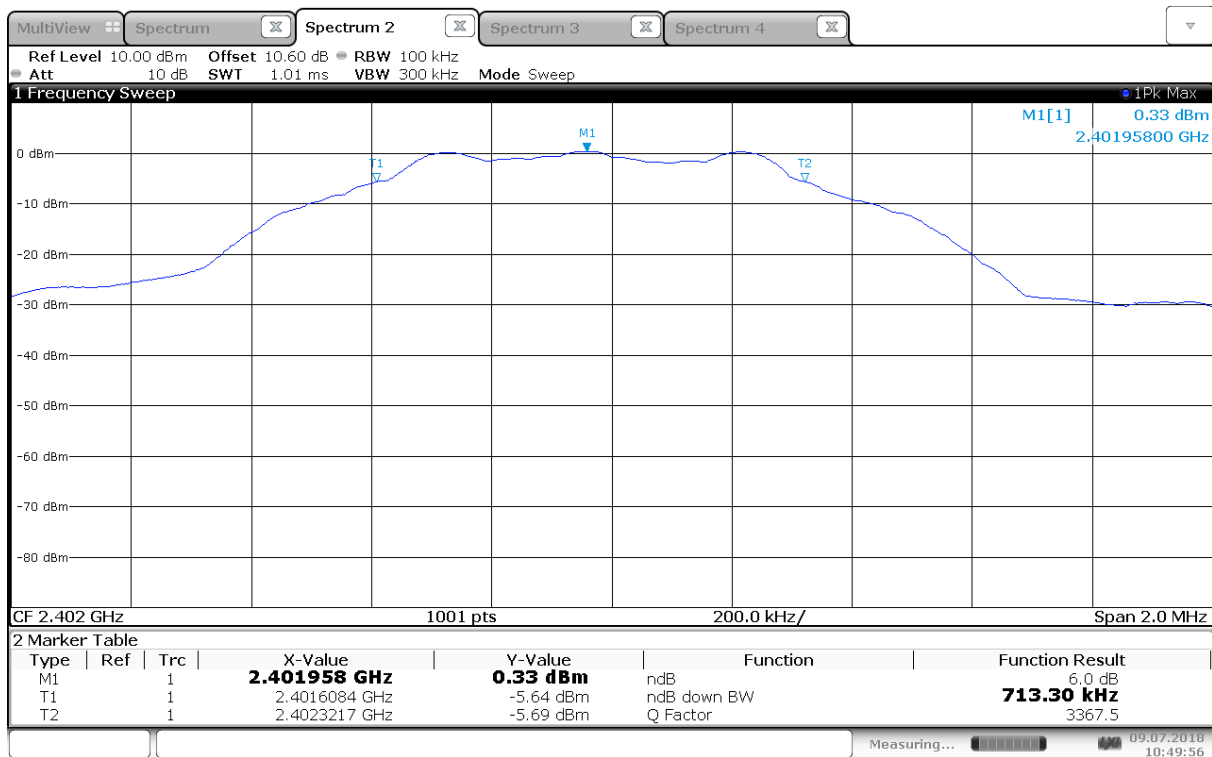
**Test Results:** Complies

**Measurement Data:**

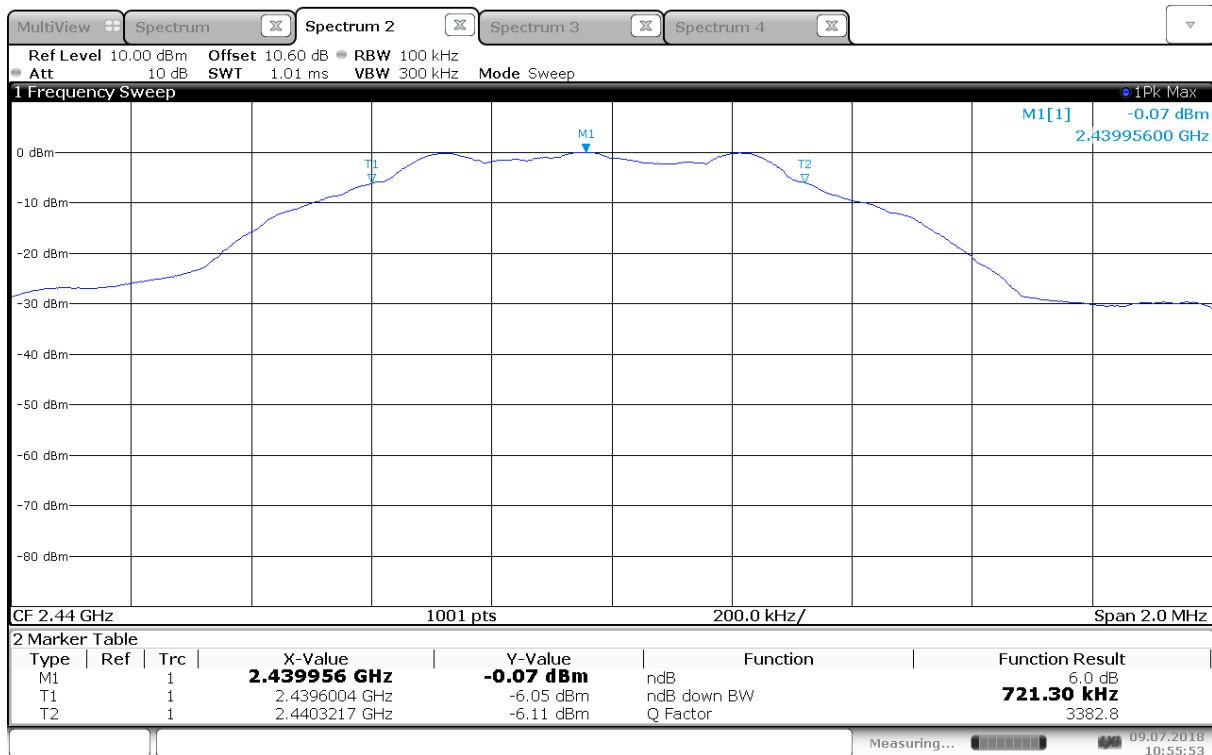
| Modulation type<br>and bitrate | Measured DTS Bandwidth |
|--------------------------------|------------------------|
| 2402 MHz                       | 713 kHz                |
| 2440 MHz                       | 721 kHz                |
| 2480 MHz                       | 713 kHz                |

**Requirements:**

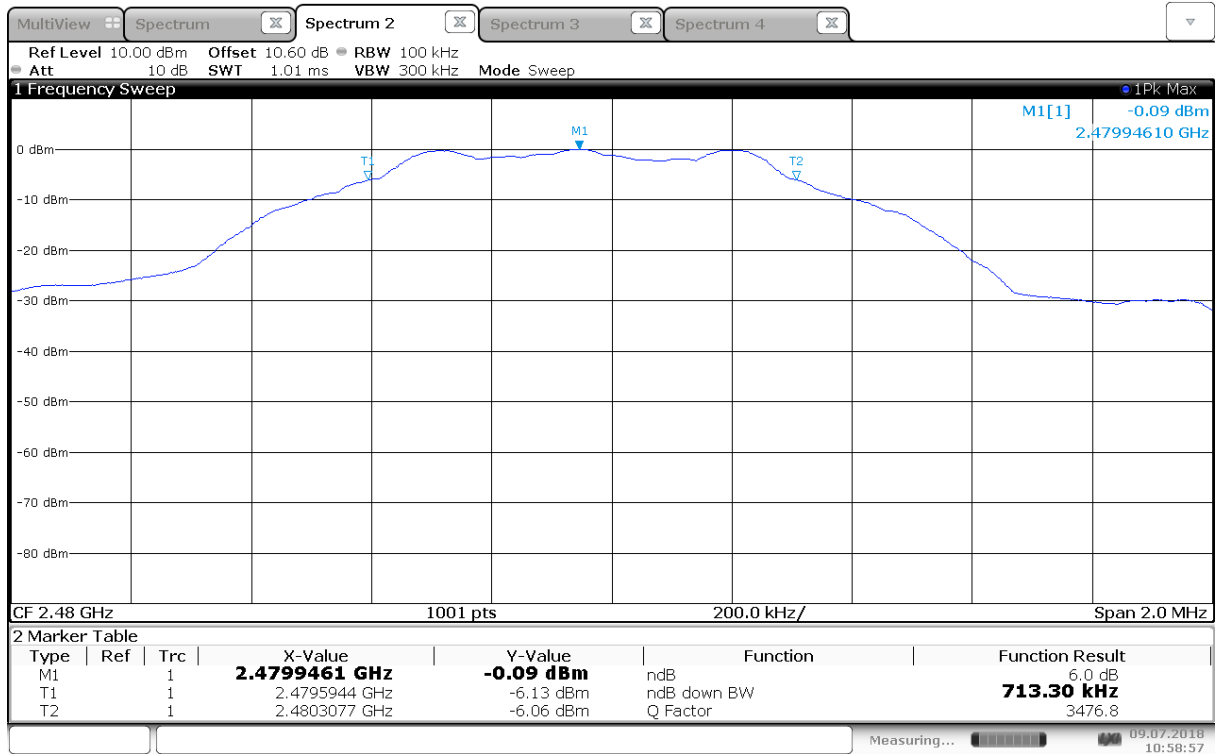
For Digital Transmission Systems in the 2400–2483.5 MHz band the minimum 6 dB bandwidth shall be at least 500 kHz.



DTS Bandwidth, 2402 MHz



DTS Bandwidth, 2440 MHz



DTS Bandwidth, 2480 MHz

### 3.4 Peak Power Output

FCC 15.247 (b)

RSS-247 Issue 2, Clause 5.4 (d)

Test Results: Complies

Measurement Data:

| Maximum Peak Power      |          |          |          |
|-------------------------|----------|----------|----------|
|                         | 2402 MHz | 2440 MHz | 2480 MHz |
| Peak Power (dBm)        | 1.01     | 0.67     | 0.61     |
| Peak Power (mW)         | 1.26     | 1.17     | 1.15     |
| Field Strength (dBμV/m) | 88.13    | 88.49    | 92.19    |
| EIRP, Calculated (mW)   | 0.20     | 0.21     | 0.50     |
| Antenna Gain (dBi)      | -8.1     | -7.4     | -3.6     |

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.

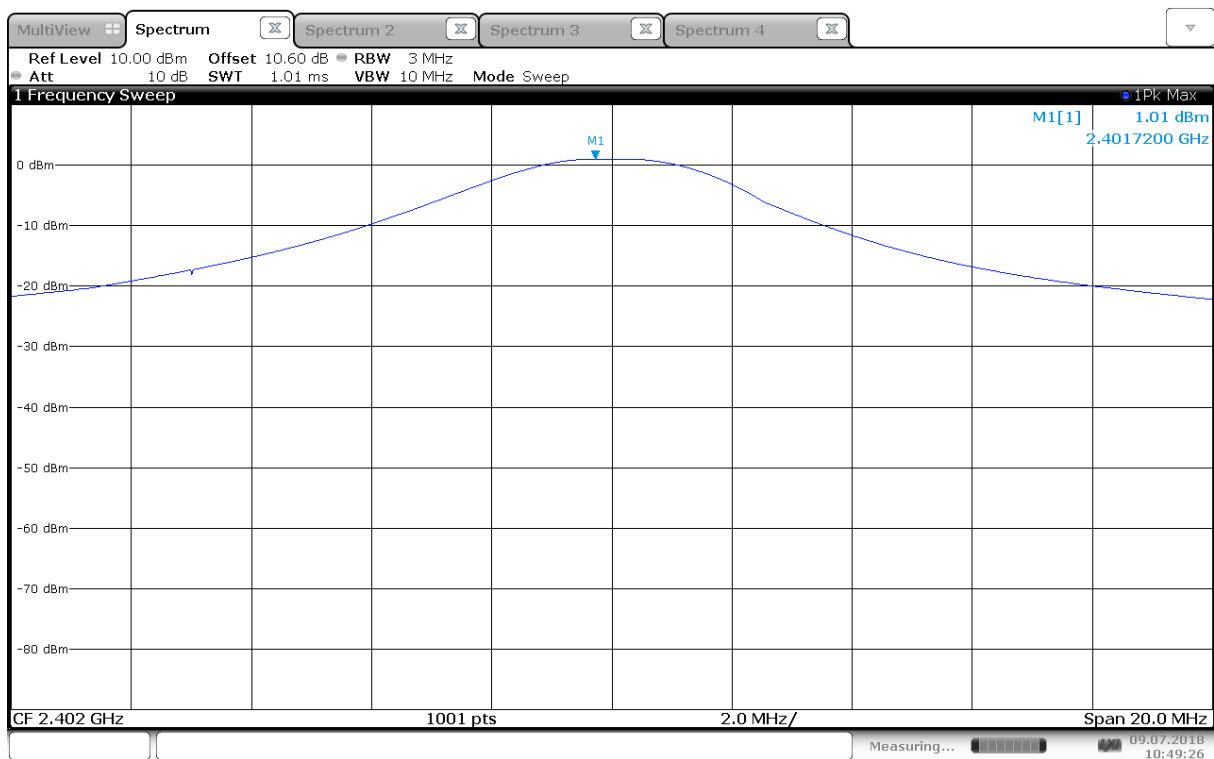
See attached plots.

#### Requirements:

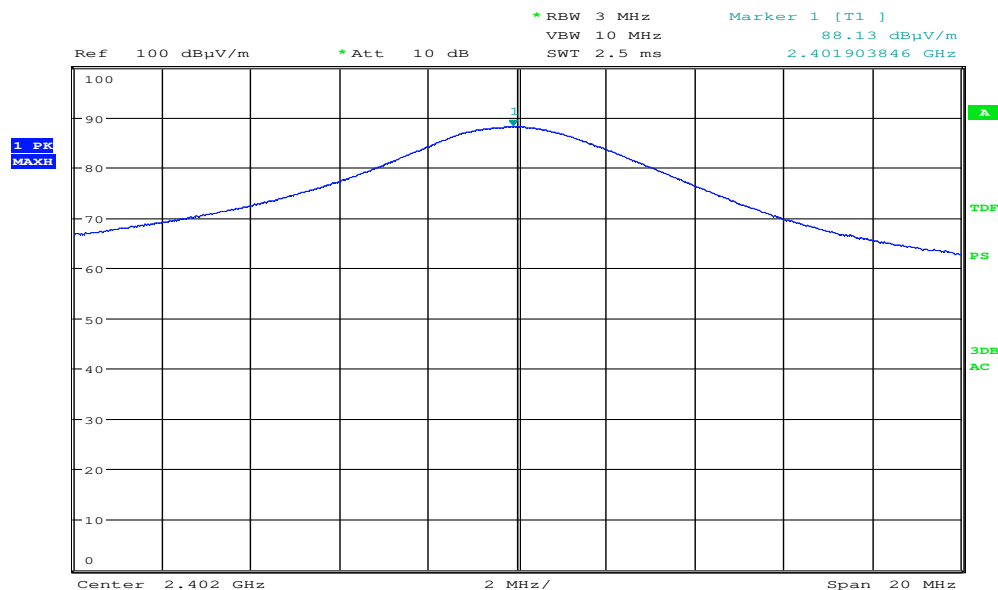
The maximum peak output power shall not exceed the following limits:

For 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.

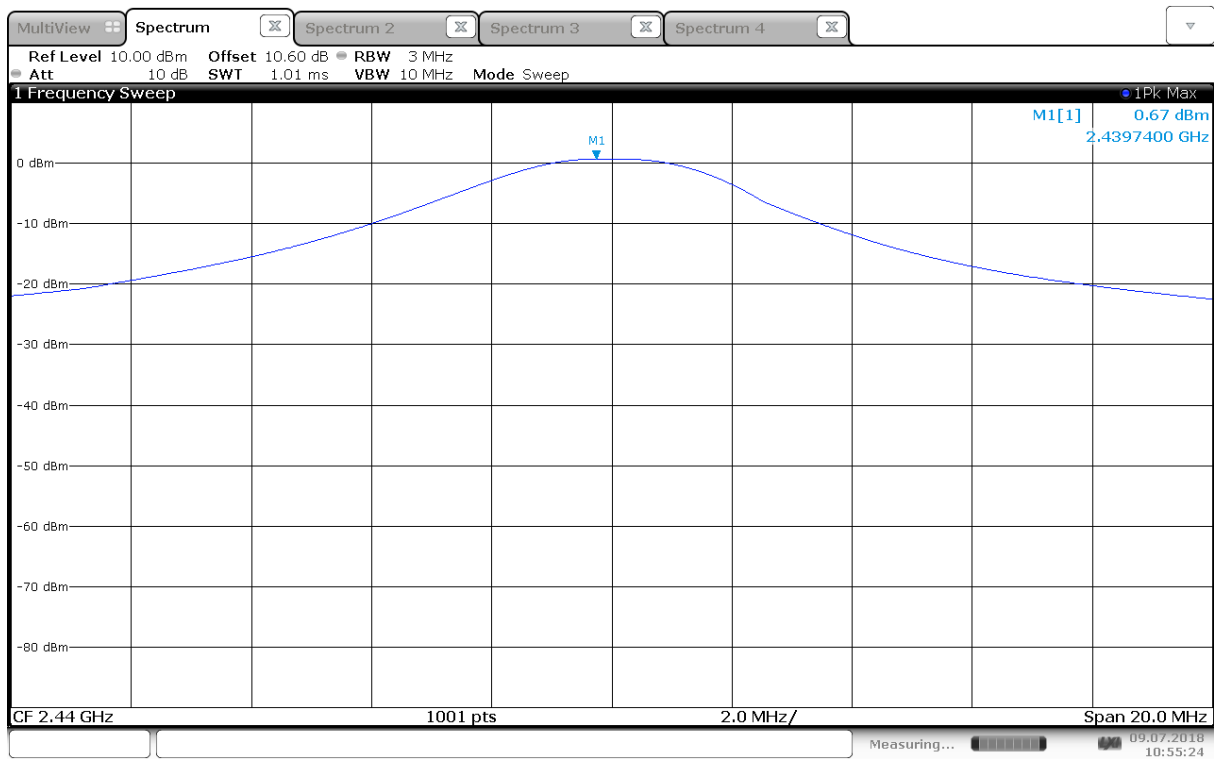


Conducted Output Power, 2402 MHz

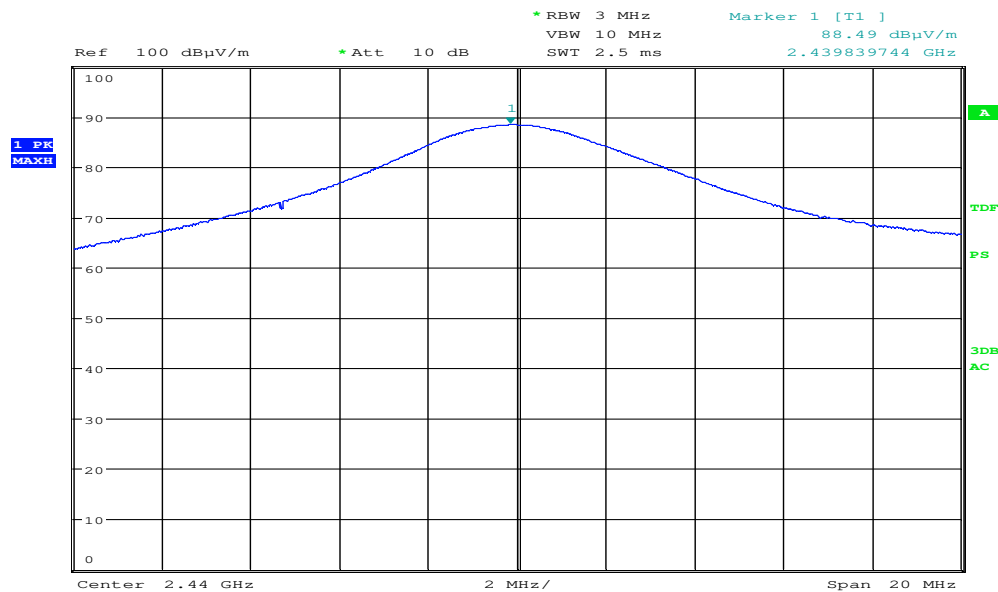


Date: 25.JUN.2018 18:15:32

Radiated Power, 2402 MHz (Max: HP, 267deg, 374cm)

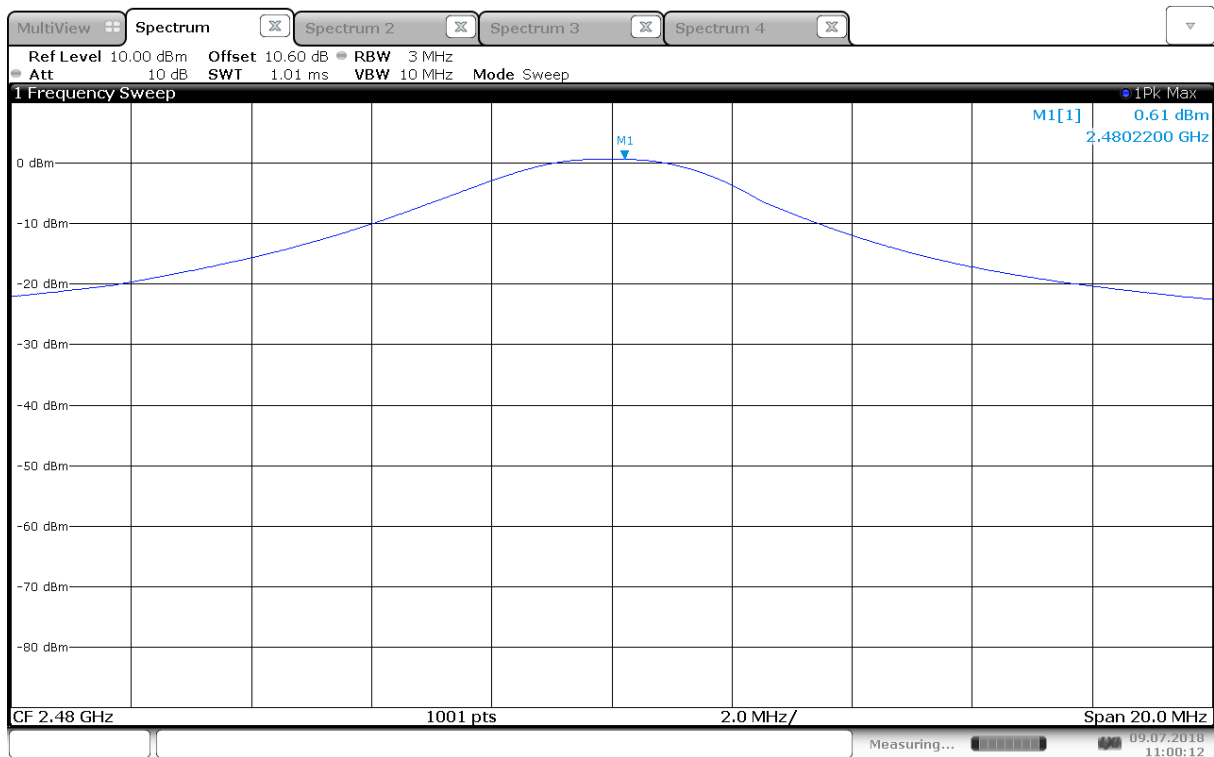


### Conducted Output Power, 2440 MHz

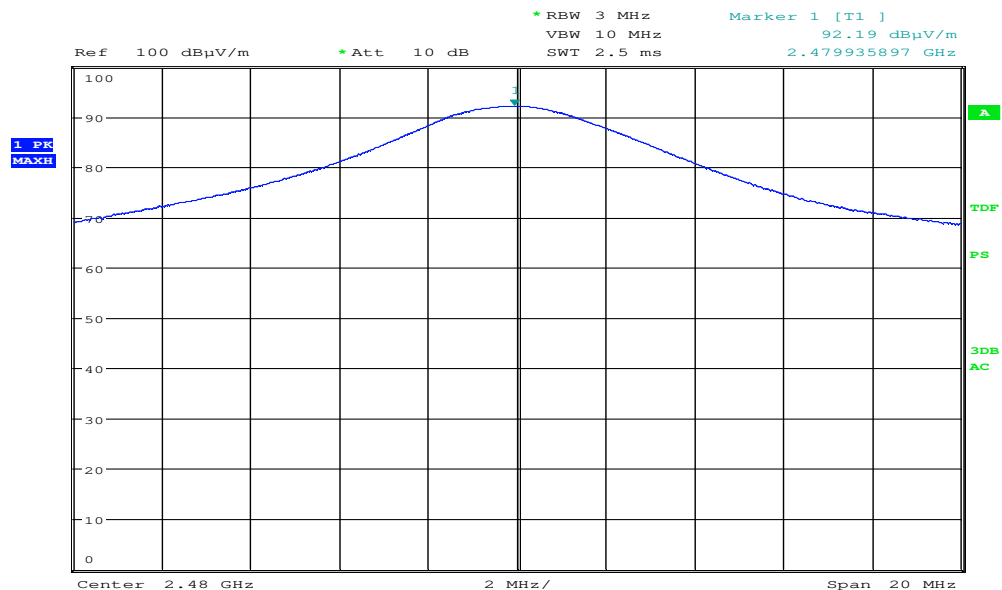


Date: 25.JUN.2018 18:16:28

### Radiated Power, 2440 MHz (Max: HP, 267deg, 374cm)



### Conducted Output Power, 2480 MHz



Date: 25.JUN.2018 18:08:52

### Radiated Power, 2480 MHz (Max: HP, 267deg, 374cm)

### 3.5 Conducted Emissions at Antenna Connector

FCC Part 15.247 (d)

RSS-247 Issue 2, Clause 5.5

Test Results: Complies

**Measurement Data:**

| Carrier Frequency | Highest Value (dBc) | Margin (dB) | Verdict |
|-------------------|---------------------|-------------|---------|
| All               | > 30                | > 10        | Pass    |

Measured with Peak Detector

Out-of-Band emissions were measured with the EUT transmitting at 4 frequencies, 2402, 2440 and 2480 MHz.

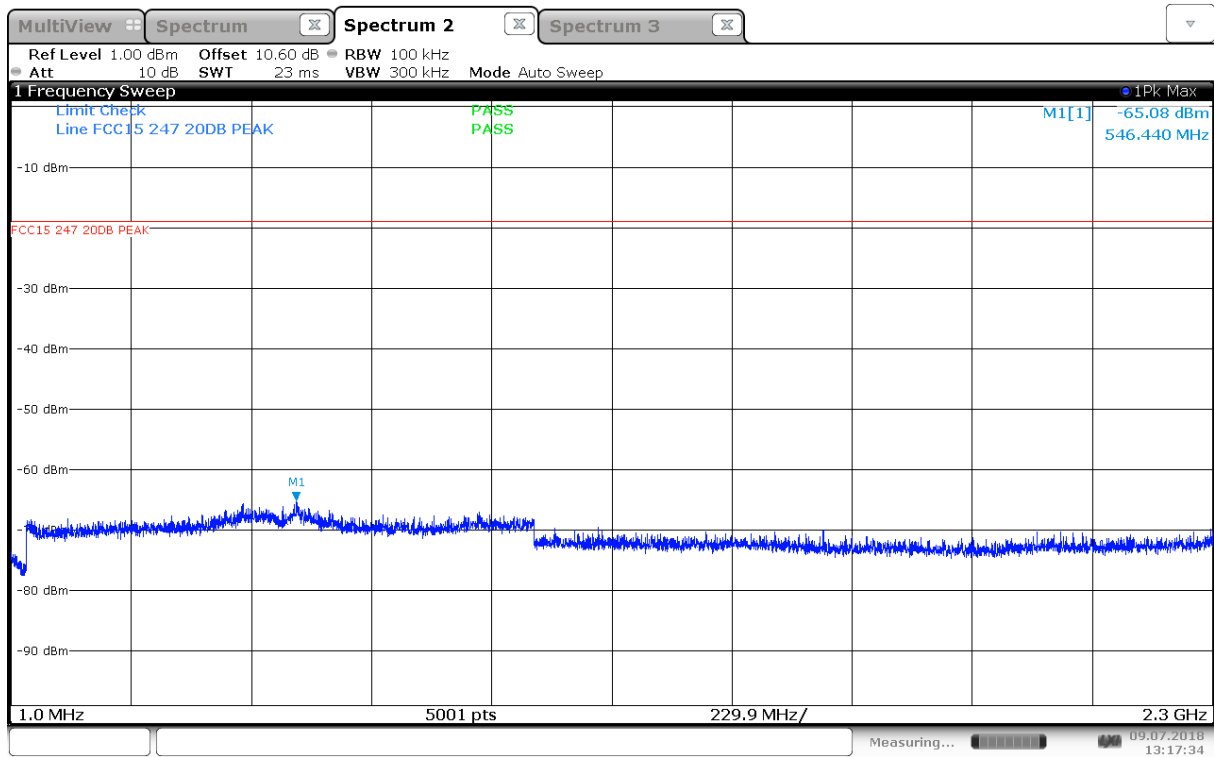
**RF conducted power** to 25 GHz: see attached plots.

**Limit**

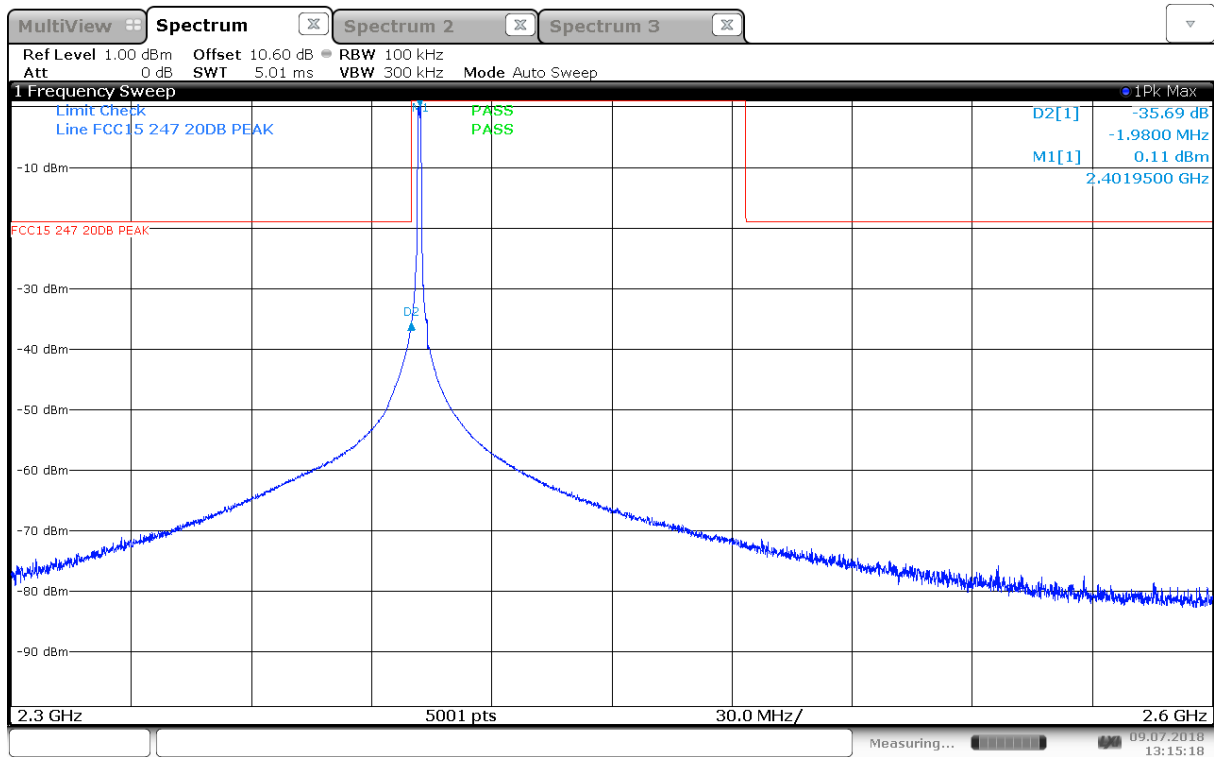
| Peak measurement                    | RMS averaging                       |
|-------------------------------------|-------------------------------------|
| 20 dBc or more in 100 kHz bandwidth | 30 dBc or more in 100 kHz bandwidth |

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

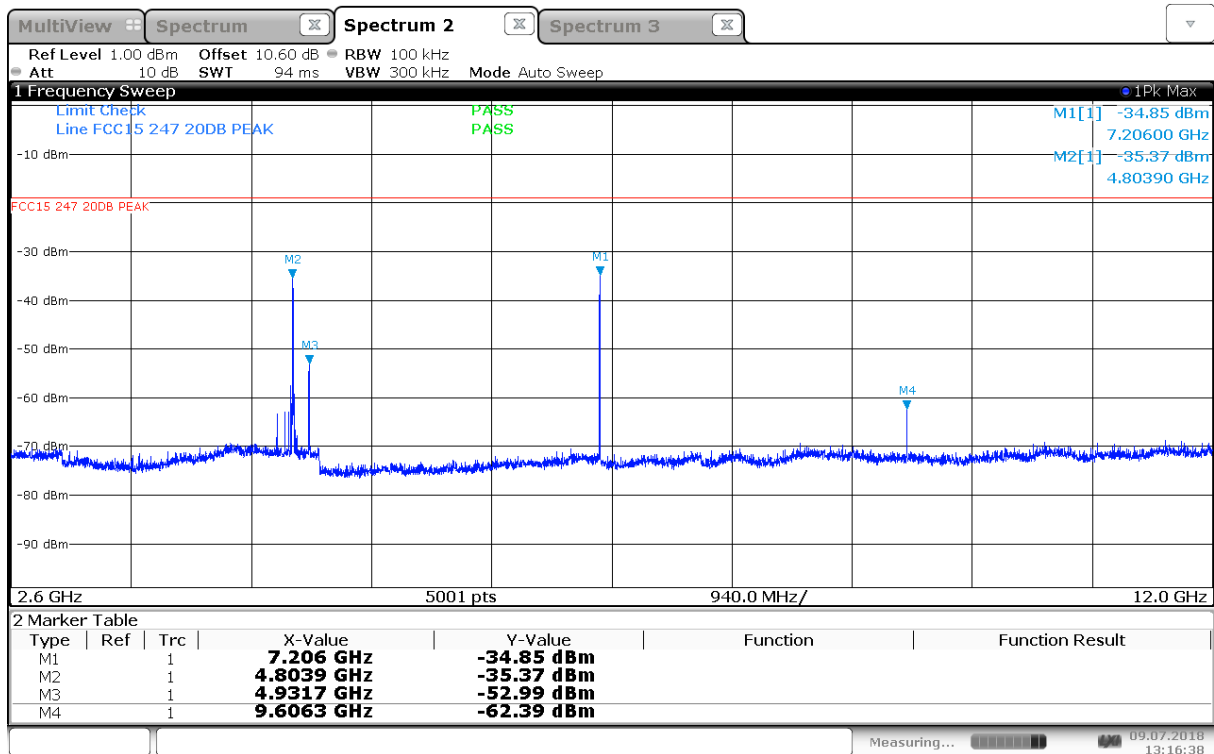
Attenuation below the general limits specified in part 15.209(a) and RSS-GEN Issue 5, clause 8.9, is not required.



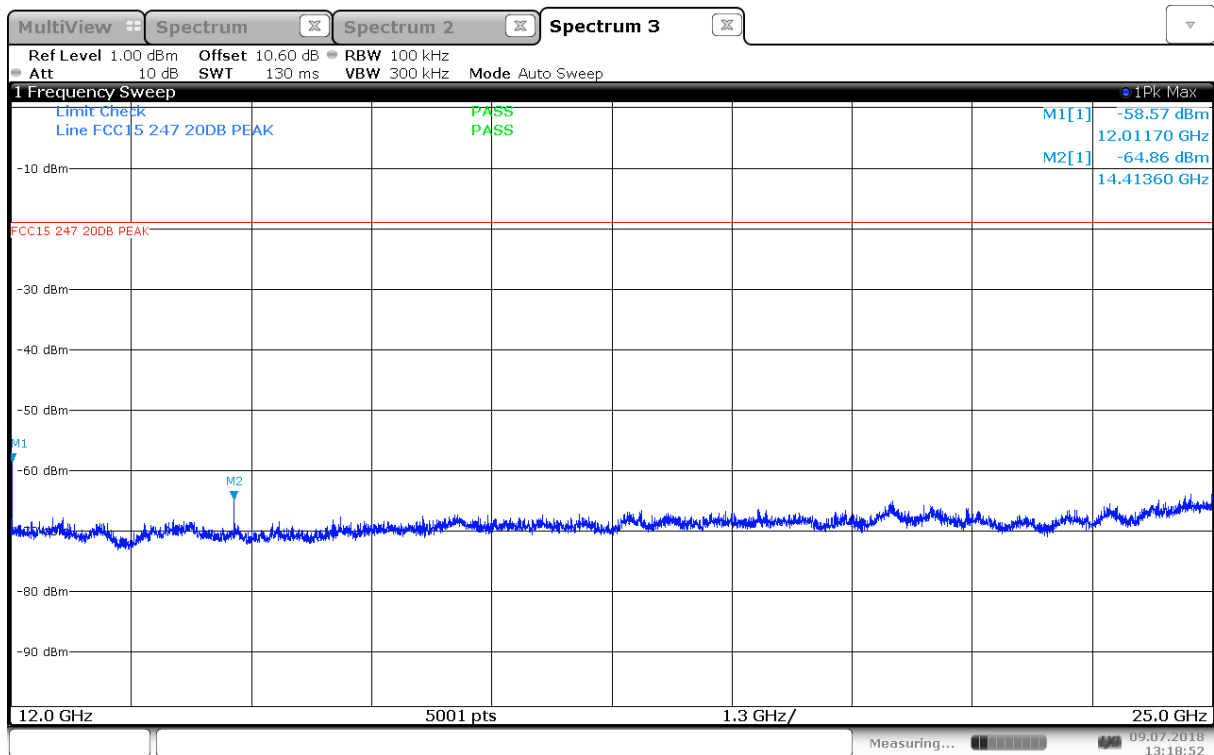
Conducted Emissions, 1 – 2300 MHz, 2402 MHz



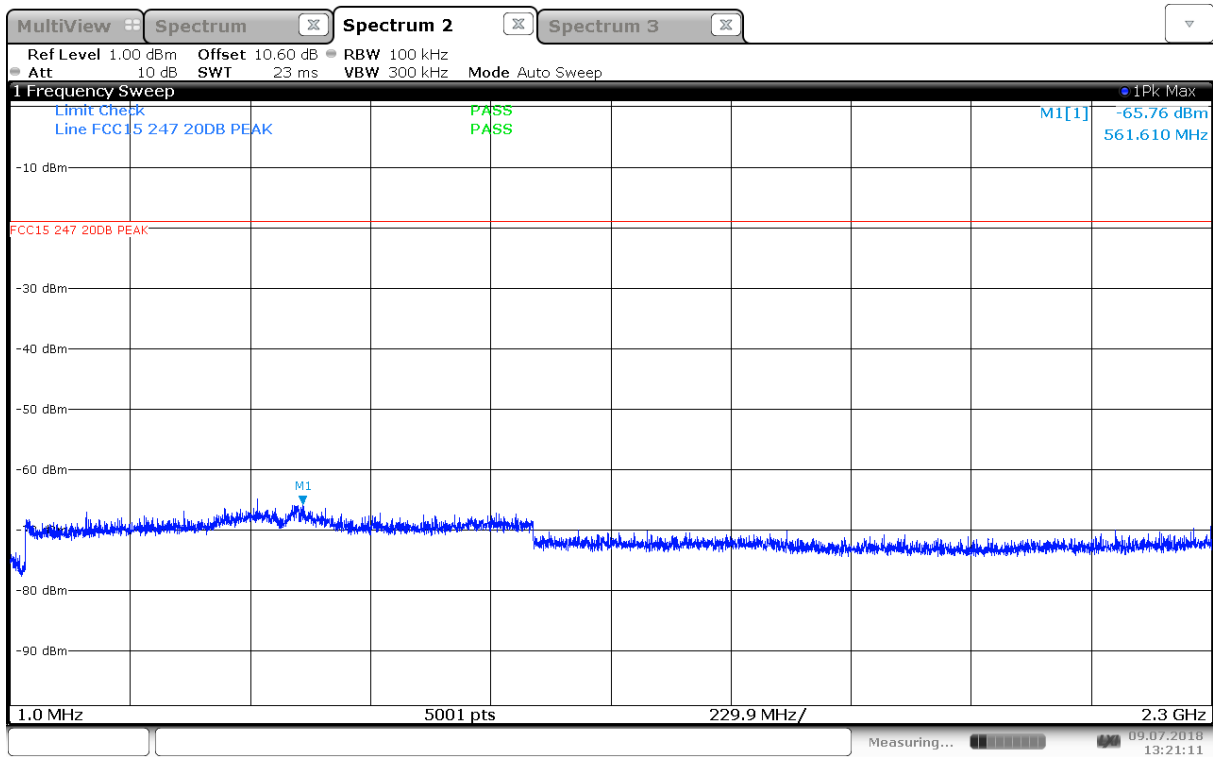
Conducted Emissions, 2300 – 2600 MHz, 2402 MHz



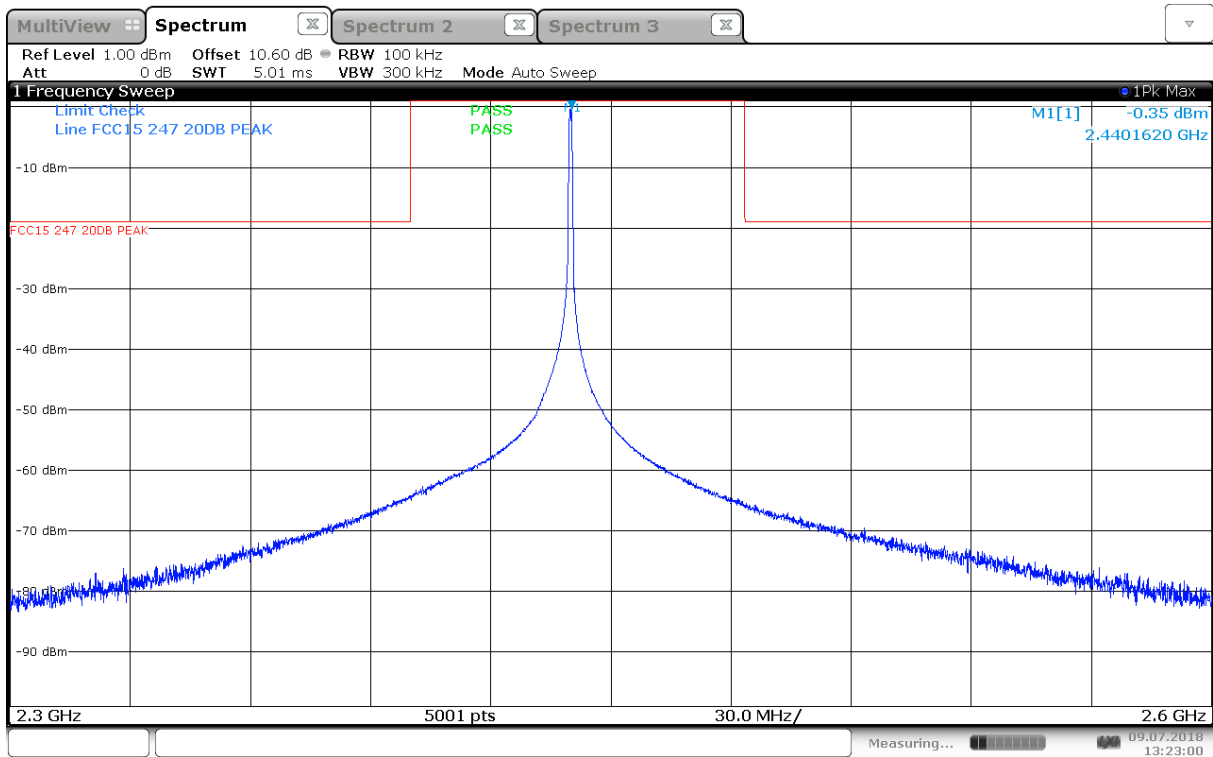
#### Conducted Emissions, 2600 – 12000 MHz, 2402 MHz



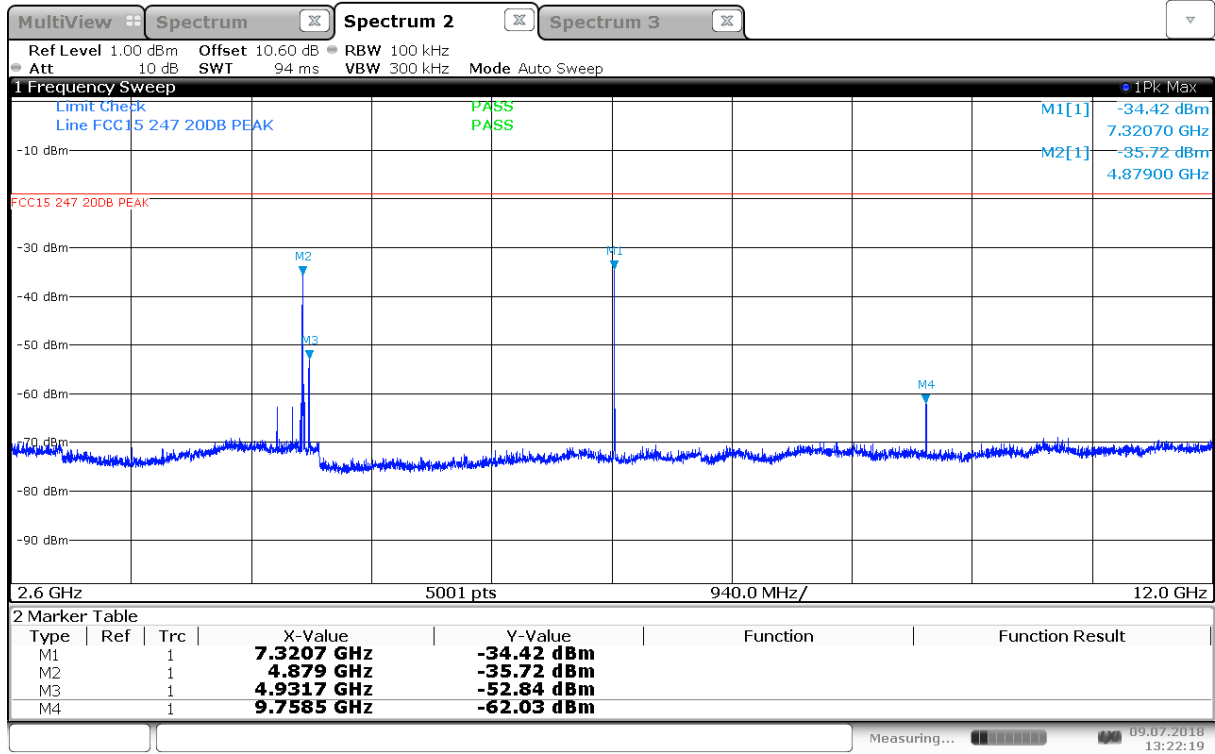
#### Conducted Emissions, 12000 – 25000 MHz, 2402 MHz



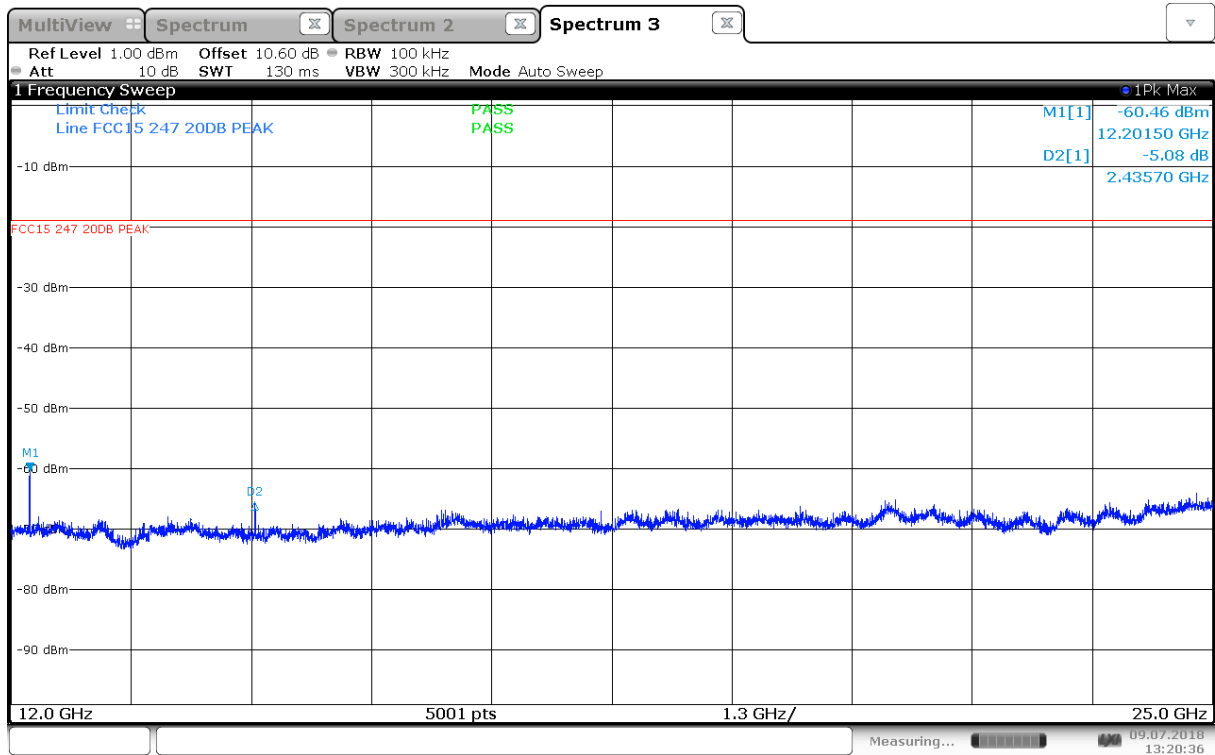
Conducted Emissions, 1 – 2300 MHz, 2440 MHz



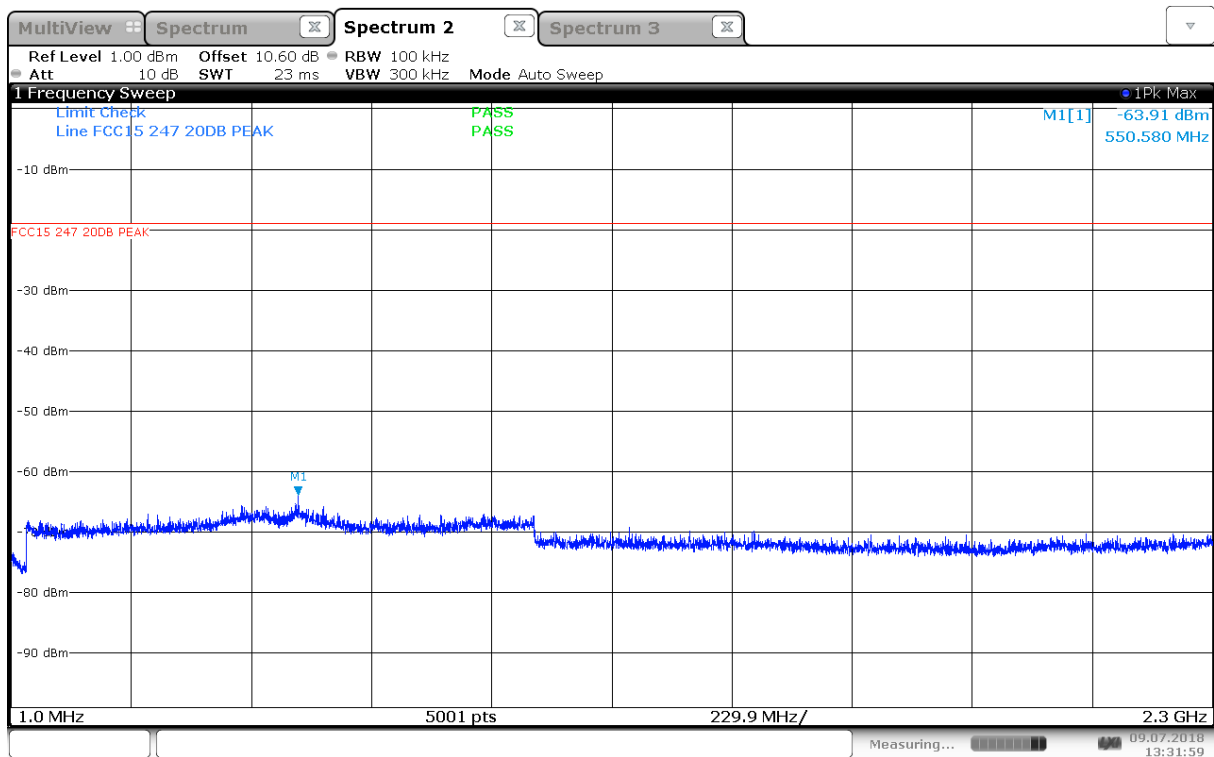
Conducted Emissions, 2300 – 2600 MHz, 2440 MHz



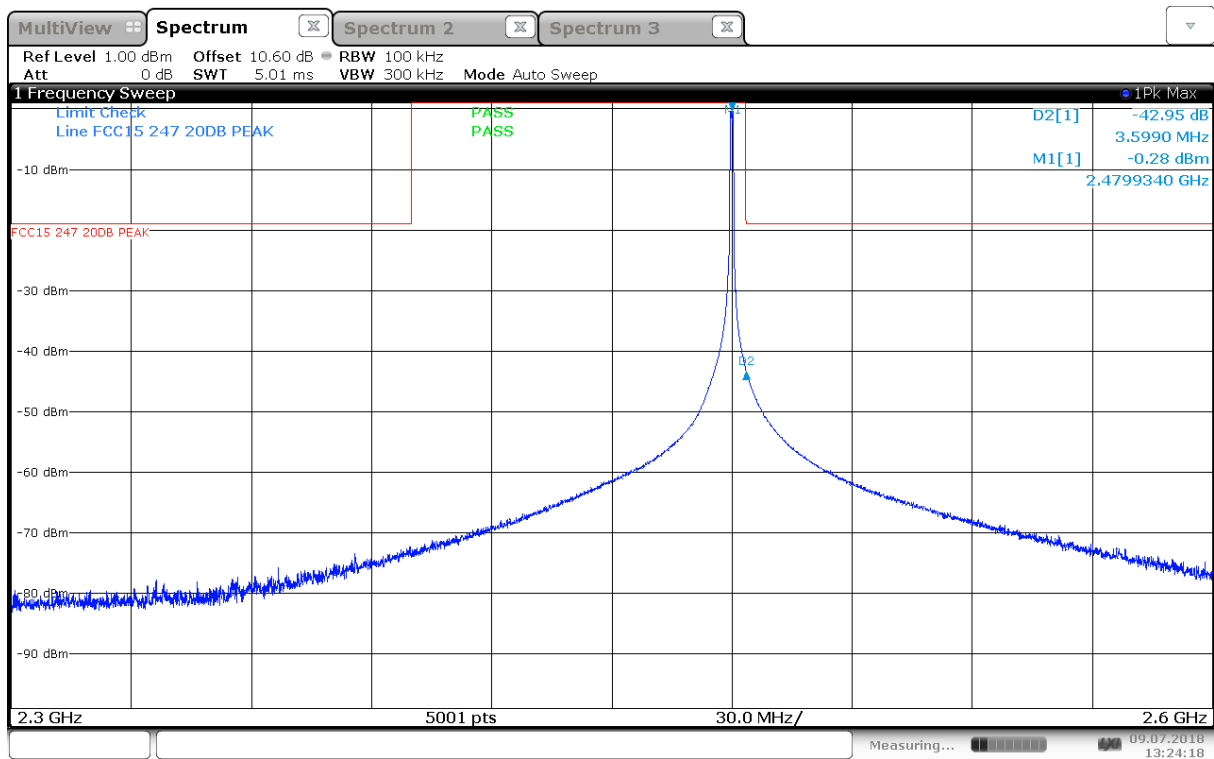
#### Conducted Emissions, 2600 – 12000 MHz, 2440 MHz



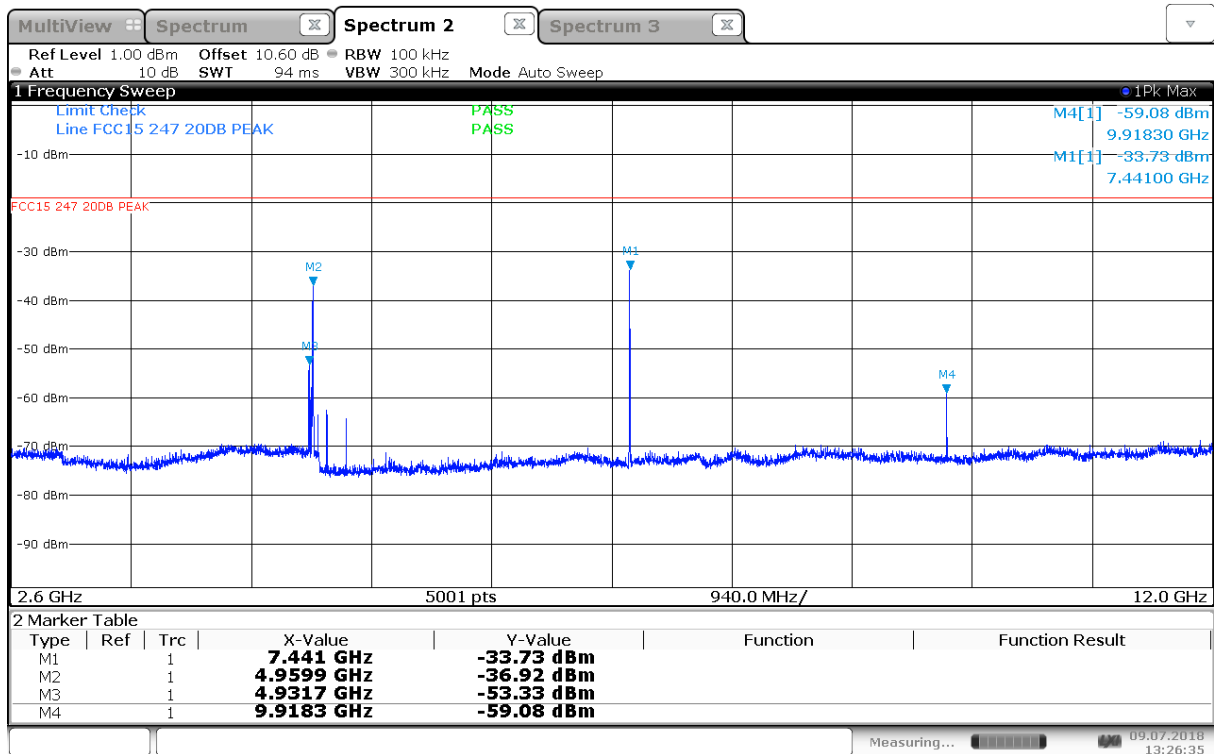
#### Conducted Emissions, 12000 – 25000 MHz, 2440 MHz



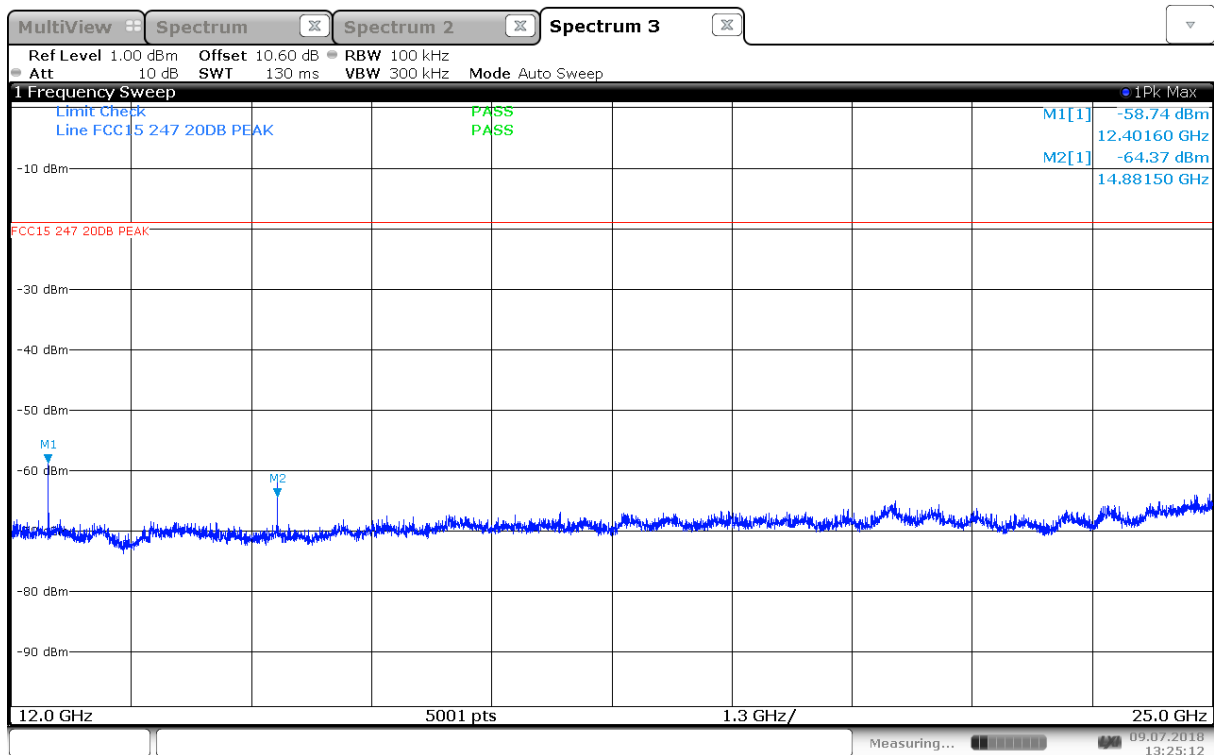
Conducted Emissions, 1 – 2300 MHz, 2480 MHz



Conducted Emissions, 2300 – 2600 MHz, 2480 MHz



#### Conducted Emissions, 2600 – 12000 MHz, 2480 MHz



#### Conducted Emissions, 12000 – 25000 MHz, 2480 MHz

### 3.6 Restricted Bands of operation

Restricted Bands of operation for FCC and ISSED are defined in FCC Part 15.205 and ISSED RSS-GEN, Issue 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)                           | ISED (MHz)         | FCC (GHz)                            | ISED (GHz)        |
|-------------------------------------|--------------------|--------------------------------------|-------------------|
| 0.090-0.110                         |                    | <b>0.96-1.24</b><br><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                        |                   |
| N/A                                 | <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                            |                   |
| N/A                                 | <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><br><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                             |                    |                                      |                   |

### 3.7 Band Edge Emissions (Radiated)

FCC Part 15.209

ISED Canada RSS-GEN Issue 5, Clause 8.9

Test Results: Complies

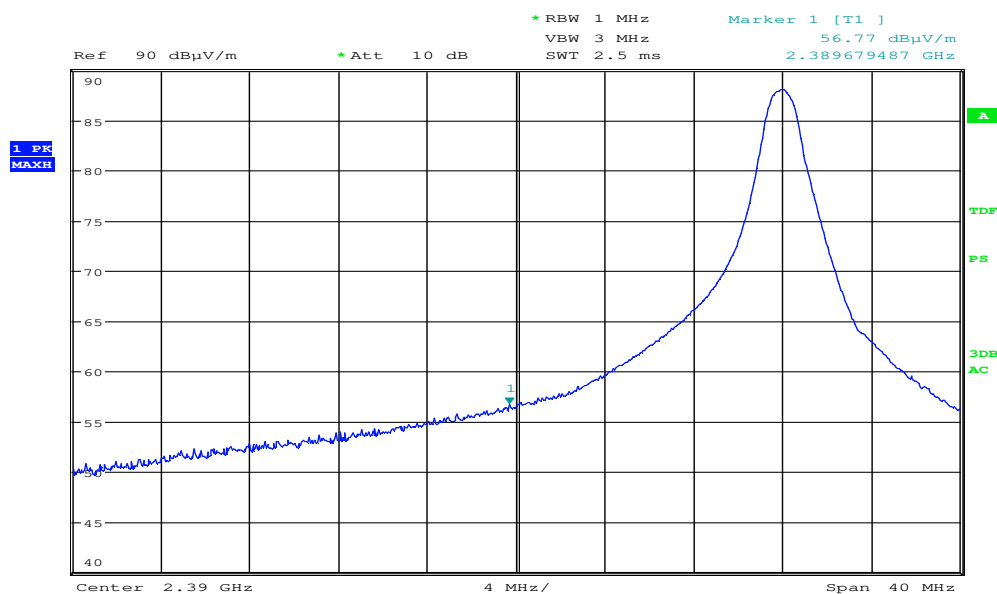
Measurement Data:

|                  | Measured field strength (dBμV/m) |            | Limit    | Margin |     |
|------------------|----------------------------------|------------|----------|--------|-----|
|                  | 2390 MHz                         | 2483.5 MHz | (dBμV/m) | (dB)   |     |
| Peak Detector    | 56.8                             | 68.6       | 74       | 17.2   | 5.4 |
| Average Detector | 36.8                             | 48.6       | 54       | 17.2   | 5.4 |

The EUT was transmitting a modulated signal with constant Duty-Cycle for this measurement.

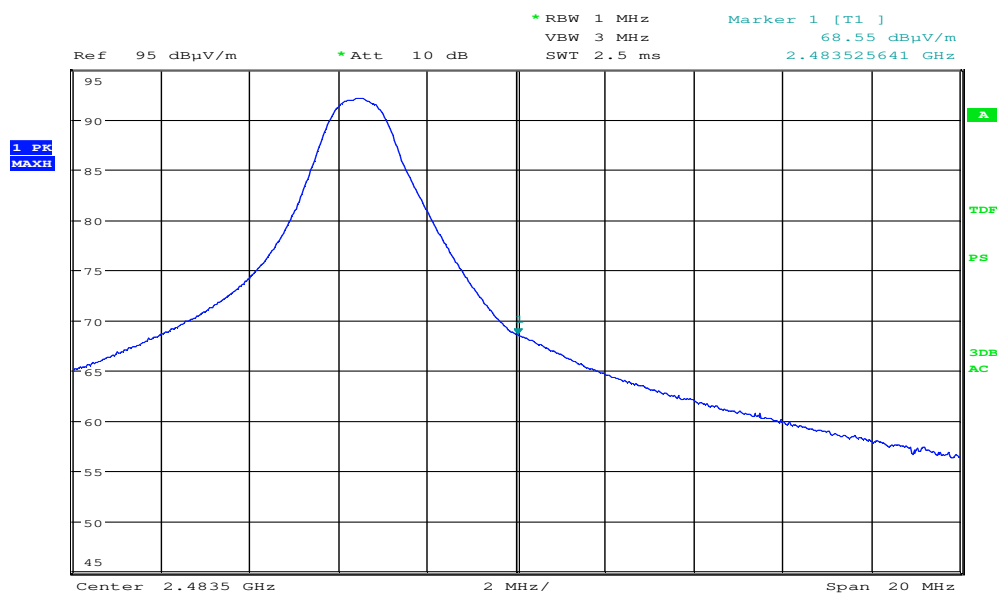
The EUTs uses BT Low Energy, Duty Cycle Correction Factor 20 dB is used to calculate Average detector values.

See attached plots.



Date: 25.JUN.2018 18:14:11

### Band Edge, Lower, Peak, 2402 MHz



Date: 25.JUN.2018 18:11:08

### Band Edge, Upper, Peak, 2480 MHz

### 3.8 Radiated Emissions, 30 – 1000 MHz.

FCC 15.205, 15.209

ISED RSS-GEN, Issue 5, Clause 8.9

Test Results: Complies

#### Radiated emission 30–1000 MHz

Measuring distance 3 m.

Tested in test mode with EUT transmitting on 3 hopping channels.

All measurements were performed with the EUT transmitting at Max Power.

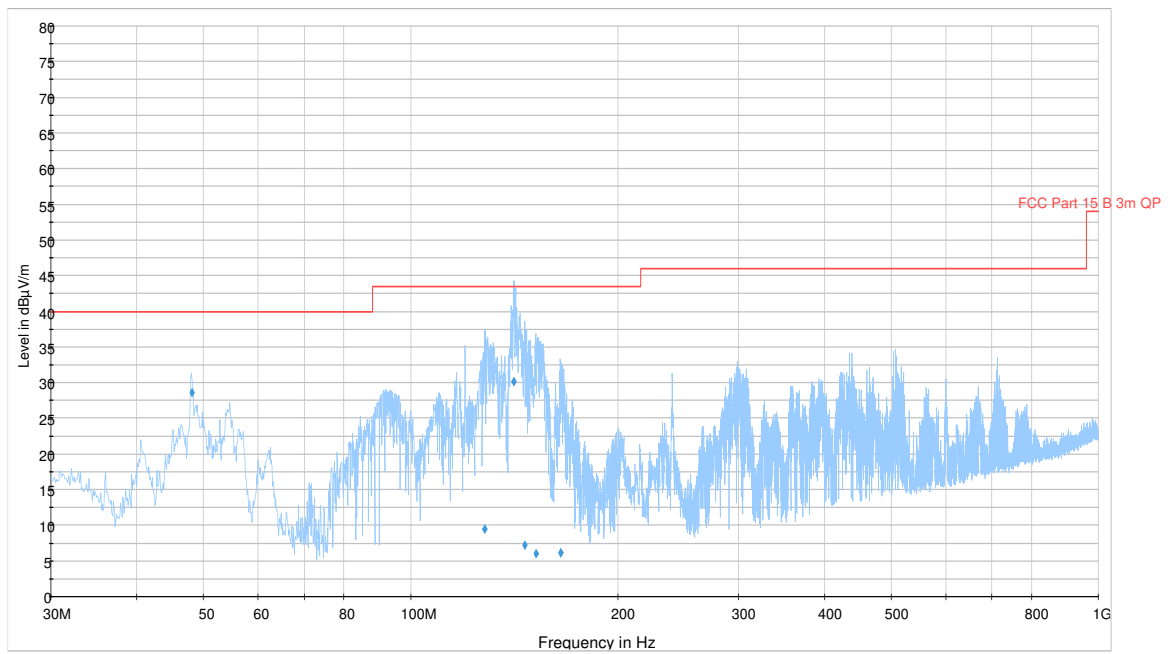
#### Measured values:

| Frequency (MHz) | QuasiPeak (dBμV/m) | Limit (dBμV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB) |
|-----------------|--------------------|----------------|-------------|-----------------|-----------------|-------------|-----|---------------|------------|
| 48.116750       | 28.55              | 40.00          | 11.45       | 1000.0          | 120.000         | 104.0       | V   | 147.0         | -20.8      |
| 128.269150      | 9.44               | 43.50          | 34.06       | 1000.0          | 120.000         | 384.0       | V   | 346.0         | -17.4      |
| 141.170100      | 30.08              | 43.50          | 13.42       | 1000.0          | 120.000         | 184.0       | H   | 86.0          | -17.7      |
| 146.519450      | 7.19               | 43.50          | 36.31       | 1000.0          | 120.000         | 199.0       | H   | 277.0         | -18.0      |
| 152.259350      | 6.02               | 43.50          | 37.48       | 1000.0          | 120.000         | 199.0       | H   | 296.0         | -18.4      |
| 165.256400      | 6.12               | 43.50          | 37.38       | 1000.0          | 120.000         | 198.0       | H   | 275.0         | -19.0      |

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 |                     |
|                 | Radiated emission limit @3 meters                                |                     |
| Frequency (MHz) | Quasi Peak (μV/m)                                                | Quasi Peak (dBμV/m) |
| 30–88           | 100                                                              | 40.0                |
| 88–216          | 150                                                              | 43.5                |
| 216–960         | 200                                                              | 46.0                |
| Above 960       | 500                                                              | 54.0                |



### Radiated Emissions, 30–1000 MHz

### 3.9 Radiated Emissions, 1 – 25 GHz

FCC 15.205, 15.209

ISED RSS-GEN, Issue 5, Clause 8.9

Test Results: Complies

Measurement Data:

Measuring distance: 3 m (1–18 GHz)  
10 cm (18-25 GHz)

A pre-scan at approx. 10 cm was performed above 18 GHz and no spurious emissions were detected.

Measured values:

| Frequency (MHz) | Channel | Polarization | Peak (dBμV/m) | Average (dBμV/m) | Peak Margin (dB) | Av Margin (dB) |
|-----------------|---------|--------------|---------------|------------------|------------------|----------------|
| 4804            | 0       | VP           | 53.7          | 33.7             | 20.3             | 20.3           |
| 7206            | 0       | VP           | 65.3          | 45.3             | 8.7              | 8.7            |
| 4880            | 19      | VP           | 55.4          | 35.4             | 18.6             | 18.6           |
| 7320            | 19      | VP           | 65.8          | 45.8             | 8.2              | 8.2            |
| 4960            | 39      | VP           | 56.8          | 36.8             | 17.2             | 17.2           |
| 7440            | 39      | VP           | 65.0          | 45.0             | 9.0              | 9.0            |

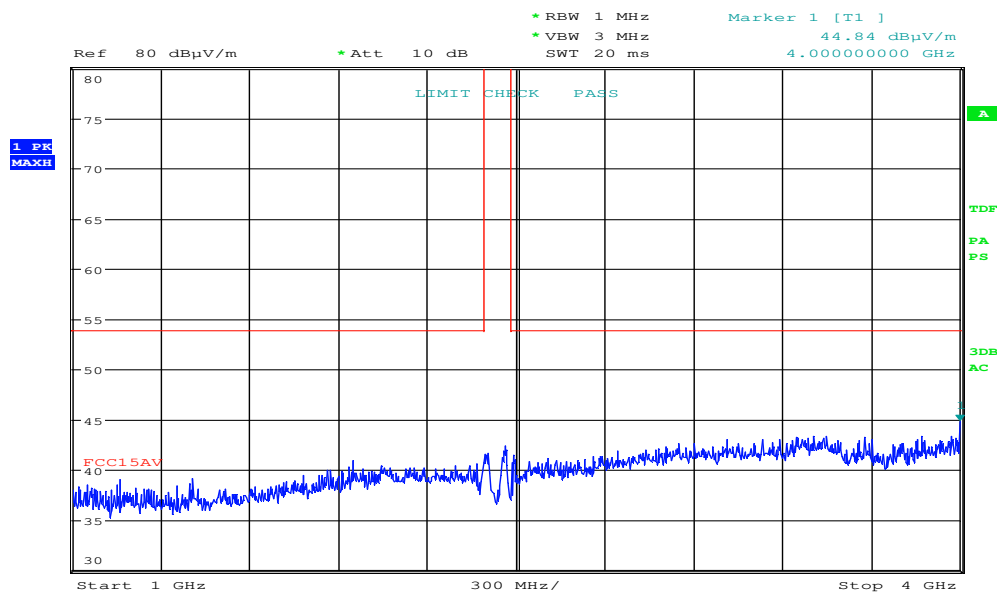
All Peak values are more than 12 dB below the limit.

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

See plots.

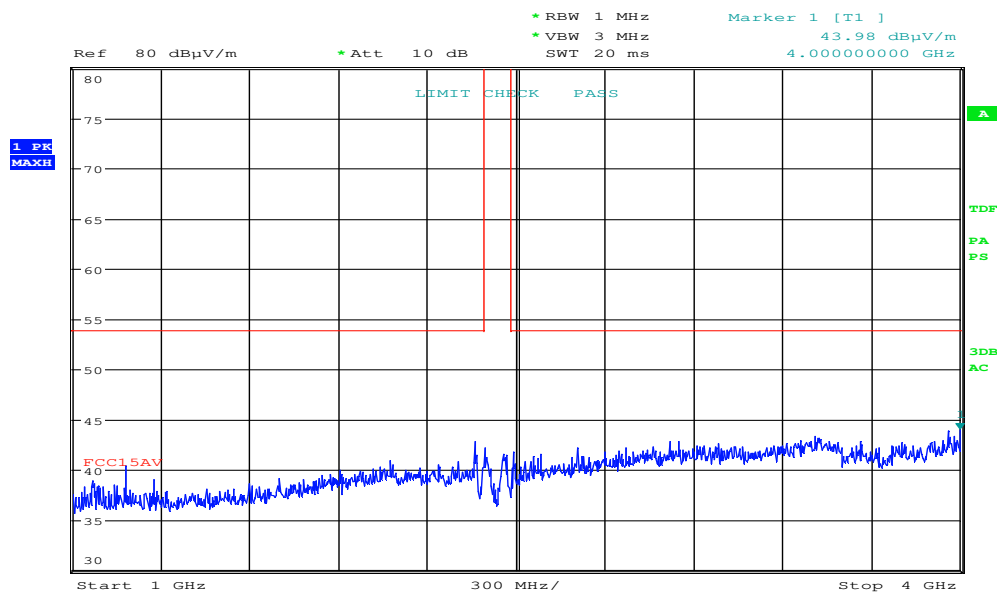
#### Requirements/Limit

|                 |                                                                  |               |
|-----------------|------------------------------------------------------------------|---------------|
| 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 (MHz) | AV (dBμV/m)                                                      | Peak (dBμV/m) |
| Above 1 GHz     | 54.0                                                             | 74.0          |



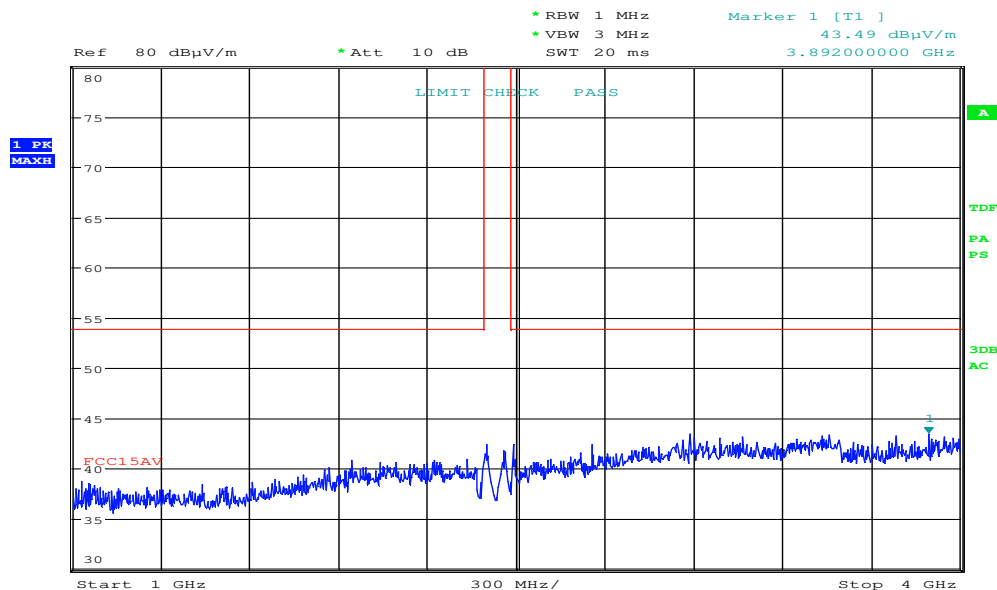
Date: 25.JUN.2018 17:44:40

#### Radiated Emissions, 1000 – 4000 MHz, 2402 MHz, HP



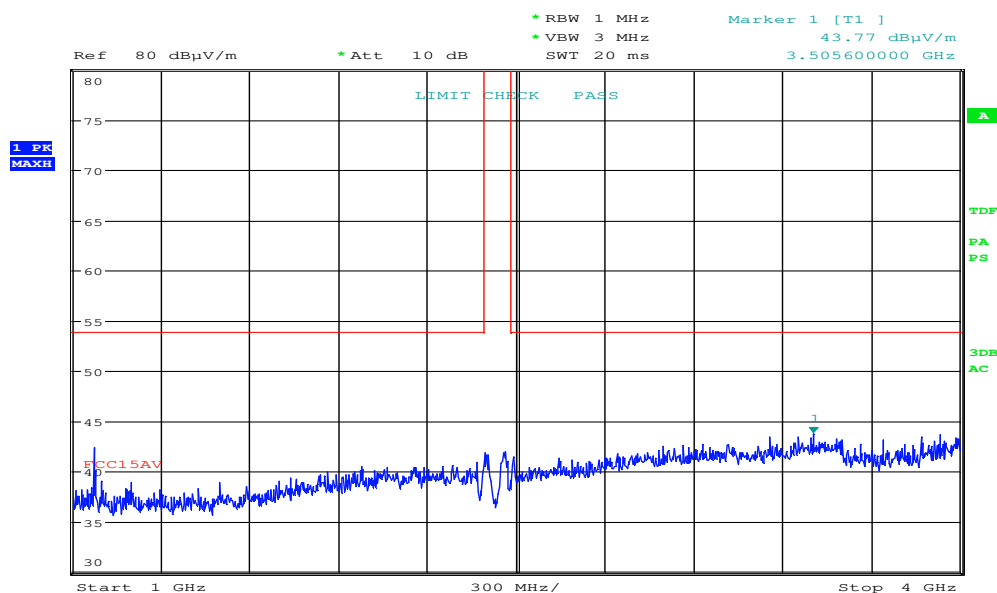
Date: 25.JUN.2018 17:42:47

#### Radiated Emissions, 1000 – 4000 MHz, 2402 MHz, VP



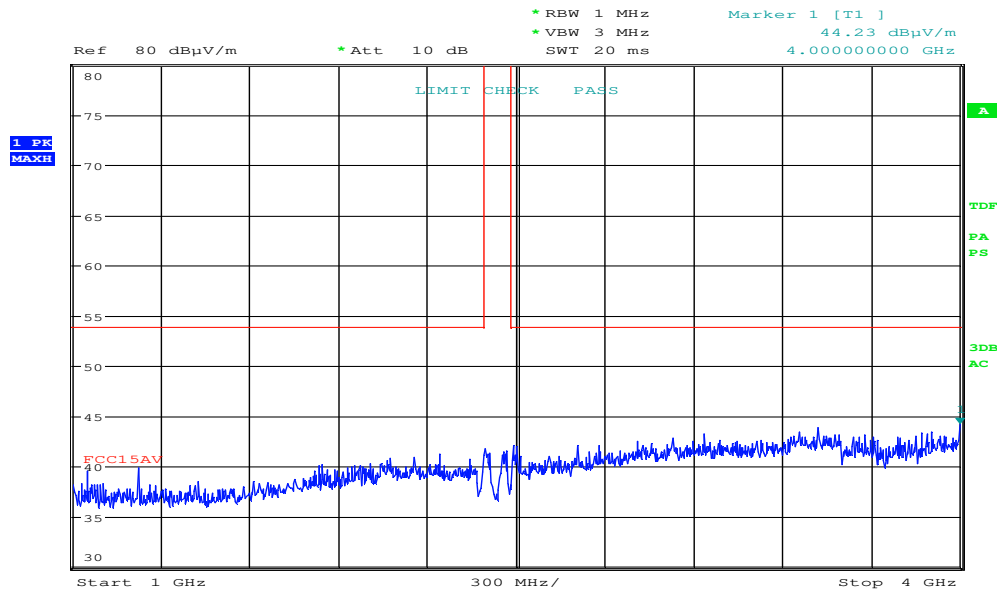
Date: 25.JUN.2018 17:49:16

#### Radiated Emissions, 1000 – 4000 MHz, 2440 MHz, HP



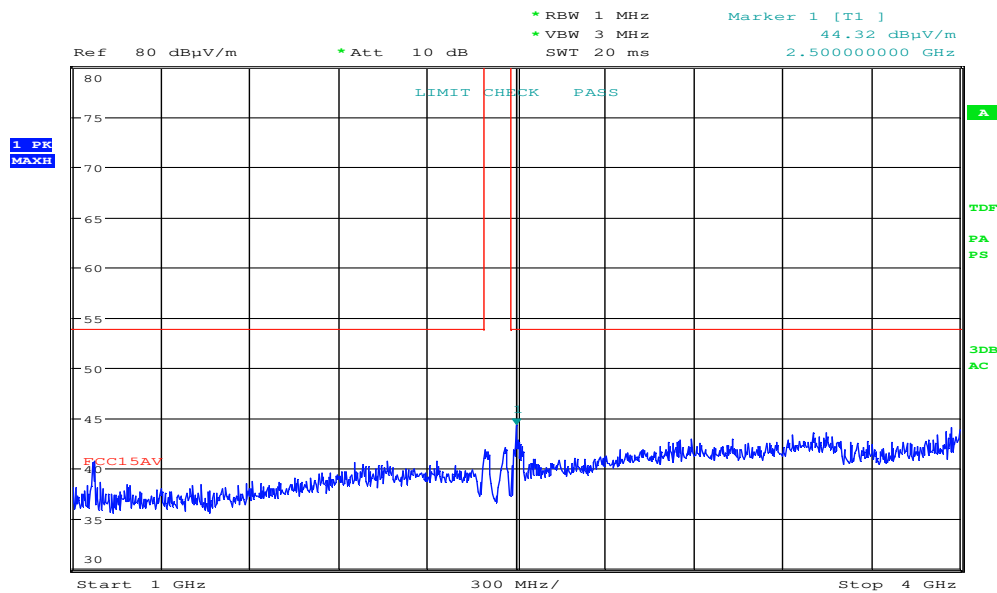
Date: 25.JUN.2018 17:47:22

#### Radiated Emissions, 1000 – 4000 MHz, 2440 MHz, VP



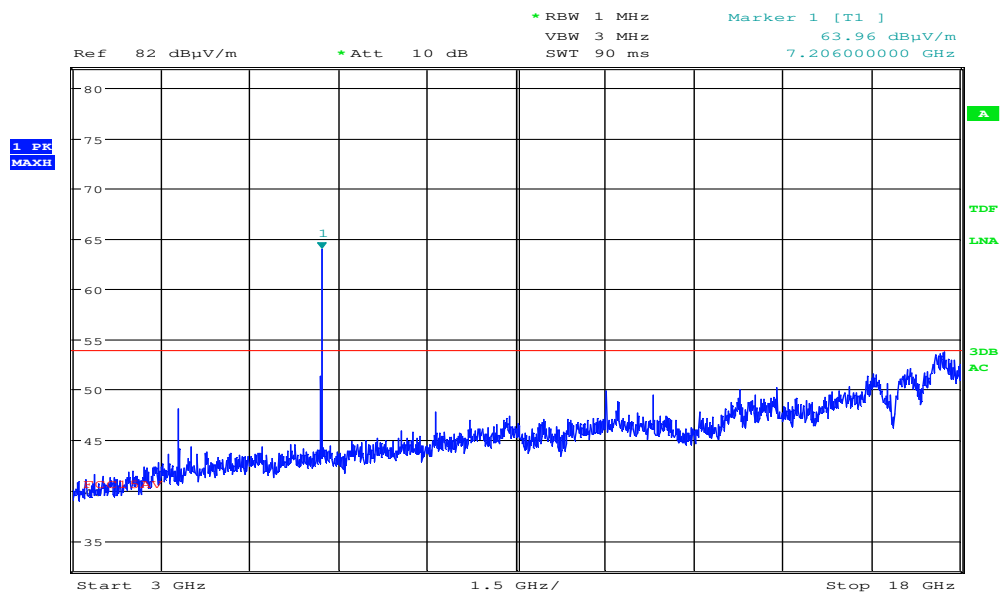
Date: 25.JUN.2018 17:53:41

#### Radiated Emissions, 1000 – 4000 MHz, 2480 MHz, HP



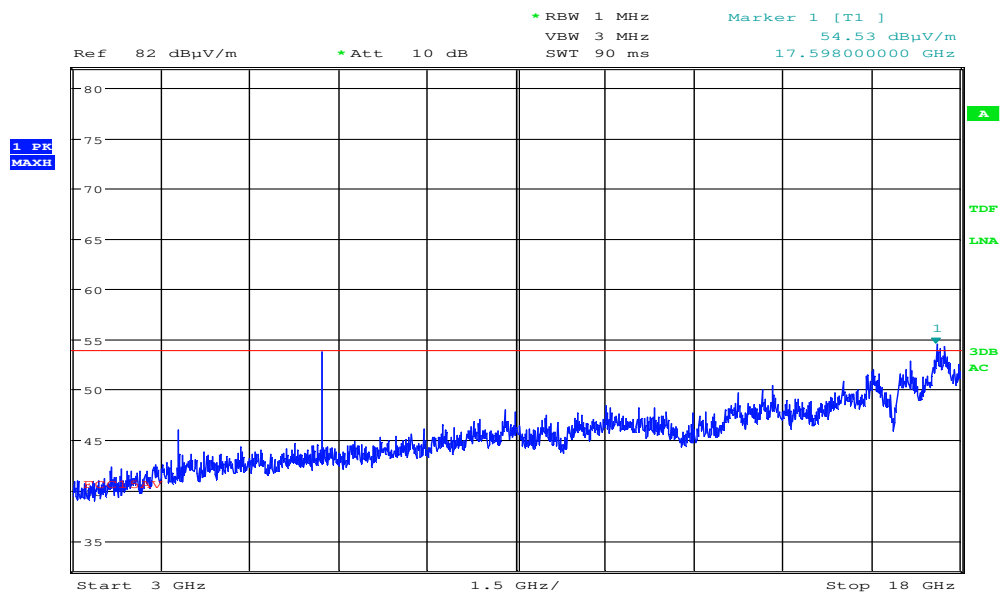
Date: 25.JUN.2018 17:51:47

#### Radiated Emissions, 1000 – 4000 MHz, 2480 MHz, VP



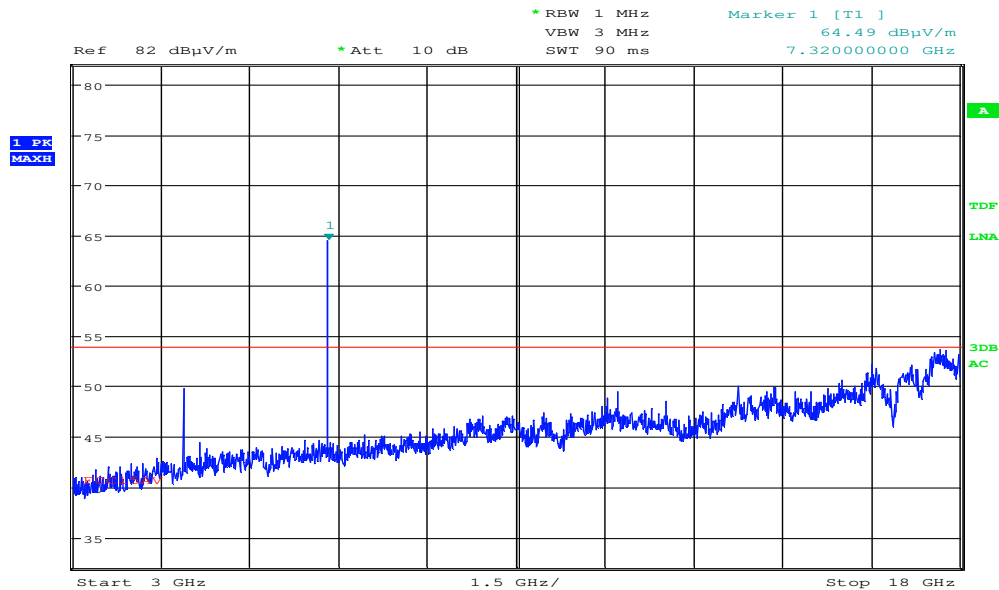
Date: 25.JUN.2018 18:43:27

#### Radiated Emissions, 3000 – 18000 MHz, 2402 MHz, HP



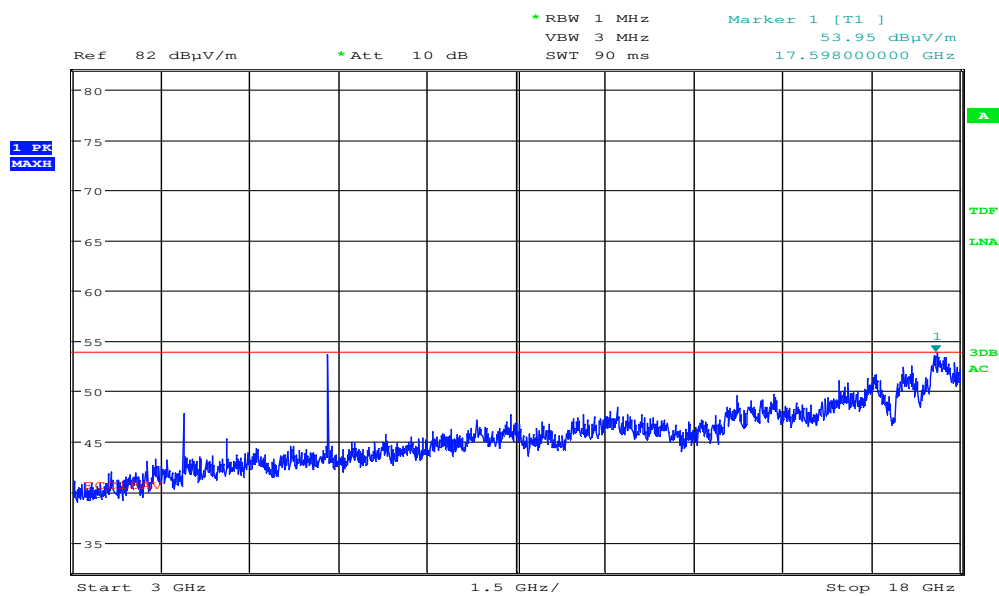
Date: 25.JUN.2018 18:41:33

#### Radiated Emissions, 3000 – 18000 MHz, 2402 MHz, VP



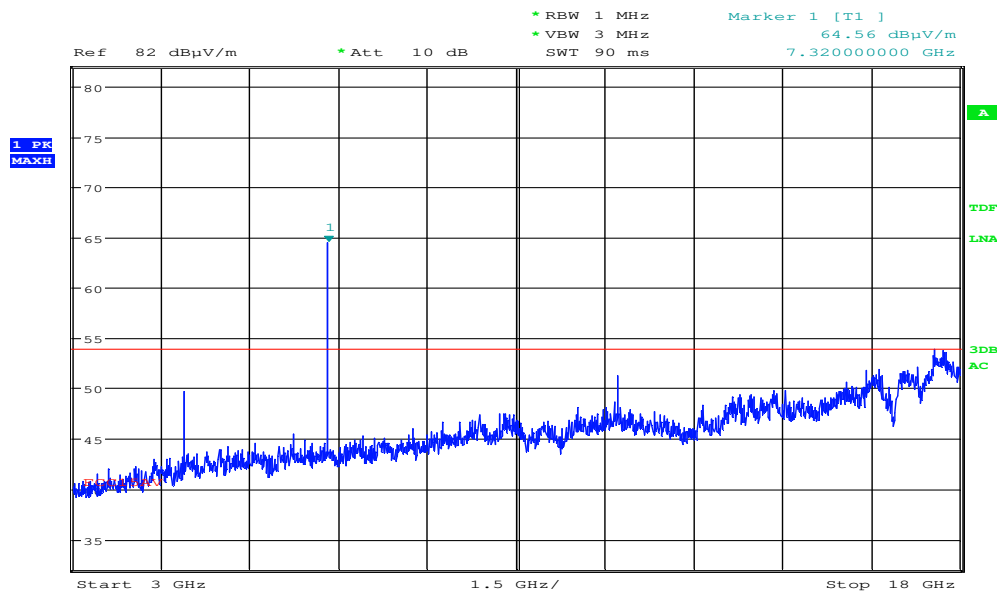
Date: 25.JUN.2018 18:36:57

#### Radiated Emissions, 3000 – 18000 MHz, 2440 MHz, HP



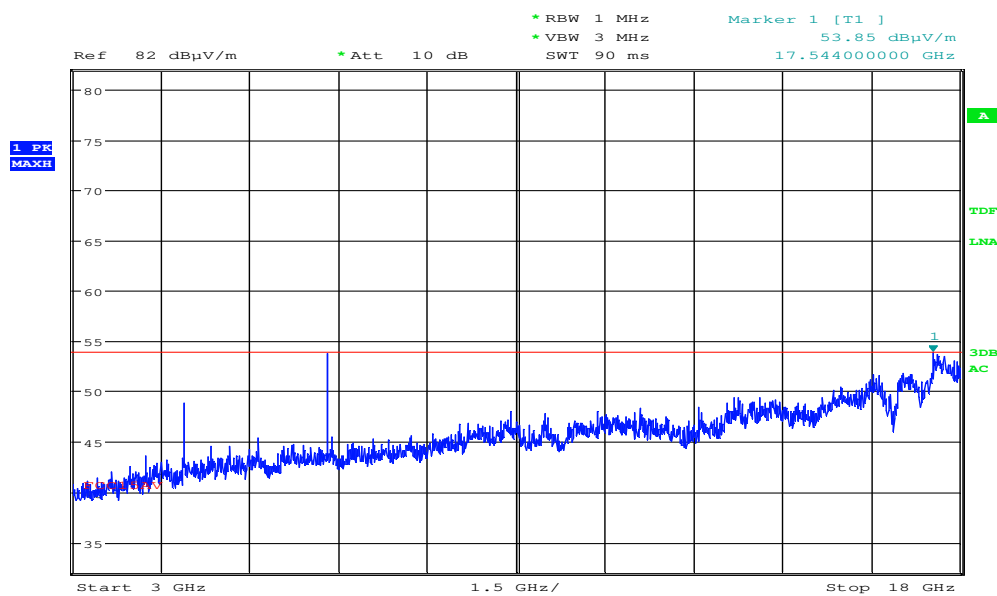
Date: 25.JUN.2018 18:35:03

#### Radiated Emissions, 3000 – 18000 MHz, 2440 MHz, VP



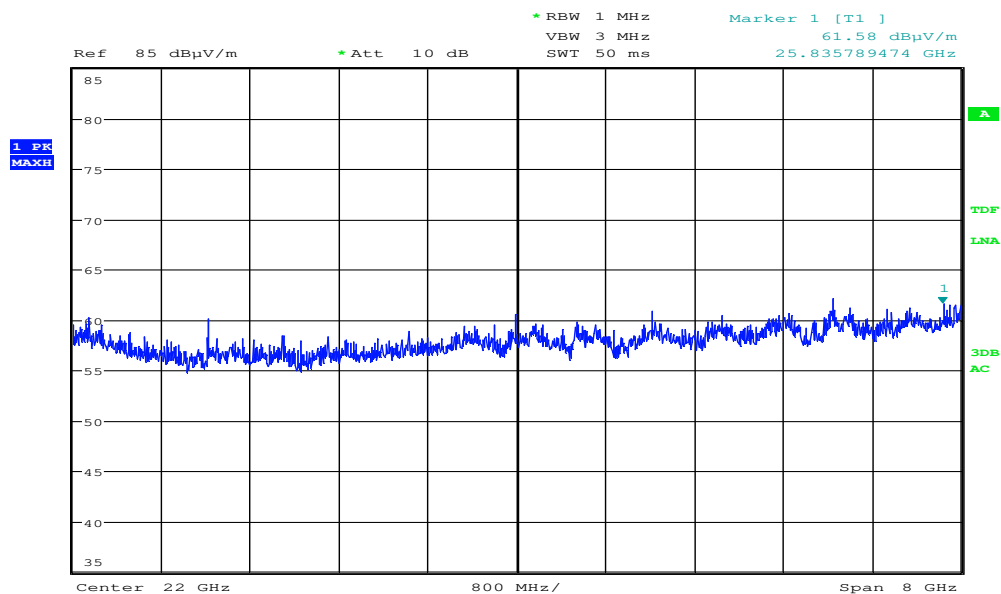
Date: 25.JUN.2018 18:31:29

#### Radiated Emissions, 3000 – 18000 MHz, 2480 MHz, HP



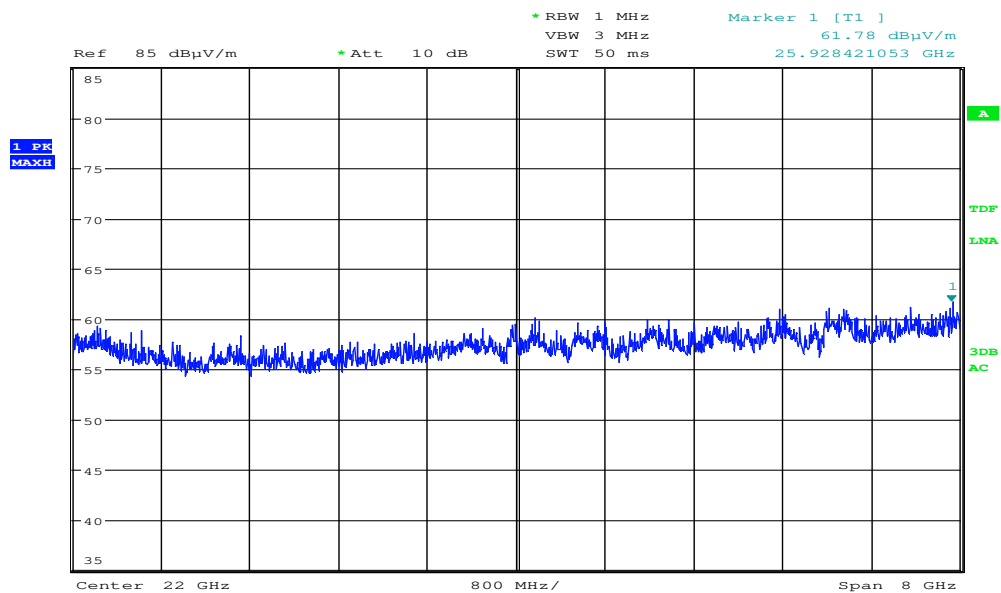
Date: 25.JUN.2018 18:29:35

#### Radiated Emissions, 3000 – 18000 MHz, 2480 MHz, VP



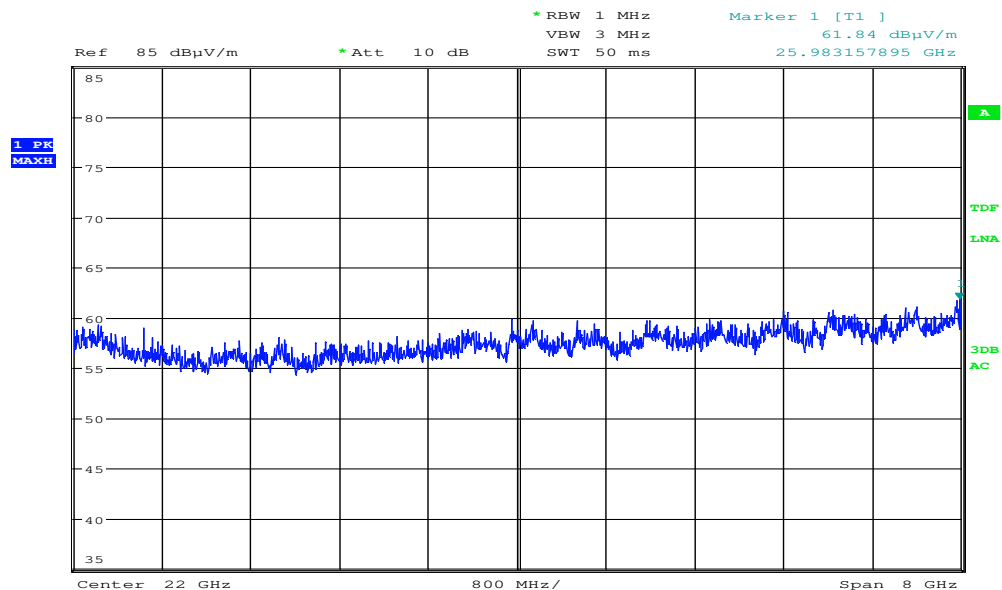
Date: 26.JUN.2018 10:47:09

Pre-scan, 18 – 26 GHz, 2402 MHz, VP/HP, @10cm



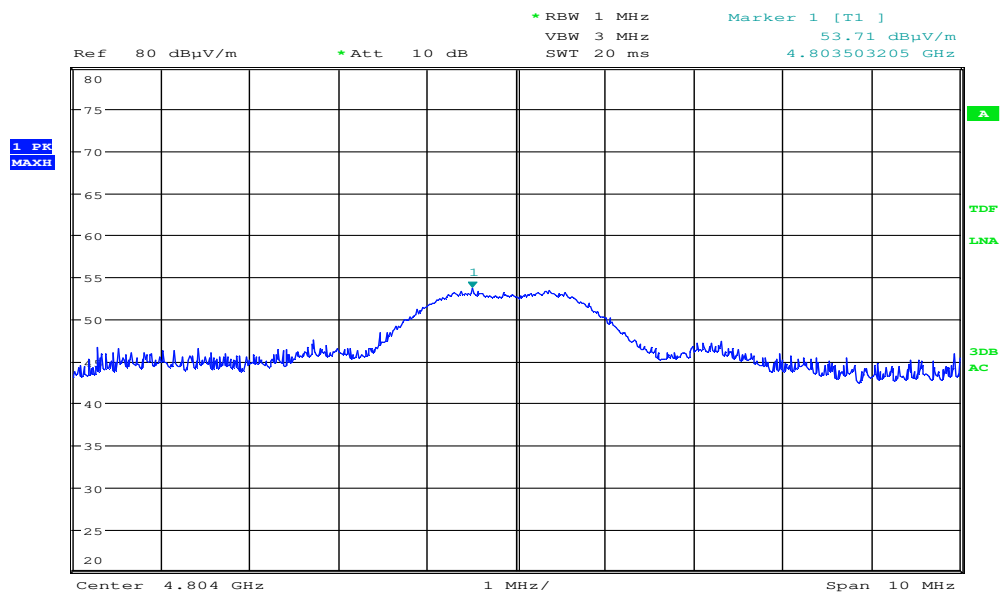
Date: 26.JUN.2018 10:51:28

Pre-scan, 18 – 26 GHz, 2440 MHz, VP/HP, @10cm



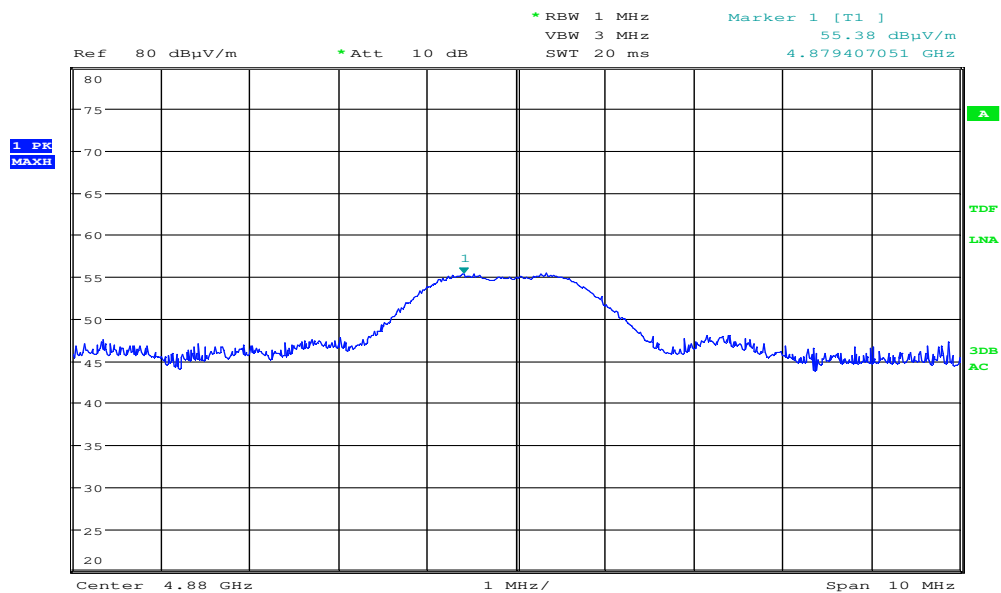
Date: 26.JUN.2018 10:53:31

Pre-scan, 18 – 26 GHz, 2480 MHz, VP/HP, @10cm



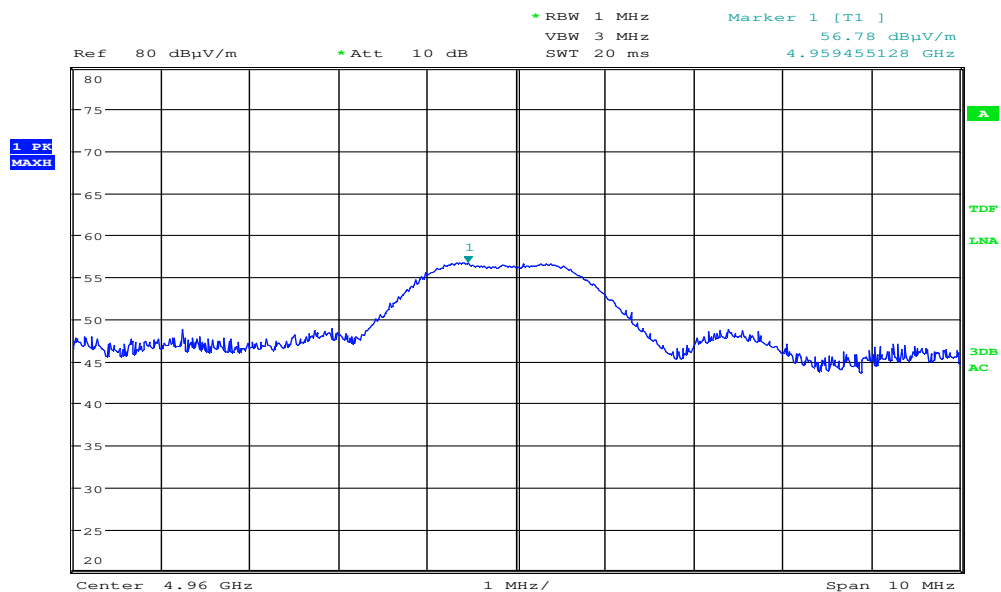
Date: 25.JUN.2018 19:17:14

#### Radiated Emissions, 4804 MHz, 2402 MHz, Peak (Max: HP)



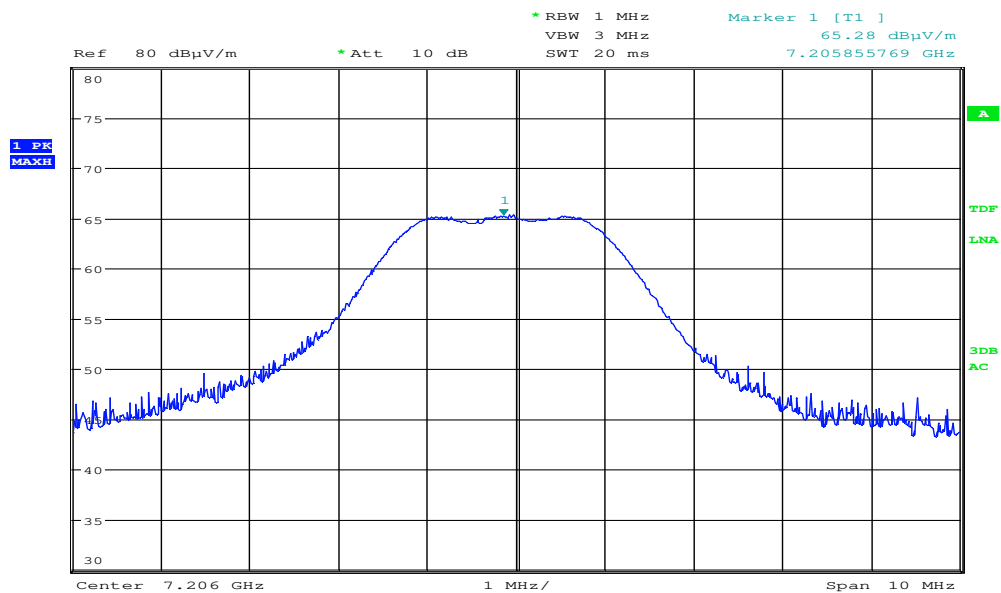
Date: 25.JUN.2018 19:16:18

#### Radiated Emissions, 4880 MHz, 2440 MHz, Peak (Max: HP)



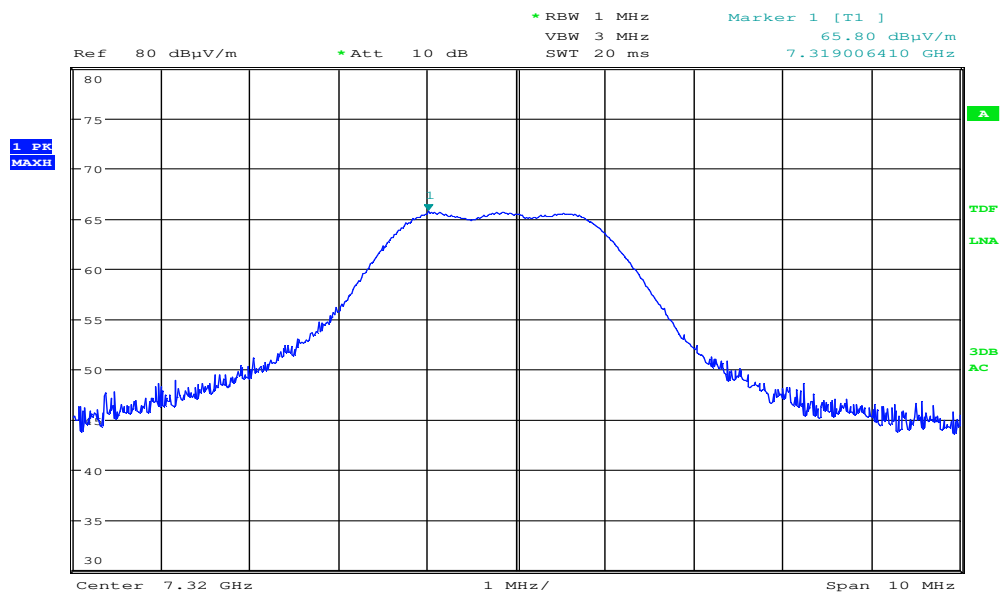
Date: 25.JUN.2018 19:14:07

#### Radiated Emissions, 4960 MHz, 2480 MHz, Peak (Max: HP)



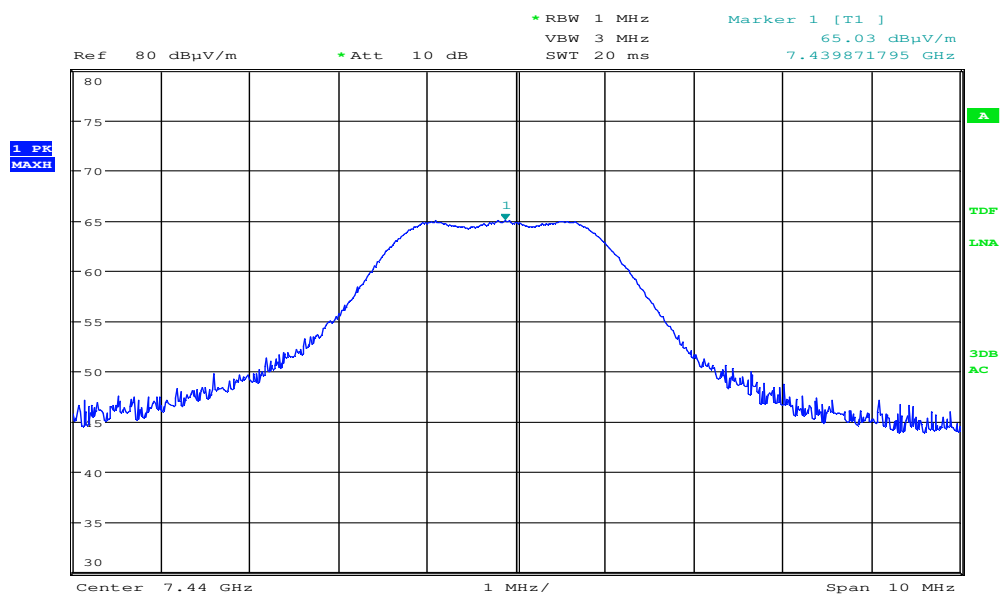
Date: 25.JUN.2018 18:58:06

#### Radiated Emissions, 7206 MHz, 2402 MHz, Peak (Max: HP)



Date: 25.JUN.2018 19:00:01

#### Radiated Emissions, 7320 MHz, 2440 MHz, Peak (Max: HP)



Date: 25.JUN.2018 19:01:09

#### Radiated Emissions, 7440 MHz, 2480 MHz, Peak (Max: HP)

### 3.10 Power Spectral Density (PSD)

FCC Part 15.247 (d)

Test Results: Passed

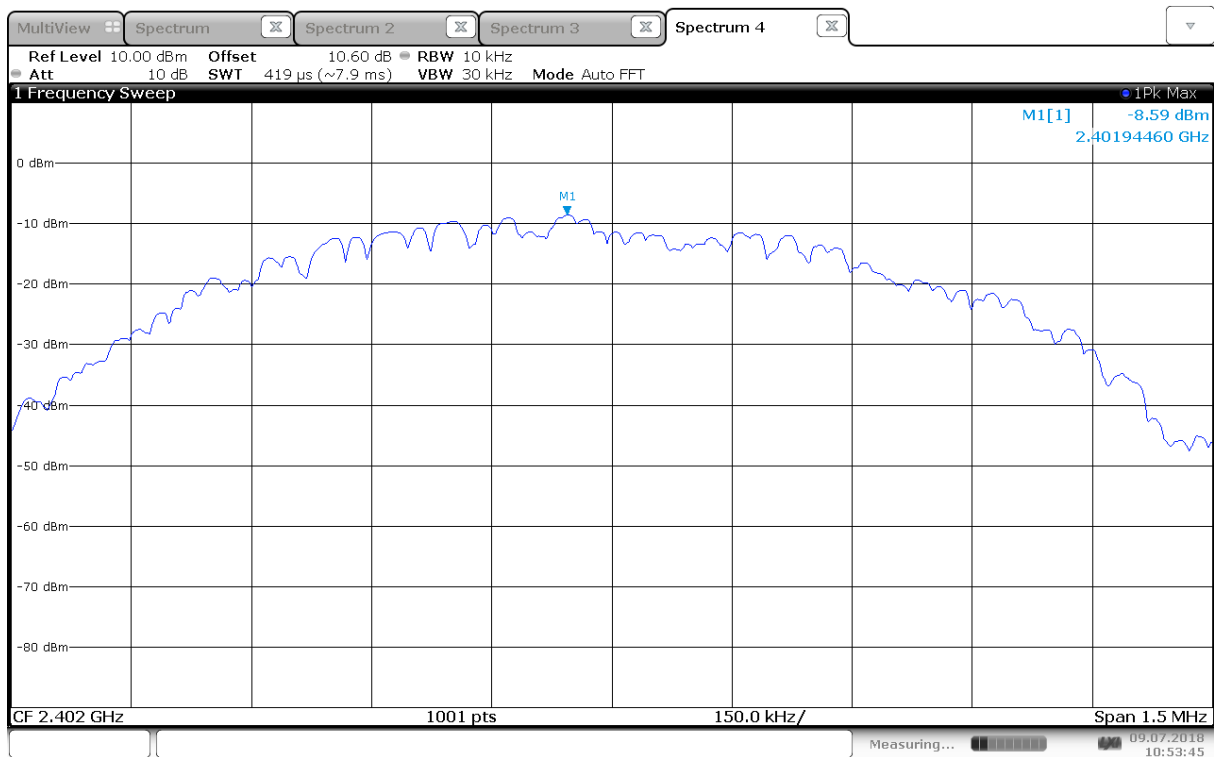
#### Measured and Calculated Data:

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

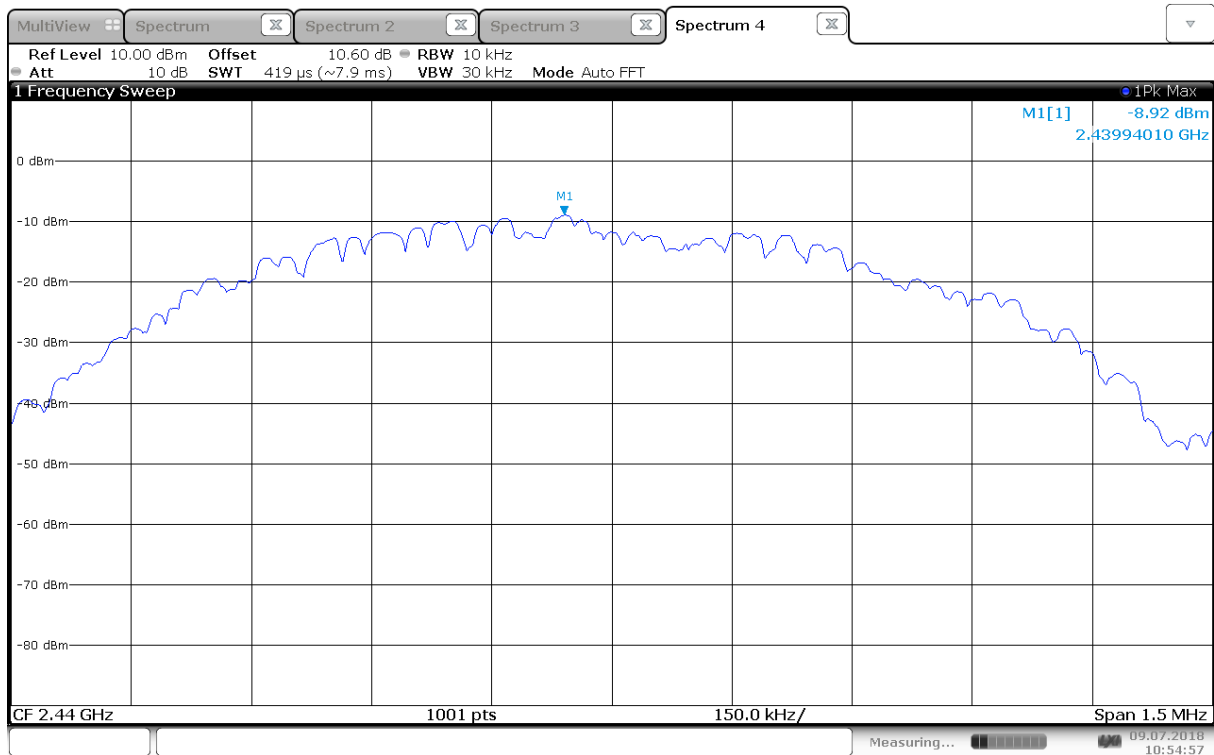
| Carrier Frequency<br>(MHz) | Power Spectral Density<br>(dBm/10 kHz) |
|----------------------------|----------------------------------------|
| 2402                       | -8.6                                   |
| 2440                       | -8.9                                   |
| 2480                       | -9.1                                   |

#### Requirements:

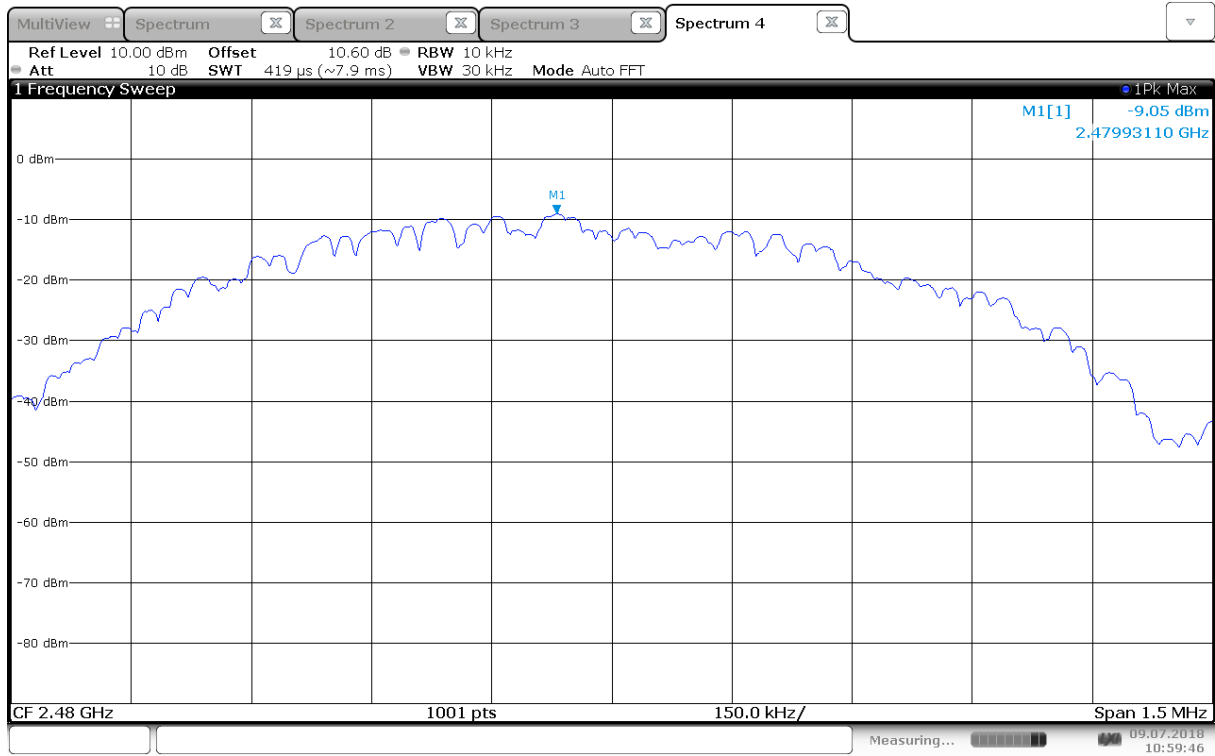
The Power Spectral Density of a Digital Transmission System shall be no greater than +8 dBm in any 3 kHz band.



Power Spectral Density, 2402 MHz



Power Spectral Density, 2440 MHz



Power Spectral Density, 2480 MHz

## 4 Measurement Uncertainty

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

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

## 5 LIST OF TEST EQUIPMENT

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

| No. | Model number  | Description          | Manufacturer    | Ref. no.    | Cal. date          | Cal. Due           |
|-----|---------------|----------------------|-----------------|-------------|--------------------|--------------------|
| 1   | FSW43         | Spectrum Analyzer    | Rohde & Schwarz | LR 1690     | 2018.01<br>2019.01 | 2019.01<br>2020.01 |
| 2   | ESU40         | Measuring Receiver   | Rohde & Schwarz | LR 1639     | 2018-01<br>2019-01 | 2019-01<br>2020-01 |
| 3   | 6810.17B      | Attenuator           | Suhner          | LR 1669     | COU                |                    |
| 4   | 6HC3000/18000 | Highpass Filter      | Trilithic       | LR 1614     | COU                |                    |
| 5   | JB3           | BiLog Antenna        | Sunol Sciences  | N-4525      | 2016.05            | 2019.05            |
| 6   | 317           | Preamplifier         | Sonoma Inst.    | LR 1687     | 2018.07            | 2019.07            |
| 7   | 8449A         | Pre-amplifier        | Hewlett Packard | LR 1322     | 2018.07            | 2019.07            |
| 8   | 3115          | Horn Antenna         | EMCO            | LR 1330     | 2016.10            | 2019.12            |
| 9   | 3117-PA       | Horn Antenna +PreAmp | EMCO            | LR 1717     | 2017-12            | 2019-12            |
| 10  | 638           | Antenna Horn         | Narda           | LR 1480     | 2010-06            | 2020-06            |
| 11  | 6032A         | Power Supply         | Hewlett Packard | LR 1051     | COU                |                    |
| 12  | CPX400S       | Power Supply         | TTI             | LR 1712     | COU                |                    |
| 14  | Model 87 V    | Multimeter           | Fluke           | LR 1597     | 2018-02            | 2020-02            |
| 15  | ENV216        | Two Line V-Network   | Rohde & Schwarz | LR 1665     | 2017-11            | 2019-11            |
| 16  | ESCI3         | Measuring Receiver   | Rohde & Schwarz | N-4259      | 2017-10            | 2019-10            |
| 17  | ST18/SMA/N/36 | RF Cable             | Suhner          | LR 1627     | COU                |                    |
| 18  | SF102/1000MM  | RF Cable             | Suhner          | SN 50113/2  | COU                |                    |
| 19  | SF102/2000MM  | RF Cable             | Suhner          | SN 500100/2 | COU                |                    |

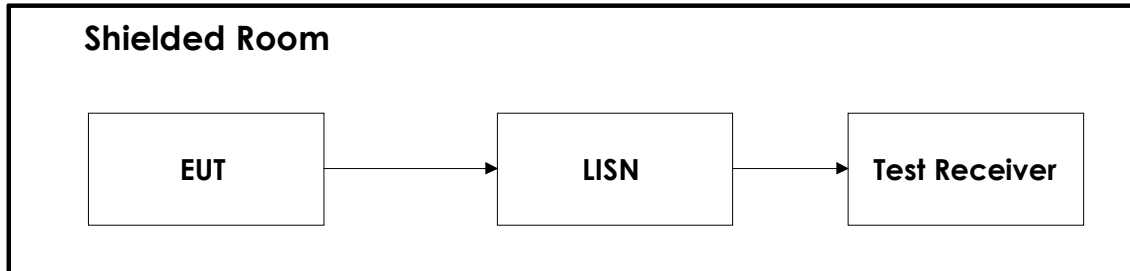
COU – Calibrate on Use

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

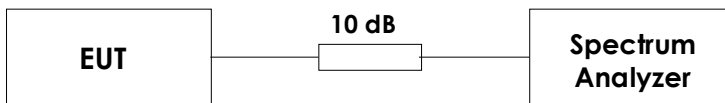
| No. | Manufacturer    | Name    | Version  | Comment                                 |
|-----|-----------------|---------|----------|-----------------------------------------|
| 1   | Rohde & Schwarz | EMC32   | 10.30.10 | Power Line Conducted test software      |
| 2   | Rohde & Schwarz | EMC32   | 10.30.10 | Radiated Emission test software         |
| 3   | Rohde & Schwarz | GPBShot | 2.7      | Screenshots from R&S Spectrum Analyzers |

## 6 BLOCK DIAGRAM

### 6.1 Power Line Conducted Emission

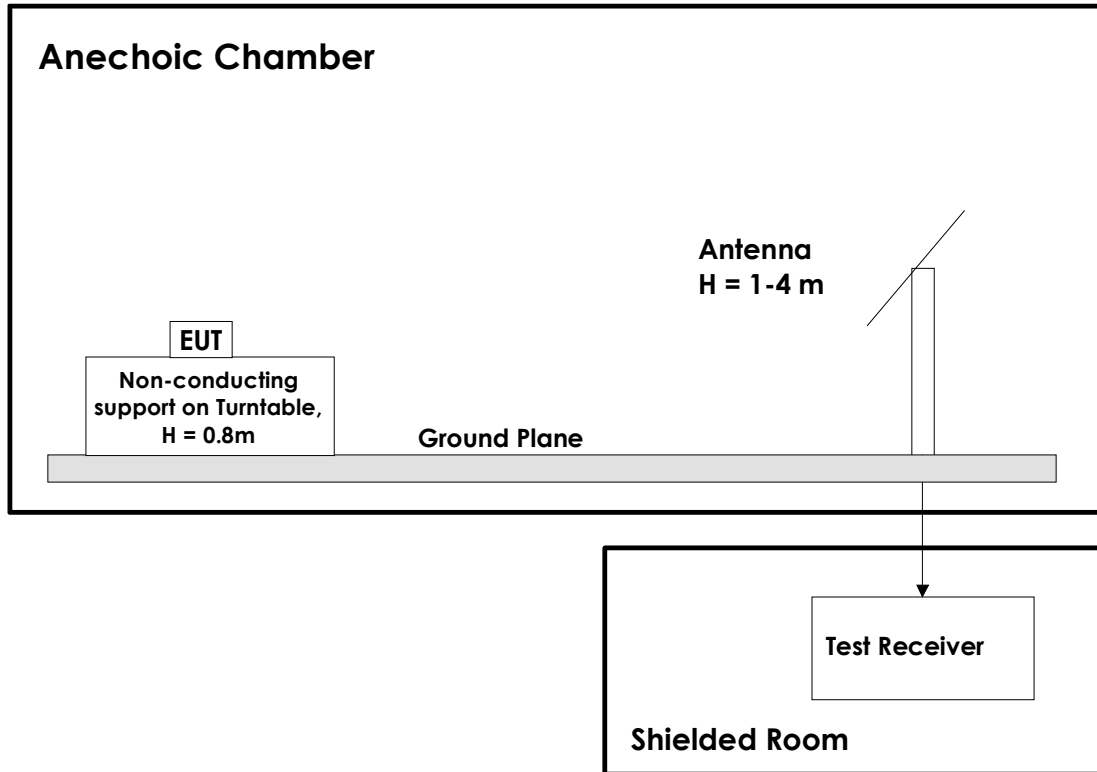


### 6.2 Conducted Tests



This test set-up is used for all Conducted tests.

### 6.3 Test Site Radiated Emission



This test setup is used for all radiated emissions tests. Measuring distance is 3m for all frequencies up to 18 GHz. Above 18 GHz measuring distance is 1m.

Emissions above 1 GHz are measured with a Spectrum Analyzer and Horn Antenna.

All measurements at 1 GHz 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, and High-Pass filter is used for all harmonics.

Above 18 GHz the test receiver is moved inside the anechoic chamber and located next to the antenna to minimize the cable loss.

### Revision history

| Version | Date       | Comment       | Sign |
|---------|------------|---------------|------|
| 1.0     | 2018.08.08 | First Edition | FS   |
|         |            |               |      |