

# Test Report

|                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Product</b>                                                                                                                                                                                                                                                                                                                                                                                     | <b>Hearing Protection with Bluetooth</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Name and address of the applicant</b>                                                                                                                                                                                                                                                                                                                                                           | <b>Husqvarna AB<br/>Drottninggatan 2<br/>SE-561 82 Huskvarna, Sweden</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Name and address of the manufacturer</b>                                                                                                                                                                                                                                                                                                                                                        | <b>Husqvarna AB<br/>Drottninggatan 2<br/>SE-561 82 Huskvarna, Sweden</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Model</b>                                                                                                                                                                                                                                                                                                                                                                                       | <b>HP500BT-1, HP500BT-2</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Rating</b>                                                                                                                                                                                                                                                                                                                                                                                      | <b>3.7Vdc max. 200mA</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Trademark</b>                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Additional information</b>                                                                                                                                                                                                                                                                                                                                                                      | <b>Bluetooth</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <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>Digital Transmission Systems (DTSS), Frequency Hopping Systems (FHSs) and<br>Licence-Exempt Local Area Network (LE-LAN) Devices                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Order number</b>                                                                                                                                                                                                                                                                                                                                                                                | <b>PRJ0014324</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Tested in period</b>                                                                                                                                                                                                                                                                                                                                                                            | <b>2022-10-18 to 2022-10-25</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>Issue date</b>                                                                                                                                                                                                                                                                                                                                                                                  | <b>2023-06-30</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <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/> Nemko Scandinavia AS<br/> Instituttveien 6<br/> 2007 Kjeller, Norway<br/> www.nemko.com </div> <div style="text-align: center;"> CAB Number:<br/> FCC: NO0001<br/> ISED: NO0470<br/> ISED No: 2040D-1 </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 Sveinsen] </div> <div style="text-align: center;"> <br/> Approved by [G.Suhanthakumar] </div> </div> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
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## Revision history

| Revision | Date       | Comment       | Sign |
|----------|------------|---------------|------|
| A        | 2023-06-30 | First edition | FS   |
|          |            |               |      |

## GENERAL REMARKS

This report applies only to the sample(s) tested. It is the manufacturer's responsibility to ensure the additional production units of this product are manufactured with identical electrical and mechanical components. The manufacturer is solely responsible for any modifications to the product that could result in non-compliance with the relevant regulations.

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Opinions expressed within this report regarding general assessments and qualifications for PASS or FAIL to the standards limits and requirements, are not part of the current accreditation. Neither are opinions expressed regarding model variants covered by the testing of this report.

## CALIBRATION

All instruments used in the tests given in this test report are calibrated and traceable to national or international standards. Between calibrations all test set-ups are controlled and verified on a regular basis by periodic checks to ensure, with 95% confidence, that the instruments remain within the calibrated levels.

## MEASUREMENT UNCERTAINTY

Measurement uncertainties are calculated or considered for all instruments and instrument set-ups used during these tests. Uncertainty figures are found in a separate clause in this report.

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## 1 INFORMATION

### 1.1 Test Item

|                                  |                                                                                                      |
|----------------------------------|------------------------------------------------------------------------------------------------------|
| Name                             | Husqvarna                                                                                            |
| Model/version                    | HP500BT-1, HP500BT-2                                                                                 |
| FCC ID                           | ZASHP500BT                                                                                           |
| ISED ID                          | 23307-HP500BT                                                                                        |
| Serial number                    | Conducted Sample: R317<br>Radiated Sample: R313                                                      |
| Hardware identity and/or version | 853505                                                                                               |
| Software identity and/or version | 0.1.0-EP1_Cert                                                                                       |
| Frequency Range                  | 2402 – 2480 MHz                                                                                      |
| Number of Channels               | 40                                                                                                   |
| Operating Modes                  | Bluetooth Low Energy <input checked="" type="checkbox"/> 1Mb <input checked="" type="checkbox"/> 2Mb |
| Type of Modulation               | GFSK                                                                                                 |
| Conducted Output Power           | 0.76 mW                                                                                              |
| Antenna Connector                | None                                                                                                 |
| Number of Antennas               | 1                                                                                                    |
| Diversity or Smart Antennas      | No                                                                                                   |
| Power Supply                     | Secondary Battery (3.7V Li-Ion)                                                                      |
| Interfaces                       | UCB-C port for charging                                                                              |

### Description of Test Item

The EUT is a Hearing Protection with Bluetooth.

This Bluetooth Low Energy part has been tested as a DTS device and fulfils all requirements DTS devices.

The models covered by this report are identical to the models HP500C-1 and HP500C-2 (FCC ID: ZASHP500 and IC: 23307-HP500), except the DECT transceiver is removed on the models HP500BT-1 and HP500BT-2.

All tests were performed on a HP500C-1 with all transceivers mounted.

### 1.2 Model Overview

| Name         | Model No  | Style        | BT/BLE | DECT | FCC ID     | IC ID         |
|--------------|-----------|--------------|--------|------|------------|---------------|
| X-COM Active | HP500C-1  | Headband     | YES    | YES  | ZASHP500   | 23307-HP500   |
|              | HP500C-2  | Helmet Mount | YES    | YES  | ZASHP500   | 23307-HP500   |
| X-SYNC       | HP500BT-1 | Headband     | YES    | NO   | ZASHP500BT | 23307-HP500BT |
|              | HP500BT-2 | Helmet Mount | YES    | NO   | ZASHP500BT | 23307-HP500BT |

The Headband and Helmet Mount models are electrically identical.

### 1.3 Normal test condition

|                      |                                    |
|----------------------|------------------------------------|
| Temperature:         | 20 - 24 °C                         |
| Relative humidity:   | 20 - 50 %                          |
| Normal test voltage: | 3.7 V DC (Nominal Battery Voltage) |

The values are the limit registered during the test period.

### 1.4 Test Engineer

Frode Sveinsen

### 1.5 Antenna Requirement

|                                                                                                                     |                              |                                        |
|---------------------------------------------------------------------------------------------------------------------|------------------------------|----------------------------------------|
| Does the EUT have detachable antenna(s)?                                                                            | <input type="checkbox"/> YES | <input checked="" type="checkbox"/> NO |
| If detachable, is the antenna connector(s) non-standard?                                                            | <input type="checkbox"/> YES | <input type="checkbox"/> NO            |
| The tested equipment has only integral antennas. Conducted tests were performed with a temporary antenna connector. |                              |                                        |

Requirement: FCC 15.203, 15.204

### 1.6 EUT Operating Modes

|                        |                                                                                                                                                                        |
|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Operating modes        | Radiated Emissions and Power Line Conducted Emissions were performed with the EUT set to transmit at the channel with the highest output power as worst-case scenario. |
| Additional information | Power Level: PL3                                                                                                                                                       |

### 1.7 Comments

All measurements were done with the EUT powered by a fully charged battery.

All ports were populated during spurious emission measurements.

## 2 TEST REPORT SUMMARY

### 2.1 General

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

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

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

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

|                                                     |                                                     |
|-----------------------------------------------------|-----------------------------------------------------|
| <input checked="" type="checkbox"/> New Submission  | <input checked="" type="checkbox"/> Production Unit |
| <input type="checkbox"/> Class II Permissive Change | <input type="checkbox"/> Pre-production Unit        |
| DTS Equipment Code                                  | <input type="checkbox"/> Family Listing             |

### 2.2 Test Summary

| Name of test                           | FCC Part 15 reference               | RSS-247 Issue 2,<br>RSS-GEN Issue 5<br>reference | ANSI C63.10-2013<br>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          | 15.107(a)<br>15.207(a)              | 7.2 / 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 (1) (RSS-247)                                | 11.8 Option 2                             | Complies |
| Peak Power Output                      | 15.247(b)                           | 5.4 (RSS-247)                                    | 11.9.1.1                                  | Complies |
| Power Spectral Density                 | 15.247(d)                           | 5.2 (2) (RSS-247)                                | 11.10.2 PKPSD (DTS)                       | Complies |
| Spurious Emissions (Antenna Conducted) | 15.247(c)                           | 5.5 (RSS-247)                                    | 6.7<br>11.11 (DTS)                        | Complies |
| Spurious Emissions (Radiated)          | 15.247(c)<br>15.109(a)<br>15.209(a) | 5.5 (RSS-247)<br>7.3 (RSS-GEN)<br>8.9 (RSS-GEN)  | 6.3, 6.5, 6.6, 6.10<br>11.12, 11.13 (DTS) | Complies |

### 3 TEST RESULTS

#### 3.1 Power Line Conducted Emissions

FCC Part 15.207

ISED RSS-GEN Issue 5, Clause 7.2 / 8.8

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

Test Results: Complies

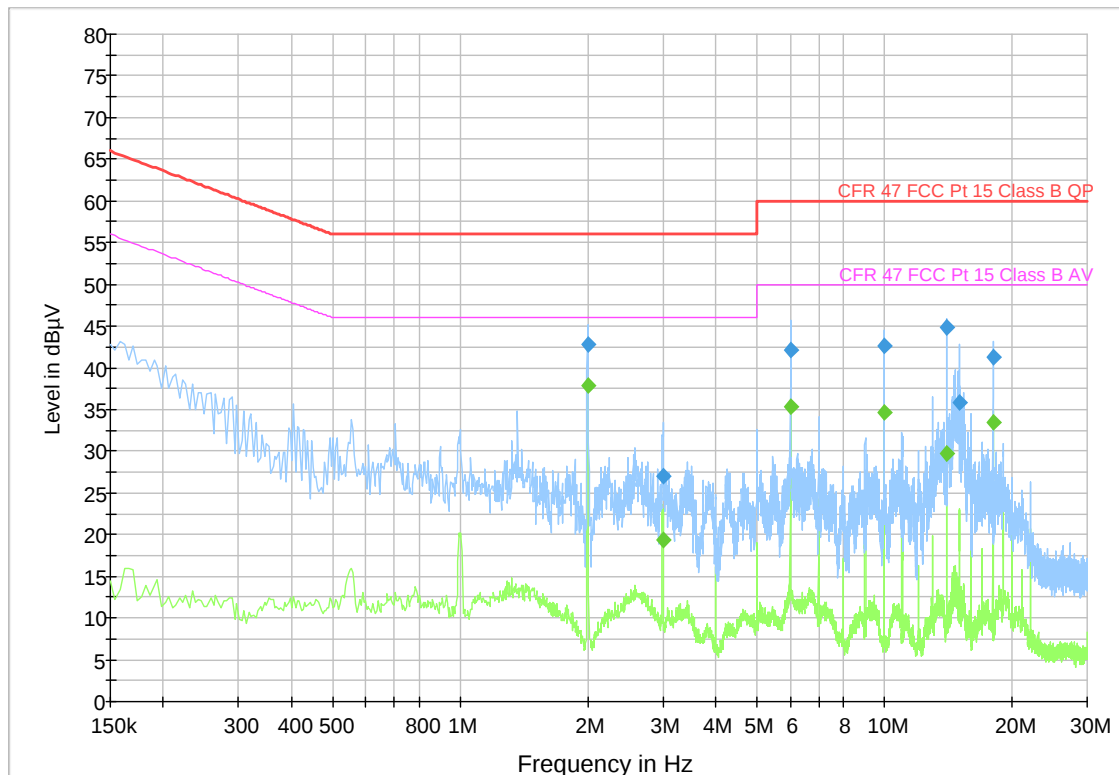
Measurement Data: EUT Charging from USB Charger, 120V 60Hz.

See attached plots.

Highest measured value (L1 and N):

| Frequency (MHz) | QuasiPeak (dB $\mu$ V) | Average (dB $\mu$ V) | Limit (dB $\mu$ V) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Line | Filter | Corr. (dB) |
|-----------------|------------------------|----------------------|--------------------|-------------|-----------------|-----------------|------|--------|------------|
| 1.998000        | 42.87                  | ---                  | 56.00              | 13.13       | 15000.0         | 9.000           | L1   | OFF    | 9.7        |
| 2.002000        | ---                    | 37.82                | 46.00              | 8.18        | 15000.0         | 9.000           | L1   | OFF    | 9.7        |
| 6.002000        | ---                    | 35.29                | 50.00              | 14.71       | 15000.0         | 9.000           | L1   | OFF    | 9.8        |
| 6.002000        | 42.07                  | ---                  | 60.00              | 17.93       | 15000.0         | 9.000           | N    | OFF    | 9.6        |
| 10.002000       | ---                    | 34.67                | 50.00              | 15.33       | 15000.0         | 9.000           | N    | OFF    | 9.6        |
| 10.002000       | 42.65                  | ---                  | 60.00              | 17.35       | 15000.0         | 9.000           | N    | OFF    | 9.6        |
| 14.002000       | 44.86                  | ---                  | 60.00              | 15.14       | 15000.0         | 9.000           | N    | OFF    | 9.7        |
| 18.002000       | ---                    | 33.53                | 50.00              | 16.47       | 15000.0         | 9.000           | N    | OFF    | 9.7        |
| 18.002000       | 41.19                  | ---                  | 60.00              | 18.81       | 15000.0         | 9.000           | L1   | OFF    | 9.9        |

Full Spectrum



## 3.2 Occupied Bandwidth (99% BW)

ISED Canada RSS-GEN Issue 5, Clause 6.7

Measurement procedure: ANSI C63.10-2013 Clause 6.9.2

Test Results: Complies

Measurement Data:

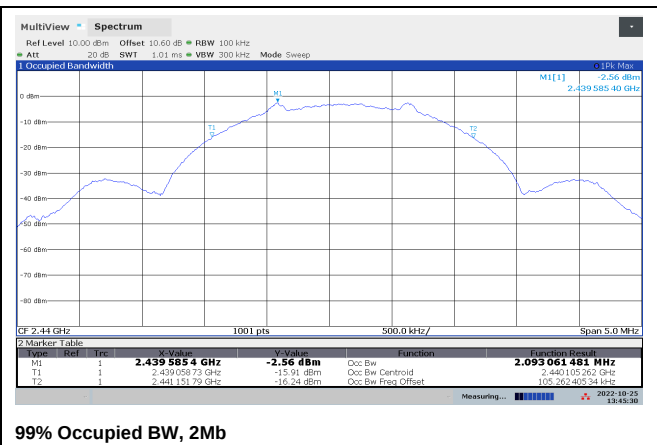
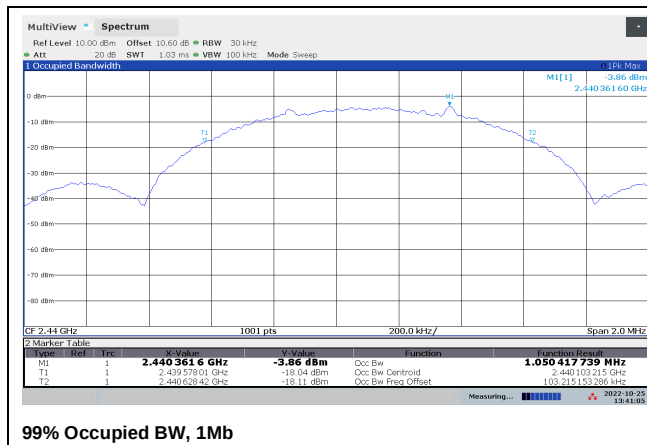
| Carrier Frequency, Data Rate | Occupied Bandwidth (99% BW) |
|------------------------------|-----------------------------|
| 2440 MHz, 1Mb                | 1.05 MHz                    |
| 2440 MHz, 2Mb                | 2.09 MHz                    |

Occupied Bandwidth is the same for all channels.

See attached plots.

### Requirements:

No requirements for Digital Transmission Systems.



### 3.3 DTS Bandwidth

FCC Part 15.247 (a)(2)

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

Measurement procedure: ANSI C63.10-2013 Clause 11.8

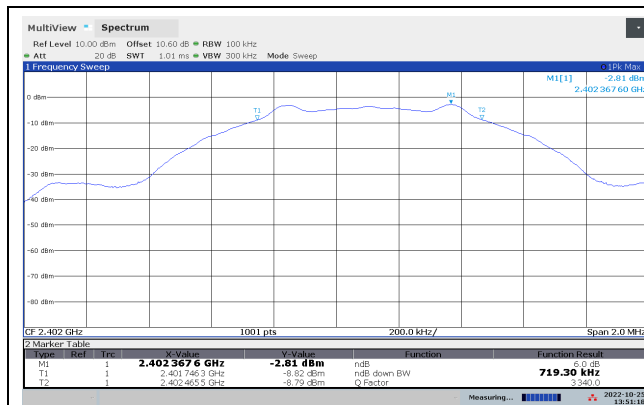
Test Results: Complies

Measurement Data:

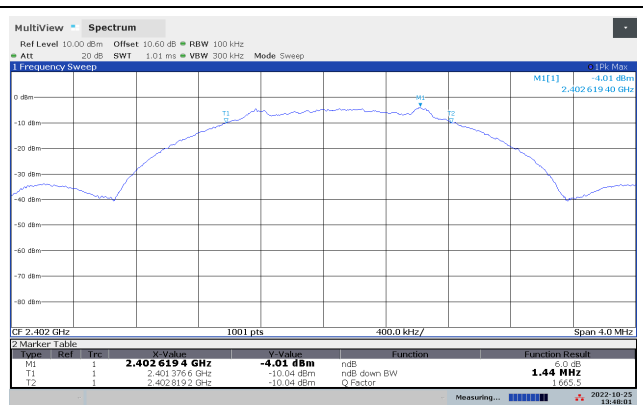
| Bitrate | Measured DTS Bandwidth |          |          |
|---------|------------------------|----------|----------|
|         | 2402 MHz               | 2440 MHz | 2480 MHz |
| 1 Mb    | 719 kHz                | 721 kHz  | 719 kHz  |
| 2 Mb    | 1.44 MHz               | 1.48 MHz | 1.45 MHz |

Power supply variation within 85 % to 115% of nominal value has no influence on measured value.

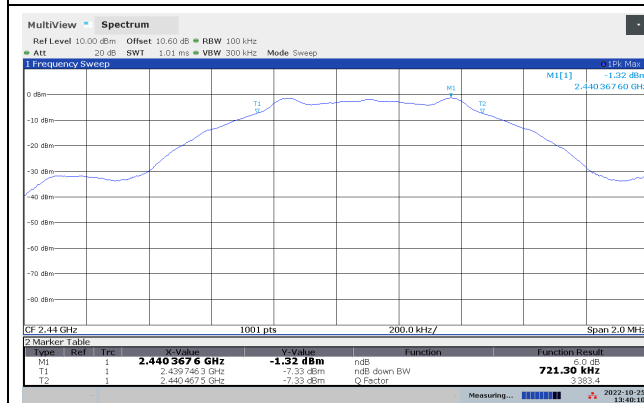
| Frequency Band  | Requirement for systems using Digital Modulation      |
|-----------------|-------------------------------------------------------|
| 902-928 MHz     | The minimum 6 dB bandwidth shall be at least 500 kHz. |
| 2400-2483.5 MHz |                                                       |
| 5725-5850 MHz   |                                                       |



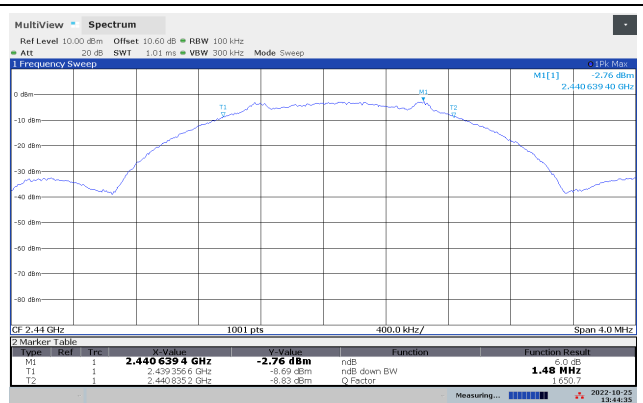
DTS BW, 2402 MHz, 1Mb



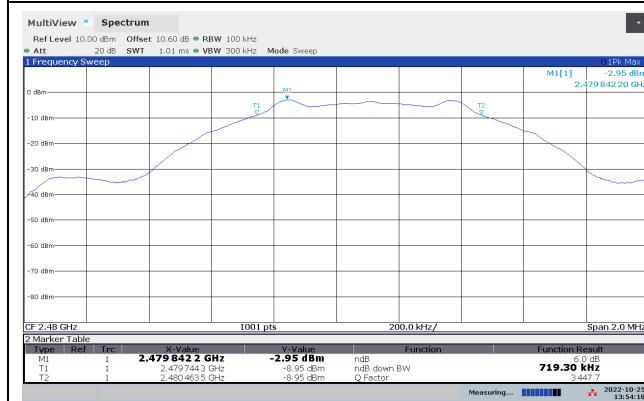
DTS BW, 2402 MHz, 2Mb



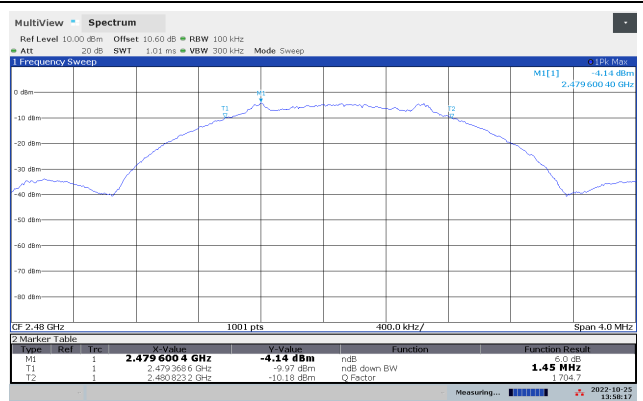
DTS BW, 2440 MHz, 1Mb



DTS BW, 2440 MHz, 2Mb



DTS BW, 2480 MHz, 1Mb



DTS BW, 2480 MHz, 2Mb

### 3.4 Peak Power Output

FCC Part 15.247 (b)

ISED Canada RSS-247 Issue 2, Clause 5.4

Measurement procedure: ANSI C63.10-2013 Clause 11.9.1.2

Test Results: Complies

#### Measurement Data:

| Carrier Frequency | Peak Conducted Power, dBm |      | Field Strength, dBμV/m @3m | Peak EIRP, dBm | Antenna Gain, dBi |
|-------------------|---------------------------|------|----------------------------|----------------|-------------------|
|                   | 1Mb                       | 2Mb  | 1Mb                        | 1Mb            |                   |
| 2402 MHz          | -2.7                      | -2.6 | 99.9                       | 4.7            | 7.4               |
| 2440 MHz          | -1.3                      | -1.2 | 100.4                      | 5.2            | 6.4               |
| 2480 MHz          | -2.8                      | -2.8 | 99.2                       | 4.0            | 6.8               |

| Carrier Frequency | Peak Conducted Power, mW |      |
|-------------------|--------------------------|------|
|                   | 1Mb                      | 2Mb  |
| 2402 MHz          | 0.54                     | 0.55 |
| 2440 MHz          | 0.75                     | 0.76 |
| 2480 MHz          | 0.52                     | 0.53 |

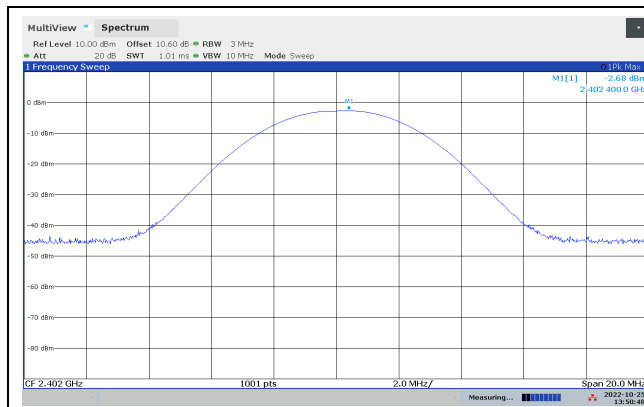
Output Power reported is Maximum Peak Power.

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

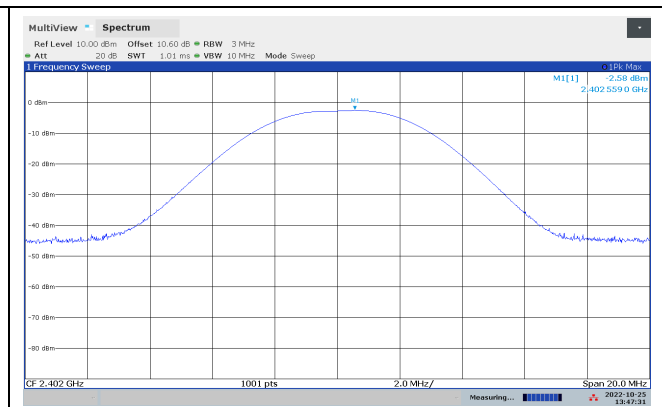
See attached plots.

Antenna Gain is above 6 dBi, maximum allowed output power is reduced by the amount in dB that exceeds 6 dBi.

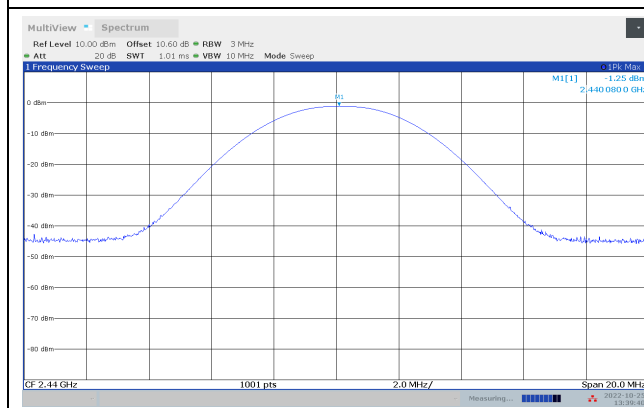
| Requirements for Digital Modulation systems                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| As an alternative to a peak power measurement, compliance with the 1 Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the <i>maximum conducted output power</i> is the highest total transmit power occurring in any mode. |
| Maximum allowed Antenna Gain                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 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.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |



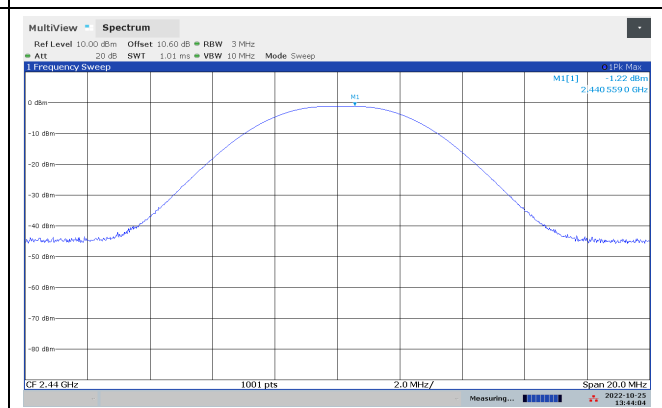
Peak Power, 2402 MHz, 1Mb



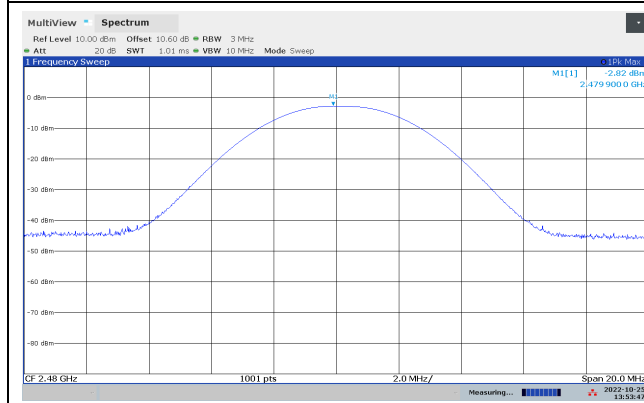
Peak Power, 2402 MHz, 2Mb



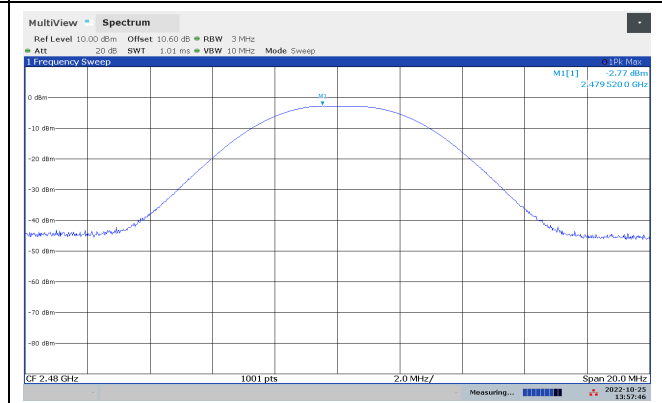
Peak Power, 2440 MHz, 1Mb



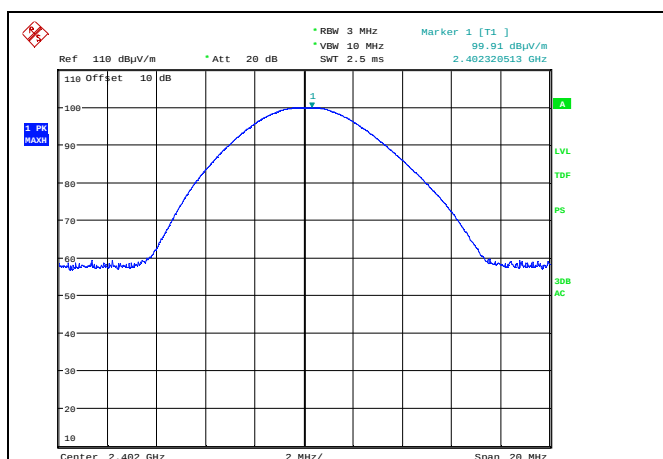
Peak Power, 2440 MHz, 2Mb



Peak Power, 2480 MHz, 1Mb

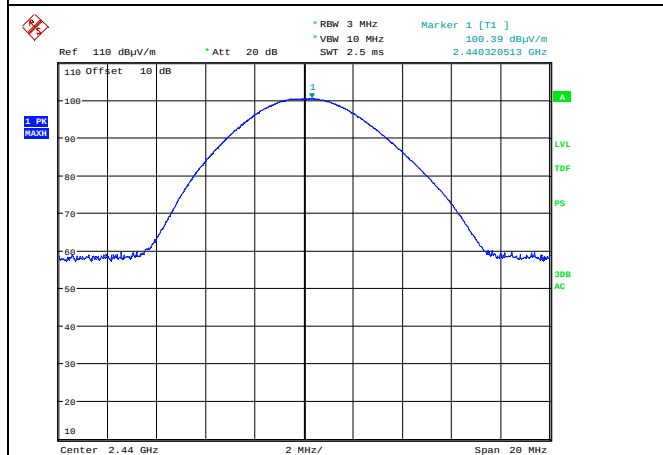


Peak Power, 2480 MHz, 2Mb



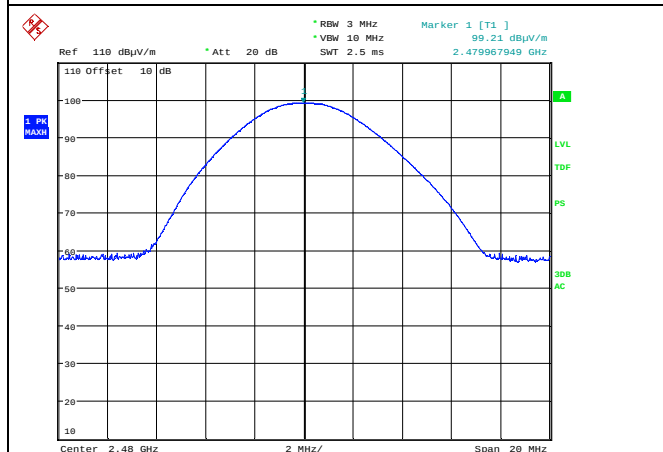
Date: 18.OCT.2022 12:48:47

#### Maximum Peak EIRP, 2402 MHz, 1Mb



Date: 18.OCT.2022 12:25:17

#### Maximum Peak EIRP, 2440 MHz, 1Mb



Date: 18.OCT.2022 12:19:24

#### Maximum Peak EIRP, 2480 MHz, 1Mb

### 3.5 Conducted Emissions at Antenna Connector

FCC Part 15.247 (d)

ISED Canada RSS-247 Issue 2, Clause 5.5

Measurement procedure: ANSI C63.10-2013 Clause 11.11

Test Results: Complies

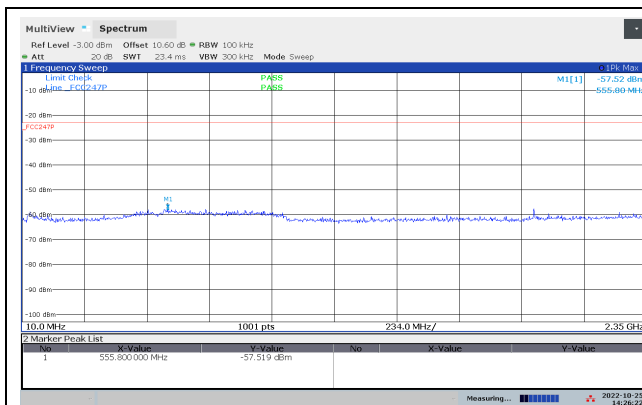
#### Measurement Data:

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

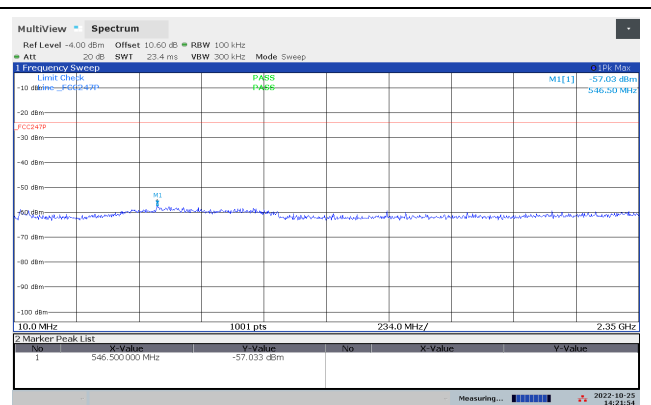
Measured with Peak Detector

RF conducted power to 25 GHz: see attached plots.

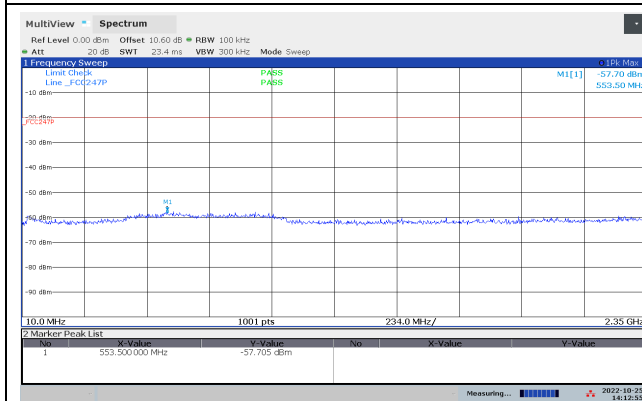
| Requirements for all systems                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                           |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------|
| Peak measurement                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | RMS averaging (alternative measurement)                   |
| 20 dB or more below carrier measured in 100 kHz bandwidth                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 30 dB or more below carrier measured in 100 kHz bandwidth |
| <p>In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.</p> <p>Attenuation below the general limits specified in § 15.209(a) is not required.</p> |                                                           |



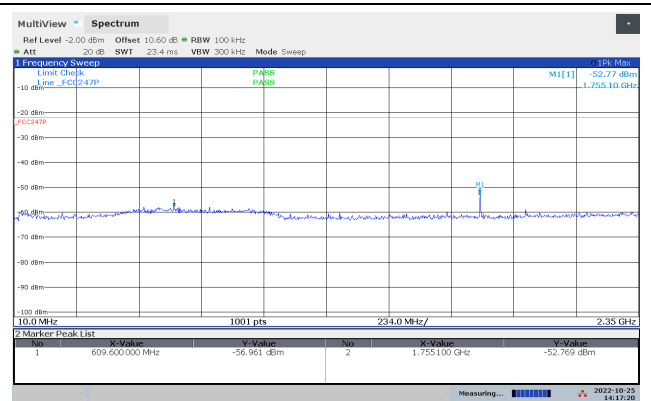
Conducted Emissions 10-2350 MHz, 2402 MHz, 1Mb



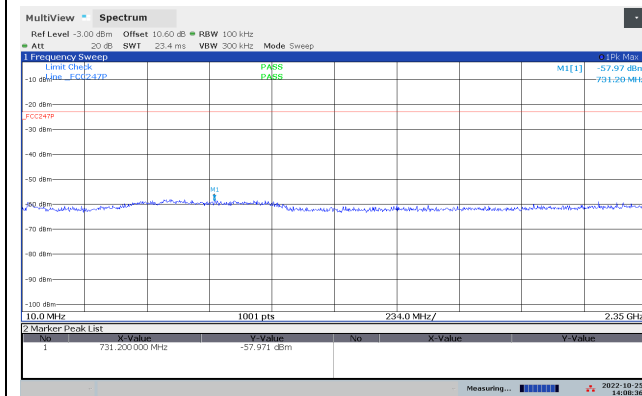
Conducted Emissions 10-2350 MHz, 2402 MHz, 2Mb



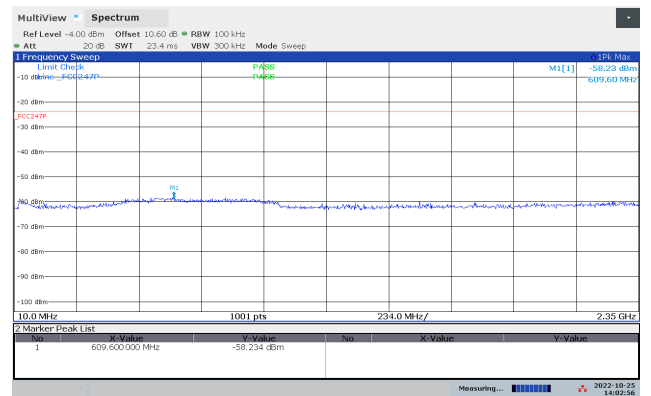
Conducted Emissions 10-2350 MHz, 2440 MHz, 1Mb



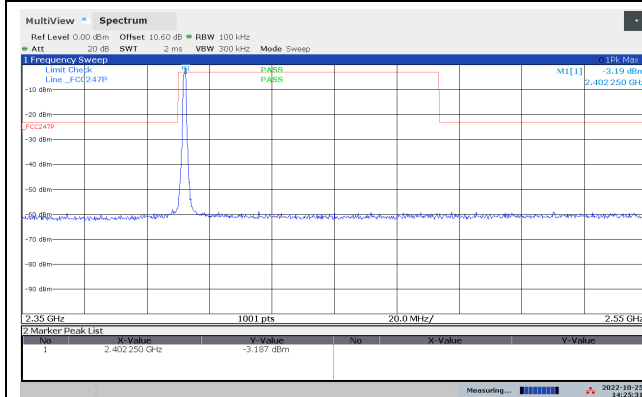
Conducted Emissions 10-2350 MHz, 2440 MHz, 2Mb



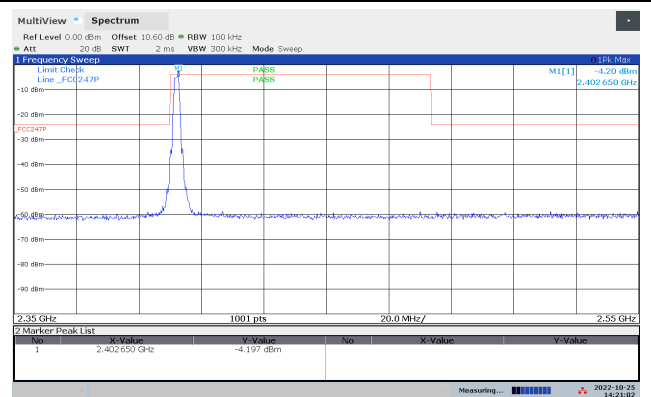
Conducted Emissions 10-2350 MHz, 2480 MHz, 1Mb



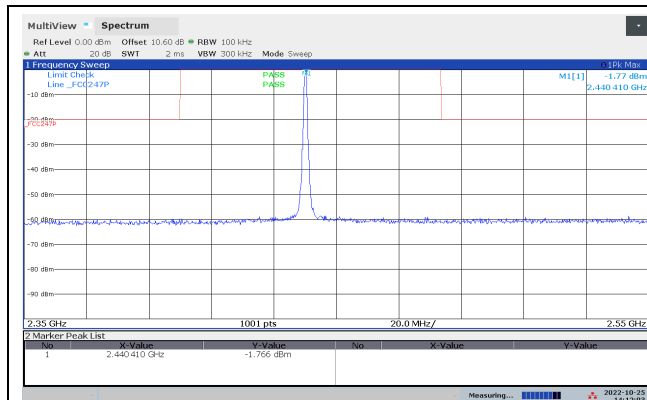
Conducted Emissions 10-2350 MHz, 2480 MHz, 2Mb



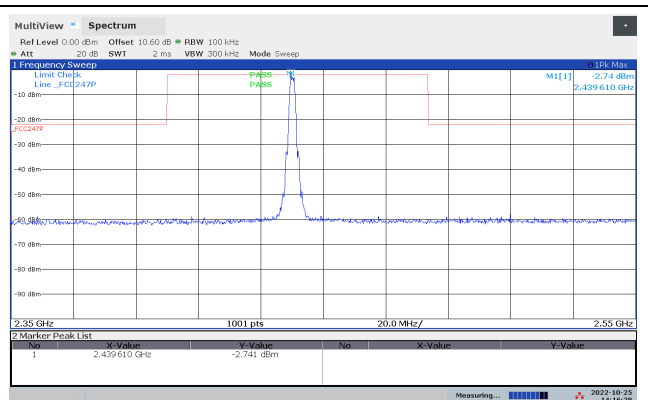
Conducted Emissions 2350-2550 MHz, 2402 MHz, 1Mb



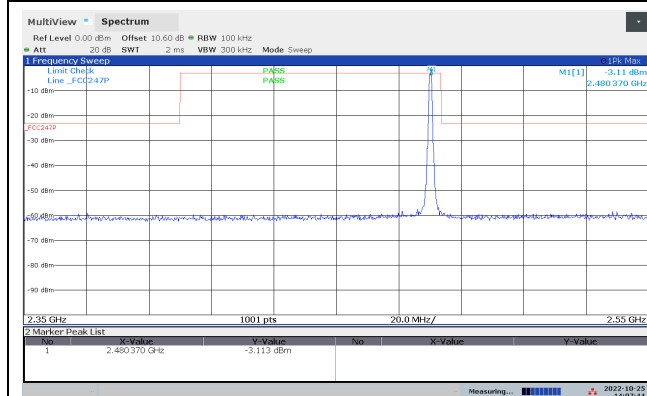
Conducted Emissions 2350-2550 MHz, 2402 MHz, 2Mb



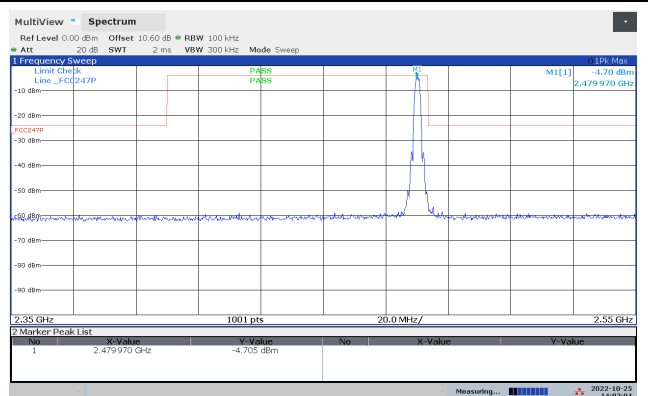
Conducted Emissions 2350-2550 MHz, 2440 MHz, 1Mb



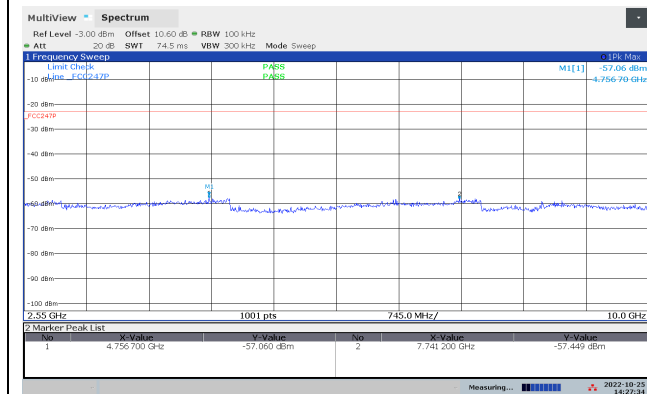
Conducted Emissions 2350-2550 MHz, 2440 MHz, 2Mb



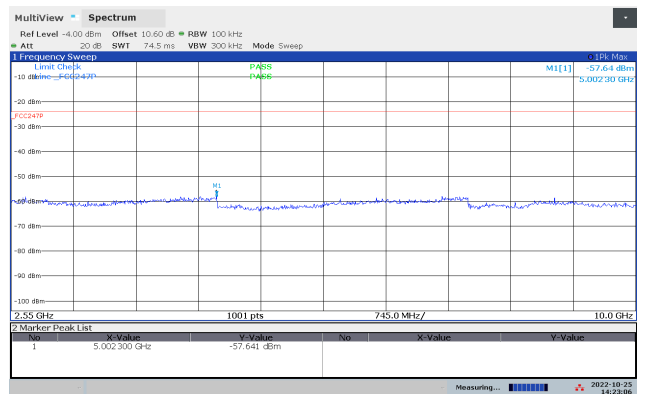
Conducted Emissions 2350-2550 MHz, 2480 MHz, 1Mb



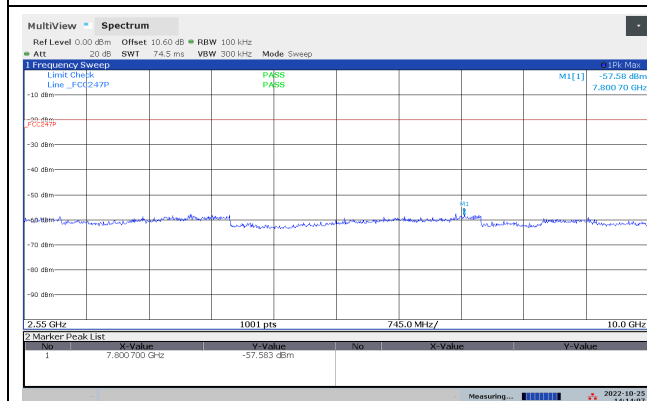
Conducted Emissions 2350-2550 MHz, 2480 MHz, 2Mb



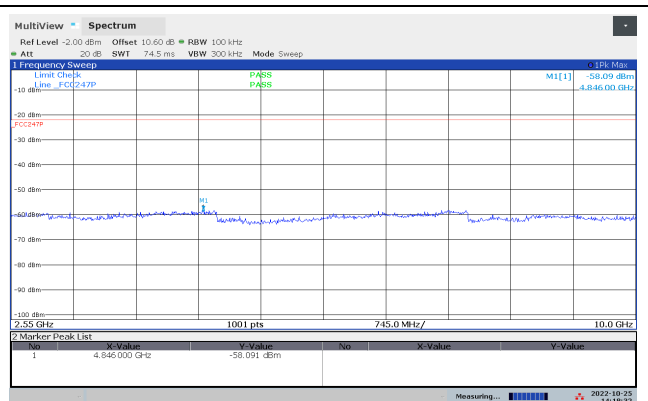
Conducted Emissions 2.55-10 GHz, 2402 MHz, 1Mb



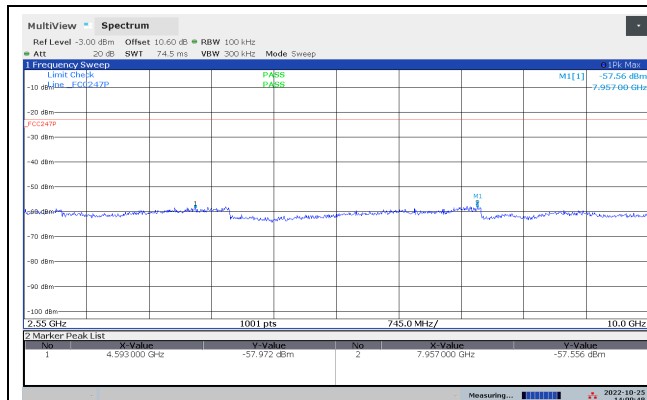
Conducted Emissions 2.55-10 GHz, 2402 MHz, 2Mb



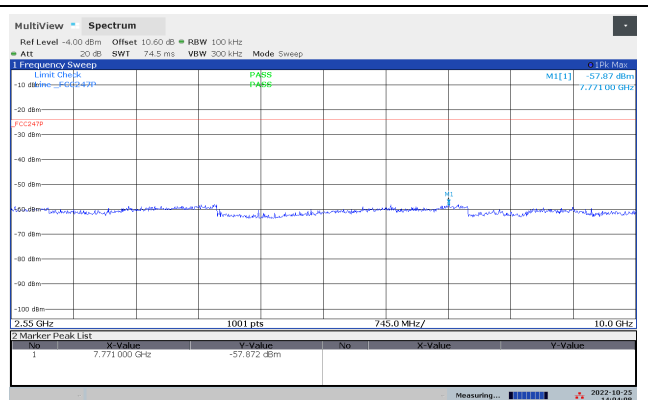
Conducted Emissions 2.55-10 GHz, 2440 MHz, 1Mb



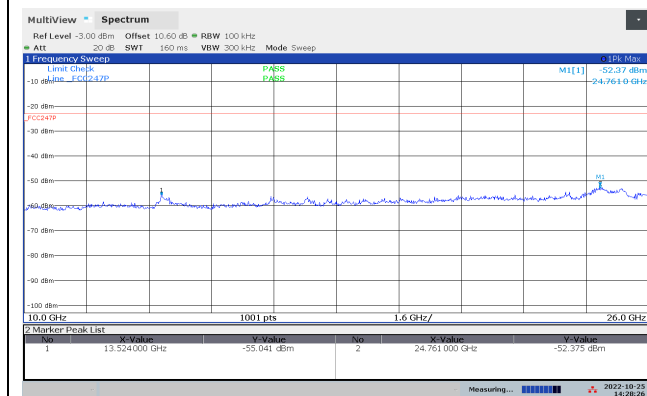
Conducted Emissions 2.55-10 GHz, 2440 MHz, 2Mb



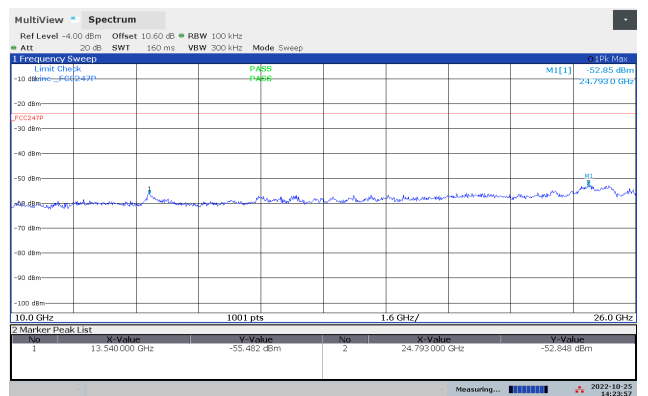
Conducted Emissions 2.55-10 GHz, 2480 MHz, 1Mb



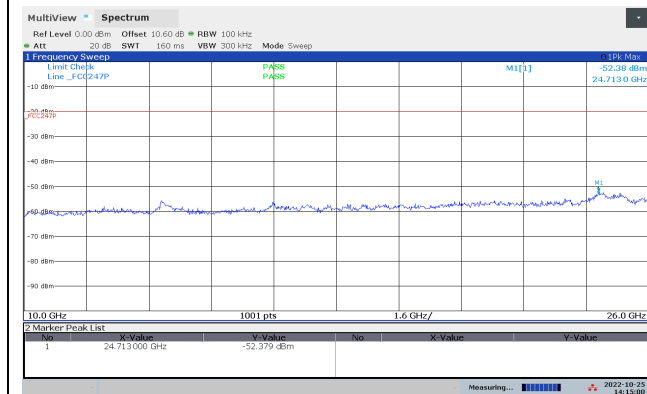
Conducted Emissions 2.55-10 GHz, 2480 MHz, 2Mb



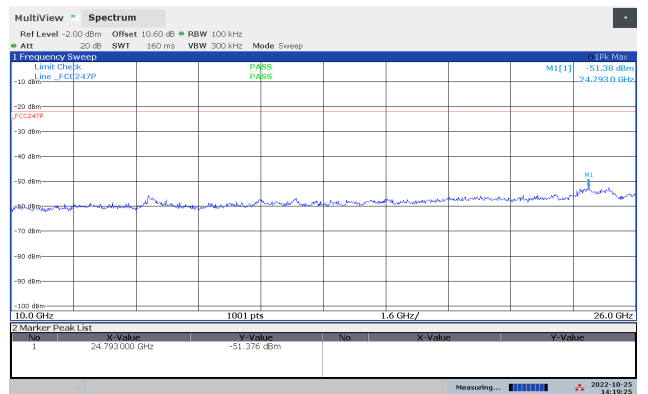
Conducted Emissions 10-26 GHz, 2402 MHz, 1Mb



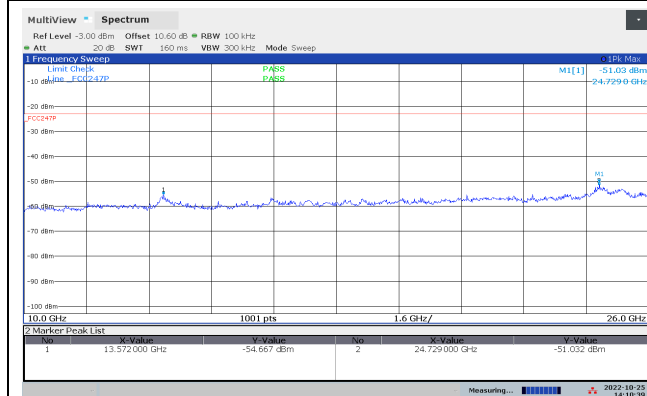
Conducted Emissions 10-26 GHz, 2402 MHz, 2Mb



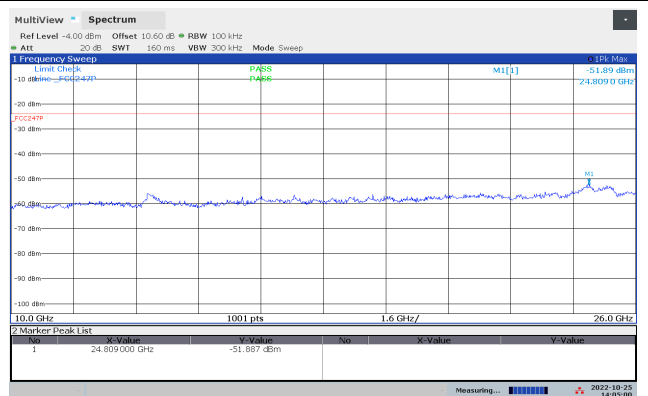
Conducted Emissions 10-26 GHz, 2440 MHz, 1Mb



Conducted Emissions 10-26 GHz, 2440 MHz, 2Mb



Conducted Emissions 10-26 GHz, 2480 MHz, 1Mb



Conducted Emissions 10-26 GHz, 2480 MHz, 2Mb

### 3.6 Restricted Bands of operation

Restricted Bands of operation for FCC and ISSED are defined in FCC Part 15.205 and ISSED RSS-GEN, Issue 5 clause 8.10.

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

| FCC (MHz)                           | ISSED (MHz)        | FCC (GHz)                            | ISSED (GHz)       |
|-------------------------------------|--------------------|--------------------------------------|-------------------|
| 0.090-0.110                         |                    | <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                        |                   |
|                                     | <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><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                             |                    |                                      |                   |

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

### 3.7 Radiated Emissions, Band Edge

FCC Part 15.209 (a)

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

Measurement procedure: ANSI C63.10-2013 Clause 11.12

Test Results: Complies

Measurement Data:

| Peak Detector          |                                  |            |       |        |      |
|------------------------|----------------------------------|------------|-------|--------|------|
| Modulation and Bitrate | Measured field strength (dBμV/m) |            | Limit | Margin |      |
|                        | 2390 MHz                         | 2483.5 MHz | dB    | dB     |      |
| GFSK, 1Mb              | 53.2                             | 60.4       | 74    | 20.8   | 13.6 |
| GFSK, 2Mb              | 55.3                             | 64.7       | 74    | 18.7   | 9.3  |

| Average Detector       |                                  |            |       |        |     |
|------------------------|----------------------------------|------------|-------|--------|-----|
| Modulation and Bitrate | Measured field strength (dBμV/m) |            | Limit | Margin |     |
|                        | 2390 MHz                         | 2483.5 MHz | dB    | dB     |     |
| GFSK, 1Mb              | 40.3                             | 47.5       | 54    | 13.7   | 6.5 |
| GFSK, 2Mb              | 36.9                             | 46.3       | 54    | 17.1   | 7.1 |

Average values were measured using Peak Detector and corrected for Duty Cycle.

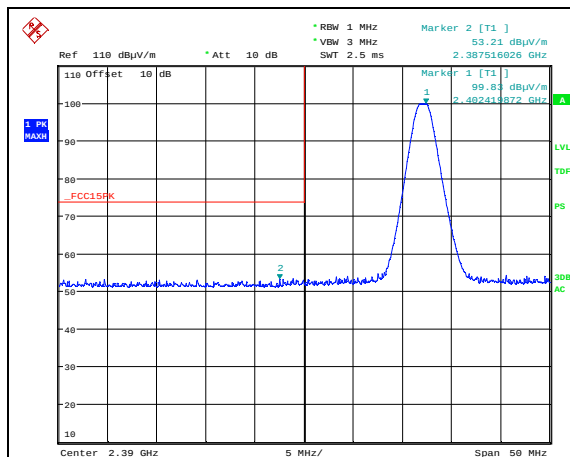
See attached plots.

DC Corrections Factor Actual Use

| Bitrate | Packet Length | Frame Length | # Control Channels | # Hopping Channels | DC Correction Factor |
|---------|---------------|--------------|--------------------|--------------------|----------------------|
| 1Mb     | 393 μs        | 626 μs       | 3                  | 37                 | 12.9 dB              |
| 2Mb     | 208 μs        | 626 μs       | 3                  | 37                 | 18.4 dB              |

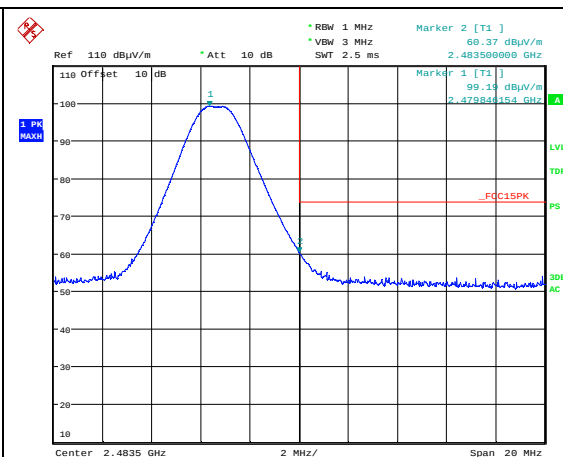
DC During Measurement =  $-20 \cdot \log(\text{Packet Length} / \text{Frame Length})$

DC During Actual Use =  $20 \cdot \log((\text{packet length} / (\text{\#Control Channels} \cdot \text{Frame Length})) + (\text{packet length} / (\text{\#Hopping channels} \cdot \text{Frame Length})))$



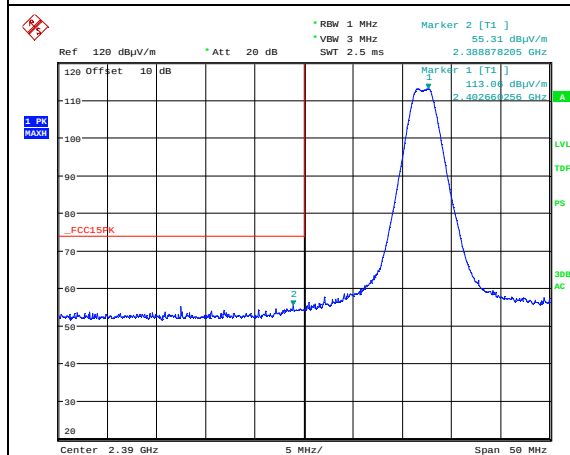
Date: 18.OCT.2022 12:50:22

Lower Band Edge, 2402 MHz, 1Mb, Peak



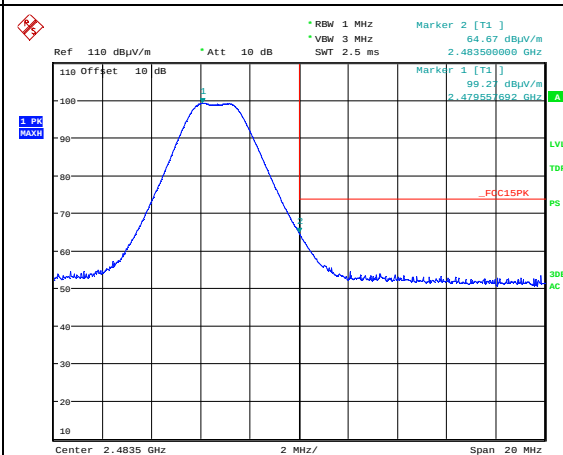
Date: 18.OCT.2022 12:18:40

Upper Band Edge, 2480 MHz, 1Mb, Peak



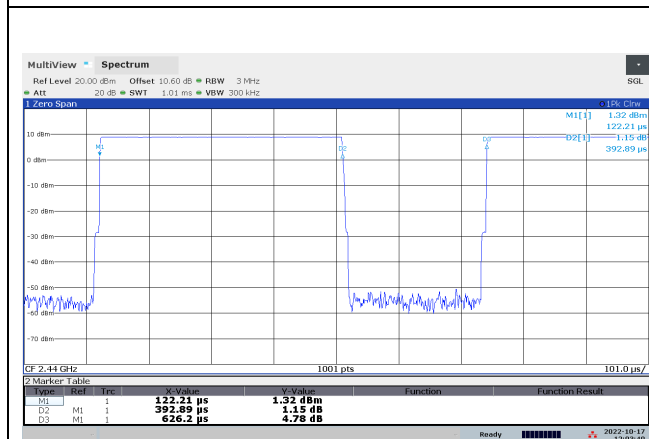
Date: 18.OCT.2022 11:17:41

Lower Band Edge, 2402 MHz, 2Mb, Peak

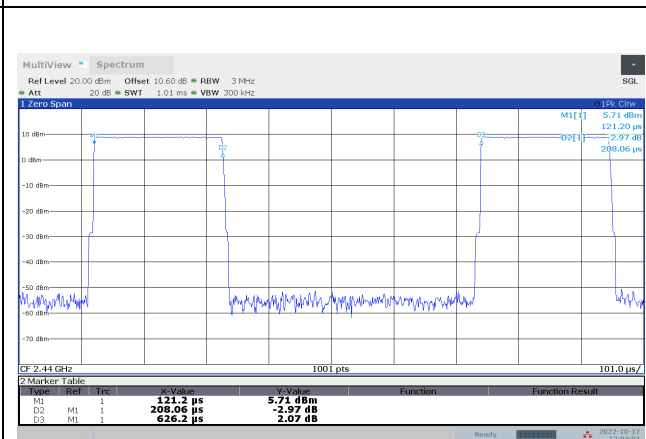


Date: 18.OCT.2022 12:21:48

Upper Band Edge, 2480 MHz, 2Mb, Peak



Frame Length 1Mb



Frame Length 2Mb

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

FCC Part 15.209 (a)

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

Measurement procedure: ANSI C63.10-2013 Clause 11.12

Test Results: Complies

#### Measurement Data:

Detector: Peak

Measuring distance 3 m

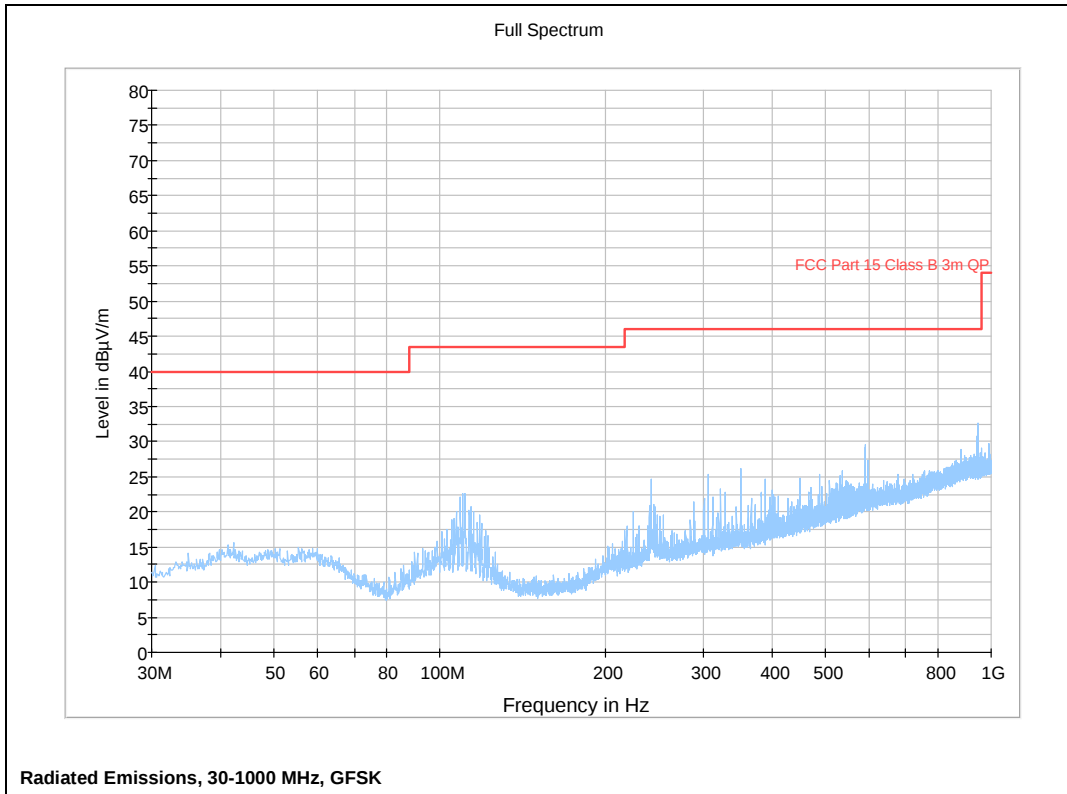
Tested in test mode with transmitter active

| Measured Frequency (MHz) | Carrier Frequency (MHz) | Modulation | Measured Emission (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
|--------------------------|-------------------------|------------|----------------------------|----------------|-------------|
| 30 – 88                  | 2440                    | GFSK       | < 20                       | 40.0           | > 20        |
| 88 – 216                 | 2440                    | GFSK       | < 23.5                     | 43.5           | > 20        |
| 216 – 960                | 2440                    | GFSK       | < 36                       | 46.0           | > 10        |
| 960 – 1000               | 2440                    | GFSK       | < 34                       | 54.0           | > 20        |

See attached plots.

#### Requirements/Limit

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



### 3.9 Radiated Emissions, 1 – 26 GHz

FCC Part 15.209 (a)

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

Measurement procedure: ANSI C63.10-2013 Clause 11.12

Test Results: Complies

Measurement Data:

Measuring distance: 3m (1 – 18 GHz)

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

| Carrier freq.<br>(MHz) | Measured<br>Frequency<br>(GHz) | Modulation | Measured Emission<br>(dBµV/m) |         | Limit<br>(dBµV/m) |    | Margin<br>(dB) |      |
|------------------------|--------------------------------|------------|-------------------------------|---------|-------------------|----|----------------|------|
|                        |                                |            | Peak                          | Average | Pk                | Av | Pk             | Av   |
| 2480                   | 9920                           | GFSK       | 55.8                          | 42.9    | 74                | 54 | 18.2           | 11.1 |
|                        | 14880                          | GFSK       | 58.5                          | 45.6    | 74                | 54 | 15.5           | 8.4  |

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

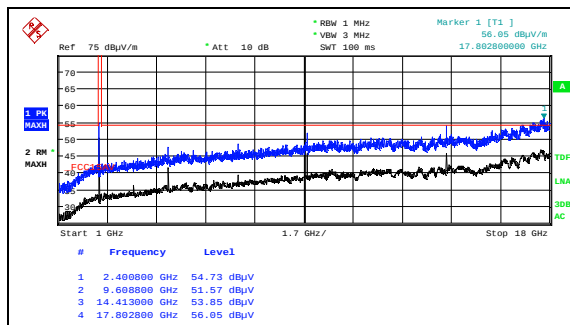
Antenna factor, amplifier gain and cable loss are included in spectrum analyzer "Transducer factor".

Average values are found by using peak values and correcting for duty cycle.

See plots.

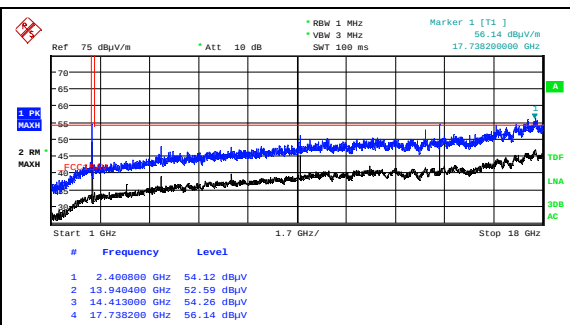
#### Requirements/Limit

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



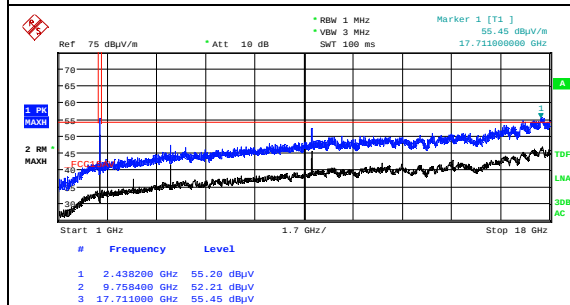
Date: 18.OCT.2022 15:37:06

### Radiated Emissions 1 - 18 GHz, 2402 MHz, 1Mb, HP



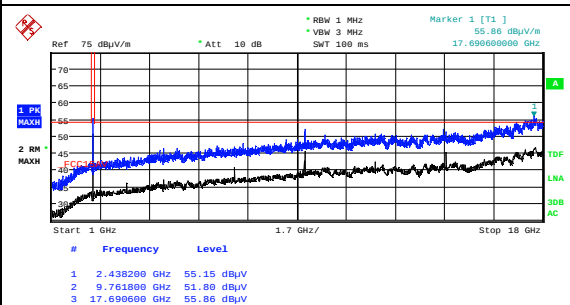
Date: 18.OCT.2022 15:35:04

### VP



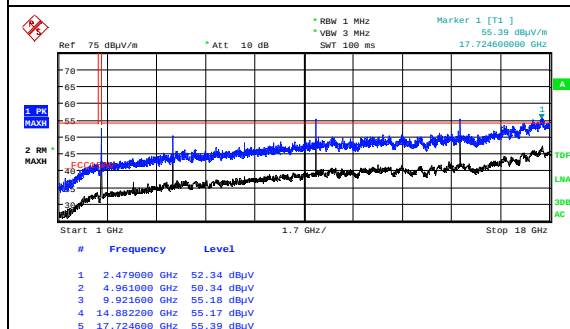
Date: 18.OCT.2022 15:26:15

### Radiated Emissions 1 - 18 GHz, 2440 MHz, 1Mb, HP



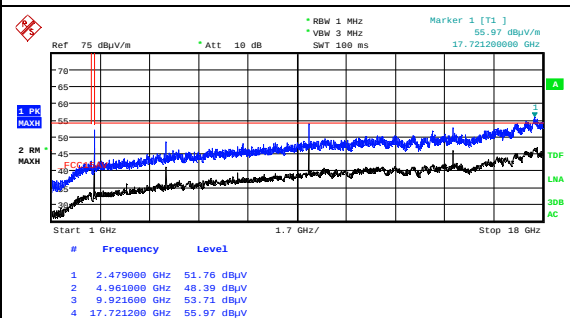
Date: 18.OCT.2022 15:24:19

### VP



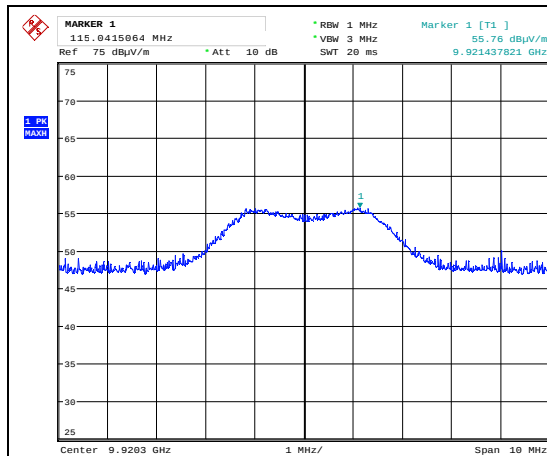
Date: 18.OCT.2022 15:43:33

### Radiated Emissions 1 - 18 GHz, 2480 MHz, 1Mb, HP



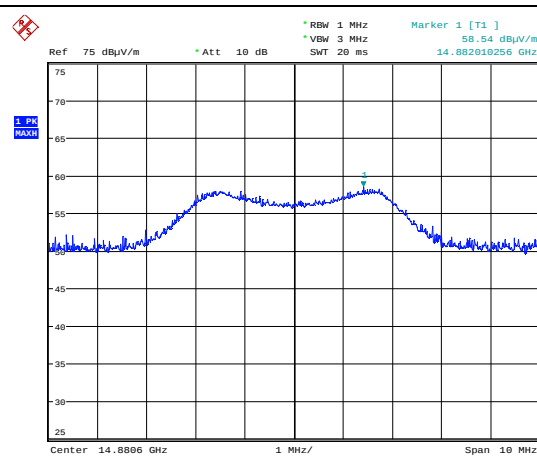
Date: 18.OCT.2022 15:41:31

### VP



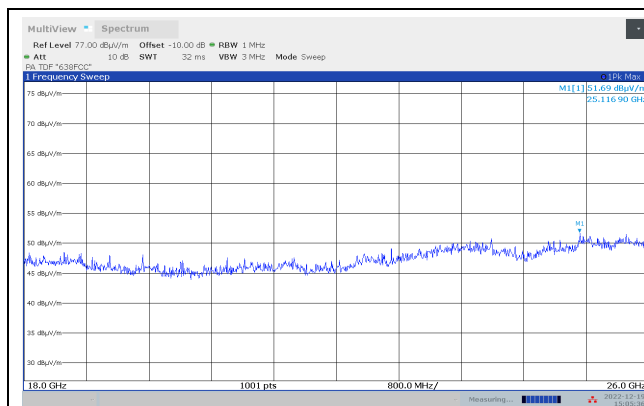
Date: 18.OCT.2022 15:55:49

Spurious 9920 MHz, 2480 MHz, 1Mb, Max: HP, Peak

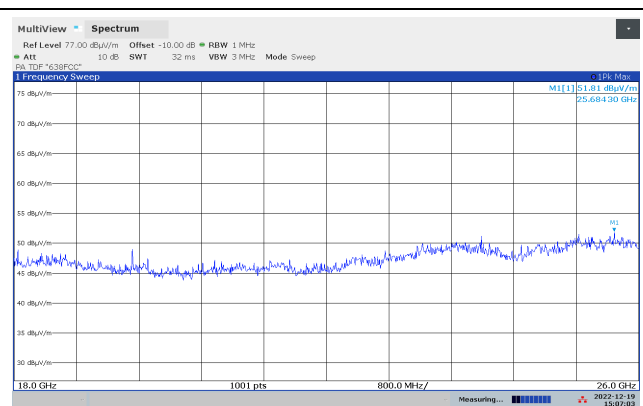


Date: 18.OCT.2022 16:03:18

Spurious 14880 MHz, 2480 MHz, 1Mb, Max: HP, Peak



Pre-scan 18 - 26 GHz, 2440 MHz, 1Mb, @10cm



Pre-scan 18 - 26 GHz, 2440 MHz, 2Mb, @10cm

### 3.10 Power Spectral Density (PSD)

FCC part 15.247(d)

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

Measurement procedure: ANSI C63.10-2013 Clause 11.10

Test Results: Complies

#### Measurement Data:

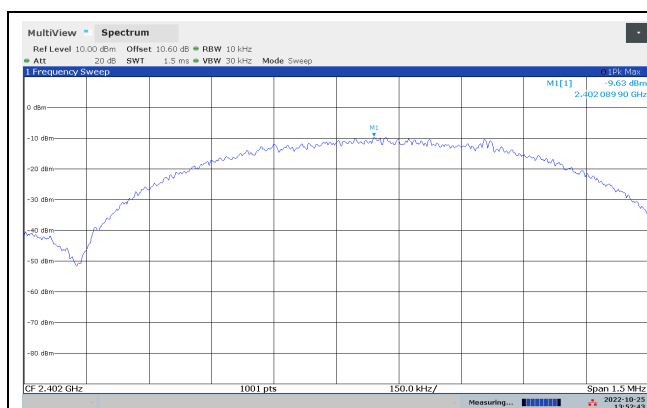
The measurement procedure PKPSD described in ANSI C63.10-2013 was used.

| Modulation Type and Bitrate | Measured Power Spectral Density (dBm/3kHz) |          |          |
|-----------------------------|--------------------------------------------|----------|----------|
|                             | 2402 MHz                                   | 2440 MHz | 2480 MHz |
| GFSK 1Mb                    | -14.9                                      | -13.3    | -14.9    |
| GFSK 2Mb                    | -17.5                                      | -15.7    | -17.4    |

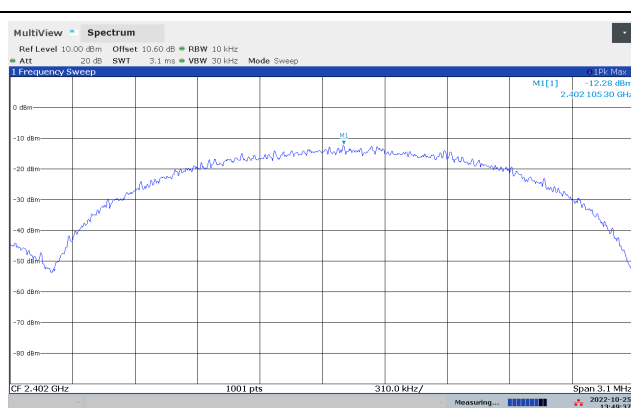
The measured values with 10kHz RBW are corrected by a Bandwidth Correction Factor of -5.2 dB.

#### Requirements:

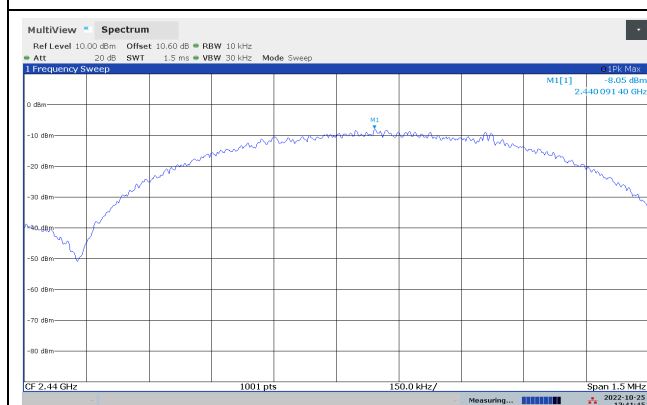
The Power Spectral Density of a Digital Transmission System shall be no greater than +8 dBm in any 3 kHz band



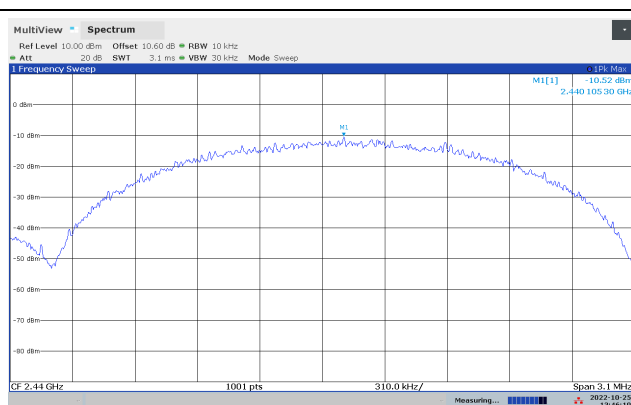
PSD, 2402 MHz, 1Mb



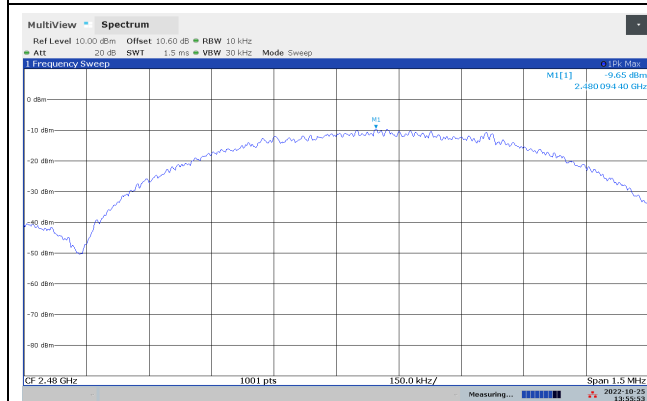
PSD, 2402 MHz, 2Mb



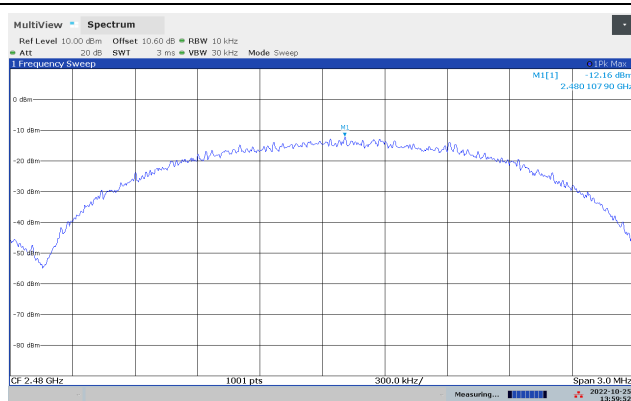
PSD, 2440 MHz, 1Mb



PSD, 2440 MHz, 2Mb



PSD, 2480 MHz, 1Mb



PSD, 2480 MHz, 2Mb

## 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.

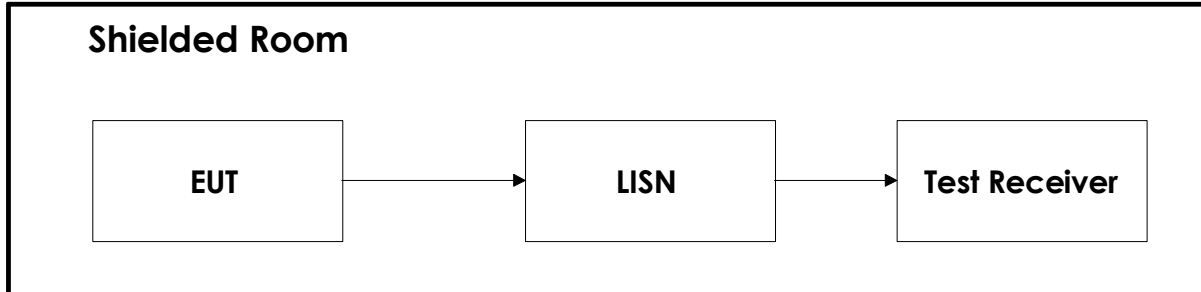
| No. | Model number  | Description                  | Manufacturer       | Ref. no. | Cal. date | Cal. Due |
|-----|---------------|------------------------------|--------------------|----------|-----------|----------|
| 1   | FSW43         | Spectrum Analyzer            | Rohde & Schwarz    | LR 1690  | 2022-01   | 2023-01  |
| 2   | ESU40         | Measuring Receiver           | Rohde & Schwarz    | LR 1639  | 2022-01   | 2023-01  |
| 3   | 6810.17B      | Attenuator                   | Suhner             | LR 1669  | 2019-07   | 2020-07  |
| 4   | NO324415      | Band Reject Filter (2.4 GHz) | Microwave Circuits | LR 1760  | COU       |          |
| 5   | VULB 9163     | BiLog Antenna                | Schwarzbech        | LR 1616  | 2021-05   | 2024-05  |
| 6   | 317           | Pre-amplifier                | Sonoma Inst.       | LR 1687  | 2022-08   | 2023-08  |
| 7   | 3117-PA       | Horn Antenna +PreAmp         | EMCO               | LR 1717  | 2022-08   | 2023-08  |
| 8   | L01G18G1      | LowPass Filter (1 GHz)       | Microwave Circuits | LR 1768  | COU       |          |
| 9   | 8449B         | Pre-amplifier                | Hewlett Packard    | LR 1322  | 2022-08   | 2023-08  |
| 10  | 638           | Antenna Horn                 | Narda              | LR 1480  | N/A       |          |
| 11  | 6812B         | AC Power Source              | Agilent            | LR 1515  | 2022-11   | 2024-11  |
| 12  | Model 87V     | Multimeter                   | Fluke              | LR 1600  | 2022-03   | 2024-03  |
| 13  | ESC13         | Measuring Receiver           | Rohde & Schwarz    | N-4259   | 2021-10   | 2023-10  |
| 14  | ENV216        | Two Line V-Network           | Rohde & Schwarz    | LR 1665  | 2021-12   | 2023-12  |
| 15  | ST18/SMA/N/36 | RF Cable                     | Suhner             | LR 1627  | COU       |          |

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

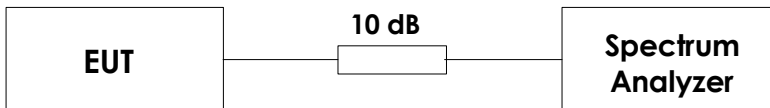
| No. | Manufacturer    | Name   | Version  | Comment                                    |
|-----|-----------------|--------|----------|--------------------------------------------|
| 1   | Rohde & Schwarz | EMC32  | 10.50.40 | EMC test software                          |
| 2   | Nemko AS        | RSPlot | 1.0.8.0  | Screen capture from R&S Spectrum Analyzers |
|     |                 |        |          |                                            |

## 6 BLOCK DIAGRAM

### 6.1 Power Line Conducted Emission

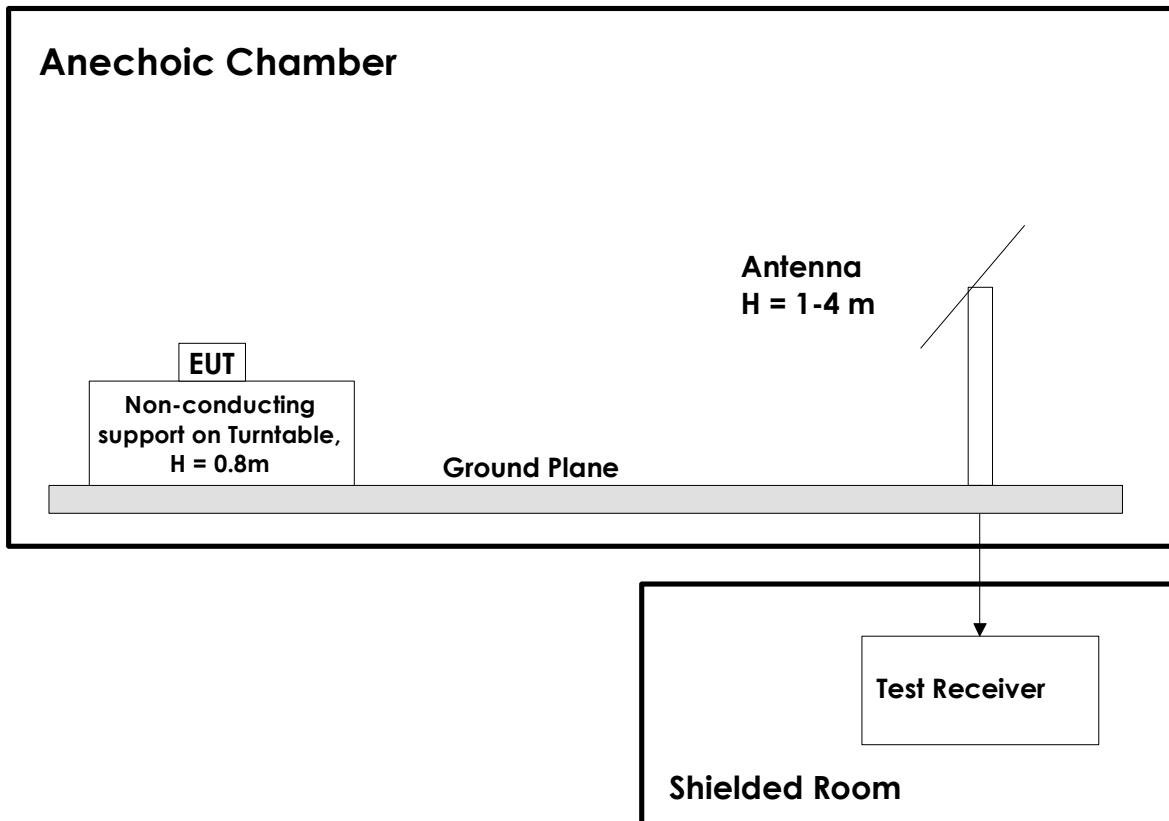


### 6.2 Conducted Tests



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. 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.