

Test Report

| | |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Product | Reader and Communication Controller |
| Name and address of the applicant | ASSA ABLOY Global Solutions Norway AS P.O. Box 340, Anolitveien 1-3, N-1402 SKI - Norway |
| Name and address of the manufacturer | ASSA ABLOY Global Solutions Norway AS P.O. Box 340, Anolitveien 1-3, N-1402 SKI - Norway |
| Model | RCC 6470 |
| Rating | Bluetooth low energy 2402 – 2480 MHz, Internal batteries (3x1.5V DC) |
| Trademark | vingcard ASSA ABLOY |
| Additional information | - |
| Tested according to | FCC Part 15.247 Frequency Hopping Transmitters / Digital Transmission Systems Industry Canada RSS-247, Issue 3 Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices |
| Order number | PRJ0051915 |
| Tested in period | 2024-09-01 – 2024-09-10 |
| Issue date | 2025-03-06 |
| Name and address of the testing laboratory | <div style="display: flex; justify-content: space-between; align-items: flex-start;"> <div style="text-align: center;">  Nemko Scandinavia AS Instituttveien 6 2007 Kjeller, Norway www.nemko.com </div> <div style="text-align: center;"> CAB Number: FCC: NO0001 ISED: NO0470 ISED No: 2040D-1 </div> <div style="text-align: center;">   </div> </div> <p style="text-align: center; color: red; font-weight: bold;">An accredited technical test executed under the Norwegian accreditation scheme</p> |
| <div style="display: flex; justify-content: space-around; align-items: flex-end;"> <div style="text-align: center;">  Prepared by [Jan G Eriksen] </div> <div style="text-align: center;">  Approved by [Frode Sveinsen] </div> </div> | |
| This report was originally distributed electronically with digital signatures. For more information, please contact Nemko Scandinavia AS. | |

Revision history

| Revision | Date | Comment | Sign |
|----------|------------|------------------------------------------|------|
| A | 2024-10-29 | First edition | JGER |
| B | 2025-02-05 | Corrections in table of used instruments | JGER |
| C | 2025-03-06 | Corrections in table of used instruments | JGER |

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 | Reader and Communication Controller |
| Model/version | RCC 6470 |
| FCC ID | Y7V-RCC6470C1 |
| ISED ID | 9514A-RCC6470C1 |
| Serial number | Radiated tests: 2423 HAN 00061 Conducted tests: 2423 HAN 00045 / 101 |
| Hardware identity and/or version | RCC6470C1 |
| Software identity and/or version | Ver.1.4 |
| Frequency Range | 2402 – 2480 MHz |
| Number of Channels | 40 |
| Operating Modes | Bluetooth Low Energy <input checked="" type="checkbox"/> 1Mb <input type="checkbox"/> 2Mb |
| Type of Modulation | GFSK |
| Conducted Output Power | 4.2 mW |
| Antenna Connector | None |
| Number of Antennas | 1 |
| Diversity or Smart Antennas | No |
| Power Supply | Battery 4.5 V during radiated tests. Regulated power supply 4.5 V DC during conducted tests. |
| Desktop Charger | NA |

Description of Test Item

The tested device is a wireless module for transmission in the 2.4 GHz frequency band.

1.2 Normal test condition

| | |
|----------------------|------------|
| Temperature: | 20 - 24 °C |
| Relative humidity: | 20 - 50 % |
| Normal test voltage: | 4.5 V DC |

The values are the limit registered during the test period.

1.3 Test Engineer(s)

Jan G Eriksen

1.4 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

1.5 EUT Operating Modes

| | |
|--------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Description of operating modes | <p>Radiated Emissions and Conducted measurements were performed with the EUT set to transmit at three channels (2402, 2440, and 2480 MHz) with a rated output power of +8 dBm.</p> <p>Conducted mains measurements were performed with the EUT set to transmit at 2440 MHz with a rated output power of +8 dBm.</p> |
| Additional information | / |

1.6 Comments

Conducted measurements were done with the EUT powered by regulated power supply at 4.5 V DC. It was checked that power variations between 85% and 115% did not have any influence on the measurements.

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

2 TEST REPORT SUMMARY

2.1 General

The tests were conducted on a sample of the equipment for demonstrating compliance with one or more of the following standards.

| Standard | Description |
|------------------------|------------------------------------------------------------------------------------------------------------------------------|
| FCC CFR 47 Part 15.247 | Operation within the bands 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz |
| ISED RSS-247, Issue 3 | Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices |
| ISED RSS-GEN Issue 5 | General Requirements for Compliance of Radio Apparatus |

The following standards and documents were used for one or more measurements:

| Standard | Description |
|--------------------|-------------------------------------------------------------------|
| ANSI C63.4-2014 | Unintentional Radiators |
| ANSI C63.10-2013 | Intentional Radiators |
| FCC KDB 558074 D01 | 15.247 Measurement Guidance for DTS and Frequency Hopping Systems |
| FCC KDB 412172 D01 | Determining ERP and EIRP |

All measurements are traceable to national standards.

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

| | |
|-----------------------------------------------------|-----------------------------------------------------|
| <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 Class | <input type="checkbox"/> Family Listing |

2.2 Test Summary

| Name of test | FCC Part 15 reference | RSS-247 Issue 3, RSS-GEN Issue 5 reference | ANSI C63.10-2013 Reference | Result |
|----------------------------------------|-------------------------------------|--------------------------------------------------|-------------------------------------------|--------|
| Supply Voltage Variations | 15.31(e) | 6.11 (RSS-GEN) | 5.13 | Pass |
| Antenna Requirement | 15.203 | 6.8 (RSS-GEN) | 5.8 | Pass |
| Power Line Conducted Emission | 15.107(a) 15.207(a) | 7.2 / 8.8 (RSS-GEN) | 6.2 | N/A |
| Occupied Bandwidth (99% BW) | N/A | 6.7 (RSS-GEN) | 6.9.3 | Pass |
| DTS Bandwidth | 15.247(a)(2) | 5.2 (1) (RSS-247) | 11.8 Option 2 | Pass |
| Peak Power Output | 15.247(b) | 5.4 (RSS-247) | 11.9.1.1 | Pass |
| Power Spectral Density | 15.247(d) | 5.2 (2) (RSS-247) | 11.10.2 PKPSD (DTS) | Pass |
| Spurious Emissions (Antenna Conducted) | 15.247(c) | 5.5 (RSS-247) | 6.7 11.11 (DTS) | Pass |
| Spurious Emissions (Radiated) | 15.247(c) 15.109(a) 15.209(a) | 3.3 (RSS-247) 7.3 (RSS-GEN) 8.9 (RSS-GEN) | 6.3, 6.5, 6.6, 6.10 11.12, 11.13 (DTS) | Pass |

3 TEST RESULTS

3.1 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:

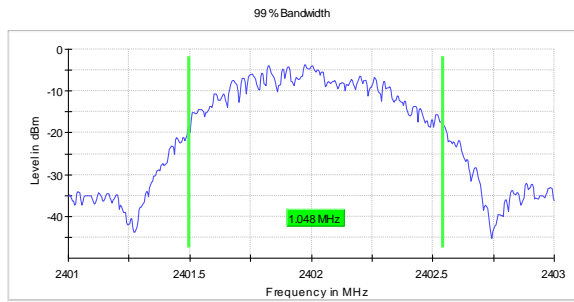
| Carrier Frequency, Data Rate | Occupied Bandwidth (99% BW) |
|------------------------------|-----------------------------|
| 2402 MHz, 1Mb | 1048 kHz |
| 2440 MHz, 1Mb | 1048 kHz |
| 2480 MHz, 1Mb | 1048 kHz |

Occupied Bandwidth is the same for all channels

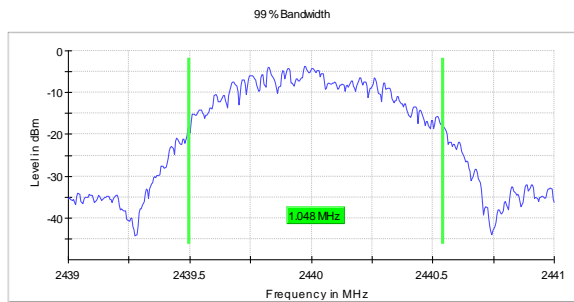
See attached plots

Requirements:

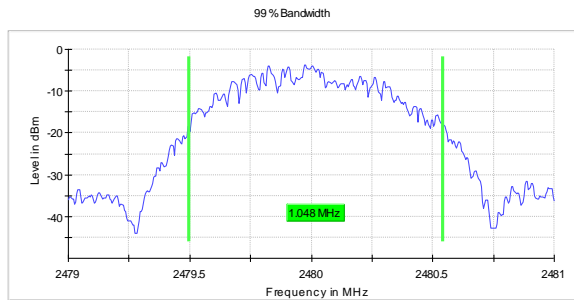
No requirement for 99% BW, reported for information only.



2402 MHz: 99% Occupied BW, 1Mb



2440 MHz: 99% Occupied BW, 1Mb



2480 MHz: 99% Occupied BW, 1Mb

3.2 DTS Bandwidth

FCC Part 15.247 (a)(2)

ISED Canada RSS-247 Issue 3, Clause 5.2 (a)

Measurement procedure: ANSI C63.10-2013 Clause 11.8

Test Results: Complies

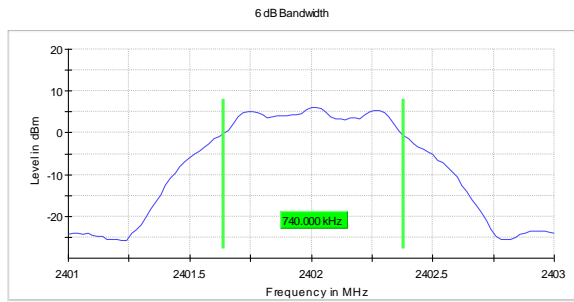
Measurement Data:

| Modulation type and bitrate | Measured DTS Bandwidth (kHz) | | |
|-----------------------------|------------------------------|----------|----------|
| | 2402 MHz | 2440 MHz | 2480 MHz |
| GFSK 1 Mbps | 740 | 740 | 740 |

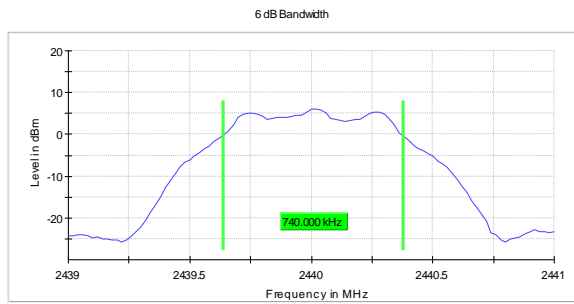
Power supply variation within 85 % to 115% of nominal value has no influence on measured value.

| 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 | |

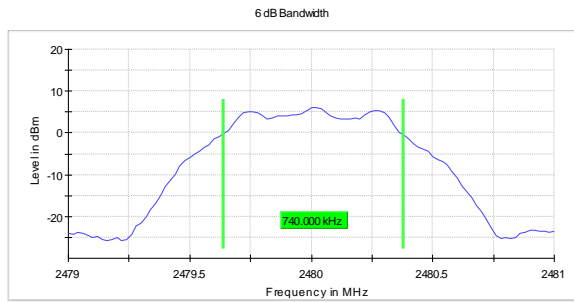
No requirements for Frequency Hopping Systems.



2402 MHz: DTS BW, 1M



2440 MHz: DTS BW, 1M



2480 MHz: DTS BW, 1M

3.3 Peak Power Output

FCC Part 15.247 (b)

ISED Canada RSS-247 Issue 3, Clause 5.4

Measurement procedure: ANSI C63.10-2013 Clause 11.9.1.2

Test Results: Complies

Measurement Data:

| Carrier Frequency | Peak Conducted Power | Peak Field Strength @ 3m | Peak EIRP | Antenna gain |
|-------------------|----------------------|-----------------------------|-----------|--------------|
| | dBm | dBuV/m | dBm | dB |
| 2402 MHz | 6.1 | 98.8 | 3.6 | -2.5 |
| 2440 MHz | 6.2 | 96.0 | 0.8 | -5.4 |
| 2480 MHz | 6.1 | 95.1 | -0.1 | -6.2 |

Output Power reported is Maximum Peak Power. The measurement is performed with the power meter function of the TS8996 test system.

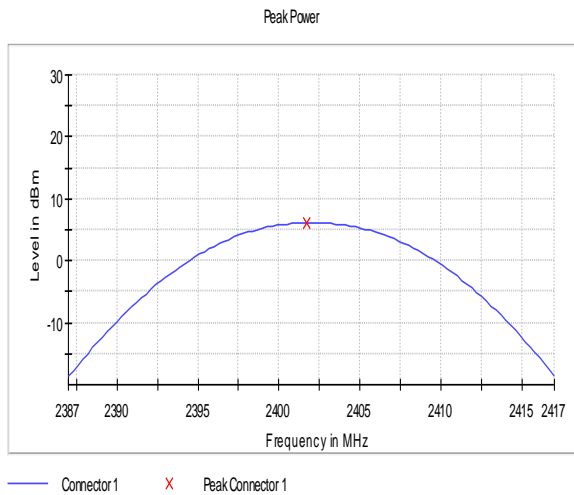
The Integrated Band Power Method was used to measure Output Power

Radiated Power was calculated from measured Field Strength (measured at 3 meters distance) using the method described in ANSI C63.10, Clause 9.5.

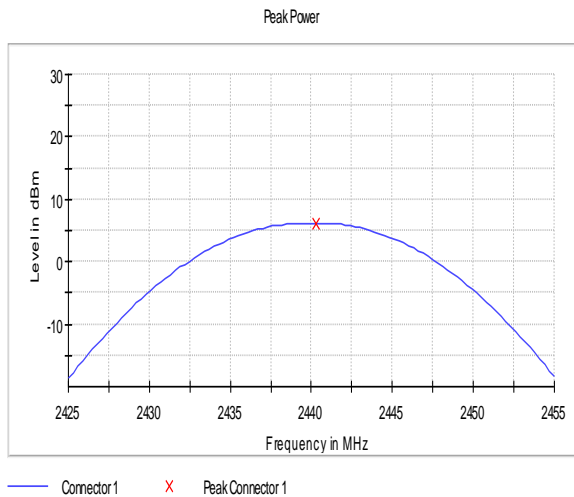
Antenna Gain is less than 6 dBi.

See attached plots.

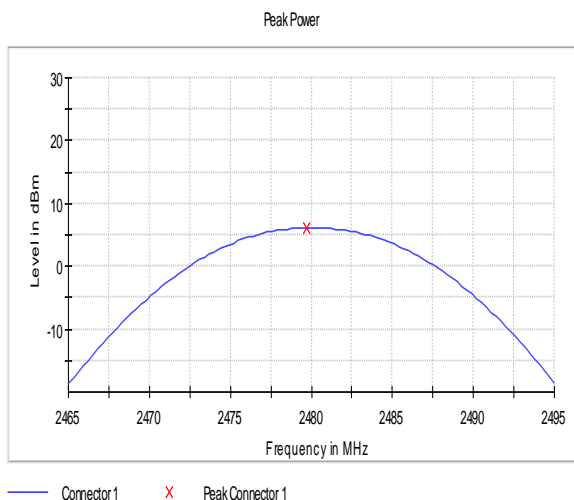
| Requirements for Digital Modulation systems |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 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. |



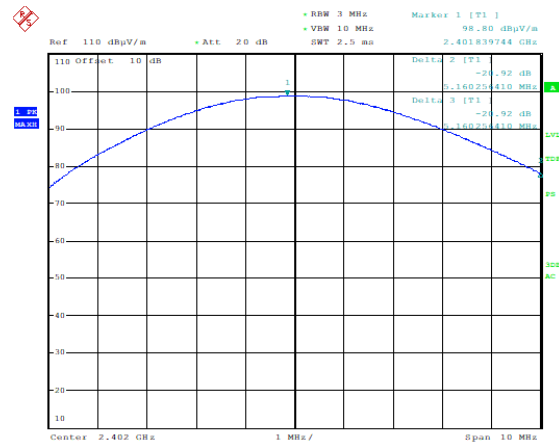
Peak Power, 2402 MHz, 1Mb



Peak Power, 2440 MHz, 1Mb

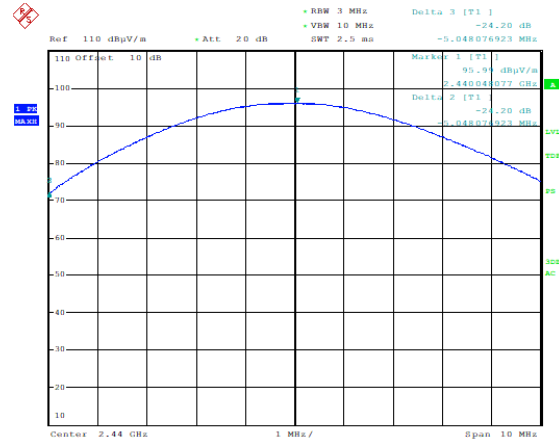


Peak Power, 2480 MHz, 1Mb



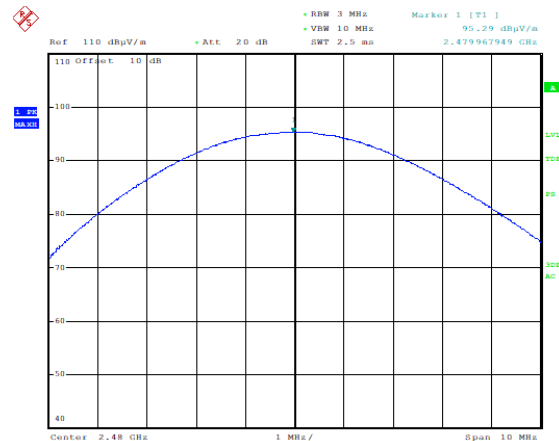
Date: 28.AUG.2024 07:14:09

Peak EIRP, 2402 MHz, 1Mb



Date: 28.AUG.2024 07:34:53

Peak EIRP, 2440 MHz, 1Mb



Date: 28.AUG.2024 06:54:26

Peak EIRP, 2480 MHz, 1Mb

3.4 Conducted Emissions at Antenna Connector

FCC Part 15.247 (d)

ISED Canada RSS-247 Issue 3, Clause 5.5

Measurement procedure: ANSI C63.10-2013 Clause 11.11

Test Results: Complies

Measurement Data:

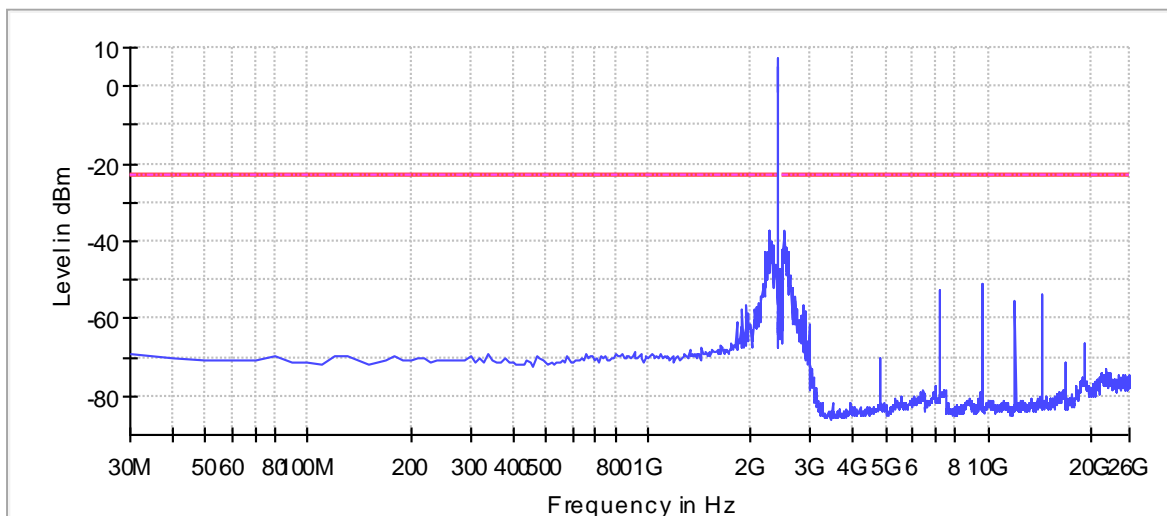
| Carrier Frequency | Measured Peak TX level (dBm) | Highest Value (dBc) | Margin (dB) | Verdict |
|-------------------|------------------------------|---------------------|-------------|---------|
| 2402 MHz | 7.2 | 44.5 | 14.6 | Pass |
| 2440 MHz | 6.9 | 43.9 | 13.9 | Pass |
| 2480 MHz | 6.4 | 43.4 | 13.4 | Pass |

Measured with Peak Detector and spectrum analyzer.

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> | |

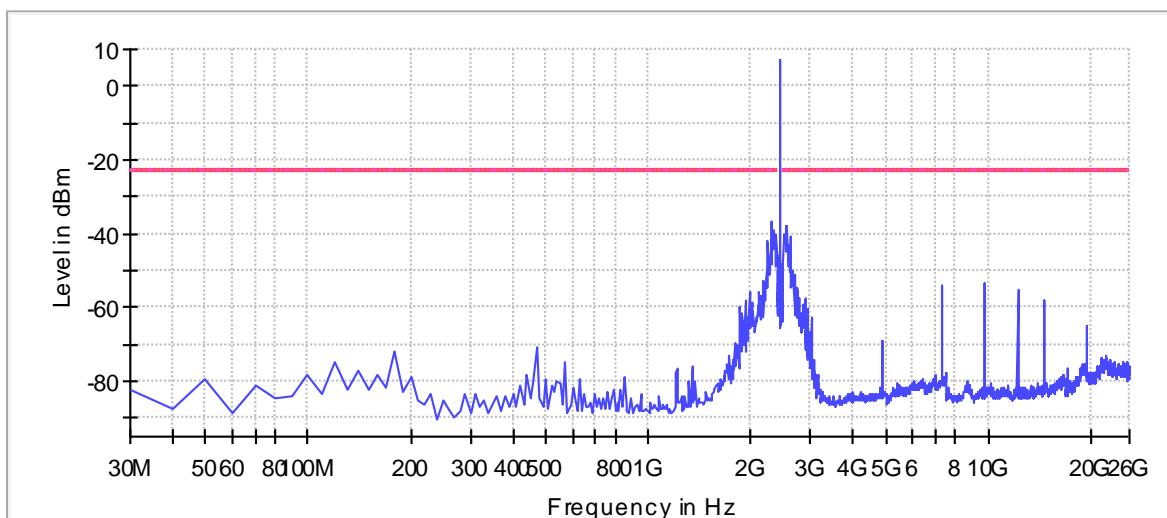
Spurious



— Limit — SumLevel - - - - - Threshold X Critical X Final Critical

Conducted Emissions 30-26000 MHz, 2405 MHz, 1Mb

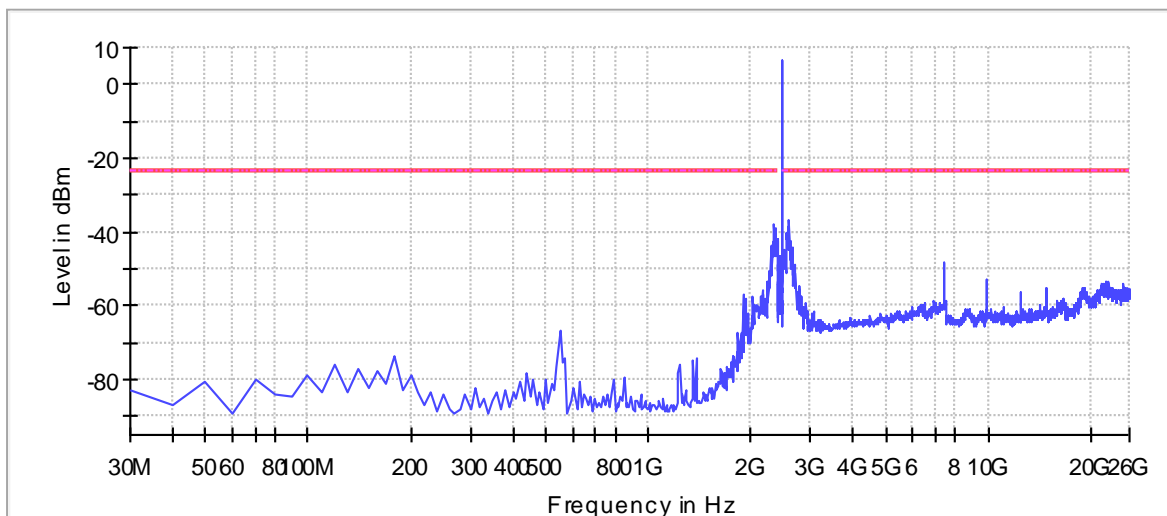
Spurious



— Limit — SumLevel - - - - - Threshold X Critical X Final Critical

Conducted Emissions 30-26000 MHz, 2440 MHz, 1Mb

Spurious



— Limit — SumLevel - - - Threshold × Critical × Final Critical

Conducted Emissions 30-26000 MHz, 2480 MHz, 1Mb

3.5 Restricted Bands of operation

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

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

| FCC (MHz) | ISED (MHz) | FCC (GHz) | ISED (GHz) |
|-------------------------------------|--------------------|--------------------------------------|-------------------|
| 0.090-0.110 | | 0.96-1.24 1.3-1.427 | 0.96-1.427 |
| 0.495-0.505 | | 1.435-1.6265 | |
| 2.1735-2.1905 | | 1.6455-1.6465 | |
| | 3.020-3.026 | 1.660-1.710 | |
| 4.125-4.128 | | 1.7188-1.7222 | |
| 4.17725-4.17775 | | 2.2-2.3 | |
| 4.20725-4.20775 | | 2.31-2.39 | |
| | 5.677-5.683 | 2.4835-2.5 | |
| 6.215-6.218 | | 2.69-2.9 | 2.655-2.9 |
| 6.26775-6.26825 | | 3.26-3.267 | |
| 6.31175-6.31225 | | 3.332-3.339 | |
| 8.291-8.294 | | 3.3458-3.358 | |
| 8.362-8.366 | | 3.6-4.4 | 3.5-4.4 |
| 8.37625-8.38675 | | 4.5-5.15 | |
| 8.41425-8.41475 | | 5.35-5.46 | |
| 12.29-12.293 | | 7.25-7.75 | |
| 12.51975-12.52025 | | 8.025-8.5 | |
| 12.57675-12.57725 | | 9.0-9.2 | |
| 13.36-13.41 | | 9.3-9.5 | |
| 16.42-16.423 | | 10.6-12.7 | |
| 16.69475-16.69525 | | 13.25-13.4 | |
| 16.80425-16.80475 | | 14.47-14.5 | |
| 25.5-25.67 | | 15.35-16.2 | |
| 37.5-38.25 | | 17.7-21.4 | |
| 73-74.6 | | 22.01-23.12 | |
| 74.8-75.2 | | 23.6-24.0 | |
| 108-121.94 123-138 | 108-138 | 31.2-31.8 | |
| 149.9-150.05 | | 36.43-36.5 | |
| 156.52475-156.52525 | | Above 38.6 | |
| 156.7-156.9 | | | |
| 162.0125-167.17 | | | |
| 167.72-173.2 | | | |
| 240-285 | | | |
| 322-335.4 | | | |
| 399.9-410 | | | |
| 608-614 | | | |

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

3.6 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 dB | Margin | |
| | 2390 MHz | 2483.5 MHz | | dB | |
| GFSK, 1Mb | 57.2 | 58.9 | 74 | 16.8 | 15.1 |

| Average Detector | | | | | |
|------------------------|---------------------------------------------------------------------|------------|-------------|--------|------|
| Modulation and Bitrate | Measured field strength (dBμV/m) total Duty Cycle taken included | | Limit dB | Margin | |
| | 2390 MHz | 2483.5 MHz | | dB | |
| GFSK, 1Mb | 27.9 | 31.7 | 54 | 26.1 | 22.3 |

Average values were measured using trace averaging as described in ANSI C63.10-2013 clause 11.12.2.5.1 (Duty Cycle ≈62.5%) – see duty cycle plots below.

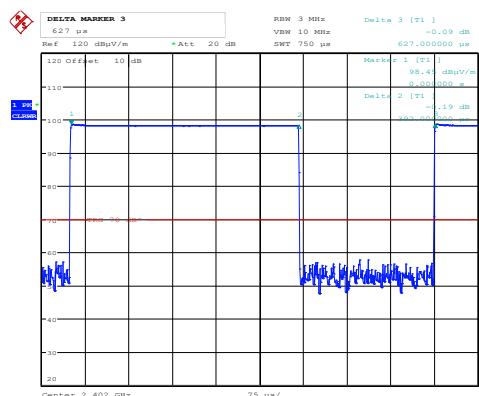
See attached plots on next page.

Calculated Average values:

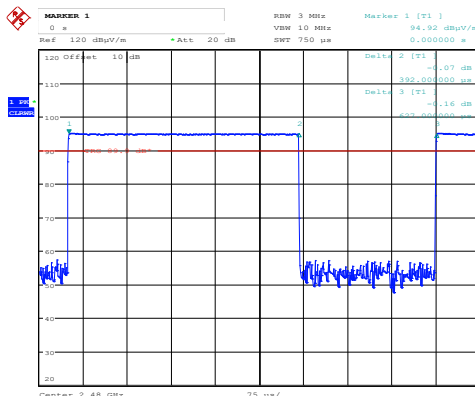
Lower Band Edge: 45.9 – 18 = 27.9

Higher Band Edge: 49.7 – 18 = 31.7

Duty Cycle measurements:



Date: 28.AUG.2024 07:21:13

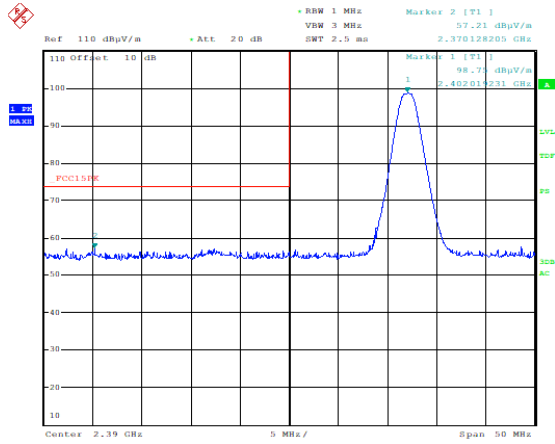


Date: 28.AUG.2024 07:01:34

Duty cycle: Pulse period = 627us. Pulse length = 392 us. DC= 62.5% → DC correction factor = 2.0 dB which should be added to the average measurement values in plots below.

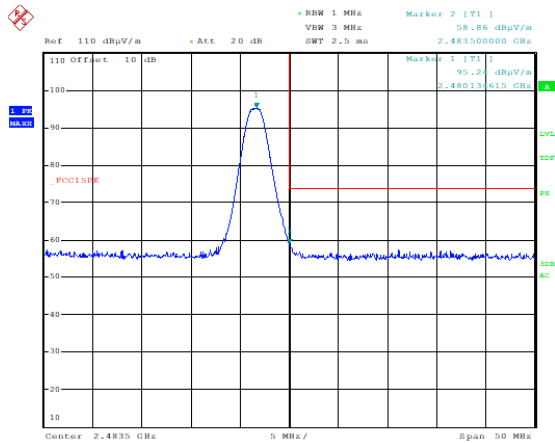
Also, according to the manufacturer the device will have a maximum CSMA/CA transmission period of 2.368 ms, and a Data Frame transmission of 4.256 ms – giving a maximum transmission time of 6.624 ms per 100 ms. This gives an additional Duty Cycle correction factor of 20 dB which is used to obtain the average Band Edge levels.

The total Duty Cycle correction factor is thus 18 dB which is used to calculate average detector values above.



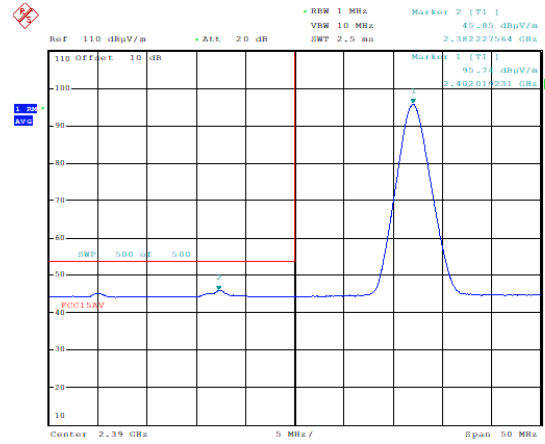
Date: 28.AUG.2024 07:17:20

Lower Band Edge, 2402 MHz, 1Mb, Peak



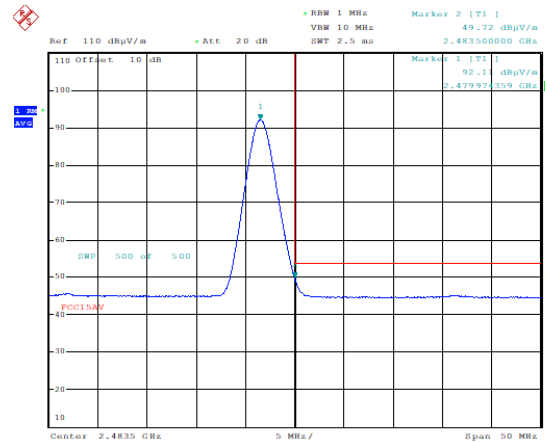
Date: 28.AUG.2024 06:56:28

Upper Band Edge, 2480 MHz, 1Mb, Peak



Date: 28.AUG.2024 07:18:37

Lower Band Edge, 2402 MHz, 1Mb, Average



Date: 28.AUG.2024 06:57:56

Upper Band Edge, 2480 MHz, 1Mb, Average

3.7 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: Quasi-Peak

Measuring distance 3m

Tested in test mode with EUT transmitting on ch19

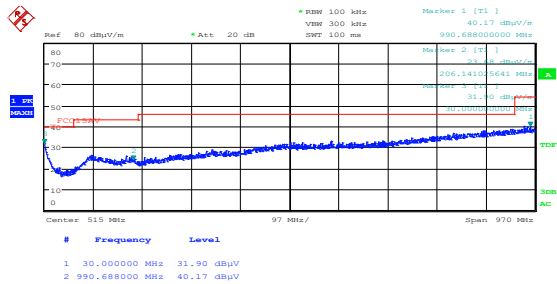
| Measured Frequency (MHz) | Carrier Frequency (MHz) | Modulation | Measured Emission (dBµV/m) | Limit (dBµV/m) | Margin (dB) |
|--------------------------|-------------------------|------------|----------------------------|----------------|-------------|
| 30 – 88 | 2402/2440/2480 | GFSK | <35.0 *) | 40.0 | 8.0 |
| 88 – 216 | 2402/2440/2480 | GFSK | < 30.0 *) | 43.5 | 18.9 |
| 216 – 960 | 2402/2440/2480 | GFSK | < 40.0 *) | 46.0 | 5.1 |
| 960 – 1000 | 2402/2440/2480 | GFSK | < 45.0 *) | 54.0 | 13.8 |

*) There is no functionality in the measurement software to find maximum levels with markers within specific frequency bands. Thus, it is slightly difficult to find the exact maximum spurious levels within the frequency bands in the table above and less than levels are indicated.

See attached plots

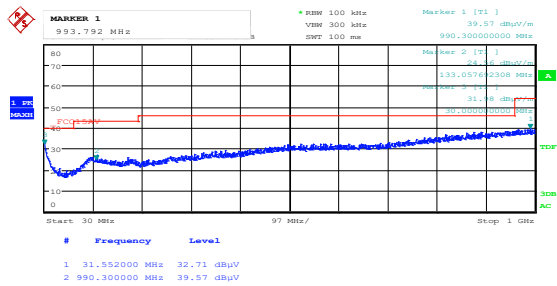
Requirements/Limit

| 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 | |



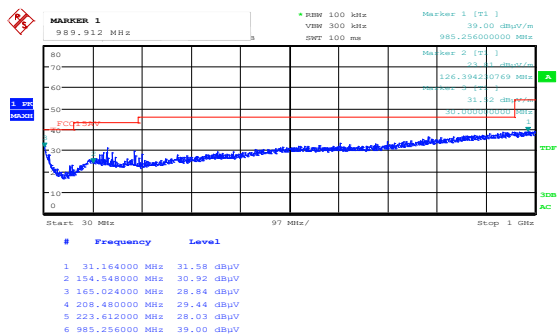
Date: 27.AUG.2024 08:38:29

Radiated Emissions 30 - 1000 MHz, 2402 MHz, 1Mb, HP



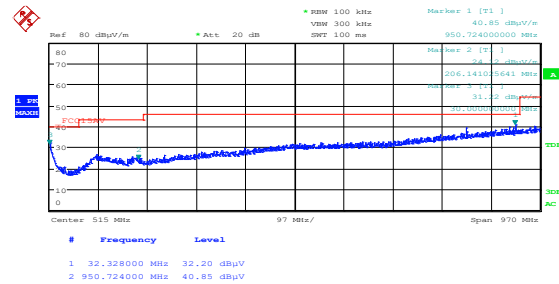
Date: 27.AUG.2024 08:46:04

Radiated Emissions 30 - 1000 MHz, 2440 MHz, 1Mb, HP



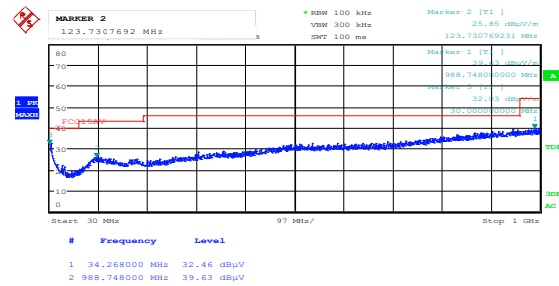
Date: 27.AUG.2024 09:00:44

Radiated Emissions 30 - 1000 MHz, 2480 MHz, 1Mb, HP



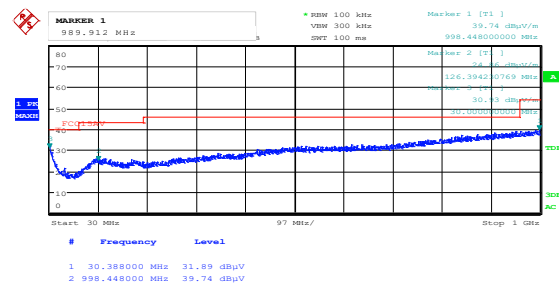
Date: 27.AUG.2024 08:36:32

, VP



Date: 27.AUG.2024 08:44:07

, VP



Date: 27.AUG.2024 08:58:46

, VP

3.8 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.

RBW=1 MHz

| Carrier Frequency (MHz) | Measured Frequency (GHz) | Mode | Measured Emissions (dBµV/m) | | Limit (dBµV/m) | | Margin (dB) | |
|-------------------------|--------------------------|----------|-----------------------------|---------|----------------|----|-------------|------|
| | | | Peak | Average | Pk | Av | Pk | Av |
| 2402 | 2 nd Harm | TX BLE1M | 53.3 | / | 74 | 54 | 20.7 | / |
| 2402 | 3 rd Harm | TX BLE1M | 62.8 | 42.8 *) | 74 | 54 | 11.2 | 11.2 |
| 2440 | 2 nd Harm | TX BLE1M | 53.0 | / | 74 | 54 | 21.0 | / |
| 2440 | 3 rd Harm | TX BLE1M | 60.8 | 40.8 *) | 74 | 54 | 13.2 | 13.2 |
| 2480 | 2 nd Harm | TX BLE1M | 52.3 | / | 74 | 54 | 21.7 | / |
| 2480 | 3 rd Harm | TX BLE1M | 62.8 | 42.8 *) | 74 | 54 | 11.2 | 11.2 |

According to the manufacturer the device will have a maximum CSMA/CA transmission period of 2.368 ms, and a Data Frame transmission of 4.256 ms – giving a maximum transmission time of 6.624 ms per 100 ms. This gives a maximum Duty Cycle correction factor of 20 dB.

*) Average level not measured - the average level is calculated using the measured Peak level and reducing the value by Duty Cycle correction factor.

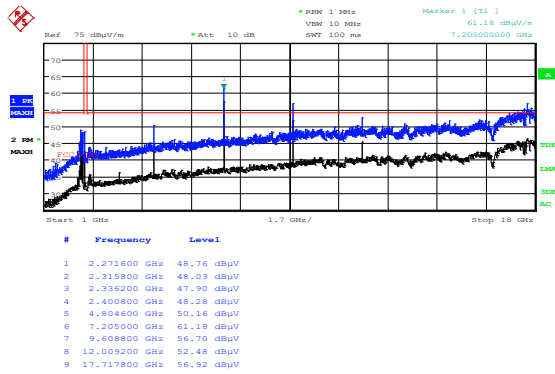
A Band Reject Filter was used for measurements from 1 GHz to 18 GHz

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

See plots.

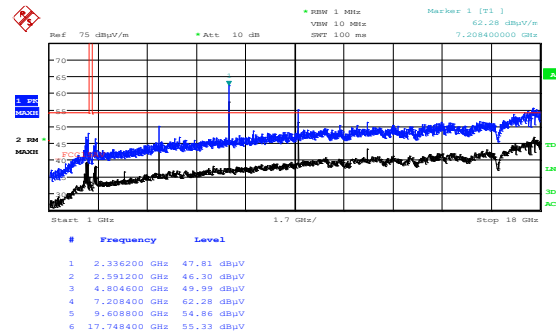
Requirements/Limit

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



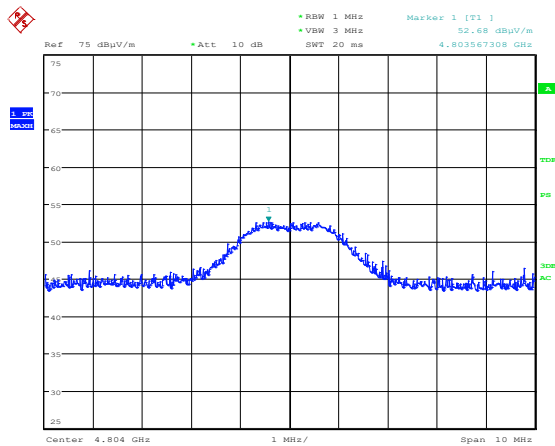
Date: 28.AUG.2024 09:30:49

Radiated Emissions 1 - 18 GHz, 2402 MHz, 1M, HP



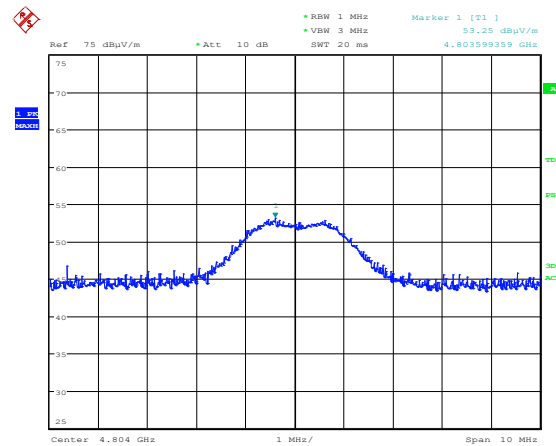
Date: 28.AUG.2024 09:28:52

, VP



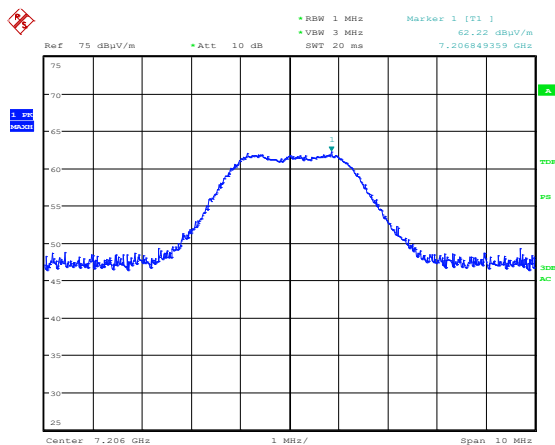
Date: 28.AUG.2024 10:00:31

Radiated Emissions 4804 MHz, 2402 MHz, 1M, HP



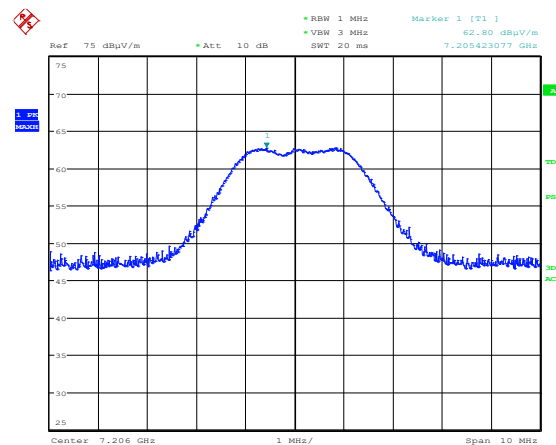
Date: 28.AUG.2024 09:58:38

, VP



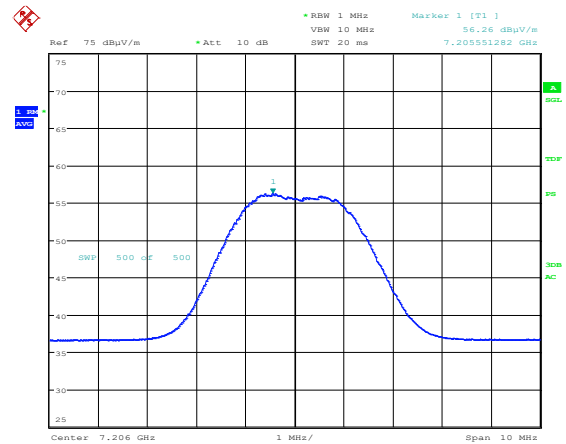
Date: 28.AUG.2024 09:46:13

Radiated Emissions 7206 MHz, 2402 MHz, 1M, HP



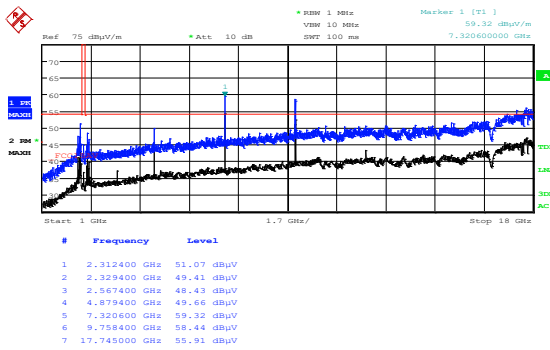
Date: 28.AUG.2024 09:47:40

, VP



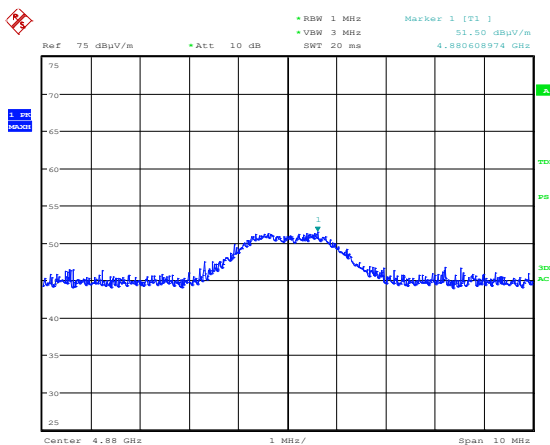
Date: 28.AUG.2024 09:48:29

Radiated Emissions 7206 MHz, 2402 MHz, 1M, VP – AVG Det.



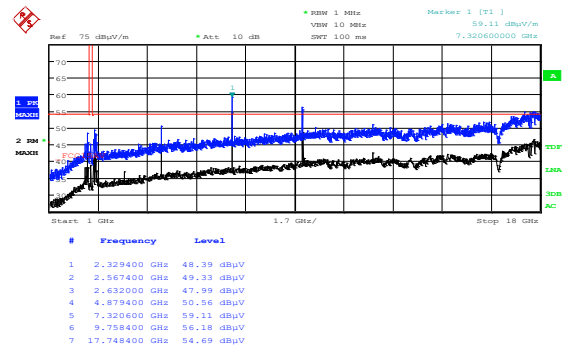
Date: 28.AUG.2024 07:55:55

Radiated Emissions 1 - 18 GHz, 2440 MHz, 1M, HP



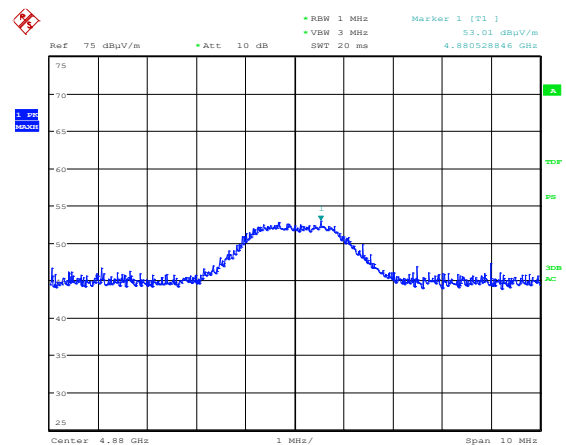
Date: 28.AUG.2024 08:32:01

Radiated Emissions 4880 MHz, 2440 MHz, 1M, HP



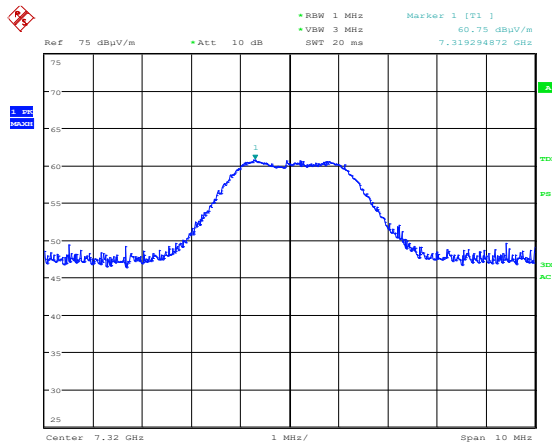
Date: 28.AUG.2024 07:53:58

, VP



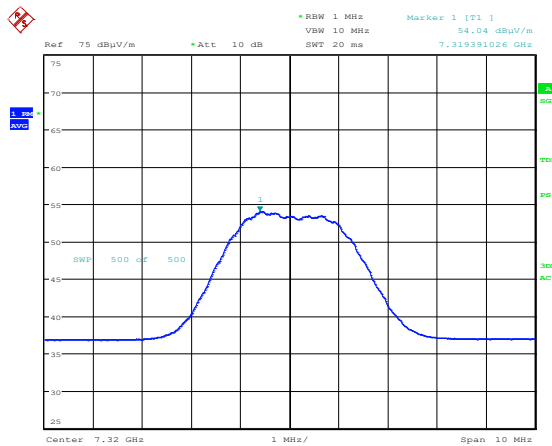
Date: 28.AUG.2024 08:30:12

, VP



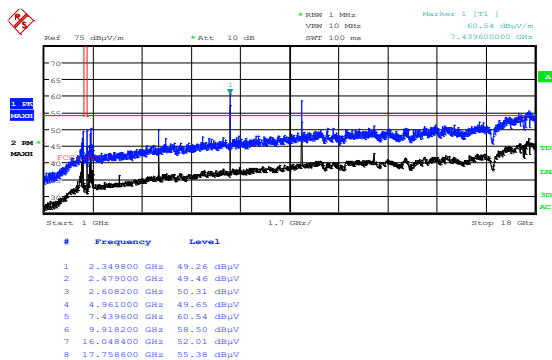
Date: 28.AUG.2024 08:10:00

Radiated Emissions 7320 MHz, 2440 MHz, 1M, HP



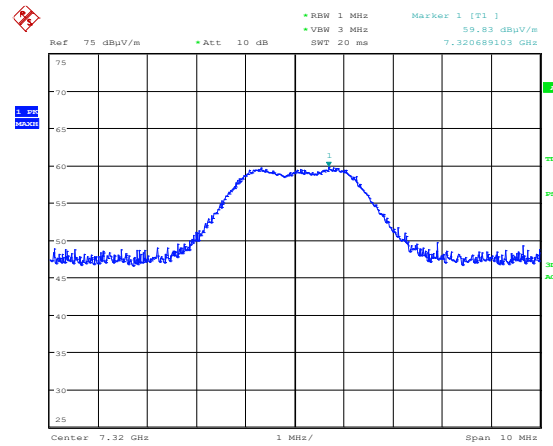
Date: 28.AUG.2024 08:16:10

Radiated Emissions 7320 MHz, 2440 MHz, 1M, HP – AVG Det



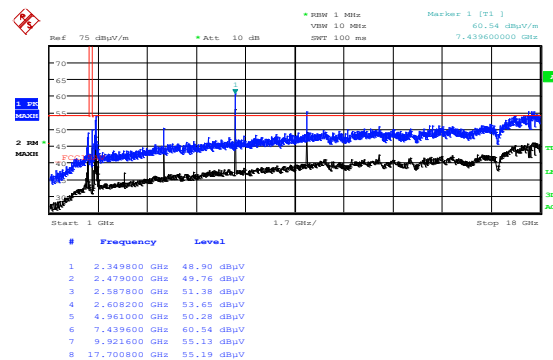
Date: 28.AUG.2024 08:53:24

Radiated Emissions 1 - 18 GHz, 2480 MHz, 1M, HP



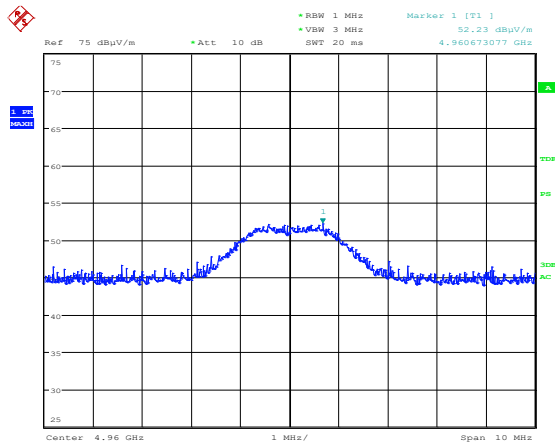
Date: 28.AUG.2024 08:08:10

, VP



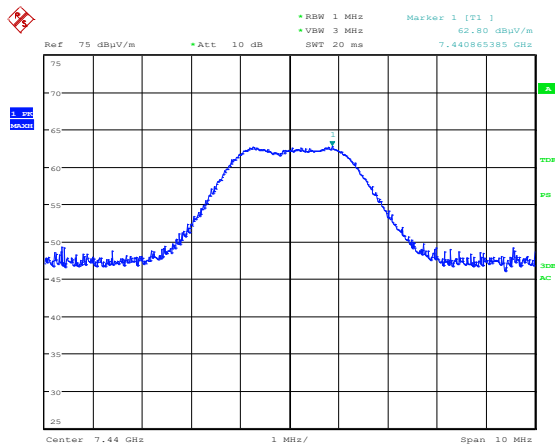
Date: 28.AUG.2024 08:51:27

, VP



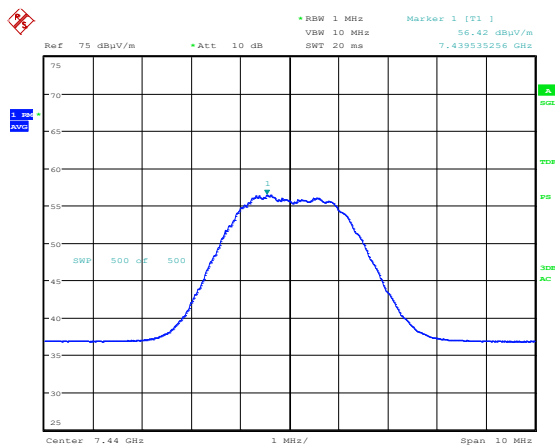
Date: 28.AUG.2024 09:17:29

Radiated Emissions 4960 MHz, 2480 MHz, 1M, HP



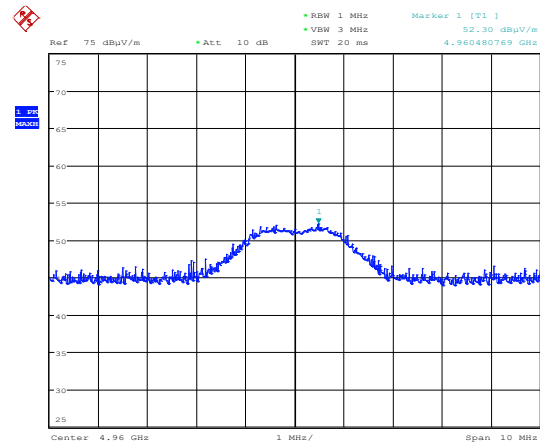
Date: 28.AUG.2024 09:02:50

Radiated Emissions 7440 MHz, 2480 MHz, 1M, HP



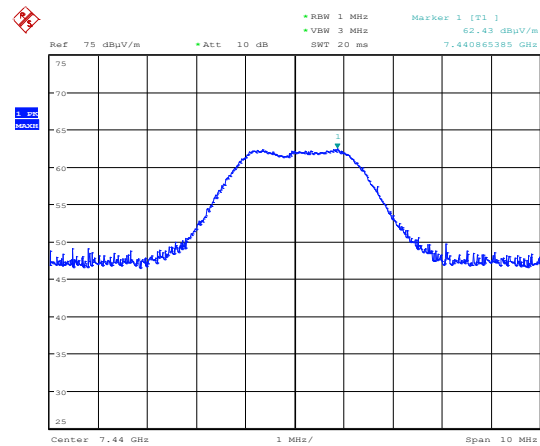
Date: 28.AUG.2024 09:05:53

Radiated Emissions 7440 MHz, 2480 MHz, 1M, HP – AVG det.



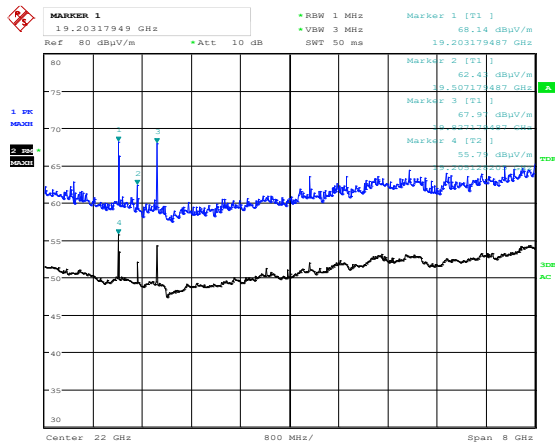
Date: 28.AUG.2024 09:19:00

, VP



Date: 28.AUG.2024 09:04:34

, VP



Date: 28.AUG.2024 11:27:53

This prescan was performed with the measurement antenna 5-10 cms above the module. Using 10 cms as distance the measured values should be decreased by 29.5 dB.

Thus, it is clear that both the peak and average measurement values are below the limits of 74 and 54 dBuV/m respectively – even if average levels are increased by the 2 dB due to Duty Cycle during measurement (63.5%).

The average levels should also be decreased due to the actual transmission DC of 6.6% during 100 ms

3.9 Power Spectral Density (PSD)

FCC part 15.247(d)

ISED Canada RSS-247 Issue 3, Clause 5.2 (2)

Measurement procedure: ANSI C63.10-2013 Clause 11.10

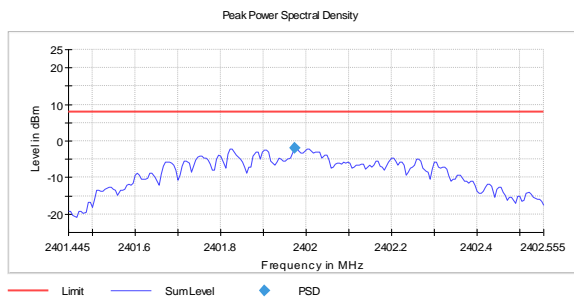
Test Results: Complies

Measurement Data:

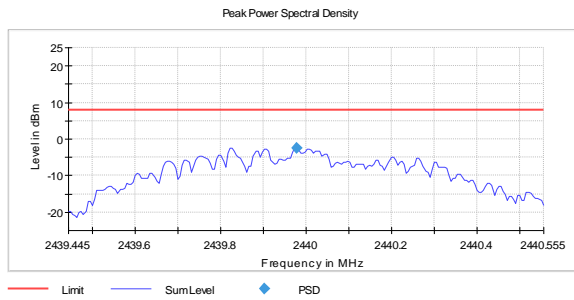
The measurement procedure PKPSD described in ANSI C63.10-2013 was used.

| Modulation Type and Bitrate | Measured Power Spectral Density (dBm/3kHz) | | |
|-----------------------------|--------------------------------------------|----------|----------|
| | 2402 MHz | 2440 MHz | 2480 MHz |
| GFSK 1Mb | -2.0 | -2.4 | -2.2 |

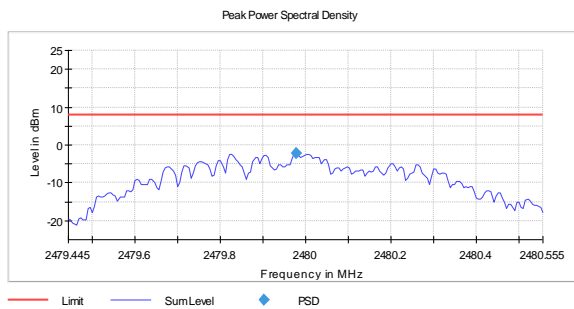
| Requirement for systems using Digital Modulation |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| The power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. |
| No requirements for Frequency Hopping Systems. |



PSD, 2402 MHz, 1Mb



PSD, 2440 MHz, 1Mb



PSD, 2480 MHz, 1Mb

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 testhouse.

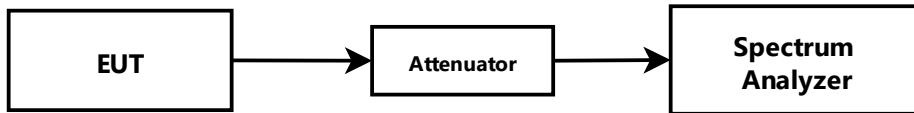
| No. | Model number | Description | Manufacturer | Ref. no. | Cal. date | Cal. Due |
|------|--------------------------|----------------------------------|--------------------|----------|-----------|----------|
| 1 | ESU40 | Measuring Receiver | Rohde & Schwarz | LR 1639 | 2024-02 | 2025-02 |
| 2 | 6810.17B | Attenuator | Suhner | LR 1669 | COU | |
| 3 | JB3 | Bilog Antenna | SunAR | N 4525 | 2023.04 | 2025.04 |
| 4 | 310 | Preamplifier | Sonoma Inst. | LR 1686 | 2024-09 | 2025-09 |
| 5 | NO324415 | Band Reject Filter | Microwave Circuits | LR 1760 | COU | |
| 6 | 3117-PA | Horn Antenna +PreAmp | EMCO | LR 1717 | 2025-02 | 2028-05 |
| 7 | 8449A | Pre-amplifier | Hewlett Packard | LR 1322 | 2024-06 | 2025-06 |
| 8 | 3115 | Double Ridged Horn Antenna | EMCO | LR 1330 | 2022.11 | 2025.11 |
| 9 | WLK5-1100-1485-7000-40SS | Low Pass Filter | Wainwright Inst. | LR 1761 | COU | |
| 10 | Model 87V | Multimeter | Fluke | LR 1599 | 2023-04 | 2025-04 |
| 11 | ST18/SMA/N/36 | RF Cable | Suhner | LR 1627 | COU | |
| 12 | TS8997 | Test System | Rohde & Schwarz | / | | |
| 12.1 | FSVA3044 | Spectrum analyzer | Rohde & Schwarz | LR 1808 | 2024.07 | 2026.01 |
| 12.2 | OSP220 | open switch and control platform | Rohde & Schwarz | LR 1806 | 2024.07 | 2026.08 |
| 12.3 | OSP120 | open switch and control platform | Rohde & Schwarz | LR 1793 | 2024.07 | 2026.08 |

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 | Rohde & Schwarz | GPBShot | 2.7 | Screenshots from R&S Spectrum Analyzers |
| | | | | |

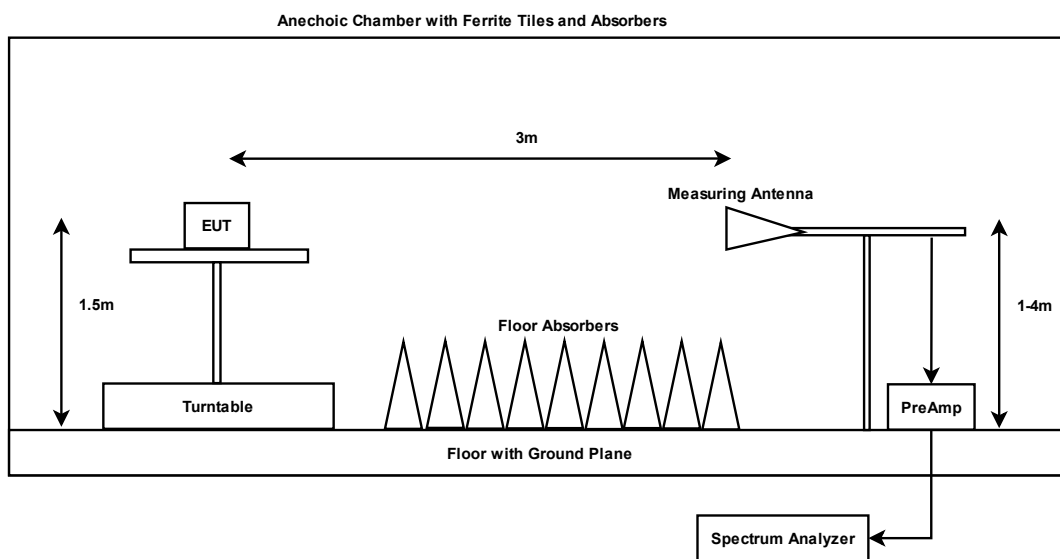
6 BLOCK DIAGRAMS OF TEST SET-UP

6.1 Conducted Tests



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

6.2 Test Site Radiated Emission



This test setup is used for all radiated emissions tests.

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.