

Test Report

Product	Maritime Broadband Radio
Name and address of the applicant	Kongsberg Discovery AS, Seatex Havnegata 9 N-7010 Trondheim, Norway
Name and address of the manufacturer	Kongsberg Discovery AS, Seatex Havnegata 9 N-7010 Trondheim, Norway
Model	MBR 189 MK2
Rating	300W (24-48 V _{DC})
Trademark	 KONGSBERG
Additional information	Operates in U-NII-3 band
Tested according to	FCC Part 15.407 Unlicensed National Information Infrastructure Devices (U-NII)
Order number	PRJ0034517
Tested in period	2023-05-15 to 2023-08-16 and 2024-03-13
Issue date	2024-03-14
Name and address of the testing laboratory	 Nemko Scandinavia AS Instituttveien 6 2007 Kjeller, Norway www.nemko.com CAB Number: FCC: NO0001   An accredited technical test executed under the Norwegian accreditation scheme
 Prepared by [Frode Sveinsen]  Approved by [Roy Uggerud]	
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Revision history

Revision	Date	Comment	Sign
A	2023-09-20	First Edition	FS
B	2023-11-16	Company Name updated	FS
C	2024-03-14	Added data for Channel III and updated EIRP measurements	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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2 INFORMATION

2.1 Test Item

Name	Kongsberg
Model	MBR 189 MK2
FCC ID	Q8IMBR189MK2
Serial number	2641
Hardware identity and/or version	Rev1
Software identity and/or version	2.20
Frequency Ranges	5735 – 5840 MHz (U-NII-3 Band)
Number of Channels	4
Type of Modulation	GMSK
RMS Output Power	180 W (EIRP, RMS)
Antenna Connector	None
Description of Antennas	Phased Array with 60 antenna elements
Antenna Diversity Supported	No
MIMO Supported	No
TPC Supported	Not required in U-NII-3 Band
DFS Supported	Not required in U-NII-3 Band
Ad-hoc Mode	N/A
Hotspot Mode	N/A
Power Supply	External DC Supply (24-48 V _{DC})

Description of Test Item

The EUT is a Maritime Broadband Radio for fixed installations.

2.3 Normal test conditions

Temperature:	20 - 24 °C
Relative humidity:	20 - 50 %
Normal test voltage:	48 V DC

The values are the limit registered during the test period.

2.4 Test Engineers

Frode Sveinsen

2.5 Antenna Requirement

Is the antenna detachable?	☐ Yes	☒ No
If detachable, is the antenna connector non-standard?	☐ Yes	☐ No
Type of antenna connector: N/A, Integral Antenna		

2.6 EUT Operating Modes

Description of operating modes	Continuous TX with Modulation
Additional information	The test was performed with the EUT transmitting continuously on highest and lowest channel and on one channel in the middle of the band. Output Power was reduced by 5.0 dB from the pre-programmed value for all channels.

2.7 Comments

All ports were populated during spurious emission measurements.

3 TEST REPORT SUMMARY

3.1 General

All measurements are traceable to national standards.

The tests were conducted to demonstrate compliance with FCC CFR 47 Part 15, paragraph 15.407.

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

Radiated tests were performed in a semi-anechoic chamber at measuring distances of 1m and 3m.

☒ New Submission	☒ Production Unit
☐ Class II Permissive Change	☐ Pre-production Unit
NII Equipment Code	☐ Family Listing

3.2 Test Summary

Name of test	FCC Part 15 reference	Result
Supply Voltage Variations	15.31(e)	Complies
Antenna Requirement	15.203	Complies
Power Line Conducted Emissions	15.107(a) 15.207(a)	N/A
Maximum Output Power	15.407(a)	Complies
Power Spectral Density	15.407(a)	Complies
Emission Bandwidth	15.407(a)(2)	Complies
Unwanted Emissions	15.407(b)	Complies
6 dB Bandwidth	15.407(e)	Complies
Radiated Emissions	15.205 15.209	Complies

4 TEST RESULTS

4.1 Maximum Output Power, EIRP

FCC 15.407 (a)

Measurement procedure: ANSI C63.10-2013 Clause 12.3, method SA-1

Test Results: Complies

Measurement Data:

Channel No.	Nominal Frequency (MHz)	Maximum Field Strength RMS (dBμV/m)	Maximum e.i.r.p. RMS, (dBm)	Maximum e.i.r.p. RMS, (Watts)
I	5735	147.8	52.5	180
II	5770	147.2	52.0	157
III	5805	145.3	50.1	102
IV	5840	146.5	51.3	134

The EUT operates continuously; therefore, method SA-1 of ANSI C63.10-2013 clause 12.3 was used.

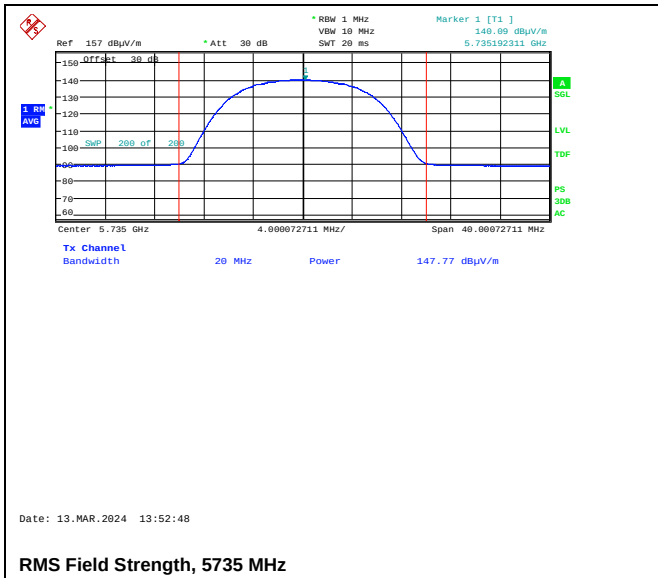
Field Strength was measured radiated at 3m.

EIRP values are calculated from Field Strength values using the method described in KDB 412172 D01.

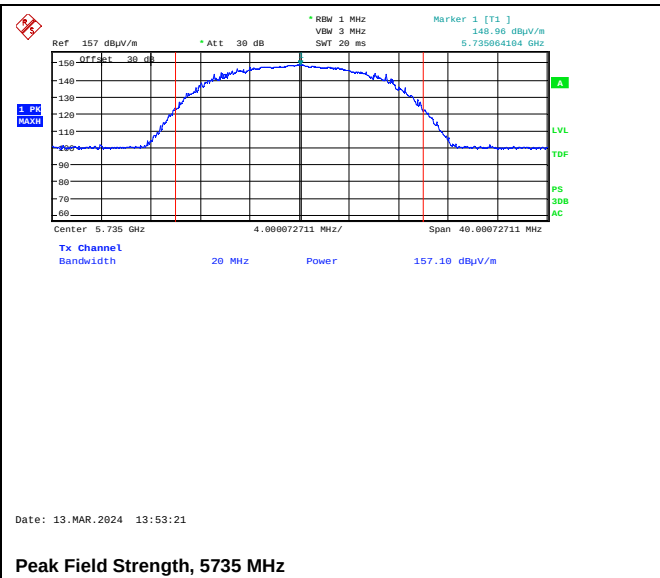
This is an outdoor device with smart antennas; no antenna connector was available.

Limits for Indoor Device:

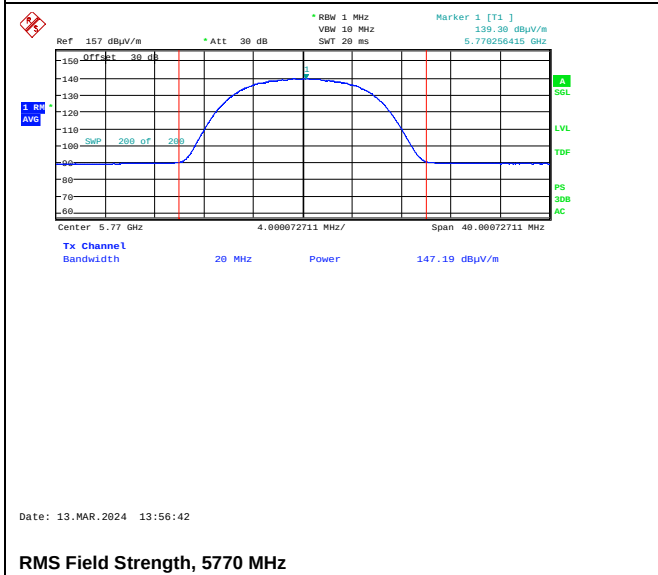
Frequency Band	FCC 15.407(a)
5725 – 5825 MHz	Less than 1 Watt
	If Antenna Gain is more than 6 dBi the Power Limit is reduced by the amount exceeding 6 dBi



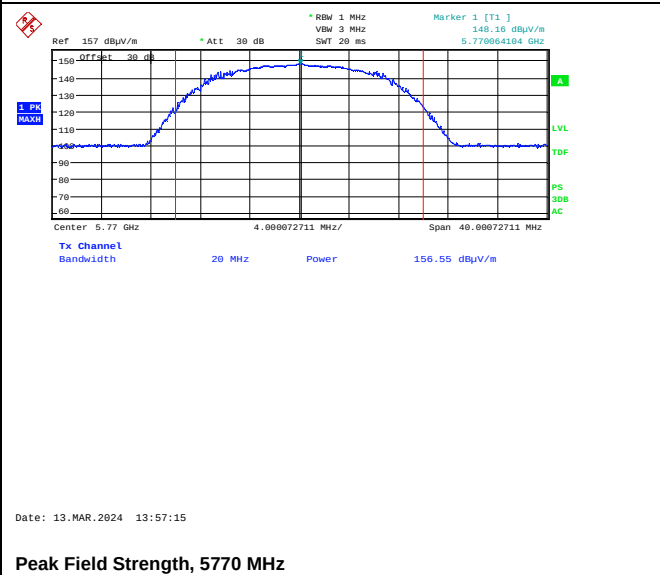
RMS Field Strength, 5735 MHz



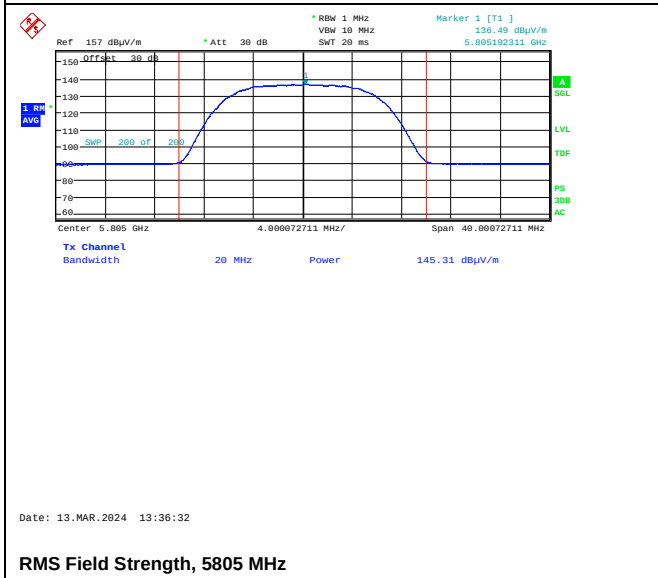
Peak Field Strength, 5735 MHz



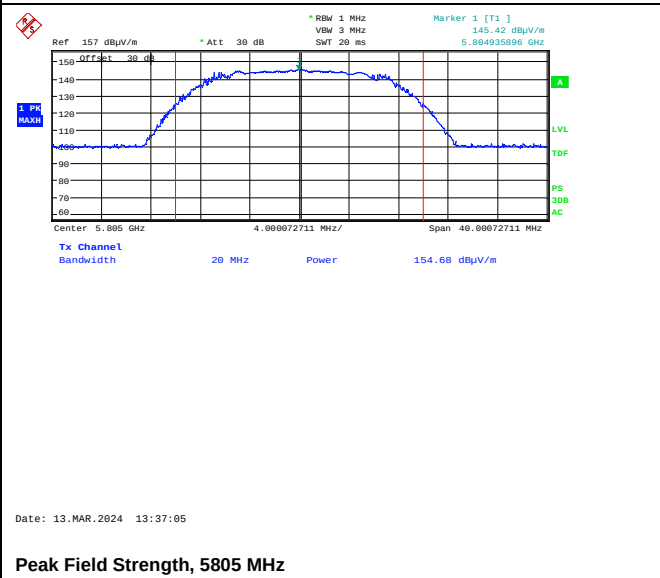
RMS Field Strength, 5770 MHz



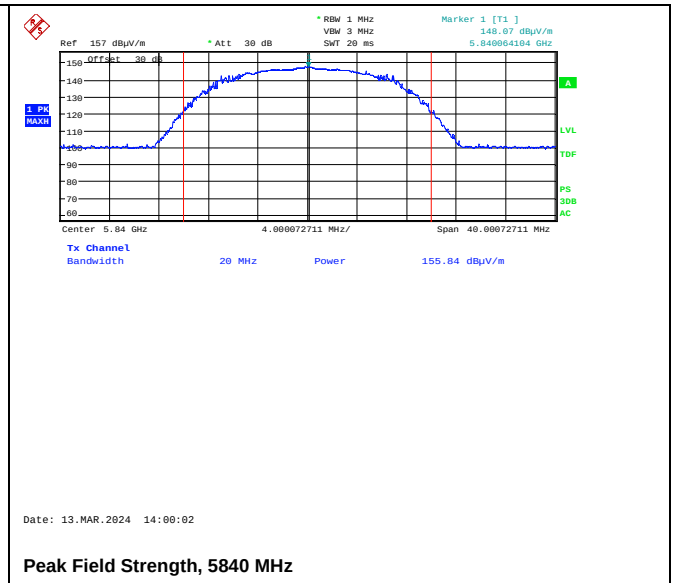
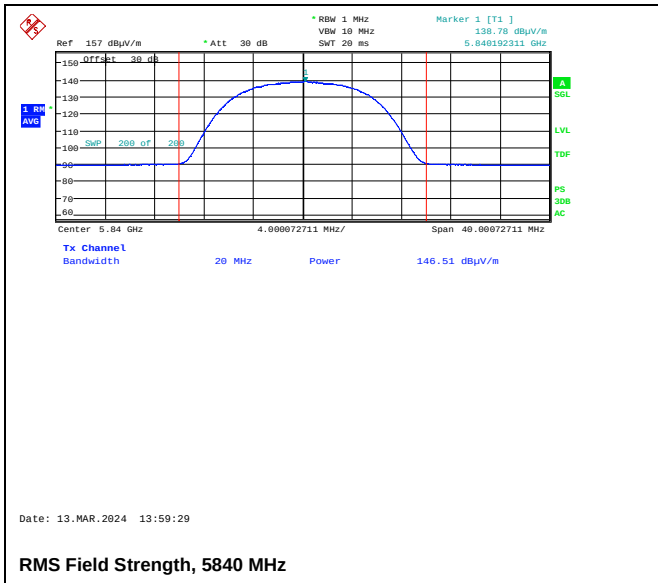
Peak Field Strength, 5770 MHz



RMS Field Strength, 5805 MHz



Peak Field Strength, 5805 MHz



4.3 Spectrum Mask

Para. No.: ETSI EN 303 276 V1.2.1 (2021-01)

Measurement procedure: ETSI EN 303 276 V1.2.1, clause 4.3.4

Test Results: Complies

Since the dynamic range of the spectrum analyzer is not large enough to measure down to -80 dBc, as required, the measurement had to be performed in two steps. The first step measured the carrier directly without filter; in the second step a tuned band-stop filter was used to measure the levels below -70 dBc.

Limit:

Output Power must be within the mask below; but does not need to be below the general spurious limit.

The measurement is performed with Max Hold and Resolution Bandwidth 1 MHz.

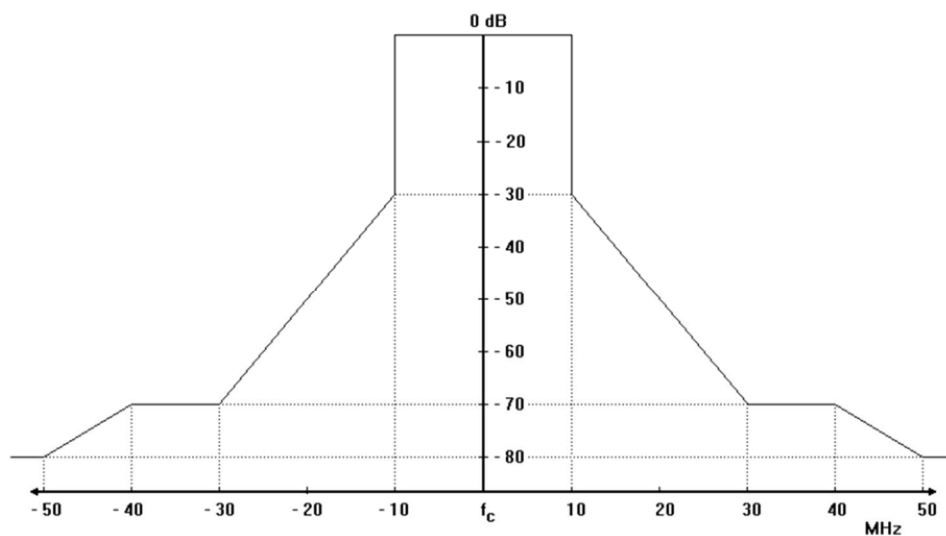
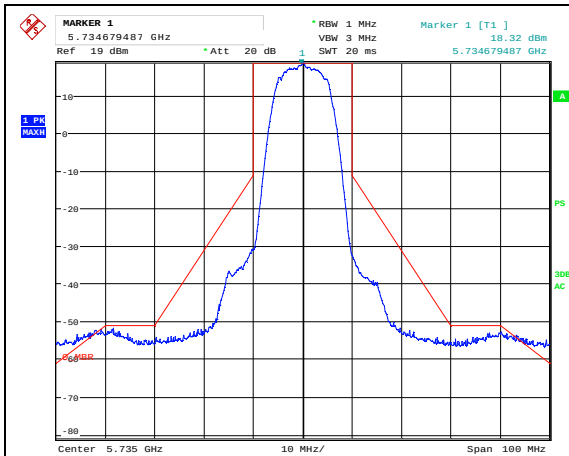
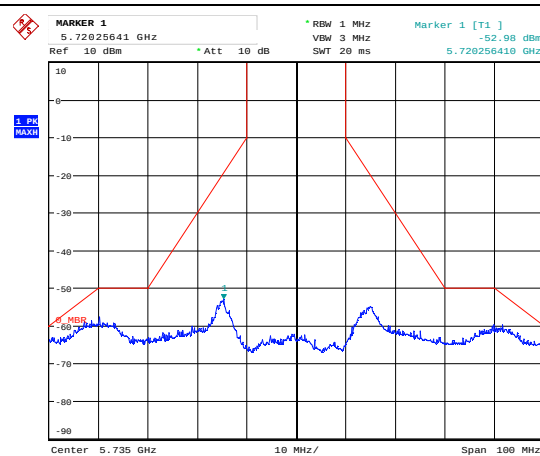


Figure 5: Transmitter power spectrum mask



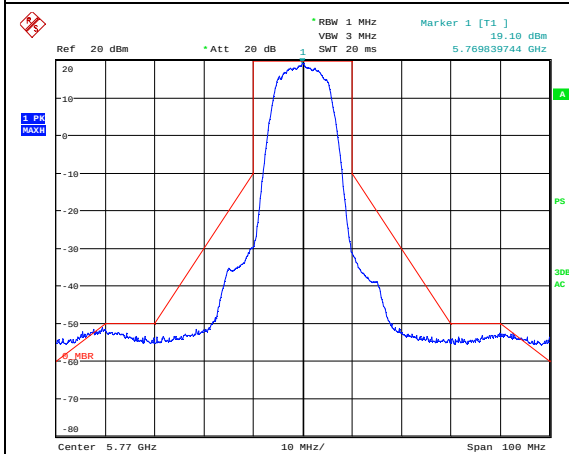
Date: 29.JUN.2023 14:47:58

Spectrum Mask, 5735 MHz



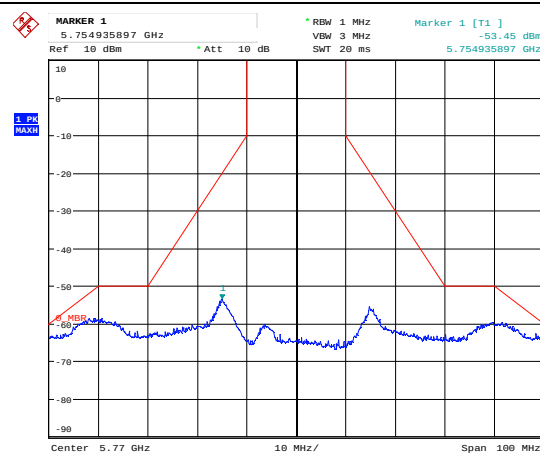
Date: 29.JUN.2023 15:22:52

Carrier with Filter, 5735 MHz



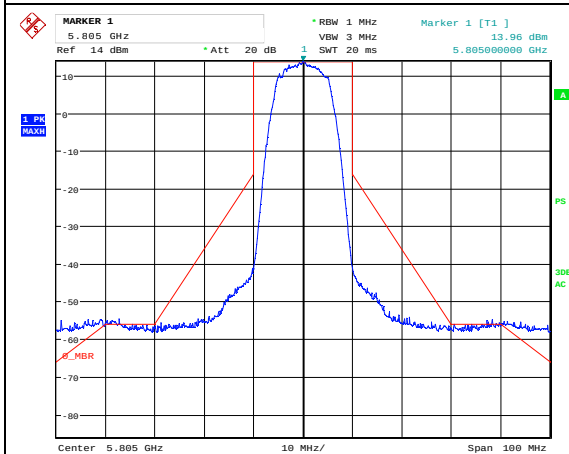
Date: 29.JUN.2023 14:44:47

Spectrum Mask, 5770 MHz



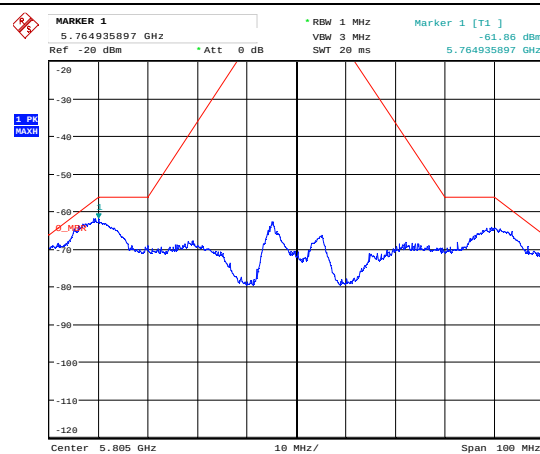
Date: 29.JUN.2023 15:15:18

Carrier with Filter, 5770 MHz



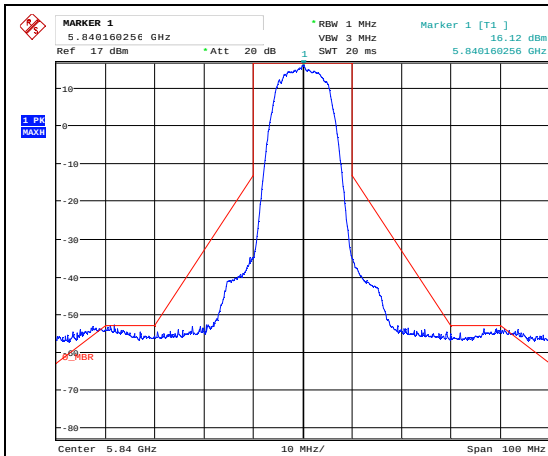
Date: 13.MAR.2024 17:01:08

Spectrum Mask, 5805 MHz



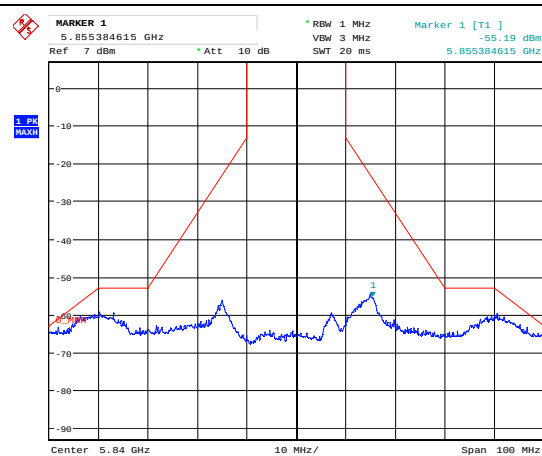
Date: 13.MAR.2024 17:23:52

Carrier with Filter, 5805 MHz



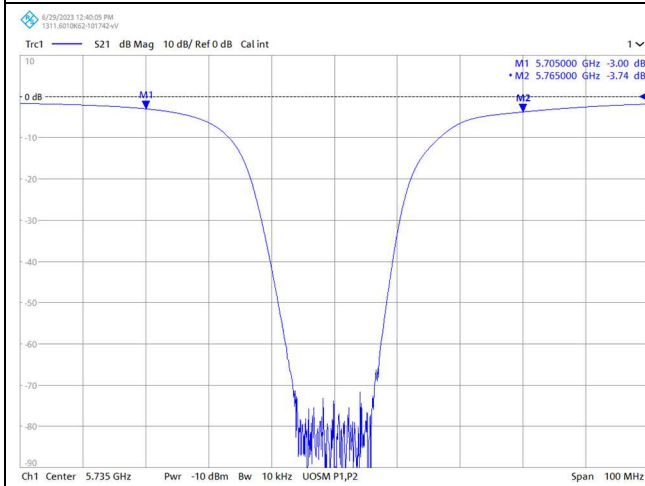
Date: 29 JUN. 2023 15:38:49

Spectrum Mask, 5840 MHz

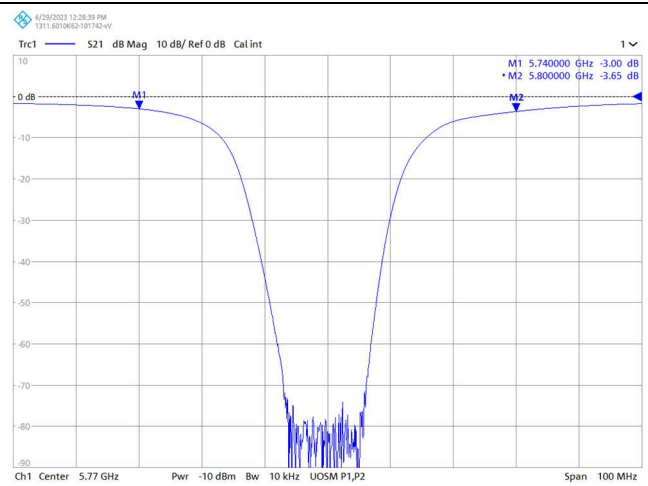


Date: 29 JUN. 2023 15:32:38

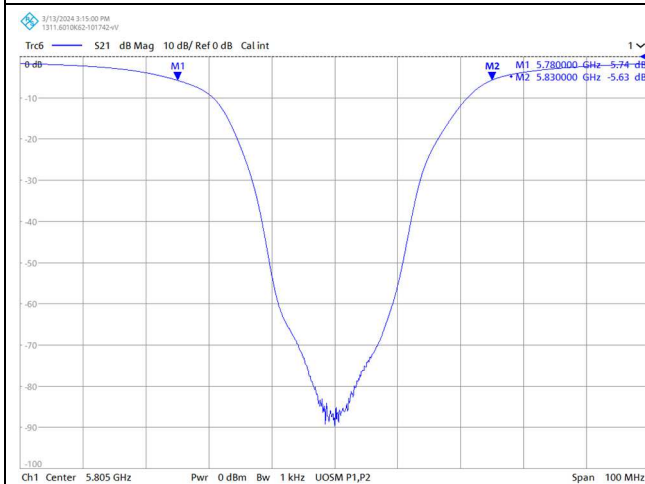
Carrier with Filter, 5840 MHz



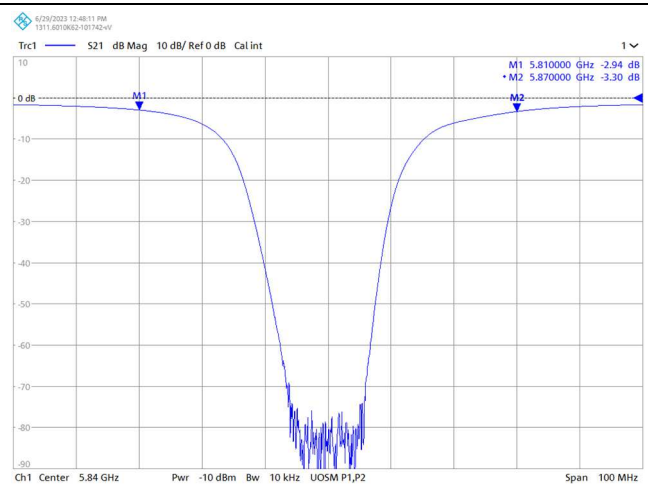
Filter response, 5735 MHz



Filter response, 5770 MHz



Filter response, 5805 MHz



Filter response, 5840 MHz

4.4 Emission Bandwidth / Occupied BW (99%)

Para. No.: 15.407(a)(2)

Measurement procedure: ANSI C63.10-2013 Clause 6.9.3 and 12.4.1

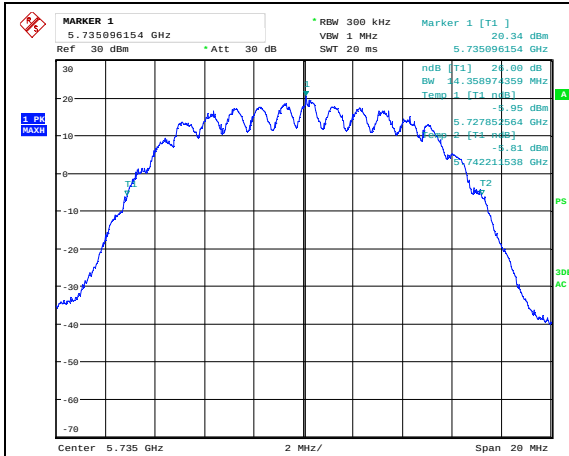
Test Results: Complies

Measurement Data:

Ch. No.	Nominal Frequency	Emission BW B (26dB BW)	Occupied BW (99%)
I	5735 MHz	14.4 MHz	12.0 MHz
II	5770 MHz	14.5 MHz	12.1 MHz
III	5805 MHz	14.5 MHz	12.0 MHz
IV	5840 MHz	14.6 MHz	12.0 MHz

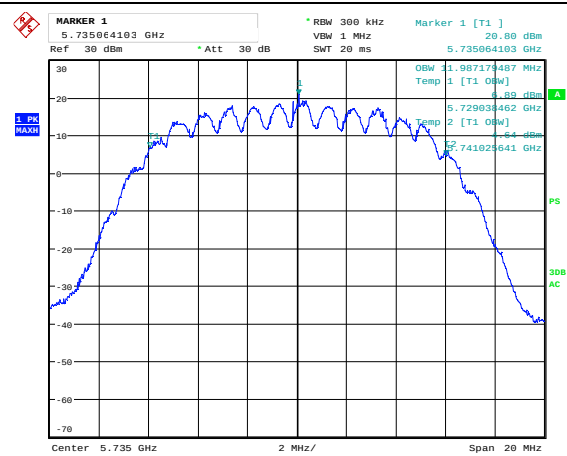
Limit:

No requirements as long as the emissions are within the band-edges.



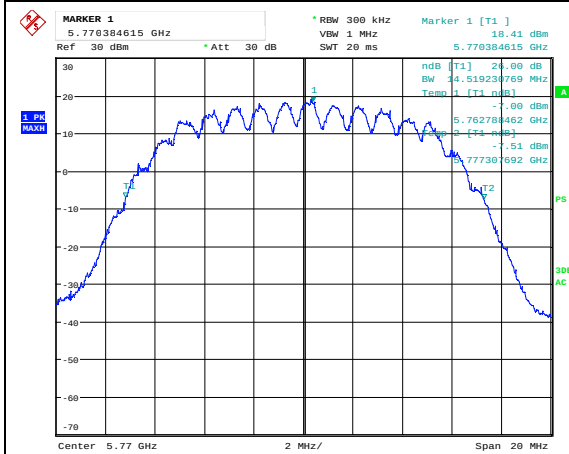
Date: 29.JUN.2023 17:03:24

Emission Bandwidth B, 5735 MHz



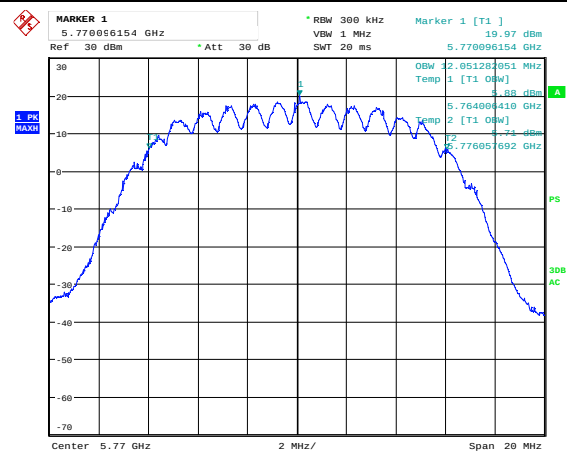
Date: 29.JUN.2023 17:03:56

99% Occupied Bandwidth, 5735 MHz



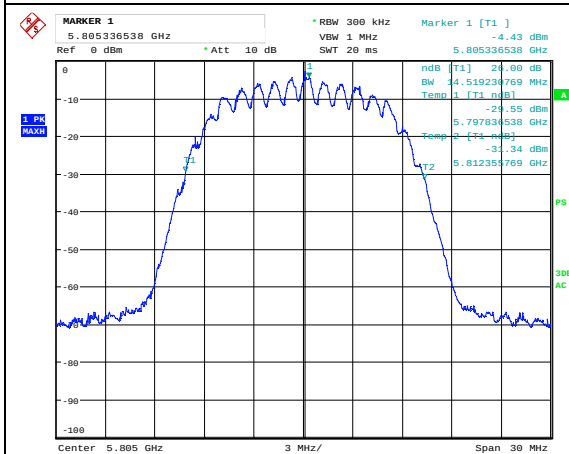
Date: 29.JUN.2023 16:57:55

Emission Bandwidth B, 5770 MHz



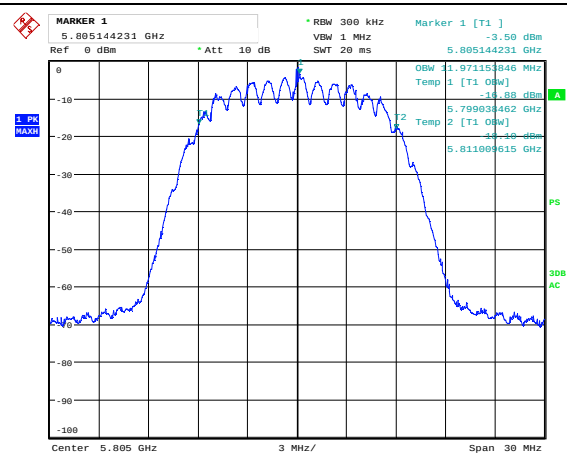
Date: 29.JUN.2023 16:57:13

99% Occupied Bandwidth, 5770 MHz



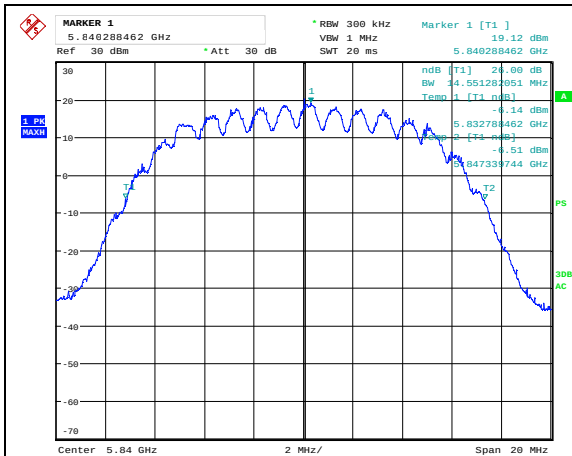
Date: 13.MAR.2024 14:14:17

Emission Bandwidth B, 5770 MHz



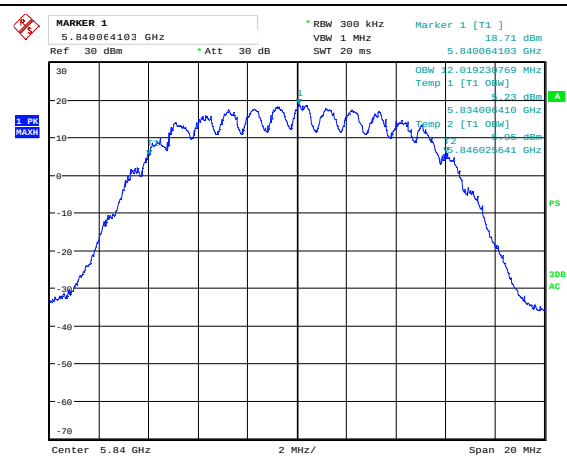
Date: 13.MAR.2024 14:12:37

99% Occupied Bandwidth, 5770 MHz



Date: 29.JUN.2023 16:54:31

Emission Bandwidth B, 5840 MHz



Date: 29.JUN.2023 16:55:12

99% Occupied Bandwidth, 5840 MHz

4.5 DTS Bandwidth

Para. No.: 15.407(e)

Measurement procedure: ANSI C63.10-2013 Clause 11.8, Option 1

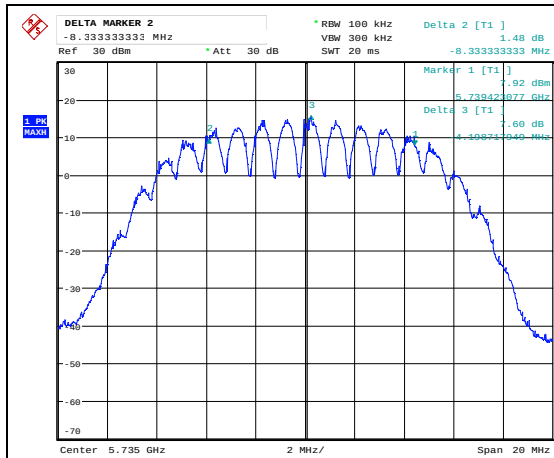
Test Results: Complies

Measurement Data:

Ch. No.	Nominal Frequency	DTS Bandwidth (6 dB)
I	5735 MHz	8.3 MHz
II	5770 MHz	8.3 MHz
III	5805 MHz	9.4 MHz
IV	5840 MHz	8.5 MHz

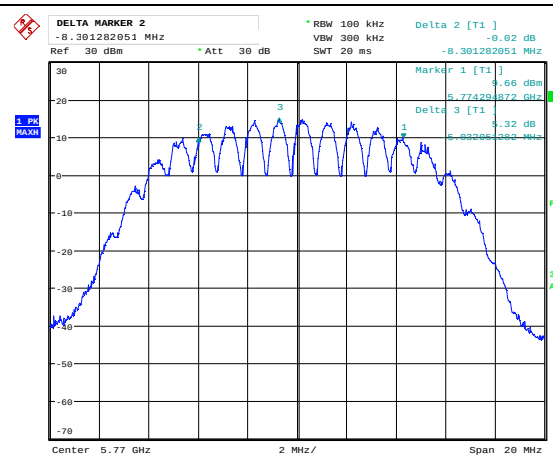
Limit:

Within the 5.725-5.85 GHz band, the minimum 6 dB bandwidth of U-NII devices shall be at least 500 kHz.



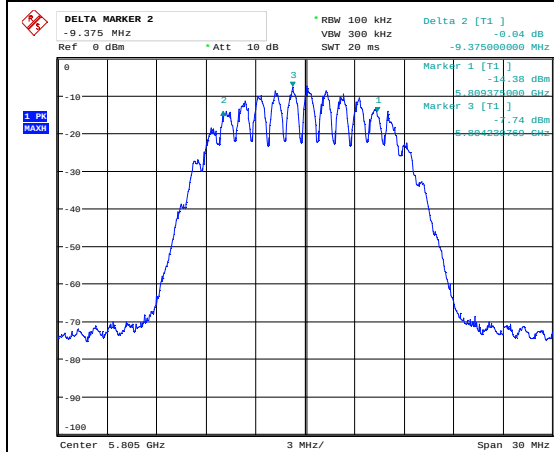
Date: 29 JUN 2023 17:02:56

DTS BW, 5735 MHz



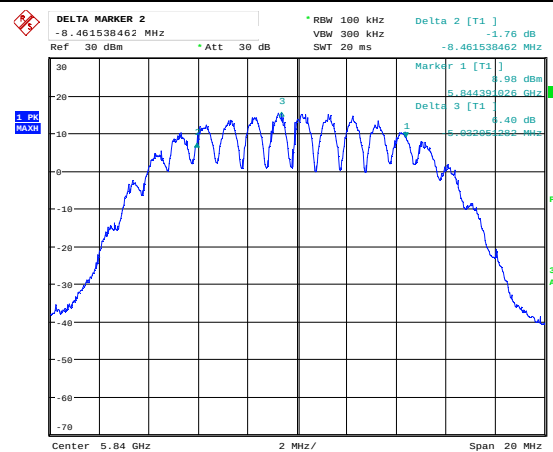
Date: 29 JUN 2023 16:59:57

DTS BW, 5770 MHz



Date: 13 MAR 2024 14:16:24

DTS BW, 5805 MHz



Date: 29 JUN 2023 16:53:38

DTS BW, 5840 MHz

4.6 Peak Power Spectral Density

FCC 15.407(a)

Measurement procedure: ANSI C63.10-2013 Clause 12.5

Test Results: Complies

Measurement Data:

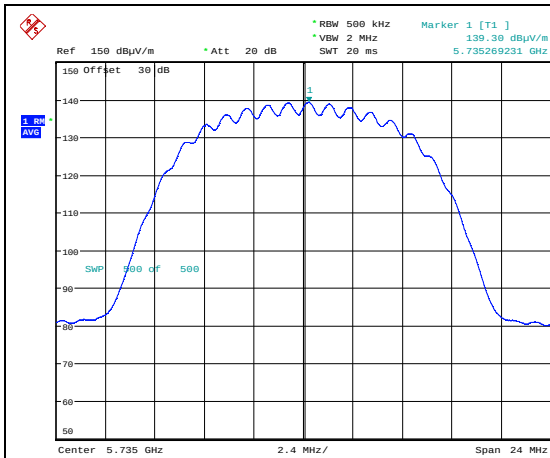
Ch. No.	Nominal Frequency	Average PSD (dBμV/m / 500kHz @3m)	Average PSD (dBm / 500kHz)
I	5735 MHz	139.3	44.1
II	5770 MHz	138.8	43.6
IV	5840 MHz	138.2	43.0

Field Strength was converted to EIRP using the method described in KDB 412172.

This is an outdoor device with smart antennas; no antenna connector was available.

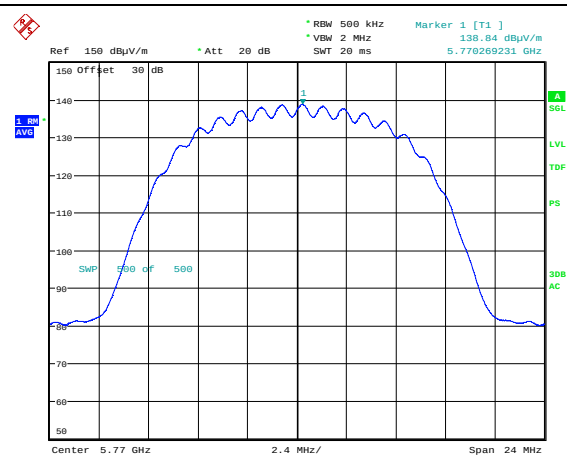
Limits:

Frequency Band	FCC 15.407(a)
5725 – 5825 MHz	Less than 30 dBm/500kHz
	If Antenna Gain is more than 6 dBi the limit above is reduced by the amount exceeding 6 dBi



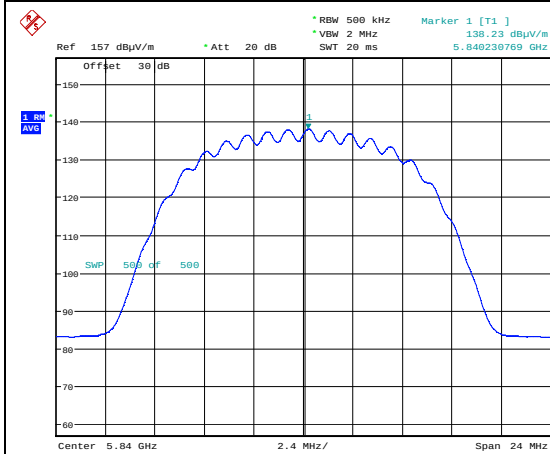
Date: 16.AUG.2023 13:03:51

PSD, 5735 MHz



Date: 16.AUG.2023 13:20:24

PSD, 5770 MHz



Date: 16.AUG.2023 13:12:36

PSD, 5840 MHz

4.7 Unwanted Emissions

FCC 15.407 (b)

Measurement procedure: ANSI C63.10-2013 Clause 12.7

Test Results: Complies

Measurement Data

Band Edge Emissions:

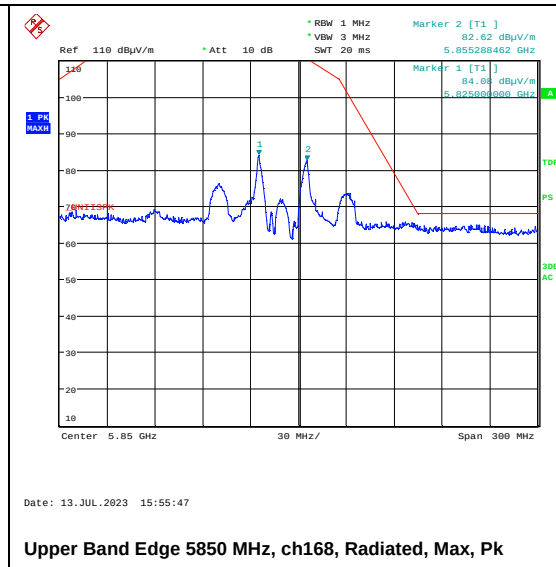
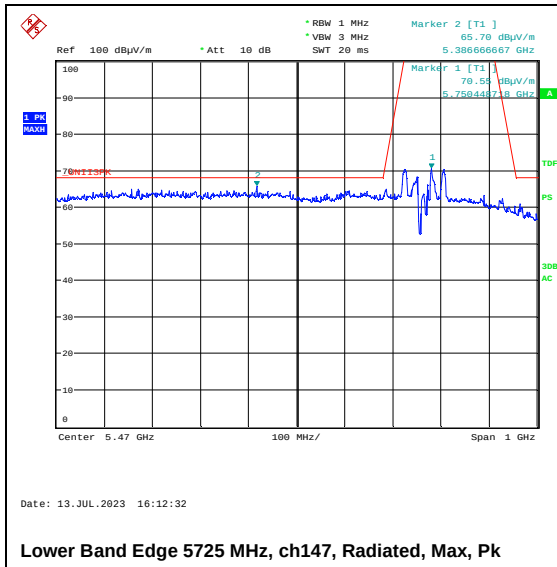
Ch. No.	Carrier Frequency (MHz)	Band Edge Frequency (MHz)	Measured Values (dBm/MHz e.i.r.p.)
			802.11a 6Mb
I	5735	5650	< -40
IV	5840	5875	< -45

The measurement was performed radiated.

EIRP values were calculated from field strength using the method in KDB 412172 D01.

Limits:

Operating Frequency band	Limit for Emissions Outside Operating Frequency Band
5725 – 5825 MHz	See FCC 15.407(b)(4)(i) or 15.407(b)(4)(ii)



4.8 Restricted Bands of operation

Restricted Bands of operation for FCC are defined in FCC Part 15.205.

Generally, no fundamentals are allowed in the restricted bands and all emissions must comply with the limits in FCC 15.209.

FCC (MHz)	FCC (GHz)
0.090-0.110	0.96-1.24 1.3-1.427
0.495-0.505	1.435-1.6265
2.1735-2.1905	1.6455-1.6465
	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
	2.4835-2.5
6.215-6.218	2.69-2.9
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
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	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	

4.9 Radiated Emissions, 30 – 1000 MHz

FCC 15.205, 15.209, 15.407

Measurement procedure: ANSI C63.10-2013 Clause 12.7

Test Results: Complies

Measurement Data:

Detector: QuasiPeak (Prescan with Peak Detector)

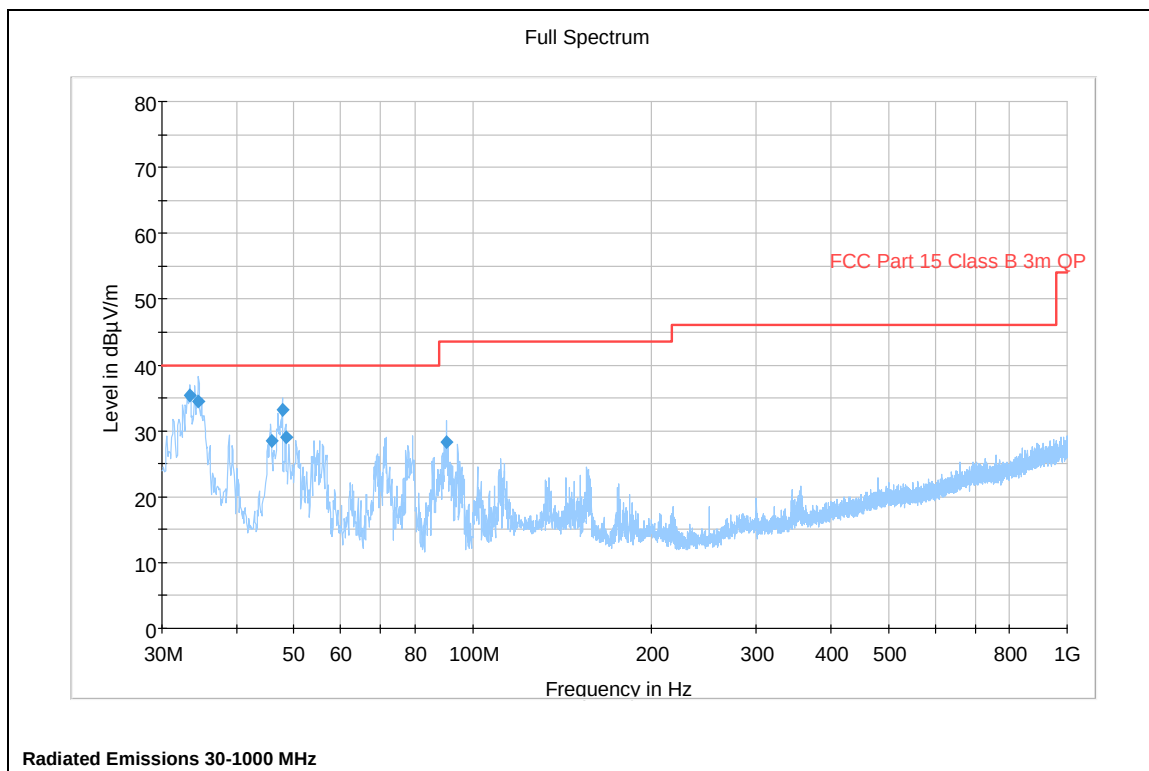
Measuring distance 3m

Frequency (MHz)	QuasiPeak (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
33.448316	35.32	40.00	4.68	15000.0	120.000	100.0	V	1.0	-7.0
34.575272	34.48	40.00	5.52	15000.0	120.000	150.0	V	204.0	-7.9
45.781860	28.42	40.00	11.58	15000.0	120.000	102.0	V	187.0	-13.8
47.797782	33.22	40.00	6.78	15000.0	120.000	232.0	V	204.0	-14.5
48.468826	28.98	40.00	11.02	15000.0	120.000	136.0	V	63.0	-14.7
90.328222	28.32	43.50	15.18	15000.0	120.000	118.0	V	279.0	-16.1

See attached plots.

Requirements/Limit

FCC	Part 15.209 @ frequencies defined in §15.205	
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		



4.10 Radiated Emissions, 1 – 40 GHz

FCC 15.205, 15.209, 15.407

Measurement procedure: ANSI C63.10-2013 Clause 12.7

Test Results: Complies

Measurement Data:

Measuring distance 3m up to 18 GHz.

A prescan at 1m was performed from 18 – 40 GHz

Carrier Freq. (MHz)	Measured Freq. (GHz)	Measured Emission (dBμV/m)		Limit (dBμV/m)		Margin (dB)	
		Peak	Average	Pk	Av	Pk	Av
Any	Any	< 65	< 50	74	54	> 9	> 4

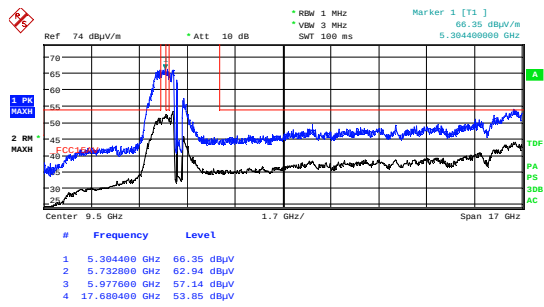
No spurious emissions were detected.

Antenna factor, amplifier gain, and cable loss are included in Spectrum Analyzer “Transducer factor”.

See attached plots.

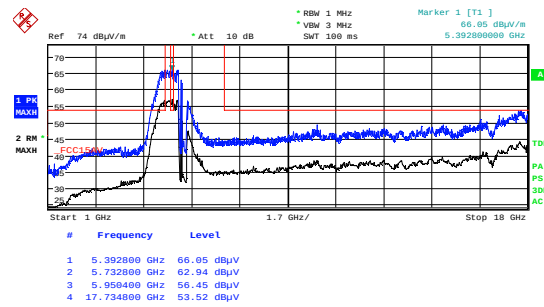
Requirements/Limit

FCC	Part 15.209 @ frequencies defined in §15.205	
	Radiated emission limit @3 meters	
Frequency	Average Detector (dBμV/m)	Peak Detector (dBμV/m)
1 – 40 GHz	54	74



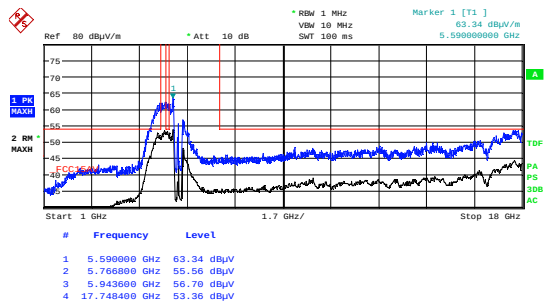
Date: 15.MAY.2023 15:40:47

Radiated Emissions 1-18 GHz, 5735 MHz, HP



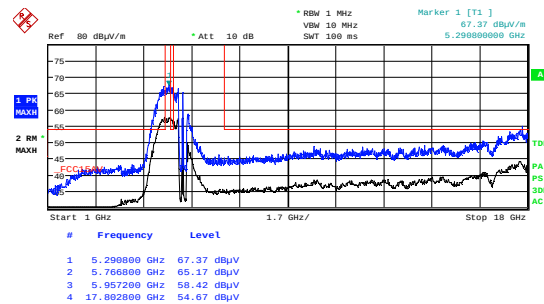
Date: 15.MAY.2023 15:38:50

VP



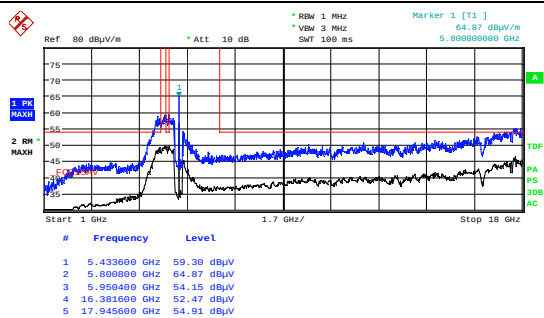
Date: 15.MAY.2023 15:08:35

Radiated Emissions 1-18 GHz, 5770 MHz, HP



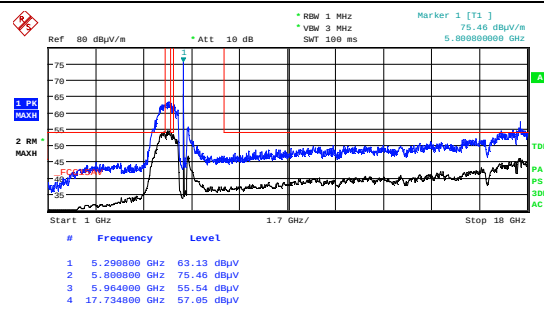
Date: 15.MAY.2023 15:06:38

VP



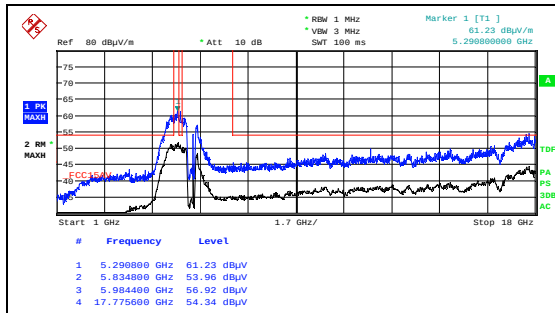
Date: 13.MAR.2024 14:58:56

Radiated Emissions 1-18 GHz, 5805 MHz, HP



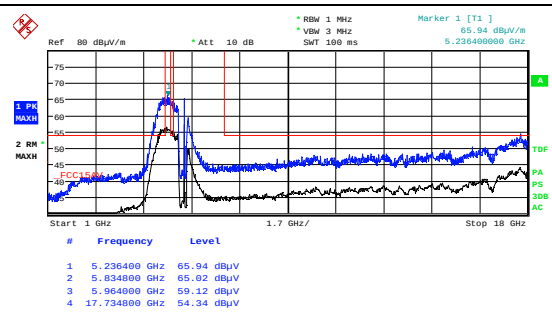
Date: 13.MAR.2024 14:57:00

VP



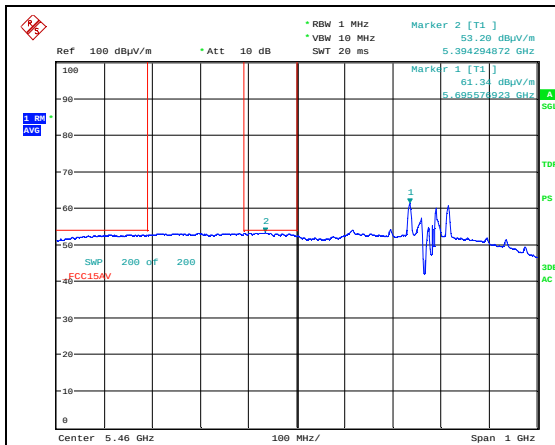
Date: 15.MAY.2023 15:56:34

Radiated Emissions 1-18 GHz, 5840 MHz, HP



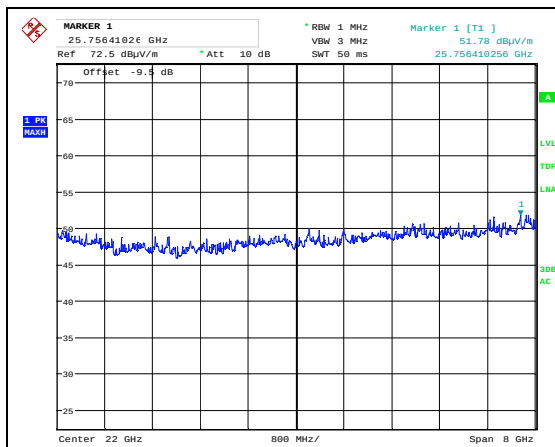
Date: 15.MAY.2023 15:54:38

VP



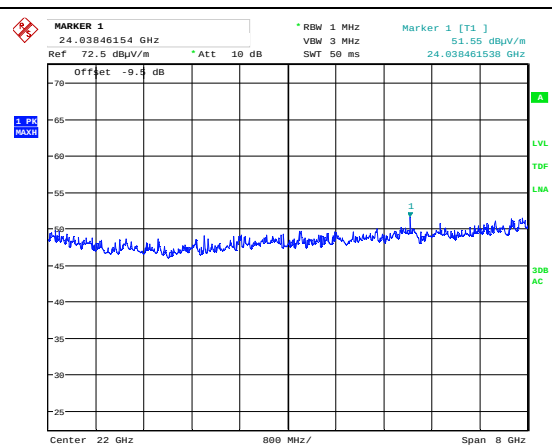
Date: 13.JUL.2023 16:13:22

Lower Band Edge 5725 MHz, ch147, Radiated, Max, Av



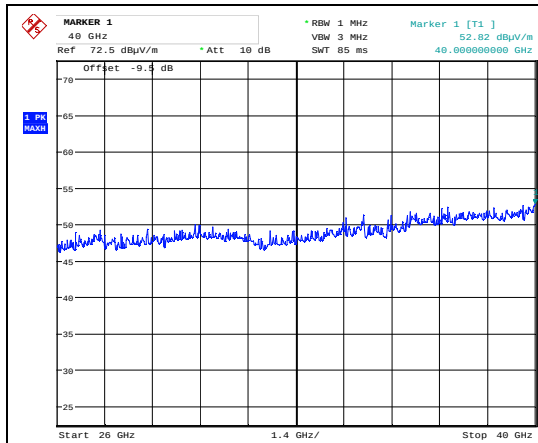
Date: 29.JUN.2023 13:47:37

Pre-scan @1m, 18-26 GHz, 5770 MHz, HP



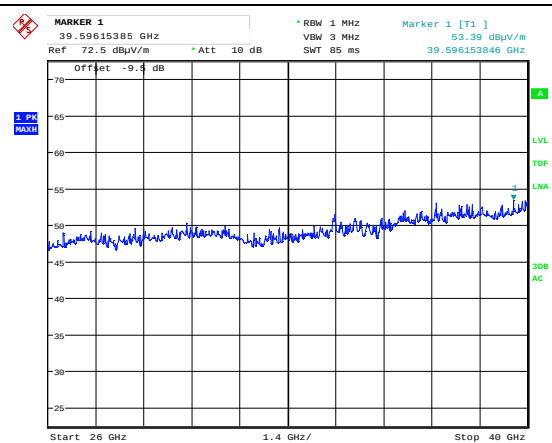
Date: 29.JUN.2023 13:45:04

VP



Date: 29.JUN.2023 13:40:41

Pre-scan @1m, 26-40 GHz, 5770 MHz, HP



Date: 29.JUN.2023 13:38:17

VP

5 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

6 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	ESU40	Measuring Receiver	Rohde & Schwarz	LR 1639	2022-01 2024-01	2023-01 2025-01
2	3117-PA	Horn Antenna +PreAmp	EMCO	LR 1717	2022-08 2023-08	2023-08 2024-08
3	6810-17B	Attenuator	Suhner	LR 1669	COU	
4	N0257881	BandStop Filter (5.8 GHz)	Wainwright Inst.	LR 1764	COU	
5	L01G18G1	LowPass Filter (1 GHz)	Microwave Circuits	LR 1768	COU	
6	VULB 9163	Hybrid Antenna	Schwarzbeck	LR 1616	2021-05	2024-05
7	310	Preamplifier	Sonoma Inst.	LR 1686	2022-08	2023-08
8	Model 638	Antenna Horn	Narda	LR 1480	N/A	
9	Model V637	Horn Antenna	Narda	LR 099	N/A	
10	JS4-20004000	Preamplifier	Miteq	LR 1591	2022-08	2023-08
11	Model 87 V	Multimeter	Fluke	LR 1600	2022-03	2024-03
12	5920_N-50-010	Attenuator	Suhner	LR 1832	COU	
13	3115	Horn Antenna	EMCO	LR 1226	2022-12	2027-12
14	8449B	Preamplifier	Hewlett Packard	LR 1322	2022-08 2023-08	2023-08 2024-08

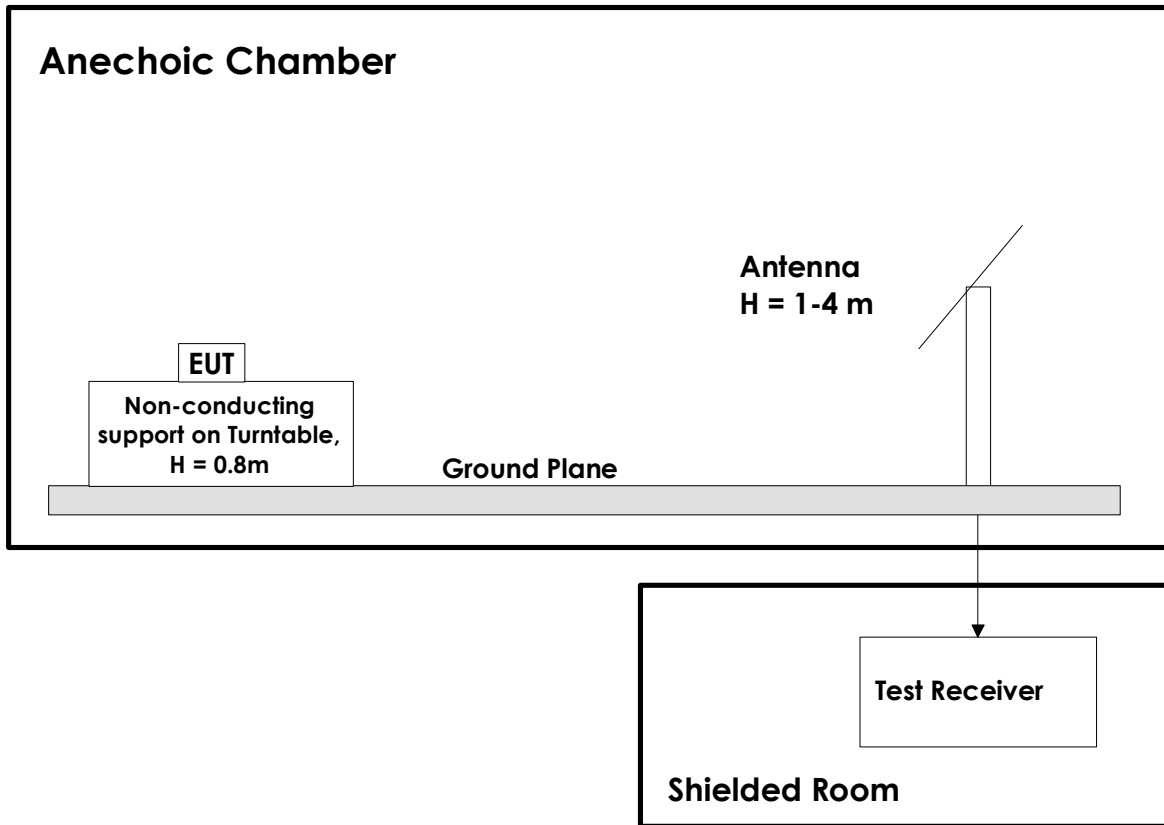
Note: COU – calibrate on use; N/A – Not Applicable

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

No.	Manufacturer	Name	Version	Comment
1	Rohde & Schwarz	EMC32	10.50.30	EMC test software
2	Nemko	RSPlot	1.0.8.0	Screenshots from R&S Spectrum Analyzers

7 BLOCK DIAGRAM

7.1 Test Site Radiated Emission



This test setup is used for all radiated emissions tests. Measuring distance is 3m for all frequencies.

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

All measurements at 1GHz and above were performed with turntable height 1.5m and with the ground plane covered by absorbers.

A pre-amplifier was used for all measurements.

For carrier measurements, up to 30 dB attenuation was used to avoid overloading the preamp.

A Band-Stop filter was used for Spurious Emissions and Band Edge measurements below 18 GHz.

A Low-Pass Filter was used below 1 GHz.