

Test Report

HELEM2311000468-1



INTENTIONAL RADIATOR TESTS ACCORDING TO FCC PART 15 C AND ISED CANADA REQUIREMENTS

Equipment Under Test: Virtual Reality Headset

Trademark: Varjo

Model: HS-10C

Manufacturer / Customer: Varjo Technologies Oy
Vuorikatu 20
FI-00100 Helsinki
Finland

FCC Rule Part: §15.247
IC Rule Part: RSS-247, Issue 3, 2023
RSS-Gen, Issue 5 Amendment 2, 2021
KDB: 558074 D01 15.247 Meas Guidance v05r02
Guidance for Compliance Measurements on Digital Transmission Systems,
Frequency Hopping Spread Spectrum System, and Hybrid System Devices
Operating Under §15.247 of the FCC rules (April 2, 2019)

- *partial testing, see test suite for details*

Date: 7 February 2024

Issued by:

A handwritten signature in blue ink, appearing to read 'Henri Mäki'.

Henri Mäki
Testing Engineer

Date: 7 February 2024

Checked by:

A handwritten signature in blue ink, appearing to read 'Rauno Repo'.

Rauno Repo
Senior EMC Specialist

TABLE OF CONTENTS

TABLE OF CONTENTS	2
GENERAL REMARKS	3
Disclaimer	3
RELEASE HISTORY	4
PRODUCT DESCRIPTION	5
Equipment Under Test	5
General Description	5
Ratings and declarations	5
Port and Cables	6
Peripherals	6
SUMMARY OF TESTING	7
EUT Test Conditions during Testing	7
Test Facility	8
TEST RESULTS	9
Antenna Requirement	9
AC Power-Line Conducted Emissions	10
Unwanted Emissions (radiated)	12
TEST EQUIPMENT	25
AC Power-Line Conducted Emissions	25
Radiated Emissions	25

GENERAL REMARKS

Disclaimer

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Unless otherwise stated the results shown in this test report refer only to the sample(s) tested and such sample(s) are retained for 30 days only.

RELEASE HISTORY

Version	Changes	Issued
1.0	Initial release	2 January 2024
1.1	Test equipment list updated: measurement cables added	2 February 2024
1.2	Test equipment list updated: measurement antenna (inv. 8013) added	7 February 2024

PRODUCT DESCRIPTION

Equipment Under Test

Equipment Under Test:	Virtual Reality Headset
Trademark:	Varjo
Model:	HS-10C
Type:	-
Serial no:	8RF02FA14D1220113
FCC ID:	2AROD-005 (proprietary radio)
Contains FCC ID:	SH6MDBT50Q (Bluetooth Low Energy)
IC:	24483-005 (proprietary radio)
Contains IC:	8017A-MDBT50Q (Bluetooth Low Energy)
Radio module or chip:	Raytac Corporation MDBT50Q-P1MV2 (Bluetooth Low Energy) Nordic Semiconductor nRF52840-QIAA-F-R (proprietary 2.4 GHz radio)

General Description

The equipment under test is a virtual reality headset including two Bluetooth Low Energy modules and a 2.4 GHz RF chip with a proprietary protocol for controller connections. The EUT connects to a headset adapter and a PC with 5 m USB-C and 5 m DisplayPort cables.

Classification

Fixed device	☐
Mobile Device (Human body distance > 20cm)	☐
Portable Device (Human body distance < 20cm)	☒

Samples and Modifications

No.	Name	Description
1	EUT	Test sample with an RF test firmware

Ratings and declarations

Operating frequency range:	2402 – 2480 MHz
Nominal channel bandwidth:	2 MHz
Number of channels:	40
Channel separation:	2 MHz
Transmission technique:	DSSS
Modulation:	GFSK
Data rate:	1 Mbps, 2 Mbps
Antenna type:	Integral inverted L antenna (proprietary radio) Integral PCB antenna (BLE radios)
Antenna gain:	+2.8829 dBi (proprietary radio) +0.41 dBi (BLE radios)
Antenna count:	1 per radio module
EUT dimensions:	Height: 150...185 mm Width: 200 mm Length: 330...400 mm
Power requirements:	15 VDC, 3 A
Operating temperature range:	+10...+35 °C

Product Description**Port and Cables**

Cable / Port	Description
DisplayPort	Connected to the peripheral laptop
USB-C	Connected to the peripheral headset adapter

Peripherals

Peripheral	Description / Usage
Laptop	MSI Vector GP66 12UH, configuring the EUT
AC/DC power supply	Chicony A18-280P1A, power supply to laptop
Headset adapter	Varjo LB-4, power supply and data communication to EUT
AC/DC power supply	Varjo CH-01, power supply to headset adapter

The peripherals were supplied by the customer.

SUMMARY OF TESTING

Test Specification	Description of Test	Result
§15.203	Antenna Requirement	PASS
§15.205 / RSS-Gen 8.8	AC Power-Line Conducted Emissions	PASS
§15.247(a)(2) / RSS-247 5.2 a)	6 dB Bandwidth	N/T
RSS-Gen 6.7	Occupied Bandwidth 99 %	N/T
§15.247(b)(3) / RSS-247 5.4 d)	Maximum Peak Conducted Output Power	N/T
§15.247(d) / RSS-247 5.5	Unwanted Emissions	PASS
§15.247(e) / RSS-247 5.2 b)	Power Spectral Density	N/T

The decision rule applied for the tests results stated in this test report is according to the requirements of section 1.3 of ANSI C63.10-2013.

EUT Test Conditions during Testing

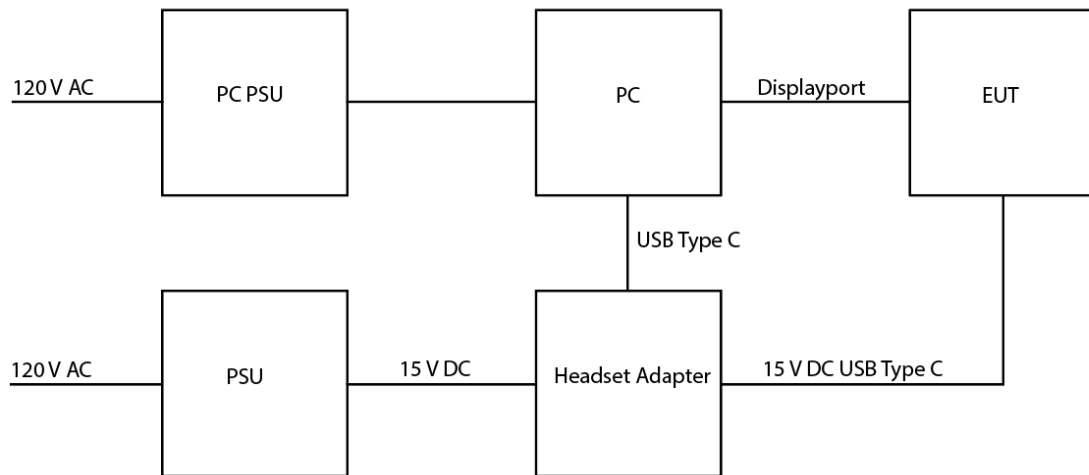
The radio was configured with a software provided by the manufacturer (nRF Connect), using the Direct Test Mode application with the following settings:

- Transmit power 4 dBm (proprietary radio), 8 dBm (BLE radios)
- Physical layer LE 1Mbps
- Packet type PRBS9
- Packet length 40 bytes

The radios were set to transmit simultaneously with the following channel configurations:

Configuration	BLE1 freq. [MHz]	BLE2 freq. [MHz]	Proprietary freq. [MHz]
1	2402	2440	2480
2	2440	2480	2402
3	2480	2402	2440

Tests were performed in a semi-anechoic chamber with a measurement distance of 3 meters. During measurements above 1 GHz absorbers were placed on the floor.

**Figure 1:** Test setup block diagram

Test Facility

Testing Laboratory / address: FCC designation number: FI0002 ISED CAB identifier: T004	SGS Fimko Ltd Takomotie 8 FI-00380, HELSINKI FINLAND
Test Site:	☐ K10LAB, ISED Canada registration number: 8708A-1 ☒ K5LAB, ISED Canada registration number: 8708A-2 ☐ T10LAB

TEST RESULTS

Antenna Requirement

Standard: FCC Rule §15.203
Tested by: HEM
Date: 4 December 2023

FCC Rule: §15.203

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device.

Specification	Requirement (at least one of the following shall be applied)	Conclusion
§15.203	1. Permanently attached antenna 2. Unique coupling to the intentional radiator 3. Professionally installed radio. The installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.	PASS
Note	Option 1 is used	

AC Power-Line Conducted Emissions

Standard:	ANSI C63.10-2013
Tested by:	HEM
Date:	8 December 2023
Temperature:	22.8 °C
Humidity:	27 %RH
Measurement uncertainty:	± 2.9 dB, level of confidence 95 % (k = 2)
Test result:	PASS

FCC Rule: §15.207(a)

RSS-Gen clause 8.8

An intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in §15.207(a) and RSS-Gen clause 8.8, as measured using a 50 µH/50 ohms line impedance stabilization network (LISN).

For equipment that connects to the AC power lines indirectly, through another device, the requirement for compliance with the limits shall apply at the terminals of the AC power-line mains cable of a representative support device, while it provides power to the equipment.

The emissions are measured with a LISN from 150 kHz to 30 MHz with a resolution bandwidth of 9 kHz using peak and average detectors.

The correction factor in the final result table contains the sum of the transducers (LISN + cables). The result value is the measured value corrected with the correction factor.

AC Power-Line Conducted Emissions

Test results

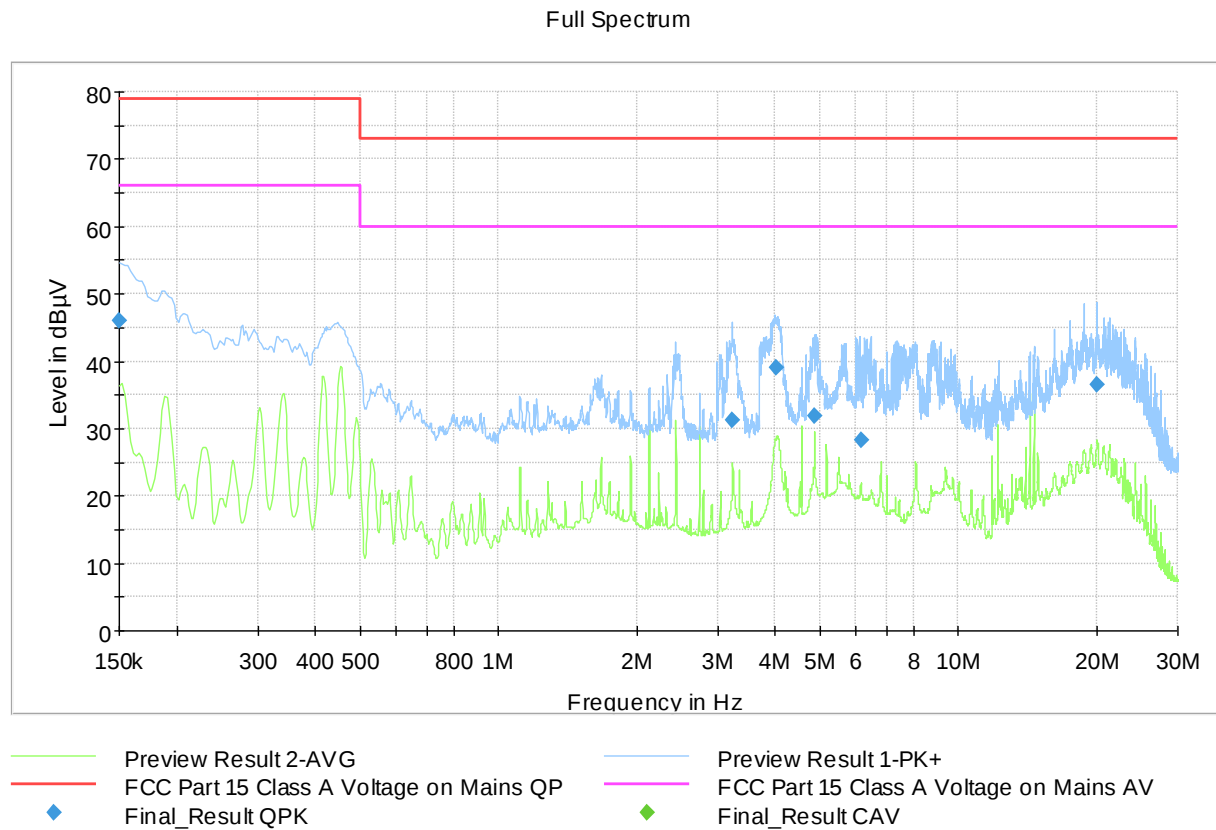


Figure 2: AC Power-Line Conducted Emissions

Table 1: Test results for AC Power-Line Conducted Emissions

Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)
0.150000	46.07	---	79.00	32.93	15 x 1000.0	9.000	N	9.7
3.230000	31.27	---	73.00	41.73	15 x 1000.0	9.000	N	9.9
4.010250	39.08	---	73.00	33.92	15 x 1000.0	9.000	L1	10.0
4.882500	31.87	---	73.00	41.13	15 x 1000.0	9.000	L1	10.0
6.143500	28.38	---	73.00	44.62	15 x 1000.0	9.000	N	10.1
20.051500	36.57	---	73.00	36.43	15 x 1000.0	9.000	N	10.6

Unwanted Emissions (radiated)

Standard:	ANSI C63.10-2013	
Tested by:	HEM	
Date:	4 December 2023	5 December 2023
Temperature:	22.8 – 23.5 °C	22.5 – 23.6 °C
Humidity:	24 – 31 %RH	24 – 30 %RH
Measurement uncertainty:	± 4.51 dB, level of confidence 95 % (k = 2)	
Test result:	PASS	

FCC Rule: §15.247(d)**RSS-247 clause 5.5**

In any 100 kHz bandwidth outside the frequency band in which the 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. Attenuation below the general limits specified in §15.209(a) and RSS-Gen clause 8.9 is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a) and RSS-Gen clause 8.10, must also comply with the radiated emission limits specified in §15.209(a) and RSS-Gen clause 8.9.

The correction factor in the final result table contains the sum of the transducers (antenna + amplifier + cables). The result value is the measured value corrected with the correction factor.

Unwanted Emissions (radiated)

Test results (channel configuration 1)

Table 2: Test results with quasi-peak detector (ch. config. 1)

Frequency (MHz)	QuasiPeak (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
37.840000	34.96	40.00	5.04	15 x 1000.0	120.000	224.0	V	105.0	16.7
74.038000	35.61	40.00	4.39	15 x 1000.0	120.000	158.0	H	9.0	15.0

Table 3: Test results with average detector (ch. config. 1)

Frequency (MHz)	CAverage (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
12008.700000	42.37	54.00	11.63	15 x 1000.0	1000.000	123.0	H	31.0	17.4
12116.300000	34.33	54.00	19.67	15 x 1000.0	1000.000	123.0	H	286.0	17.4
12198.900000	39.77	54.00	14.23	15 x 1000.0	1000.000	100.0	H	309.0	17.3

Table 4: Test results with peak detector (ch. config. 1)

Frequency (MHz)	MaxPeak (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
2400.000000	59.86	74.00	14.14	15 x 1000.0	1000.000	207.0	H	8.0	13.7
2402.000000	92.24	---	---	15 x 1000.0	1000.000	230.0	H	6.0	13.7
2440.000000	96.61	---	---	15 x 1000.0	1000.000	247.0	H	16.0	13.6
2480.200000	94.49	---	---	15 x 1000.0	1000.000	100.0	H	70.0	13.7
2483.500000	55.82	74.00	18.18	15 x 1000.0	1000.000	283.0	H	71.0	13.7
9758.900000	49.46	76.61 *)	27.15	15 x 1000.0	1000.000	234.0	H	0.0	14.7
12008.700000	57.20	74.00	16.80	15 x 1000.0	1000.000	214.0	V	343.0	17.4
12105.900000	59.71	74.00	14.29	15 x 1000.0	1000.000	306.0	H	47.0	17.2
12199.900000	55.22	74.00	18.78	15 x 1000.0	1000.000	100.0	H	311.0	17.3

*) -20 dBc relative to transmitter fundamental level at 2440 MHz

Unwanted Emissions (radiated)

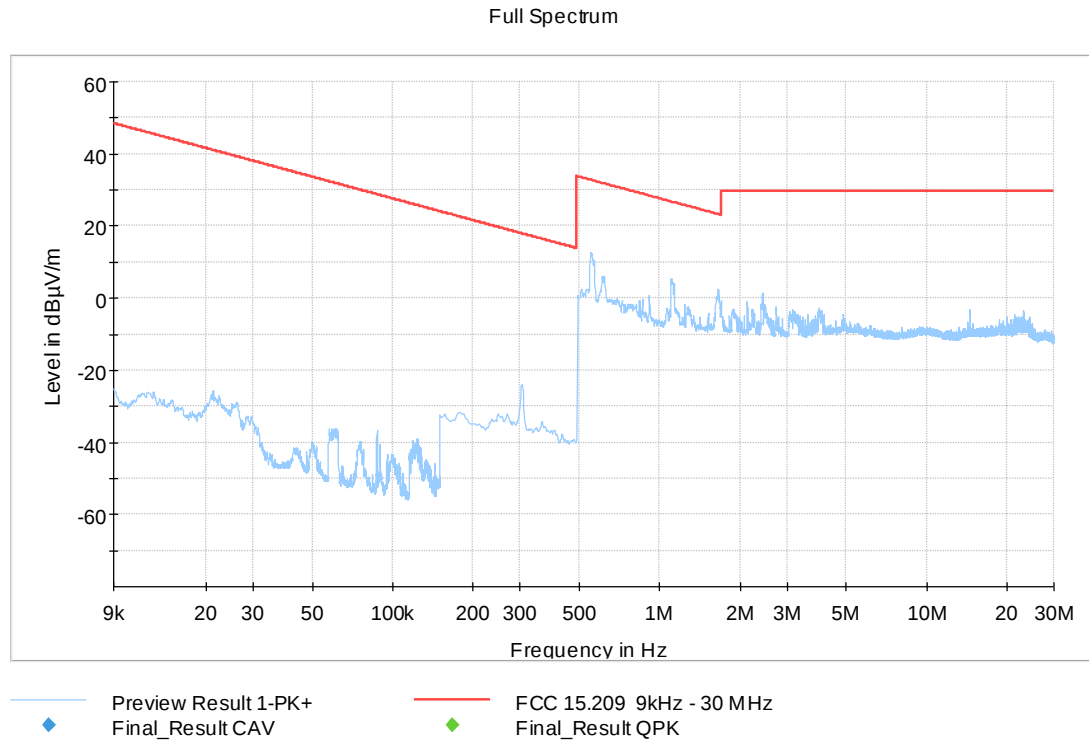


Figure 3: Unwanted emissions 9 kHz – 30 MHz (ch. config. 1)

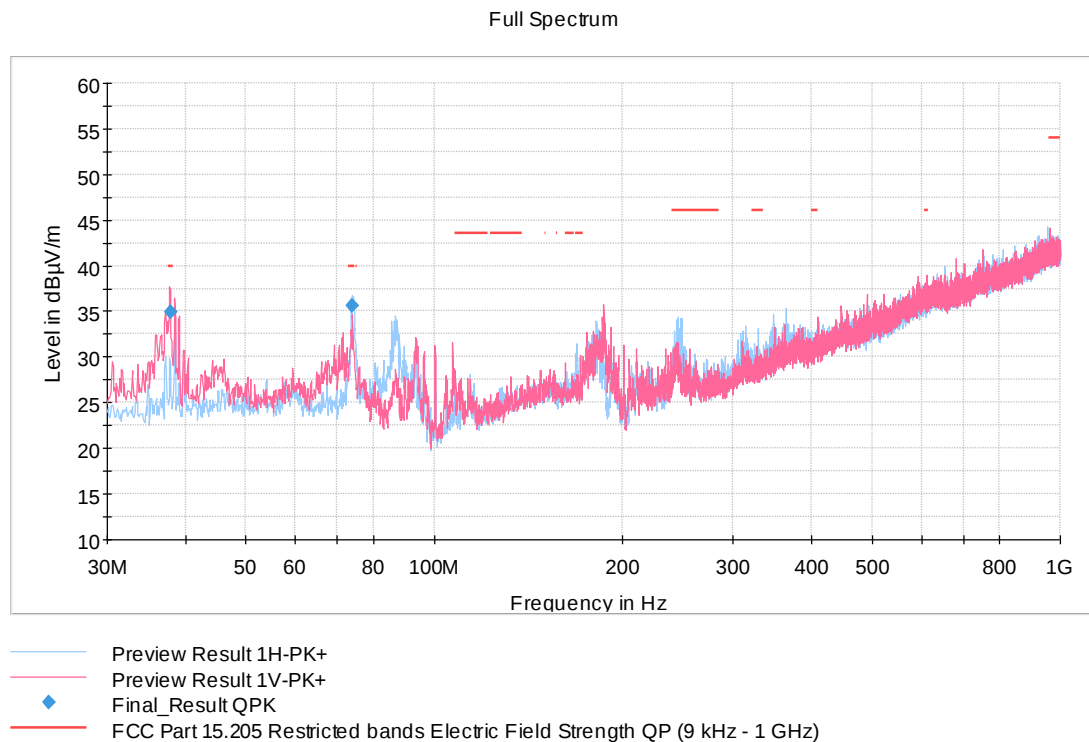


Figure 4: Unwanted emissions 30 - 1000 MHz (ch. config. 1)

Unwanted Emissions (radiated)

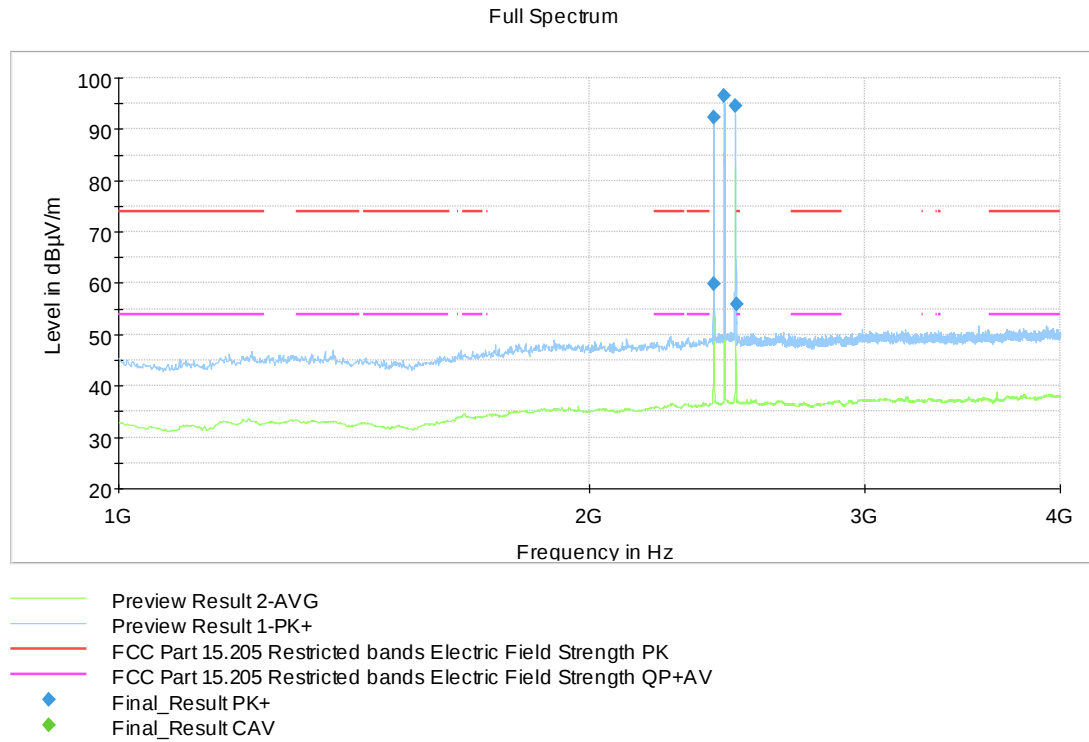


Figure 5: Unwanted emissions 1 – 4 GHz (ch. config. 1)

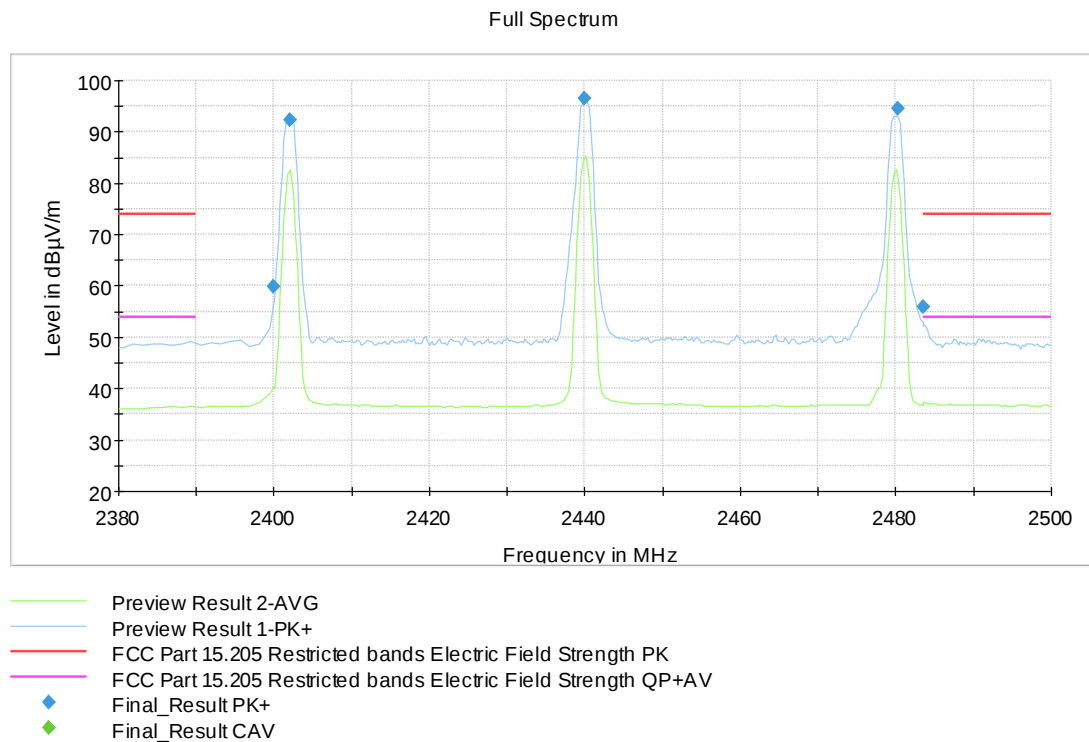


Figure 6: Band-edge measurement (ch. config. 1)

Unwanted Emissions (radiated)

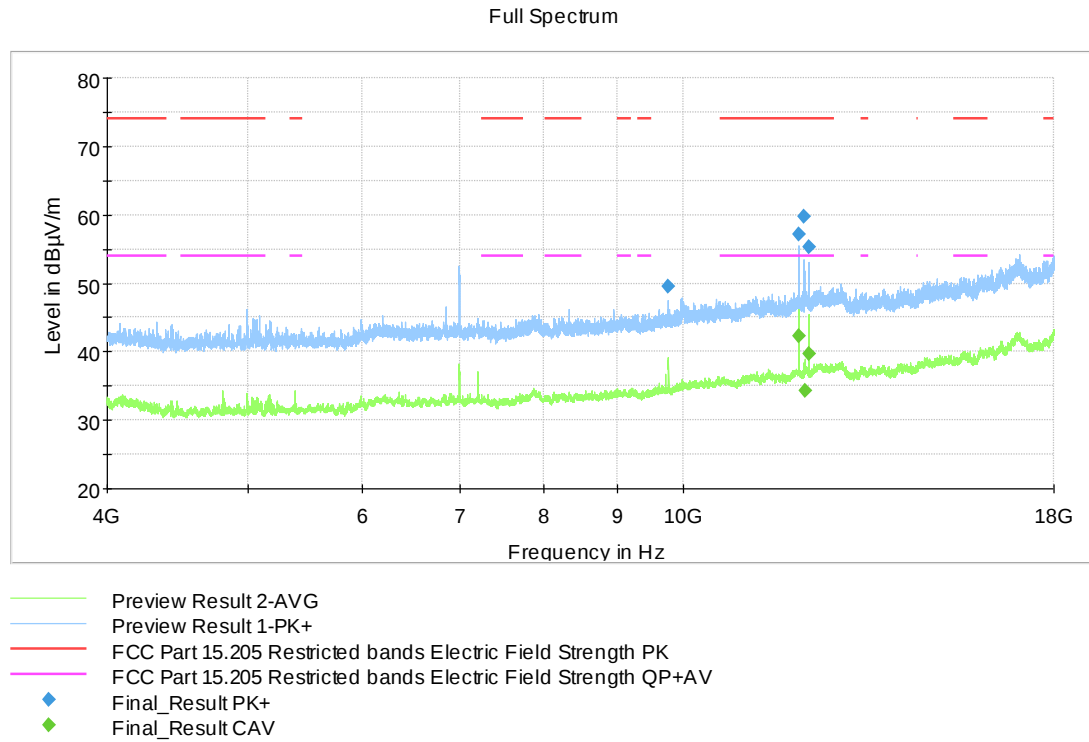


Figure 7: Unwanted emissions 4 – 18 GHz (ch. config. 1)



Figure 8: Unwanted emissions 18 - 25 GHz (ch. config. 1)

Unwanted Emissions (radiated)

Test results (channel configuration 2)

Table 5: Test results with quasi-peak detector (ch. config. 2)

Frequency (MHz)	QuasiPeak (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
37.820000	35.07	40.00	4.93	15 x 1000.0	120.000	254.0	V	72.0	16.7
74.058000	35.43	40.00	4.57	15 x 1000.0	120.000	261.0	H	344.0	15.0

Table 6: Test results with average detector (ch. config. 2)

Frequency (MHz)	CAverage (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
8073.600000	30.93	54.00	23.07	15 x 1000.0	1000.000	100.0	V	307.0	11.0
12198.700000	39.44	54.00	14.56	15 x 1000.0	1000.000	123.0	H	324.0	17.3

Table 7: Test results with peak detector (ch. config. 2)

Frequency (MHz)	MaxPeak (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
2400.000000	61.57	74.00	12.43	15 x 1000.0	1000.000	183.0	H	63.0	13.7
2402.200000	90.92	---	---	15 x 1000.0	1000.000	213.0	H	63.0	13.7
2439.950000	92.17	---	---	15 x 1000.0	1000.000	128.0	H	6.0	13.6
2480.250000	96.75	---	---	15 x 1000.0	1000.000	262.0	H	16.0	13.7
2483.500000	54.12	74.00	19.88	15 x 1000.0	1000.000	118.0	H	19.0	13.7
6998.900000	58.75	74.00	15.25	15 x 1000.0	1000.000	107.0	V	145.0	10.3
8072.500000	63.07	74.00	10.93	15 x 1000.0	1000.000	153.0	V	274.0	11.0
9759.200000	53.09	74.00	20.91	15 x 1000.0	1000.000	107.0	H	52.0	14.7
9918.900000	51.07	76.75 *)	25.68	15 x 1000.0	1000.000	138.0	V	12.0	14.8
12198.600000	54.05	74.00	19.95	15 x 1000.0	1000.000	107.0	H	323.0	17.3
12398.800000	51.33	74.00	22.67	15 x 1000.0	1000.000	107.0	H	303.0	17.6

*) -20 dBc relative to transmitter fundamental level at 2480 MHz

Unwanted Emissions (radiated)

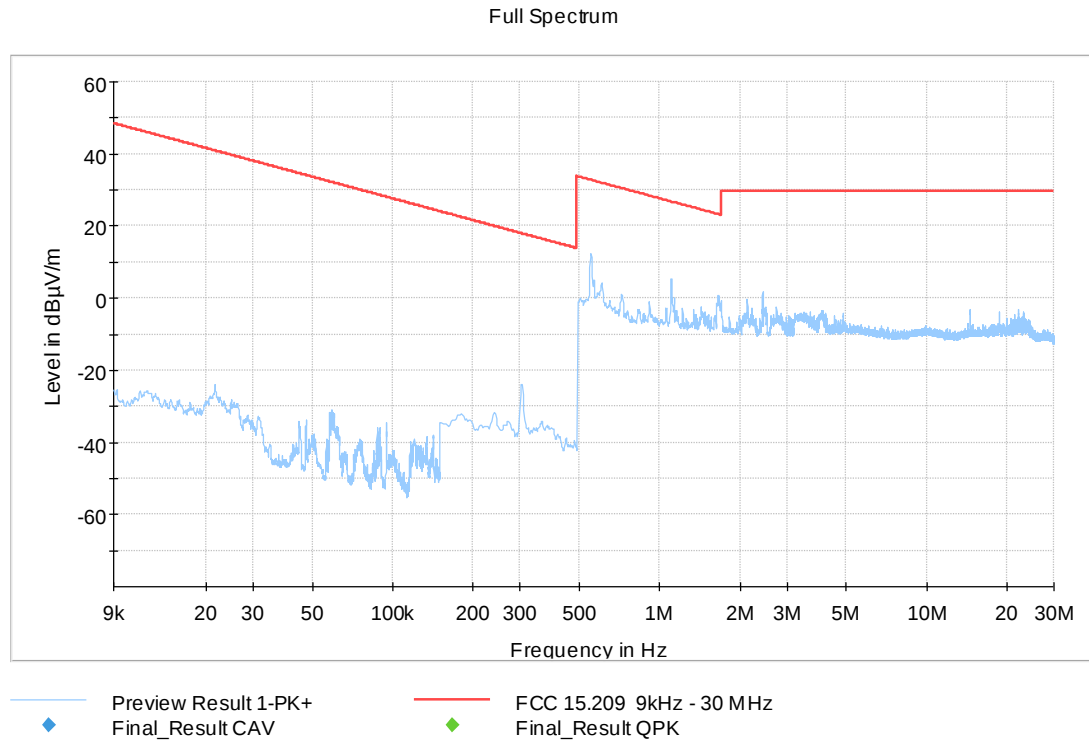


Figure 9: Unwanted emissions 9 kHz – 30 MHz (ch. config. 2)

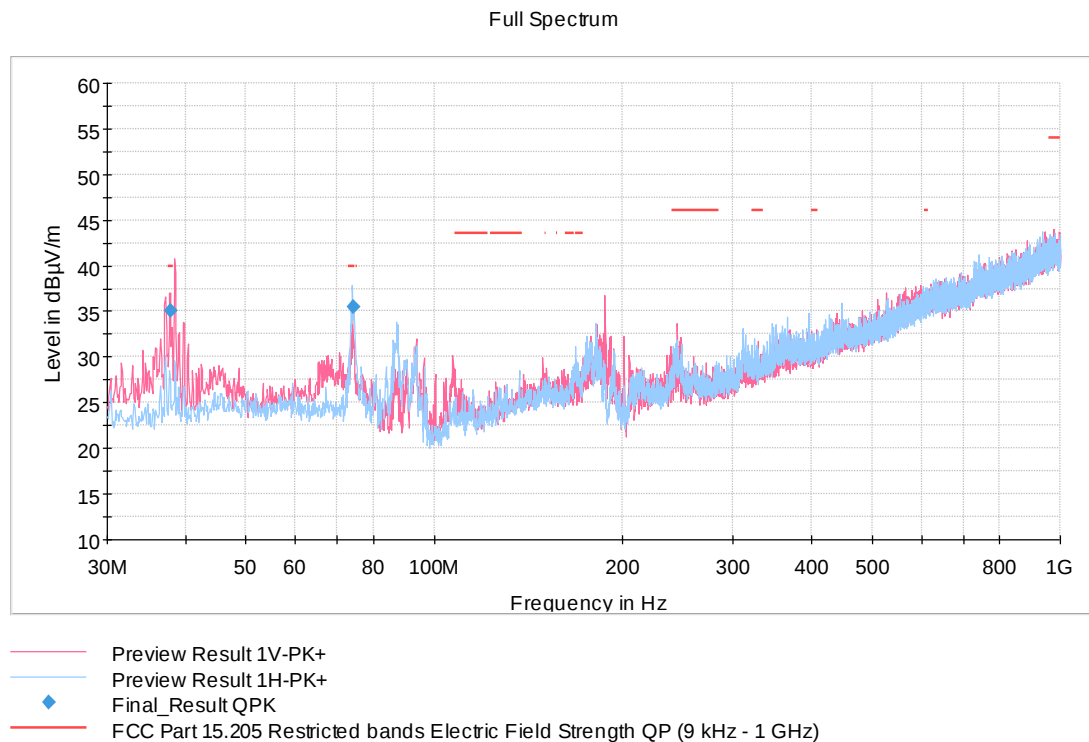


Figure 10: Unwanted emissions 30 – 1000 MHz (ch. config. 2)

Unwanted Emissions (radiated)

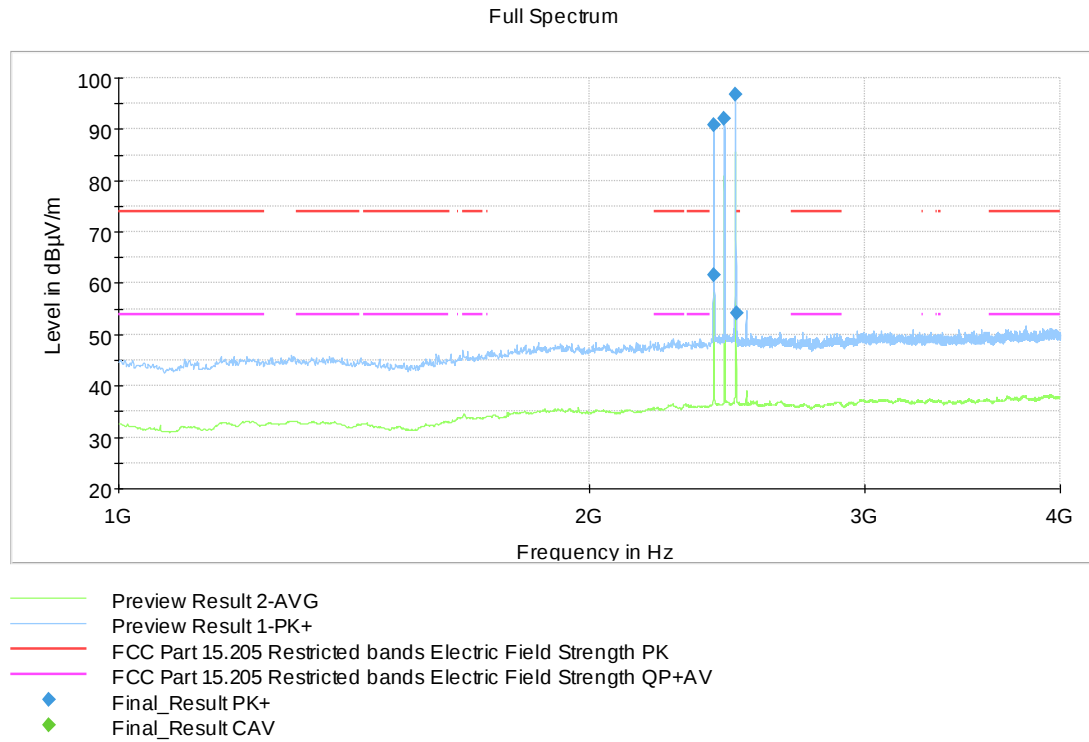


Figure 11: Unwanted emissions 1 – 4 GHz (ch. config. 2)

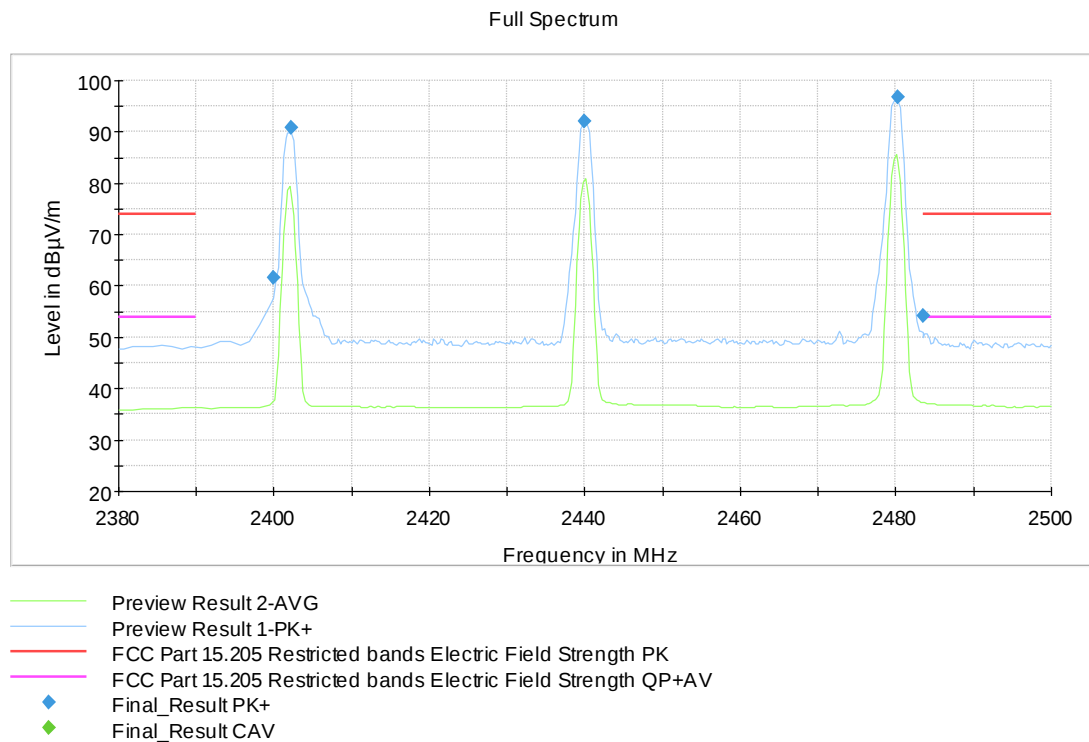


Figure 12: Band-edge measurement (ch. config. 2)

Unwanted Emissions (radiated)

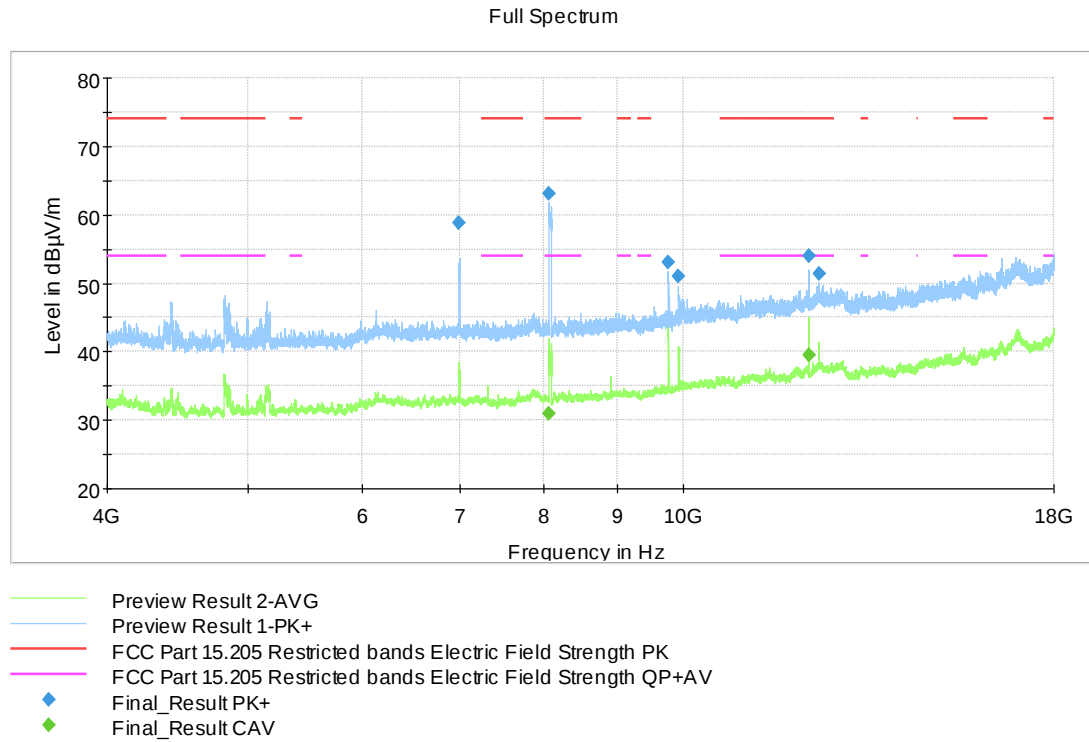


Figure 13: Unwanted emissions 4 – 18 GHz (ch. config. 2)



Figure 14: Unwanted emissions 18 – 25 GHz (ch. config. 2)

Unwanted Emissions (radiated)

Test results (channel configuration 3)

Table 8: Test results with quasi-peak detector (ch. config. 3)

Frequency (MHz)	QuasiPeak (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
0.551750	13.46	32.77	19.31	15 x 1000.0	9.000	*)	V	200.0	-20.4
37.820000	36.22	40.00	3.78	15 x 1000.0	120.000	109.0	V	329.0	16.7
74.101000	35.18	40.00	4.82	15 x 1000.0	120.000	219.0	H	69.0	15.0

*) Measurement loop antenna in coaxial orientation

Table 9: Test results with average detector (ch. config. 3)

Frequency (MHz)	CAverage (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
8085.300000	31.06	54.00	22.94	15 x 1000.0	1000.000	168.0	V	306.0	10.9
12008.900000	43.10	54.00	10.90	15 x 1000.0	1000.000	123.0	H	310.0	17.4

Table 10: Test results with peak detector (ch. config. 3)

Frequency (MHz)	MaxPeak (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
2400.000000	63.86	75.44 *)	11.58	15 x 1000.0	1000.000	250.0	H	16.0	13.7
2402.000000	95.44	---	---	15 x 1000.0	1000.000	247.0	H	15.0	13.7
2440.250000	92.23	---	---	15 x 1000.0	1000.000	203.0	H	68.0	13.6
2479.750000	91.16	---	---	15 x 1000.0	1000.000	122.0	H	6.0	13.7
2483.500000	51.05	74.00	22.95	15 x 1000.0	1000.000	153.0	H	83.0	13.7
7000.500000	53.11	74.00	20.89	15 x 1000.0	1000.000	107.0	V	208.0	10.3
8073.700000	65.99	74.00	8.01	15 x 1000.0	1000.000	246.0	V	278.0	11.0
9918.900000	55.30	74.00	18.70	15 x 1000.0	1000.000	122.0	H	56.0	14.8
12011.300000	58.32	74.00	15.68	15 x 1000.0	1000.000	107.0	H	307.0	17.4
12398.600000	51.67	74.00	22.33	15 x 1000.0	1000.000	107.0	H	324.0	17.6

*) -20 dBc relative to transmitter fundamental level at 2402 MHz

Unwanted Emissions (radiated)

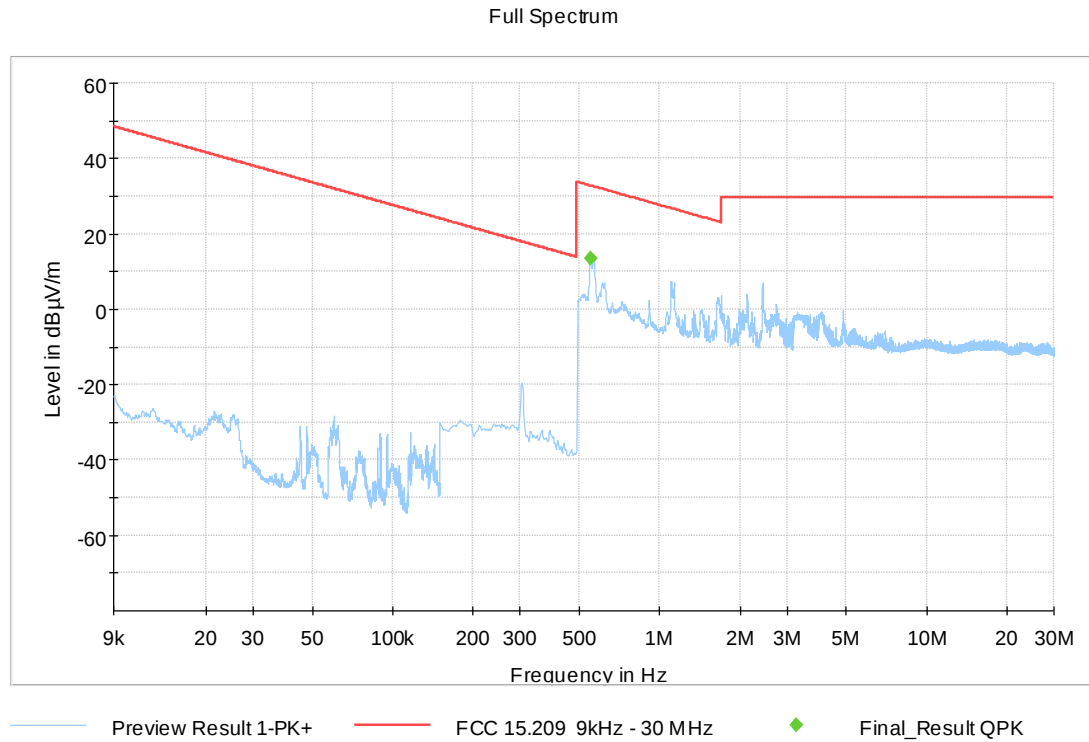


Figure 15: Unwanted emissions 9 kHz – 30 MHz (ch. config. 3)

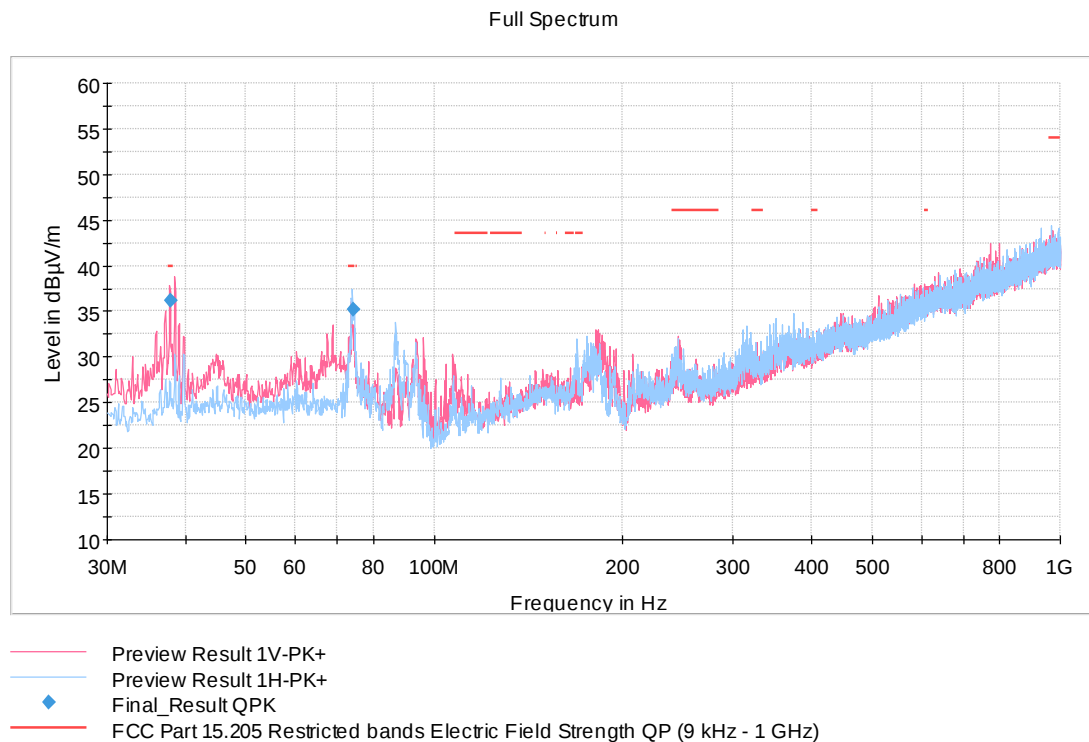


Figure 16: Unwanted emissions 30 – 1000 MHz (ch. config. 3)

Unwanted Emissions (radiated)

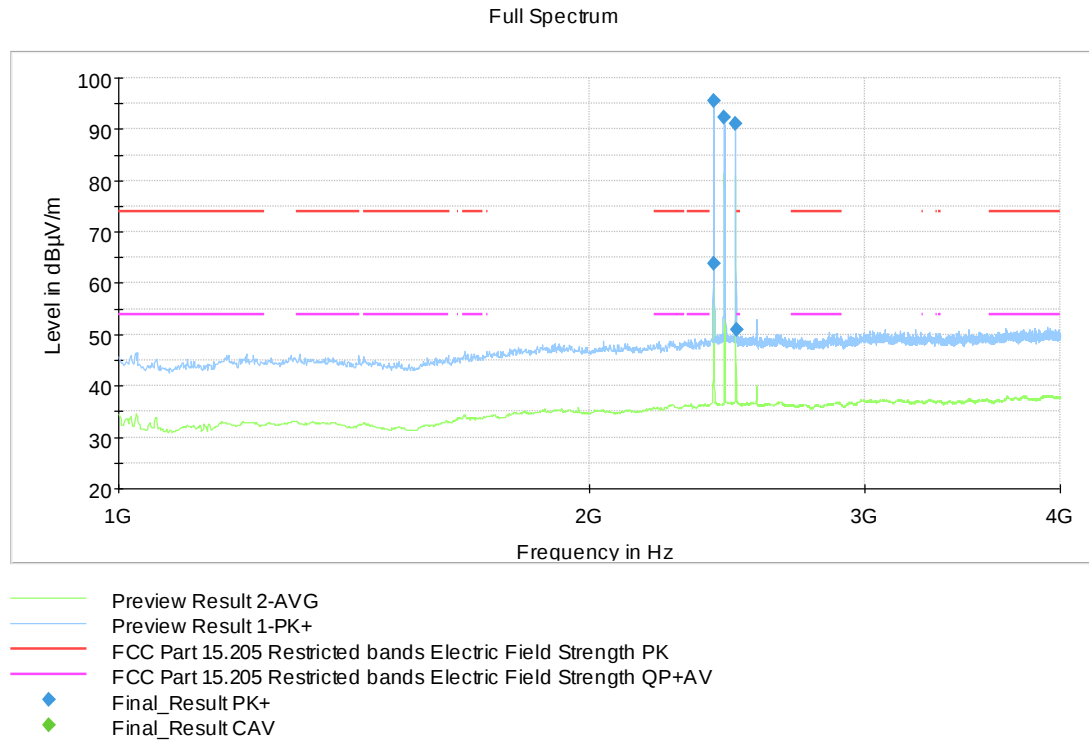


Figure 17: Unwanted emissions 1 – 4 GHz (ch. config. 3)

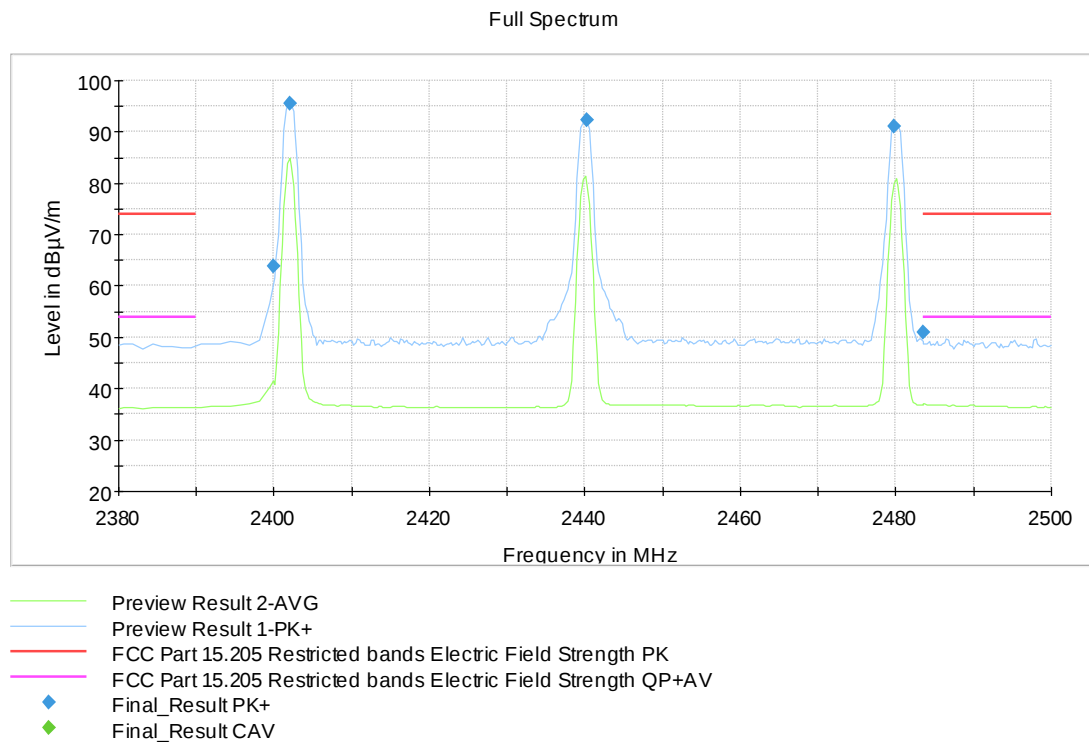


Figure 18: Band-edge measurement (ch. config. 3)

Unwanted Emissions (radiated)

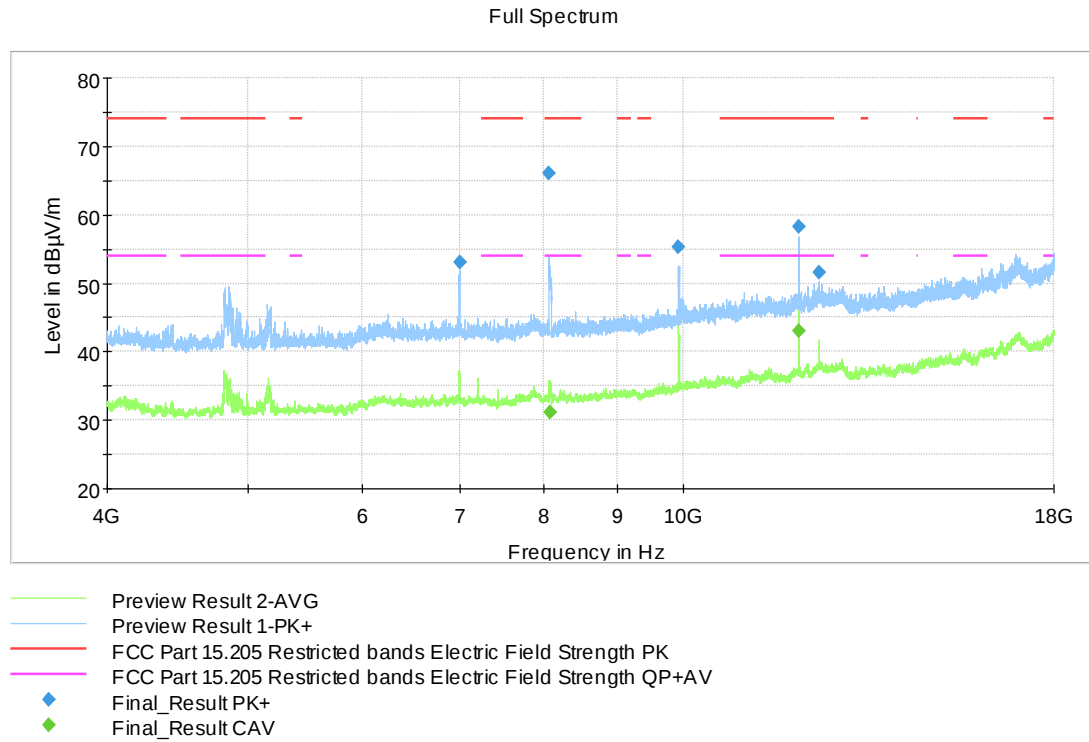


Figure 19: Unwanted emissions 4 – 18 GHz (ch. config. 3)



Figure 20: Unwanted emissions 18 – 25 GHz (ch. config. 3)

TEST EQUIPMENT

AC Power-Line Conducted Emissions

Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
CABLE	HUBER & SUHNER	RG223/U	inv. C054	2023-04-12	2024-04-12
EMI TEST RECEIVER	ROHDE & SCHWARZ	ESW44	sn. 103039	2023-04-12	2024-04-12
LISN	ROHDE & SCHWARZ	ENV216	inv. 9611	2023-02-01	2024-02-01
LISN	ROHDE & SCHWARZ	ESH3-Z5	inv. 8019	2023-05-23	2024-05-23
POWER SUPPLY	CALIFORNIA INSTR.	5001 iX Series II	inv. 7826	NCR	NCR
TEMPERATURE/ HUMIDITY SENSOR	EDS	OW-ENV-TH, K5 SAC	inv. 10517	2023-10-30	2024-10-30
TEST SOFTWARE	ROHDE & SCHWARZ	EMC-32	-	-	-

Radiated Emissions

Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
ANTENNA	EMCO	3117, emi 1-18GHz	inv. 7293	2022-06-16	2024-06-16
ANTENNA	ROHDE & SCHWARZ	HFH2-Z2 , 335.4711.52	inv. 8013	2022-10-25	2024-10-25
ANTENNA	SCHWARZBECK	VULB 9168	inv. 8911	2022-11-29	2024-11-29
ANTENNA MAST	MATURO	TAM 4.0E	inv. 10181	NCR	NCR
ATTENUATOR	PASTERNAK	10 dB, DC-40 GHz	sn. A1	2023-03-20	2025-03-20
ATTENUATOR	PASTERNAK	PE 7004-4 (4dB)	inv. 10126	2023-03-13	2024-03-13
CABLE	HUBER & SUHNER	SUCOFLEX 104, 2m	inv. C053	2023-04-12	2024-04-12
CABLE	HUBER & SUHNER	SUCOFLEX 126E, 1m	inv. C134	2023-04-12	2024-04-12
CABLE	HUBER & SUHNER	SUCOFLEX 126E, 2m	inv. C135	2023-04-12	2024-04-12
CABLE	HUBER & SUHNER	SUCOFLEX 126E, 1m	inv. C136	2023-04-12	2024-04-12
CABLE	HUBER & SUHNER	SUCOFLEX 126EA, 10m	inv. C137	2023-04-12	2024-04-12
CABLE	HUBER & SUHNER	SUCOFLEX 126EA, 10m	inv. C149	2023-04-12	2024-04-12
EMI TEST RECEIVER	ROHDE & SCHWARZ	ESW44	sn. 103039	2023-04-12	2024-04-12
FILTER	WAINWRIGHT	HP, WHKX4.0/18G-10SS	inv. 10403	2023-01-09	2025-01-09
MAST & TURNTABLE CONTROLLER	MATURO	NCD	inv. 10183	NCR	NCR
POWER SUPPLY	CALIFORNIA INSTR.	5001 iX Series II	inv. 7826	NCR	NCR
RF PREAMPLIFIER	CIAO	CA118-3123	inv. 10278	2023-09-15	2024-09-15
TEMPERATURE/ HUMIDITY SENSOR	EDS	OW-ENV-TH, K5 SAC	inv. 10517	2023-10-30	2024-10-30
TEST SOFTWARE	ROHDE & SCHWARZ	EMC-32	-	-	-
TURNTABLE	MATURO	DS430 UPGRADED	inv. 10182	NCR	NCR

NCR = No Calibration Required

END OF REPORT