Test Report

T004 (EN ISO/IEC 17025)

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

Equipment Under Test:	Virtual Reality Headset
Model:	Varjo Aero
Manufacturer:	Varjo Technologies Oy Vuorikatu 20 FI-00100, Helsinki Finland
Customer:	Varjo Technologies Oy Vuorikatu 20 FI-00100, Helsinki Finland
FCC Rule Part:	15.247
IC Rule Part:	RSS-247, Issue 2, 2017 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 Summary of Testing for details*

Date:	21 October 2021	Date:	21 October 2021
Issued by:	Henri Mäki Testing Engineer	Checked by:	Mikko Halonen Development Engineer

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GENERAL REMARKS

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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	24 September 2021
1.1	Figure 6 caption updated	21 October 2021

PRODUCT DESCRIPTION

Equipment Under Test

Trade mark:	Varjo
Model:	Varjo Aero
Type:	-
Serial no:	V0032D811AE0210076
FCC ID:	2AROD-004
IC:	24483-004

General Description

The equipment under test is a virtual reality headset.

Classification

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

Modifications Incorporated in the EUT

No modifications.

Ratings and declarations

Operating Frequency Range (OFR):	2402 - 2480 MHz
Channels:	40
Channel separation:	2 MHz
Transmission technique:	DSSS
Modulation:	GFSK
Antenna type:	Integrated ceramic chip antennas
Antenna count:	2
Integral Antenna gain:	1.1 dBi

Power Supply

Rated voltage:	12 V
Rated current:	3 A
Rated frequency:	DC

Mechanical Size of the EUT

Height: 170 mm	Width: 200 mm	Length: 300 mm

Peripherals

VR adapter:	Power supply and data communication between laptop and EUT.
Laptop:	Razer Blade RZ09-0330. Device configuration.
AC/DC power supply:	Razer RC30-024801. Power supply to laptop.
AC/DC power supply:	Adapter Technology ATS036T-W120V. Power supply to EUT.

The peripherals were provided by the customer.

SUMMARY OF TESTING

Test Specification	Description of Test	Result
§15.203	Antenna requirement	**PASS**
§15.207(a) / RSS-GEN 8.8	Conducted Emissions on Power Supply Lines	**N/T**
§15.247(b)(3) / RSS-247 5.4(d)	Maximum Peak Conducted Output Power	**PASS**
§15.247(a)(2) / RSS-247 5.2(a)	6 dB Bandwidth	**N/T**
§15.247(e) / RSS-247 5.2(b)	Power Spectral Density	**N/T**
RSS-GEN 6.7	99% Occupied Bandwidth	**N/T**
§15.247(d) / RSS-247 5.5	100 kHz Bandwidth of Frequency Band Edges and Conducted Spurious Emissions	**N/T**
§15.209(a), §15.247(d) / RSS-247 5.5	Radiated Emissions Within the Restricted Bands	**PASS**

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 EUT's radio was in continuous transmit mode during all the tests and was configured into the wanted channel using software provided by the manufacturer. During testing a test image was visible on the displays, the eye tracking cameras were running in test mode, Steam tracking was running, cooling fan was set to constant 10% running speed, white noise was played from the earphones, and internal logging of temperatures, voltage and current consumption was running.

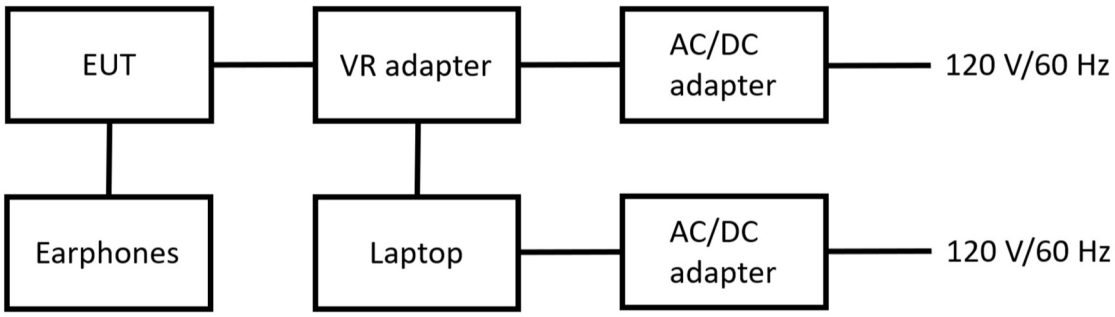

Figure 1: Test setup block diagram

Table 1: Test frequencies and settings

Channel	Frequency (MHz)
Low	2402
Mid	2440
High	2480

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: 20 September 2021

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	

Maximum Peak Conducted Output Power

Standard:	ANSI C63.10-2013	
Tested by:	HEM	
Date:	20 September 2021	
Temperature:	22 °C	
Humidity:	30 %RH	
Measurement uncertainty:	± 2.87dB	Level of confidence 95 % (k = 2)

FCC Rule: 15.247(b)(3)
RSS-247 5.4(d)

For systems using digital modulation in the 2400-2483.5 MHz bands the limit is 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power.

Measured values are peak values.

Results:

Table 2: Maximum conducted output power

Channel	Left Antenna [dBm]	Right Antenna [dBm]	Left Antenna [W]	Right Antenna [W]	Sum [W]	Limit [W]	Result
Low	-1.3	-1.8	0.00074	0.00066	0.00140	1	PASS
Mid	-1.6	-2.6	0.00069	0.00055	0.00124	1	PASS
High	-2.6	-3.4	0.00055	0.00046	0.00101	1	PASS

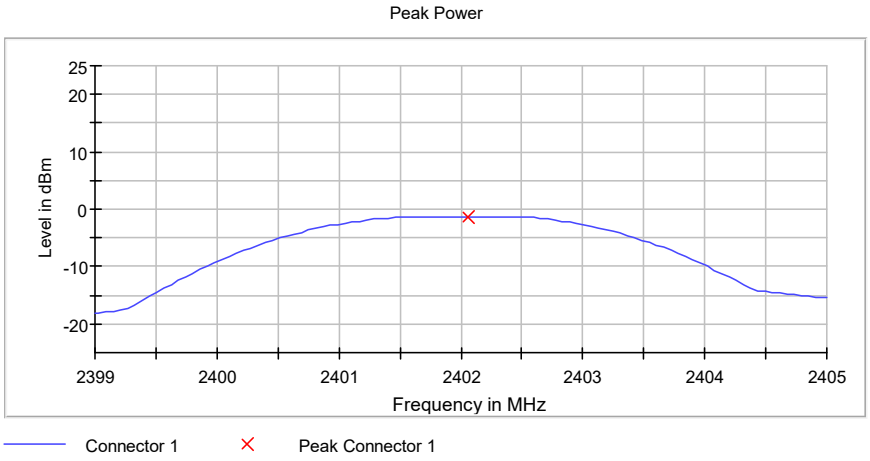

Figure 2: Conducted power, Channel LOW (left antenna)

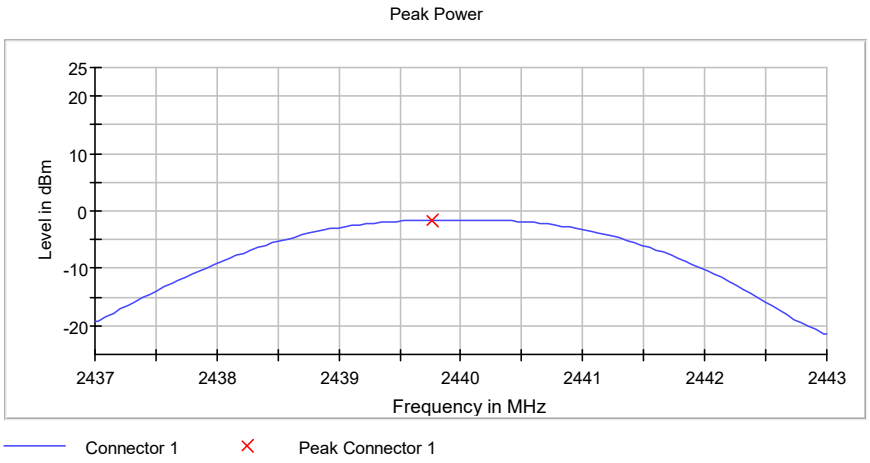

Figure 3: Conducted power, Channel MID (left antenna)

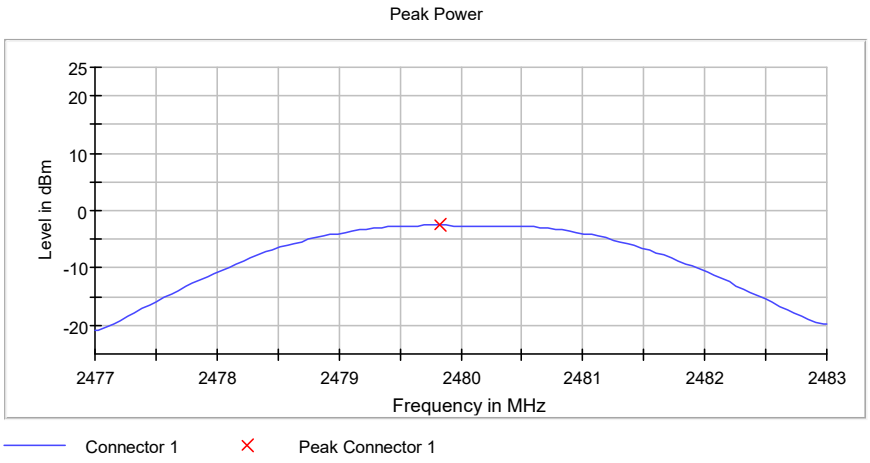

Figure 4: Conducted power, Channel HIGH (left antenna)

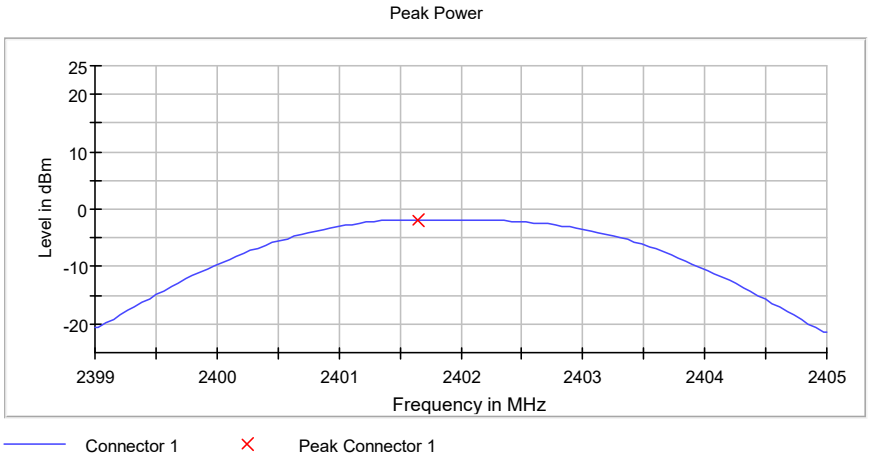

Figure 5: Conducted power, Channel LOW (right antenna)

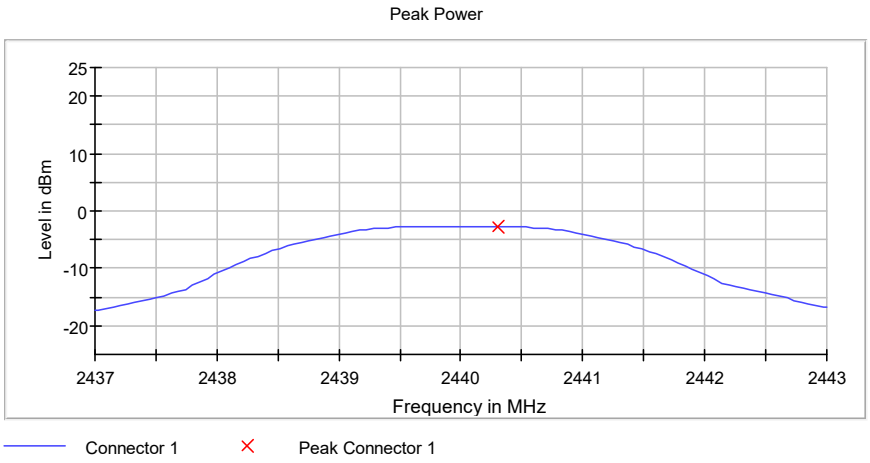

Figure 6: Conducted power, Channel MID (right antenna)

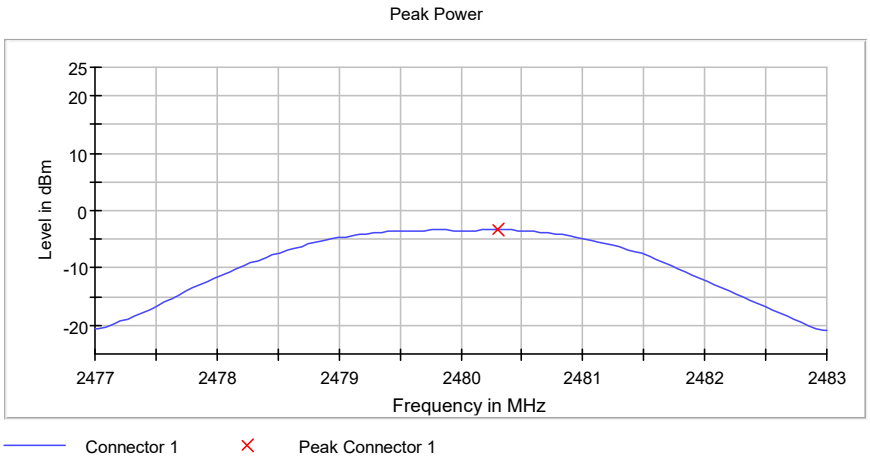

Figure 7: Conducted power, Channel HIGH (right antenna)

Table 3: Measurement settings, Maximum Conducted Output Power

Setting	Instrument Value	Target Value
Span	6.000 MHz	6.000 MHz
RBW	2.000 MHz	>= 1.000 MHz
VBW	10.000 MHz	>= 6.000 MHz
SweepPoints	101	~ 101
Sweeptime	953.450 ns	AUTO
Reference Level	20.000 dBm	20.000 dBm
Attenuation	40.000 dB	AUTO
Detector	MaxPeak	MaxPeak
SweepCount	100	100
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
Sweeptype	FFT	AUTO
Preamp	off	off
Stablemode	Trace	Trace
Stablevalue	0.50 dB	0.50 dB
Run	4 / max. 150	max. 150
Stable	3 / 3	3
Max Stable Difference	0.03 dB	0.50 dB

Transmitter Radiated Spurious Emissions 9 kHz – 26.5 GHz

Standard:	ANSI C63.10-2013	
Tested by:	HEM, HEE	
Date:	20 September 2021	
Temperature:	23 °C	
Humidity:	27 %RH	
Measurement uncertainty:	± 4.51 dB	Level of confidence 95 % (k = 2)

FCC Rule: 15.247(d), 15.209(a)
RSS-247 5.5

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. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a).

At the request of the customer the emissions below 1000 MHz are additionally compared to the general limits specified in Section 15.209(a), whether or not they fall in the restricted bands.

Frequency range [MHz]	Limit [µV/m]	Limit [dBµV/m]	Detector
0.009 - 0.490	2400/F(kHz)	48.5 - 13.8	Quasi-peak
0.490 - 1.705	24000/F(kHz)	33.8 - 22.97	Quasi-peak
1.705 - 30.0	30	29.54	Quasi-peak
30 - 80	100	40.0	Quasi-peak
88 - 216	150	43.5	Quasi-peak
216 - 960	200	46.0	Quasi-peak
960 - 1000	500	53.9	Quasi-peak
Above 1000	500	53.9	Average
Above 1000	5000	73.9	Peak

During testing both antennas were set to transmit at the same frequency.

The measurements below 30 MHz were performed with MID channel only.

Results LOW channel

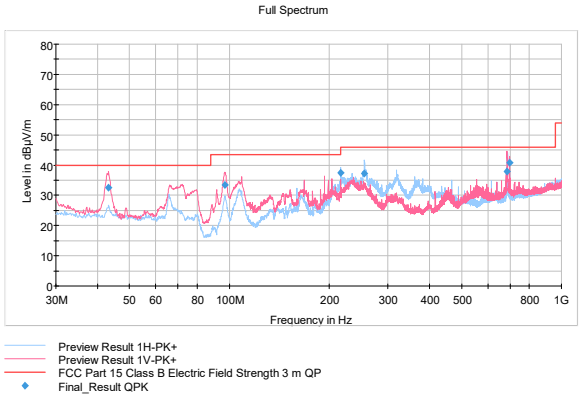

Figure 8: LOW channel (30 – 1000 MHz)

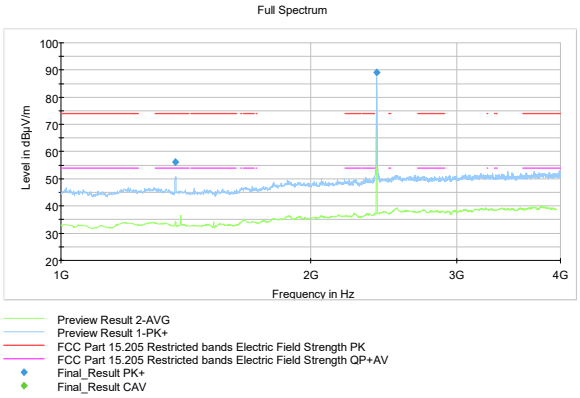

Figure 9: LOW channel (1 – 4 GHz)

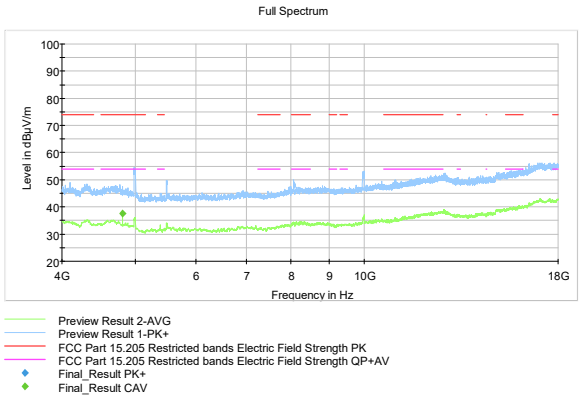

Figure 10: LOW channel (4 – 18 GHz)

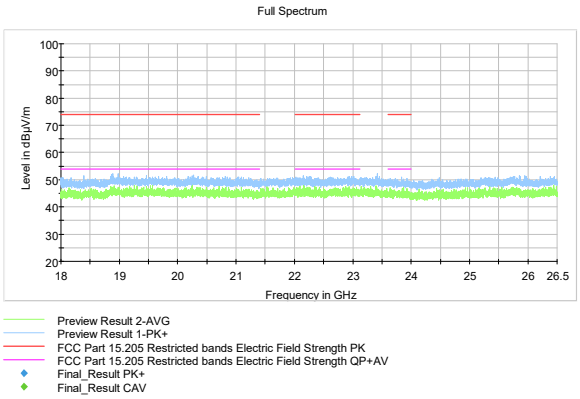

Figure 11: LOW channel (18 – 26.5 GHz)

Table 4: Quasi-peak results LOW channel

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
43.215000 *)	32.47	40.00	7.53	15 x 1000.0	120.000	118.0	V	151.0	17.5
96.935000 *)	33.39	43.50	10.11	15 x 1000.0	120.000	121.0	V	97.0	13.1
216.005000 *)	37.36	46.00	8.64	15 x 1000.0	120.000	162.0	H	83.0	15.5
255.115000	37.31	46.00	8.69	15 x 1000.0	120.000	114.0	H	285.0	17.7
686.365000 *)	37.89	46.00	8.11	15 x 1000.0	120.000	163.0	V	98.0	28.1
697.485000 *)	40.74	46.00	5.26	15 x 1000.0	120.000	105.0	V	193.0	28.3

*) The emission not within a restricted band.

Table 5: Average results LOW channel

Frequency (MHz)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
4803.975000	37.70	53.90	16.20	15 x 1000.0	1000.000	179.0	V	103.0	7.6

Table 6: Peak results LOW channel

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1372.625000	56.15	73.90	17.75	15 x 1000.0	1000.000	242.0	V	267.0	9.5
2401.675000	89.13	---	---	15 x 1000.0	1000.000	204.0	V	35.0	14.1

The correction factor (dB) in the final result tables contains the sum of the transducers (antenna + amplifier + cables). QuasiPeak, CAverage, and MaxPeak values are the measured values corrected with the correction factor.

Results MID channel

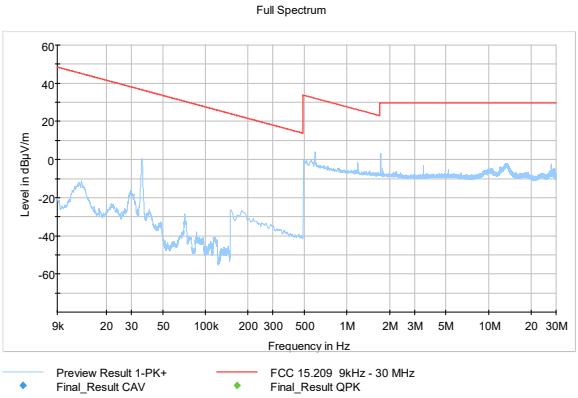

Figure 12: MID channel (9 kHz – 30 MHz)

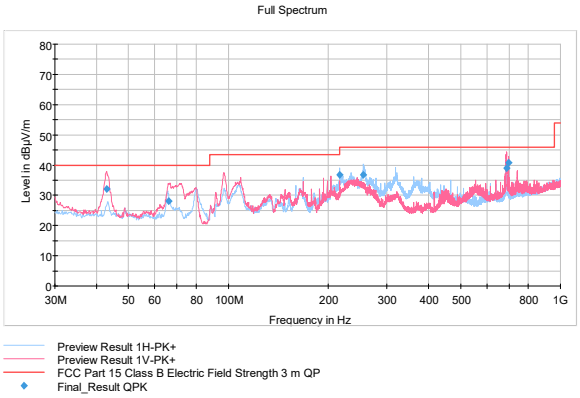

Figure 13: MID channel (30 – 1000 MHz)

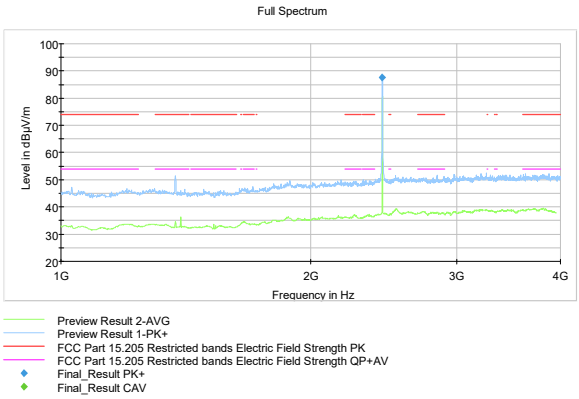

Figure 14: MID channel (1 – 4 GHz)

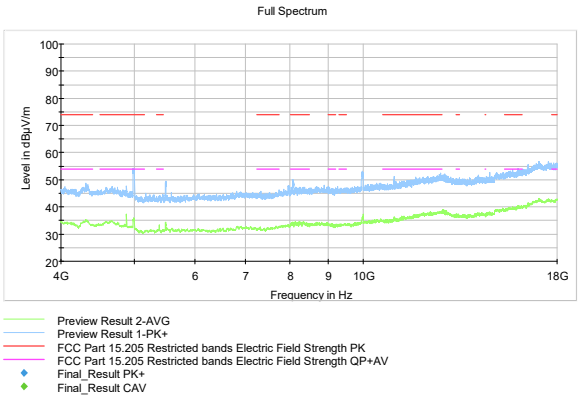

Figure 15: MID channel (4 – 18 GHz)

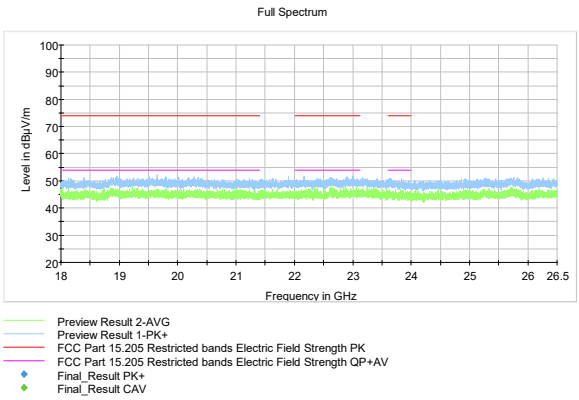

Figure 16: MID channel (18 – 26.5 GHz)

Table 7: Quasi-peak results MID channel

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
42.935000 *)	32.13	40.00	7.87	15 x 1000.0	120.000	111.0	V	112.0	17.4
66.095000 *)	28.01	40.00	11.99	15 x 1000.0	120.000	105.0	V	173.0	17.0
215.985000 *)	36.74	43.50	6.76	15 x 1000.0	120.000	157.0	H	80.0	15.5
255.115000	36.80	46.00	9.20	15 x 1000.0	120.000	111.0	H	55.0	17.7
687.545000 *)	39.01	46.00	6.99	15 x 1000.0	120.000	163.0	V	104.0	28.1
697.485000 *)	40.71	46.00	5.29	15 x 1000.0	120.000	105.0	V	193.0	28.3

*) The emission not within a restricted band.

Table 8: Peak results MID channel

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
2439.625000	87.53	---	---	15 x 1000.0	1000.000	100.0	H	13.0	13.8

The correction factor (dB) in the final result tables contains the sum of the transducers (antenna + amplifier + cables). QuasiPeak, CAverage, and MaxPeak values are the measured values corrected with the correction factor.

Results HIGH channel

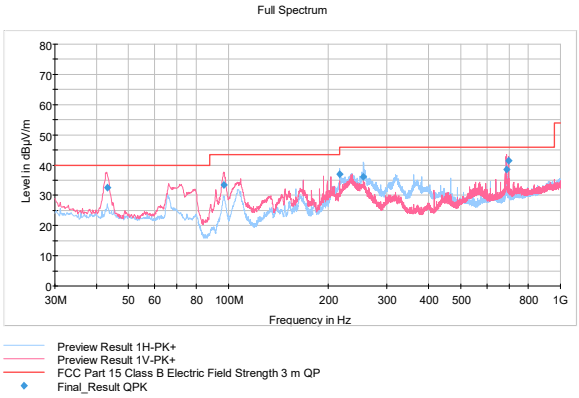

Figure 17: HIGH channel (30 – 1000 MHz)

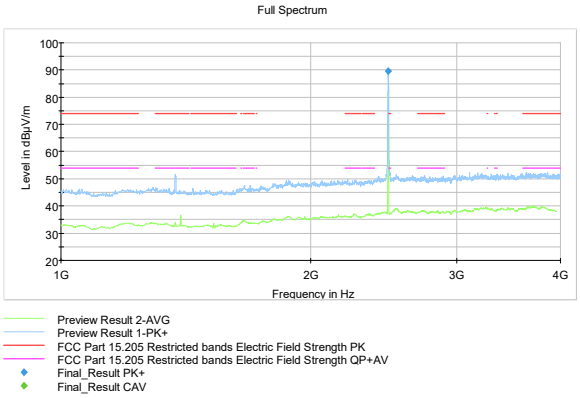

Figure 18: HIGH channel (1 – 4 GHz)

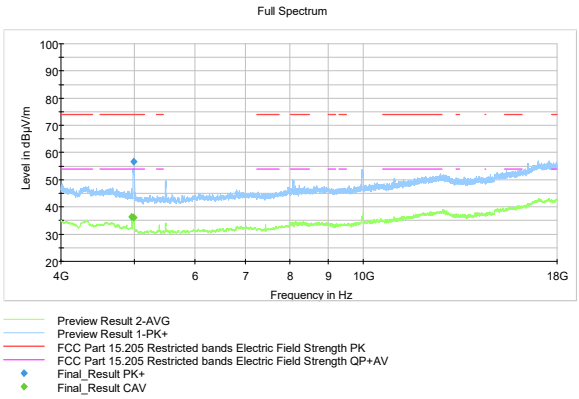

Figure 19: HIGH channel (4 – 18 GHz)

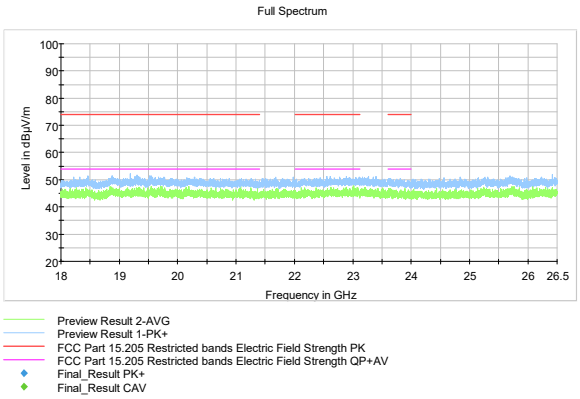

Figure 20: HIGH channel (18 – 26.5 GHz)

Table 9: Quasi-peak results HIGH channel

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
43.235000 *)	32.48	40.00	7.52	15 x 1000.0	120.000	124.0	V	188.0	17.5
96.715000 *)	33.34	43.50	10.16	15 x 1000.0	120.000	105.0	V	95.0	13.1
216.005000 *)	36.97	46.00	9.03	15 x 1000.0	120.000	154.0	H	75.0	15.5
255.155000	36.17	46.00	9.83	15 x 1000.0	120.000	139.0	H	291.0	17.7
687.505000 *)	38.63	46.00	7.37	15 x 1000.0	120.000	177.0	V	98.0	28.1
697.485000 *)	41.54	46.00	4.46	15 x 1000.0	120.000	100.0	V	191.0	28.3

*) The emission not within a restricted band.

Table 10: Average results HIGH channel

Frequency (MHz)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
4959.775000	36.42	53.90	17.58	15 x 1000.0	1000.000	320.0	V	58.0	7.5
4984.875000	36.10	53.90	17.90	15 x 1000.0	1000.000	157.0	V	58.0	7.3

Table 11: Peak results HIGH channel

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
2479.625000	89.68	---	---	15 x 1000.0	1000.000	183.0	H	14.0	13.9
4990.975000	56.57	73.90	17.43	15 x 1000.0	1000.000	170.0	V	61.0	7.2

The correction factor (dB) in the final result tables contains the sum of the transducers (antenna + amplifier + cables). QuasiPeak, CAverage, and MaxPeak values are the measured values corrected with the correction factor.

TEST EQUIPMENT

Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
ANTENNA	EMCO	3160-09, emi 18-26.5GHz	inv. 7294	2021-02-19	2022-02-19
ANTENNA	EMCO	3117, emi 1-18GHz	inv. 7293	2020-03-11	2022-03-11
ANTENNA	ROHDE & SCHWARZ	HFH2-Z2 , 335.4711.52	inv. 8013	2020-10-28	2022-10-28
ANTENNA	SCHWARZBECK	VULB 9168	inv. 8911	2020-11-04	2022-11-04
ANTENNA MAST	MATURO	TAM 4.0E	inv. 10181	NCR	NCR
ATTENUATOR	HUBER & SUHNER	6610.19.AA (10dB)	sn. A4	2021-01-25	2023-01-25
ATTENUATOR	PASTERNACK	PE 7004-4 (4Db)	inv. 10126	2021-03-26	2022-03-26
EMI TEST RECEIVER	ROHDE & SCHWARZ	ESW26	inv. 10679	2021-06-21	2022-06-21
FILTER	WAINWRIGHT	WHKX4.0/18G-10SS	inv. 10403	2021-01-29	2023-01-29
MAST & TURNTABLE CONTROLLER	MATURO	NCD	inv. 10183	NCR	NCR
OSP BASE UNIT	ROHDE & SCHWARZ	OSP120	inv. 10882	2021-03-24	2023-03-24
OSP-B157W 8 PORT	ROHDE & SCHWARZ	OSP-B157W8	inv. 10883	2021-03-19	2023-03-19
OSP-B157WX	ROHDE & SCHWARZ	OSP-B157WX	inv. 10884	2021-03-24	2023-03-24
POWER SUPPLY	CALIFORNIA INSTR.	5001 iX Series II	inv. 7826	-	-
RF PREAMPLIFIER	CIAO	CA118-3123	inv. 10278	2020-10-09	2021-10-09
RF PREAMPLIFIER	CIAO	CA1840-5019	inv. 10593	2020-10-09	2021-10-09
SPECTRUM ANALYZER	ROHDE & SCHWARZ	FSV40	inv. 10881	2021-06-22	2022-06-22
SWITCH UNIT	ROHDE & SCHWARZ	OSP 120	inv. 9289	2019-02-28	2022-02-28
TEST SOFTWARE	ROHDE & SCHWARZ	EMC-32	-	-	-
TURNTABLE	MATURO	DS430 UPGRADED	inv. 10182	NCR	NCR

NCR = No Calibration Required

END OF REPORT