Test Report

HELEM2207000317-2

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

Equipment Under Test:	Breathing sensor and smart garment
Model:	Oxa1
Type:	-
Trademark:	OXA
Manufacturer / Customer:	Nanoleq AG Hofwisenstrasse 50 A 8153 Rümlang Switzerland
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 test suite for details*

Date:	14 November 2022	Date:	14 November 2022
Issued by:	Henri Mäki Testing Engineer	Checked by:	Rauno Repo Senior EMC Specialist

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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	10 November 2022
1.1	EUT model name corrected	14 November 2022

PRODUCT DESCRIPTION

Equipment Under Test

Equipment Under Test:	Breathing sensor and smart garment
Model:	Oxa1
Type:	-
Trademark:	OXA
Serial no:	-
Contains FCC ID:	2AAQS-ISP1507
Contains IC:	11306A-ISP1507
Radio module or chip:	Insight SiP ISP1507

General Description

The equipment under test is a breathing sensor and a smart garment. The sensor monitors heartbeat, breath, and temperature change in real-time. The garment includes a breathing band to provide breathing rate and depth, and electrodes to provide heart rate and heart rate variability.

The sensor includes a Bluetooth 5.0 Low Energy module in order to connect to a mobile device for guided breathing sessions.

Classification

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

Modifications Incorporated in the EUT

The sensor has been modified to have UART cables accessible for using test software.

Ratings and declarations

Operating Frequency Range (OFR):	2402 - 2480 MHz
Channels:	40
Channel separation:	2 MHz
Transmission technique:	DSSS
Modulation:	GFSK
Antenna type:	Integral
Integral Antenna gain:	+0.6 dBi

Power Supply

Operating voltage range:	- (battery operated, charging via USB-C)
AC/DC adapter:	Huawei HW-050100E01 (provided by the laboratory)
Input:	100-240 VAC, 50/60 Hz, 0.2 A
Output:	5 VDC, 1 A

Mechanical Size of the EUT

Height: - mm	Width: - mm	Length: - mm

SUMMARY OF TESTING

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

*) Radiated emissions were measured only with the highest channel. Band-edge measurement was performed with the lowest and highest channels.

Test Conditions

Configuration of the EUT was made to correspond to the actual assembling conditions as far as possible. During radiated tests the sensor was attached to the garment, and the Bluetooth radio was configured with nRF Connect v3.12.0 software using Direct Test Mode application with following settings:

- Physical layer LE 1Mbps
- Packet type PRBS9
- Packet length 255 bytes (max)
- TX power 0 dBm (the default setting for the module)

During AC Power-Line Conducted Emissions test the sensor was charged with the peripheral AC/DC adapter and was transmitting at the three BLE advertising channels (2402, 2426, 2480 MHz).

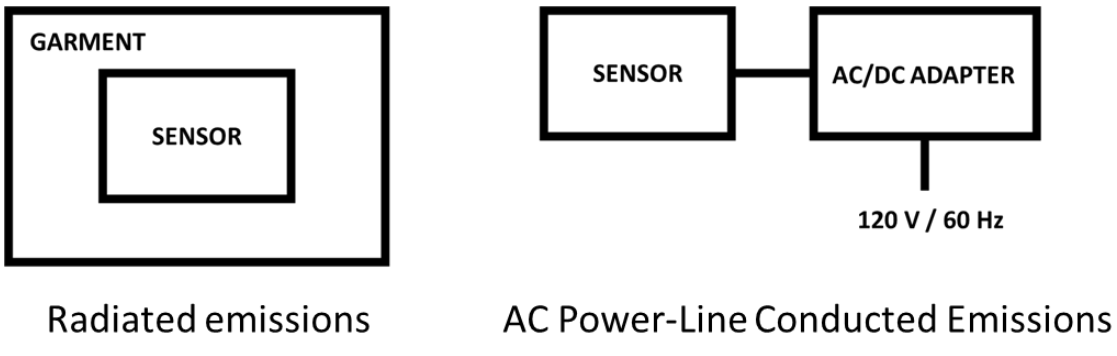

Figure 1: Test setup block diagram

Table 1: Test frequencies

Channel	Frequency [MHz]
Bottom	2402
Middle	2440
Top	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: 4 November 2022

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:	PKA	
Date:	7 November 2022	
Temperature:	24 °C	
Humidity:	44 %RH	
Measurement uncertainty:	± 2.9 dB	Level of confidence 95 % (k = 2)

FCC Rule: 15.207(a)
RSS-GEN 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 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.

Conducted disturbance voltage was measured with an artificial mains network from 150 kHz to 30 MHz with a resolution bandwidth of 9 kHz. Measurements were carried out with peak and average detectors.

Frequency of emission (MHz)	Conducted limit (dBµV)	
	Quasi-peak	Average
0.15-0.5	66 to 56 *)	56 to 46 *)
0.5-5	56	46
5-30	60	50

*) The level decreases linearly with the logarithm of the frequency

Test results

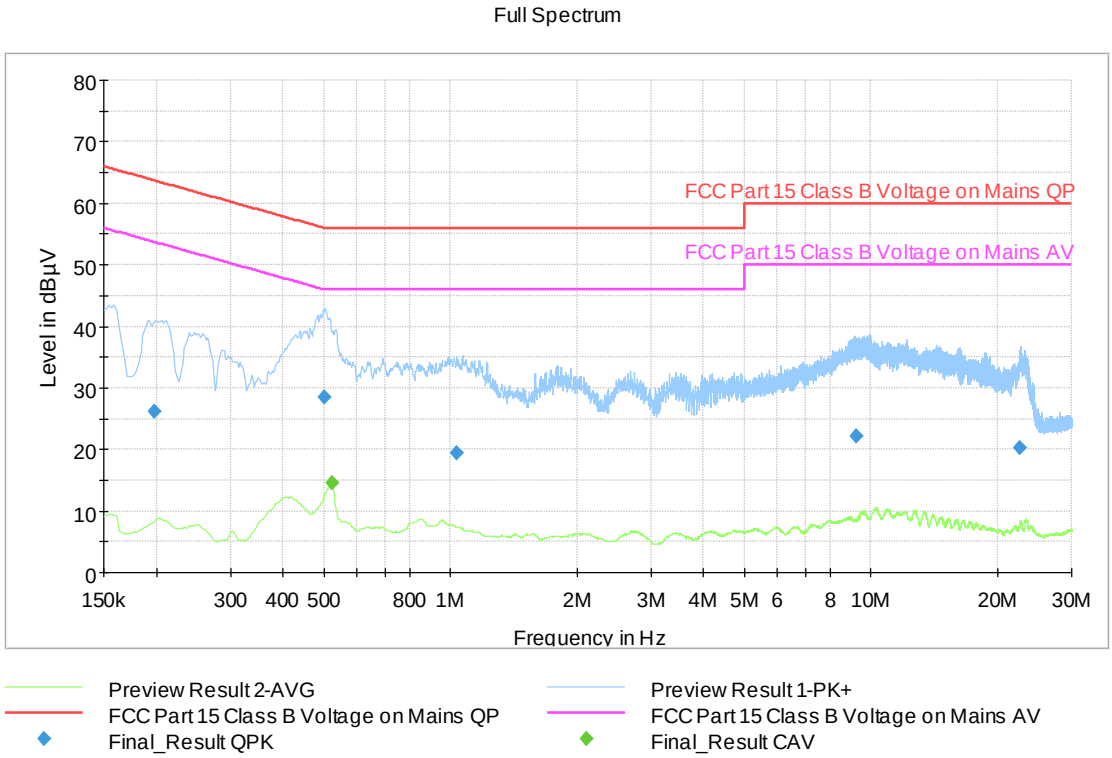

Figure 2: Graphical presentation for AC Power-Line Conducted Emissions

Table 2: 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)
0.198000	26.24	---	63.69	37.45	15 x 1000.0	9.000	L1	9.7
0.500500	28.42	---	56.00	27.58	15 x 1000.0	9.000	L1	9.7
0.522500	---	14.54	46.00	31.46	15 x 1000.0	9.000	L1	9.7
1.032750	19.42	---	56.00	36.58	15 x 1000.0	9.000	L1	9.8
9.212000	22.08	---	60.00	37.92	15 x 1000.0	9.000	L1	10.2
22.600750	20.33	---	60.00	39.67	15 x 1000.0	9.000	L1	10.6

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.

Maximum Peak Conducted Output Power

Standard:	ANSI C63.10-2013	
Tested by:	HEM	
Date:	8 November 2022	
Temperature:	24 °C	
Humidity:	44 %RH	
Measurement uncertainty:	± 4.51 dB	Level of confidence 95 % (k = 2)
Test result:	**PASS**	

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.

The test is performed as a radiated measurement by first measuring the field strength and then converting the result to EIRP. The equivalent conducted output power is then determined by subtracting the antenna gain from the EIRP. The relationship between field strength and EIRP can be found using formula in ANSI C63.10-2013 clause G.2. In logarithmic terms (at a measurement distance of 3 meters) the formula is:

$$EIRP\ [\mathrm{dBm}] = E[\mathrm{dB\mu V/m}] - 95.23$$

Test results:

Table 3: Test results for Maximum Peak Conducted Output Power

Channel	Field strength [dBµV/m]	EIRP [dBm]	Max. Output Power [dBm]
Bottom	77.31 + 13.7 = 91.01	-4.22	-4.82
Middle	76.48 + 13.7 = 90.18	-5.05	-5.65
Top	75.97 + 13.7 = 89.67	-5.56	-6.16

Note: the field strength correction factor (13.7 dB) includes antenna factor + amplifier + cables.
The antenna gain of the EUT is +0.6 dBi.

The spectrum analyser screenshot at bottom channel is presented.

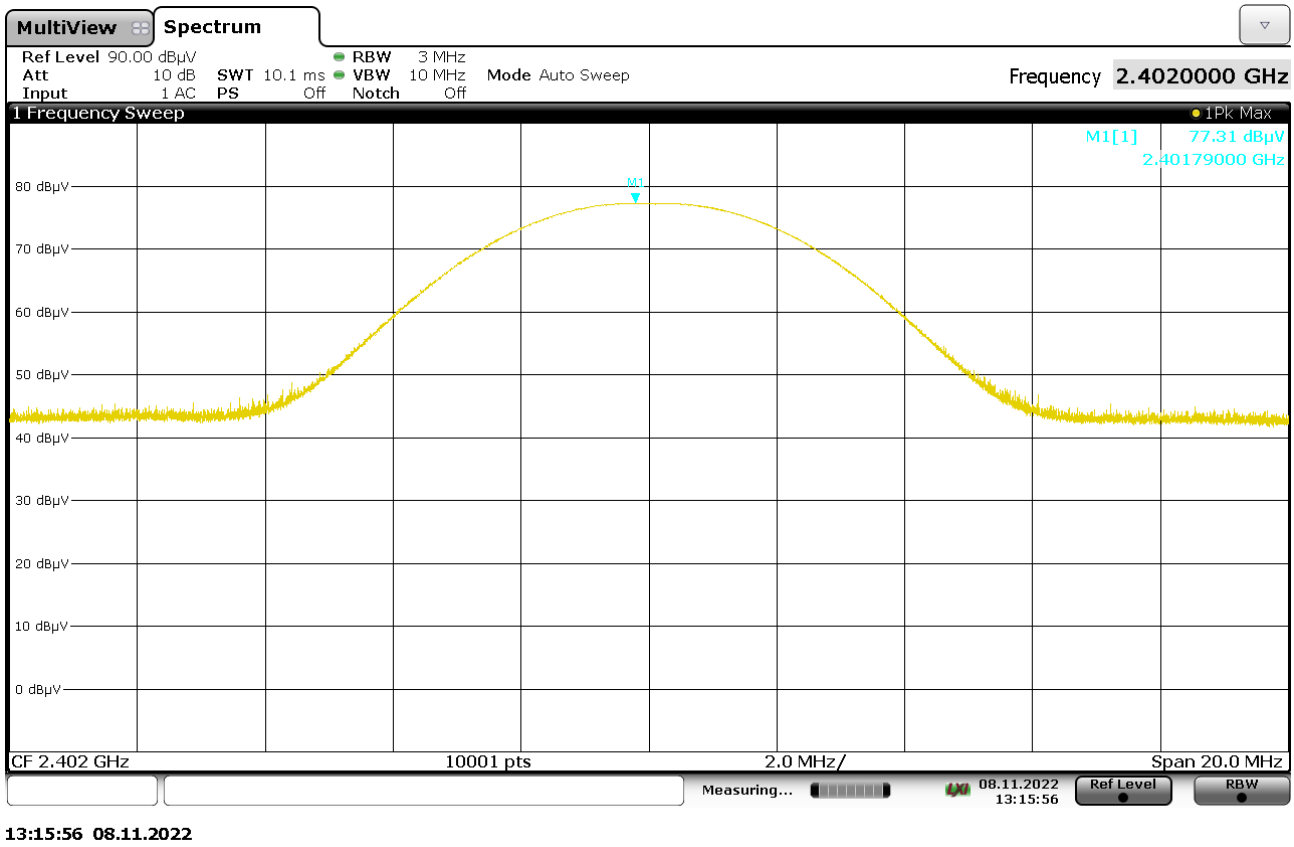

Figure 3: Field strength (without correction factor), bottom channel

Radiated Emissions and Band-Edge Measurement (9 kHz to 25 GHz)

Standard:	ANSI C63.10-2013	
Tested by:	HEM	
Date:	4 November 2022	7 November 2022
Temperature:	24 °C	24 °C
Humidity:	39 %RH	44 %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. Attenuation below the general limits specified in §15.209(a) and RSS-Gen 8.9 is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a) and RSS-Gen 8.10, must also comply with the radiated emission limits specified in §15.209(a) and RSS-Gen 8.9.

Frequency range [MHz]	Limit [µV/m]	Distance [m]	Detector
0.009 – 0.490	2400/F(kHz)	300	Quasi-peak
0.490 – 1.705	24000/F(kHz)	30	Quasi-peak
1.705 – 30	30	30	Quasi-peak
30 – 88	100	3	Quasi-peak
88 – 216	150	3	Quasi-peak
216 – 960	200	3	Quasi-peak
960 – 1000	500	3	Quasi-peak

The measurements are performed at a distance of 3 meters, and the results are extrapolated to the specified distance by using the square of an inverse linear distance extrapolation factor (40 dB/decade).

In the frequency range 9 kHz to 30 MHz no unwanted emissions within 20 dB of the limit were observed. The results above 30 MHz are presented.

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.

Test results (bottom channel)

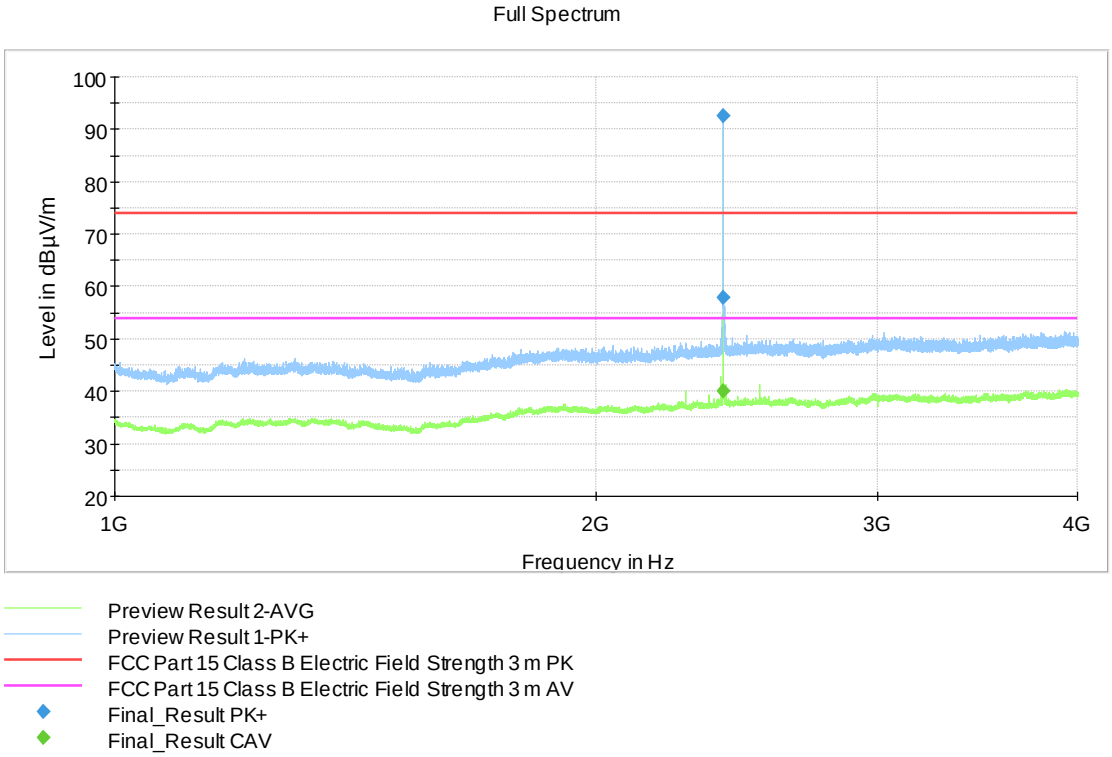

Figure 4: Bottom channel (1-4 GHz)

Table 4: Average results for Radiated emissions (bottom channel)

Frequency (MHz)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
2400.000000	40.00	53.90	12.95	15 x 1000.0	1000.000	293.0	H	356.0	13.6

Table 5: Peak results for Radiated emissions (bottom channel)

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	57.89	73.90	16.01	15 x 1000.0	1000.000	107.0	V	230.0	13.7
2401.750000	92.45	---	---	15 x 1000.0	1000.000	239.0	H	356.0	13.7

Test results (top channel)

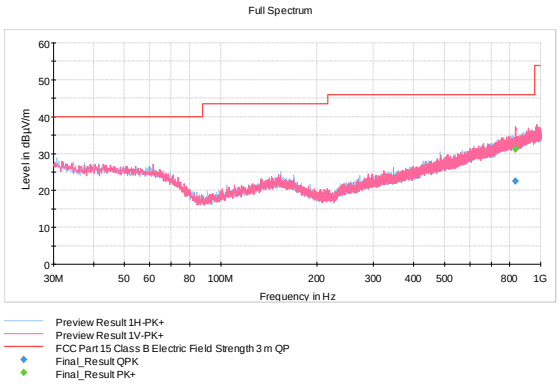

Figure 5: Top channel (30-1000 MHz)

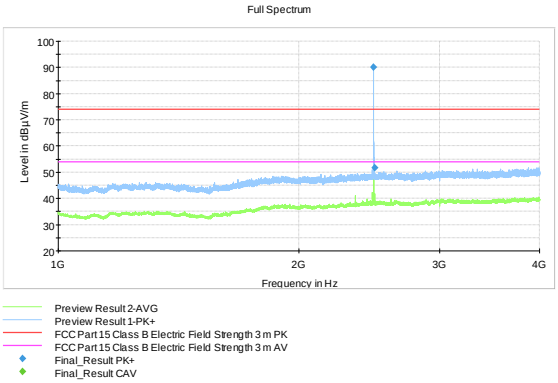

Figure 6: Top channel (1-4 GHz)

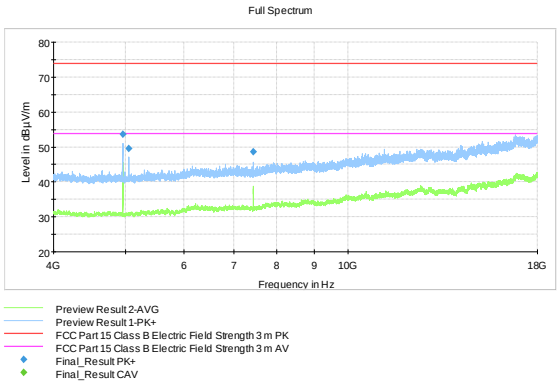

Figure 7: Top channel (4-18 GHz)

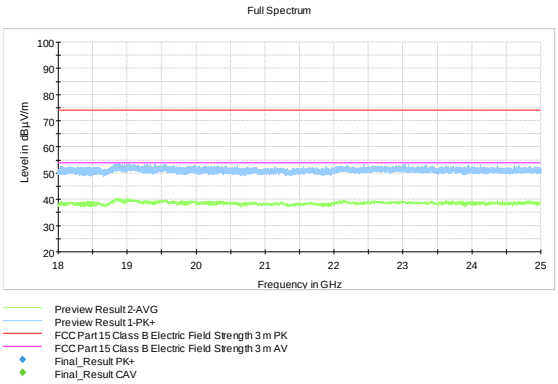

Figure 8: Top channel (18-25 GHz)

Table 6: Quasi-peak results for Radiated emissions (top channel)

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
833.012000	22.58	46.00	23.42	15 x 1000.0	120.000	395.0	V	219.0	30.3

Table 7: Peak results for Radiated emissions (top channel)

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
2479.750000	90.10	---	---	15 x 1000.0	1000.000	275.0	H	352.0	13.7
2483.500000	51.65	73.90	22.25	15 x 1000.0	1000.000	305.0	H	349.0	13.8
4960.000000	53.61	73.90	20.29	15 x 1000.0	1000.000	169.0	H	4.0	7.3
5054.500000	49.51	73.90	24.39	15 x 1000.0	1000.000	131.0	H	4.0	7.4
7440.700000	48.61	73.90	25.29	15 x 1000.0	1000.000	216.0	H	137.0	10.4

TEST EQUIPMENT

AC Power-Line Conducted Emissions

Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
EMI TEST RECEIVER	ROHDE & SCHWARZ	ESW26	inv. 10679	2022-06-20	2023-06-20
LISN	ROHDE & SCHWARZ	ENV216	inv. 9611	2022-02-02	2023-02-02
POWER SUPPLY	CALIFORNIA INSTR.	5001 iX Series II	inv. 7826	NCR	NCR
TEST SOFTWARE	ROHDE & SCHWARZ	EMC-32	-	-	-

Radiated Emissions

Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
ANTENNA	ROHDE & SCHWARZ	HFH2-Z2 , 335.4711.52	inv. 8013	2022-10-25	2024-10-25
ANTENNA	SCHWARZBECK	VULB 9168	inv. 8911	2020-11-04	2022-11-04
ANTENNA	SCHWARZBECK	VULB 9168	inv. 10682	2022-07-26	2024-07-26
ANTENNA	EMCO	3160-09	inv. 7294	2022-02-22	2023-02-22
ANTENNA	EMCO	3117	inv. 7293	2022-06-16	2024-06-16
ANTENNA MAST	MATURO	TAM 4.0E	inv. 10181	NCR	NCR
ATTENUATOR	PASTERNACK	10 dB, DC-40 GHz	sn. A1	2021-04-20	2023-04-20
ATTENUATOR	PASTERNACK	PE 7004-4 (4dB)	inv. 10126	2021-03-30	2023-03-30
EMI TEST RECEIVER	ROHDE & SCHWARZ	ESW26	inv. 10679	2022-06-20	2023-06-20
FILTER	WAINWRIGHT	WHKX4.0/18G-10SS	inv. 10403	2021-01-29	2023-01-29
MAST & TURNTABLE CONTROLLER	MATURO	NCD	inv. 10183	NCR	NCR
RF PREAMPLIFIER	CIAO	CA118-3123	inv. 10278	2022-09-21	2023-09-21
RF PREAMPLIFIER	CIAO	CA1840-5019	inv. 10593	2022-09-21	2023-09-21
TEST SOFTWARE	ROHDE & SCHWARZ	EMC-32	-	-	-
TURNTABLE	MATURO	DS430 UPGRADED	inv. 10182	NCR	NCR

NCR = No Calibration Required

END OF REPORT