

Test Report



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

Equipment Under Test: Handheld PTT communication device

Type: Aina Kepler

Applicant: AINA Wireless Finland Oy
Joensuunkatu 7 G
FI-24100 Salo
FINLAND

Manufacturer: AINA Wireless Finland Oy
Joensuunkatu 7 G
FI-24100 Salo
FINLAND

FCC Rule Part: 15.247: 2018
IC Rule Part: RSS-247, Issue 2, 2017
RSS-GEN Issue 5 Amendment 1, 2019
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

Date: 3 April 2023

Issued by:

A blue ink signature of Pekka Kälviäinen.

Pekka Kälviäinen
Testing Engineer

Date: 3 April 2023

Checked by:

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Rauno Repo
Senior EMC/RF 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	7 April 2022
1.1	The type of the antenna changed	3 April 2023

PRODUCT DESCRIPTION

Equipment Under Test

Handheld PTT communication device

Type: Aina Kepler
Serial no: -
FCC ID: 2AH78-AKEPLER
IC: 21419-AKEPLER

Cellular module: Quectel EC25-AF
FCC ID: 2AH78 201808EC25AF
IC: 21419-2018EC25AF

Battery: Rechargeable Li-Polymer Battery
Type: VARTA Storage GmbH, EZPack XL

Charger: Travel Adapter (used only during Conducted Emissions on Power Supply Lines test)
Type: Samsung ETA-U90EWE, s/n: SC4DC21HS/B-E

General Description

The equipment under test (EUT) is hand held PTT communication device with 2.4GHz ISM, 13.56 MHz NFC, GNSS and cellular capabilities.

Classification

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

Modifications Incorporated in the EUT

No modifications were applied during the tests.

Ratings and declarations

Operating Frequency Range (OFR): 2413.0 – 2470.0 MHz
Channels: 20
Channel separation: 3 MHz
Transmission technique: FHSS
Antenna type: Johanson Technology, Mini 2.45 GHz Antenna, P/N: 2450AT07A0100
Integral Antenna gain: 1.0 dBi

Power Supply

EUT:	Rechargeable Li-Polymer Battery
Nominal Voltage:	3.7 VDC
Battery:	
Rated capacity:	3.7V 2400mAh 8.9Wh
Charger:	
Rated input:	100-240VAC 50-60Hz / 0.35A (120V/60Hz was used)
Rated output:	5VDC / 2A

Mechanical Size of the EUT

Height: 125 mm	Width: 80 mm	Depth: 45 mm
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Cables

DC cable, EUT-charger	shielded, 1.0 m
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Peripherals

none

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	PASS
§15.247(b)(3) / RSS-247 5.4(d)	Maximum Peak Conducted Output Power	PASS
§15.247(a)(1) / RSS-247 5.1	Hopping Channel Carrier Frequency Separation	not tested
§15.247(a)(1) / RSS-247 5.1	Number of Hopping Frequencies	not tested
§15.247(a)(1) / RSS-247 5.1	Average Time of Occupancy of Hopping Frequency	not tested
§15.247(a)(1) / RSS-247 5.1	20 dB Bandwidth	not tested
§15.247(a)(2) / RSS-247 5.2(a)	6 dB Bandwidth	not tested
§15.247(e) / RSS-247 5.2(b)	Power Spectral Density	N/T ⁽¹⁾
RSS-GEN 6.7	99% Occupied Bandwidth	not tested
§15.247(d) / RSS-247 5.5	100 kHz Bandwidth of Frequency Band Edges	PASS
§15.209(a), §15.247(d) / RSS-247 5.5	Radiated Emissions Within the Restricted Bands	PASS

1) Not applicable for FHSS

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.

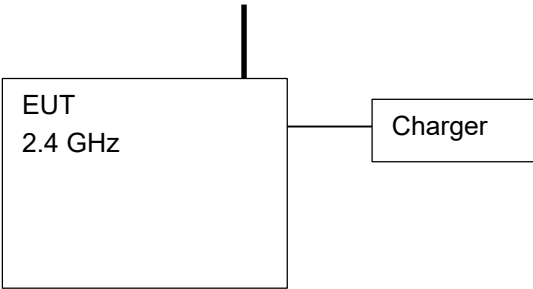
EUT Test Conditions during Testing

Test	Operating mode
Conducted Emissions on Power Supply Lines	continuous transmit
Maximum Peak Conducted Output Power	continuous transmit
100 kHz Bandwidth of Frequency Band Edges	continuous transmit
Radiated Emissions Within the Restricted Bands	continuous transmit

Table 1: Test frequencies

Channel	Frequency (MHz)
low	2413.0
middle	2440.0
high	2470.0

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: PKA
Date: 7 April 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	

Conducted Emissions In The Frequency Range 150 kHz - 30 MHz**Conducted Emissions In The Frequency Range 150 kHz - 30 MHz**

Standard: ANSI C63.10 (2013)
Tested by: HEM
Date: 4 April 2022
Temperature: $23 \pm 3^{\circ}\text{C}$
Humidity: 20 - 60 % RH
Barometric pressure: 1001 hPa
Measurement uncertainty: $\pm 2.9 \text{ dB}$ Level of confidence 95 % ($k = 2$)

FCC Rule: 15.207 (a)
RSS-GEN 8.8

Conducted disturbance voltage was measured with an artificial main 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 (dB μ V)	
	Quasi-peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50

*Decreases with the logarithm of the frequency.

120V 60Hz AC input of the changer.

Full Spectrum

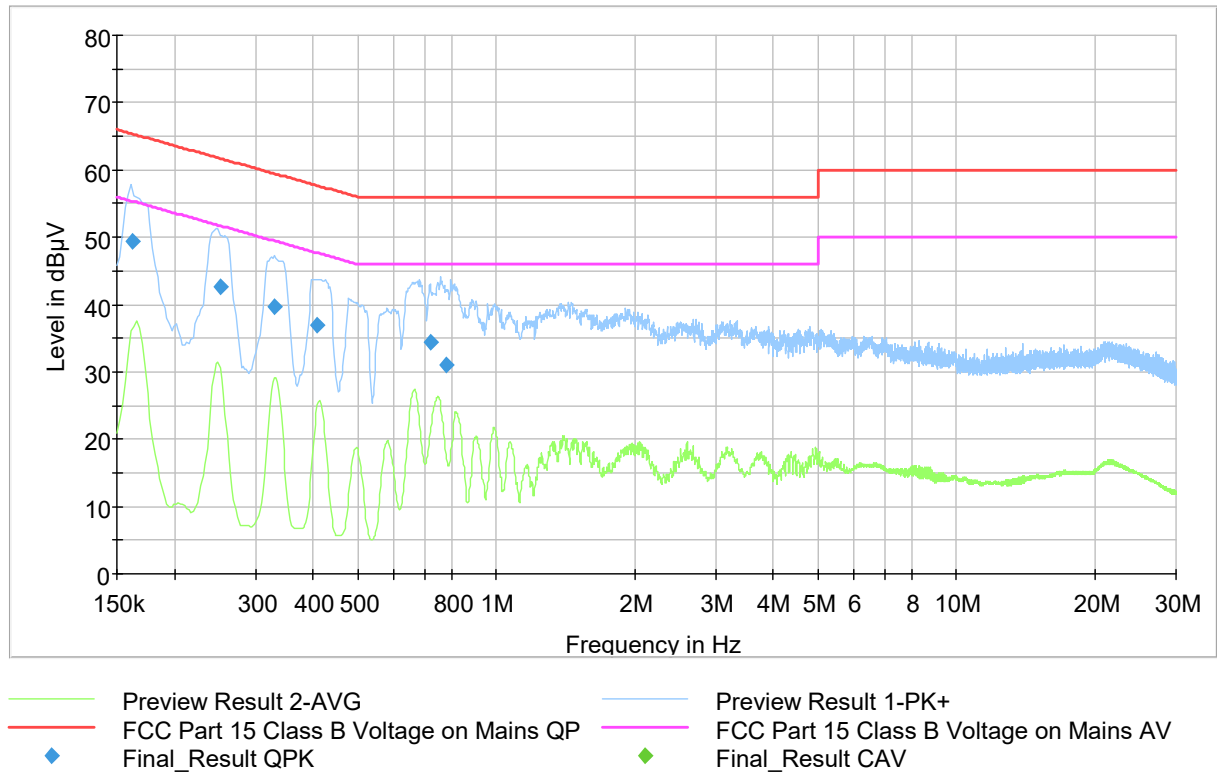


Figure 1: The measured curves with peak- and average detector

Final measurements from the worst frequencies

Table 2: Final QuasiPeak and Average measurements from the worst frequencies

Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Filter	Corr. (dB)
0.162000	49.48	---	65.36	15.88	1000.0	9.000	N	ON	9.7
0.252000	42.58	---	61.69	19.11	1000.0	9.000	N	ON	9.7
0.329000	39.58	---	59.48	19.90	1000.0	9.000	N	ON	9.7
0.409750	36.95	---	57.65	20.70	1000.0	9.000	N	ON	9.7
0.718250	34.34	---	56.00	21.66	1000.0	9.000	L1	ON	9.8
0.780500	31.06	---	56.00	24.94	1000.0	9.000	L1	ON	9.8

The correction factor in the final result table contains the sum of the transducers.

The result value is the measured value corrected with the correction factor.

Maximum Peak Conducted Output Power**Maximum Peak Conducted Output Power**

Standard: ANSI C63.10 (2013)
Tested by: PKA
Date: 5 April 2022
Temperature: 23 ± 3 °C
Humidity: 20 - 60 % RH
Measurement uncertainty: ± 2.87 dB Level of confidence 95 % ($k = 2$)

FCC Rule: 15.247(b)(1)
RSS-247 5.4(d)

Test according to FCC title 47 part 15 §15.247(b), KDB 558074 D01 DTS Meas Guidance v05 and ANSI C63.10-2013 7.8.5

Measured values are peak values.

Results:

Table 3: Maximum conducted output power

Channel	Conducted Power [dBm]	Limit [dBm]	Margin [dBm]	Result
low	19.15	21	1.85	PASS
mid	18.48	21	2.52	PASS
high	17.58	21	3.42	PASS

Maximum Peak Conducted Output Power

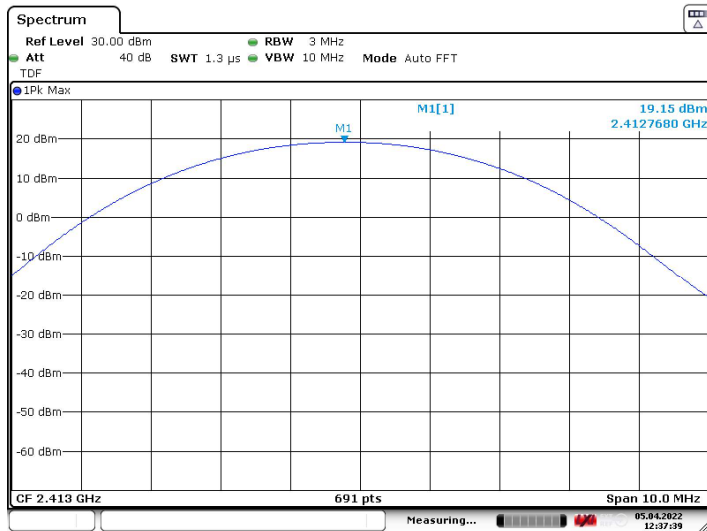


Figure 2: Maximum conducted power, channel low

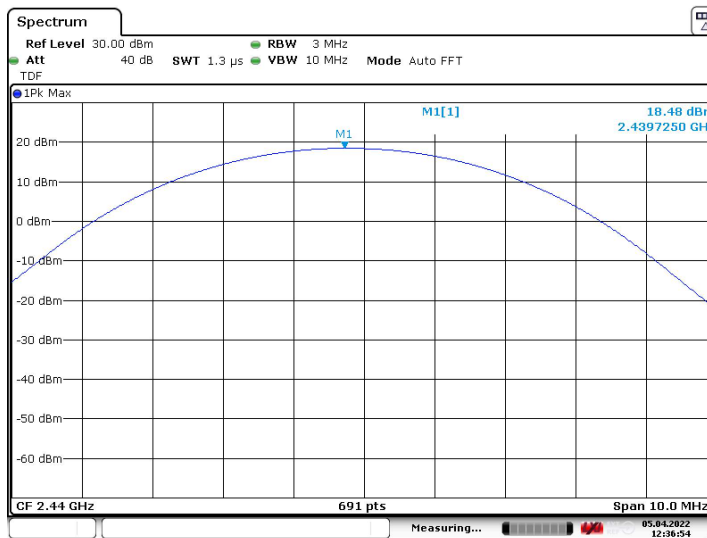


Figure 3: Maximum conducted power, channel mid

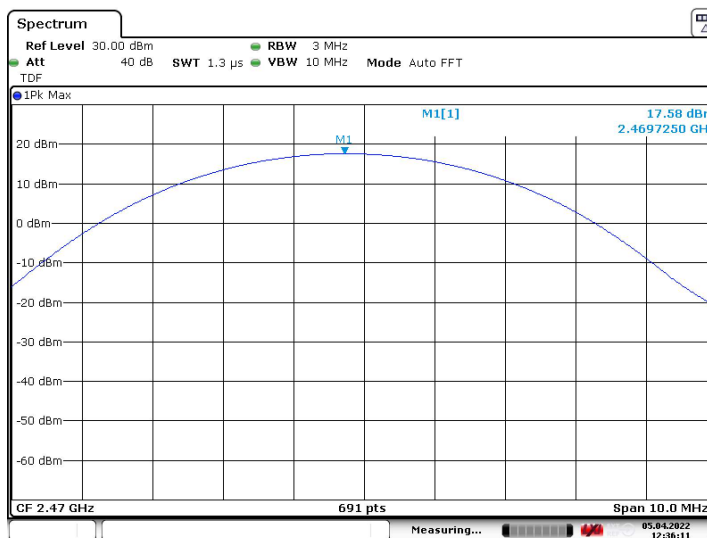


Figure 4: Maximum conducted power, channel high

Transmitter Radiated Spurious Emissions 9 kHz – 26.5 GHz

Transmitter Radiated Spurious Emissions 9 kHz – 26.5 GHz

Standard: ANSI C63.10 (2013)
Tested by: PKA, HEM
Date: 1 and 4 April 2022
Temperature: 23 ± 3 °C
Humidity: 20 - 60 % 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).

According to ANSI C63.10 (clause 5.3.2) and RSS-Gen (Clause 4.11) the measurements below 30 MHz can be performed at a closer distance than the EUT limit distance, the results shall be extrapolated to limit distance by using the square of an inverse linear distance extrapolation factor (40 dB/ decade). This method was used when performing measurements at a distance of 3 m instead of limit distances 300 m or 30 m.

The correction factor in the final result table contains the sum of the transducers (antenna + amplifier + cables).

Peak values of emissions below 1000 MHz measured for reference as well as transmitter fundamental.

The pre-measurements were performed with the EUT being in three orthogonal positions (X, Y, Z). Final measurements were done in worst position.

Frequency range [MHz]	Limit [$\mu\text{V/m}$]	Limit [dB $\mu\text{V/m}$]	Detector
0.009-0.490	2400/F(kHz)	300	Quasi-peak
0.490-1.705	24000/F(kHz)	30	Quasi-peak
1.705-30.0	30	30	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

Transmitter Radiated Spurious Emissions 9 kHz – 26.5 GHz

Table 4: Quasipeak results below 1GHz

Channel	Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
mid	999.935	24.90	54.00	29.10	1000.0	120.000	100.0	V	159.0	32.2
high	960.035	31.54	54.00	22.46	1000.0	120.000	108.0	V	169.0	31.9

Table 5: Peak results above 1GHz

Channel	Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
low	2390.000	53.11	74.00	20.89	1000.0	1000.000	126.0	V	287.0	13.7
	2393.600	-56.93	-20dBc	36.93	1000.0	1000.000	136.0	V	298.0	13.7
	2413.000	110.51	N/A Tx	---	1000.0	1000.000	131.0	V	294.0	13.7
high	2485.700	54.01	74.00	19.99	1000.0	1000.000	105.0	V	236.0	14.0

Table 6: Average results above 1GHz

Channel	Frequency (MHz)	CAverag (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
low	2390.000	43.45	54.00	10.55	1000.0	1000.000	110.0	V	280.0	13.7
	9453.100	31.81	54.00	22.19	1000.0	1000.000	169.0	H	260.0	14.1
	12513.800	35.21	54.00	18.79	1000.0	1000.000	107.0	V	279.0	17.5
	13335.500	35.06	54.00	18.94	1000.0	1000.000	151.0	H	0.0	18.0
	14497.100	34.13	54.00	19.87	1000.0	1000.000	146.0	V	0.0	18.7
	15850.400	35.82	54.00	18.18	1000.0	1000.000	162.0	H	334.0	21.5
	19159.300	37.92	54.00	16.08	1000.0	1000.000	100.0	V	326.0	7.0
	22603.850	38.03	54.00	15.97	1000.0	1000.000	100.0	H	51.0	8.3
mid	23635.950	38.15	54.00	15.85	1000.0	1000.000	100.0	H	242.0	5.3
	8138.400	31.56	54.00	22.44	1000.0	1000.000	154.0	V	30.0	11.8
	9491.200	31.47	54.00	22.53	1000.0	1000.000	208.0	H	341.0	13.9
	12533.700	35.17	54.00	18.83	1000.0	1000.000	123.0	H	124.0	17.5
	13335.000	35.06	54.00	18.94	1000.0	1000.000	154.0	V	303.0	18.0
	14497.800	34.15	54.00	19.85	1000.0	1000.000	146.0	H	28.0	18.7
	15953.300	35.32	54.00	18.68	1000.0	1000.000	115.0	V	345.0	21.3
	22879.700	38.02	54.00	15.98	1000.0	1000.000	125.0	H	88.0	7.5
high	2488.900	43.57	54.00	10.43	1000.0	1000.000	126.0	V	224.0	14.0
	9454.100	31.80	54.00	22.20	1000.0	1000.000	138.0	V	80.0	14.1
	11999.700	34.91	54.00	19.09	1000.0	1000.000	177.0	H	348.0	17.9
	13343.800	35.08	54.00	18.92	1000.0	1000.000	182.0	H	338.0	17.9
	14484.800	34.18	54.00	19.82	1000.0	1000.000	146.0	V	348.0	18.7
	15953.300	35.38	54.00	18.62	1000.0	1000.000	189.0	V	333.0	21.3
	22638.350	37.97	54.00	16.03	1000.0	1000.000	100.0	V	284.0	8.1

Transmitter Radiated Spurious Emissions 9 kHz – 26.5 GHz

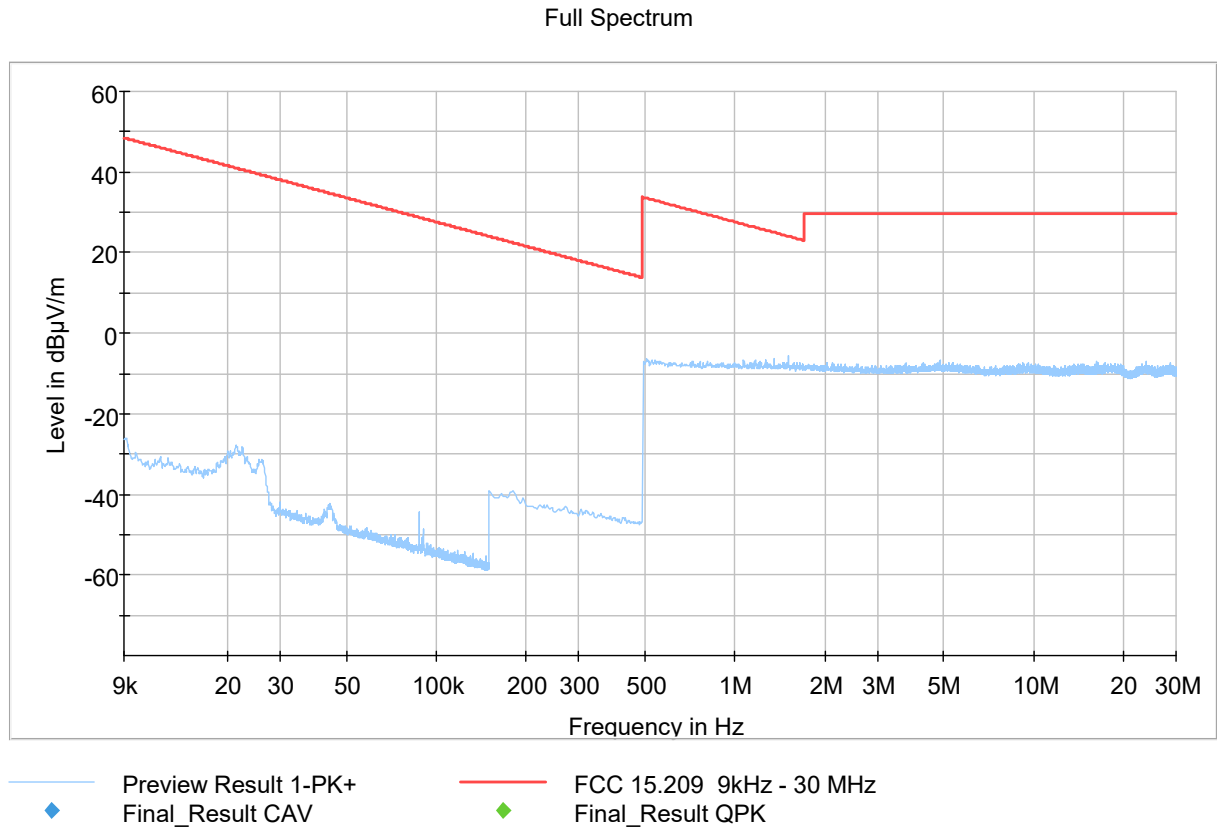


Figure 5: 9 kHz – 30 MHz, channel low

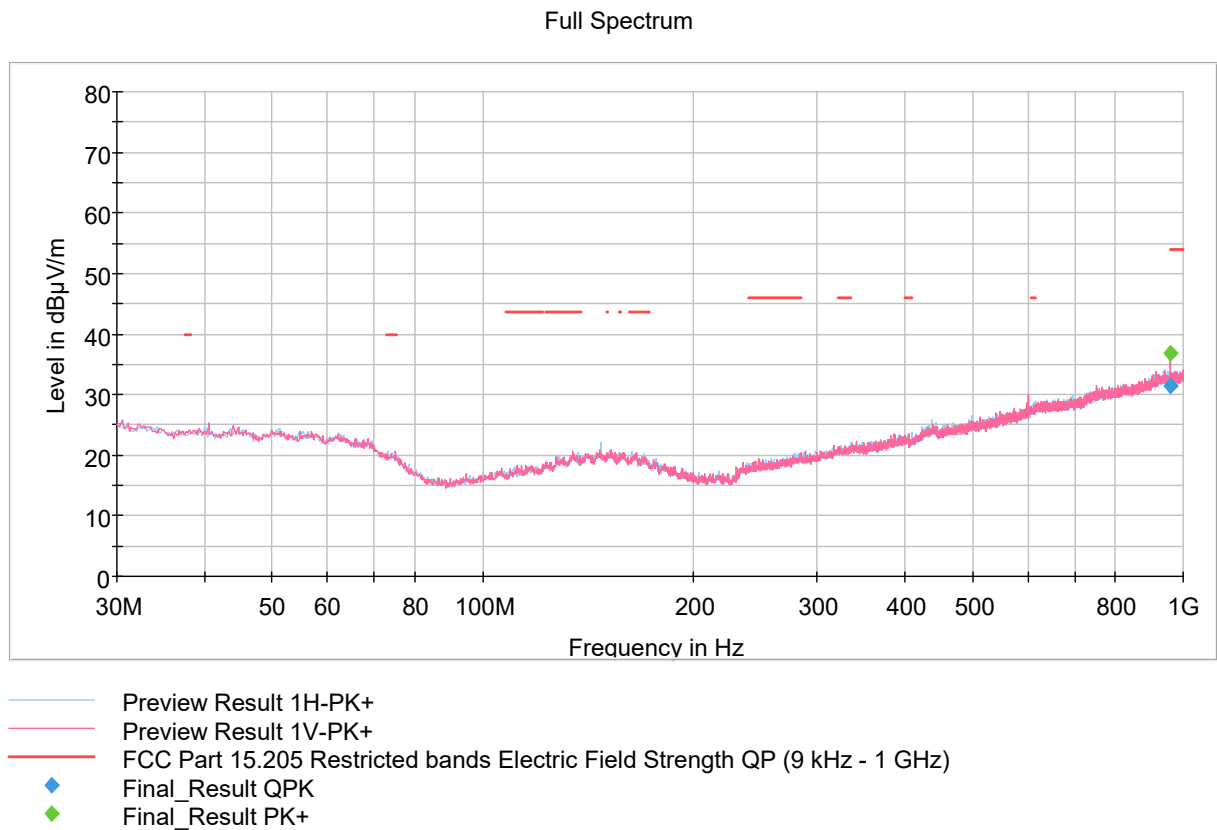


Figure 6: 30 MHz – 1000 MHz, channel high

Transmitter Radiated Spurious Emissions 9 kHz – 26.5 GHz

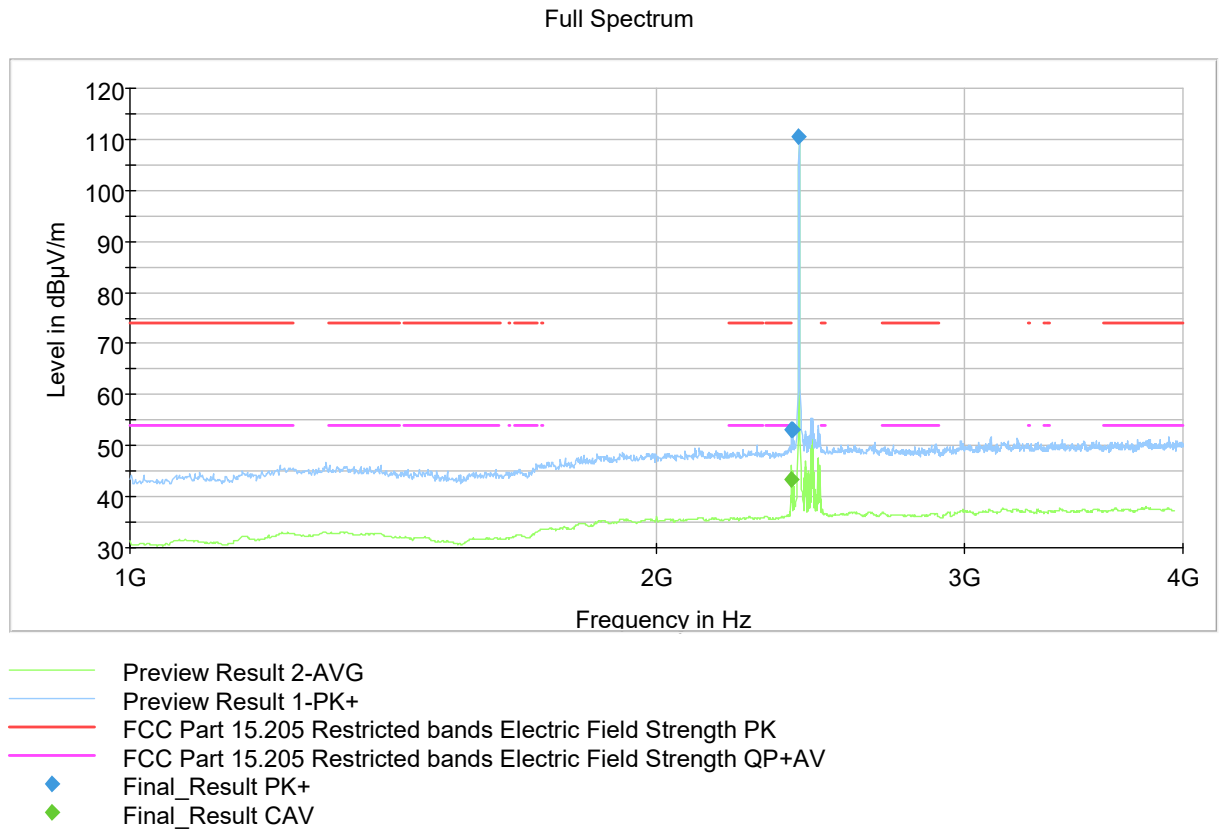


Figure 7: 1 GHz – 4 GHz, channel low, band edge

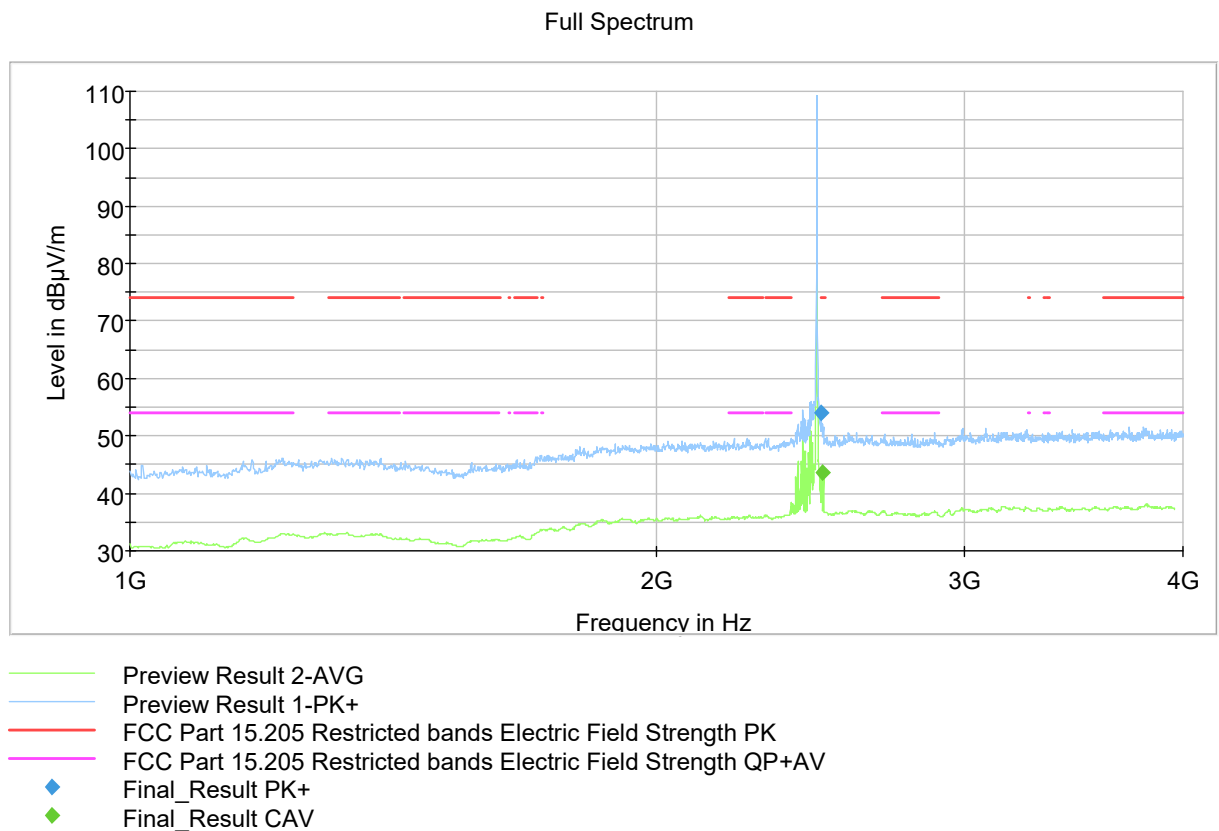


Figure 8: 1 GHz – 4 GHz, channel high, band edge

Transmitter Radiated Spurious Emissions 9 kHz – 26.5 GHz

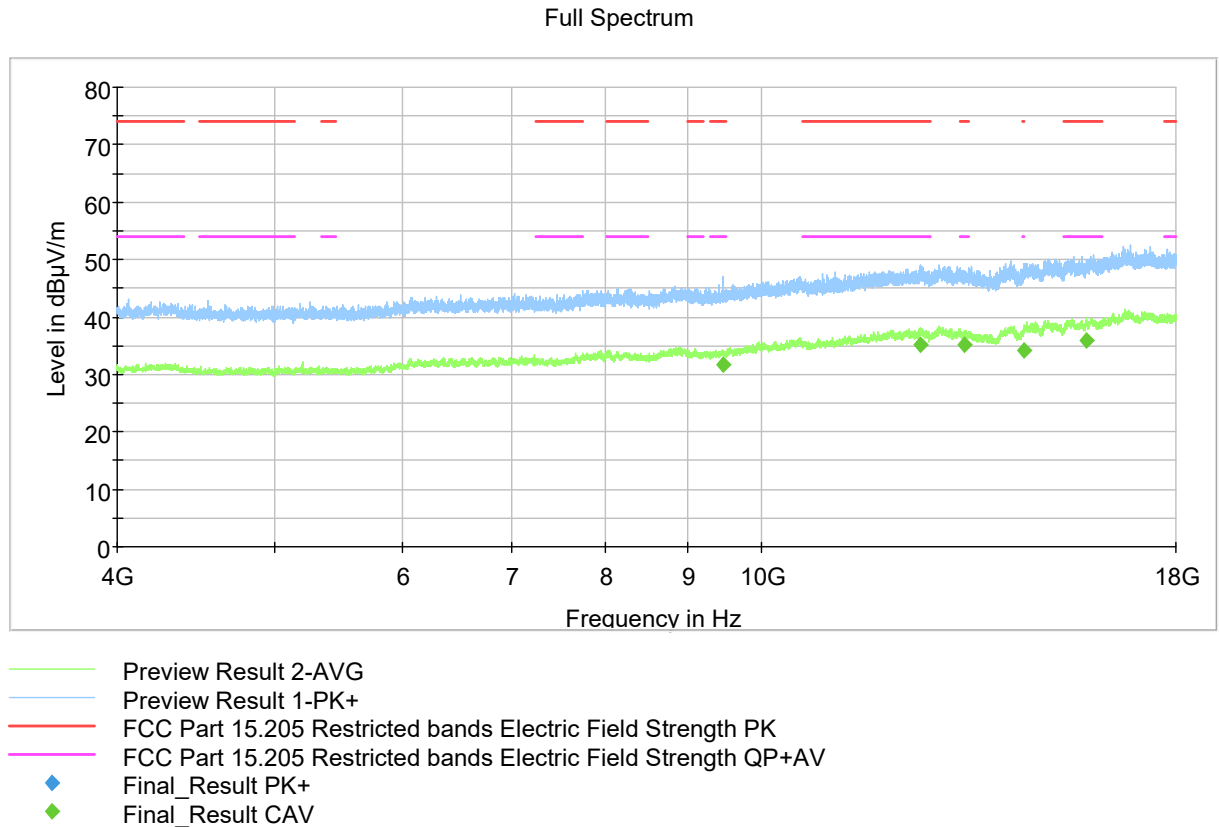


Figure 9: 4 GHz – 18 GHz, channel low

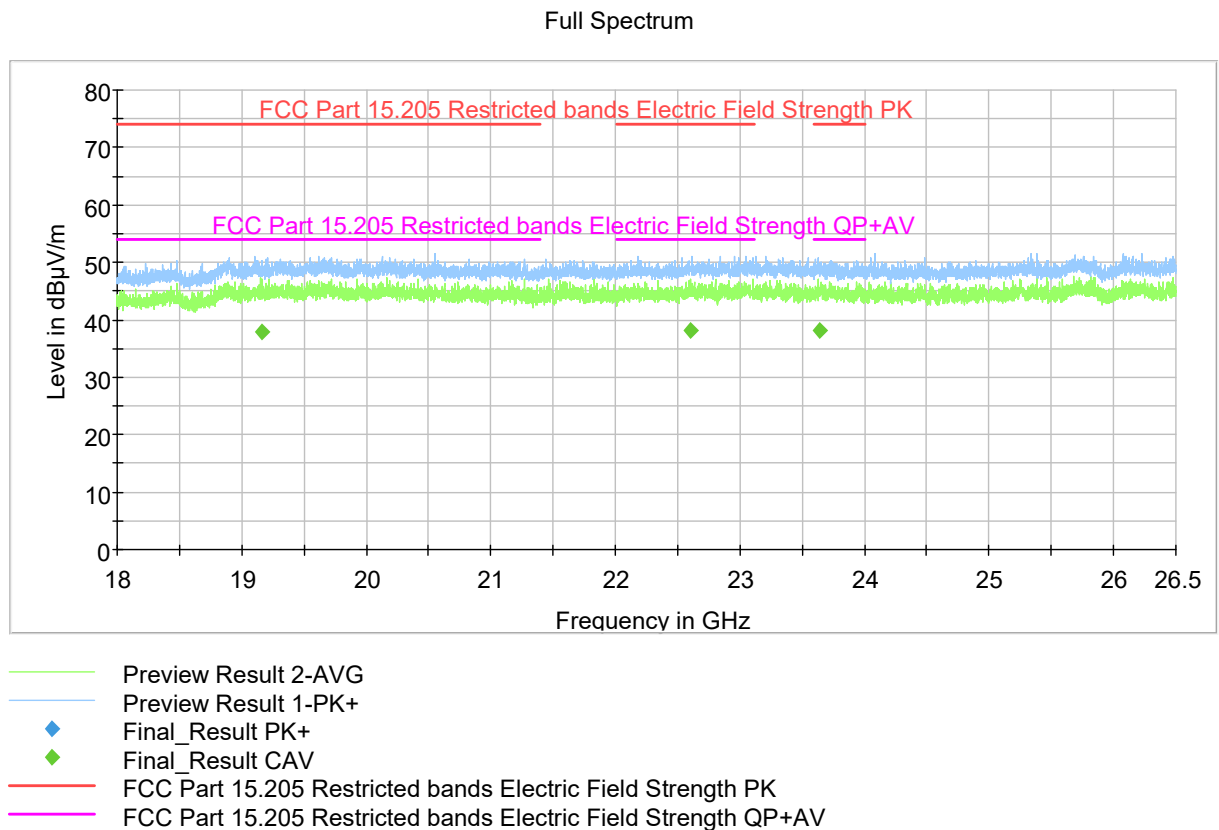


Figure 10: 18 GHz – 26.5 GHz, channel low

TEST EQUIPMENT

RF-Test Equipment

Equipment	Manufacturer	Type	Inv or serial	Prev Calib	Next Calib
RF PREAMPLIFIER	CIAO	CA118-3123	inv:10278	2021-10-05	2022-10-05
RF PREAMPLIFIER	CIAO	CA1840-5019	inv:10593	2021-10-05	2022-10-05
ANTENNA	EMCO	3117, emi 1-18GHz	inv:9569	2021-04-09	2023-04-09
ANTENNA	EMCO	3160-09, emi 18-26.5GHz	inv:7294	2022-02-22	2023-02-22
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
ATTENUATOR	PASTERNAK	PE 7004-4 (4dB)	inv:10126	2022-02-23	2024-02-23
ATTENUATOR	HUBER&SUHNER	6606.19.AA (A4)	inv:10393	2021-04-01	2023-04-01
TURNTABLE	MATURO	DS430 UPGRADED	inv:10182	NCR	-
MAST & TURNTABLE CONTROLLER	MATURO	NCD	inv:10183	NCR	-
ANTENNA MAST	MATURO	TAM 4.0E	inv:10181	NCR	-
TEST SOFTWARE	ROHDE & SCHWARZ	EMC-32	-	NCR	-
EMI TEST RECEIVER	ROHDE & SCHWARZ	ESW26	inv:10679	2021-06-21	2022-06-21
SPECTRUM ANALYZER	ROHDE & SCHWARZ	FSV40	inv:9093	2021-12-06	2022-12-06
FILTER	WAINWRIGHT	HP, WHKX4.0/18G-10SS	inv:10403	2021-01-29	2023-01-29
TEMPERATURE/ HUMIDITY SENSOR	EDS	OW-ENV-TH, K5 SAC	inv:10517	2021-10-22	2022-10-22

Conducted Emissions

Equipment	Manufacturer	Type	Inv or serial	Prev Calib	Next Calib
POWER SUPPLY	CALIFORNIA INSTR.	5001i-400	inv:9488	NCR	-
TEST SOFTWARE	ROHDE & SCHWARZ	EMC-32	-	NCR	-
LISN	ROHDE & SCHWARZ	ENV216	inv:9611	2022-02-02	2023-02-02
EMI TEST RECEIVER	ROHDE & SCHWARZ	ESW26	inv:10679	2021-06-21	2022-06-21
TEMPERATURE/ HUMIDITY SENSOR	EDS	OW-ENV-TH, K5 SAC	inv:10517	2021-10-22	2022-10-22

NCR = No calibration required

END OF TEST REPORT