Test Report

FINAS
Finnish Accreditation Service
T004 (EN ISO/IEC 17025)

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

Equipment Under Test:	Handheld PTT communication device
Type:	Aina Kepler
Customer / Manufacturer:	AINA Wireless Finland Oy Joensuunkatu 7 G FI-24100 Salo FINLAND
FCC Rule Part:	15.209: 2019 15.225: 2019
IC Rule Part:	RSS-210, Issue 9, 2016 RSS-GEN, Issue 5, Amendment 1, 2019

Date:	15 May 2020	Date:	15 May 2020
Issued by:	Pekka Kälviäinen Testing Engineer	Checked by:	Rauno Repo Senior EMC/RF Specialist

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Equipment Under Test (EUT)

Handheld PTT communication device

Type:	Aina Kepler
Serial no:	NA2
FCC ID:	2AH78-AKEPLER
IC:	21419-AKEPLER
Cellular module:	Quectel EC25-AF
FCC ID:	XMR201808EC25AF
IC:	10224A-2018EC25AF
Battery:	Rechargeable Li-Polymer Battery
Type:	VARTA Storage GmbH, EZPack XL
Charger:	I.T.E Power Supply (used only during Conducted Emissions on Power Supply Lines test)
Type:	Friwo Gerätebau GmbH, FW8000USB/05

Classification of the device

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

Description of the EUT

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

Ratings and declarations, HF

Operating Frequency Range (OFR):	13.56 MHz
Channels:	1 transmit channel
Effective radiated or conducted power:	-
Modulation:	-
Antenna:	Integral antenna

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/300-150mA (120V/60Hz was used)
Rated output:	5VDC/2200mA

Mechanical Size of the EUT

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

Cables

DC cable, EUT-charger	shielded, 1.0 m

Peripherals

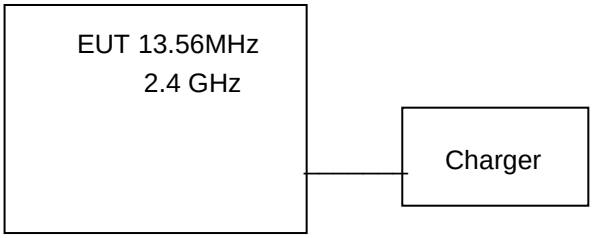
none

Disclaimer

Summary of Testing

Test Specification	Description of Test	Result
§15.203	Antenna requirement	**PASS**
§15.209, RSS-210, RSS-GEN	Radiated Emissions 9 kHz to 1 GHz	**PASS**
§15.225	Operation within the band 13.110-14.010 MHz	**PASS**
§15.225	Frequency Stability	**PASS**
RSS-GEN	Occupied Bandwidth	**PASS**

Block Diagram



EUT Test Conditions During Testing

Configuration of the EUT was made to correspond to the actual assembling conditions as far as possible.

Table 1. Normal and extreme test conditions

Test conditions:		Temperature [ºC]:	Voltage [V]:	Frequency [Hz]:
Normal		20 – 25	3.70 V	DC
Extreme	Minimum	-10	3.51 V	
	Maximum	+60	4.26 V	

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: 28 November 2019

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.

Standard:	ANSI C63.10	(2013)
Tested by:	PKA	
Date:	21 October 2019	
Temperature:	23 °C	
Humidity:	44 % RH	
Barometric pressure:	1018 hPa	
Measurement uncertainty:	± 2.9 dB	Level of confidence 95 % (k = 2)

FCC Rule: 15.207 (a)

Conducted disturbance voltage was measured with an artificial main network from 150 kHz to 30 MHz with 4.5 kHz steps and a resolution bandwidth of 9 kHz. Measurements were carried out with peak and average detectors.

During the test the EUT was powered from the separate power supply through the LISN.

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

*Decreases with the logarithm of the frequency.

Test results

120V 60Hz AC input of the changer. All transmitters operate.

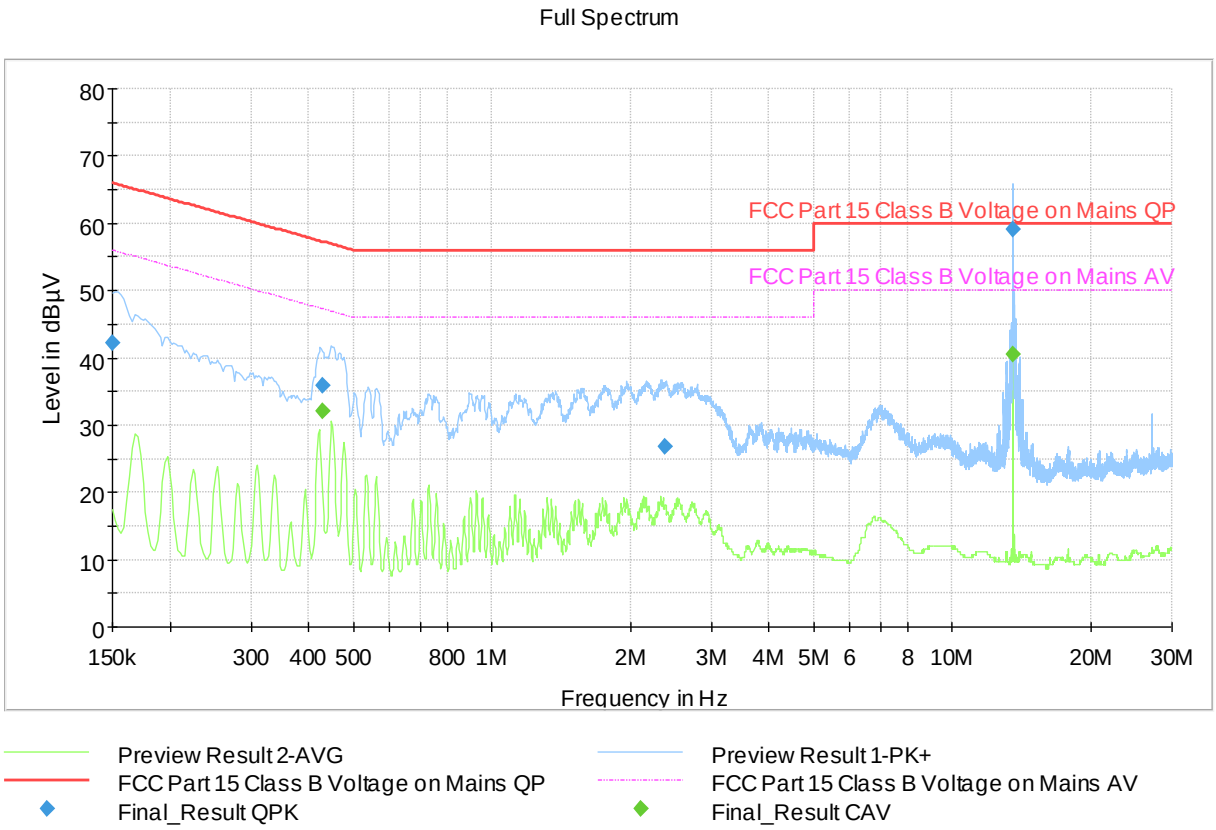


Figure 1: The measured curves with peak- and average detector

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)
0.150000	**42.20**	**---**	**66.00**	**23.80**	**1000.0**	**9.000**	**L1**	**ON**	**9.6**
0.428250	**---**	**32.14**	**47.29**	**15.15**	**1000.0**	**9.000**	**N**	**ON**	**9.7**
0.428250	**35.93**	**---**	**57.29**	**21.36**	**1000.0**	**9.000**	**N**	**ON**	**9.7**
2.381500	**26.82**	**---**	**56.00**	**29.18**	**1000.0**	**9.000**	**N**	**ON**	**9.9**
13.556750	**---**	**40.50**	**50.00**	**9.50**	**1000.0**	**9.000**	**L1**	**ON**	**10.3**
13.558500	**59.06**	**---**	**60.00**	**0.94**	**1000.0**	**9.000**	**L1**	**ON**	**10.3**

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.

Radiated Emissions In The Frequency Range 9 kHz – 1 GHz

Standard:	ANSI C63.10
Tested by:	HEM, PKA
Date:	16 - 17 October 2019
Temperature:	23 °C
Humidity:	43 - 44 % RH
Barometric pressure:	1003 – 1007 hPa

Measurement uncertainty ± 4.5 dB Level of confidence 95 % (k = 2)

FCC Rule: 15.209

The emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
0.009-0.490	**2400/F(kHz)**	**300**
0.490-1.705	**24000/F(kHz)**	**30**
1.705-30.0	**30**	**30**
30-88	**100 ****	**3**
88-216	**150 ****	**3**
216-960	**200 ****	**3**
Above 960	**500**	**3**

The level of any unwanted emissions from an intentional radiator operating under these general provisions shall not exceed the level of the fundamental emission. The emission limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9-90 kHz, 110-490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector.

All three positions (x, y, z) have been measured, worst case test results reported.

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 + cables + distance).
The result value is the measured value corrected with the correction factor.

Test results

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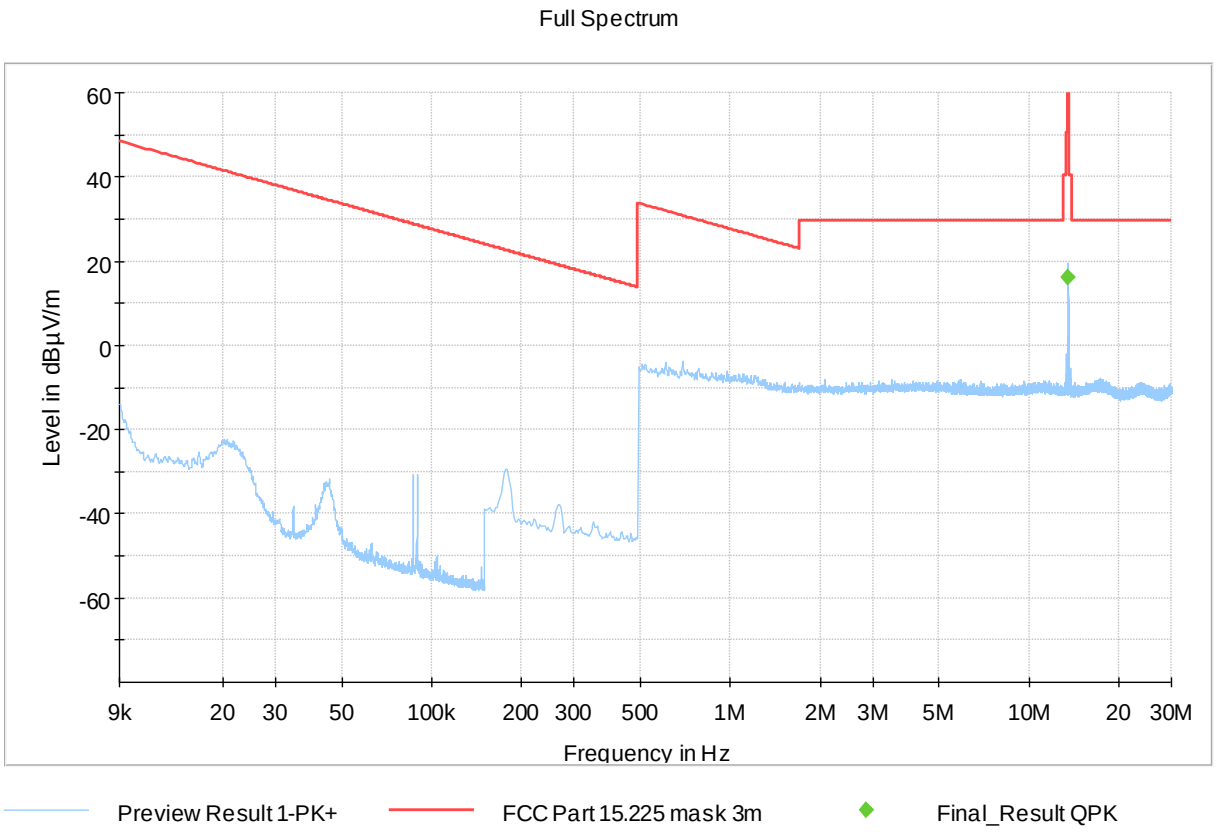

Figure 2. TX Radiated emission 9 kHz to 30MHz

No final measurements were made due margin being more than 20 dB.

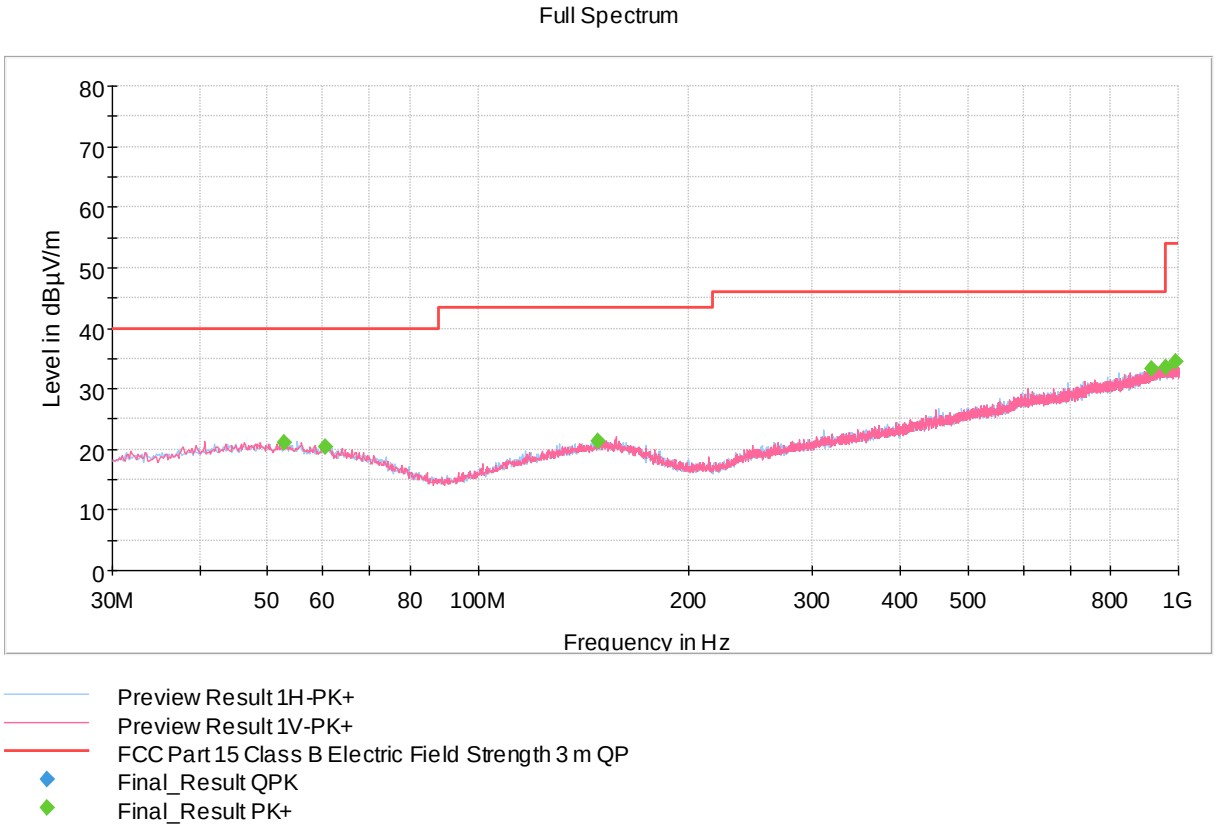

Figure 3. TX Radiated emission 30 MHz to 1000 MHz

Table 3. The final results with quasi-peak and peak detectors

Frequency (MHz)	QuasiPeak (dBµV/m)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
52.875000	---	21.20	40.00	18.80	1000.0	120.000	100.0	H	345.0	17.7
60.425000	---	20.40	40.00	19.60	1000.0	120.000	100.0	H	225.0	16.8
147.975000	---	21.40	43.50	22.10	1000.0	120.000	100.0	V	345.0	17.2
915.975000	---	33.30	46.00	12.70	1000.0	120.000	100.0	H	315.0	27.4
959.925000	---	33.60	46.00	12.40	1000.0	120.000	100.0	V	195.0	27.8
990.825000	---	34.50	53.90	19.40	1000.0	120.000	100.0	H	105.0	28.0

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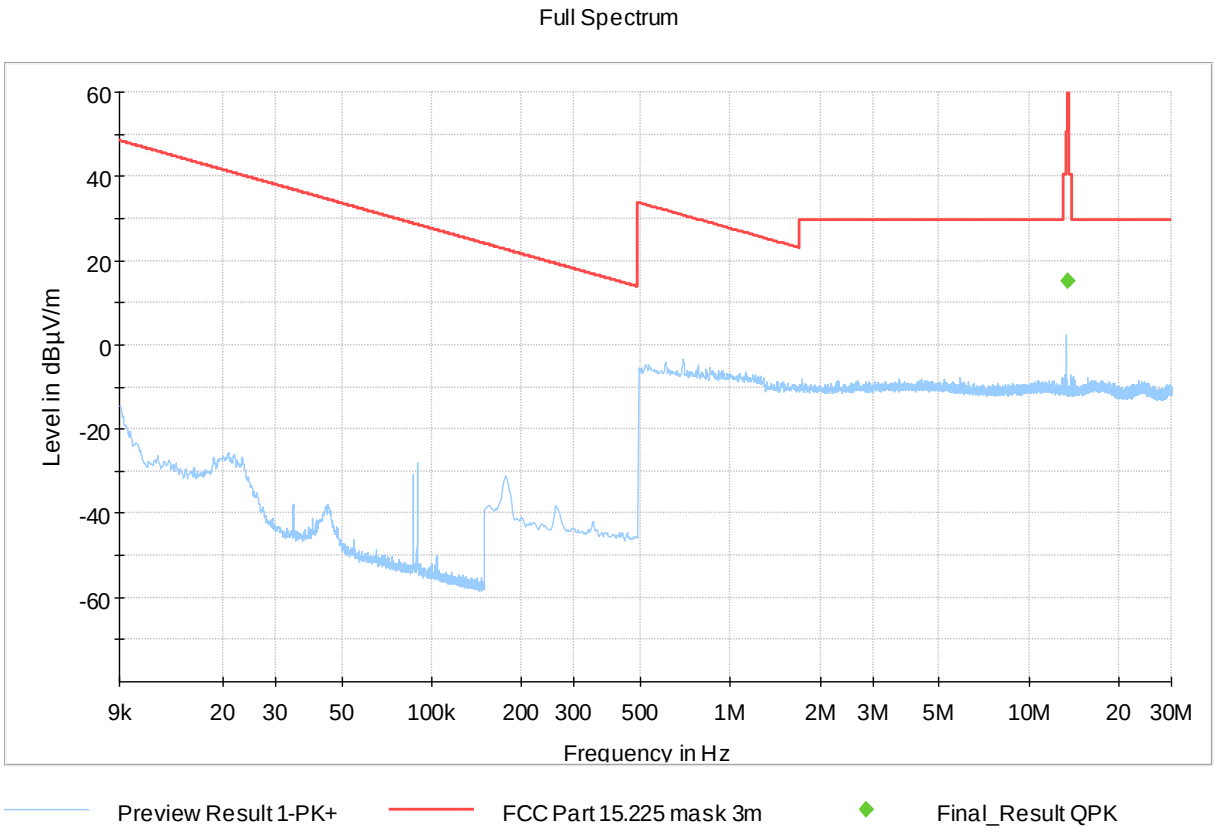

Figure 4. TX radiated emission 9 kHz to 30MHz

Final measurements from the worst frequencies

No final measurements were made due margin being more than 20 dB.

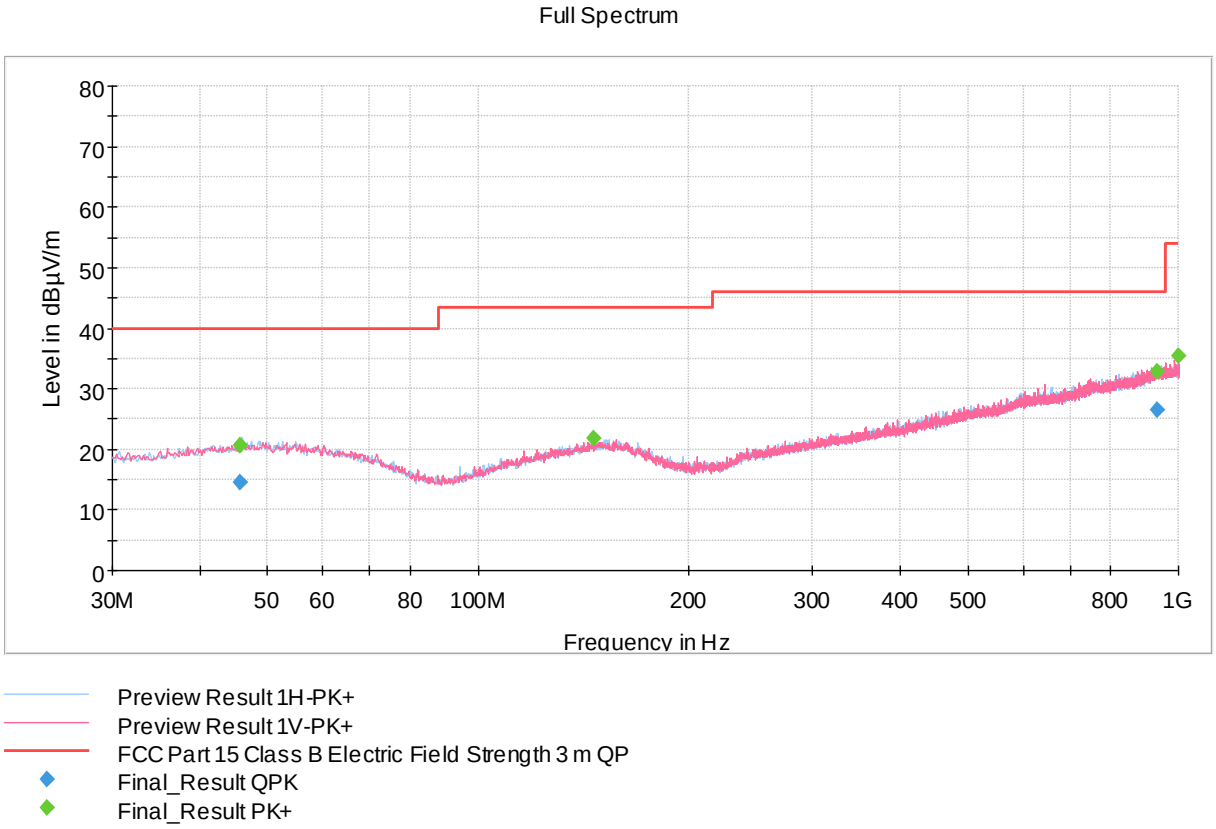

Figure 5. TX radiated emission 30 MHz to 1000 MHz

Final measurements from the worst frequencies

Table 4. The final results with quasi-peak and peak detectors

Frequency (MHz)	QuasiPeak (dBµV/m)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
45.755000	14.47	---	40.00	25.53	1000.0	120.000	245.0	H	250.0	17.8
45.755000	---	20.67	40.00	19.33	1000.0	120.000	245.0	H	250.0	17.8
145.725000	---	21.80	43.50	21.70	1000.0	120.000	100.0	H	75.0	17.1
933.105000	26.62	---	46.00	19.38	1000.0	120.000	277.0	V	355.0	27.6
933.105000	---	32.87	46.00	13.13	1000.0	120.000	277.0	V	355.0	27.6
999.375000	---	35.40	53.90	18.50	1000.0	120.000	100.0	V	135.0	28.1

Operation within the band 13.110 – 14.010 MHz

Standard:	ANSI C63.10	
Tested by:	HEM, PKA	
Date:	16 - 17 October 2019	
Temperature:	23 °C	
Humidity:	43 - 44 % RH	
Barometric pressure:	1003 – 1007 hPa	
Measurement uncertainty	± 4.5 dB	Level of confidence 95 % (k = 2)

FCC Rule: 15.225

The emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (MHz)	Field Strength (dBµV/m)	Measurement Distance (m)
13.110 – 13.410	**40.5**	**30**
13.410 – 13.553	**50.5**	**30**
13.553 – 13.567	**84.0**	**30**
13.567 – 13.710	**50.5**	**30**
13.710 – 14.010	**40.5**	**30**

Test results

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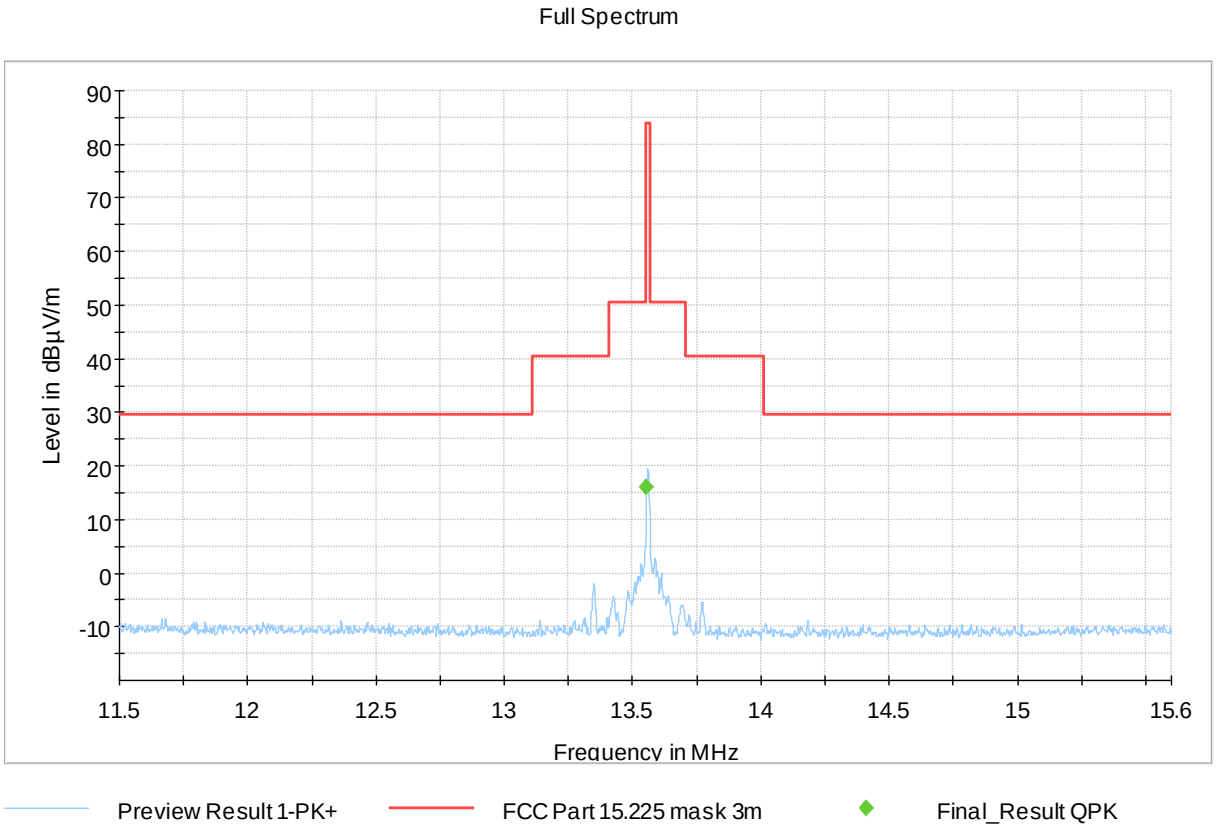

Figure 6. TX radiated emission within the band 13.110 to 14.010 MHz

Table 5. The final results with quasi-peak detector

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
13.555000	**16.10**	**84.00**	**67.90**	**1000.0**	**9.000**	**190.0**	**V**	**237.0**	**-20.5**

with tag

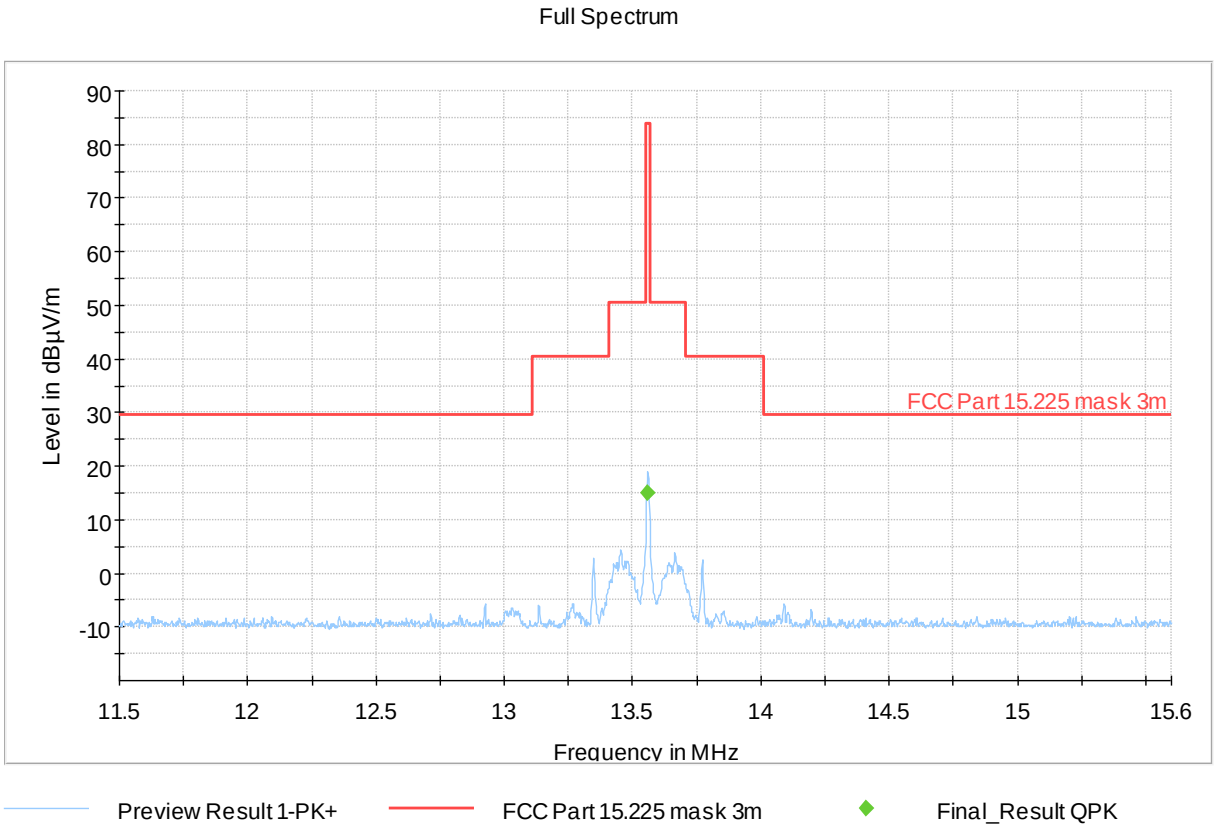

Figure 7. TX radiated emission within the band 13.110 to 14.010 MHz

Table 6. The final results with quasi-peak detector

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
13.560200	**15.00**	**84.00**	**69.00**	**1000.0**	**9.000**	**190.0**	**V**	**80.0**	**-20.5**

Frequency Stabilty

Standard: ANSI C63.10
Tested by: HEM
Date: 29 and 30 October 2019
Temperature: 23 °C
Humidity: 24 - 26 % RH
Barometric pressure: 1010 – 1019 hPa

FCC Rule: 15.225(e)
IC Rule: RSS-210, RS-GEN (6.11)

The frequency tolerance of the carrier signal shall be maintained within ± 0.01% of the operating frequency over a temperature variation of -10 °C to +60 °C at normal supply voltage, and for a variation in the primary supply voltage from 85% to 115% of the rated supply voltage at a temperature of 20°C. For battery operated equipment, the equipment tests shall be performed using a new battery.

Test results

Table 7. Frequency stability test, extreme conditions

Test conditions		Frequency	deviation from nominal	Result
Temperature [°C]	Voltage [V]	(MHz)	(%)	
-10	**3.70**	**13.56030812**	**0.002272271**	**PASS**
0	**3.70**	**13.56028405**	**0.002094764**	**PASS**
10	**3.70**	**13.56024718**	**0.001822861**	**PASS**
20	**3.51**	**13.56023281**	**0.001716888**	**PASS**
20	**3.70**	**13.56022656**	**0.001670796**	**PASS**
20	**4.26**	**13.56022906**	**0.001689233**	**PASS**
30	**3.70**	**13.56019843**	**0.001463348**	**PASS**
40	**3.70**	**13.56018499**	**0.001364233**	**PASS**
50	**3.70**	**13.56019281**	**0.001421903**	**PASS**
60	**3.70**	**13.56022343**	**0.001647714**	**PASS**

20 dB Bandwidth

Standard:	ANSI C63.10
Tested by:	HEM
Date:	30 October 2019
Temperature:	23 °C
Humidity:	24 %RH
Barometric pressure:	1019 hPa

FCC Rule: 15.215(c)

Intentional radiators operating under the alternative provisions to the general emission limits, as contained in Sections 15.217 through 15.257 and in Subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission is contained within the frequency band designated in the rule.

Test results

Table 8. 20 dB Bandwidth

20 dB Bandwidth	Resolution Bandwidth	Video Bandwidth
118.059 kHz	**10 kHz**	**30 kHz**

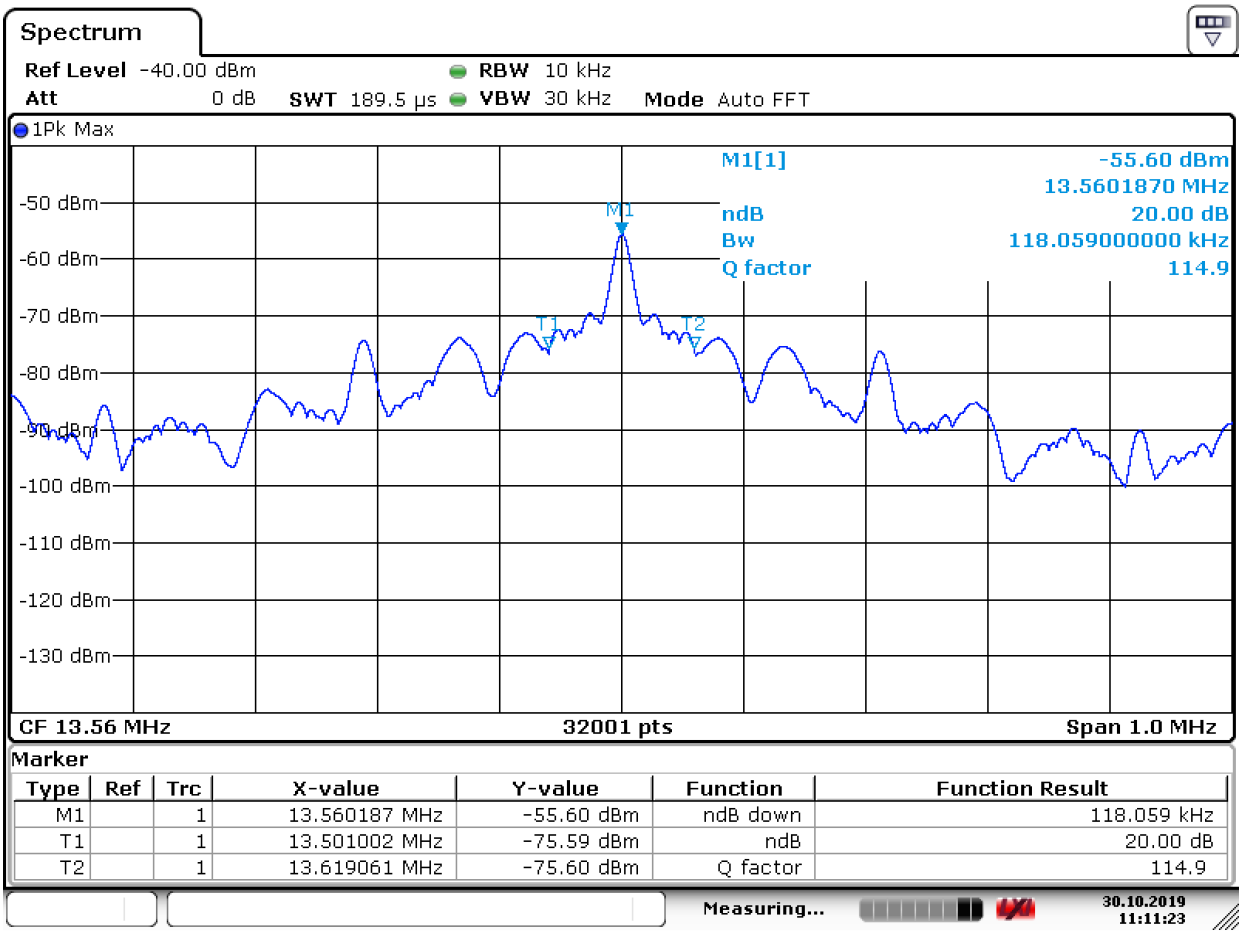

Figure 8: 20 dB bandwidth

99% Power Bandwidth

Standard:	RSS-GEN
Tested by:	HEM
Date:	30 October 2019
Temperature:	23 °C
Humidity:	24 %RH
Barometric pressure:	1019 hPa

IC Rule: RSS-GEN (6.7)

The occupied bandwidth or the “99% emission bandwidth” is defined as the frequency range between two points, one above and the other below the carrier frequency, within which 99% of the total transmitted power of the fundamental transmitted emission is contained. The occupied bandwidth shall be reported for all equipment in addition to the specified bandwidth required in the applicable RSSs.

The transmitter shall be operated at its maximum carrier power measured under normal test conditions. The resolution bandwidth (RBW) shall be in the range of 1% to 5% of the actual occupied bandwidth and the video bandwidth (VBW) shall not be smaller than three times the RBW value.

Test results

Table 9. EUT1 99% Power Bandwidth

99% Power Bandwidth	Resolution Bandwidth	Video Bandwidth
535.796 kHz	**10 kHz**	**30 kHz**

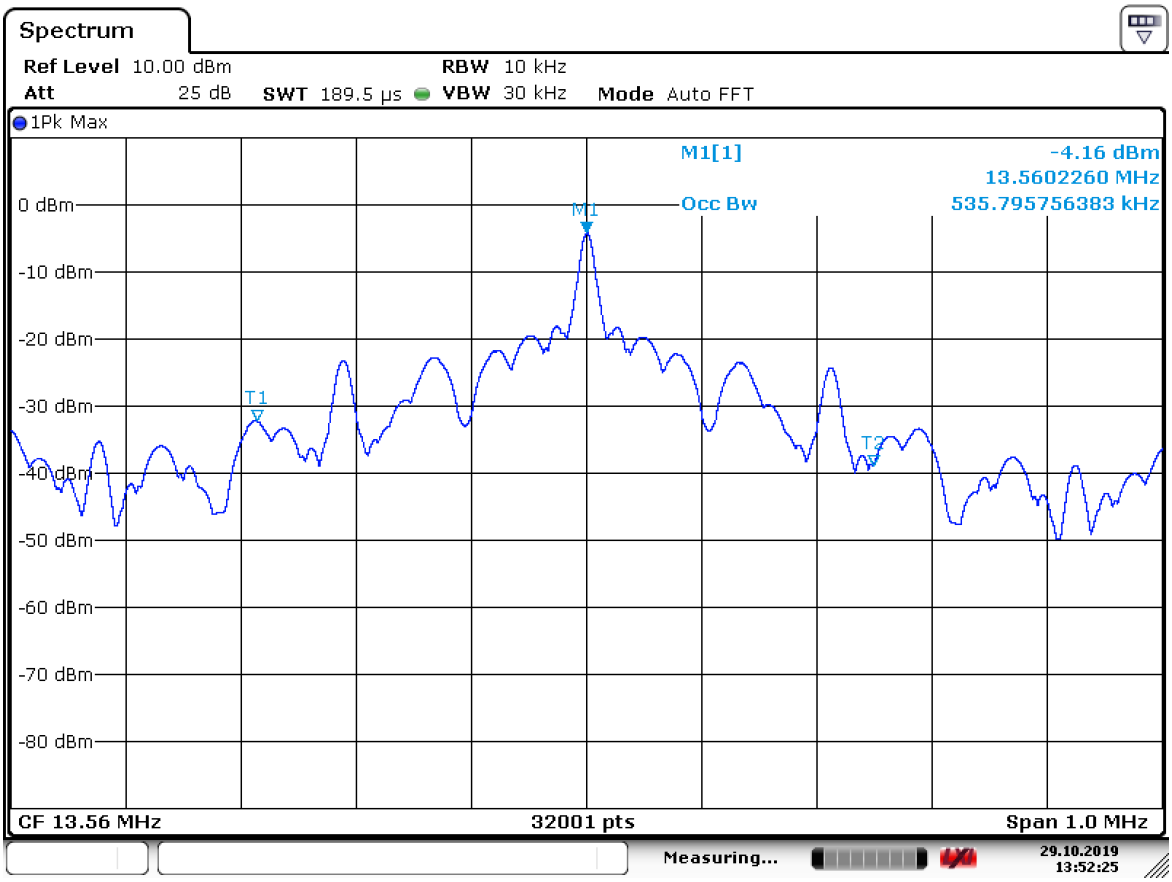

Figure 9. 99% Power Bandwidth

TEST EQUIPMENT

RF-Test Equipment

Equipment	Manufacturer	Type	Inv or serial	Prev Calib	Next Calib
POWER SUPPLY	CALIFORNIA INSTR.	5001 iX Series II	inv:7826	NCR	-
ANTENNA	ROHDE & SCHWARZ	HFH2-Z2	inv:8013	2018-03-23	2020-03-23
ANTENNA	SCHWARZBECK	VULB 9168	inv:8911	2018-10-25	2020-10-25
TURNTABLE	MATURO	DS430 UPGRADED	inv:10182	NCR	-
MAST & TURNTABLE CONTROLLER	MATURO	NCD	inv:10183	NCR	-
ANTENNA MAST	MATURO	TAM 4.0E	inv:10181	NCR	-
ATTENUATOR	PASTERNACK	PE 7004-4	inv:10126	NCR	-
TEST SOFTWARE	ROHDE & SCHWARZ	EMC-32	-	NCR	-
EMI TEST RECEIVER	ROHDE & SCHWARZ	ESW26	inv:10679	2019-06-28	2020-06-27
SIGNAL ANALYZER	ROHDE & SCHWARZ	FSV40	inv:9093	2018-06-28	2020-06-28
LISN	ROHDE & SCHWARZ	ENV216	inv:9611	2019-03-01	2020-03-01
TEMPERATURE/ HUMIDITY METER	VAISALA	HMT 333	inv:8638	2019-04-10	2020-04-10
TEMPERATURE CHAMBER	VÖTSCH	VC4033	inv:10412	NCR	-
NEAR-FIELD PROBE	ROHDE & SCHWARZ	HZ-14 1026.7744.02	inv:7883	NCR	-

NCR = No calibration required

END OF TEST REPORT