Test Report

HELEM2402000056-1

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

INTENTIONAL RADIATOR TESTS ACCORDING TO FCC PART 15 F REQUIREMENTS

Equipment Under Test:	Tag of Indoor Positioning System
Trademark:	Iiwari
Model:	CloudTag
Customer / Manufacturer:	Iiwari Tracking Solutions Oy Kidekuja 2 FI-88610 Vuokatti Finland
FCC Rule Part:	§15.519
KDB:	393764 D01 UWB FAQ v02r01

Date:	2 September 2024	Date:	2 September 2024
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	2 September 2024

PRODUCT DESCIPTION

Equipment Under Test

Trademark:	Iiwari
Model:	CloudTag
Type:	-
Serial no:	-
FCC ID:	2BFQ6TAG101
Radio module or chip:	Decawave DW1000

General Description

The equipment under test is a battery powered tag for indoor positioning system. The positioning system is built by attaching the base stations to the ceiling or the walls. Tracked objects have a tracking tag that communicates with base stations using ultra-wideband signals.

Classification

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

Samples and Modifications

No.	Name	Description
1	Sample 1	The sample was modified to have DC power input wires (normally battery-operated)

Ratings and declarations

Nominal center frequency:	3993.6 MHz (UWB channel 2)
UWB bandwidth:	543.5 MHz (measured)
UWB device type:	Handheld UWB device
Antenna type:	Integral PCB trace antenna
Antenna gain:	+3.5 dBi
EUT dimensions:	9 x 27 x 51 mm, 0.05 kg
Power requirements:	Battery-powered (3 V CR2450)
Operating temperature range:	-40…+60 °C

Ports and Cables

Cable / Port	Description
-	-

Peripherals

Peripheral	Description / Usage
-	-

SUMMARY OF TESTING

Test Specification	Description of Test	Result
§15.203	Antenna Requirement	**PASS**
§15.207(a)	AC Power-Line Conducted Emissions	**N/A**
§15.519(e), §15.521(g)	Peak Power Within a 50 MHz Bandwidth	**PASS**
§15.519(b)	10 dB Bandwidth	**PASS**
§15.519(c), §15.521(c)-(d)	Radiated Emissions 9 kHz – 960 MHz	**PASS**
§15.519(c)-(d), §15.521(c)-(d)	Radiated Emissions 960 MHz – 40 GHz	**PASS**
§15.519(a)(1)	Transmission Time	**PASS**

The decision rule applied for the tests results stated in this test report is according to the requirements of section 1.4 of ANSI C63.10-2020.

EUT Test Conditions during Testing

During the tests the configuration of the EUT was made to correspond to the actual assembling conditions as far as possible. During the tests EUT was set into continuous transmit mode by using a test software. Normal modulation and maximum transmit power was used during the tests.

All tests were performed as radiated measurements. Preliminary measurements were made in three orthogonal orientations in order to determine the worst-case orientation. The final measurements were performed in the worst-case orientation.

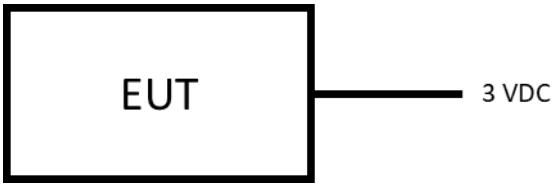

Figure 1: Test setup block diagram

Table 1: Test frequency and channel

UWB channel	Frequency [MHz]
2	3993.6

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: 22 July 2024

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	

Peak Power Within a 50 MHz Bandwidth

Standard:	ANSI C63.10-2020
Tested by:	HEM
Date:	22 July 2024
Temperature:	20 °C
Humidity:	61 %RH
Barometric pressure:	1014 hPa
Measurement uncertainty:	± 5.44 dB, level of confidence 95 % (k = 2)

FCC Rule: §15.519(e), §15.521(g)

There is a limit on the peak level of the emissions contained within a 50 MHz bandwidth centered on the frequency at which the highest radiated emission occurs, f_M. That limit is 0 dBm EIRP. This may be converted to a peak field strength level at 3 meters using E(dBµV/m) = P(dBm EIRP) + 95.2.

Test results:

Table 2: Peak power within 50 MHz bandwidth

Frequency [MHz]	Height [cm]	Polarization	Azimuth [deg]	Level [dBµV/m]	Level [dBm]	Result
3994.000	130	H	92	93.02	-2.18	PASS

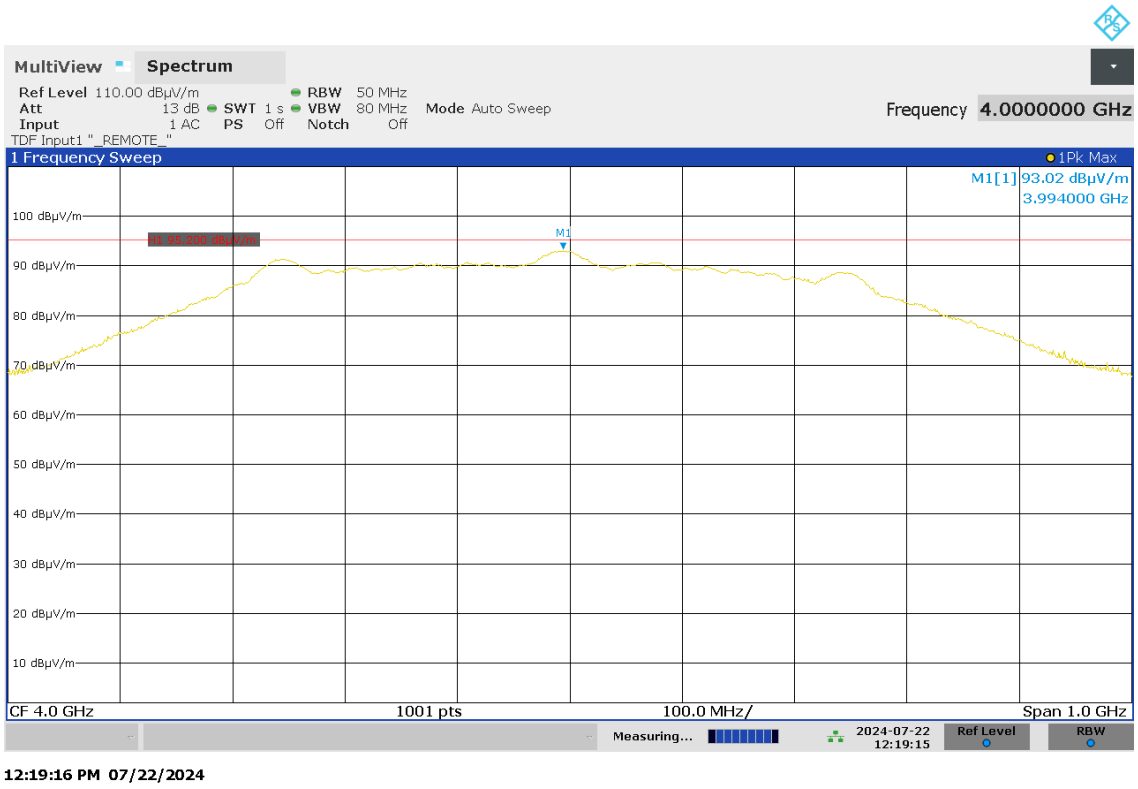

Figure 2: Peak Power Within a 50 MHz Bandwidth

10 dB Bandwidth

Standard:	ANSI C63.10-2020
Tested by:	HEM
Date:	22 July 2024
Temperature:	20 °C
Humidity:	61 %RH
Barometric pressure:	1014 hPa

FCC Rule: §15.519(b)

UWB bandwidth is the frequency band bounded by the points that are 10 dB below the highest radiated emission, as based on the complete transmission system including the antenna. The upper boundary is designated f_H and the lower boundary is designated f_L. The frequency at which the highest radiated emission occurs is designated f_M. The UWB bandwidth must be contained between 3100 MHz and 10600 MHz.

A UWB transmitter is an intentional radiator that, at any point in time, has a fractional bandwidth equal to or greater than 0.20 or has a UWB bandwidth equal to or greater than 500 MHz, regardless of the fractional bandwidth.

Test results:

Table 3: Test results for 10 dB Bandwidth

f_L [MHz]	f_H [MHz]	f_M [MHz]	f_C [MHz]	B_{-10} [MHz]	μ_{-10}	Result
3689.3	4232.8	4077.9	3961.05	543.5	0.137	PASS

$$f_C = (f_H + f_L)/2, \quad B_{-10} = f_H - f_L, \quad \mu_{-10} = B_{-10}/f_C$$

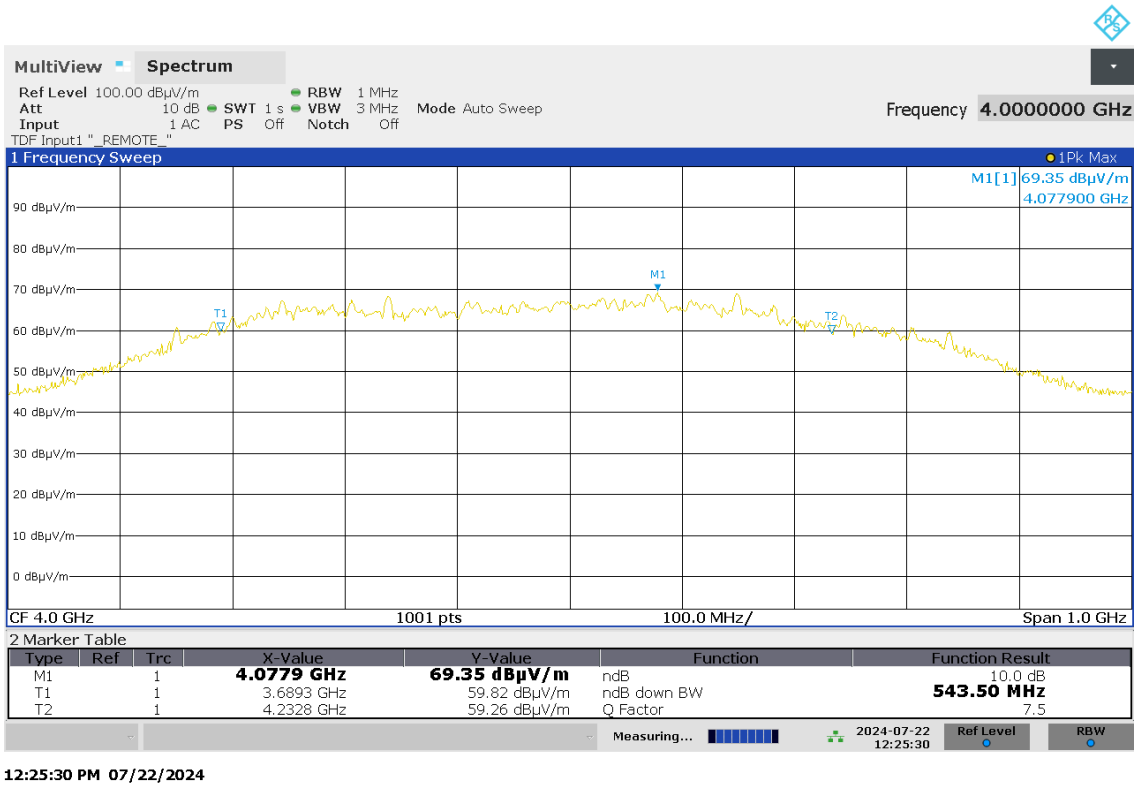

Figure 3: 10 dB Bandwidth

Radiated Emissions 9 kHz – 960 MHz

Standard:	ANSI C63.10-2020
Tested by:	HEM
Date:	24 July 2024
Temperature:	20 °C
Humidity:	64 %RH
Barometric pressure:	1013 hPa
Measurement uncertainty:	± 4.5 dB, level of confidence 95 % (k = 2)

FCC Rule: §15.519(c), §15.521(c)-(d)

The radiated emissions at or below 960 MHz from a handheld UWB device shall not exceed the emission levels in §15.209:

Frequency [MHz]	Field strength [µV/m]	Field strength [dBµV/m]	Measurement distance [m]
0.009-0.490	2400/F(kHz)	48.52-13.80	300
0.490-1.705	24000/F(kHz)	33.80-22.97	30
1.705-30	30	29.54	30
30-88	100	40.00	3
88-216	150	43.52	3
216-960	200	46.02	3

The measurements are performed at a distance of 3 meters. The results below 30 MHz are extrapolated to the specified distance by using the square of an inverse linear distance extrapolation factor (40 dB/decade).

Test results

Table 4: Test results for Radiated emissions 9 kHz – 960 MHz

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
58.692000	**12.82**	**40.00**	**27.18**	**15 x 1000.0**	**120.000**	**400.0**	**H**	**34.0**	**17.9**

Note: The correction factor (dB/m) in the result table contains the sum of the transducers. The reported quasi-peak values include the correction factor.

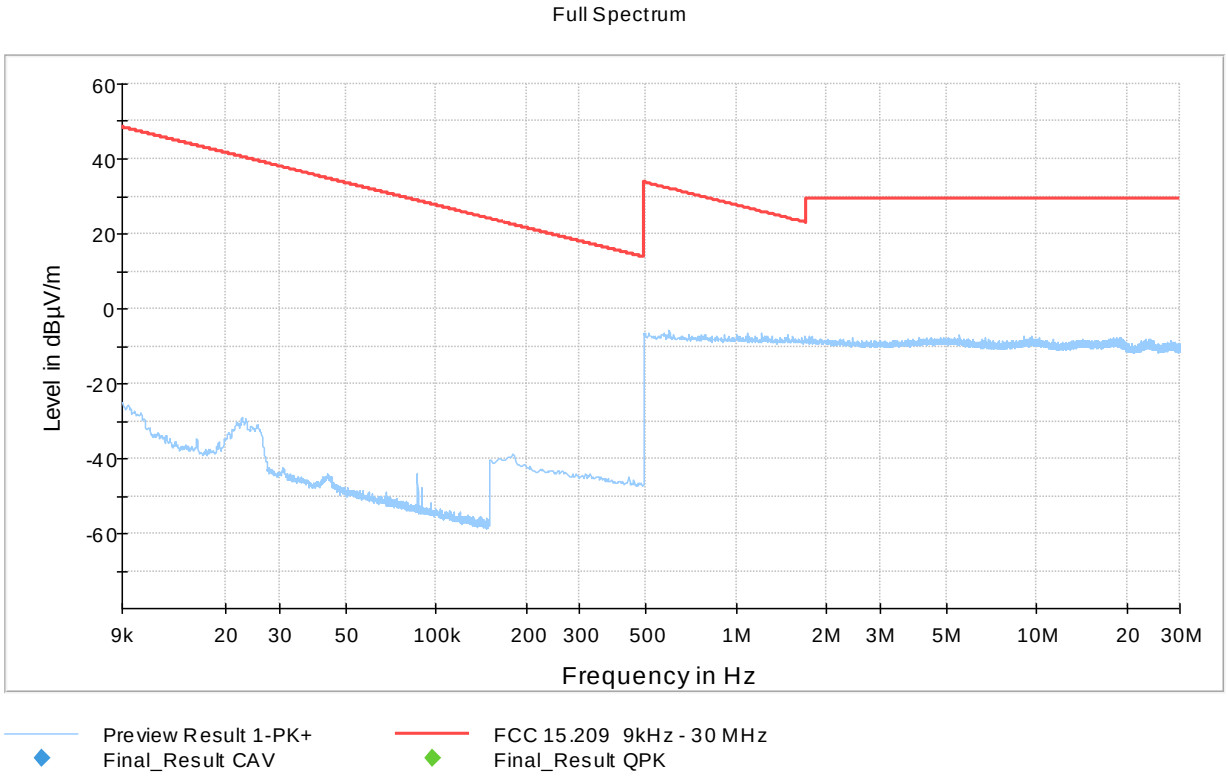

Figure 4: Radiated emissions 9 kHz – 30 MHz

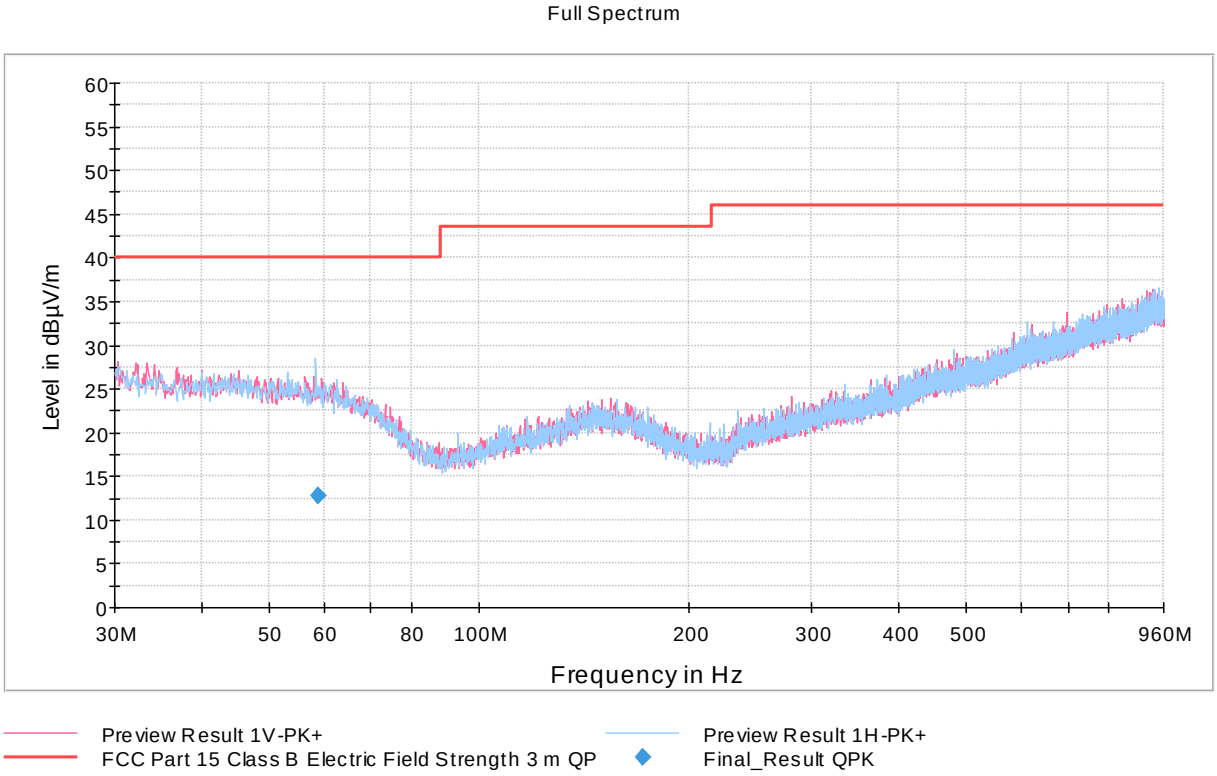

Figure 5: Radiated emissions 30 – 960 MHz

Radiated Emissions 960 MHz – 40 GHz

Standard:	ANSI C63.10-2020		
Tested by:	HEM		
Date:	22 July 2024	23 July 2024	24 July 2024
Temperature:	20 °C	20 °C	20 °C
Humidity:	61 %RH	61 %RH	64 %RH
Barometric pressure:	1014 hPa	1014 hPa	1013 hPa
Measurement uncertainty:	± 5.44 dB, level of confidence 95 % (k = 2)		

FCC Rule: §15.519(c)-(d), §15.521(c)-(d)

The radiated emissions above 960 MHz from a handheld UWB device shall not exceed the following average limits when measured using a resolution bandwidth of 1 MHz:

Frequency [MHz]	EIRP [dBm]	Field strength at 3 m [dBµV/m]	Field strength at 1 m [dBµV/m]	Field strength at 0.5 m [dBµV/m]
960-1610	-75.30	19.90	29.44	35.46
1610-1990	-63.30	31.90	41.44	47.46
1990-3100	-61.30	33.90	43.44	49.46
3100-10600	-41.30	53.90	63.44	69.46
Above 10600	-61.30	33.90	43.44	49.46

In addition, UWB transmitters shall not exceed the following average limits when measured using a resolution bandwidth of no less than 1 kHz:

Frequency [MHz]	EIRP [dBm]	Field strength at 3 m [dBµV/m]
1164-1240	-85.30	9.90
1559-1610	-85.30	9.90

In the tables above the EIRP limit is converted to a field strength limit at 3 meters using the following formula:

$$E[\mathrm{dB\mu V/m}]_{3\ \mathrm{m}} = P[\mathrm{dBm\ EIRP}] + 95.2$$

The field strength limit at 3 meters is converted to other distances using the following formula:

$$E[\mathrm{dB\mu V/m}]_{x\ \mathrm{m}} = E[\mathrm{dB\mu V/m}]_{3\ \mathrm{m}} + 20\log(3/x)$$

The measurements were performed at following distances:

Frequency	Meas. distance [m]
960 – 1000 MHz	1
1000 – 1610 MHz	0.5
1610 – 3500 MHz	3
4.5 – 10.6 GHz	3
10.6 – 18 GHz	0.5
18 – 26.5 GHz	0.5
26.5 – 40 GHz	0.5
1164 – 1240 MHz (GPS band)	3
1559 – 1610 MHz (GPS band)	3

Test results

Table 5: Test results for radiated emissions within 960 MHz – 40 GHz (measured field strength)

Frequency (MHz)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
962.438000	22.93	29.44	6.51	15 x 1000.0	1000.000	400.0	H	194.0	5.9
1355.020500	23.90	35.46	11.56	15 x 1000.0	1000.000	200.0	H	327.0	1.2
2450.843500	27.86	33.90	6.04	15 x 1000.0	1000.000	291.0	V	103.0	5.3
7987.370000	42.22	53.90	11.68	15 x 1000.0	1000.000	128.0	H	180.0	13.0
17994.550000	47.48	49.46	1.98	15 x 1000.0	1000.000	128.0	V	183.0	28.6
18858.900000	40.79	49.46	8.67	15 x 1000.0	1000.000	100.0	V	55.0	8.6
38667.655577	48.32	49.46	1.14	15 x 1000.0	1000.000	150.0	V	123.0	-0.3

Table 6: Test results for radiated emissions within 960 MHz – 40 GHz (conversion to EIRP)

Frequency (MHz)	RMS (dBµV/m)	Limit (dBµV/m)	Meas. Dist. (m)	RMS (dBm)	Limit (dBm)	Margin (dB)
962.438000	22.93	29.44	1	-81.81	-75.30	6.51
1355.020500	23.90	35.46	0.5	-86.86	-75.30	11.56
2450.843500	27.86	33.90	3	-67.34	-61.30	6.04
7987.370000	42.22	53.90	3	-52.98	-41.30	11.68
17994.550000	47.48	49.46	0.5	-63.28	-61.30	1.98
18858.900000	40.79	49.46	0.5	-69.97	-61.30	8.67
38667.655577	48.32	49.46	0.5	-62.44	-61.30	1.14

Table 7: Test results for radiated emissions within GPS bands (measured field strength)

Frequency (MHz)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1165.008200	-5.76	9.90	15.66	15 x 1000.0	1.000	400.0	V	20.0	0.4
1575.753400	-6.58	9.90	16.48	15 x 1000.0	1.000	336.0	H	201.0	0.6

Table 8: Test results for radiated emissions within GPS bands (conversion to EIRP)

Frequency (MHz)	RMS (dBµV/m)	Limit (dBµV/m)	Meas. Dist. (m)	RMS (dBm)	Limit (dBm)	Margin (dB)
1165.008200	-5.76	9.90	3	-100.96	-85.30	15.66
1575.753400	-6.58	9.90	3	-101.78	-85.30	16.48

Note: The correction factor (dB/m) in the result table contains the sum of the transducers. The reported RMS values include the correction factor.

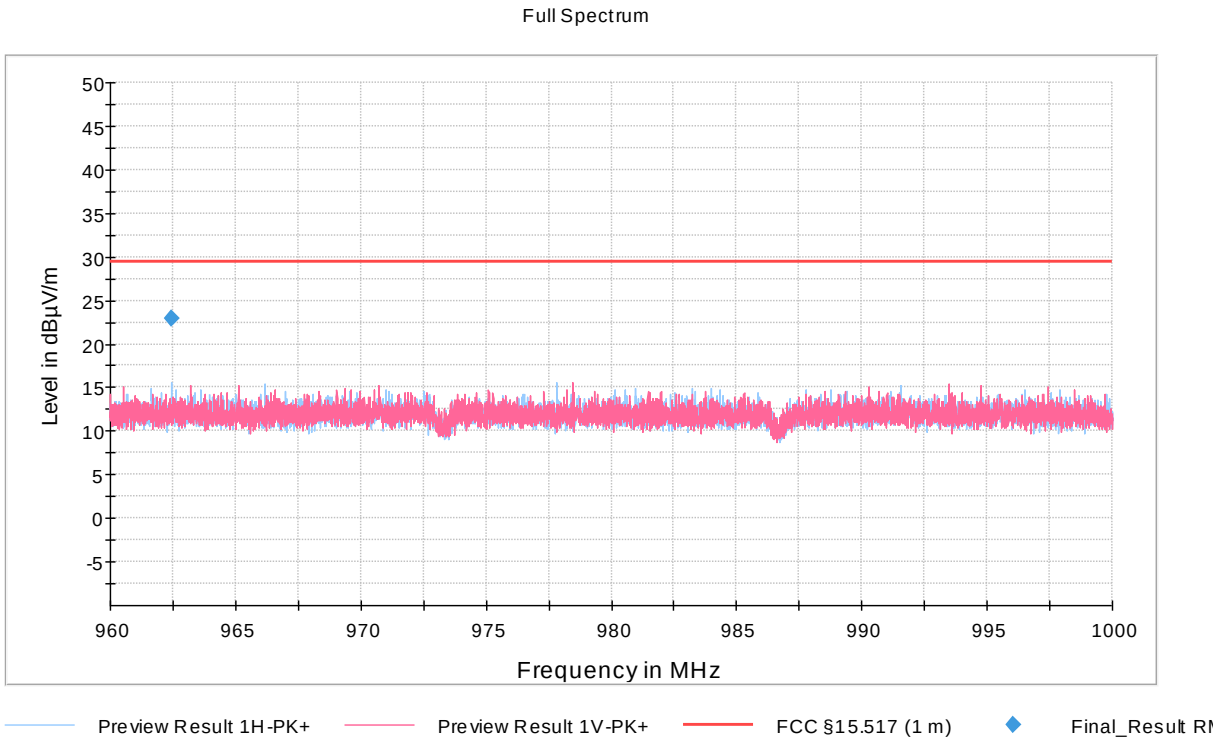

Figure 6: Radiated emissions 960 – 1000 MHz

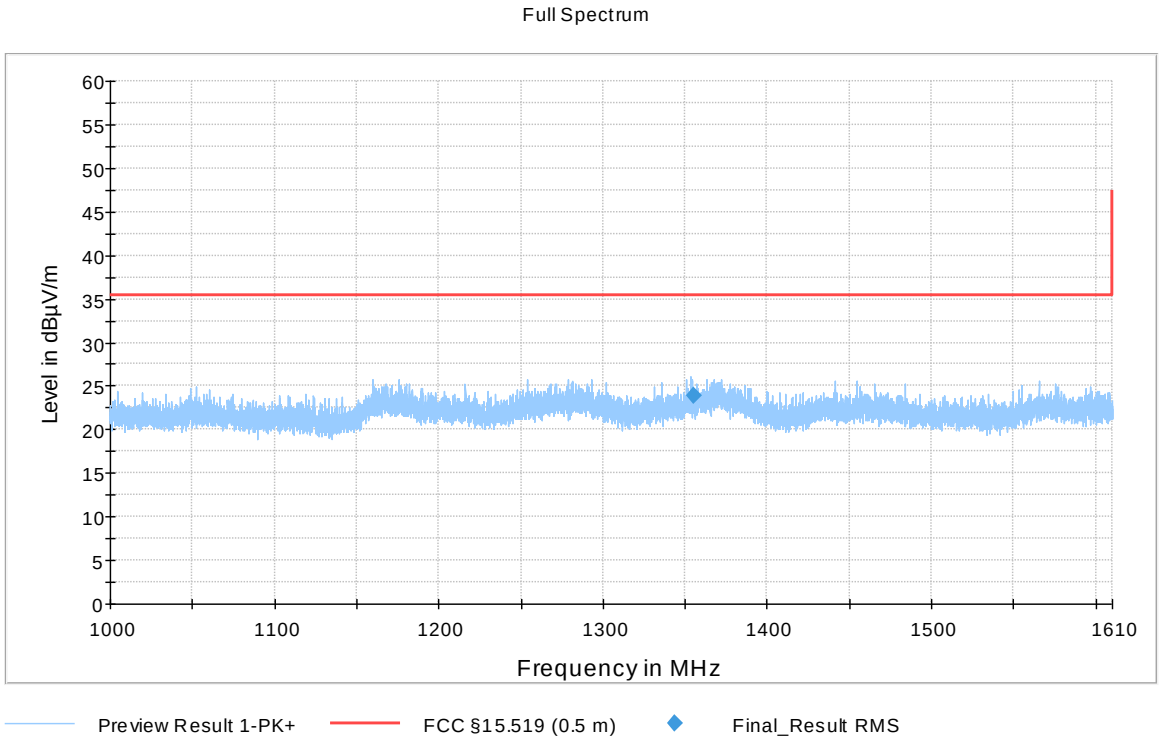

Figure 7: Radiated emissions 1000 – 1610 MHz

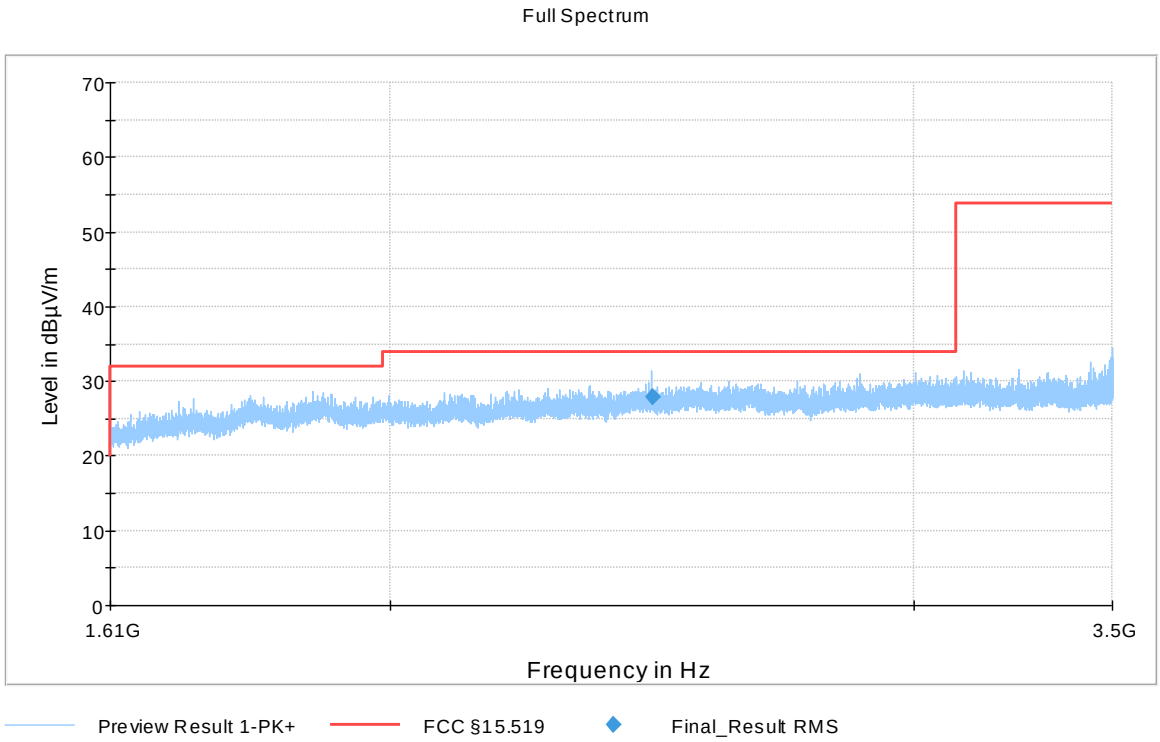

Figure 8: Radiated emissions 1610 – 3500 MHz

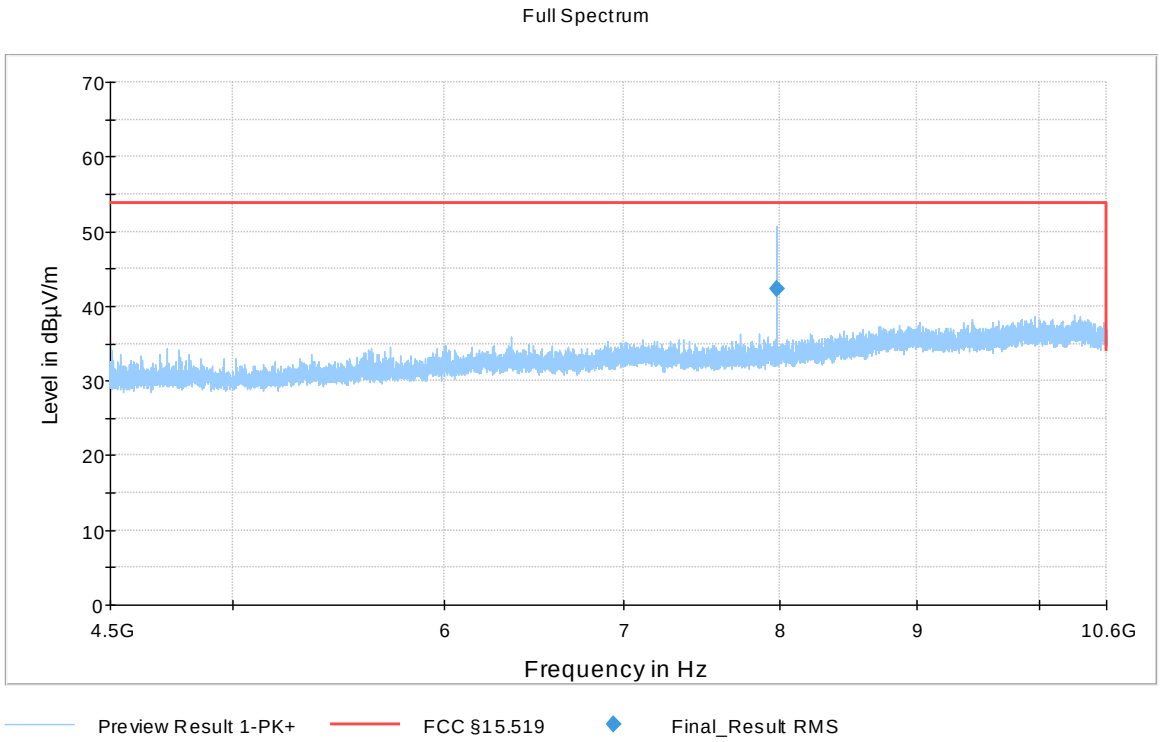

Figure 9: Radiated emissions 4.5 – 10.6 GHz

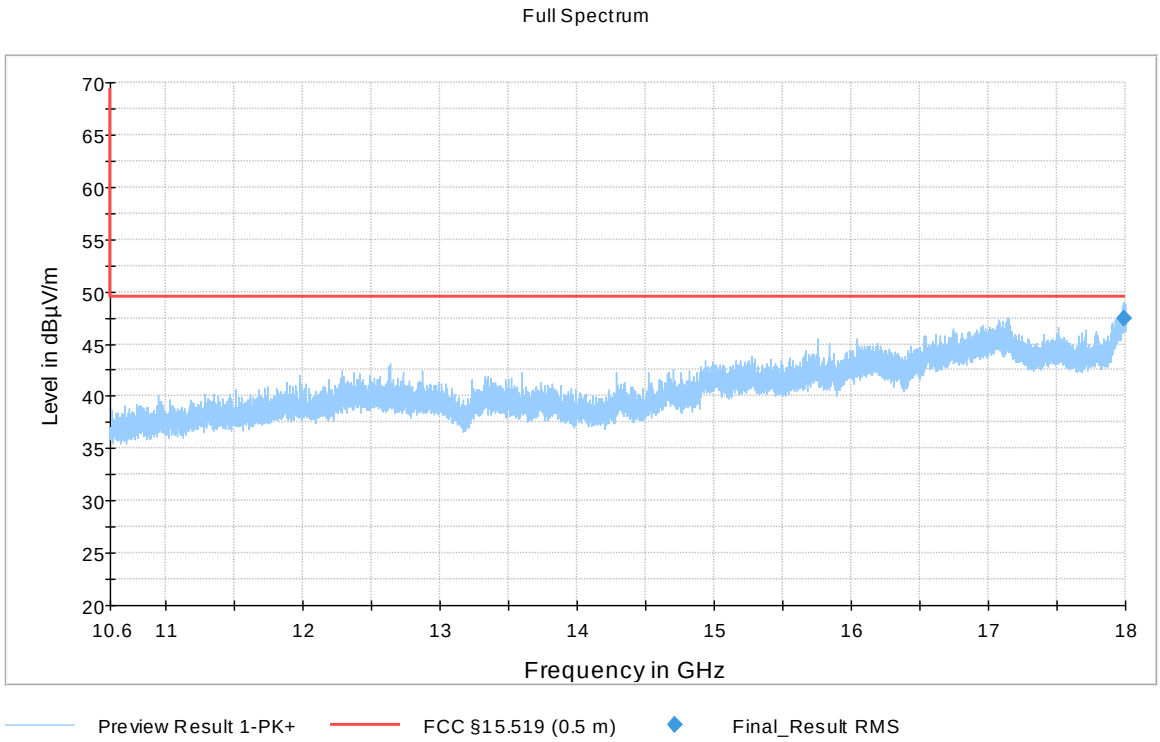

Figure 10: Radiated emissions 10.6 – 18 GHz

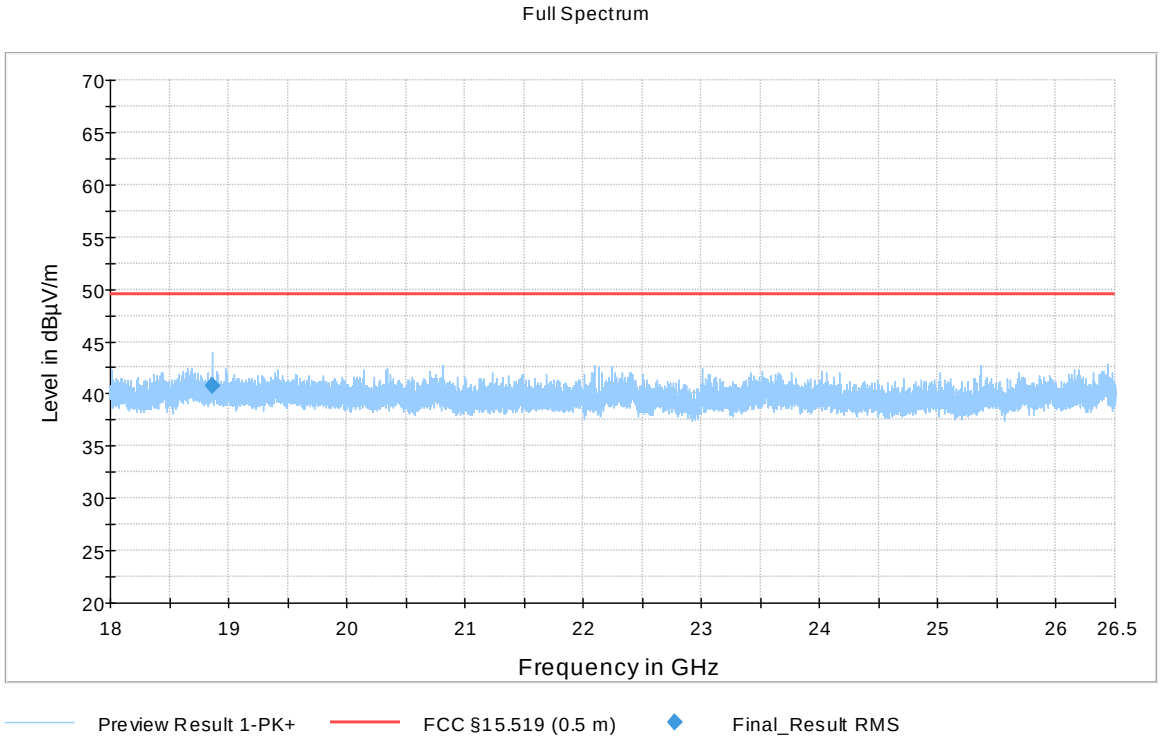

Figure 11: Radiated emissions 18 – 26.5 GHz

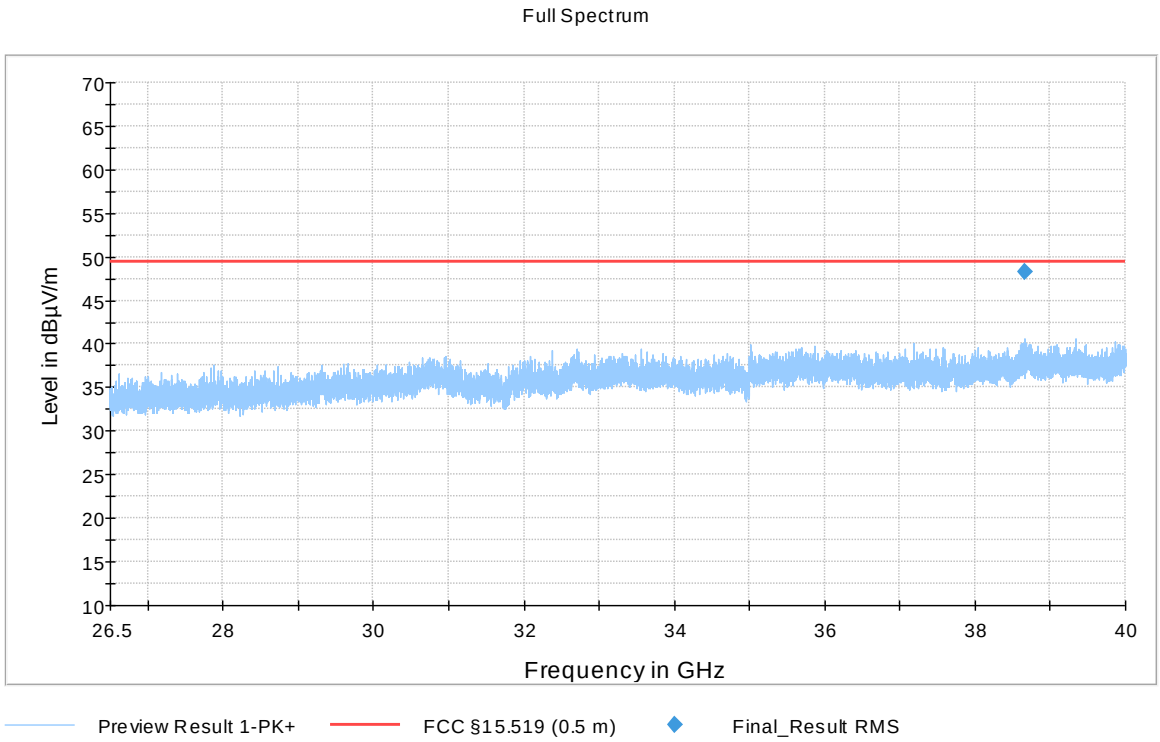

Figure 12: Radiated emissions 26.5 – 40 GHz

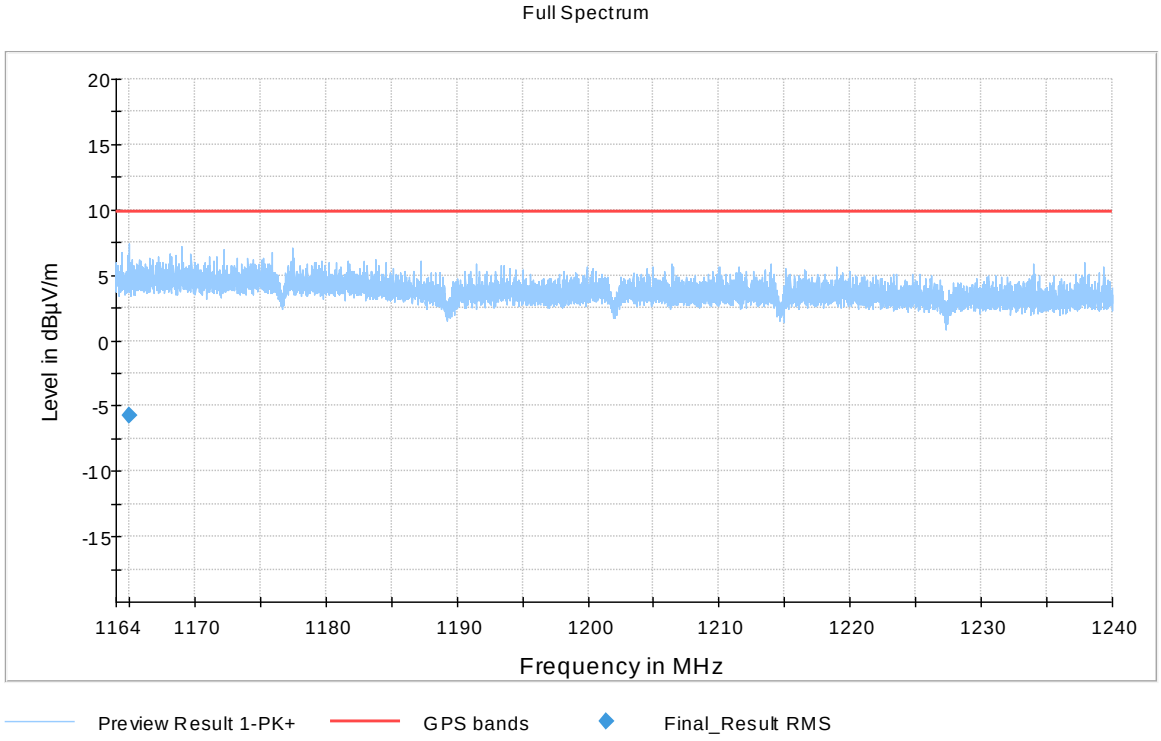

Figure 13: Radiated emissions 1164 – 1240 MHz (1 kHz RBW)

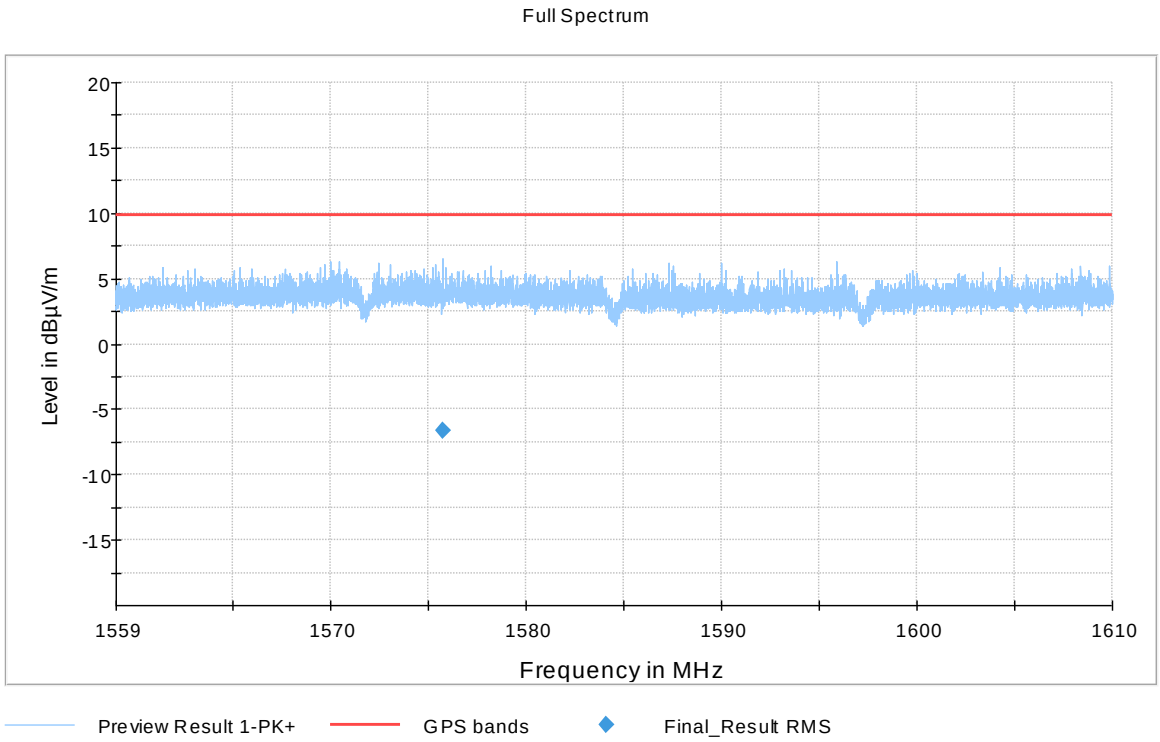

Figure 14: Radiated emissions 1559 – 1610 MHz (1 kHz RBW)

Transmission Time

Standard:	FCC Rule §15.519(a)(1)
Tested by:	HEM
Date:	24 July 2024
Temperature:	20 °C
Humidity:	64 %RH
Barometric pressure:	1013 hPa

FCC Rule: §15.519(a)(1)

A handheld UWB device shall transmit only when it is sending information to an associated receiver. The UWB intentional radiator shall cease transmissions within 10 seconds unless it receives an acknowledgement from the associated receiver that its transmission is being received. An acknowledgment of reception must continue to be received by the UWB intentional radiator at least every 10 seconds or the UWB device must cease transmitting.

Test results

According to the manufacturer the EUT (tag) transmits 7 blink messages at 1-second intervals and does not listen for ACK messages. After this the EUT transmits 3 blink messages and listens for ACK messages after each of them. If the EUT receives at least one ACK message, the EUT will continue to transmit 7 blink messages.

If the EUT does not receive any ACK messages during the three receiving periods, it will pause for 10 seconds. After the pause the EUT will transmit test messages at 10-second intervals. After each test message the EUT goes into receive mode to listen for ACK messages from a base station. If the EUT receives at least one ACK message it will continue to transmit 7 blink messages again.

The functionality was tested with the peripheral master base station. After receiving ACK messages for a while, the base station was turned off. After turning off the base station the EUT ceased transmissions after 9.39 seconds. The EUT continued to send test messages at approximately 10-second intervals.

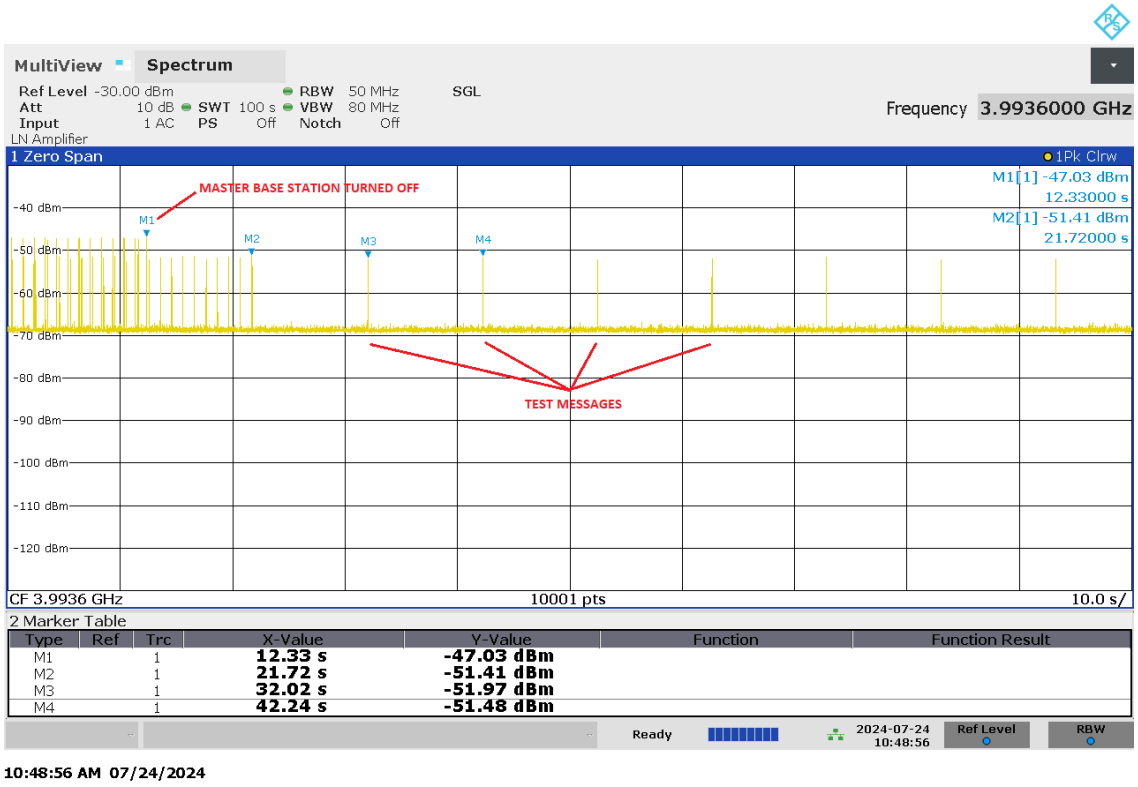

Figure 15: Transmission time

TEST EQUIPMENT

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	2022-11-29	2024-11-29
ANTENNA	EMCO	3160-09, emi 18-26.5GHz	inv. 7294	2024-01-31	2025-01-31
ANTENNA	ETS LINDGREN	3117	inv. 9569	2023-05-05	2025-05-05
ANTENNA	ETS LINDGREN	3160-10, emi 26.5-40GHz	inv. 9151	2024-05-31	2025-05-31
ANTENNA MAST	MATURO	TAM 4.0E	inv. 10181	NCR	NCR
ATTENUATOR	PASTERNACK	PE 7004-4 (4dB)	inv. 10126	2024-02-16	2025-02-16
CABLE	SUHNER	SUCOFLEX 102 (1m) 26.5-40GHz	inv. C113	2024-04-05	2025-04-05
CABLE	SUHNER	SUCOFLEX 126E 18-26.5GHz	inv. C134	2024-04-05	2025-04-05
CABLE	SUHNER	SUCOFLEX 126E 1-18GHz	inv. C137	2024-04-05	2025-04-05
CABLE	SUHNER	SUCOFLEX 102 (2m) 26.5-40GHz	inv. C114	2024-04-05	2025-05-05
COAX CHAIN K5 EMI < 1GHz	-	C053+FP3AirC+C138	-	2024-03-28	2025-03-28
COAX CHAIN K5 EMI 1GHz-26.5GHz	-	C135+C149	-	2024-03-28	2025-03-28
EMI TEST RECEIVER	ROHDE & SCHWARZ	ESW26	inv. 10679	2024-06-12	2025-06-11
POWER SUPPLY	THANDAR	PL330TP	inv. 9787	NCR	NCR
RF PREAMPLIFIER	CIAO	CA1840-5019	inv. 10593	2023-09-15	2024-09-15
RF PREAMPLIFIER	CIAO	CA118-3123	inv. 10278	2023-09-15	2024-09-15
RF PREAMPLIFIER	SGS FIMKO	Module: ZFL-1000LN (20 dB)	inv. 8364	2024-02-07	2025-02-07
SPECTRUM ANALYZER	ROHDE & SCHWARZ	FSV40	inv. 9093	2024-06-13	2025-06-12
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