
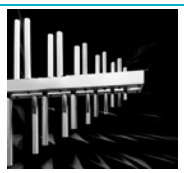
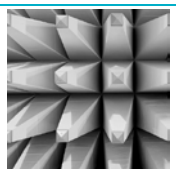

CTC advanced
member of RWTÜV group

Bundesnetzagentur

BNetzA-CAB-02/21-102

TEST REPORT

Test report no.: 1-9100/19-01-13

Testing laboratory

CTC advanced GmbH
Untertuerkheimer Strasse 6 – 10
66117 Saarbruecken / Germany
Phone: + 49 681 5 98 - 0
Fax: + 49 681 5 98 - 9075
Internet: http://www.ctcadvanced.com
e-mail: mail@ctcadvanced.com

Accredited Testing Laboratory:
The testing laboratory (area of testing) is accredited according to DIN EN ISO/IEC 17025 (2018-03) by the Deutsche Akkreditierungsstelle GmbH (DAkkS)
The accreditation is valid for the scope of testing procedures as stated in the accreditation certificate starting with the registration number: D-PL-12076-01.

Applicant

Hexagon Geosystems Services AG
Zweigniederlassung Hexagon Mining
Baarerstrasse 133
6300 Zug / SWITZERLAND
Phone: -/-
Contact: André Reichmuth
e-mail: andre.reichmuth@hexagon.com
Phone: -/-

Manufacturer

Hexagon Geosystems Services AG
Zweigniederlassung Hexagon Mining
Baarerstrasse 133
6300 Zug / SWITZERLAND

Test standard/s

47 CFR Part 15	Title 47 of the Code of Federal Regulations; Chapter I; Part 15 - Radio frequency devices

For further applied test standards please refer to section 3 of this test report.

Test Item

Kind of test item:	**Collison Avoidance Main Unit**
Model name:	**QC1000**
FCC ID:	**ZKSQC1000A**
Frequency:	5.925 GHz to 7.250 GHZ
Antenna:	Integrated antenna
Power supply:	24 V DC, by battery
Temperature range:	-30°C to +70°C

This test report is electronically signed and valid without handwritten signature. For verification of the electronic signatures, the public keys can be requested at the testing laboratory.

Test report authorized:

M. Walla

cn=Meheza Walla, o=CTC advanced GmbH, ou=WAL-200806, email=meheza.walla@ctcadvanced.com, c=DE
2021.03.26 10:40:52 +01'00'

Meheza Walla
Lab Manager
Radio Communications & EMC

Test performed:

cn=Sebastian Janoschka, o=CTC advanced GmbH, ou=JKA-190527, email=sebastian.janoschka@ctcadvanced.com, c=DE
2021.03.26 10:17:12 +01'00'

Sebastian Janoschka
Lab Manager
Radio Communications & EMC

1 Table of contents

2 General information

2.1 Notes and disclaimer

The test results of this test report relate exclusively to the test item specified in this test report. CTC advanced GmbH does not assume responsibility for any conclusions and generalizations drawn from the test results with regard to other specimens or samples of the type of the equipment represented by the test item.
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This test report is electronically signed and valid without handwritten signature. For verification of the electronic signatures, the public keys can be requested at the testing laboratory.

2.2 Application details

Date of receipt of order:	2019-11-06
Date of receipt of test item:	2020-07-06
Start of test:	2020-07-06
End of test:	2021-03-24
Person(s) present during the test:	-/-

2.3 Test laboratories sub-contracted

None

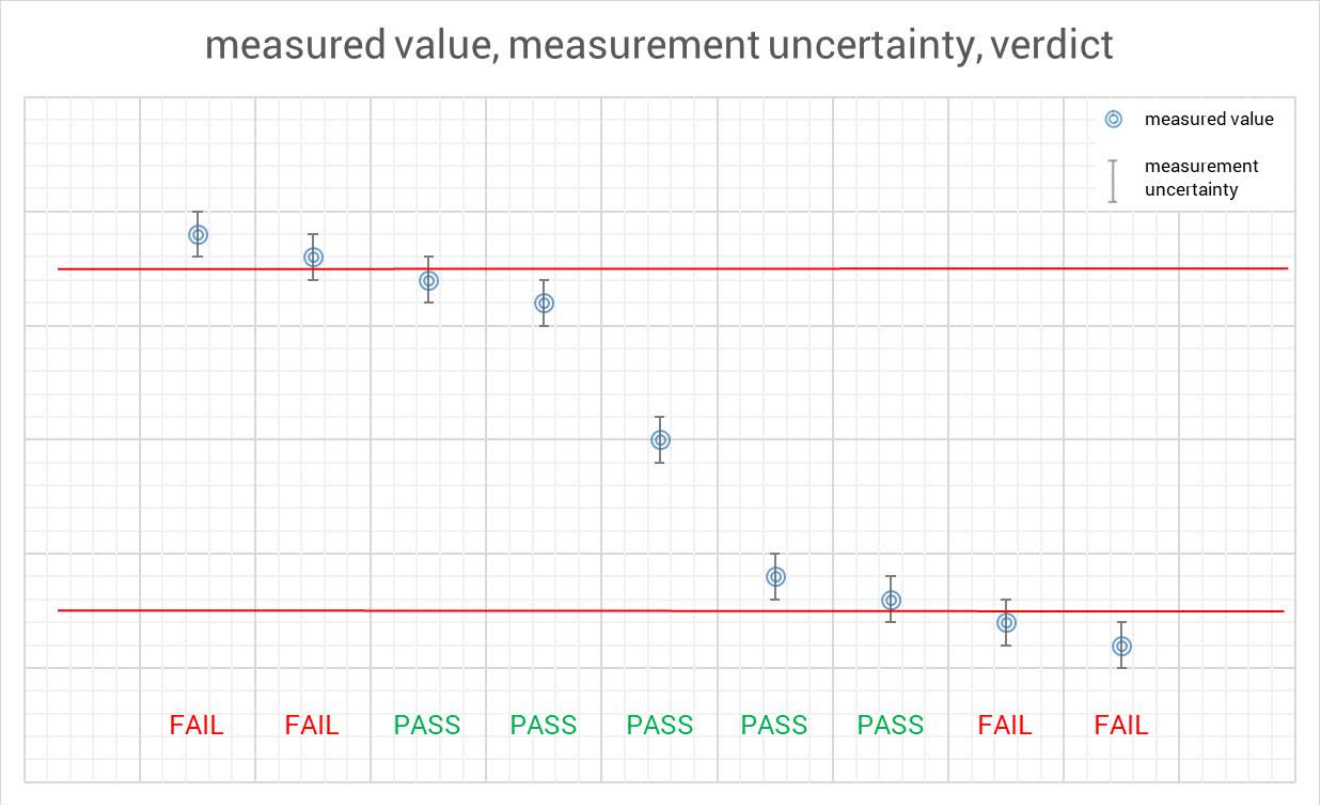
3 Test standard/s and references

Test standard	Date	Description
47 CFR Part 15		Title 47 of the Code of Federal Regulations; Chapter I; Part 15 - Radio frequency devices

Guidance	Version	Description
ANSI C63.4-2014	-/-	American national standard for methods of measurement of radio-noise emissions from low-voltage electrical and electronic equipment in the range of 9 kHz to 40 GHz
ANSI C63.10-2013	-/-	American national standard of procedures for compliance testing of unlicensed wireless devices

4 Reporting statements of conformity – decision rule

Only the measured values related to their corresponding limits will be used to decide whether the equipment under test meets the requirements of the test standards listed in chapter 3.
The measurement uncertainty is mentioned in this test report, see chapter 9, but is not taken into account - neither to the limits nor to the measurement results. Measurement results with a smaller margin to the corresponding limits than the measurement uncertainty have a potential risk of more than 5% that the decision might be wrong."



5 Test environment

Temperature	:	T_{nom} T_{max} T_{min}	+22 °C during room temperature tests +70 °C during high temperature tests -30 °C during low temperature tests
Relative humidity content	:		47 %
Barometric pressure	:		1021 hpa
Power supply	:	V_{nom}	24 V DC, by external power supply

6 Test item

6.1 General description

Kind of test item	:	Collison Avoidance Main Unit
Model name	:	QC1000
S/N serial number	:	Sample 101
Frequency band	:	5.925 GHz to 7.250 GHZ
Type of radio transmission Use of frequency spectrum	: :	UWB
Type of modulation	:	BPSK / BPM
Number of channels	:	1
Antenna	:	Integrated antenna
Power supply	:	24 V DC, by battery
Temperature range	:	-30°C to +70°C

6.2 Additional information

A special test mode is used with a cycle time of 1ms:

To set up the EUT in transmitter test mode, the following commands where send via serial interface

Channel 7
1. *$radio,init,1,7,101* 2. *$radio,cf,w,1000,200*

Transmitter test mode parameters:

Channel	7 / 6489.6GHz*
Power Setting	101 (program setting)
Cycle time	1000 ms
Pulse length	200 ms

*IEEE802.15.4.-2011 UWB channel centre frequency

Test setup- and EUT-photos are included in test report: 1-9100/19-01-13_AnnexA
1-9100/19-01-13_AnnexB
1-9100/19-01-13_AnnexD

7 Description of the test setup

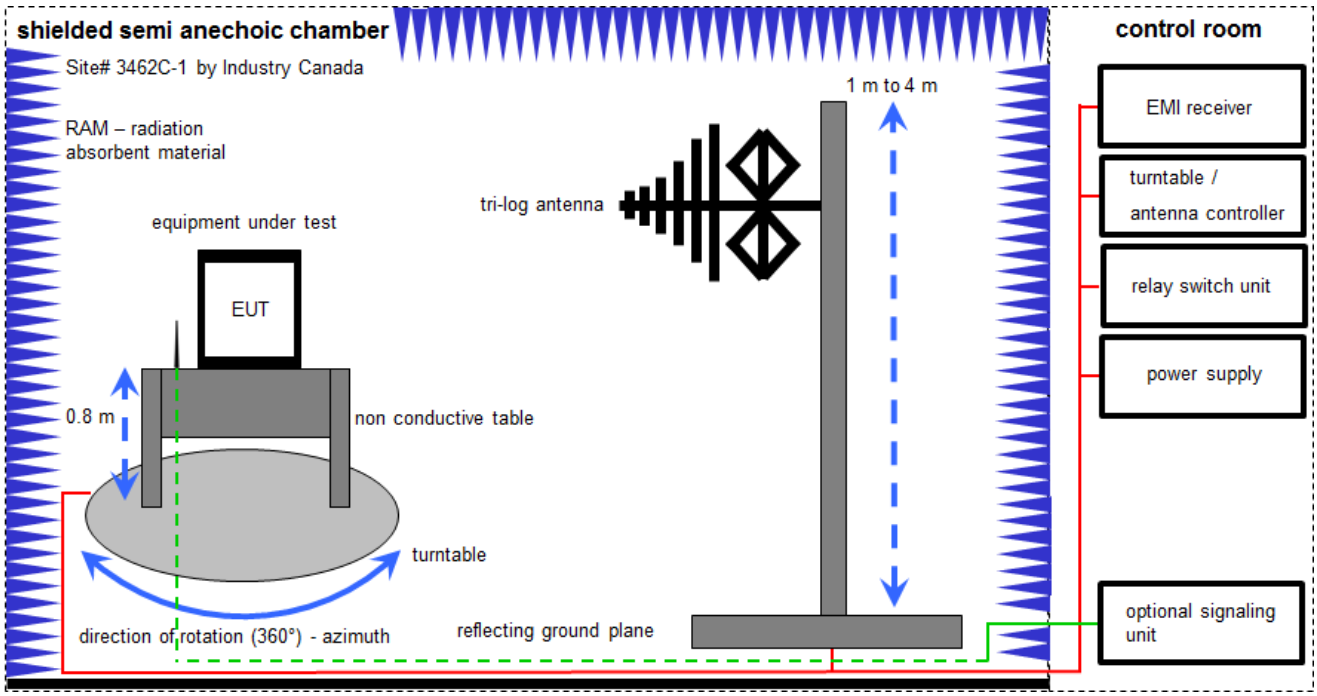
Typically, the calibrations of the test apparatus are commissioned to and performed by an accredited calibration laboratory. The calibration intervals are determined in accordance with the DIN EN ISO/IEC 17025. In addition to the external calibrations, the laboratory executes comparison measurements with other calibrated test systems or effective verifications. Weekly chamber inspections and range calibrations are performed. Where possible, RF generating and signaling equipment as well as measuring receivers and analyzers are connected to an external high-precision 10 MHz reference (GPS-based or rubidium frequency standard).

In order to simplify the identification of the equipment used at some special tests, some items of test equipment and ancillaries can be provided with an identifier or number in the equipment list below (Lab/Item).

Agenda: Kind of Calibration

k	calibration / calibrated	EK	limited calibration
ne	not required (k, ev, izw, zw not required)	zw	cyclical maintenance (external cyclical maintenance)
ev	periodic self verification	izw	internal cyclical maintenance
Ve	long-term stability recognized	g	blocked for accredited testing
vlkl!	Attention: extended calibration interval		
NK!	Attention: not calibrated	*)	next calibration ordered / currently in progress

7.1 Shielded semi anechoic chamber



Measurement distance: tri-log antenna 10 meter

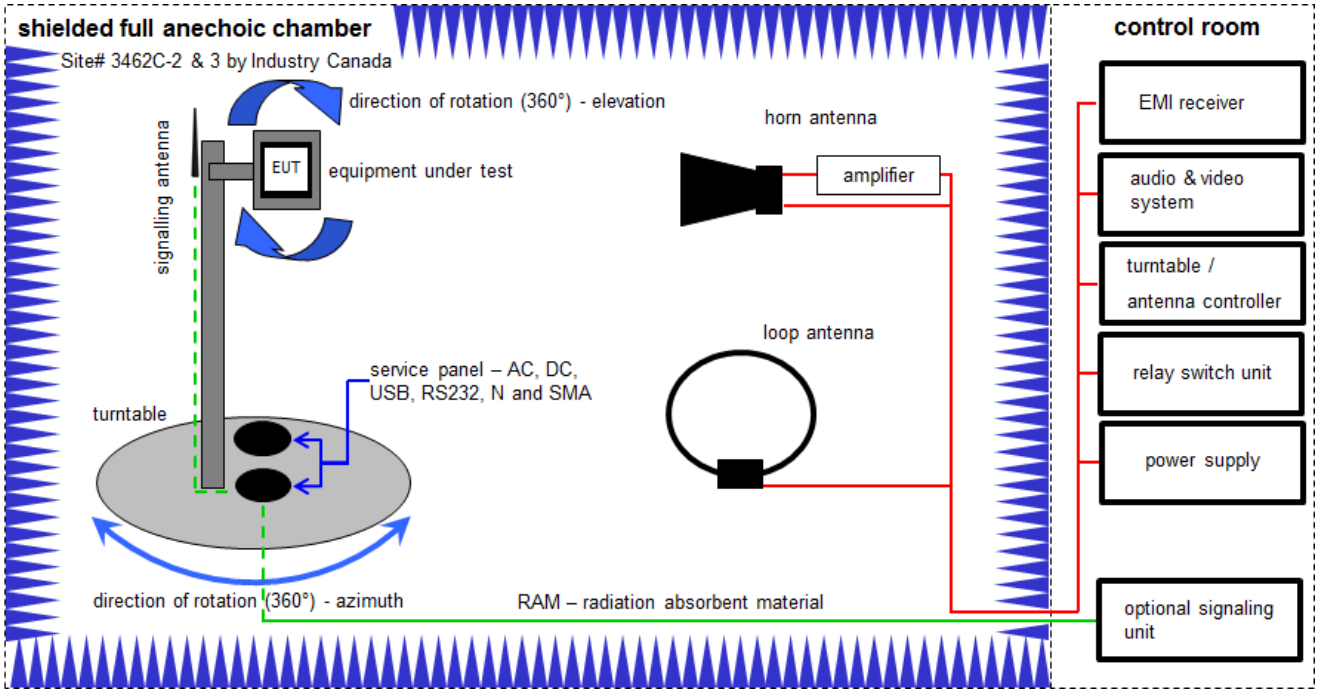
FS = UR + CL + AF
(FS-field strength; UR-voltage at the receiver; CL-loss of the cable; AF-antenna factor)

Example calculation:
FS [dBµV/m] = 12.35 [dBµV/m] + 1.90 [dB] + 16.80 [dB/m] = 31.05 [dBµV/m] (35.69 µV/m)

Equipment table:

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	n. a.	Switch-Unit	3488A	HP	2719A14505	300000368	ev	-/-	-/-
2	n. a.	DC power supply, 60Vdc, 50A, 1200 W	6032A	HP	2920A04466	300000580	ne	-/-	-/-
3	n. a.	Meßkabine 1	HF-Absorberhalle	MWB AG 300023		300000551	ne	-/-	-/-
4	n. a.	EMI Test Receiver	ESCI 3	R&S	100083	300003312	k	09.12.2020	08.12.2021
5	n. a.	Antenna Tower	Model 2175	ETS-Lindgren	64762	300003745	izw	-/-	-/-
6	n. a.	Positioning Controller	Model 2090	ETS-Lindgren	64672	300003746	izw	-/-	-/-
7	n. a.	Turntable Interface-Box	Model 105637	ETS-Lindgren	44583	300003747	izw	-/-	-/-
8	n. a.	TRILOG Broadband Test-Antenna 30 MHz - 3 GHz	VULB9163	Schwarzbeck Mess - Elektronik	318	300003696	vlKl!	04.09.2019	03.09.2021
9	n. a.	Switch-Unit	3488A	HP	2719A14505	300000368	ev	-/-	-/-
10	n. a.	EMI Test Receiver	ESR3	Rohde & Schwarz	102587	300005771	k	10.12.2020	09.06.2022
11	n. a.	PC	TecLine	F+W		300004388	ne	-/-	-/-

7.2 Shielded fully anechoic chamber



Measurement distance: horn antenna 3 meter; loop antenna 3 meter / 1 meter

FS = UR + CA + AF
(FS-field strength; UR-voltage at the receiver; CA-loss of the signal path; AF-antenna factor)

Example calculation:
FS [dBµV/m] = 40.0 [dBµV/m] + (-35.8) [dB] + 32.9 [dB/m] = 37.1 [dBµV/m] (71.61 µV/m)

OP = AV + D - G + CA
(OP-radiated output power; AV-analyzer value; D-free field attenuation of measurement distance; G-antenna gain+amplifier gain; CA-loss signal path)

Example calculation:
OP [dBm] = -39.0 [dBm] + 57.0 [dB] - 12.0 [dBi] + (-36.0) [dB] = -30 [dBm] (1 µW)

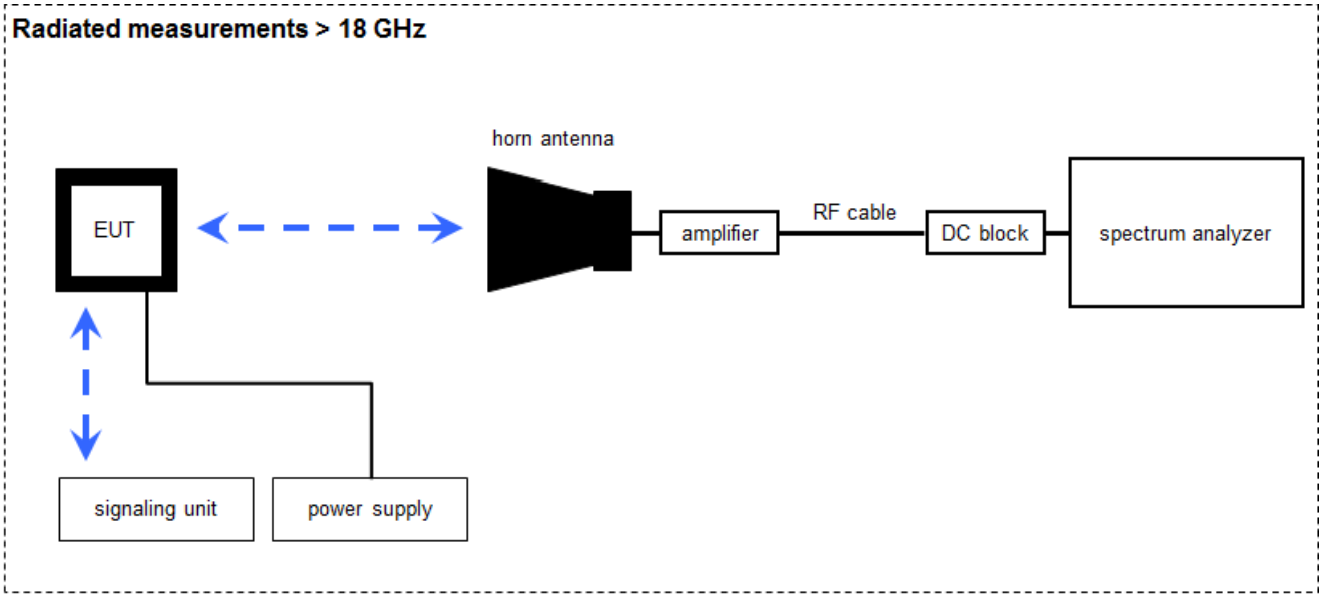
Equipment table (Chamber C):

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	A,B,C	DC power supply, 60Vdc, 50A, 1200 W	6032A	HP	2818A03450	300001040	vIKI!	09.12.2020	08.12.2023
2	A,B,C	Anechoic chamber	FAC 3/5m	MWB / TDK	87400/02	300000996	ev	-/-	-/-
3	A,B,C	Switch / Control Unit	3488A	HP	*	300000199	ne	-/-	-/-
4	A,B,C	Variable isolating transformer	MPL IEC625 Bus Variable isolating transformer	Erfi	91350	300001155	ne	-/-	-/-
5	A,B,C	EMI Test Receiver 20Hz- 26,5GHz	ESU26	R&S	100037	300003555	k	11.12.2020	10.12.2021
6	A,B,C	4U RF Switch Platform	L4491A	Agilent Technologies	MY50000037	300004509	ne	-/-	-/-
7	A,B,C	NEXIO EMV-Software	BAT EMC V3.16.0.49	EMCO		300004682	ne	-/-	-/-
8	A,B,C	PC	ExOne	F+W		300004703	ne	-/-	-/-
9	n. a.	Active Loop Antenna 9 kHz to 30 MHz	6502	EMCO	2210	300001015	vIKI!	13.06.2019	12.06.2021

Equipment table (OTA):

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	A,B,C	Power supply GPIB dc power supply, 0-50 Vdc, 0-2 A	6633A	HP	2851A01222	300001530	vIKI!	10.12.2019	09.12.2022
2	A,B,C	CTIA-Chamber	CTIA-Chamber AMS 8500	ETS-Lindgren Finnland		300003327	ne	-/-	-/-
3	A,B,C	CTIA-Chamber - Positioning Equipment	CTIA-Chamber - Positioning Equipment	EMCO/2		300003328	ne	-/-	-/-
4	A,B,C	Signal- and Spectrum Analyzer	FSW26	R&S	101371	300005697	k	09.12.2020	08.12.2021
5	A,B,C	PC	Precision M4800	DELL	19414201934	300004957	-/-		
6	A,B,C	EMC Software Chamber A	EMC32-MEB	R&S	n.a.	300005477	-/-		
7	A,B,C	RF Amplifier	AMF-7D-01001800-22-10P	NARDA-MITEQ Inc	2089864	300005633	ev		
8	A	Std. Gain Horn Antenna 11.90-18.00 GHz	1824-20	Flann	263	300002471	ev	-/-	-/-
9	B	Double-Ridged Waveguide Horn Antenna 1-18.0GHz	3115	EMCO	9709-5290	300000212	ev	-/-	-/-
10		Lowpass Filter (Chebyshev)	WLKX14-4700-4900-21000-30SS	Wainwright Instruments GmbH	1	300005655	ev		
11		High Pass Filter (Chebyshev)	WHNX6-8374-10600-26500-40CC	Wainwright Instruments GmbH	1	300005656	ev		

7.3 Radiated measurements > 18 GHz



Measurement distance: horn antenna 50 cm

FS = UR + CA + AF
(FS-field strength; UR-voltage at the receiver; CA-loss signal path & distance correction; AF-antenna factor)

Example calculation:
FS [dBµV/m] = 40.0 [dBµV/m] + (-60.1) [dB] + 36.74 [dB/m] = 16.64 [dBµV/m] (6.79 µV/m)

OP = AV + D - G + CA
(OP-radiated output power; AV-analyzer value; D-free field attenuation of measurement distance;
G-antenna gain+amplifier gain; CA-loss signal path)

Example calculation:
OP [dBm] = -59.0 [dBm] + 44.0 [dB] - 20.0 [dBi] + 5.0 [dB] = -30 [dBm] (1 µW)

Equipment table:

Equipment table:

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No CTC	Kind of Calibration	Last Calibration	Next Calibration
1	A	Std. Gain Horn Antenna 26.5-40.0 GHz	V637	Narda	7911	300001751	ev	-/-	-/-
2	A	Std. Gain Horn Antenna 18.0-26.5 GHz	638	Narda		300000487	ev	-/-	-/-
3	A	Spectrum Analyzer 2 Hz - 85 GHz	FSW85	R&S	101333	300005568	k	17.06.2020	16.06.2021
4	A	Broadband LNA 18-50 GHz	CBL18503070PN	CERNEX	25240	300004948	ev	-/-	-/-
5	A	DC Power Supply, 60V, 10A	6038A	HP	2933A08295	300001519	vIKI!	08.12.2020	07.12.2023

8 Sequence of testing

8.1 Sequence of testing radiated spurious 9 kHz to 30 MHz

Setup

- The equipment is set up to simulate normal operation mode as described in the user manual or defined by the manufacturer.
- If the EUT is a tabletop system, it is placed on a table with 0.8 m height.
- If the EUT is a floor standing device, it is placed directly on the turn table.
- Auxiliary equipment and cables are positioned to simulate normal operation conditions as described in ANSI C 63.4.
- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.
- Measurement distance is 3 m (see ANSI C 63.4) – see test details.
- EUT is set into operation.

Premeasurement*

- The turntable rotates from 0° to 315° using 45° steps.
- The antenna height is 1 m.
- At each turntable position the analyzer sweeps with positive-peak detector to find the maximum of all emissions.

Final measurement

- Identified emissions during the pre-measurement are maximized by the software by rotating the turntable from 0° to 360°.
- Loop antenna is rotated about its vertical axis for maximum response at each azimuth about the EUT. (For certain applications, the loop antenna plane may also need to be positioned horizontally at the specified distance from the EUT)
- The final measurement is done in the position (turntable and elevation) causing the highest emissions with quasi-peak (as described in ANSI C 63.4).
- Final levels, frequency, measuring time, bandwidth, turntable position, correction factor, margin to the limit and limit will be recorded. A plot with the graph of the premeasurement and the limit is stored.

*)Note: The sequence will be repeated three times with different EUT orientations.

8.2 Sequence of testing radiated spurious 30 MHz to 1 GHz

Setup

- The equipment is set up to simulate normal operation mode as described in the user manual or defined by the manufacturer.
- If the EUT is a tabletop system, a table with 0.8 m height is used, which is placed on the ground plane.
- If the EUT is a floor standing device, it is placed on the ground plane with insulation between both.
- Auxiliary equipment and cables are positioned to simulate normal operation conditions as described in ANSI C 63.4.
- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.
- Measurement distance is 10 m or 3 m (see ANSI C 63.4) – see test details.
- EUT is set into operation.

Premeasurement

- The turntable rotates from 0° to 315° using 45° steps.
- The antenna is polarized vertical and horizontal.
- The antenna height changes from 1 m to 3 m.
- At each turntable position, antenna polarization and height the analyzer sweeps three times in peak to find the maximum of all emissions.

Final measurement

- The final measurement is performed for at least six highest peaks according to the requirements of the ANSI C63.4.
- Based on antenna and turntable positions at which the peak values are measured the software maximize the peaks by changing turntable position ± 45° and antenna height between 1 and 4 m.
- The final measurement is done with quasi-peak detector (as described in ANSI C 63.4).
- Final levels, frequency, measuring time, bandwidth, antenna height, antenna polarization, turntable angle, correction factor, margin to the limit and limit are recorded. A plot with the graph of the premeasurement with marked maximum final results and the limit is stored.

8.3 Sequence of testing radiated spurious 1 GHz to 18 GHz

Setup

- The equipment is set up to simulate normal operation mode as described in the user manual or defined by the manufacturer.
- If the EUT is a tabletop system, a 2-axis positioner with 1.5 m height is used.
- If the EUT is a floor standing device, it is placed directly on the turn table.
- Auxiliary equipment and cables are positioned to simulate normal operation conditions as described in ANSI C 63.4.
- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.
- Measurement distance is 3 m (see ANSI C 63.4) – see test details.
- EUT is set into operation.

Premeasurement

- The turntable rotates from 0° to 315° using 45° steps.
- The antenna is polarized vertical and horizontal.
- The antenna height is 1.5 m.
- At each turntable position and antenna polarization the analyzer sweeps with positive peak detector to find the maximum of all emissions.

Final measurement

- The final measurement is performed for at least six highest peaks according to the requirements of the ANSI C63.4.
- Based on antenna and turntable positions at which the peak values are measured the software maximizes the peaks by rotating the turntable from 0° to 360°. This measurement is repeated for different EUT-table positions (0° to 150° in 30°-steps) and for both antenna polarizations.
- The final measurement is done in the position (turntable, EUT-table and antenna polarization) causing the highest emissions with Peak and RMS detector (as described in ANSI C 63.4).
- Final levels, frequency, measuring time, bandwidth, turntable position, EUT-table position, antenna polarization, correction factor, margin to the limit and limit are recorded. A plot with the graph of the premeasurement with marked maximum final results and the limit is stored.

8.4 Sequence of testing radiated spurious above 18 GHz

Setup

- The equipment is set up to simulate normal operation mode as described in the user manual or defined by the manufacturer.
- Auxiliary equipment and cables are positioned to simulate normal operation conditions as described in ANSI C 63.4.
- The AC power port of the EUT (if available) is connected to a power outlet.
- The measurement distance is as appropriate (e.g. 0.5 m).
- The EUT is set into operation.

Premeasurement

- The test antenna is handheld and moved carefully over the EUT to cover the EUT's whole sphere and different polarizations of the antenna.

Final measurement

- The final measurement is performed at the position and antenna orientation causing the highest emissions with Peak and RMS detector (as described in ANSI C 63.4).
- Final levels, frequency, measuring time, bandwidth, correction factor, margin to the limit and limit are recorded. A plot with the graph of the premeasurement and the limit is stored.

9 Measurement uncertainty

Test case	Uncertainty
Equivalent isotropically radiated power (e.i.r.p.)	Conducted value ± 1 dB Radiated value ± 3 dB
Permitted range of operating frequencies	± 100 kHz
Conducted unwanted emissions in the spurious domain (up to 40 GHZ)	± 1 dB
Radiated unwanted emissions in the spurious domain (up to 40 GHz)	± 3 dB
Conducted unwanted emissions in the spurious domain (40 to 50 GHZ)	± 4 dB
Radiated unwanted emissions in the spurious domain (40 to 50 GHz)	± 4 dB
Conducted unwanted emissions in the spurious domain (50 to 300 GHZ)	± 5 dB
Radiated unwanted emissions in the spurious domain (50 to 300 GHz)	± 5 dB
DC and low frequency voltages	± 3 %
Temperature	± 1 °C
Humidity	± 3 %

10 Summary of measurement results

☒	**No deviations from the technical specifications were ascertained**
☐	There were deviations from the technical specifications ascertained
☐	This test report is only a partial test report. The content and verdict of the performed test cases are listed below.

TC Identifier	Description	Verdict	Date	Remark
RF-Testing	CFR47 Part 15	see table	2021-03-26	-/-

Test specification clause	Test case	Temperature conditions	Power source	Pass	Fail	NA	NP	Remark
§15.250 (b)	10 dB Bandwidth	Nominal	Nominal	☒	☐	☐	☐	complies
§15.250 (d) (1)-(5) §15.209	TX Radiated Emissions	Nominal	Nominal	☒	☐	☐	☐	complies

Note: NA = Not Applicable; NP = Not Performed

11 Measurement results

11.1 10 dB - Bandwidth

Description:

(a) *WB bandwidth.* For the purpose of this subpart, the WB 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.

Measurement:

Measurement parameter	
Detector:	Peak
Video bandwidth:	1 MHz
Resolution bandwidth:	3 MHz
Trace-Mode:	Max Hold

Test Setup: 7.3

Limits:

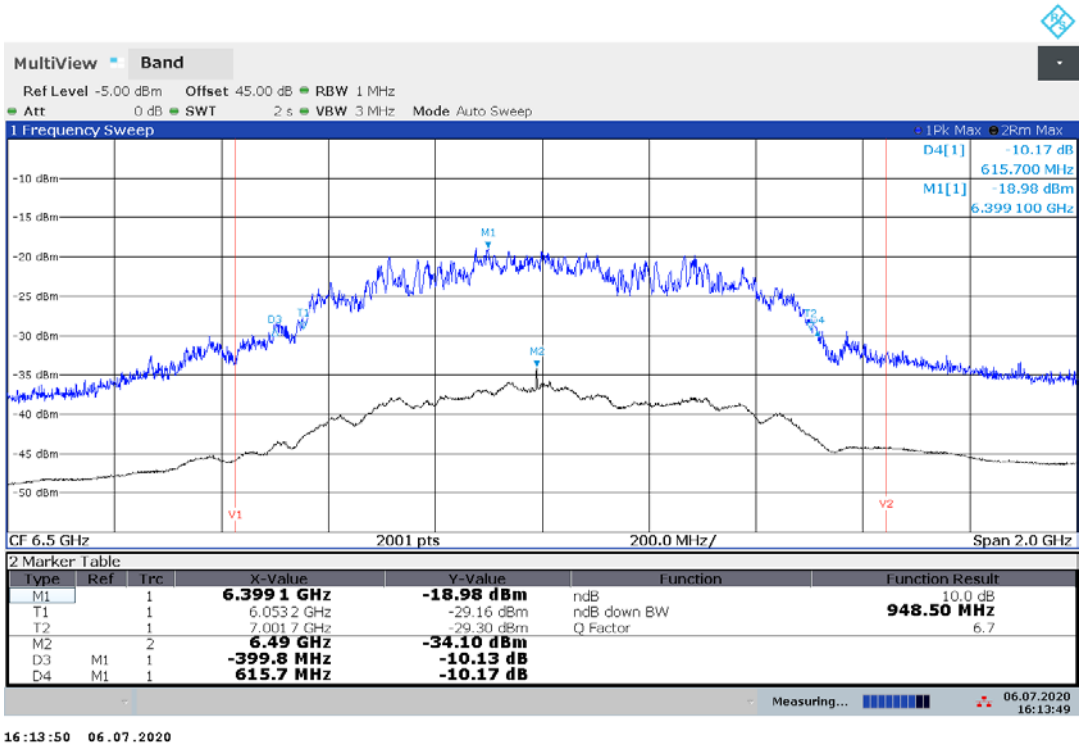
>50 MHz

Results:

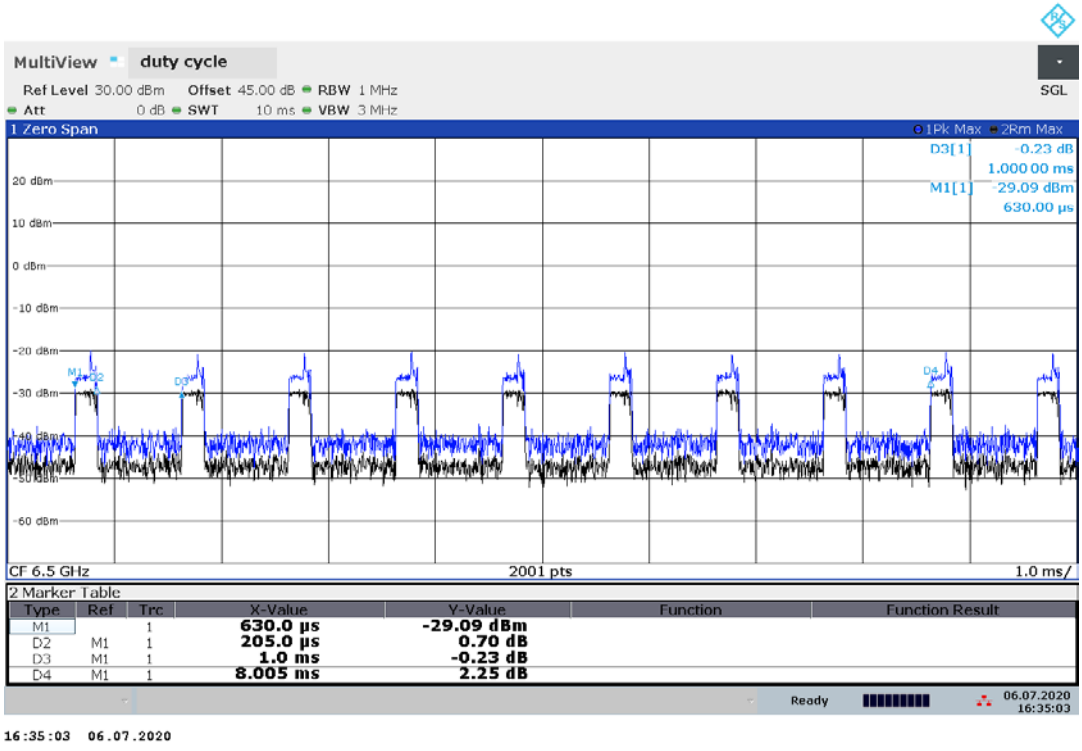
Temperature	Lower -10 dB point [GHz]	Higher -10 dB point [GHz]	UWB bandwidth [MHz]
22 °C	6.0532	7.0017	948.5

Verdict: **Compliant**

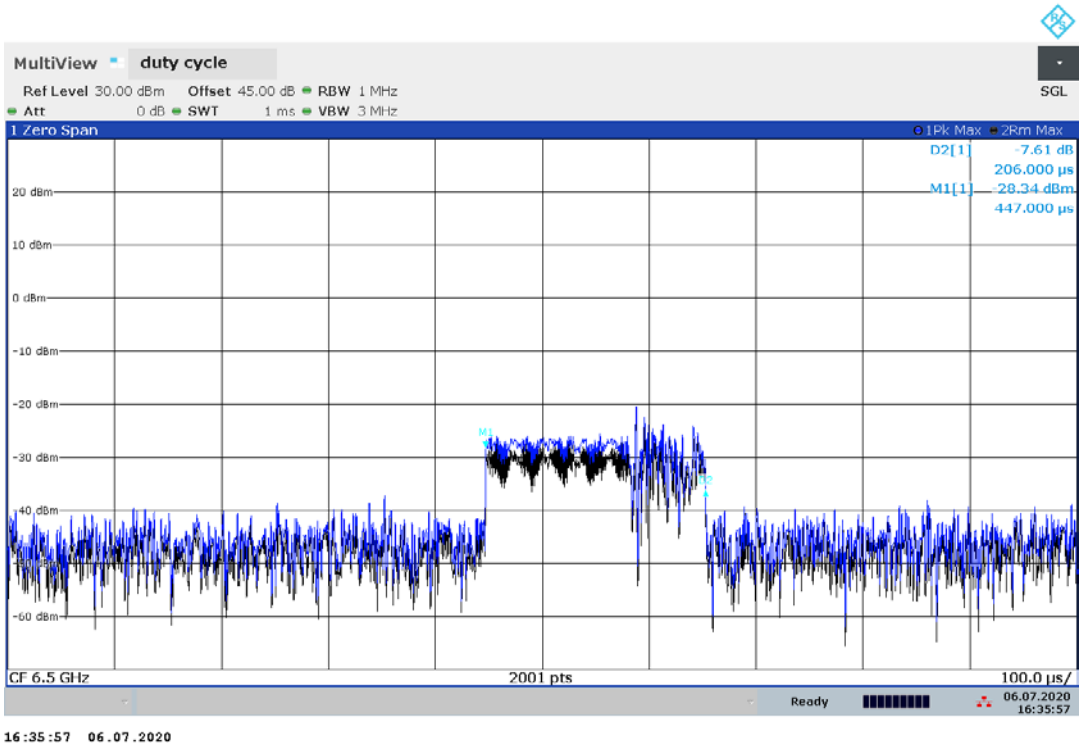
Plot 1: 10 dB down



Plot 2: Duty Cycle, test mode



Plot 3: Duty Cycle, Burst duration, test mode



11.2 TX Radiated Emissions

Description:

Measurement of the radiated spurious emissions in transmit mode.

Measurement:

§15.209 / §15.250 (d) (4):

Average Measurement parameter	
Detector:	Peak/QPeak
Sweep time:	1 s
Number of points	8001
Resolution bandwidth:	120kHz
Video bandwidth:	≥ RBW
Trace-Mode:	Max Hold

§15.250 (d) (1):

Average Measurement parameter	
Detector:	RMS
Sweep time:	1 ms/pt
Number of points	1001/10001
Resolution bandwidth:	1 MHz
Video bandwidth:	3 MHz
Trace-Mode:	Max Hold

§15.250 (d) (2):

Average Measurement parameter	
Detector:	RMS
Sweep time:	1 ms/pt
Number of points	10001
Resolution bandwidth:	1 kHz
Video bandwidth:	3 kHz
Trace-Mode:	Max Hold

§15.250 (d) (3):

Peak Measurement parameter	
Detector:	Max Peak
Sweep time:	101 ms
Resolution bandwidth:	50 MHz
Video bandwidth:	80 MHz
Span:	Zero span
Trace-Mode:	Max Hold

Emission limits below 960 MHz (§15.209):

Frequency (MHz)	Field strength (µV/m)	Measurement distance (m)
0.009 – 0.490	2400/F(kHz)	300
0.490 – 1.705	24000/F(kHz)	30
1.705 – 30	30 (29.5 dBµV/m)	30
30 – 88	100 (40 dBµv/m)	3
88 – 216	150 (43.5 dBµV/m)	3
216 – 960	200 (46 dBµV/m)	3
> 960	500 (54 dBµV/m)	3

WB-emission-Limits:

FCC CFR 47:

§15.250 (d) (1)
The radiated emissions above 960 MHz from a device operating under the provisions of this section shall not exceed the following RMS average limits based on measurements using a 1 MHz resolution bandwidth:

Frequency in MHz	EIRP in dBm
960 to 1610	-75.3
1610 to 1990	-63.3
1990 to 3100	-61.3
3100 to 5925	-51.3
5925 to 7250	-41.3
7250 to 10600	-51.3
Above 10600	-61.3

§15.250 (d) (2)
In addition to the radiated emission limits specified in the table in paragraph (d)(1) of this section, transmitters operating under the provisions of this section shall not exceed the following RMS average limits when measured using a resolution bandwidth of no less than 1 kHz:

Frequency in MHz	EIRP in dBm
1164 to 1240	-85.3
1559 to 1610	-85.3

§15.250 (d) (3)
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 and this 50 MHz bandwidth must be contained within the 5925-7250 MHz band. The peak EIRP limit is 20 log (RBW/50) dBm where RBW is the resolution bandwidth in megahertz that is employed by the measurement instrument. RBW shall not be lower than 1 MHz or greater than 50 MHz. The video bandwidth of the measurement instrument shall not be less than RBW. If RBW is greater than 3 MHz, the application for certification filed with the Commission shall contain a detailed description of the test procedure, calibration of the test setup, and the instrumentation employed in the testing.

§15.250 (d) (4)
Radiated emissions at or below 960 MHz shall not exceed the emission levels in §15.209.

§15.250 (d) (5)
Emissions from digital circuitry used to enable the operation of the transmitter may comply with the limits in §15.209 provided it can be clearly demonstrated that those emissions are due solely to emissions from digital circuitry contained within the transmitter and the emissions are not intended to be radiated from the transmitter's antenna. Emissions from associated digital devices, as defined in §15.3(k), e.g., emissions from digital circuitry used to control additional functions or capabilities other than the operation of the transmitter, are subject to the limits contained in subpart B of this part. Emissisons from these digital circuits shall not be employed in determining the −10 dB bandwidth of the fundamental emission or the frequency at which the highest emission level occurs.

Result:

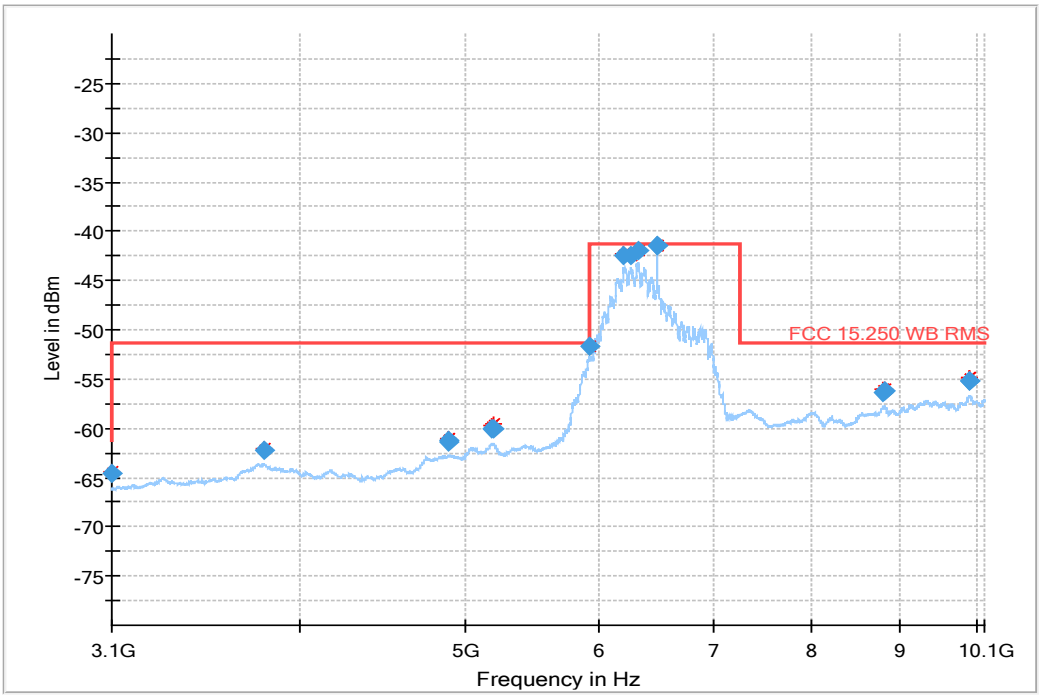
	Channel	Frequency in MHz	Max e.i.r.p. / dBm		Plot
			average value	peak value	
Max E.I.R.P	7	6489.63	-41.41	-2.73	9,10

Emissions outside the band:

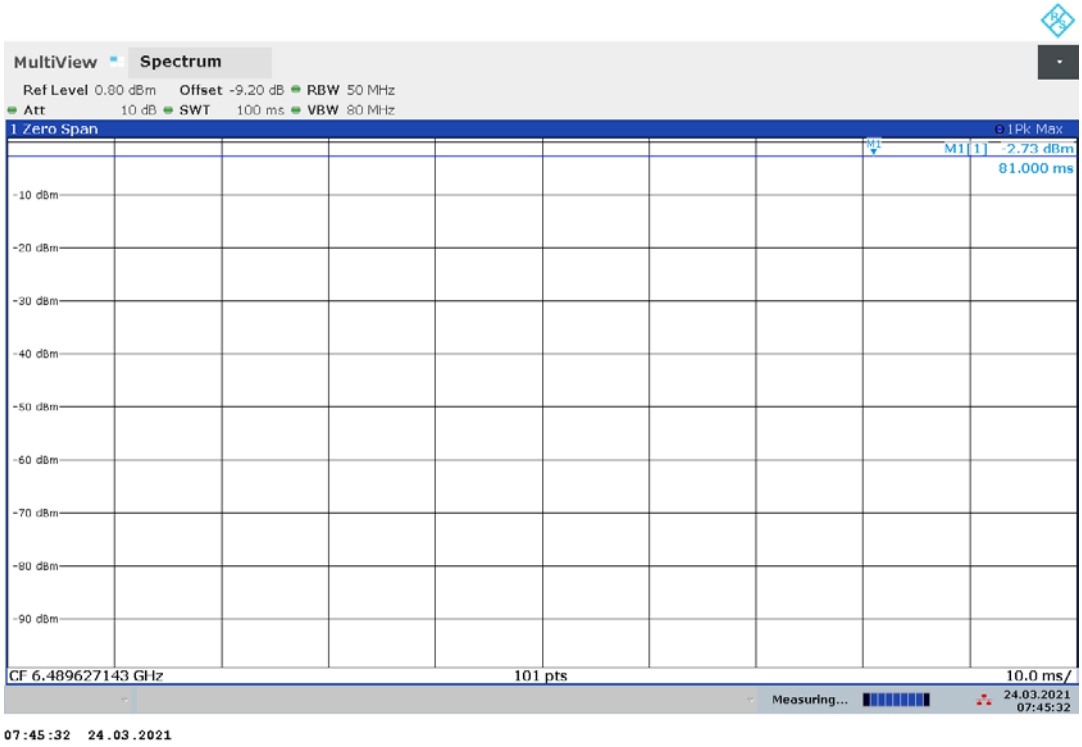
For emissions below 1 GHz, please refer to plots 7 and 8.
For emissions above 1 GHz, please refer to plots 7 and 8.

Verdict: **complies**

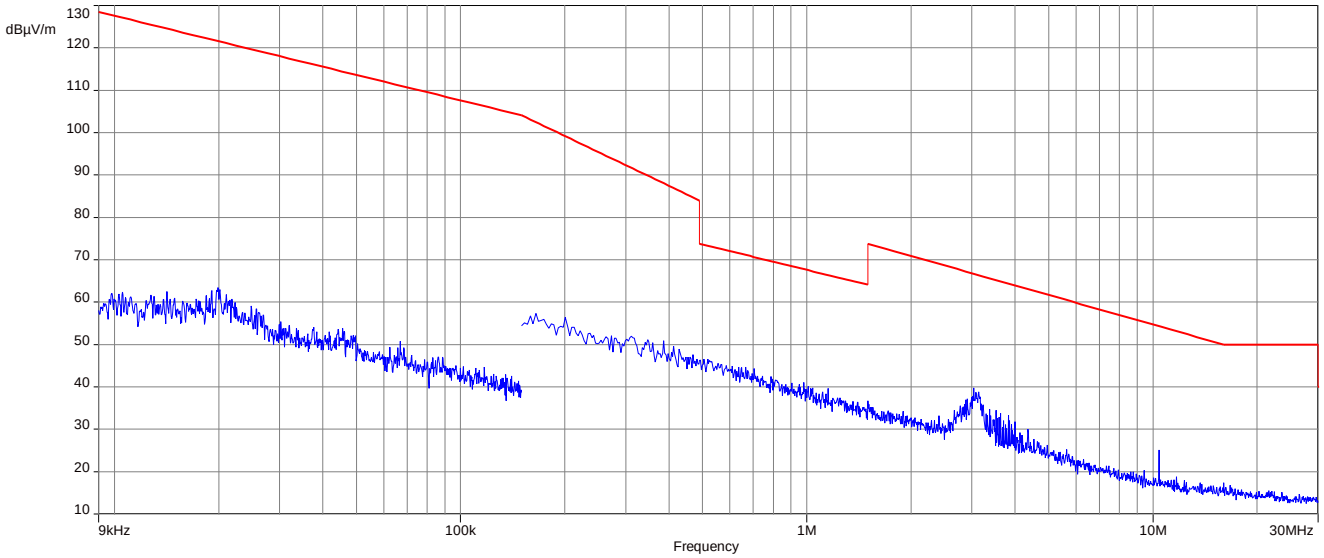
Plot 4: RMS power



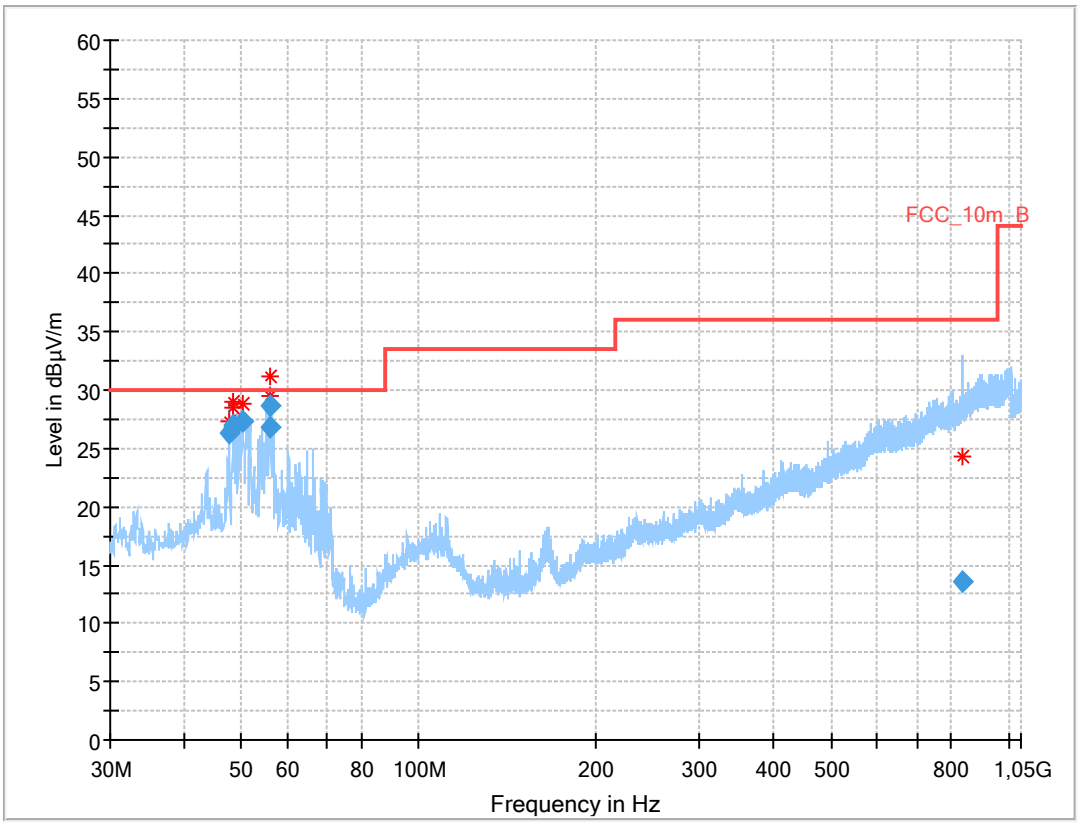
Plot 5: Peak power



Plot 6: 15.209, TX 9 kHz – 30 MHz



Plot 7: 30 MHz – 1 GHz

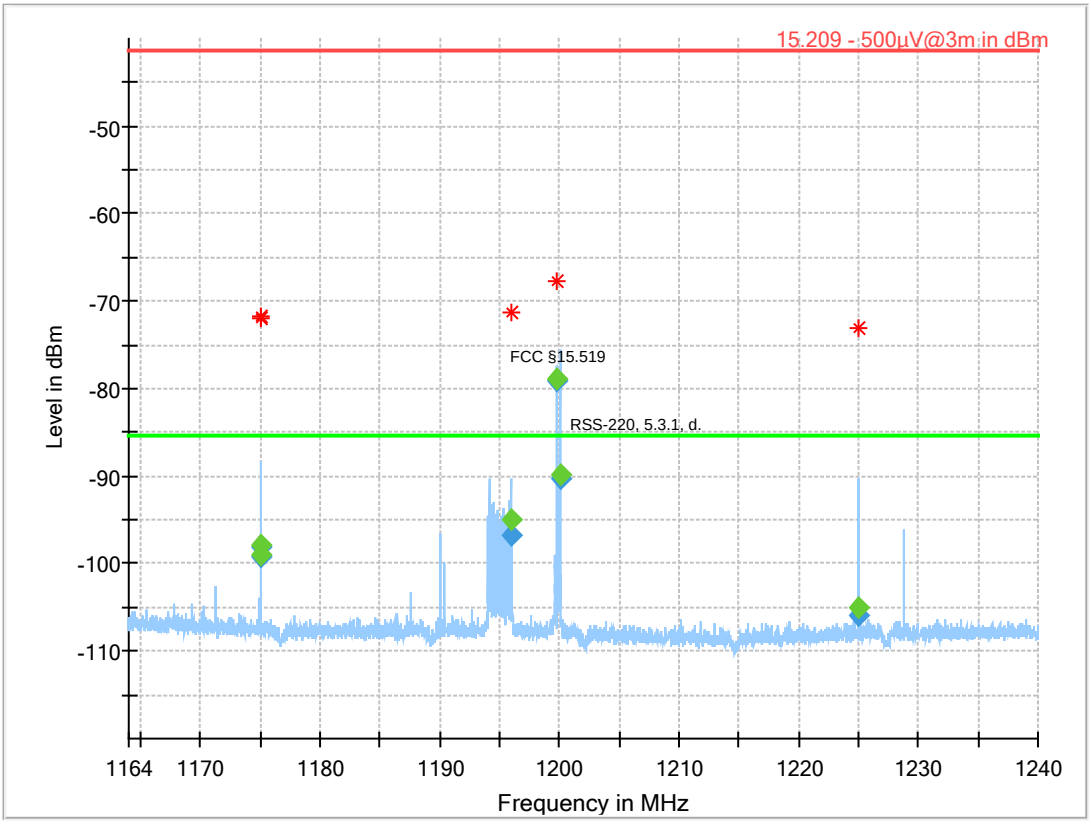


Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
47.802	26.29	30.0	3.7	1000	120.0	100.0	V	60	14
48.441	26.79	30.0	3.2	1000	120.0	103.0	V	-19	14
48.461	27.05	30.0	3.0	1000	120.0	115.0	V	270	14
50.442	27.27	30.0	2.7	1000	120.0	104.0	V	-17	14
55.828	26.80	30.0	3.2	1000	120.0	216.0	V	150	15
56.021	28.74	30.0	1.3	1000	120.0	211.0	V	-35	15
832.774	13.64	36.0	22.4	1000	120.0	400.0	V	76	23

Plot 8: Lower GPS Band, UWB Module on

According to §15.250 (d)(5), emissions from digital circuitry used to enable the operation of the transmitter may comply with the limits in §15.209.

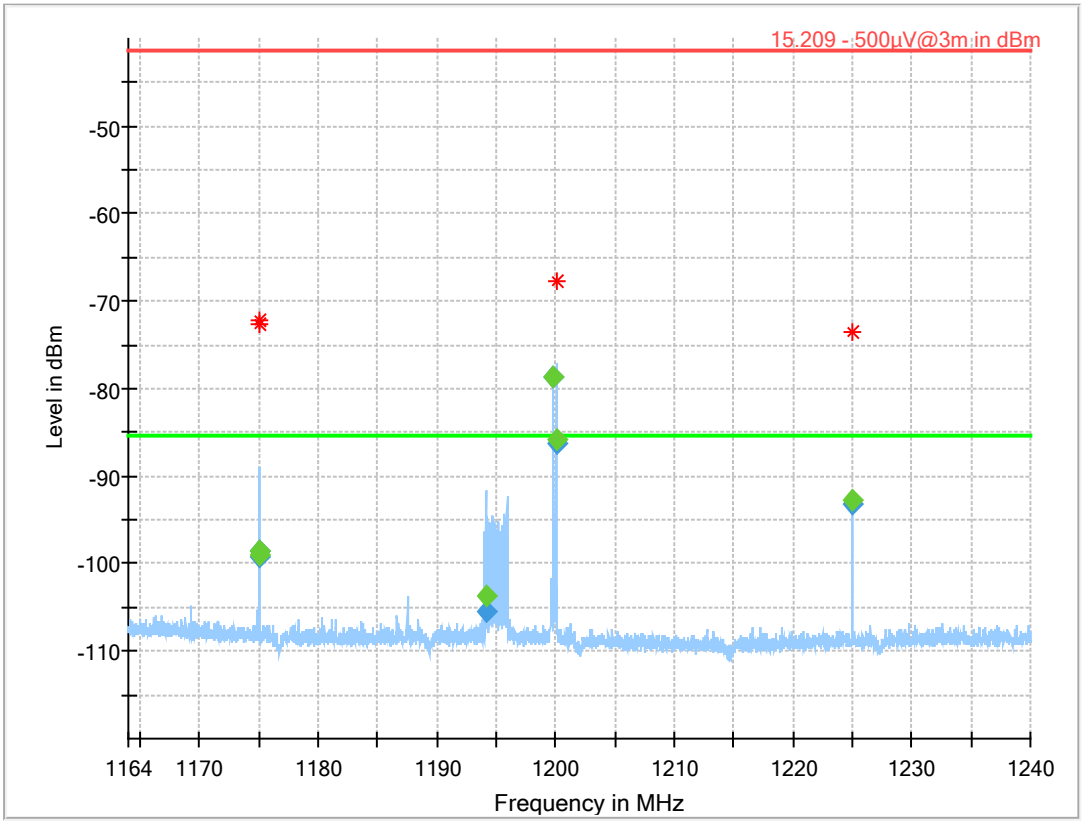


Final_Result

Frequency (MHz)	RMS (dBm)	Limit (dBm)	Margin (dB)	Bandwidth (kHz)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB)
1175.024905	-99.21	-85.30	13.91	1.000	V	10.0	105.0	-144.0
1175.024947	-98.16	-85.30	12.86	1.000	V	10.0	78.0	-144.0
1195.908253	-96.79	-85.30	11.49	1.000	H	324.0	165.0	-144.2
1199.818621	-79.04	-85.30	-6.26	1.000	H	301.0	162.0	-144.3
1200.033280	-90.30	-85.30	5.00	1.000	H	9.0	237.0	-144.3
1225.038617	-105.83	-85.30	20.53	1.000	V	330.0	135.0	-144.3

Plot 9: Lower GPS Band, UWB Module off

According to §15.250 (d)(5), emissions from digital circuitry used to enable the operation of the transmitter may comply with the limits in §15.209.

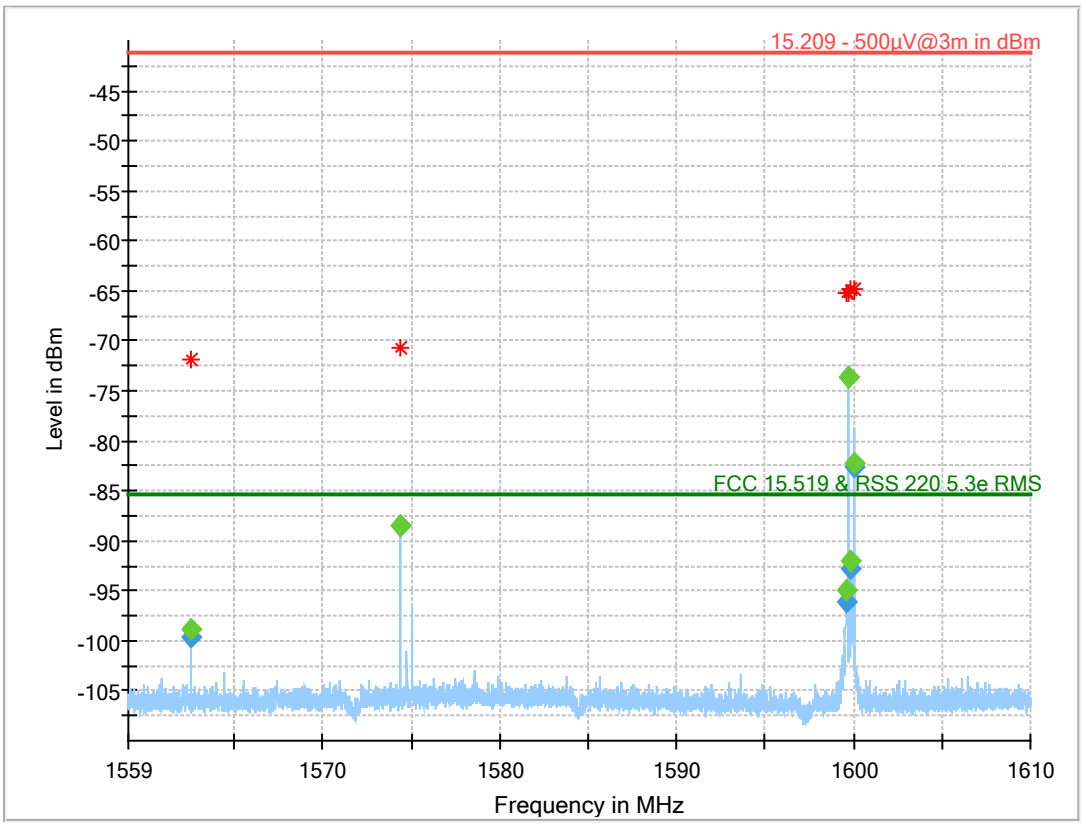


Final_Result

Frequency (MHz)	RMS (dBm)	Limit (dBm)	Margin (dB)	Bandwidth (kHz)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB)
1175.023998	-99.20	-85.30	13.90	1.000	V	1.0	105.0	-144.0
1175.024058	-98.63	-85.30	13.33	1.000	V	3.0	87.0	-144.0
1194.099300	-105.38	-85.30	20.08	1.000	H	10.0	252.0	-144.2
1199.817611	-78.67	-85.30	-6.63	1.000	H	322.0	136.0	-144.3
1200.027160	-86.17	-85.30	0.87	1.000	H	20.0	1.0	-144.3
1225.030233	-93.13	-85.30	7.83	1.000	V	311.0	165.0	-144.3

Plot 10: Upper GPS Band, UWB Module on

According to §15.250 (d)(5), emissions from digital circuitry used to enable the operation of the transmitter may comply with the limits in §15.209.



Final_Result

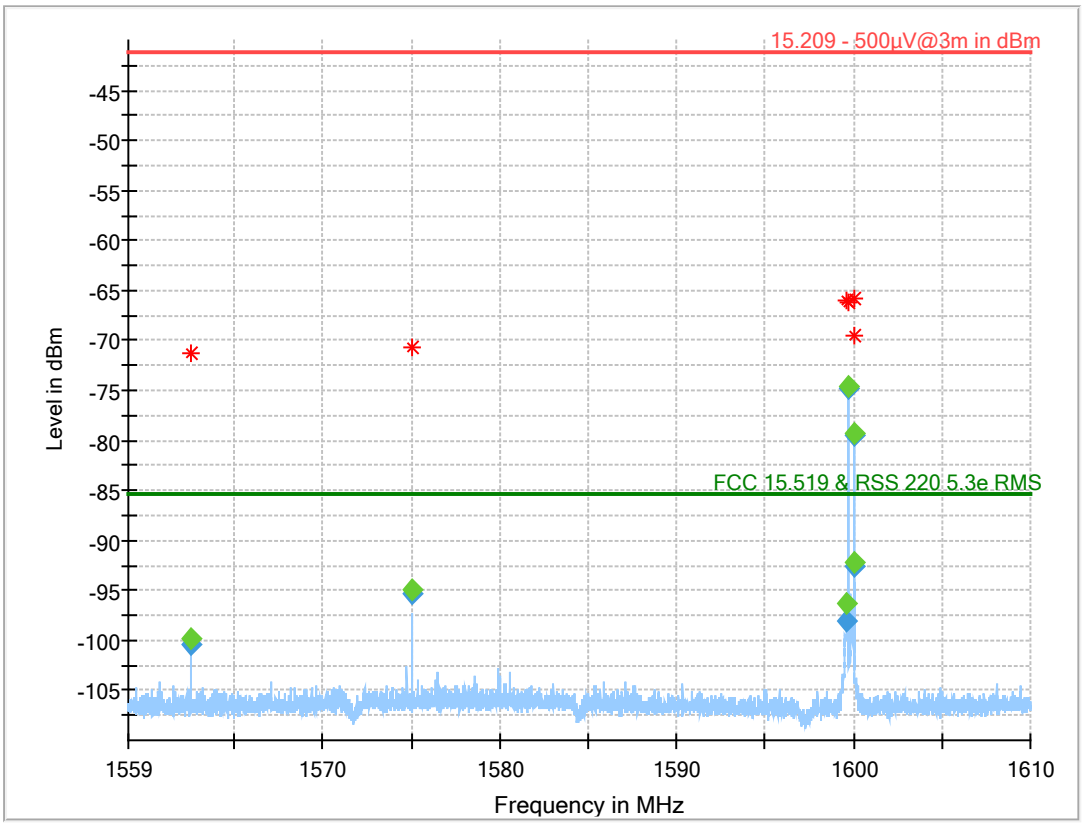
Frequency (MHz)	RMS (dBm)	Limit (dBm)	Margin (dB)	Bandwidth (kHz)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB)
1562.539275	-99.64	-85.30	14.34	1.000	H	273.0	75.0	-141.7
1574.399777	-88.55	-85.30	3.25	1.000	H	251.0	122.0	-141.7
1599.609180	-96.07	-85.30	10.77	1.000	H	271.0	108.0	-141.8
1599.757353	-73.70	-85.30	-11.60	1.000	H	261.0	111.0	-141.8
1599.851300	-92.81	-85.30	7.51	1.000	H	264.0	111.0	-141.8
1600.042753	-82.58	-85.30	-2.72	1.000	H	271.0	18.0	-141.8

Limit according to FCC 15.209

Frequency (MHz)	RMS (dBm)	Limit (dBm)	Margin (dB)	Bandwidth (kHz)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB)
1562.539275	-99.64	-41.23	58.41	1.000	H	273.0	75.0	-141.7
1574.399777	-88.55	-41.23	47.32	1.000	H	251.0	122.0	-141.7
1599.609180	-96.07	-41.23	54.84	1.000	H	271.0	108.0	-141.8
1599.757353	-73.70	-41.23	32.47	1.000	H	261.0	111.0	-141.8
1599.851300	-92.81	-41.23	51.58	1.000	H	264.0	111.0	-141.8
1600.042753	-82.58	-41.23	41.35	1.000	H	271.0	18.0	-141.8

Plot 11: Upper GPS Band, UWB Module off

According to §15.250 (d)(5), emissions from digital circuitry used to enable the operation of the transmitter may comply with the limits in §15.209.

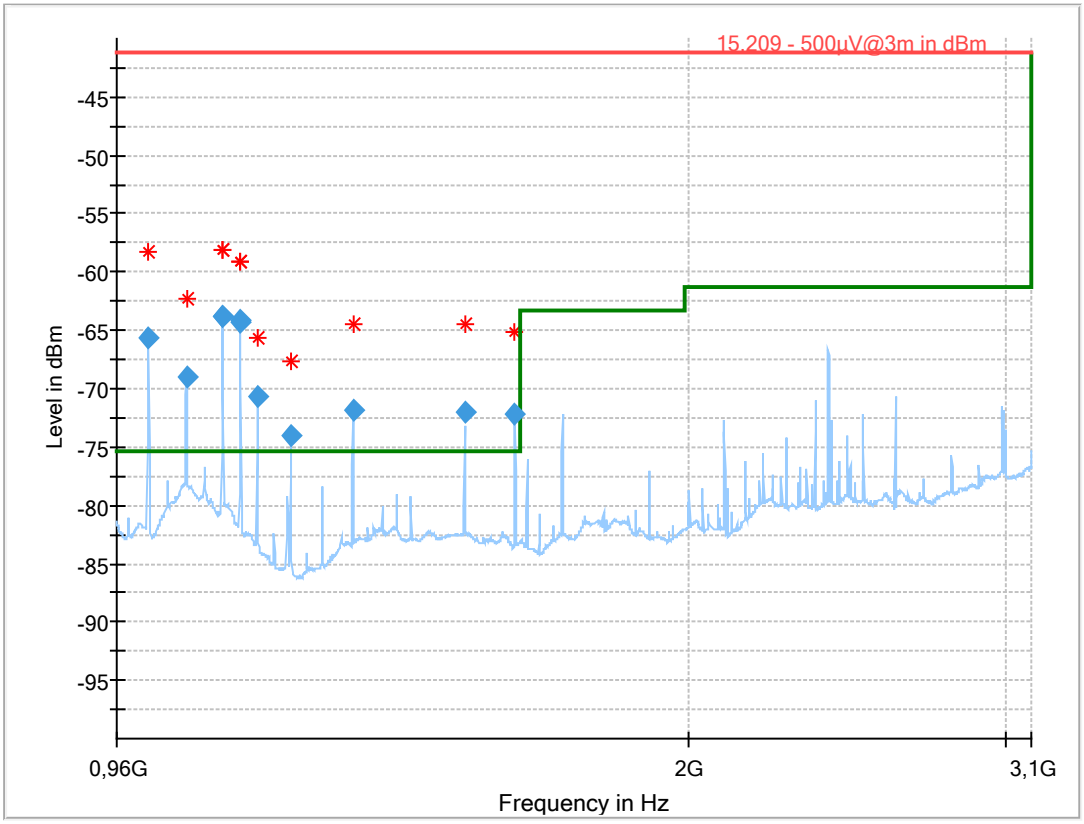


Final_Result

Frequency (MHz)	RMS (dBm)	Limit (dBm)	Margin (dB)	Bandwidth (kHz)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB)
1562.538355	-100.39	-85.30	15.09	1.000	H	284.0	81.0	-141.7
1575.041183	-95.28	-85.30	9.98	1.000	V	316.0	139.0	-141.7
1599.614933	-98.12	-85.30	12.82	1.000	H	276.0	13.0	-141.8
1599.756603	-74.75	-85.30	-10.56	1.000	H	256.0	124.0	-141.8
1599.999973	-92.66	-85.30	7.36	1.000	H	163.0	101.0	-141.8
1600.039388	-79.54	-85.30	-5.76	1.000	H	284.0	11.0	-141.8

Plot 12: 960 MHz – 3.1 GHz, UWB Module on

According to §15.250 (d)(5), emissions from digital circuitry used to enable the operation of the transmitter may comply with the limits in §15.209.



Final_Result

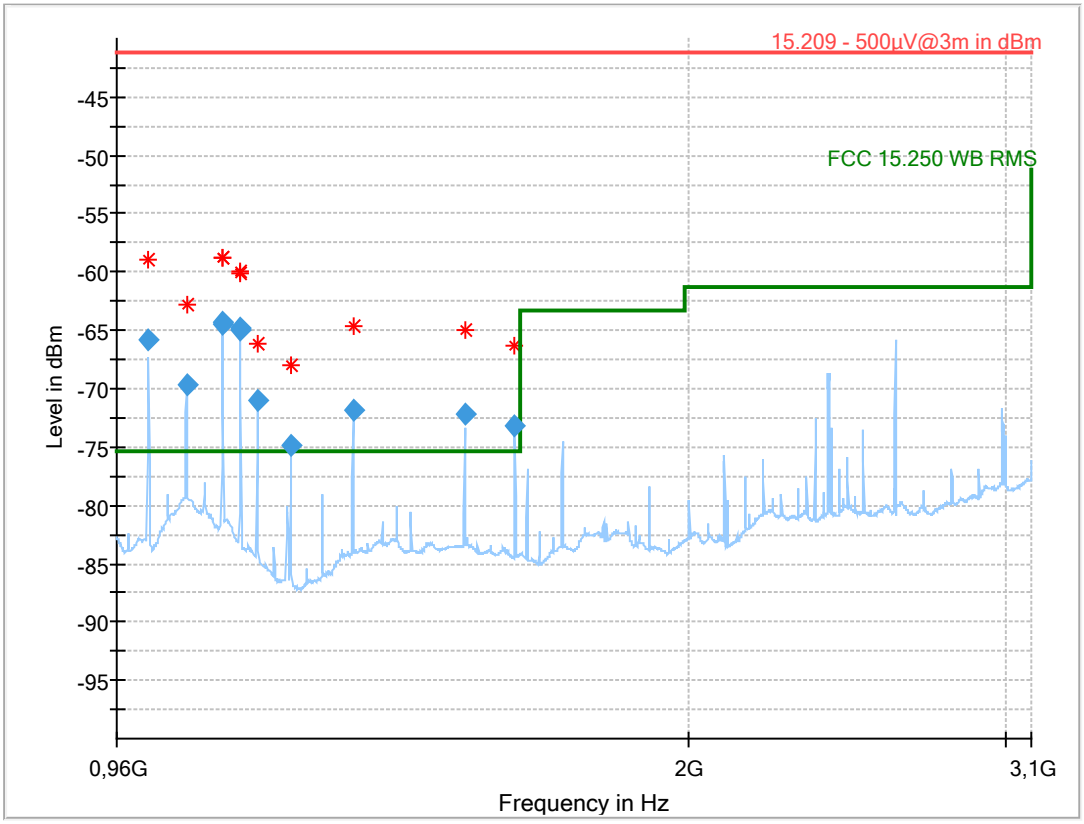
Frequency (MHz)	RMS (dBm)	Limit (dBm)	Margin (dB)	Bandwidth (kHz)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB)
999.927667	-65.57	-75.30	-9.73	1000.000	H	347.0	3.0	-144.2
1050.012000	-68.98	-75.30	-6.32	1000.000	H	349.0	15.0	-144.6
1099.875333	-63.76	-75.30	-11.54	1000.000	H	346.0	12.0	-144.5
1099.963333	-63.75	-75.30	-11.55	1000.000	H	346.0	9.0	-144.5
1125.063000	-64.06	-75.30	-11.24	1000.000	H	354.0	0.0	-142.8
1125.087000	-64.34	-75.30	-10.96	1000.000	H	346.0	8.0	-142.8
1150.017667	-70.70	-75.30	-4.60	1000.000	V	354.0	105.0	-142.7
1199.950000	-74.09	-75.30	-1.21	1000.000	H	17.0	0.0	-144.3
1299.754667	-71.92	-75.30	-3.38	1000.000	H	31.0	2.0	-142.1
1499.841333	-72.09	-75.30	-3.21	1000.000	H	285.0	71.0	-140.8
1599.874000	-72.23	-75.30	-3.07	1000.000	H	272.0	9.0	-141.8

Limit according to FCC 15.209

Frequency (MHz)	RMS (dBm)	Limit (dBm)	Margin (dB)	Bandwidth (kHz)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB)
999.927667	-65.57	-41.23	24.34	1000.000	H	347.0	3.0	-144.2
1050.012000	-68.98	-41.23	27.75	1000.000	H	349.0	15.0	-144.6
1099.875333	-63.76	-41.23	22.53	1000.000	H	346.0	12.0	-144.5
1099.963333	-63.75	-41.23	22.52	1000.000	H	346.0	9.0	-144.5
1125.063000	-64.06	-41.23	22.83	1000.000	H	354.0	0.0	-142.8
1125.087000	-64.34	-41.23	23.11	1000.000	H	346.0	8.0	-142.8
1150.017667	-70.70	-41.23	29.47	1000.000	V	354.0	105.0	-142.7
1199.950000	-74.09	-41.23	32.86	1000.000	H	17.0	0.0	-144.3
1299.754667	-71.92	-41.23	30.69	1000.000	H	31.0	2.0	-142.1
1499.841333	-72.09	-41.23	30.86	1000.000	H	285.0	71.0	-140.8
1599.874000	-72.23	-41.23	31.00	1000.000	H	272.0	9.0	-141.8

Plot 13: 960 MHz – 3.1 GHz, UWB Module off

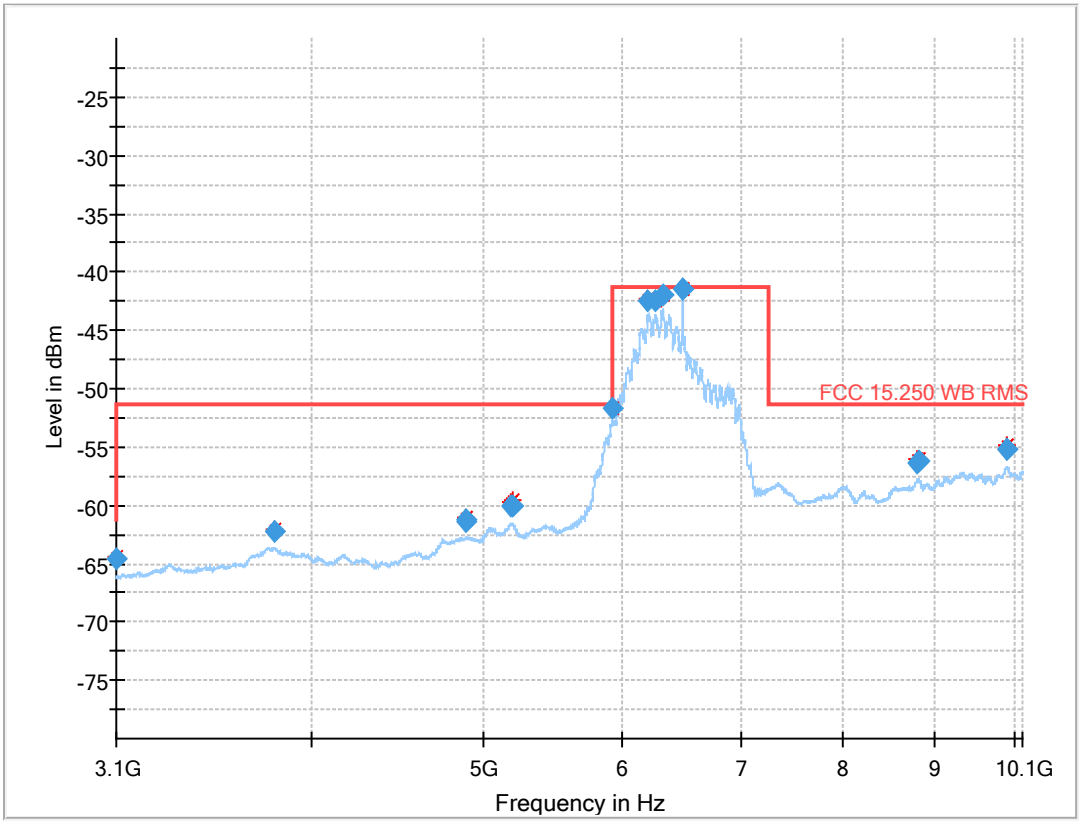
According to §15.250 (d)(5), emissions from digital circuitry used to enable the operation of the transmitter may comply with the limits in §15.209.



Final_Result

Frequency (MHz)	RMS (dBm)	Limit (dBm)	Margin (dB)	Bandwidth (kHz)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB)
999.880333	-65.80	-75.30	-9.50	1000.000	V	356.0	75.0	-144.2
1050.005000	-69.74	-75.30	-5.56	1000.000	V	354.0	105.0	-144.6
1099.944333	-64.30	-75.30	-11.00	1000.000	H	350.0	15.0	-144.5
1099.976333	-64.47	-75.30	-10.83	1000.000	H	350.0	0.0	-144.5
1125.039000	-64.87	-75.30	-10.43	1000.000	H	356.0	1.0	-142.8
1125.054000	-65.04	-75.30	-10.26	1000.000	H	0.0	1.0	-142.8
1150.021667	-70.98	-75.30	-4.32	1000.000	V	-5.0	105.0	-142.7
1199.961000	-74.87	-75.30	-0.43	1000.000	H	16.0	0.0	-144.3
1299.917667	-71.78	-75.30	-3.52	1000.000	H	27.0	15.0	-142.1
1499.813333	-72.25	-75.30	-3.05	1000.000	H	286.0	63.0	-140.8
1599.817000	-73.23	-75.30	-2.07	1000.000	H	251.0	114.0	-141.8

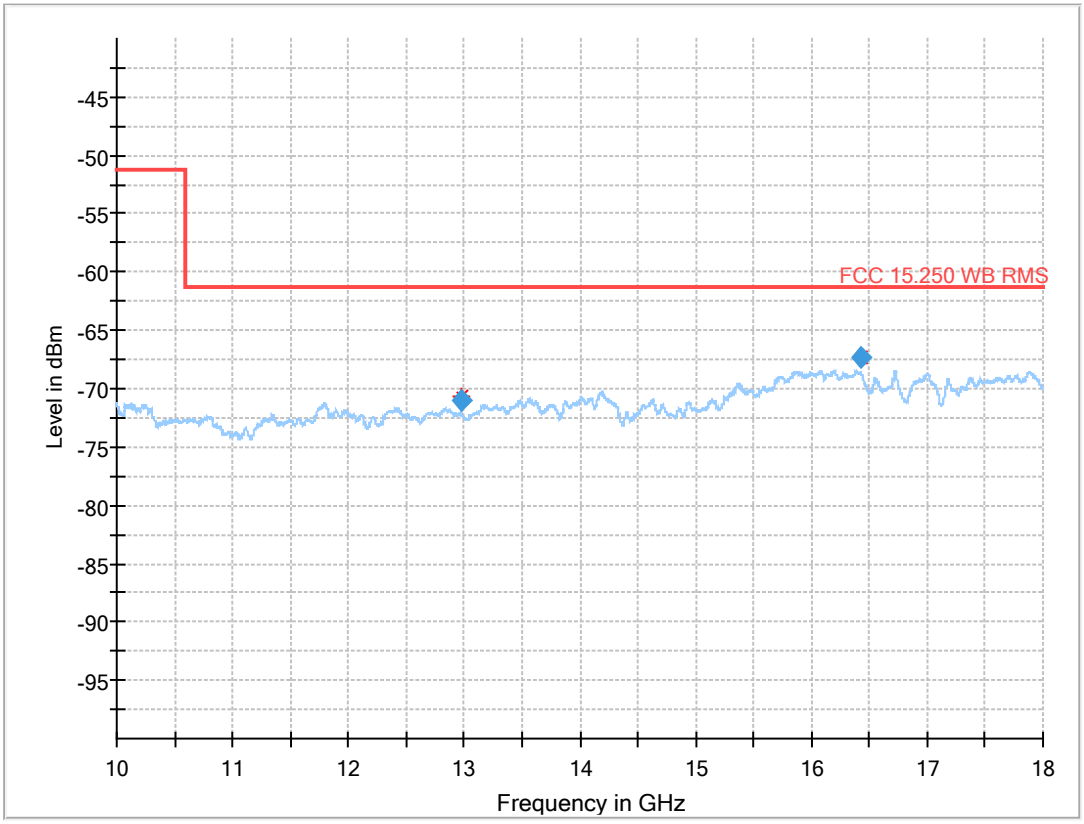
Plot 14: 3.1 GHz – 10 GHz



Final_Result

Frequency (MHz)	RMS (dBm)	Limit (dBm)	Margin (dB)	Bandwidth (kHz)	Pol	Azimuth (deg)	Corr. (dB)
3100.772714	-64.58	-51.30	13.28	1000.000	H	255.0	-121.8
3812.080714	-62.26	-51.30	10.96	1000.000	H	295.0	-119.2
4886.748000	-61.29	-51.30	9.99	1000.000	V	335.0	-118.0
4894.765857	-61.34	-51.30	10.04	1000.000	H	245.0	-118.0
5186.028429	-60.07	-51.30	8.77	1000.000	V	86.0	-116.8
5196.524857	-60.00	-51.30	8.70	1000.000	H	75.0	-116.8
5916.609143	-51.69	-51.30	0.39	1000.000	H	299.0	-116.9
6201.687143	-42.39	-41.30	1.09	1000.000	H	36.0	-117.2
6255.750571	-42.52	-41.30	1.22	1000.000	H	36.0	-116.9
6318.642571	-41.94	-41.30	0.64	1000.000	H	37.0	-116.5
6489.610000	-41.45	-41.30	0.15	1000.000	H	35.0	-116.2
6489.627143	-41.41	-41.30	0.11	1000.000	H	35.0	-116.2
8810.540571	-56.32	-51.30	5.02	1000.000	V	255.0	-113.9
8817.584000	-56.27	-51.30	4.97	1000.000	H	89.0	-114.0
9897.815857	-55.21	-51.30	3.91	1000.000	H	225.0	-112.5
9900.152286	-55.22	-51.30	3.92	1000.000	V	90.0	-112.5

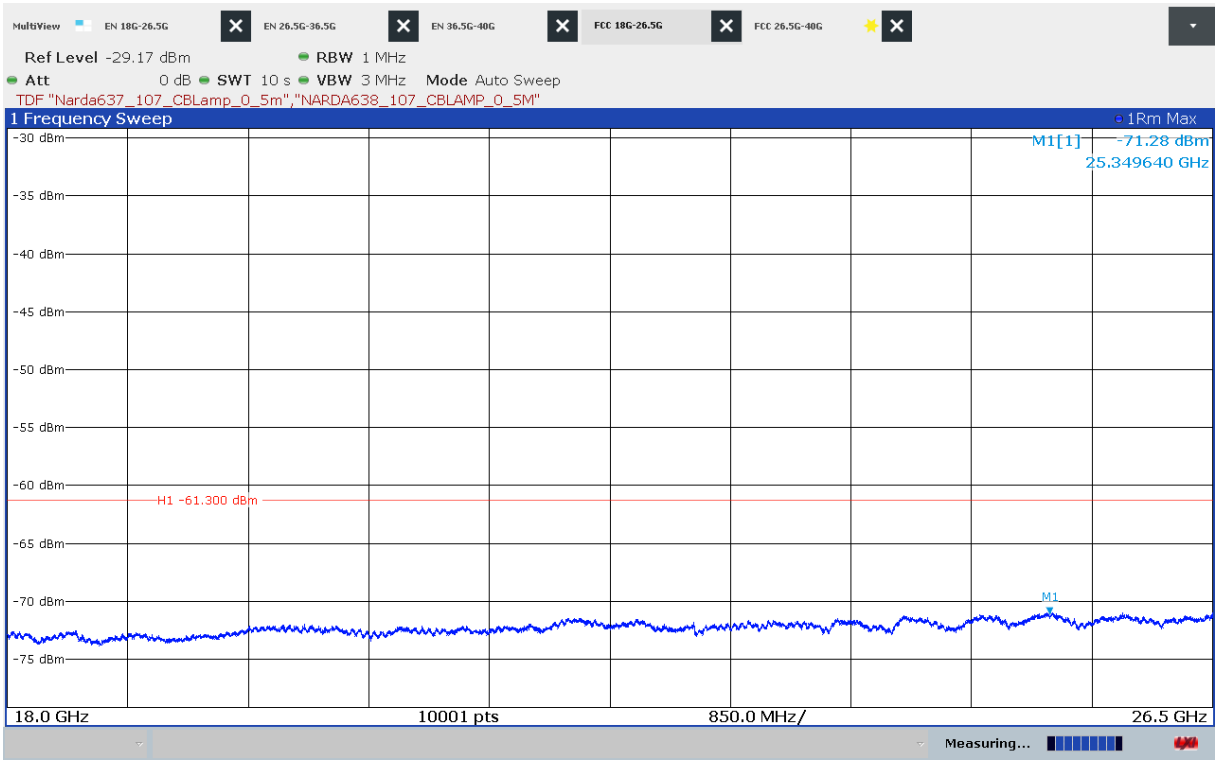
Plot 15: 10 GHz – 18 GHz



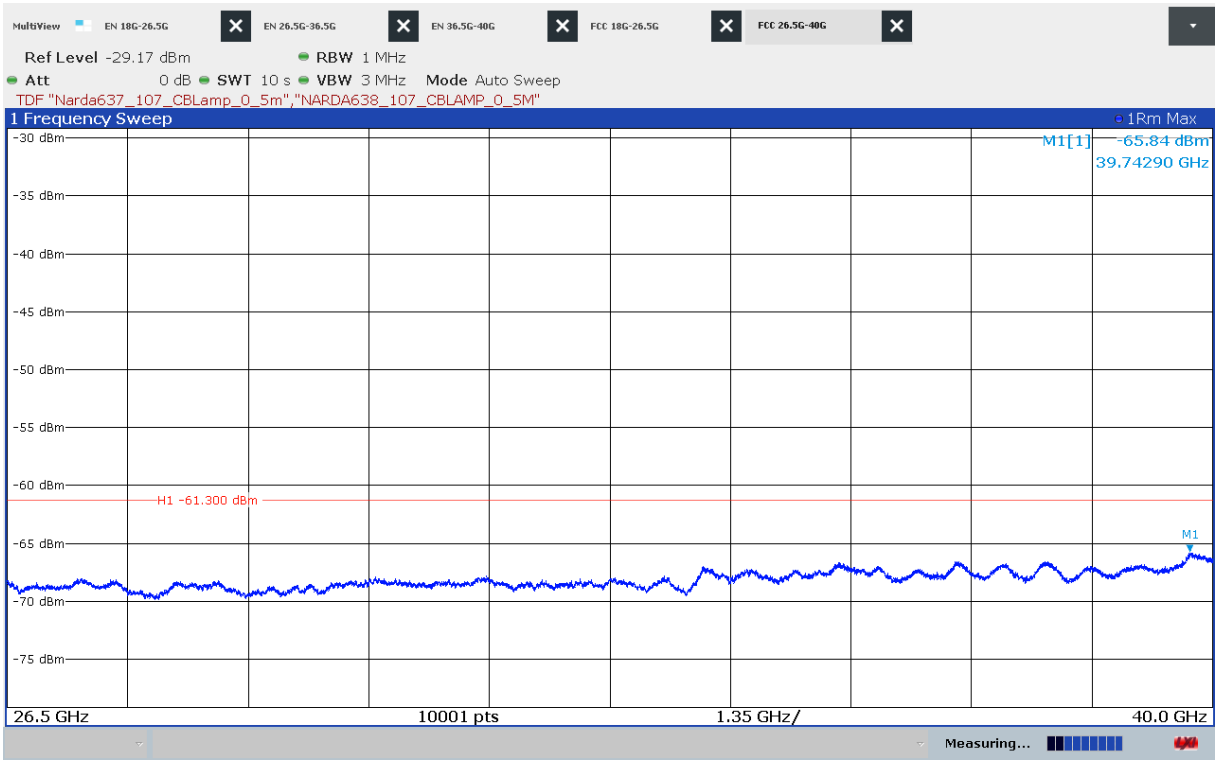
Final_Result

Frequency (MHz)	RMS (dBm)	Limit (dBm)	Margin (dB)	Bandwidth (kHz)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB)
12978.622500	-71.01	-61.30	9.71	1000.000	V	335.0	136.0	-127.7
16426.732500	-67.36	-61.30	6.06	1000.000	V	5.0	15.0	-123.1

Plot 16: 18 GHz – 26.5 GHz



Plot 17: 26.5 GHz – 40 GHz



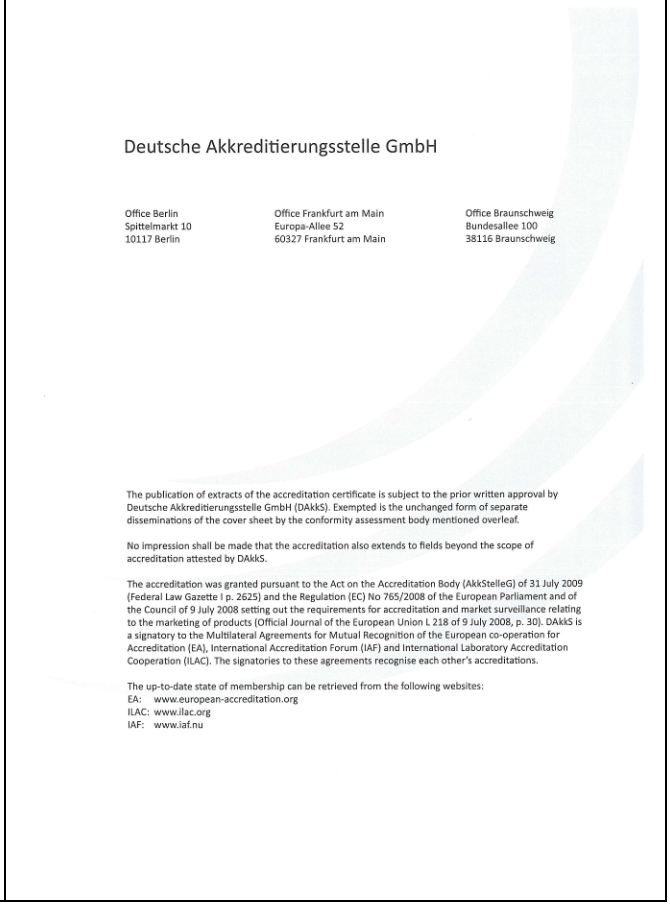
12 Glossary

EUT	Equipment under test
DUT	Device under test
UUT	Unit under test
GUE	GNSS User Equipment
ETSI	European Telecommunications Standards Institute
EN	European Standard
FCC	Federal Communications Commission
FCC ID	Company Identifier at FCC
IC	Industry Canada
PMN	Product marketing name
HMN	Host marketing name
HVIN	Hardware version identification number
FVIN	Firmware version identification number
EMC	Electromagnetic Compatibility
HW	Hardware
SW	Software
Inv. No.	Inventory number
S/N or SN	Serial number
C	Compliant
NC	Not compliant
NA	Not applicable
NP	Not performed
PP	Positive peak
QP	Quasi peak
AVG	Average
OC	Operating channel
OCW	Operating channel bandwidth
OBW	Occupied bandwidth
OOB	Out of band
DFS	Dynamic frequency selection
CAC	Channel availability check
OP	Occupancy period
NOP	Non occupancy period
DC	Duty cycle
PER	Packet error rate
CW	Clean wave
MC	Modulated carrier
WLAN	Wireless local area network
RLAN	Radio local area network
DSSS	Dynamic sequence spread spectrum
OFDM	Orthogonal frequency division multiplexing
FHSS	Frequency hopping spread spectrum
GNSS	Global Navigation Satellite System
C/N_0	Carrier to noise-density ratio, expressed in dB-Hz

13 Document history

Version	Applied changes	Date of release
-/-	Initial release	2021-03-26

14 Accreditation Certificate – D-PL-12076-01-05

first page	last page
	

Note: The current certificate annex is published on the website (link see below) of the Accreditation Body DAkkS or may be received by CTC advanced GmbH on request

https://www.dakks.de/as/ast/d/D-PL-12076-01-05e.pdf

########## END OF TEST REPORT ##########