
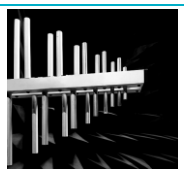
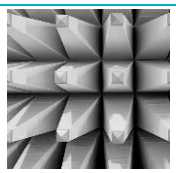

CTC advanced
member of RWTÜV group

Bundesnetzagentur

BNetzA-CAB-02/21-102

PARTIAL TEST REPORT

Test report no.: 1-9100/19-02-20

Testing laboratory

CTC advanced GmbH
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66117 Saarbruecken / Germany
Phone: + 49 681 5 98 - 0
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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
Baarerstrasse 133
6300 Zug / SWITZERLAND
Phone: +41 41 729 87 66
Contact: André Reichmuth
e-mail: andre.reichmuth@hexagon.com

Manufacturer

Hexagon Geosystems Services AG
Baarerstrasse 133
6300 Zug / SWITZERLAND

Test standard/s

FCC - Title 47 CFR Part 15	FCC - 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:	**Next Generation CAS Multi Functional Antenna**
Model name:	**QC1000 Rev. B**
FCC ID:	**ZKSQC1000B**
Frequency:	5925-7250 MHz
Technology tested:	WB
Antenna:	Integrated antenna
Power supply:	9 V to 36 V DC by external power supply
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:

Thomas Vogler
cn=Thomas Vogler, o=CTC advanced GmbH, ou=VOG-211118, email=thomas.vogler@ctcadvanced.com, c=DE
2022.06.21 16:01:30 +02'00'

Thomas Vogler
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Test performed:

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2022.06.21 15:49:40 +02'00'

Frank Heussner
Testing Manager
Radio Communications

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:	2022-04-01
Date of receipt of test item:	2022-04-14
Start of test:*	2022-06-02
End of test:*	2022-06-08
Person(s) present during the test:	-/-

*Date of each measurement, if not shown in the plot, can be requested. Dates are stored in the measurement software.

2.3 Test laboratories sub-contracted

None

3 Test standard/s, references and accreditations

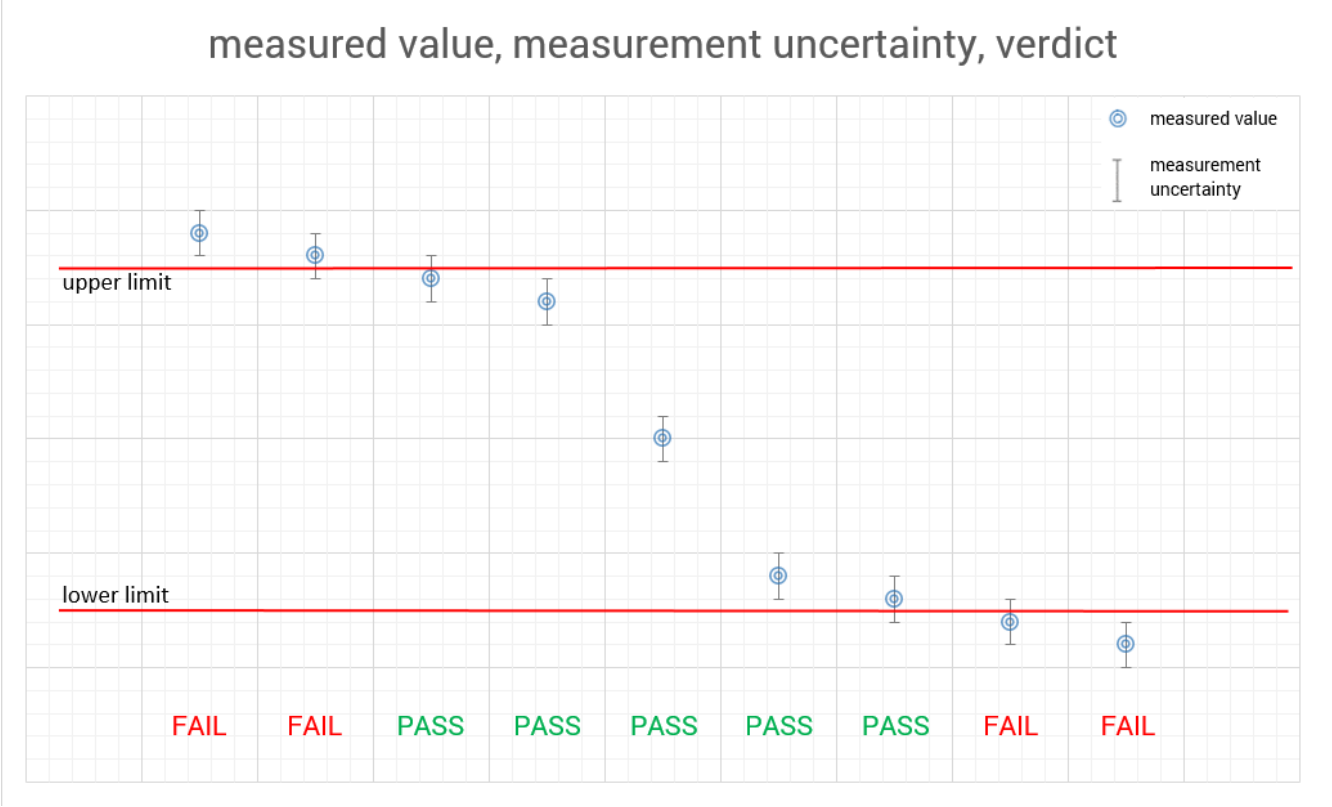
Test standard	Date	Description
FCC - Title 47 CFR Part 15		FCC - Title 47 of the Code of Federal Regulations; Chapter I; Part 15 - Radio frequency devices

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
UWB KDB	v02	393764 D01 UWB FAQ v02: ULTRA-WIDEBAND (UWB) DEVICES FREQUENTLY ASKED QUESTIONS

Accreditation	Description
D-PL-12076-01-05	Telecommunication FCC requirements https://www.dakks.de/files/data/as/pdf/D-PL-12076-01-05e.pdf

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	:		49 %
Barometric pressure	:		990 hPa to 1010 hPa
Power supply	:	V_{nom} V_{max} V_{min}	24 V DC by external power supply 36 V 9 V

6 Test item

6.1 General description

Kind of test item	:	Next Generation CAS Multi Functional Antenna
Model name	:	QC1000 Rev. B
S/N serial number	:	90271201080
Power setting		101 (see chapter 11:Additional comments)
Hardware status	:	B
Software status	:	-/-
Firmware status	:	10.3.3
Frequency band	:	5925-7250 MHz
Type of radio transmission Use of frequency spectrum	: :	Pulse
Type of modulation	:	BPSK / BPM
Number of channels	:	1
Antenna	:	Integrated antenna
Power supply	:	9 V to 36 V DC by external power supply
Temperature range	:	-30°C to +70°C

6.2 Additional information

The content of the following annexes is defined in the QA. It may be that not all of the listed annexes are necessary for this report, thus some values in between may be missing.

Test setup and EUT photos are included in test report: 1-9100/19-02-01_AnnexA
1-9100/19-02-01_AnnexB
1-9100/19-02-01_AnnexD

7 Description of the test setup

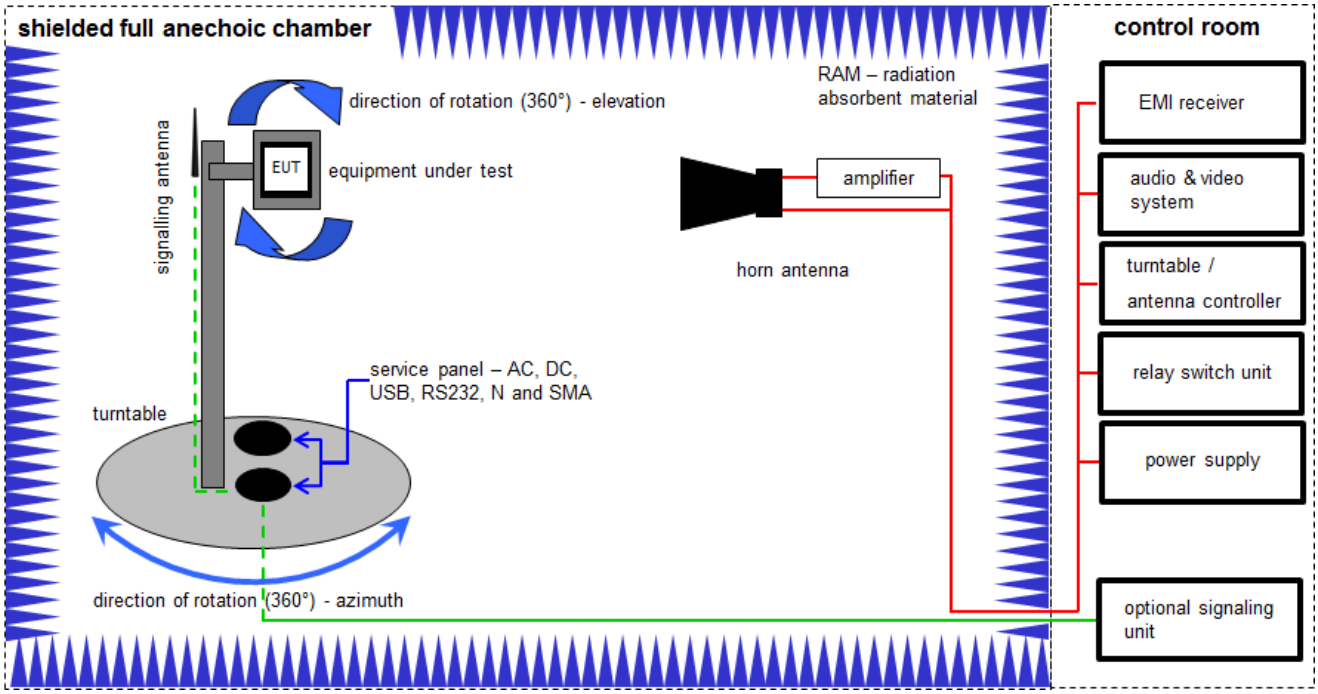
Typically, the calibrations of the test apparatus are commissioned to and performed by an accredited calibration laboratory. The calibration intervals are determined in accordance with the DIN EN ISO/IEC 17025. In addition to the external calibrations, the laboratory executes comparison measurements 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 fully anechoic chamber



Measurement distance: 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] = -65.0 [dBm] + 50 [dB] - 20 [dBi] + 5 [dB] = -30 [dBm] (1 µW)

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,D	CTIA-Chamber	CTIA-Chamber AMS 8500	ETS-Lindgren Finnland		300003327	ne	-/-	-/-
3	A,B,C,D	CTIA-Chamber - Positioning Equipment	CTIA-Chamber - Positioning Equipment	EMCO/2		300003328	ne	-/-	-/-
4	A,B,C,D	Signal- and Spectrum Analyzer	FSW26	R&S	101371	300005697	k	09.12.2021	08.12.2022
5	A,B,C,D	PC	Precision M4800	DELL	19414201934	300004957	-/-	-/-	-/-
6	A,B,C,D	EMC Software	EMC32-MEB	R&S	n.a.	300005477	-/-	-/-	-/-
7	A,B,C,D	RF Amplifier	AMF-7D-01001800-22-10P	NARDA-MITEQ Inc	2089864	300005633	ev	-/-	-/-
8	B, C,D	Lowpass Filter (Chebyshev)	WLKX14-4700-4900-21000-30SS	Wainwright Instruments GmbH	1	300005655	ev	-/-	-/-
9	A,D	High Pass Filter (Chebyshev)	WHNX6-8374-10600-26500-40CC	Wainwright Instruments GmbH	1	300005656	ev	-/-	-/-
10	A,B,D	Double-Ridged Waveguide Horn Antenna 1-18.0GHz	3115	EMCO	9709-5290	300000212	ev	-/-	-/-
11	D	Double-Ridged Waveguide Horn Antenna 1-18.0GHz	3115	EMCO	9709-5289	300000213	vIKI!	14.07.2020	13.07.2022
12	D	MXG Microwave Analog Signal Generator	N5183A	Agilent Technologies	MY47420220	300003813	vIKI!	12.12.2019	11.12.2022

Equipment table (Frequency stability):

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	A	Double-Ridged Waveguide Horn Antenna 1-18.0GHz	3115	EMCO	9709-5289	300000213	vIKI!	14.07.2020	13.07.2022
2	A	Temperature Test Chamber	T-40/50	CTS GmbH	064023	300003540	ev	09.05.2022	08.05.2024
3	A	Signal- and Spectrum Analyzer 3 Hz - 50 GHz	PXA N9030A	Agilent Technologies	US51350267	300004338	k	01.04.2022	30.04.2023

8 Sequence of testing

8.1 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.

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 18 GHz)	± 1 dB
Radiated unwanted emissions in the spurious domain (up to 18 GHz)	± 3 dB
Conducted unwanted emissions in the spurious domain (18 to 40 GHz)	± 4 dB
Radiated unwanted emissions in the spurious domain (18 to 40 GHz)	± 4 dB
Conducted unwanted emissions in the spurious domain (40 to 50 GHz)	± 4.5 dB
Radiated unwanted emissions in the spurious domain (40 to 50 GHz)	± 4.5 dB
Conducted unwanted emissions in the spurious domain (above 50 GHz)	± 5 dB
Radiated unwanted emissions in the spurious domain (above 50 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 §15.207, §15.209, §15.250	see table	2022-06-21	-/-

Test specification clause	Test case	Temperature conditions	Power source	Pass	Fail	NA	NP	Remark
§15.250 (a), (b), (e)(4)	10 dB Bandwidth	Nominal	Nominal	☒	☐	☐	☐	complies
§15.209 §15.250 (d), (e)(1-3)	TX Radiated Emissions	Nominal	Nominal	☐	☐	☐	☐	Only partially performed, see corresponding chapter12.2 for details
§15.250(a), (e)(4) § 2.1055	Frequency Stability	Nominal Extreme	Nominal Extreme	☒	☐	☐	☐	complies
§15.207	Conducted Emissions < 30 MHz	Nominal	Nominal	☐	☐	☐	☒	-/-

Note: NA = Not Applicable; NP = Not Performed

11 Additional comments

Reference documents: None

Special test descriptions: None

Configuration descriptions: None

Test mode: ☐ No test mode available.

☒ Special test mode/software is used.

Test device (EUT):

- EUT 1: Only one device is available for the tests see chapter 6.1 for more information. The EUT can switch between the different modes by software.

Description of test modes as declared by customer:

- UWB test mode (Test mode 1):
  - Cycle time 1 ms
  - Remaining transmission parameters as in case of normal operation mode
  - Parameters (e.g. payload) selected so that the maximum average and peak output power is obtained
- Test mode for emissions of digital circuitry (Test mode 2):
  - UWB emissions turned off
  - Using this test mode, it can be clearly demonstrated that an emission from the UWB transmitter is due solely to emissions from digital circuitry contained within the transmitter, and that the emission is not intended to be radiated from the transmitter's antenna
- Test modes are configured by software commands (see below)

Details on test mode settings:
According to the customer's instructions, the following steps and commands were used to configure the test modes:

- UWB test mode 1:
  1) Power cycling
  2) Open serial interface (Bbau = 115200 / Data = 8 bits / No Parity / No FlowControl)
  3) Send "LETSBREAKTHINGS"
  4) Send "$log,setlevel,1,threat,4"
  5) Send "$uwb,init,1,7,101" → Power setting: 101
  6) Send "$uwb,cf,1000,200"

- Test mode 2 for emissions of digital circuitry (UWB turned off):
  1) Send „$uwb,off“

12 Measurement results

12.1 10 dB - Bandwidth

Description:

Measurement of the -10 dB bandwidth of the wanted signal.

§15.250(a)
The –10 dB bandwidth of a device operating under the provisions of this section must be contained within the 5925-7250 MHz band under all conditions of operation including the effects from stepped frequency, frequency hopping or other modulation techniques that may be employed as well as the frequency stability of the transmitter over expected variations in temperature and supply voltage.

§15.250(b)
The –10 dB bandwidth of the fundamental emission shall be at least 50 MHz. For transmitters that employ frequency hopping, stepped frequency or similar modulation types, measurement of the –10 dB minimum bandwidth specified in this paragraph shall be made with the frequency hop or step function disabled and with the transmitter operating continuously at a fundamental frequency following the provisions of § 15.31(m).

§15.250(e)(4)
The –10 dB bandwidth is based on measurement using a peak detector, a 1 MHz resolution bandwidth, and a video bandwidth greater than or equal to the resolution bandwidth.

Measurement:

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

Limits:

§15.250(a),

Lower -10 dB point > 5925 MHz Upper -10 dB point < 7250 MHz

§15.250(b)

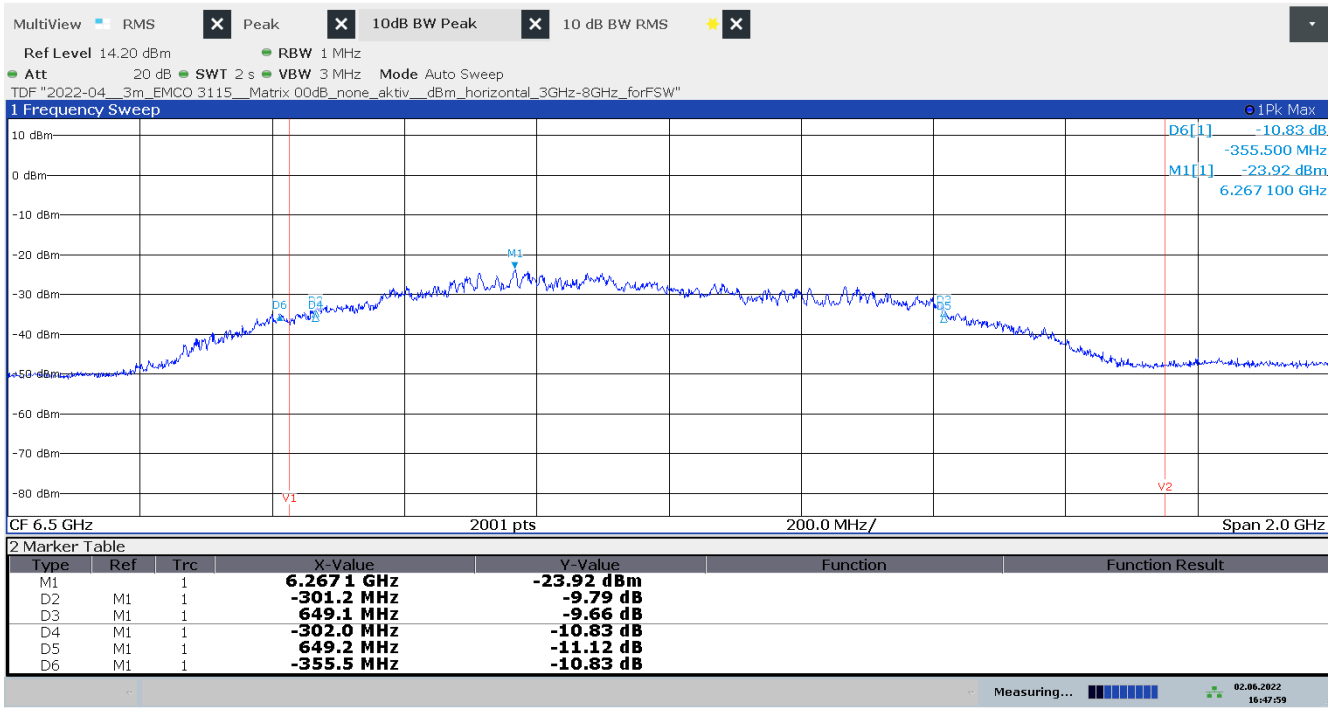
-10 dB bandwidth > 50 MHz

Results:

Lower -10 dB point [MHz]	Upper -10 dB point [MHz]	- 10 dB bandwidth [MHz]	Plot
5965	6916	951	1

Verdict: Compliant

Plot 1: -10 dB bandwidth



12.2 TX Radiated Emissions

Description:

Measurement of the radiated emissions in transmit mode.

Measurement:

§15.250(d)(4), §15.209,

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

§15.250(d)(1),

Measurement parameter	
Detector:	RMS
Sweep time:	1 ms/pt
Resolution bandwidth:	1 MHz
Video bandwidth:	3 MHz
Trace-Mode:	Max Hold

§15.250(d)(2),

Measurement parameter	
Detector:	RMS
Sweep time:	1 ms/pt
Resolution bandwidth:	30 kHz / 1 kHz
Video bandwidth:	300 kHz / 3 kHz
Trace-Mode:	Max Hold

§15.250(d)(3),

Measurement parameter	
Detector:	Pos-Peak
Resolution bandwidth:	50 MHz
Video bandwidth:	80 MHz
Span:	Zero span
Trace-Mode:	Max Hold

Limits:

Radiated emissions at or below 960 MHz (§15.250(d)(4), §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

§15.250(d)
Emissions from a transmitter operating under this section shall not exceed the following equivalent isotropically radiated power (EIRP) density levels:

§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.

Further provisions of CFR 47 §15.250:

§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. Emissions 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.

§15.250(e)(1)
All emissions at and below 960 MHz are based on measurements employing a CISPR quasi-peak detector. Unless otherwise specified, all RMS average emission levels specified in this section are to be measured utilizing a 1 MHz resolution bandwidth with a one millisecond dwell over each 1 MHz segment. The frequency span of the analyzer should equal the number of sampling bins times 1 MHz and the sweep rate of the analyzer should equal the number of sampling bins times one millisecond. The provision in § 15.35(c) that allows emissions to be averaged over a 100 millisecond period does not apply to devices operating under this section. The video bandwidth of the measurement instrument shall not be less than the resolution bandwidth and trace averaging shall not be employed. The RMS average emission measurement is to be repeated over multiple sweeps with the analyzer set for maximum hold until the amplitude stabilizes.

§15.250(e)(2)
The peak emission measurement is to be repeated over multiple sweeps with the analyzer set for maximum hold until the amplitude stabilizes.

§15.250(e)(3)
For transmitters that employ frequency hopping, stepped frequency or similar modulation types, the peak emission level measurement, the measurement of the RMS average emission levels, and the measurement to determine the frequency at which the highest level emission occurs shall be made with the frequency hop or step function active. Gated signals may be measured with the gating active. The provisions of § 15.31(c) continue to apply to transmitters that employ swept frequency modulation.

Results:

Fundamental emission:

Frequency [MHz]	Max RMS power [dBm/MHz]	Limit [dBm/MHz]	Margin [dB]	Plot
6489.6	-41.37	-41.3	0.07	2

Frequency [MHz]	Max Peak power [dBm/50 MHz]	Limit [dBm/50 MHz]	Margin [dB]	Plot
6489.6	-3.62	0	3.62	3

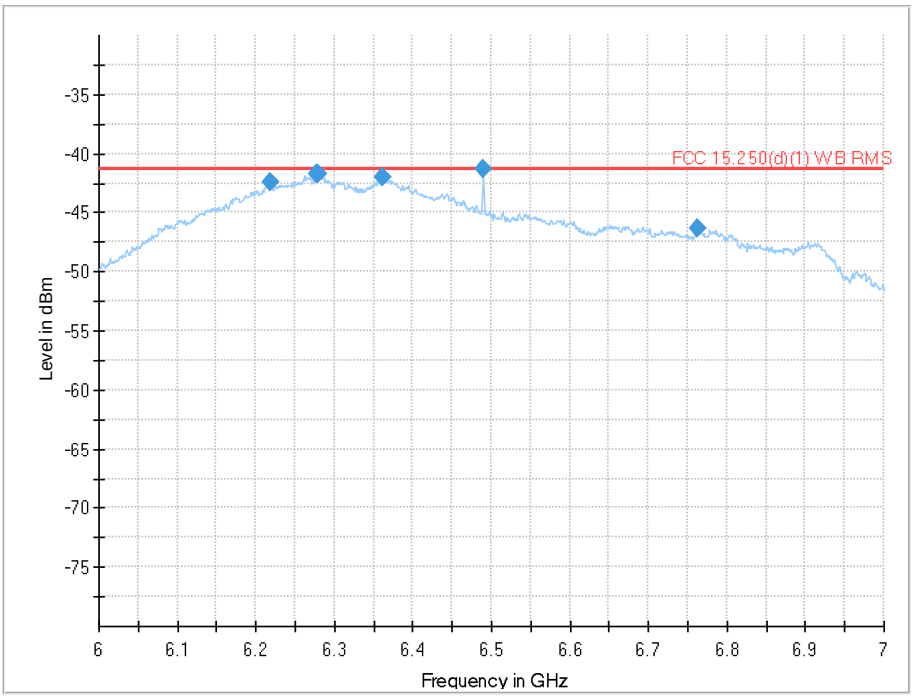
Emissions outside the band:

Frequency f [MHz]	Detector	Measured level [dBµV/m]	Limit [dBµV/m]	Margin [dB]
No critical peaks found. For details, please refer to plots.				
-/-	-/-	-/-	-/-	-/-
-/-	-/-	-/-	-/-	-/-
-/-	-/-	-/-	-/-	-/-

Frequency f [MHz]	Detector	Measured level [dBm]	Limit [dBm]	Margin [dB]
No critical peaks found. For details, please refer to plots.				
-/-	-/-	-/-	-/-	-/-
-/-	-/-	-/-	-/-	-/-
-/-	-/-	-/-	-/-	-/-

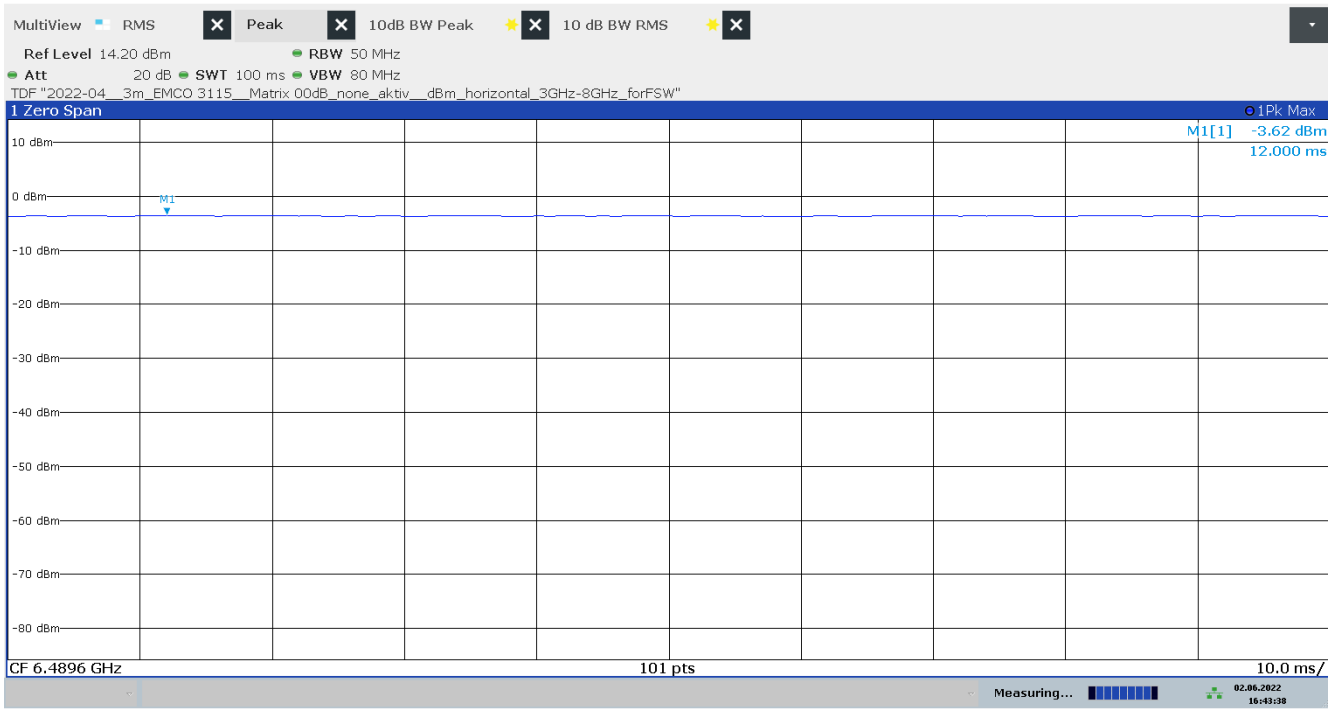
Verdict: Compliant

Plot 2: Fundamental emission: RMS (Test mode 1, UWB turned on)

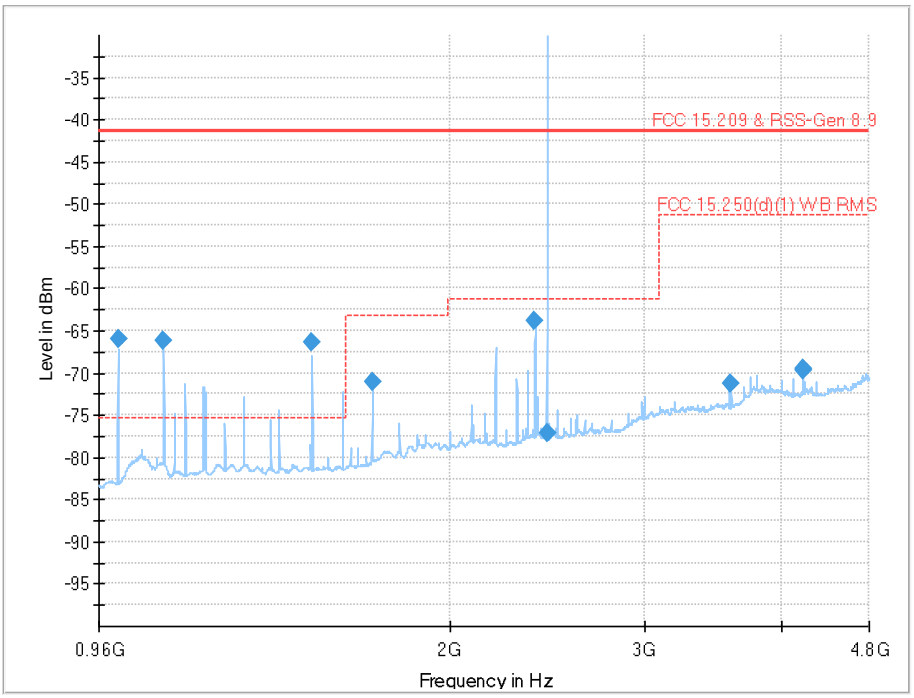


Frequency (MHz)	RMS (dBm)	Limit (dBm)	Margin (dB)	Bandwidth (kHz)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB)
6217.452000	-42.42	-41.30	1.12	1000.000	H	38.0	85.0	-117.6
6278.290000	-41.68	-41.30	0.38	1000.000	H	44.0	88.0	-117.2
6278.391000	-41.77	-41.30	0.47	1000.000	H	42.0	89.0	-117.2
6361.890000	-42.01	-41.30	0.71	1000.000	H	40.0	76.0	-117.4
6489.607000	-41.37	-41.30	0.07	1000.000	H	39.0	95.0	-117.1
6761.649000	-46.38	-41.30	5.08	1000.000	H	35.0	88.0	-116.5

Plot 3: Fundamental emission: Max Peak (Test mode 1, UWB turned on)



Plot 4: 960 MHz to 4.8 GHz (Test mode 1, UWB turned on)



Frequency (MHz)	RMS (dBm)	Limit (dBm)	Margin (dB)	Bandwidth (kHz)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB)
999.835200	-65.99	-41.30	24.69	1000.000	H	250.0	58.0	-141.6
1099.962000	-66.22	-41.30	24.92	1000.000	H	352.0	89.0	-139.3
1499.800800	-66.46	-41.30	25.16	1000.000	H	279.0	150.0	-139.1
1699.719000	-71.01	-41.30	29.71	1000.000	V	31.0	45.0	-137.9
2388.189600	-63.91	-41.30	22.61	1000.000	H	262.0	154.0	-134.7
2449.866600	-77.21	-41.30	35.91	1000.000	V	314.0	151.0	-134.8
3599.361000	-71.18	-41.30	29.88	1000.000	H	39.0	148.0	-130.4
4181.249400	-69.58	-41.30	28.28	1000.000	H	338.0	157.0	-128.4
4184.278200	-69.60	-41.30	28.30	1000.000	H	337.0	150.0	-128.6

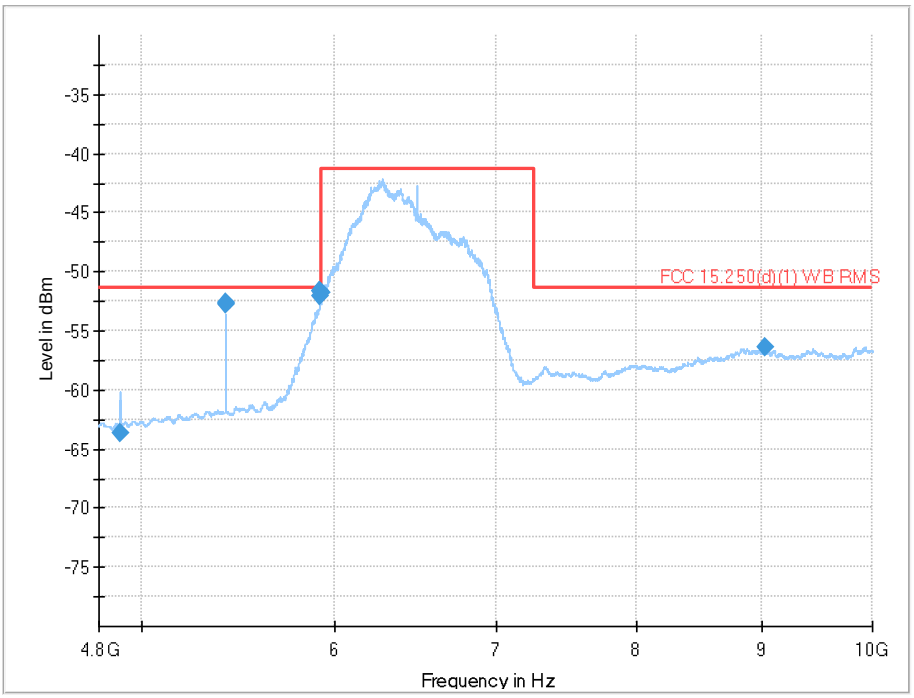
Note:

- As stated by the customer and as shown on plot 4, 6 and 7, the emissions within the frequency range discussed here are presumably due to the digital circuit of the device. According to §15.250 (d)(5), emissions from digital circuitry used to enable the operation of the transmitter shall comply with the limits in §15.209, rather than the limits specified in § 15.250 (d).

- The conversion of the limit mentioned in §15.209 is done according to ANSI C63.10-2013 9.6. Applicable limit above 960 MHz according to §15.209 : -41.3 dBm.

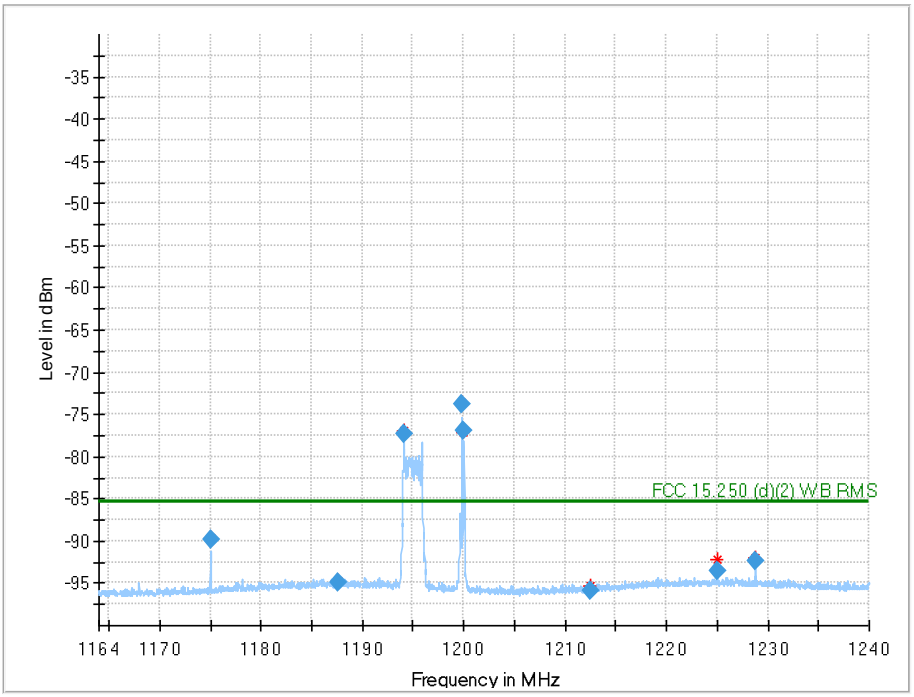
- The observed emission in the frequency range around 2450 MHz is due to the utilization of additional radio technology in the DUT. It is tested separately (see corresponding tests reports). Hence, this emission is not relevant for the measurements and limits shown here.

Plot 5: 4.8 GHz to 10.5 GHz (Test mode 1, UWB turned on)



Frequency (MHz)	RMS (dBm)	Limit (dBm)	Margin (dB)	Bandwidth (kHz)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB)
3099.237571	-66.13	-61.30	4.83	1000.000	H	327.0	14.0	-122.3
3838.111714	-63.59	-51.30	12.29	1000.000	H	165.0	20.0	-119.8
4900.657000	-63.68	-51.30	12.38	1000.000	V	323.0	68.0	-119.8
5413.146143	-52.81	-51.30	1.51	1000.000	H	258.0	53.0	-118.2
5413.263143	-52.64	-51.30	1.34	1000.000	H	260.0	54.0	-118.2
5921.513857	-52.10	-51.30	0.80	1000.000	H	36.0	80.0	-117.9
5924.498286	-51.71	-51.30	0.41	1000.000	H	39.0	79.0	-117.7
5924.533571	-51.66	-51.30	0.36	1000.000	H	38.0	82.0	-117.7
5924.552143	-51.78	-51.30	0.48	1000.000	H	37.0	81.0	-117.7
9029.321571	-56.46	-51.30	5.16	1000.000	H	196.0	81.0	-111.9

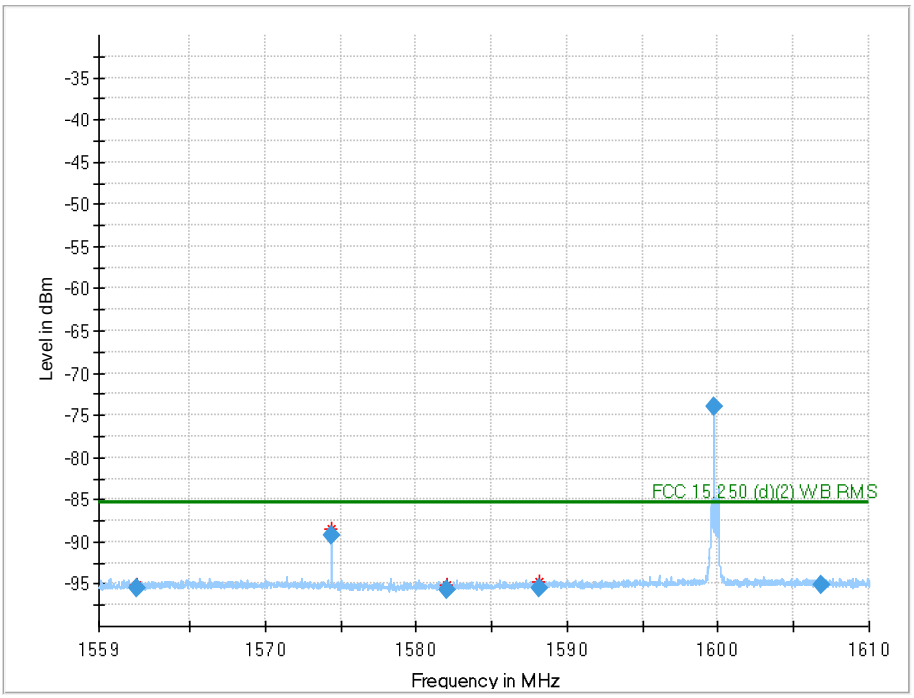
Plot6: 1164 MHz to 1240 MHz §15.250 (d)(2), (Test mode 1, UWB turned on)



Frequency (MHz)	RMS (dBm)	Limit (dBm)	Margin (dB)	Bandwidth (kHz)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB)
1175.022280	-89.75	-85.30	4.45	30.000	H	3.0	125.0	-139.7
1187.587523	-94.94	-85.30	9.64	30.000	H	285.0	164.0	-138.0
1194.087437	-77.25	-85.30	-8.05	30.000	H	-2.0	61.0	-138.3
1199.803830	-73.79	-85.30	-11.51	30.000	H	6.0	57.0	-139.2
1200.022260	-76.91	-85.30	-8.39	30.000	H	280.0	148.0	-139.3
1212.488133	-95.99	-85.30	10.69	30.000	H	291.0	121.0	-139.1
1225.026950	-93.45	-85.30	8.15	30.000	H	277.0	163.0	-137.8
1228.799307	-92.37	-85.30	7.07	30.000	V	313.0	25.0	-138.4

Note: Limit of §15.250 (d)(2) not applicable. See note on page 22 and detailed verification on page 26 to 29. Applicable limit above 960 MHz according to §15.209: -41.3 dBm.

Plot7: 1559 MHz to 1610 MHz §15.250 (d)(2), (Test mode 1, UWB turned on)



Frequency (MHz)	RMS (dBm)	Limit (dBm)	Margin (dB)	Bandwidth (kHz)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB)
1561.513040	-95.58	-85.30	10.28	30.000	H	168.0	54.0	-138.2
1574.404670	-89.19	-85.30	3.89	30.000	H	90.0	45.0	-138.6
1582.093720	-95.73	-85.30	10.43	30.000	H	320.0	54.0	-138.7
1588.166370	-95.45	-85.30	10.15	30.000	H	8.0	81.0	-138.4
1599.736310	-73.92	-85.30	-11.38	30.000	H	304.0	81.0	-137.8
1606.829570	-95.19	-85.30	9.89	30.000	V	147.0	54.0	-138.4

Note: Limit of §15.250 (d)(2) not applicable. See note on page 22 and detailed verification on page 26 to 29. Applicable limit above 960 MHz according to §15.209: -41.3 dBm.

Verification of the emissions from digital circuitry:

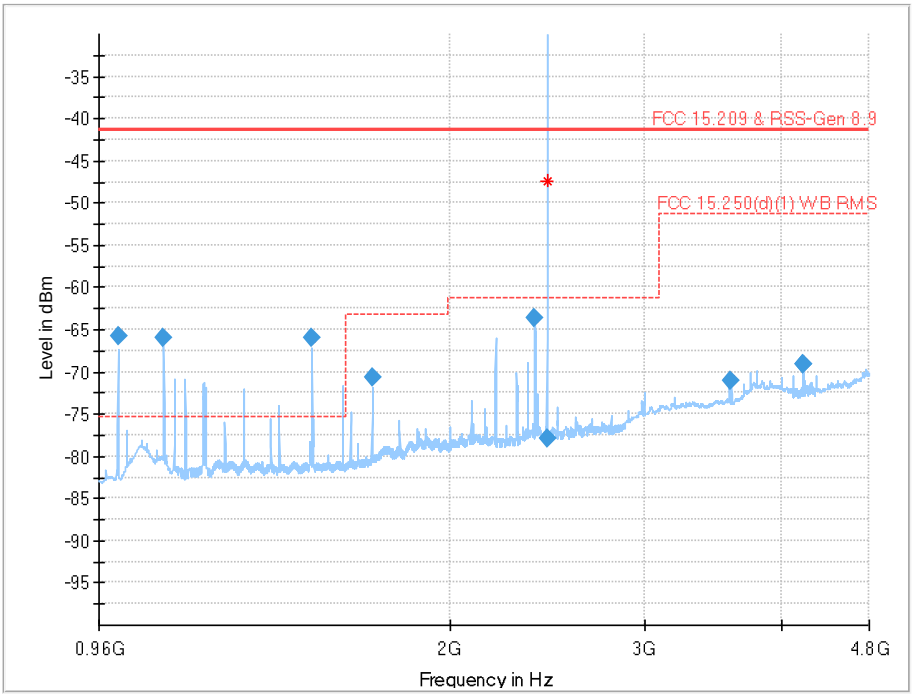
Description:
According to §15.250 (d)(5), emissions from digital circuitry used to enable the operation of the transmitter shall comply with the limits in §15.209, rather than the limits specified in § 15.250 (d).

The conversion of the limit mentioned in §15.209 is done according to ANSI C63.10-2013 9.6.
Applicable limit above 960 MHz according to §15.209: -41.3 dBm.

To verify the emissions of the digital circuitry, the EUT is switched by software to test mode 2. In these mode the WB transmission is off. Detailed information can be found in chapter 11.

Results:
The results shown in plot 8 to 10 indicate that the emissions observed in this frequency ranges are due to the digital circuitry of the device. Hence, according to §15.250 (d)(5) the limits mentioned in §15.209 are considered applicable.

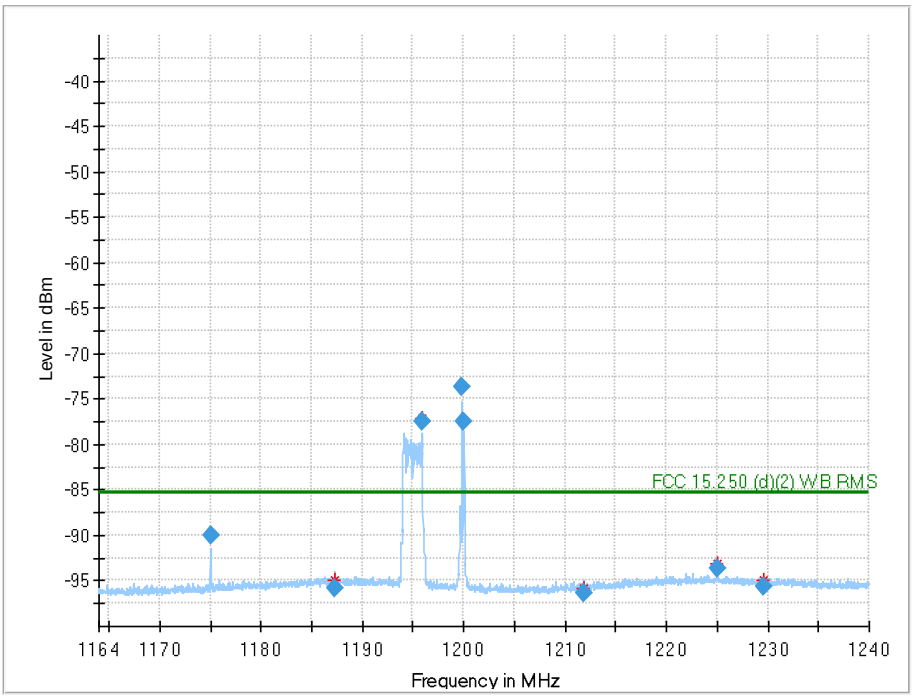
Plot 8: 960 MHz to 4.8 GHz (Test mode 2, UWB turned off)



Applicable limit above 960 MHz according to §15.209: -41.3 dBm.

Frequency (MHz)	RMS (dBm)	Limit (dBm)	Margin (dB)	Bandwidth (kHz)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB)
999.855600	-65.69	-41.30	24.39	1000.000	H	250.0	60.0	-141.6
1099.942200	-66.03	-41.30	24.73	1000.000	V	-6.0	180.0	-139.5
1499.830200	-65.95	-41.30	24.65	1000.000	H	278.0	152.0	-139.1
1699.698000	-70.71	-41.30	29.41	1000.000	V	29.0	46.0	-137.9
2388.192600	-63.57	-41.30	22.27	1000.000	H	263.0	154.0	-134.7
2448.769200	-77.85	-41.30	36.55	1000.000	V	45.0	98.0	-134.7
3599.365800	-70.97	-41.30	29.67	1000.000	H	35.0	142.0	-130.4
4182.279000	-69.20	-41.30	27.90	1000.000	H	314.0	156.0	-128.5
4182.831000	-69.19	-41.30	27.89	1000.000	H	318.0	153.0	-128.5

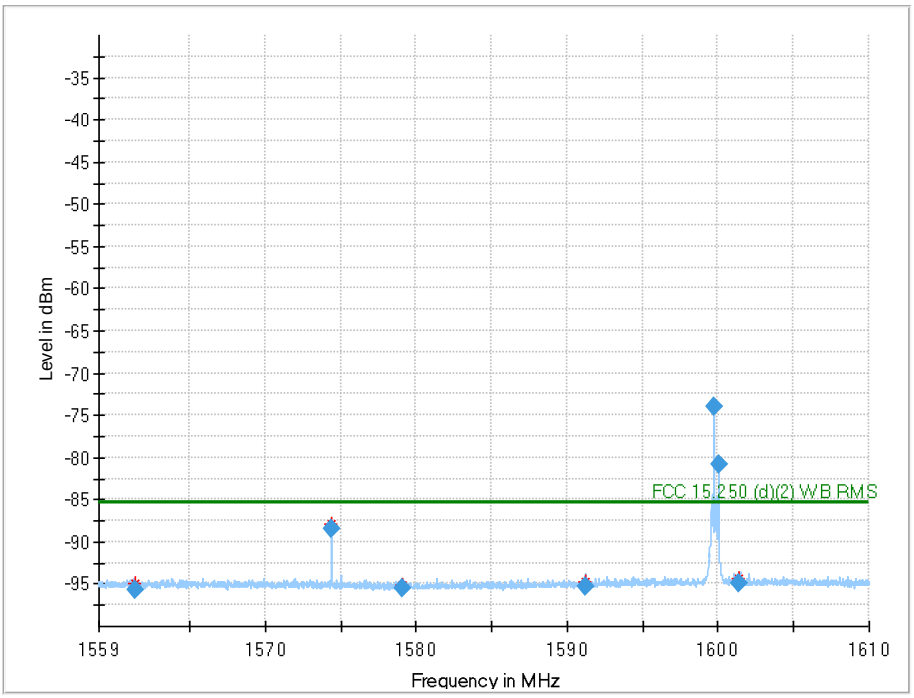
Plot 9: 1164 MHz to 1240 MHz §15.250 (d)(2) (Test mode 2, UWB turned off)



Applicable limit above 960 MHz according to §15.209: -41.3 dBm.
Reference plot for this frequency range is plot 8.

Frequency (MHz)	RMS (dBm)	Limit (dBm)	Margin (dB)	Bandwidth (kHz)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB)
1175.023990	-89.99	-85.30	4.69	30.000	H	7.0	138.0	-139.7
1187.258387	-95.78	-85.30	10.48	30.000	H	160.0	27.0	-138.0
1195.888697	-77.45	-85.30	-7.85	30.000	H	-7.0	65.0	-138.6
1199.805330	-73.67	-85.30	-11.63	30.000	H	2.0	65.0	-139.2
1200.023040	-77.43	-85.30	-7.87	30.000	H	10.0	121.0	-139.3
1211.835183	-96.32	-85.30	11.02	30.000	V	357.0	34.0	-139.3
1225.031360	-93.66	-85.30	8.36	30.000	H	16.0	105.0	-137.8
1229.575430	-95.66	-85.30	10.36	30.000	H	322.0	121.0	-138.3

Plot 10: 1559 MHz to 1610 MHz §15.250 (d)(2) (Test mode 2, UWB turned off)



Applicable limit above 960 MHz according to §15.209: -41.3 dBm.
Reference plot for this frequency range is plot 8.

Frequency (MHz)	RMS (dBm)	Limit (dBm)	Margin (dB)	Bandwidth (kHz)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB)
1561.367810	-95.69	-85.30	10.39	30.000	H	36.0	55.0	-138.2
1574.398520	-88.40	-85.30	3.10	30.000	H	298.0	60.0	-138.6
1579.128610	-95.57	-85.30	10.27	30.000	H	45.0	165.0	-138.8
1591.228580	-95.33	-85.30	10.03	30.000	H	293.0	84.0	-138.2
1599.737270	-74.08	-85.30	-11.22	30.000	H	306.0	80.0	-137.8
1600.030980	-80.86	-85.30	-4.44	30.000	V	30.0	41.0	-138.1
1601.411030	-94.85	-85.30	9.55	30.000	H	124.0	96.0	-137.9

12.3 Frequency Stability

Description:

§15.250(a)
The −10 dB bandwidth of a device operating under the provisions of this section must be contained within the 5925-7250 MHz band under all conditions of operation including the effects from stepped frequency, frequency hopping or other modulation techniques that may be employed as well as the frequency stability of the transmitter over expected variations in temperature and supply voltage.

Additional information: see chapter 12.1.

Measurement:

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

Limits:

§15.250(a),

Lower -10 dB point > 5925 MHz Upper -10 dB point < 7250 MHz

§15.250(b)

-10 dB bandwidth > 50 MHz

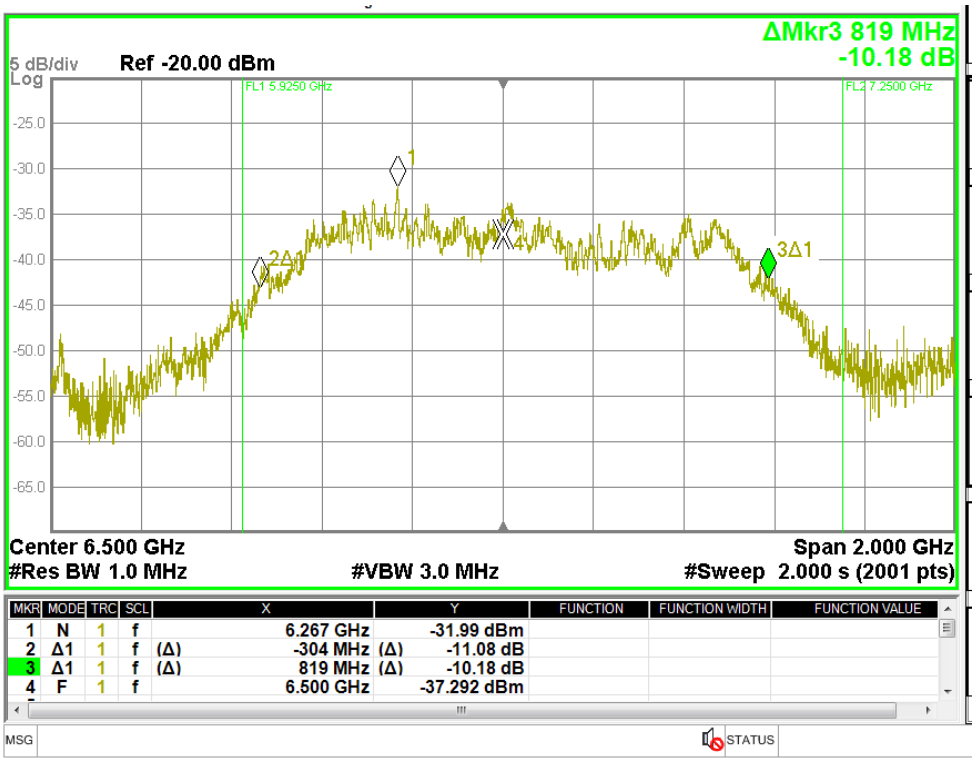
Results:

Test Condition	Lower -10 dB point [MHz]	Upper -10 dB point [MHz]	- 10 dB bandwidth [MHz]	Plot
T_{min} / V_{nom}	5963.00	7086.00	1123.00	11
-20 °C / V_{nom}	5960.00	7095.00	1135.00	12
-10 °C / V_{nom}	5968.00	7089.00	1121.00	13
0 °C / V_{nom}	5971.00	7081.00	1110.00	14
+10 °C / V_{nom}	5962.00	7042.00	1080.00	15
+20 °C / V_{min}	5965.00	7041.00	1076.00	16
+20 °C / V_{nom}	5962.00	7030.00	1068.00	17

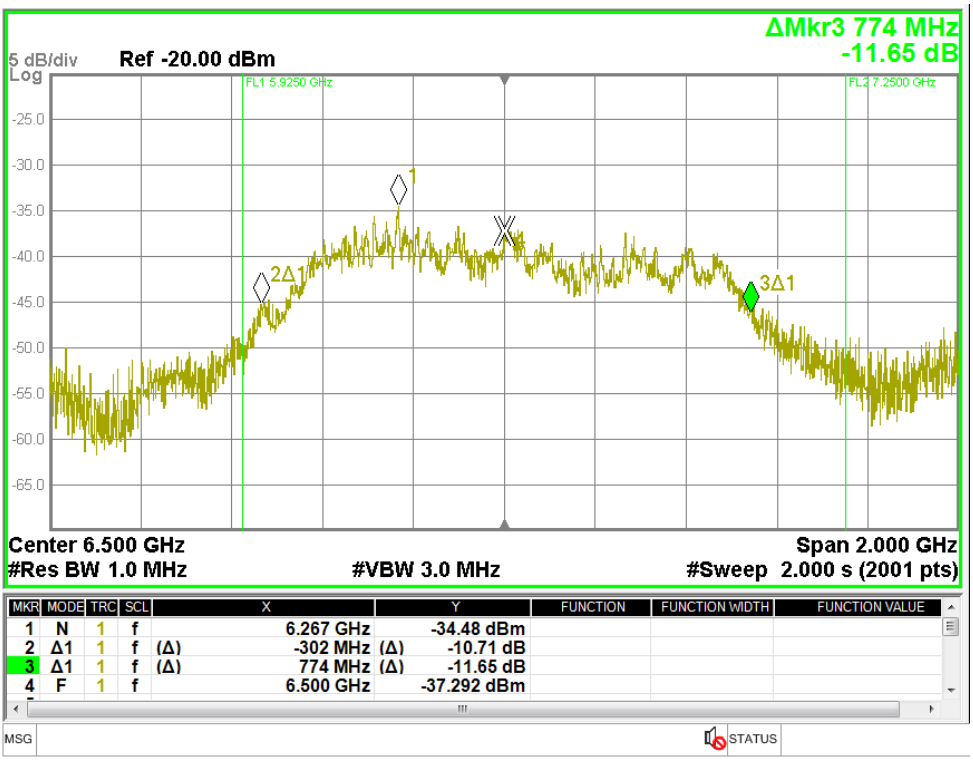
+20 °C / V_{max}	5973.00	7036.00	1063.00	18
+30 °C / V_{nom}	6001.00	7021.00	1020.00	19
+40 °C / V_{nom}	6021.00	7018.00	997.00	20
+50 °C / V_{nom}	6022.00	7018.00	996.00	21
+60 °C / V_{nom}	5972.00	7034.00	1062.00	22
T_{max} / V_{nom}	5958.00	7018.00	1060.00	23

Verdict: Compliant

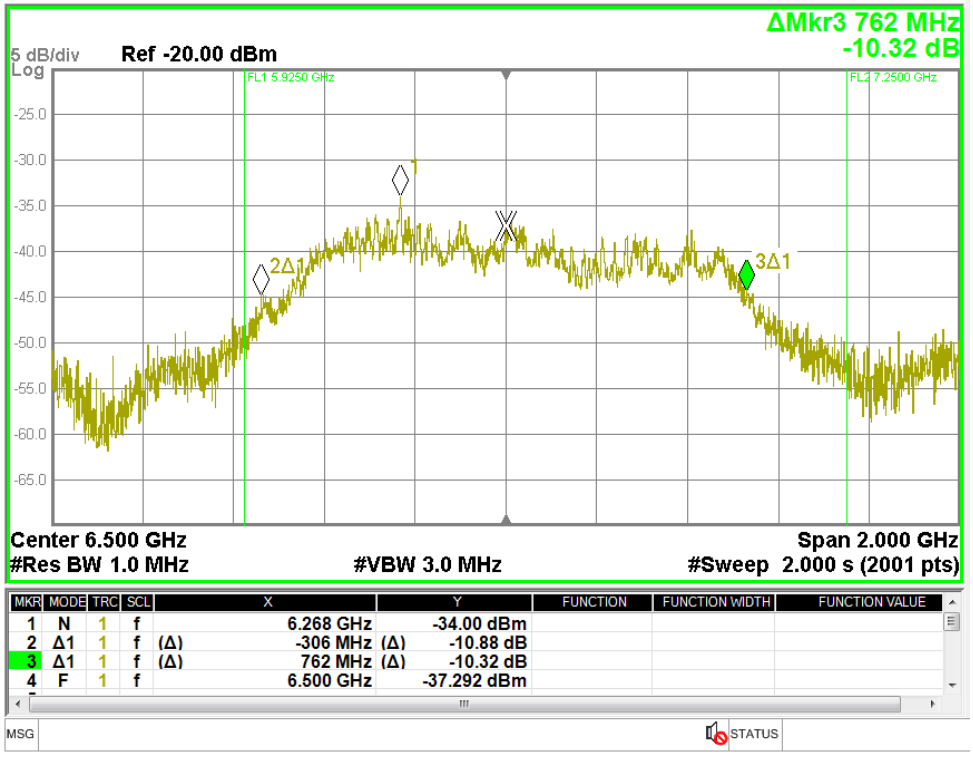
Plot 11: Tmin, Vnom



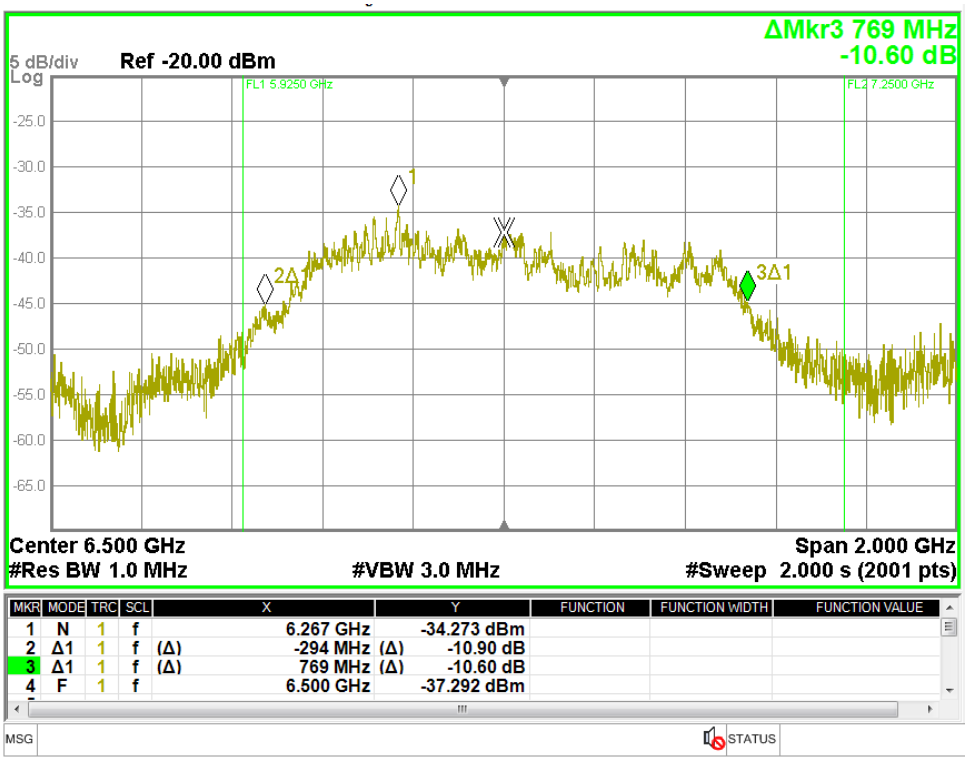
Plot 16: +20 °C, Vmin



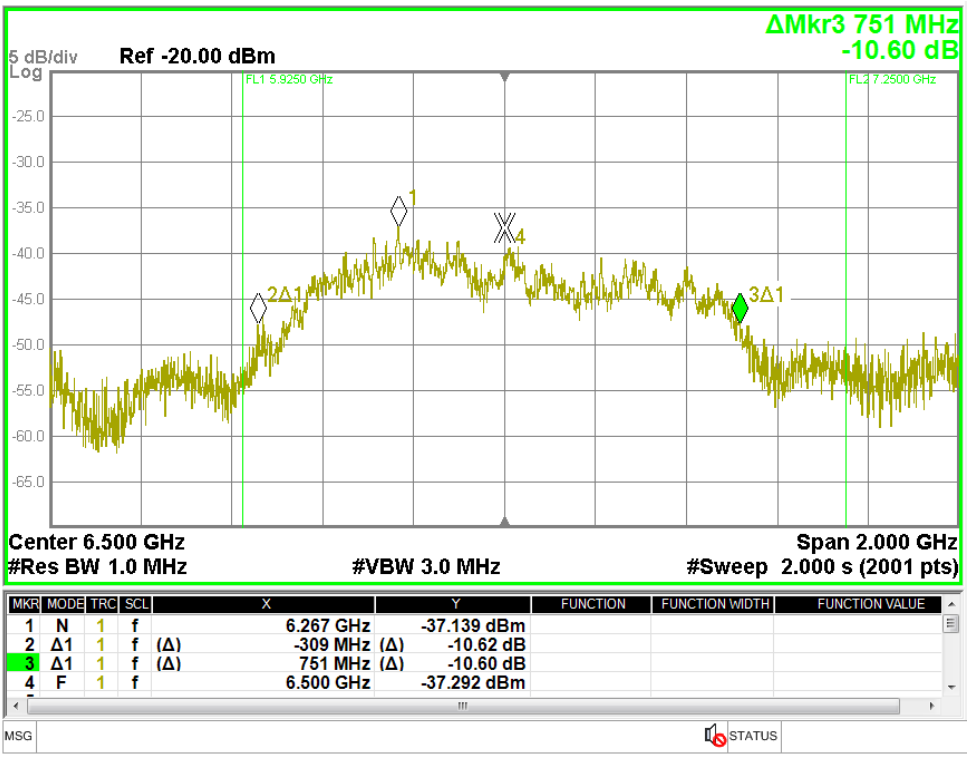
Plot 17: +20 °C, Vnom



Plot 18: +20 °C, Vmax



Plot 23: Tmax, Vnom



13 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

14 Document history

Version	Applied changes	Date of release
-/-	Initial release	2022-06-21

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

first page	last page
	

Note: The current certificate annex is published on the websites (link see below).

https://www.dakks.de/files/data/as/pdf/D-PL-12076-01-05e.pdf
or
https://ctcadvanced.com/app/uploads/2020/06/D-PL-12076-01-05_TCB_USA.pdf

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