
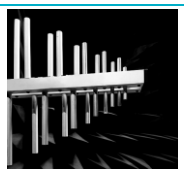
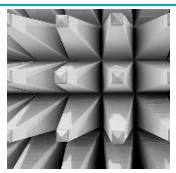

CTC advanced
member of RWTÜV group

Bundesnetzagentur

BNetzA-CAB-02/21-102

TEST REPORT

Test report no.: 1-5168/17-01-18-B

DAkkS Deutsche Akkreditierungsstelle D-PL-12076-01-03

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 (2005) by the Deutsche Akkreditierungsstelle GmbH (DAkkS)
The accreditation is valid for the scope of testing procedures as stated in the accreditation certificate with the registration number: D-PL-12076-01-03

Applicant

SAFEmine (part of Hexagon Mining)
Lindenstr. 4
6340 Baar / SWITZERLAND
Phone:
Contact: André Reichmuth
e-mail: andre.reichmuth@hexagonmining.com
Phone:

Manufacturer

SAFEmine (part of Hexagon Mining)
Lindenstr. 4
6340 Baar / 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:	**Personal Alert Tag**
Model name:	**Personal Alert Tag**
FCC ID:	**ZKSQT360**
Frequency:	5.925 GHz to 7.250 GHZ
Antenna:	Integrated antenna
Power supply:	2.5 V to 4.2 V DC, by battery
Temperature range:	-20°C to +50°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:

p.o. Thomas Vogler

DN: cn=Thomas Vogler, o=CTC advanced GmbH, ou=VOG-161125, email=thomas.vogler@ctcadvanced.com, c=DE
Datum: 2019.04.05 10:55:07 +02'00'

Karsten Geraldy
Lab Manager
Radio Communications & EMC

Test performed:

B. Gerber

cn=Benedikt Gerber, o=CTC advanced GmbH, ou=GRB-180503, email=benedikt.gerber@ctcadvanced.com, c=DE
2019.04.05 10:52:37 +02'00'

Benedikt Gerber
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 replaces the test report with the number 1-5168/17-01-18-A and dated 2019-03-29.

2.2 Application details

Date of receipt of order:	2017-12-07
Date of receipt of test item:	2018-01-09
Start of test:	2018-01-09
End of test:	2019-02-18
Person(s) present during the test:	Mr. Beat Sigrist

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 Test environment

Temperature	:	T_{nom} T_{max} T_{min}	+22 °C during room temperature tests +50 °C during high temperature tests -20 °C during low temperature tests
Relative humidity content	:		55 %
Barometric pressure	:		1021 hpa
Power supply	:	V_{nom} V_{max} V_{min}	3.7 V DC, by battery 4.2 V 2.5 V

5 Test item

5.1 General description

Kind of test item	:	Personal Alert Tag
Type identification	:	Personal Alert Tag
S/N serial number	:	21360200199
HW hardware status	:	Rev-A Rev-B (used for retest of §15-250 (d) (2))
SW software status	:	0.1.7-485
Frequency band	:	5.925 GHz to 7.250 GHZ
Type of radio transmission Use of frequency spectrum	: :	Pulse
Type of modulation	:	BPSK / BPM
Number of channels	:	6 channels programmable **1 channel tested**
Antenna	:	Integrated antenna
Power supply	:	2.5 V to 4.2 V DC, by battery
Temperature range	:	-20°C to +50°C

5.2 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. *$radio,init,1,7,107* 2. *$radio,cf,w,1000,200*

Transmitter test mode parameters:

Channel	7 / 6489.6GHz*
Power Setting	107 (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: 1-5168/17-01-18_AnnexA
1-5168/17-01-18_AnnexB
1-5168/17-01-18_AnnexC

Declarations of the manufacturer are included in test report: 1-5168/17-01-18_AnnexD

6 Description of the test setup

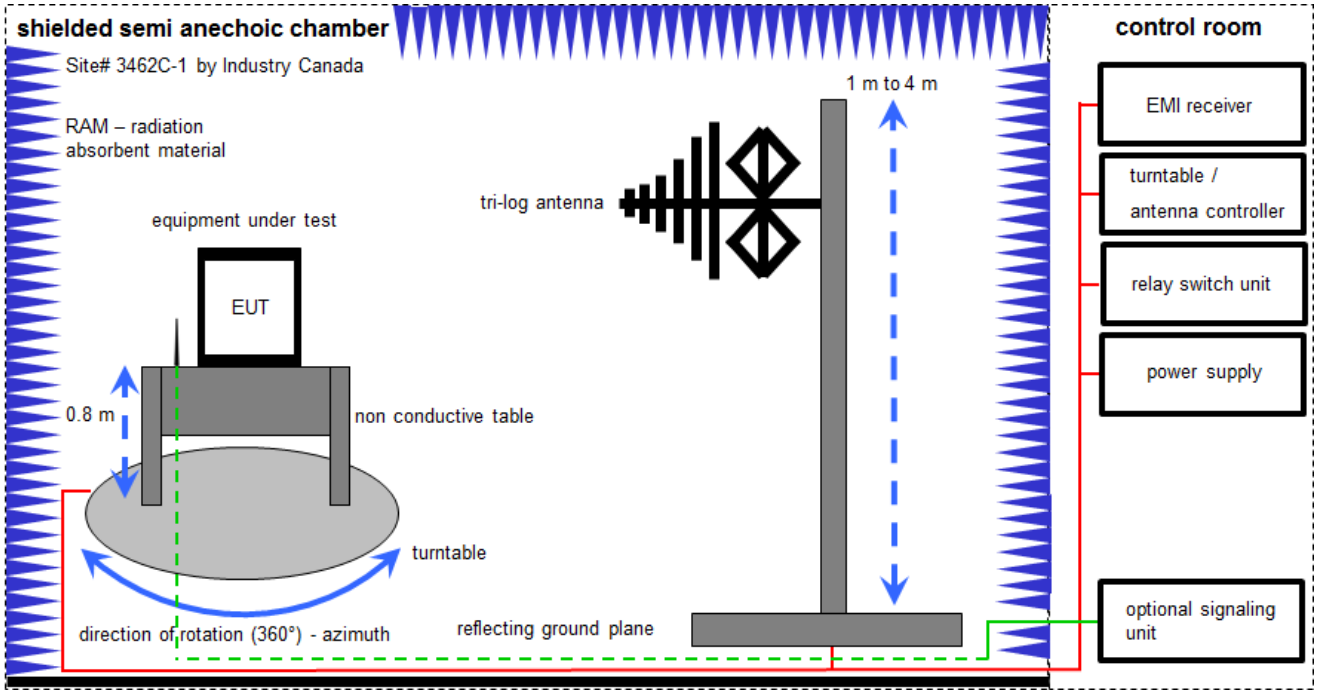
Typically, the calibrations of the test apparatus are commissioned to and performed by an accredited calibration laboratory. The calibration intervals are determined in accordance with the DIN EN ISO/IEC 17025. In addition to the external calibrations, the laboratory executes comparison measurements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

6.1 Shielded semi anechoic chamber



Measurement distance: tri-log antenna 10 meter

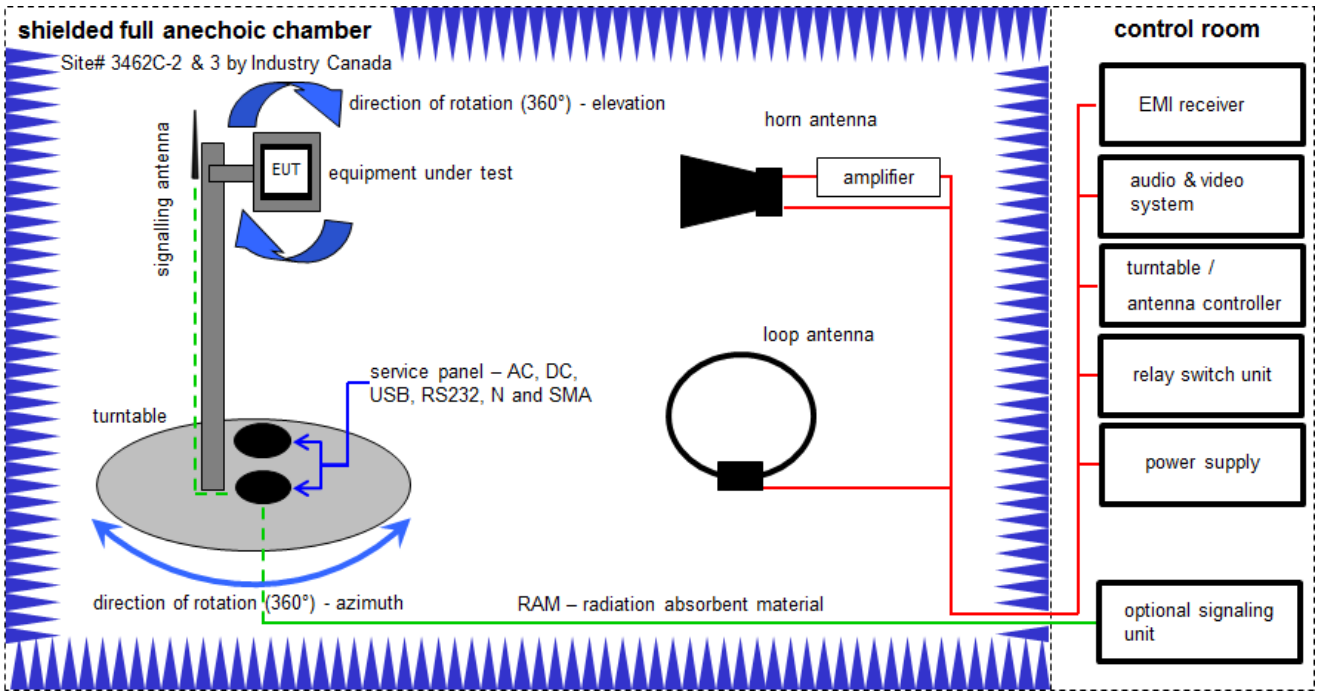
FS = UR + CL + AF
(FS-field strength; UR-voltage at the receiver; CL-loss of the cable; AF-antenna factor)

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	45	Switch-Unit	3488A	HP	2719A14505	300000368	ev	-/-	-/-
2	50	DC power supply, 60Vdc, 50A, 1200 W	6032A	HP	2920A04466	300000580	ne	-/-	-/-
3	93	Meßkabine 1	HF-Absorberhalle	MWB AG 300023		300000551	ne	-/-	-/-
4	n. a.	EMI Test Receiver	ESCI 3	R&S	100083	300003312	k	15.12.2017 12.12.2018	14.12.2018 11.12.2019
5	n. a.	Analyzer-Reference-System (Harmonics and Flicker)	ARS 16/1	SPS	A3509 07/0 0205	300003314	vlKl!	15.01.2018	14.01.2020
6	n. a.	Antenna Tower	Model 2175	ETS-Lindgren	64762	300003745	izw	-/-	-/-
7	n. a.	Positioning Controller	Model 2090	ETS-Lindgren	64672	300003746	izw	-/-	-/-
8	n. a.	Turntable Interface-Box	Model 105637	ETS-Lindgren	44583	300003747	izw	-/-	-/-
9	n. a.	TRILOG Broadband Test-Antenna 30 MHz - 3 GHz	VULB9163	Schwarzbeck Mess - Elektronik	371	300003854	vlKl!	24.11.2017	23.11.2020

6.2 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)

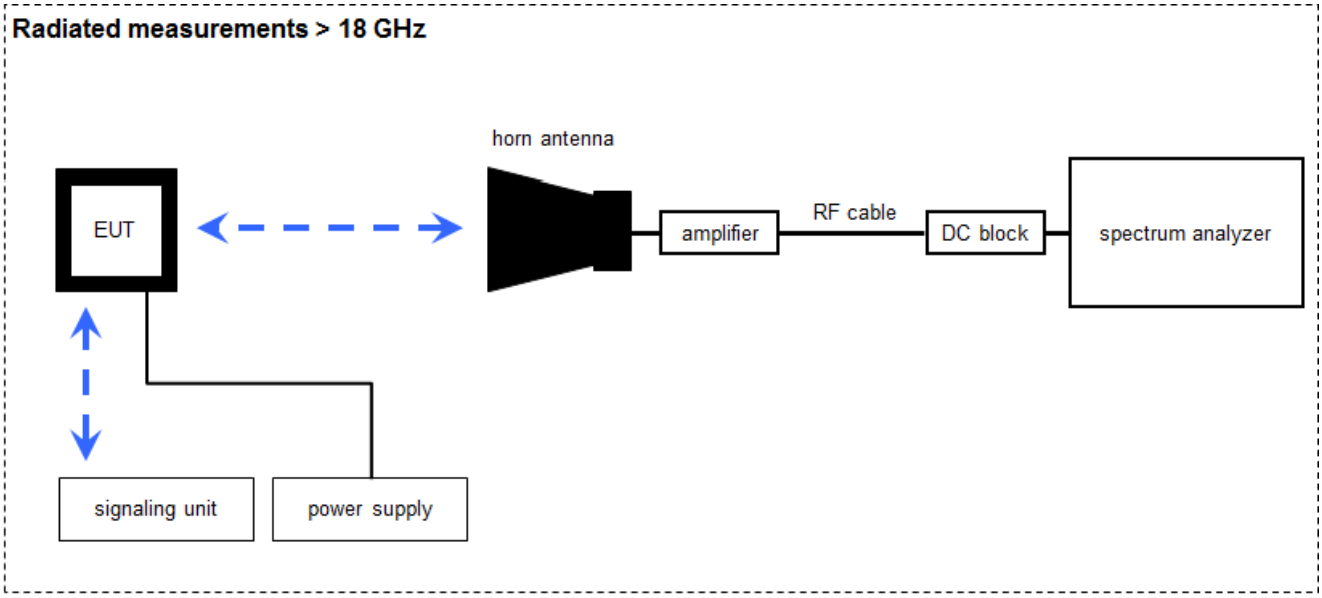
OP = AV + D - G + CA
(OP-radiated output power; AV-analyzer value; D-free field attenuation of measurement distance; G-antenna gain+amplifier gain; CA-loss signal path)

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

Equipment table:

No.		Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	1	n. a.	DC power supply, 60Vdc, 50A, 1200 W	6032A	HP	2818A03450	300001040	vlKl!	12.12.2017	11.12.2020
2	2	n. a.	Anechoic chamber	FAC 3/5m	MWB / TDK	87400/02	300000996	ev	-/-	-/-
3	3	19	Double-Ridged Waveguide Horn Antenna 1-18.0GHz	3115	EMCO	9107-3697	300001605	vlKl!	14.02.2017	13.02.2019
4		135	Double-Ridged Waveguide Horn Antenna 1-18.0GHz	3115	EMCO	8812-3089	300000307	vlKl!	07.07.2017	06.07.2019
5	4	n. a.	Switch / Control Unit	3488A	HP	*	300000199	ne	-/-	-/-
6	5	n. a.	EMI Test Receiver 20Hz- 26,5GHz	ESU26	R&S	100037	300003555			
7		n. a.	Signal- and Spectrum Analyzer	FSW26	R&S	101455	300004528	k	20.12.2017	19.12.2018

6.3 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)

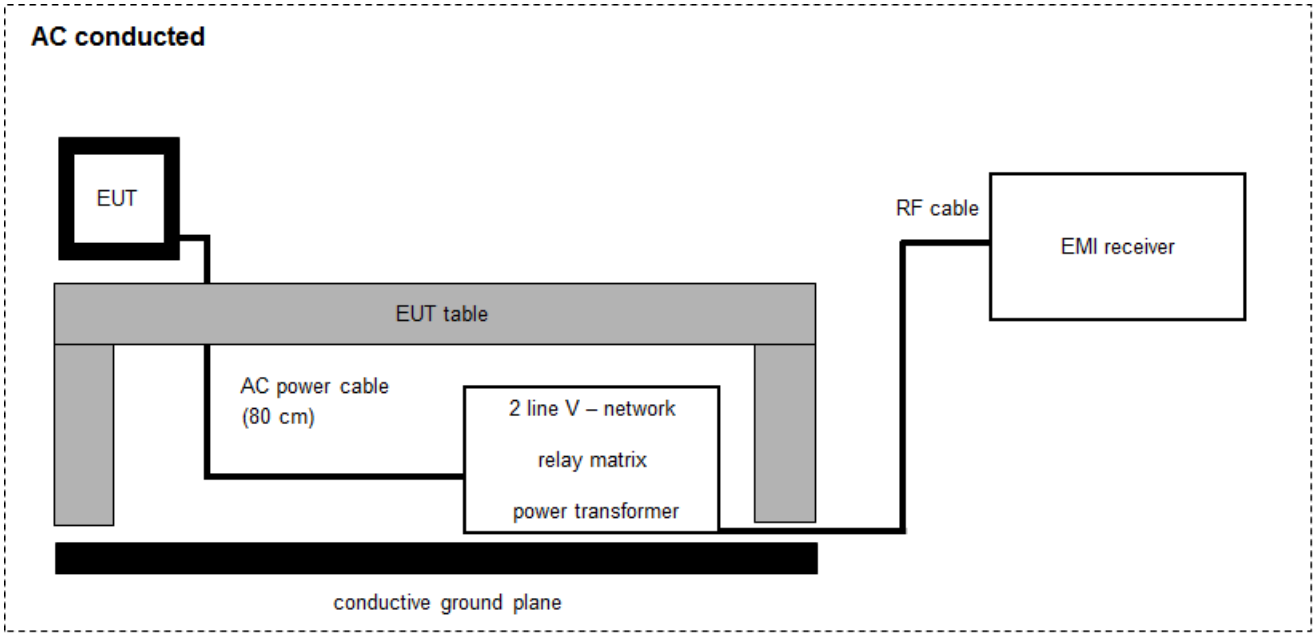
OP = AV + D - G + CA
(OP-radiated output power; AV-analyzer value; D-free field attenuation of measurement distance;
G-antenna gain+amplifier gain; CA-loss signal path)

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

Equipment table:

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	CR 79	Std. Gain Horn Antenna 26.5-40.0 GHz	V637	Narda	7911	300001751	ne	-/-	-/-
2	A027	Std. Gain Horn Antenna 18.0-26.5 GHz	638	Narda		300000486	k	13.12.2017	12.12.2019
3	n. a.	Spectrum Analyzer 20 Hz - 50 GHz	FSU50	R&S	200012	300003443	k	28.10.2016	27.10.2018
4	n. a.	PXA Spectrum Analyzer 3Hz to 50GHz	N9030A PXA Signal Analyzer	Agilent Technologies	US51350267	300004338	k	05.03.2018	04.03.2019
5	n. a.	Broadband LNA 18-50 GHz	CBL18503070PN	CERNEX	25240	300004948	ev	-/-	-/-
6	n. a.	Signal- and Spectrum Analyzer	FSW26	R&S	101455	300004528	k	20.12.2017	19.12.2018

6.4 AC conducted



FS = UR + CF + VC
(FS-field strength; UR-voltage at the receiver; CR-loss of the cable and filter; VC-correction factor of the ISN)

Example calculation:
FS [dBµV/m] = 37.62 [dBµV/m] + 9.90 [dB] + 0.23 [dB] = 47.75 [dBµV/m] (244.06 µV/m)

Equipment table:

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	101	Two-line V-Network (LISN) 9 kHz to 30 MHz	ESH3-Z5	R&S	893045/004	300000584	k	13.12.2017	12.12.2018
2	67	RF-Filter-section	85420E	HP	3427A00162	300002214	k	27.11.2006	-/-
3	27	EM-Injection Clamp	FCC-203i	emv	232	300000626	ev	18.05.2001	-/-
4	n. a.	Magnetfeldantenne	MS 100	EM-Test	-----	300002659	ev	24.04.2000	-/-
5	n. a.	AC-Spannungsquelle variabel	MV2616-V	EM-Test	0397-12	300003259	vlKl!	18.12.2017	17.12.2019
6	n. a.	Analyzer-Reference-System (Harmonics and Flicker)	ARS 16/1	SPS	A3509 07/0 0205	300003314	vlKl!	15.01.2018	14.01.2020
7	n. a.	Hochpass 150 kHz	EZ-25	R&S	100010	300003798	ev	08.04.2008	-/-
8	n. a.	Power Supply	NGSM 32/10	R&S	3939	400000192	vlKl!	31.01.2017	30.01.2020
9	n. a.	MXE EMI Receiver 20 Hz to 26,5 GHz	N9038A	Agilent Technologies	MY51210197	300004405	k	18.12.2017	17.12.2018

7 Sequence of testing

7.1 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.

7.2 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.

7.3 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.

7.4 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.

8 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 %

9 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	2019-04-05	-/-

Test specification clause	Test case	Temperature conditions	Power source	Pass	Fail	NA	NP	Remark
§15.250 (a)	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

10 Measurement results

10.1 10 dB - Bandwidth

Description:

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

Measurement:

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

Test Setup: 7.3

Limits:

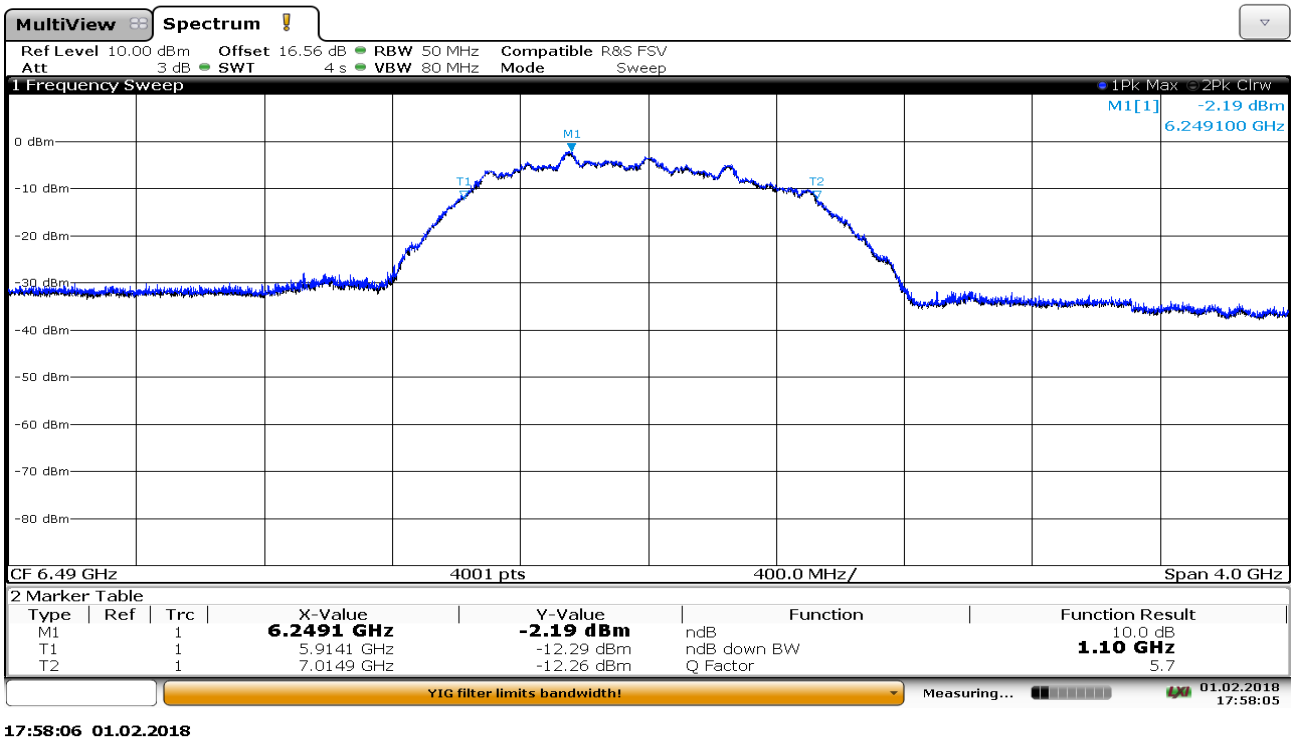
>500 MHz

Results:

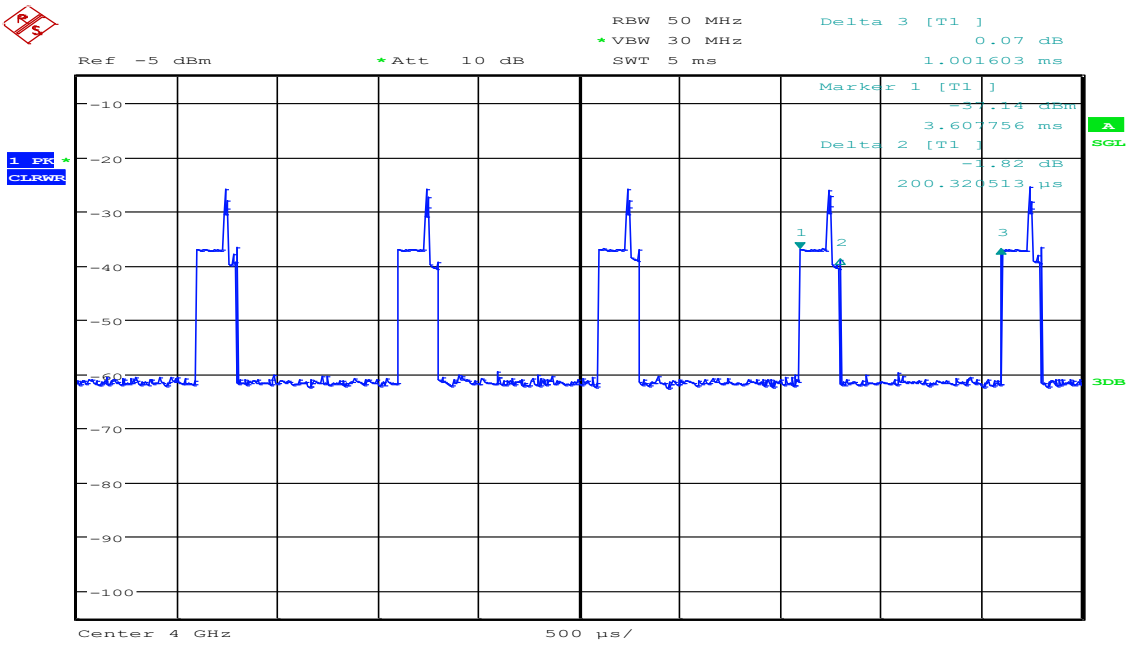
Temperature	Channel	Lower -10 dB point [GHz]	Higher -10 dB point [GHz]	UWB bandwidth [MHz]
22 °C	7	5.9141	7.0149	1100.00

Verdict: **Compliant**

Plot 1: Channel 7, 10 dB down

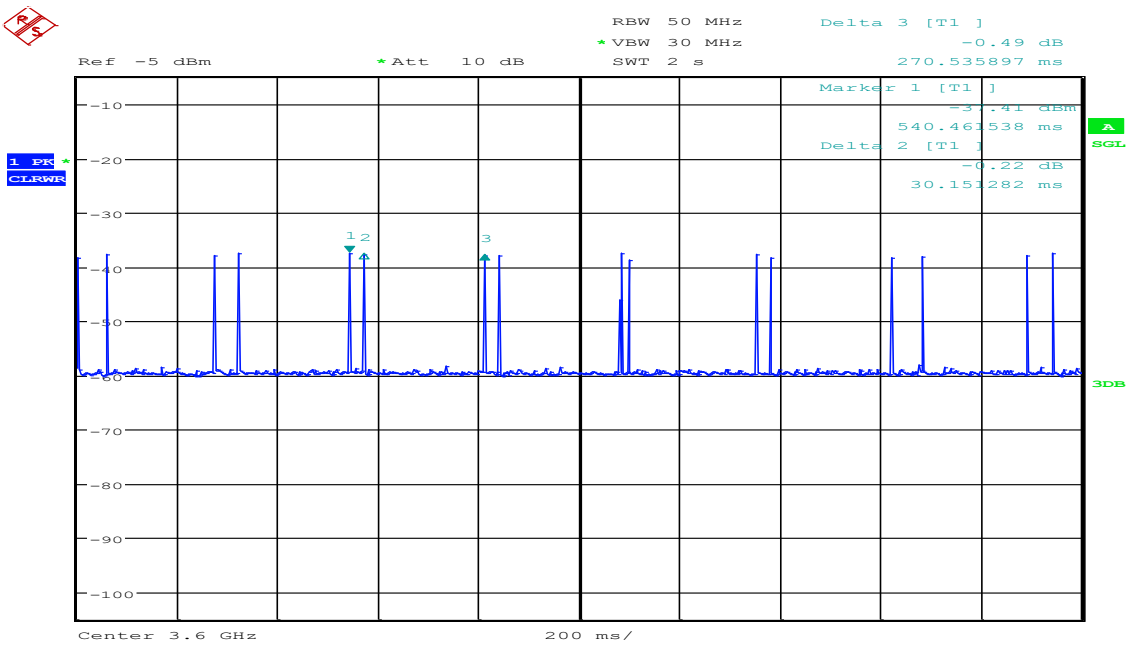


Plot 2: Duty Cycle, test mode



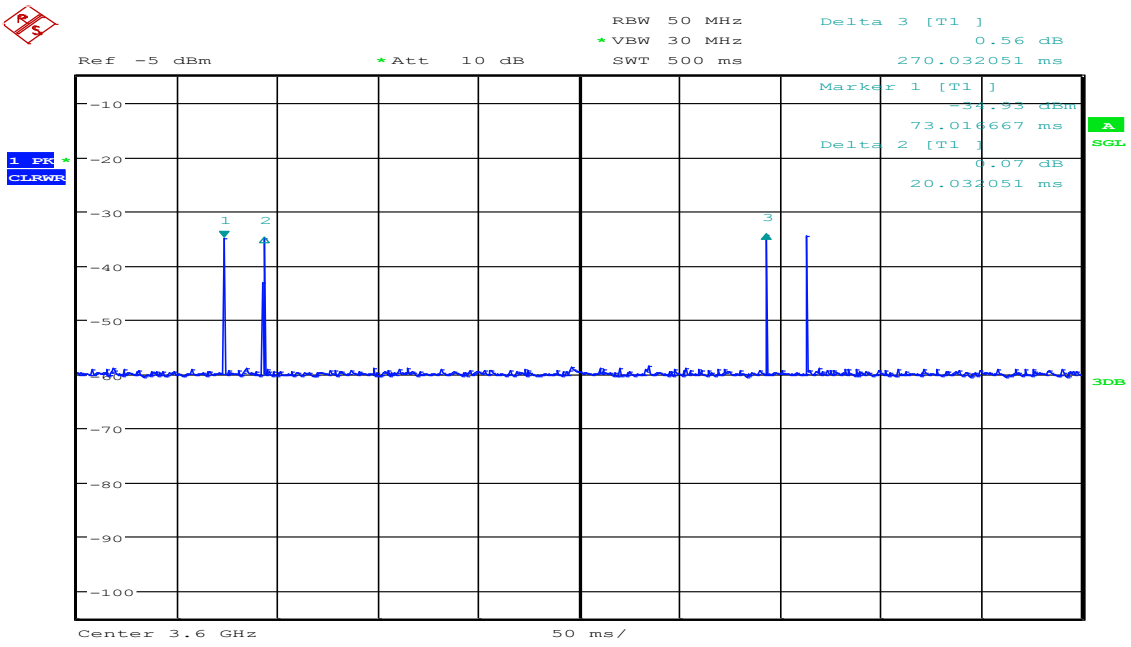
Date: 13.MAR.2018 14:03:03

Plot 3: Duty Cycle, normal mode



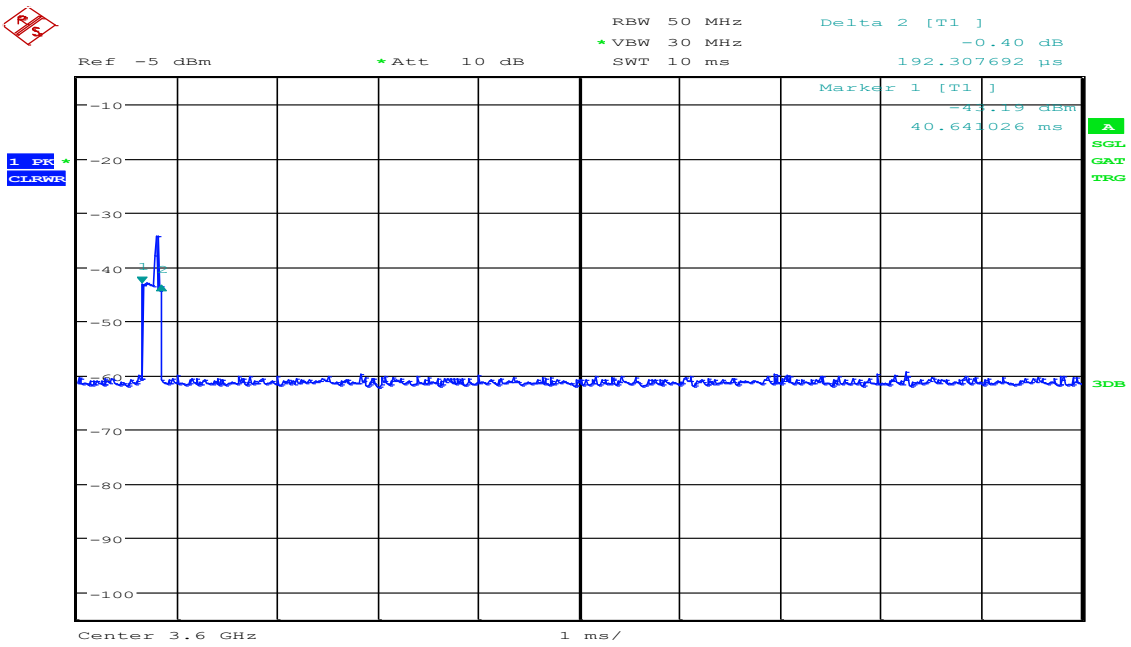
Date: 13.MAR.2018 13:42:08

Plot 4: Duty Cycle, normal mode



Date: 13.MAR.2018 13:42:52

Plot 5: Duty Cycle, normal mode



Date: 13.MAR.2018 13:50:55

10.2 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:	1 s
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

UWB-emission-Limits:

FCC CFR 47:

§15.519 (c)
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 10600	-41.3
Above 10600	-61.3

§15.519 (d)
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

(e) 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. It is acceptable to employ a different resolution bandwidth, and a correspondingly different peak emission limit, following the procedures described in §15.521.

Result:

	Channel	Frequency in MHz	Max e.i.r.p. / dBm		Plot
			average value	peak value	
Max E.I.R.P	7	6490.0	-41.45	-3.25	9,10

Emissions outside the band:

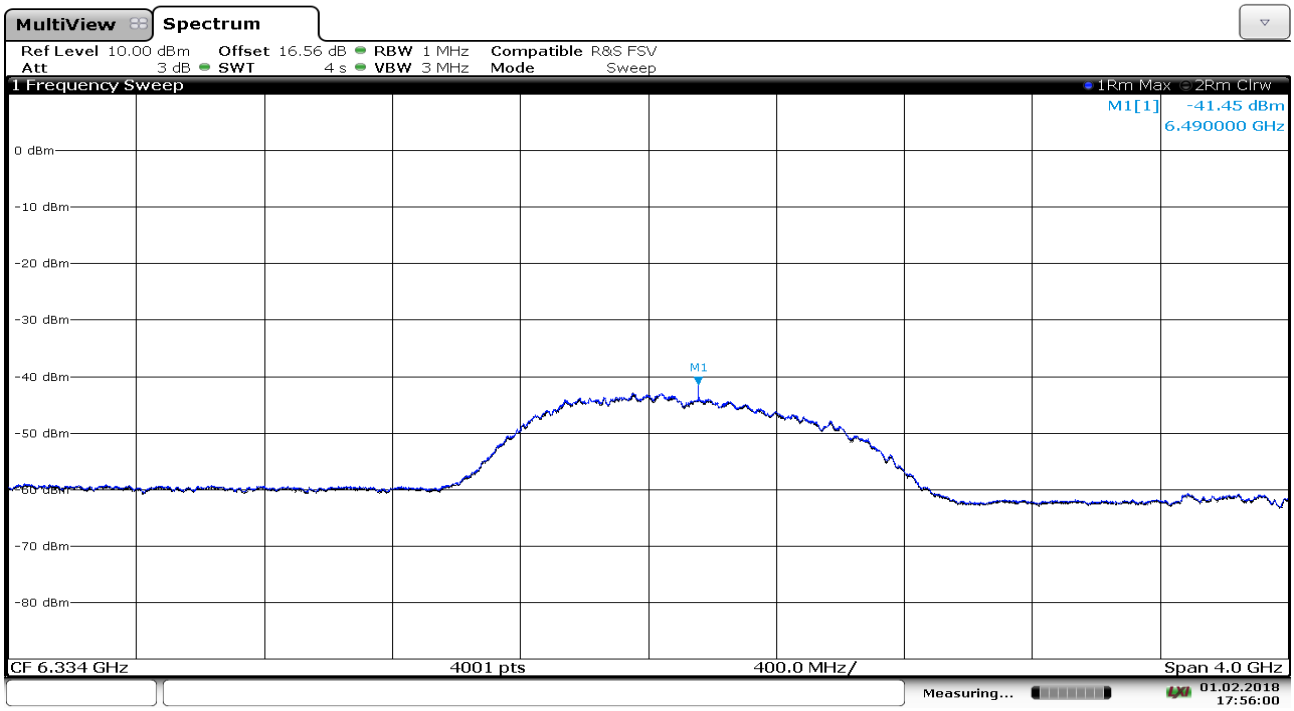
Channel	Frequency in GHZ	Detector	Filter type	Bandwidth	Level in dBm	Limit in dBm	Margin in dB
7	1.95811	RMS	6 dB	1 MHz	-75.9	-63.3	12.6
7	2.07337	RMS	6 dB	1 MHz	-77.1	-61.3	15.8
7	2.15038	RMS	6 dB	1 MHz	-71.2	-61.3	9.9
7	4.11841	RMS	6 dB	1 MHz	-71.0	-41.3	29.7
7	4.24324	RMS	6 dB	1 MHz	-70.7	-41.3	29.4
7	12.9790	RMS	6 dB	1 MHz	-64.4	-61.3	3.1
7	1.5744	RMS	6 dB	1 kHz	-82.5	-85.3	-2.8*

*please refer to chapter 10.4 of this test report for further documentation

For emissions below 1 GHz, please refer to plots 10 to 11.

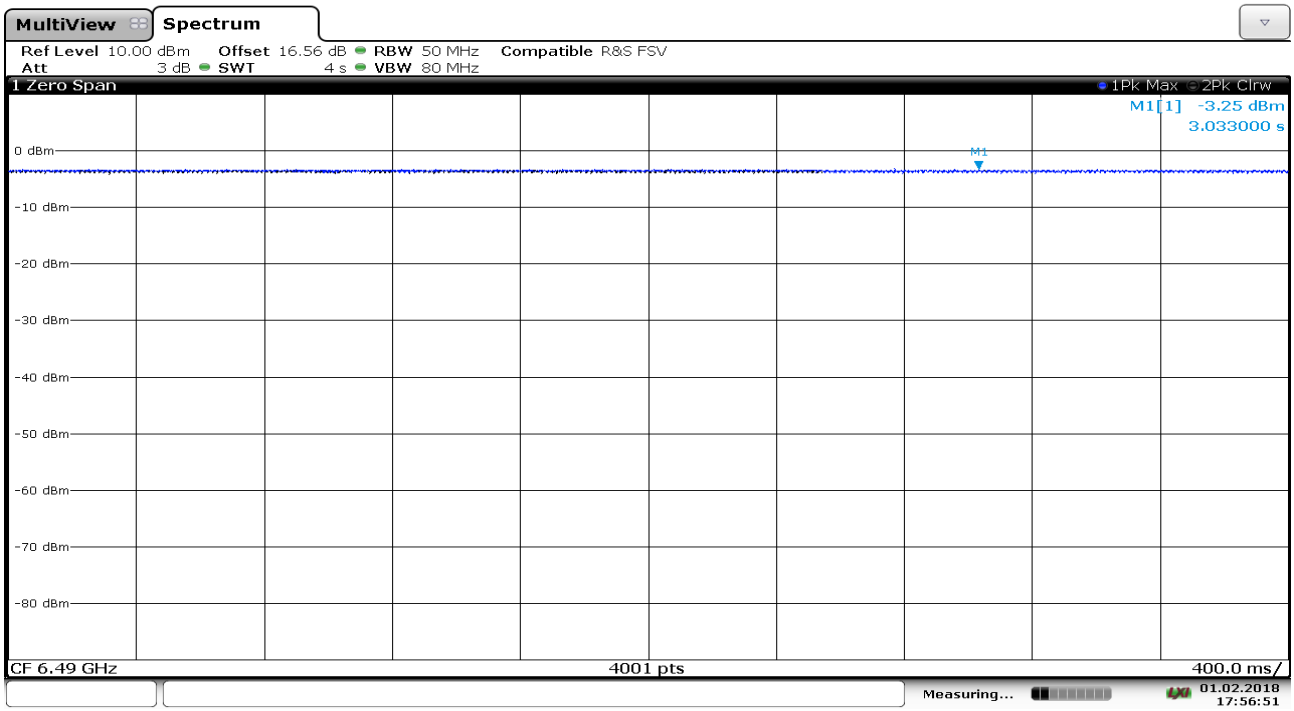
Verdict: **complies**

Plot 6: Channel 7, RMS power



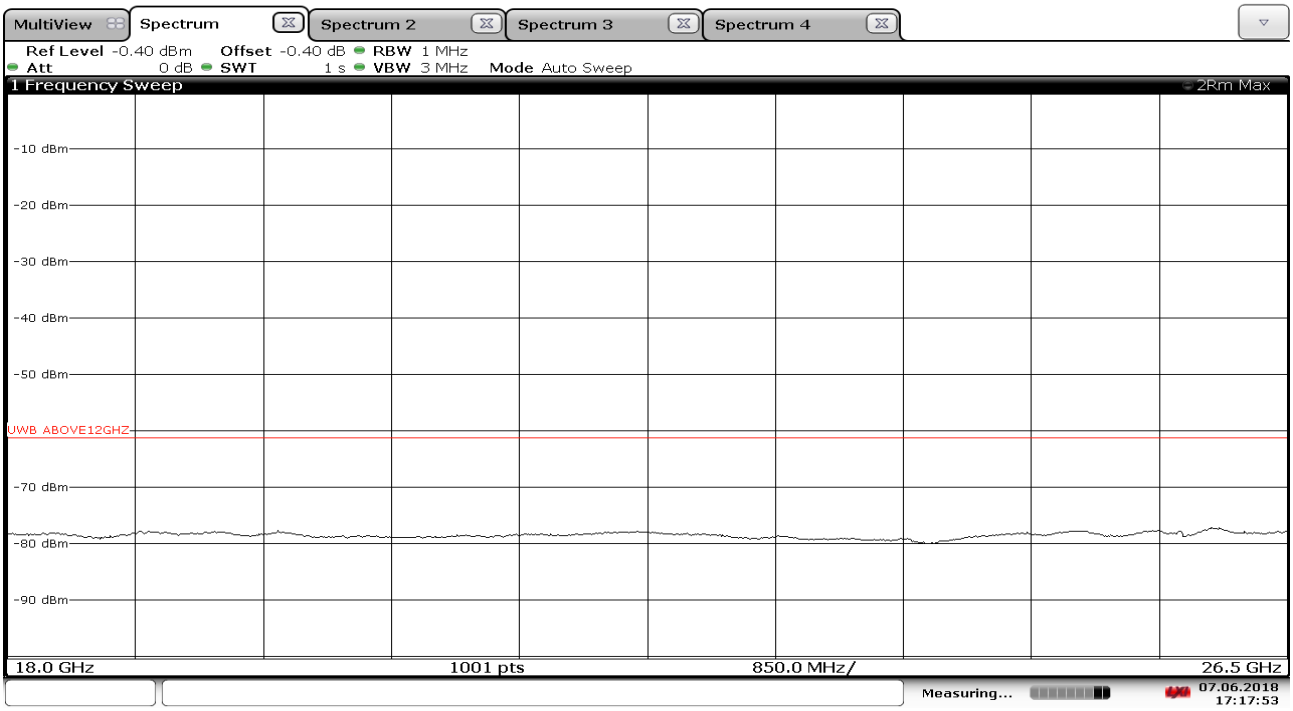
17:56:01 01.02.2018

Plot 7: Channel 7, Peak power



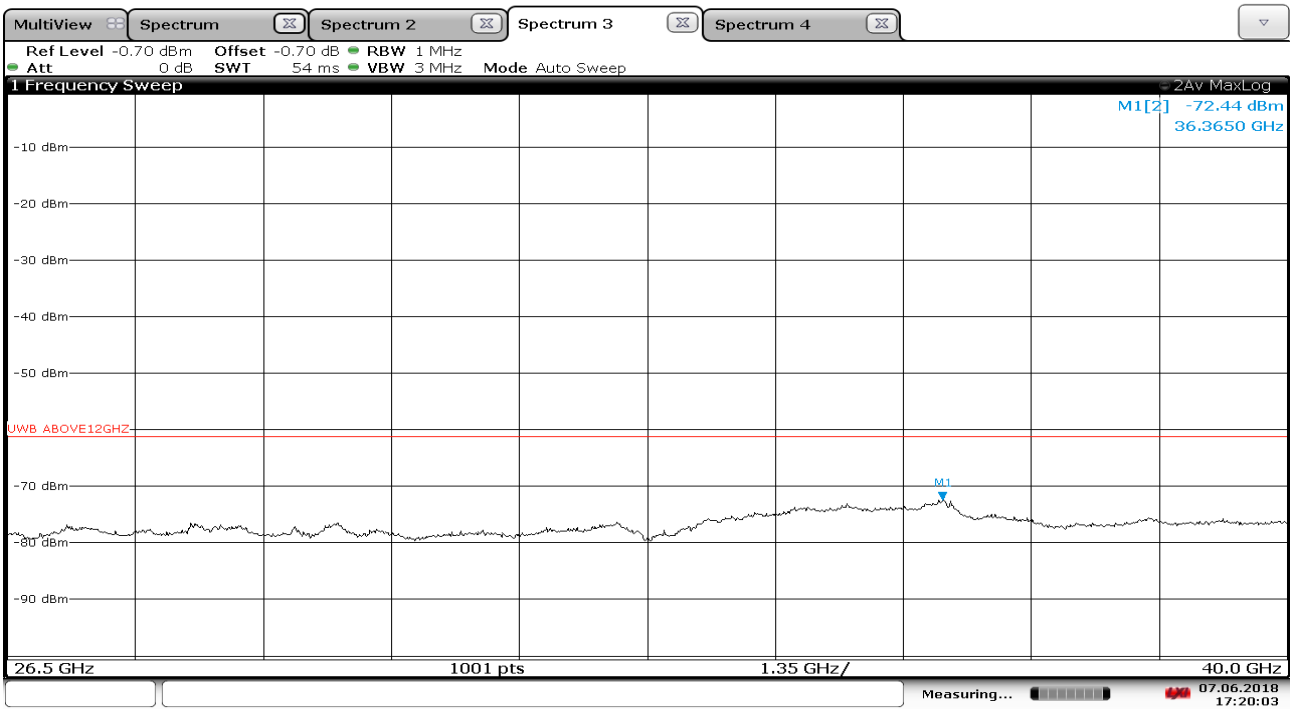
17:56:52 01.02.2018

Plot 8: Channel 7, 18 GHz – 26.5 GHz



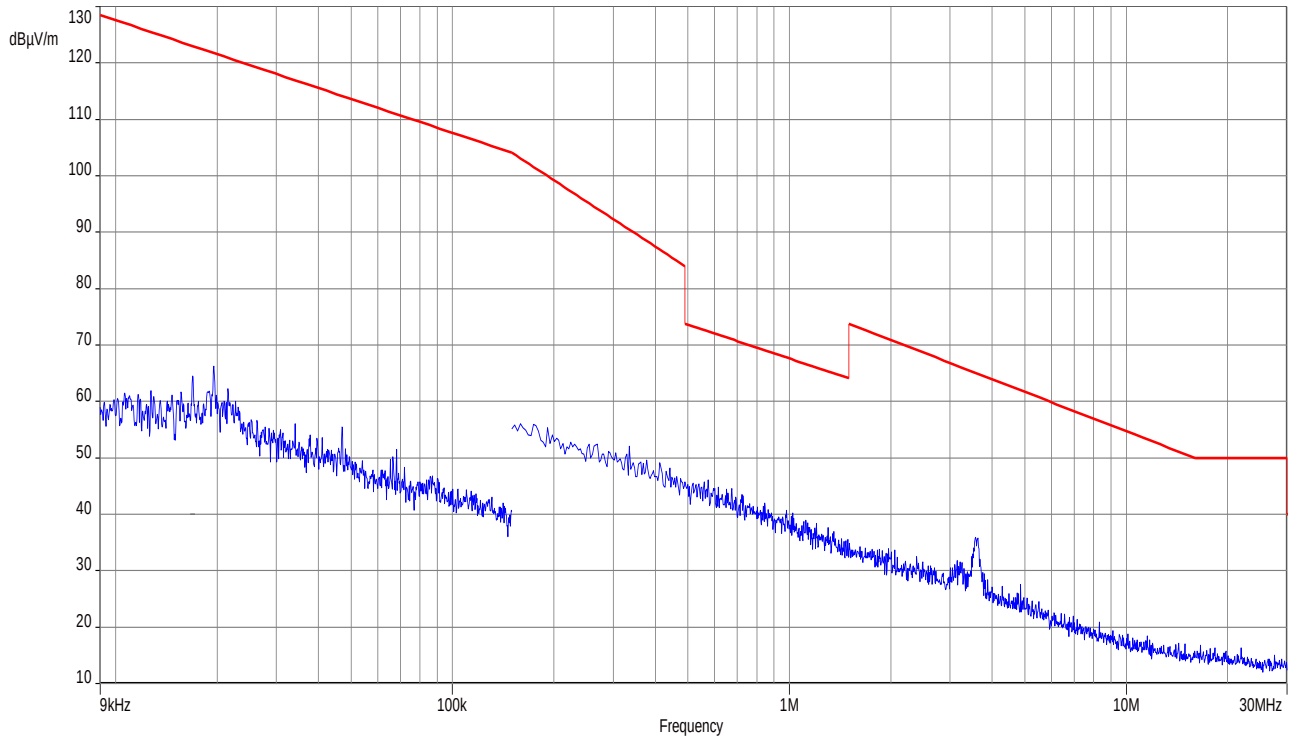
17:17:53 07.06.2018

Plot 9: Channel 7, 26.5 GHz –40 GHz

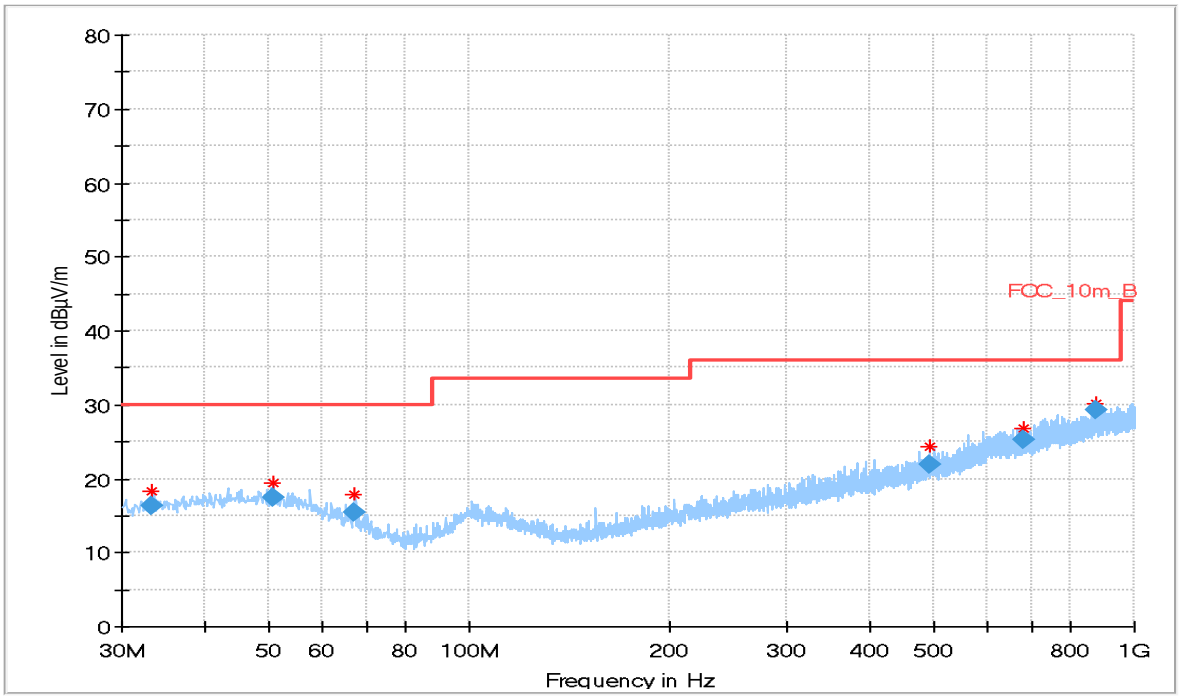


17:20:03 07.06.2018

Plot 10: Channel 7, 15.209, TX Magnetic



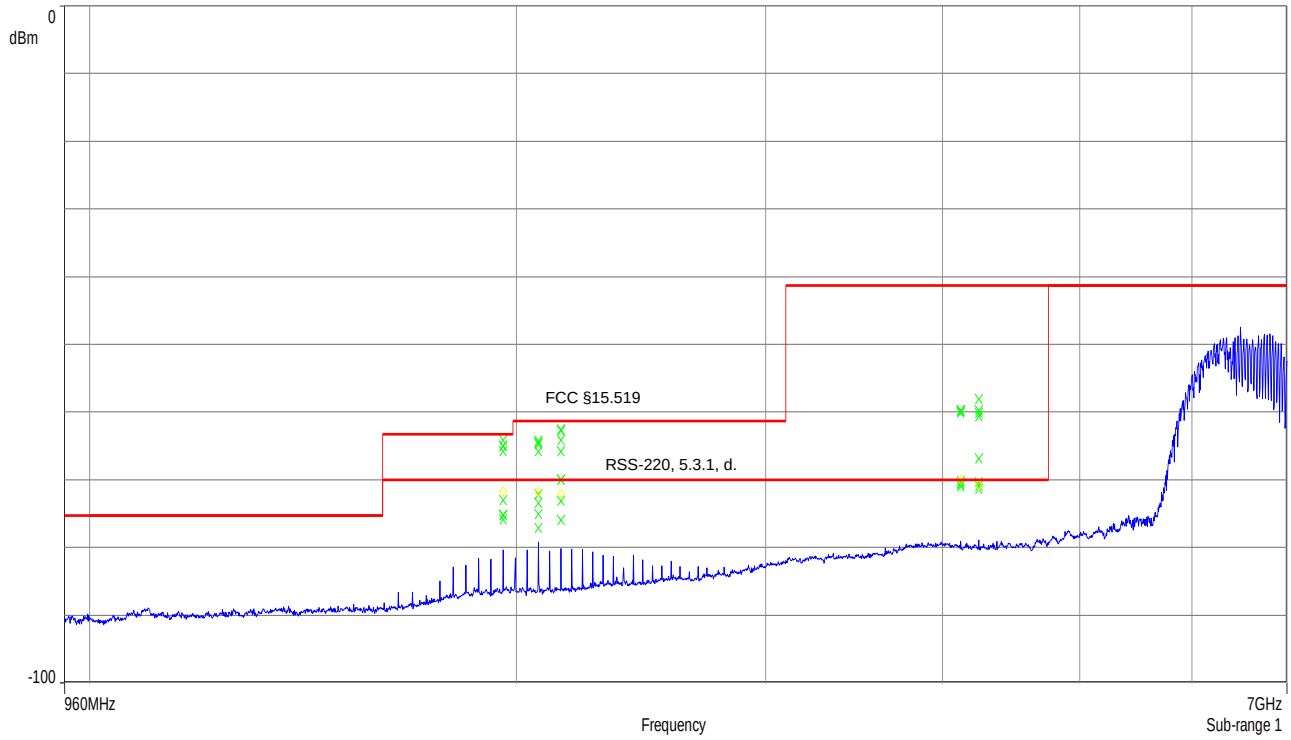
Plot 11: Channel 7, 15.209, 30 MHz – 1 GHz



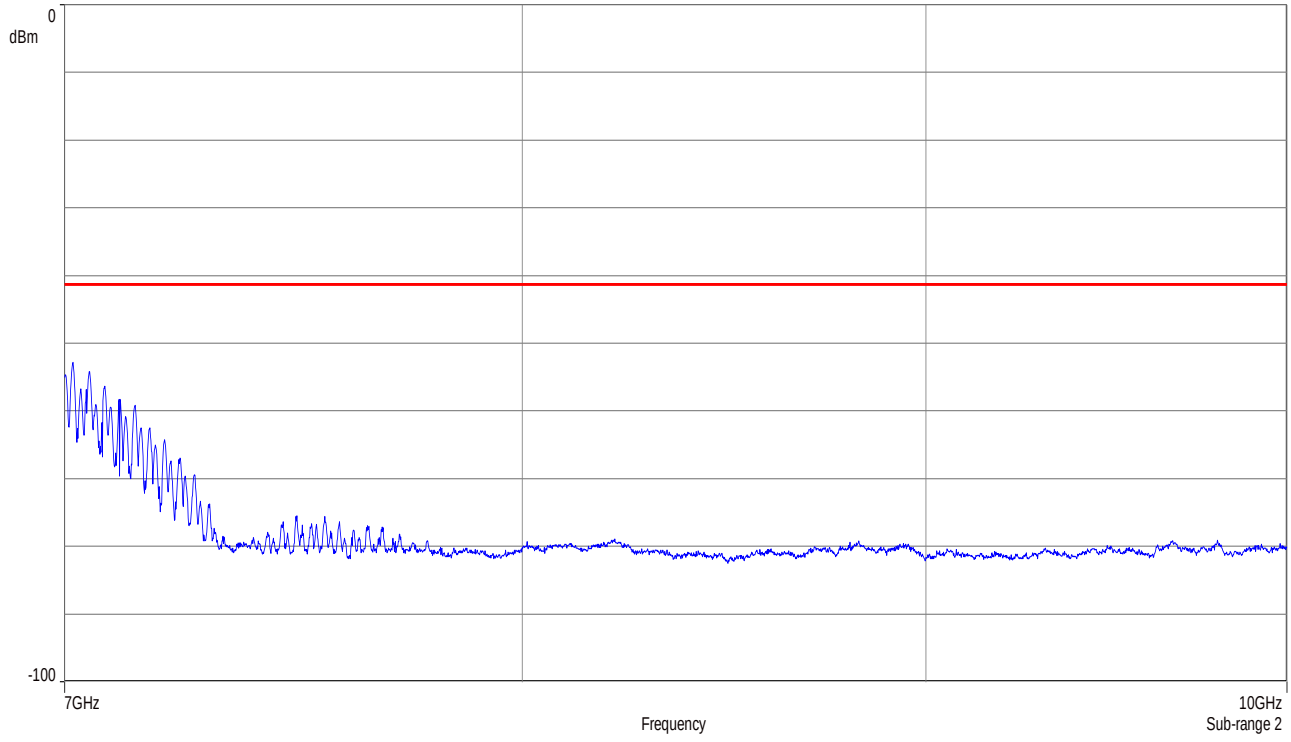
Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
33.368	16.31	30.0	13.69	1000	120	98.0	V	348.0	12.4
50.549	17.35	30.0	12.65	1000	120	170.0	H	212.0	13.7
67.215	15.40	30.0	14.60	1000	120	101.0	V	141.0	10.3
491.317	21.93	36.0	14.07	1000	120	170.0	V	257.0	18.5
682.325	25.20	36.0	10.80	1000	120	98.0	H	311.0	21.4
874.693	29.18	36.0	6.82	1000	120	170.0	V	269.0	23.9

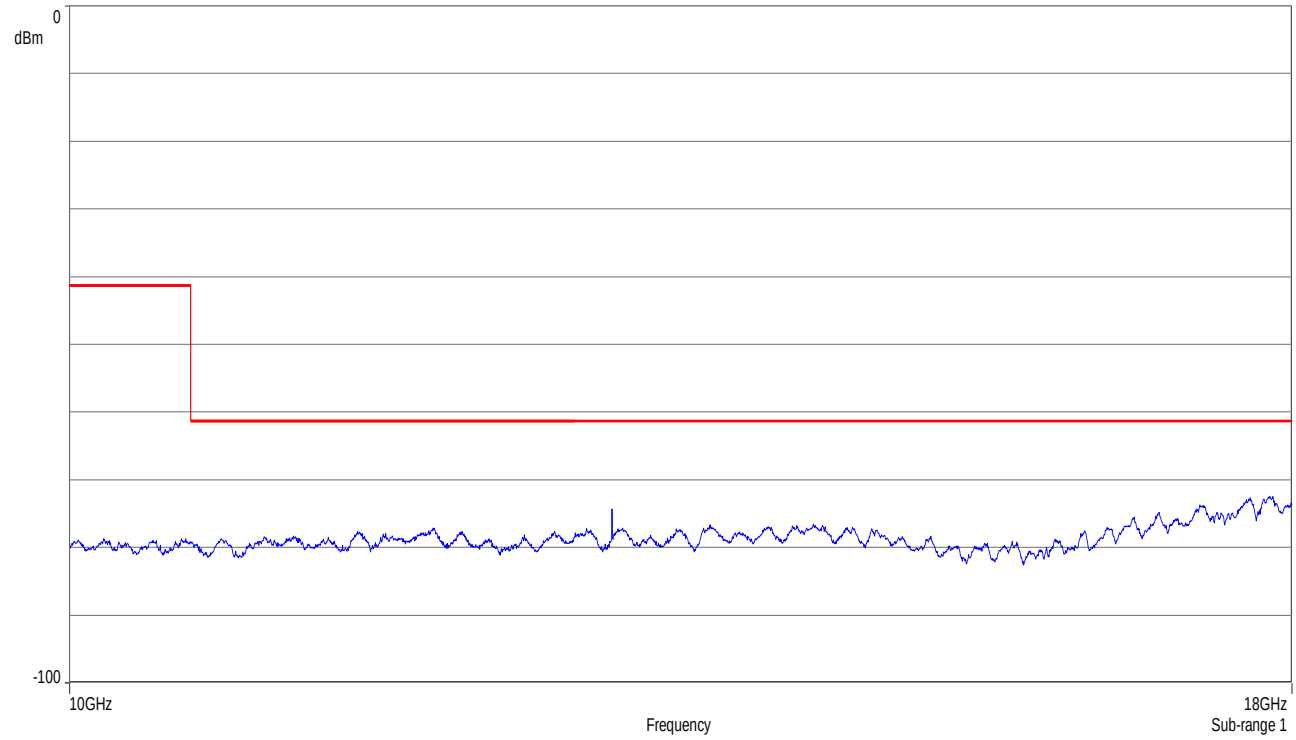
Plot 12: Channel 7, 960 MHz – 7 GHz



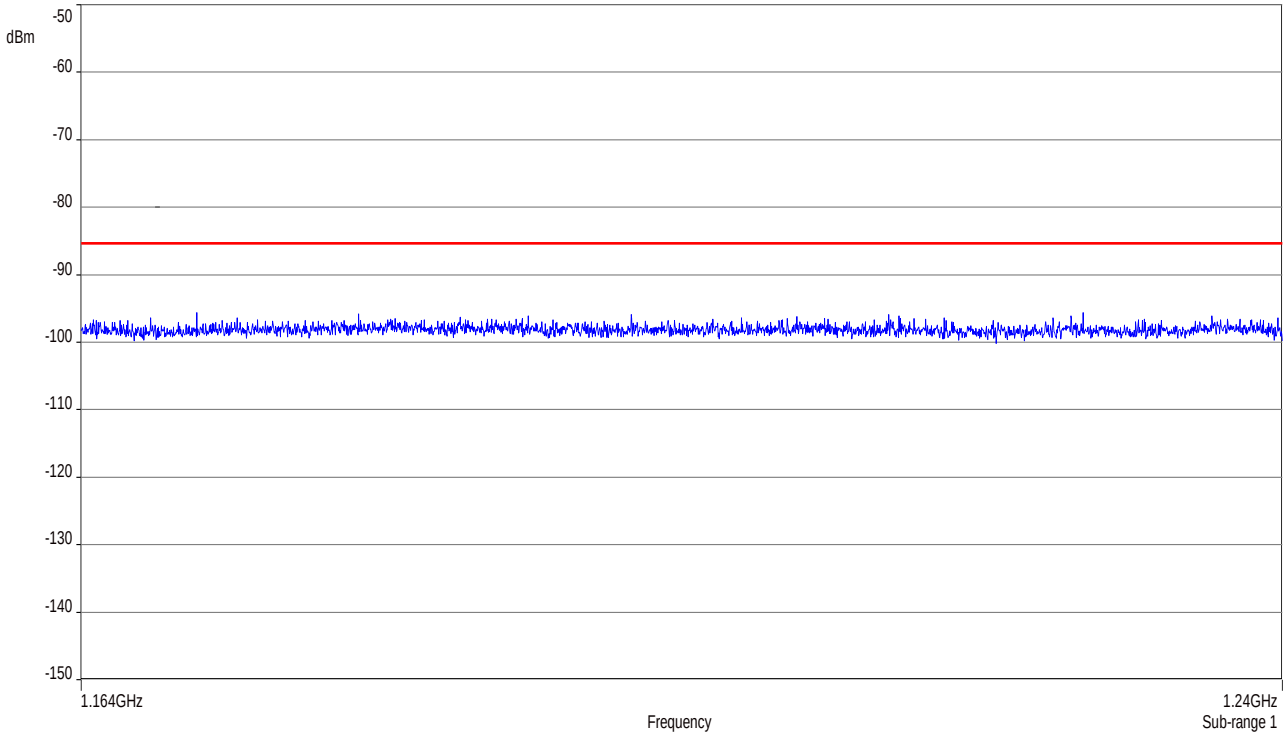
Plot 13: Channel 7, 7 GHz – 10 GHz



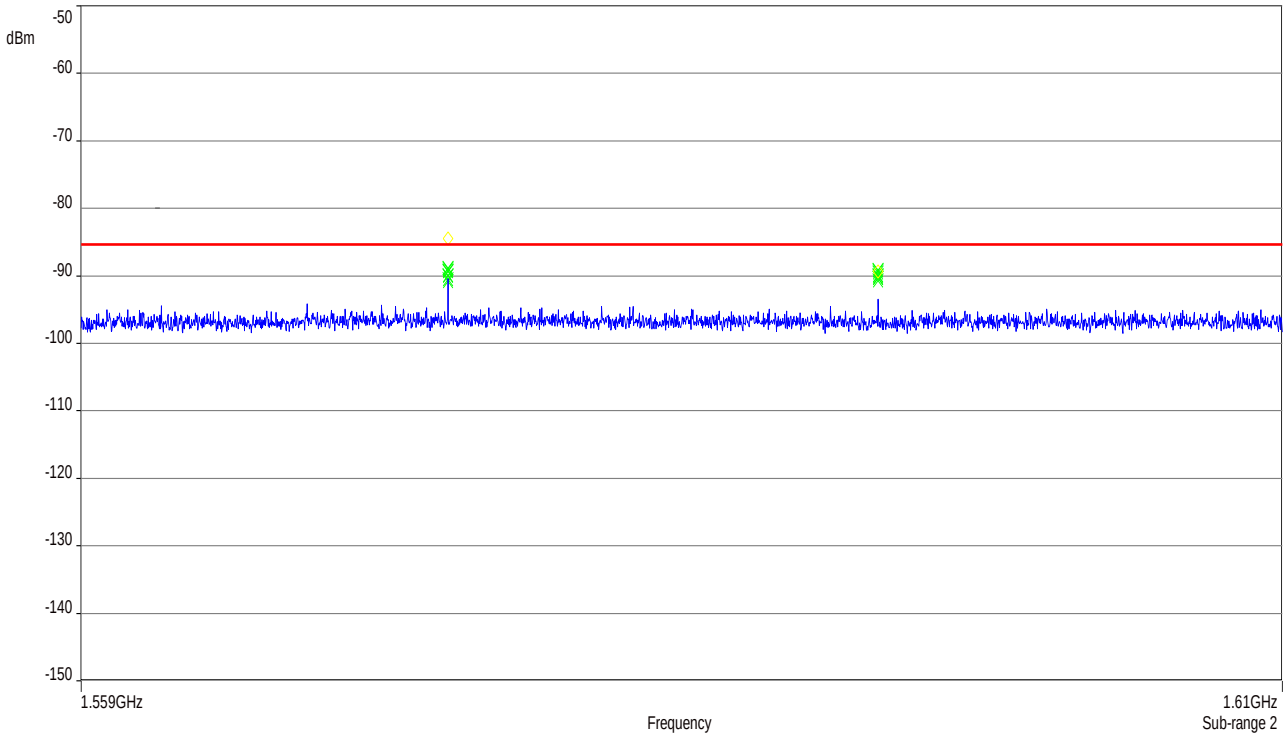
Plot 14: Channel 7, 10 GHz – 18 GHz



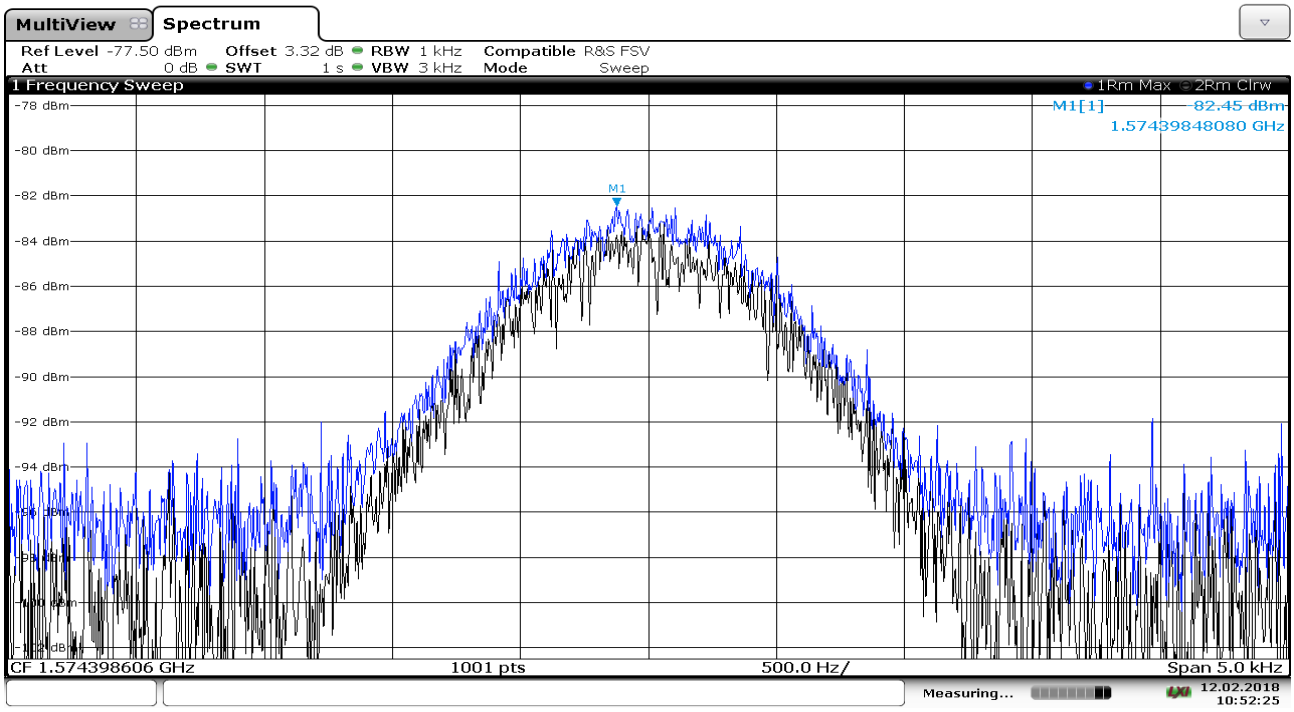
Plot 15: Channel 7, 1.164 GHz – 1.240 GHz



Plot 16: Channel 7, 1.559 GHz – 1.610 GHz



Plot 17: Channel 7, 1.5744 GHz, ABOVE LIMIT



10.3 Modification of the EUT

Description:

In order to reduce the emissions of the tests according to §15-250 (d)(2) modifications on the PCB-Layout have been performed. Said test is repeated with a modified production sample.

Fotos of the both EUT variants are included in the corresponding annexes (see chapter 5.2).

Measurement

§15.519 (d):

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

UWB-emission-Limits:

§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

Declaration of manufacturer:

Annex D of this test report shows the statement of the manufacturer to assure that the modification is applied to all future products.

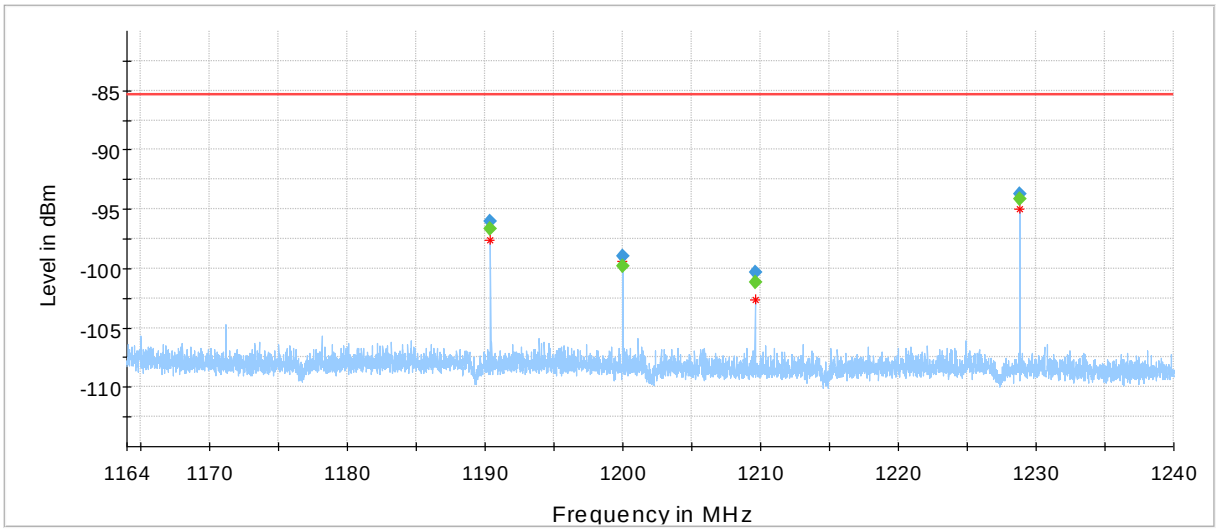
Result:

The measurement is passed. For the detailed measurement results, please refer to the plots below.

Verdict: complies

Plot 18: Channel 7, 1.164 GHz – 1.240 GHz

Full Spectrum

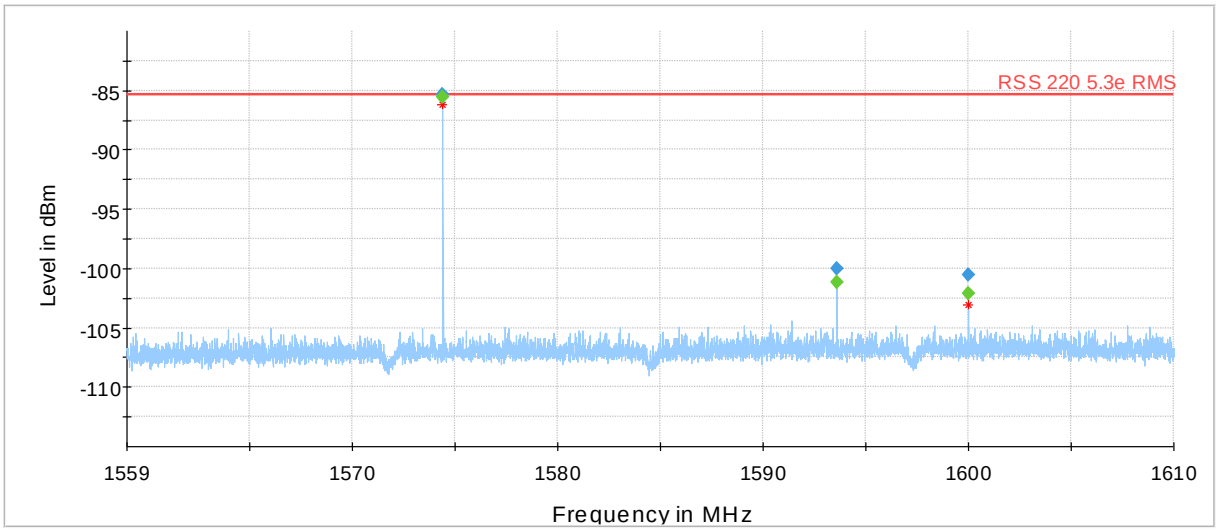


Final_Result

Frequency (MHz)	MaxPeak (dBm)	RMS (dBm)	Limit (dBm)	Margin (dB)	Bandwidth (kHz)	distance (cm)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB)
1190.3991	-96.04	---	---	---	1.000	100.0	H	170.0	0.0	-143.9
1190.3991	---	-96.67	-85.30		1.000	100.0	H	170.0	0.0	-143.9
1200.0000	-98.93	---	---	---	1.000	100.0	V	180.0	60.0	-144.0
1200.0000	---	-99.80	-85.30		1.000	100.0	V	180.0	60.0	-144.0
1209.5992	-100.35	---	---	---	1.000	100.0	H	150.0	0.0	-144.2
1209.5992	---	-101.17	-85.30		1.000	100.0	H	150.0	0.0	-144.2
1228.7991	-93.73	---	---	---	1.000	100.0	H	10.0	150.0	-144.4
1228.7991	---	-94.12	-85.30		1.000	100.0	H	10.0	150.0	-144.4

Plot 19: Channel 7, 1.559 GHz – 1.610 GHz

Full Spectrum



Final_Result

Frequency (MHz)	MaxPeak (dBm)	RMS (dBm)	Limit (dBm)	Margin (dB)	Bandwidth (kHz)	distance (cm)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB)
1574.3989	-85.37	---	---	---	1.000	100.0	H	10.0	150.0	-142.6
1574.3989	---	-85.56	-85.30		1.000	100.0	H	10.0	150.0	-142.6
1593.5989	-100.03	---	---	---	1.000	100.0	V	10.0	90.0	-142.3
1593.5989	---	-101.12	-85.30		1.000	100.0	V	10.0	90.0	-142.3
1599.9999	-100.50	---	---	---	1.000	100.0	V	120.0	120.0	-142.4
1599.9999	---	-102.07	-85.30		1.000	100.0	V	120.0	120.0	-142.4

10.4 Spurious emissions < 30 MHz on AC line while charging

Description:

Measurement of the conducted spurious emissions in charging mode below 30 MHz. The EUT is connected to its charging station. Both power lines, phase and neutral line, are measured. Found peaks are remeasured with average and quasi peak detection to show compliance to the limits.

Measurement:

Measurement parameter	
Detector:	Peak - Quasi Peak / Average
Sweep time:	Auto
Video bandwidth:	F < 150 kHz: 200 Hz F > 150 kHz: 9 kHz
Resolution bandwidth:	F < 150 kHz: 1 kHz F > 150 kHz: 100 kHz
Span:	9 kHz to 30 MHz
Trace-Mode:	Max Hold

Limits:

FCC		IC
CFR Part 15.107(a)		ICES-003, Issue 5
RX Spurious Emissions Conducted < 30 MHz		
Frequency (MHz)	Quasi-Peak (dBµV/m)	Average (dBµV/m)
0.15 – 0.5	66 to 56*	56 to 46*
0.5 – 5	56	46
5 – 30.0	60	50

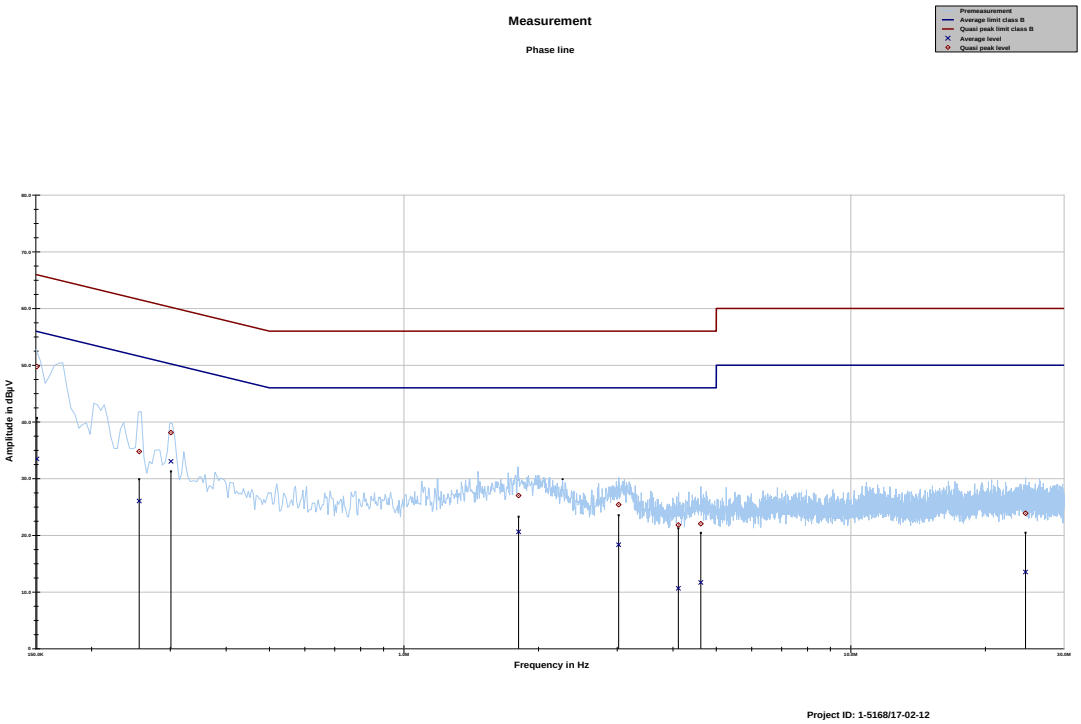
*Decreases with the logarithm of the frequency

Result:

RX Spurious Emissions Conducted < 30 MHz [dBµV/m]		
F [MHz]	Detector	Level [dBµV/m]
No critical peaks detected!		
Measurement uncertainty	± 3 dB	

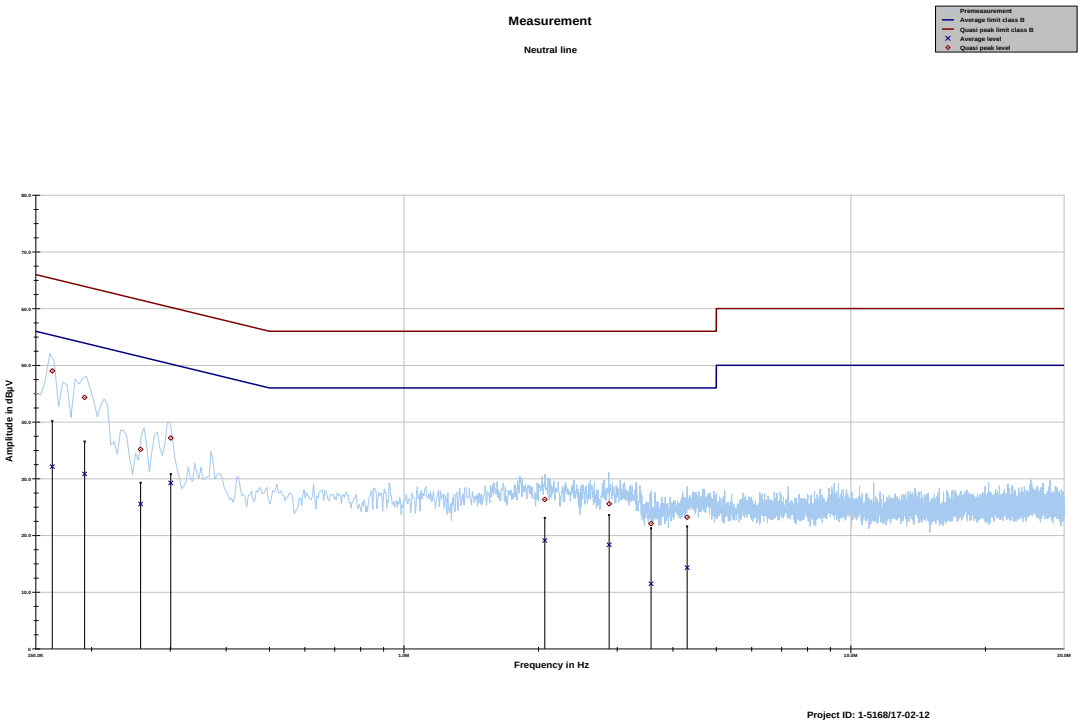
Verdict: complies

Plot 20: Charging mode, phase line



Frequency	Quasi peak level	Margin quasi peak	Limit QP	Average level	Margin average	Limit AV
MHz	dBµV	dB	dBµV	dBµV	dB	dBµV
0.150878	49.76	16.19	65.952	33.48	22.49	55.975
0.255606	34.77	26.80	61.573	26.05	26.94	52.983
0.301010	38.11	22.11	60.215	33.04	18.65	51.685
1.804995	27.02	28.98	56.000	20.61	25.39	46.000
3.023062	25.40	30.60	56.000	18.34	27.66	46.000
4.113137	21.84	34.16	56.000	10.66	35.34	46.000
4.615782	22.05	33.95	56.000	11.70	34.30	46.000
24.605291	23.88	36.12	60.000	13.53	36.47	50.000

Plot 21: Charging mode, neutral line



Frequency	Quasi peak level	Margin quasi peak	Limit QP	Average level	Margin average	Limit AV
MHz	dBµV	dB	dBµV	dBµV	dB	dBµV
0.163366	49.01	16.28	65.291	32.14	23.48	55.618
0.192989	44.33	19.58	63.907	30.84	23.93	54.772
0.257468	35.17	26.34	61.513	25.55	27.38	52.929
0.300740	37.18	23.05	60.222	29.26	22.43	51.693
2.065967	26.34	29.66	56.000	19.10	26.90	46.000
2.879491	25.58	30.42	56.000	18.36	27.64	46.000
3.572598	22.08	33.92	56.000	11.49	34.51	46.000
4.304299	23.22	32.78	56.000	14.31	31.69	46.000

11 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

12 Document history

Version	Applied changes	Date of release
-/-	Initial release	2019-02-22
-A	minor editorial changes	2019-03-29
-B	Centre frequency of channel 7 added (chapter 5.2)	2019-04-05

13 Accreditation Certificate

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

http://www.dakks.de/as/ast/d/D-PL-12076-01-03.pdf