Test report

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RF test report

160583-AU01+W03

Industry Canada Industrie Canada

DewertOkin GmbH

RF Gateway

Bluetooth RF-Gateway
(SRD mode)

EMV TESTHAUS

The test result refers exclusively to the model tested.
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EMV **TESTHAUS** GmbH

DAkkS Deutsche Akkreditierungsstelle
D-PL-12155-01-00

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Accreditation:

DAkkS
Deutsche
Akkreditierungsstelle
D-PL-12155-01-00

FCC facility registration number: 221458
Test Firm Type “2.948 listed”: Valid until 2017-04-22
Test Firm Type “accredited”: Valid until 2017-06-09
MRA US-EU, FCC designation number: DE0010
BnetzA-CAB-02/21-02/04 Valid until 2018-11-27

Industry Canada test site numbers with registration expiry date:
3472A-1, expiring 2018-11-09
3472A-2, expiring 2018-11-12

Test laboratory:

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The technical accuracy is guaranteed through the quality management of EMV **TESTHAUS** GmbH.

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1 Summary of test results

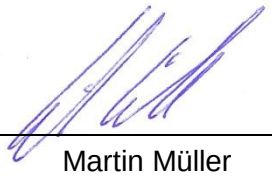
System type: Digital transmission system (DTS)

47 CFR part and section	*Test*	*Equivalent to IC radio standard(s)*	*Page*	*Result*	*Note(s)*
15.207	AC power line conducted emissions 150 kHz to 30 MHz	RSS-Gen Issue 4, section 8.8	21	Passed	---
15.247(a)(1) KDB 558074, section 8	20 dB bandwidth	RSS-247 Issue 2, section 5.1(b)	25	Passed	---
15.247(a)(2) KDB 558074, section 8	6 dB bandwidth	RSS-247 Issue 2, section 5.2(a)	29	Passed	1
2.202(a) ANSI C63.10	Occupied bandwidth (99 %)	RSS-Gen Issue 4, section 6.6	33	For reference only	1
15.247(b) KDB 558074, section 9	Maximum conducted output power	RSS-Gen Issue 4, section 6.12 RSS-247 Issue 2, section 5.4	37	Passed	---
15.247(e) KDB 558074, section 10	Power spectral density	RSS-247 Issue 2, section 5.2(b)	41	Passed	---
15.247(d) KDB 558074, sections 11 & 12	Antenna-port conducted measurements	RSS-247 Issue 2, section 5.5	---	Not applicable	2
15.247(d) KDB 558074, section 13	Band-edge compliance (radiated)	RSS-247 Issue 2, section 5.5	48	Passed	---
15.247(d) KDB 558074, sections 11 & 12	Spurious radiated emissions 9 kHz to 10th harmonic	RSS-Gen Issue 4, section 6.13 RSS-247 Issue 2, section 5.5	55	Passed	---
2.1091	RF exposure evaluation for mobile devices	RSS-Gen Issue 4, section 3.2 (exempted form SAR and RF evaluation)	73	Passed	---

Notes:

1 For systems using digital modulation techniques the 6 dB bandwidth (DTS bandwidth) is regarded as the occupied bandwidth.
2 Spurious radiated emissions 9 kHz to 10th harmonic performed

Straubing, March 8, 2017



Martin Müller
Test engineer
EMV **TESTHAUS** GmbH

Rainer Heller
Head of EMC / radio department
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2 Referenced publications

Publication	*Title*
CFR 47 Part 2 October 2016	Code of Federal Regulations, Title 47 (Telecommunication), Part 2 (Frequency allocation and radio treaty matters; General rules and regulations) of the Federal Communication Commission (FCC)
CFR 47 Part 15 October 2016	Code of Federal Regulations, Title 47 (Telecommunication), Part 15 (Radio Frequency Devices) of the Federal Communication Commission (FCC)
KDB Publication no. 412172 August 7, 2015	Guidelines for determining the Effective Radiated Power (ERP) and Equivalent Isotropically Radiated Power (EIRP) of an RF transmitting system
KDB Publication no. 447498 October 23, 2015	RF exposure procedures and equipment authorization policies for mobile and portable devices
KDB Publication no. 558074 April 8, 2016	Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247
KDB Publication no. 558074 April 8, 2016	Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247
ANSI C63.10 June 2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
RSS-Gen, Issue 4 November 2014	Spectrum Management and Telecommunications - Radio Standards Specification - General Requirements for Compliance of Radio Apparatus
RSS-102, Issue 5 March 2015	Spectrum Management and Telecommunications - Radio Standards Specification - Radio Frequency Exposure Compliance of Radiocommunications Apperatus
RSS-247, Issue 2 February 2017	Spectrum Management and Telecommunications - Radio Standards Specification - Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices

3 Equipment under test (EUT)

Product type:	RF Gateway	
Model name:	Bluetooth RF-Gateway	
Serial number(s):	D123456 0001 -> for radiated tests D123456 0002 -> for conducted tests	
Applicant:	DewertOkin GmbH	
Manufacturer:	DewertOkin GmbH	
Version:	Hardware: Software:	--- ---
Additional modifications:	None	
FCC ID:	O3YGATEWAY1089	
IC registration number:	10744A-GATEWAY1089	
Application frequency band:	2400.0 MHz - 2483.5 MHz	
Frequency range:	2403.0 MHz - 2480.0 MHz	
Operating frequencies:	2403.0 MHz - 2480.0 MHz	
Channel spacing:	1 MHz	
Number of RF channels:	76	
System type:	Digital transmission system (DTS)	
Modulation type(s):	GFSK	
Class of emission:	F1D	
Antenna type(s):	PCB antenna (F-Antenna layouted)	
Antenna gain(s):	approximately 0 dBi	
Power supply:	AC supply	
	Nominal voltage: Minimum voltage: Maximum voltage: Nominal frequency:	120.0 V 100.0 V 240.0 V 60 Hz
Temperature range:	0 °C to +40 °C	
Device type:	☐ Portable	☒ Mobile ☐ Fixed

4 Test configuration and mode of operation

4.1 Test configuration

Device	*Type designation*	*Serial or inventory no.*	*Manufacturer*
RF Gateway	Bluetooth RF-Gateway	D123456 0001	DewertOkin GmbH
RF Gateway	Bluetooth RF-Gateway	D123456 0002	DewertOkin GmbH
AC power source (120 VAC / 60 Hz)	61605	SEB00214	CHROMA A.T.E.

Table 1: Devices used for testing

Port	*Classification*	*Cable type*	*Cable length*	
			used	*maximum*[1]
AC power	ac power	Unshielded	1.5 m	---

Table 2: Ports of EUT and appropriate cables

4.2 Attenuation of test cable(s)

Frequency (MHz)	*Attenuation (dB).*
2403.0	0.54
2440.0	0.55
2480.0	0.55

Table 3: Attenuation of test cable

4.3 Mode of operation

EUT was tested in following mode(s) of operation:

SRD mode

Channel low -> 2403.0 MHz (modulated / unmodulated)
Channel mid -> 2440.0 MHz (modulated / unmodulated)
Channel high -> 2480.0 MHz (modulated / unmodulated)

Note: Test results of EUT operating in BLE mode can be found in test report no. 160583-AU01+W04.

[1] As specified by applicant

5 Measurement Procedures

5.1 AC power line conducted emissions 150 kHz to 30 MHz

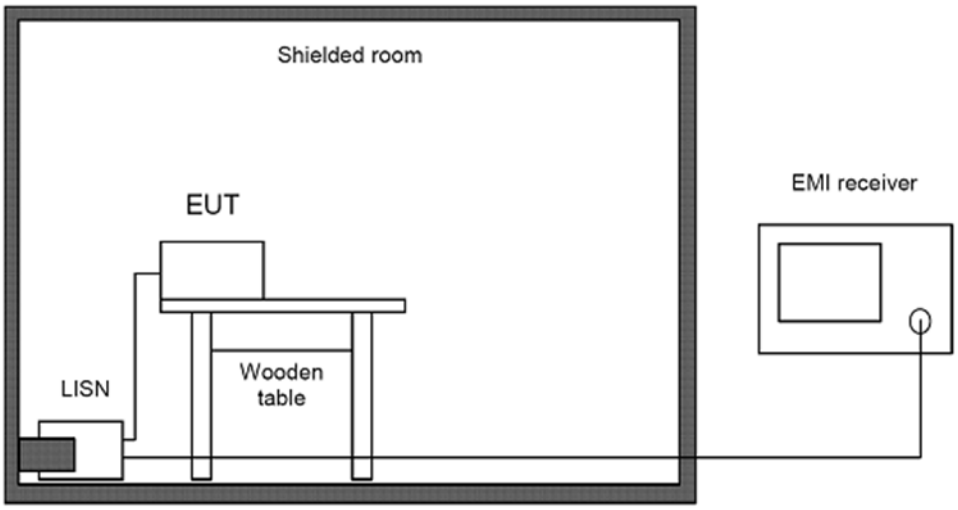


Figure 1: Setup for AC power line conducted emissions test 150 kHz to 30 MHz

The AC power line conducted emissions test method refers to section 6.2 of ANSI C63.10 and shall be as follows:
The tests of conducted emission are carried out in a shielded room using a line impedance stabilization network (LISN) 50 µH/50 Ohms and a EMI test receiver. The EMI test receiver is connected to the LISN and set to a measurement bandwidth of 9 kHz in the frequency range from 0.15 MHz to 30 MHz. The EUT is placed on a wooden table and connected to the LISN.
For prescan covering the whole frequency range from 0.15 MHz to 30 MHz the detector function oft he EMI test receiver is set to peak. After that, all peak values with less margin than 10 dB to quasi-peak limit or exceeding the limit are marked and re-measured with quasi-peak detector. If all values are below the average limit no additional measurement is necessary. Otherwise these values are re-measured using an average detector.
All peripheral devices are decoupled by connecting them to an additional line stabilization network.

5.2 20 dB bandwidth (DTS)

The 20 dB bandwidth test method for DTS systems shall be analog to the 6 dB bandwidth test method for DTS systems.

For test setup see clause 5.9.

5.3 6 dB bandwidth (DTS)

The 6 dB bandwidth (DTS bandwidth) test method for DTS systems refers to section 8.0 of KDB 558074 D01 and shall be as follows:

Spectrum analyzer settings:
Span = centered on a channel, wide enough to capture the whole channel
RBW = 100 kHz
VBW ≥ 3 x RBW
Sweep time = auto coupled
Detector function = peak
Trace mode = max hold
Reference level: more than 10·log(OBW/RBW) dB above peak of spectral envelope

Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.
If possible, use the automatic bandwidth measurement capability of the spectrum analyzer using the X dB bandwidth mode with X set to 6 dB. Submit this plot(s).

For test setup see clause 5.9.

5.4 Occupied bandwidth (99%)

The occupied bandwidth test method refers to section 6.9.3 of ANSI C63.10 and shall be as follows:

Spectrum analyzer settings:
Span = between 1.5 times and 5.0 times of the OBW, centered on a channel
RBW ≥ in the range of 1% to 5% of the OBW
VBW ≥ approximately three times the RBW
Sweep time = auto coupled
Detector function = peak
Trace mode = max hold
Reference level: more than 10·log(OBW/RBW) dB above peak of spectral envelope

Use the 99% power bandwidth function of the spectrum analyzer and report the measured bandwidth.

For test setup see clause 5.9.

5.5 Maximum conducted output power (DTS)

The maximum conducted output power test method for DTS systems refers to section 9.1.1 of KDB 558074 D01 and shall be as follows:

Spectrum analyzer settings:
Span ≥ 3 x RBW, centered on a channel
RBW ≥ DTS bandwidth
VBW ≥ 3 x RBW
Sweep time = auto coupled
Detector function = peak
Trace mode = max hold
Reference level: more than 10·log(OBW/RBW) dB above peak of spectral envelope

Allow the trace to stabilize. Use the marker-to-peak function to set the marker to the peak of the emission. The indicated level is the maximum conducted output power. Submit this plot(s).

For test setup see clause 5.9.

5.6 Power spectral density

The power spectral density test method refers to section 10.2 of KDB 558074 D01 and shall be as follows:

Spectrum analyzer settings:
Span = 1.5 times the DTS bandwidth, centered on a channel
RBW: 3 kHz ≤ RBW ≤ 100 kHz
VBW ≥ 3 x RBW
Sweep time = auto coupled or ≥ span/RBW in seconds, whichever is greater
Detector function = peak
Trace mode = max hold
Reference level: more than 10·log(OBW/RBW) dB above peak of spectral envelope

Allow the trace to stabilize. Use the marker-to-peak function to set the marker to the peak of the emission. The indicated level is the power spectral density. Submit this plot(s).

For test setup see clause 5.9.

5.7 Band-edge compliance (radiated)

For test setup and test method see clause 5.10.

5.8 Spurious radiated emissions 9 kHz to 10th harmonic

For test setup and test method see clause 5.10.

5.9 Conducted emissions at antenna connector

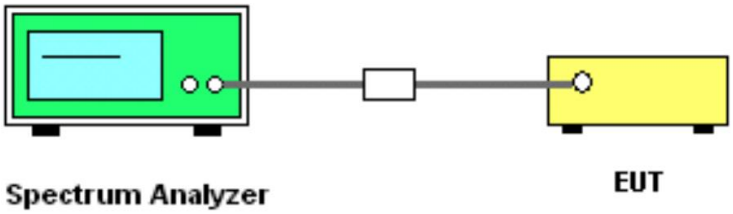


Figure 2: Setup for conducted emission test at antenna connector

The RF signal of the EUT is measured at the antenna connector. In case of no permanent antenna connector, a temporary antenna connector is supplied by the manufacturer. The specific insertion loss of the signal path, which is matched to 50 Ohm, is evaluated within a calibration. The test receiver is set to analyzer mode with pre-selector activated. The measurement readings on the test receiver are corrected by the signal path loss.

5.10 Radiated emissions

5.10.1 Radiated emissions below 30 MHz

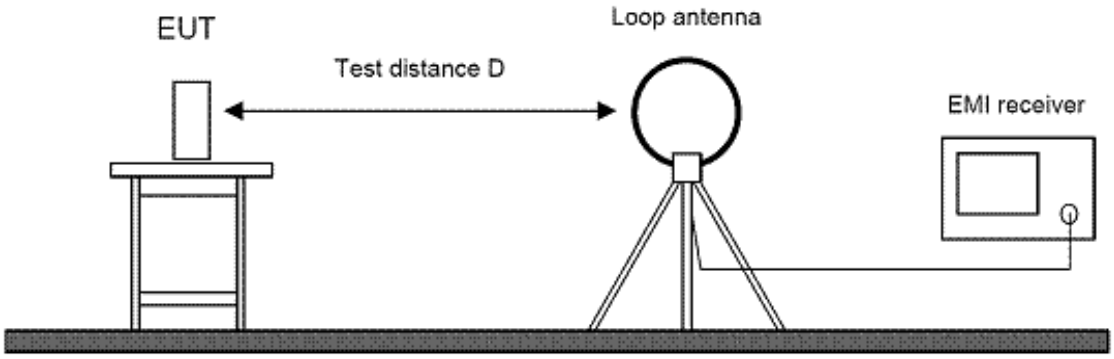


Figure 3: Setup for radiated emission test below 30 MHz

The test method for radiated emissions below 30 MHz refers to section 6.4 of ANSI C63.10 and shall be as follows:

1. EUT is configured according to ANSI C63.10. It is placed on the turntable 0.8 meter above ground. The receiving antenna is located 3 meters from the EUT. The test setup is placed inside a compact diagnostic chamber.
2. EUT and all peripherals are powered on.
3. The loop antenna is set in parallel with the antenna of the EUT.
4. The EMI receiver performs a scan from 9 kHz to 30 MHz with peak detector and measurement bandwidth set to 200 Hz for frequencies up to 150 kHz and 9 or 10 kHz for frequencies above.
5. The turn table is rotated to 8 different positions (360° / 8).
6. The antenna is set in line with the antenna of the EUT and steps 4 and 5 are repeated.
7. Then the test setup is placed in an OATS with 3 m distance and all peak values over the limit or with less margin than 10 dB are marked and re-measured with a quasi-peak detector except for the frequency bands 9 to 90 kHz and 110 to 490 k Hz, where average detector applies.
8. The turntable is rotated by 360 degrees to determine the position of the highest radiation.
9. The highest value for each frequency is recorded.

5.10.2 Radiated emissions from 30 MHz to 1 GHz

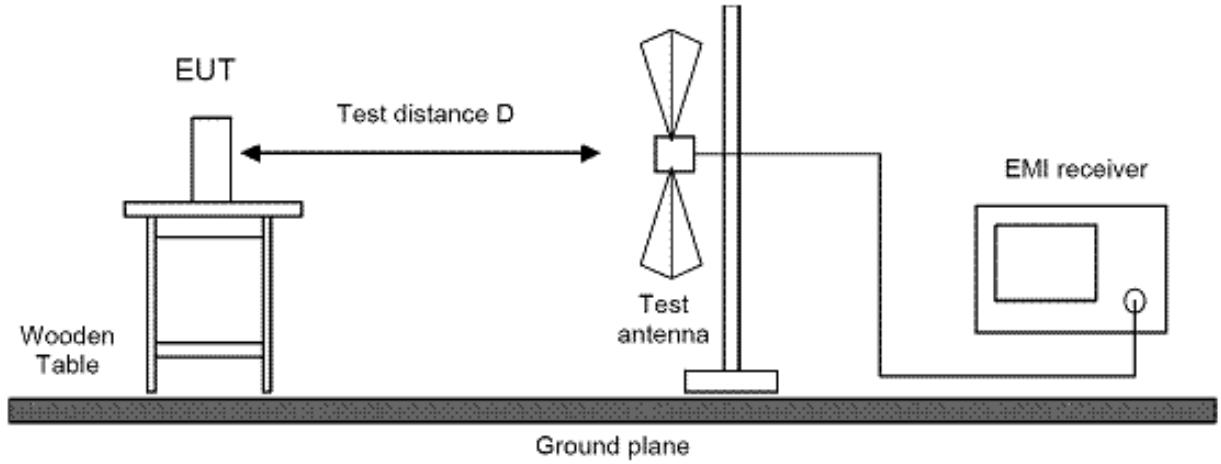


Figure 4: Setup for radiated emission test from 30 MHz to 1 GHz

The test method for radiated emissions from 30 MHz to 1 GHz refers to section 6.5 of ANSI C63.10 and shall be as follows:

1. EUT is configured according to ANSI C63.10. It is placed on the turntable 0.8 meter above ground. The receiving antenna is located 3 meters from the EUT. The test setup is placed inside a compact diagnostic chamber.
2. EUT and all peripherals are powered on.
3. The broadband antenna is set to vertical polarization.
4. The EMI receiver performs a scan from 30 MHz to 1000 MHz with peak detector and measurement bandwidth set to 120 kHz.
5. The turn table is rotated to 6 different positions (360° / 6).
6. The antenna polarization is changed to horizontal and steps 4 and 5 are repeated.
7. Then the test setup is placed in an OATS at 3 m distance and all peak values over the limit or with less margin than 10 dB are marked and re-measured with a quasi-peak detector.
8. The turntable is rotated by 360 degrees to determine the position of the highest radiation.
9. The height of the broadband receiving antenna is varied between 1 meter and 4 meters above ground to find the maximum emission field strength of both horizontal and vertical polarization.
10. The highest value for each frequency is recorded.

5.10.3 Radiated emissions from above 1 GHz

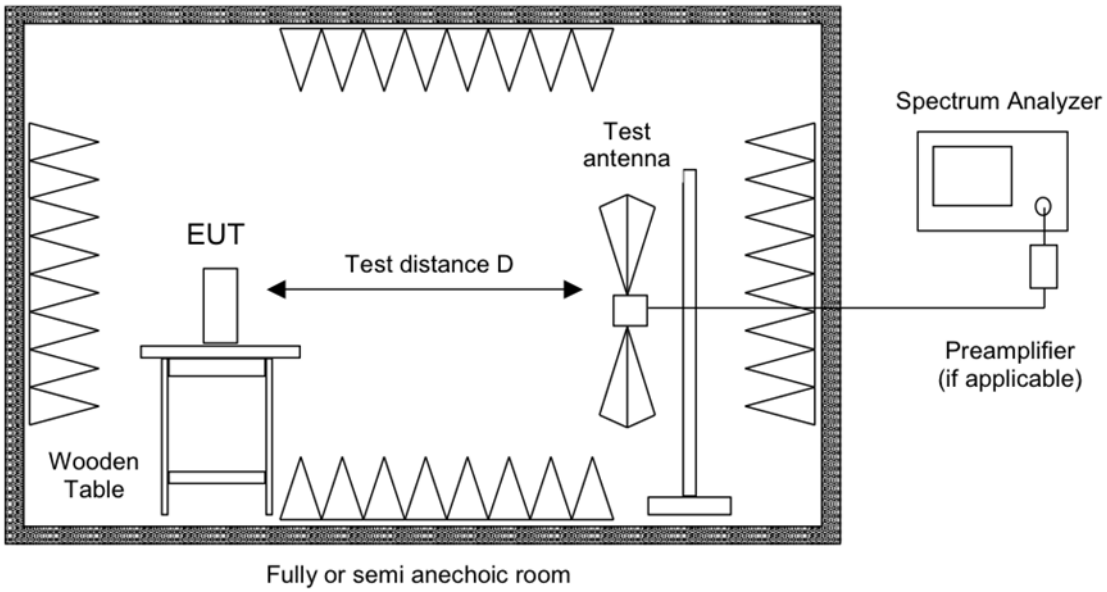


Figure 5: Setup for radiated emission test above 1 GHz

The test method for radiated emissions above 1 GHz refers to section 6.6 of ANSI C63.10 and shall be as follows:

1. EUT is configured according to ANSI C63.10. It is placed on the turntable 1.5 meter above ground. The test setup is placed inside a semi-anechoic chamber with RF absorbers on the floor.
2. EUT and all peripherals are powered on.
3. To identify the critical frequencies, extrapolatory radiated emission tests are performed at a closer distance than 3 meters (e.g. 1 meter). The critical frequencies found are noted.
4. For pre-scan the receiving antenna is located 3 meters from the EUT.
5. The broadband horn antenna is set to vertical polarization.
6. The EMI receiver performs a scan from 1 GHz to the 10th harmonic of the fundamental frequency with peak and average detector activated simultaneously and measurement bandwidth set to 1 MHz. The trace data is recorded using the max hold function.
7. The turntable is rotated in steps of 15°.
8. After a full turn by 360° the antenna polarization is changed to horizontal and steps 4 and 5 are repeated.
9. After the scan all peak values over the limit or with less margin than 10 dB are marked. If critical frequencies recorded during extrapolatory radiated emission tests are not contained, they are added to this list.
10. Emission levels at listed frequencies are maximized by moving the turntable and varying the antenna height until maximum of emission is found.
11. The turntable is rotated by 360 degrees to determine the position of the highest radiation.

12. The height of the broadband receiving antenna is varied between 1 meter and the upper height above ground to find the maximum emission field strength of both horizontal and vertical polarization. For equipment that is tested in multiple orientations, the upper height is limited to 2.5 meters or 0.5 meters above the top of the EUT, whichever is higher. For all other equipment the upper height is 4 meters.
13. The highest value for each frequency is recorded.

6 Test results

This clause gives details about the test results as collected in the summary of test results on page 6.

6.1 AC power line conducted emissions 150 kHz to 30 MHz

47 CFR part and section: 15.207

Equivalent to IC radio standard(s): RSS-Gen Issue 4, section 8.8

Measurement procedure: See 5.1

Performed by:	Martin Müller	Date of test:	February 20, 2017
Result	☒ Test passed	☐ Test not passed	

6.1.1 Test equipment

	Type	*Designation*	*Manufacturer*	*Inventory no.*
☒	Shielded room	P92007	Siemens Matsushita	E00107
☐	EMI test receiver	ESCI 3	Rohde & Schwarz	E00001
☐	EMI test receiver	ESU 26	Rohde & Schwarz	W00002
☒	EMI test receiver	ESCS 30	Rohde & Schwarz	E00003
☒	Artificial mains network	ESH2-Z5	Rohde & Schwarz	E00004
☐	Artificial mains network	ESH2-Z5	Rohde & Schwarz	E00005
☒	Attenuator (10 dB)	50FHB-010-10	JFW Industries	E00471
☒	Measurement software	E10	ib comPLAN	E00443

6.1.2 Limits

Frequency [MHz]	**Quasi-peak [dBµV]**	**Avarage [dBµV]**
0.15 – 0.5	66 – 56	56 – 46
0.5 – 5.0	56	46
5 – 30	60	50

6.1.3 Test results

Frequency range	*Step size*	*IF Bandwidth*	*Detector*		*Measurement Time*		*Preamplifier*
			Prescan	*Final scan*	*Prescan*	*Final scan*	
150 kHz – 30 MHz	4 kHz	9 kHz	PK	AV	1 ms	1 s	off
150 kHz – 30 MHz	4 kHz	9 kHz	PK	QPK	1 ms	1 s	off

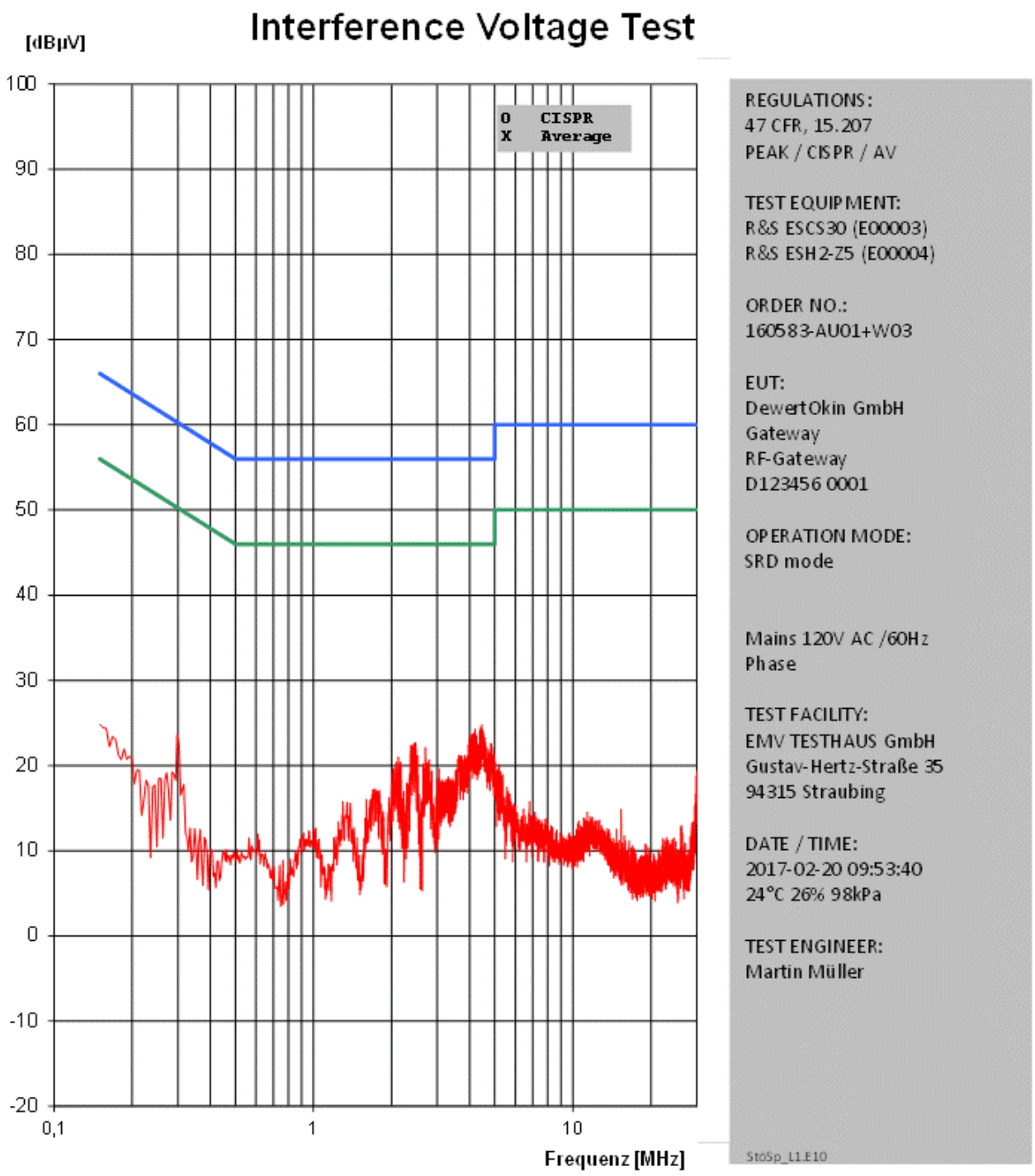


Figure 6: Chart of AC power line conducted emissions test 150 kHz to 30 MHz – phase L1

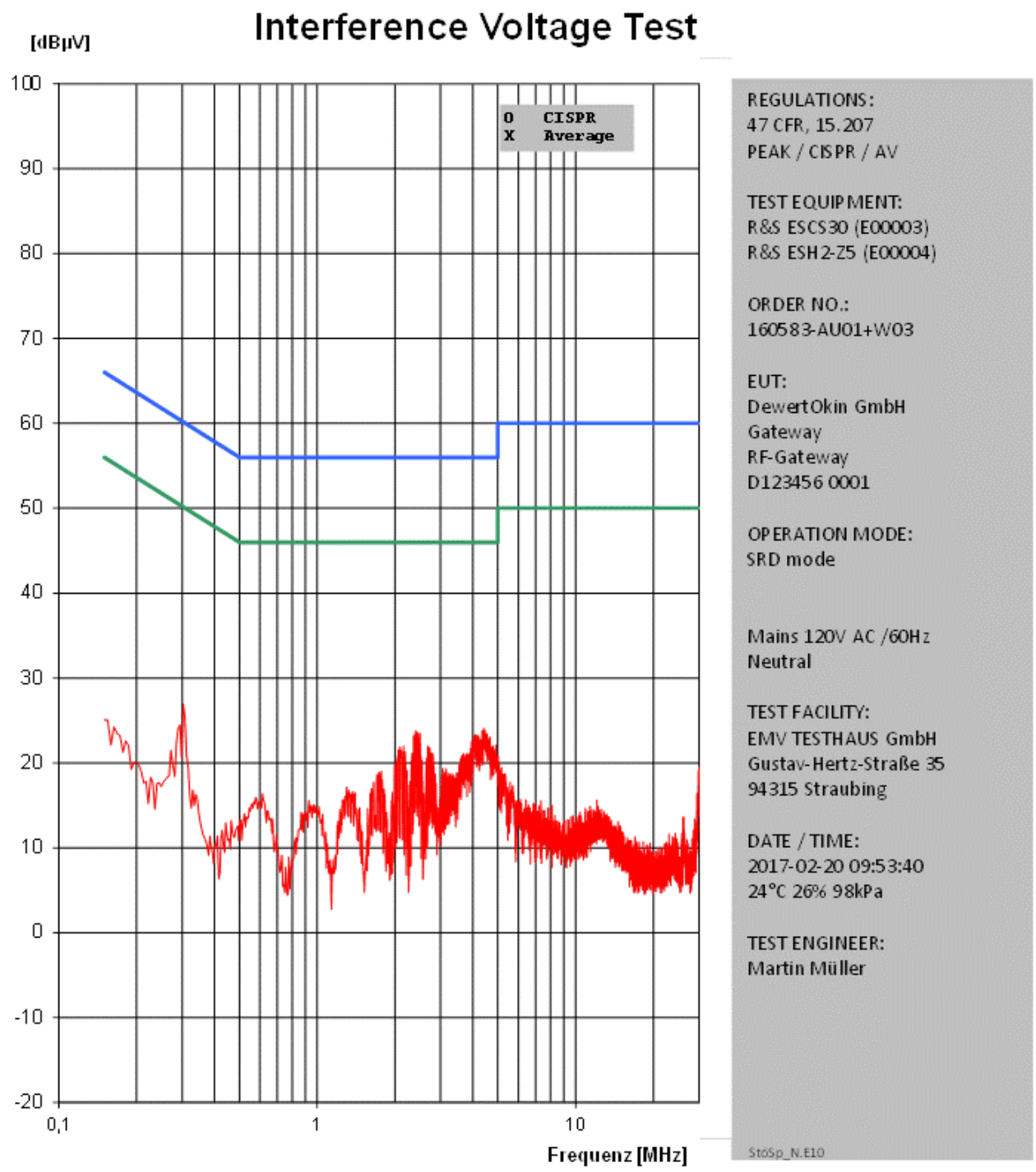


Figure 7: Chart of AC power line conducted emissions test 150 kHz to 30 MHz – phase N

6.2 20 dB bandwidth

47 CFR part and section:	15.247(a)(1)
Equivalent to IC radio standard(s):	RSS-247 Issue 2, section 5.1(b)
Measurement procedure:	See 5.2

Performed by:	Martin Müller	Date of test:	February 10, 2017
Result	☒ Test passed	☐ Test not passed	

6.2.1 Test equipment

	Type	*Designation*	*Manufacturer*	*Inventory no.*
☒	Laboratory environment	---	---	---
☐	EMI test receiver	ESCI 3	Rohde & Schwarz	E00001
☒	EMI test receiver	ESU 26	Rohde & Schwarz	W00002

6.2.2 Limits for digital transmission systems

None -> results recorded for information only.

6.2.3 Test results

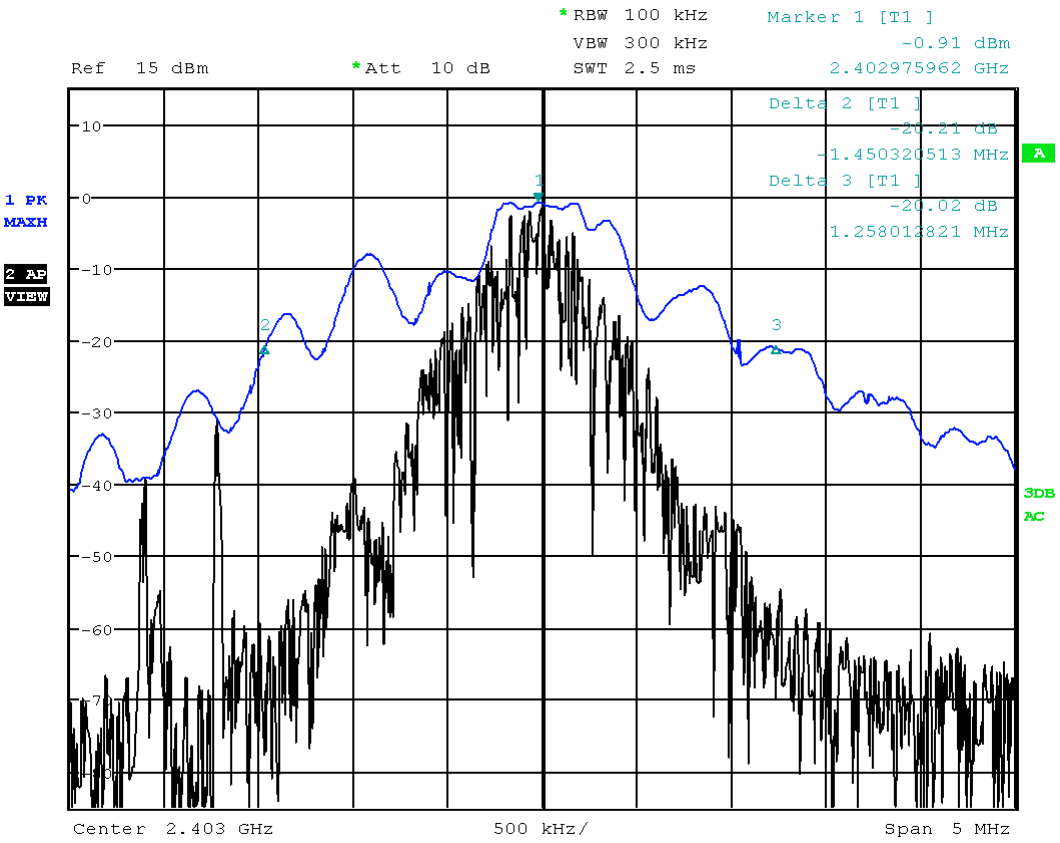


Figure 8: Chart of 20 dB bandwidth test, channel low

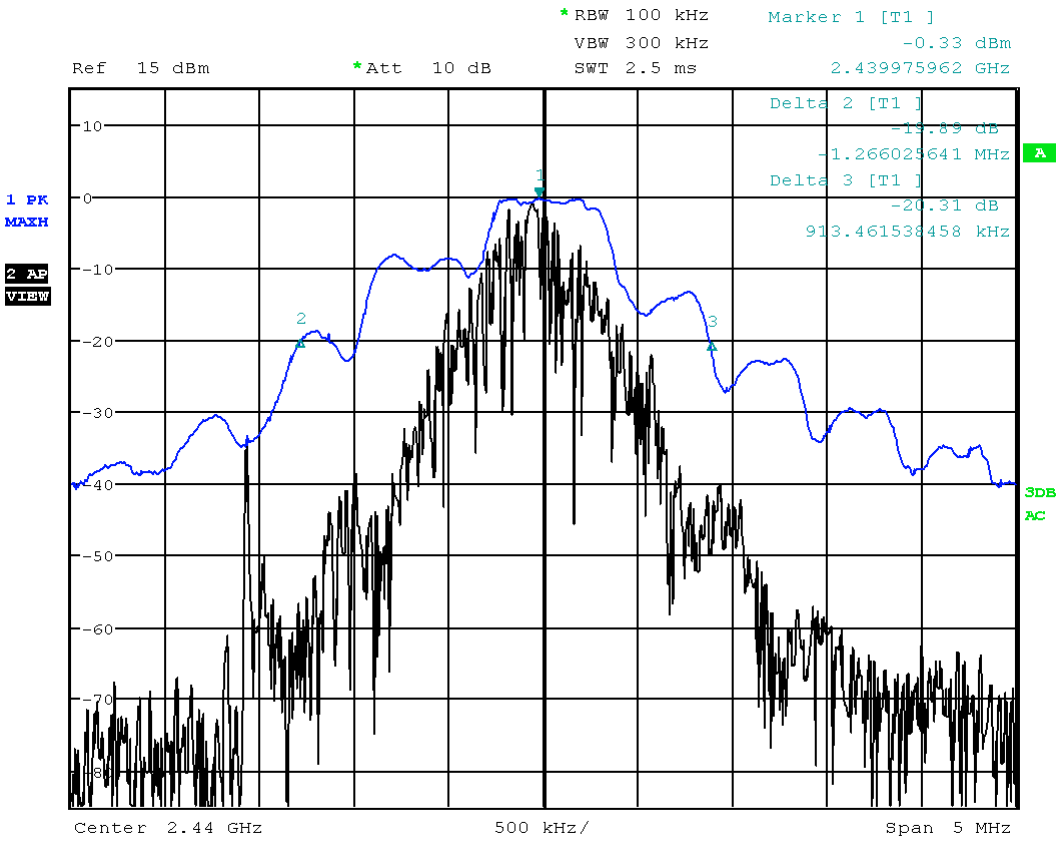


Figure 9: Chart of 20 dB bandwidth test, channel mid

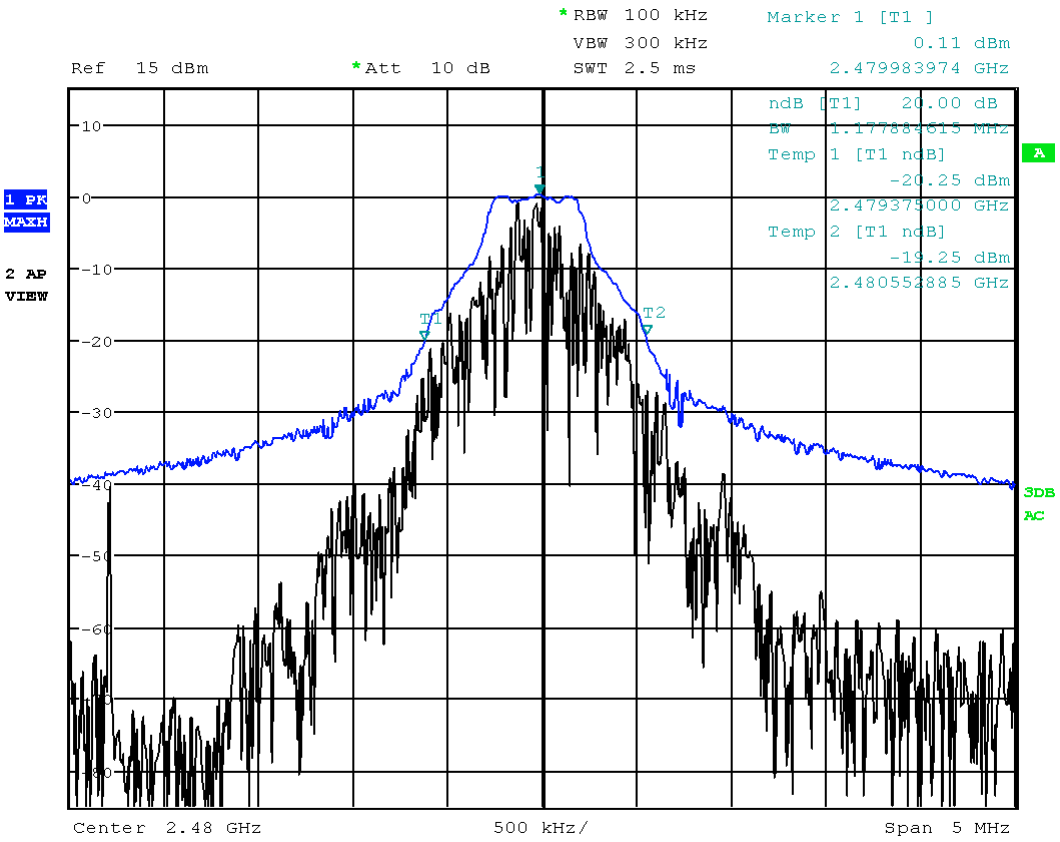


Figure 10: Chart of 20 dB bandwidth test, channel high

f [MHz]	20dB-BW [MHz]	f_{lower} [MHz]	f_{upper} [MHz]	Lower band edge [MHz]	Upper band edge [MHz]	Result
2402.976	2.708	2401.526	2404.234	2400.0	2483.5	within band
2439.976	2.179	2438.710	2440.889	2400.0	2483.5	within band
2479.984	1.178	2479.375	2480.553	2400.0	2483.5	within band

Table 4: Final results of 20 dB bandwidth test

Note: Different shape of traces recorded in maxhold mode is caused by behavior of temporary spikes (for snapshot see second trace in view mode)

6.3 6 dB bandwidth

47 CFR part and section:	15.247(a)(2)
Equivalent to IC radio standard(s):	RSS-247 Issue 2, section 5.2(a)
Measurement procedure:	See 5.3

Performed by:	Martin Müller	Date of test:	February 10, 2017
Result:	☒ Test passed	☐ Test not passed	

6.3.1 Test equipment

	Type	*Designation*	*Manufacturer*	*Inventory no.*
☒	Laboratory environment	---	---	---
☐	EMI test receiver	ESCI 3	Rohde & Schwarz	E00001
☒	EMI test receiver	ESU 26	Rohde & Schwarz	W00002

6.3.2 Limits for digital transmission systems

The minimum 6 dB bandwidth shall be at least 500 kHz.
In addition the 6 dB bandwidth must be contained within the designated frequency band.

6.3.3 Test results

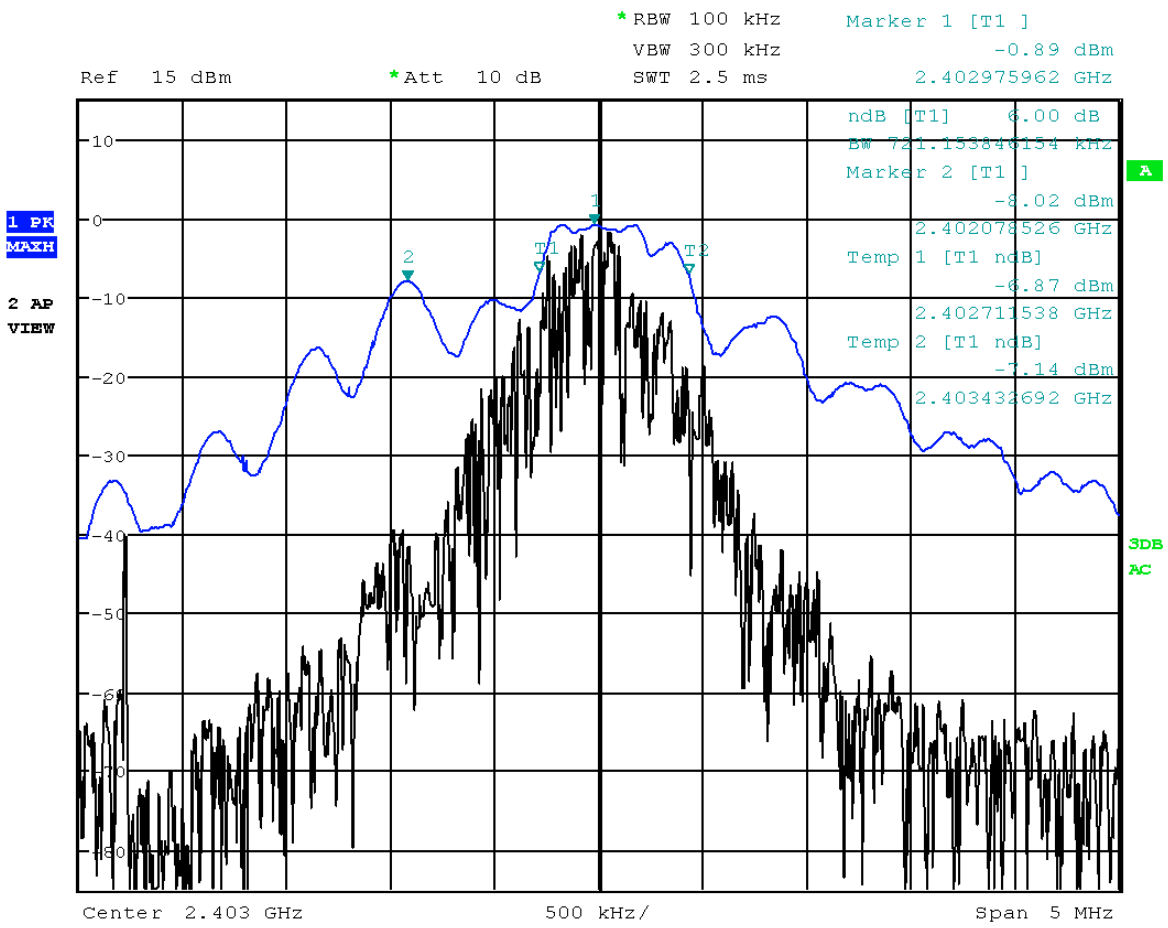


Figure 11: Chart of 6 dB bandwidth test, channel low

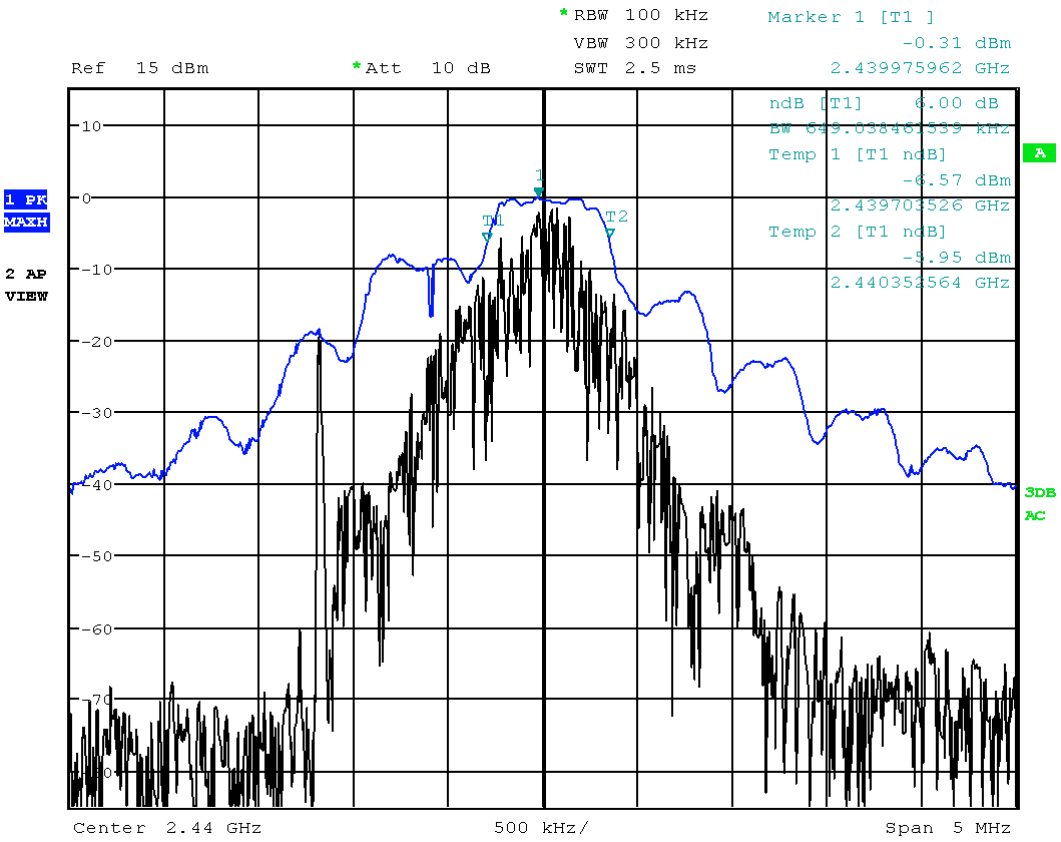


Figure 12: Chart of 6 dB bandwidth test, channel mid

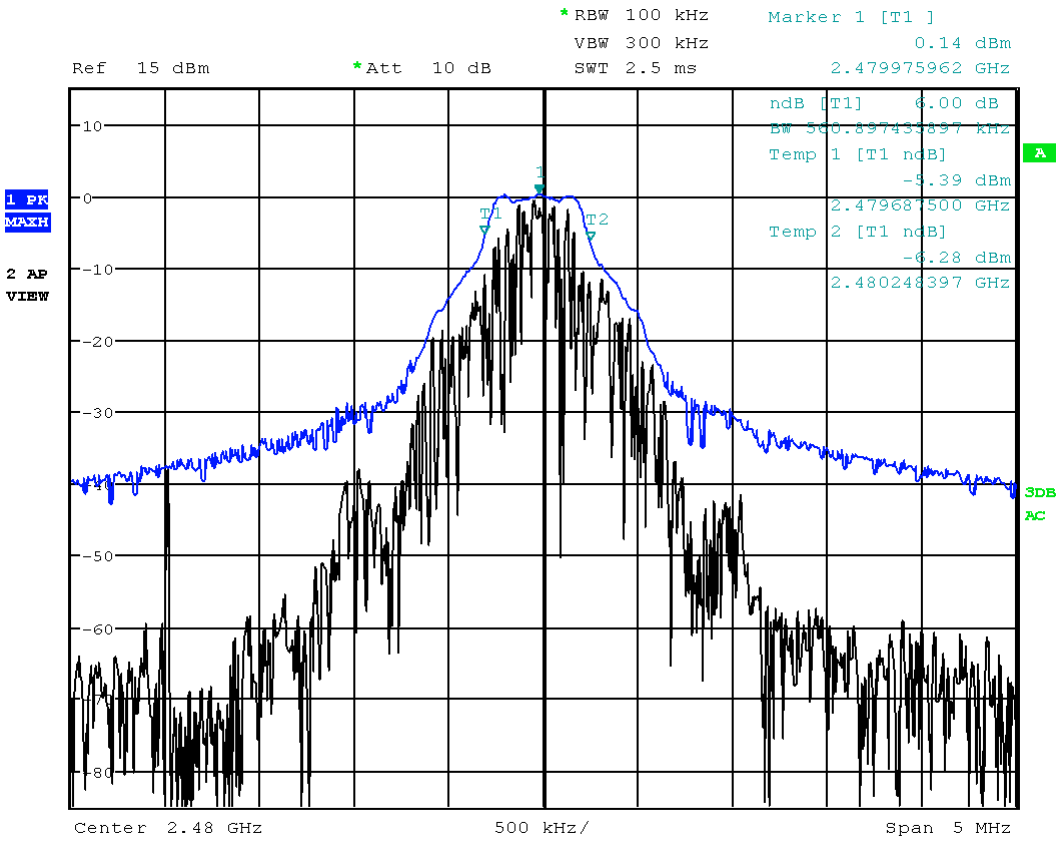


Figure 13: Chart of 6 dB bandwidth test, channel high

f [MHz]	6dB-BW [MHz]	f_{lower} [MHz]	f_{upper} [MHz]	Lower band edge [MHz]	Upper band edge [MHz]	Result
2402.976	0.721	2402.079	2403.432	2400.0	2483.5	Pass
2439.976	0.649	2439.704	2440.353	2400.0	2483.5	Pass
2479.976	0.561	2479.688	2480.248	2400.0	2483.5	Pass

Table 5: Final results of 6 dB bandwidth test

Note: Different shape of traces recorded in maxhold mode is caused by behavior of temporary spikes (for snapshot see second trace in view mode)

6.4 Occupied bandwidth

47 CFR part and section:	2.202(a)
Equivalent to IC radio standard(s):	RSS-Gen Issue 4, section 6.6
Measurement procedure:	See 5.4

Performed by:	Martin Müller	Date of test:	February 10, 2017
Result	☒ Test passed	☐ Test not passed	

6.4.1 Test equipment

	Type	*Designation*	*Manufacturer*	*Inventory no.*
☒	Laboratory environment	---	---	---
☐	EMI test receiver	ESCI 3	Rohde & Schwarz	E00001
☒	EMI test receiver	ESU 26	Rohde & Schwarz	W00002

6.4.2 Limits

None -> results recorded for setting the proper reference level.

6.4.3 Test results

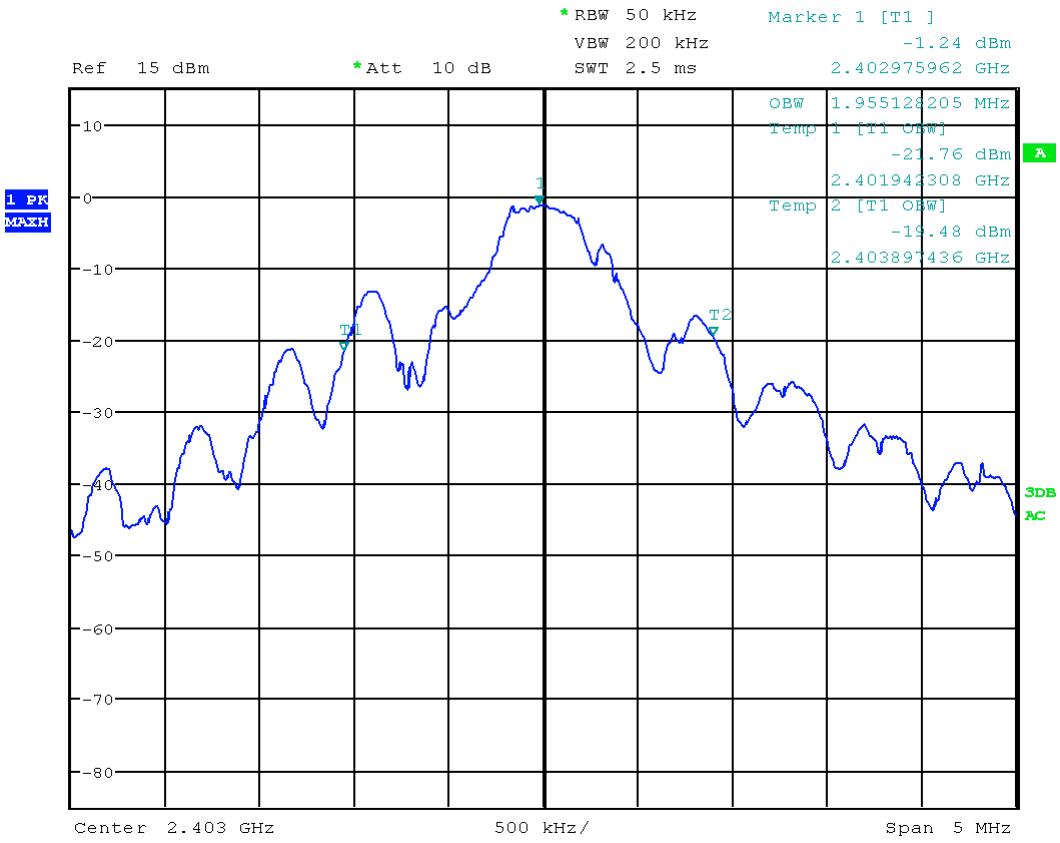


Figure 14: Chart of occupied bandwidth test, channel low

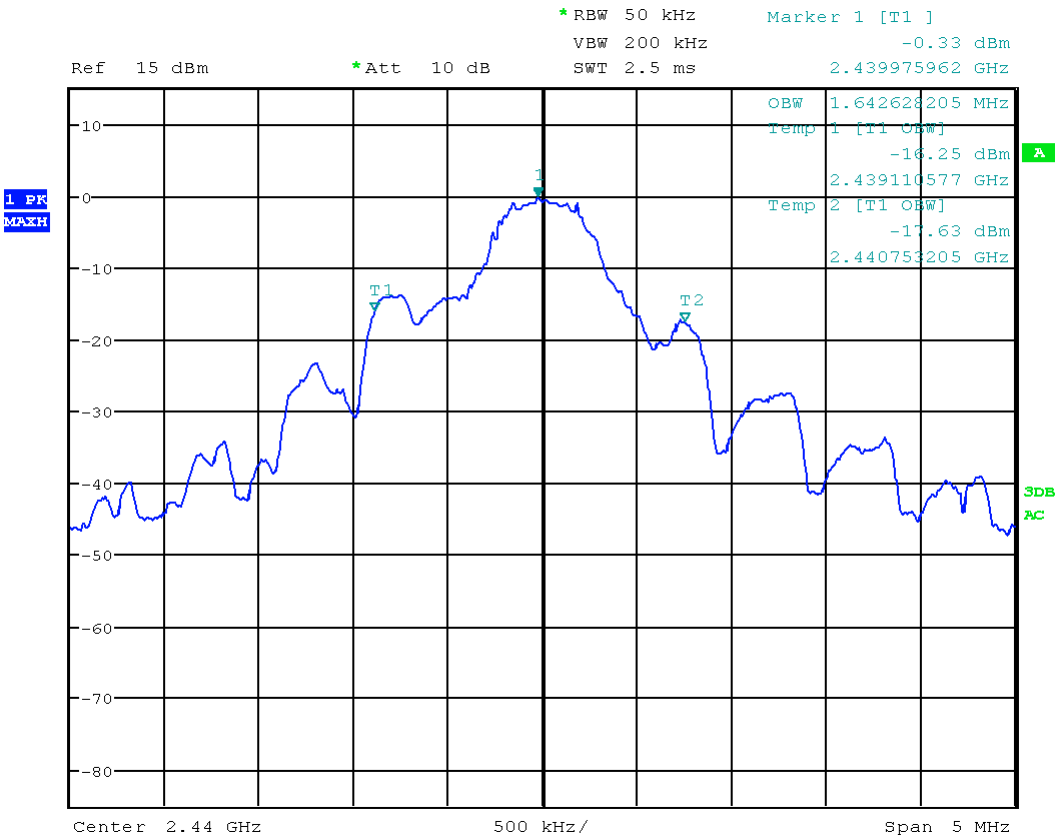


Figure 15: Chart of occupied bandwidth test, channel mid

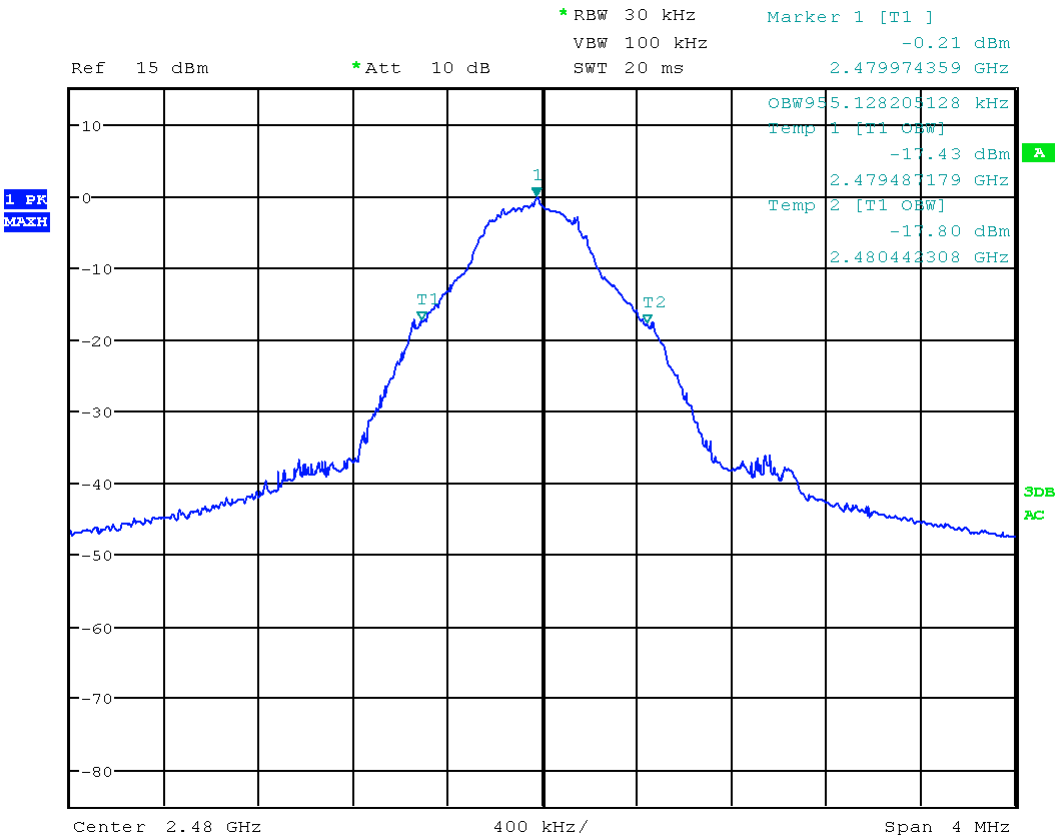


Figure 16: Chart of occupied bandwidth test, channel high

f [MHz]	Occ. BW [MHz]	f_{lower} [MHz]	f_{upper} [MHz]	Lower band edge [MHz]	Upper band edge [MHz]	Result
2402.976	1.955	2401.942	2403.897	2400.0	2483.5	within band
2439.976	1.643	2439.111	2440.753	2400.0	2483.5	within band
2479.974	0.955	2479.487	2480.442	2400.0	2483.5	within band

Table 6: Final results of occupied bandwidth test

Note: Different shape of traces recorded in maxhold mode is caused by behavior of temporary spikes

6.5 Maximum conducted output power

47 CFR part and section:	15.247(b)
Equivalent to IC radio standard(s):	RSS-Gen Issue 4, section 6.12 RSS-247 Issue 2, section 5.4
Measurement procedure:	See 5.5

Performed by:	Martin Müller	Date of test:	February 23, 2017
Result	☒ Test passed	☐ Test not passed	

6.5.1 Test equipment

	Type	*Designation*	*Manufacturer*	*Inventory no.*
☒	Laboratory environment	---	---	---
☐	EMI test receiver	ESCI 3	Rohde & Schwarz	E00001
☒	EMI test receiver	ESU 26	Rohde & Schwarz	W00002

6.5.2 Limits for digital transmission systems

1 watt (30 dBm)

6.5.3 Test results

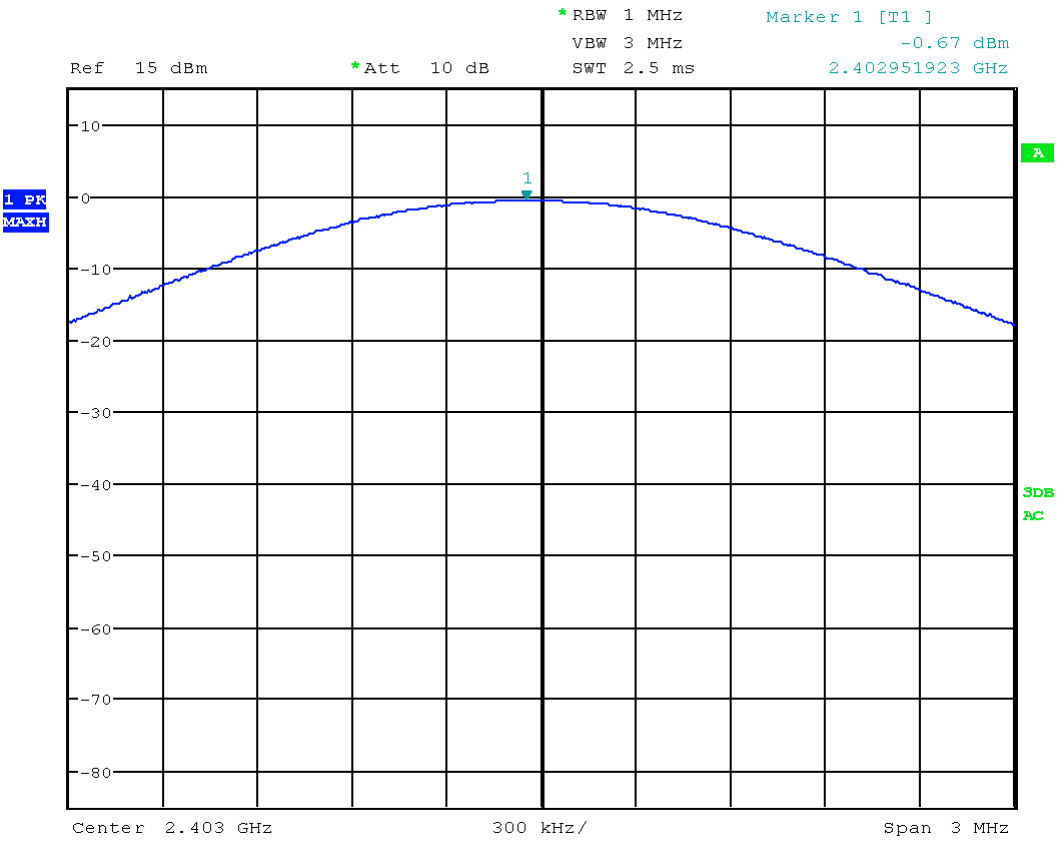


Figure 17: Chart of maximum conducted output power test, channel low

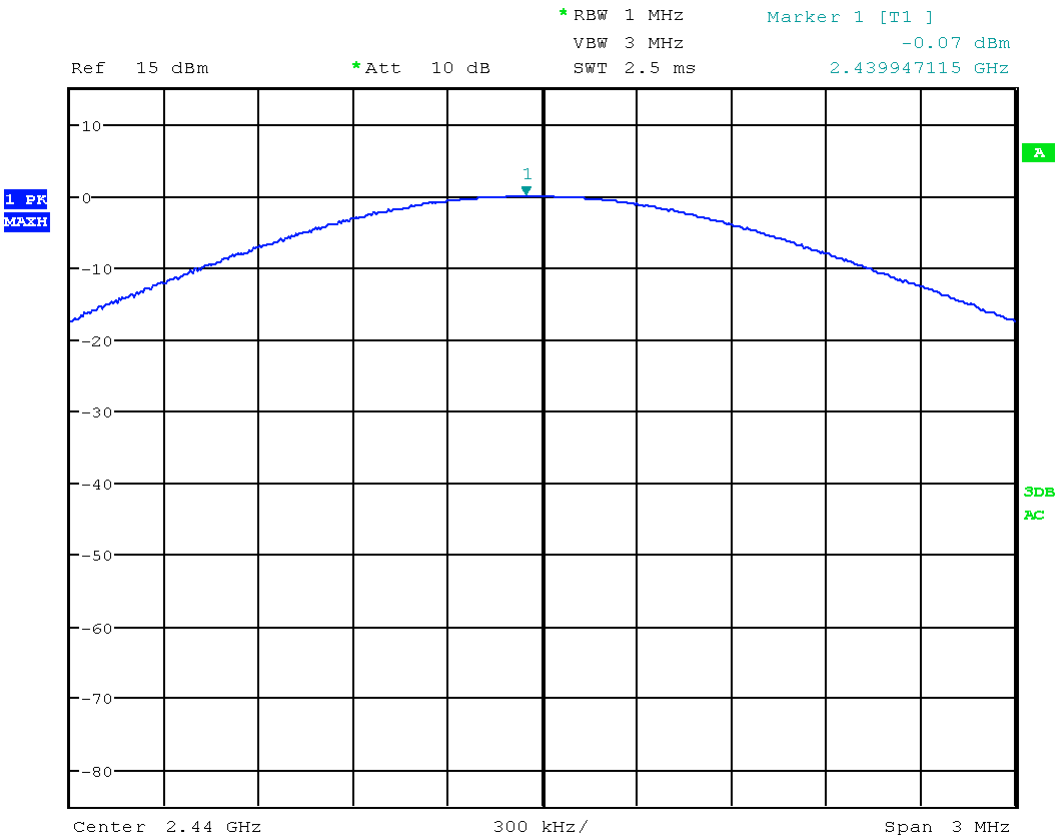


Figure 18: Chart of maximum conducted output power test, channel mid

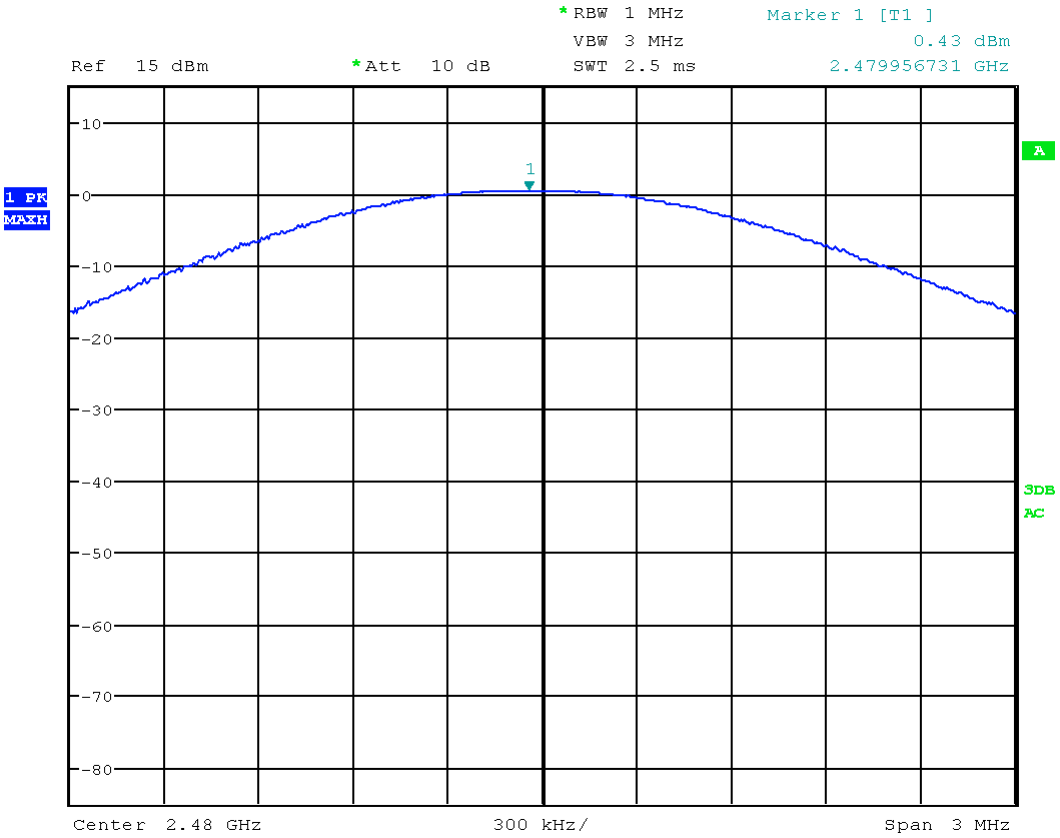


Figure 19: Chart of maximum conducted output power test, channel high

f [MHz]	P_{meas} [dBm]	$a_{testcable}$ [dB]	Maximum conducted output power [dBm]	Limit [dBm]	Result
2402.952	-0.67	0.54	-0.13	30.0	Pass
2439.947	-0.07	0.55	0.48	30.0	Pass
2479.957	0.43	0.55	0.98	30.0	Pass

Table 7: Final results of maximum conducted output power test

6.6 Power spectral density

47 CFR part and section:	15.247(e)
Equivalent to IC radio standard(s):	RSS-247 Issue 2, section 5.2(b)
Measurement procedure:	See 5.6

Performed by:	Martin Müller	Date of test:	February 23, 2017
Result	☒ Test passed	☐ Test not passed	

6.6.1 Test equipment

	Type	*Designation*	*Manufacturer*	*Inventory no.*
☒	Laboratory environment	---	---	---
☐	EMI test receiver	ESCI 3	Rohde & Schwarz	E00001
☒	EMI test receiver	ESU 26	Rohde & Schwarz	W00002

6.6.2 Limits

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

6.6.3 Test results

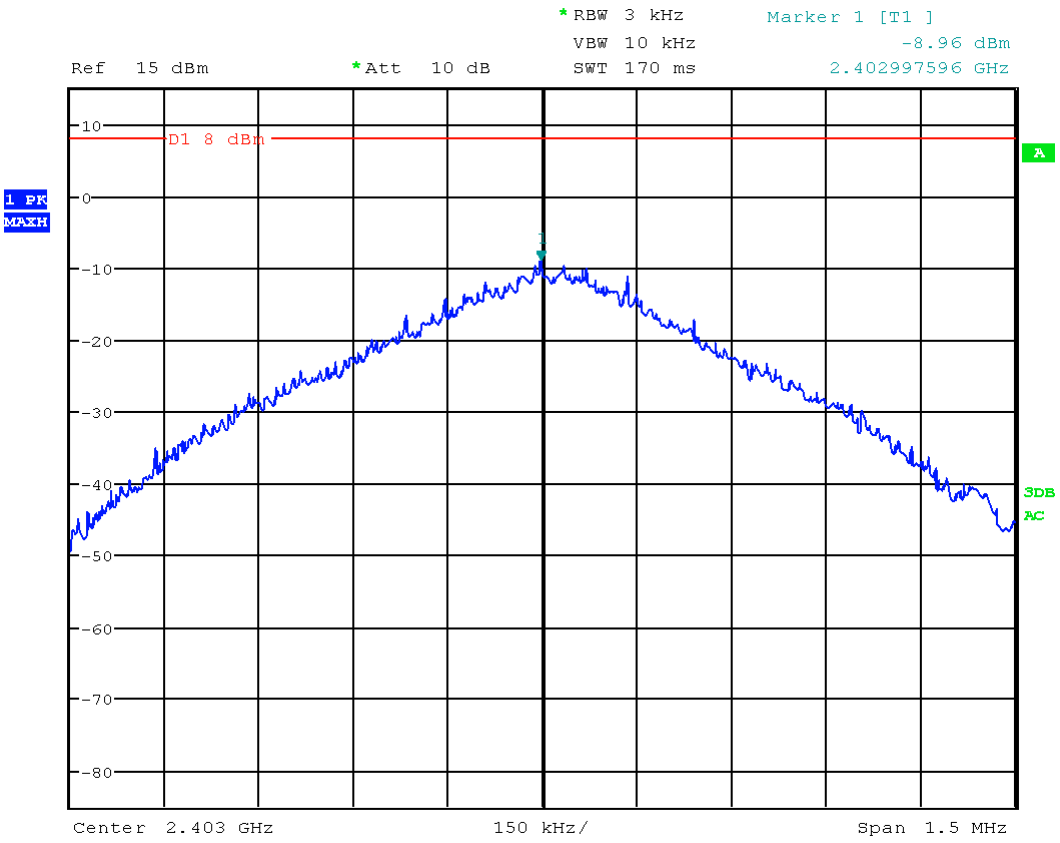


Figure 20: Chart of power spectral density test, channel low - complete carrier

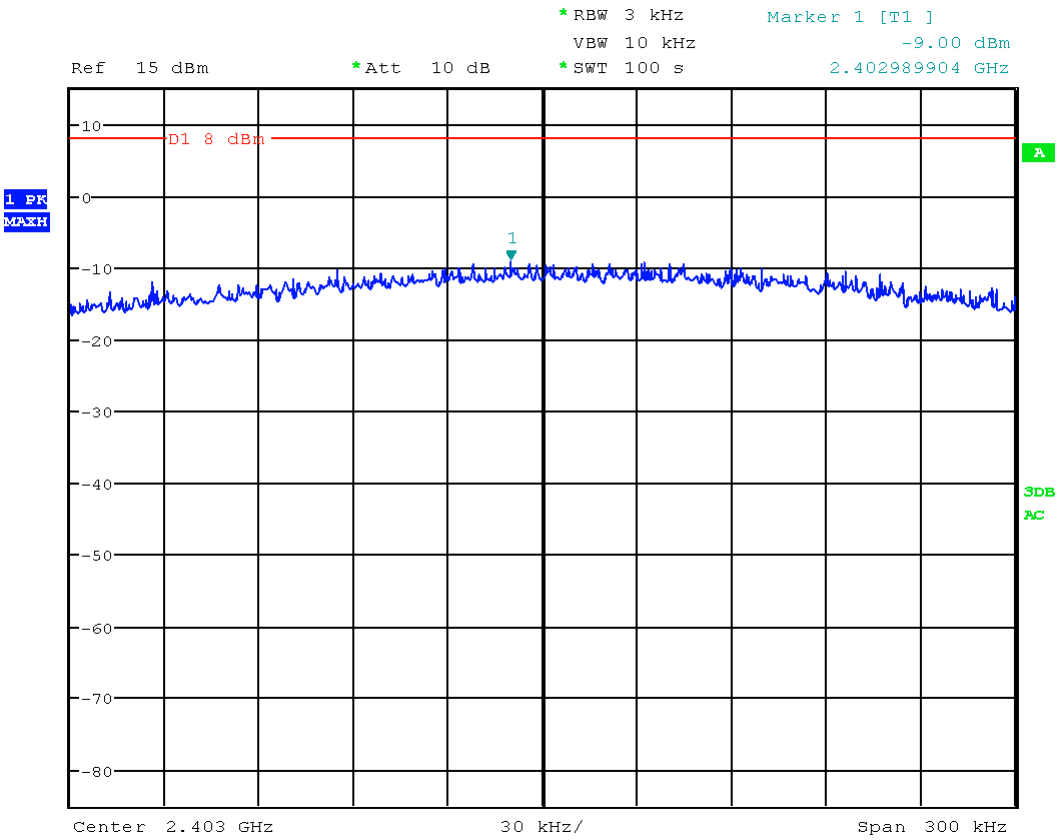


Figure 21: Chart of power spectral density test, channel low - zoom to maximum

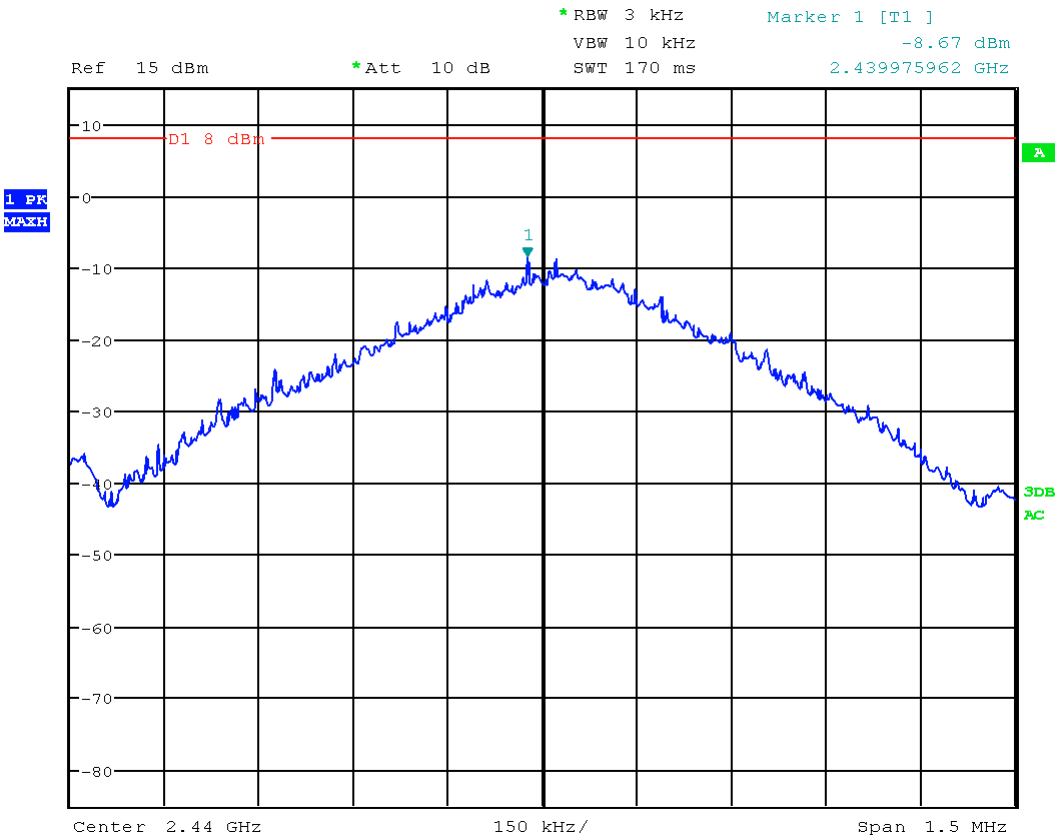


Figure 22: Chart of power spectral density test, channel mid - complete carrier

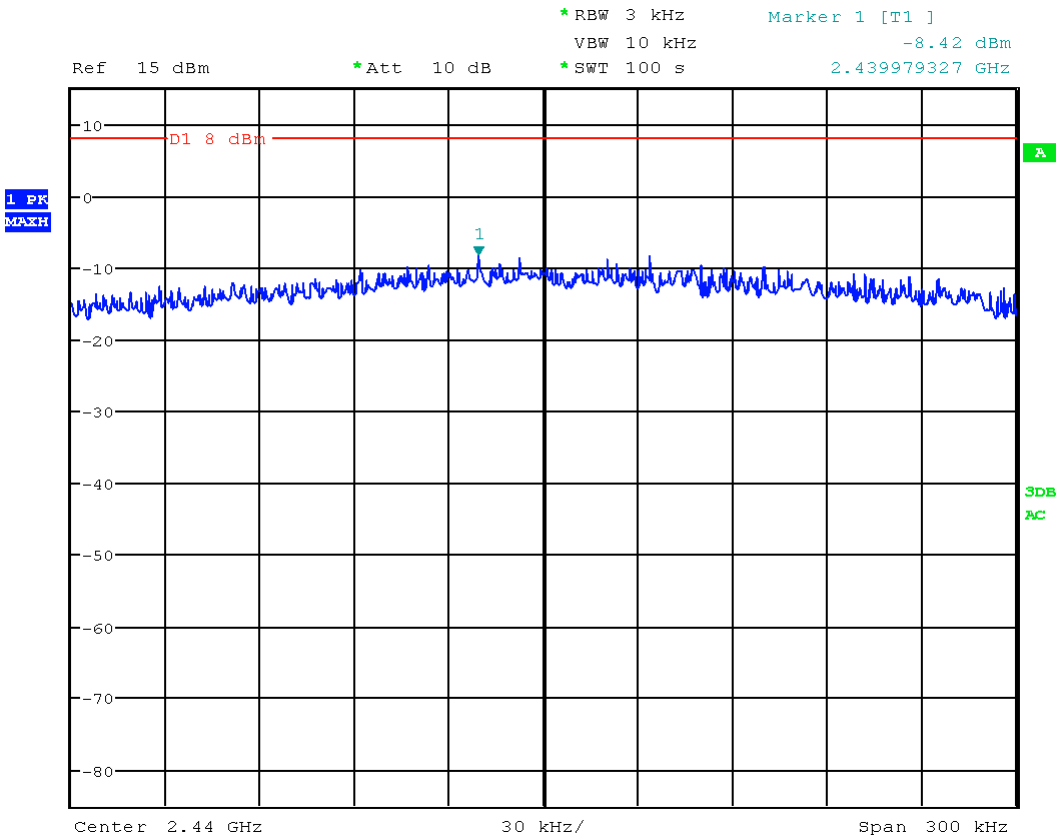


Figure 23: Chart of power spectral density test, channel mid - zoom to maximum

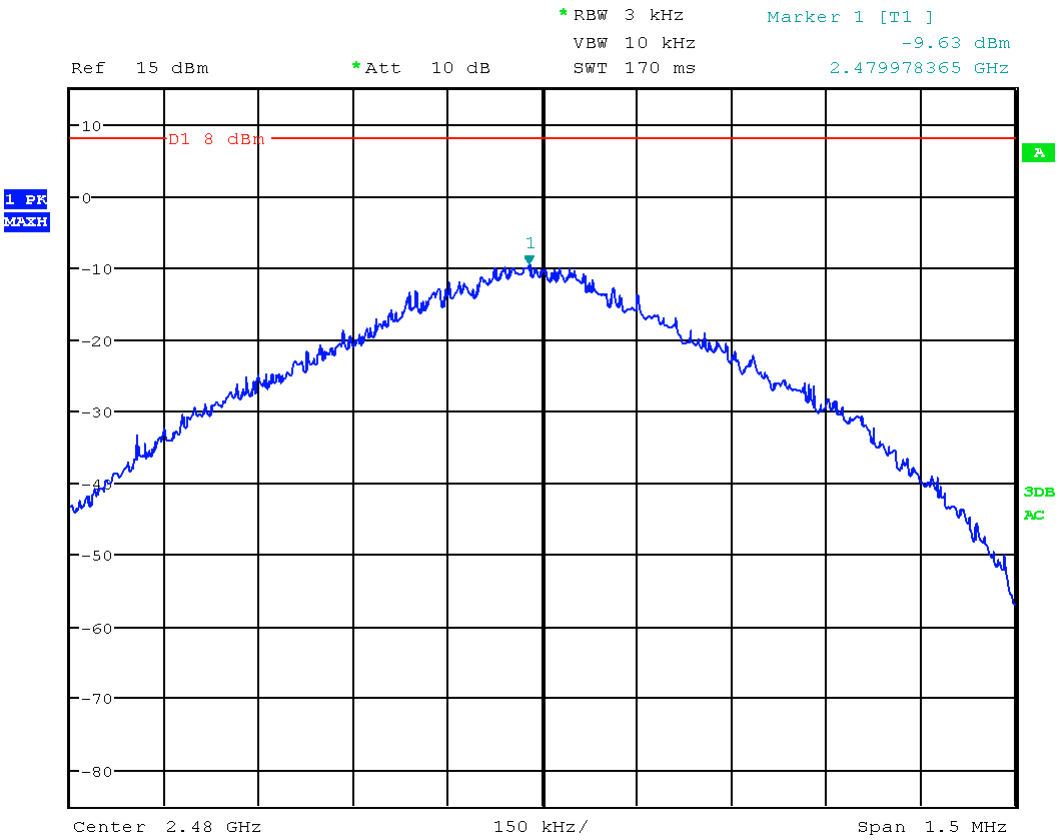


Figure 24: Chart of power spectral density test, channel high - complete carrier

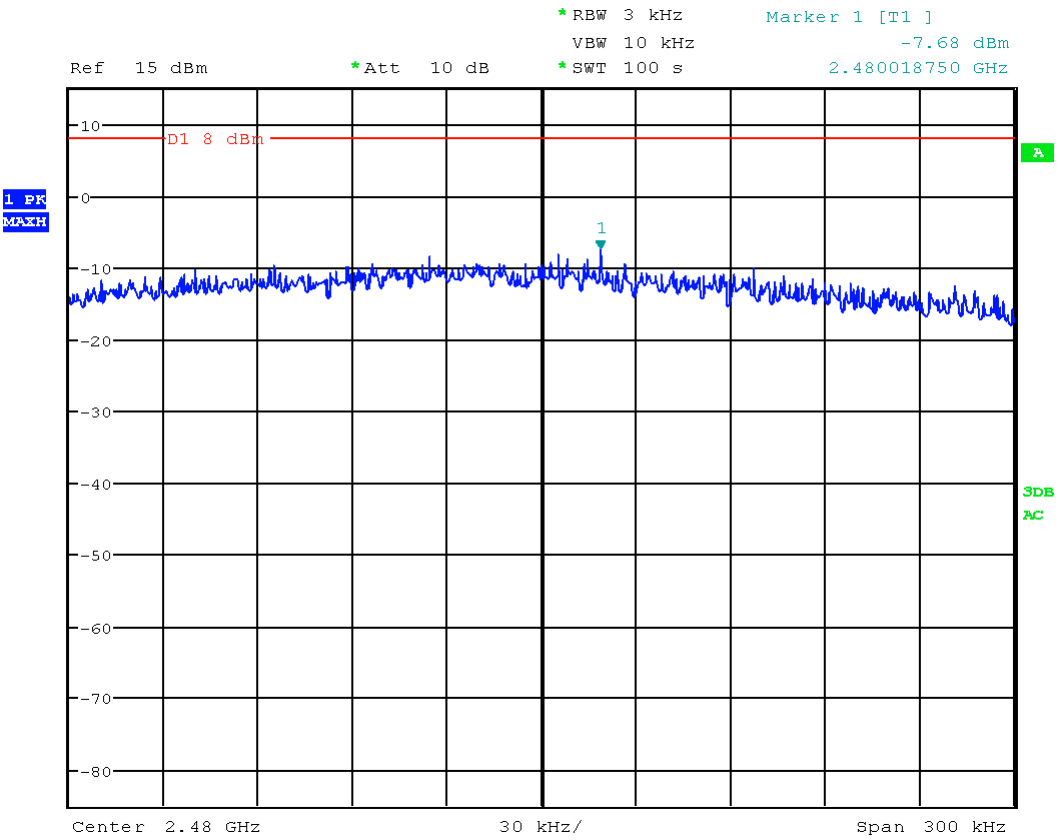


Figure 25: Chart of power spectral density test, channel high - zoom to maximum

f [MHz]	P_{meas} [dBm]	$a_{testcable}$ [dB]	Power spectral density [dBm / 3 kHz]	Limit [dBm / 3 kHz]	Result
2402.998	-8.96	0.54	-8.42	8.0	Pass
2439.979	-8.42	0.55	-7.87	8.0	Pass
2480.019	-7.68	0.55	-7.13	8.0	Pass

Table 8: Final results of power spectral density test

6.7 Band-edge compliance (radiated)

47 CFR part and section:	15.247(d)
Equivalent to IC radio standard(s):	RSS-247 Issue 2, section 5.5
Measurement procedure:	See 5.7

Performed by:	Martin Müller	Date of test:	February 16, 2017
Result	☒ Test passed	☐ Test not passed	

6.7.1 Test equipment

	Type	*Designation*	*Manufacturer*	*Inventory no.*
☐	Compact Diagnostic Chamber (CDC)	VK041.0174	Albatross Projects	E00026
☐	Open Area Test Site (OATS)	---	EMV **TESTHAUS** GmbH	E00354
☐	Semi Anechoic Chamber (SAC)	---	Albatross Projects	E00716
☒	Anechoic Chamber (AC)	---	EMV **TESTHAUS** GmbH	E00100
☐	EMI test receiver (CDC)	ESCI 3	Rohde & Schwarz	E00001
☐	EMI test receiver	ESU 26	Rohde & Schwarz	W00002
☐	EMI test receiver (SAC)	ESR 7	Rohde & Schwarz	E00739
☐	EMI test receiver (OATS)	ESCI 3	Rohde & Schwarz	E00552
☒	EMI test receiver	ESW 44	Rohde & Schwarz	E00895
☐	Preamplifier	AMF-5D-00501800	Miteq	W00089
☐	Preamplifier	AMF-6F-16002650	Miteq	W00090
☐	Loop antenna	HFH2-Z2	Rohde & Schwarz	E00060
☐	TRILOG broadband antenna (CDC)	VULB 9160	Schwarzbeck	E00011
☐	TRILOG broadband antenna (OATS)	VULB 9163	Schwarzbeck	E00013
☐	TRILOG broadband antenna (SAC)	VULB 9162	Schwarzbeck	E00643
☐	Horn antenna	BBHA 9120D	Schwarzbeck	W00052
☒	Horn antenna	BBHA 9120D	Schwarzbeck	W00053
☐	Horn antenna	BBHA 9170	Schwarzbeck	W00055
☐	Measurement software	E10	ib comPLAN	E00443
☐	Measurement software	EMC 32	Rohde & Schwarz	E00777

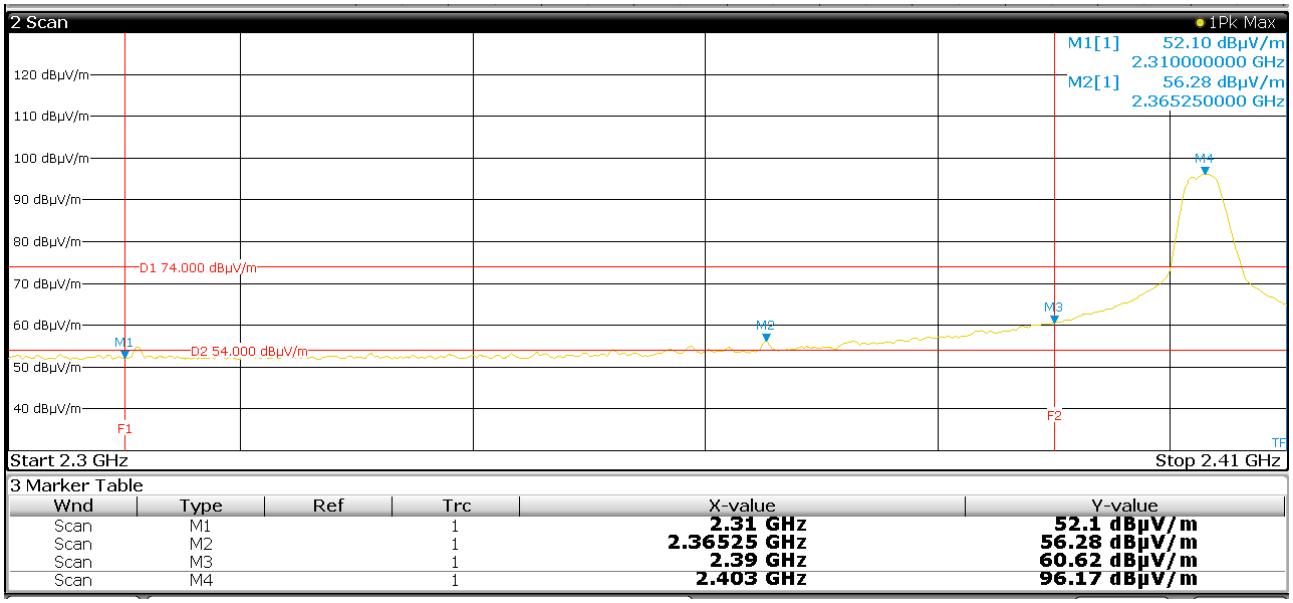
6.7.2 Limits

< -20 dBc outside restricted bands
< 54 dBµV/m (average detector) inside restricted bands
< 74 dBµV/m (peak detector) inside restricted bands

6.7.3 Test results

Test distance:	Prescan:	☐ 1 m	☒ 3 m	☐ ….. m
	Final scan:	☒ 3 m	☐ 10 m	☐ ….. m
Polarisation:	☐ horizontal	☒ vertical		
EUT Position:	☒ Position 1	☐ Position 2	☐ Position 3	

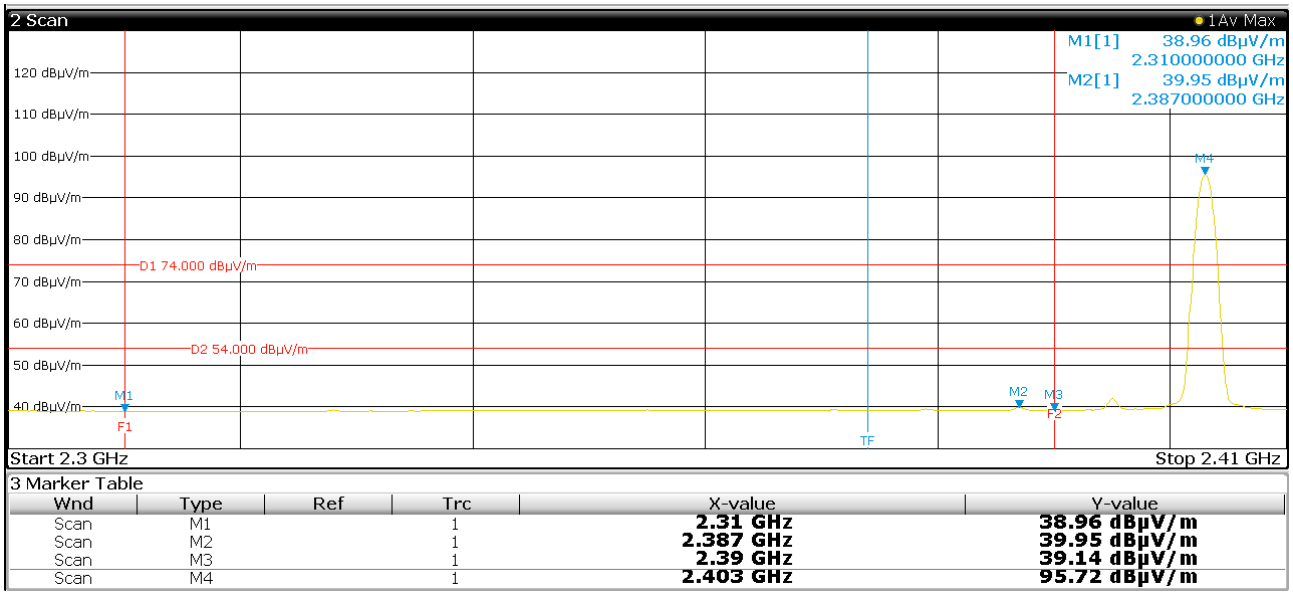
Frequency range	*Step size*	*IF Band-width*	*Detector*		*Measurement Time*		*Preamplifier*
			Prescan	*Final scan*	*Prescan*	*Final scan*	
2.30 GHz – 2.51 GHz	250 kHz	1 MHz	PK	PK	100 ms	100 ms	30 dB
2.30 GHz – 2.51 GHz	250 kHz	1 MHz	AV	AV	100 ms	100 ms	30 dB



3 Marker Table

Wnd	Type	Ref	Trc	X-value	Y-value
Scan	M1		1	**2.31 GHz**	**52.1 dBµV/m**
Scan	M2		1	**2.36525 GHz**	**56.28 dBµV/m**
Scan	M3		1	**2.39 GHz**	**60.62 dBµV/m**
Scan	M4		1	**2.403 GHz**	**96.17 dBµV/m**

Figure 26: Chart of band edge compliance test, lower band edge - PK



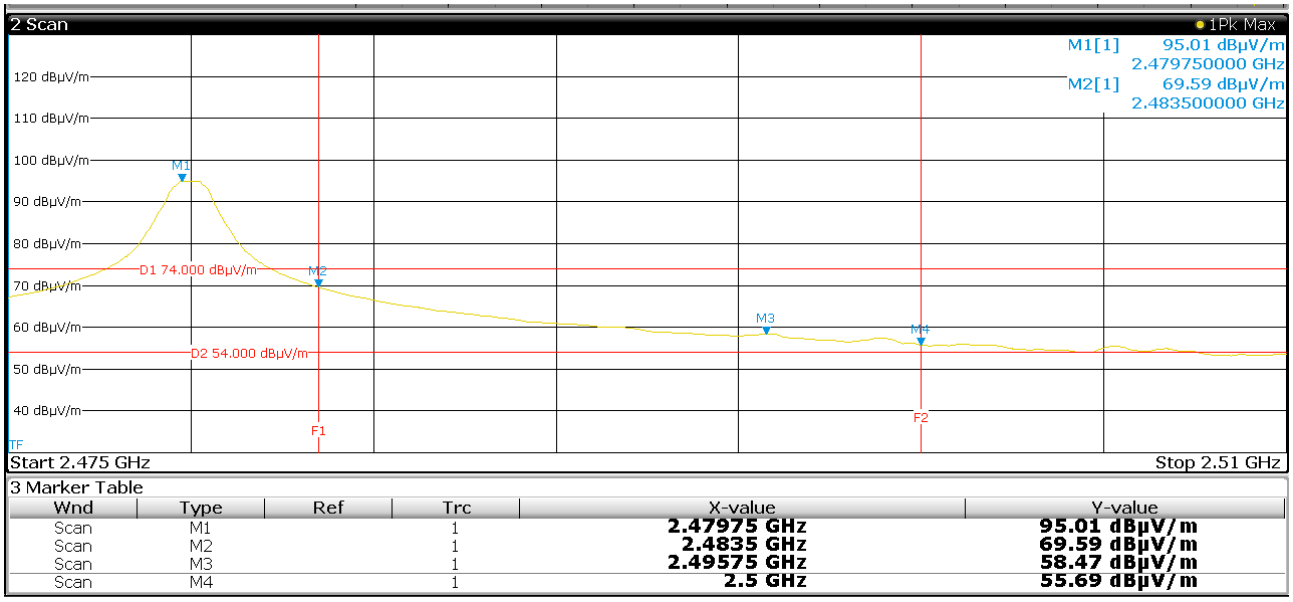
3 Marker Table

Wnd	Type	Ref	Trc	X-value	Y-value
Scan	M1		1	**2.31 GHz**	**38.96 dBµV/m**
Scan	M2		1	**2.387 GHz**	**39.95 dBµV/m**
Scan	M3		1	**2.39 GHz**	**39.14 dBµV/m**
Scan	M4		1	**2.403 GHz**	**95.72 dBµV/m**

Figure 27: Chart of band edge compliance test, lower band edge - AV

f[MHz]	E_{meas} [dBµV/m]	Detector	Restricted Band	Limit [dBµV/m]	Result
2310.000	52.10	PK	Yes	74	Pass
2310.000	38.96	AV		54	Pass
2365.250	56.28	PK		74	Pass
2387.000	39.95	AV		54	Pass
2390.000	60.62	PK		74	Pass
2390.000	39.14	AV		54	Pass
2403.000	96.17	PK	No	----	Carrier
2403.000	95.72	AV		----	Carrier

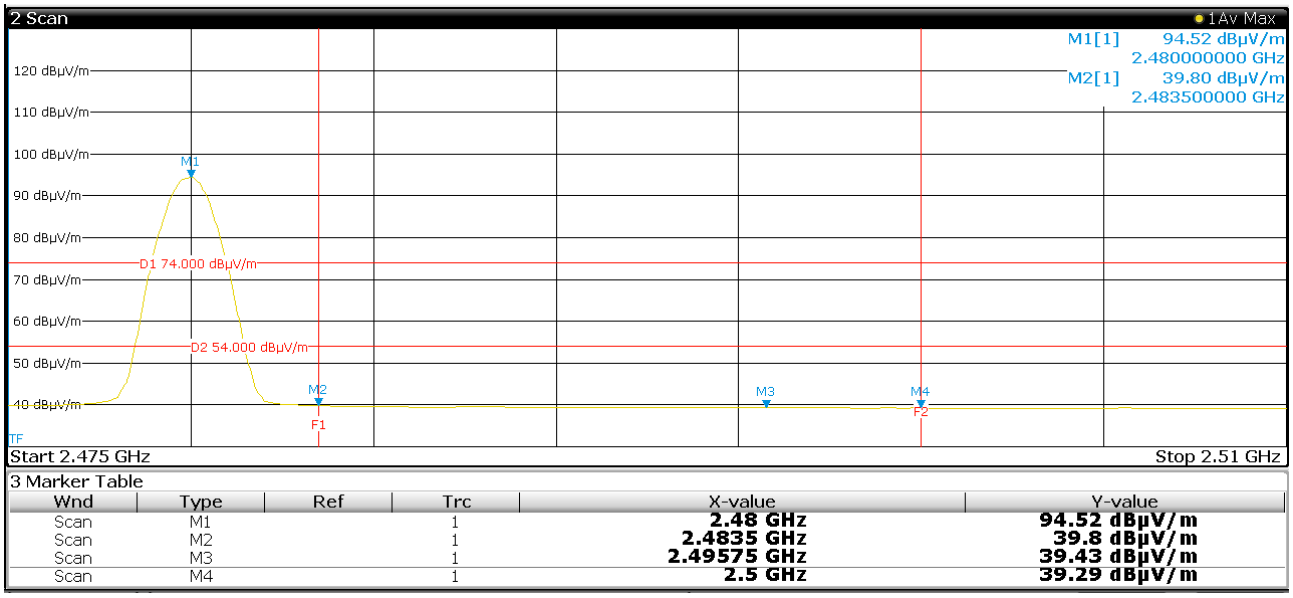
Table 9: Final result of band edge compliance test, lower band edge



3 Marker Table

Wnd	Type	Ref	Trc	X-value	Y-value
Scan	M1		1	2.47975 GHz	95.01 dBµV/m
Scan	M2		1	2.4835 GHz	69.59 dBµV/m
Scan	M3		1	2.49575 GHz	58.47 dBµV/m
Scan	M4		1	2.5 GHz	55.69 dBµV/m

Figure 28: Chart of band edge compliance test, upper band edge - PK



3 Marker Table

Wnd	Type	Ref	Trc	X-value	Y-value
Scan	M1		1	2.48 GHz	94.52 dBµV/m
Scan	M2		1	2.4835 GHz	39.8 dBµV/m
Scan	M3		1	2.49575 GHz	39.43 dBµV/m
Scan	M4		1	2.5 GHz	39.29 dBµV/m

Figure 29: Chart of band edge compliance test, upper band edge - AV

f[MHz]	E_{meas} [dBµV/m]	Detector	Restricted Band	Limit [dBµV/m]	Result
2479.750	95.01	PK	No	----	Carrier
2480.000	94.52	AV		----	Carrier
2483.500	69.59	PK	Yes	74	Pass
2483.500	39.80	AV		54	Pass
2495.750	58.47	PK		74	Pass
2495.750	39.43	AV		54	Pass
2500.000	55.69	PK		74	Pass
2500.000	39.29	AV		54	Pass

Table 10: Final result of band edge compliance test, upper band edge

6.8 Spurious radiated emissions 9 kHz to 10th harmonic

47 CFR part and section:	15.247 (d)
Equivalent to IC radio standard(s):	RSS-Gen Issue 4, section 6.13 RSS-247 Issue 2, section 5.5
Measurement procedure:	See 5.8

Performed by:	Martin Müller	Date of test:	March 6, 2017
Result:	☒ Test passed	☐ Test not passed	

6.8.1 Test equipment

	Type	*Designation*	*Manufacturer*	*Inventory no.*
☒	Compact Diagnostic Chamber (CDC)	VK041.0174	Albatross Projects	E00026
☒	Open Area Test Site (OATS)	---	EMV **TESTHAUS** GmbH	E00354
☐	Semi Anechoic Chamber (SAC)	---	Albatross Projects	E00716
☒	Anechoic Chamber (AC)	---	EMV **TESTHAUS** GmbH	E00100
☒	EMI test receiver (CDC)	ESCI 3	Rohde & Schwarz	E00001
☒	EMI test receiver	ESU 26	Rohde & Schwarz	W00002
☐	EMI test receiver (SAC)	ESR 7	Rohde & Schwarz	E00739
☒	EMI test receiver (OATS)	ESCI 3	Rohde & Schwarz	E00552
☒	EMI test receiver	ESW 44	Rohde & Schwarz	E00895
☐	Preamplifier	AMF-5D-00501800	Miteq	W00089
☒	Preamplifier	AMF-6F-16002650	Miteq	W00090
☒	Loop antenna	HFH2-Z2	Rohde & Schwarz	E00060
☒	TRILOG broadband antenna (CDC)	VULB 9160	Schwarzbeck	E00011
☒	TRILOG broadband antenna (OATS)	VULB 9163	Schwarzbeck	E00013
☐	TRILOG broadband antenna (SAC)	VULB 9162	Schwarzbeck	E00643
☐	Horn antenna	BBHA 9120D	Schwarzbeck	W00052
☒	Horn antenna	BBHA 9120D	Schwarzbeck	W00053
☒	Horn antenna	BBHA 9170	Schwarzbeck	W00055
☒	Measurement software	E10	ib comPLAN	E00443
☐	Measurement software	EMC 32	Rohde & Schwarz	E00777

6.8.2 Limits < 1 GHz

Frequency [MHz]	Field strength Fs [µV/m]	Field strength [dBµV/m]	Measurement distance d [m]
0.009 – 0.490	266.6 – 4.9	48.5 – 13.8	300
0.490 – 1.705	48.98 – 14.08	33.8 – 22.97	30
1.705 – 30.0	30	29.54	30
30 – 88	100	40	3
88 – 216	150	43.5	3
216 - 960	200	46	3
Above 960	500	54	3

Recalculation factor is determined according to ANSI C63.10, section 6.4.4.2 “Extrapolation from the measurement of a single point”:

$d_{near\ field}$ = 47.77 / f_{MHz}, or

f_{MHz} = 47.77 / $d_{near\ field}$

The frequency f_{MHz} at which the near field distance is equal to the limit and/or test distance is important for selection of the right formula for determining the recalculation factor:

f_{MHz}(300 m) ≈ 0.159 MHz
f_{MHz}(30 m) ≈ 1.592 MHz
f_{MHz}(3 m) ≈ 15.923 MHz

For 9 kHz ≤ f ≤ 159 kHz and 490 kHz < f ≤ 1.592 MHz:
Recalculation factor = $-40 \log(d_{limit} / d_{measure})$
For 159 kHz < f ≤ 490 kHz and 1.592 MHz < f ≤ 15.923 MHz:
Recalculation factor = $-40 \log(d_{near\ field} / d_{measure}) - 20 \log(d_{limit} / d_{near\ field})$
For f > 15.923 MHz:
Recalculation factor = $-20 \log(d_{limit} / d_{measure})$

The limits in the graphics and value lists are derived from the general radiated emission limits as specified in 15.209 using the recalculation factor as described above.

6.8.3 Limits > 1 GHz

< -20 dBc outside restricted bands
< 54 dBµV/m (average detector) inside restricted bands
< 74 dBµV/m (peak detector) inside restricted bands

6.8.4 Test results from 9 kHz to 30 MHz

Test distance:	Prescan:	☒ 3 m		
	Final scan:	☐ 3 m	☐ 10 m	☐ ….. m
Polarisation:	☐ parallel	☒ in line	☐ angle: ….°	
EUT Position:	☒ Position 1	☐ Position 2	☐ Position 3	

Frequency range	*Step size*	*IF Bandwidth*	*Detector*		*Measurement Time*		*Preamplifier*
			Prescan	*Final scan*	*Prescan*	*Final scan*	
9 kHz – 90 kHz	80 Hz	200 Hz	PK	AV	1 ms	1 s	off
90 kHz – 110 kHz	80 Hz	200 Hz	PK	QPK	1 ms	1 s	off
110 kHz – 150 kHz	80 Hz	200 Hz	PK	AV	1 ms	1 s	off
150 kHz – 490 kHz	4 kHz	9 kHz	PK	AV	1 ms	1 s	off
490 kHz – 30 MHz	4 kHz	9 kHz	PK	QPK	1 ms	1 s	off

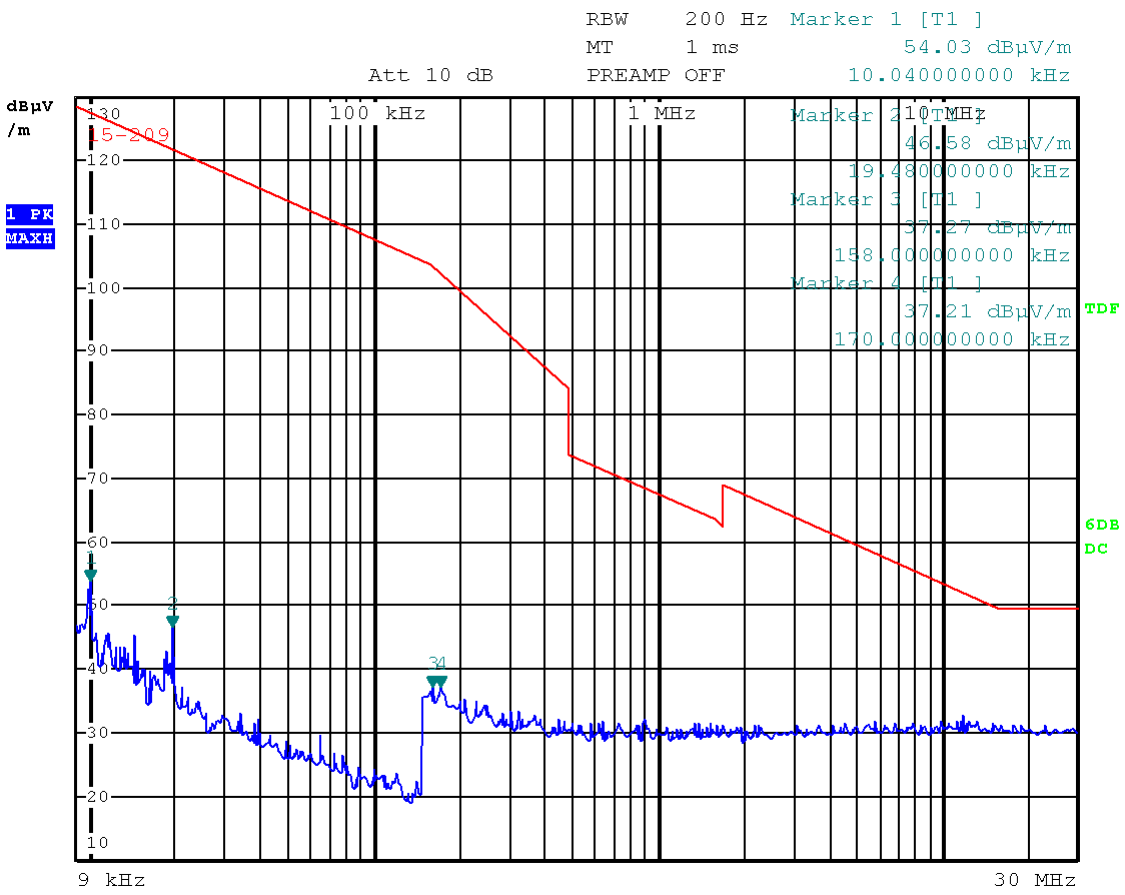


Figure 30: Chart of spurious radiated emission test 9 kHz - 30 MHz, channel low

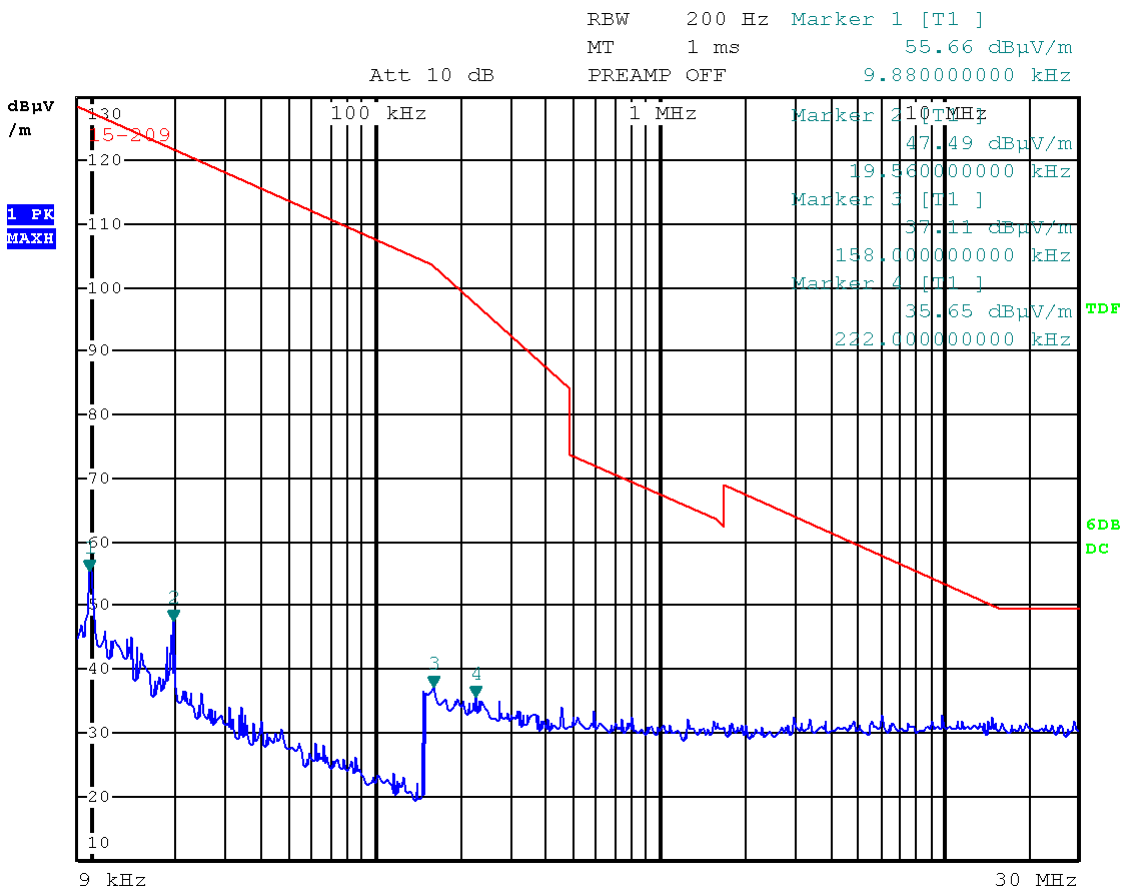


Figure 31: Chart of spurious radiated emission test 9 kHz - 30 MHz, channel mid

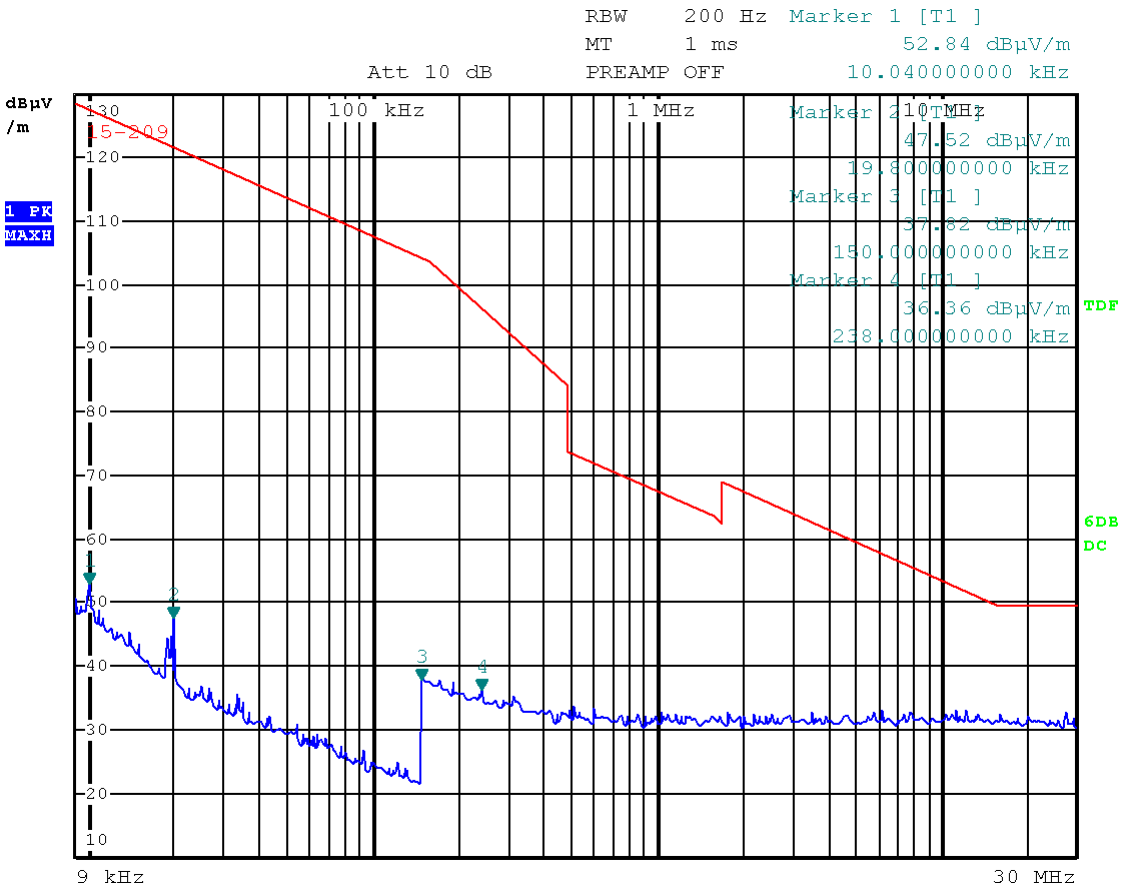


Figure 32: Chart of spurious radiated emission test 9 kHz - 30 MHz, channel high

6.8.5 Test results from 30 MHz to 1 GHz

Test distance:	Prescan:	☒ 3 m		
	Final scan:	☐ 3 m	☐ 10 m	☐ ….. m
Polarisation:	☒ horizontal	☒ vertical		
EUT Position:	☒ Position 1	☐ Position 2	☐ Position 3	

Frequency range	*Step size*	*IF Band-width*	*Detector*		*Measurement Time*		*Preamplifier*
			Prescan	*Final scan*	*Prescan*	*Final scan*	
30 MHz – 1 GHz	60 kHz	120 kHz	PK	QPK	1 ms	1 s	20 dB

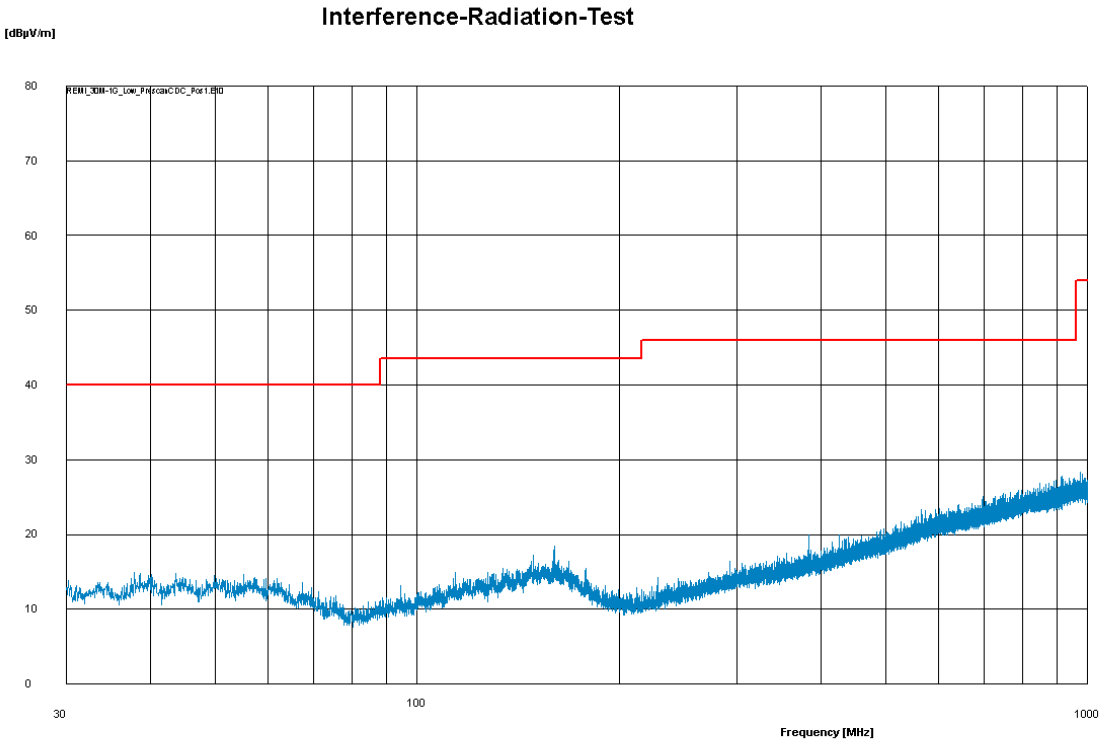


Figure 33: Chart of spurious radiated emission test 30 MHz - 1 GHz, channel low

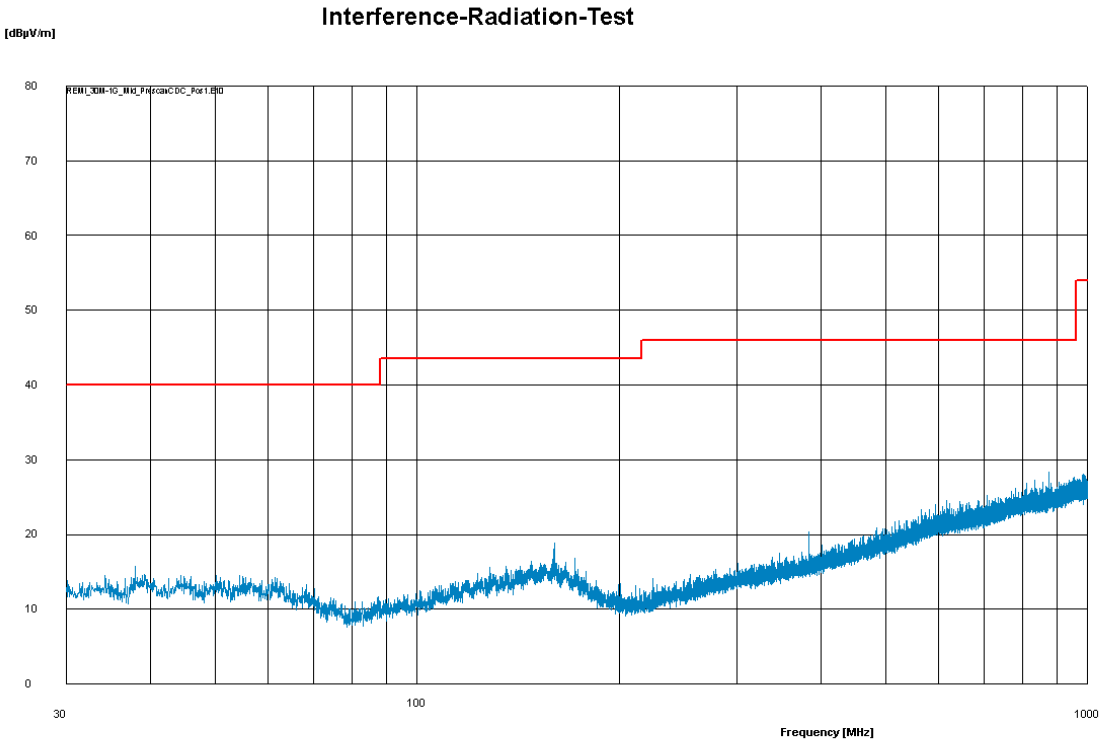


Figure 34: Chart of spurious radiated emission test 30 MHz - 1 GHz, channel mid

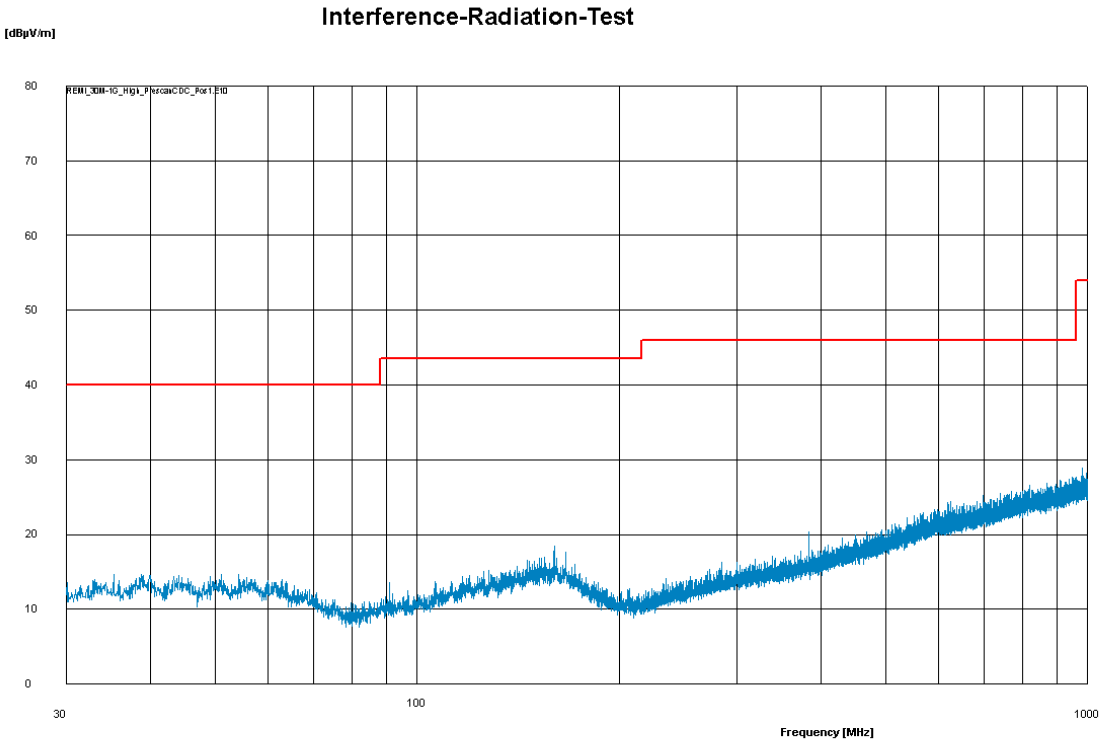


Figure 35: Chart of spurious radiated emission test 30 MHz - 1 GHz, channel high

6.8.6 Test results from 1 GHz to 10th harmonic

Test distance:	Prescan:	☒ 1 m	☒ 3 m	☐ ….. m
	Final scan:	☒ 3 m	☐ 10 m	☐ ….. m
Polarisation:	☒ horizontal	☒ vertical		
EUT Position:	☒ Position 1	☐ Position 2	☒ Position 3	

Frequency range	*Step size*	*IF Band-width*	*Detector*		*Measurement Time*		*Preamplifier*
			Prescan	*Final scan*	*Prescan*	*Final scan*	
1 GHz – 26 GHz	250 kHz	1 MHz	PK	PK	100 ms	100 ms	external
1 GHz – 26 GHz	250 kHz	1 MHz	AV	AV	100 ms	100 ms	external

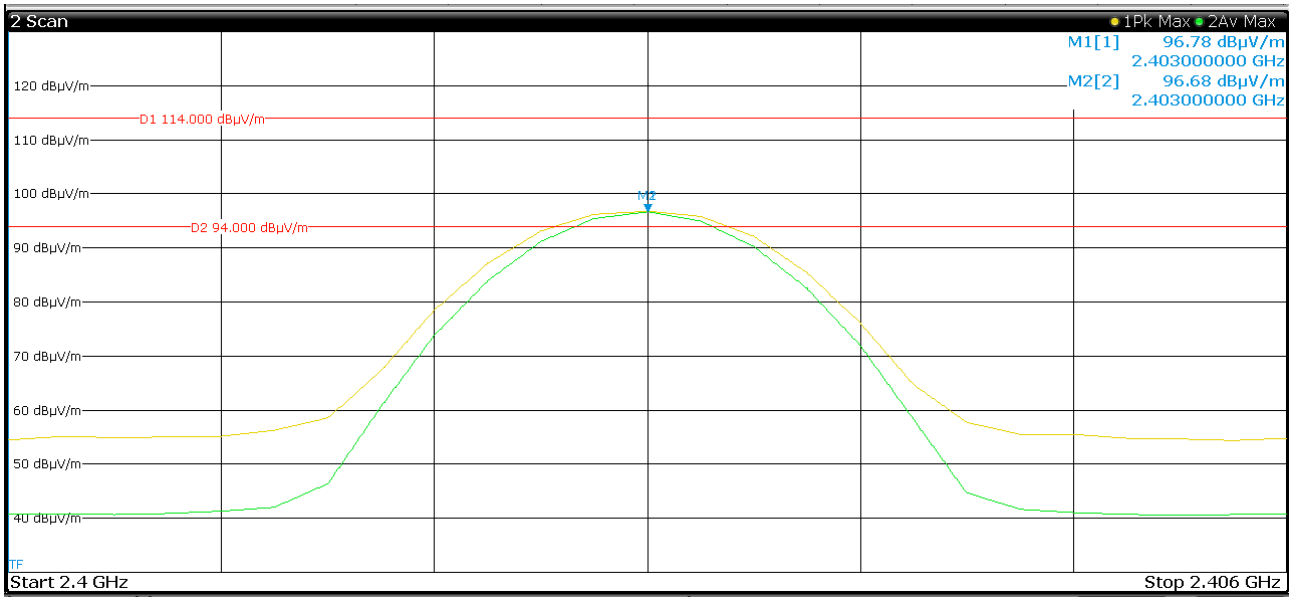


Figure 36: 1st Chart of spurious radiated emission test 1 GHz to 10th harmonic, channel low

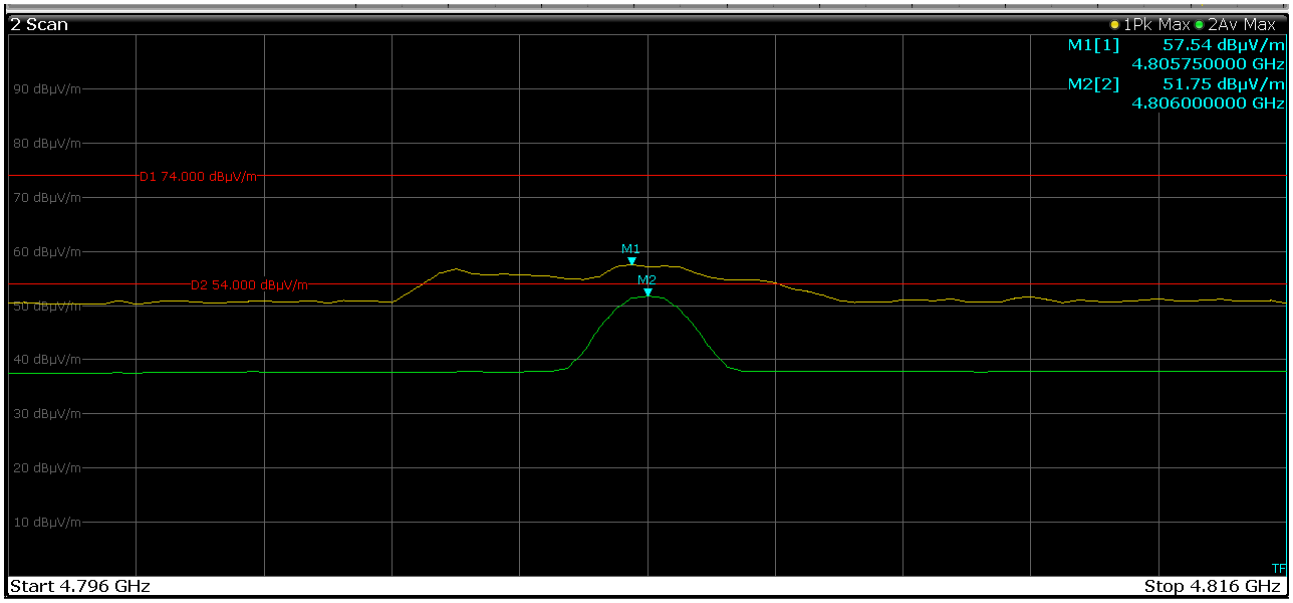


Figure 37: 2nd Chart of spurious radiated emission test 1 GHz to 10th harmonic, channel low

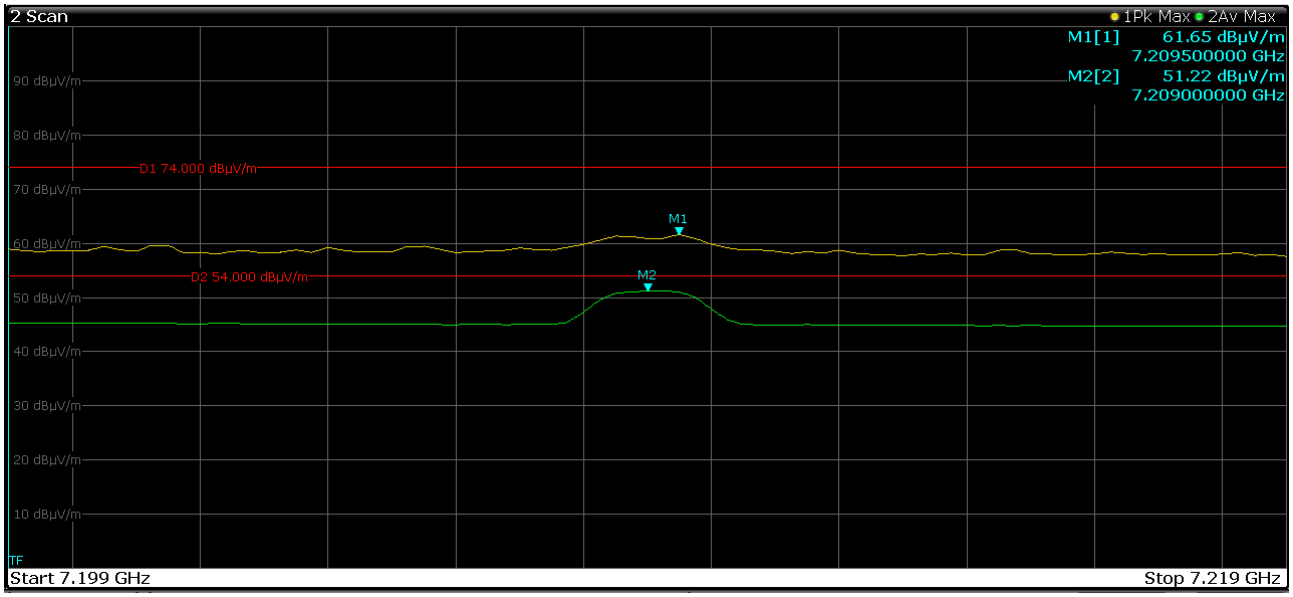


Figure 38: 3rd Chart of spurious radiated emission test 1 GHz to 10th harmonic, channel low

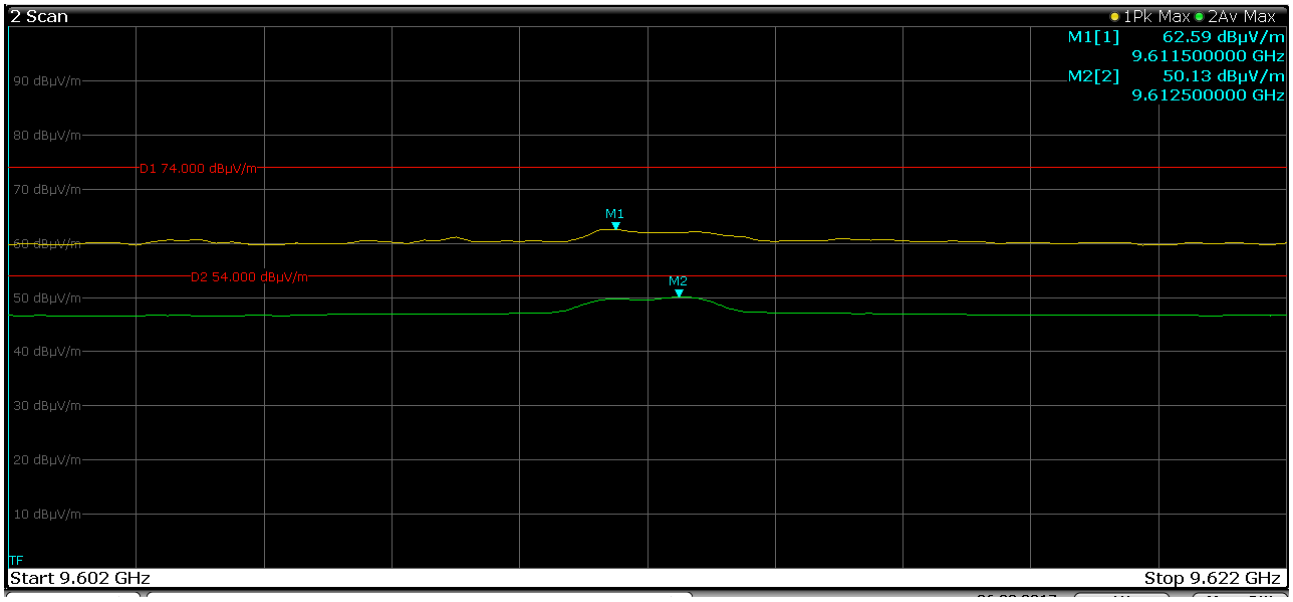


Figure 39: 4th Chart of spurious radiated emission test 1 GHz to 10th harmonic, channel low

Channel low									
f[GHz]	**E_{meas} [dBµV/m]**	**EUT-Pos**	**Polari-zation**	**Table [°]**	**Height [cm]**	**Detector**	**Restr. Band**	**Limit [dBµV/m]**	**Result**
2.4030	96.78	1	V	71	140	PK	No	---	Carrier
2.4030	96.68					AV		---	Carrier
4.8058	57.54	3	H	249	161	PK	Yes	74	Pass
4.8060	51.75					AV		54	Pass
7.2095	61.65	3	H	39	156	PK	No	-20dBc	Pass
7.2090	51.22					AV		-20dBc	Pass
9.6115	62.59	3	H	258	162	PK	No	-20dBc	Pass
9.6125	50.13					AV		-20dBc	Pass

Table 11: Final result of spurious radiated emission test 1 GHz to 10th harmonic, channel low

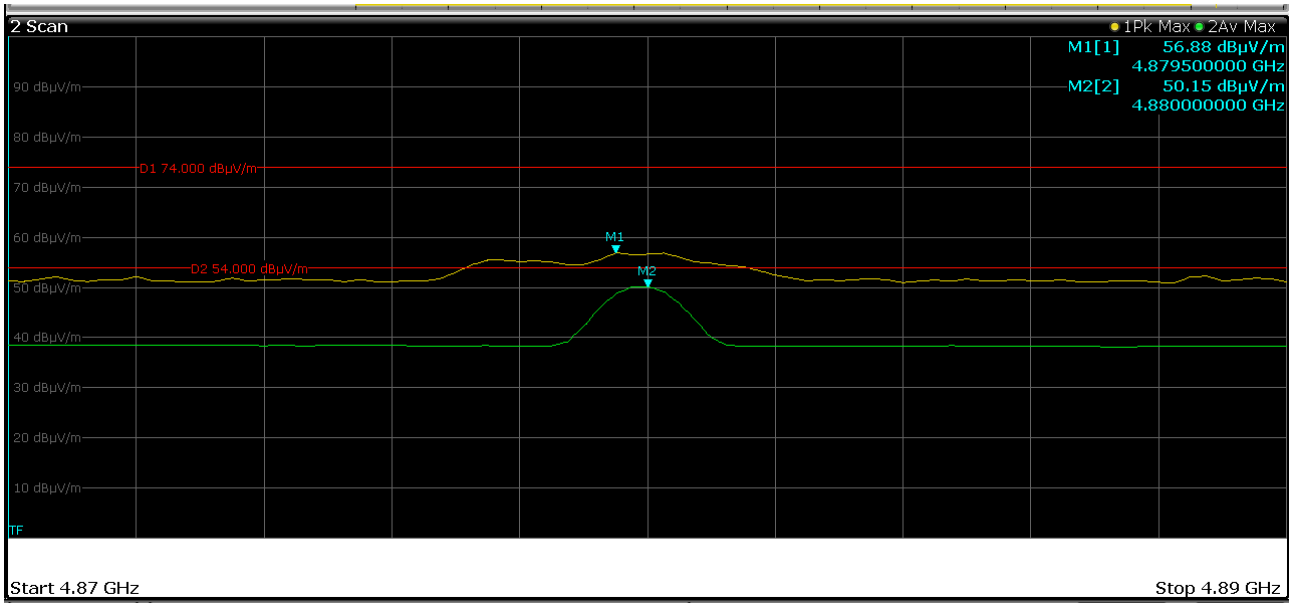


Figure 40: 1st Chart of spurious radiated emission test 1 GHz to 10th harmonic, channel mid

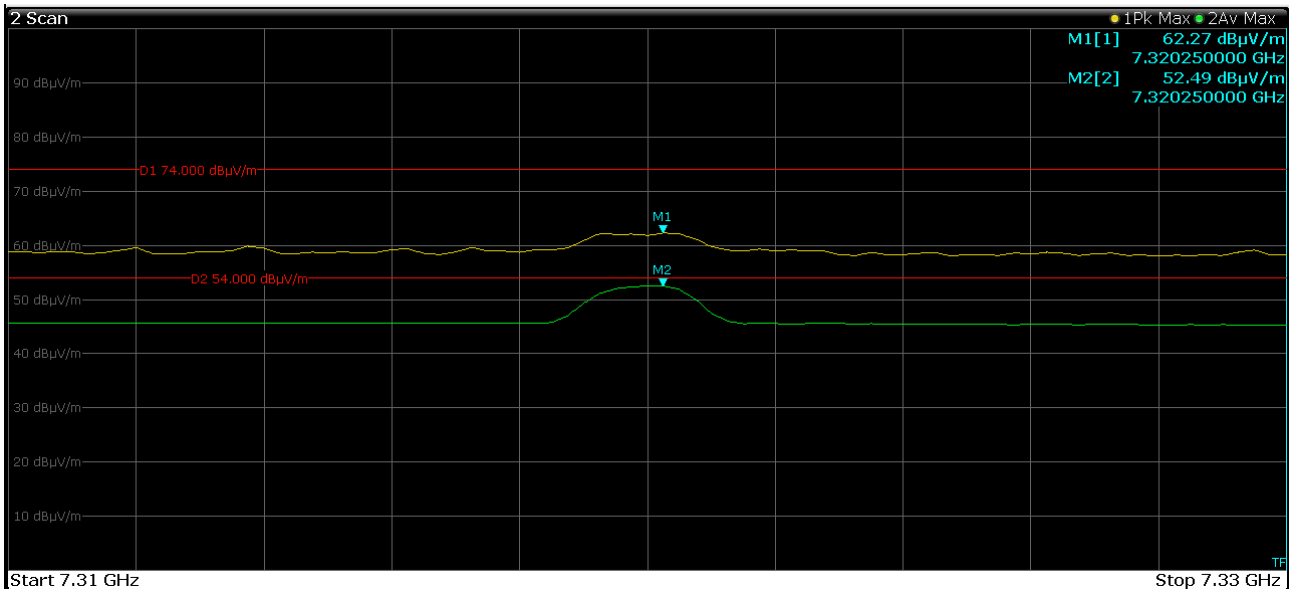


Figure 41: 2nd Chart of spurious radiated emission test 1 GHz to 10th harmonic, channel mid

Channel mid									
f[GHz]	**E_{meas} [dBµV/m]**	**EUT-Pos**	**Polari-zation**	**Table [°]**	**Height [cm]**	**Detector**	**Restr. Band**	**Limit [dBµV/m]**	**Result**
4.8795	56.88	3	H	302	154	PK	Yes	74	Pass
4.8800	50.15					AV		54	Pass
7.3203	62.27	3	H	48	187	PK	Yes	74	Pass
7.3203	52.49					AV		54	Pass

Table 12: Final result of spurious radiated emission test 1 GHz to 10th harmonic, channel mid

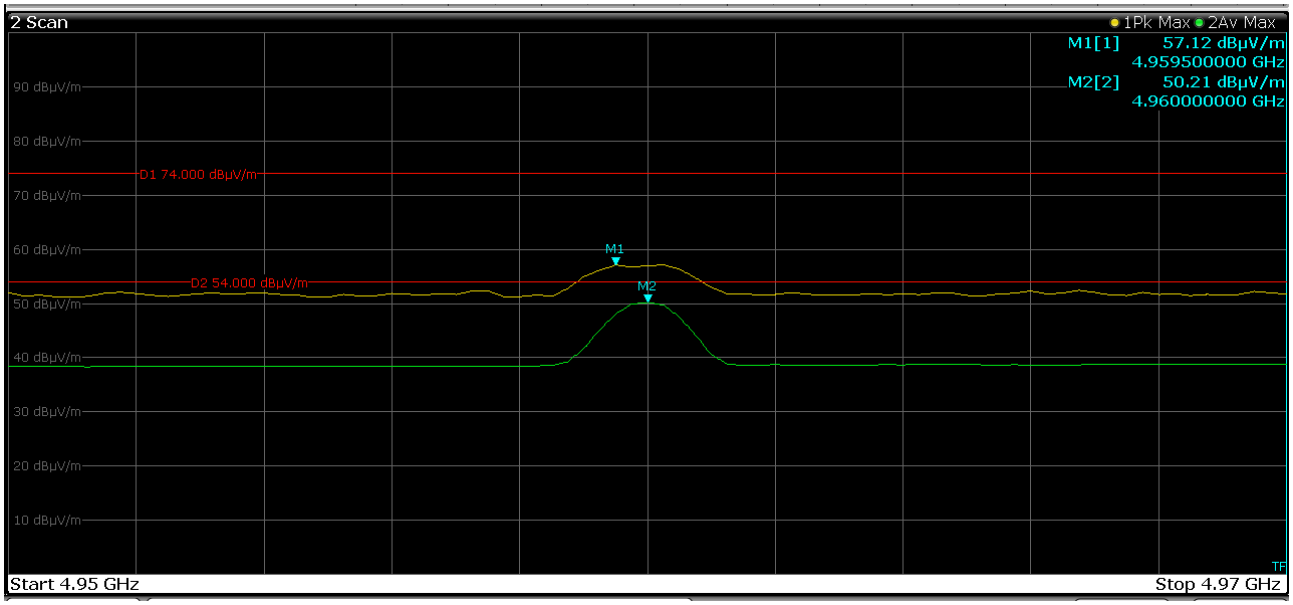


Figure 42: 1st Chart of spurious radiated emission test 1 GHz to 10th harmonic, channel high

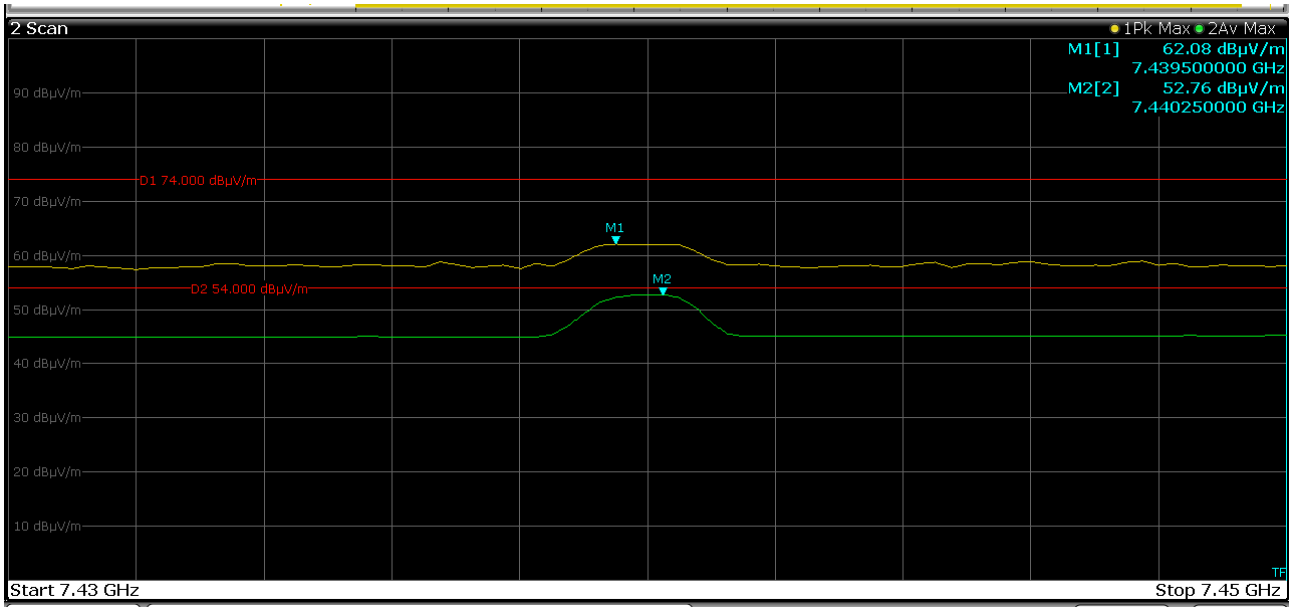


Figure 43: 2nd Chart of spurious radiated emission test 1 GHz to 10th harmonic, channel high

Channel high									
f[GHz]	**E_{meas} [dBµV/m]**	**EUT-Pos**	**Polari-zation**	**Table [°]**	**Height [cm]**	**Detector**	**Restr. Band**	**Limit [dBµV/m]**	**Result**
4.9595	57.12	3	H	308	141	PK	Yes	74	Pass
4.9600	50.21					AV		54	Pass
7.4395	62.08	3	H	13	179	PK	Yes	74	Pass
7.4403	52.76					AV		54	Pass

Table 13: Final result of spurious radiated emission test 1 GHz to 10th harmonic, channel high

6.9 Radio frequency radiation exposure evaluation for mobile devices

Reference(s): 47 CFR Part 2, §2.1091
KDB 447498 D01, section 7
RSS Gen Issue 4, section 3.2
RSS-102 Issue 5, section 2.5.2

Performed by:	Martin Müller	Date of test:	March 8, 2017
Result:	☒ Test passed	☐ Test not passed	

6.9.1 Data of equipment under test (EUT)

Antenna connector (see clause 3):	☐ permanent	☒ temporary	☐ none
Antenna detachable:	☐ yes	☒ no	
Tune-up function:	☐ yes	☒ no	

Maximum antenna gain (see clause 3):	logarithmic 0.0 dBi	numeric 1.0
Maximum conducted output power (see clause 6.5):	logarithmic 0.98 dBm	numeric 1.25 mW
Maximum equivalent isotropically radiated power:	logarithmic 0.98 dBm	numeric 1.25 mW
Maximum operation frequency (see clause 3):	2478.000 MHz	

6.9.2 Standalone Requirements for EUT

6.9.2.1 Requirements

This estimation follows the general guidelines for RF Exposure according to KDB 447498.

As noted in §2.1091(b) a mobile device is defined as “a transmitting device designed to be used in other than fixed locations and to generally be used in such a way that a **separation distance of at least 20 centimeters** is normally maintained between the transmitter's radiating structure(s) and the body of the user or nearby persons.”
According to §2.1091(c) the limits to be used for evaluation are defined in §1.1310.

As specified in §1.1310(d)(2) at operating frequencies less than or equal to 6 GHz, the limits for maximum permissible exposure (MPE), derived from whole-body SAR limits and listed in Table 1 of §1.1310(e) may be used.

Table 14 below shows the limits for Maximum Permissible Exposure (MPE) to radiofrequency electromagnetic fields.

Frequency range (MHz)	**Electric field strength (V/m)**	**Magnetic field strength (A/m)**	**Power density (mW/cm^2)**	**Averaging time (minutes)**
(A) Limits for Occupational/Controlled Exposure				
0.3 - 3.0	614	1.63	*100	6
3.0 - 30	1842/f	4.89/f	*900/f2	6
30 - 300	61.4	0.163	1.0	6
300 - 1500			f/300	6
1500 - 100000			5	6
(B) Limits for General Population/Uncontrolled Exposure				
0.3 - 1.34	614	1.63	*100	30
1.34 - 30	824/f	2.19/f	$*180/f^2$	30
30 - 300	27.5	0.073	0.2	30
300 - 1500			f/1500	30
1500 - 100000			1.0	30

Table 14: Limits for maximum permissible exposure (MPE) according to table 1 of §1.1310(e)

Notes:
1. f = frequency in MHz.
2. * = Plane-wave equivalent power density.

Appropriate RF Field Strength Limits for Devices Used by the General Public (Uncontrolled Environment) can be found in table 4 of RSS-102, section 4:

Frequency Range (MHz)	Electric Field (V/m rms)	Magnetic Field (A/m rms)	Power Density (W/m^2)	Reference Period (minutes)
0.003-10	83	90	-	Instantaneous*
0.1-10	-	0.73/f	-	6**
1.1-10	$87/f^{0.5}$	-	-	6**
10-20	27.46	0.0728	2	6
20-48	$58.07/f^{0.25}$	$0.1540/f^{0.25}$	$8.944/f^{0.5}$	6
48-300	22.06	0.05852	1.291	6
300-6000	$3.142\ f^{0.3417}$	$0.008335\ f^{0.3417}$	$0.02619\ f^{0.6834}$	6
6000-15000	61.4	0.163	10	6
15000-150000	61.4	0.163	10	$616000/f^{1.2}$
150000-300000	$0.158\ f^{0.5}$	$4.21 \times 10^{-4}\ f^{0.5}$	$6.67 \times 10^{-5}\ f$	$616000/f^{1.2}$
Note: f is frequency in MHz. *Based on nerve stimulation (NS). ** Based on specific absorption rate (SAR).				

Table 15: RF field strength limits according to table 4 of RSS-102

6.9.2.2 Results

Maximum peak value of electric field strength measured at 2403.0 MHz in a distance of 3 m:
$E_{radiated}$(3 m) = 96.17 dBµV/m (see clause 6.7)

Alternatively, the maximum peak value of electric field strength can be calculated using the maximum equivalent isotropically radiated power EIRP according to the formula noted in section 1.1 of KDB Publication no. 412172 D01. The value of EIRP is the product of the linear values of the measured maximum conducted output power and the antenna gain (see clause 6.9.1).

$$E_{conducted}(3\ m) = \frac{\sqrt{30 \cdot EIRP}}{d} = \frac{\sqrt{30 \cdot 1.25 \cdot 10^{-3} W}}{3\ m} = 0.0645\ V/m$$

$E_{conducted}$(3 m) = 96.20 dBµV/m

For further calculations the maximum of both values is selected as the measured value:
E_{meas}(3 m) = 96.20 dBµV/m

Recalculation factor is determined according to ANSI C63.10, section 6.4.4.2 “Extrapolation from the measurement of a single point”:

f_{MHz} = 47.77 / $d_{near\ field}$

The frequency f_{MHz} at which the near field distance is equal to the limit and/or test distance is important for selection of the right formula for determining the recalculation factor:

f_{MHz}(3 m) ≈ 15.923 MHz
f_{MHz}(20 cm) ≈ 238.850 MHz << 2400 MHz

⇒ Recalculation factor = -20 log(d_{limit} / $d_{measure}$)

Although expressed in “dBµV/m” the source of the field strength is magnetic and the value is recorded with a loop antenna measuring magnetic field. Using wave impedance in free space of about 120·π Ω (51.5 dB) magnetic field strength results in:
H_{meas}(3 m) = E_{meas}(3 m) - 51.5 dB = 96.20 dBµV/m - 51.5 dB = 44.70 dBµA/m

Worst case field strength is calculated for a separation distance of 20 centimeters.

Using an extrapolation factor of 20 dB/decade (~ r^{-1}) results in:
E_{calc}(20 cm) = 96.20 dBµV/m - 20 · log(0.2 m / 3 m) = 96.20 dBµV/m + 23.52 dB
E_{calc} (20 cm) = 119.72 dBµV/m = 0.968 V/m

Using an extrapolation factor of 20 dB/decade (~ r^{-1}) results in:
H_{calc}(20 cm) = 44.70 dBµA/m - 20 · log(0.2 m / 3 m) = 44.70 dBµA/m + 23.52 dB
H_{calc}(20 cm) = 68.22 dBµA/m = 2.576 · 10^{-3} A/m

Worst case power density is calculated for a separation distance of 20 centimeters by using the respective field strenghts for an extrapolation factor of 20 dB/decade (~ r^{-1}):

S_{calc}(20 cm) = E_{calc}(20 cm) · H_{calc}(20 cm) = 0.968 V/m · 2.576 · 10^{-3} A/m
S_{calc}(20 cm) = 0.0025 W/m^2 = 0.00025 mW/cm^2

Comparing the calculated results to the limits for general population/uncontrolled exposure at 2400.0 MHz shows that even with worst case calculation using peak values the limits are kept.

E-field			
E_{calc}(20 cm) (V/m)	Limit 47 CFR Par 1, §1.1310(e) (V/m)		Limit RSS-102, table 2 (V/m)
0.968	---		44.898
H-field			
H_{calc}(20 cm) (A/m)	Limit 47 CFR Par 1, §1.1310(e) (A/m)		Limit RSS-102, table 2 (A/m)
0.0026	---		0.119
Power density			
S_{calc}(20 cm) (mW/cm^2)	Limit 47 CFR Par 1, §1.1310(e) (mW/cm^2)	S_{calc}(20 cm) (W/m^2)	Limit RSS-102, table 2 (W/m^2)
0.00025	1.0	0.0025	5.348

Table 16: Calculated results compared to RF field strength limits

6.9.3 Requirements for simultaneous transmission

According to customer, simultaneous transmission of SRD and BLE is not intended to be used. However, the following calculations show that MPE and RF field strength limits would be kept even with simultaneous transmission of SRD and BLE.

6.9.3.1 Requirements

As noted in KDB 447498 D01, section 7.2, simultaneous transmission MPE test exclusion applies when the sum of the MPE ratios for all simultaneously transmitting antennas incorporated in a host device is ≤ 1.0, according to calculated/estimated, numerically modeled, or measured field strengths or power density.

In case of simultaneous transmission the standalone results are used for calculation according to the following formulas:

$$\sum_{i=SRD}^{BLE} \frac{E_i}{E_{limit\ i}} \leq 1 \Leftrightarrow \frac{E_{SRD}(V/m)}{E_{limit\ SRD}(V/m)} + \frac{E_{BLE}(V/m)}{E_{limit\ BLE}(V/m)} \leq 1$$

$$\sum_{i=SRD}^{BLE} \frac{H_i}{H_{limit\ i}} \leq 1 \Leftrightarrow \frac{H_{SRD}(A/m)}{H_{limit\ SRD}(A/m)} + \frac{H_{BLE}(A/m)}{H_{limit\ BLE}(A/m)} \leq 1$$

$$\sum_{i=SRD}^{BLE} \frac{S_i}{S_{limit\ i}} \leq 1 \Leftrightarrow \frac{S_{SRD}(W/m^2)}{S_{limit\ SRD}(W/m^2)} + \frac{S_{BLE}(W/m^2)}{S_{limit\ BLE}(W/m^2)} \leq 1$$

Note: As for power density using the limit according to RSS-102, table 2, gives the worst case ratio, the values in W/m² are selected.

6.9.3.2 Results

With values for BLE mode taken from clause 6.9.2.2 of test report no. 160583-AU01+W04 the results are:

$$\frac{E_{SRD}(V/m)}{E_{limit\ SRD}(V/m)} + \frac{E_{BLE}(V/m)}{E_{limit\ BLE}(V/m)} = \frac{0.968\ V/m + 0.802\ V/m}{44.898\ V/m} \approx 0.039 \leq 1\ \checkmark$$

$$\frac{H_{SRD}(A/m)}{H_{limit\ SRD}(A/m)} + \frac{H_{BLE}(A/m)}{H_{limit\ BLE}(A/m)} = \frac{0.0026\ A/m + 0.0021\ A/m}{0.119\ A/m} \approx 0.039 \leq 1\ \checkmark$$

$$\frac{S_{SRD}(W/m^2)}{S_{limit\ SRD}(W/m^2)} + \frac{S_{BLE}(W/m^2)}{S_{limit\ BLE}(W/m^2)} = \frac{0.0025\ W/m^2 + 0.0017\ W/m^2}{5.348\ W/m^2} \approx 0.0008 \leq 1\ \checkmark$$

7 Equipment calibration status

Description	Modell number	Serial number	Inventory number(s)	Last calibration	Next calibration
Test receiver	ESCI 3	100013	E00001	2016-02	2018-02
Test receiver	ESCI 3	100328	E00552	2016-09	2018-09
Test receiver	ESCS 30	825442/0002	E00003	2016-04	2018-04
Test receiver	ESU 26	100026	W00002	2016-02	2018-02
Test receiver	ESR 7	101059	E00739	2016-04	2018-04
Test receiver	ESW 44	101538	E00895	2016-12	2018-12
Broadband horn antenna	BBHA 9120D	9120D-593	W00053	2016-03	2018-03
Broadband horn antenna	BBHA 9170	BBHA 9170	W00055	2016-03	2018-03
Preamplifier	AMF-5D-00501800-28-13P	1319793	W00089	2015-06	2017-06
Preamplifier	AMF-6F-16002650-25-10P	1317552	W00090	2015-06	2017-06
LISN	ESH2-Z5	893406/009	E00005	2016-02	2018-02
Loop antenna	HFH2-Z2	871398/0050	E00060	2016-09	2018-09
Broadband antenna	VULB 9160	9160-3050	E00011	2015-09	2017-09
Broadband antenna	VULB 9163	9163-114	E00013	2015-09	2017-09
Shielded room	P92007	B83117C1109T211	E00107	N/A	
Compact diagnostic chamber (CDC)	VK041.0174	D62128-A502-A69-2-0006	E00026	N/A	
Open area test site (OATS)	---	---	E00354	2015-10	2017-10
Semi anechoic chamber (SAC)	SAC3	C62128-A520-A643-x-0006	E00716	2015-09	2017-09
Climatic chamber 340 l	VC³ 4034	58566123250010	C00015	2016-10	2018-10
Cable set shielded room	Cable no. 30	---	E00424	2016-07	2018-07
Cable set CDC	Cables no. 37 and 38	---	E00459 E00460	2015-05	2017-05
Cable set OATS 3 m	Cables no. 19, 34 and 36	---	E00453 E00456 E00458	2015-11	2017-11
Cable set SAC 3 m	Cables no. 57, 58 and 59	---	E00453 E00455 E00458	2015-10	2017-10

Table 17: Equipment calibration status

Note 1: Expiration date of measurement facility registration (OATS) by
- FCC (registration number 221458): 2017-04
- Industry Canada (test sites number 3472A-1 and 3472A-2): 2018-11

Note 2: Expiration date of test firm accreditation for OATS and SAC:
FCC test firm type “accredited”: 2017-06

8 Measurement uncertainties

Description	Max. deviation	k=
Conducted emission AMN (9kHz to 30 MHz)	± 4.1 dB	2
Carrier frequency separation Number of hopping frequencies Time of occupancy (dwell time)	± 5.0 %	2
Bandwidth tests	± 2.0 %	2
Maximum conducted output power	± 1.5 dB	2
Power spectral density	± 3.0 dB	2
Spurious RF conducted emissions	± 3.0 dB	2
Radiated emission open field or semi-anechoic chamber 9 kHz to 30 MHz 30 MHz to 300 MHz 300MHz to 1 GHz	 ± 4.8 dB ± 5.4 dB ± 5.9 dB	2
Radiated emission anechoic chamber (> 1000 MHz)	± 4.5 dB	2

Table 18: Measurement uncertainty

The uncertainty stated is the expanded uncertainty obtained by multiplying the standard uncertainty by the coverage factor k. For a confidence level of 95 % the coverage factor k is 2.

9 Revision history

Revision	*Date*	*Issued by*	*Description of modifications*
0	2017-03-08	Martin Müller	First edition