Test Report

Customer:

DESKO GmbH

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RF test report

170855-AU01+W02

DESKO GmbH

Passport Scanner

PENTA Scanner

EMV **TESTHAUS** GmbH

Gustav-Hertz-Straße 35
94315 Straubing
Tel.: +49 9421 56868-0
Fax: +49 9421 56868-100
Email: info@emv-testhaus.com

Accreditation:

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

Test Firm Type “accredited”: Valid until 2019-05-06
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:

EMV **TESTHAUS** GmbH
Gustav-Hertz-Straße 35
94315 Straubing
Germany

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

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1 Test regulations

47 CFR Part 2: 10-2017	Code of Federal Regulations Part 2 (Frequency allocation and radio treaty matters; General rules and regulations) of the Federal Communication Commission (FCC)
47 CFR Part 15: 03-2017	Code of Federal Regulations Part 15 (Radio Frequency Devices) of the Federal Communication Commission (FCC)
ANSI C63.10:2013-06	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
FCC KDB 174176 D01 June 3, 2015	AC power-line conducted emissions Frequently Asked Questions
ICES-003 Issue 6, January 2016	Spectrum Management and Telecommunications Interference-Causing Equipment Standard Information Technology Equipment (ITE) – Limits and methods of measurement
RSS-Gen Issue 4, November 2014	Spectrum Management and Telecommunications Radio Standards Specification General Requirements and Information for the Certification of Radiocommunication Equimpment
RSS-210 Issue 9, August 2016	Spectrum Management and Telecommunications Radio Standards Specification License-exempt Radio Apparatus (All Frequency Bands): Category I Equipment

2 Summary of test results

Standard	Test result
47 CFR Part 15, sections 15.207 and 15.225	Passed
RSS-210 Issue 9 Section 4.3 and Annex B6 (with appropriate references to RSS-Gen Issue 4)	Passed

Straubing, April 11, 2018

Andreas Menacher
Test engineer
EMV **TESTHAUS** GmbH

Christian Kiermeier
Head of EMC department
EMV **TESTHAUS** GmbH

3 Equipment under Test (EUT)

Product type:	Passport Scanner
Model Name:	PENTA Scanner
Applicant:	DESKO GmbH
Manufacturer:	DESKO GmbH
Serial number:	201750 01472
FCC ID:	WTM-P432PEN1
IC certification number:	7998A-P432PEN1
Application frequency band:	13.110 to 14.010 MHz
Frequency range:	13.560 MHz
Operating frequency:	13.560 MHz
Number of RF-channels:	1
Modulation:	ASK
Antenna connector:	☒ permanent ☐ temporary ☐ none
Antenna types:	PCB antenna
	☒ detachable ☐ not detachable
Maximum antenna gain:	N/A
Maximum conducted power:	N/A
Power supply:	Minimum: 100 V
	Maximum: 240 V
	Frequency: 50 – 60 Hz
Temperature range:	0℃ to +40℃
Modifications:	Ferrite **Würth 742 711 11** on VCC – and USB cable.

All measurements were performed by 120 V / 60 Hz.

3.1 Photo documentation

For external photos of the EUT see annex B, for internal ones see annex C.
For photos taken during testing and including EUT-positions see annex A.

3.2 Short description of the EUT

EUT is a Passport Scanner with internal RFID reader (13.56 MHz). The EUT has two antennas which are not working at the same time.

3.3 Operation mode

During the pre-tests it was observed that the “continuous-tag-reading-mode” is the respective worst- case. Therefore this mode was selected for final testing. The device was configured by manufacturer to scan the RFID-Tag and send the data to the Test-PC.

The EUT was tested in 3 orthogonal positions. This is documented in annex A.

3.4 Configuration

The following peripheral devices and interface cables were connected during the tests:

Device	Model:	Serial or inventory no.
Passport Scanner	PENTA Scanner	201750 01472
Power Supply	GT-46200-2005-T3	TR9CA4000YL4-N(R6B)
RFID tag	13.56 MHz	----
Notebook	LIFEBOOK U772	DSDA005103
DC supply	Statron 3231.1	E00017

3.5 Used cables

Count	Description (type / lengths / remarks)	Serial no.
1	USB cable (3 m, shielded)	---
1	AC Power cable (1 m unshielded)	---

4 AC power line conducted emissions

according to 47 CFR Part 15, section 15.207, and RSS-210, section 3.1 with RSS-Gen, section 8.8

4.1 Test location

Description	Manufacturer	Inventory No.
Shielded room	Siemens - Matsushita	E00107

4.2 Test instruments

	Description	Manufacturer	Inventory No.
☒	ESCS 30	Rohde & Schwarz	E00003
☐	ESU 26	Rohde & Schwarz	W00002
☐	ESCI	Rohde & Schwarz	E00001
☐	ESH3-Z2	Rohde & Schwarz	E00028
☒	ESH2-Z5	Rohde & Schwarz	E00004
☐	ESH2-Z5	Rohde & Schwarz	E00005
☒	Cable set shielded room	Huber + Suhner	E00424

4.3 Limits

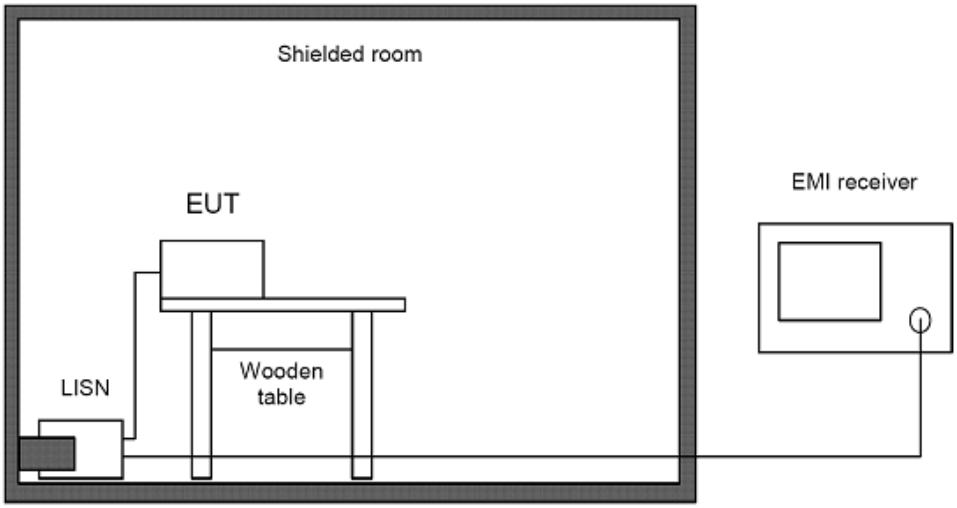
Frequency [MHz]	Quasi-peak [dBµV]	Avarage [dBµV]
0.15 – 0.5	66 – 56	56 – 46
0.5 – 5.0	56	46
5 – 30	60	50

4.4 Test procedure

1. The tests of conducted emission were carried out in a shielded room using a line impedance stabilization network (LISN) 50 µH/50 Ohms and an EMI test receiver.
2. The EMI test receiver was connected to the LISN and set to a measurement bandwidth of 9 kHz in the frequency range from 0.15 MHz to 30 MHz.
3. The EUT was placed on a wooden table and connected to the LISN.
4. To accelerate the measurement the detector of the EMI test receiver was set to peak and the whole frequency range form 0.15 MHz to 30 MHz was scanned.
5. After that all peaks values with less margin than 10 dB to quasi-peak limit or exceeding the limit were marked and re-measured with quasi-peak detector.
6. If after that all values are under the average limit no addition measurement is necessary. In case there are still values between quasi-peak and average limit then these values were re-measured with average detector.
7. These measurements were done on all power lines.

According to ANSI C63.10, section 6.2.2 testing of intentional radiators with detachable antennas shall be done with a dummy load otherwise the tests should be done with connected antenna and if adjustable fully extended.

4.5 Test setup

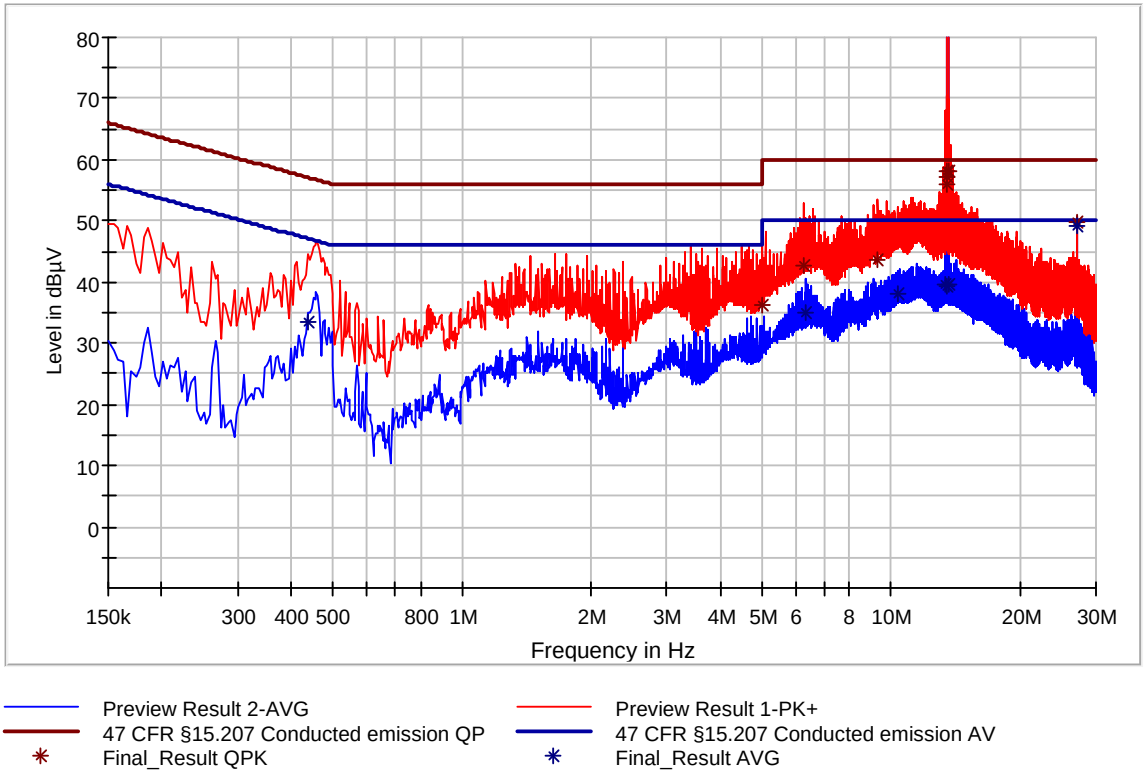


Picture 1: Outline of conducted emission test setup

Comments: All peripheral devices were additionally decoupled by means of a line stabilization network.

4.6 Test results

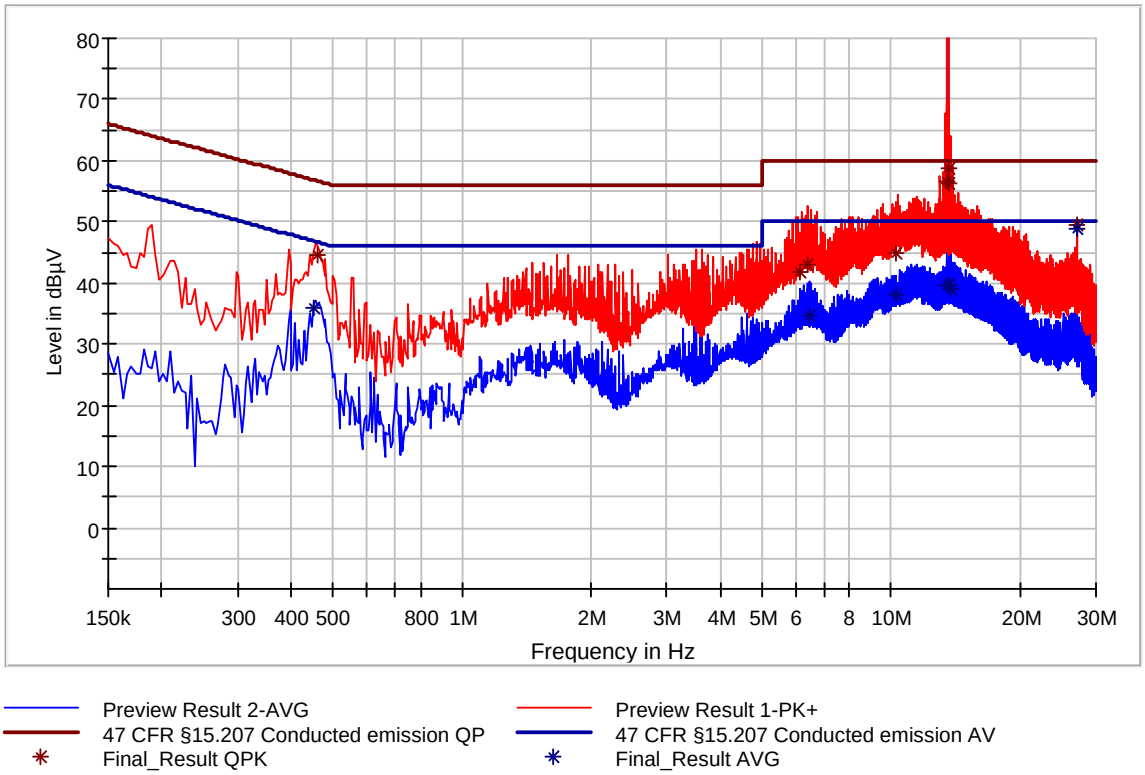
Temperature:	22℃	Humidity:	35%
Tested by:	Andreas Menacher	Test date:	2018-03-28



Picture 2: Graphic - Conducted emission on mains, phase 1 (without termination), antenna 1

Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	PE	Corr. (dB)
0.437000	---	33.48	47.12	13.64	1000.0	9.000	L1	GND	10.1
5.033000	36.25	---	60.00	23.75	1000.0	9.000	L1	GND	10.8
6.245000	42.83	---	60.00	17.17	1000.0	9.000	L1	GND	11.0
6.297000	---	34.88	50.00	15.12	1000.0	9.000	L1	GND	11.0
9.297000	43.69	---	60.00	16.31	1000.0	9.000	L1	GND	11.2
10.385000	---	38.14	50.00	11.86	1000.0	9.000	L1	GND	11.4
13.353000	---	39.62	50.00	10.38	1000.0	9.000	L1	GND	11.7
13.461000	58.02	---	60.00	1.98	1000.0	9.000	L1	GND	11.8
13.473000	57.11	---	60.00	2.89	1000.0	9.000	L1	GND	11.8
13.485000	---	39.24	50.00	10.76	1000.0	9.000	L1	GND	11.8
13.489000	56.10	---	60.00	3.90	1000.0	9.000	L1	GND	11.8
13.561000	87.18	---	60.00	-27.18	1000.0	9.000	L1	GND	11.8
13.561000	---	87.24	50.00	-37.24	1000.0	9.000	L1	GND	11.8
13.661000	---	39.57	50.00	10.43	1000.0	9.000	L1	GND	11.8
13.673000	58.19	---	60.00	1.81	1000.0	9.000	L1	GND	11.8
27.121000	---	49.27	50.00	0.73	1000.0	9.000	L1	GND	12.5
27.121000	49.90	---	60.00	10.10	1000.0	9.000	L1	GND	12.5

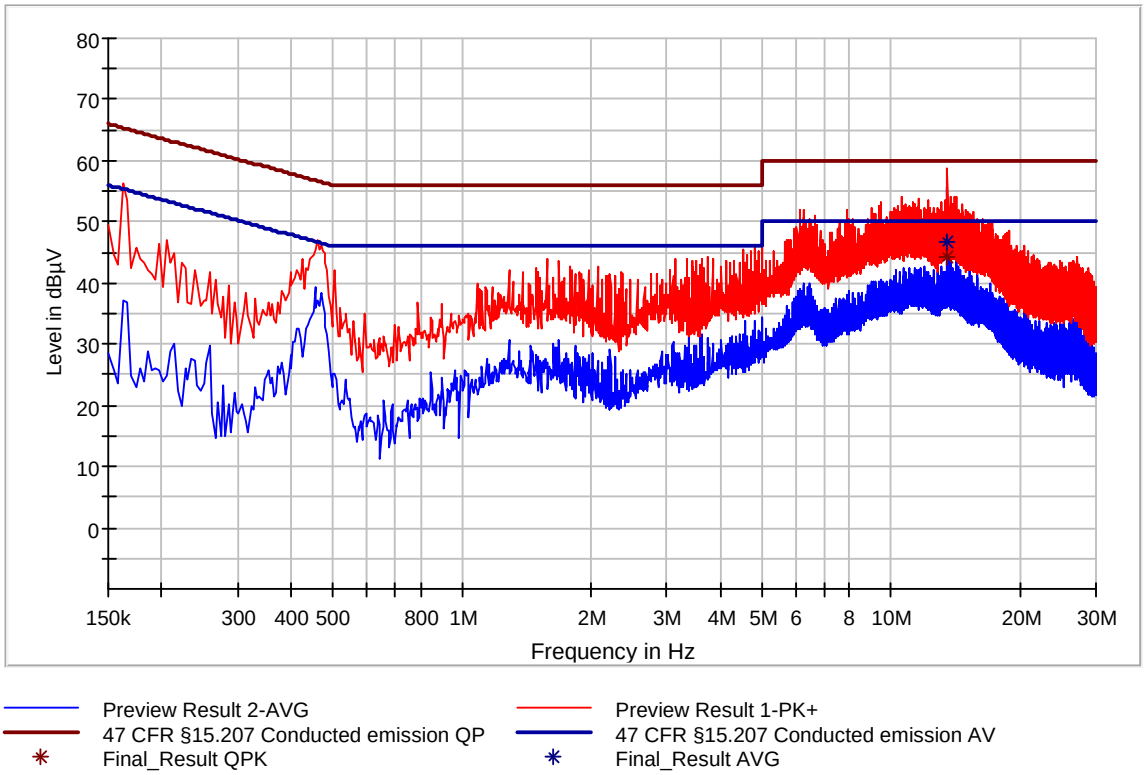
Picture 3: Table - Conducted emission on mains, phase 1 (without termination), antenna 1



Picture 4: Graphic - Conducted emission on mains, neutral (without termination), antenna 1

Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	PE	Corr. (dB)
0.453000	---	35.94	46.82	10.88	1000.0	9.000	N	GND	10.1
0.461000	44.55	---	56.68	12.12	1000.0	9.000	N	GND	10.1
6.129000	41.80	---	60.00	18.20	1000.0	9.000	N	GND	11.0
6.389000	43.16	---	60.00	16.84	1000.0	9.000	N	GND	11.1
6.465000	---	34.72	50.00	15.28	1000.0	9.000	N	GND	11.1
10.269000	---	38.05	50.00	11.95	1000.0	9.000	N	GND	11.6
10.305000	44.81	---	60.00	15.19	1000.0	9.000	N	GND	11.6
13.445000	56.61	---	60.00	3.39	1000.0	9.000	N	GND	12.0
13.457000	---	39.57	50.00	10.43	1000.0	9.000	N	GND	12.0
13.561000	87.13	---	60.00	-27.13	1000.0	9.000	N	GND	12.0
13.561000	---	87.19	50.00	-37.19	1000.0	9.000	N	GND	12.0
13.633000	56.23	---	60.00	3.77	1000.0	9.000	N	GND	12.0
13.661000	58.59	---	60.00	1.41	1000.0	9.000	N	GND	12.0
13.693000	---	39.52	50.00	10.48	1000.0	9.000	N	GND	12.0
13.709000	---	39.13	50.00	10.87	1000.0	9.000	N	GND	12.0
27.121000	---	48.79	50.00	1.21	1000.0	9.000	N	GND	12.5
27.121000	49.47	---	60.00	10.53	1000.0	9.000	N	GND	12.5

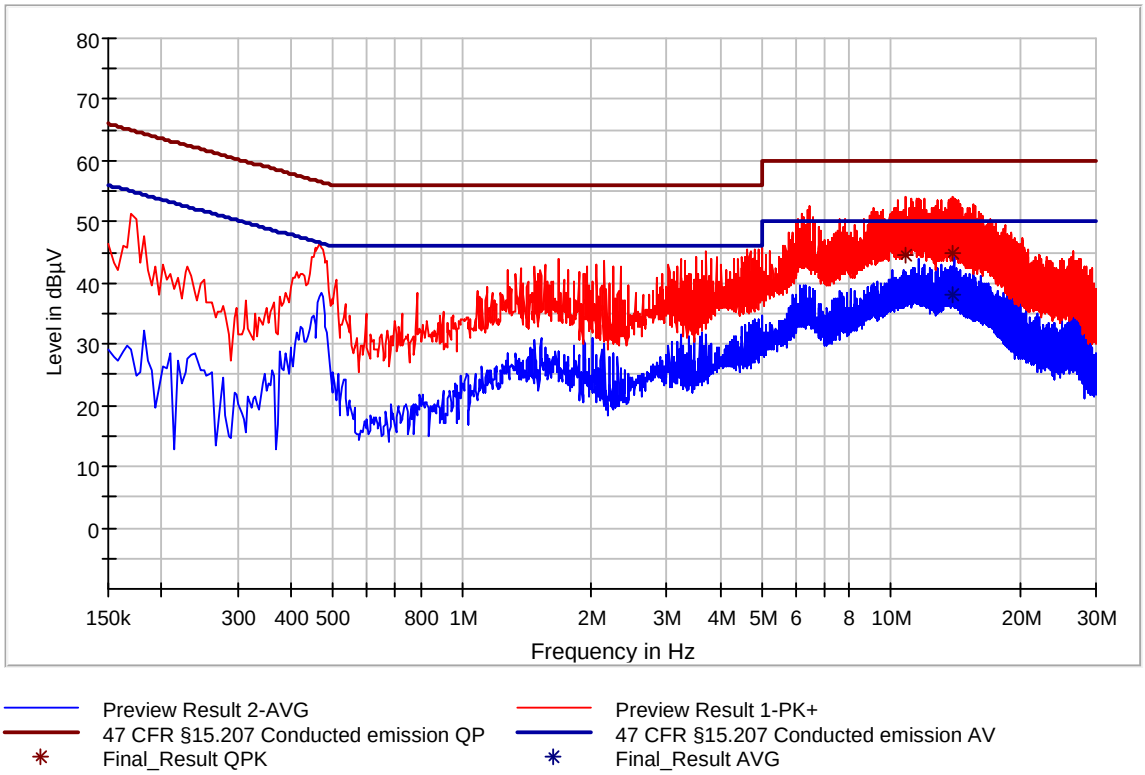
Picture 5: Table - Conducted emission on mains, neutral (without termination), antenna 1



Picture 6: Graphic - Conducted emission on mains, phase L1 (with termination), antenna 1

Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	PE	Corr. (dB)
13.541000	44.31	---	60.00	15.69	1000.0	9.000	L1	GND	11.8
13.561000	---	46.82	50.00	3.18	1000.0	9.000	L1	GND	11.8

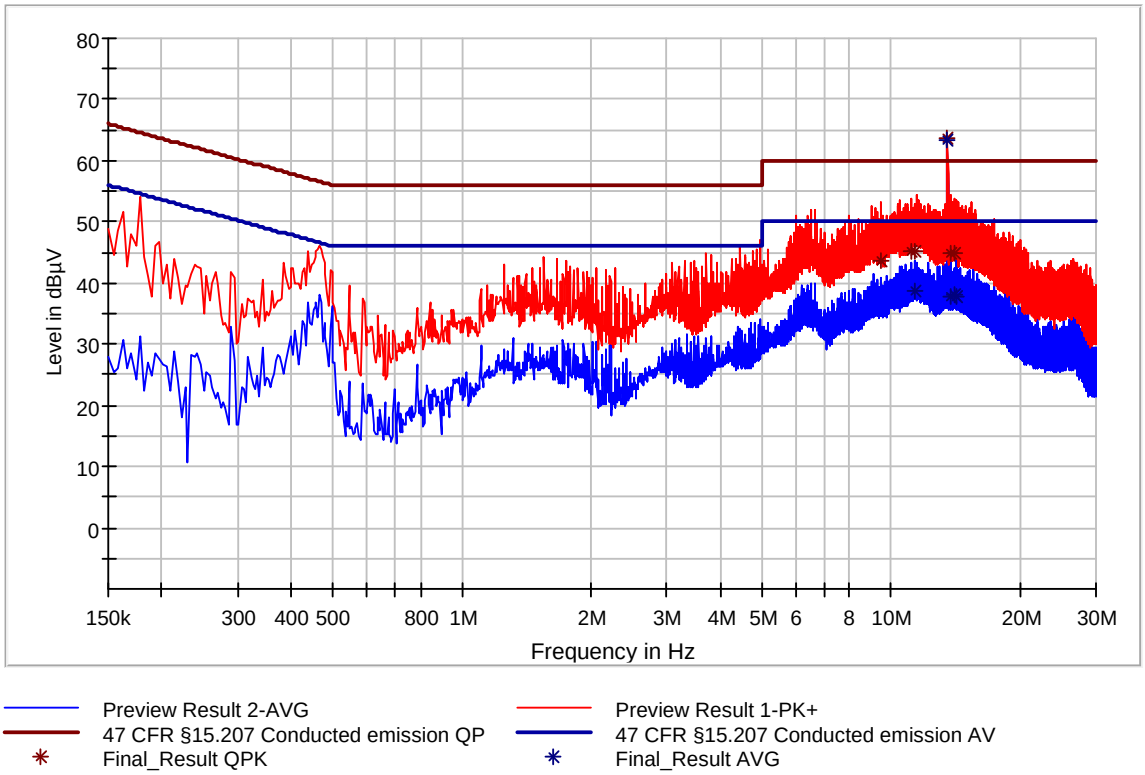
Picture 7: Table - Conducted emission on mains, phase L1 (with termination), antenna 1



Picture 8: Graphic - Conducted emission on mains, neutral (with termination), antenna 1

Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	PE	Corr. (dB)
10.857000	44.68	---	60.00	15.32	1000.0	9.000	N	GND	11.6
13.857000	44.85	---	60.00	15.15	1000.0	9.000	N	GND	12.0
13.957000	---	38.00	50.00	12.00	1000.0	9.000	N	GND	12.0

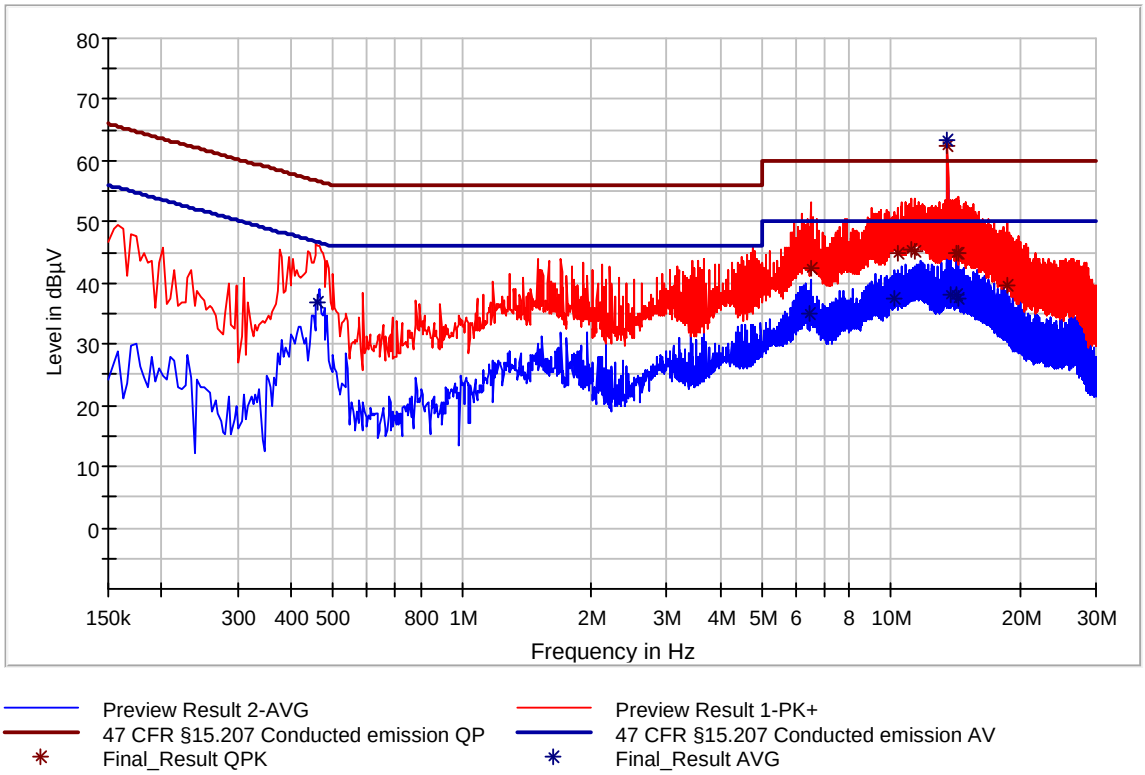
Picture 9: Table - Conducted emission on mains, neutral (with termination), antenna 1



Picture 10: Graphic - Conducted emission on mains, phase 1 (without termination), antenna 2

Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	PE	Corr. (dB)
9.457000	43.49	---	60.00	16.51	1000.0	9.000	L1	GND	11.3
11.181000	45.15	---	60.00	14.85	1000.0	9.000	L1	GND	11.5
11.309000	---	38.63	50.00	11.37	1000.0	9.000	L1	GND	11.5
11.417000	45.25	---	60.00	14.75	1000.0	9.000	L1	GND	11.5
13.561000	---	63.44	50.00	-13.44	1000.0	9.000	L1	GND	11.8
13.561000	63.68	---	60.00	-3.68	1000.0	9.000	L1	GND	11.8
13.801000	44.77	---	60.00	15.23	1000.0	9.000	L1	GND	11.8
13.801000	---	37.88	50.00	12.12	1000.0	9.000	L1	GND	11.8
14.005000	44.94	---	60.00	15.06	1000.0	9.000	L1	GND	11.8
14.109000	---	37.96	50.00	12.04	1000.0	9.000	L1	GND	11.8
14.257000	---	37.67	50.00	12.33	1000.0	9.000	L1	GND	11.8

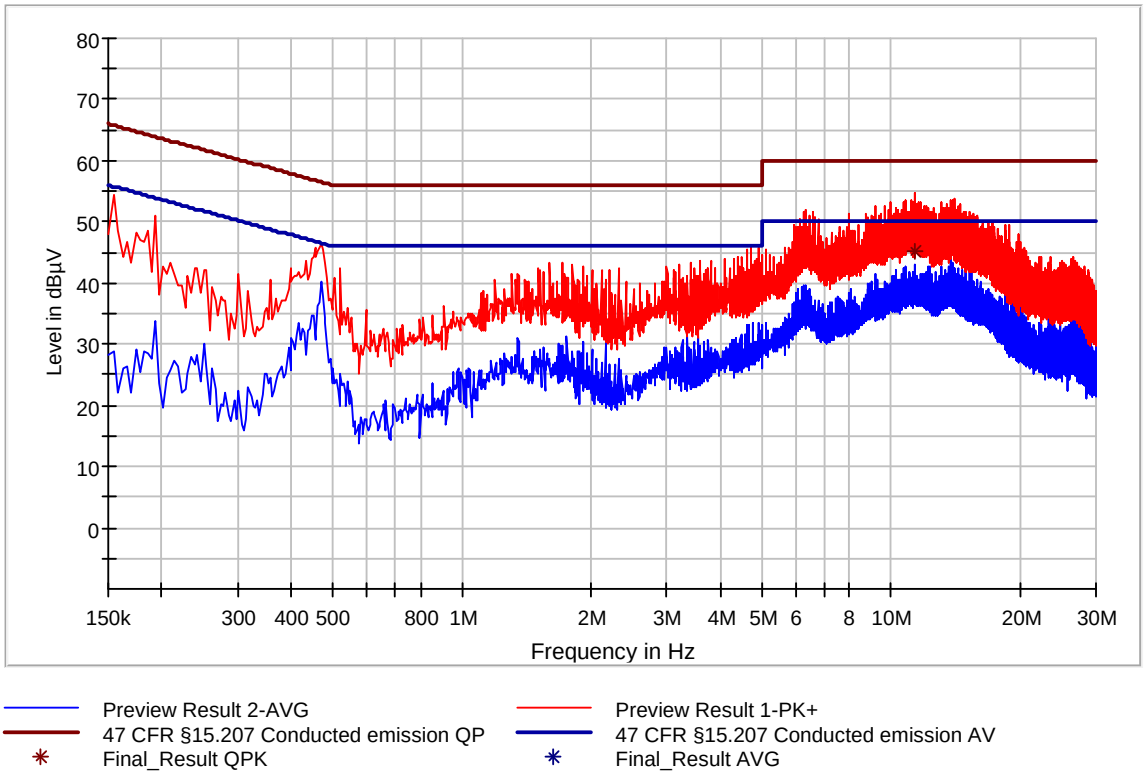
Picture 11: Table - Conducted emission on mains, phase 1 (without termination), antenna 2



Picture 12: Graphic - Conducted emission on mains, neutral (without termination), antenna 2

Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	PE	Corr. (dB)
0.461000	---	36.74	46.68	9.93	1000.0	9.000	N	GND	10.1
6.441000	---	34.94	50.00	15.06	1000.0	9.000	N	GND	11.1
6.513000	42.36	---	60.00	17.64	1000.0	9.000	N	GND	11.1
10.189000	---	37.53	50.00	12.47	1000.0	9.000	N	GND	11.5
10.375000	44.92	---	60.00	15.08	1000.0	9.000	N	GND	11.6
11.113000	45.40	---	60.00	14.60	1000.0	9.000	N	GND	11.7
11.321000	45.11	---	60.00	14.89	1000.0	9.000	N	GND	11.7
13.561000	62.43	---	60.00	-2.43	1000.0	9.000	N	GND	12.0
13.561000	---	63.23	50.00	-13.23	1000.0	9.000	N	GND	12.0
13.737000	---	38.02	50.00	11.98	1000.0	9.000	N	GND	12.0
14.161000	44.86	---	60.00	15.14	1000.0	9.000	N	GND	12.0
14.197000	---	38.09	50.00	11.91	1000.0	9.000	N	GND	12.0
14.301000	44.89	---	60.00	15.11	1000.0	9.000	N	GND	12.0
14.325000	---	37.45	50.00	12.55	1000.0	9.000	N	GND	12.0
18.609000	39.74	---	60.00	20.26	1000.0	9.000	N	GND	12.4

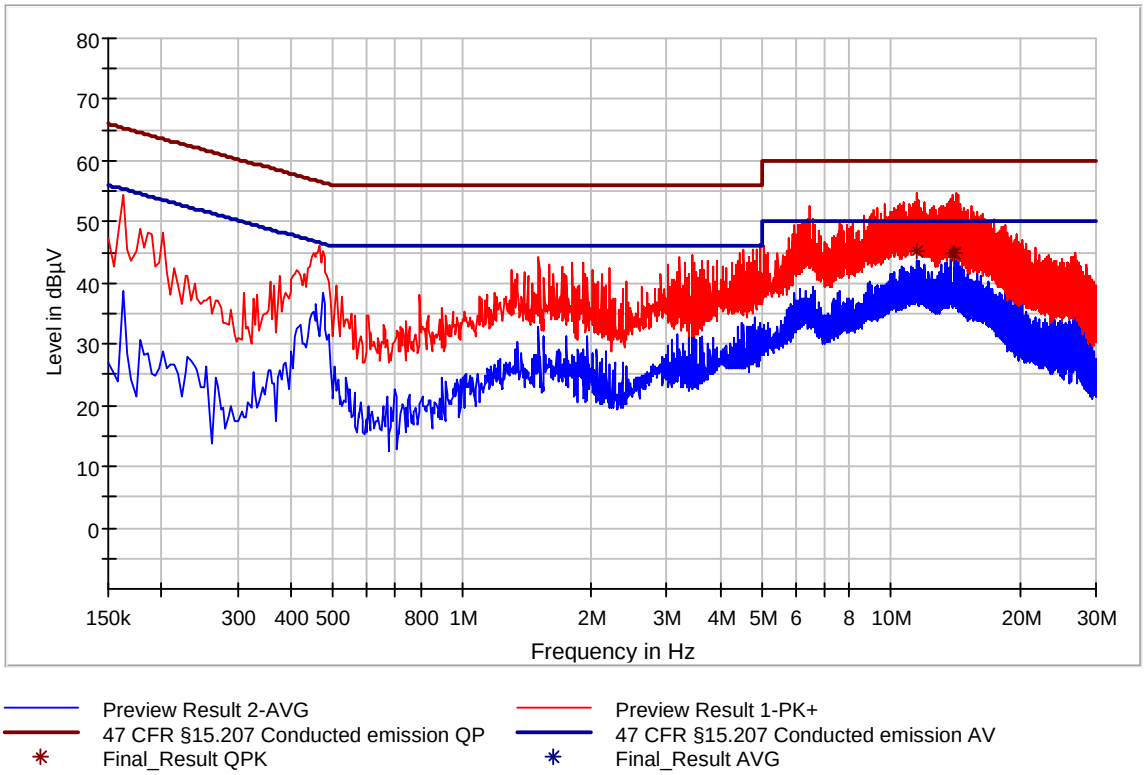
Picture 13: Table - Conducted emission on mains, neutral (without termination), antenna 2



Picture 14: Graphic - Conducted emission on mains, phase L1 (with termination), antenna 2

Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	PE	Corr. (dB)
11.317000	45.05	---	60.00	14.95	1000.0	9.000	L1	GND	11.5

Picture 15: Table - Conducted emission on mains, phase L1 (with termination), antenna 2



Picture 16: Graphic - Conducted emission on mains, neutral (with termination), antenna 2

Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	PE	Corr. (dB)
11.505000	45.29	---	60.00	14.71	1000.0	9.000	N	GND	11.7
13.975000	44.94	---	60.00	15.06	1000.0	9.000	N	GND	12.0
14.097000	44.91	---	60.00	15.09	1000.0	9.000	N	GND	12.0

Picture 17: Table - Conducted emission on mains, neutral (with termination), antenna 2

5 Radiated emission measurement (<1 GHz)

according to 47 CFR Part 15, section 15.205(a), 15.209(a), 15.225(a) to (e), and RSS-210, section 4.3 and Annex B6 with RSS-Gen, sections 8.10 and 8.9

5.1 Test Location

Emission < 30 MHz

☒ Scan with PK / AV detector in 3 m CDC.

☒ Final CISPR measurement with QP detector in 3 m OATS

Emission > 30 MHz

☒ Scan with QP detector in 3 m SAC.

☒ Final CISPR measurement with QP detector in 3 m SAC

5.2 Test instruments

	Type	*Designation*	*Manufacturer*	*Inventory no.*
☒	Compact Diagnostic Chamber (CDC)	VK041.0174	Albatross Projects	E00026
☒	Semi Anechoic Chamber (SAC)	---	Albatross Projects	E00716
☒	Open area test site	---	EMV **TESTHAUS** GmbH	E00354
☒	EMI test receiver (CDC / OATS)	ESCI 3	Rohde & Schwarz	E00552
☒	EMI test receiver (SAC)	ESR 7	Rohde & Schwarz	E00739
☐	TRILOG broadband antenna (CDC)	VULB 9160	Schwarzbeck	E00011
☐	TRILOG broadband antenna (OATS)	VULB 9163	Schwarzbeck	E00013
☒	TRILOG broadband antenna (SAC)	VULB 9162	Schwarzbeck	E00643
☒	Loop Antenna	HFH2-Z2	Rohde & Schwarz	E00060
☐	Switch box	COSB 4-1-26	Conformitas	W00091
☐	Preamplifier	AMF-5D-00501800	Parzich	W00089
☐	Measurement software	E10 v1.4.12	EMV TESTHAUS GmbH	E00443
☒	Measurement software	EMC 32	Rohde & Schwarz	---
☒	Cable set SAC 3 m	---	Huber + Suhner	E00434 E00755 E00320

5.3 Limits

The field strength of any emissions appearing outside of the 13.110 to 14.010 MHz band including spurious emissions falling into restricted bands as specified in 15.205(a) shall not exceed the general radiated emission limits as specified in 15.209.

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

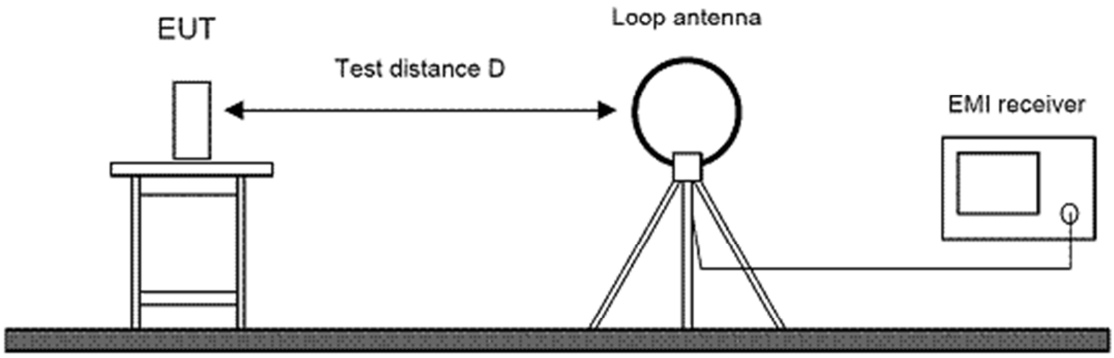
As noted in 15.205(d)(7) devices according to 15.225 are exempt from complying with restricted band requirements for the 13.36 to 13.41 MHz band. Instead they have to comply with the limits as specified in 15.225 (a) to (d):

Frequency [MHz]	Field strength Fs [µV/m]	Field strength [dBµV/m]	Measurement distance d [m]
13.553 - 13.567	15,848	84	30
13.410 - 13.553	334	50.47	30
13.567 - 13.710	334	50.47	30
13.110 - 13.410	106	40.51	30
13.710 - 14.010	106	40.51	30
f < 13.110	according to limits in §15.209		
f > 14.010			

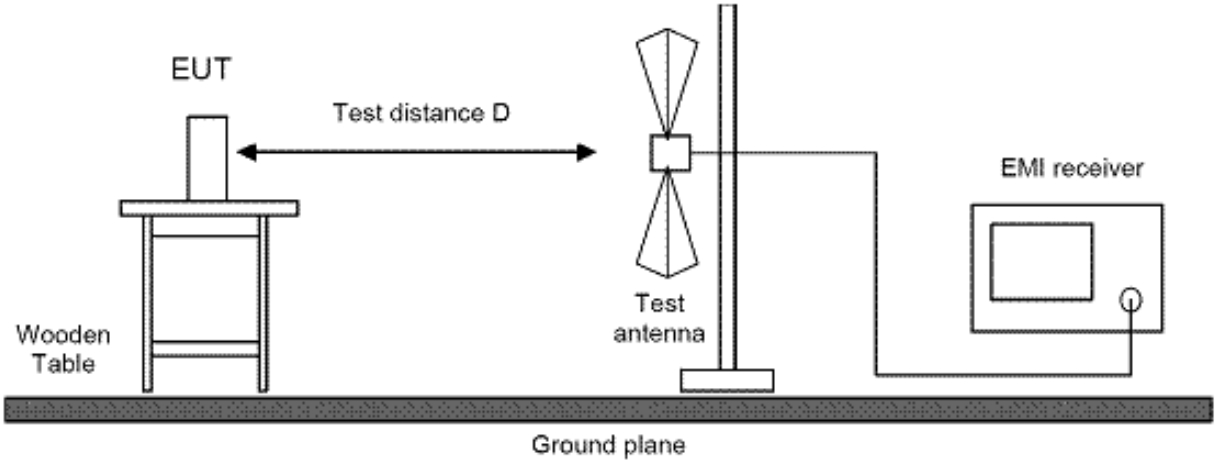
5.4 Test procedure

1. EUT was configured according to ANSI C63.10. It was placed on the top of the turntable 0.8 meter above ground. The receiving antenna was placed 3 meters from the turntable. The test setup was placed inside a compact diagnostic chamber.
2. EUT and all peripherals were powered on.
3. The broadband antenna was set to vertical polarization.
4. The EMI receiver performed a scan from 30 MHz to 1000 MHz with peak detector peak and measurement bandwidth set to 120 kHz.
5. The turn table was rotated to 6 different positions (360°/ 6) and the antenna polarization was changed to horizontal.
6. Test procedure at step 4 and 5 was repeated.
7. The test setup was then placed in an OATS at 3 m distance and all peak values over or with less margin to the limit than 6dB were marked and re-measured with a quasi-peak detector.
8. The turntable was rotated by 360 degrees to determine the position of the highest radiation.
9. The height of the broadband receiving antenna was varied between one meter and four meters above ground to find the maximum emission field strength of both horizontal and vertical polarization. The highest value was recorded.
10. For emissions below 30 MHz measurements were done using a loop antenna. Prescan was performed with peak detector and final measurements with quasi-peak except for the frequency bands 9 to 90 kHz and 110 to 490 k Hz where average detector applies. Antenna height was not changed during this test. Appropriate CISPR bandwidths of 200 Hz for frequencies up to 150 kHz and 9 or 10 kHz for frequencies above were used.

5.5 Test setup



Picture 18: Test setup for radiated emission measurement (< 30 MHz)



Picture 19: Test setup for radiated emission measurement (< 1 GHz)

5.6 Test deviation

There is no deviation from the standards referred to.

5.7 Test results

Temperature:	21℃	Humidity:	35%
Tested by:	Andreas Menacher	Test date:	2018-03-19

Radiated Emission Measurement 9 kHz - 30 MHz

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:

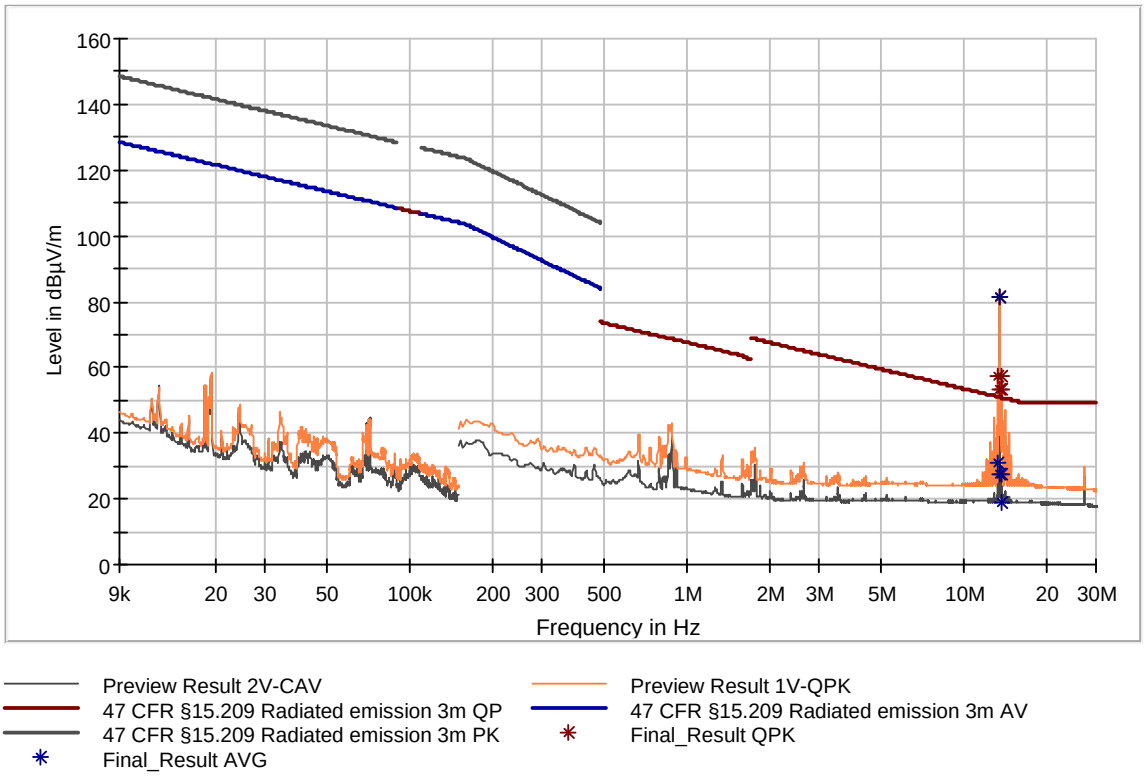
f_{MHz}(300 m) ≈ 0.159 MHz
f_{MHz}(30 m) ≈ 1.592 MHz
f_{MHz}(3 m) ≈ 15.923 MHz

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.

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

The following picture shows the worst-case-emissions for the spurious emissions for antenna 1 at EUT-position 3, loop antenna parallel.

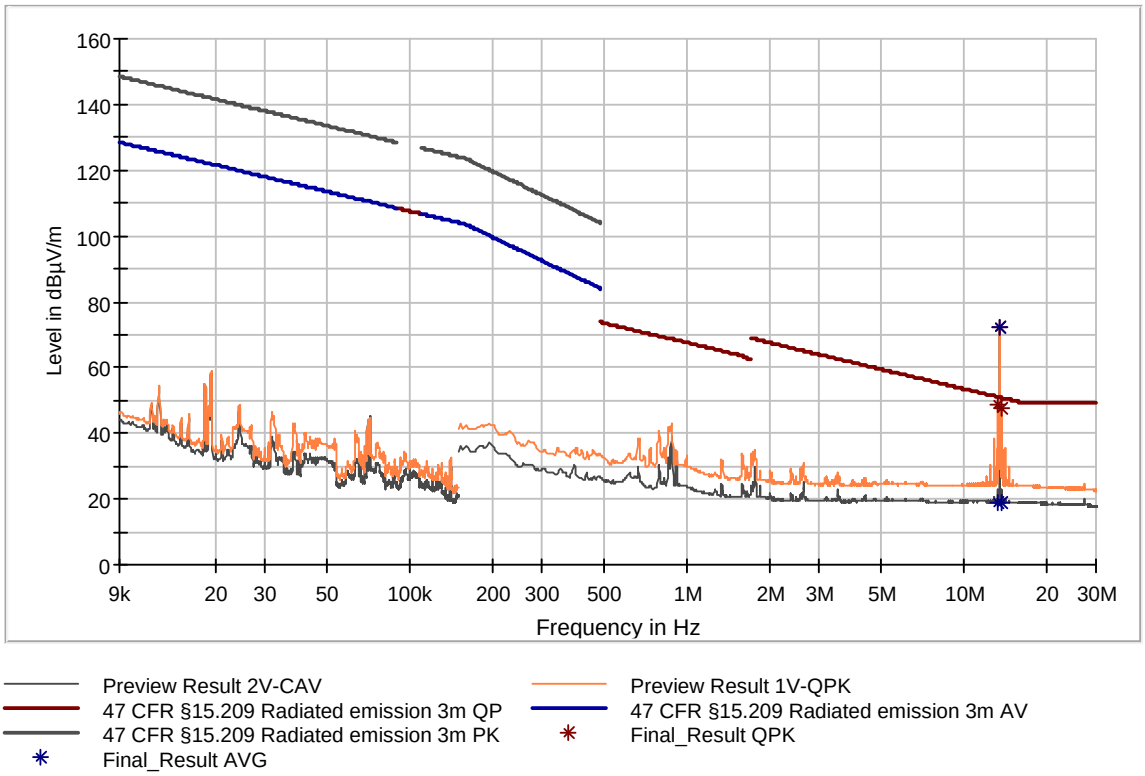


Frequency [MHz]	Measured value [dBµV/m]	Detector	Recalculation factor [dB]	Field strength [dBµV/m]	Limit [dBµV/m]	Margin	Result
13.348	31.11	AV	-21.53	9.58	---	---	Carrier
13.348	57.16	QP	-21.53	35.63	40.51	4.88	Carrier
13.456	27.58	AV	-21.46	6.12	---	---	Carrier
13.456	53.30	QP	-21.46	31.84	50.47	18.63	Carrier
13.560	81.47	AV	-21.40	60.07	---	---	Carrier
13.560	81.52	QP	-21.40	60.12	84.00	23.88	Carrier
13.665	27.44	AV	-21.32	6.12	---	---	Carrier
13.665	53.29	QP	-21.32	31.97	50.47	18.50	Carrier

Frequency [MHz]	Measured value [dBµV/m]	Detector	Recalculation factor [dB]	Field strength [dBµV/m]	Limit [dBµV/m]	Margin	Result
13.773	18.73	AV					
13.773	57.50	QP			50.76	3.62	PASS

Picture 20: Radiated emission 9 kHz – 30 MHz @ 3m distance

The following picture shows the worst-case-emissions for the spurious emissions for antenna 2 at EUT-position 2, loop antenna parallel.



Frequency [MHz]	Measured value [dBµV/m]	Detector	Recalculation factor [dB]	Field strength [dBµV/m]	Limit [dBµV/m]	Margin	Result
13.348	18.96	AV	-21.53	-2.57	---	---	Carrier
13.348	48.62	QP	-21.53	27.09	40.51	13.42	Carrier
13.560	72.24	AV	-21.40	50.84	---	---	Carrier
13.560	72.30	QP	-21.40	50.90	84.00	33.10	Carrier
13.773	18.67	AV	-21.26	-2.59	---	---	Carrier
13.773	47.50	QP	-21.26	26.24	40.51	14.27	Carrier

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}

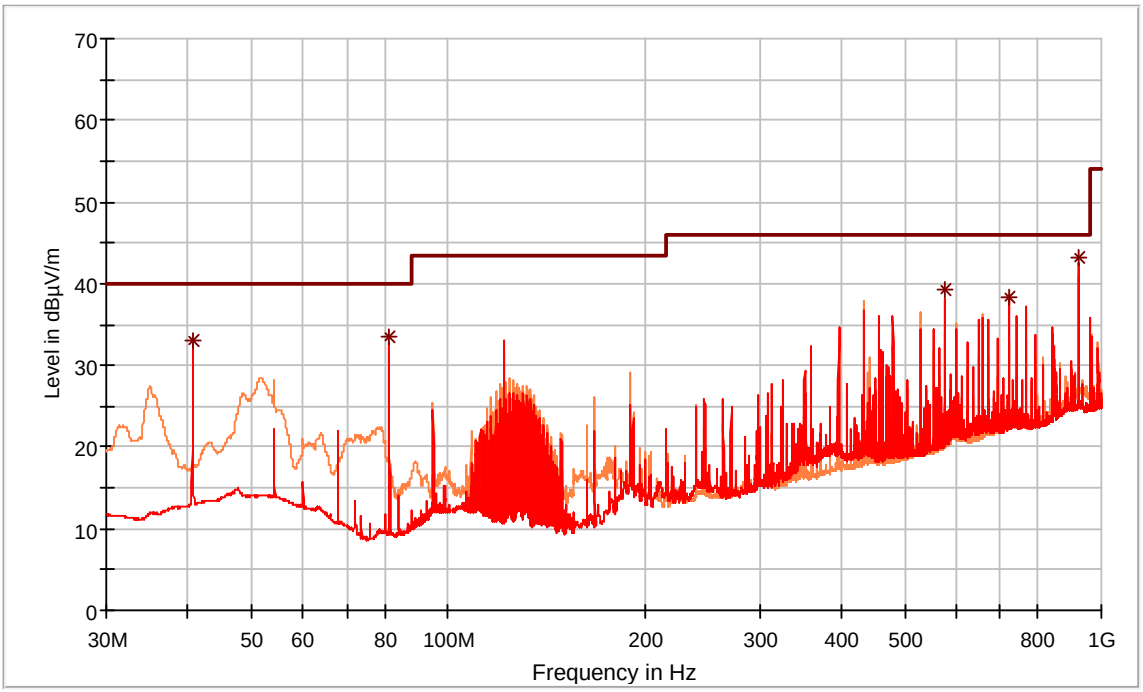
Recalculation factor = -40 log($d_{near\ field}$ / $d_{measure}$) - 20 log(d_{limit} / $d_{near\ field}$)

f_{MHz} [MHz]	$d_{near\ field}$ [m]	$d_{measure}$ [m]	d_{limit} [m]	Recalculation factor [dB]
13.348	3.578	3.0	30.0	-21.53
13.456	3.550	3.0	30.0	-21.46
13.560	3.523	3.0	30.0	-21.40
13.665	3.495	3.0	30.0	-21.32
13.773	3.468	3.0	30.0	-21.26

Radiated Emission Measurement 30 MHz - 1000 MHz

Frequency range	*Polari-sation*	*Step size*	*IF Band-width*	*Detector*		*Measurement Time*		*Pre-amplifier*
				Prescan	*Final scan*	*Prescan*	*Final scan*	
30 MHz – 1 GHz	H / V	50 kHz	120 kHz	PK	QPK	1 ms	1 s	20 dB

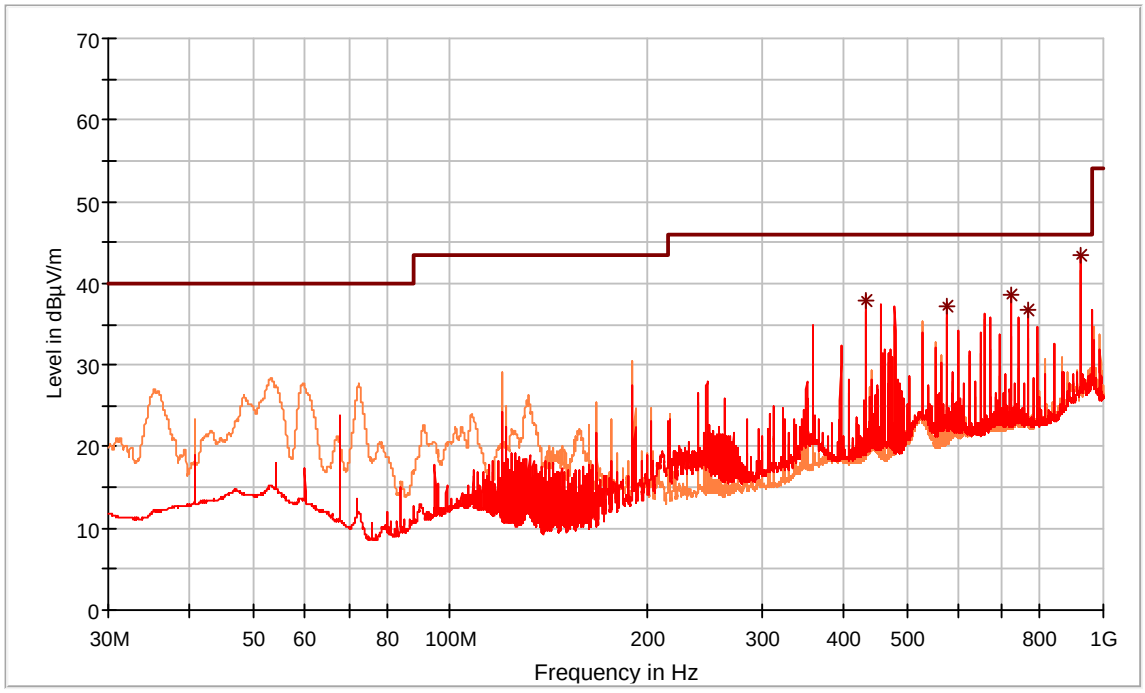
The following pictures show the worst-case-emissions for antenna 1 at EUT-position 1.



Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)
40.680000	32.94	40.00	7.06	201.0	H	163.0
81.360000	33.56	40.00	6.44	218.0	H	189.0
576.030000	39.20	46.00	6.80	129.0	H	253.0
720.030000	38.34	46.00	7.66	100.0	H	176.0
924.030000	43.17	46.00	2.83	100.0	H	83.0

Picture 21: Radiated emission 30 MHz - 1000MHz @ 3m distance, antenna 1

The following pictures show the worst-case-emissions for antenna 2 at EUT-position 1.



Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)
432.000000	37.93	46.00	8.07	225.0	H	116.0
576.030000	37.12	46.00	8.88	147.0	H	240.0
720.030000	38.60	46.00	7.40	101.0	H	176.0
768.030000	36.64	46.00	9.36	101.0	H	185.0
924.030000	43.45	46.00	2.55	100.0	H	65.0

Picture 22: Radiated emission 30 MHz - 1000MHz @ 3m distance, antenna 2

Spectrum Mask

Test procedure

The EUT was placed in a fully anechoic chamber and the testing was performed in accordance with ANSI C63.10 and 47 CFR Part 15, section 15.225 (a) to (d). The measurement distance was 3 m. To find the closest margin of the spectrum to the limit mask adapted to the test distance the EUT was rotated by 360 degrees with detector of the test receiver set to peak. The loop antenna placed in a fixed height of 1 meter was rotated by 360 degrees to get the maximum of emission. In case of exceeding the limits the detector is switched to quasi peak for final testing in position of maximum emission.

Test result

Temperature:	21℃	Humidity:	35%
Tested by:	Andreas Menacher	Test date:	2018-03-19

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:

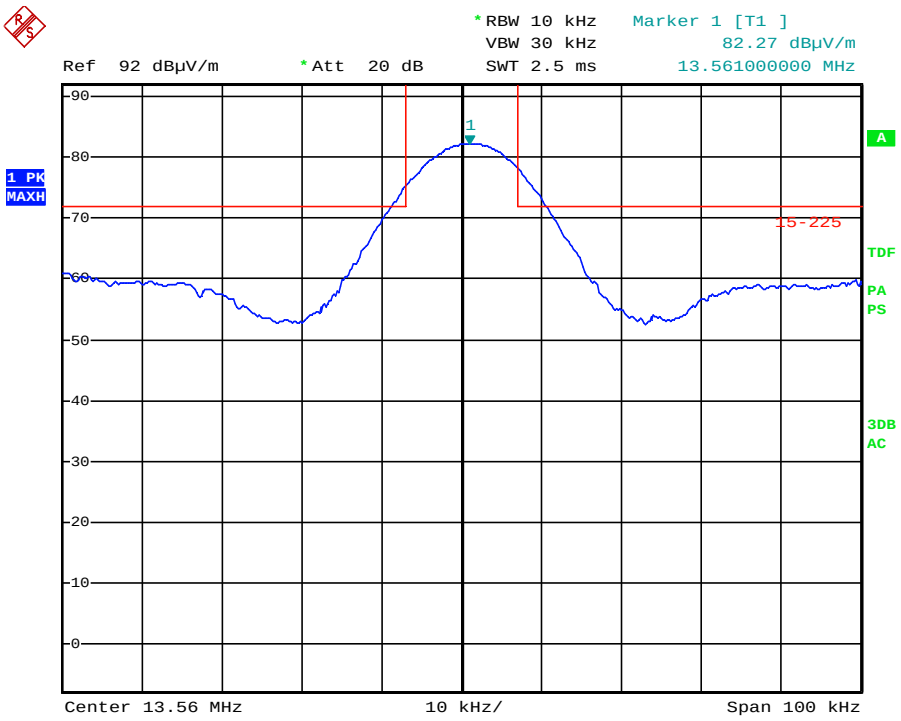
f_{MHz}(300 m) ≈ 0.159 MHz
f_{MHz}(30 m) ≈ 1.592 MHz
f_{MHz}(3 m) ≈ 15.923 MHz

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 = $-20 \log(d_{limit} / d_{measure})$

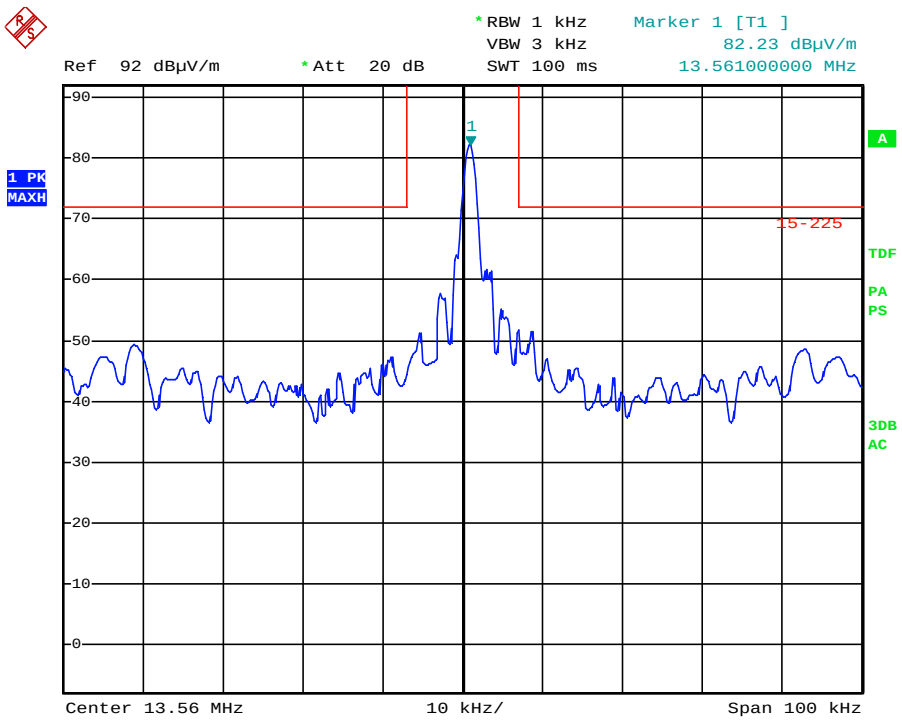
The limits in the graphics and value lists are derived from the general radiated emission limits as specified in 15.209 using the recalculation factor as described above.

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

The following pictures show the worst-case-emissions for spectrum mask for antenna 1 at EUT-position 3, antenna parallel.



Picture 23: Spectrum mask for 13.56 MHz @ 3m distance (10 kHz BW), antenna 1



Picture 24: Spectrum mask for 13.56 MHz @ 3m distance (1 kHz BW), antenna 1

Frequency [MHz]	Measured value [dBµV/m]	Detector	Recalculation factor [dB]	Field strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]	BW [kHz]	Correction delta marker [dB]
13.561	82.23*	PK	-21.39	60.84	84.00	23.16	1	0.04
13.561	82.27	PK	-21.39	60.88	84.00	23.12	10	---

*including correction

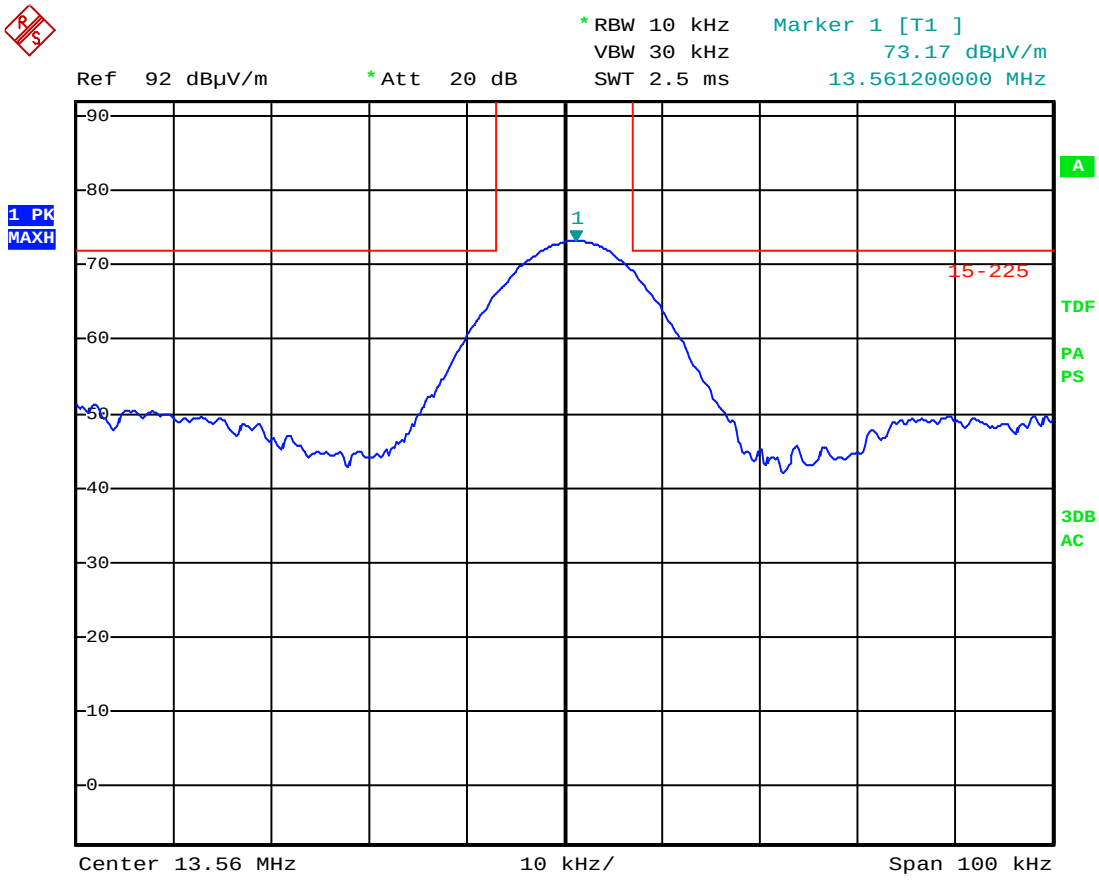
Recalculation factor is determined according to ANSI C63.10, section 6.4.4.2 “Extrapolation from the measurement of a single point”:

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

Recalculation factor = -40 log($d_{near\ field}$ / $d_{measure}$) - 20 log(d_{limit} / $d_{near\ field}$)

f_{MHz} [MHz]	$d_{near\ field}$ [m]	$d_{measure}$ [m]	d_{limit} [m]	Recalculation factor [dB]
13.561	3.522	3.000	30.000	-21.39

The following pictures show the worst-case-emissions for spectrum mask for antenna 2 at EUT-position 2, antenna parallel.



Picture 25: Spectrum mask for 13.56 MHz @ 3m distance (10 kHz BW), antenna 2

6 Radiated emission measurement (>1 GHz)

according to 47 CFR Part 15, section 15.209(a), RSS-210, section 4.3 with RSS-Gen, section 8.9

Remark:

This measurement needs not to be applied for the RFID part because the intentional radiator operates below 10 GHz and tenth harmonic of the highest fundamental frequency is lower than 1 GHz (see 47 CFR Part 15, section 15.33(a)(1), and RSS-Gen, section 6.13).

7 Carrier frequency stability

according to CFR 47 Part 15, section 15.225(e), and RSS-210, Annex B6 with RSS-Gen, section 6.11

7.1 Test Location

	Description	Manufacturer	Inventory No.
☐	Climatic chamber VC 4100	Vötsch Industrietechnik	C00014
☒	Climatic chamber VC³ 4034	Vötsch Industrietechnik	C00015

7.2 Test instruments

	Description	Manufacturer	Inventory No.
☐	ESU 26	Rohde & Schwarz	W00002
☒	ESCI	Rohde & Schwarz	E00001
☒	RF-R 400-1	Langer EMV-Technik	E00270

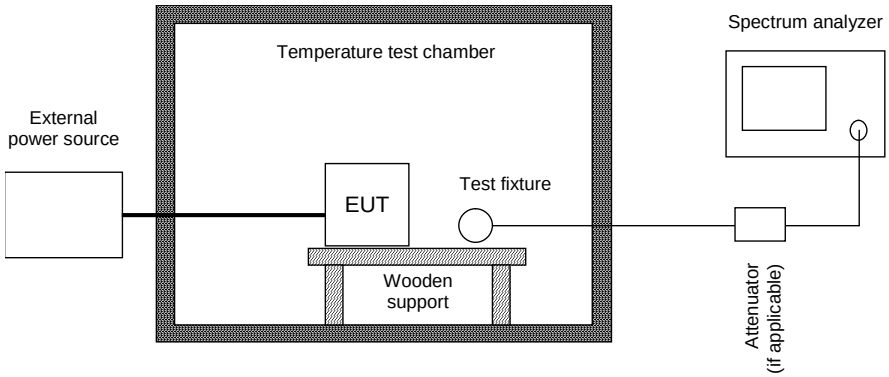
7.3 Limits

The frequency tolerance of the carrier signal shall be maintained within ±0.01% (100 ppm) of the operating frequency over a temperature variation of -20 degrees to +50 degrees C at normal supply voltage, and for a variation in the primary supply voltage from 85% to 115% of the rated supply voltage at a temperature of 20 degrees C.
For battery operated equipment, the equipment tests shall be performed using a new battery. Alternatively, an external supply voltage can be used and set at the battery nominal voltage, and again at the battery operating end point voltage which must be specified by the equipment manufacturer.

7.4 Test procedure

1. If possible EUT is operating providing an unmodulated carrier. The peak detector of the spectrum analyzer is selected and resolution as well as video bandwidth are set to values appropriate to the shape of the spectrum of the EUT. The frequency counter mode of the spectrum analyzer is used to maximize the accuracy of the measured frequency tolerance.
   If an unmodulated carrier is not available a significant and stable point on the spectrum is selected and the span is reduced to a value that delivers an accuracy which shall be better than 1% of the maximum frequency tolerance allowed for the carrier signal. This method may be performed as long as the margin to the frequency tolerance allowed is larger than the uncertainty of the measured frequency tolerance.
2. The carrier frequency is measured depending on the variation in the primary supply voltage from 85% to 115% of the rated supply voltage at a temperature of 20 degrees C. For battery operated equipment an external supply voltage can be used and set at the battery nominal voltage, and again at the battery operating end point voltage which must be specified by the equipment manufacturer. Alternatively, tests shall be performed using a new battery.
3. The carrier frequency is measured over a temperature variation of -20 degrees to +50 degrees C at normal supply voltage.

7.5 Test setup



Picture 26: Test setup for carrier frequency stability measurement

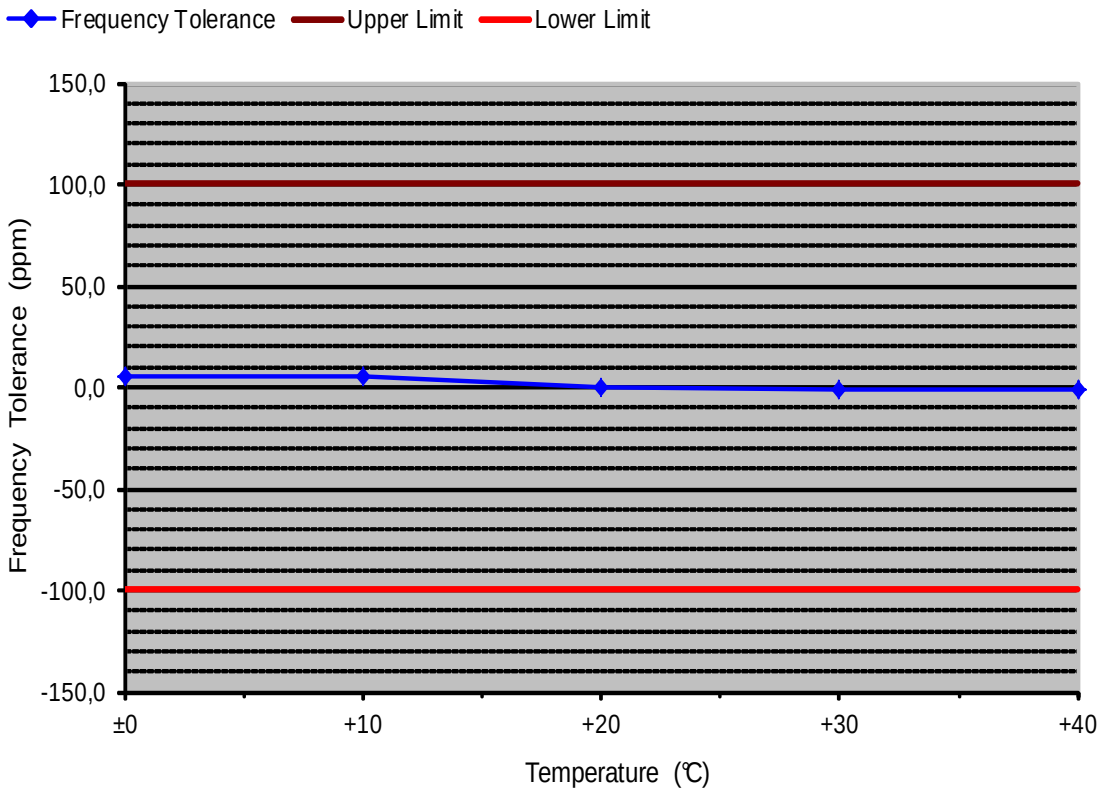
7.6 Test deviation

There is no deviation from the standards referred to.

7.7 Test result

Temperature:	22.5°C	Humidity:	34.5%
Tested by:	Andreas Menacher	Test date:	2018-03-20

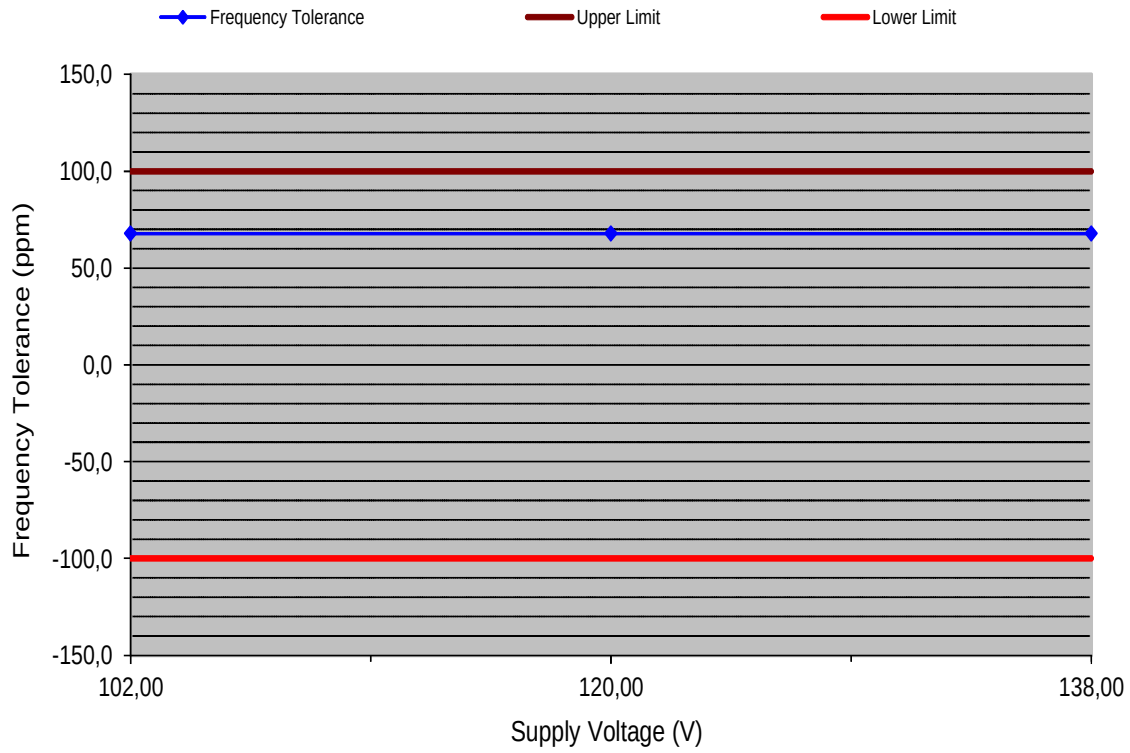
Carrier frequency stability vs. temperature



Supply voltage:	5 V	Frequency under nominal conditions:	13,56092 MHz

Temperature (°C)	Frequency (MHz)	Frequency Tolerance (Hz)	Frequency Tolerance (ppm)	Upper Limit (ppm)	Lower Limit (ppm)	Margin (ppm)
±0	13,561000	80	5,9	+100,0	-100,0	94,1
+10	13,561000	80	5,9	+100,0	-100,0	94,1
+20	13,560920	0	0,0	+100,0	-100,0	100,0
+30	13,560900	-20	-1,5	+100,0	-100,0	98,5
+40	13,560900	-20	-1,5	+100,0	-100,0	98,5

Carrier frequency stability vs. supply voltage



Temperature:	+20 °C	Battery End Point:	Not applicable
Frequency under nominal conditions:	13,56 MHz		

Supply Voltage (V)	Frequency (MHz)	Frequency Tolerance (Hz)	Frequency Tolerance (ppm)	Upper Limit (ppm)	Lower Limit (ppm)	Margin (ppm)
102,00	13,560920	920	67,8	+100,0	-100,0	**32,2**
120,00	13,560920	920	67,8	+100,0	-100,0	**32,2**
138,00	13,560920	920	67,8	+100,0	-100,0	**32,2**

8 Bandwidths

according to CFR 47 Part 2, section 2.202(a), and RSS-Gen, section 6.6

8.1 Test Location

See clause 5.1 on page 21.

8.2 Test instruments

See clause 0 on page 21.

8.3 Limits

The bandwidths are recorded only. There are no limits specified in CFR 47 Part 15, section 15.225, and RSS-210, Annex B6

8.4 Test setup

See clause 5.5 on page 24.

8.5 Test deviation

There is no deviation from the standards referred to.

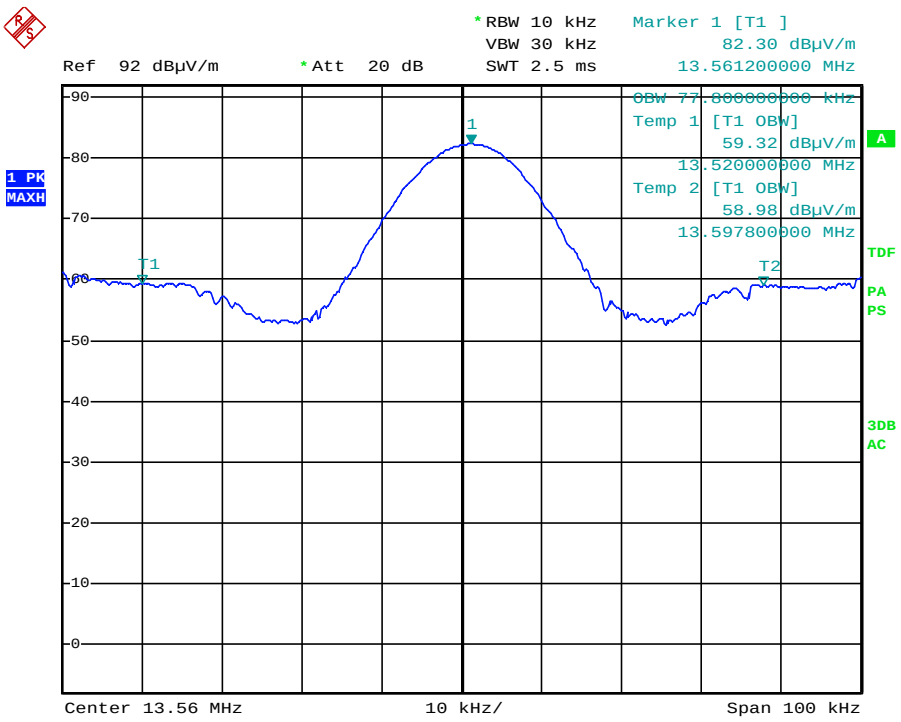
8.6 Test results

Temperature:	21℃	Humidity:	35%
Tested by:	Andreas Menacher	Test date:	2018-03-19

Occupied bandwidth (99 %)

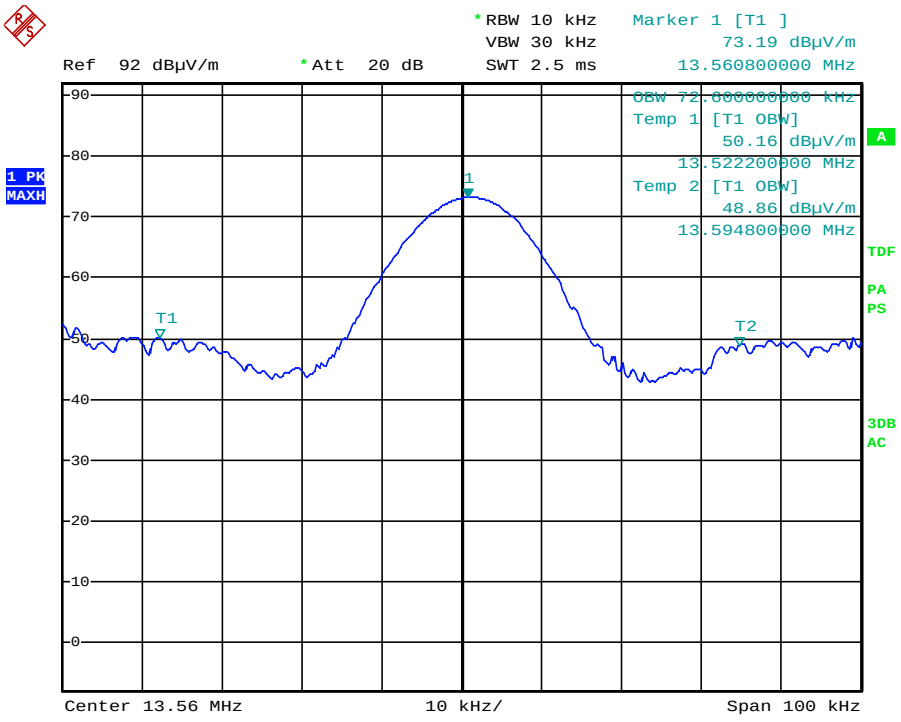
Test procedure

When an occupied bandwidth value is not specified in the applicable RSS, the transmitted signal bandwidth to be reported is to be its 99% emission bandwidth, as calculated or measured. The transmitter shall be operated at its maximum carrier power measured under normal test conditions.
The span of the analyzer shall be set to capture all products of the modulation process, including the emission skirts. The resolution bandwidth shall be set to as close to 1% of the selected span as is possible without being below 1%. The video bandwidth shall be set to 3 times the resolution bandwidth. Video averaging is not permitted. Where practical, a sampling detector shall be used given that a peak or peak hold may produce a wider bandwidth than actual.
The trace data points are recovered and directly summed in linear terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached and that frequency recorded. The process is repeated for the highest frequency data points. This frequency is recorded. The span between the two recorded frequencies is the occupied bandwidth. For this purpose the appropriate measurement function of the spectrum analyzer is used.



Picture 27: Occupied bandwidth (99 %), antenna 1

Measured occupied bandwidth (99 %), antenna 1: 77.800 kHz



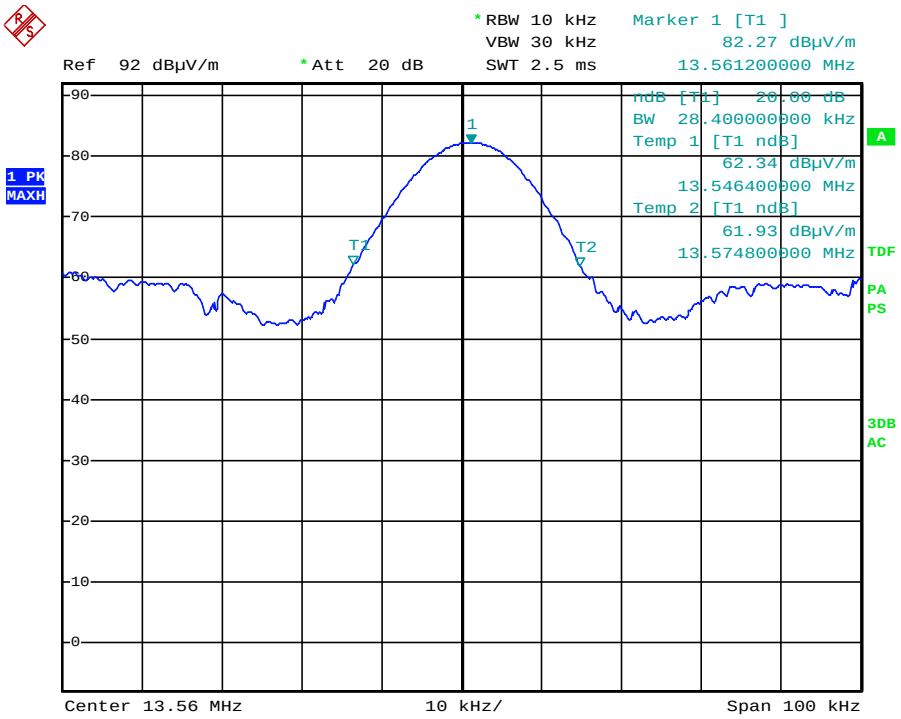
Picture 28: Occupied bandwidth (99 %), antenna 2

Measured occupied bandwidth (99 %), antenna 2: 72.600 kHz

-20 dB emission bandwidth

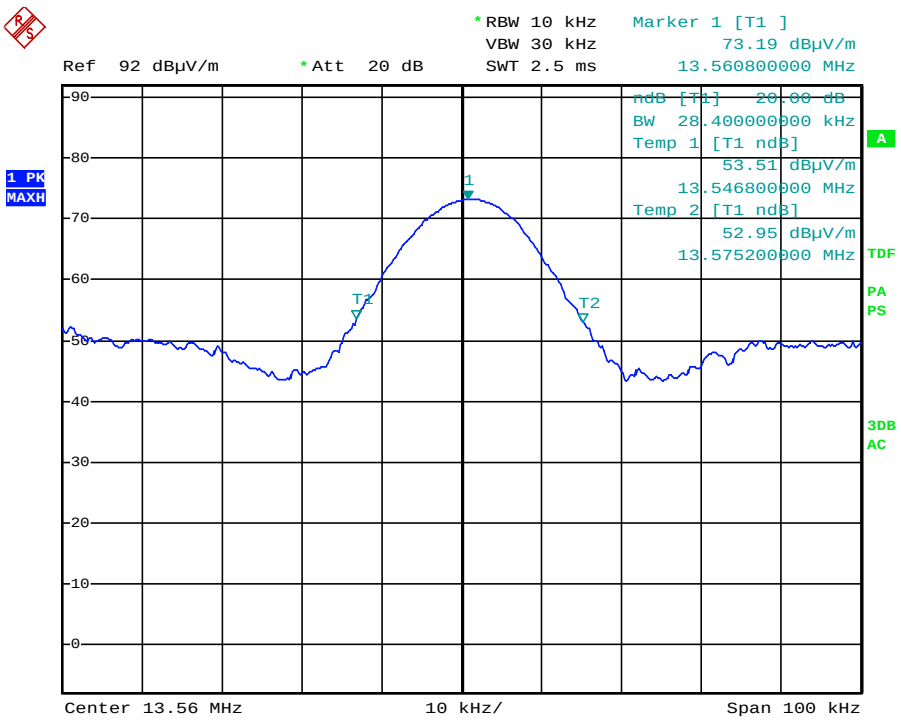
Test procedure

Where indicated, the -20 dB emission bandwidth is defined as the frequency range between two points, one above and one below the carrier frequency, at which the spectral density of the emission is attenuated 20 dB below the maximum in-band spectral density of the modulated signal. Spectral density (power per unit bandwidth) is to be measured with a detector of resolution bandwidth equal to approximately 1.0% of the emission bandwidth.



Picture 29: -20 dB emission bandwidths, antenna 1

Measured -20 dB emission bandwidth, antenna 1: 28.400 kHz



Picture 30: -20 dB emission bandwidths, antenna 2

Measured -20 dB emission bandwidth, antenna 2: 28.400 kHz

Antenna 1:

$f_{assigned}$ (MHz)	Index	f_{-20dB} (MHz)	Δf_T (kHz)	Δf_U (kHz)	$f_{-20dB(T, U)}$ (MHz)	Limit (MHz)	Margin (kHz)	Result
13.561200	low	13,546400	0.300	0.280	13.545820	13.110000	435.820	Passed
	high	13,574800	0.000	0.000	13.574800	14.010000	435.200	Passed
	Bandwidth	28.400 kHz			28.980 kHz			

with:
$f_{-20dB(low)}$ = lower frequency in MHz where emission is at least 20 dB below the carrier
$f_{-20dB(high)}$ = upper frequency in MHz where emission is at least 20 dB below the carrier
$f_{assigned}$ = assigned frequency in kHz
$\Delta f_{T(low)}$ = maximum absolute value of negative frequency offset to frequency at nominal conditions caused by temperature variation in kHz
$\Delta f_{U(low)}$ = maximum absolute value of negative frequency offset to frequency at nominal conditions caused by voltage variation in kHz
$\Delta f_{T(high)}$ = maximum absolute value of positive frequency offset to frequency at nominal conditions caused by temperature variation in kHz
$\Delta f_{U(high)}$ = maximum absolute value of positive frequency offset to frequency at nominal conditions caused by voltage variation in kHz
$\Delta f_{volt(high)}$ = maximum absolute value of positive frequency offset to frequency at nominal conditions caused by voltage variation in kHz
$f_{-20dB(T, U)}$ = frequency in MHz where emission is at least 20 dB below the carrier, including offset caused by variations of temperature and supply voltage as recorded in clause 7.7

Measured -20 dB emission bandwidth:
At nominal conditions: 28.400 kHz
Including variations in temperature and supply voltage: 28.980 kHz

Antenna 2:

$f_{assigned}$ (MHz)	Index	f_{-20dB} (MHz)	Δf_T (kHz)	Δf_U (kHz)	$f_{-20dB(T, U)}$ (MHz)	Limit (MHz)	Margin (kHz)	Result
13.560800	low	13,546800	0.000	0.000	13.546800	13.110000	436.800	Passed
	high	13,575200	0.200	0.120	13.575520	14.010000	434.480	Passed
	Bandwidth	28.400 kHz			28.720 kHz			

with:
$f_{-20dB(low)}$ = lower frequency in MHz where emission is at least 20 dB below the carrier
$f_{-20dB(high)}$ = upper frequency in MHz where emission is at least 20 dB below the carrier
$f_{assigned}$ = assigned frequency in kHz
$\Delta f_{T(low)}$ = maximum absolute value of negative frequency offset to frequency at nominal conditions caused by temperature variation in kHz
$\Delta f_{U(low)}$ = maximum absolute value of negative frequency offset to frequency at nominal conditions caused by voltage variation in kHz
$\Delta f_{T(high)}$ = maximum absolute value of positive frequency offset to frequency at nominal

conditions caused by temperature variation in kHz

$\Delta f_{U(high)}$ = maximum absolute value of positive frequency offset to frequency at nominal conditions caused by voltage variation in kHz

$\Delta f_{volt(high)}$ = maximum absolute value of positive frequency offset to frequency at nominal conditions caused by voltage variation in kHz

$f_{-20dB(T, U)}$ = frequency in MHz where emission is at least 20 dB below the carrier, including offset caused by variations of temperature and supply voltage as recorded in clause 7.7

Measured -20 dB emission bandwidth:

At nominal conditions:	28.400 kHz
Including variations in temperature and supply voltage:	28.720 kHz

9 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	ESR 7	101059	E00739	2016-02	2019-02
LISN	ESH2-Z5	893406/009	E00005	2016-02	2019-02
Loop antenna	HFH2-Z2	871398/0050	E00060	2016-09	2018-09
Broadband antenna	VULB 9162	9160-3050	E00011	2018-03	2020-03
Shielded room	P92007	B83117C1109T211	E00107	N/A	
Compact diagnostic chamber (CDC)	VK041.0174	D62128-A502-A69-2-0006	E00026	N/A	
Cable set shielded room	Cable no. 30	---	E00424	2016-07	2018-07
Cable set CDC	Cables no. 37 and 38	---	E00459 E00460	2017-05	2019-05
Cable set OATS 3 m	Cables no. 19, 34 and 36	---	E00453 E00456 E00458	2015-11	2018-11
Cable set SAC 3 m	Cables no. 04, 52 and 12	---	E00434 E00755 E00320	2015-11	2018-11

Table 1: Equipment calibration status

Note 1: 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”: 2019-05

10 Measurement uncertainty

Description	Max. deviation	k=
Conducted emission AMN (150 kHz to 30 MHz)	± 3.4 dB	2
Radiated emission open field (3 m) (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 absorber chamber (> 1000 MHz)	± 4.5 dB	2

Table 2: 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.

11 Revision History

Date	Description	Person	Revision
2018-04-11	First edition	Andreas Menacher	0