Test Report

Customer:

GiS - Gesellschaft für Informatik und Steuerungstechnik mbH

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RF test report

170086-AU01+W02

GiS - Gesellschaft für Informatik und Steuerungstechnik mbH

134 kHz RFID Reader

TS-RW82AC

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

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:

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: 03-2017	Code of Federal Regulations Part 2 - Frequency allocation and radio treaty matters; General rules and regulations
47 CFR Part 15: 03-2017	Code of Federal Regulations Part 15 - Radio Frequency Devices
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 Licence-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 15.209	Passed
RSS-210 Issue 9 Section 4.3 and Annex B6 (with appropriate references to RSS-Gen Issue 4)	Passed

Straubing, April 24, 2017

Martin Müller
Test engineer
EMV **TESTHAUS** GmbH

Christian Kiermeier
Technical executive
EMV **TESTHAUS** GmbH

3 Equipment under Test (EUT)

Product type:	134 kHz RFID Reader
Model Name:	TS-RW82AC
Applicant:	GiS - Gesellschaft für Informatik und Steuerungstechnik mbH
Manufacturer:	GiS - Gesellschaft für Informatik und Steuerungstechnik mbH
Serial number:	see chapter 3.3
FCC ID:	WR5TSRW82MUX
IC certification number:	N/A
Application frequency band:	n/a
Frequency range:	134.2 kHz
Operating frequency:	134.2 kHz
Number of RF-channels:	1
Modulation:	ASK
Antenna types:	Cylindrical antenna
	☒ detachable ☐ not detachable
Power supply:	External power source nominal: 24.0 VDC
Temperature range:	-10°C to +55°C

Remark:
The tests were performed with 120V AC / 60Hz.

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 Operation mode

For testing “continuous-wave-mode” was used.
During the pre-tests it was observed if worst-case for the respective testis with or without transponder. The table below shows which case was used for testing.

EUT is not able to use two or more antennas at the same time (no simultaneous operation possible).

3.3 Configuration

EUT			
Device	*Type designation*	*Serial or inventory no.*	*Manufacturer*
MUX component	TS-RW82AC-MUX	1621-V1.03#0006 02/17	GiS - Gesellschaft für Informatik und Steuerungstechnik mbH
Antenna	Cylindrical	---	GiS - Gesellschaft für Informatik und Steuerungstechnik mbH
CPU component	TS-RW82AC-CPU	160-294V1.03#0002 02/17	GiS - Gesellschaft für Informatik und Steuerungstechnik mbH
PSU 120 V / 60 Hz to 24 V DC	MDR-10-24	EB23046178	Mean Well
Transponder	FDX, green, 30 mm	---	GiS - Gesellschaft für Informatik und Steuerungstechnik mbH
Peripheral devices			
Device	*Type designation*	*Serial or inventory no.*	*Manufacturer*
Notebook	Lifebook A531	E00521	Fujitsu Siemens
AC power source	61602	616020002099	Chroma A.T.E. Europe

Table 1: Devices used for testing

Port	*Classification*	*Cable type*	*Cable length*	
			used	*maximum*[1]
AC supply	ac power	Unshielded	1.00 m	----
DC supply	dc power	Unshielded	0.15 m	----
Antenna cable	signal/control	Shielded	2.00 m	----
USB (for configuration of EUT only)	signal/control	Shielded	1.50 m	----

Table 2: Ports of EUT and appropriate cables

[1] As specified by applicant

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
☒	E10 test software	ib comPLAN	E00443
☐	EMC32 test software	Rohde & Schwarz	E00777

4.3 Limits

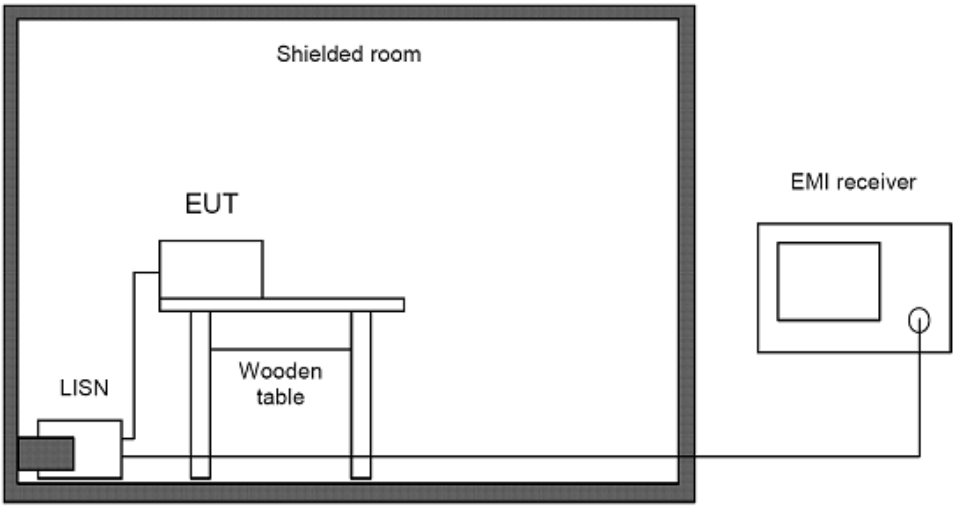
Frequency [MHz]	Quasi-peak [dBµV]	Avarage [dBµV]
0.15 – 0.5	66 – 56	56 – 46
0.5 – 5.0	56	46
5 – 30	60	50

4.4 Test procedure

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.

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.

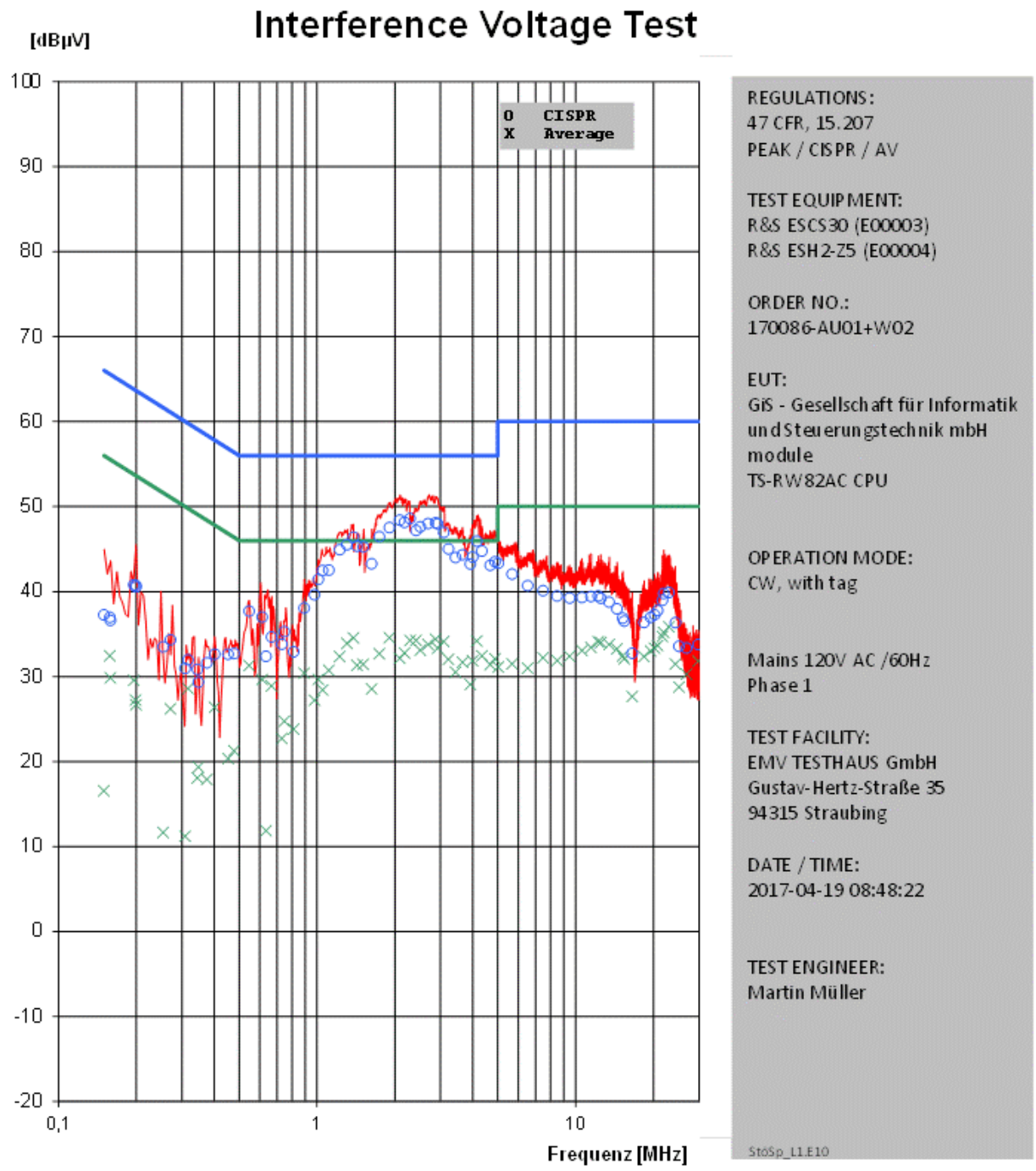
4.5 Test setup



Picture 1: Outline of conducted emission test setup

4.6 Test results

Temperature:	20°C	Humidity:	41%
Tested by:	Martin Müller	Test date:	2017-04-19



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

Interference Voltage Test

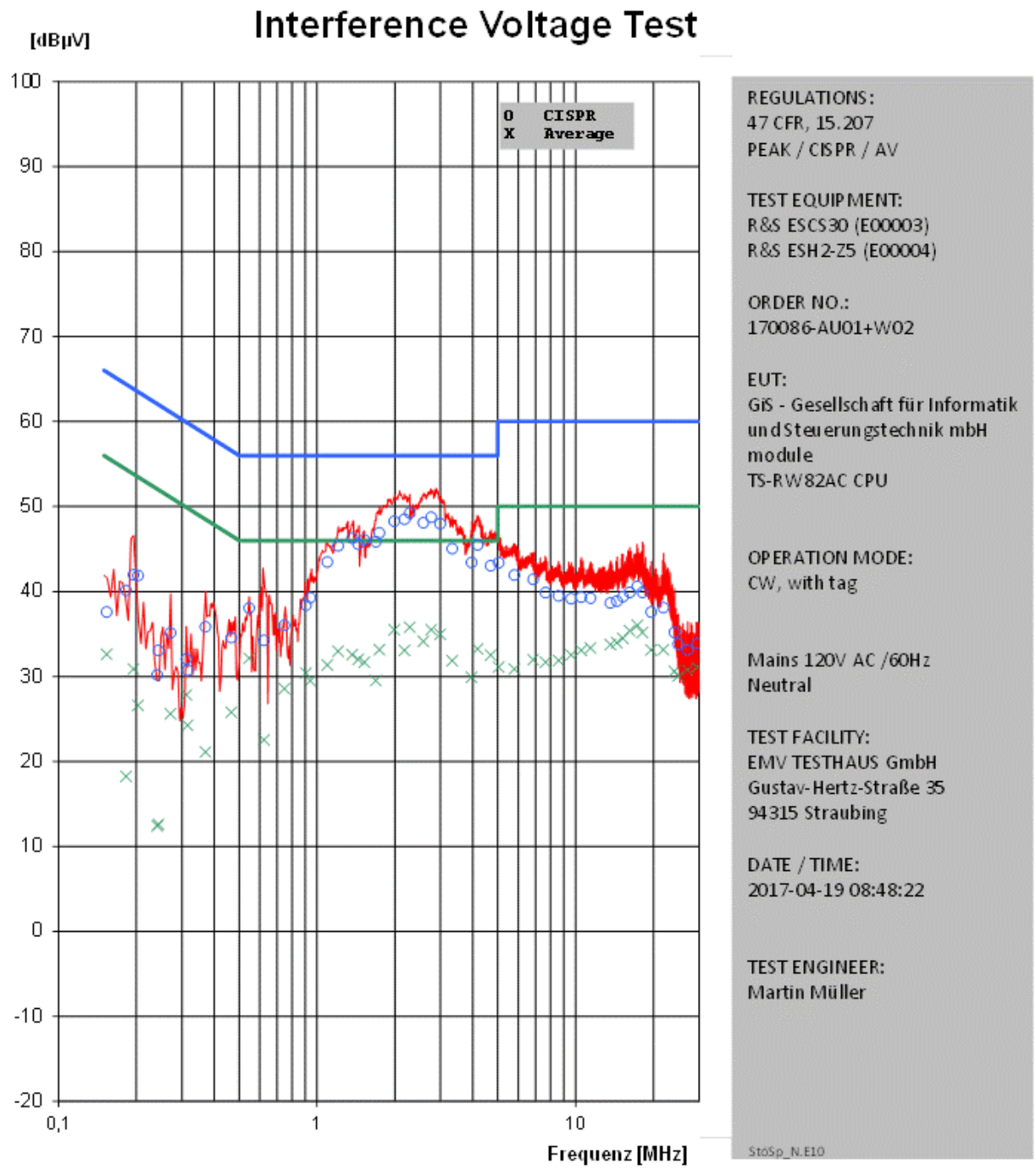
Freq. [MHz]	U_CISPR [dBµV]	Limit [dBµV]	delta_U [dB]	U_AV [dBµV]	Limit [dBµV]	delta_U [dB]	Corr. [dB]	Remark
0,15	37,3	66,0	28,7	16,6	56,0	39,4	0,0	
0,16	36,6	65,5	28,9	29,8	55,5	25,7	0,0	
0,16	37,0	65,6	28,6	32,4	55,6	23,1	0,0	
0,20	40,8	63,8	23,0	29,5	53,8	24,3	0,0	
0,20	40,5	63,6	23,1	26,7	53,6	27,0	0,0	
0,20	40,7	63,7	22,9	27,2	53,7	26,4	0,0	
0,25	33,5	61,6	28,1	11,6	51,6	40,0	0,0	
0,27	34,3	61,1	26,8	26,2	51,1	24,9	0,0	
0,31	30,9	60,0	29,1	11,2	50,0	38,8	0,0	
0,32	32,0	59,8	27,8	28,6	49,8	21,2	0,0	
0,34	30,8	59,1	28,3	18,1	49,1	31,0	0,0	
0,35	29,3	59,0	29,7	19,3	49,0	29,7	0,0	
0,38	31,6	58,4	26,8	17,9	48,4	30,5	0,0	
0,40	32,6	57,8	25,2	26,4	47,8	21,4	0,0	
0,45	32,6	56,8	24,2	20,3	46,8	26,5	0,0	
0,48	32,7	56,4	23,7	21,2	46,4	25,1	0,0	
0,55	37,7	56,0	18,3	31,3	46,0	14,7	0,0	
0,61	37,0	56,0	19,0	29,7	46,0	16,3	0,0	
0,64	32,4	56,0	23,6	11,8	46,0	34,2	0,0	
0,67	34,7	56,0	21,3	28,9	46,0	17,1	0,0	
0,73	33,8	56,0	22,2	22,7	46,0	23,3	0,0	
0,75	35,3	56,0	20,7	24,7	46,0	21,3	0,0	
0,81	32,9	56,0	23,1	23,8	46,0	22,2	0,0	
0,89	38,1	56,0	17,9	30,4	46,0	15,6	0,0	
0,98	39,6	56,0	16,4	27,2	46,0	18,8	0,0	
1,01	41,4	56,0	14,6	29,6	46,0	16,4	0,0	
1,05	42,5	56,0	13,5	28,4	46,0	17,6	0,0	
1,11	42,5	56,0	13,5	30,7	46,0	15,3	0,0	
1,22	44,9	56,0	11,1	32,3	46,0	13,7	0,0	
1,31	45,5	56,0	10,5	33,9	46,0	12,1	0,0	
1,38	46,4	56,0	9,6	34,5	46,0	11,5	0,0	
1,43	45,3	56,0	10,7	31,3	46,0	14,7	0,0	
1,51	45,2	56,0	10,8	31,4	46,0	14,6	0,0	
1,63	43,3	56,0	12,8	28,5	46,0	17,5	0,0	
1,74	46,4	56,0	9,6	32,7	46,0	13,3	0,0	
1,90	47,5	56,0	8,5	34,6	46,0	11,4	0,0	
2,09	48,4	56,0	7,6	32,1	46,0	13,9	0,0	
2,18	48,1	56,0	7,9	32,8	46,0	13,3	0,0	
2,29	48,6	56,0	7,4	34,2	46,0	11,8	0,0	
2,42	47,2	56,0	8,8	34,2	46,0	11,8	0,0	

Picture 3: Table01 - Conducted emission on mains, phase 1 (without termination)

Interference Voltage Test

Freq. [MHz]	U_CISPR [dBµV]	Limit [dBµV]	delta_U [dB]	U_AV [dBµV]	Limit [dBµV]	delta_U [dB]	Corr. [dB]	Remark
2,51	47,6	56,0	8,4	33,1	46,0	12,9	0,0	
2,69	48,0	56,0	8,0	33,8	46,0	12,2	0,0	
2,88	48,1	56,0	7,9	34,4	46,0	11,6	0,0	
2,93	48,0	56,0	8,0	33,3	46,0	12,7	0,0	
3,09	47,0	56,0	9,1	34,1	46,0	11,9	0,0	
3,23	45,0	56,0	11,0	32,0	46,0	14,0	0,0	
3,43	44,0	56,0	12,0	30,5	46,0	15,5	0,0	
3,66	44,3	56,0	11,7	31,7	46,0	14,4	0,0	
3,92	43,2	56,0	12,8	29,1	46,0	17,0	0,0	
4,00	44,1	56,0	11,9	31,8	46,0	14,2	0,0	
4,15	45,9	56,0	10,1	34,2	46,0	11,8	0,0	
4,35	44,8	56,0	11,2	32,4	46,0	13,6	0,0	
4,68	43,1	56,0	12,9	31,4	46,0	14,6	0,0	
4,88	43,5	56,0	12,5	32,1	46,0	13,9	0,0	
5,02	43,3	60,0	16,7	31,1	50,0	18,9	0,0	
5,68	42,0	60,0	18,0	31,5	50,0	18,5	0,0	
6,53	40,7	60,0	19,3	31,0	50,0	19,0	0,0	
7,48	40,1	60,0	19,9	32,2	50,0	17,8	0,0	
8,49	39,5	60,0	20,5	31,9	50,0	18,1	0,0	
9,48	39,2	60,0	20,8	32,4	50,0	17,6	0,0	
10,58	39,3	60,0	20,7	33,1	50,0	17,0	0,0	
11,48	39,4	60,0	20,6	33,4	50,0	16,6	0,0	
12,25	39,5	60,0	20,5	34,1	50,0	15,9	0,0	
12,52	39,2	60,0	20,8	34,0	50,0	16,0	0,0	
13,49	38,8	60,0	21,2	33,8	50,0	16,2	0,0	
14,47	38,0	60,0	22,0	33,2	50,0	16,8	0,0	
15,21	36,9	60,0	23,1	32,4	50,0	17,6	0,0	
15,43	36,5	60,0	23,5	32,1	50,0	17,9	0,0	
16,55	32,7	60,0	27,3	27,6	50,0	22,4	0,0	
18,41	36,4	60,0	23,6	32,3	50,0	17,7	0,0	
19,51	37,0	60,0	23,1	33,0	50,0	17,0	0,0	
20,21	37,3	60,0	22,8	33,3	50,0	16,7	0,0	
20,75	37,8	60,0	22,3	33,7	50,0	16,4	0,0	
21,67	39,0	60,0	21,0	34,7	50,0	15,3	0,0	
21,93	39,8	60,0	20,2	35,2	50,0	14,8	0,0	
22,97	39,9	60,0	20,1	35,8	50,0	14,2	0,0	
24,33	36,3	60,0	23,7	31,5	50,0	18,5	0,0	
25,10	33,6	60,0	26,5	28,8	50,0	21,2	0,0	
26,84	33,4	60,0	26,6	30,3	50,0	19,7	0,0	
29,79	33,8	60,0	26,2	31,8	50,0	18,2	0,0	

Picture 4: Table02 - Conducted emission on mains, phase 1 (without termination)



Picture 5: Graphic - Conducted emission on mains, neutral (without termination)

Interference Voltage Test

Freq. [MHz]	U_CISPR [dBµV]	Limit [dBµV]	delta_U [dB]	U_AV [dBµV]	Limit [dBµV]	delta_U [dB]	Corr. [dB]	Remark
0,15	37,6	65,8	28,2	32,6	55,8	23,2	0,0	
0,18	40,1	64,4	24,3	18,2	54,4	36,1	0,0	
0,20	42,0	63,8	21,9	30,9	53,8	23,0	0,0	
0,20	41,9	63,5	21,6	26,6	53,5	26,9	0,0	
0,24	30,2	62,1	31,9	12,4	52,1	39,6	0,0	
0,24	33,1	62,0	28,9	12,6	52,0	39,4	0,0	
0,27	35,1	61,1	25,9	25,6	51,1	25,5	0,0	
0,31	32,1	59,9	27,9	27,8	49,9	22,1	0,0	
0,32	30,7	59,8	29,1	24,3	49,8	25,6	0,0	
0,37	35,8	58,5	22,6	21,1	48,5	27,4	0,0	
0,47	34,6	56,6	22,0	25,8	46,6	20,8	0,0	
0,55	38,1	56,0	18,0	32,1	46,0	13,9	0,0	
0,62	34,2	56,0	21,8	22,5	46,0	23,5	0,0	
0,75	36,0	56,0	20,0	28,6	46,0	17,4	0,0	
0,91	38,4	56,0	17,6	30,4	46,0	15,6	0,0	
0,94	39,3	56,0	16,7	29,5	46,0	16,5	0,0	
1,10	43,5	56,0	12,5	31,3	46,0	14,7	0,0	
1,21	45,4	56,0	10,6	33,0	46,0	13,0	0,0	
1,37	46,3	56,0	9,7	32,6	46,0	13,5	0,0	
1,45	45,6	56,0	10,5	32,0	46,0	14,0	0,0	
1,52	46,1	56,0	10,0	31,7	46,0	14,3	0,0	
1,69	45,8	56,0	10,2	29,5	46,0	16,5	0,0	
1,74	46,9	56,0	9,1	33,1	46,0	12,9	0,0	
1,99	48,2	56,0	7,8	35,5	46,0	10,5	0,0	
2,18	48,5	56,0	7,5	33,1	46,0	12,9	0,0	
2,28	49,2	56,0	6,8	35,8	46,0	10,2	0,0	
2,58	48,1	56,0	7,9	34,1	46,0	11,9	0,0	
2,77	48,7	56,0	7,3	35,5	46,0	10,5	0,0	
3,00	48,0	56,0	8,0	34,9	46,0	11,1	0,0	
3,33	45,0	56,0	11,0	31,8	46,0	14,2	0,0	
3,97	43,4	56,0	12,6	29,9	46,0	16,1	0,0	
4,18	45,5	56,0	10,5	33,2	46,0	12,8	0,0	
4,69	43,0	56,0	13,0	32,5	46,0	13,5	0,0	
5,05	43,4	60,0	16,6	31,1	50,0	18,9	0,0	
5,80	41,9	60,0	18,1	30,9	50,0	19,1	0,0	
6,86	41,4	60,0	18,6	32,0	50,0	18,0	0,0	
7,66	39,9	60,0	20,1	31,7	50,0	18,3	0,0	
8,59	39,5	60,0	20,5	31,9	50,0	18,1	0,0	
9,62	39,2	60,0	20,9	32,5	50,0	17,5	0,0	
10,53	39,3	60,0	20,7	33,1	50,0	17,0	0,0	

Picture 6: Table01 - Conducted emission on mains, neutral (without termination)

Interference Voltage Test

Freq. [MHz]	U_CISPR [dBµV]	Limit [dBµV]	delta_U [dB]	U_AV [dBµV]	Limit [dBµV]	delta_U [dB]	Corr. [dB]	Remark
11,42	39,2	60,0	20,8	33,3	50,0	16,7	0,0	
13,65	38,6	60,0	21,4	33,7	50,0	16,3	0,0	
14,46	38,9	60,0	21,2	34,0	50,0	16,0	0,0	
15,23	39,4	60,0	20,6	34,5	50,0	15,5	0,0	
16,20	39,9	60,0	20,1	35,4	50,0	14,6	0,0	
17,32	40,6	60,0	19,4	36,0	50,0	14,0	0,0	
18,15	39,9	60,0	20,1	35,2	50,0	14,8	0,0	
19,60	37,6	60,0	22,4	33,1	50,0	16,9	0,0	
21,88	38,1	60,0	21,9	33,1	50,0	16,9	0,0	
24,15	35,2	60,0	24,8	30,6	50,0	19,4	0,0	
24,96	33,8	60,0	26,2	30,0	50,0	20,0	0,0	
27,11	33,1	60,0	26,9	30,8	50,0	19,3	0,0	
29,52	33,9	60,0	26,1	31,1	50,0	18,9	0,0	

Picture 7: Table02 - Conducted emission on mains, neutral (without termination)

5 Radiated emission measurement (<1 GHz)

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

5.1 Test Location

☒ Scan with peak detector in 3 m CDC.

☒ Final CISPR measurement with quasi peak detector on 3 m open area test site.

Description	Manufacturer	Inventory No.
CDC	Albatross Projects	E00026
Open area test site (OATS)	EMV **TESTHAUS** GmbH	E00354

5.2 Test instruments

	Description	Manufacturer	Inventory No.
☐	ESU 26	Rohde & Schwarz	W00002
☒	ESCI (OATS)	Rohde & Schwarz	E00552
☒	ESCI (CDC)	Rohde & Schwarz	E00001
☒	VULB 9163 (OATS)	Schwarzbeck	E00013
☒	VULB 9160 (CDC)	Schwarzbeck	E00011
☒	HFH2-Z2	Rohde & Schwarz	E00060
☒	Cable set CDC	Huber + Suhner	E00060
☒	Cable set OATS 3 m	Huber + Suhner	E00453, E00456, E00458
☐	Cable set OATS 10 m	Huber + Suhner	E00453, E00455, E00458
☒	E10 test software	ib comPLAN	E00443
☐	EMC32 test software	Rohde & Schwarz	E00777

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

5.4 Test procedure < 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:

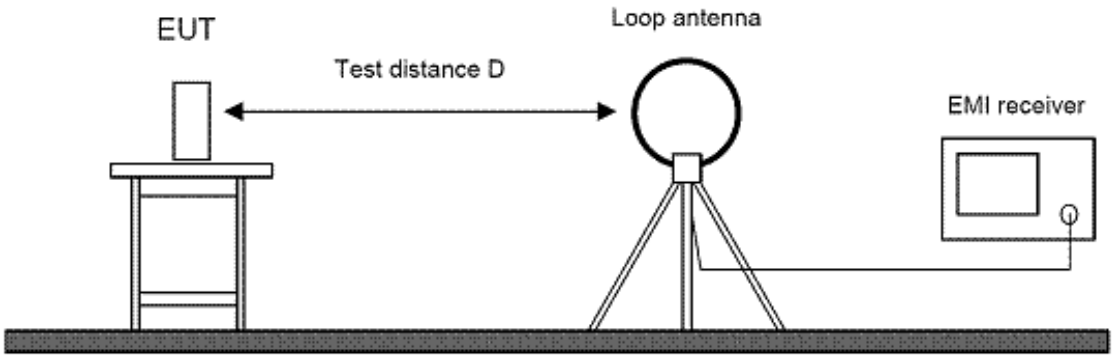
1. EUT is configured according to ANSI C63.10. It is placed on the turntable 0.8 meter above ground. The receiving antenna is located 3 meters from the EUT. The test setup is placed inside a compact diagnostic chamber.
2. EUT and all peripherals are powered on.
3. The loop antenna is set in parallel 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.

5.5 Test procedure < 1 GHz

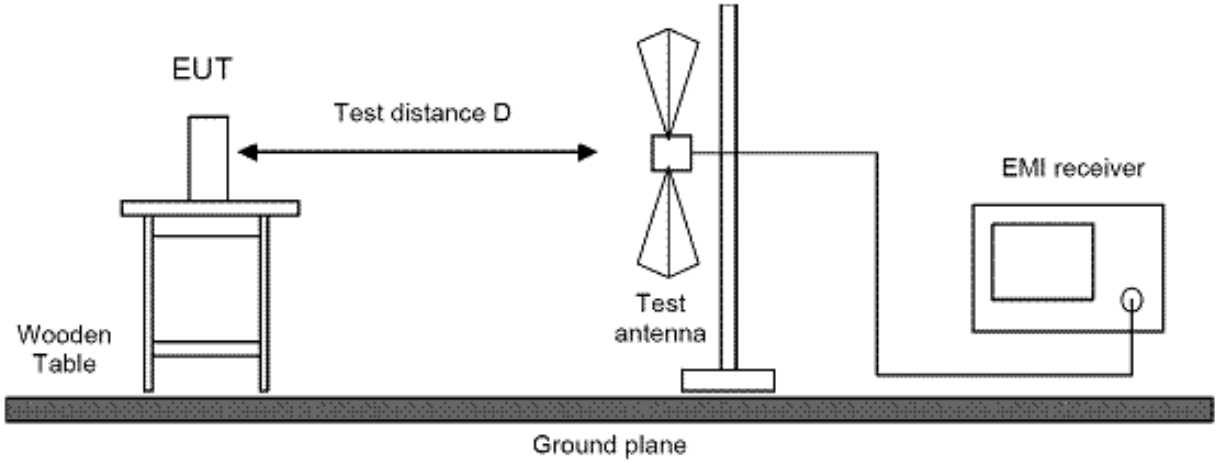
The test method for radiated emissions from 30 MHz to 1 GHz refers to section 6.5 of ANSI C63.10 and shall be as follows:

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.

5.6 Test setup



Picture 8: Test setup for radiated emission measurement (< 30 MHz)



Picture 9: Test setup for radiated emission measurement (< 1 GHz)

5.7 Test deviation

There is no deviation from the standards referred to.

5.8 Test results

Radiated Emission Measurement 9 kHz - 30 MHz

Temperature:	20°C	Humidity:	41%
Tested by:	Martin Müller	Test date:	2017-04-13

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:

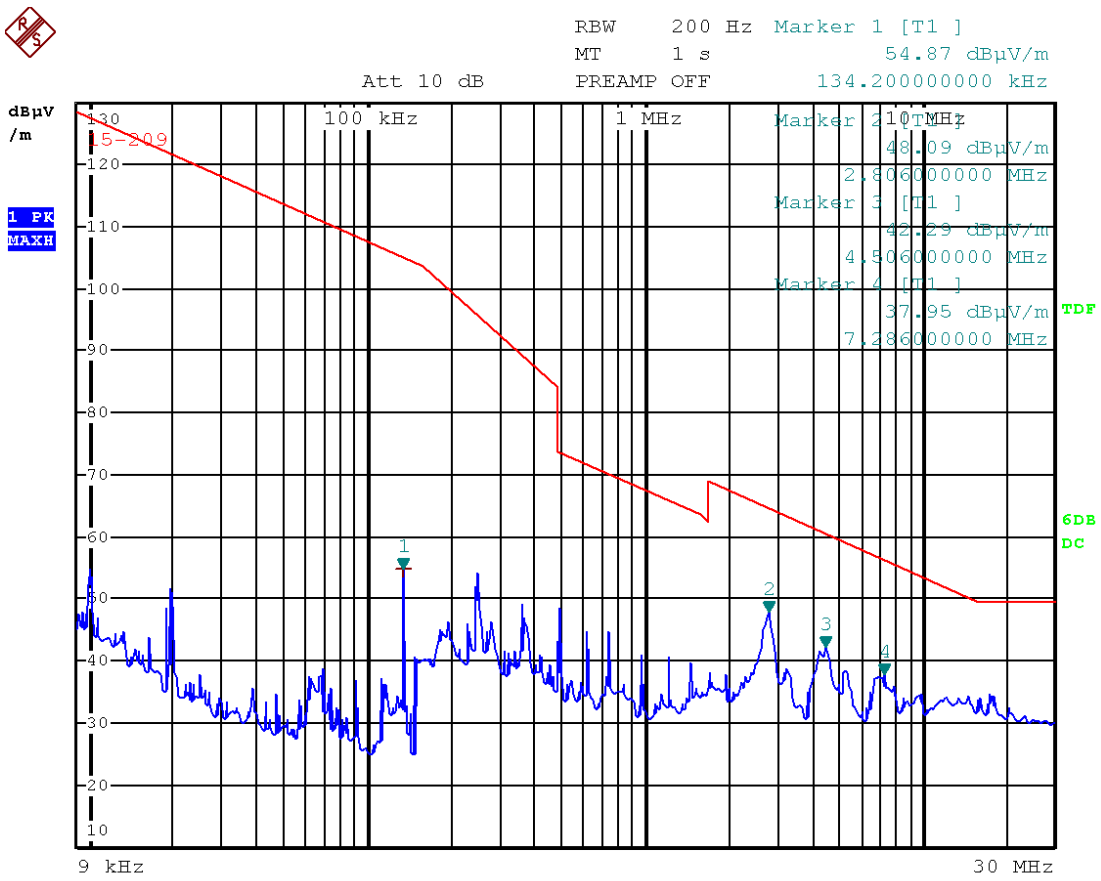
f_{MHz}(300 m) ≈ 0.159 MHz
f_{MHz}(30 m) ≈ 1.592 MHz
f_{MHz}(3 m) ≈ 15.923 MHz

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.

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	

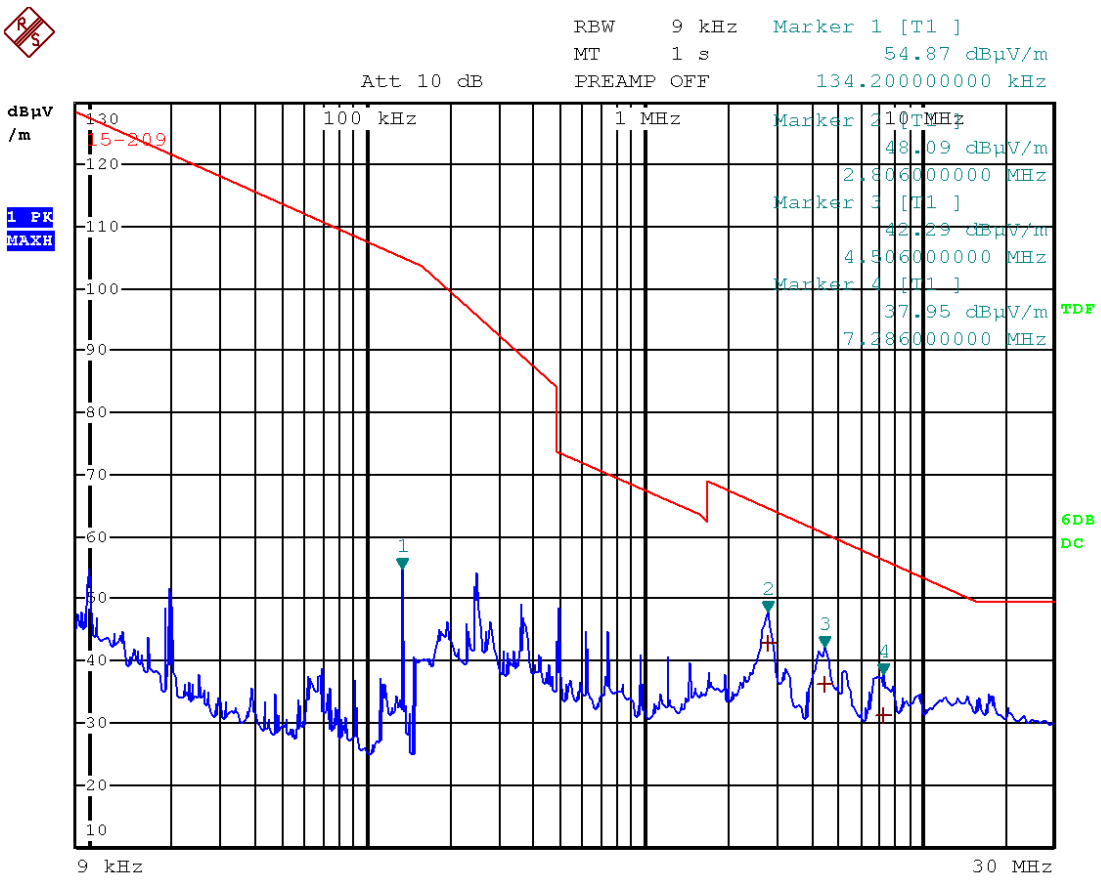
Frequency range	*Step size*	*IF Bandwidth*	*Detector*		*Measurement Time*		*Preamplifier*
			Prescan	*Final scan*	*Prescan*	*Final scan*	
9 kHz – 90 kHz	80 Hz	200 Hz	PK	AV	1 ms	1 s	off
90 kHz – 110 kHz	80 Hz	200 Hz	PK	QPK	1 ms	1 s	off
110 kHz – 150 kHz	80 Hz	200 Hz	PK	AV	1 ms	1 s	off
150 kHz – 490 kHz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



Picture 10: Radiated emission 9 kHz – 30 MHz, AV

Frequency [MHz]	Measured value [dBµV/m]	Detector	Recalculation factor [dB]	Field strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Result
0.134200	54.87	PK	-80.0	-25.13	---	---	---
0.134200	54.79	AV	-80.0	-25.04	25.05	-50.09	Pass

Remark: Emissions other than carrier frequency (134.2 kHz) are ambient noise level or from peripheral devices (e.g. notebook).



Picture 11: Radiated emission 9 kHz – 30 MHz, QPK

Frequency [MHz]	Measured value [dBµV/m]	Detector	Recalculation factor [dB]	Field strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Result
2.806000	42.84	QPK	-35.08	7.76	29.54	-21.78	Pass
4.506000	36.16	QPK	-30.96	5.20	29.54	-24.34	Pass
7.286000	31.22	QPK	-26.79	4.43	29.54	-25.11	Pass

Remark: Emissions other than carrier frequency (134.2 kHz) are ambient noise level or from peripheral devices (e.g. notebook).

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_{limit} / $d_{measure}$)

f_{MHz} [MHz]	$d_{near\ field}$ [m]	$d_{measure}$ [m]	d_{limit} [m]	Recalculation factor [dB]
0.134200	355.961	3.0	300.0	-80.0

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]
2.806000	17.024	3.0	30.0	-35.08
4.506000	10.601	3.0	30.0	-30.96
7.286000	6.556	3.0	30.0	-26.79

Restricted band of operation from 0.090 MHz - 0.110 MHz

Temperature:	20°C	Humidity:	41%
Tested by:	Martin Müller	Test date:	2017-04-13

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:

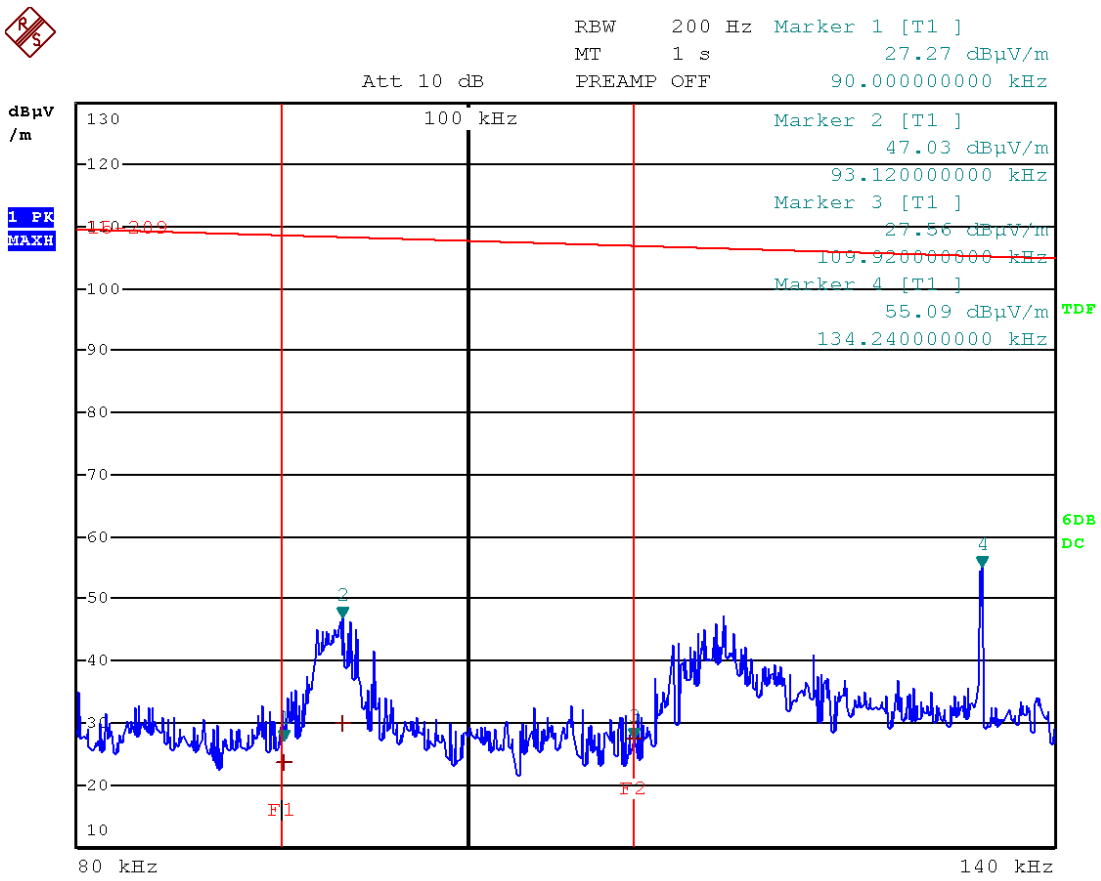
f_{MHz}(300 m) ≈ 0.159 MHz
f_{MHz}(30 m) ≈ 1.592 MHz
f_{MHz}(3 m) ≈ 15.923 MHz

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.

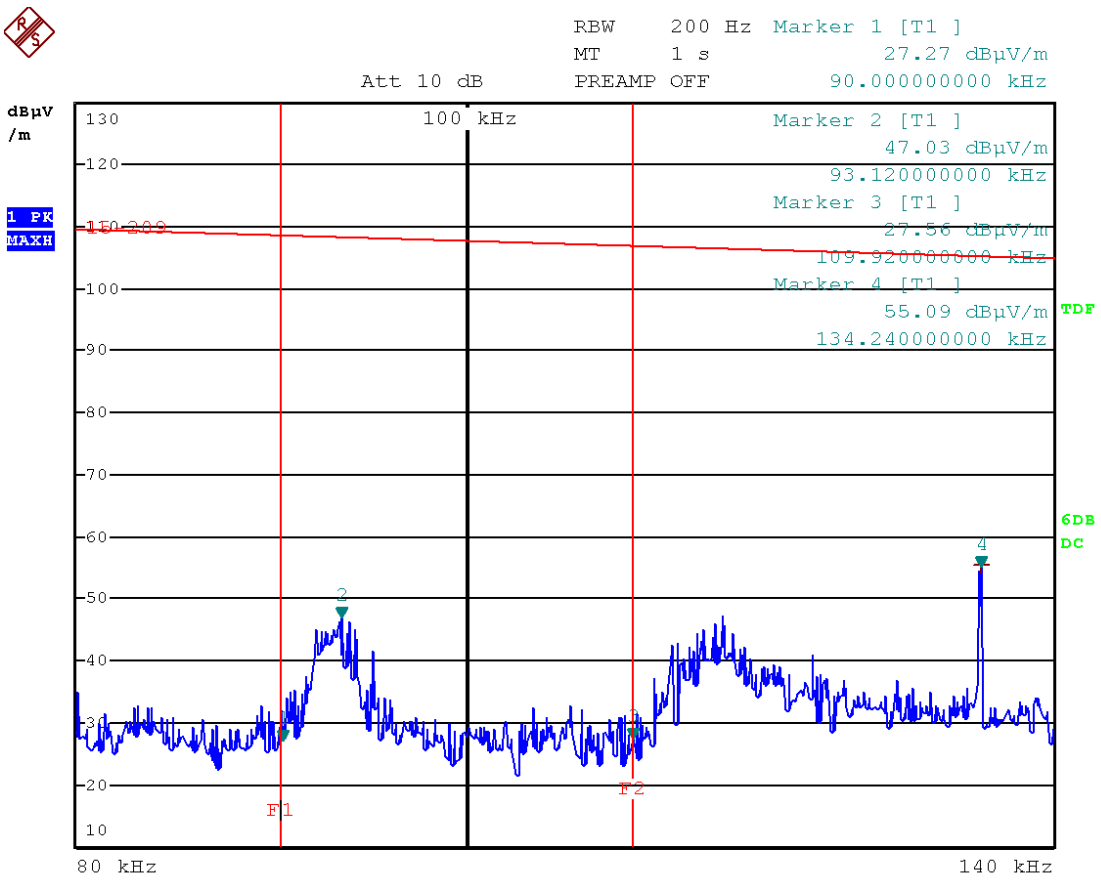
Test distance:	Prescan:	☒ 3 m		
	Final scan:	☒ 3 m	☐ 10 m	☐ ….. m
Polarisation:	☒ parallel	☐ in line	☐ angle: ….°	
EUT Position:	☐ Position 1	☐ Position 2	☒ Position 3	

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



Picture 12: Restricted band of operation from 0.090 MHz - 0.110 MHz, QPK

Frequency [MHz]	Measured value [dBµV/m]	Detector	Recalculation factor [dB]	Field strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Result
0.090000	23.67	QPK	-80.0	-56.33	28.52	-84.85	Pass
0.093120	30.11	QPK	-80.0	-49.89	28.22	-78.11	Pass
0.109920	27.44	QPK	-80.0	-52.56	26.78	-79.34	Pass



Picture 13: Restricted band of operation from 0.090 MHz - 0.110 MHz, AV

Frequency [MHz]	Measured value [dBµV/m]	Detector	Recalculation factor [dB]	Field strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]	Result
0.134240	55.09	PK	-80.0	-24.91	---	---	---
0.134240	55.02	AV	-80.0	-24.58	25.05	-49.63	Pass

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_{limit} / $d_{measure}$)

f_{MHz} [MHz]	$d_{near\ field}$ [m]	$d_{measure}$ [m]	d_{limit} [m]	Recalculation factor [dB]
0.090000	530.778	3.0	300.0	-80.0
0.093120	512.994	3.0	300.0	-80.0
0.109920	434.589	3.0	300.0	-80.0
0.134240	355.855	3.0	300.0	-80.0

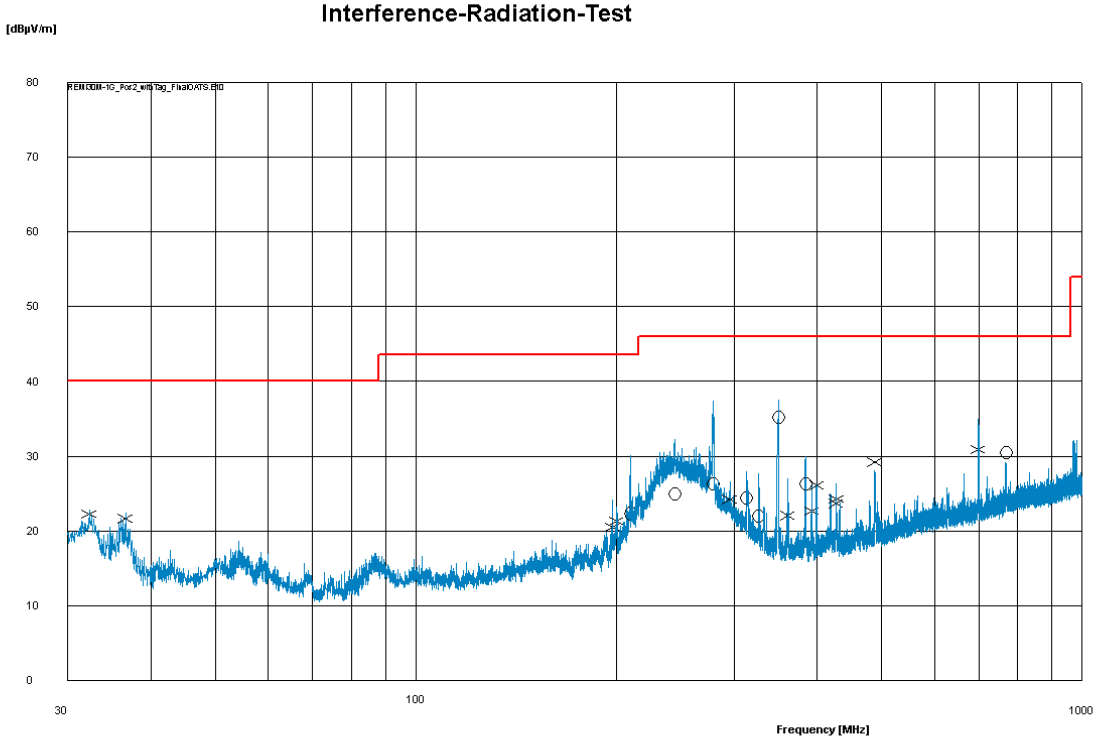
Radiated Emission Measurement 30 MHz - 1000 MHz

Temperature:	20°C	Humidity:	41%
Tested by:	Martin Müller	Test date:	2017-04-18

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	*Polarisation*	*Step size*	*IF Bandwidth*	*Detector*		*Measurement Time*		*Preamplifier*
				Prescan	*Final scan*	*Prescan*	*Final scan*	
30 MHz – 1 GHz	H / V	60 kHz	120 kHz	PK	QPK	1 ms	1 s	20 dB

Interference-Radiation-Test



f [MHz]	E_{final} [dBV/m]	Limit [dBµV/m]	Height [cm]	TT [°]	Polarisation	Result
32.34	22.26	40	100	60.1	V	Pass
36.66	21.68	40	100	75.4	V	Pass
197.22	20.50	43.52	100	80.1	V	Pass
199.92	21.34	43.52	100	83.5	V	Pass
209.88	22.34	43.52	107	64.1	H	Pass
244.56	24.99	46.02	100	59.8	H	Pass
279.06	26.35	46.02	134	48.9	H	Pass
295.92	24.21	46.02	100	135.3	V	Pass
313.68	24.38	46.02	100	287.8	H	Pass
327.12	22.03	46.02	100	16.9	H	Pass
349.86	35.16	46.02	100	264.2	H	Pass
361.44	22.06	46.02	100	264.1	V	Pass
384.78	26.29	46.02	100	245.4	H	Pass
392.58	22.70	46.02	100	56.9	V	Pass
399.84	26.15	46.02	100	224.9	V	Pass
427.02	23.67	46.02	100	79.9	V	Pass
427.44	24.30	46.02	100	91	V	Pass
487.92	29.20	46.02	100	347.5	V	Pass
698.16	30.90	46.02	119	59.2	V	Pass

Picture 14: Radiated emission 30 MHz - 1000MHz antenna 2010

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 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), and
- the digital part of the device does not generate or use internal frequencies higher than 108 MHz (see 47 CFR Part 15 section 15.33(b)(1), and RSS-Gen, section 2.3.3 with ICES-003, section 6.2).

7 Bandwidths

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

7.1 Test Location

See clause 5.1 on page 18.

7.2 Test instruments

See clause 5.2 on page 18.

7.3 Limits

No limits specified. The bandwidths are recorded for information only.

7.4 Test procedure “occupied bandwidth (99%)”

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.

7.5 Test procedure “-20 dB emission bandwidth”

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.

7.6 Test setup

See clause 5.4 on page 20.

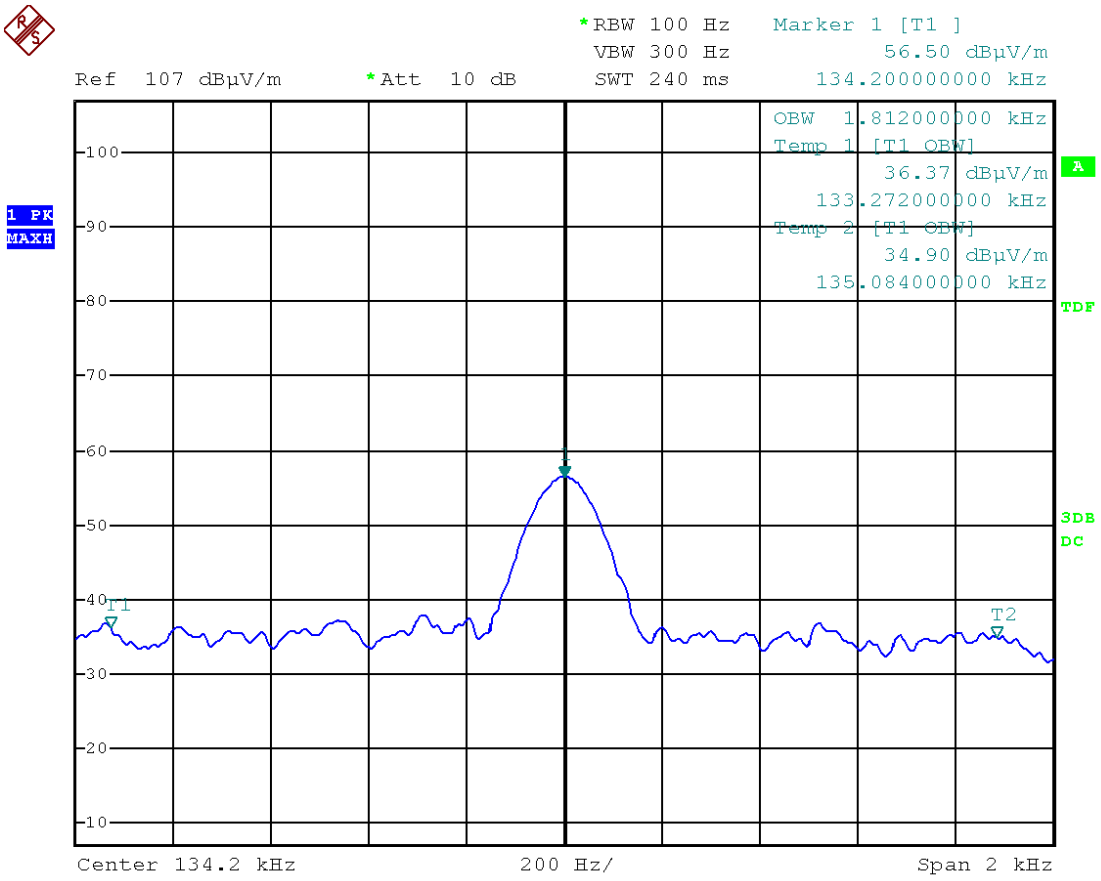
7.7 Test deviation

There is no deviation from the standards referred to.

7.8 Test results

Temperature:	20°C	Humidity:	41%
Tested by:	Martin Müller	Test date:	2017-04-13

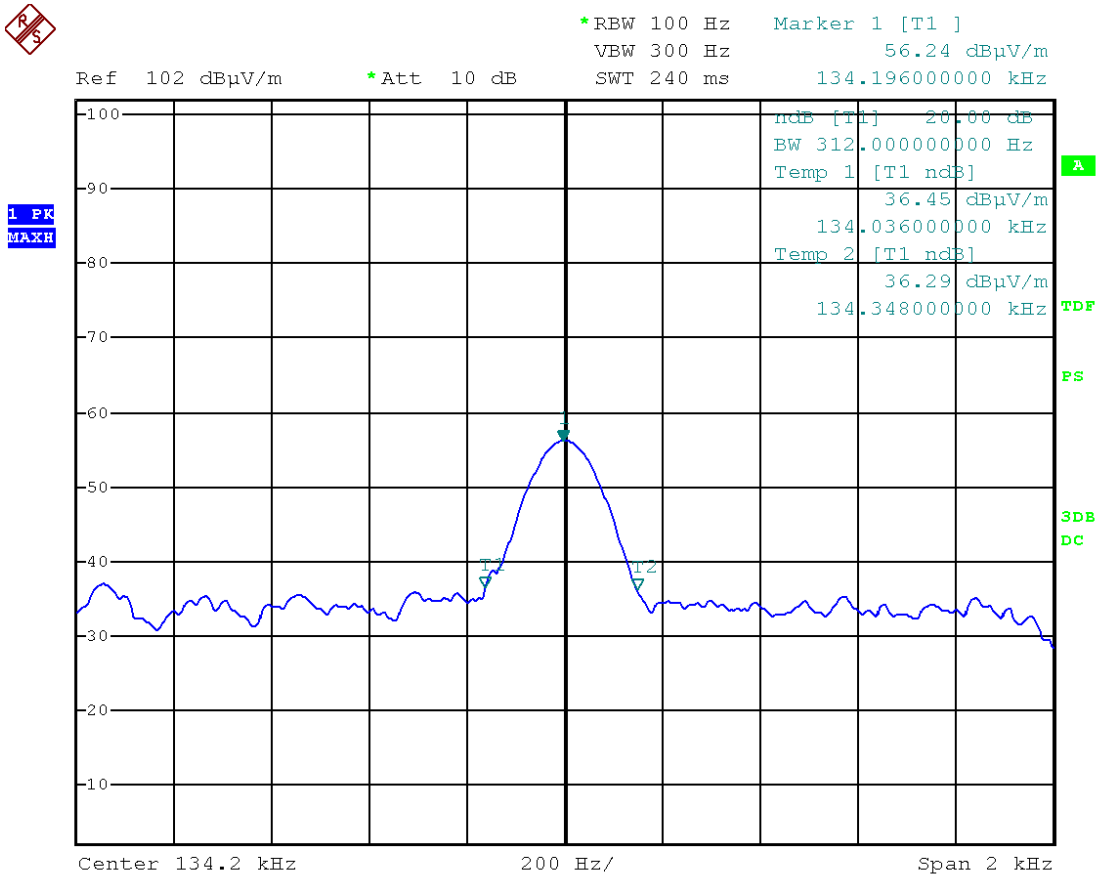
Occupied bandwidth (99 %)



Picture 15: Occupied bandwidth (99 %)

Measured occupied bandwidth (99 %): 1.812 kHz

-20 dB emission bandwidth



Picture 16: -20 dB emission bandwidth

Measured -20 dB emission bandwidth: 0.312 kHz

8 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
LISN	ESH2-Z5	881362/037	E00004	2016-10	2018-10
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
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

Table 3: Equipment calibration status

Note 1: Used for relative measurements only (see test instruments for “

Note 2: 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 3: Expiration date of test firm accreditation for OATS and SAC:
FCC test firm type “accredited”: 2017-06

9 Measurement uncertainty

Description	Max. deviation	k=
Conducted emission AMN (9kHz to 30 MHz)	± 3.8 dB	2
Radiated emission open field (3 m) (30 MHz to 300 MHz) (300MHz to 1 GHz)	 ± 5.4 dB ± 5.9 dB	2
Radiated emission absorber chamber (> 1000 MHz)	± 4.5 dB	2

Table 4: 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.

10 Revision History

Date	Description	Person	Revision
2017-04-24	First edition	M. Müller	---