Test Report

Customer:

DESKO GmbH

Gottlieb-Keim-Str. 56
95448 Bayreuth

Tel.: +49 92 79279-0
Fax: +49 92 79279-14

RF test report

170569-AU02+W03

Industry Canada Industrie Canada

DESKO GmbH

Passport Scanner

PENTA Scanner Cube

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 “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 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 15.225	Passed
RSS-210 Issue 9 Section 4.3 and Annex B6 (with appropriate references to RSS-Gen Issue 4)	Passed

Straubing, October 24, 2017

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 Cube
Applicant:	DESKO GmbH
Manufacturer:	DESKO GmbH
Serial number:	201738 01021
FCC ID:	WTM-P43CUBE1
IC certification number:	7998A-P43CUBE1
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:	5.0 VDC ± 5 %
Temperature range:	0℃ to +40℃

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)

3.3 Operation mode

During the pre-tests it was observed that the “continuous-scan-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 Cube	201738 01021
Power Supply	GlobTek TR9CA4000YL4-N(R6B)	N/A
RFID tag	13.56 MHz	----
Test-PC	Fujitsu ESPRIMO P910-L	E00773
Monitor	Fujitsu Scaleoview L22W-1GT	YE8A006487
DC supply	Statron 3231.1	E00017
USB-Tastatur	Cherry G230	00002742-V17
USB-Maus	Fujitsu LZ237A31B8H	810-002868

3.5 Used cables

Count	Description (type / lengths / remarks)	Serial no.
1	USB cable (2.5 m, shielded)	---
1	AC Power cable (1,5 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

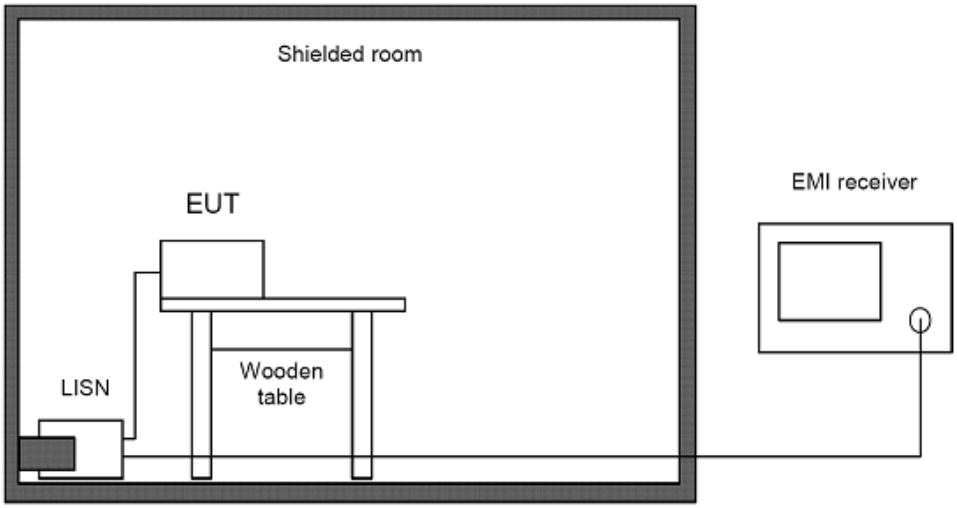
Frequency [MHz]	Quasi-peak [dBµV]	Avarage [dBµV]
0.15 – 0.5	66 – 56	56 – 46
0.5 – 5.0	56	46
5 – 30	60	50

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

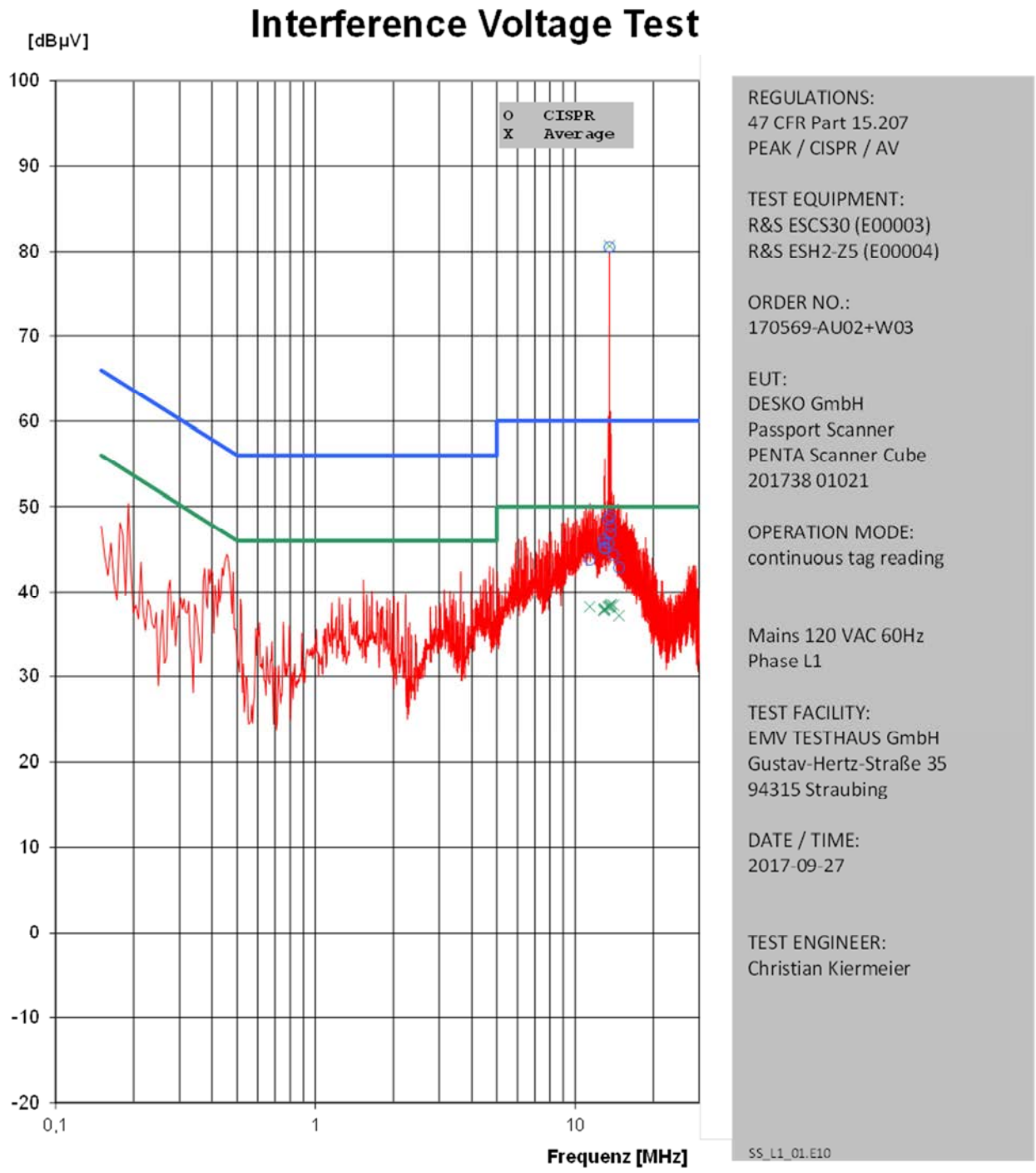


Picture 1: Outline of conducted emission test setup

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

4.6 Test results

Temperature:	22℃	Humidity:	41%
Tested by:	Christian Kiermeier	Test date:	2017-09-27

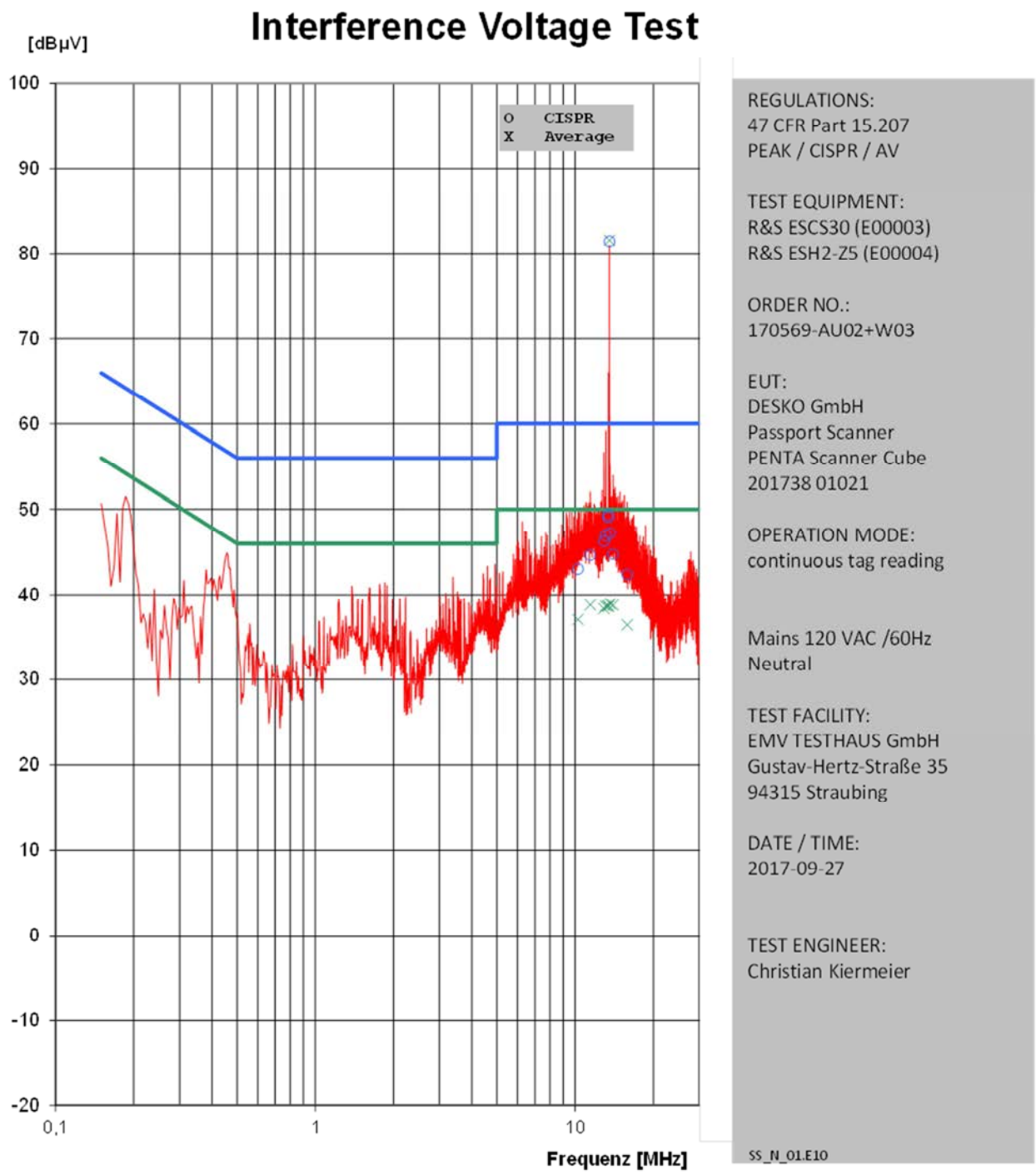


Picture 2: Graphic - Conducted emission on mains, phase 1 (without termination)

Interference Voltage Test

Freq. [MHz]	U_CISPR [dBµV]	Limit [dBµV]	delta_U [dB]	U_AV [dBµV]	Limit [dBµV]	delta_U [dB]	Corr. [dB]	Remark
								SS_L1_01.E10
11,40	43,8	60,0	16,3	38,2	50,0	11,8	0,0	
12,93	45,8	60,0	14,3	37,7	50,0	12,3	0,0	
12,93	46,1	60,0	13,9	37,8	50,0	12,2	0,0	
13,01	45,1	60,0	14,9	37,8	50,0	12,2	0,0	
13,01	45,1	60,0	14,9	38,0	50,0	12,0	0,0	
13,43	48,5	60,0	11,5	38,1	50,0	11,9	0,0	
13,49	45,7	60,0	14,3	38,2	50,0	11,8	0,0	
13,56	80,5	60,0	-20,5	80,7	50,0	-30,7	0,0	
13,64	49,0	60,0	11,0	38,2	50,0	11,8	0,0	
13,69	46,9	60,0	13,2	38,3	50,0	11,7	0,0	
13,77	47,7	60,0	12,3	38,5	50,0	11,5	0,0	
14,08	44,3	60,0	15,8	38,4	50,0	11,6	0,0	
14,77	42,8	60,0	17,2	37,1	50,0	12,9	0,0	

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

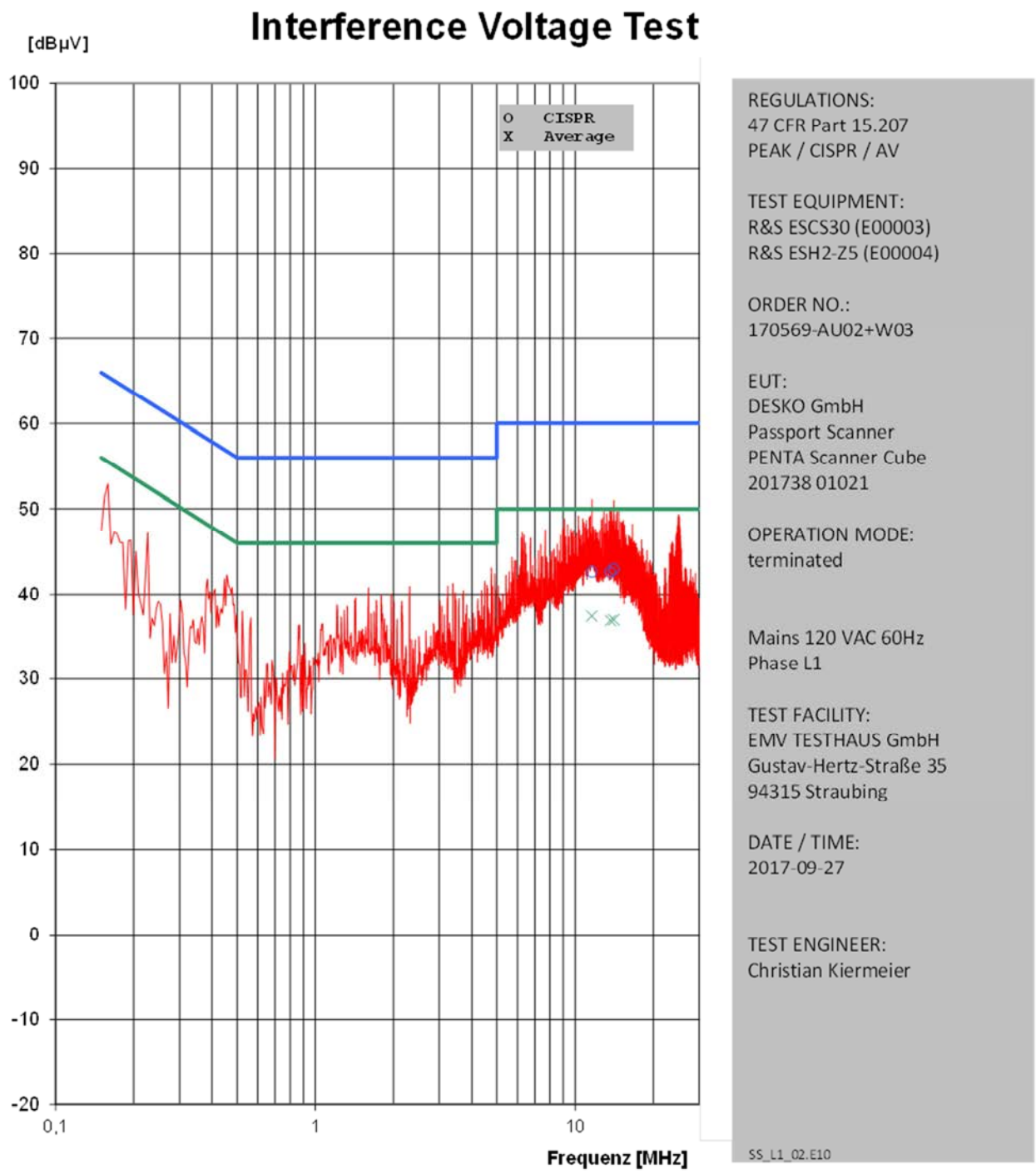


Picture 4: Graphic - Conducted emission on mains, neutral (without termination)

Interference Voltage Test

Freq. [MHz]	U_CISPR [dBµV]	Limit [dBµV]	delta_U [dB]	U_AV [dBµV]	Limit [dBµV]	delta_U [dB]	Corr. [dB]	Remark
								SS_N_01_E10
10,26	43,0	60,0	17,0	37,0	50,0	13,0	0,0	
11,46	44,6	60,0	15,4	38,8	50,0	11,2	0,0	
12,93	46,3	60,0	13,7	38,3	50,0	11,7	0,0	
13,14	46,9	60,0	13,1	38,6	50,0	11,4	0,0	
13,43	49,1	60,0	10,9	38,7	50,0	11,3	0,0	
13,43	49,3	60,0	10,7	38,6	50,0	11,4	0,0	
13,56	81,4	60,0	-21,4	81,6	50,0	-31,6	0,0	
13,63	47,2	60,0	12,8	38,9	50,0	11,1	0,0	
14,00	44,7	60,0	15,3	38,7	50,0	11,3	0,0	
15,87	42,4	60,0	17,6	36,4	50,0	13,6	0,0	

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

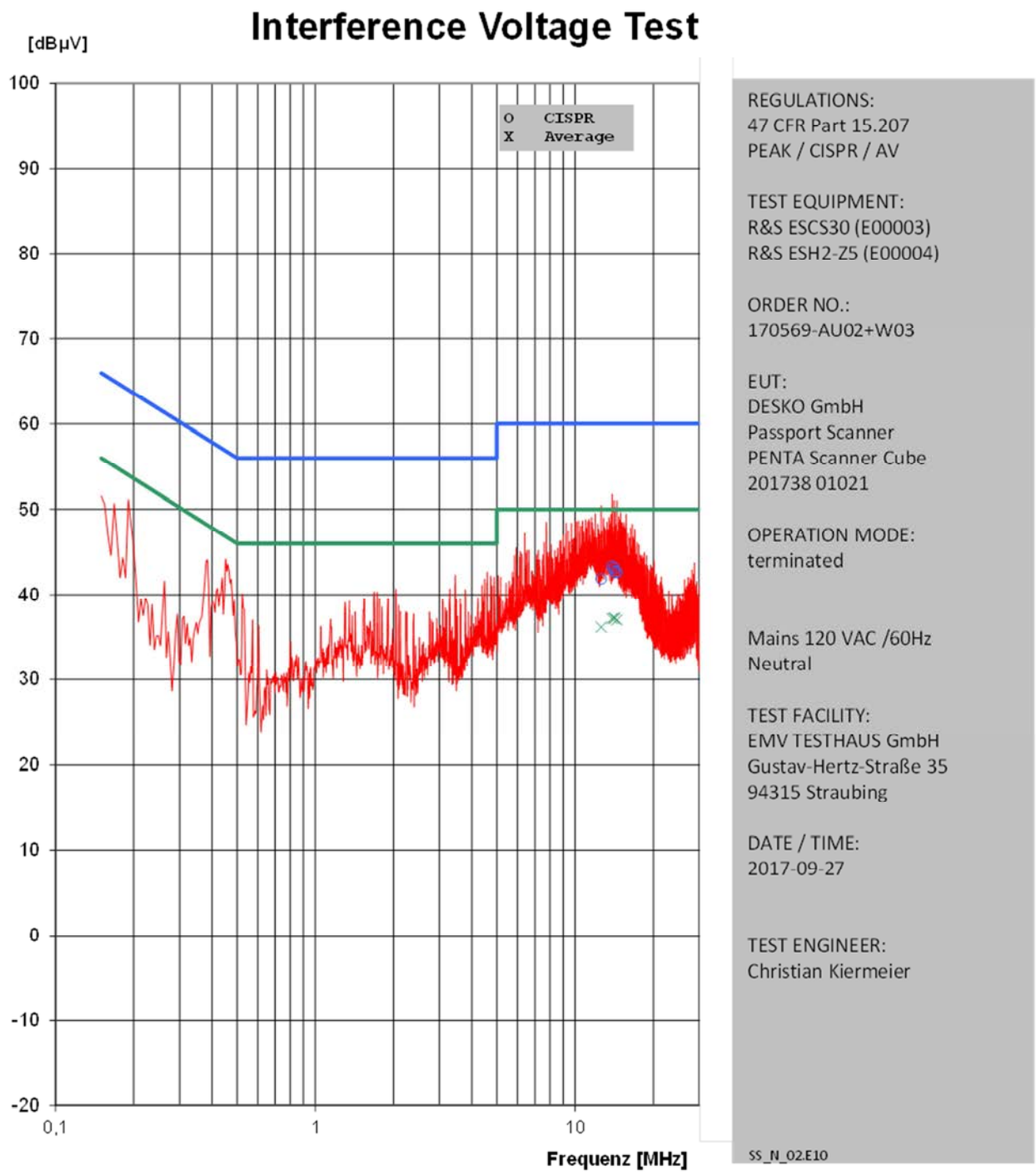


Picture 6: Graphic - Conducted emission on mains, phase L1 (with termination)

Interference Voltage Test

Freq. [MHz]	U_CISPR [dBµV]	Limit [dBµV]	delta_U [dB]	U_AV [dBµV]	Limit [dBµV]	delta_U [dB]	Corr. [dB]	Remark
								SS_L1_02.E10
11,61	42,6	60,0	17,4	37,4	50,0	12,6	0,0	
13,71	42,6	60,0	17,4	36,8	50,0	13,2	0,0	
14,11	43,0	60,0	17,0	36,9	50,0	13,1	0,0	

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



Picture 8: Graphic - Conducted emission on mains, neutral (with 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
								SS_N_02_E10
12,61	41,9	60,0	18,2	36,1	50,0	13,9	0,0	
13,88	43,3	60,0	16,7	37,1	50,0	12,9	0,0	
14,13	43,1	60,0	16,9	37,2	50,0	12,8	0,0	
14,23	42,7	60,0	17,3	37,2	50,0	12,8	0,0	
14,48	42,6	60,0	17,4	37,0	50,0	13,0	0,0	

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

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	E00001
☒	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

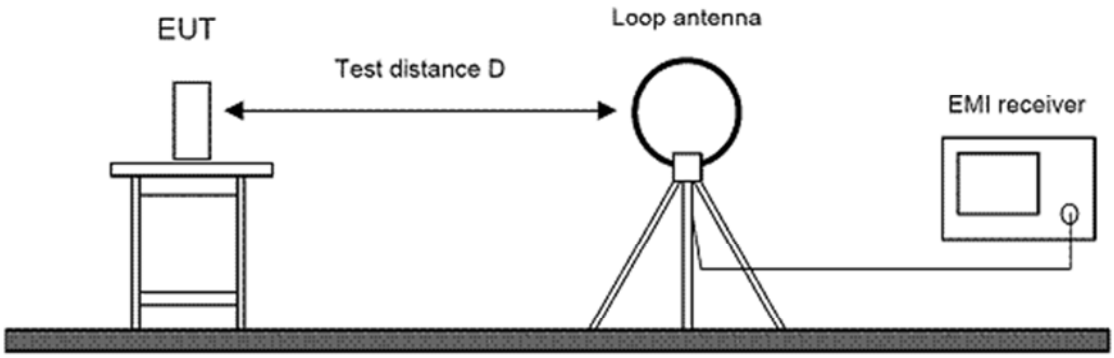
As noted in 15.205(d)(7) devices according to 15.225 are exempt from complying with restricted band requirements for the 13.36 to 13.41 MHz band. Instead they have to comply with the limits as specified in 15.225 (a) to (d):

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			

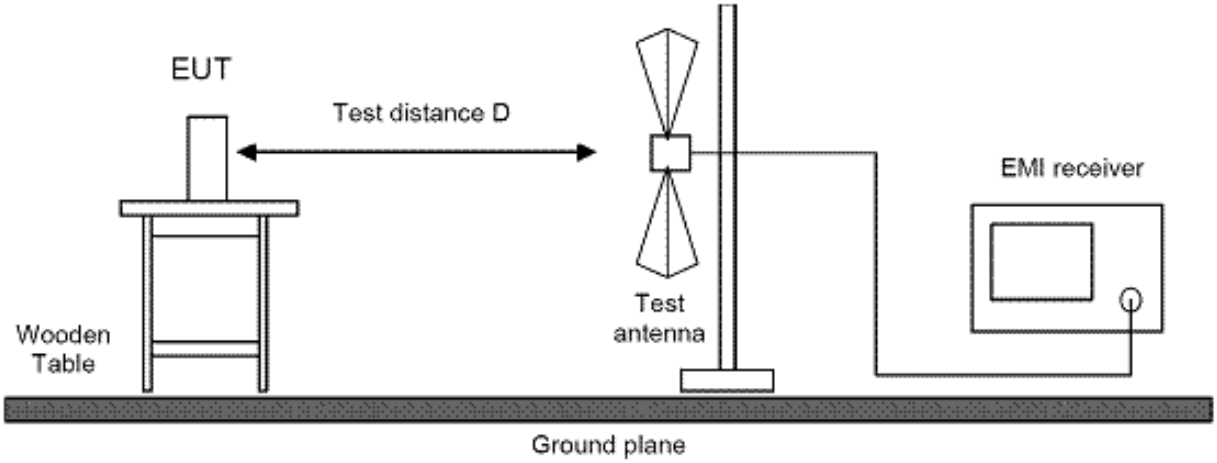
5.4 Test procedure

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



Picture 11: 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:	20℃	Humidity:	41%
Tested by:	Christian Kiermeier	Test date:	2017-06-08

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:

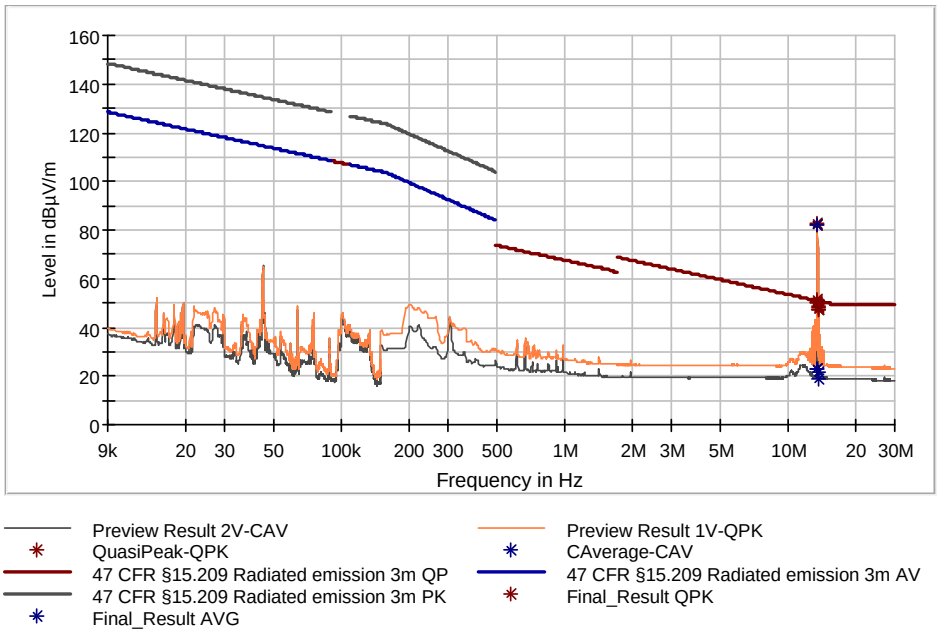
f_{MHz}(300 m) ≈ 0.159 MHz
f_{MHz}(30 m) ≈ 1.592 MHz
f_{MHz}(3 m) ≈ 15.923 MHz

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 at EUT-position 1, antenna in line.



Picture 12: Radiated emission 9 kHz – 30 MHz @ 3m distance

Frequency [MHz]	**Measured value [dBµV/m]**	**Detector**	**Recalculation factor [dB]**	**Field strength [dBµV/m]**	**Limit [dBµV/m]**	**Margin**	**Result**
13.348	23.14	AV					
13.348	50.00	QPK			51.04	1.04	PASS
13.476	22.88	AV					
13.476	49.82	QPK			50.95	1.13	PASS
13.560	82.40	PK	-21.40	61.00	---	---	Carrier
13.560	82.38	QP	-21.40	60.98	84.00	23.02	Carrier
13.645	18.94	AV					
13.645	48.10	QPK			50.85	2.74	PASS
13.773	21.87	AV					
13.773	47.15	QPK			50.76	3.62	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}

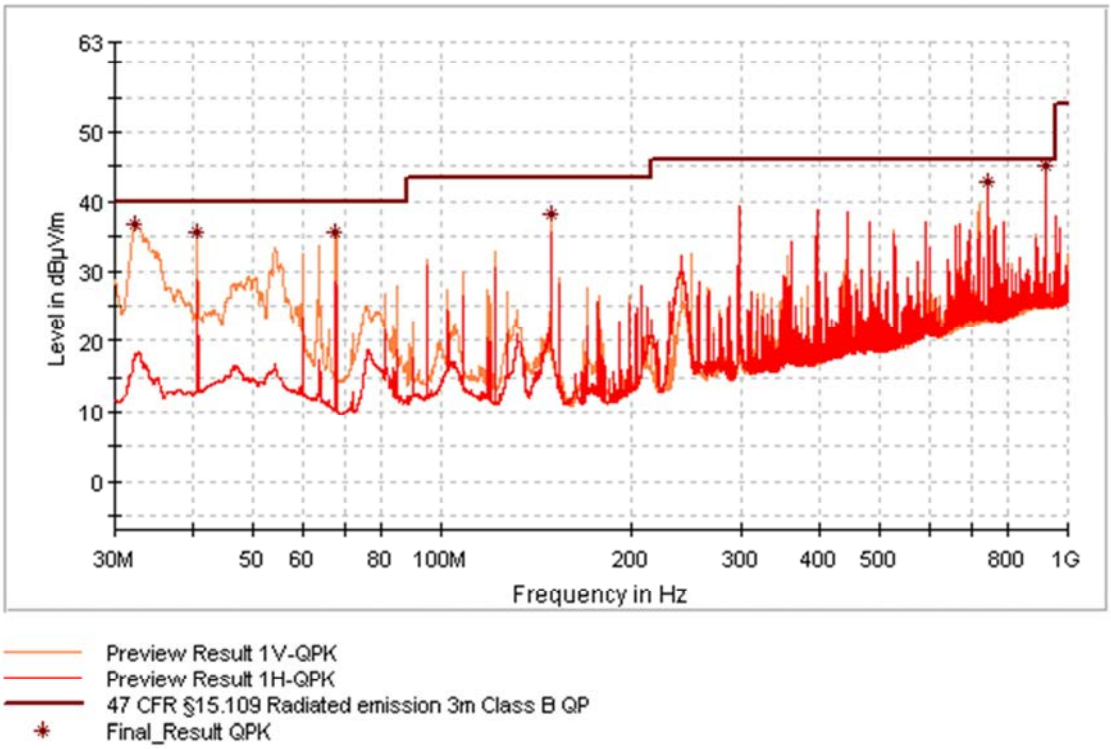
Recalculation factor = -40 log($d_{near\ field}$ / $d_{measure}$) - 20 log(d_{limit} / $d_{near\ field}$)

f_{MHz} [MHz]	$d_{near\ field}$ [m]	$d_{measure}$ [m]	d_{limit} [m]	Recalculation factor [dB]
13.56	3.523	3.0	30.0	21.40

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 at EUT-position 1.



f [MHz]	E_{final} [dBV/m]	Limit [dBµV/m]	Height [cm]	TT [°]	Polarisation	Result
32.37	36.68	40,00	100	327	V	Pass
40.68	35.63	40,00	100	52	V	Pass
67.80	35.61	40,00	100	220	V	Pass
148.50	38.36	43,50	101	52	V	Pass
742.53	42.83	46,00	106	297	H	Pass
924.03	45.04	46,00	100	48	H	Pass

Picture 13: Radiated emission 30 MHz - 1000MHz @ 3m distance

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:	20℃	Humidity:	41%
Tested by:	Andreas Menacher	Test date:	2017-10-06

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:

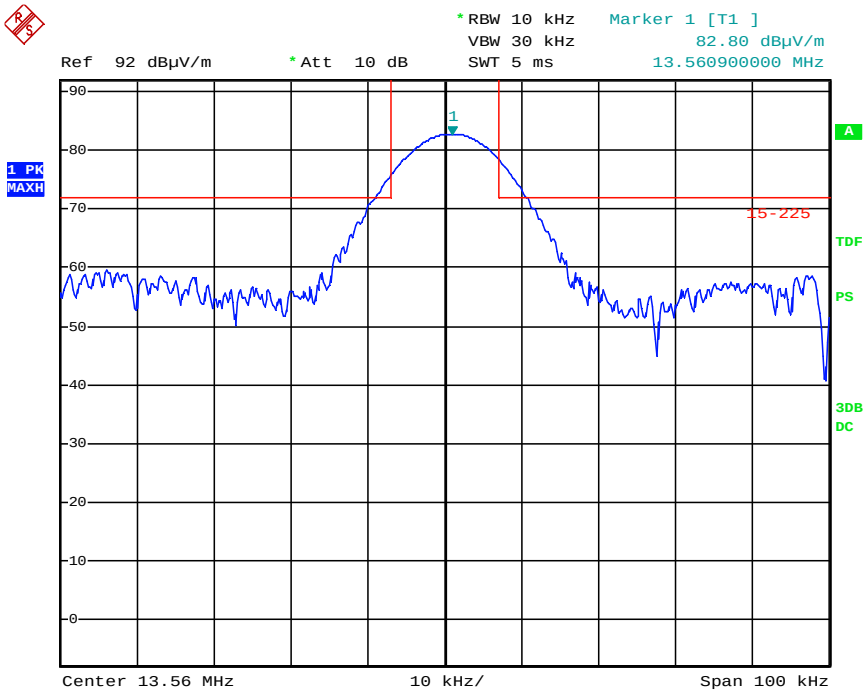
f_{MHz}(300 m) ≈ 0.159 MHz
f_{MHz}(30 m) ≈ 1.592 MHz
f_{MHz}(3 m) ≈ 15.923 MHz

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

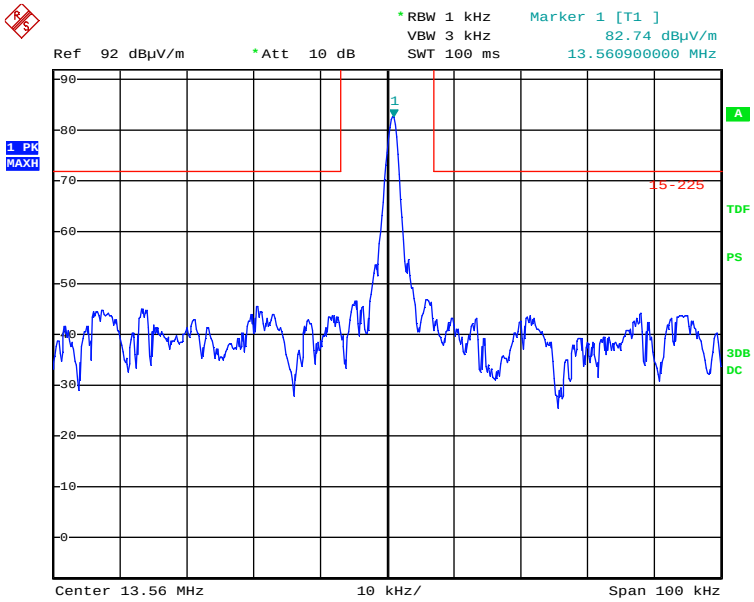
The limits in the graphics and value lists are derived from the general radiated emission limits as specified in 15.209 using the recalculation factor as described above.

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 picture shows the worst-case-emissions for spectrum mask at EUT-position 1, antenna in line.



Picture 14: Spectrum mask for 13.56 MHz @ 3m distance (10 kHz BW)



Picture 15: Spectrum mask for 13.56 MHz @ 3m distance (1 kHz BW)

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]
13.560	82.80*	PK	-21.40	61.40	84.00	22.60	1	0.06
13.560	82.80	PK	-21.40	61.40	84.00	22.60	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]
13.560	3.523	3.000	30.000	-21.40

6 Radiated emission measurement (>1 GHz)

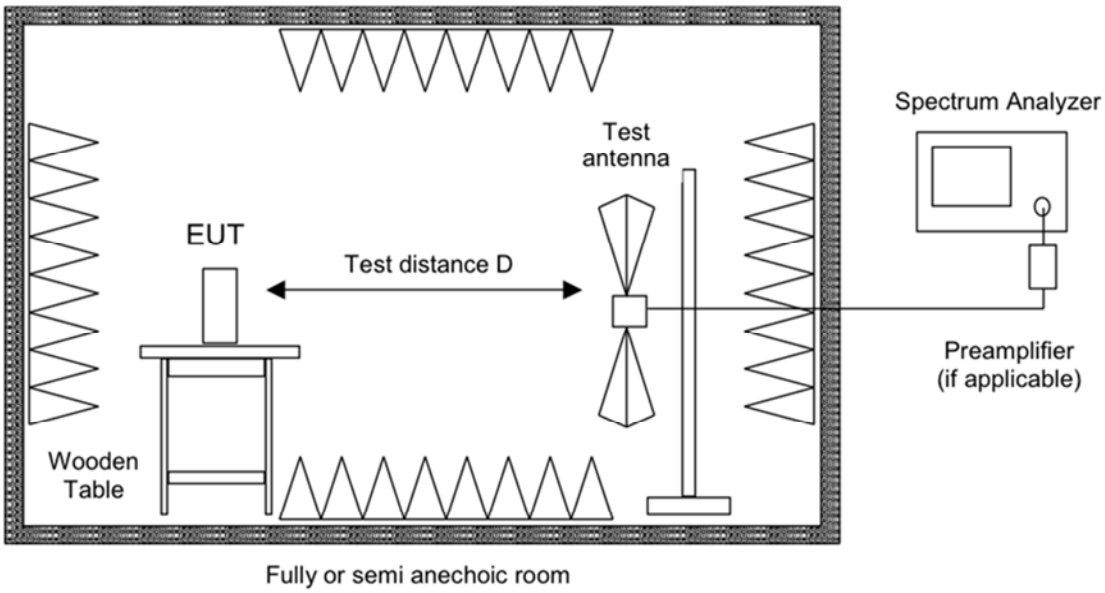
according to 47 CFR Part 15, section 15.109(a),
RSS-210, section 4.3 with RSS-Gen, section 8.9

Temperature:	20℃	Humidity:	41%
Tested by:	Andreas Menacher	Test date:	2017-10-06

6.1 Test equipment

Type	*Designation*	*Manufacturer*	*Inventory no.*
☐ Compact Diagnostic Chamber (CDC)	VK041.0174	Albatross Projects	E00026
☒ Semi Anechoic Chamber (SAC)	---	Albatross Projects	E00716
☐ 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)	ESCS 30	Rohde & Schwarz	E00551
☒ Switch box	COSB 4-1-26	Conformitas	W00091
☒ Preamplifier	AMF-5D-00501800	Parzich	W00089
☒ Horn antenna	BBHA 9120	Schwarzbeck	W00052
☐ Horn antenna	BBHA 9120	Schwarzbeck	W00053
☐ TRILOG broadband antenna (CDC)	VULB 9160	Schwarzbeck	E00011
☐ TRILOG broadband antenna (OATS)	VULB 9163	Schwarzbeck	E00013
☐ TRILOG broadband antenna (SAC)	VULB 9162	Schwarzbeck	E00643
☒ Measurement software	EMC 32	Rohde & Schwarz	---

6.2 Test setup



Picture 16: Test setup of radiated emission (above 1 GHz)

6.3 Test method to demonstrate compliance

1. The test setup is placed inside a semi anechoic chamber with floor absorbers between receiving antenna and EUT.
2. EUT and peripherals are configured according to ANSI C63.4. EUT is placed on the top of the turntable 0.8 meter above ground. EUT and all peripherals are powered on.
3. Exploratory radiated emissions measurements are performed by moving the receiving antenna over all sides of the EUT at a closer distance while observing the display of the test receiver to find the emissions to be re-tested during final radiated emission measurements. As a result a list of frequencies containing position of EUT as well as polarization of receiving antenna.
4. For final radiated emission measurements the receiving antenna is placed 3 meters from the turntable.
5. The receiving antenna is set to vertical polarization.
6. The EMI receiver performs a scan from 1000 MHz to max. the 5th harmonic of the highest generated or used frequency with detector set to Peak and Average measurement bandwidth set to 1 MHz (VBW ≥ 3 MHz).
7. The turn table is rotated to 6 different positions (360° / 6 = 60°) and the antenna is moved between 1 m and 4 m height. The tilt of the antenna is changed automatically by changing the height of the antenna.
8. Change polarization to horizontal and repeat step 6 and 7.
9. After recording prescan values in horizontal and vertical polarization data reduction is performed using a margin of 10 dB to the appropriate limit.
   The critical frequencies are re-measured using a Peak and Average detector with a

bandwidth set
to 1 MHz. At every frequency the polarization with the emission closest to the limit is selected for final test.

10. During Final measurement the turntable is rotated by +/ - 60°to determine the position of the highest radiation around the maximum emission found during the prescan.
11. The height of the broadband receiving antenna is varied between 1 m and 4 m above ground, the slope of the antenna is changed automatically by variation of the antenna height to find the maximum emissions field strength of both horizontal and vertical polarization. The highest value is recorded.

Highest frequency generated or used in the device or on which the device operates or tunes (MHz)	Upper frequency of measurement range (MHz)
108 – 500	2000
500 – 1000	5000
Above 1000	5th harmonic of the highest frequency or 40 GHz, whichever is lower.

Class B digital devices			
Frequency [MHz]	Field strength FS [µV/m]	Field strength [µV/m]	Measurement distance d [m]
Above 960	500	54	3

Class A digital devices			
Frequency [MHz]	Field strength FS [µV/m]	Field strength [µV/m]	Measurement distance d [m]
Above 960	300	49,5	10

Class A digital devices			
Frequency [MHz]	Field strength FS [µV/m]	Field strength [µV/m]	Measurement distance d [m]
Above 960	1000	60	3

To calculate the limit for 3 m measurement distance for Class A digital devices the following calculation is used according to Part 15.31.

$$L_{dm} = L_d + (-20\frac{dB}{dec} * (\log(dm) - \log(d))$$

Ldm = Limit at the new distance
Ld = Limit according FCC Part 15.109
d = Distance according to FCC Part 15.109
dm = New distance for limit

$$L_{dm} = 49.5\frac{dB\mu V}{m} + (-20\frac{dB}{dec} * (\log(3m) - \log(10m)) = 60dB\frac{dB\mu V}{m}$$ above 960MHz

6.4 Test results

Subrange	Step Size	Detector	IF Bandwidth	Measurement Time	Preamplifier
1 GHz – 6 GHz	250 kHz	PK / AV	1 MHz	100 ms	external

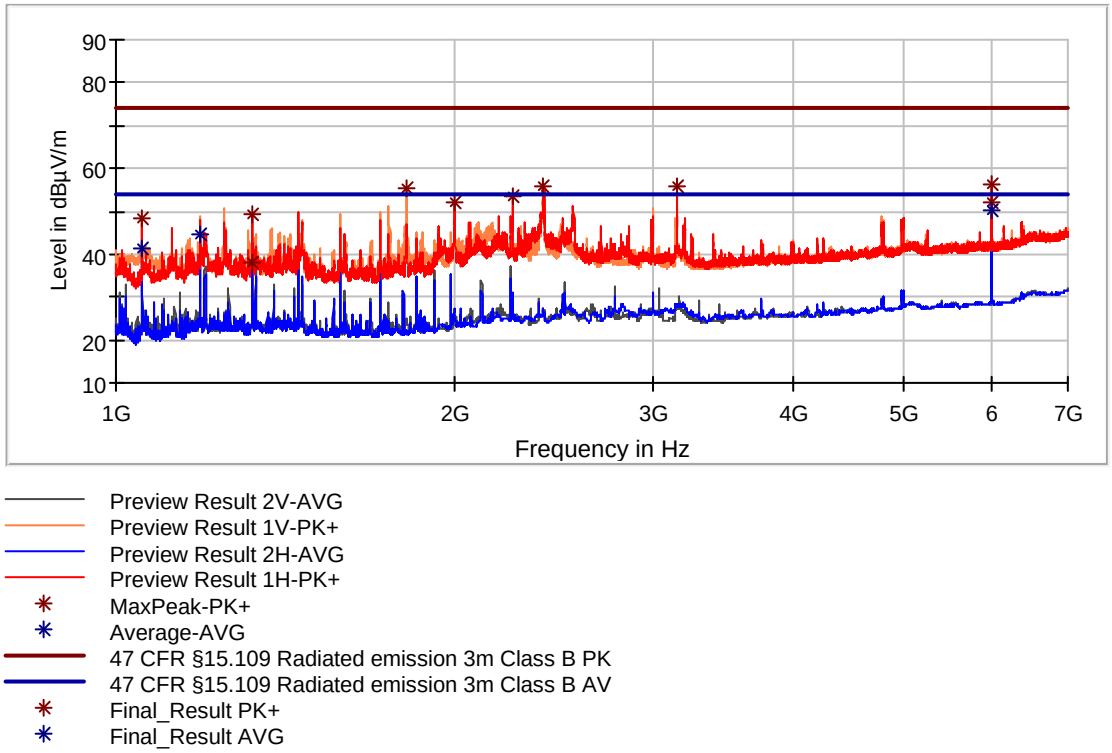


Figure 1: Chart of radiated emissions test

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
1055.750000	---	41.14	54.00	12.86	1000.0	1000.000	150.0	V	60.0
1056.000000	48.49	---	74.00	25.51	1000.0	1000.000	150.0	V	60.0
1188.000000	---	44.73	54.00	9.27	1000.0	1000.000	100.0	H	210.0
1319.000000	38.29	---	74.00	35.71	1000.0	1000.000	300.0	V	180.0
1320.000000	49.10	---	74.00	24.90	1000.0	1000.000	250.0	H	180.0
1810.750000	55.46	---	74.00	18.54	1000.0	1000.000	100.0	V	240.0
1998.000000	52.31	---	74.00	21.69	1000.0	1000.000	100.0	H	30.0
2248.000000	53.40	---	74.00	20.60	1000.0	1000.000	200.0	H	240.0
2390.000000	55.66	---	74.00	18.34	1000.0	1000.000	100.0	H	210.0
3149.500000	55.82	---	74.00	18.18	1000.0	1000.000	100.0	H	240.0
5983.000000	52.23	---	74.00	21.77	1000.0	1000.000	150.0	V	240.0
5999.750000	56.20	---	74.00	17.80	1000.0	1000.000	100.0	H	0.0
6000.000000	---	50.24	54.00	3.76	1000.0	1000.000	100.0	H	0.0

Figure 2: Final results of radiated emissions test

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

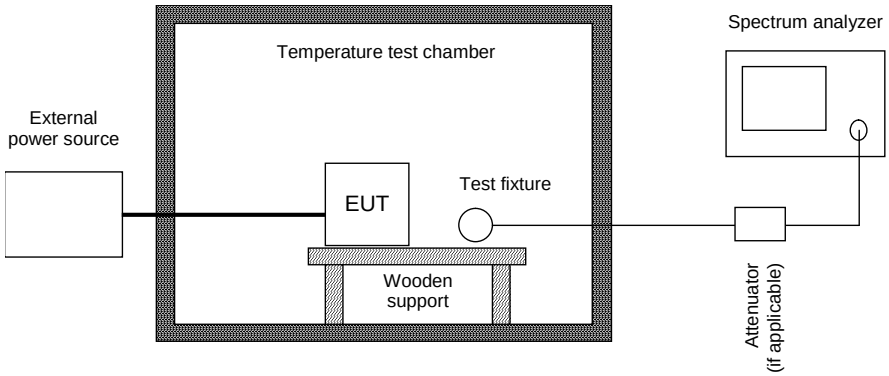
7.3 Limits

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 17: Test setup for carrier frequency stability measurement

7.6 Test deviation

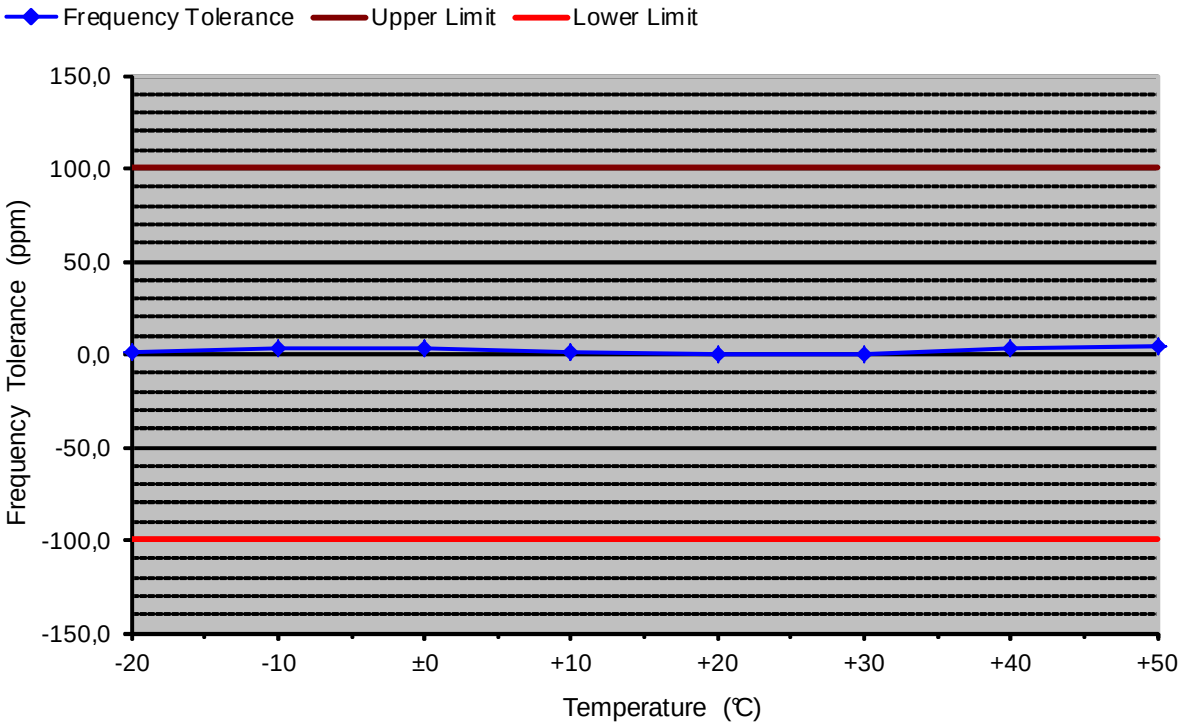
There is no deviation from the standards referred to.

7.7 Test result

Temperature:	20°C	Humidity:	41%
Tested by:	Andreas Menacher	Test date:	2017-10-09

Carrier frequency stability vs. temperature

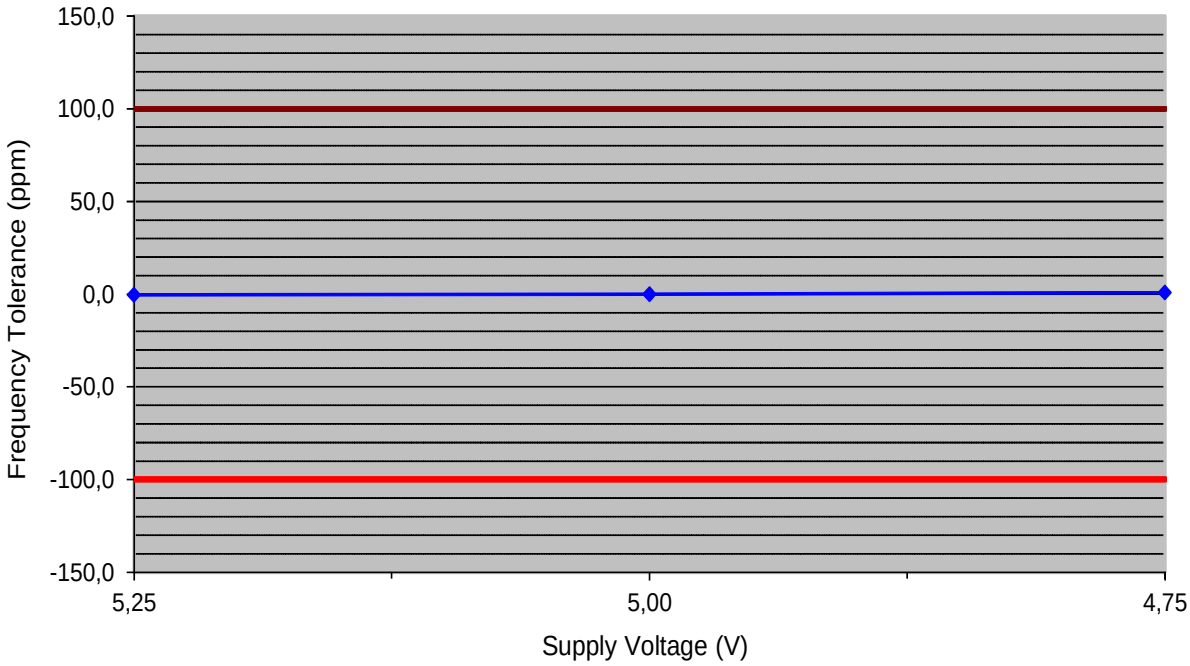
Ausgabebereich



Supply voltage:	5 V	Frequency under nominal conditions:	13,56 MHz

Temperature (°C)	Frequency (MHz)	Frequency Tolerance (Hz)	Frequency Tolerance (ppm)	Upper Limit (ppm)	Lower Limit (ppm)	Margin (ppm)
-20	13,560847	10	0,7	+100,0	-100,0	99,3
-10	13,560845	42	3,1	+100,0	-100,0	96,9
±0	13,560842	48	3,5	+100,0	-100,0	96,5
+10	13,560841	15	1,1	+100,0	-100,0	98,9
+20	13,560831	0	0,0	+100,0	-100,0	100,0
+30	13,560823	-2	-0,1	+100,0	-100,0	99,9

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)
5,25	13,559995	-5	-0,4	+100,0	-100,0	99,6
5,00	13,560000	0	0,0	+100,0	-100,0	100,0
4,75	13,560012	12	0,9	+100,0	-100,0	**99,1**

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 20.

8.2 Test instruments

See clause 0 on page 20.

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 23.

8.5 Test deviation

There is no deviation from the standards referred to.

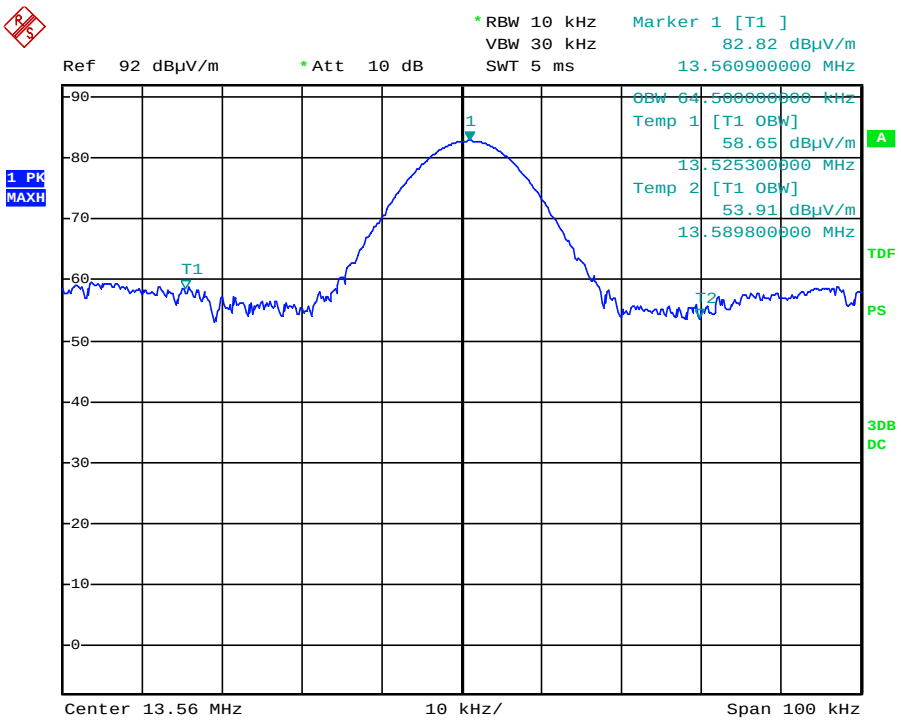
8.6 Test results

Temperature:	20℃	Humidity:	41%
Tested by:	Christian Kiermeier	Test date:	2017-10-06

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.



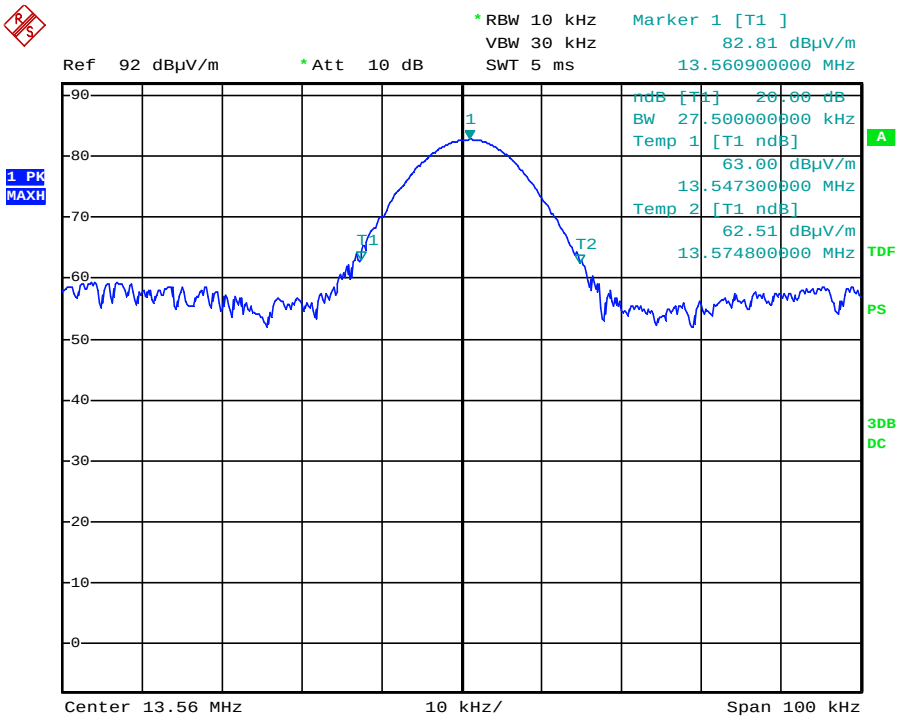
Picture 18: Occupied bandwidth (99 %)

Measured occupied bandwidth (99 %): 64,500 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 19: -20 dB emission bandwidth

Measured -20 dB emission bandwidth: 27,500 kHz

$f_{assigned}$ (MHz)	Index	f_{-20dB} (MHz)	Δf_T (kHz)	Δf_U (kHz)	$f_{-20dB(T, U)}$ (MHz)	Limit (MHz)	Margin (kHz)	Result
13.560900	low	13,547300	0.000	0.000	13.547300	13.110000	437.300	Passed
	high	13,574800	0.000	0.000	13.574800	14.010000	435.200	Passed
	Bandwidth	27.500 kHz			27.500 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 30 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: 27.500 kHz
Including variations in temperature and supply voltage: 27.500 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	2018-02
LISN	ESH2-Z5	893406/009	E00005	2016-02	2018-02
Loop antenna	HFH2-Z2	871398/0050	E00060	2016-09	2018-09
Broadband antenna	VULB 9162	9160-3050	E00011	2015-11	2017-11
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	2017-05	2019-05
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. 04, 52 and 12	---	E00434 E00755 E00320	2015-11	2017-11

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 (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 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
2017-06-10	First edition	Ch. Kiermeier	0