Test report

Customer:

Röckab AB

Kientalstrasse 7
454 93 BRASRAD
Sweden

RF test report

170137-AU01+W01

Röckab AB

Handheld transmitter 915 MHz

us819

Deutsche Akkreditierungsstelle
D-PL-12155-01-00

EMV **TESTHAUS** GmbH

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Accreditation:

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

Location of Testing:

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Germany

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

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1 Summary of test results

47 CFR part and section	*Test*	*Page*	*Result*	*Note(s)*
15.207	AC power line conducted emissions 9 kHz to 30 MHz	---	Not applicable	1
15.249(a) 15.249(d) 15.209	Emissions radiated outside of the specified frequency bands 9 kHz to 10th harmonic		Passed	
	9 kHz to 30 MHz	20	Passed	
	30 MHz to 1 GHz	23	Passed	
	1 GHz to 10th harmonic	26	Passed	
15.215(c)	20 dB bandwidth	29	Passed	

Notes (for information about EUT see clause 3):

1 According to §15.207(c), measurements to demonstrate compliance with the conducted limits are not required for devices which only employ battery power for operation and which do not operate from the AC power lines or contain provisions for operation while connected to the AC power lines.

Straubing, April 26, 2018

Alexander Grill
Test engineer
EMV **TESTHAUS** GmbH

Christian Kiermeier
Technical executive
EMV **TESTHAUS** GmbH

2 Referenced publications

In this report, any reference to publications without stating the issue date explicitly refers to the versions as listed below.

Publication	*Title*
47 CFR Part 2:2017-10	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 15:2017-10	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

3 Equipment under test (EUT)

All Information in this clause is declared by customer.

3.1 General information

Product type:	Handheld transmitter 915 MHz	
Model name:	us819	
Serial number(s):	Sample no. 1	
FCC ID:	2AMIB-USTU01	
Manufacturer:	Röckab AB	
Version:	Hardware:	---
	Firmware:	ARCS-915-HS8_V2
Short description:	EUT is a handheld transmitter working on the frequency 915 MHz. The transmitter is triggered manually.	
Additional modifications:	None	
Power supply:	Leclanché or lithium battery supply	
	Nominal voltage:	3.0 V
Temperature range:	-10 °C to +55 °C (Portable)	

3.2 Radio specifications

Application(s):	Handheld remote control		
Operating frequencies:	915 MHz		
Modulation:	FSK		
Antenna:	Type:	PCB antenna	
	Style:	☒ integral	☐ dedicated
	Connector:	☐ external	☐ internal
		☐ temporary	☒ none

4 Photo documentation

For external photos of the EUT see annex B, for internal ones see annex C.
Photos taken during testing including EUT positions can be found in annex A.

5 Test configuration and mode of operation

5.1 Test configuration

EUT			
Device	*Type designation*	*Serial or inventory no.*	*Manufacturer*
Handheld transmitter	ARCS-S8-1606-AX5043-V2	Sample no. 1	Röckab AB

Table 1: Devices used for testing

5.2 Mode of operation

5.2.1 Orientation

The EUT is tested in its typical setup configuration, as per the manufacturer's instructions in the user manual. If the device can be operated in various orientations (e.g. tabletop and wall-mount), it is tested in each orientation in which it is intended to be used.

☐ EUT has one position of use which is selected for testing.
☒ EUT is tested in three orthogonal orientations.

For photos of EUT positions, see annex A.

5.2.2 Operational modes

Carrier wave 915 MHz with FSK modulation.

Button 1 (top left) pressed permanently

6 Test procedures

6.1 General specifications

Tabletop devices are placed on a non-conductive table with a height of 0.8 m. In case of AC power-line conducted emissions test, the rear of the EUT is located 40 cm to the vertical wall of the RF-shielded (screened) room which is used as vertical conducting plane. For radiated emission measurements above 1 GHz, tabletop devices are placed at a height of 1.5 m above the floor using a support made of styrene placed on top of the non-conductive table.

Floor-standing devices are placed either directly on the reference ground-plane or on insulating material (see clause 6.3.3 of ANSI C63.4-2014 for more details).

All other surfaces of tabletop or floor-standing EUTs are at least 80 cm from any other grounded conducting surface. This includes the case or cases of one or more LISNs when performing an AC power-line conducted emissions test.

Radiated emission measurements of equipment that can be used in multiple orientations (e.g. portable or handheld devices) are performed with the EUT in each of three orthogonal axis positions.

6.2 AC power-line conducted emissions

AC power-line conducted emissions are measured according to clause 6.2 of ANSI C63.10 over the frequency range from 150 kHz to 30 MHz to determine the line-to-ground radio-noise voltage that is conducted from all of the EUT current-carrying power input terminals that are directly (or indirectly via separate transformers or power supplies) connected to a public power network. The tests are performed in a shielded room.

If the EUT normally receives power from another device that in turn connects to the public utility ac power lines, measurements are made on that device with the EUT in operation to demonstrate that the device continues to comply with the appropriate limits while providing the EUT with power. If the EUT is operated only from internal or dedicated batteries, with no provisions for connection to the public utility ac power lines (600 VAC or less) to operate the EUT (such as an adapter), then ac power-line conducted measurements are not required.
For direct current (dc) powered devices where the ac power adapter is not supplied with the device, an “off-the-shelf” unmodified ac power adapter is used. If the device is supposed to be installed in a host (e.g., the device is a module or PC card), then it is tested in a typical compliant host.

Frequency (f)	*Measurement receiver bandwidth*	*Step size*	*Detector type*		
			Prescan	*Prescan with FFT*	*Final scan*
150 kHz ≤ f < 30 MHz	9 kHz	≤ 4.5 kHz	Peak, Average	Quasi-peak, Average	Quasi-peak, Average

Table 2: Bandwidth and detector type for AC power-line conducted emissions test

The AC power-line conducted emissions test is performed in the following steps:

a) The EUT is arranged as tabletop or floor-standing equipment, as applicable, and connected to a line impedance stabilization network (LISN) with 50 µH / 50 Ω. If required, a second LISN of the same type and terminated by 50 Ω is used for peripheral devices. The EUT is switched on.
b) The measurement equipment is connected to the LISN for the EUT and set-up according to the specifications of the test (see table 2). At the LISN, the neutral line is selected to be tested.
c) The prescan is performed with both detectors activated at the same time. If the test receiver is capable of FFT analysis, it is used for prescan, but not for final scan.
d) When the prescan is completed, maximum levels with less margin than 10 dB or exceeding the limit are determined and collected in a list.
e) With the first frequency of the list selected, a frequency zoom over a range of ten times of the measurement receiver bandwidth around this frequency is performed. If the EUT has no significant drift in frequency, the frequency zoom can be skipped.
f) For final scan, the emission level is measured and the maximum is recorded.
g) Steps e) to f) are repeated for all other frequencies in the list. At least the six highest EUT emissions relative to the limit have to be recorded.
h) Steps c) to g) are repeated for all current-carrying conductors of all of the power cords of EUT, i.e. all phase and (if used) neutral line(s).

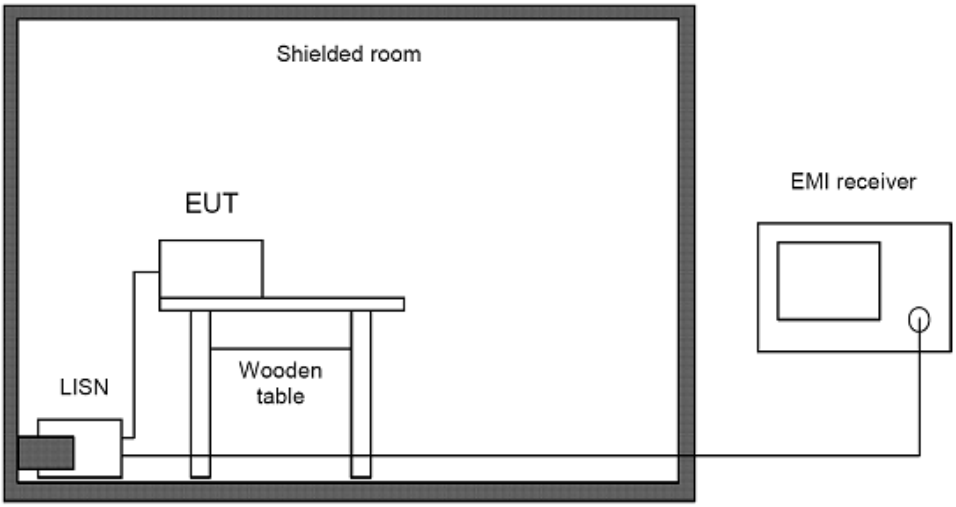

Figure 1: Setup for AC power-line conducted emissions test from 9 kHz to 30 MHz

6.3 Radiated emissions below 30 MHz

Radiated emissions below 30 MHz are measured according to clause 6.4 of ANSI C63.10 using an inductive shielded loop antenna. As this antenna measures the magnetic field only, its antenna factors are converted to electric field strength values assuming a free space impedance of 377 Ω as described in clause 4.3.1 of ANSI C63.10. This results in an additional correction of 51.53 dB.

6.3.1 Extrapolation at frequencies below 30 MHz

According to clause 6.4.3 of ANSI C63.10, at frequencies below 30 MHz, measurements may be performed at a distance closer than that specified in the requirements. In this case, the results are extrapolated to the specified distance by using a recalculation factor determined according to one of the methods described in clause 6.4.4 of ANSI C63.10, provided that the maximum dimension of the device is equal to or less than 0.625 times the wavelength at the frequency being measured. As the minimum wavelength is 10 meters corresponding to the maximum frequency of 30 MHz, this requirement is fulfilled if the maximum dimension of the device is equal to or less than 6.25 meters.

Unless otherwise stated, the recalculation factor is determined according to clause 6.4.4.2 “Extrapolation from the measurement of a single point” of ANSI C63.10:

$d_{near\ field}$ = 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 to determine the recalculation factor:

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

Based on the test distances for the general radiated emission limits as specified in §15.209 of 47 CFR Part 15, the following formulas are used to determine the recalculation factor:

Frequency (f)	d_{limit}	$d_{measure}$	*Formula for recalculation factor*
9 kHz ≤ f ≤ 159 kHz 490 kHz < f ≤ 1.592 MHz	300 m 30 m	3 m	-40 log(d_{limit} / $d_{measure}$)
159 kHz < f ≤ 490 kHz 1.592 MHz < f ≤ 15.923 MHz	300 m 30 m	3 m	-40 log($d_{near\ field}$ / $d_{measure}$) - 20 log(d_{limit} / $d_{near\ field}$)
f > 15.923 MHz	30 m	3 m	-20 log(d_{limit} / $d_{measure}$)

Table 3: Recalculation factors for extrapolation

6.3.2 Measuring radiated emissions below 30 MHz

Prescans for radiated measurements below 30 MHz are performed in a fully anechoic room (called “CDC”). The measurement distance is 3 meters. The emissions of the EUT are recorded with an EMI test receiver configured as described in table 4.

Frequency (f)	*Measurement receiver bandwidth*	*Step size*	*Detector type*		
			Prescan	*Prescan with FFT*	*Final scan*
9 kHz ≤ f < 150 kHz	200 Hz	≤ 100 Hz	Peak, Average	Peak Quasi-peak, Average	Peak Quasi-peak, Average
150 kHz ≤ f < 30 MHz	9 kHz	≤ 4.5 kHz	Peak, Average	Peak Quasi-peak, Average	Peak Quasi-peak, Average

Table 4: Bandwidth and detector type for radiated emissions test below 30 MHz

Prescans are performed with all detectors activated at the same time. If the test receiver is capable of FFT analysis, it is used for prescans, but not for final scans. If no limit is specified for certain detectors, final scan measurement with these detectors may be omitted.

The radiated emissions test below 30 MHz is performed in the following steps:

a) The loop antenna is positioned with its plane perpendicular to the ground with the lowest height of the antenna 1 m above the ground.
b) The EUT is placed in its standard position on a turntable capable of rotation through 360° in the horizontal plane and arranged as tabletop or floor-standing equipment, as applicable. The EUT is switched on.
c) The measurement equipment is connected to the loop antenna and set-up according to the specifications of the test (see table 4).
d) The EUT is turned to a position likely to get the maximum and the test antenna is rotated to detect the maximum of the fundamental in this EUT position.
e) Then the EUT is rotated in a horizontal plane through 360° in steps of 45°. Starting at 0°, at each table position the spectrum for the full frequency range is recorded. If the emission at a certain frequency is higher than the levels already recorded, the current table position is noted as the maximum position.
f) After the last prescan, the significant maximum emissions and their table positions are determined and collected in a list.
g) With the test receiver set to the first frequency of the list, the EUT is rotated by ±45° around the table position found during prescans while measuring the emission level continuously. For final scan, the worst-case table position is set and the maximum emission level is recorded.
h) Step g) is repeated for all other frequencies in the list.
i) Finally, for frequencies with critical emissions the loop antenna is rotated again to find the maximum of emission. At least, frequency and level of the six highest emissions relative to the limit have to be recorded. However, emissions more than 20 dB below the limit do not need to be reported.

If the EUT may be used in various positions, steps a) to i) are repeated in two other orthogonal positions. If the EUT may be used in one position only, steps a) to i) are repeated in one orthogonal position.

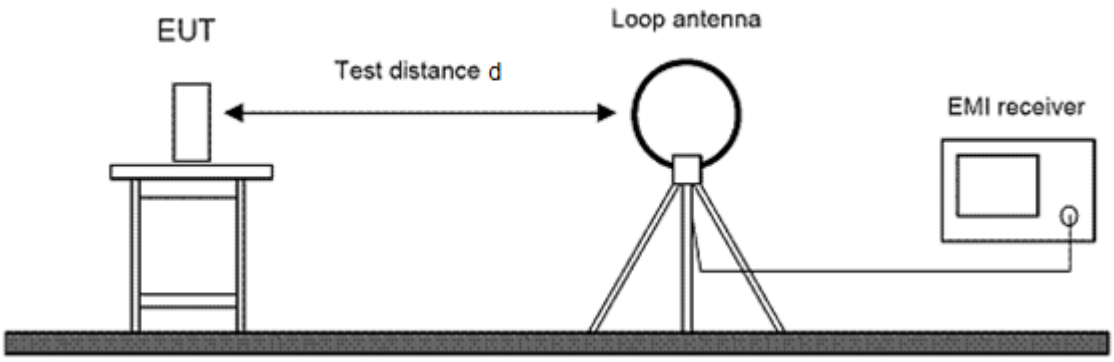

Figure 2: Setup for radiated emissions test below 30 MHz

6.4 Radiated emissions from 30 MHz to 1 GHz

Radiated emissions in the frequency range 30 MHz to 1 GHz are measured according to clause 6.5 of ANSI C63.10 using a semi-anechoic chamber (SAC) with a ground plane on the floor. The measurement distance is 3 meters. The emissions of the EUT are recorded with an EMI test receiver configured as described in table 5.

Frequency (f)	*Measurement receiver bandwidth*	*Step size*	*Detector type*		
			Prescan	*Prescan with FFT*	*Final scan*
30 MHz ≤ f ≤ 1 GHz	120 kHz	≤ 60 kHz	Peak	Quasi-peak	Quasi-peak

Table 5: Bandwidth and detector type for radiated emissions test from 30 MHz to 1 GHz

The measurement antenna is a combination of a biconical antenna and a logarithmic-periodic dipole array antenna. It is mounted on a support capable of allowing the antenna to be used in either horizontal or vertical polarization and in a height between 1 m and 4 m above the ground plane.

If the test receiver is capable of FFT analysis, it is used for prescans, but not for final scans.

The radiated emissions test from 30 MHz to 1 GHz is performed in the following steps:
a) The measurement antenna is oriented initially for vertical polarization.
b) The EUT is placed in its standard position on a turntable capable of rotation through 360° in the horizontal plane and arranged as tabletop or floor-standing equipment, as applicable. The EUT is switched on.
c) The measurement equipment is connected to the measurement antenna and set-up according to the specifications of the test (see table 5).
d) The table position is set to 0°.
e) The antenna height is set to 1 m.

f) The spectrum for the full frequency range is recorded. If the emission at a certain frequency is higher than the levels already recorded, the polarization and height of the measurement antenna as well as the current table position are noted as the maximum position.
g) The antenna height is increased to 4 m in steps of 50 cm. At each height, step f) is repeated.
h) The polarization of the measurement antenna is changed to horizontal.
i) The antenna height is decreased from 4 m to 1 m in steps of 50 cm. At each height, step f) is repeated.
j) The EUT is rotated in a horizontal plane through 360° in steps of 60°. At each table position, steps e) to i) are repeated.
k) After the last prescan, the significant maximum emissions with their polarizations and heights of the measurement antenna as well as their table positions are determined and collected in a list.
l) With the test receiver set to the first frequency of the list, the measurement antenna is set to the polarization and height and the table is moved to the position as determined during prescans.
m) The antenna is moved by ±50 cm around this height and the EUT is rotated by ±60° around this table position while measuring the emission level continuously.
n) For final scan, the worst-case positions of antenna and table are set and the maximum emission level is recorded.
o) Steps l) to n) are repeated for all other frequencies in the list. At least, frequency and level of the six highest emissions relative to the limit have to be recorded. However, emissions more than 20 dB below the limit do not need to be reported.

If the EUT may be used in various positions, steps a) to o) are repeated in two other orthogonal positions.

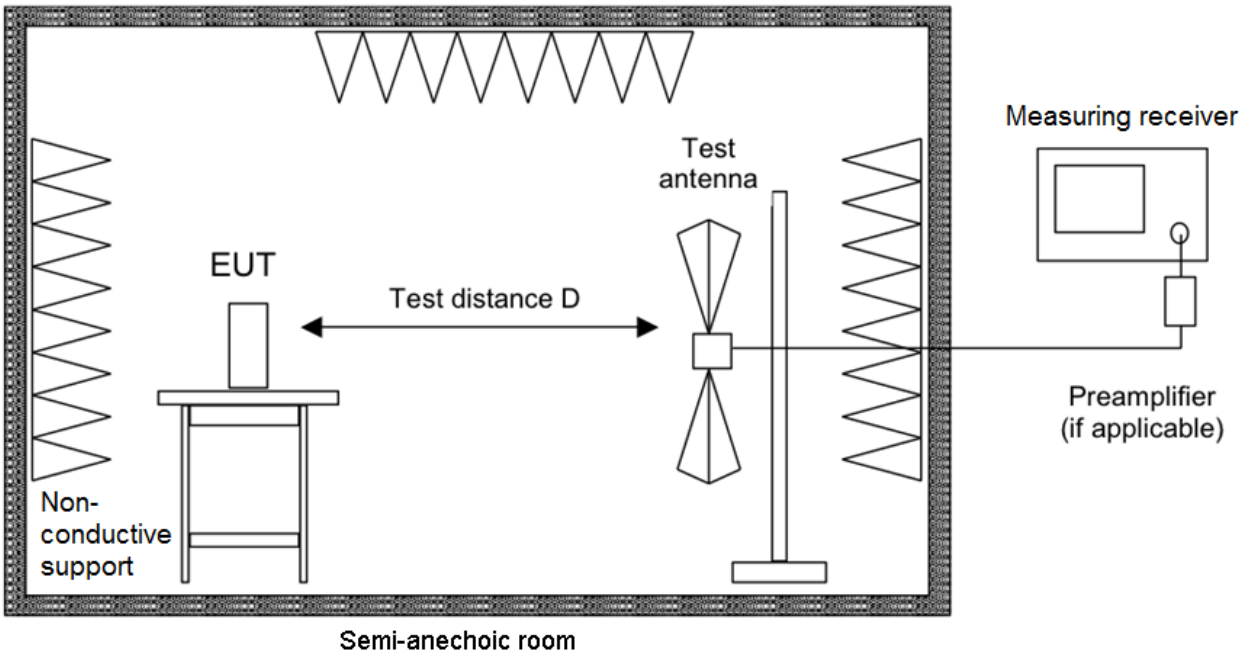

Figure 3: Setup for radiated emissions test from 30 MHz to 1 GHz

6.5 Radiated emissions above 1 GHz

Radiated emissions above 1 GHz are measured according to clause 6.6 of ANSI C63.10 by conducting exploratory and final radiated emission tests. According to clause 6.6.4.1 of ANSI C63.10, measurements may be performed at a distance closer than that specified in the requirements. However, an attempt shall be made to avoid making final measurements in the near field of both the measurement antenna and the EUT.

For measurement of radiated emissions above 1 GHz, horn antennas are used.

6.5.1 Exploratory radiated emissions measurements

Exploratory radiated emissions above 1 GHz are measured in a semi-anechoic chamber with RF absorbing material on the floor or a fully anechoic room. They are performed by moving the receiving antenna over all sides of the EUT at a closer distance (e.g. 0.5 or 1 m) while observing the display of the test receiver to find the emissions to be re-tested during final radiated emission measurements.

According to clause 5.3.3 of ANSI C63.10, when performing measurements at a distance other than that specified, the results shall be extrapolated to the specified distance using an extrapolation factor of 20 dB/decade of distance (inverse of linear distance for field-strength measurements). To simplify testing and documentation, the limits are increased accordingly instead of decreasing the results.

The emissions of the EUT are displayed and recorded with an EMI test receiver operating in the spectrum analyzer mode using the settings as described in table 6.

Frequency (f)	*Resolution bandwidth*	*Video bandwidth*	Sweep time	*Trace detector(s)*	*Trace mode(s)*	*Test*
f ≥ 1 GHz	1 MHz	3 MHz	AUTO	Max Peak, Average	Clear Write	Searching
					Max Hold	Recording

Table 6: Bandwidth and trace settings for exploratory radiated emissions test above 1 GHz

If during exploratory radiated emissions measurements no levels to be re-tested are found, the final radiated emissions measurement may be omitted. In this case, the chart of the exploratory radiated emissions measurements has to be reported.

6.5.2 Final radiated emissions measurements

Final radiated emissions above 1 GHz are measured in a semi-anechoic chamber (SAC) with RF absorbing material on the floor between measurement antenna and EUT. The measurement distance is 3 meters. The emissions of the EUT are recorded with an EMI test receiver configured as described in table 7.

Frequency (f)	*Measurement receiver bandwidth*	*Step size*	*Detector type*	
			Prescan	*Final scan*
f ≥ 1 GHz	1 MHz	≤ 500 kHz	Peak, Average	Peak, Average

Table 7: Bandwidth and detector type for final radiated emissions test above 1 GHz

Prescans are performed with both detectors activated at the same time. If the test receiver is capable of FFT analysis, it is used for prescans, but not for final scans.

The horn antenna is mounted on a support capable of allowing the antenna to be used in either horizontal or vertical polarization and to be moved in a scan height range between 1 m and the scan height upper range defined in clause 6.6.3.3 of ANSI C63.10. When the EUT is manipulated through three different orientations, the scan height upper range for the measurement antenna is limited to 2.5 m above the ground plane.or 0.5 m above the top of the EUT, whichever is higher. Otherwise, the scan height upper range is 4 m above the ground plane.
To keep the emission signal within the illumination area of the 3 dB beamwidth of the measurement antenna, the automatic tilt function of the antenna support device is used to point the antenna at an angle toward the source of the emission.

The final radiated emissions test above 1 GHz is performed in the following steps:

a) The measurement antenna is oriented initially for vertical polarization.
b) The EUT is placed in its standard position on a turntable capable of rotation through 360° in the horizontal plane and arranged as tabletop or floor-standing equipment, as applicable. The EUT is switched on.
c) The measurement equipment is connected to the measurement antenna and set-up according to the specifications of the test (see table 7).
d) The table position is set to 0°.
e) The antenna height is set to 1 m.
f) The spectrum for the full frequency range is recorded. If the emission at a certain frequency is higher than the levels already recorded, the polarization and height of the measurement antenna as well as the current table position are noted as the maximum position.
   g) The antenna height is increased to the scan height upper range in steps of 50 cm. At each height, step f) is repeated.
h) The polarization of the measurement antenna is changed to horizontal.
i) The antenna height is decreased from the scan height upper range to 1 m in steps of 50 cm. At each height, step f) is repeated.
j) The EUT is rotated in a horizontal plane through 360° in steps of 30°. At each table position, steps e) to i) are repeated.
k) After the last prescan, the significant maximum emissions with their polarizations and heights of the measurement antenna as well as their table positions are determined and collected in a list.

l) With the test receiver set to the first frequency of the list, the measurement antenna is set to the polarization and height and the table is moved to the position as determined during prescans.
m) The antenna is moved by ±50 cm around this height and the EUT is rotated by ±30° around this table position while measuring the emission level continuously.
n) For final scan, the worst-case positions of antenna and table are set and the maximum emission level is recorded.
o) Steps l) to n) are repeated for all other frequencies in the list. At least, frequency and level of the six highest emissions relative to the limit have to be recorded. However, emissions more than 20 dB below the limit do not need to be reported.

If the EUT may be used in various positions, steps a) to o) are repeated in two other orthogonal positions.

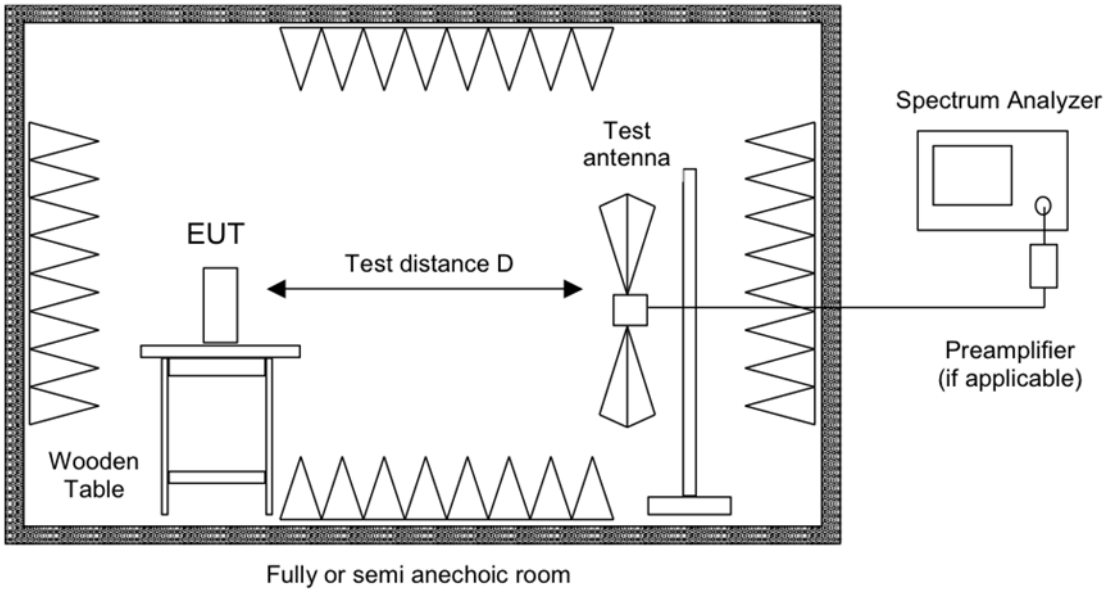

Figure 4: Setup for radiated emissions test above 1 GHz

7 Test results

This clause gives details about the test results as collected in the summary of test results starting on page 5.

7.1 Radiated emissions

7.1.1 Radiated emissions below 30 MHz

Section(s) in 47 CFR Part 15: Requirement: 15.209
Reference(s): ANSI C63.10, clause 6.4

Result[1]: ☒ Test passed ☐ Test not passed

7.1.1.1 Test equipment

	Type	*Designation*	*Manufacturer*	*Inventory no.*
☒	Compact Diagnostic Chamber (CDC)	VK041.0174	Albatross Projects	E00026
☐	Open area test site (OATS)	---	EMV **TESTHAUS**	E00354
☐	Semi-anechoic chamber (SAC)	SAC3	Albatross Projects	E00716
☐	EMI test receiver (CDC)	ESCI 3	Rohde & Schwarz	E00552
☐	EMI test receiver (OATS)	ESCI 3	Rohde & Schwarz	E00001
☒	EMI test receiver	ESR 7	Rohde & Schwarz	E00739
☐	EMI test receiver	ESU 26	Rohde & Schwarz	W00002
☐	EMI test receiver	ESW 44	Rohde & Schwarz	E00895
☐	Field probe	RF-R 400-1	Langer EMV-Technik	E00270
☒	Loop antenna	HFH2-Z2	Rohde & Schwarz	E00060
☐	TRILOG broadband antenna (CDC)	VULB 9160	Schwarzbeck	E00011
☐	TRILOG broadband antenna (OATS)	VULB 9163	Schwarzbeck	E00013
☐	TRILOG broadband antenna (SAC)	VULB 9162	Schwarzbeck	E00643
☒	Cable set CDC	RF cable(s)	Huber + Suhner AME HF-Technik AME HF-Technik Stabo	E00446 E00920 E00921 E01215
☐	Test software	EMC32-EB (V10.35)	Rohde & Schwarz	E00777
☒	Test software	EMC32-MEB (V10.35)	Rohde & Schwarz	E00778
☐	Test software	EMC32-MEB (V10.35)	Rohde & Schwarz	E01073

[1] For information about measurement uncertainties see page 73.

7.1.1.2 Limits

As specified in section 15.209 of 47 CFR Part 15, the emissions from an intentional radiator shall not exceed the field strength levels specified in table 8:

Frequency	*Field strength*		*Measurement distance*
[MHz]	*[µV/m]*	*[dBµV/m]*	*[m]*
0.009 – 0.490	2400/F(kHz) (266.67 – 4.90)	48.52 – 13.80	300
0.490 – 1.705	24000/F(kHz) (48.98 – 14.08)	33.80 – 22.97	30
1.705 – 30	30	29.54	30

Table 8: General radiated emission limits according to §15.209

In case of measurements are performed at other distances than that specified in the requirements, the limits in the charts and tables reported with the test results are derived from the general radiated emission limits as listed in table 8 using the recalculation factor as described in clause 6.3.1.

Frequency range *[MHz]*	*Limit in 3 m distance* *Quasi-peak* *[dBµA/m]*
0.009 – 0.070	69
0.070 – 0.1485	Decreasing linearly with logarithm of frequency from 69 to 39
0.1485 – 4.0	Decreasing linearly with logarithm of frequency from 39 to 3
4.0 – 30	3

Table 9: Magnetic field strength limits according to CISPR 11

7.1.1.3 Test procedure

Radiated emissions below 30 MHz are measured using the test procedure as described in clause 6.3.

7.1.1.4 Test results

Performed by:	Alexander Grill	Date of test:	December 5, 2017
Climatic conditions:	Ambient temperature 20.0 °C	Relative humidity 41.0 %	Barometric pressure 98.2 kPa
Test distance:	☒ 3 m	☐ 10 m	☐ ….. m
Antenna alignment:	☒ in 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 – 150 kHz	50 Hz	200 Hz	QP, PK, CAV	QP, PK, AV	2 s	1 s	Off
150 kHz – 30 MHz	2.25 kHz	9 kHz	QP, PK, CAV	QP, PK, AV	2 s	1 s	Off

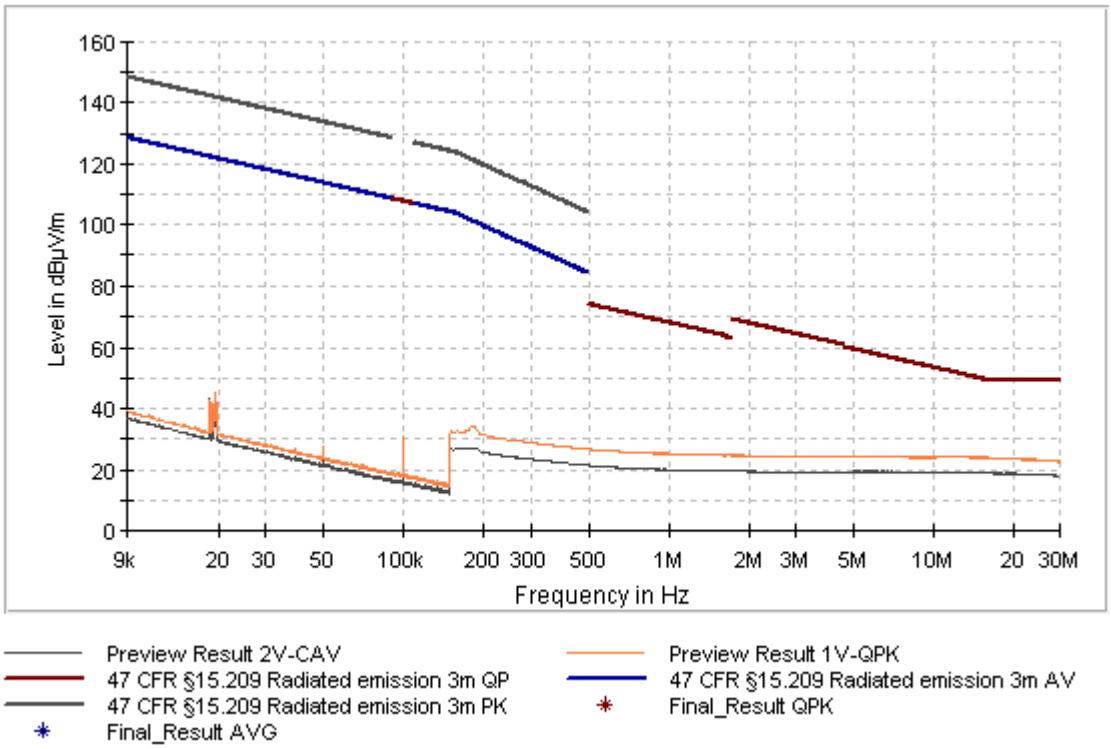

Figure 5: Chart of radiated emissions test below 30 MHz according to §15.209

7.1.2 Radiated emissions from 30 MHz to 1 GHz

Section(s) in 47 CFR Part 15:	Requirement:	15.209
	Reference(s):	ANSI C63.10, clause 6.5
Section(s) in 47 CFR Part 15:	Requirement:	15.249(a)
	Reference(s):	ANSI C63.10, clause 6.5

Result[2]: ☒ Test passed ☐ Test not passed

7.1.2.1 Test equipment

	Type	*Designation*	*Manufacturer*	*Inventory no.*
☐	Compact Diagnostic Chamber (CDC)	VK041.0174	Albatross Projects	E00026
☐	Open area test site (OATS)	---	EMV **TESTHAUS**	E00354
☒	Semi-anechoic chamber (SAC)	SAC3	Albatross Projects	E00716
☐	EMI test receiver (CDC)	ESCI 3	Rohde & Schwarz	E00552
☐	EMI test receiver (OATS)	ESCI 3	Rohde & Schwarz	E00001
☐	EMI test receiver	ESR 7	Rohde & Schwarz	E00739
☐	EMI test receiver	ESU 26	Rohde & Schwarz	W00002
☒	EMI test receiver	ESW 44	Rohde & Schwarz	E00895
☐	Field probe	RF-R 400-1	Langer EMV-Technik	E00270
☐	Loop antenna	HFH2-Z2	Rohde & Schwarz	E00060
☐	TRILOG broadband antenna (CDC)	VULB 9160	Schwarzbeck	E00011
☐	TRILOG broadband antenna (OATS)	VULB 9163	Schwarzbeck	E00013
☒	TRILOG broadband antenna (SAC)	VULB 9162	Schwarzbeck	E00643
☒	Cable set SAC	RF cable(s)	Huber + Suhner	E00755 E01033 E01034
☒	Test software	EMC32-EB (V10.35)	Rohde & Schwarz	E00777
☐	Test software	EMC32-MEB (V10.35)	Rohde & Schwarz	E00778
☐	Test software	EMC32-MEB (V10.35)	Rohde & Schwarz	E01073

[2] For information about measurement uncertainties see page 73.

7.1.2.2 Limits

As specified in section 15.209 of 47 CFR Part 15, the emissions from an intentional radiator shall not exceed the field strength levels specified in table 10:

Frequency	*Field strength*		*Measurement distance*
[MHz]	*[µV/m]*	*[dBµV/m]*	*[m]*
30 – 88	100	40.00	3
88 – 216	150	43.52	3
216 - 960	200	46.02	3
Above 960	500	53.98	3

Table 10: General radiated emission limits according to §15.209

Frequency range *[MHz]*	*Quasi-peak level of electric field strength in 10 m distance* *[dBµV/m]*	*Quasi-peak level of electric field strength in 3 m distance* *[dBµV/m]*
30 – 80.872	30	40
80.872 – 81.848	50	60
81.848 – 134.786	30	40
134.786 – 136.414	50	60
136.414 – 230	30	40
230 – 1000	37	47

Table 11: Electric field strength limits according to CISPR 11

Note: According to clause 5.2.2, class B devices may be tested at distances between 3 m and 10 m. Calculation of limits for 3 m using an extrapolation factor of 20 dB/decade (inverse linear-distance for field strength measurements) gives slightly higher limits, but to be consistent with later versions of CISPR 11, the values for 3 m distance as listed in table 11 are selected.

7.1.2.3 Test procedure

Radiated emissions from 30 MHz to 1 GHz are measured using the test procedure as described in clause 6.4.

7.1.2.4 Test results

Performed by:	Alexander Grill	Date of test:	February 26, 2018
Climatic conditions:	Ambient temperature 22.6 °C	Relative humidity 35.3 %	Barometric pressure 97.4 kPa
Test distance:	☒ 3 m	☐ 10 m	☐ ….. m
EUT position:	☐ Position 1	☐ Position 2	☒ Position 3

Frequency range	*Step size*	*IF Bandwidth*	*Detector*		*Measurement Time*		*Preamplifier*
			Prescan	*Final scan*	*Prescan*	*Final scan*	
30 MHz – 1 GHz	30 kHz	120 kHz	QP	QP	1 s	1 s	20 dB

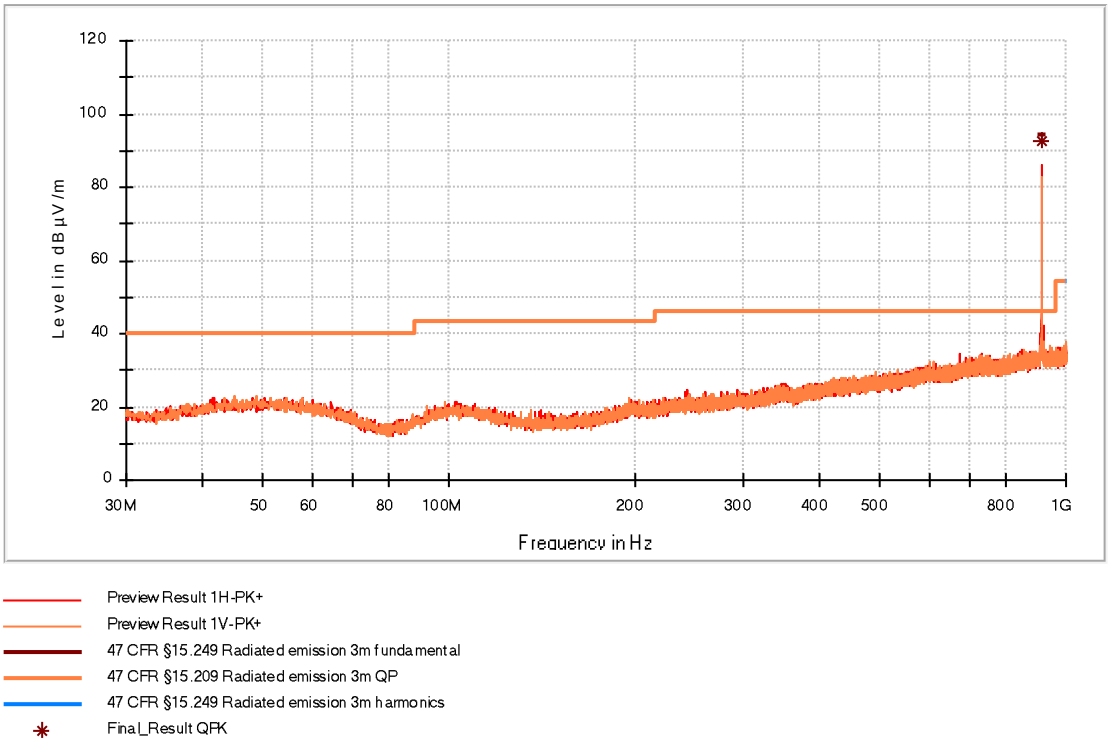

Figure 6: Chart of radiated emissions test 30 MHz to 1 GHz according to §15.209 and field strength of fundamental wave according to §15.249(a)

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
914.998000	**92.59**	**93.98**	**1.39**	**1000.0**	**120.000**	**100.0**	**H**	**0.0**	**25.8**

Table 12: Results of field strength of fundamental wave according to §15.249(a)

7.1.3 Radiated emissions from 1 GHz to 10th harmonic

Section(s) in 47 CFR Part 15: Requirement: 15.209
Reference(s): ANSI C63.10, clause 6.6

Result[3]: ☒ Test passed ☐ Test not passed

7.1.3.1 Test equipment

	Type	*Designation*	*Manufacturer*	*Inventory no.*
☐	Compact Diagnostic Chamber (CDC)	VK041.0174	Albatross Projects	E00026
☐	Open area test site (OATS)	---	EMV **TESTHAUS**	E00354
☒	Semi-anechoic chamber (SAC)	SAC3	Albatross Projects	E00716
☐	EMI test receiver (CDC)	ESCI 3	Rohde & Schwarz	E00552
☐	EMI test receiver (OATS)	ESCI 3	Rohde & Schwarz	E00001
☐	EMI test receiver	ESR 7	Rohde & Schwarz	E00739
☐	EMI test receiver	ESU 26	Rohde & Schwarz	W00002
☒	EMI test receiver	ESW 44	Rohde & Schwarz	E00895
☐	Field probe	RF-R 400-1	Langer EMV-Technik	E00270
☐	Loop antenna	HFH2-Z2	Rohde & Schwarz	E00060
☒	Horn antenna	BBHA 9120D	Schwarzbeck	W00052
☐	TRILOG broadband antenna (CDC)	VULB 9160	Schwarzbeck	E00011
☐	TRILOG broadband antenna (OATS)	VULB 9163	Schwarzbeck	E00013
☐	TRILOG broadband antenna (SAC)	VULB 9162	Schwarzbeck	E00643
☒	Cable set SAC	RF cable(s)	Huber + Suhner	E00755 E01033 E01034
☒	Preamplifier (1 GHz - 18 GHz)	ALS05749	Aldetec	W01007
☒	Test software	EMC32-EB (V10.35)	Rohde & Schwarz	E00777
☐	Test software	EMC32-MEB (V10.35)	Rohde & Schwarz	E00778
☐	Test software	EMC32-MEB (V10.35)	Rohde & Schwarz	E01073

[3] For information about measurement uncertainties see page 75.

7.1.3.2 Limits

As specified in section 15.209 of 47 CFR Part 15, the emissions from an intentional radiator shall not exceed the field strength levels specified in Table 13:

Frequency	*Field strength*		*Measurement distance*
[MHz]	*[µV/m]*	*[dBµV/m]*	*[m]*
Above 960	500	53.98	3

Table 13: General radiated emission limits according to §15.209

Note: The limit as shown in Table 13 is the average limit. The limit on peak radio frequency emissions is 20 dB above the average limit.

7.1.3.3 Test procedure

Radiated emissions from 1 GHz to 10 GHz are measured using the test procedure as described in clause 6.5.

7.1.3.4 Test results

Performed by:	Alexander Grill	Date of test:	February 26, 2018
Climatic conditions:	Ambient temperature 22.6 °C	Relative humidity 35.3 %	Barometric pressure 97.4 kPa
Test distance:	☒ 3 m	☐ 10 m	☐ ….. m
EUT position:	☐ Position 1	☐ Position 2	☒ Position 3

It was investigated during premeasurements that the EUT position 2 is the respective worst case position for the channels.

Frequency range	*Step size*	*IF Bandwidth*	*Detector*		*Measurement Time*		*Preamplifier*
			Prescan	*Final scan*	*Prescan*	*Final scan*	
1 GHz – 10 GHz	500 kHz	1 MHz	PK + AV	PK + AV	0.1 s	1.5 s	30 dB

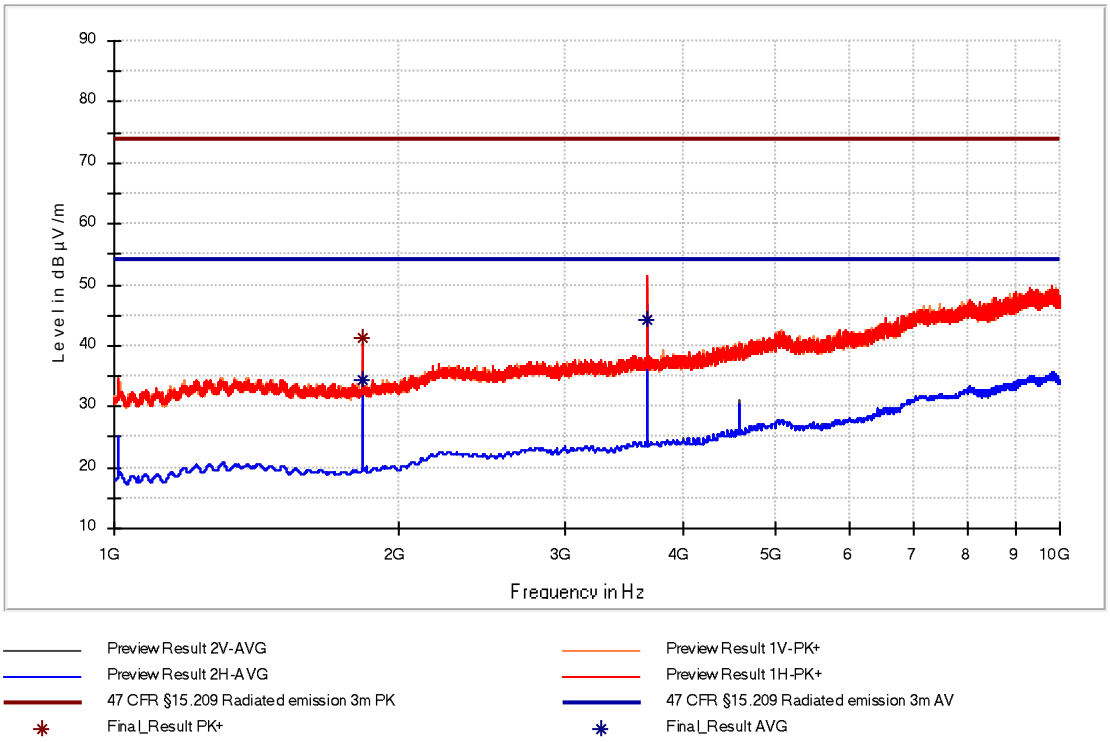

Figure 7: Chart of radiated emissions test from 1 GHz to 10 GHz

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
1830.000000	41.42	---	74.00	32.58	1000.0	1000.000	130.0	H	48.0
1830.000000	---	34.42	54.00	19.58	1000.0	1000.000	130.0	H	48.0
3660.000000	---	44.29	54.00	9.71	1000.0	1000.000	100.0	H	196.0

Table 14: Results of radiated emissions test from 1 GHz to 10 GHz

7.2 20 dB bandwidth

Section(s) in 47 CFR Part 15: Requirement: 15.215(c)
Reference(s): ANSI C63.10, clause 6.5

	Type	*Designation*	*Manufacturer*	*Inventory no.*
☐	Compact Diagnostic Chamber (CDC)	VK041.0174	Albatross Projects	E00026
☐	Open area test site (OATS)	---	EMV **TESTHAUS**	E00354
☒	Semi-anechoic chamber (SAC)	SAC3	Albatross Projects	E00716
☐	EMI test receiver (CDC)	ESCI 3	Rohde & Schwarz	E00552
☐	EMI test receiver (OATS)	ESCI 3	Rohde & Schwarz	E00001
☐	EMI test receiver	ESR 7	Rohde & Schwarz	E00739
☐	EMI test receiver	ESU 26	Rohde & Schwarz	W00002
☒	EMI test receiver	ESW 44	Rohde & Schwarz	E00895
☐	Field probe	RF-R 400-1	Langer EMV-Technik	E00270
☐	Loop antenna	HFH2-Z2	Rohde & Schwarz	E00060
☐	TRILOG broadband antenna (CDC)	VULB 9160	Schwarzbeck	E00011
☐	TRILOG broadband antenna (OATS)	VULB 9163	Schwarzbeck	E00013
☒	TRILOG broadband antenna (SAC)	VULB 9162	Schwarzbeck	E00643
☒	Cable set SAC	RF cable(s)	Huber + Suhner	E00755 E01033 E01034
☐	Test software	EMC32-EB (V10.35)	Rohde & Schwarz	E00777
☐	Test software	EMC32-MEB (V10.35)	Rohde & Schwarz	E00778
☐	Test software	EMC32-MEB (V10.35)	Rohde & Schwarz	E01073

7.2.1 Limits

20 dB bandwidth must be contained within the designated frequency band.

7.2.2 Test procedure

Radiated emissions from 30 MHz to 1 GHz are measured using the test procedure as described in clause 6.4.

7.2.3 Test results

Performed by:	Alexander Grill	Date of test:	February 26, 2018
Climatic conditions:	Ambient temperature 23.2 °C	Relative humidity 39.4 %	Barometric pressure 97.9 kPa
Test distance:	☒ 3 m	☐ 10 m	☐ ….. m
Antenna alignment:	☐ Vertical	☒ Horizontal	
EUT position:	☐ Position 1	☐ Position 2	☒ Position 3

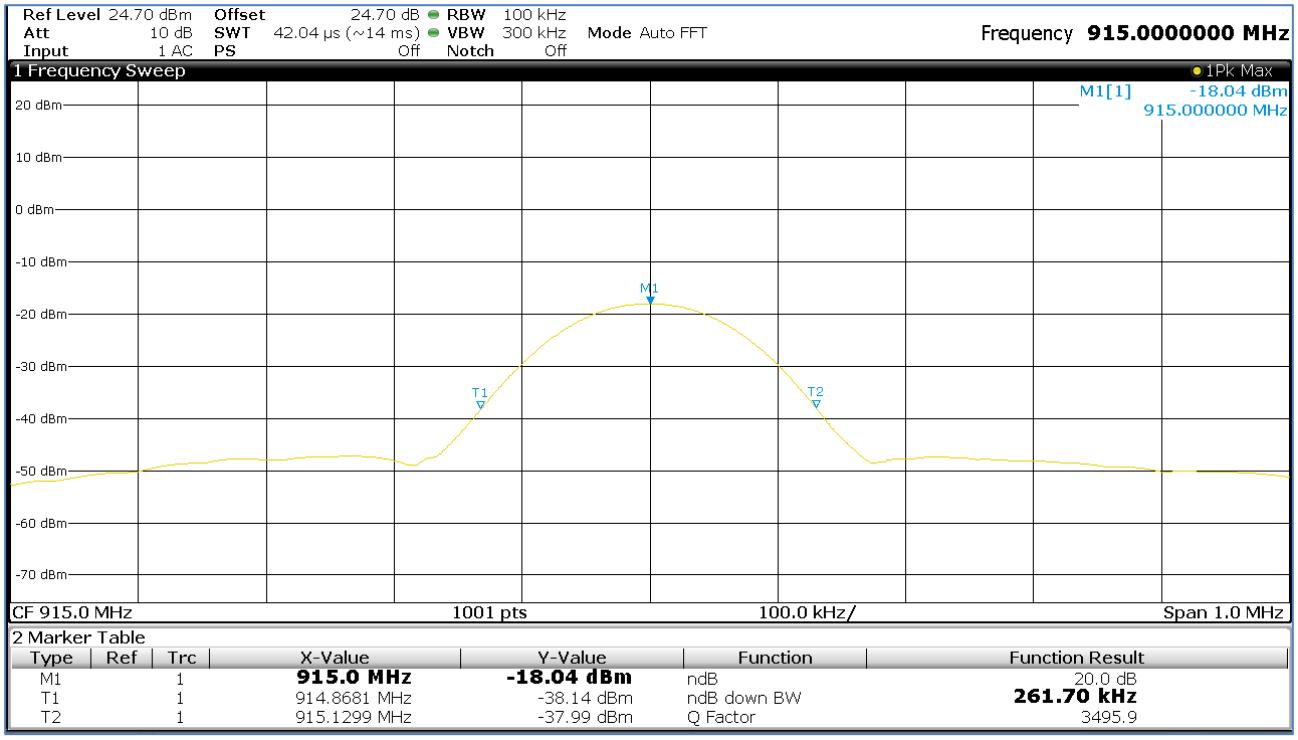

Figure 8: Chart of 20 dB bandwidth

8 Equipment calibration status

Description	*Modell number*	*Serial number*	*Inventory number(s)*	*Last calibration*	*Next calibration*
EMI test receiver	ESW44	101538	E00895	2016-12 2018-04	2018-04 2020-04
EMI test receiver	ESR7	101059	E00739	2016-02	2018-05
EMI test receiver	ESCS30	825442/0002	E00003	2016-04	2018-04
Attenuator (10 dB)	50FHB-010-10	---	E00471	2017-02	2019-02
Artficial mains network (AMN)	ESH2-Z5	881362/037	E00004	2016-10	2018-10
Loop antenna	HFH2-Z2	871398/0050	E00060	2016-09	2018-09
TRILOG broadband antenna (SAC)	VULB 9162	9162-041	E00643	2015-11	2018-11
Horn antenna	BBHA 9120D	9120D-592	W00052	2017-04	2019-04
Shielded room	P92007	B 83117 C 1109 T 211	E00107	N/A	
Compact diagnostic chamber (CDC)	VK041.0174	D62128-A502-A69-2-0006	E00026	N/A	
Semi-anechoic chamber (SAC)	SAC3	C62128-A520-A643-x-0006	E00716	See notes 1 and 2	
Cable set shielded room	RG 223/U	---	E00741	2017-02	2019-02
	RG 223/U	---	E00804	2017-02	2019-02
Cable set CDC	RG214/U	---	E00446	2018-01	2020-01
	LMR400	1718020006	E00920	2018-01	2020-01
	RG214 Hiflex	171802007	E00921	2018-01	2020-01
	LCF12-50J	---	E01215	2018-01	2020-01
Cable set SAC	SF104EA/11PC35/11PC35/10000MM	501347/4EA	E00755	2017-12	2019-12
	SF104E/11PC35/11PC35/2000MM	507410/4E	E01033	2017-12	2019-12
	SF104E/11PC35/11PC35/2000MM	507411/4E	E01034	2017-09	2019-09

Note 2: Expiration date of test firm accreditation for OATS and SAC:
FCC test firm type “accredited”: 2019-05

9 Measurement uncertainties

Description	*Uncertainty*	*k=*
AC power line conducted emissions (with AMN) 9 kHz to 150 kHz 150 kHz to 30 MHz	 ±3.8 dB ±3.4 dB	2
Radiated emissions in semi-anechoic chamber or open area test site 9 kHz to 30 MHz 30 MHz to 300 MHz 300MHz to 1 GHz	 ± 4.8 dB ± 5.4 dB ± 4.7 dB	2
Radiated emissions in semi-anechoic chamber with RF absorbing material on the floor or fully anechoic room 1 GHz to 18 GHz	 ± 4.5 dB	2

Comment: 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.

All used test instrument as well as the test accessories are calibrated at regular intervals.

10 Revision history

Revision	*Date*	*Issued by*	*Description of modifications*
0	2018-04-26	Alexander Grill	First edition