TEST REPORT

Test Report No. : UL-RPT-RP-12947326-1116-FCC

Applicant	:	Boxine GmbH
Model No.	:	03-xxxx (colour coding)
FCC ID	:	2AU47-00001
Technology	:	RFID 13.56 MHz
Test Standard(s)	:	FCC Parts 15.207, 15.209(a) & 15.225
		For details of applied tests refer to test result summary

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2. The results in this report apply only to the sample tested.
3. The test results in this report are traceable to the national or international standards.
4. **Test Report Version 1.2 supersede Version 1.1 with immediate effect**
   Test Report No. UL-RPT-RP-12947326-1116-FCC Version 1.1, Issue Date 21 AUGUST 2020 replaces
   Test Report No. UL-RPT-RP-12947326-1116-FCC Version 1.1, Issue Date 17 AUGUST 2020, which is no longer valid.
5. Result of the tested sample: **PASS**

Prepared by: Sercan, Usta
Title: Laboratory Engineer
Date: 21 August 2020

Approved by: Ajit, Phadtare
Title: Lead Test Engineer
Date: 21 August 2020

DAkkS Deutsche Akkreditierungsstelle D-PL-19381-02-00

This laboratory is accredited by DAkkS.
The tests reported herein have been performed in accordance with its' terms of accreditation.

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Table of Contents

1. Customer Information

1.1.Applicant Information

Company Name:	Boxine GmbH
Company Address:	Am Wehrhahn 50, 40211 Düsseldorf, GERMANY
Contact Person:	Mr. Klaus Raske
Contact E-Mail Address:	klaus.raske@boxine.de
Contact Phone No.:	+49 211 54254049 / +49 176 80703188

1.2.Manufacturer Information

Company Name:	Boxine GmbH
Company Address:	Grafenberger Allee 120, 40237 Düsseldorf, GERMANY
Contact Person:	Mr. Jürgen Popp
Contact E-Mail Address:	juergen.popp@boxine.de
Contact Phone No.:	+49 160 91682699

2. Summary of Testing

2.1. General Information

Applied Standards

Specification Reference:	47CFR15.225
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Radio Frequency Devices) - Section 15.225
Specification Reference:	47CFR15.207 and 47CFR15.209
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) - Sections 15.207 and 15.209

Location

Location of Testing:	UL International Germany GmbH Hedelfinger Str. 61 70327 Stuttgart Germany
Test Firm Registration:	399704

Date information

Order Date:	23 July 2019
EUT arrived:	12 August 2019 & 29 October 2019
Test Dates:	06 May 2020 to 21 August 2020
EUT returned:	-/-

2.2. Summary of Test Results

Clause	Measurement	Complied	Did not comply	Not performed	Not applicable
Part 15.207	Transmitter AC Conducted Emissions	☒	☐	☐	☐
Part 15.215(c)	Transmitter 20 dB Bandwidth	☒	☐	☐	☐
Part 15.225(a)(b)(c)(d)	Transmitter Fundamental Field Strength	☒	☐	☐	☐
Part 15.209(a)/ 15.225(d)	Transmitter Radiated Emissions	☒	☐	☐	☐
Part 15.225(e)	Transmitter Frequency Stability (Temperature & Voltage Variation)	☒	☐	☐	☐

Note(s):

2.3. Methods and Procedures

Reference:	ANSI C63.4-2014
Title:	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.
Reference:	ANSI C63.10-2013
Title:	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
Reference:	KDB 414788 D01 Radiated Test Site v01r01
Title:	TEST SITES FOR RADIATED EMISSION MEASUREMENTS
Reference:	KDB 174176 D01 Line Conducted FAQ v01r01 June 3, 2015
Title:	AC Power-Line Conducted Emissions Frequently Asked Questions

2.4. Deviations from the Test Specification

For the measurements contained within this test report, there were no deviations from, additions to, or exclusions from the test specification identified above.

3. Equipment Under Test (EUT)

3.1. Identification of Equipment Under Test (EUT)

Brand Name:	Toniebox Starterset
Model Name or Number:	03-xxxx (colour coding)
Serial Number:	TB1.1 PROT2 *(Radiated Sample)*
MAC ID :	38:0B:3C:F0:14:8B
Hardware Version Number:	1.2
Firmware Version Number:	EU 3.0.4
FCC ID:	2AU47-00001

Brand Name:	Boxine
Model Name or Number:	Tonie Figure
Serial Number:	Not stated
Hardware Version Number:	Not Stated
Firmware Version Number:	Not Stated
Additional Details:	Passive RFID-13.56 MHz Key

Brand Name:	Tonies
Model Name or Number:	DYS-618-090150W
Serial Number:	DY618-090150-16525B
Hardware Version Number:	Not Stated
Firmware Version Number:	Not Stated
Additional Details:	AC-DC Adapter- Switching Mode Power supply
	100-240 V AC / 0.5 A / 50 Hz to 9 V DC / 1.5 A

3.2. Description of EUT

The equipment under test was a Toniebox Starterset consists of the Toniebox itself, a power supply including docking station DYS 619 and Tonie Lauscher (headset). Toniebox Starterset is an Audio system for children. Tonie figures to be purchased separately are placed on the Toniebox (TB).

An RFID receiver in the Toniebox reads the product ID from the figure (passive RFID chip in the Tonie figure). Via the WLAN module in the TB, the audio content is downloaded from the Boxine-Tonie cloud to the TB's internal memory (flash drive) via the Internet and played back via the TB speaker or Headphone.

3.3. Modifications Incorporated in the EUT

No modifications were applied to the EUT during testing.

3.4. Additional Information Related to Testing

Tested Technology:	RFID 13.56 MHz	
Category of Equipment:	Transceiver	
Channel Spacing:	Single channel device	
Transmit Frequency Range:	13.56 MHz	
Power supply Type 1:	AC-DC Adapter- Switching Mode Power supply	
Power supply Requirement(s):	100-240 V AC / 0.5 A / 50 Hz to 9 V DC / 1.5 A	
Power supply Type 2:	Internal Rechargeable Battery via AC /DC Adapter	
Power supply Requirement(s):	3.6 V DC / 0.1 A	
Tested Temperature Range:	Minimum	-20 °C
	Maximum	+50 °C

3.5. Support Equipment

The following support equipment was used to exercise the EUT during testing:

Item	Description	Brand Name	Model Name or Number	Serial Number
1	-/-	-/-	-/-	-/-

4. Operation and Monitoring of the EUT during Testing

4.1. Operating Modes

The EUT was tested in the following operating mode(s):
☒ Continuous transmitting modulated carrier at maximum power in RFID-13.56 MHz test mode.

4.2. Configuration and Peripherals

The EUT was tested in the following configuration(s):

EUT Power supply:

- The EUT can powered via either with AC/DC power adapter or charged internal battery.
- The critical tests (frequency stability, 20 dB bandwidth) were performed once with AC/DC power adapter and also with fully charged internal battery.
- The results from AC/DC power adapter found to be worst case (maximum power); therefore, radiated spurious emissions have been performed only with EUT powered via AC/DC power adapter.
- For AC conducted line emissions measurement the EUT was powered via AC/DC power adapter. The measurements were carried out with 120 VAC /60 Hz & 240 VAC/60 Hz.

Test Mode Activations:

- For RFID 13.56 MHz test mode, the Tonie Figure was placed on the EUT; which then reads the product ID from the Tonie figure & activates the RFID communication.

Radiated Measurements:

- In accordance with ANSI C63.10 section 5.10.7, the EUT allows for the connection of external accessories, including external electrical control signals. Hence emission tests shall be performed with the EUT and accessories configured in a manner that tends to produce maximum emissions; therefore, all radiated tests were with EUT powered via AC/DC power adapter 120 VAC / 60 Hz.
- Before starting final radiated spurious emission measurements “worst case verification” with the EUT in Standing-position & Laying-position was performed by Lab.
- The EUT in Laying-position was found to be the worst case therefore this report includes relevant results.
- Radiated spurious emissions were performed with the EUT positioned on the turn table and rotating 360 degrees while the antenna height varies from 1 m to 4 m over the measurement frequency range
- EMC32 V10.1.0 Software was used for the Radiated spurious emission measurements. EMC32 V10.1.0 Software was used for the Radiated spurious emission measurements.

5. Measurements, Examinations and Derived Results

5.1. General Comments

Measurement uncertainties are evaluated in accordance with current best practice. Our reported expanded uncertainties are based on standard uncertainties, which are multiplied by an appropriate coverage factor to provide a statistical confidence level of approximately 95%. Please refer to Section 6 *Measurement Uncertainty* for details.

In accordance with DAkkS requirements all the measurement equipment is on a calibration schedule. All equipment was within the calibration period on the date of testing.

5.2. Test Results

5.2.1. Transmitter AC Conducted Spurious Emissions

Test Summary:

Test Engineer:	Devang Chauhan	**Test Date:**	25 June 2020
Test Sample Serial Number:	TB1.1 PROT2 *(Radiated Sample)*		
Test Site Identification	SR 7/8		

FCC Reference:	Part 15.207
Test Method Used:	ANSI C63.10 Section 6.2 / FCC KDB 174176 and notes below

Environmental Conditions:

Temperature (°C):	23
Relative Humidity (%):	48

Settings of the Instrument

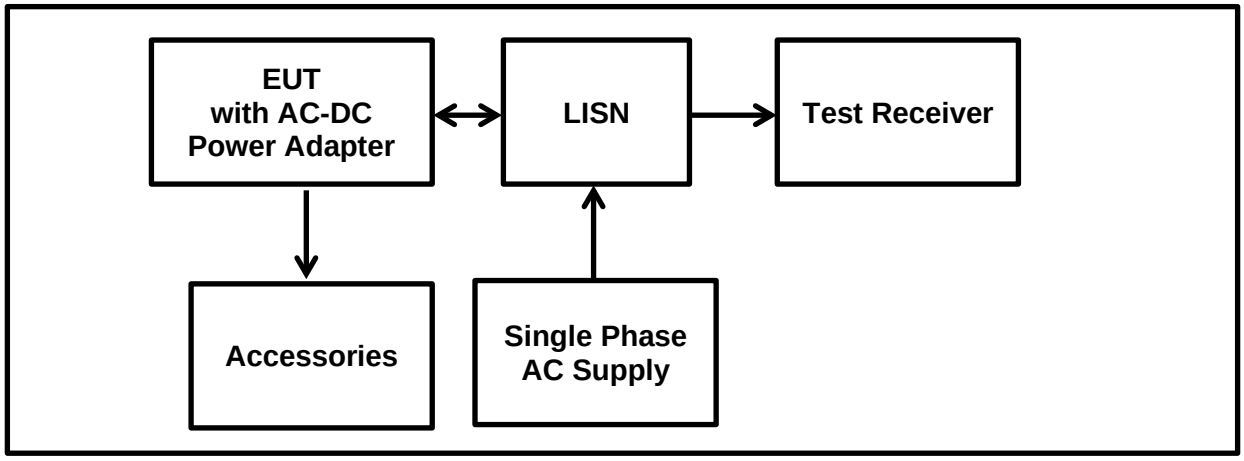
Detector	Quasi Peak/ Average Peak

Note(s):

1. The EUT was plugged into an AC/DC Power supply. The Power supply was connected to 120 VAC / 60 Hz single phase supply via a LISN.
2. In accordance with FCC KDB 174176 Q4, tests were performed with a 240 VAC 60 Hz single phase supply as this was within the voltage range marked on the 100-240 VAC~50/60 Hz power supply. The EUT was configured on RFID 13.56 MHz : Single Channel.
3. The EUT's RFID 13.56 MHz output port was terminated 50 Ω termination (dummy load).
4. Pre-scans were performed, and markers placed on the highest live and neutral measured levels. Final measurements were performed on the marker frequencies and the results entered into the tables below.
5. The final measured value, for the given emission, in the table below incorporates the cable loss.
6. All other emissions shown on the pre-scan plot were investigated. Only the highest 6 emissions have been reported in the tables below in accordance with ANSI C63.10 section 6.2.5.
7. Measurements were performed in shielded room (SR7/ 8 Asset Number 1603671). The EUT was placed at a height of 80 cm above the reference ground plane and in a distance of 40 cm from the vertical ground plane at the edge of the table.
8. Measurement software used: Toyo EMI Software; CE measurement software EP5/CE Ver 4.0.1.

Transmitter AC Conducted Spurious Emissions (continued)

Test setup:



Transmitter AC Conducted Spurious Emissions (continued)

Results: Live / Quasi Peak / 120 VAC 60 Hz

Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.1506	Live	53.10	66.00	12.90	Complied
0.1824	Live	53.40	64.40	11.00	Complied
0.2359	Live	43.80	62.20	18.40	Complied
0.2720	Live	41.20	61.10	19.90	Complied
2.2229	Live	26.30	56.00	29.70	Complied
13.5594	Live	36.40	60.00	23.60	Complied

Results: Live / Average / 120 VAC 60 Hz

Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.1506	Live	35.40	56.00	20.60	Complied
0.1824	Live	37.90	54.40	16.50	Complied
0.2359	Live	31.60	52.20	20.60	Complied
0.2720	Live	26.50	51.10	24.60	Complied
2.2229	Live	19.50	46.00	26.50	Complied
13.5594	Live	35.70	50.00	14.30	Complied

Results: Neutral / Quasi Peak / 120 VAC 60 Hz

Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.1525	Neutral	52.90	65.90	13.00	Complied
0.1805	Neutral	52.70	64.50	11.80	Complied
0.2742	Neutral	42.00	61.00	19.00	Complied
0.3772	Neutral	33.30	58.30	25.00	Complied
2.1797	Neutral	31.50	56.00	24.50	Complied
0.1525	Neutral	52.90	65.90	13.00	Complied

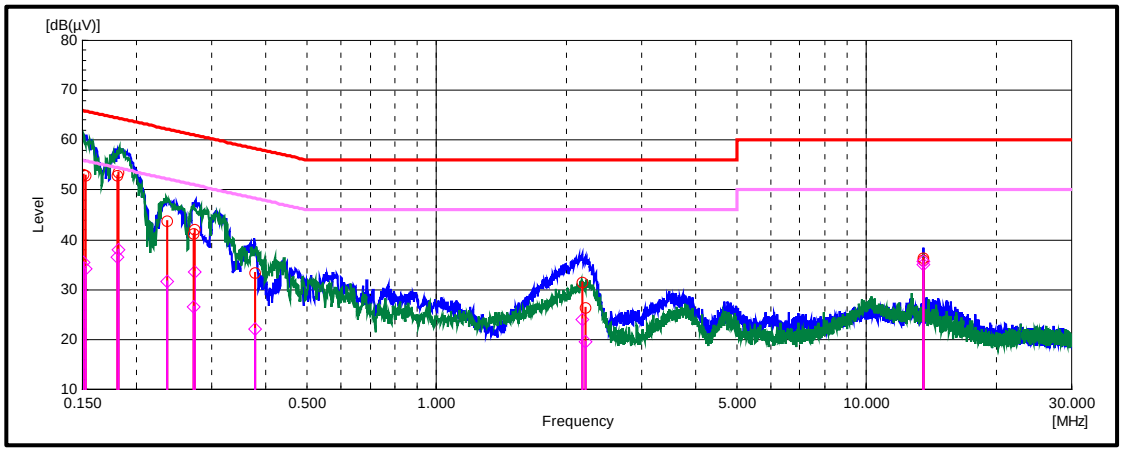
Results: Neutral / Average / 120 VAC 60 Hz

Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.1525	Neutral	34.20	55.90	21.70	Complied
0.1805	Neutral	36.40	54.50	18.10	Complied
0.2742	Neutral	33.60	51.00	17.40	Complied
0.3772	Neutral	22.10	48.30	26.20	Complied
2.1797	Neutral	24.00	46.00	22.00	Complied
13.5611	Neutral	35.10	50.00	14.90	Complied

Result: Pass

Transmitter AC Conducted Spurious Emissions (continued)

Plot: Live and Neutral Line / 120 VAC 60 Hz



Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.

Transmitter AC Conducted Spurious Emissions (continued)

Results: Live / Quasi Peak / 240 VAC 60 Hz

Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.1752	Live	51.80	64.70	12.90	Complied
0.2174	Live	48.70	62.90	14.20	Complied
0.2603	Live	44.60	61.40	16.80	Complied
0.4367	Live	28.10	57.10	29.00	Complied
2.0721	Live	26.30	56.00	29.70	Complied
13.5607	Live	36.00	60.00	24.00	Complied

Results: Live / Average / 240 VAC 60 Hz

Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.1752	Live	38.20	54.70	16.50	Complied
0.2174	Live	38.70	52.90	14.20	Complied
0.2603	Live	35.70	51.40	15.70	Complied
0.4367	Live	19.60	47.10	27.50	Complied
2.0721	Live	17.60	46.00	28.40	Complied
13.5607	Live	35.50	50.00	14.50	Complied

Results: Neutral / Quasi Peak / 240 VAC 60 Hz

Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.1501	Neutral	51.70	66.00	14.30	Complied
0.1604	Neutral	48.10	65.40	17.30	Complied
0.2164	Neutral	48.40	63.00	14.60	Complied
0.2671	Neutral	43.40	61.20	17.80	Complied
2.1053	Neutral	32.40	56.00	23.60	Complied
13.5604	Neutral	51.70	66.00	14.30	Complied

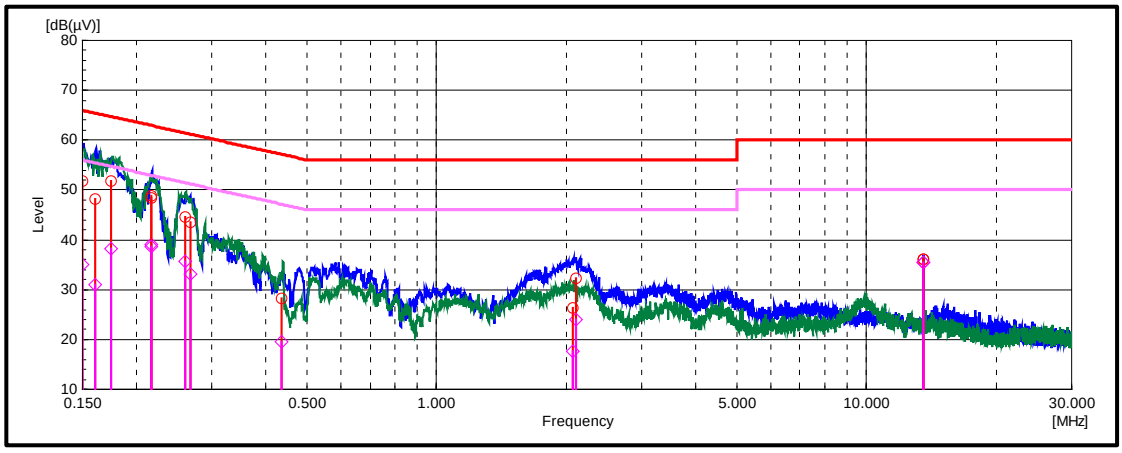
Results: Neutral / Average / 240 VAC 60 Hz

Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.1501	Neutral	34.90	56.00	21.10	Complied
0.1604	Neutral	31.00	55.40	24.40	Complied
0.2164	Neutral	39.00	53.00	14.00	Complied
0.2671	Neutral	33.10	51.20	18.10	Complied
2.1053	Neutral	24.00	46.00	22.00	Complied
13.5604	Neutral	34.90	56.00	21.10	Complied

Result: Pass

Transmitter AC Conducted Spurious Emissions (continued)

Plot: Live and Neutral Line / 240 VAC 60 Hz



Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.

5.2.2. Transmitter 20 dB Bandwidth

Test Summary:

Test Engineer:	Sercan, Usta	**Test Dates:**	21 August 2020
Test Sample Serial Number:	TB1.1 PROT2 *(Radiated Sample)*		
Test Site Identification	SR 9		

FCC Reference:	Part 15.215(c)
Test Method Used:	ANSI C63.10 Section 6.9.2 deviations in accordance with FCC Inquiry

Environmental Conditions:

Temperature (°C):	29
Relative Humidity (%):	33

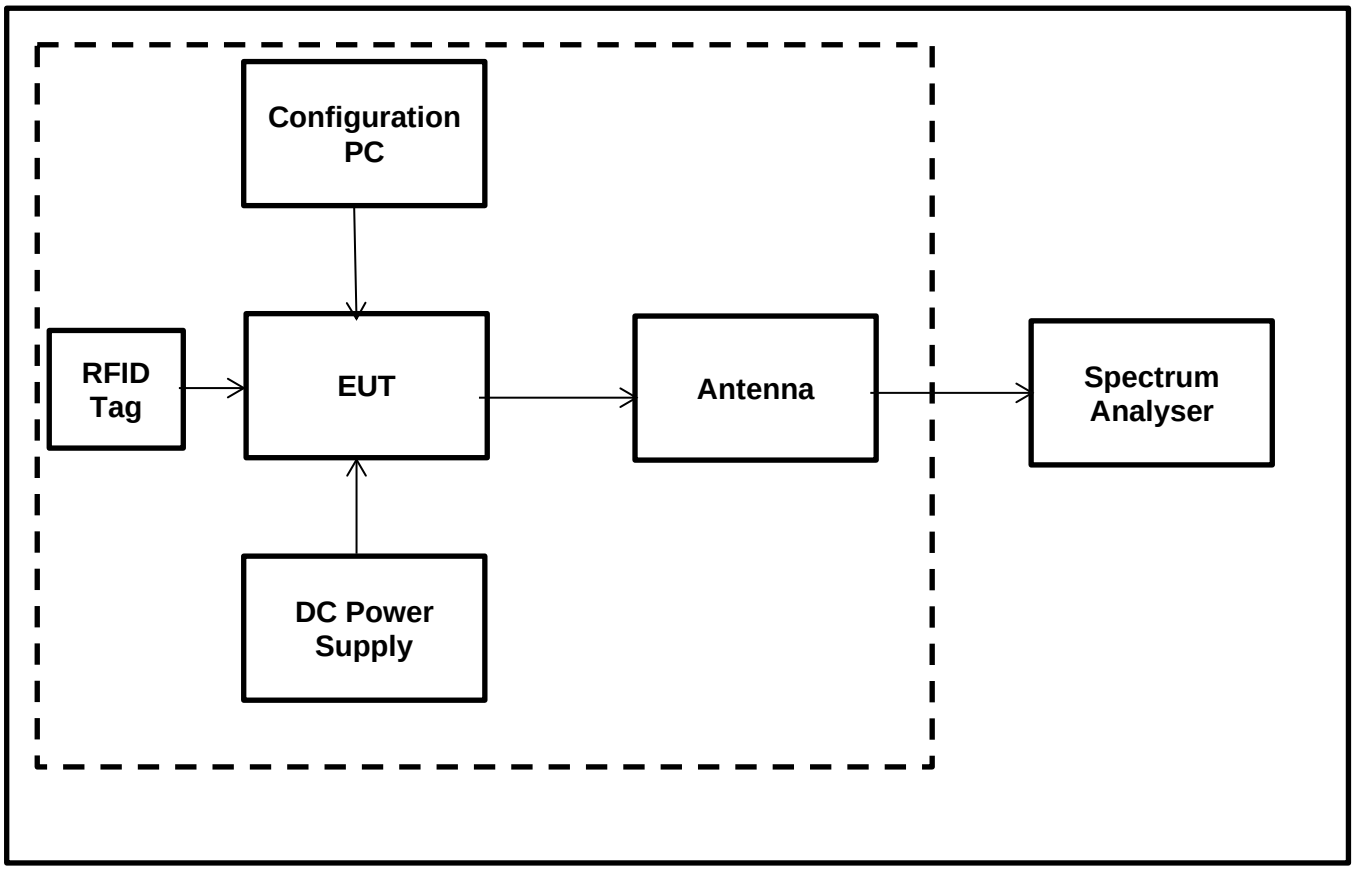
Settings of the Instrument:

RBW/VBW	3 kHz / 10 kHz
Span	70 kHz
Sweep time	Auto
Detector	MaxPeak

Notes:

1. As EUT can be operated either with AC/DC power adapter or charged internal battery; frequency stability tests were performed were performed once with AC/DC power adapter and also with fully charged internal battery.
2. In response to an FCC inquiry; reasonable deviations to test method ANSI C63.10 Section 6.9.2 were made to satisfy following requirements:
    - Larger values of RBW than those mentioned in ANSI C63.10 Section 6.9.2
    - Frequency span wide enough to capture all side bands of the signal
3. The n dB down function of the spectrum analyzer was set to 20 dB.
4. The emission shown on 20 dB Bandwidth plots show the single RFID channel at the frequency 13.56 MHz is the fundamental emission.

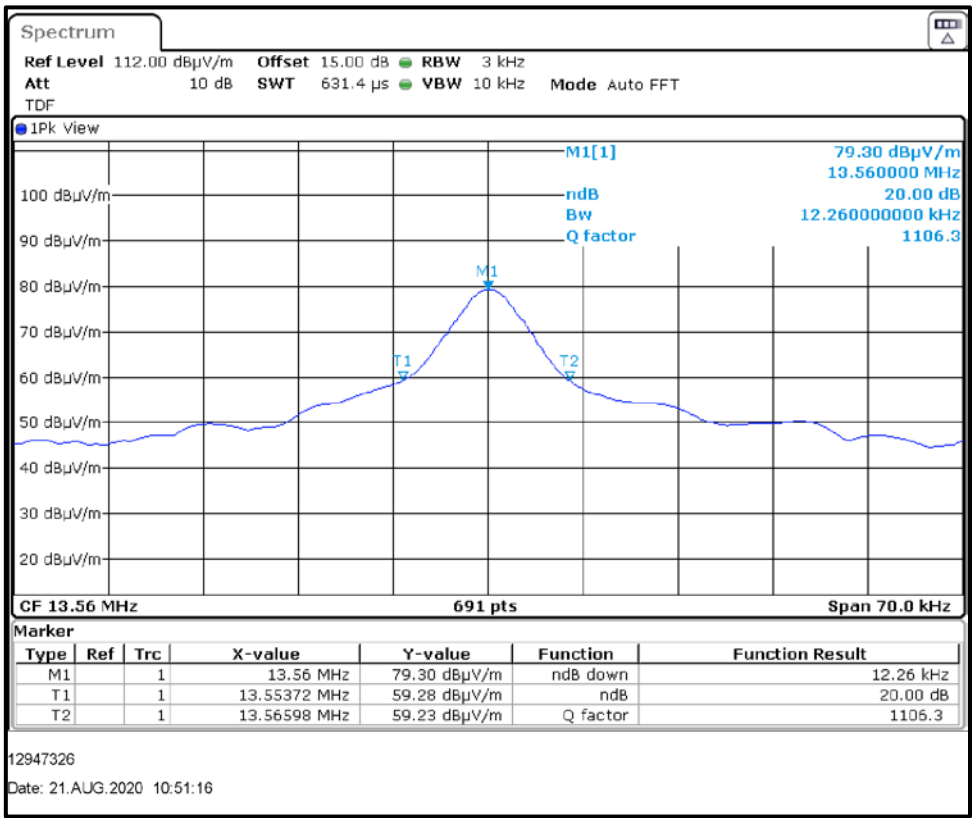
Test Setup:


Configuration PC
RFID Tag
EUT
Antenna
Spectrum Analyser
DC Power Supply

Transmitter 20 dB Bandwidth (continued)

Results: AC-DC Power Supply / RFID 13.56 MHz

RFID Channel	20 dB Bandwidth (kHz)
13.56 MHz	12.260



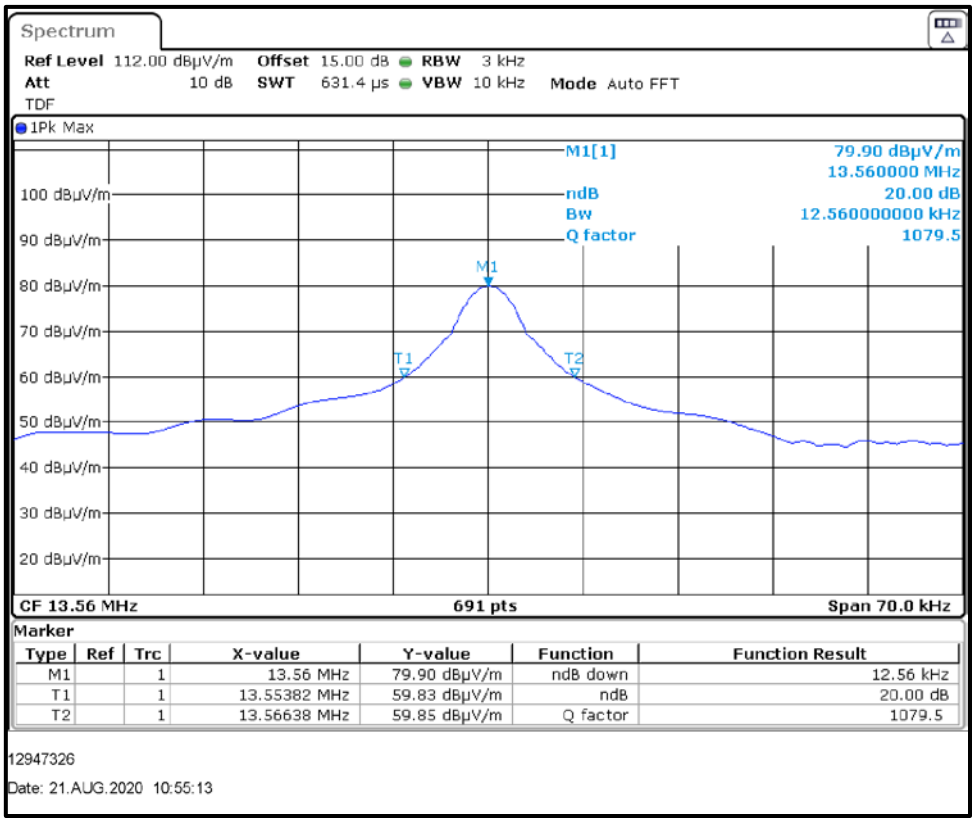
RFID 13.56 MHz

Result: Pass

Transmitter 20 dB Bandwidth (continued)

Results: Fully Charged Internal Battery / RFID 13.56 MHz

RFID Channel	20 dB Bandwidth (kHz)
13.56 MHz	12.560



RFID 13.56 MHz

Result: Pass

5.2.3. Transmitter Fundamental Field Strength

Test Summary:

Test Engineer:	Sercan Usta	**Test Date:**	06 May 2020
Test Sample Serial Number:	TB1.1 PROT2 *(Radiated Sample)*		
Test Site Identification	SR 1/2		

FCC Reference:	Part 15.225(a)(b)(c)(d)
Test Method Used:	ANSI C63.10 Section 6.4

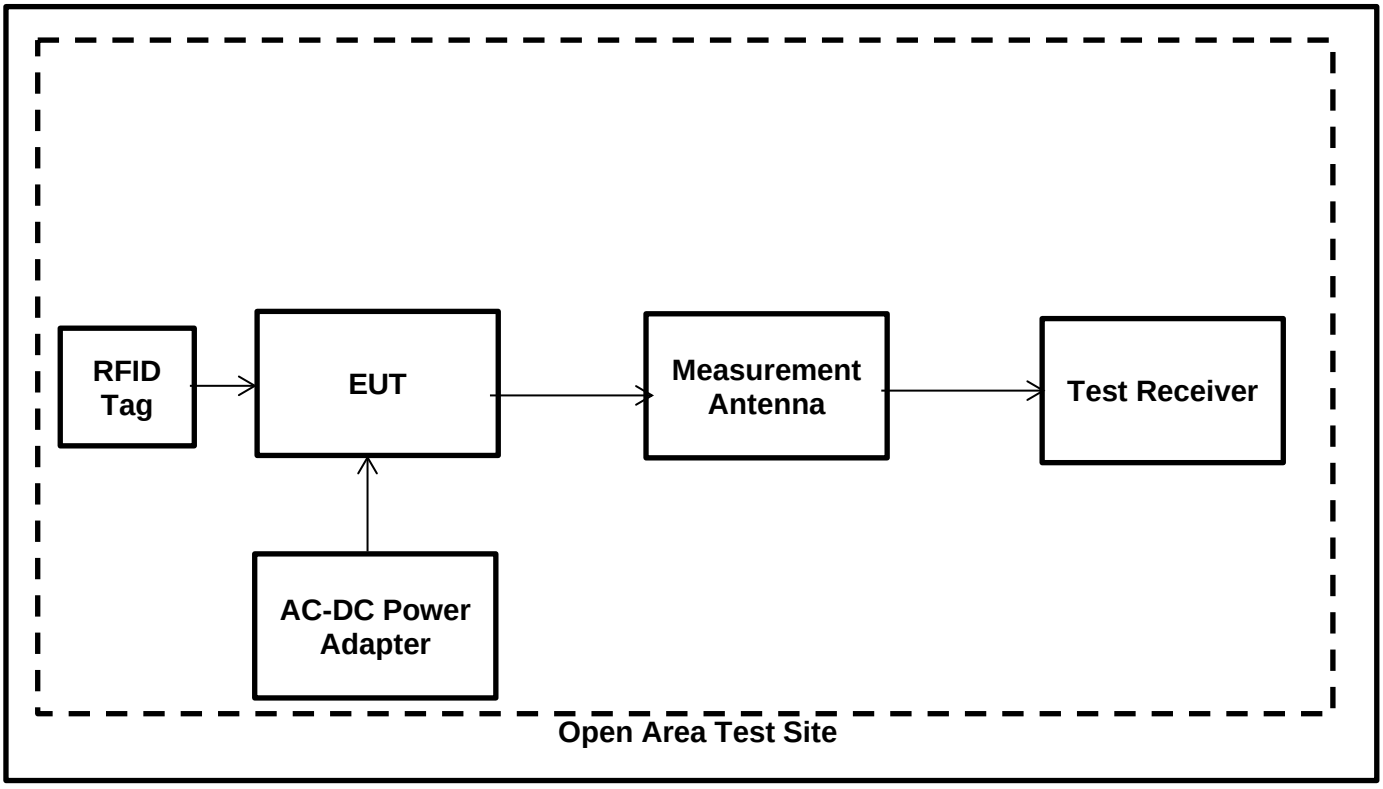
Environmental Conditions:

Temperature (°C):	22
Relative Humidity (%):	36

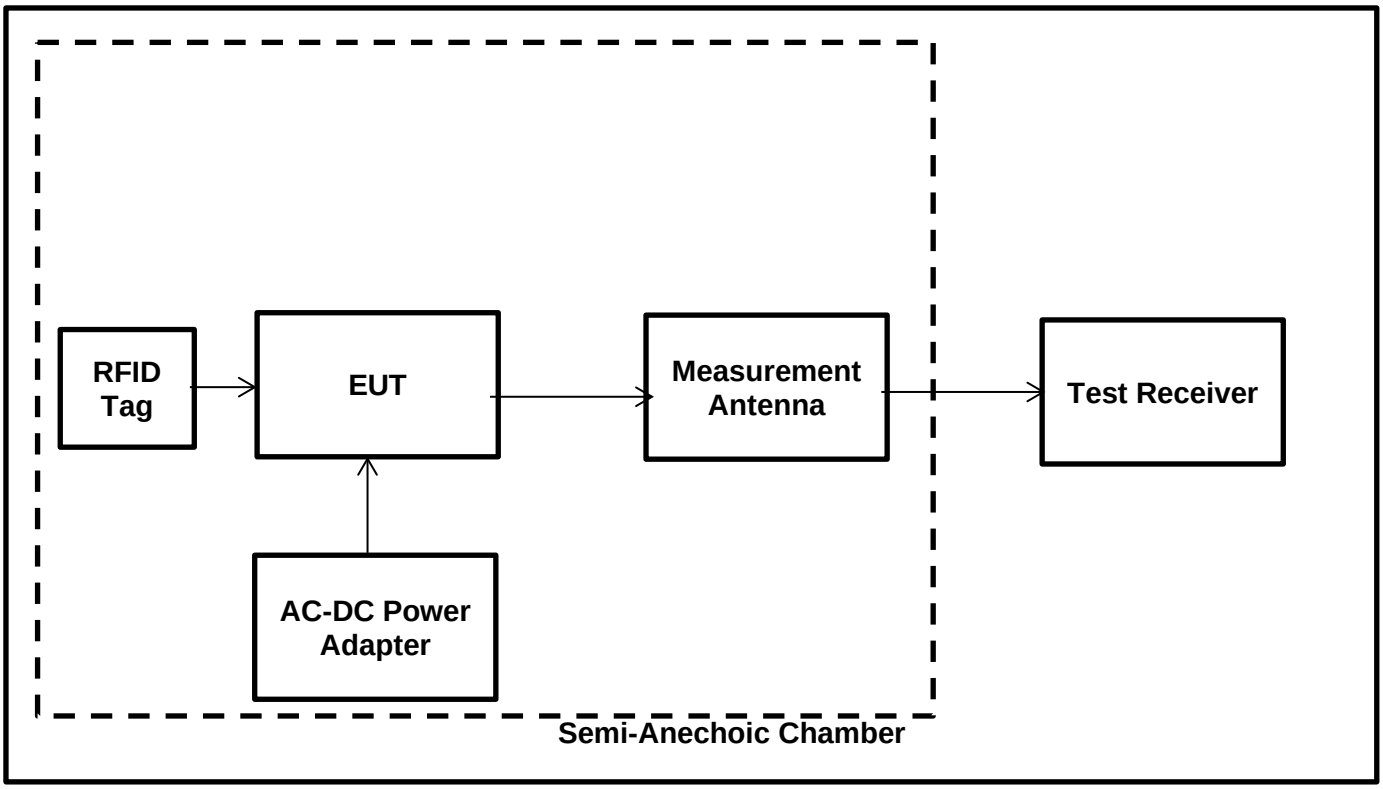
Note(s):

1. The limit is specified at a test distance of 30 metres. However, as specified by FCC Section 15.31 (f)(2), measurements may be performed at a closer distance and the measured level corrected to the specified measurement distance by using the square of an inverse linear distance extrapolation factor (40 dB/decade).
2. In accordance with 414788 D01 Radiated Test Site v01 an alternative Test Site was used. Instead of an OATS a Semi Anechoic Chamber was used where evidence was shown that the behaviour is the same. A maximum deviation of 1.38 dB for 13.56 MHz could be determined. This deviation is also taken into account to the result.
3. The measurement was performed at a measurement distance of 3 m. This value was later extrapolated to a distance of 30 m by subtracting 40 dB from the result.
4. Pre-scan measurements were performed using a spectrum analyser with a peak detector and measurement bandwidth of 10 kHz. The fundamental field strength was maximized by rotating the measurement antenna and EUT. The spectrum analyser was then switched to test receiver mode and the final measurement on the maximized level was performed. In accordance with ANSI C63.10 Clause 4.1.4.2.1 a quasi-peak detector was used in conjunction with a measurement bandwidth of 9 kHz and 0.2 second sweep time.
5. Compliance with the spectrum mask is shown by final measurements performed in a semi-anechoic chamber. For the field strength measurements in a semi-anechoic chamber, a transducer factor on the measuring instrument was used to extrapolate the results at 3 m to a distance of 30 m. A distance extrapolation factor of 40 dB was used.
6. A transducer factor was used on the spectrum analyser during measurement. This factor includes correction between the fixed gain of the magnetic loop antenna and the calibration values. It also includes the value of the RF cable used to connect the antenna to the spectrum analyser which was incorporated into the annual calibration of the magnetic loop antenna.

Transmitter Fundamental Field Strength(continued)
Open Area Test Site



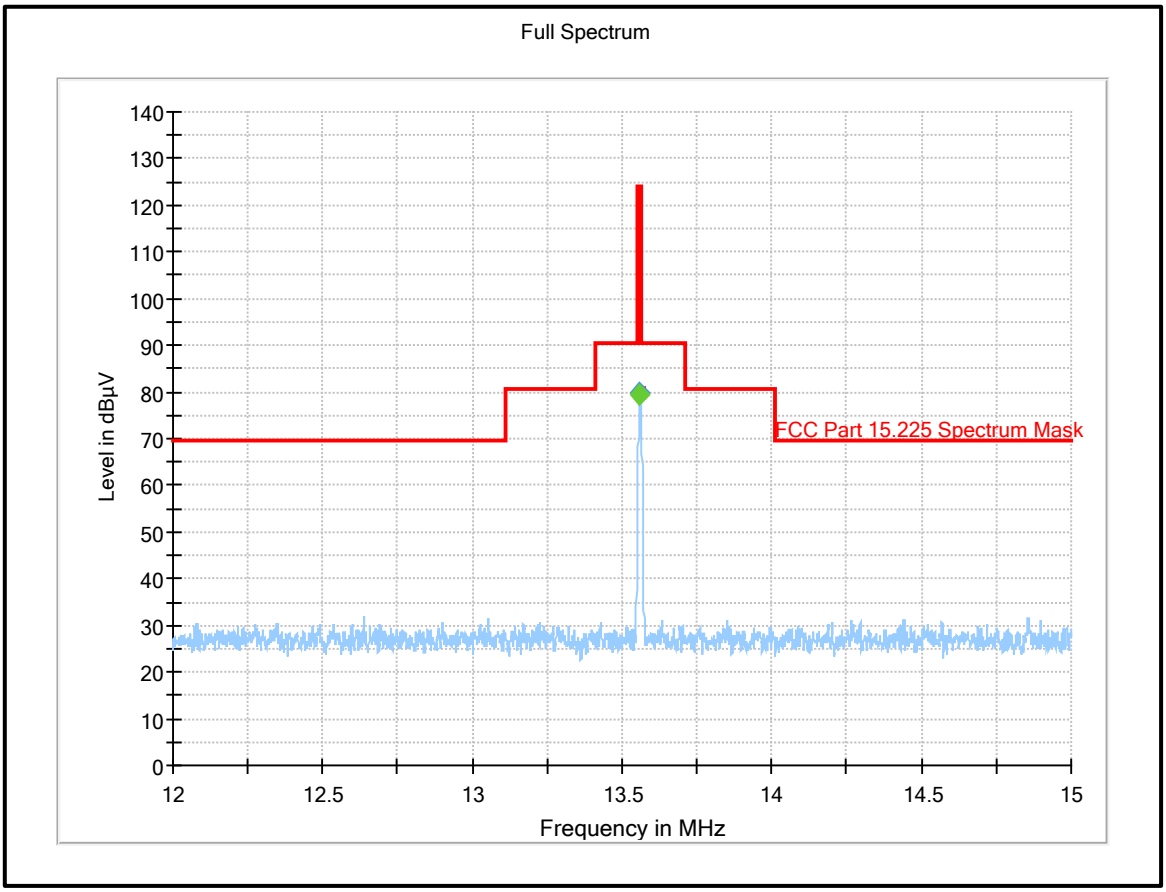
Semi Anechoic Chamber



Transmitter Fundamental Field Strength(continued)
Results: AC-DC Power supply / RFID 13.56 MHz

Frequency (MHz)	Antenna Polarization	Level at 3 m (dBµV/m)	Level at 30 m (dBµV/m)	Deviation from OATS to SAC	Level at 30 m (dBµV/m) with deviation added	Limit at 30 m (dBµV/m)	Margin (dB)	Result
13.56	Vertical	79.74	39.74	1.38	41.12	84.0	42.88	Complied

Result: Pass



Fundamental field strength and spectrum mask / measured at 3 metres extrapolated to 30 metres / measured in a semi-anechoic chamber

5.2.4.Transmitter Radiated Spurious Emissions

Test Summary:

Test Engineer:	Sercan Usta	**Test Date:**	06 May 2020
Test Sample Serial Number:	TB1.1 PROT2 *(Radiated Sample)*		
Test Site Identification	SR 1/2		

FCC Reference:	Parts 15.225(d) & 15.209(a)
Test Method Used:	ANSI C63.10:2013 Sections 6.3 and 6.4
Frequency Range:	9 kHz to 30 MHz

Environmental Conditions:

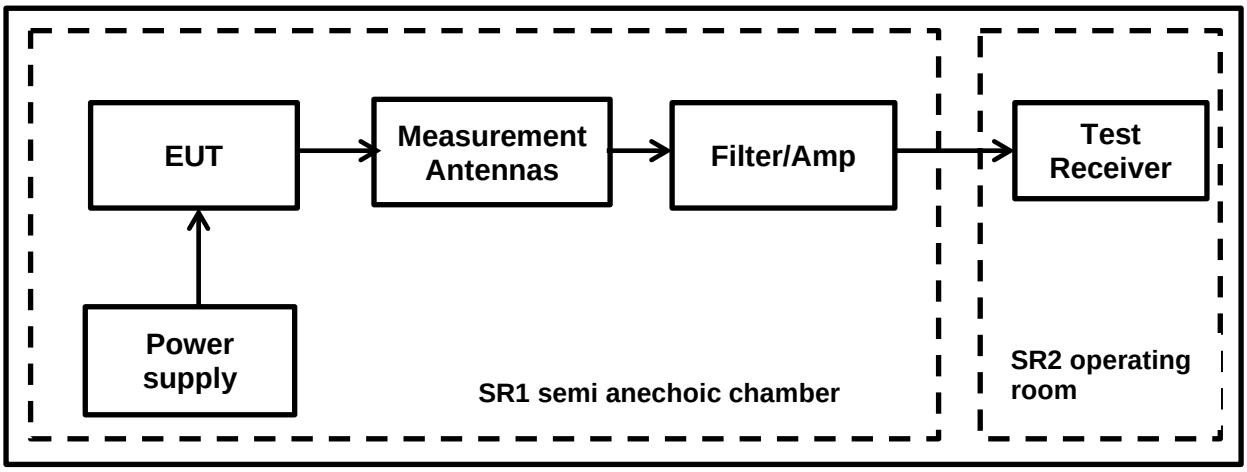
Temperature (°C):	22
Relative Humidity (%):	36

Note(s):

1. In accordance with FCC KDB 414788, an alternative test site may be used for the measurement below 30 MHz (The OATS / SAC comparison data is available upon request). Therefore the result from the semi-anechoic chamber tests is shown in this section of the test report.
2. The limits are specified at a test distance of 30 m & 300 m. However, as specified by FCC Section 15.31 (f)(2), measurements may be performed at a closer distance and the measured level corrected to the specified measurement distance by using the square of an inverse linear distance extrapolation factor.
3. Therefore the limit values are extrapolated to a measurement distance of 3 m where field strength of X dBµV/m was measured.
   - 9 kHz- 490 kHz: limits extrapolated from 300 m to 3 m adding 80 dB at 40 dB /decade.
   - 490 kHz-1705 kHz: limits extrapolated from 30 m to 3 m by adding 40 dB at 40 dB /decade.
4. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
5. All emissions shown on the pre-scan plots were investigated and found to be ambient or > 20 dB below the appropriate limit.
6. Measurements below 30 MHz were performed in a semi-anechoic chamber SR1/ 2 (Asset Number 1603665) at a distance of 3 m. The EUT was placed at a height of 80 cm above the reference ground plane in the centre of the chamber turntable. The measurement loop antenna height was 1 m.
7. Pre-scans were performed and markers placed on the highest measured levels. The test receiver was set to:
   - Frequency range: 9 kHz-150 kHz : RBW: 300 Hz /VBW: 1 kHz
   - Frequency range: 150 kHz – 30 MHz: RBW: 10 kHz /VBW: 30 kHz
   - Detector: Max-Peak detector
   - Trace Mode: Max Hold
8. Final measurements were performed on the marker frequencies and the results entered into the table below.
9. The emissions shown at frequencies approximately 13.56 MHz on the 9 kHz to 30 MHz plots are the EUT RFID 13.56 MHz fundamental for the tested channel.

Transmitter Radiated Spurious Emission test setup

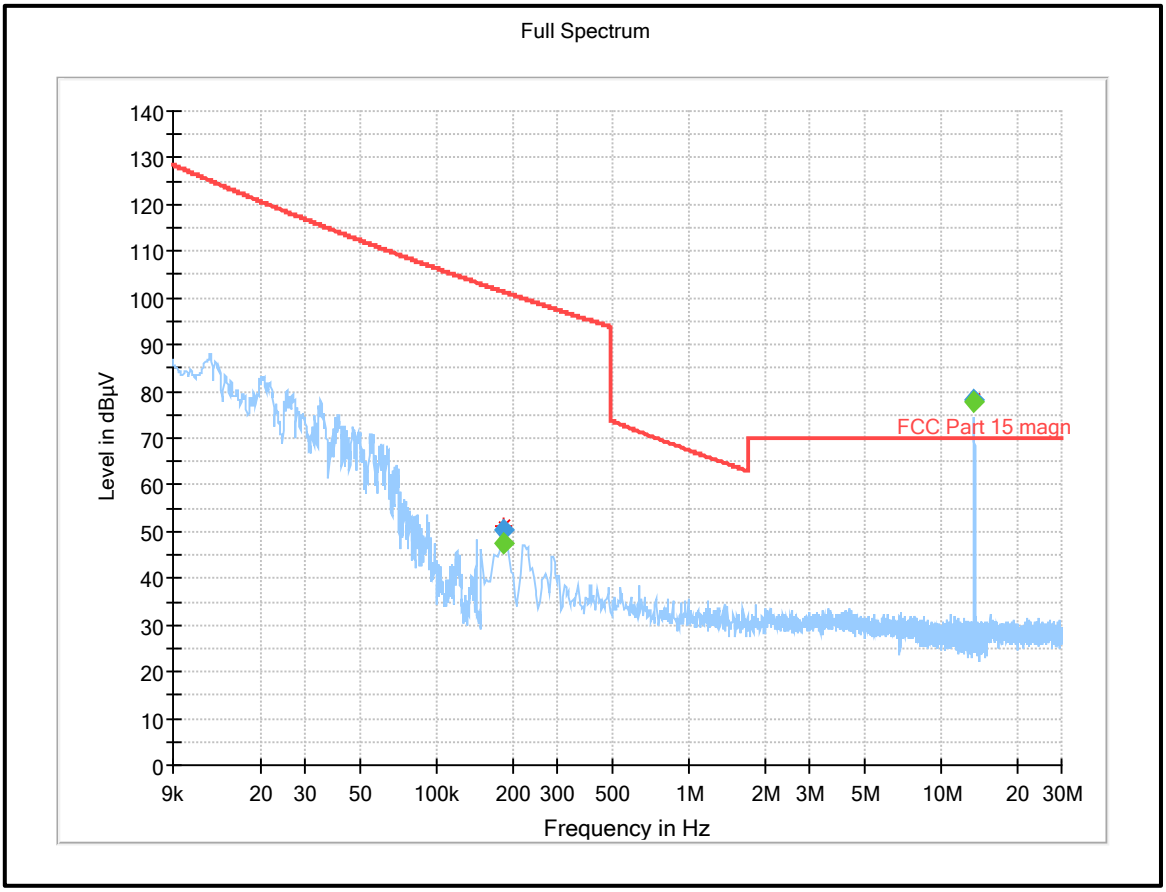
Test Setup:



Transmitter Radiated Emissions (continued)

Results: AC-DC Power supply / RFID 13.56 MHz

Frequency (MHz)	Antenna Polarization	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
No critical spurious emissions were found					



Result: Pass

Transmitter Radiated Emissions (continued)

Test Summary:

Test Engineer:	Sercan Usta	**Test Date:**	06 May 2020
Test Sample Serial Number:	TB1.1 PROT2		
Test Site Identification	SR 1/2		

FCC Reference:	Parts 15.225(d) & 15.209(a)
Test Method Used:	ANSI C63.10:2013 Sections 6.3 and 6.5
Frequency Range:	30 MHz to 1000 MHz

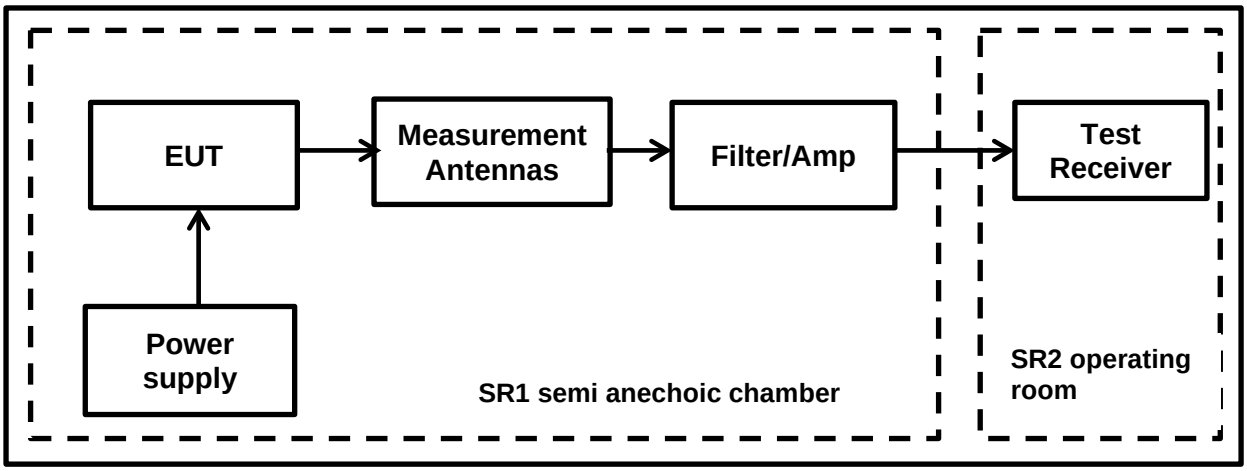
Environmental Conditions:

Temperature (°C):	22
Relative Humidity (%):	36

Note(s):

1. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
2. All other emissions shown on the pre-scan plot were investigated and found to be ambient or >20 dB below the appropriate limit or below the measurement system noise floor.
3. Measurements below 1 GHz were performed in a semi-anechoic chamber SR1/ 2 (Asset Number 1603665) at a distance of 3 m. The EUT was placed at a height of 80 cm above the reference ground plane in the centre of the chamber turntable. Maximum emission levels were determined by height searching the measurement antenna over the range 1 m to 4 m.
4. Pre-scans were performed and markers placed on the highest measured levels. The test receiver resolution bandwidth was set to 100 kHz and video bandwidth 300 kHz. A peak detector was used, sweep time was set to auto and trace mode was Max Hold.
5. Final measurements were performed on the marker frequencies and the results entered into the table below.

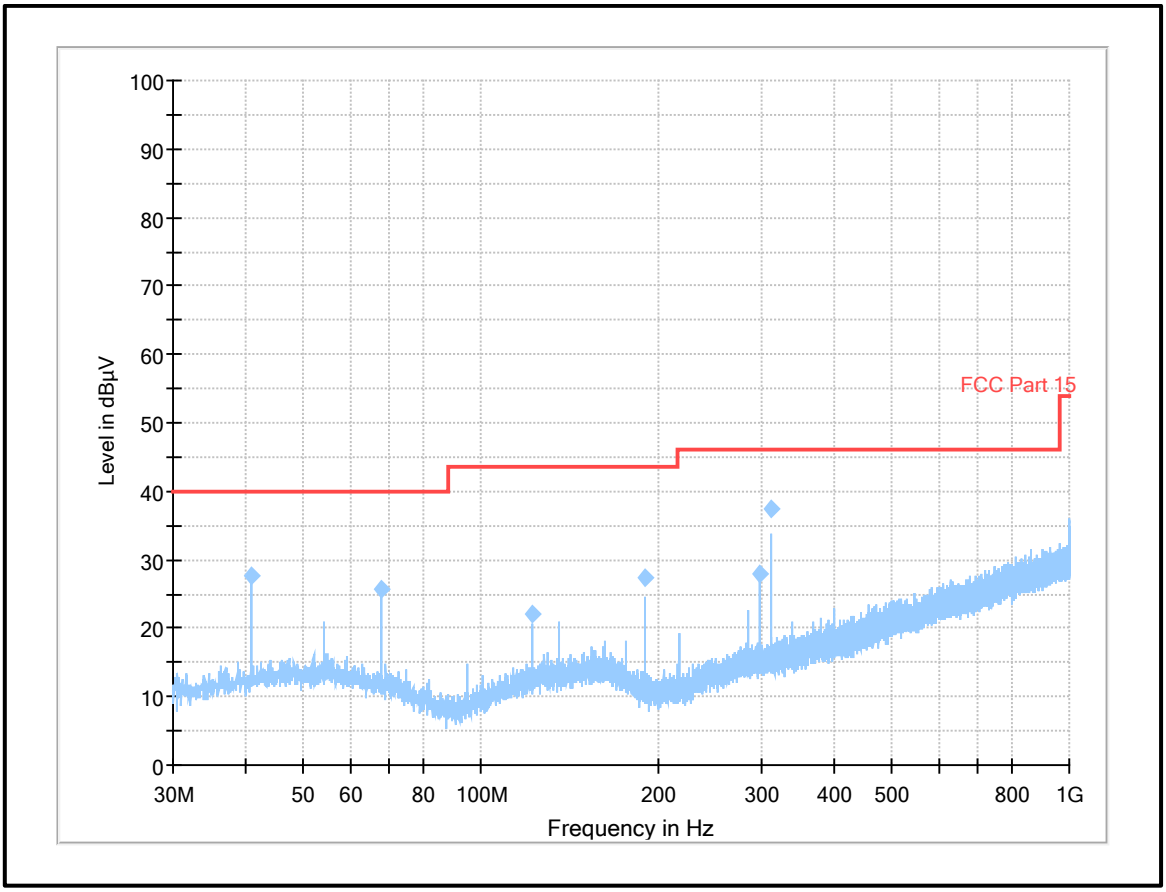
Transmitter Radiated Spurious Emission test setup
Test Setup:



Transmitter Radiated Emissions (continued)

Results: AC-DC Power supply / RFID 13.56 MHz

Frequency (MHz)	Antenna Polarization	MaxPeak Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
40.67	Vertical	27.64	40.00	12.36	Complied
67.80	Vertical	25.65	40.00	14.35	Complied
122.03	Vertical	22.01	43.50	21.49	Complied
189.84	Vertical	27.35	43.50	16.15	Complied
298.34	Horizontal	27.93	46.00	18.07	Complied
311.87	Horizontal	37.33	46.00	8.67	Complied



Result: Pass

5.2.5. Transmitter Frequency Stability (Temperature & Voltage Variation)

Test Summary:

Test Engineer:	Krume Ivanov	**Test Date:**	06 May 2020 to 07 May 2020
Test Sample Serial Number:	TB1.1 PROT2 *(Radiated Sample)*		
Test Site Identification	SR 9		

FCC Reference:	Part 15.225(e)
Test Method Used:	ANSI C63.10 Sections 6.8.1 and 6.8.2

Environmental Conditions:

Ambient Temperature (°C):	26 to 27
Ambient Relative Humidity (%):	30 to 32

Settings of the Instrument

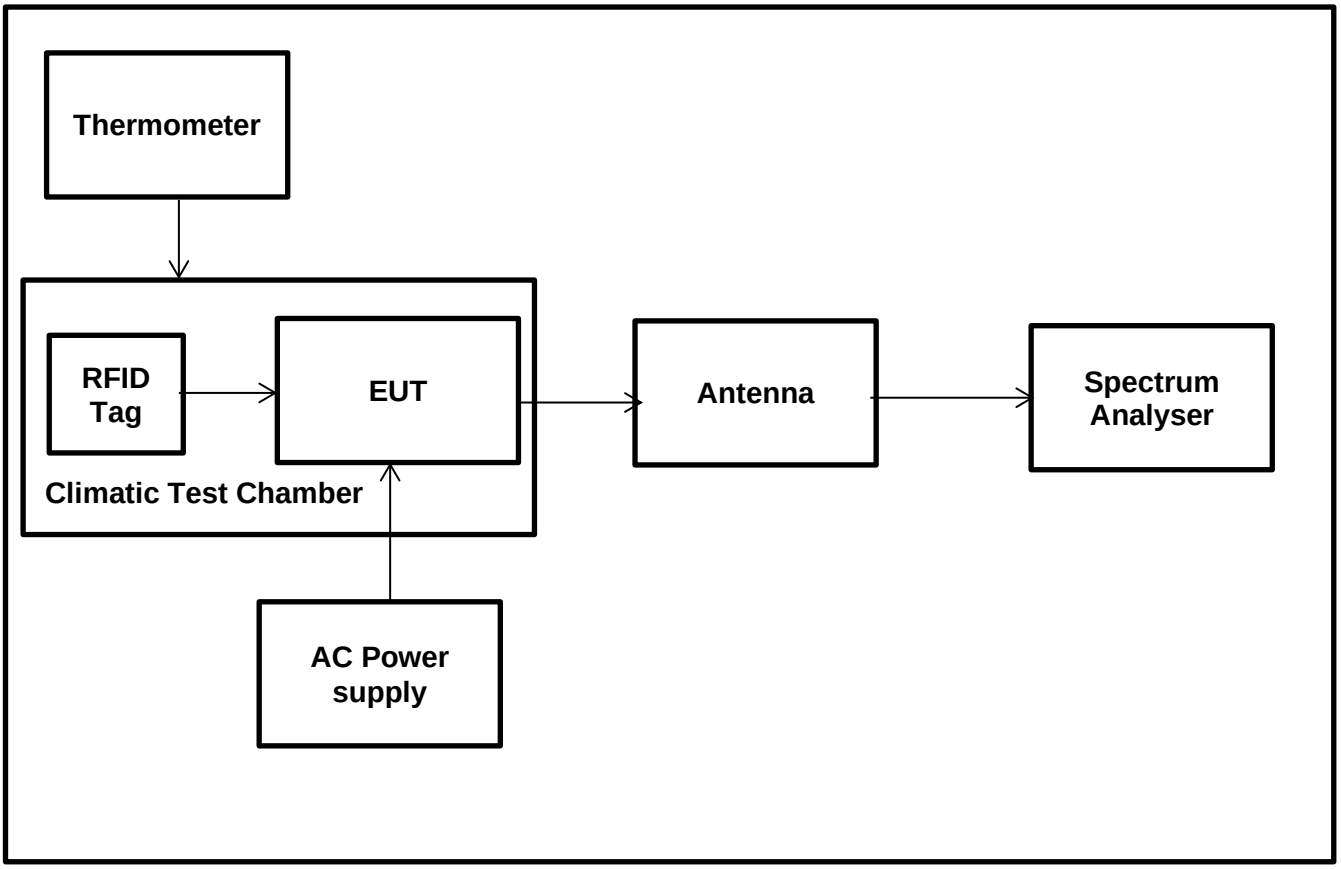
RBW/VBW	30 Hz/30 kHz
Span	4 kHz
Sweep Time	Auto
Sweep Mode	Single Sweep
Detector	Peak
Marker Function	Signal Count

Note(s):

1. The EUT was kept inside the environmental/climatic test chamber. The tests were performed with extreme temperature & extreme voltage variations.
2. The temperature variations were monitored throughout the tests using a calibrated digital thermometer. The voltage variations were monitored throughout the tests using a calibrated digital multimeter.
3. For accurate measurment of frequency deviations, Signal Count / frequency counter function was activated on the spectrum analyser.
4. The applicant's declared operating frequency 13.560 MHz was used as reference frequency.
5. The difference between operating /reference frequency & measured frequency was reported as a frequency error.
6. The frequency tolerance of the carrier signal shall be maintained within ±0.01% or 100 ppm of the operating frequency
7. As EUT can be operated either with AC/DC power adapter or charged internal battery; frequency stability tests were performed were performed once with AC/DC power adapter and also with fully charged internal battery.

Transmitter Frequency Stability (Temperature & Voltage Variation) (continued)

Test Setup : Frequency Stability Tests -Temperature & Voltage Variations



Transmitter Frequency Stability (Temperature & Voltage Variation) (continued)

Results: AC-DC Power supply / RFID 13.56 MHz / Temperature Variations

Extreme Temperature (°C)	Time after EUT Power-up	Measured Frequency (MHz)	Frequency Error		Frequency Error Limits		Result
			%	ppm	%	ppm	
-20	at 0 minutes	13.560049483	+0.000365	+3.65	± 0.01	± 100	Complied
	at 2 minutes	13.560056386	+0.000416	+4.16	± 0.01	± 100	Complied
	at 5 minutes	13.560064993	+0.000479	+4.79	± 0.01	± 100	Complied
	at 10 minutes	13.560078111	+0.000576	+5.76	± 0.01	± 100	Complied
-10	at 0 minutes	13.560009439	+0.000070	+0.70	± 0.01	± 100	Complied
	at 2 minutes	13.560016295	+0.000120	+1.20	± 0.01	± 100	Complied
	at 5 minutes	13.560023809	+0.000176	+1.76	± 0.01	± 100	Complied
	at 10 minutes	13.560036512	+0.000269	+2.69	± 0.01	± 100	Complied
0	at 0 minutes	13.559976355	-0.000174	-1.74	± 0.01	± 100	Complied
	at 2 minutes	13.559981399	-0.000137	-1.37	± 0.01	± 100	Complied
	at 5 minutes	13.559988064	-0.000088	-0.88	± 0.01	± 100	Complied
	at 10 minutes	13.559998416	-0.000012	-0.12	± 0.01	± 100	Complied
+10	at 0 minutes	13.559953251	-0.000345	-3.45	± 0.01	± 100	Complied
	at 2 minutes	13.559956602	-0.000320	-3.20	± 0.01	± 100	Complied
	at 5 minutes	13.559961450	-0.000284	-2.84	± 0.01	± 100	Complied
	at 10 minutes	13.559969021	-0.000228	-2.28	± 0.01	± 100	Complied
+20	at 0 minutes	13.559940617	-0.000438	-4.38	± 0.01	± 100	Complied
	at 2 minutes	13.559942140	-0.000427	-4.27	± 0.01	± 100	Complied
	at 5 minutes	13.559944749	-0.000407	-4.07	± 0.01	± 100	Complied
	at 10 minutes	13.559949738	-0.000371	-3.71	± 0.01	± 100	Complied
+30	at 0 minutes	13.559967563	-0.000239	-2.39	± 0.01	± 100	Complied
	at 2 minutes	13.559965572	-0.000254	-2.54	± 0.01	± 100	Complied
	at 5 minutes	13.559966046	-0.000250	-2.50	± 0.01	± 100	Complied
	at 10 minutes	13.559966877	-0.000244	-2.44	± 0.01	± 100	Complied
+40	at 0 minutes	13.559964826	-0.000259	-2.59	± 0.01	± 100	Complied
	at 2 minutes	13.559960920	-0.000288	-2.88	± 0.01	± 100	Complied
	at 5 minutes	13.559956907	-0.000318	-3.18	± 0.01	± 100	Complied
	at 10 minutes	13.559953269	-0.000345	-3.45	± 0.01	± 100	Complied
+50	at 0 minutes	13.559950136	-0.000368	-3.68	± 0.01	± 100	Complied
	at 2 minutes	13.559948460	-0.000380	-3.80	± 0.01	± 100	Complied
	at 5 minutes	13.559946242	-0.000396	-3.96	± 0.01	± 100	Complied
	at 10 minutes	13.559942723	-0.000422	-4.22	± 0.01	± 100	Complied

Result: Pass

Transmitter Frequency Stability (Temperature & Voltage Variation) (continued)

Results: AC-DC Power supply / RFID 13.56 MHz / Voltage Variations

Extreme Voltage Conditions	Extreme AC Voltage (V)	Measured Frequency (MHz)	Frequency Error		Frequency Error Limits		Result
			%	ppm	%	ppm	
85% of Rated Voltage	102	13.559968616	-0.000231	-2.31	± 0.01	± 100	Complied
Rated Voltage	120	13.559968360	-0.000233	-2.33	± 0.01	± 100	Complied
115% of Rated Voltage	138	13.559968398	-0.000233	-2.33	± 0.01	± 100	Complied

Result: Pass

Transmitter Frequency Stability (Temperature & Voltage Variation) (continued)

Results: Fully Charged Internal Battery / RFID 13.56 MHz / Temperature Variations

Extreme Temperature (°C)	Time after EUT Power-up	Measured Frequency (MHz)	Frequency Error		Frequency Error Limits		Result
			%	ppm	%	ppm	
-20	at 0 minutes	13.560093348	+0.000688	+6.88	± 0.01	± 100	Complied
	at 2 minutes	13.560098823	+0.000729	+7.29	± 0.01	± 100	Complied
	at 5 minutes	13.560105941	+0.000781	+7.81	± 0.01	± 100	Complied
	at 10 minutes	13.560116517	+0.000859	+8.59	± 0.01	± 100	Complied
-10	at 0 minutes	13.560124414	+0.000918	+9.18	± 0.01	± 100	Complied
	at 2 minutes	13.560125971	+0.000929	+9.29	± 0.01	± 100	Complied
	at 5 minutes	13.560127389	+0.000939	+9.39	± 0.01	± 100	Complied
	at 10 minutes	13.560129391	+0.000954	+9.54	± 0.01	± 100	Complied
0	at 0 minutes	13.560130444	+0.000962	+9.62	± 0.01	± 100	Complied
	at 2 minutes	13.560129835	+0.000957	+9.57	± 0.01	± 100	Complied
	at 5 minutes	13.560128603	+0.000948	+9.48	± 0.01	± 100	Complied
	at 10 minutes	13.560126659	+0.000934	+9.34	± 0.01	± 100	Complied
+10	at 0 minutes	13.560123892	+0.000914	+9.14	± 0.01	± 100	Complied
	at 2 minutes	13.560122024	+0.000900	+9.00	± 0.01	± 100	Complied
	at 5 minutes	13.560119012	+0.000878	+8.78	± 0.01	± 100	Complied
	at 10 minutes	13.560113881	+0.000840	+8.40	± 0.01	± 100	Complied
+20	at 0 minutes	13.560003532	+0.000026	+0.26	± 0.01	± 100	Complied
	at 2 minutes	13.560004585	+0.000034	+0.34	± 0.01	± 100	Complied
	at 5 minutes	13.560006310	+0.000047	+0.47	± 0.01	± 100	Complied
	at 10 minutes	13.560009028	+0.000067	+0.67	± 0.01	± 100	Complied
+30	at 0 minutes	13.560011026	+0.000081	+0.81	± 0.01	± 100	Complied
	at 2 minutes	13.560010880	+0.000080	+0.80	± 0.01	± 100	Complied
	at 5 minutes	13.560009943	+0.000073	+0.73	± 0.01	± 100	Complied
	at 10 minutes	13.560007499	+0.000055	+0.55	± 0.01	± 100	Complied
+40	at 0 minutes	13.560003152	+0.000023	+0.23	± 0.01	± 100	Complied
	at 2 minutes	13.560001043	+0.000008	+0.08	± 0.01	± 100	Complied
	at 5 minutes	13.559997713	-0.000017	-0.17	± 0.01	± 100	Complied
	at 10 minutes	13.559992408	-0.000056	-0.56	± 0.01	± 100	Complied
+50	at 0 minutes	13.559988676	-0.000084	-0.84	± 0.01	± 100	Complied
	at 2 minutes	13.559985552	-0.000107	-1.07	± 0.01	± 100	Complied
	at 5 minutes	13.559980584	-0.000143	-1.43	± 0.01	± 100	Complied
	at 10 minutes	13.559973304	-0.000197	-1.97	± 0.01	± 100	Complied

Result: Pass

Transmitter Frequency Stability (Temperature & Voltage Variation) (continued)

Results: Fully Charged Internal Battery / RFID 13.56 MHz / Voltage Variations

Extreme Voltage Conditions	Extreme DC Voltage (V)	Measured Frequency (MHz)	Frequency Error		Frequency Error Limits		Result
			%	ppm	%	ppm	
85% of Rated Voltage	3.06	13.559996513	-0.000026	-0.26	± 0.01	± 100	Complied
Rated Voltage	3.60	13.559967687	-0.000238	-2.38	± 0.01	± 100	Complied
115% of Rated Voltage	4.14	13.559967563	-0.000239	-2.39	± 0.01	± 100	Complied

Result: Pass

6. Measurement Uncertainty

The expression of uncertainty of a measurement result allows realistic comparison of results with reference values and limits given in specifications and standards.

The uncertainty of the result may need to be taken into account when interpreting the measurement results.

The reported expanded uncertainties below are based on a standard uncertainty multiplied by an appropriate coverage factor such that a confidence level of approximately 95% is maintained. For the purposes of this document “approximately” is interpreted as meaning “effectively” or “for most practical purposes”.

Measurement Type	Confidence Level (%)	Calculated Uncertainty
AC Conducted Spurious Emissions	95%	±2.49 dB
20 dB Bandwidth	95%	±0.87 %
Fundamental Field Strength	95%	±3.10 dB
Radiated Spurious Emissions	95%	±3.10 dB
Frequency Stability	95%	±92 Hz

The methods used to calculate the above uncertainties are in line with those recommended within the various measurement specifications. Where measurement specifications do not include guidelines for the evaluation of measurement uncertainty the published guidance of the appropriate accreditation body is followed.

7. Used equipment

Test site: SR 1/2

ID	Manufacturer	Type	Model	Serial	Calibration Date	Cal. Cycle (months)
1	Rohde & Schwarz	Antenna, Loop	HFH2-Z2	831247/012	11/07/2019	36
460	Deisl	Turntable	DT 4250 S	n/a	n/a	n/a
465	Schwarzbeck	Antenna, Trilog Broadband	VULB 9168	9168-240	20/03/2019	24
587	Maturo	antenna mast, tilting	TAM 4.0-E	011/7180311	n/a	n/a
588	Maturo	Controller	NCD	029/7180311	n/a	n/a
591	Rohde & Schwarz	Receiver	ESU 40	100244/040	09/072019	12
608	Rohde & Schwarz	Switch Matrix	OSP 120	101227	lab verification	n/a
628	Maturo	Antenna mast	CAM 4.0-P	224/19590716	n/a	n/a
629	Maturo	Kippeinrichtung	KE 2.5-R-M	MAT002	n/a	n/a
-/-	Testo	Thermo-Hygrometer	608-H1	01	lab verification	n/a
328	SPS	AC/DC power distribution system	PAS 5000	A2464 00/2 0200	lab verification	n/a
1603665	Siemens Matsushita Components	semi-anechoic chamber SR1/ 2	-/-	B83117-A1421-T161	n/a	n/a

Test site: SR 7/8

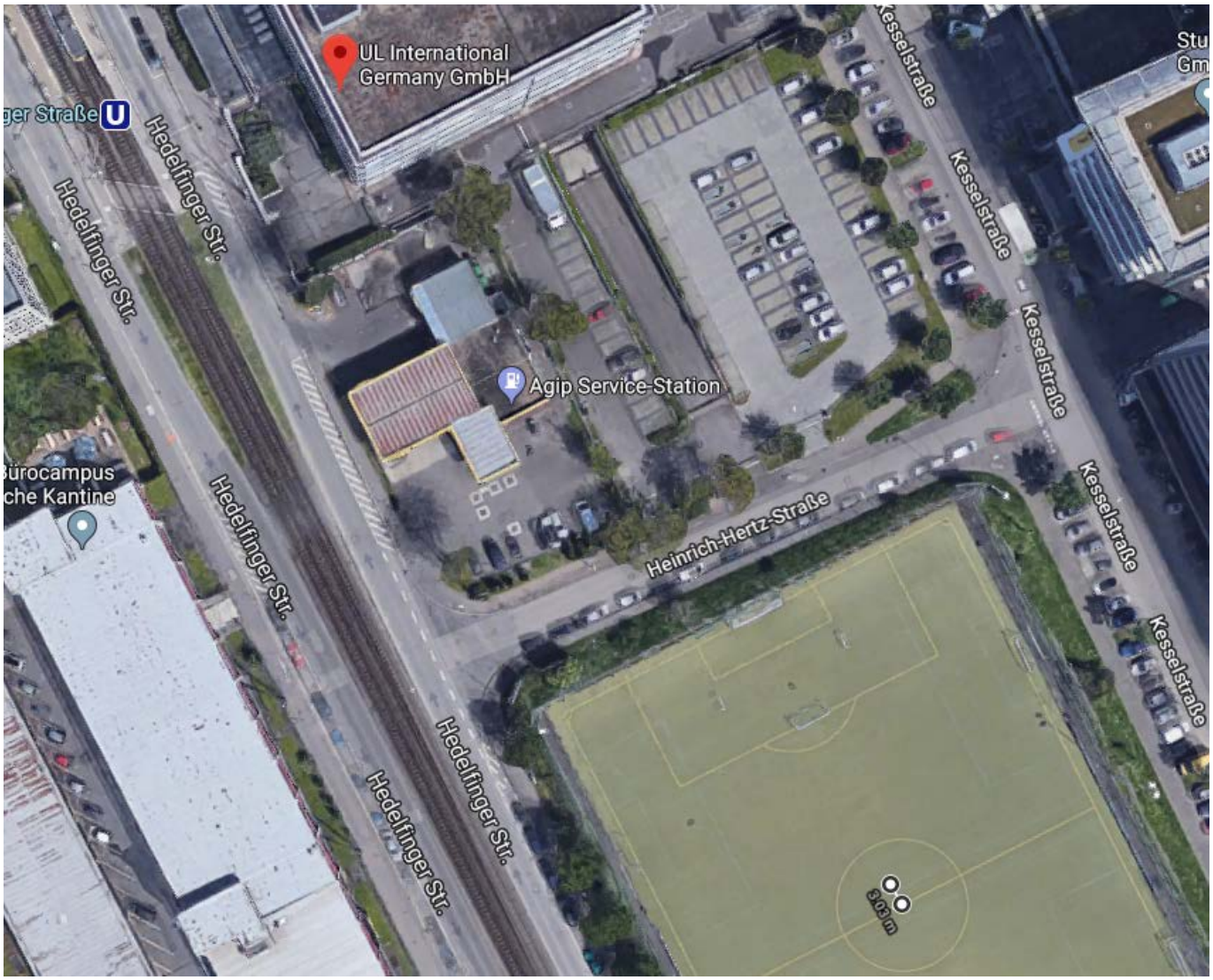
ID	Manufacturer	Type	Model	Serial	Calibration Date	Cal. Cycle (months)
23	Rohde & Schwarz	Artificial Mains Network	ESH3-Z5	831767/013	09/07/2019	12
349	Rohde & Schwarz	Receiver, EMI Test	ESIB7	836697/009	10/07/2019	12
-/-	Testo	Thermo-Hygrometer	608-H1	08	lab verification	n/a
327	SPS	AC/DC power distribution system	PAS 5000	A2464 00/1 0200	lab verification	n/a

Test site: SR 9

ID	Manufacturer	Type	Model	Serial	Calibration Date	Cal. Cycle (months)
621	Ahlborn-Almemo	Temperatur-/ Feuchtemessgerät	MA2470-S2	H16080099	15/03/2019	12
625	Schwarzbeck	Antenna, H-field	HFSL 7101	109	lab verification only relative measurements	n/a
637	Rohde & Schwarz	Spectrum Analyser	FSV40	101587	11/07/2019	12
-/-	Testo	Thermo-Hygrometer	608-H1	07	lab verification	n/a
645	Weiss Umwelttechnik	Climatic Chamber	LabEvent T/110/70/3	5822619794 0010	lab verification	n/a
194	Hewlett Packard	Digital Multimeter	34401A	US36020807	08/07/2019	12
327	SPS	AC/DC power distribution system	PAS 5000	A2464 00/1 0200	lab verification	n/a

8. Open-Area-Test Site comparison

GPS coordinates
Latitude: 48.765746, Longitude: 9.250684



Open-Area-Test Site comparison (continued)

The following listed equipment was used for the measurement:

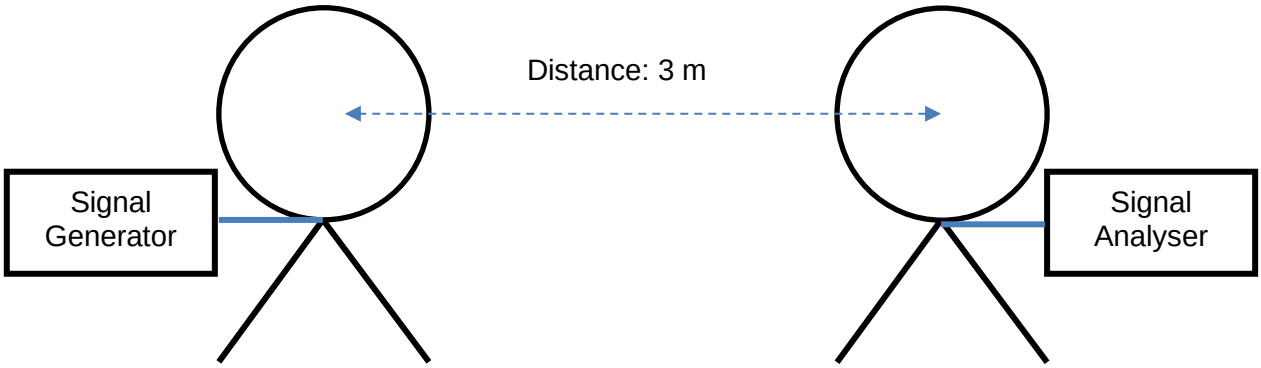
Manufacturer	Type	Model	Frequency Range
Rohde & Schwarz	Signal generator	SML03	9 kHz – 30 MHz
Rohde & Schwarz	Receiver, EMI Test	ESIB7	20 Hz – 7 GHz
Rohde & Schwarz	Antenna, Loop	HFH2-Z2	1 kHz – 30 MHz
ETS LINDGREN	Antenna, Loop	6512	1 kHz – 30 MHz
HUBER+SUHNER	RF Cable	-/-	-/-
Elspec	BNC Cable	-/-	-/-

The transmit signal to the ETS Lindgren loop antenna is supplied by the SML signal generator.

The distance of the transmit and receive antenna was 3 m. No other distances can be achieved in SR1 so 10 m and 30 m distances are not possible. Due to this no comparison is possible.

The Results are valid for equipment which is not larger as the loop antenna which represents in the comparison the EUT.
If an EUT is bigger measurements on an OATS are needed.

The measurement was performed on the lowest frequency 9 kHz and was increased by 10 kHz Steps up to 100 kHz. Then the step size was 100 kHz up to 1000 kHz. From 1 MHz up to the last frequency of 30 MHz the step size was 1 MHz. The HFH2-Z2 loop antenna placed at 80 cm height was used as the receive antenna. The intercepted RF signal from this antenna was measured with the ESIB7 Test Receiver and the values were recorded accordingly.



Open-Area-Test Site comparison (continued)

Numeric values:

Frequency (MHz)	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.10	0.125	0.20
SR1 Measured power (dBµV)	87.91	87.22	87.01	86.98	86.40	86.32	85.98	85.20	84.30	83.80	82.96	82.55
OATS Measured power (dBµV)	86.22	87.42	87.50	86.49	86.01	85.39	84.32	84.29	84.20	83.10	83.60	82.32
Delta (dB)	-1.69	0.20	0.49	-0.49	-0.39	-0.93	-1.66	-0.91	-0.10	-0.70	0.64	-0.23

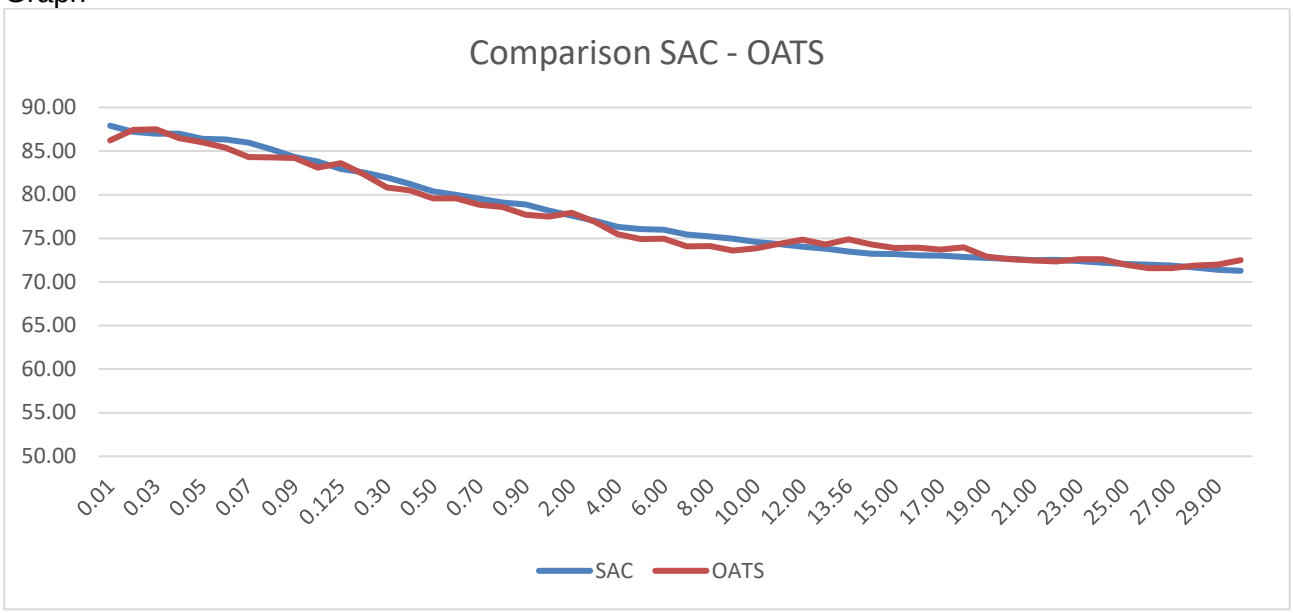
Frequency (MHz)	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	2.00	3.00	4.00	5.00
SR1 Measured power (dBµV)	81.98	81.23	80.39	80.00	79.53	79.10	78.87	78.20	77.60	77.01	76.32	76.04
OATS Measured power (dBµV)	80.84	80.49	79.58	79.58	78.85	78.59	77.69	77.50	77.91	76.90	75.45	74.90
Delta (dB)	-1.14	-0.74	-0.81	-0.42	-0.68	-0.51	-1.18	-0.70	0.31	-0.11	-0.87	-1.14

Frequency (MHz)	6.00	7.00	8.00	9.00	10.00	11.00	12.00	13.00	13.56	14.00	15.00	16.00
SR1 Measured power (dBµV)	75.98	75.43	75.20	74.97	74.59	74.32	74.05	73.83	73.50	73.22	73.20	73.05
OATS Measured power (dBµV)	74.94	74.09	74.11	73.58	73.87	74.38	74.84	74.31	74.88	74.29	73.90	73.93
Delta (dB)	-1.04	-1.34	-1.09	-1.39	-0.72	0.06	0.79	0.48	1.38	1.07	0.70	0.88

Frequency (MHz)	17.00	18.00	19.00	20.00	21.00	22.00	23.00	24.00	25.00	26.00	27.00	28.00	29.00	30.00
SR1 Measured power (dBµV)	73.00	72.86	72.74	72.64	72.50	72.52	72.39	72.20	72.04	71.97	71.86	71.64	71.41	71.27
OATS Measured power (dBµV)	73.70	73.98	72.90	72.60	72.45	72.34	72.59	72.59	71.97	71.59	71.58	71.88	71.98	72.49
Delta (dB)	0.70	1.12	0.16	-0.04	-0.05	-0.18	0.20	0.39	-0.07	-0.38	-0.28	0.24	0.57	1.22

Open-Area-Test Site comparison (continued)

Graph



Conclusion: Maximum difference is 1.69 dB @ 9 kHz

9. Report Revision History

Version Number	Revision Details		
	Page No(s)	**Clause**	**Details**
1.0	-	-	Initial Version
Test Report Version 1.1 supersede Version 1.0 with immediate effect Test Report No. UL-RPT-RP-12947326-1116-FCC Version 1.1, Issue Date 17 AUGUST 2020 replaces Test Report No. UL-RPT-RP-12947326-1116-FCC Version 1.0, Issue Date 28 JULY 2020, which is no longer valid.			
1.1	as below	as below	
	5	2	Formatting updated
	11	5.2.1	Note 2 & Note 6 wording updated
	17,19,20	5.2.2	Retesting of 20 dB Bandwidth. Result tables updated in accordance with new plots
	21	5.2.3	Note 4 Clause reference corrected
Test Report Version 1.2 supersede Version 1.1 with immediate effect Test Report No. UL-RPT-RP-12947326-1116-FCC Version 1.1, Issue Date 21 AUGUST 2020 replaces Test Report No. UL-RPT-RP-12947326-1116-FCC Version 1.1, Issue Date 17 AUGUST 2020, which is no longer valid.			
1.2	as below	as below	Current Version
	17	5.2.2	Retesting of 20 dB Bandwdith in accordance with FCC Inquiry response Test Method, Test Settings & Notes sections updated
	19,20	5.2.2	Retesting of 20 dB Bandwdith in accordance with FCC Inquiry response Result tables & plots are updated
	27	5.2.4	Notes section updated