TEST REPORT

Test Report No.: UL-RPT-RP-14804061-316-FCC

Applicant *	:	Schreder SA
Model No. *	:	MESHNODE N NAM
FCC ID *	:	2AW4F-OW4NMNAM
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

1. This test report shall not be reproduced in full or partial, without the written approval of UL International Germany GmbH.
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 1.1 supersede Version 1.0 with immediate effect**
   Test Report No. UL-RPT-RP-14804061-316-FCC Version 1.1, Issue Date 26 SEPTEMBER 2023 replaces
   Test Report No. UL-RPT-RP-14804061-316-FCC Version 1.0, Issue Date 22 SEPTEMBER 2023, which is no longer valid.
5. Result of the tested sample: **PASS**
6. All information marked with a (*) were provided by customer / applicant or authorized representative

Prepared by: Muhammad Faiq Khan
Title: Project Engineer
Date: 26 September 2023

Approved by: Rachid Acharkaoui
Title: Operations Manager
Date: 26 September 2023

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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1. Customer Information *

1.1.Applicant Information

Company Name:	Schreder SA
Company Address:	Rue de Lusambo 67, 1190 Brussels - Belgium
Contact Person:	Filipe Vieira de Almeida
Contact E-Mail Address:	falmeida@schreder.com
Contact Phone No.:	+351 914 110 049

1.2.Manufacturer Information

Company Name:	Schreder SA
Company Address:	Rue de Lusambo 67, 1190 Brussels - Belgium
Contact Person:	Laurent Maghe
Contact E-Mail Address:	lmaghe@schreder.com
Contact Phone No.:	+32 4 224 71 65

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:	12 May 2023
EUT arrived:	07 August 2023
Test Dates:	17 August 2023 to 29 August 2023
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 & Spectrum Mask (continued)	☒	☐	☐	☐
Part 15.209(a)/ 15.225(d)	Transmitter Radiated Emissions	☒	☐	☐	☐
Part 15.225(e)	Transmitter Frequency Stability (Temperature & Voltage Variation)	☒	☐	☐	☐

Decision rule:
If the decision rule is not included in the applied customer specification or testing standard, the binary statement for simple acceptance, as defined in ILAC G8: 2019 Section 4.2.1, is applied as the decision rule for a pass/ fail statement.

If the measured value is on the limit, the result is defined as a pass. In this case the risk of a false positive is 50%. For further information regarding risk assessment refer to ILAC G8: 2019.

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:	FCC 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:	Schréder
Model Name or Number:	MESHNODE N NAM
Serial Number:	14EFCF011C000002 (Radiated test sample)
Hardware Version Number:	4.0
Firmware Version Number:	4.3.2.1
FCC ID:	2AW4F-OW4NMNAM

Brand Name:	Schréder
Model Name or Number:	MESHNODE N NAM
Serial Number:	14EFCF011C000008 (Radiated test sample with Terminated antenna)
Hardware Version Number:	4.0
Firmware Version Number:	4.3.2.1
FCC ID:	2AW4F-OW4NMNAM

3.2. Description of EUT *

The equipment under test was a Luminaire controller with RFID 13.56MHz technology.

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 Requirement(s):	120V AC / 60 Hz	
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:

A. Support Equipment (In-house)

Item	Description	Brand Name	Model Name or Number	Serial Number
1	Laptop PC with Test Software: Tera Term STM32 Cube programmer	HP	ProBook 650	5CG614419V

B. . Support Equipment (Manufacturer supplied) *

Item	Description	Brand Name	Model Name or Number	Serial Number
1	Programming JIG	Schréder	Prog JIG Meshnode - V2	-/-
2	Socket	-/-	-/-	-/-
3	USB – UART cable	-/-	-/-	-/-

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):

- The customer supplied document containing the setup instructions "UL_OWLET_IV_HW_Instruction'' issued 09-05-2023 was used for configuration.

EUT Power supply:

- The EUT is powered via the 120VAC / 60 Hz AC mains supply.

Test Mode Activations:

- The EUT can be connected to the laptop via USB-UART cable through the JIG programmer.
- The JIG programmer was mounted on the EUT for configuration and was removed during the testing.
- The ''STM32 cube programmer'' was used to upload the firmware file into the EUT. The commands to activate RFID mode was then given through the terminal tool ''Tera term''.

AC Conducted Emissions Measurements:

- For AC conducted line emissions measurement the EUT was powered with 120VAC / 60 Hz and also 240 VAC / 60 Hz as it is in the range.
- In accordance with FCC KDB 174176 Q5, AC conducted emissions was also performed with the EUT's RFID 13.56 MHz Antenna terminated with a 50Ω termination (dummy load).
- The Toyo EMI Software EP5/CE Ver 4.0.1. was used for these measurements.

Radiated Measurements:

- 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 measurements below 30 MHz were performed with the EUT positioned on the turn table and rotating 360 degrees while the loop antenna height was set to 100 cm.
- Radiated measurements above 30 MHz were performed with the EUT positioned on the turn table and rotating 360 degrees while the antenna height varies from 1 to 4 m over the measurement frequency range.
- R&S®EMC32 Measurement Software V11.30.00 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:	Muhammad Faiq Khan	**Test Date:**	23 & 29 August 2023
Test Sample Serial Number:	14EFCF011C000002 (Radiated test sample) 14EFCF011C000008 (Radiated test sample with Terminated antenna)		
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 to 23.9
Relative Humidity (%):	63 to 67

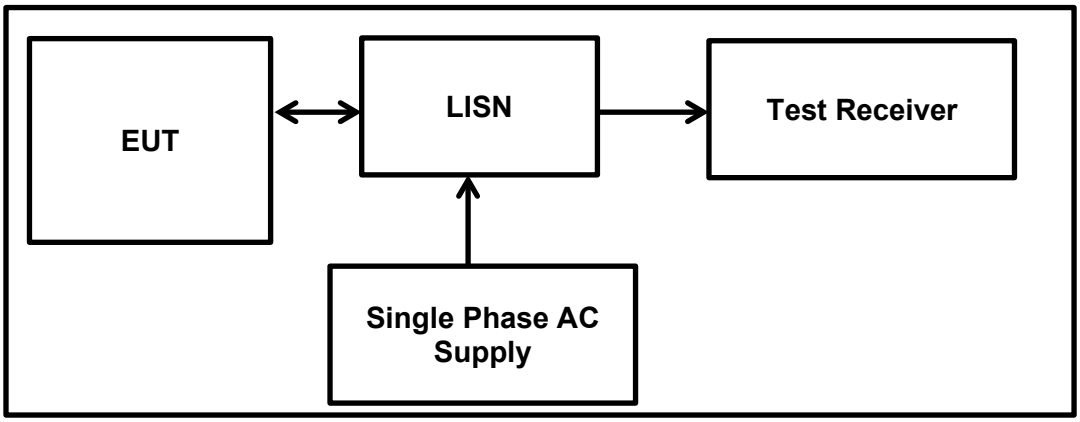
Settings of the Instrument

Detector	Quasi Peak/ Average

Note(s):

1. The EUT was powered with 120VAC / 60 Hz and also 240 VAC / 60 Hz as it is in the range of the used power supply.
2. As mentioned in FCC KDB 174176 Q5 a suitable dummy load for radio frequency termination used in place of the antenna, which has the same electrical properties as the intended antenna without radiated emissions.
3. 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.
4. The final measured value, for the given emission, in the table below incorporates the cable loss.
5. 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.
6. Measurement software used: Toyo EMI Software; CE measurement software EP5/CE Ver 4.0.1.

Test Setup:



Transmitter AC Conducted Spurious Emissions (continued)

Results: RFID Active mode

Results: Live / Quasi Peak / 120 VAC 60 Hz

Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.18098	Live	37.50	64.40	26.90	Complied
0.23459	Live	36.60	62.30	25.70	Complied
3.31713	Live	41.80	56.00	14.20	Complied
3.53421	Live	38.90	56.00	17.10	Complied
13.56047	Live	98.90	60.00	-38.90	Carrier
29.92039	Live	40.40	60.00	19.60	Complied

Results: Live / Average / 120 VAC 60 Hz

Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.18098	Live	22.00	54.40	32.40	Complied
0.23459	Live	21.20	52.30	31.10	Complied
3.31713	Live	27.50	46.00	18.50	Complied
3.53421	Live	23.70	46.00	22.30	Complied
13.56047	Live	97.50	50.00	-47.50	Carrier
29.92039	Live	29.90	50.00	20.10	Complied

Results: Neutral / Quasi Peak / 120 VAC 60 Hz

Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.19584	Neutral	36.70	63.80	27.10	Complied
0.24222	Neutral	36.60	62.00	25.40	Complied
3.28555	Neutral	40.50	56.00	15.50	Complied
3.41341	Neutral	41.30	56.00	14.70	Complied
13.56037	Neutral	99.60	60.00	-39.60	Carrier
27.12039	Neutral	46.50	60.00	13.50	Complied

Results: Neutral / Average / 120 VAC 60 Hz

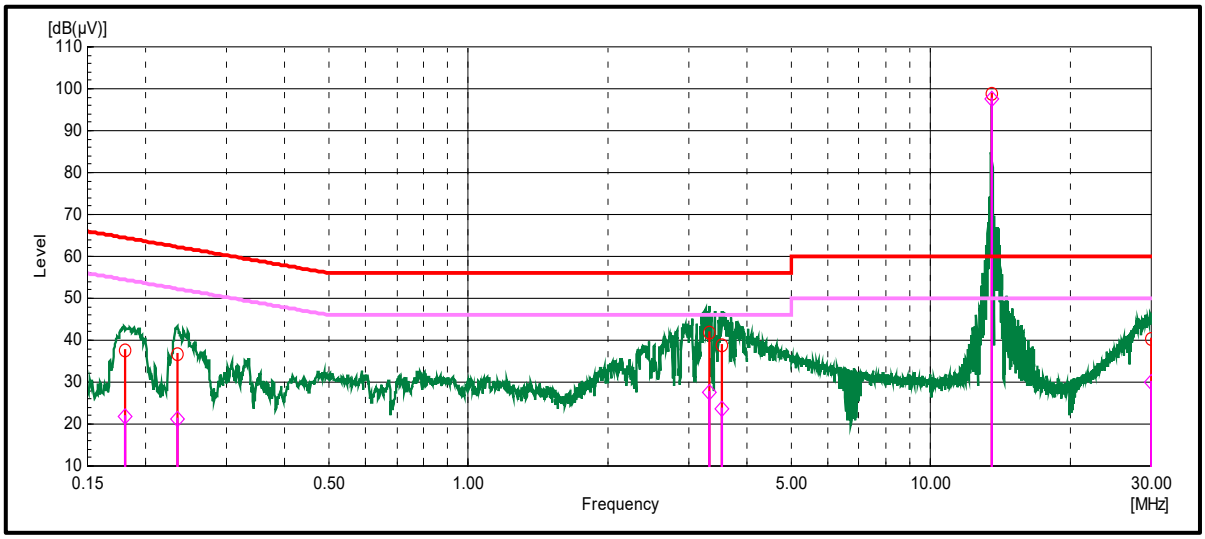
Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.19584	Neutral	22.90	53.80	30.90	Complied
0.24222	Neutral	26.10	52.00	25.90	Complied
3.28555	Neutral	24.40	46.00	21.60	Complied
3.41341	Neutral	24.90	46.00	21.10	Complied
13.56037	Neutral	98.90	50.00	-48.90	Carrier
27.12039	Neutral	30.70	50.00	19.30	Complied

Result: Pass

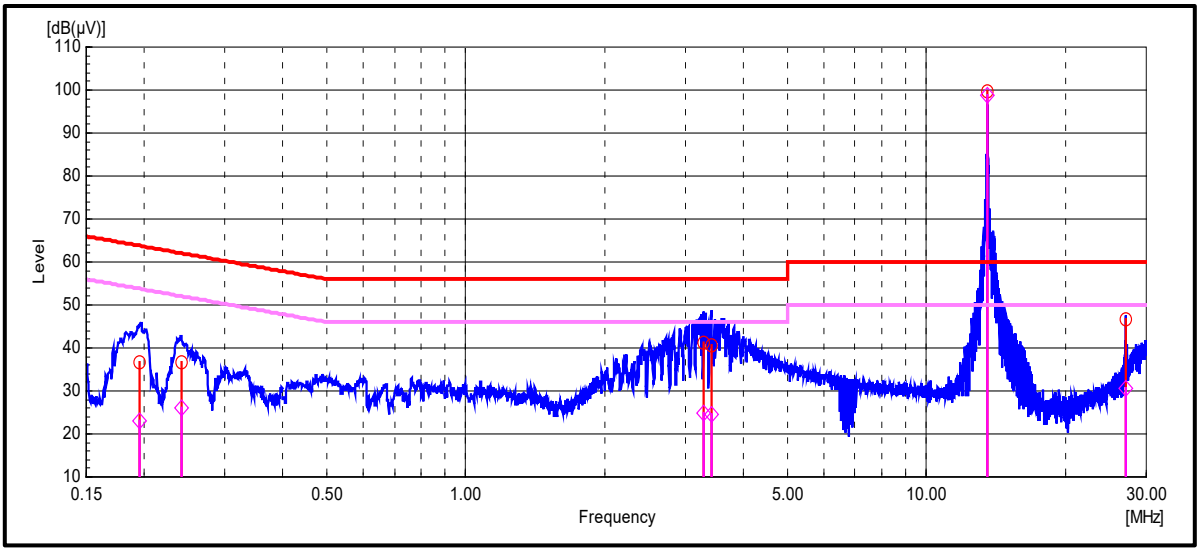
Transmitter AC Conducted Spurious Emissions (continued)

Results: RFID Active mode

Plot: Live / 120 VAC 60 Hz



Plot: Neutral / 120 VAC 60 Hz



Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables. The peaks at 13.56 MHz are the fundamental frequency of the tested technology

Transmitter AC Conducted Spurious Emissions (continued)

Results: RFID Active mode

Results: Live / Quasi Peak / 240 VAC 60 Hz

Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.18508	Live	37.40	64.30	26.90	Complied
0.25452	Live	34.00	61.60	27.60	Complied
3.24074	Live	42.60	56.00	13.40	Complied
3.46748	Live	44.60	56.00	11.40	Complied
13.56037	Live	98.80	60.00	-38.80	Carrier
27.12292	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
0.18508	Live	25.30	54.30	29.00	Complied
0.25452	Live	21.60	51.60	30.00	Complied
3.24074	Live	27.50	46.00	18.50	Complied
3.46748	Live	29.30	46.00	16.70	Complied
13.56037	Live	93.30	50.00	-43.30	Carrier
27.12292	Live	23.60	50.00	26.40	Complied

Results: Neutral / Quasi Peak / 240 VAC 60 Hz

Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.19299	Neutral	37.60	63.90	26.30	Complied
0.25443	Neutral	36.10	61.60	25.50	Complied
3.43846	Neutral	46.10	56.00	9.90	Complied
3.27256	Neutral	43.60	56.00	12.40	Complied
13.56037	Neutral	99.50	60.00	-39.50	Carrier
27.12109	Neutral	46.00	60.00	14.00	Complied

Results: Neutral / Average / 240 VAC 60 Hz

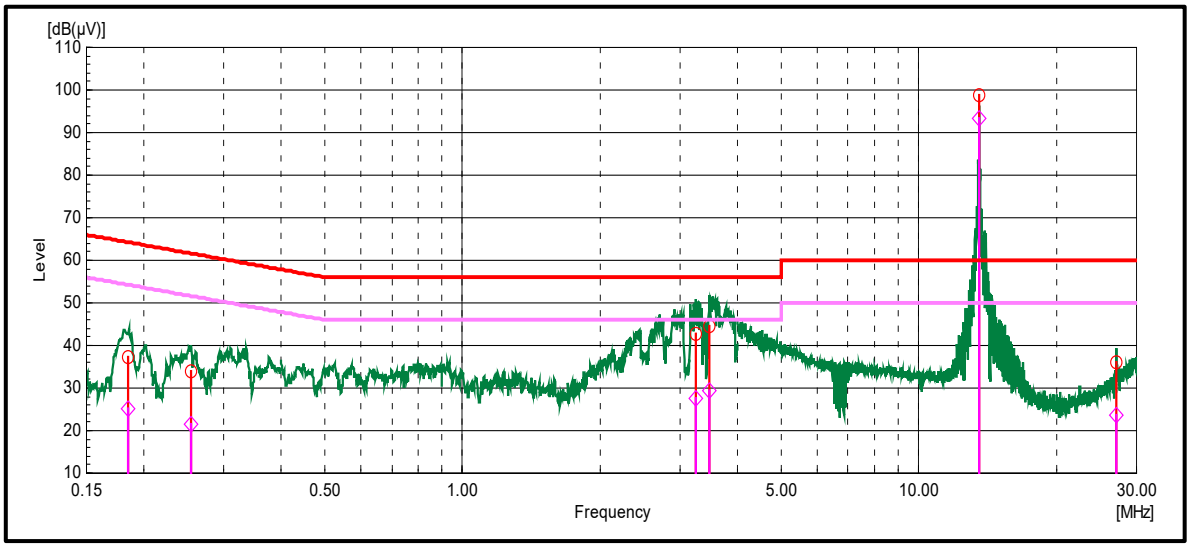
Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.19299	Neutral	27.50	53.90	26.40	Complied
0.25443	Neutral	23.70	51.60	27.90	Complied
3.43846	Neutral	31.20	46.00	14.80	Complied
3.27256	Neutral	27.80	46.00	18.20	Complied
13.56037	Neutral	94.60	50.00	-44.60	Carrier
27.12109	Neutral	30.30	50.00	19.70	Complied

Result: Pass

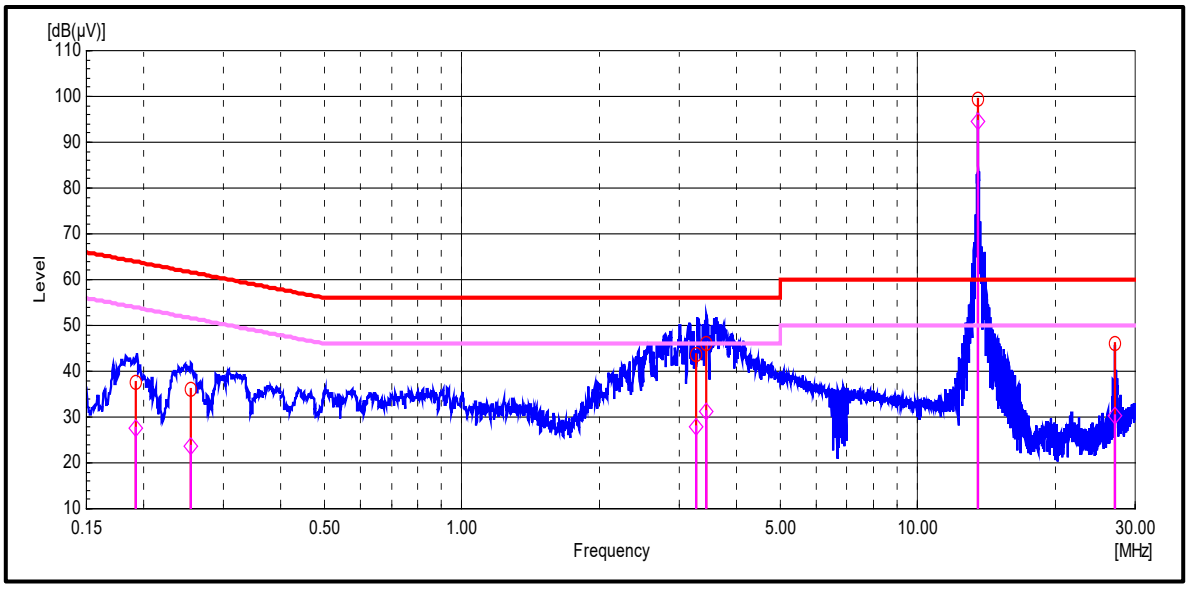
Transmitter AC Conducted Spurious Emissions (continued)

Results: RFID Active mode

Plot: Live / 240 VAC 60 Hz



Plot: Neutral / 240 VAC 60 Hz



Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables. The peaks at 13.56 MHz are the fundamental frequency of the tested technology

Transmitter AC Conducted Spurious Emissions (continued)

Results: RFID Active mode / Antenna Terminated

Results: Live / Quasi Peak / 120 VAC 60 Hz

Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.18742	Live	34.50	64.20	29.70	Complied
0.24107	Live	37.40	62.10	24.70	Complied
0.28357	Live	34.80	60.70	25.90	Complied
0.34227	Live	27.10	59.10	32.00	Complied
0.51281	Live	27.30	56.00	28.70	Complied
2.57834	Live	27.20	56.00	28.80	Complied
2.87224	Live	30.10	56.00	25.90	Complied
3.22892	Live	28.20	56.00	27.80	Complied
3.95621	Live	37.50	56.00	18.50	Complied
13.55977	Live	44.90	60.00	15.10	Complied

Results: Live / Average / 120 VAC 60 Hz

Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.18742	Live	23.10	54.20	31.10	Complied
0.24107	Live	33.60	52.10	18.50	Complied
0.28357	Live	18.50	50.70	32.20	Complied
0.34227	Live	12.40	49.10	36.70	Complied
0.51281	Live	10.30	46.00	35.70	Complied
2.57834	Live	14.30	46.00	31.70	Complied
2.87224	Live	12.70	46.00	33.30	Complied
3.22892	Live	10.90	46.00	35.10	Complied
3.95621	Live	16.70	46.00	29.30	Complied
13.55977	Live	38.80	50.00	11.20	Complied

Transmitter AC Conducted Spurious Emissions (continued)

Results: RFID Active mode / Antenna Terminated

Results: Neutral / Quasi Peak / 120 VAC 60 Hz

Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.17530	Neutral	36.30	64.70	28.40	Complied
0.25254	Neutral	35.00	61.70	26.70	Complied
0.32170	Neutral	19.50	59.70	40.20	Complied
0.43892	Neutral	24.60	57.10	32.50	Complied
0.88478	Neutral	23.50	56.00	32.50	Complied
1.18535	Neutral	21.10	56.00	34.90	Complied
3.66812	Neutral	40.10	56.00	15.90	Complied
13.56148	Neutral	44.10	60.00	15.90	Complied
26.65985	Neutral	22.00	60.00	38.00	Complied
28.44141	Neutral	26.70	60.00	33.30	Complied

.

Results: Neutral / Average / 120 VAC 60 Hz

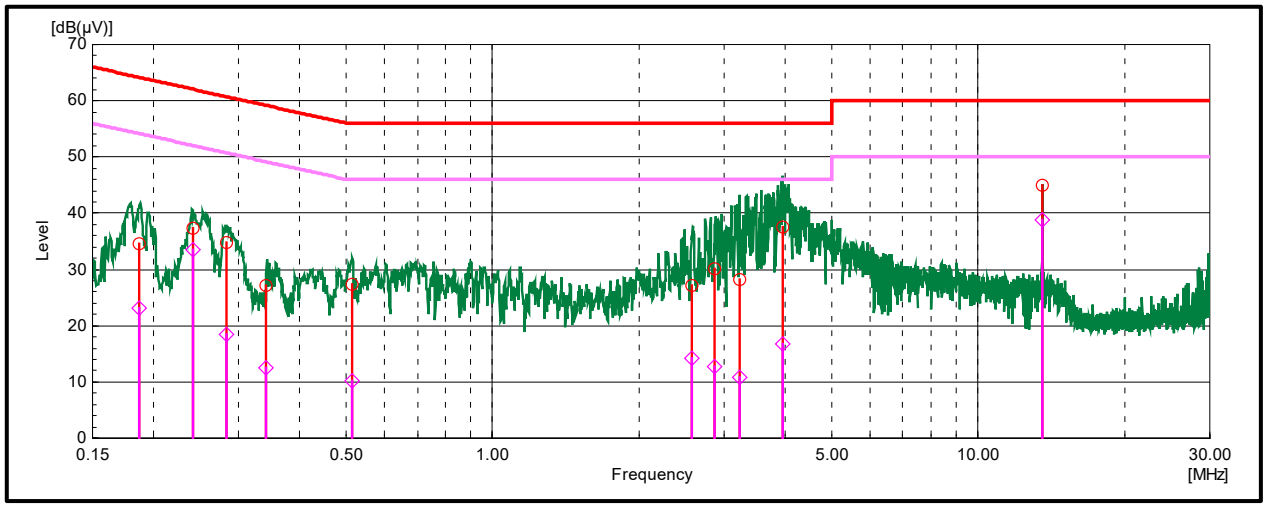
Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.17530	Neutral	23.70	54.70	31.00	Complied
0.25254	Neutral	19.10	51.70	32.60	Complied
0.32170	Neutral	9.60	49.70	40.10	Complied
0.43892	Neutral	8.70	47.10	38.40	Complied
0.88478	Neutral	7.80	46.00	38.20	Complied
1.18535	Neutral	7.30	46.00	38.70	Complied
3.66812	Neutral	26.60	46.00	19.40	Complied
13.56148	Neutral	37.90	50.00	12.10	Complied
26.65985	Neutral	9.20	50.00	40.80	Complied
28.44141	Neutral	17.60	50.00	32.40	Complied

Result: Pass

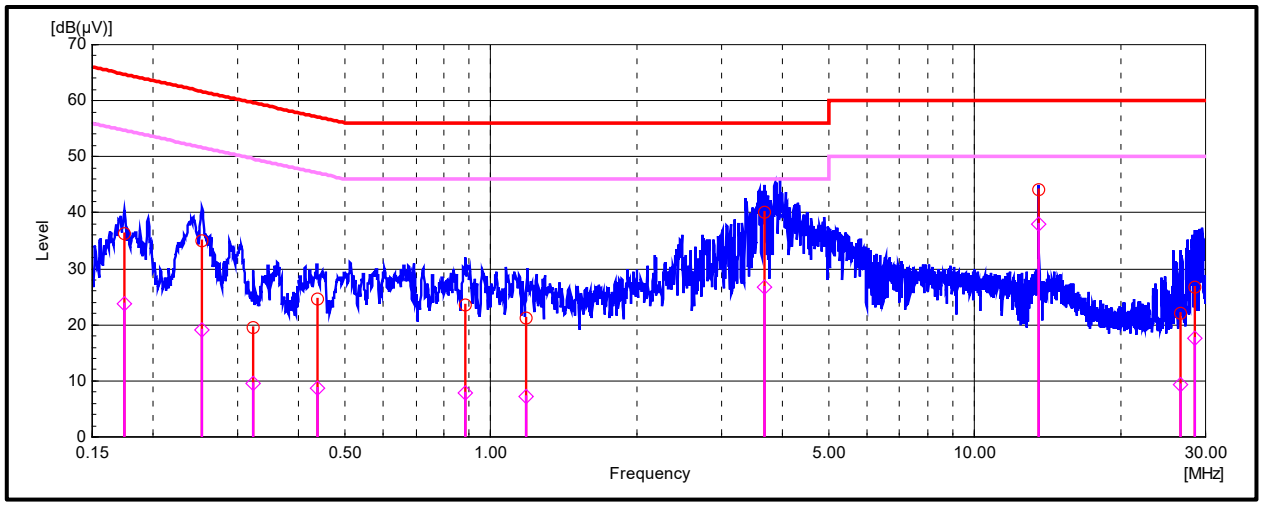
Transmitter AC Conducted Spurious Emissions (continued)

Results: RFID Active mode / Antenna Terminated

Plot: Live / 120 VAC 60 Hz



Plot: Neutral / 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: RFID Active mode / Antenna Terminated

Results: Live / Quasi Peak / 240 VAC 60 Hz

Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
13.55907	Live	42.90	60.00	17.10	Complied
3.70331	Live	44.60	56.00	11.40	Complied
3.46583	Live	40.50	56.00	15.50	Complied
0.57987	Live	32.40	56.00	23.60	Complied
0.23976	Live	39.60	62.10	22.50	Complied
0.17722	Live	35.60	64.60	29.00	Complied

Results: Live / Average / 240 VAC 60 Hz

Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
13.55907	Live	41.00	50.00	9.00	Complied
3.70331	Live	28.00	46.00	18.00	Complied
3.46583	Live	24.70	46.00	21.30	Complied
0.57987	Live	18.70	46.00	27.30	Complied
0.23976	Live	28.90	52.10	23.20	Complied
0.17722	Live	27.60	54.60	27.00	Complied

Results: Neutral / Quasi Peak / 240 VAC 60 Hz

Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.25986	Neutral	34.20	61.40	27.20	Complied
0.17227	Neutral	35.60	64.90	29.30	Complied
3.70118	Neutral	43.90	56.00	12.10	Complied
13.56158	Neutral	42.80	60.00	17.20	Complied
3.37236	Neutral	38.70	56.00	17.30	Complied
0.51163	Neutral	32.50	56.00	23.50	Complied

Results: Neutral / Average / 240 VAC 60 Hz

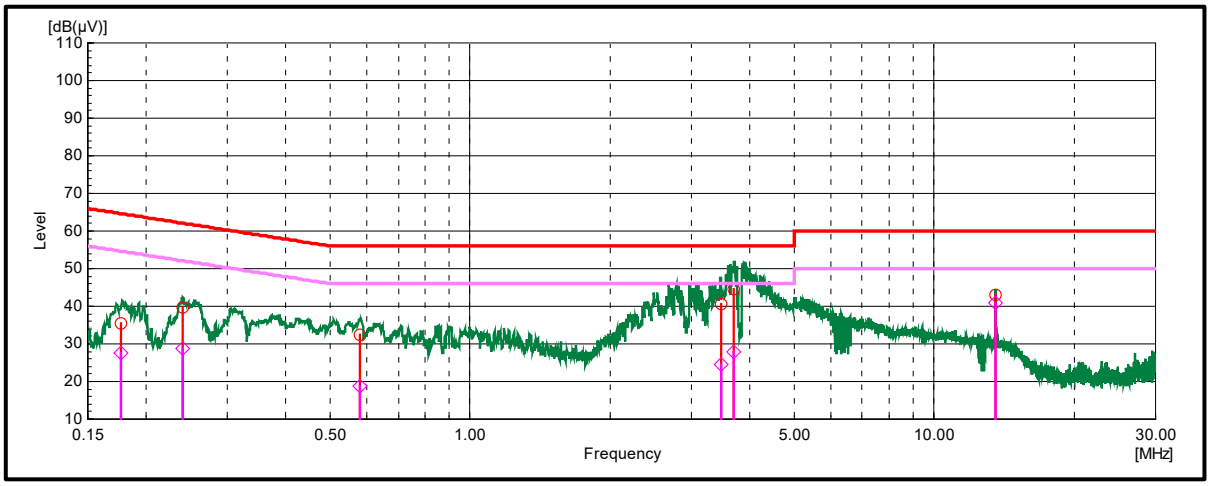
Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.25526	Neutral	23.80	51.40	27.60	Complied
13.56017	Neutral	23.10	54.90	31.80	Complied
27.11997	Neutral	28.30	46.00	17.70	Complied
23.64480	Neutral	36.70	50.00	13.30	Complied
21.39365	Neutral	25.60	46.00	20.40	Complied
29.31887	Neutral	20.90	46.00	25.10	Complied

Result: Pass

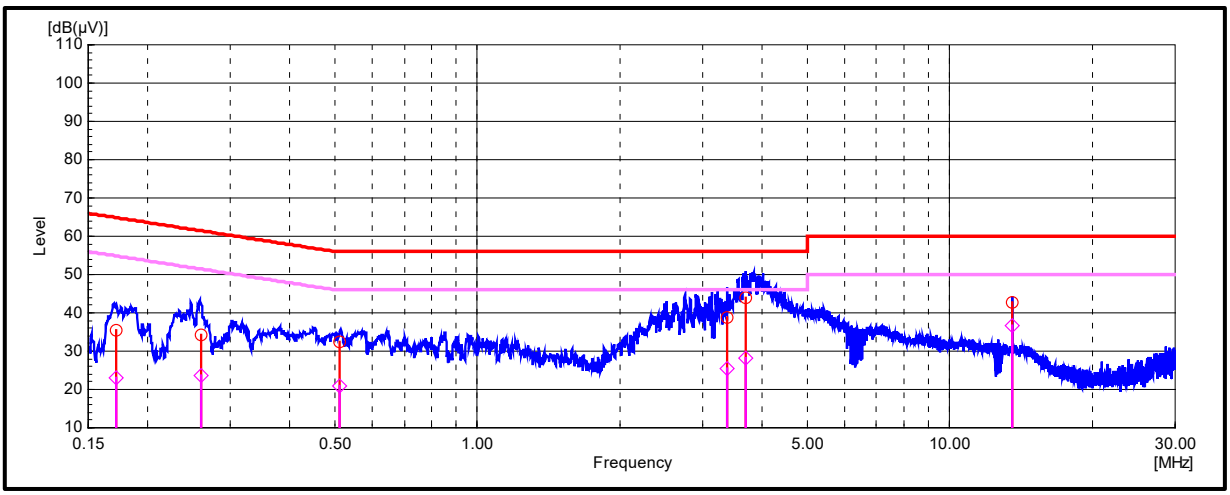
Transmitter AC Conducted Spurious Emissions (continued)

Results: RFID Active mode / Antenna Terminated

Plot: Live / 240 VAC 60 Hz



Plot: Neutral / 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:	Muhammad Faiq Khan	**Test Dates:**	17 August 2023
Test Sample Serial Number:	14EFCF011C000002 (Radiated test sample)		
Test Site Identification	SR 9		

FCC Reference:	Part 15.215(c)
Test Method Used:	ANSI C63.10 Section 6.9.2

Environmental Conditions:

Temperature (°C):	23
Relative Humidity (%):	68

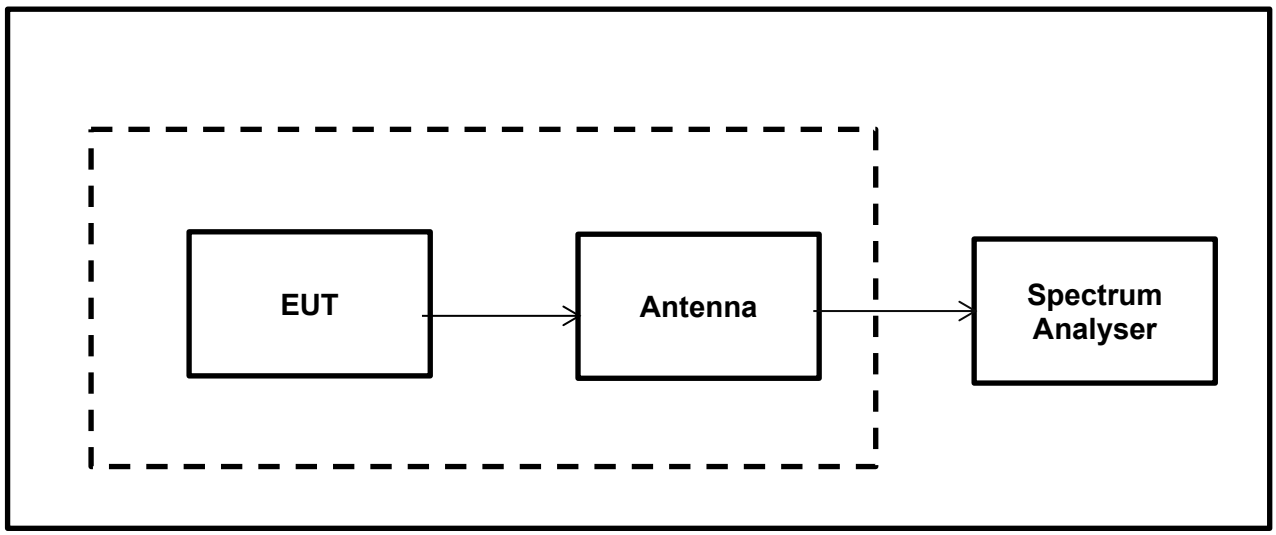
Settings of the Instrument:

RBW/VBW	5 kHz / 20 kHz
Span	250 kHz
Sweep time	Auto
Detector	MaxPeak

Notes:

1. The measurement was performed by setting the RBW to 5 kHz and the VBW to 20 kHz. The span was set to 250 kHz and Peak detector was set on Max hold. Markers were placed 20 dB below the peak level and the difference measured.

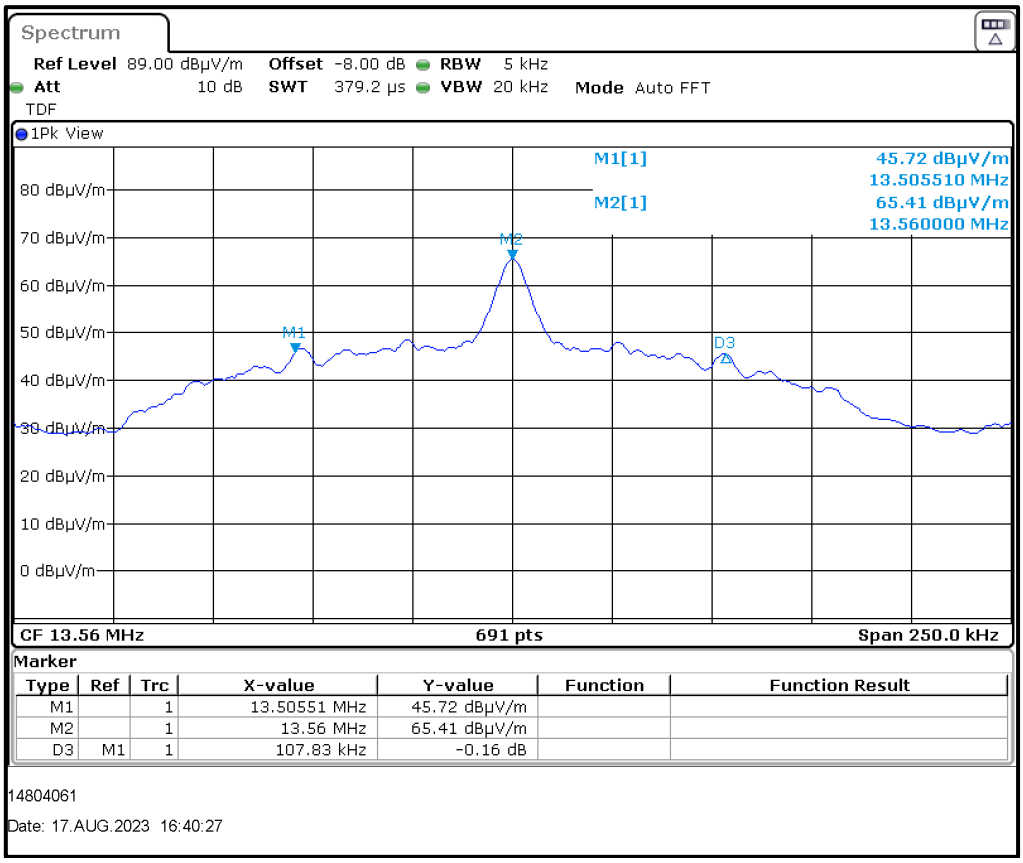
Test Setup:



Transmitter 20 dB Bandwidth (continued)

Results: RFID 13.56 MHz

RFID Channel	20 dB Bandwidth (kHz)
13.56 MHz	107.83



RFID 13.56 MHz

Result: Pass

5.2.3. Transmitter Fundamental Field Strength & Spectrum Mask

Test Summary:

Test Engineer:	Abbas Al-Hussainy	**Test Date:**	15 August 2023
Test Sample Serial Number:	14EFCF011C000002 (Radiated test 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

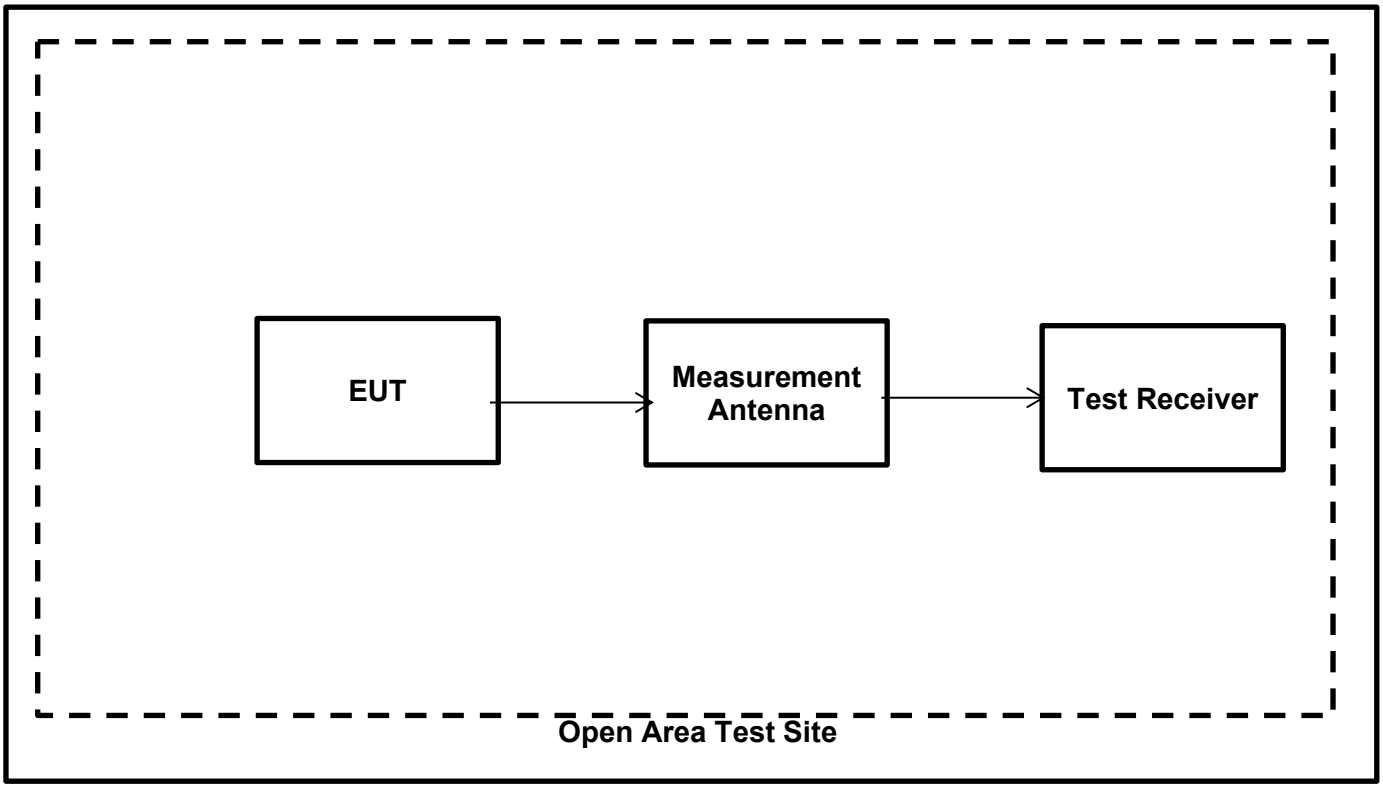
Environmental Conditions:

Temperature (°C):	26.8
Relative Humidity (%):	60.1

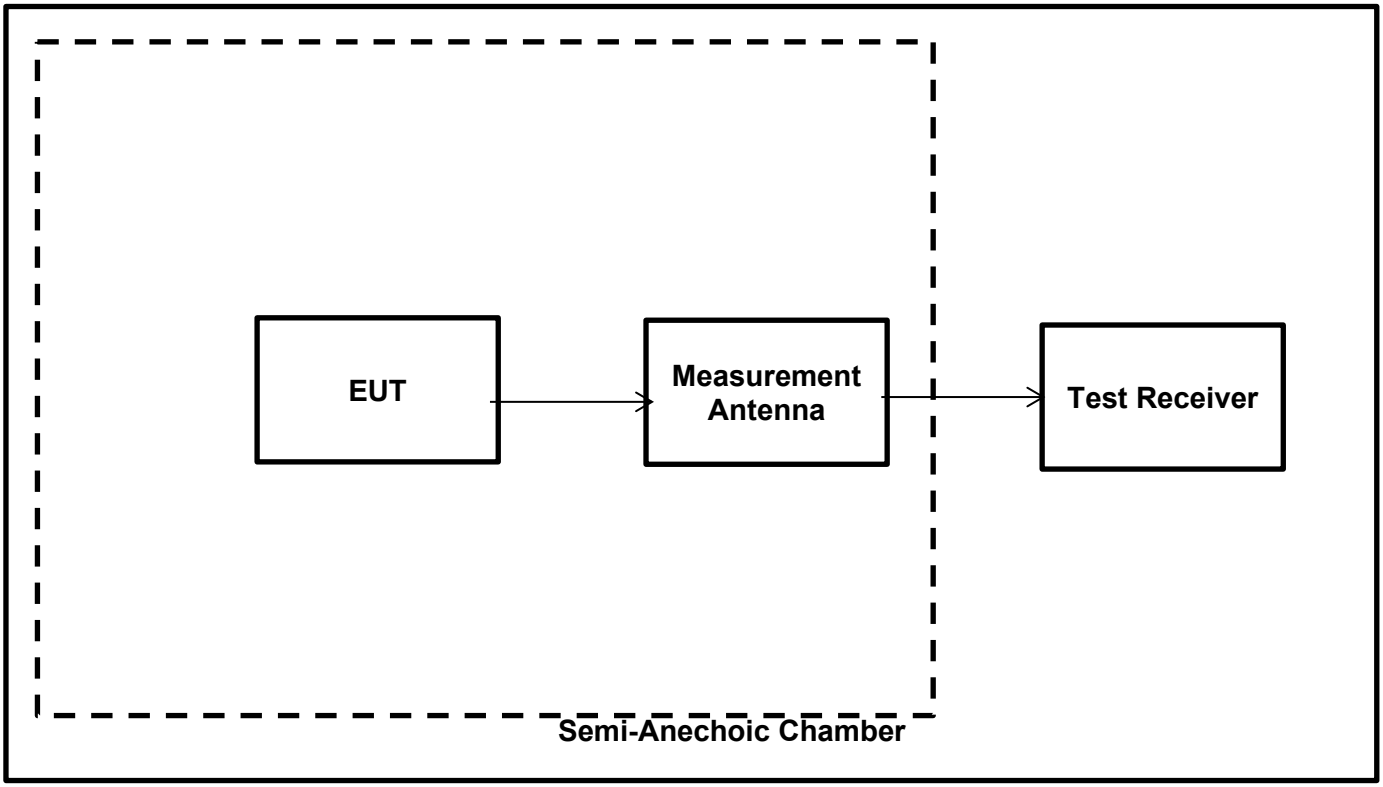
Note(s):

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 FCC KDB 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. Therefore, applicable limits were extrapolated from 30 m to 3 m using a distance extrapolation factor of 40 dB/decade. The transducer factor on the measuring instrument was used to extrapolate the measured values from 30 m to 3 m using a distance extrapolation factor of 40 dB/decade.
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.
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.
7. For the emissions appearing within the 13.110-14.010 MHz band, compliance with the spectrum mask is shown in accordance with FCC Part 15.225(a)(b)(c)(d) limits.
8. The emissions shown at frequencies approximately at 13.56 MHz on the plot represent EUT's fundamental field strength for RFID 13.56 MHz.
9. For the emissions appearing outside of the 13.110-14.010 MHz band, compliance with the spectrum mask is shown in accordance with FCC Part 15.225(d) referencing FCC Part 15.209 general radiated emission limits.

Transmitter Fundamental Field Strength & Spectrum Mask(continued)
Open Area Test Site



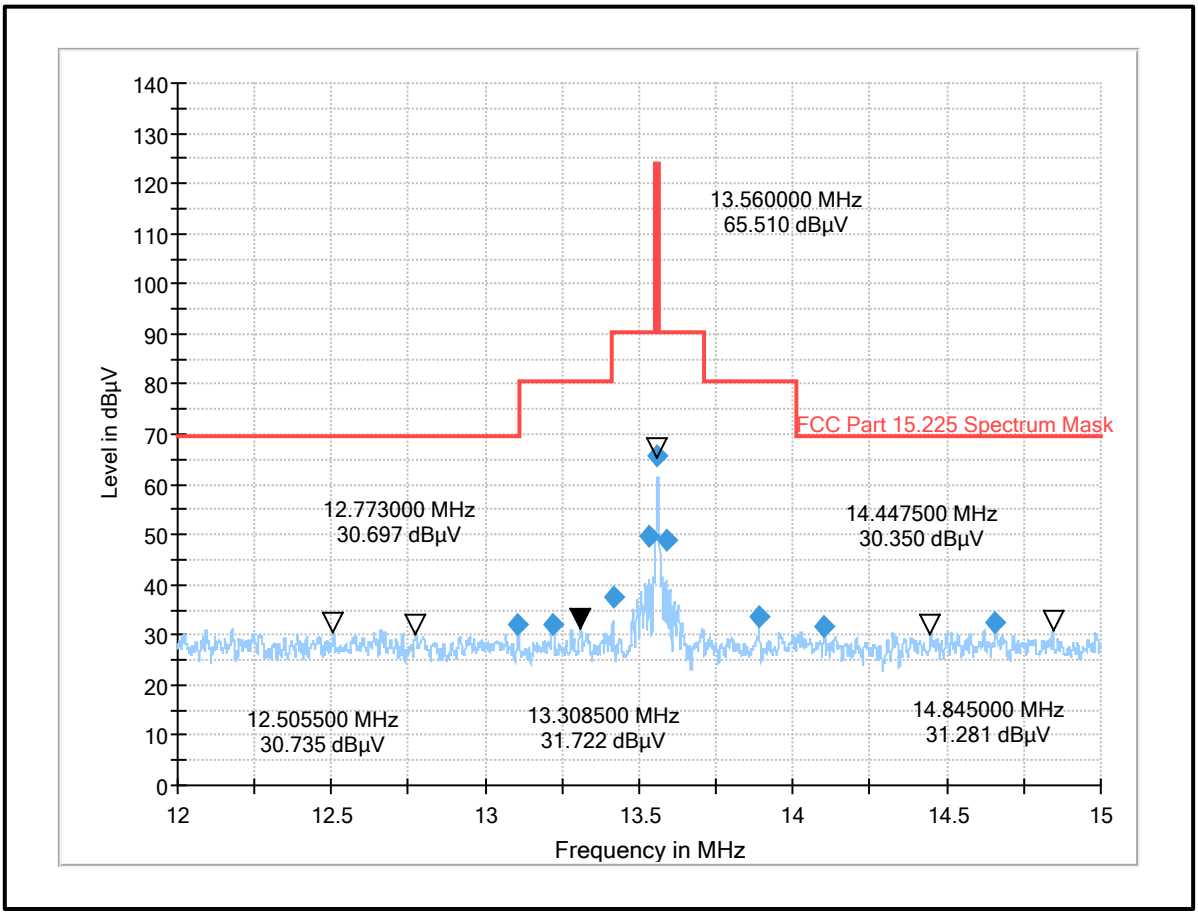
Semi Anechoic Chamber



Transmitter Fundamental Field Strength & Spectrum Mask (continued)
Results: AC Power supply / RFID 13.56 MHz

Frequency Band (MHz)	Emission Frequency (MHz)	Loop Antenna Orientation	MaxPeak Emission Level at 3 m (dBµV/m) Note 3	Deviation from OATS to SAC) (dB)	Deviation Corrected Level at 3 m (dBµV/m)	Limit at 3 m (dBµV/m) Note 3	Margin (dB)	Result
12.000 to 13.110	13.10	0° to EUT	32.22	0.48	32.70	69.50	36.8	Complied
13.110 to 13.410	13.21	0° to EUT	32.16	0.48	32.64	80.50	47.86	Complied
13.410 to 13.553	13.53	90° to EUT	49.52	1.38	50.90	90.50	39.60	Complied
13.553 to 13.567	13.56	90° to EUT	65.51	1.38	66.89	124.00	57.11	Complied
13.567 to 13.710	13.58	90° to EUT	48.93	1.38	50.31	90.50	40.19	Complied
13.710 to 14.010	13.88	0° to EUT	33.48	1.38	34.86	80.50	45.64	Complied
14.010 to 15.000	14.10	0° to EUT	31.56	1.07	32.63	69.50	36.87	Complied
	14.65	90° to EUT	32.51	0.7	32.21	69.50	36.29	Complied

Transmitter Fundamental Field Strength & Spectrum Mask (continued)
Plot: AC Power supply / RFID 13.56 MHz



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

Result: Pass

5.2.4. Transmitter Radiated Spurious Emissions

Test Summary:

Test Engineer:	Muhammad Faiq Khan	**Test Date:**	15 August 2023
Test Sample Serial Number:	14EFCF011C000002 (Radiated test 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:

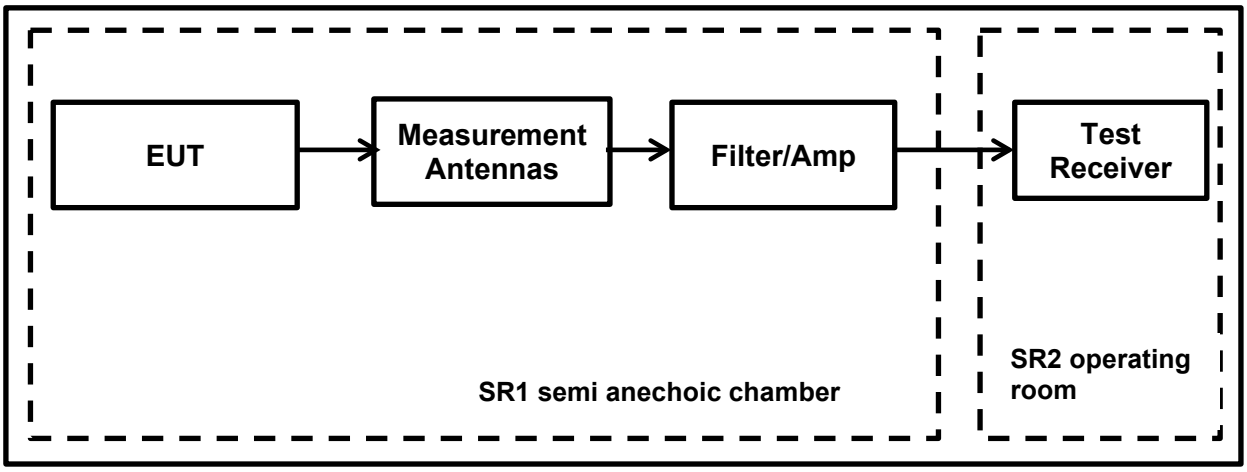
Temperature (°C):	26.9
Relative Humidity (%):	59.9

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. Measurements below 30 MHz were performed in a semi-anechoic chamber SR1/ 2 (Asset Number 1603665) at a distance of 3 m. The EUT placed on a table 80 cm from ground plane in the centre of the chamber turntable. The measurement loop antenna height was at 1 m.
6. 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
7. 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 Emission (continued)

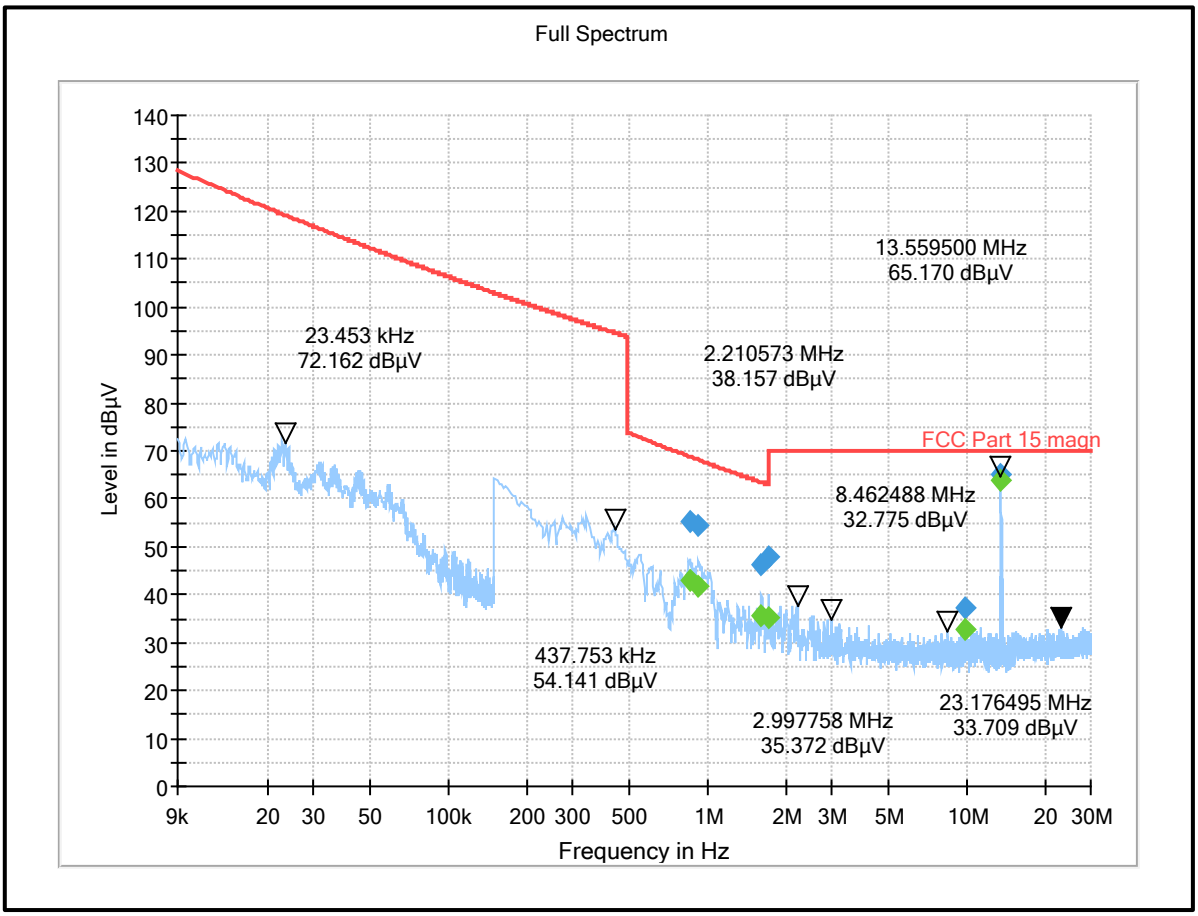
Test Setup:



Transmitter Radiated Emissions (continued)

Results: AC Power supply / RFID 13.56 MHz

Frequency (MHz)	Loop Antenna Orientation	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
0.857805	0° to EUT	55.37	68.72	13.35	Complied
0.923955	0° to EUT	54.33	68.08	13.75	Complied
1.608608	0° to EUT	46.46	63.44	16.98	Complied
1.714448	0° to EUT	48.03	70.00	21.97	Complied
9.871703	90° to EUT	37.10	70.00	32.90	Complied



Result: Pass

Transmitter Radiated Emissions (continued)

Test Summary:

Test Engineer:	Abbas Al-Hussainy	**Test Date:**	15 August 2023
Test Sample Serial Number:	14EFCF011C000002 (Radiated test 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 6.5
Frequency Range:	30 MHz to 1000 MHz

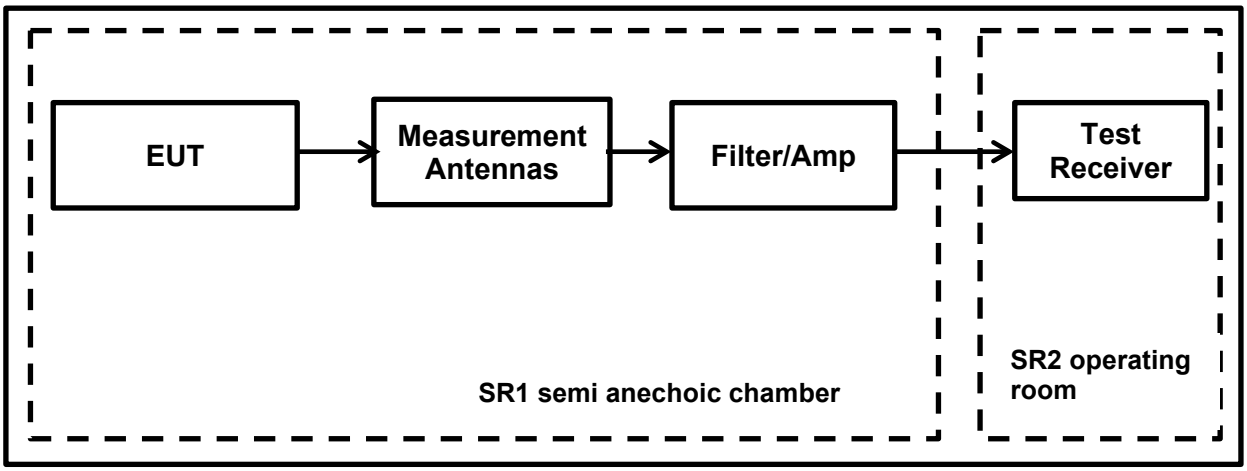
Environmental Conditions:

Temperature (°C):	26.9
Relative Humidity (%):	59.9

Note(s):

1. All 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.
2. 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 floor standing equipment and placed at on 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.
3. 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.

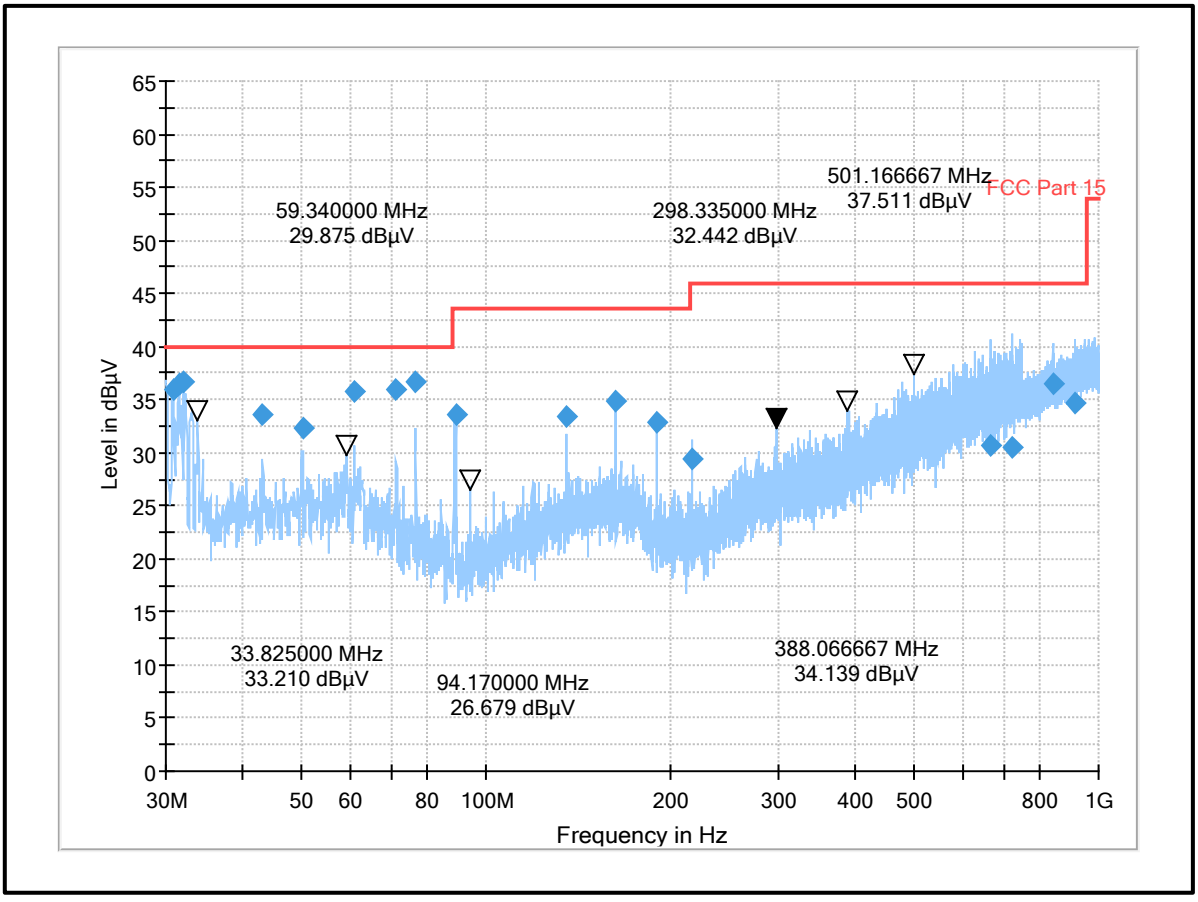
Test Setup:



Transmitter Radiated Emissions (continued)

Results: AC Power supply / RFID 13.56 MHz

Frequency (MHz)	Antenna Polarization	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
30.810000	Vertical	35.98	40.00	4.02	Complied
32.070000	Vertical	36.67	40.00	3.33	Complied
43.185000	Vertical	33.60	40.00	6.40	Complied
50.115000	Horizontal	32.24	40.00	7.76	Complied
60.915000	Vertical	35.70	40.00	4.30	Complied
71.400000	Vertical	35.94	40.00	4.06	Complied
76.620000	Vertical	36.61	40.00	3.39	Complied
89.310000	Vertical	33.57	43.50	9.93	Complied
135.615000	Vertical	33.48	43.50	10.02	Complied
162.750000	Vertical	34.79	43.50	8.71	Complied
189.840000	Vertical	32.90	43.50	10.60	Complied
216.975000	Vertical	29.48	46.00	16.52	Complied
664.500000	Horizontal	30.67	46.00	15.33	Complied
721.250000	Vertical	30.56	46.00	15.44	Complied
840.750000	Horizontal	36.56	46.00	9.44	Complied
916.875000	Vertical	34.65	46.00	11.35	Complied



Result: Pass

5.2.5. Transmitter Frequency Stability (Temperature & Voltage Variation)

Test Summary:

Test Engineer:	Muhammad Faiq Khan	**Test Dates:**	18 & 22 August 2023
Test Sample Serial Number:	14EFCF011C000002 (Radiated test 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):	23.8 to 24.7
Ambient Relative Humidity (%):	60 to 64.4

Settings of the Instrument

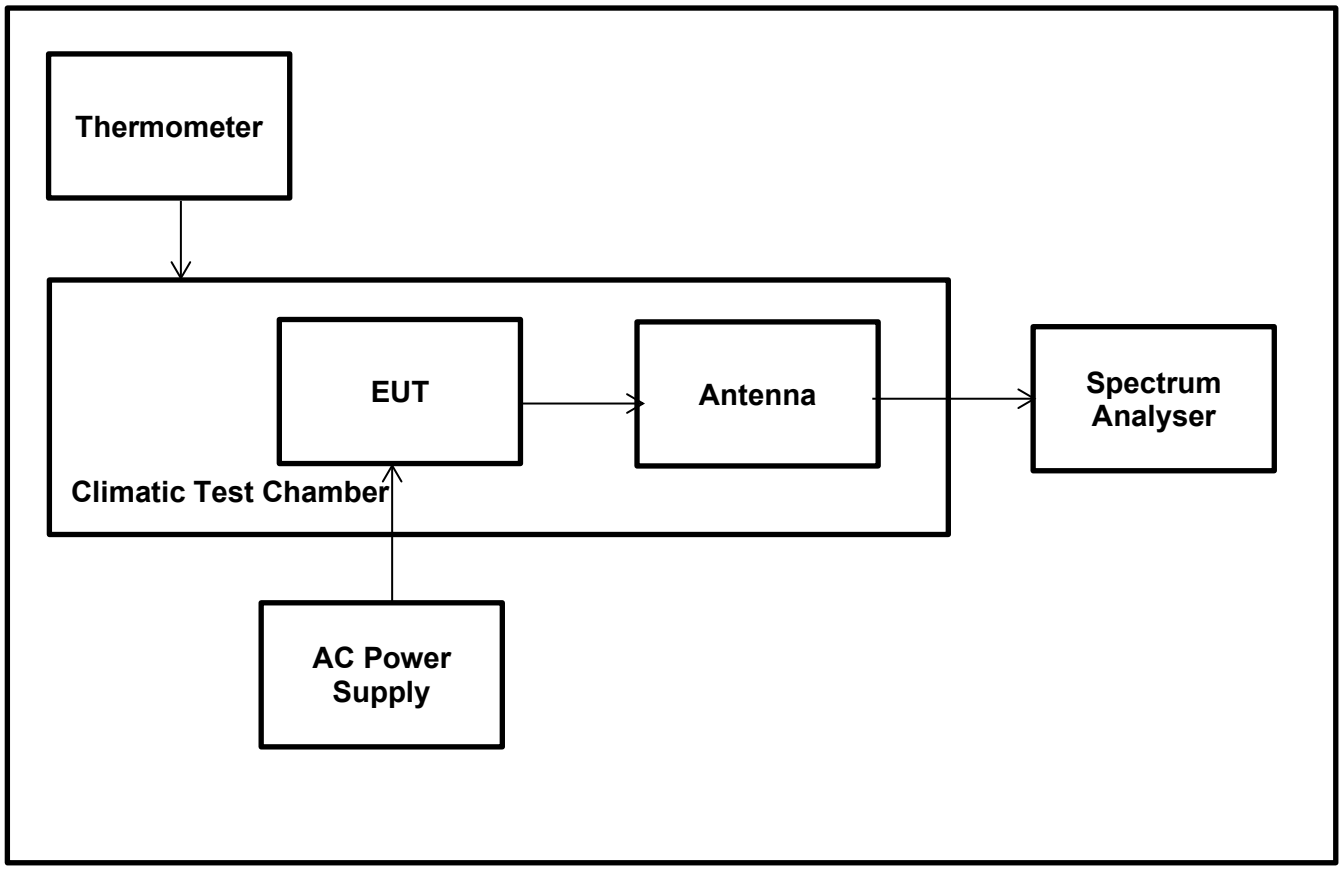
RBW/VBW	30 Hz/30 kHz
Span	4 kHz
Sweep Time	Auto
Sweep Mode	Single Sweep
Detector	Peak
Marker Function	Signal Count

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 measurement 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

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

Test Setup:



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

Results: AC 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	13.560331339	0.002443503	24.44	± 0.01	± 100	Complied
	at 2 minutes	13.560353287	0.002605361	26.05	± 0.01	± 100	Complied
	at 5 minutes	13.560357009	0.002632810	26.33	± 0.01	± 100	Complied
	at 10 minutes	13.560357569	0.002636940	26.37	± 0.01	± 100	Complied
-10	at 0 minutes	13.560352507	0.002599609	26.00	± 0.01	± 100	Complied
	at 2 minutes	13.560353296	0.002605428	26.05	± 0.01	± 100	Complied
	at 5 minutes	13.560347454	0.002562345	25.62	± 0.01	± 100	Complied
	at 10 minutes	13.560345572	0.002548466	25.48	± 0.01	± 100	Complied
0	at 0 minutes	13.560349305	0.002575996	25.76	± 0.01	± 100	Complied
	at 2 minutes	13.560340909	0.002514078	25.14	± 0.01	± 100	Complied
	at 5 minutes	13.560333225	0.002457412	24.57	± 0.01	± 100	Complied
	at 10 minutes	13.560326128	0.002405074	24.05	± 0.01	± 100	Complied
+10	at 0 minutes	13.560342722	0.002527448	25.27	± 0.01	± 100	Complied
	at 2 minutes	13.560326781	0.002409889	24.10	± 0.01	± 100	Complied
	at 5 minutes	13.560317631	0.002342412	23.42	± 0.01	± 100	Complied
	at 10 minutes	13.560307747	0.002269521	22.70	± 0.01	± 100	Complied
+20	at 0 minutes	13.560322619	0.002379196	23.79	± 0.01	± 100	Complied
	at 2 minutes	13.560315454	0.002326357	23.26	± 0.01	± 100	Complied
	at 5 minutes	13.560310827	0.002292235	22.92	± 0.01	± 100	Complied
	at 10 minutes	13.560307196	0.002265457	22.65	± 0.01	± 100	Complied
+30	at 0 minutes	13.560318907	0.002351822	23.52	± 0.01	± 100	Complied
	at 2 minutes	13.560306122	0.002257537	22.58	± 0.01	± 100	Complied
	at 5 minutes	13.560299202	0.002206504	22.07	± 0.01	± 100	Complied
	at 10 minutes	13.560292418	0.002156475	21.56	± 0.01	± 100	Complied
+40	at 0 minutes	13.560296680	0.002187906	21.88	± 0.01	± 100	Complied
	at 2 minutes	13.560286406	0.002112139	21.12	± 0.01	± 100	Complied
	at 5 minutes	13.560281902	0.002078923	20.79	± 0.01	± 100	Complied
	at 10 minutes	13.560278731	0.002055538	20.56	± 0.01	± 100	Complied
+50	at 0 minutes	13.560279489	0.002061128	20.61	± 0.01	± 100	Complied
	at 2 minutes	13.560277183	0.002044122	20.44	± 0.01	± 100	Complied
	at 5 minutes	13.560278099	0.002050878	20.51	± 0.01	± 100	Complied
	at 10 minutes	13.560280707	0.002070111	20.70	± 0.01	± 100	Complied

Result: Pass

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

Results: AC 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 Primary Supply Voltage	102	13.560322961	0.002382	23.82	± 0.01	± 100	Complied
Rated Primary Supply Voltage	120	13.560316746	0.002336	23.36	± 0.01	± 100	Complied
115% of Rated Primary Supply Voltage	138	13.560320748	0.002365	23.65	± 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	18/07/2023	36
377	BONN Elektronik	Amplifier, Low Noise Pre	BLMA 0118-1A	025294B	18/07/2023	12
460	Deisel	Turntable	DT 4250 S	n/a	n/a	n/a
465	Schwarzbeck	Antenna, Trilog Broadband	VULB 9168	9168-240	02/09/2020	36
496	Rohde & Schwarz	Antenna, log. - periodical	HL050	100297	22/08/2022	24
588	Maturo	Controller	NCD	029/7180311	n/a	n/a
591	Rohde & Schwarz	Receiver	ESU 40	100244/040	13/07/2023	12
669	Rohde & Schwarz	EMI Test Receiver	ESW 44	103087	13/07/2023	18
607	Schwarzbeck	Antenna broadband horn antenna	BBHA 9170	9170-561	15/10/2019	48
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
681	Maturo	Antenna mast, tilting	BAM4.5-P	402/0718.1	n/a	n/a

Test site: SR 9

ID	Manufacturer	Type	Model	Serial	Calibration Date	Cal. Cycle (months)
625	Schwarzbeck	Antenna, H-field	HFSL 7101	109	lab verification only relative measurements	n/a
637	Rohde & Schwarz	Spectrum Analyser	FSV40	101587	12/07/2023	12
327	SPS	AC/DC power distribution system	PAS 5000	A2464 00/1 0200	lab verification	n/a
-/-	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

Test site: SR 7/8

ID	Manufacturer	Type	Model	Serial No.	Calibration Date	Cal. Cycle
22	Rohde & Schwarz	Artificial Mains	ESH3-Z5	831767/014	18.07.2023	12
23	Rohde & Schwarz	Artificial Mains	ESH3-Z5	831767/013	18.07.2023	12
28	Rohde & Schwarz	Passive Probe	ESH2-Z3	none	13.07.2022	36
215	Rohde & Schwarz	Artificial Mains Network	ESH2-Z5	879675/002	18.07.2023	24
349	Rohde & Schwarz	Receiver, EMI Test	ESIB7	836697/009	18.07.2023	12
351	Rohde & Schwarz	network, Artificial Mains	ESH3-Z5	862770/018	18.07.2023	12
505	Rohde & Schwarz	Absorbing Clamp	MDS21	100005	21.07.2023	48

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:

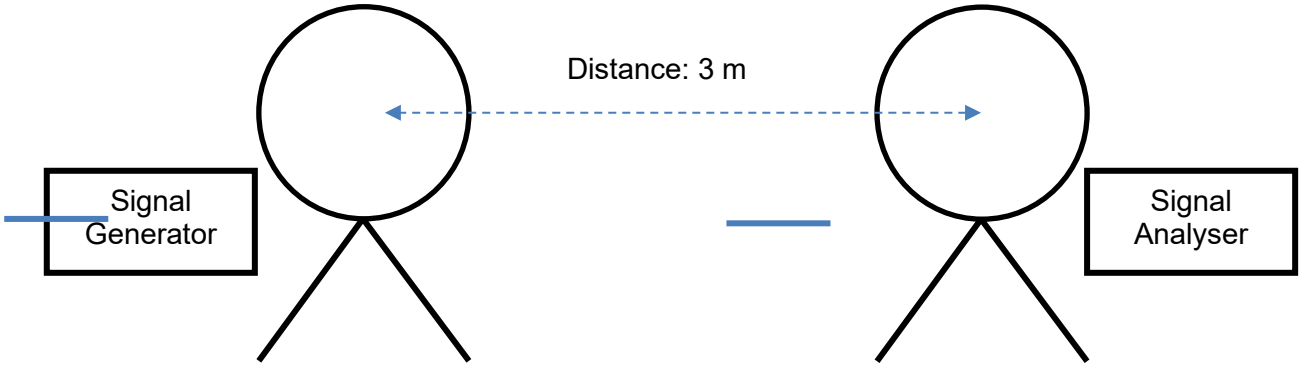
Manufacturer	Type	Model	Frequency Range
Rohde & Schwarz	Signal generator	SML03	9 kHz – 30 MHz
Rohde & Schwarz	Receiver, EMI Test	ESIB7	20 Hz – 7 GHz
Rohde & Schwarz	Antenna, Loop	HFH2-Z2	1 kHz – 30 MHz
ETS LINDGREN	Antenna, Loop	6512	1 kHz – 30 MHz
HUBER+SUHNER	RF Cable	-/-	-/-
Elspec	BNC Cable	-/-	-/-

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

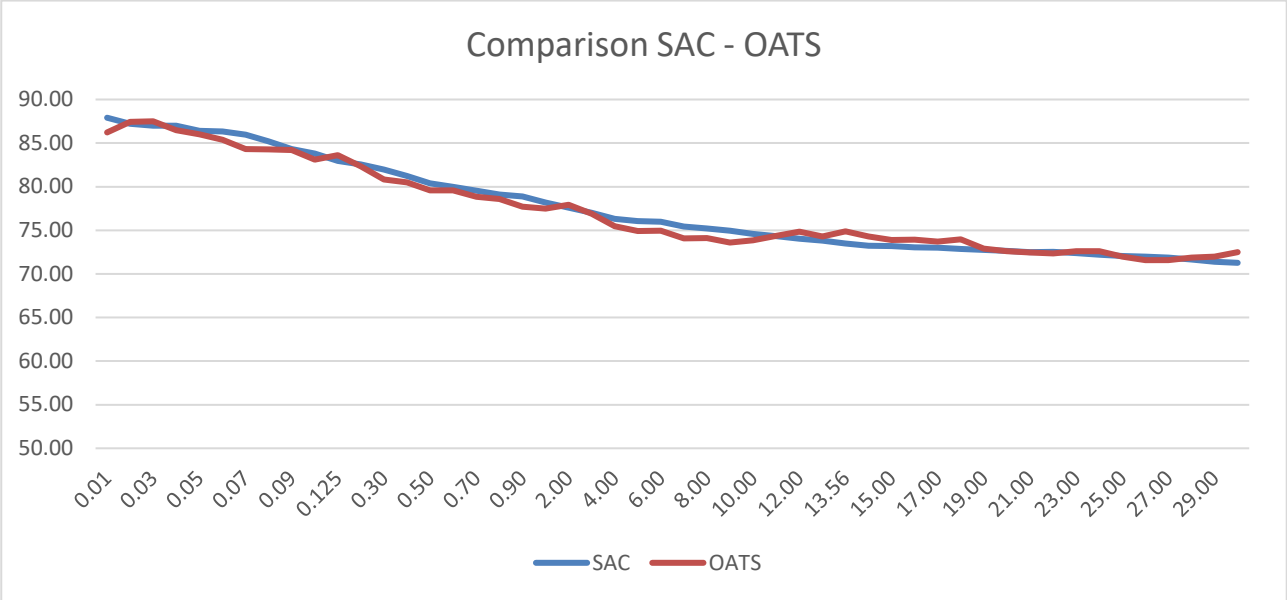
Frequency (MHz)	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	2.00	3.00	4.00	5.00
SR1 Measured power (dBµV)	81.98	81.23	80.39	80.00	79.53	79.10	78.87	78.20	77.60	77.01	76.32	76.04
OATS Measured power (dBµV)	80.84	80.49	79.58	79.58	78.85	78.59	77.69	77.50	77.91	76.90	75.45	74.90
Delta (dB)	-1.14	-0.74	-0.81	-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	42	-	Initial Version
Test Report Version 1.1 supersede Version 1.0 with immediate effect Test Report No. UL-RPT-RP-14804061-316-FCC Version 1.1, Issue Date 26 SEPTEMBER 2023 replaces Test Report No. UL-RPT-RP-14804061-316-FCC Version 1.0, Issue Date 22 SEPTEMBER 2023, which is no longer valid.			
	Page No(s)	**Clause**	**Details**
1.1	1 & 7	-	Model Name and FCC Identifier updated
	37	7	Used equipment list for Test Site SR1/2 updated

END of Test Report