



TEST REPORT

Test Report No. : UL-RPT-RP-12321316-616-FCC

Applicant : enomatic SRL
Model No. : E3_A1
FCC ID : 2AWPSE3A1
Technology : NFC 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-12321316-616-ISED Version 1.2, Issue Date 18 NOVEMBER 2020 replaces
Test Report No. UL-RPT-RP-12321316-616-ISED Version 1.1, Issue Date 04 NOVEMBER 2020, which is no longer valid.
5. Result of the tested sample: **PASS**

Prepared by: Usta, Sercan
Title: Laboratory Engineer
Date: 18 November 2020

Approved by: Ajit, Phadtare
Title: Lead Test Engineer
Date: 18 November 2020



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The tests reported herein have been performed in
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1. Customer Information

1.1.Applicant Information

Company Name:	enomatic SRL
Company Address:	Via di meleto 1/27 50022 Strada In Chianti, Firenze, Italy
Contact Person:	Giacomo Gagli
Contact E-Mail Address:	g.gagli@enomatic.it
Contact Phone No.:	+39 055 85 47 272 - 9418

1.2.Manufacturer Information

Company Name:	enomatic SRL
Company Address:	Via di meleto 1/27 50022 Strada In Chianti, Firenze, Italy
Contact Person:	Lorenzo Bencistà Falorni
Contact E-Mail Address:	info@enomatic.it
Contact Phone No.:	+39 055 85 47 272

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:	18 May 2018
EUT arrived:	16 January 2020
Test Dates:	24 April 2020 to 22 September 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 v01
Title:	TEST SITES FOR RADIATED EMISSION MEASUREMENTS
Reference:	FCC KDB Publication Number 174176 Date: 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:	enomatic
Model Name or Number:	E3_A1
Serial Number:	B00351
Hardware Version Number:	Rev.0
Firmware Version Number:	N/A
Software Version Number:	0.1.0
FCC ID:	2AWPSE3A1

Brand Name:	enomatic
Model Name or Number:	Mifare 1K
Serial Number:	Not stated
Hardware Version Number:	Not Stated
Firmware Version Number:	Not Stated
Additional Details:	Passive NFC-13.56 MHz Card

3.2. Description of EUT

The device under test was NFC module supporting operations on NFC 13.56 MHz 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:	NFC 13.56 MHz	
Type of Unit:	Transceiver	
Supported NFC Mode(s):	NFC-A, NFC-B, NFC-F	
Supported Data Rate(s):	106 Kbps, 212 Kbps, 424 Kbps, 848 Kbps	
Channel Spacing:	Single channel device	
Transmit Frequency Range:	13.56 MHz	
Power Supply Requirement(s):	Nominal	5 V DC / 150 mA max
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	-/-	-/-	-/-	-/-

B. Support Equipment (Manufacturer supplied)

Item	Description	Brand Name	Model Name or Number	Serial Number
1	Test Board	enomatic	E3_C1	N/A
2	EUT Flat Multicore Digital Communication Cable (3m)	HUNG FU	Style 2651	N/A
3	AC Power Cable	N/A	N/A	N/A

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 13.56 MHz with maximum power in worst case mode: NFC-A- 848 Kbps*

* As per applicant's declaration the EUT will implement only NFC-A mode.

*Multiple supported data rates (106 Kbps, 212 Kbps, 424 Kbps, 848 Kbps) were initially investigated to determine the above mentioned worst case data rate

4.2. Configuration and Peripherals

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

EUT Power Supply:

- The EUT was powered via 5 V DC over a long communication cable (3m) from test board. The test board was powered via 120 VAC/60 Hz AC power supply.
- The AC conducted line emissions measurement were carried out with test board powered via 120 VAC /60 Hz & 240 VAC/60 Hz.

Test Mode Activations:

- The test modes were enabled via touch screen menu on test board.
- The NFC card was placed on the EUT.
- All measurements were performed in continuous transmitting modulated carrier at 13.56 MHz with maximum power in worst case mode: NFC-A- 848 Kbps*.

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 standing-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 80 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.
- 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:	Vladimir Eppel	Test Date:	15 July 2020
Test Sample Serial Number:	B00351		
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:

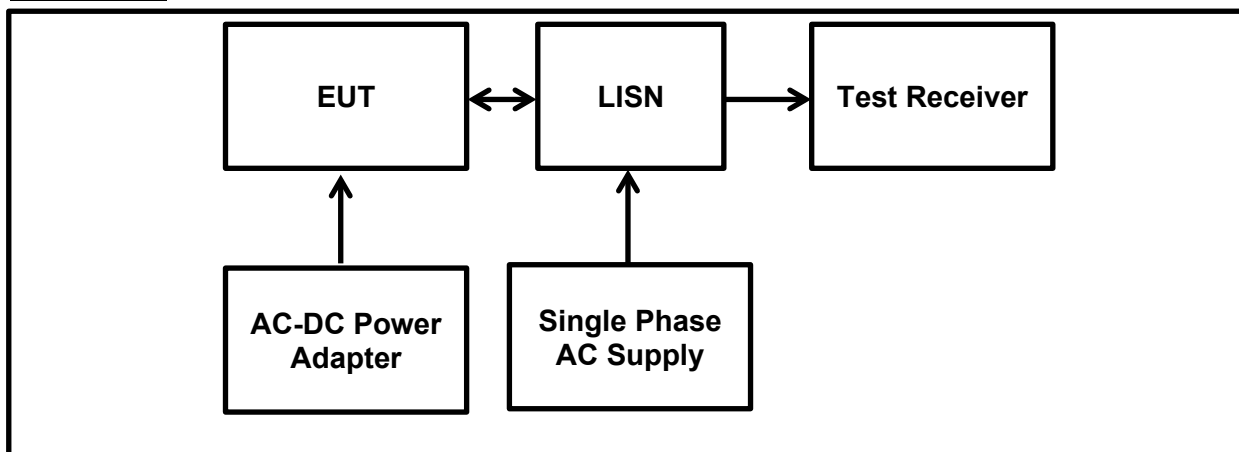
Temperature (°C):	23
Relative Humidity (%):	41

Settings of the Instrument

Detector	Quasi Peak/ Average Peak
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Note(s):

- For AC conducted line emissions measurements the EUT was powered via 5 V DC using test board which was connected to 120 VAC / 60 Hz single phase supply via a LISN.
- 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 NFC 13.56 MHz : Single Channel.
- 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.
- The final measured value, for the given emission, in the table below incorporates the cable loss.
- 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.
- 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.
- Measurement software used: Toyo EMI Software; CE measurement software EP5/CE Ver 4.0.1.
- In order to eliminate NFC 13.56 MHz coupling effect on the AC line, 2 x Ferrites (Manufacturer: WE | Model: 74272722) were put on the AC power cable on 120 V AC tests.
- In order to eliminate NFC 13.56 MHz coupling effect on the AC line, 2 x Ferrites (Manufacturer: WE | Model: 74272722) were put on the AC power cable on 240 V AC tests.

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 (dB μ V)	Limit (dB μ V)	Margin (dB)	Result
0.1507	Live	41.00	66.00	25.00	Complied
0.1741	Live	47.00	64.80	17.80	Complied
0.2163	Live	51.90	63.00	11.10	Complied
0.2363	Live	50.60	62.20	11.60	Complied
0.2627	Live	46.30	61.30	15.00	Complied
0.2822	Live	45.90	60.80	14.90	Complied
0.4275	Live	40.60	57.30	16.70	Complied
0.4507	Live	39.40	56.90	17.50	Complied
3.6649	Live	31.60	56.00	24.40	Complied

Results: Live / Average / 120 VAC 60 Hz

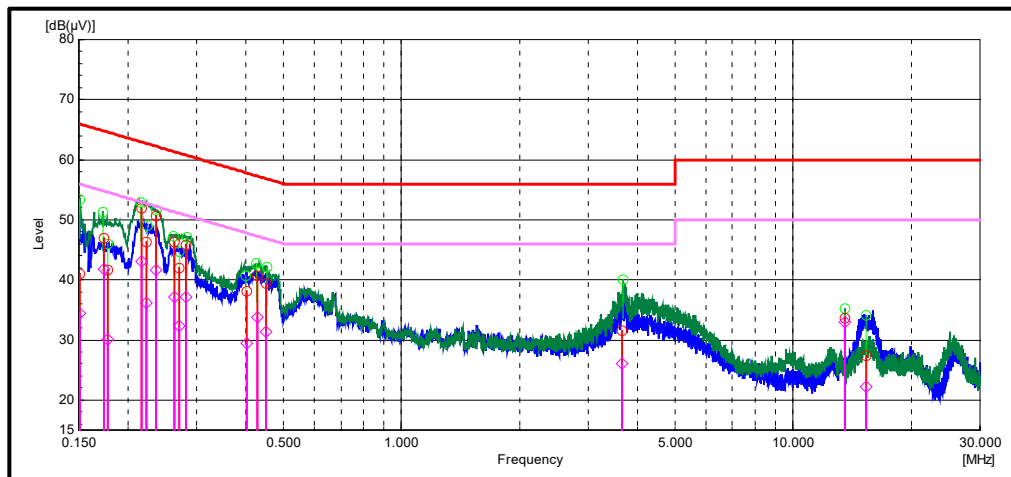
Frequency (MHz)	Line	Level (dB μ V)	Limit (dB μ V)	Margin (dB)	Result
0.1507	Live	34.40	56.00	21.60	Complied
0.1741	Live	41.80	54.80	13.00	Complied
0.2163	Live	43.10	53.00	9.90	Complied
0.2363	Live	41.60	52.20	10.60	Complied
0.2627	Live	37.20	51.30	14.10	Complied
0.2822	Live	37.10	50.80	13.70	Complied
0.4275	Live	33.80	47.30	13.50	Complied
0.4507	Live	31.30	46.90	15.60	Complied
3.6649	Live	26.10	46.00	19.90	Complied

Results: Neutral / Quasi Peak / 120 VAC 60 Hz

Frequency (MHz)	Line	Level (dB μ V)	Limit (dB μ V)	Margin (dB)	Result
0.1780	Neutral	41.60	64.60	23.00	Complied
0.2232	Neutral	46.30	62.70	16.40	Complied
0.2703	Neutral	42.00	61.10	19.10	Complied
0.4015	Neutral	38.00	57.80	19.80	Complied
13.5612	Neutral	33.70	60.00	26.30	Complied
15.3357	Neutral	27.40	60.00	32.60	Complied

Transmitter AC Conducted Spurious Emissions (continued)**Results: Neutral / Average / 120 VAC 60 Hz**

Frequency (MHz)	Line	Level (dB μ V)	Limit (dB μ V)	Margin (dB)	Result
0.1780	Neutral	30.00	54.60	24.60	Complied
0.2232	Neutral	36.20	52.70	16.50	Complied
0.2703	Neutral	32.40	51.10	18.70	Complied
0.4015	Neutral	29.40	47.80	18.40	Complied
13.5612	Neutral	32.90	50.00	17.10	Complied
15.3357	Neutral	22.30	50.00	27.70	Complied

Result: Pass**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 (dB μ V)	Limit (dB μ V)	Margin (dB)	Result
0.1508	Live	41.80	66.00	24.20	Complied
0.2128	Live	49.90	63.10	13.20	Complied
0.2240	Live	49.70	62.70	13.00	Complied
0.2386	Live	48.50	62.10	13.60	Complied
0.2593	Live	45.40	61.50	16.10	Complied
0.2893	Live	42.10	60.50	18.40	Complied
0.4293	Live	38.50	57.30	18.80	Complied

Results: Live / Average / 240 VAC 60 Hz

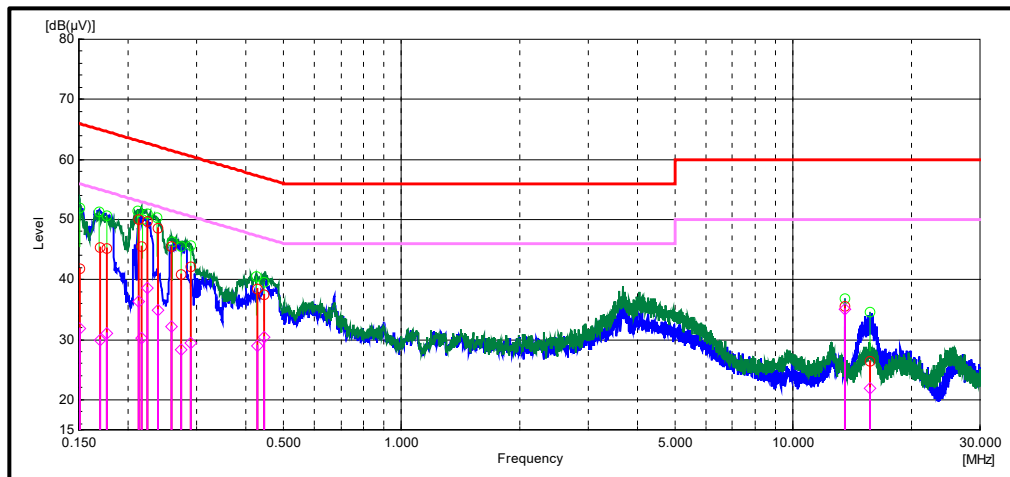
Frequency (MHz)	Line	Level (dB μ V)	Limit (dB μ V)	Margin (dB)	Result
0.1508	Live	31.80	56.00	24.20	Complied
0.2128	Live	36.30	53.10	16.80	Complied
0.2240	Live	38.60	52.70	14.10	Complied
0.2386	Live	34.90	52.10	17.20	Complied
0.2593	Live	32.20	51.50	19.30	Complied
0.2893	Live	29.40	50.50	21.10	Complied
0.4293	Live	28.90	47.30	18.40	Complied

Results: Neutral / Quasi Peak / 240 VAC 60 Hz

Frequency (MHz)	Line	Level (dB μ V)	Limit (dB μ V)	Margin (dB)	Result
0.1698	Neutral	45.40	65.00	19.60	Complied
0.1772	Neutral	45.20	64.60	19.40	Complied
0.2174	Neutral	45.50	62.90	17.40	Complied
0.2739	Neutral	40.90	61.00	20.10	Complied
0.4467	Neutral	37.50	56.90	19.40	Complied
13.5617	Neutral	35.60	60.00	24.40	Complied
15.6812	Neutral	26.30	60.00	33.70	Complied

Transmitter AC Conducted Spurious Emissions (continued)**Results: Neutral / Average / 240 VAC 60 Hz**

Frequency (MHz)	Line	Level (dB μ V)	Limit (dB μ V)	Margin (dB)	Result
0.1698	Neutral	30.00	55.00	25.00	Complied
0.1772	Neutral	31.00	54.60	23.60	Complied
0.2174	Neutral	30.20	52.90	22.70	Complied
0.2739	Neutral	28.30	51.00	22.70	Complied
0.4467	Neutral	30.40	46.90	16.50	Complied
13.5617	Neutral	35.10	50.00	14.90	Complied
15.6812	Neutral	21.90	50.00	28.10	Complied

Result: Pass**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:	Krume Ivanov	Test Dates:	22 September 2020
Test Sample Serial Number:	B00351		
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:

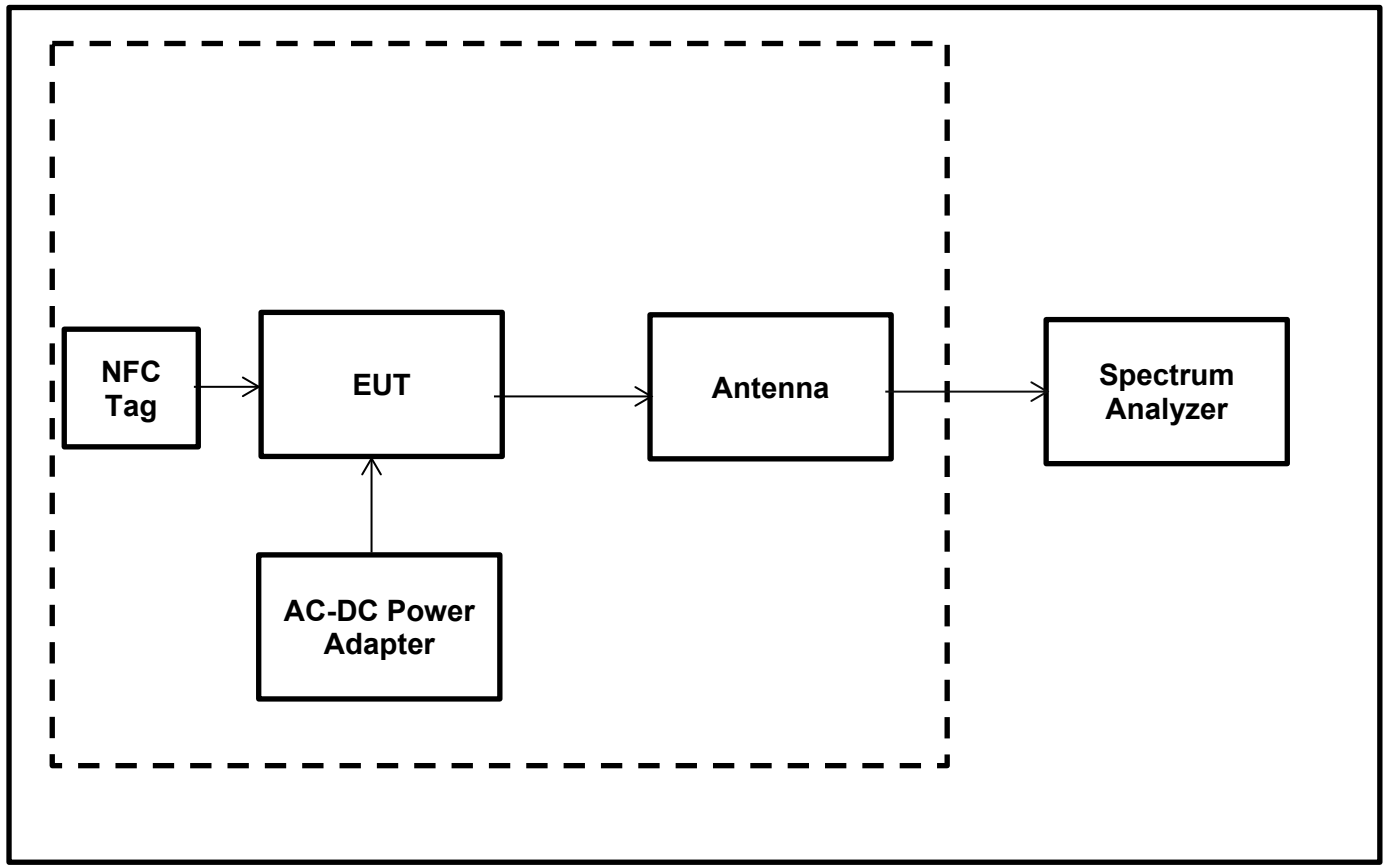
Temperature (°C):	26
Relative Humidity (%):	30

Settings of the Instrument:

RBW/VBW	300 Hz / 1 kHz
Span	3 kHz
Sweep time	10 s
Detector	MaxPeak

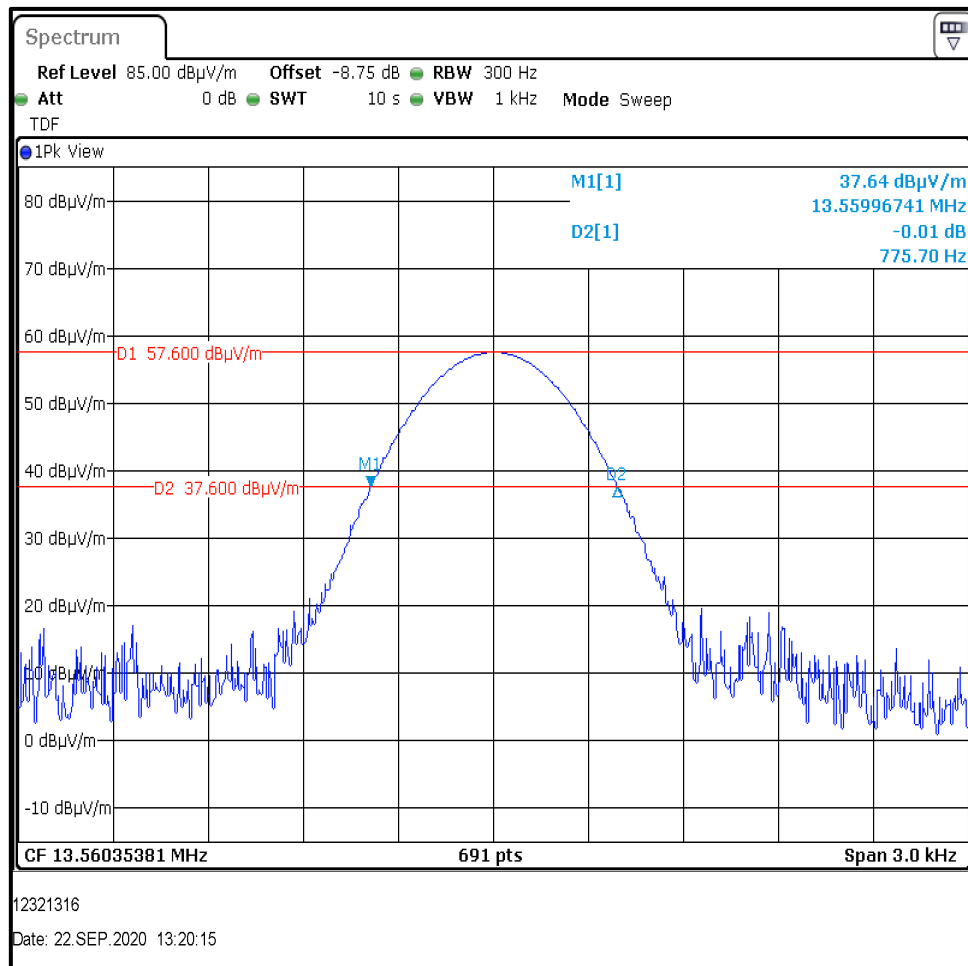
Notes:

1. In response to an FCC inquiry; reasonable deviations to test method ANSI C63.10 Section 6.9.2 were made to satisfy following requirements:
 - a. Larger values of RBW than those mentioned in ANSI C63.10 Section 6.9.2
 - b. Frequency span wide enough to capture all side bands of the signal
2. 20 dB BW determined with the lines at peak value and 20 dB below to peak. One normal and one delta marker used to measure 20 dB BW.
3. The emission shown on 20 dB Bandwidth plots show the single NFC channel at the frequency 13.56 MHz is the fundamental emission.

Transmitter 20 dB Bandwidth (Continued)**Test Setup:**

Transmitter 20 dB Bandwidth (continued)**Results: NFC-A / 848 Kbps:**

NFC Channel	20 dB Bandwidth (Hz)
13.56 MHz	775.70



NFC channel

Result: Pass

5.2.3. Transmitter Fundamental Field Strength**Test Summary:**

Test Engineer:	Sercan Usta	Test Date:	24 April 2020
Test Sample Serial Number:	B00351		
Test Site Identification	SR 1/2		

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

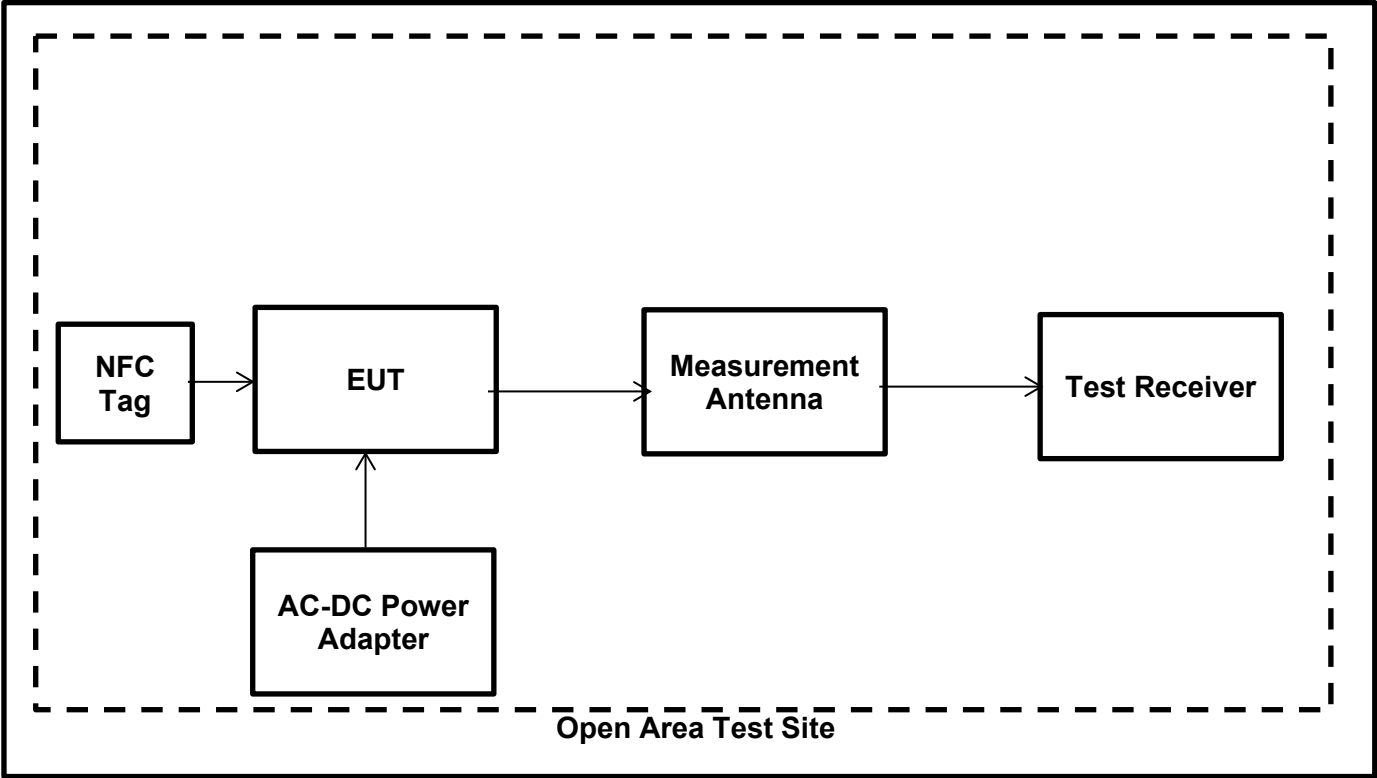
Environmental Conditions:

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

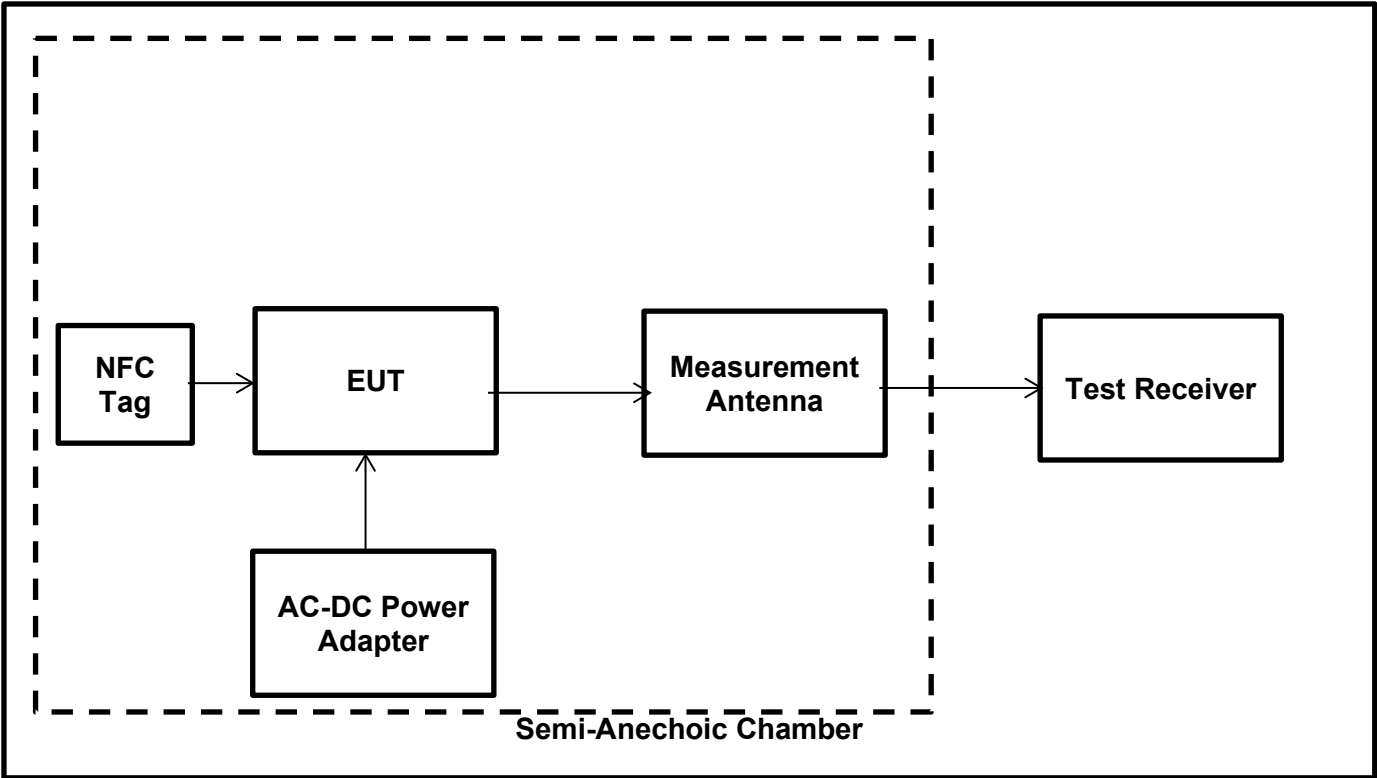
Note(s):

1. The limit is specified at a test distance of 30 metres. However, as specified in FCC Section 15.31 (f)(2) & ANSI C63.10 clause 6.4.3, measurements may be performed at a closer distance and the measured level extrapolated to the specified measurement distance using the method described in clauses 6.4.4, specifically sub-clause 6.4.4.1 which specifies that the measured level shall be extrapolated to the specified distance by conservatively presuming that the field strength decays at 40 dB/decade. Therefore, measurements were performed at a measurement distance of 3 m.
2. In accordance with 414788 D01 Radiated Test Site v01 & ANSI C63.10 clause 5.2 an alternative test site may be used. Therefore, the measurement was performed in a Semi Anechoic Chamber to which the delta of 1.38 dB at 13.56 MHz (as detailed in section 8. Open-Area-Test Site comparison of this report) was added.
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 9 kHz. The fundamental field strength was maximized by rotating the measurement antenna and EUT.
5. 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.
6. A transducer factor including the fixed gain of the magnetic loop antenna, losses of the RF cable used to connect the antenna to the spectrum analyser was also taken into account to the result.

Transmitter Fundamental Field strength test setup
Open Area Test Site

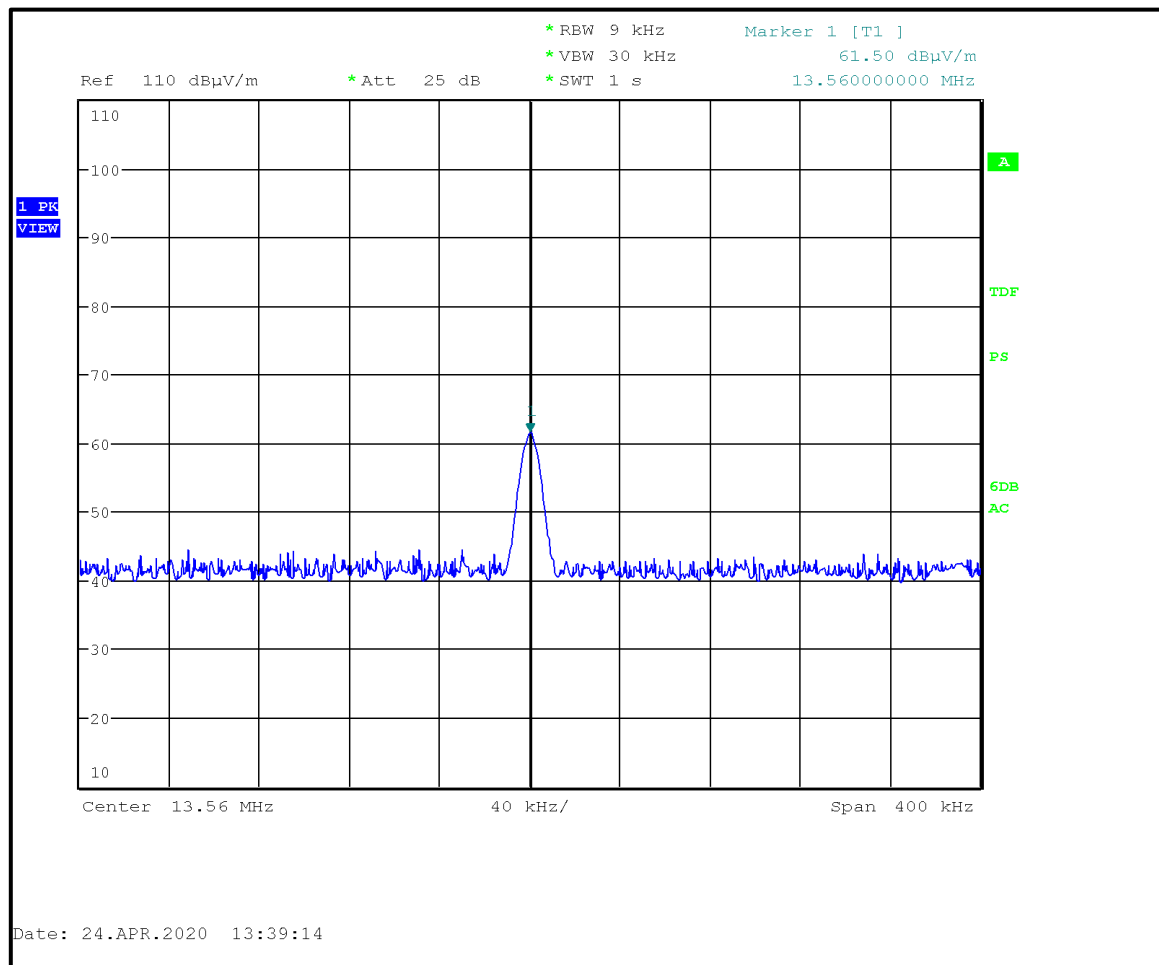


Semi Anechoic Chamber



Transmitter Radiated Emissions (continued)**Results: NFC-A / 848 Kbps:**

Frequency (MHz)	Antenna Polarity	Level at 3 m (dB μ V/m)	Deviation from OATS to SAC (dB)	Level at 3 m (dB μ V/m) with deviation added	Level at 30 m (dB μ V/m)	Limit at 30 m (dB μ V/m)	Margin (dB)	Result
13.56	Vertical	61.50	1.38	62.88	22.88	84.0	61.12	Pass

Result: Pass

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

5.2.4. Transmitter Radiated Spurious Emissions**Test Summary:**

Test Engineer:	Sercan Usta	Test Date:	15 May 2020
Test Sample Serial Number:	B00351		
Test Site Identification	SR 1/2		

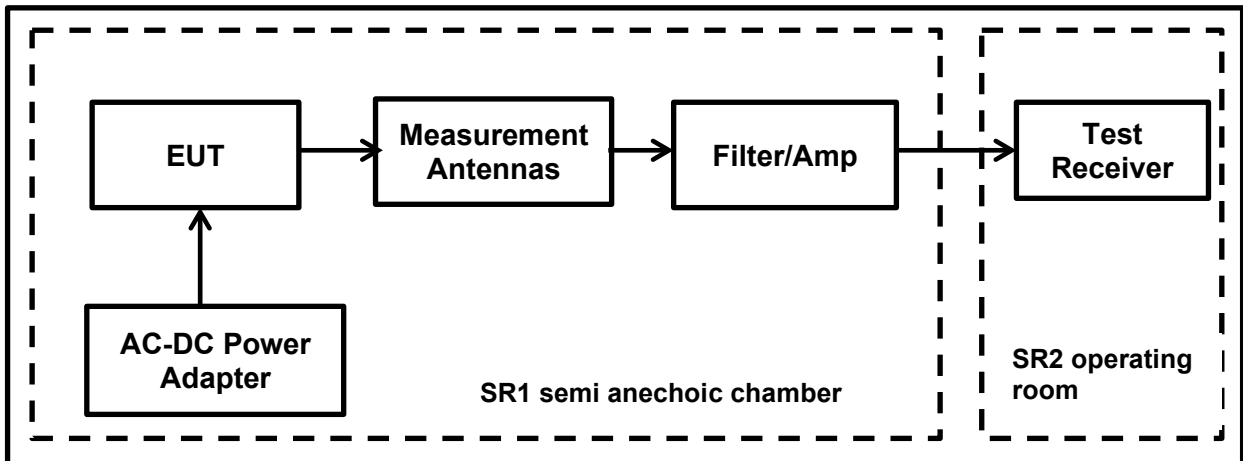
FCC Reference:	Parts 15.225(d) & 15.209(a)
Test Method Used:	ANSI C63.10:2013 Sections 6.3 and 6.4
Frequency Range:	9 kHz to 30 MHz

Environmental Conditions:

Temperature (°C):	24
Relative Humidity (%):	31

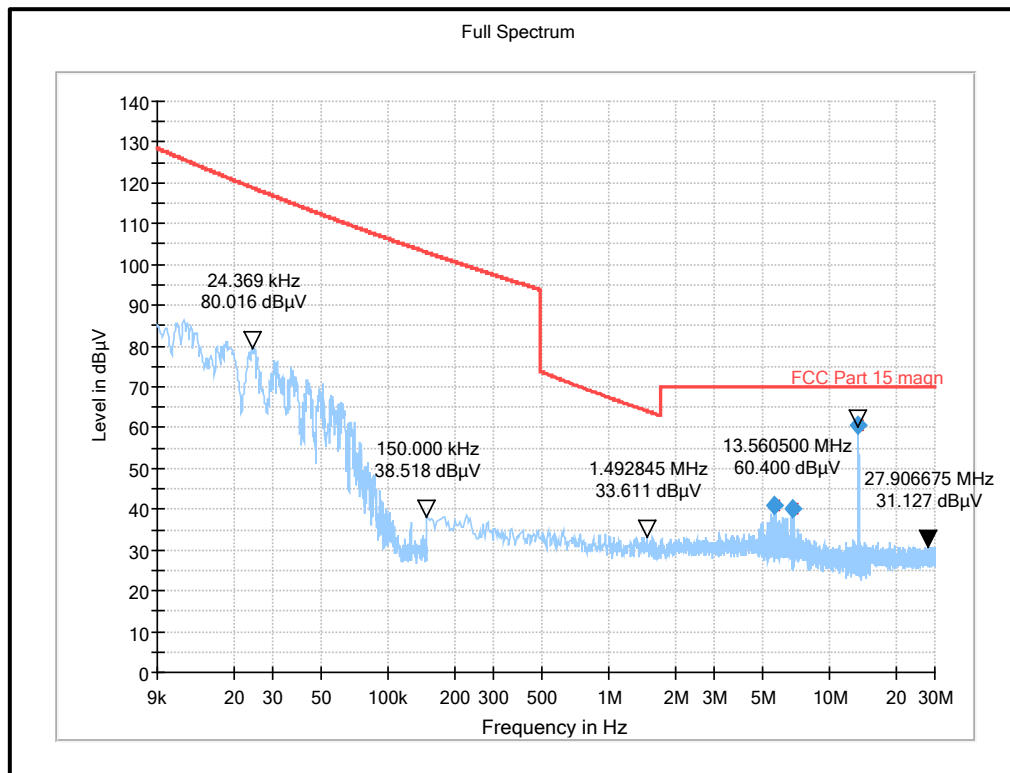
Note(s):

- In accordance with 414788 D01 Radiated Test Site v01 & ANSI C63.10 clause 5.2 an alternative test site may be used. Therefore, the measurement was performed in a Semi Anechoic Chamber.
- The limits are specified at test distances of 30 and 300 metres. However, as specified in FCC Section 15.31 (f)(2) & ANSI C63.10 clause 6.4.3, measurements may be performed at a closer distance and the measured level extrapolated to the specified measurement distance using the method described in clauses 6.4.4, specifically sub-clause 6.4.4.1 which specifies that the measured level shall be extrapolated to the specified distance by conservatively presuming that the field strength decays at 40 dB/decade. Therefore, measurements were performed at a measurement distance of 3 m.
- Therefore, the limit values are extrapolated to a measurement distance of 3 m.
 - 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.
- 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.
- 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
- The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
- All other emissions shown on the pre-scan plots were investigated and found to be below the system noise floor.
- The emissions shown at frequencies approximately 13.56 MHz on the 9 kHz to 30 MHz plots are the EUT's NFC 13.56 MHz fundamental for the tested channel.

Transmitter Radiated Spurious Emission (continued)**Test setup:**

Transmitter Radiated Emissions (continued)**Results: NFC-A / 848 Kbps:**

Frequency (MHz)	Loop Antenna Orientation	MaxPeak Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
5.580915	90° to EUT	41.05	69.50	28.45	Complied
6.784350	90° to EUT	40.14	69.50	29.36	Complied

**Result: Pass**

Transmitter Radiated Emissions (continued)**Test Summary:**

Test Engineer:	Sercan Usta	Test Date:	24 April 2020
Test Sample Serial Number:	B00351		
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

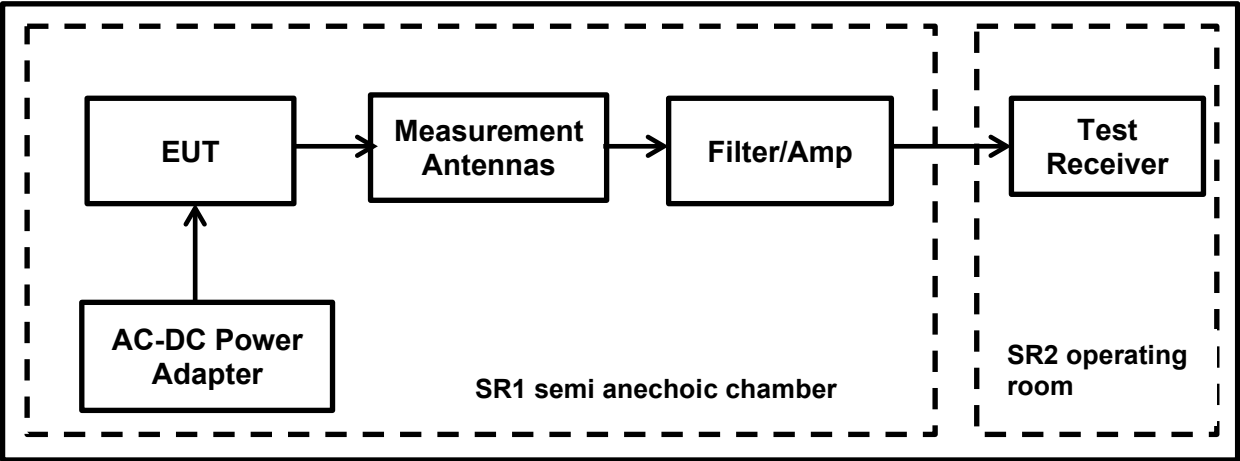
Environmental Conditions:

Temperature (°C):	24
Relative Humidity (%):	31

Note(s):

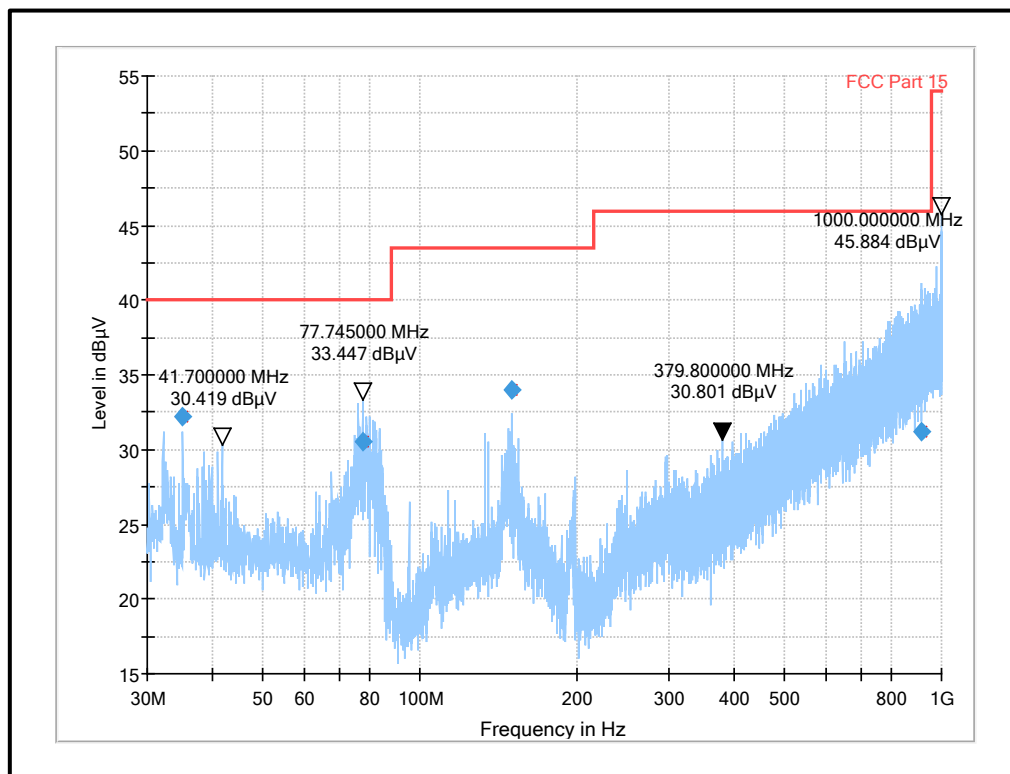
1. Measurements below 1 GHz were performed in a semi-anechoic chamber SR1/ 2 (Asset Number 1603665) at a distance of 3 m. The EUT was placed at a height of 80 cm above the reference ground plane in the centre of the chamber turntable. Maximum emission levels were determined by height searching the measurement antenna over the range 1 m to 4 m.
2. 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.
3. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss. Final measurements were performed on the marker frequencies and the results entered into the table below.
4. All other emissions shown on the pre-scan plot were investigated and found to be below the measurement system noise floor.

Transmitter Radiated Spurious Emission (continued)
Test Setup:



Transmitter Radiated Emissions (continued)**Results: NFC-A / 848 Kbps**

Frequency (MHz)	Antenna Polarization	Max Peak Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
35.13	Vertical	32.22	40.00	7.78	Complied
77.75	Vertical	30.48	40.00	9.52	Complied
150.02	Vertical	33.95	43.50	9.55	Complied
915.13	Vertical	31.15	46.00	14.85	Complied

**Result: Pass**

5.2.5. Transmitter Frequency Stability (Temperature & Voltage Variation)**Test Summary:**

Test Engineer:	Krume Ivanov	Test Date:	29 April 2020
Test Sample Serial Number:	B00351		
Test Site Identification	SR 9		

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

Environmental Conditions:

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

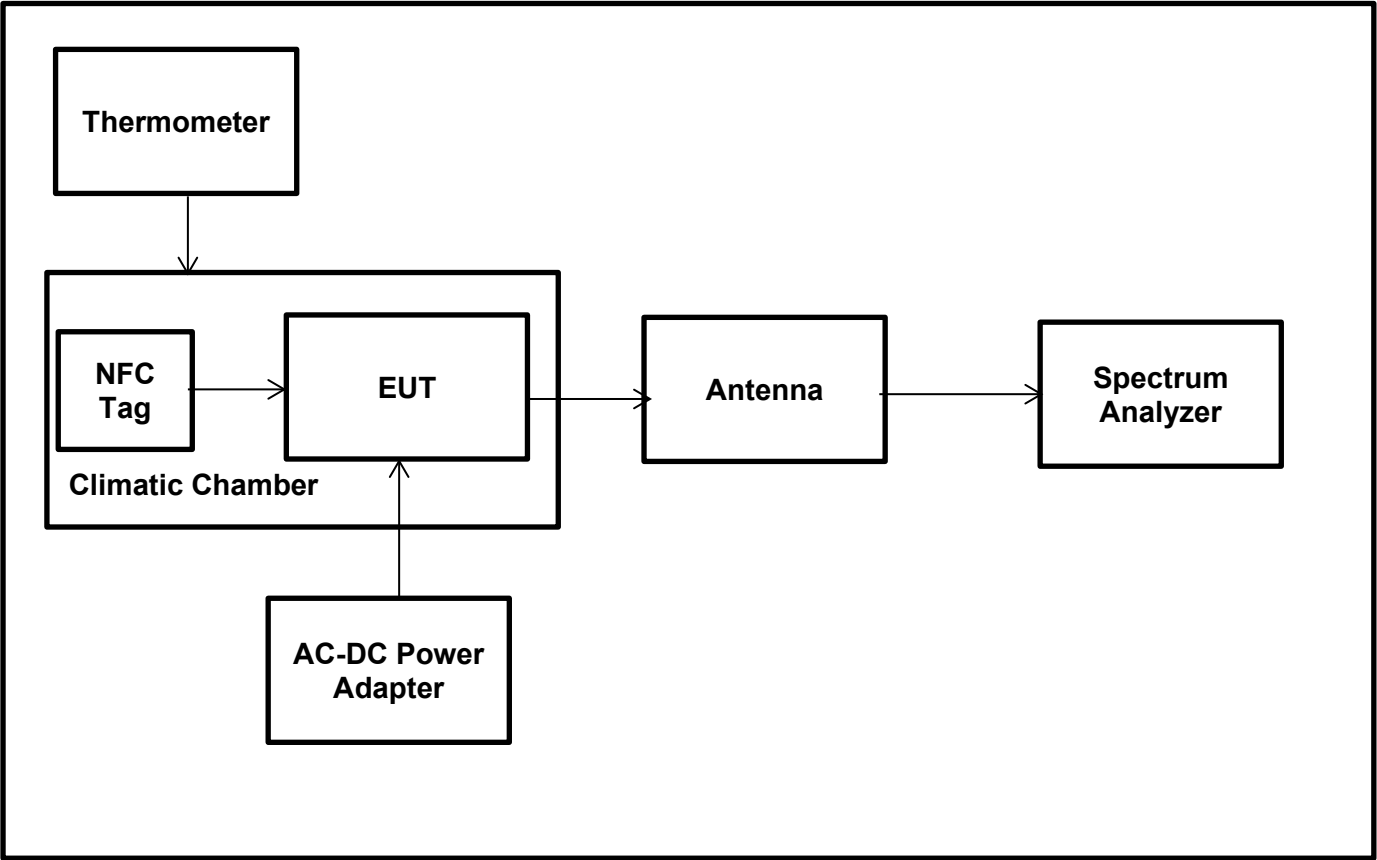
Settings of the Instrument:

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. As EUT was powered via 5 V DC using external AC-DC power supply; for voltage variations primary supply voltage (120 V AC) of AC-DC Power Supply was set to 85% of rated primary supply voltage & 115 % of rated primary supply voltage.
3. 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.
4. For accurate measurement of frequency deviations, Signal Count / frequency counter function was activated on the spectrum analyser.
5. The applicant's declared operating frequency 13.560 MHz was used as a reference frequency.
6. The difference between operating /reference frequency & measured frequency was reported as a frequency error.
7. The frequency tolerance of the carrier signal shall be maintained within $\pm 0.01\%$ or 100 ppm of the operating frequency

Transmitter Frequency Stability (Temperature & Voltage Variation) (continued)
Transmitter Frequency Stability Emissions test setup for temperature variations:



Transmitter Frequency Stability (Temperature & Voltage Variation) (continued)**Results: NFC-A / 848 Kbps / Temperature Variations**

Extreme Temperature (°C)	Time after EUT Power-up	Measured Frequency	Frequency Error		Frequency Error Limits		Result
			%	ppm	%	ppm	
-20	at 0 minutes	13.560364884	0.002691	2.691	± 0.01	± 100	Complied
	at 2 minutes	13.560360499	0.002659	2.659	± 0.01	± 100	Complied
	at 5 minutes	13.560364701	0.002690	2.690	± 0.01	± 100	Complied
	at 10 minutes	13.560345539	0.002548	2.548	± 0.01	± 100	Complied
-10	at 0 minutes	13.560393809	0.002904	2.904	± 0.01	± 100	Complied
	at 2 minutes	13.560390805	0.002882	2.882	± 0.01	± 100	Complied
	at 5 minutes	13.560389123	0.002870	2.870	± 0.01	± 100	Complied
	at 10 minutes	13.560388357	0.002864	2.864	± 0.01	± 100	Complied
0	at 0 minutes	13.560402998	0.002972	2.972	± 0.01	± 100	Complied
	at 2 minutes	13.560402958	0.002972	2.972	± 0.01	± 100	Complied
	at 5 minutes	13.560402809	0.002971	2.971	± 0.01	± 100	Complied
	at 10 minutes	13.560402694	0.002970	2.970	± 0.01	± 100	Complied
+10	at 0 minutes	13.560394832	0.002912	2.912	± 0.01	± 100	Complied
	at 2 minutes	13.560395790	0.002919	2.919	± 0.01	± 100	Complied
	at 5 minutes	13.560396404	0.002923	2.923	± 0.01	± 100	Complied
	at 10 minutes	13.560396518	0.002924	2.924	± 0.01	± 100	Complied
+20	at 0 minutes	13.560365014	0.002692	2.692	± 0.01	± 100	Complied
	at 2 minutes	13.560374440	0.002761	2.761	± 0.01	± 100	Complied
	at 5 minutes	13.560377801	0.002786	2.786	± 0.01	± 100	Complied
	at 10 minutes	13.560377345	0.002783	2.783	± 0.01	± 100	Complied
+30	at 0 minutes	13.560348670	0.002571	2.571	± 0.01	± 100	Complied
	at 2 minutes	13.560348670	0.002571	2.571	± 0.01	± 100	Complied
	at 5 minutes	13.560349753	0.002579	2.579	± 0.01	± 100	Complied
	at 10 minutes	13.560350574	0.002585	2.585	± 0.01	± 100	Complied
+40	at 0 minutes	13.560337017	0.002485	2.485	± 0.01	± 100	Complied
	at 2 minutes	13.560330311	0.002436	2.436	± 0.01	± 100	Complied
	at 5 minutes	13.560327761	0.002417	2.417	± 0.01	± 100	Complied
	at 10 minutes	13.560328009	0.002419	2.419	± 0.01	± 100	Complied
+50	at 0 minutes	13.560320537	0.002364	2.364	± 0.01	± 100	Complied
	at 2 minutes	13.560318828	0.002351	2.351	± 0.01	± 100	Complied
	at 5 minutes	13.560318666	0.002350	2.350	± 0.01	± 100	Complied
	at 10 minutes	13.560319027	0.002353	2.353	± 0.01	± 100	Complied

Result: Pass

Transmitter Frequency Stability (Temperature & Voltage Variation) (continued)**Results: NFC-A / 848 Kbps / Voltage Variations**

Extreme Voltage Conditions	Extreme AC Voltage (V)	Rated Supply Voltage DC Voltage (V)	Measured Frequency (MHz)	Frequency Error		Frequency Error Limits		Result
				%	ppm	%	ppm	
85% of Primary Supply Voltage	102	5.0	13.560364884	0.002691	2.69	± 0.01	± 100	Complied
100% of Rated Primary Supply Voltage	120	5.0	13.560360499	0.002659	2.66	± 0.01	± 100	Complied
115% of Primary Supply Voltage	138	5.0	13.560364701	0.002690	2.69	± 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
Transmitter Fundamental Field Strength	95%	±3.10 dB
Transmitter Radiated Spurious Emissions	95%	±3.10 dB
Transmitter Frequency Stability	95%	±92 Hz
Transmitter 20 dB Bandwidth	95%	±0.87 %

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	09/07/2019	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	ESH3-Z5	831767/013	07/07/2020	12
349	Rohde & Schwarz	Receiver, EMI Test	ESIB7	836697/009	09/07/2020	12
351	Rohde & Schwarz	network, Artificial Mains	ESH3-Z5	862770/018	07/07/2020	12
616	Rohde & Schwarz	ISN	ENY81-CA6	101656	07/07/2020	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	03/05/2019	24
625	Schwarzbeck	Antenna, H-field	HFSL 7101	109	lab verification only relative measurements	n/a
637	Rohde & Schwarz	Spectrum Analyser	FSV40	101587	08/07/2020	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	08/07/2020	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

48.765746, 9.250684



The following listed equipment was used for the measurement:

Manufacturer	Type	Model	Frequency Range
Rohde & Schwarz	Receiver, EMI Test	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 and Suhner	RF Cable	-	-
Elspec	BNC Cable	-	-

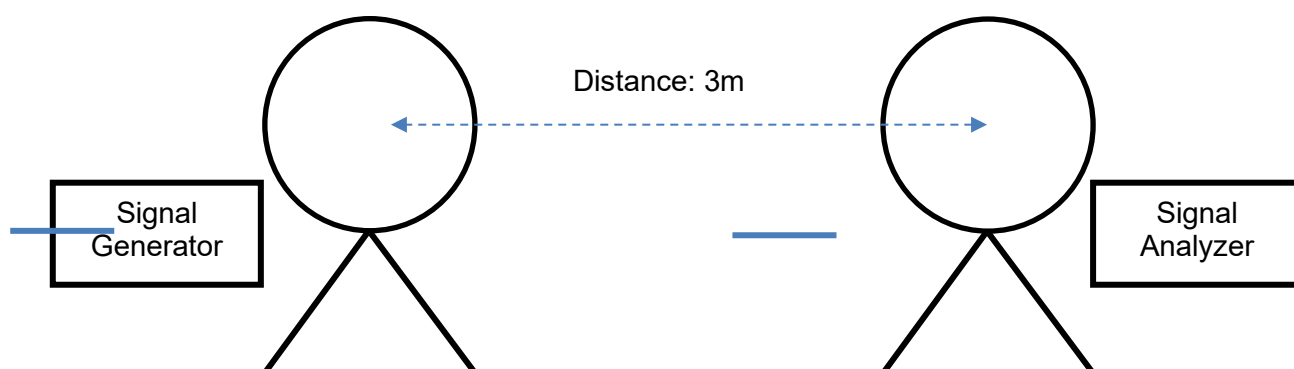
The transmit signal to the ETS Lindgren loop antenna is supplied by the SML signal generator.

The distance of the transmit and receive Antenna was 3m. No other distances can be achieved in SR1 so 10m and 30m 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.



Numeric values

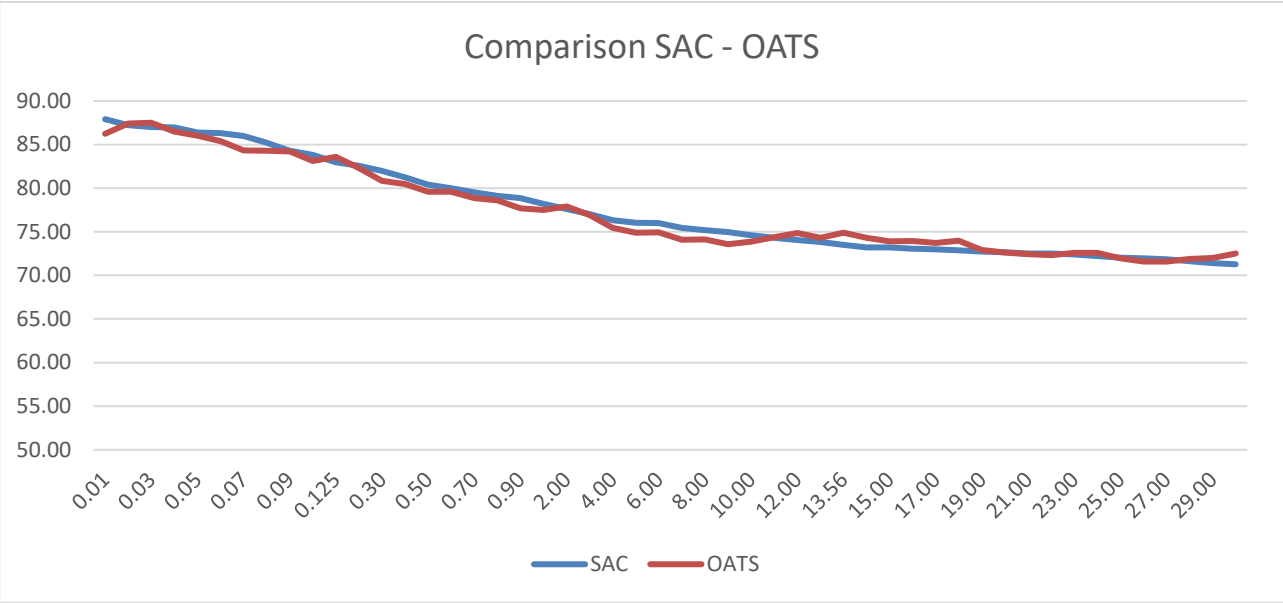
Frequency (MHz)	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.10	0.125	0.20
SR1 Measured power (dBμV)	87.91	87.22	87.01	86.98	86.40	86.32	85.98	85.20	84.30	83.80	82.96	82.55
OATS Measured power (dBμV)	86.22	87.42	87.50	86.49	86.01	85.39	84.32	84.29	84.20	83.10	83.60	82.32
Delta (dB)	-1.69	0.20	0.49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

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-12321316-616-FCC Version 1.1, Issue Date 04 NOVEMBER 2020 replaces Test Report No. UL-RPT-RP-12321316-616-FCC Version 1.0, Issue Date 26 OCTOBER 2020, which is no longer valid.			
1.1	-	-	
	1	-	Model No. corrected
	7	3.1	Model No. & Firmware Version corrected & reference to Software Version added
Test Report Version 1.2 supersede Version 1.1 with immediate effect Test Report No. UL-RPT-RP-12321316-616-ISED Version 1.2, Issue Date 18 NOVEMBER 2020 replaces Test Report No. UL-RPT-RP-12321316-616-ISED Version 1.1, Issue Date 04 NOVEMBER 2020, which is no longer valid.			
1.2	as below	as below	Current Version
	8	3.4	Tested Temperature Range corrected
	20	5.2.3	Note 1 test distance reference corrected
	23	5.2.4	Note 2 test distance reference corrected
	25	5.2.4	Transmitter Radiated Emissions Limits & Margin corrected
	34	7	Test site: SR 9 Used Equipment List Calibration Date updated

END OF REPORT