TEST REPORT

Test Report No. : UL-RPT-RP12755335-416A V2.0

Manufacturer	:	Nestlé Nespresso SA
Model No.	:	O by Nespresso
FCC ID	:	2AUF9B10
Technology	:	NFC – 13.56 MHz
Test Standard(s)	:	FCC Parts 15.207, 15.209(a) & 15.225

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2. The results in this report apply only to the sample(s) tested.
3. The sample tested is in compliance with the above standard(s).
4. The test results in this report are traceable to the national or international standards.
5. Version 2.0 supersedes all previous versions.

Date of Issue: 27 November 2019

Checked by:

Ben Mercer
Senior Test Engineer, Radio Laboratory

Company Signatory:

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Senior Test Engineer, Radio Laboratory
UL VS LTD

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

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1. Customer Information

Company Name:	Nestlé Nespresso SA
Address:	Av. d'Ouchy 4-6 CH-1006 Lausanne Switzerland

2. Summary of Testing

2.1. General Information

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
Site Registration:	621311
Location of Testing:	UL VS LTD, Unit 3 Horizon, Wade Road, Kingsland Business Park, Basingstoke, Hampshire, RG24 8AH, United Kingdom
Test Dates:	04 October 2019 to 30 October 2019

2.2. Summary of Test Results

FCC Reference (47CFR)	Measurement	Result
Part 15.207	Transmitter AC Conducted Emissions	✓
Part 15.225(a)(b)(c)(d)	Transmitter Fundamental Field Strength	✓
Part 15.209(a)/15.225(d)	Transmitter Radiated Emissions	✓
Part 15.209(a)/15.225(c)(d)	Transmitter Band Edge Radiated Emissions	✓
Part 2.1049	Transmitter 20 dB Bandwidth	✓
Part 15.225(e)	Transmitter Frequency Stability (Temperature & Voltage Variation)	✓

Key to Results

✓ = Complied ✗ = Did not comply

2.3. Methods and Procedures

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 July 12, 2018
Title:	Test Site Requirements for Radiated Emissions 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:	Nespresso
Model Name or Number:	O by Nespresso
Test Sample Serial Number:	19182B10L005972D07e
Hardware Version:	Pre-TS Build
Software Version:	Main MCU: RPC v1.0 RC3 Combo: BLUE-MFG-Wifi (Wifi test SW) Basestation (=NFC) : cont. wave test SW
FCC ID:	2AUF9B10

3.2. Description of EUT

The equipment under test was a coffee maker incorporating a 13.56 MHz NFC module.

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	
Category of Equipment:	Transceiver	
Channel Spacing:	Single channel device	
Transmit Frequency Range:	13.56 MHz	
Power Supply Requirement:	Nominal	120 VAC 60 Hz
	Minimum	102 VAC 60 Hz
	Maximum	138 VAC 60 Hz
Tested Temperature Range:	Minimum	-20°C
	Maximum	50°C

3.5. Support Equipment

No support equipment was used to exercise the EUT during testing:

4. Operation and Monitoring of the EUT during Testing

4.1. Operating Modes

The EUT was tested in the following operating mode(s):

- Constantly transmitting at full power with a modulated carrier in NFC test mode.

4.2. Configuration and Peripherals

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

- The NFC transmitter test mode was enabled when the EUT was powered as stated in the customer supplied document *"Setup information NN Blue FCC intermods and nfc test doc.pdf"*.
- Testing at voltage extremes was performed with the EUT connected to a variable AC power supply. For all other measurements the EUT was powered from a 120 VAC 60 Hz single phase mains supply.
- Refer to Appendix 1 of this test report for details of radiated tests on an open field test site.

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 Uncertainties* for details.

In accordance with UKAS 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:	Alison Johnston	**Test Date:**	04 October 2019
Test Sample Serial Number:	19182B10L005972D07e		

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

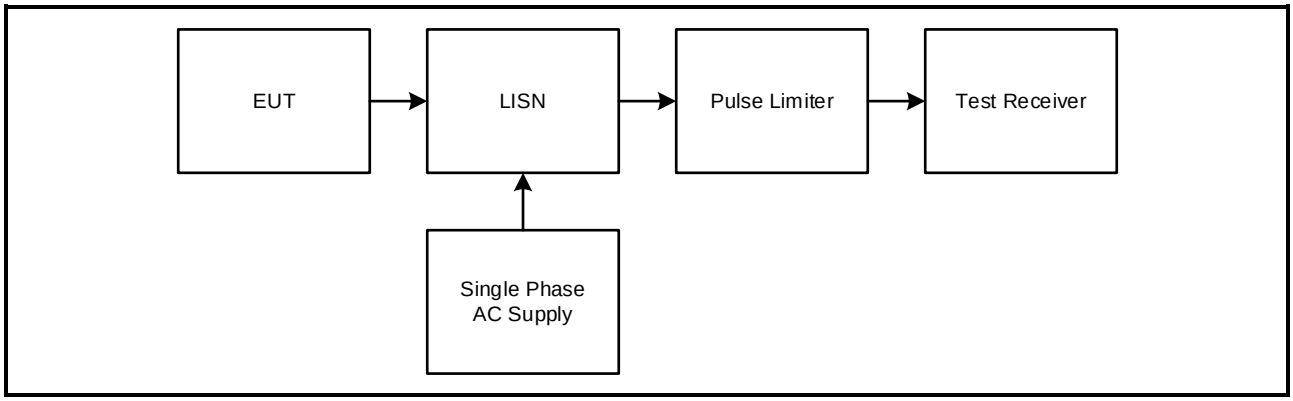
Environmental Conditions:

Temperature (°C):	22
Relative Humidity (%):	50

Note(s):

1. The EUT was connected to a 120 VAC 60 Hz single phase supply via a LISN.
2. The level of the fundamental emission at approximately 13.56 MHz was found to be below the relevant limits, therefore testing was only performed using the EUT's internal antenna.
3. A pulse limiter was fitted between the LISN and the test receiver.
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.

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
0.416	Live	42.6	57.5	14.9	Complied
0.690	Live	37.3	56.0	18.7	Complied
0.965	Live	35.3	56.0	20.7	Complied
3.764	Live	36.0	56.0	20.0	Complied
13.560	Live	48.1	60.0	11.9	Complied
27.119	Live	48.0	60.0	12.0	Complied

Results: Live / Average / 120 VAC 60 Hz

Frequency (MHz)	Line	Level (dBμV)	Limit (dBμV)	Margin (dB)	Result
0.573	Live	29.4	46.0	16.6	Complied
0.623	Live	30.5	46.0	15.5	Complied
0.812	Live	27.8	46.0	18.2	Complied
3.687	Live	22.7	46.0	23.3	Complied
13.560	Live	47.5	50.0	2.5	Complied
27.119	Live	47.5	50.0	2.5	Complied

Results: Neutral / Quasi Peak / 120 VAC 60 Hz

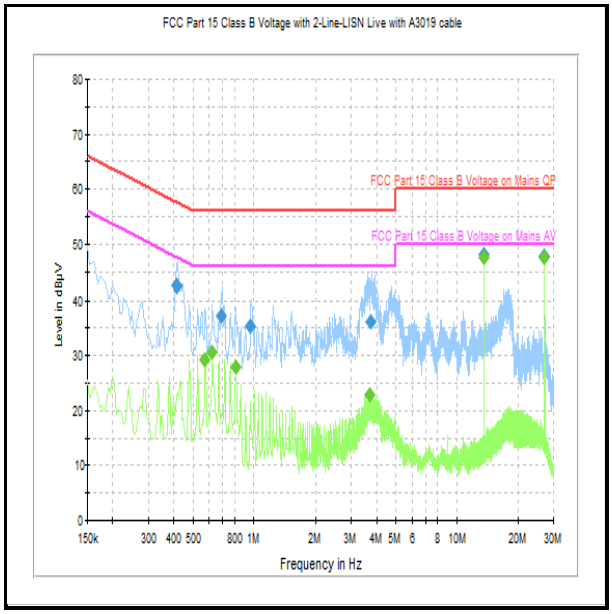
Frequency (MHz)	Line	Level (dBμV)	Limit (dBμV)	Margin (dB)	Result
0.416	Neutral	40.7	57.5	16.8	Complied
0.546	Neutral	33.6	56.0	22.4	Complied
3.764	Neutral	38.2	56.0	17.8	Complied
13.560	Neutral	48.6	60.0	11.4	Complied
17.880	Neutral	31.3	60.0	28.7	Complied
27.119	Neutral	48.6	60.0	11.4	Complied

Results: Neutral / Average / 120 VAC 60 Hz

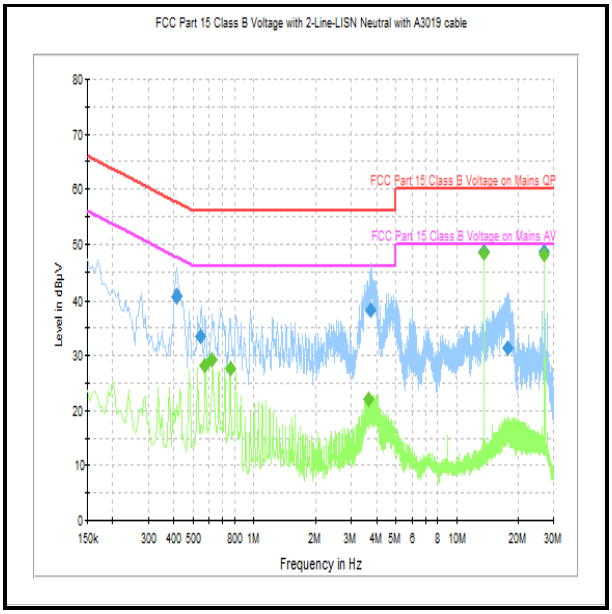
Frequency (MHz)	Line	Level (dBμV)	Limit (dBμV)	Margin (dB)	Result
0.573	Neutral	28.1	46.0	17.9	Complied
0.623	Neutral	29.1	46.0	16.9	Complied
0.767	Neutral	27.7	46.0	18.3	Complied
3.638	Neutral	22.2	46.0	23.8	Complied
13.560	Neutral	48.4	50.0	1.6	Complied
27.119	Neutral	48.2	50.0	1.8	Complied

Transmitter AC Conducted Spurious Emissions (continued)

Results: 120 VAC 60 Hz



Live



Neutral

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

Test Equipment Used:

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2037	Thermohygrometer	Testo	608-H1	45124925	06 Jan 2020	12
A649	LISN	Rohde & Schwarz	ESH3-Z5	825562/008	08 Aug 2020	12
A1830	Pulse Limiter	Rohde & Schwarz	ESH3-Z2	100668	10 Apr 2020	12
M1273	Test Receiver	Rohde & Schwarz	ESIB 26	100275	18 Dec 2019	12

Test Measurement Software/Firmware Used:

Name	Version	Release Date
Rohde & Schwarz EMC32	6.30.0	2008

5.2.2. Transmitter Fundamental Field Strength

Test Summary:

Test Engineers:	Ian Watch, Nick Tye & Matthew Botfield	**Test Dates:**	22 October 2019 & 25 October 2019
Test Sample Serial Number:	19182B10L005972D07e		

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

Environmental Conditions:

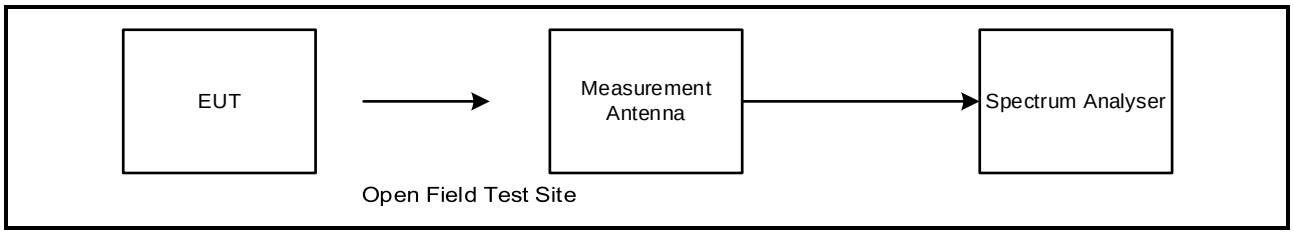
Temperature (°C):	19 to 21
Relative Humidity (%):	42 to 50

Note(s):

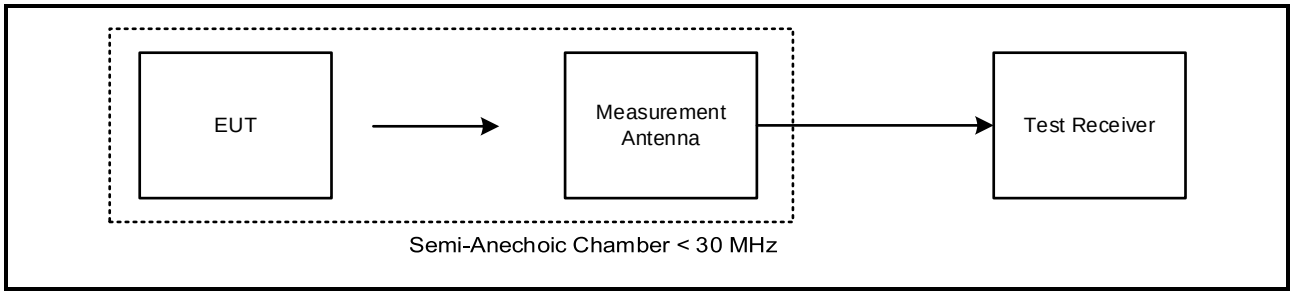
1. In accordance with FCC KDB 414788, a *bona fide* attempt was made to perform measurements at the distances specified in Part 15.209(a). It was not possible to determine the emission value at the test distances specified below 30 MHz on an open field test site, therefore in accordance with 47 CFR 15.31(f), measurements were made at closer distances. Attempts were made to measure the fundamental at 30 metres on an open field test site on 22 October 2019. The fundamental could not be seen above the ambient emissions or the noise floor of the measurement system at a distance of 30 metres, therefore the measurement was repeated at a reduced measurement distance of 3 metres using a measurement bandwidth of 10 kHz. Background scans of the open field test site and further information are shown in Appendix 1 of this test report.
2. The fundamental field strength level was maximised by rotating the measurement antenna and EUT. A peak level of 36.5 dBµV/m in a 10 kHz measurement bandwidth, at a measurement distance of 3 metres was recorded and shown on the pre-scan plots below. The measurement was repeated in a semi-anechoic chamber at 3 metres on 25 October 2019. 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 and CISPR 16-1-1, a quasi-peak detector was used in conjunction with a measurement bandwidth of 9 kHz and 0.2 second sweep time. A quasi-peak level of 34.5 dBµV/m was recorded.
3. A transducer factor was used on the spectrum analyser during open field tests. This factor includes correction between the fixed gain of the magnetic loop antenna and the calibration values. It also includes the insertion loss 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.
4. 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 (40dB/decade), which has been applied to the result table below.
5. The level of the transmitter fundamental field strength at 3 metres on an in a semi-anechoic chamber is used to show compliance to the limit.

Transmitter Fundamental Field Strength (continued)

Test Setup for Measurements on an Open Field Test Site



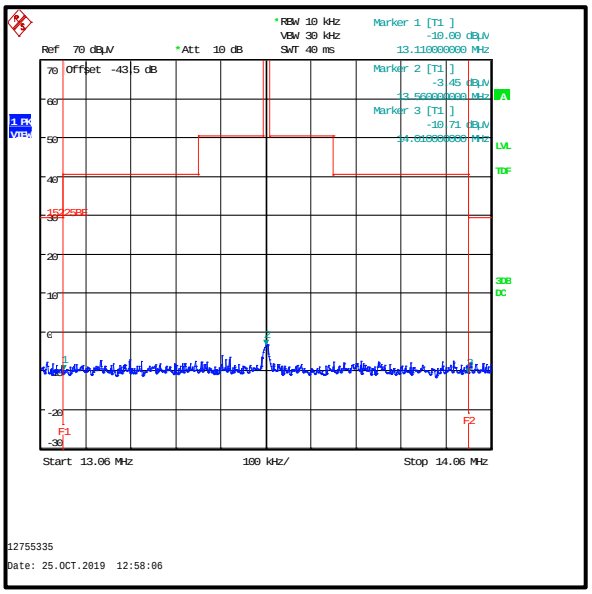
Test Setup for Measurements in a Semi-Anechoic Chamber



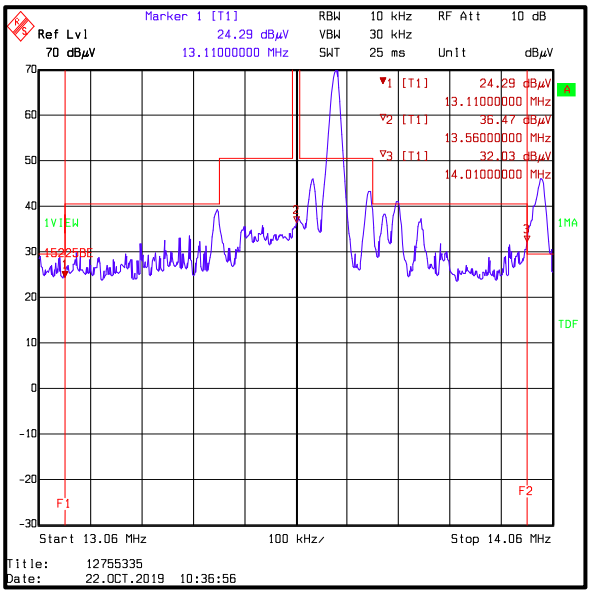
Transmitter Fundamental Field Strength (continued)

Results: Quasi Peak

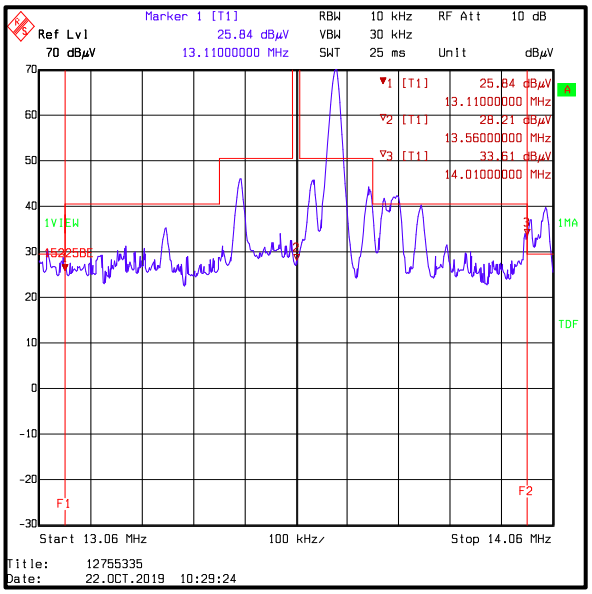
Frequency (MHz)	Antenna Orientation	Measured level at 3 metres (dBµV/m)	3 to 30 metres distance extrapolation (dB)	Calculated level at 30 metres (dBµV/m)	Limit at 30 metres (dBµV/m)	Margin (dB)	Result
13.56	90° to EUT	34.5	-40.0	-5.5	84.0	89.5	Complied



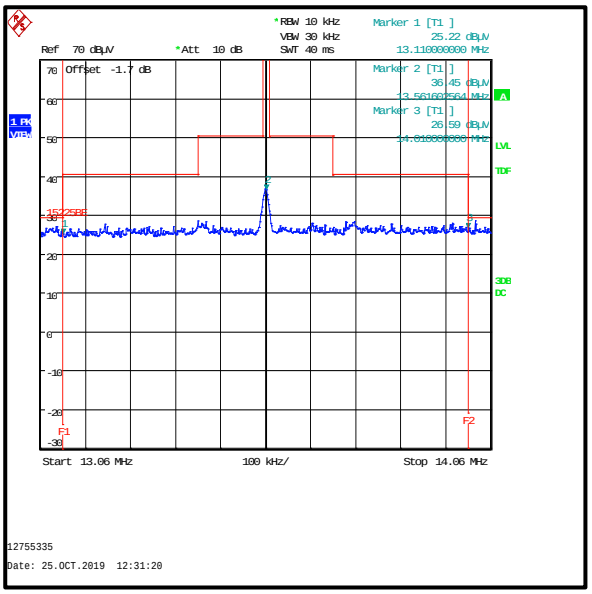
Fundamental field strength and spectrum mask / measured at 3 metres extrapolated to 30 metres / measured in a semi-anechoic chamber



Fundamental field strength / EUT operating / measured at 3 metres / measured on an open field test site



Fundamental field strength / EUT operating / measured at 30 metres / measured on an open field test site



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

Transmitter Fundamental Field Strength (continued)

Test Equipment Used:

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2040	Thermohygrometer	Testo	608-H1	45124934	06 Jan 2020	12
K0001	3m RSE Chamber	Rainford EMC	N/A	N/A	16 Oct 2020	12
M2044	Test Receiver	Rohde & Schwarz	ESU26	100122	01 Apr 2020	12
M2043	Thermohygrometer	Testo	608-H1	45120017	06 Jan 2020	12
M127	Spectrum Analyser	Rohde & Schwarz	FSEB30	842659/016	18 Dec 2019	12
A3198	Mag Loop Antenna	ETS-Lindgren	6502	00221887	27 Mar 2020	12
M2054	Precision Steel Rule 1 m/39 in	RS	Not marked or stated	1218213/42	11 Sep 2023	60
A2686	Distance Measuring Wheel	Rolson Quality Tools	50799	Not stated	Calibrated before use	-
A2955	Protractor	Not stated	9781907550980	#1	Calibration not required	-

5.2.3. Transmitter Radiated Spurious Emissions

Test Summary:

Test Engineers:	Andrew Edwards, Ian Watch & Matthew Botfield	**Test Dates:**	16 October 2019, 22 October 2019 & 30 October 2019
Test Sample Serial Number:	19182B10L005972D07e		

FCC Reference:	Parts 15.225(d) & 15.209(a)
Test Method Used:	ANSI C63.10 Sections 6.3, 6.4 and 6.5 and Notes below
Frequency Range:	9 kHz to 1000 MHz

Environmental Conditions:

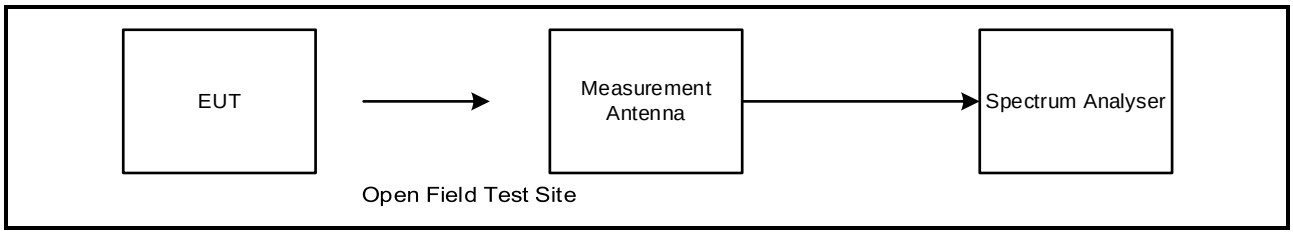
Temperature (°C):	15 to 24
Relative Humidity (%):	38 to 50

Note(s):

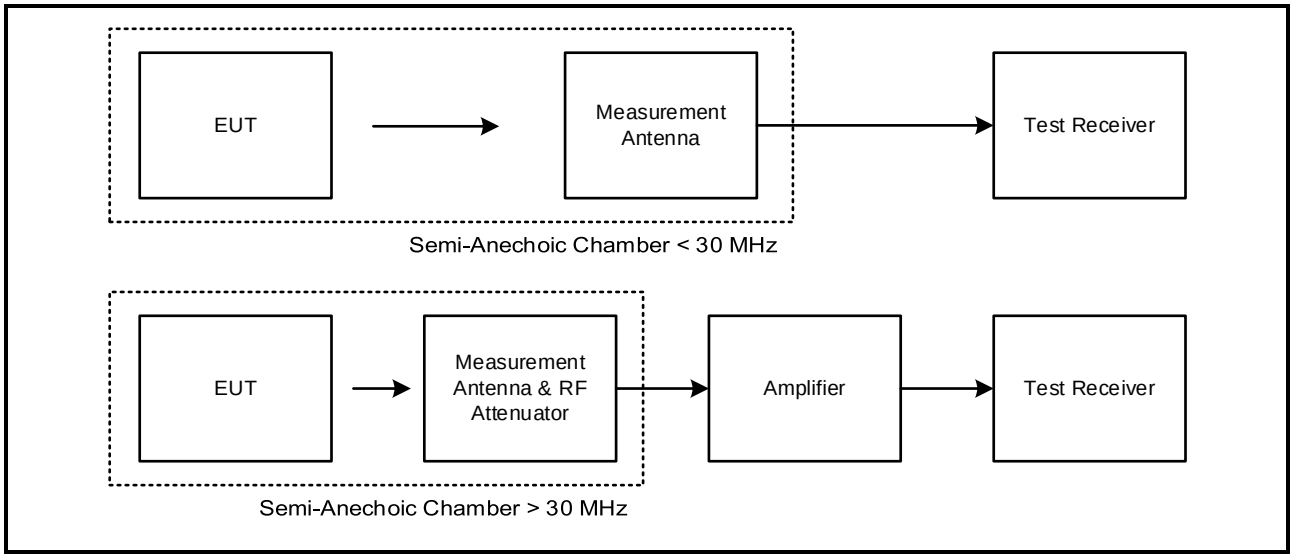
1. In accordance with FCC KDB 414788, a *bona fide* attempt was made to perform measurements at the distances specified in Part 15.209(a) on an open field test site. It was not possible to determine the spurious emission values at the test distances specified below 30 MHz on an open field test site, therefore in accordance with 47 CFR 15.31(f), measurements were made at closer distances. Attempts were made to measure spurious emissions at 3, 30 and 300 metres on an open field test site on 22 October 2019. Spurious emissions from the EUT could not be seen above the ambient emissions present at the open field test site or the noise floor of the measurement system. Final measurement results from the semi-anechoic chamber tests on 25 October 2019 are shown in this section. In addition, the open field test result plots for measurements between 9 kHz and 30 MHz are also shown. These measurement plots are identical to background scan plots of the open field test site. Background scans of the open field test site and further information are shown in Appendix 1 of this test report.
2. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss. Only the highest six spurious emissions in the range 30 MHz to 1 GHz were recorded. Markers were placed on the peaks of the pre-scan plot and final measurements were performed using a quasi-peak detector.
3. All other emissions were greater than 20 dB below the applicable limit, below the noise floor of the measurement system or ambient.
4. Measurements on 16 October 2019 were performed in a semi-anechoic chamber (UL VS LTD Asset Number K0017) at a distance of 3 metres. The EUT was placed at a height of 80 cm above the reference ground plane in the centre of the chamber turntable. Between 30 MHz and 1 GHz, maximum emission levels were determined by height searching the measurement antenna over the range 1 metre to 4 metres.
5. Measurement plots in this section for tests between 9 kHz and 30 MHz on an open field test site have markers placed on the highest level ambient emissions. This is for information only.
6. Limit lines shown on the semi-anechoic chamber plots from 9 kHz to 490 kHz have been extrapolated using a factor of 80 dB/decade to a test distance of 300 metres and 490 kHz to 30 MHz have been extrapolated using a factor of 40 dB/decade to a test distance of 30 metres.
7. There are ambient emissions seen between 2 to 30 MHz on the pre-scan plot for 490 kHz to 30 MHz performed in semi-anechoic chamber. A background scan between 490 kHz to 30 MHz is stored on the company server and is available for inspection upon request.
8. A transducer factor was used on the spectrum analyser during open field tests. 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 Radiated Spurious Emissions (continued)

Test Setup for Measurements Below 30 MHz on an Open Field Test Site



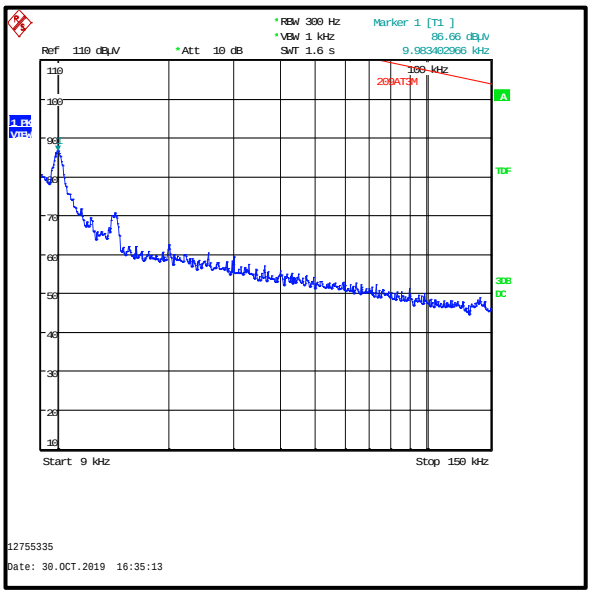
Test Setup for Measurements in a Semi-Anechoic Chamber



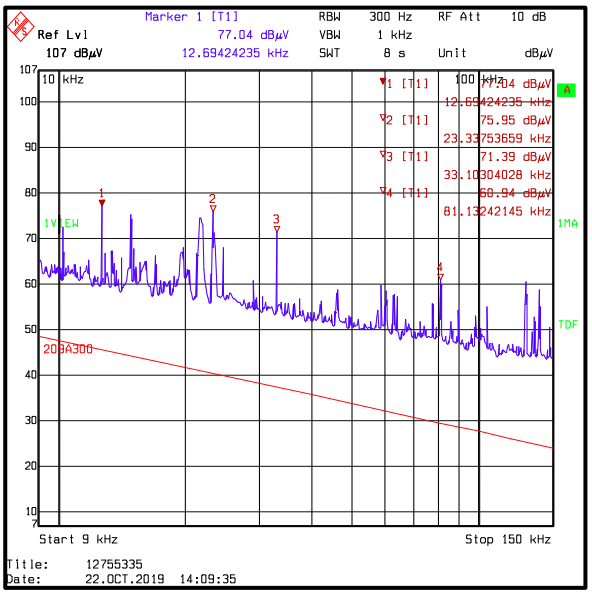
Results: Quasi Peak

Frequency (MHz)	Antenna Polarity	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
40.685	Vertical	33.7	40.0	6.3	Complied
54.261	Vertical	36.2	40.0	3.8	Complied
74.967	Vertical	29.0	40.0	11.0	Complied
80.449	Vertical	30.5	40.0	9.5	Complied
102.904	Vertical	30.1	43.5	13.4	Complied
162.705	Horizontal	29.2	43.5	14.3	Complied

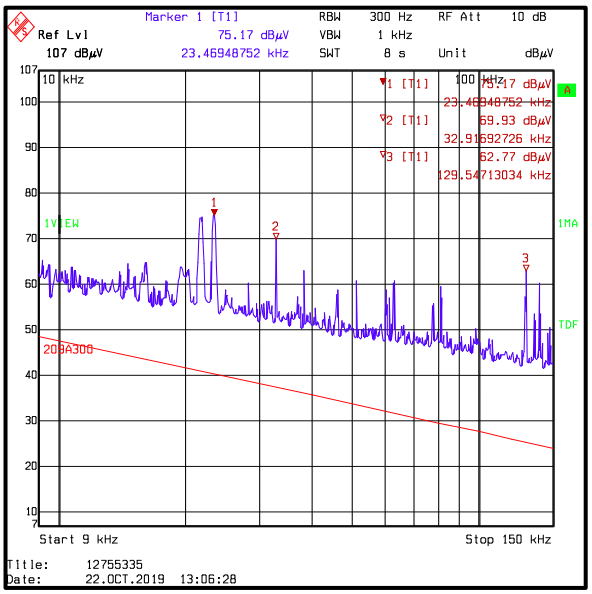
Transmitter Radiated Spurious Emissions (continued)



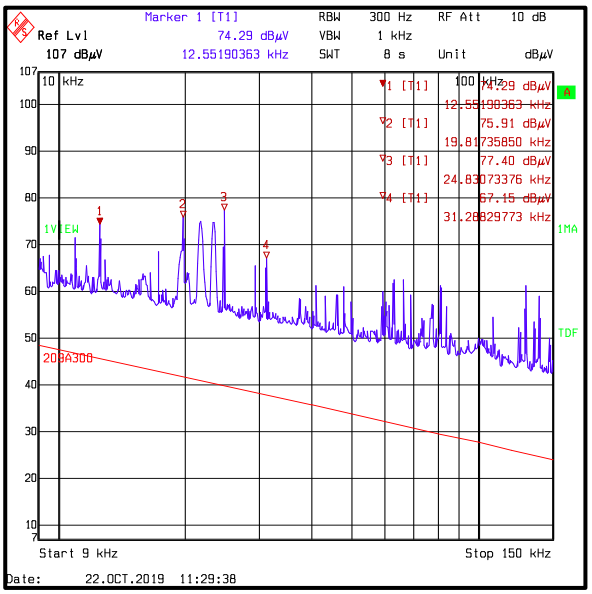
9 kHz to 150 kHz / peak detector (worst case) / measured at 3 metres extrapolated to 30 metres / measured in a semi-anechoic chamber



9 kHz to 150 kHz / peak detector (worst case) / EUT operating / measured at 3 metres on an open field test site



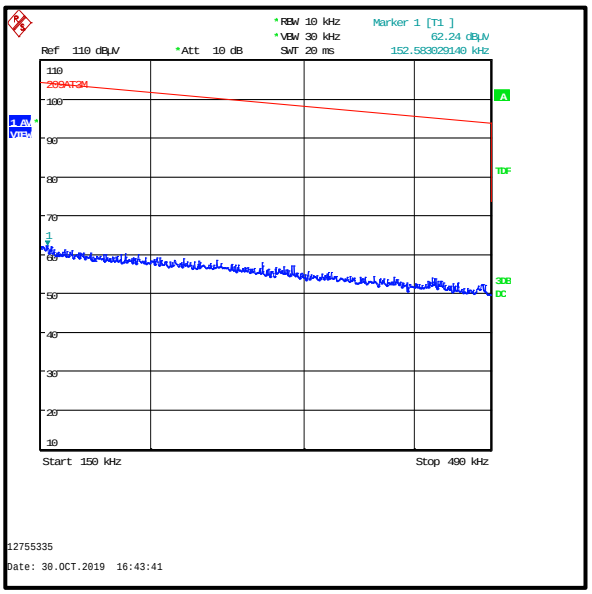
9 kHz to 150 kHz / peak detector (worst case) detector / EUT operating / measured at 30 metres on an open field test site



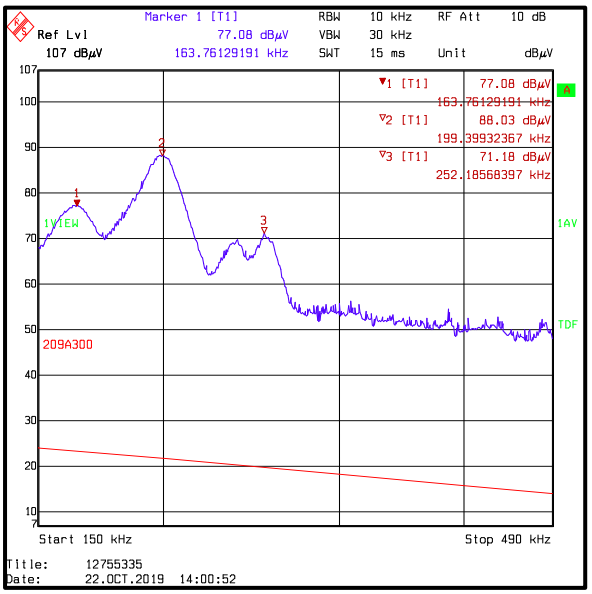
9 kHz to 150 kHz / peak detector (worst case) detector / EUT operating / measured at 300 metres on an open field test site

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

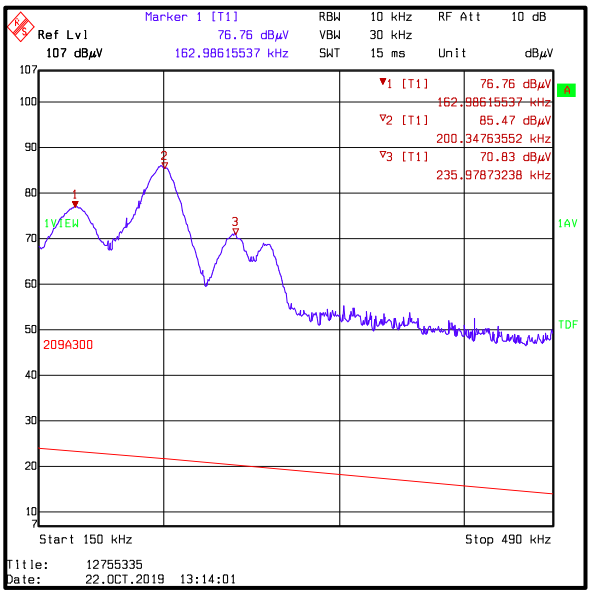
Transmitter Radiated Spurious Emissions (continued)



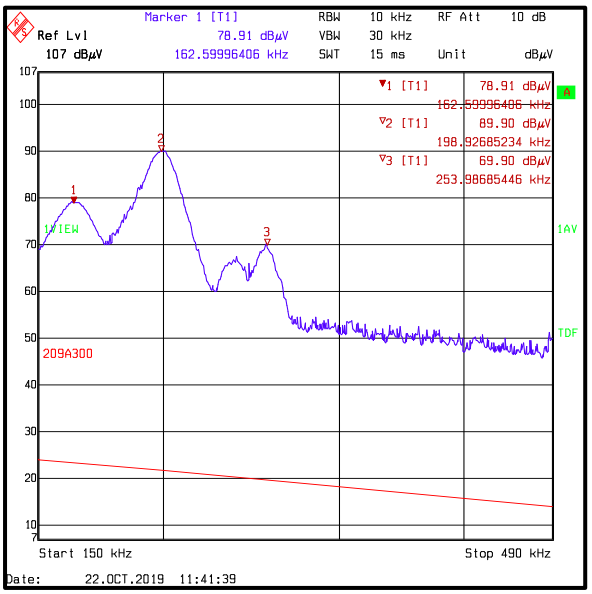
150 kHz to 490 kHz / average detector / EUT operating / measured at 3 metres extrapolated to 30 metres / measured in a semi-anechoic chamber



150 kHz to 490 kHz / average detector / EUT operating / measured at 3 metres on an open field test site



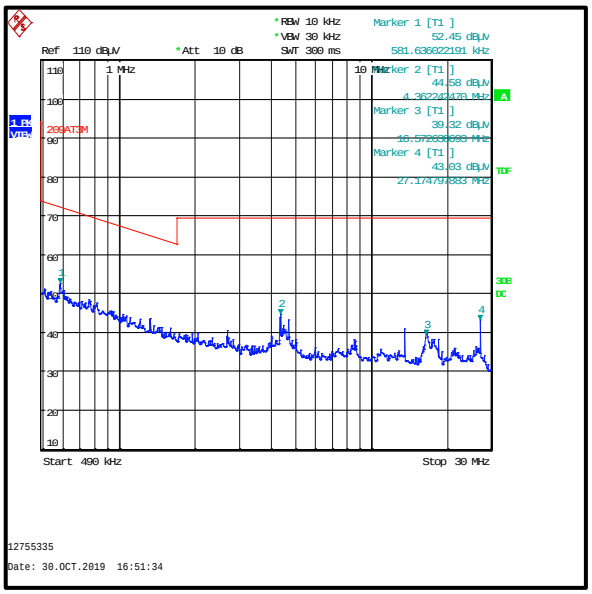
150 kHz to 490 kHz / average detector / EUT operating / measured at 30 metres on an open field test site



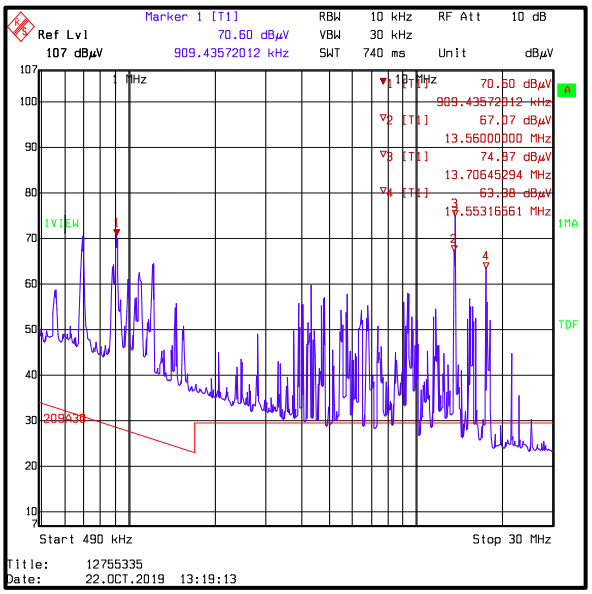
150 kHz to 490 kHz / average detector / EUT operating / measured at 300 metres on an open field test site

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

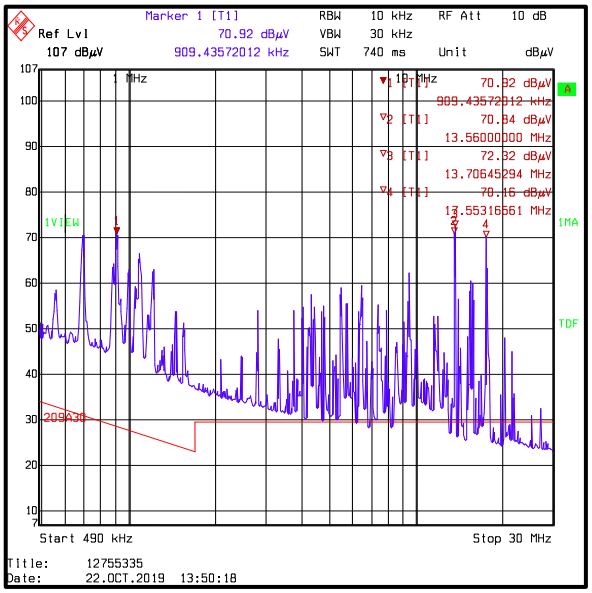
Transmitter Radiated Spurious Emissions (continued)



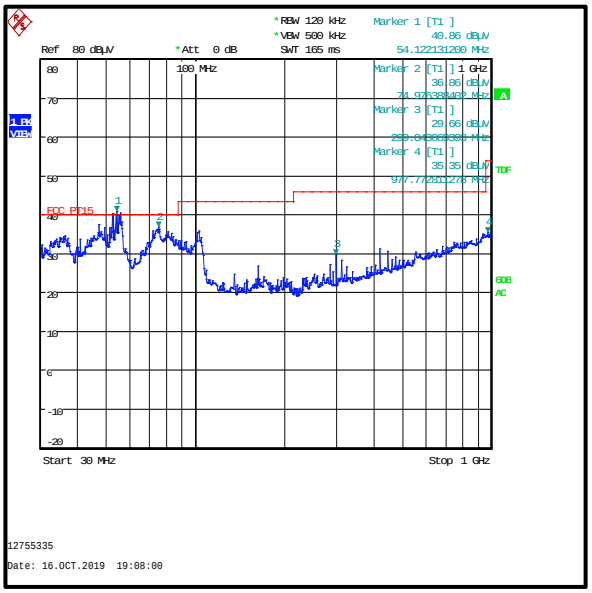
490 kHz to 30 MHz / peak detector / measured at 3 metres extrapolated to 30 metres / measured in a semi-anechoic chamber



490 kHz to 30 MHz / peak detector / EUT operating / measured at 3 metres on an open field test site



490 kHz to 30 MHz / peak detector / EUT operating / measured at 30 metres on an open field test site



30 MHz to 1 GHz / peak detector (worst case) / measured at 3 metres in a semi-anechoic chamber

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

Transmitter Radiated Spurious Emissions (continued)

Test Equipment Used:

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2040	Thermohygrometer	Testo	608-H1	45124934	06 Jan 2020	12
K0001	3m RSE Chamber	Rainford EMC	N/A	N/A	16 Oct 2020	12
M2044	Test Receiver	Rohde & Schwarz	ESU26	100122	01 Apr 2020	12
M2043	Thermohygrometer	Testo	608-H1	45120017	06 Jan 2020	12
M127	Spectrum Analyser	Rohde & Schwarz	FSEB30	842659/016	18 Dec 2019	12
A3198	Mag Loop Antenna	ETS-Lindgren	6502	00221887	27 Mar 2020	12
M2054	Precision Steel Rule 1 m/39 in	RS	Not marked or stated	1218213/42	11 Sep 2023	60
A2686	Distance Measuring Wheel	Rolson Quality Tools	50799	Not stated	Calibrated before use	-
A2955	Protractor	Not stated	9781907550980	#1	Calibration not required	-
M2003	Thermohygrometer	Testo	608-H1	45124934	06 Jan 2020	12
K0017	3m RSE Chamber	Rainford EMC	N/A	N/A	01 Aug 2020	12
M1995	Test Receiver	Rohde & Schwarz	ESU40	100428	08 May 2020	12
A3167	Pre-Amplifier	Com Power Corporation	PAM-103	18020010	14 Aug 2020	12
A490	Antenna	Chase	CBL6111A	1590	21 May 2020	12
A2148	Attenuator	AtlanTecRF	AN18-06	090202-06	21 May 2020	12

5.2.4. Transmitter Band Edge Radiated Emissions

Test Summary:

Test Engineer:	Andrew Edwards	**Test Date:**	30 October 2019
Test Sample Serial Number:	19182B10L005972D07e		

FCC Reference:	Parts 15.225(c)(d) & 15.209(a)
Test Method Used:	ANSI C63.10 Section 6.10.4 and Notes below

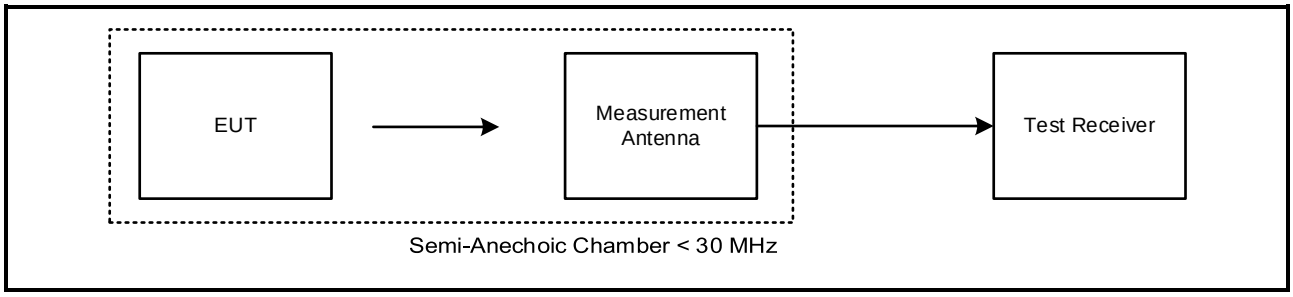
Environmental Conditions:

Temperature (°C):	21
Relative Humidity (%):	42

Note(s):

1. For the field strength measurements in a semi-anechoic chamber, an offset of -43.5 dB was used to extrapolate the results at 3 metres to a distance of 30 metres and collate measurements in a semi-anechoic chamber with measurements on an open field test site. For details on the calculations see Notes 3 and 4 in Section 5.2.2 of this test report.
2. The spectrum analyser resolution bandwidth was set to 10 kHz and video bandwidth 30 kHz. A peak detector was used, sweep time was set to auto and the trace mode was Max Hold. The span was set to 1 MHz. Markers were placed at the lower and upper band edges. The results are given in the tables below.

Test setup:



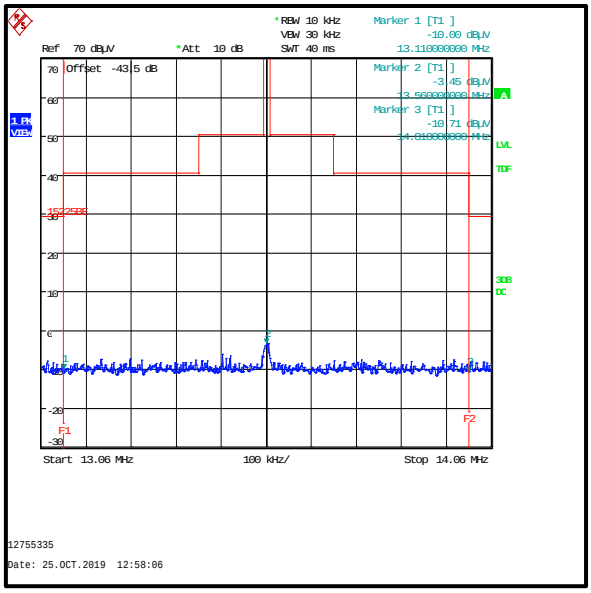
Transmitter Band Edge Radiated Emissions (continued)

Results: Peak / Lower Band Edge

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
13.11	-10.0	29.5	39.5	Complied

Results: Peak / Upper Band Edge

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
14.01	-10.7	29.5	40.2	Complied



Test Equipment Used:

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2040	Thermohygrometer	Testo	608-H1	45124934	06 Jan 2020	12
K0001	3m RSE Chamber	Rainford EMC	N/A	N/A	16 Oct 2020	12
M2044	Test Receiver	Rohde & Schwarz	ESU26	100122	01 Apr 2020	12
A3198	Mag Loop Antenna	ETS-Lindgren	6502	00221887	27 Mar 2020	12

5.2.5. Transmitter 20 dB Bandwidth

Test Summary:

Test Engineer:	Nick Tye	**Test Date:**	25 October 2019
Test Sample Serial Number:	19182B10L005972D07e		

FCC Reference:	Part 2.1049
Test Method Used:	ANSI C63.10 Section 6.9.2

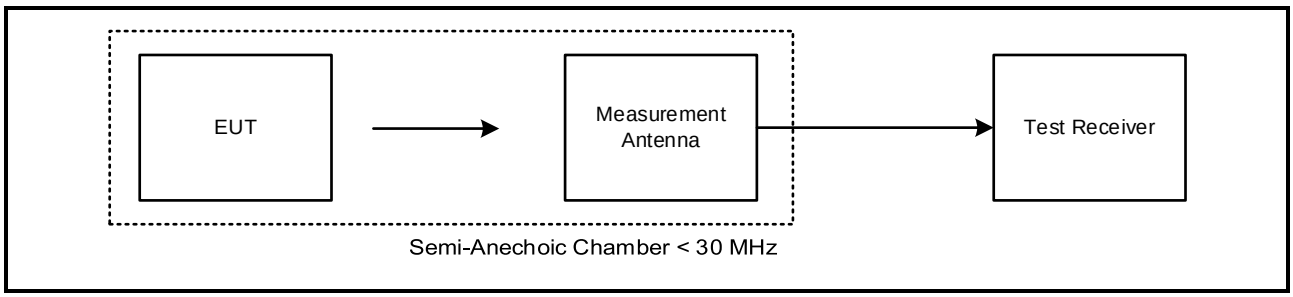
Environmental Conditions:

Temperature (°C):	23
Relative Humidity (%):	46

Note(s):

1. The test receiver resolution bandwidth was set to 5 kHz and video bandwidth 20 kHz. A peak detector was used, sweep time was set to auto and the trace mode was Max Hold. The span was set to 1 MHz. Normal and delta markers were placed 20 dB down from the peak of the carrier.

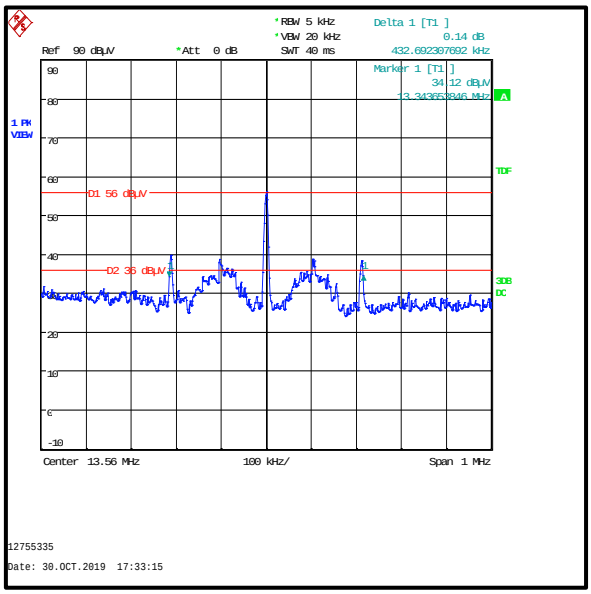
Test setup:



Transmitter 20 dB Bandwidth (continued)

Results:

20 dB Bandwidth (kHz)
432.692



Test Equipment Used:

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2040	Thermohygrometer	Testo	608-H1	45124934	06 Jan 2020	12
K0001	3m RSE Chamber	Rainford EMC	N/A	N/A	16 Oct 2020	12
M2044	Test Receiver	Rohde & Schwarz	ESU26	100122	01 Apr 2020	12
A3198	Mag Loop Antenna	ETS-Lindgren	6502	00221887	27 Mar 2020	12

5.2.6. Transmitter Frequency Stability (Temperature & Voltage Variation)

Test Summary:

Test Engineer:	James O'Reilly	**Test Date:**	06 October 2019
Test Sample Serial Number:	19182B10L005972D07e		

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

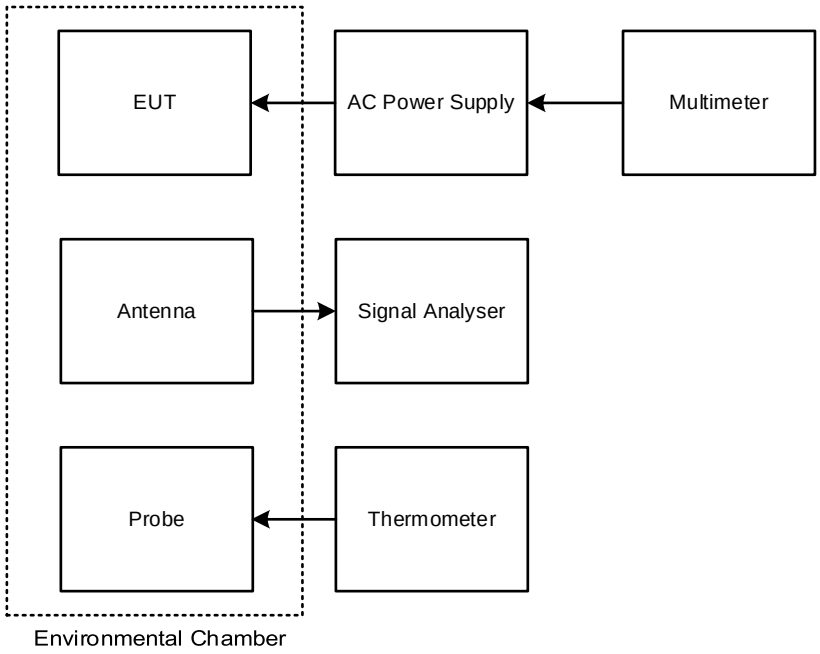
Environmental Conditions:

Ambient Temperature (°C):	23
Ambient Relative Humidity (%):	38

Note(s):

1. Testing at voltage extremes was performed with the EUT powered by a variable AC power supply.
2. Frequency stability measurements were performed with an unmodulated carrier. The measurements were performed using the spectrum analyser marker counter function. The marker counter function was set to 1 Hz resolution before any measurements were performed.
3. Temperature was monitored throughout the test with a calibrated digital thermometer.
4. Voltage was monitored throughout the test with a calibrated digital voltmeter.

Test setup:



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

Results: Maximum frequency error of the EUT with variations in ambient temperature

Temperature (°C)	Time after Start-up			
	0 minutes	2 minutes	5 minutes	10 minutes
-20	13.560305	13.560320	13.560324	13.560326
20	13.560370	13.560365	13.560363	13.560363
50	13.560334	13.560332	13.560331	13.560329

Frequency with Worst Case Deviation (MHz)	Frequency Error (Hz)	Frequency Error (%)	Limit (%)	Margin (%)	Result
13.560370	370	0.002729	0.01	0.007272	Complied

Results: Maximum frequency error of the EUT with variations in nominal operating voltage at an ambient temperature of 20°C

Supply Voltage (V)	Nominal Frequency (MHz)	Measured Frequency (MHz)	Frequency Error (Hz)	Frequency Error (%)	Limit (%)	Margin (%)	Result
102	13.56	13.560353	353	0.002605	0.01	0.007394	Complied
120	13.56	13.560352	352	0.002601	0.01	0.007398	Complied
138	13.56	13.560353	353	0.002610	0.01	0.007389	Complied

Test Equipment Used:

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1642	Thermometer	Fluke	52II	18890119	16 April 2020	12
M1674	Environmental Chamber	Espec Corporation	SU-241	92013139	Calibrated before use	N/A
M2036	Signal Analyser	Rohde & Schwarz	FSV30	101791	07 May 2020	12
S0539	Variable AC Power Supply	Kikusui	PCR 1000L	13010170	Calibrated before use	N/A
M1269	Multimeter	Fluke	179	90250210	17 April 2020	12

6. Measurement Uncertainty

No measurement or test can ever be perfect and the imperfections give rise to error of measurement in the results. Consequently the result of a measurement is only an approximation to the value of the measurand (the specific quantity subject to measurement) and is only complete when accompanied by a statement of the uncertainty of the approximation.

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	Range	Confidence Level (%)	Calculated Uncertainty
AC Conducted Spurious Emissions	0.15 MHz to 30 MHz	95%	±1.96 dB
20 dB Bandwidth	13 MHz to 14 MHz	95%	±4.59 %
Frequency Stability	13 MHz to 14 MHz	95%	±1.62 ppm
Radiated Spurious Emissions	9 kHz to 30 MHz	95%	±4.39 dB
Radiated Spurious Emissions	30 MHz to 1000 MHz	95%	±3.30 dB
Transmitter Fundamental Field Strength	13 MHz to 14 MHz	95%	±4.39 dB

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. Report Revision History

Version Number	Revision Details		
	Page No(s)	**Clause**	**Details**
1.0	-	-	Initial Version
2.0	-	Appendix 1	Removed photos.

8. Appendix 1

GPS coordinates of test location

Mag loop location (lower marker on photo)
N51° 08.739’ W001° 26.328’

30 metre test point (middle marker on photo)
N51° 08.755’ W001° 26.325’

300 metre test point (upper marker on photo)
N51° 08.895’ W001° 26.289’

Measurements at 3 and 30 metres

Temperature: 19°C
Relative Humidity: 50%
Ground conditions: Dry

The test site was free from underground metal objects.

The EUT was powered at its nominal voltage, via connected to a single phase supply. A power cable was run across the site to the EUT. An RCD was fitted to the power source.

The EUT was placed on a plastic table at a height of 0.8 metres above ground level. All associated cables and support equipment were arranged according to ANSI C63.10-2013 Section 6.12.

The spectrum analyser used for measurements was located in a vehicle 30 metres from the magnetic loop antenna. Power to the test equipment was from a single phase supply, with an RCD fitted to the power source.

The test distance was from the centre of the mag loop antenna to the closest periphery of the EUT. This distance was maintained as the EUT was rotated.

Initially, The EUT was rotated through 360 degrees in 45 degree steps at both measurement distances. The mag loop antenna was rotated through 90 degrees in 30 degree steps at every position the EUT was moved to. The EUT and mag loop antenna were then rotated in small increments in order to maximise emission levels.

Measurements at 300 metres

Temperature: 15°C
Relative Humidity: 51%
Ground conditions: Dry

The test site was free from underground metal objects.

The EUT was powered at its nominal voltage via connected to a single phase supply. An RCD was fitted to the power source. The generator was located 50 metres from the EUT and surrounded by radio absorbent material. For safety purposes, an RCD was fitted to the generator output.

The EUT was placed on a plastic table at a height of 0.8 metres above ground level. All associated cables were arranged according to ANSI C63.10-2013 Section 6.12.

The spectrum analyser used for measurements was located in a vehicle 30 metres from the magnetic loop antenna. Power to the test equipment was from a single phase supply, with an RCD fitted to the power source.

The test distance was from the centre of the mag loop antenna to the closest periphery of the EUT. This distance was maintained as the EUT was rotated.

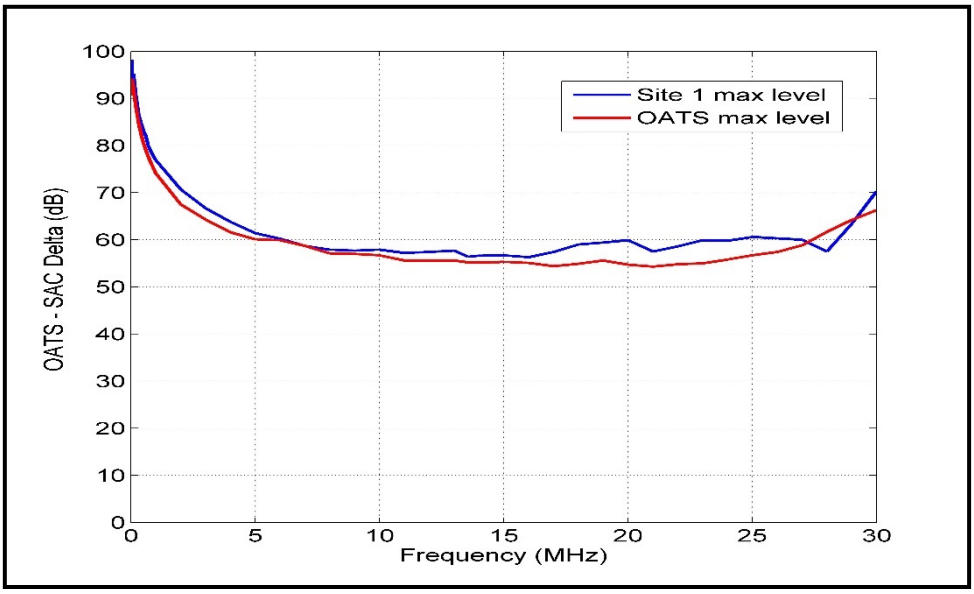
Initially, The EUT was rotated through 360 degrees in 45 degree steps at both measurement distances. The mag loop antenna was rotated through 90 degrees in 30 degree steps at every position the EUT was moved to. The EUT and mag loop antenna were then rotated in small increments in order to maximise emission levels.

Comparison of open field test site with semi-anechoic chamber measurements at 3 metres

Radiated measurements were performed an open field test site and within a 3 metre semi-anechoic chamber.

For the signal source, a modified loop antenna was connected to a signal generator at the transmit side. A standard active magnetic loop antenna was connected to a spectrum analyser at the receive side. The signal generator was set to its maximum supported output power and the signal was transmitted to the spectrum analyser via the two antennas and associated RF cables.

A sweep in small frequency increments was performed from 9 kHz to 30 MHz. The sweep was repeatedly performed with both antennas rotated about the axis in various orientations. Received levels for all orientations were recorded and the maximum levels for the open field test site and the semi-anechoic chamber are shown on the graph below. Full data for both tests are archived on the UL VS LTD IT server and available for inspection on request.



The conclusion was that the open field test site compares well with the semi-anechoic chamber at a measurement distance of 3 metres. If anything, the semi-anechoic chamber results are generally slightly higher. This means that if the measurement passes in the semi-anechoic chamber, it will pass with a higher margin on an open field test site.

The magnetic loop antenna used to perform these measurements is the same antenna or same type of antenna used during measurements contained in this test report.

Verification of open field test site and semi-anechoic chamber measurements at 3 metres prior to performing measurements

Two reference units are used for verification of the measurement system before testing commences. Both reference units are door entry systems modified by the manufacturer for test purposes only.

One reference unit transmits a continuous, unmodulated signal at a fixed frequency of 125 kHz when a 12 Volt battery is connected. The output power is fixed and known to be stable.

The second transmits a continuous, modulated signal at a fixed frequency of 13.56 MHz when a 12 Volt battery is connected. The output power is fixed and known to be stable.

Both frequencies are commonly used NFC frequencies.

A UL VS LTD internal verification document explains the procedure in detail. A brief description is given below.

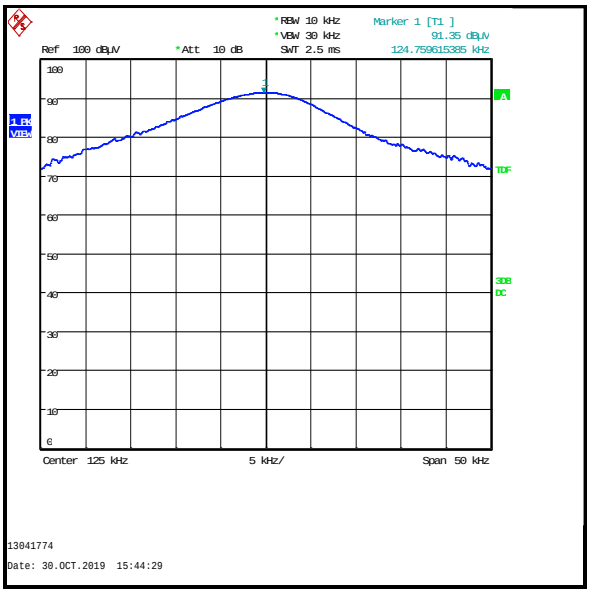
The centre of the magnetic loop antenna is placed exactly 3 metres from the reference unit. The reference unit is placed on a plastic table at a height of 0.8 metres above floor level and the centre of the mag loop antenna is 1 metre above the floor level. The mag loop antenna and reference unit are oriented in certain positions to ensure repeatability.

Each reference unit is connected to a 12 Volt power sorce and once transmitting, the maximum raw received level at each of the two frequencies is read on the spectrum analyser by using the marker peak function. The measured level has to be within certain levels as specified in the UL VS LTD internal test procedure. The plot of the verification measurement is archived on the UL VS LTD IT server. The peak level of each reference unit is recorded on a spreadsheet which is also archived on the UL VS LTD IT server.

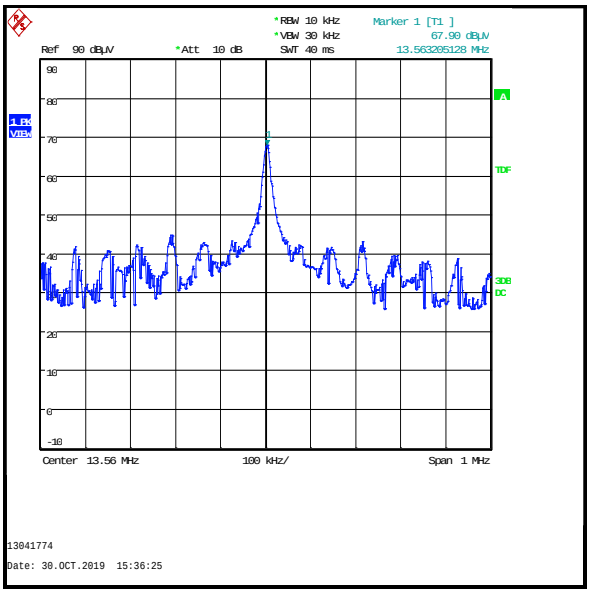
The internal verification procedure and verification plots are available for inspection on request.

Radiated measurements below 30 MHz were performed in a semi-anechoic chamber at a distance of 3 metres.

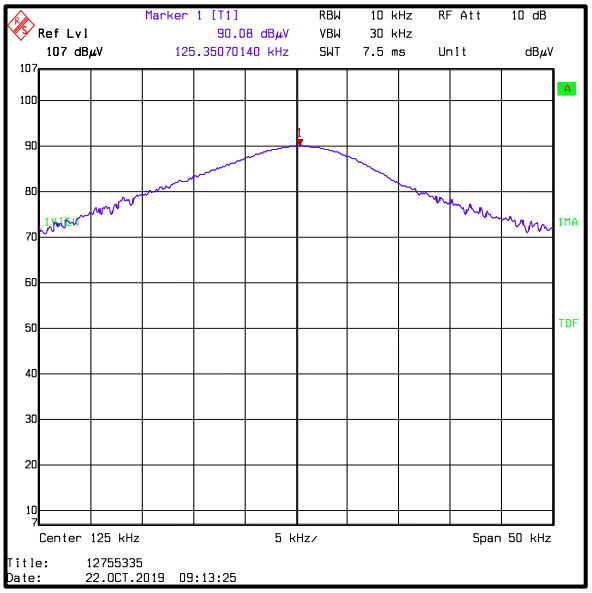
Verification plots of the two reference units at a measurement distance of 3 metres are shown on the following page. Plots were taken on an open field test site (22 October 2019 and in a semi-anechoic chamber (25 and 30 October 2019).



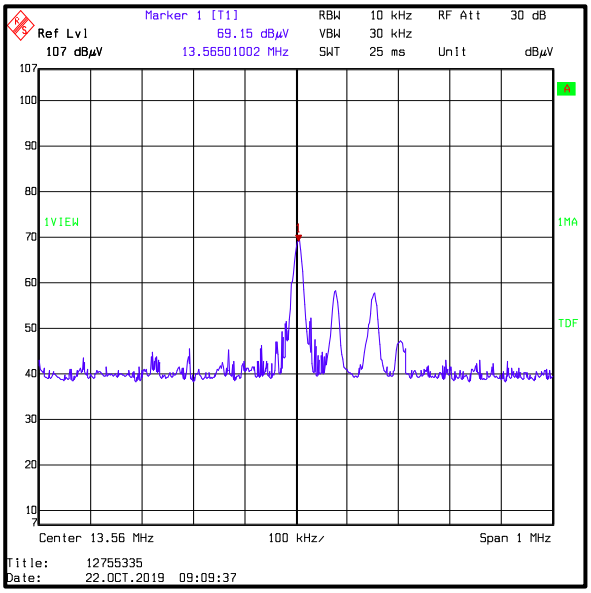
125 kHz reference unit signal at 3 metres in a semi-anechoic chamber on 30 October 2019



13.56 MHz reference unit signal at 3 metres in a semi-anechoic chamber on 30 October 2019



125 kHz reference unit signal at 3 metres on an open field test site on 22 October 2019

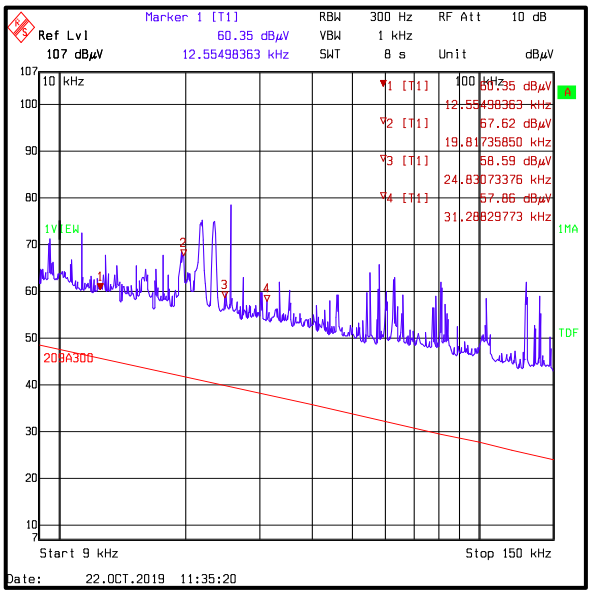


13.56 MHz reference unit signal at 3 metres on an open field test site on 22 October 2019

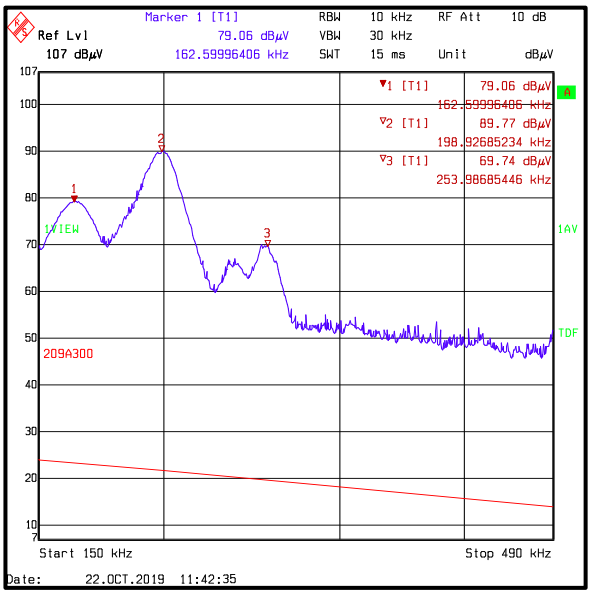
Note(s):

1. The above plots show comparable measurements of reference units on an open field test site and in a semi-anechoic chamber at spot frequencies.
2. The testing within the semi-anechoic chamber was performed over two day. The verification was performed on both day 25 and 30 October 2019. The measurements performed on 25 October 2019 are stored on the company IT server and are required upon request.

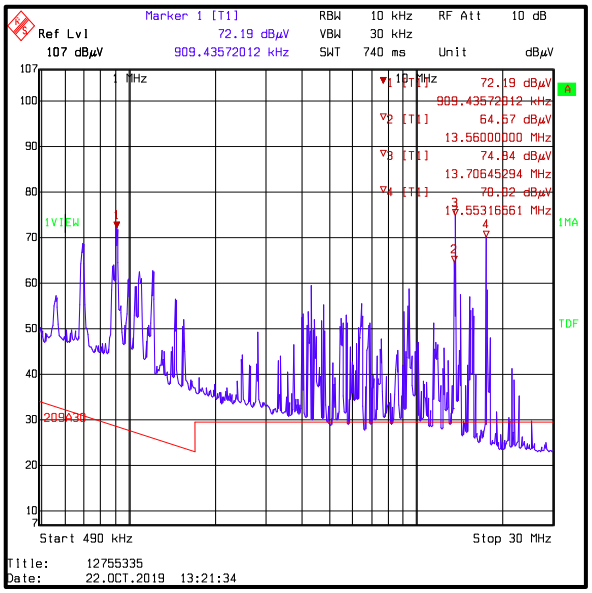
Background scans of the open field test site



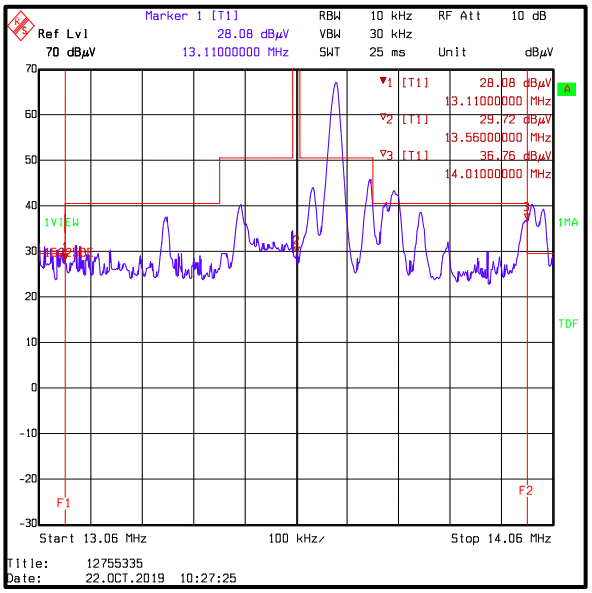
Frequency range: 9 kHz to 150 kHz
Peak detector / background scan



Frequency range: 150 kHz to 490 kHz
Average detector / background scan



Frequency range: 490 kHz to 30 MHz
Peak detector / background scan



Frequency range: 13.06 MHz to 14.06 MHz
/ background scan of the open field test site

Note(s):

1. The above plots are background scans of the open field test site. The EUT and generator (when used) were turned off when the background scans were performed.

--- END OF REPORT ---