



TEST REPORT

Test Report No. : UL-RPT-RP11378999JD01A

Manufacturer : Datecs Ltd
Model No. : Card Reader One
FCC ID : YRWCRONE
Technology : RFID – 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 1.0.

Date of Issue: 03 October 2016

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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:	Datecs Ltd
Address:	Datecs Street No 4 Sofia 1592 Bulgaria

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:	209735
Location of Testing:	UL VS LTD, Unit 3 Horizon, Wade Road, Kingsland Business Park, Basingstoke, Hampshire, RG24 8AH, United Kingdom
Test Dates:	14 September 2014 to 23 September 2016

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:	FCC KDB Publication Number 937606 Date: 10/10/2014
Title:	Test Site Requirements for Part 15 and 18 Devices Operating Below 30 MHz
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:	Datecs Ltd
Model Name or Number:	Card Reader One
Test Sample Serial Number:	1416900203
Hardware Version:	03.00.00.00
Firmware Version:	CR-ONE-V1 ver :3.0.5.0
FCC ID:	YRWCRONE

Brand Name:	Datecs Ltd
Model Name or Number:	Card Reader One
Test Sample Serial Number:	1416900214 (<i>Unit with antenna dummy load</i>)
Hardware Version:	03.00.00.00
Firmware Version:	CR-ONE-V1 ver :3.0.5.0
FCC ID:	YRWCRONE

Brand Name:	Datecs Ltd.
Model Name or Number:	Card Reader One
Test Sample Serial Number:	1416900215 (<i>Unit with external power cables</i>)
Hardware Version:	03.00.00.00
Firmware Version:	CR-ONE-V1 ver :3.0.5.0
FCC ID:	YRWCRONE

3.2. Description of EUT

The Equipment Under Test was an RFID (Contactless payment) and Bluetooth enabled mobile payment terminal, with magnetic stripe reader, contactless reader and smart card reader. Contains *Bluetooth* module with FCC ID: GT3FC018.

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	
Category of Equipment:	Transceiver	
Channel Spacing:	Single channel device	
Transmit Frequency Range:	13.56 MHz	
Power Supply Requirement:	Nominal	3.7 VDC (internal battery)
	Minimum	3.4 VDC
	Maximum	4.255 VDC
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:

Description:	USB Power Adaptor 100-240 VAC / 60 Hz to 5 VDC
Brand Name:	Apple
Model Name or Number:	A1265
Serial Number:	1x114KB8F8QZ

Description:	USB cable. Length 1.7 metres
Brand Name:	Not marked or stated
Model Name or Number:	Not marked or stated
Serial Number:	Not marked or stated

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 RFID test mode.

4.2. Configuration and Peripherals

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

- The RFID transmitter test mode was enabled using instructions provided by the customer in document 'How to start Contactless Reader.pdf' dated 27 July 2016.
- Frequency stability tests were performed with the EUT connected to a variable power supply. The sample with serial number 1416900215 was used.
- AC conducted emissions tests were performed with the EUT connected to the USB Power Adaptor. The USB Power Adaptor was connected to a 120 VAC 60 Hz single phase supply via a LISN.
- During AC conducted emissions, fundamental field strength, radiated spurious emissions and band edge radiated emissions tests, the USB cable was connected to the USB Power Adaptor. The USB Power Adaptor was connected to a 120 VAC 60 Hz single phase supply via a LISN.
- Refer to Appendix 1 of this test report for details of radiated tests on an open field test site.
- The sample with serial number 1416900203 was used for AC conducted emissions, fundamental field strength, radiated spurious emissions, band edge emissions and 20 dB bandwidth tests.
- The sample with serial number 1416900214 was also used for AC conducted emissions tests.

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:	Ian Watch	Test Date:	23 September 2016
Test Sample Serial Numbers:	1416900203 & 1416900214		

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

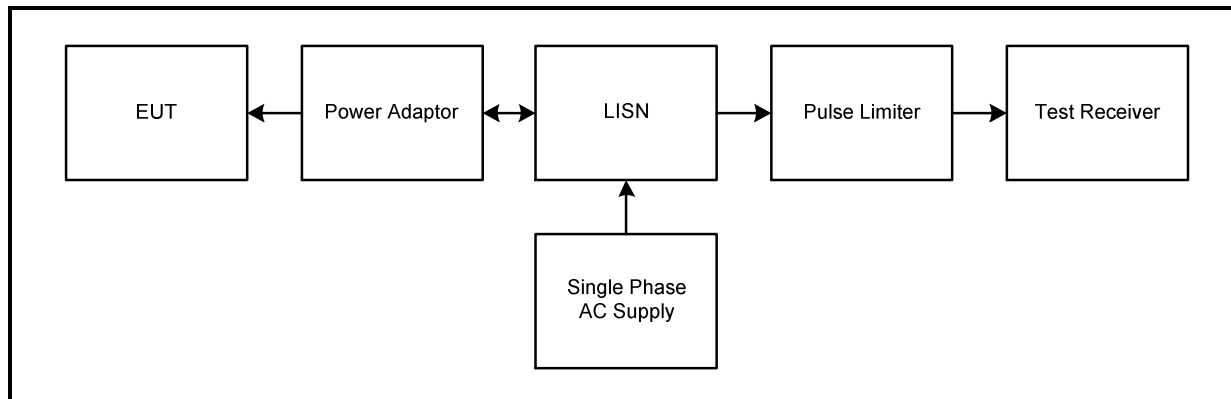
Environmental Conditions:

Temperature (°C):	23
Relative Humidity (%):	45

Note(s):

1. The EUT was connected to a USB power adaptor via a USB cable. The USB power adaptor was connected to a 120 VAC 60 Hz single phase supply via a LISN.
2. In accordance with FCC KDB 174176 Q4, tests were also performed with a 240 VAC 60 Hz single phase supply as this was within the voltage range marked on the USB power adaptor.
3. The EUT was initially tested with the standard antenna connected (Test sample serial number 1416900203) and using a 120 VAC 60 Hz single phase supply. An emission at the approximate carrier frequency of 13.56 MHz was found to be non-compliant as it exceeded the limit. The customer supplied a second, modified sample (Test sample serial number 1416900214). The standard antenna on this sample was disconnected and a dummy load fitted in accordance with FCC KDB 174176. The test was repeated and the EUT was found to be compliant.
4. * Test results with standard EUT sample (standard antenna).
5. ** Test results with EUT sample incorporating antenna dummy load.
6. A pulse limiter was fitted between the LISN and the test receiver.
7. 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
0.150	Live	39.3*	66.0	26.7	Complied
0.362	Live	40.0*	58.7	18.7	Complied
0.560	Live	34.5*	56.0	21.5	Complied
0.933	Live	39.4*	56.0	16.6	Complied
1.257	Live	36.1*	56.0	19.9	Complied
13.560	Live	53.0**	60.0	7.0	Complied

Results: Live / Average / 120 VAC 60 Hz

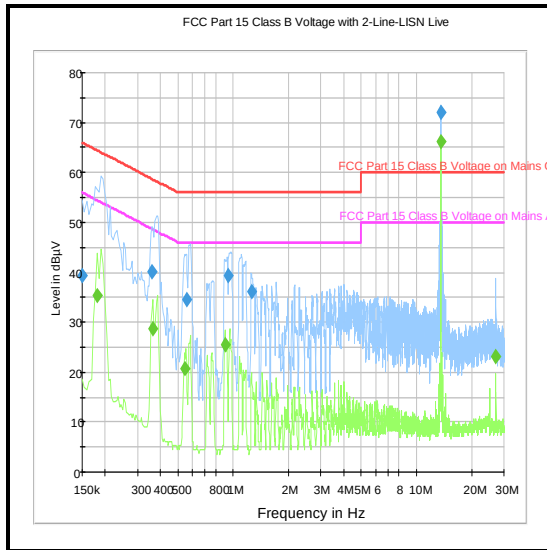
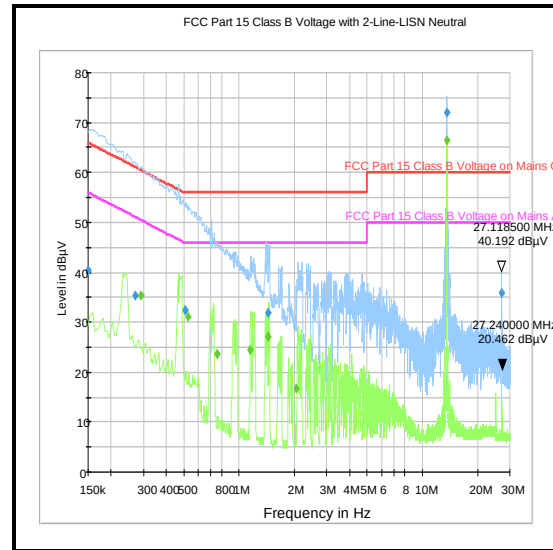
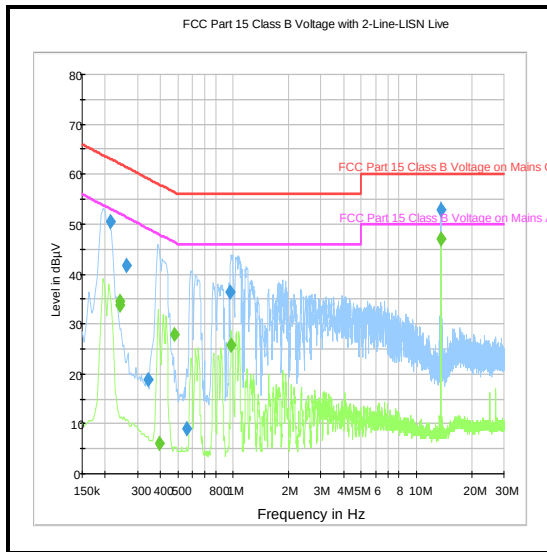
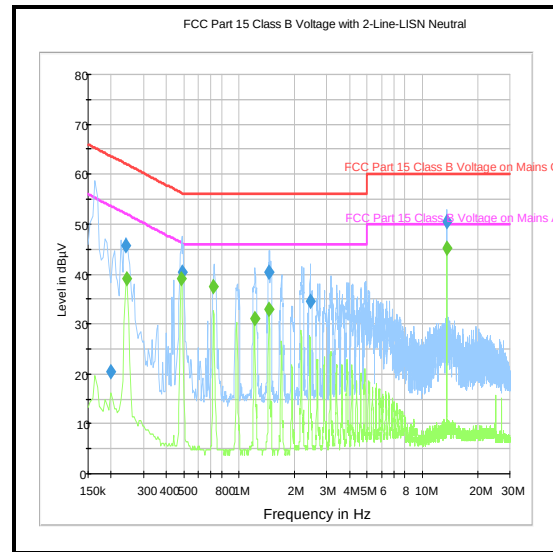
Frequency (MHz)	Line	Level (dBμV)	Limit (dBμV)	Margin (dB)	Result
0.182	Live	35.3*	54.4	19.1	Complied
0.366	Live	28.8*	48.6	19.8	Complied
0.546	Live	20.7*	46.0	25.3	Complied
0.911	Live	25.5*	46.0	20.5	Complied
13.560	Live	47.2**	50.0	2.8	Complied
27.123	Live	23.0*	50.0	27.0	Complied

Results: Neutral / Quasi Peak / 120 VAC 60 Hz

Frequency (MHz)	Line	Level (dBμV)	Limit (dBμV)	Margin (dB)	Result
0.150	Neutral	40.5*	66.0	25.5	Complied
0.272	Neutral	35.4*	61.1	25.7	Complied
0.510	Neutral	32.3*	56.0	23.7	Complied
1.437	Neutral	31.8*	56.0	24.2	Complied
13.560	Neutral	50.6**	60.0	9.4	Complied
27.123	Neutral	36.0*	60.0	24.0	Complied

Results: Neutral / Average / 120 VAC 60 Hz

Frequency (MHz)	Line	Level (dBμV)	Limit (dBμV)	Margin (dB)	Result
0.290	Neutral	35.5*	50.5	15.0	Complied
0.528	Neutral	31.2*	46.0	14.8	Complied
1.149	Neutral	24.3*	46.0	21.7	Complied
1.437	Neutral	27.2*	46.0	18.8	Complied
2.054	Neutral	16.7*	46.0	29.3	Complied
13.560	Neutral	45.3**	50.0	4.7	Complied

Transmitter AC Conducted Spurious Emissions (continued)**Results: 120 VAC 60 Hz with unmodified sample (antenna present)****Live****Neutral****Results: 120 VAC 60 Hz with modified sample (transmitter terminated into a dummy load)****Live****Neutral**

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

Transmitter AC Conducted Spurious Emissions (continued)**Results: Live / Quasi Peak / 240 VAC 60 Hz**

Frequency (MHz)	Line	Level (dBμV)	Limit (dBμV)	Margin (dB)	Result
0.159	Live	36.5*	65.5	29.0	Complied
0.600	Live	41.7*	56.0	14.3	Complied
1.023	Live	36.4*	56.0	19.6	Complied
1.748	Live	34.2*	56.0	21.8	Complied
13.560	Live	54.4**	60.0	5.6	Complied
27.123	Live	39.8*	60.0	20.2	Complied

Results: Live / Average / 240 VAC 60 Hz

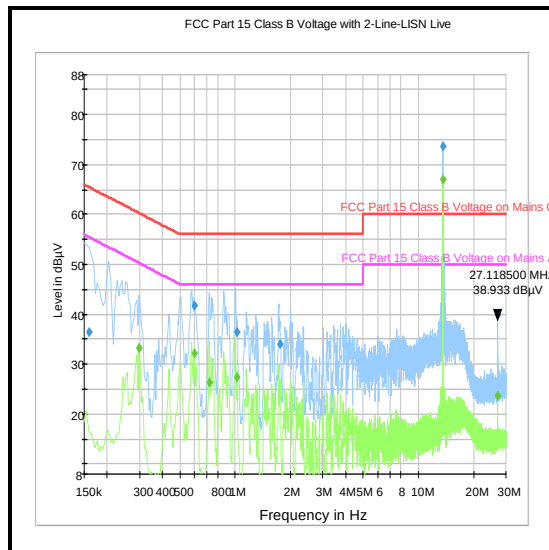
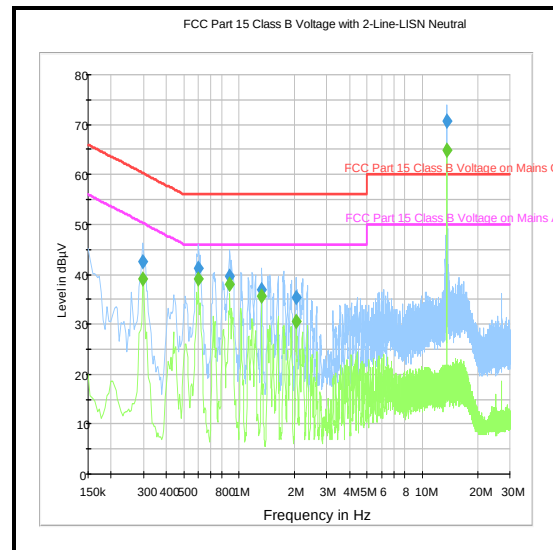
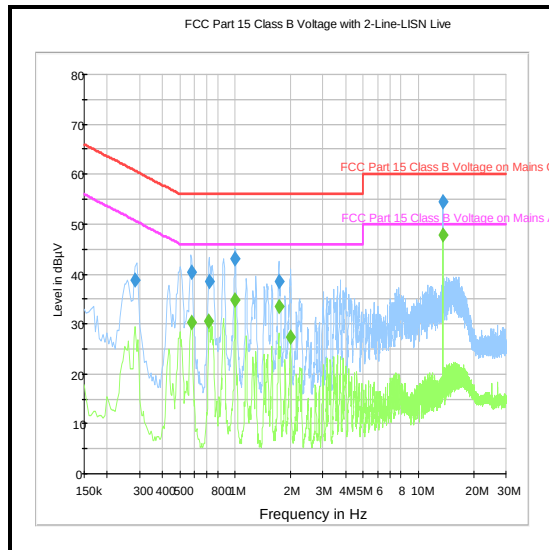
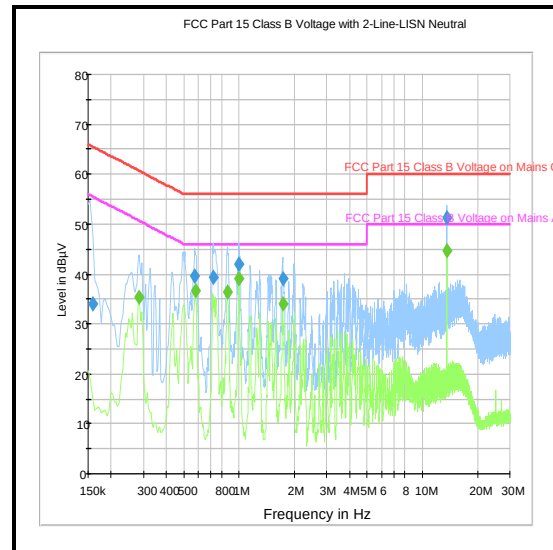
Frequency (MHz)	Line	Level (dBμV)	Limit (dBμV)	Margin (dB)	Result
0.299	Live	33.4*	50.3	16.9	Complied
0.600	Live	32.3*	46.0	13.7	Complied
0.726	Live	26.2*	46.0	19.8	Complied
1.023	Live	27.3*	46.0	18.7	Complied
13.560	Live	47.9**	50.0	2.1	Complied
27.123	Live	23.7*	50.0	26.3	Complied

Results: Neutral / Quasi Peak / 240 VAC 60 Hz

Frequency (MHz)	Line	Level (dBμV)	Limit (dBμV)	Margin (dB)	Result
0.299	Neutral	42.6*	60.3	17.7	Complied
0.600	Neutral	41.1*	56.0	14.9	Complied
0.888	Neutral	39.6*	56.0	16.4	Complied
1.325	Neutral	37.1*	56.0	18.9	Complied
2.045	Neutral	35.2*	56.0	20.8	Complied
13.560	Neutral	51.2**	60.0	8.8	Complied

Results: Neutral / Average / 240 VAC 60 Hz

Frequency (MHz)	Line	Level (dBμV)	Limit (dBμV)	Margin (dB)	Result
0.299	Neutral	39.1*	50.3	11.2	Complied
0.600	Neutral	39.1*	46.0	6.9	Complied
0.888	Neutral	38.0*	46.0	8.0	Complied
1.325	Neutral	35.6*	46.0	10.4	Complied
2.049	Neutral	30.6*	46.0	15.4	Complied
13.560	Neutral	44.6**	50.0	5.4	Complied

Transmitter AC Conducted Spurious Emissions (continued)**Results: 240 VAC 60 Hz with unmodified sample (antenna present)****Live****Neutral****Results: 240 VAC 60 Hz with modified sample (transmitter terminated into a dummy load)****Live****Neutral**

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

Transmitter AC Conducted Spurious Emissions (continued)**Test Equipment Used:**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2015	Thermohygrometer	Testo	608-H1	45046424	10 Jun 2017	12
A649	LISN	Rohde & Schwarz	ESH3-Z5	825562/008	09 Aug 2017	12
A1830	Pulse Limiter	Rohde & Schwarz	ESH3-Z2	100668	08 Mar 2017	12
M1263	Test Receiver	Rohde & Schwarz	ESIB	100265	16 Oct 2016	12
M1229	Multimeter	Fluke	179	87640015	21 Apr 2017	12

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

Test Engineer:	Ian Watch	Test Dates:	14 September 2016 & 17 September 2016
Test Sample Serial Number:	1416900203		

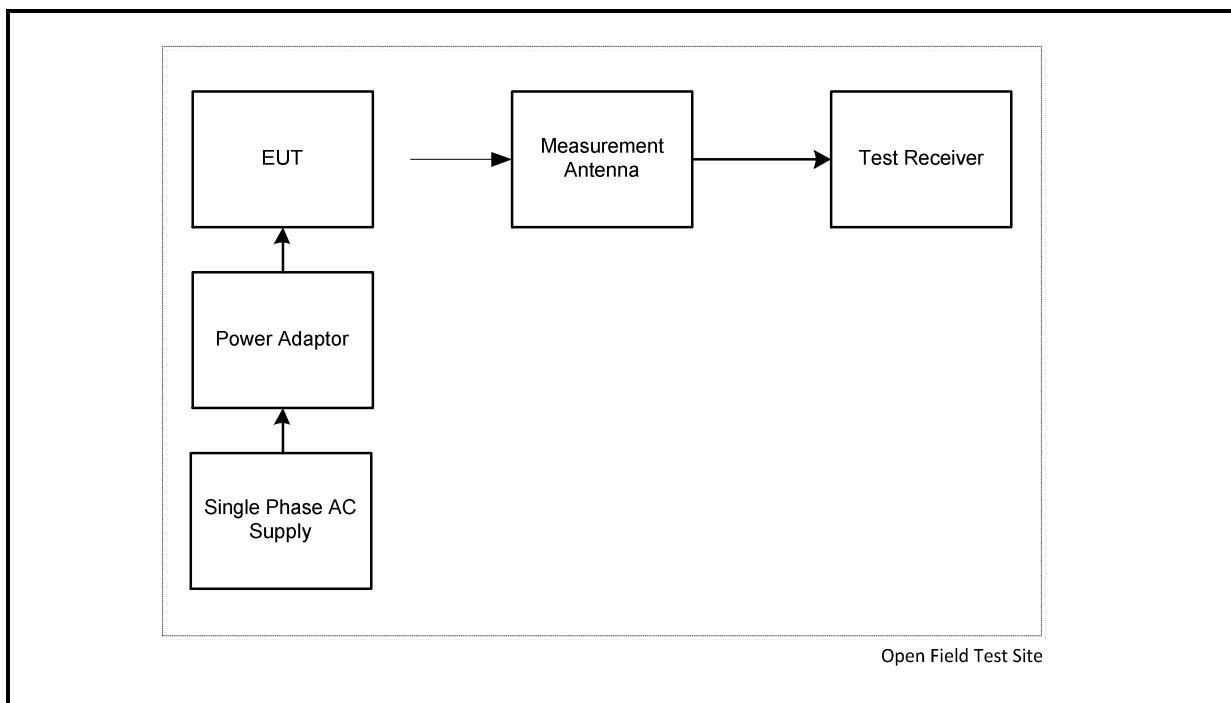
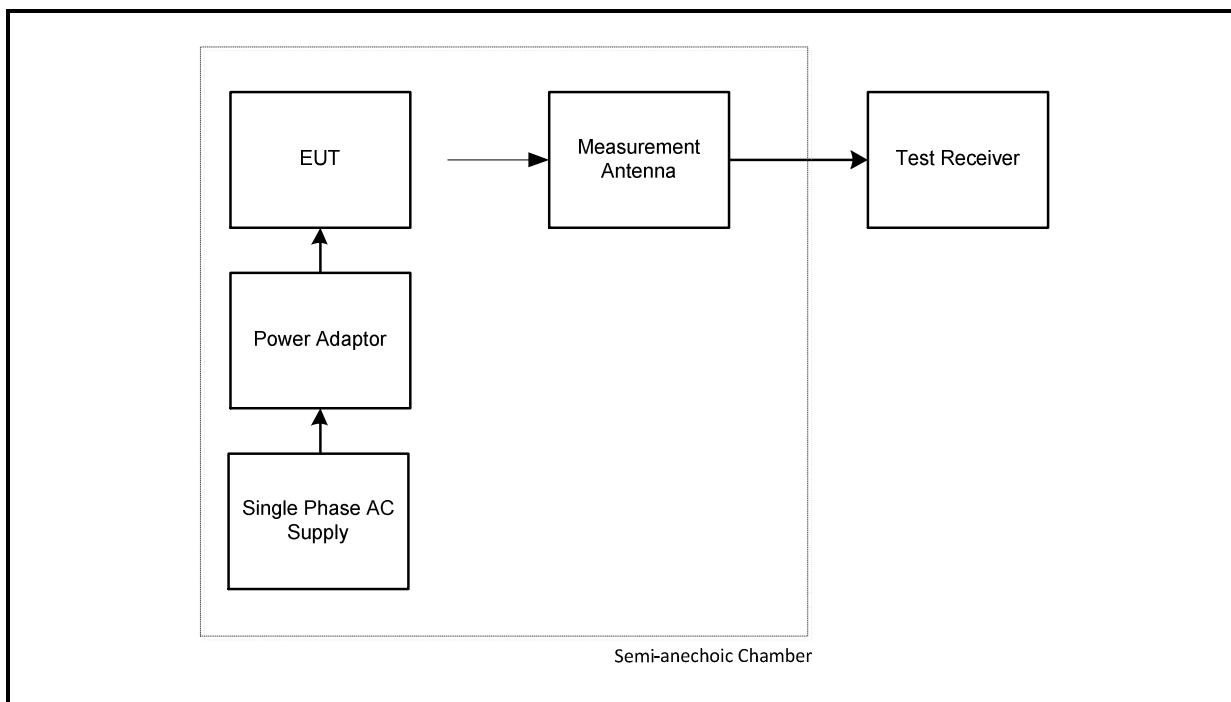
FCC Reference:	Part 15.225(a)(b)(c)(d)
Test Method Used:	ANSI C63.10 Section 6.4 and Notes below

Environmental Conditions:

Temperature (°C):	25 to 27
Relative Humidity (%):	51 to 58

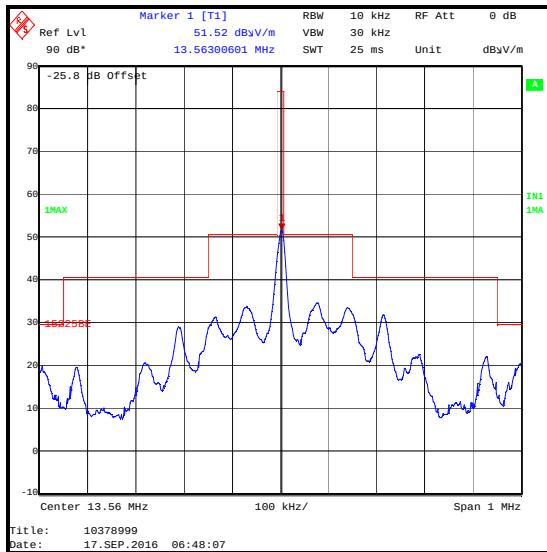
Note(s):

1. In accordance with FCC KDB 937606, measurements of the transmitter fundamental field strength at 30 metres on an open field test site are used to show compliance to the limit.
2. Due to the ambient emissions present on the open field test site, compliance with the spectrum mask is shown by measurements performed in a semi-anechoic chamber. For the field strength measurements in a semi-anechoic chamber, a reference level offset of -25.8 dB on the test receiver was used to replicate the measurement of the 13.56 MHz fundamental at 30 metres on 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.
3. Pre-scan measurements were performed using a peak detector and measurement bandwidth of 10 kHz. The fundamental field strength was maximized by rotating the measurement antenna and EUT. A peak level of 51.5 dBµV/m at a measurement distance of 30 metres was recorded and shown on the pre-scan plot below. The spectrum analyser was then switched to test receiver mode and the final measurement on the maximized level was performed. In accordance with and CISPR 16-1-1 as stated in ANSI C63.10 Clause 4.2.3.2.1, 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 51.5 dBµV/m was recorded.
4. 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.

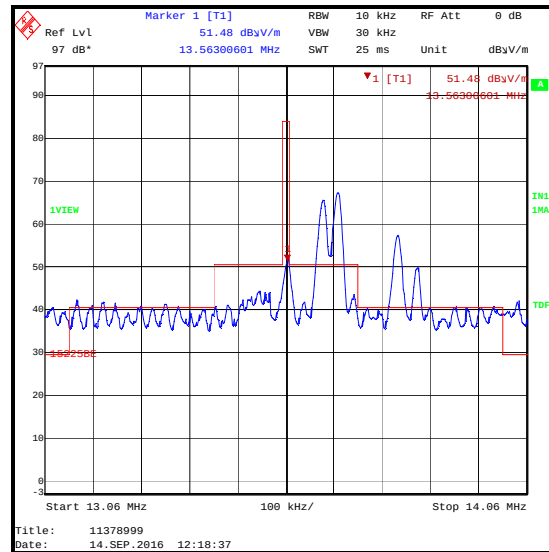
Transmitter Fundamental Field Strength (continued)**Test setup for fundamental field strength radiated measurements on an open field test site:****Test setup for fundamental field strength radiated measurements in a Semi-Anechoic Chamber:**

Transmitter Fundamental Field Strength (continued)**Results: Quasi Peak**

Frequency (MHz)	Measurement Antenna Position	Level (dB μ V/m)	Limit at 30 m (dB μ V/m)	Margin (dB)	Result
13.56	Tip of antenna 90° from EUT	51.5	84.0	32.5	Complied



Fundamental field strength and spectrum mask /
measured at 3 metres referenced to 30 metres
measurements on an open field site / measured in a
semi-anechoic chamber



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

Test Equipment Used:

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1659	Thermohygrometer	JM Handelspunkt	30.5015.13	Not stated	02 Apr 2017	12
M2014	Thermohygrometer	Testo	608-H1	45046246	10 Jun 2017	12
K0001	5m RSE Chamber	Rainford EMC	N/A	N/A	12 Jan 2017	12
M1568	Magnetic Loop Antenna	Rohde & Schwarz	HFH2-Z2	879284/2	23 May 2017	12
M1124	Test Receiver	Rohde & Schwarz	ESIB 26	100046	18 Nov 2016	12
M1273	Test Receiver	Rohde & Schwarz	ESIB 26	100275	11 Apr 2017	12
M1956	Precision Steel Rule	Rabone	(64SR) 0-35-406	4501361/2204	22 Apr 2020	60
A2686	Distance Measuring Wheel	Rolson Quality Tools	50799	Not stated	Calibrated before use	-
A2955	Protractor	Not marked or stated	9781907550 980	#1	Calibration not required	-

5.2.3. Transmitter Radiated Spurious Emissions

Test Summary:

Test Engineer:	Ian Watch	Test Dates:	14 September 2016 & 17 September 2016
Test Sample Serial Number:	1416900203		

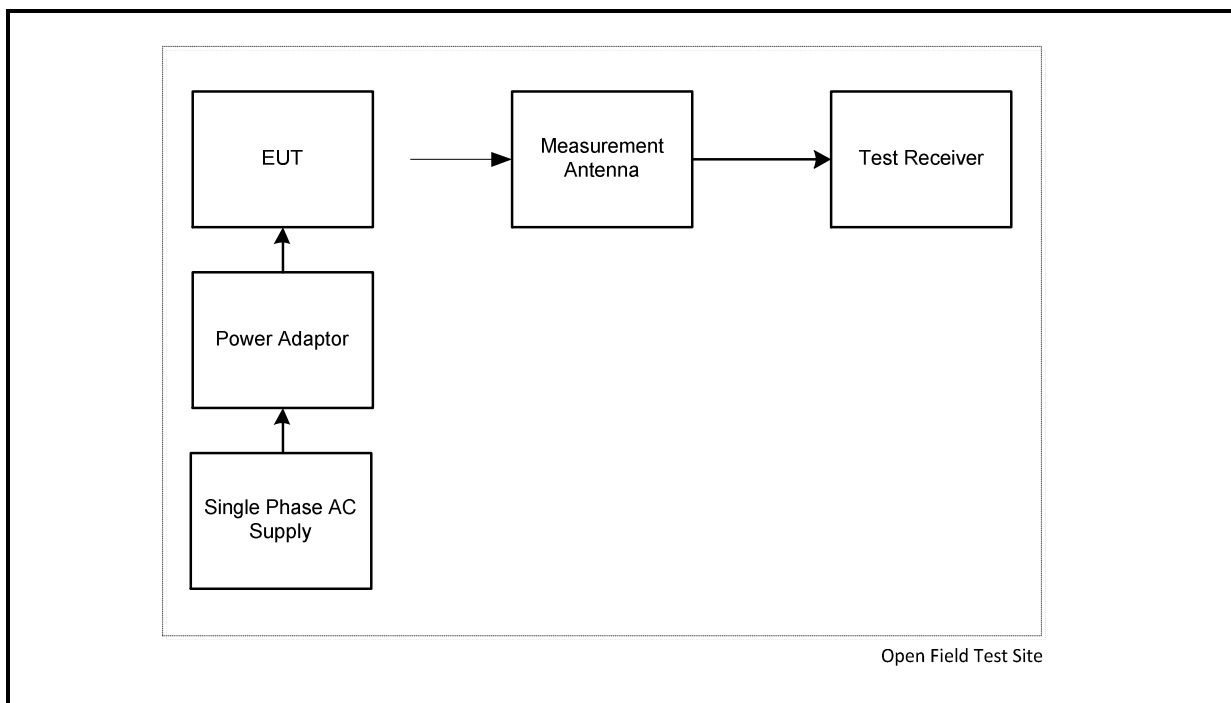
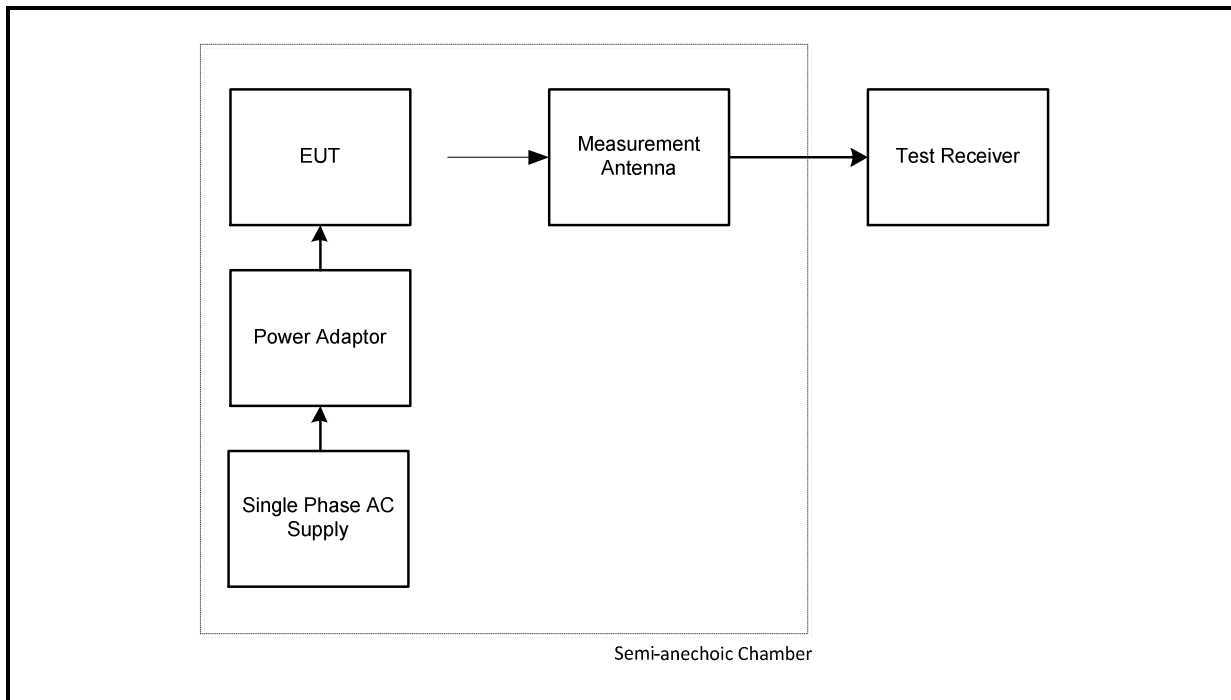
FCC Reference:	Parts 15.225(d) & 15.209(a)
Test Method Used:	ANSI C63.10 Sections 6.3, 6.4 and 6.5 and Notes below
Frequency Range:	9 kHz to 1000 MHz

Environmental Conditions:

Temperature (°C):	25 to 27
Relative Humidity (%):	51 to 58

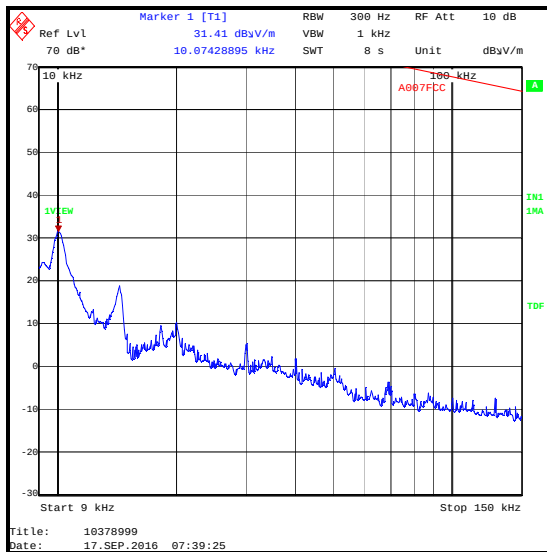
Note(s):

1. In accordance with FCC KDB 937606, 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 14 September 2016. Unfortunately, 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 17 September 2016 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 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 17 September 2016 were performed in a semi-anechoic chamber (UL VS LTD Asset Number K0001) 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 open field test site plots from 9 kHz to 490 kHz have been extrapolated using a factor of 40 dB/decade to a test distance of 30 metres and are for indication only.
7. 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.

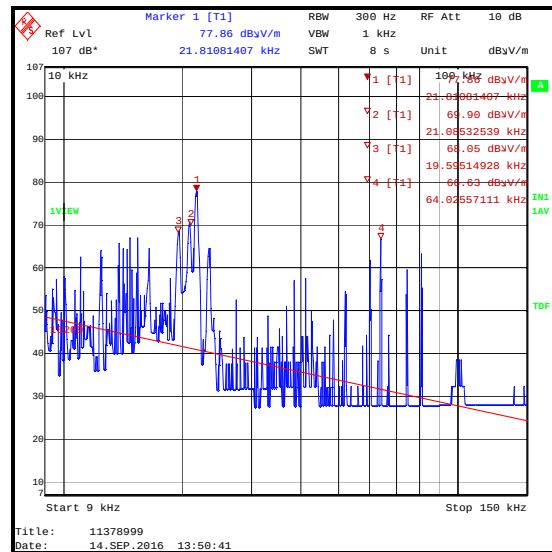
Transmitter Radiated Spurious Emissions (continued)**Test setup for radiated spurious emissions measurements on an open field test site:****Test setup for radiated spurious emissions measurements in a Semi-Anechoic Chamber:**

Transmitter Radiated Spurious Emissions (continued)**Results: Quasi Peak**

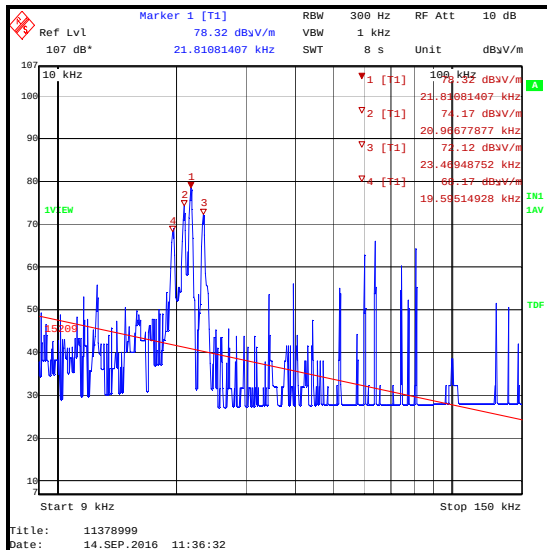
Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
40.663	Vertical	21.4	40.0	18.6	Complied
81.350	Vertical	20.1	40.0	19.9	Complied
135.599	Vertical	32.9	43.5	10.6	Complied
149.168	Vertical	25.0	43.5	18.5	Complied
162.719	Vertical	29.6	43.5	13.9	Complied
894.987	Horizontal	36.3	46.0	9.7	Complied

Transmitter Radiated Spurious Emissions (continued)

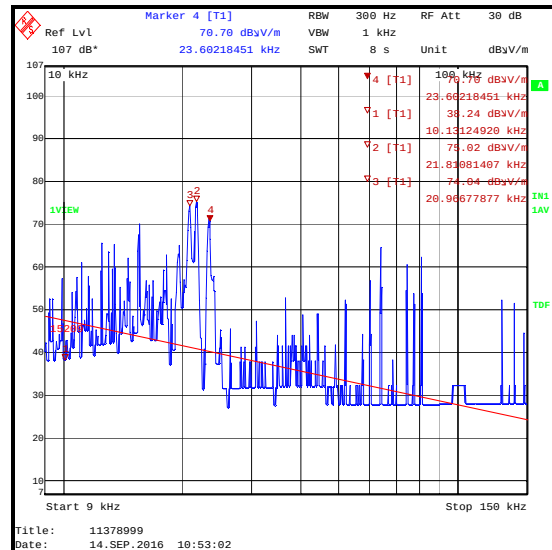
9 kHz to 150 kHz / peak detector / measured at 3 metres extrapolated to 30 metres / measured in a semi-anechoic chamber



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

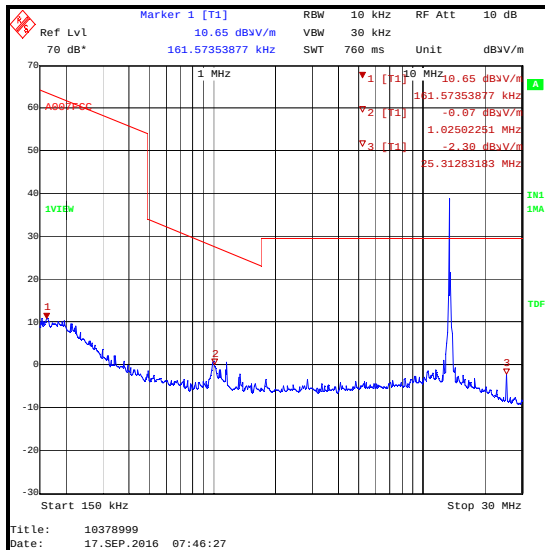


9 kHz to 150 kHz / average detector / EUT operating / measured at 30 metres on an open field test site

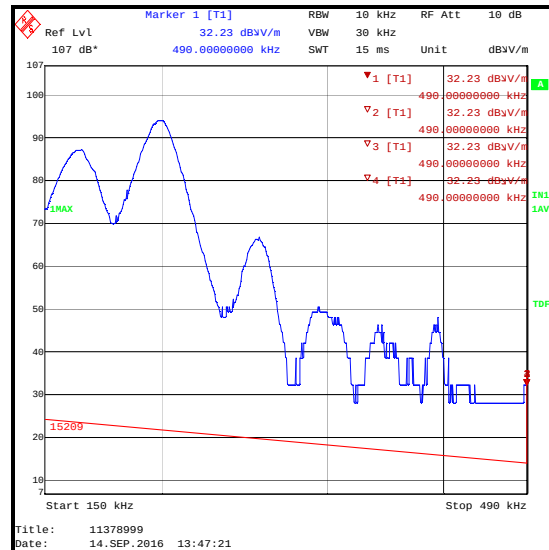


9 kHz to 150 kHz / average detector / EUT operating / measured at 300 metres on an open field test site

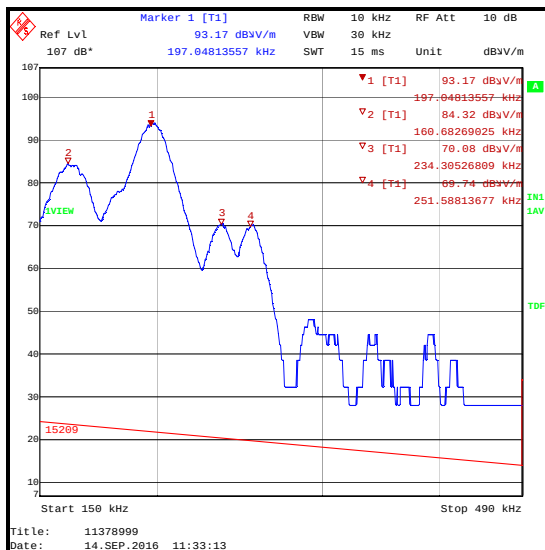
Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying table.

Transmitter Radiated Spurious Emissions (continued)

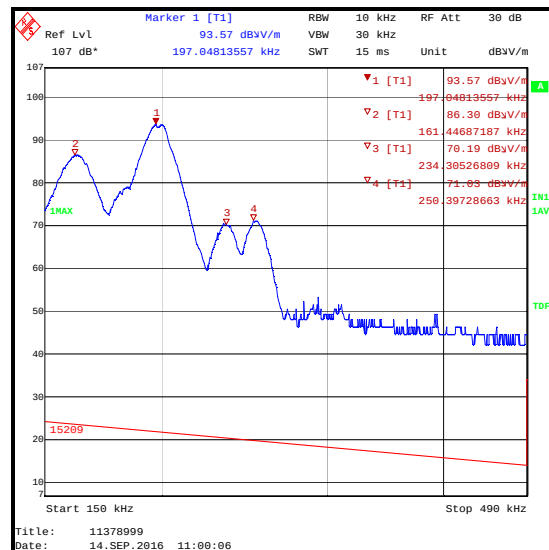
150 kHz to 30 MHz / peak detector (worst case) / EUT operating / measured at 3 metres extrapolated to 30 metres / measured in a semi-anechoic chamber



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

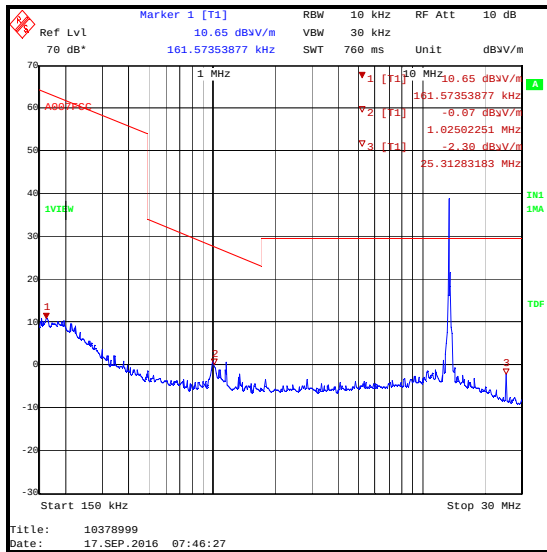


150 kHz to 490 kHz / average detector / EUT operating / measured at 30 metres on an open field test site

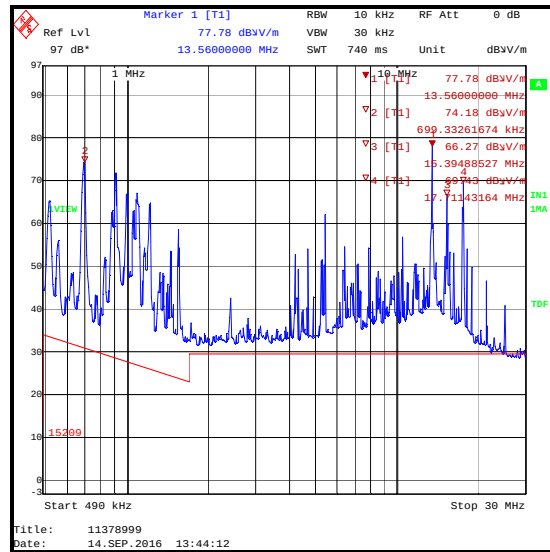


150 kHz to 490 kHz / average detector / EUT operating / measured at 300 metres on an open field test site

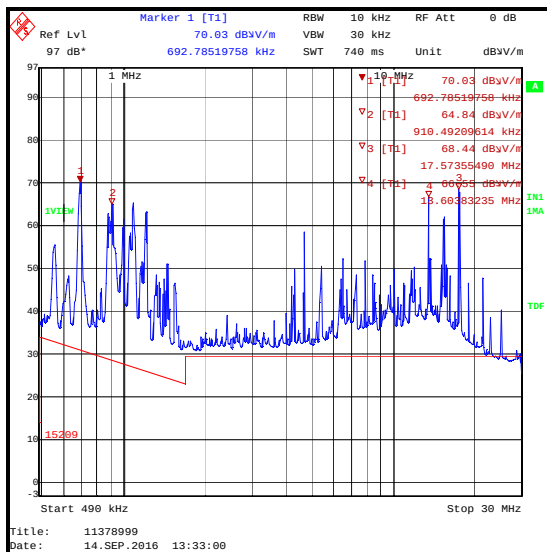
Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying table.

Transmitter Radiated Spurious Emissions (continued)

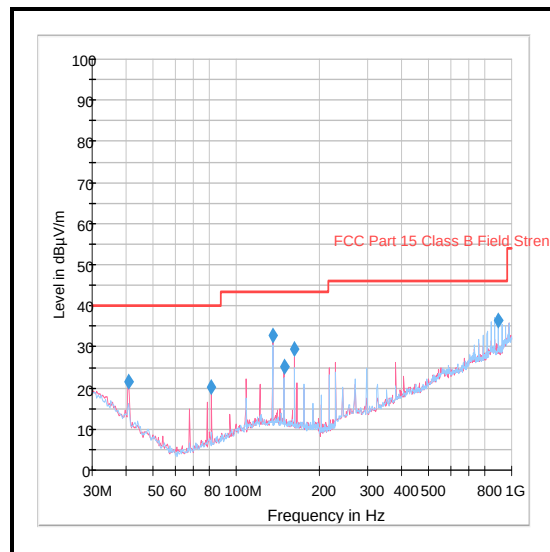
150 kHz to 30 MHz / peak detector / measured at 3 metres extrapolated to 30 metres / measured in a semi-anechoic chamber



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)
K0001	5m RSE Chamber	Rainford EMC	N/A	N/A	12 Jan 2017	12
A1834	Attenuator	Hewlett Packard	8491B	10444	30 Mar 2017	12
G0543	Amplifier	Sonoma	310N	230801	09 Dec 2016	6
M1273	Test Receiver	Rohde & Schwarz	ESIB26	100275	11 Apr 2017	12
A2903	Antenna	Schwarzbeck	VULB 9163	9163-944	06 May 2017	12
M1659	Thermohygrometer	JM Handelspunkt	30.5015.13	Not stated	02 Apr 2017	12
M2014	Thermohygrometer	Testo	608-H1	45046246	10 Jun 2017	12
M1124	Test Receiver	Rohde & Schwarz	ESIB 26	100046	18 Nov 2016	12
M1568	Magnetic Loop Antenna	Rohde & Schwarz	HFH2-Z2	879284/2	23 May 2017	12
M1956	Precision Steel Rule	Rabone	(64SR) 0-35-406	4501361/2204	22 Apr 2020	60
A2686	Distance Measuring Wheel	Rolson Quality Tools	50799	Not stated	Calibrated before use	-
A2955	Protractor	Not marked or stated	978190755 0980	#1	Calibration not required	-

5.2.4. Transmitter Band Edge Radiated Emissions**Test Summary:**

Test Engineer:	Ian Watch	Test Date:	17 September 2016
Test Sample Serial Number:	1416900203		

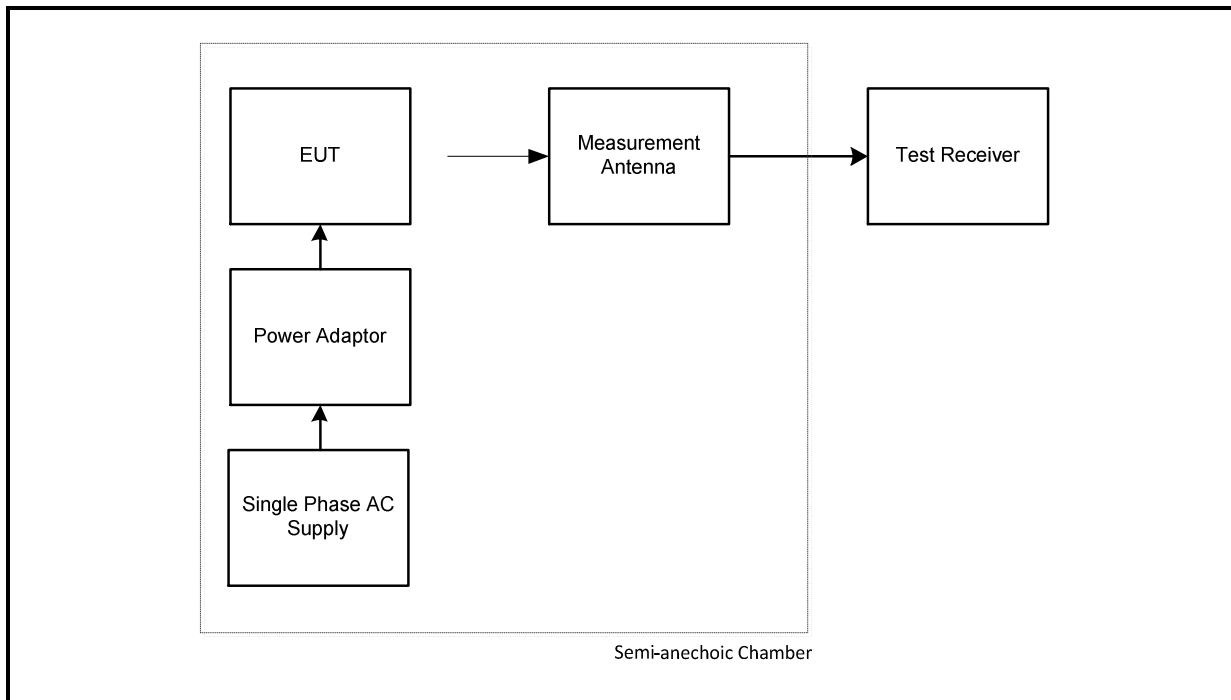
FCC Reference:	Parts 15.225(c)(d) & 15.209(a)
Test Method Used:	ANSI C63.10 Section 6.10.4 and Notes below

Environmental Conditions:

Temperature (°C):	25
Relative Humidity (%):	41

Note(s):

1. In accordance with FCC KDB 937606, 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 band edge emission values at the test distances specified below 30 MHz on an open field test site due to the presence of ambient emissions, therefore in accordance with 47 CFR 15.31(f), measurements were made at closer distances. Attempts were made to measure the fundamental and band edges at 3 metres on an open field test site on 14 September 2016. Unfortunately the emission could not be seen above the ambient emissions or the noise floor of the measurement system. Therefore the results from the semi-anechoic chamber tests on 17 September 2016 are shown in this section of the test report. Background scans of the open field test site are shown in Appendix 1 of this test report.
2. Field strength measurements in a semi-anechoic chamber had an RF level offset of -25.8 dB was applied to replicate the fundamental field strength level measured on the open field test site at 30 metres.
3. 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.

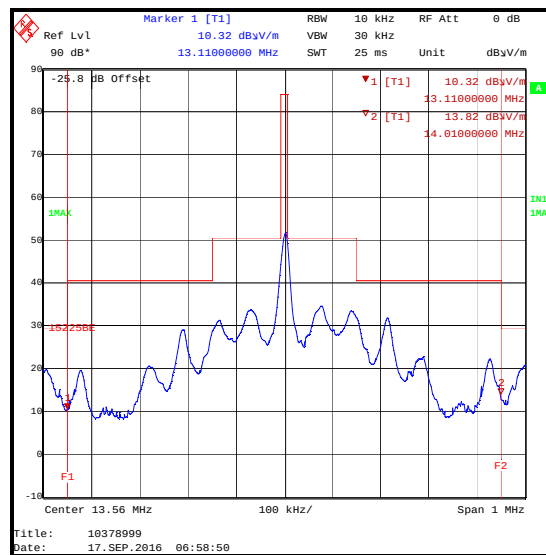
Transmitter Band Edge Radiated Emissions (continued)**Test setup:**

Transmitter Band Edge Radiated Emissions (continued)**Results: Peak / Lower Band Edge**

Frequency (MHz)	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
13.11	10.3	29.5	19.2	Complied

Results: Peak / Upper Band Edge

Frequency (MHz)	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
14.01	13.8	29.5	15.7	Complied

**Test Equipment Used:**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2014	Thermohygrometer	Testo	608-H1	45046246	10 Jun 2017	12
K0001	5m RSE Chamber	Rainford EMC	N/A	N/A	12 Jan 2017	12
M1568	Magnetic Loop Antenna	Rohde & Schwarz	HFH2-Z2	879284/2	23 May 2017	12
M1273	Test Receiver	Rohde & Schwarz	ESIB 26	100275	11 Apr 2017	12

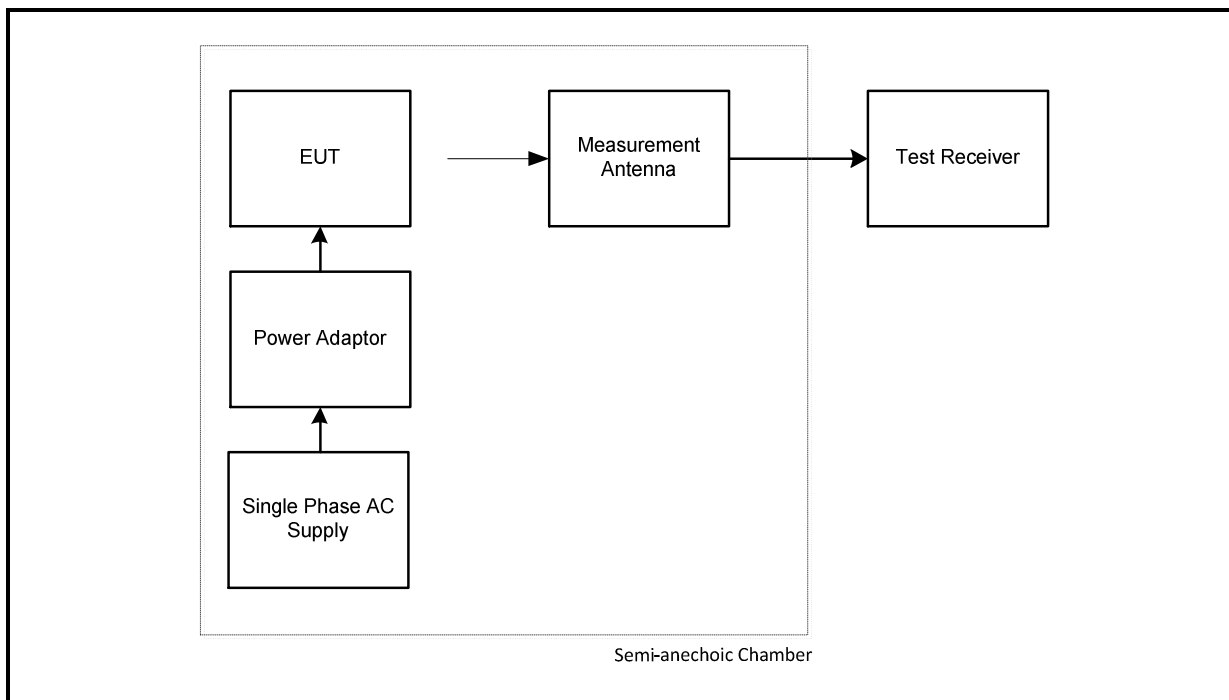
5.2.5. Transmitter 20 dB Bandwidth**Test Summary:**

Test Engineer:	Ian Watch	Test Date:	21 September 2016
Test Sample Serial Number:	1416900203		

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

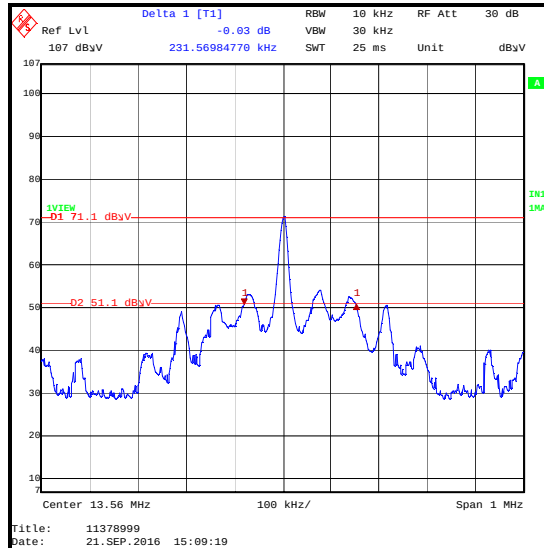
Environmental Conditions:

Temperature (°C):	24
Relative Humidity (%):	54

Test setup:

Transmitter 20 dB Bandwidth (continued)**Results:**

20 dB Bandwidth (kHz)
231.570

**Test Equipment Used:**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2014	Thermohygrometer	Testo	608-H1	45046246	10 Jun 2017	12
M1124	Test Receiver	Rohde & Schwarz	ESIB 26	100046	18 Nov 2016	12

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

Test Engineer:	Ian Watch	Test Date:	22 September 2016
Test Sample Serial Number:	1416900215		

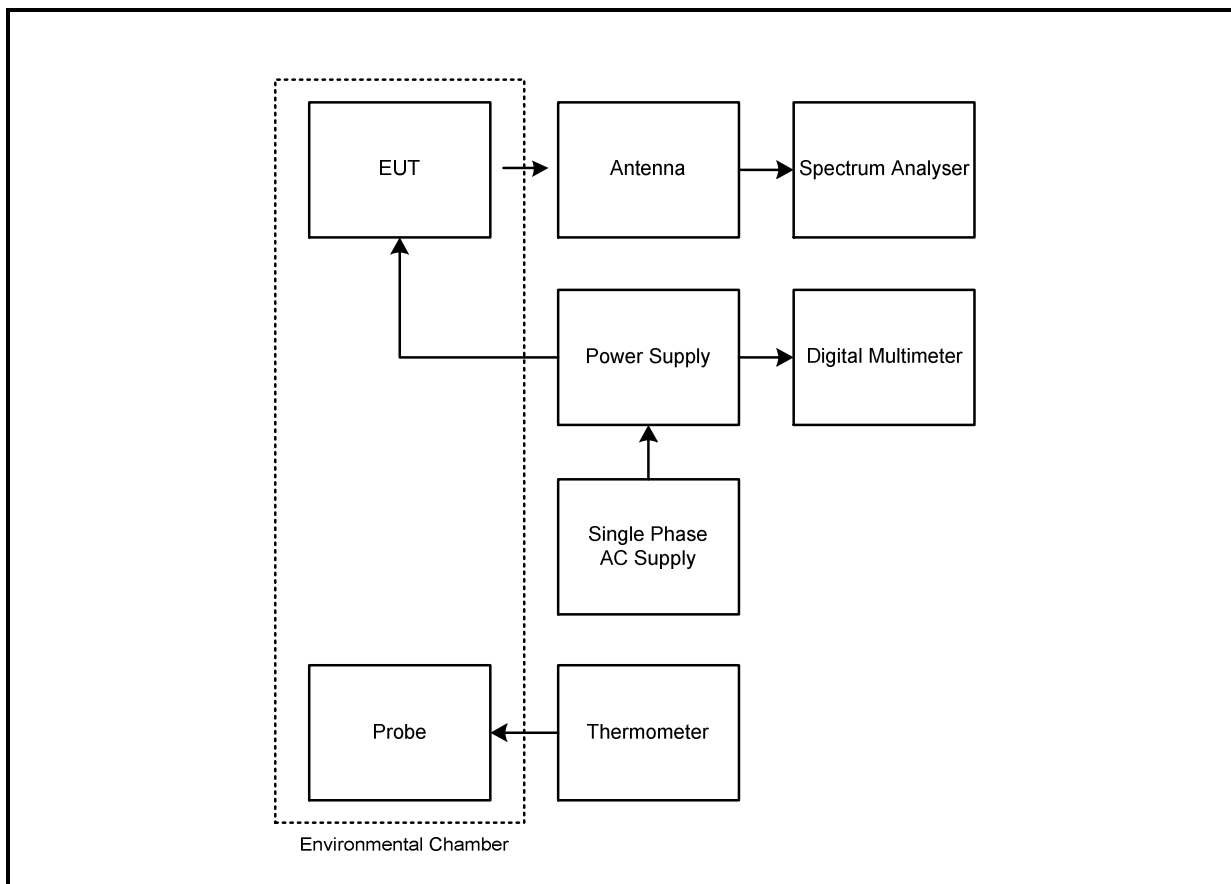
FCC Reference:	Part 15.225(e)
Test Method Used:	ANSI C63.10 Sections 6.8.1 and 6.8.2

Environmental Conditions:

Ambient Temperature (°C):	24
Ambient Relative Humidity (%):	53

Note(s):

1. Testing at voltage extremes was performed with the EUT powered by an external DC power supply. The EUT's battery was removed and the power supply was connected to the EUT's battery terminals. The manufacturer declared the minimum and maximum primary supply voltages as 3.4 and 4.255.
2. Frequency stability measurements were performed with a modulated carrier. The measurements were performed using the spectrum analyser marker counter function. The marker counter function was set to 1 Hz before any measurements were performed.
3. Frequency error was measured using a calibrated Rohde & Schwarz spectrum analyser.
4. Temperature was monitored throughout the test with a calibrated digital thermometer.
5. Voltage was monitored throughout the test with a calibrated digital voltmeter.

Transmitter Frequency Stability (Temperature & Voltage Variation) (continued)**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	13.560783 MHz	13.560788 MHz	13.560788 MHz	13.560787 MHz
20	13.560710 MHz	13.560707 MHz	13.560707 MHz	13.560708 MHz
50	13.560593 MHz	13.560589 MHz	13.560587 MHz	13.560585 MHz

Frequency with Worst Case Deviation (MHz)	Frequency Error (Hz)	Frequency Error (%)	Limit (%)	Margin (%)	Result
13.560788	788	0.005811	0.01	0.004189	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
3.4	13.56	13.560710	710	0.005236	0.01	0.004764	Complied
3.7	13.56	13.560710	710	0.005236	0.01	0.004764	Complied
4.255	13.56	13.560710	710	0.005236	0.01	0.004764	Complied

Test Equipment Used:

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1659	Thermohygrometer	JM Handelspunkt	30.5015.13	None stated	02 Apr 2017	12
E0513	Environmental Chamber	TAS	LT600	23900506	Calibrated before use	-
M1249	Thermometer	Fluke	52II	88800049	27 May 2017	12
M1229	Multimeter	Fluke	179	87640015	21 Apr 2017	12
M1124	Test Receiver	Rohde & Schwarz	ESIB 26	100046	18 Nov 2016	12
M1568	Magnetic Loop Antenna	Rohde & Schwarz	HFH2-Z2	879284/2	23 May 2017	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%	±4.69 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%	±3.73 dB
Radiated Spurious Emissions	30 MHz to 1000 MHz	95%	±5.65 dB
Transmitter Fundamental Field Strength	13 MHz to 14 MHz	95%	±3.73 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

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

The test site was free from underground metal objects.

The EUT was powered at its nominal voltage from its internal battery. The USB cable was inserted and connected to the power adaptor. The power adaptor was connected to a single phase supply. A power cable was run across the site to the EUT via the power adaptor and associated USB cable. 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.

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 60 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

The test site was free from underground metal objects.

The EUT was powered at its nominal voltage from its internal battery. The USB cable was inserted and connected to the power adaptor. The power adaptor was connected to a single phase supply from a portable generator. A power cable was run across the field to the power adaptor. 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 agricultural supply.

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.

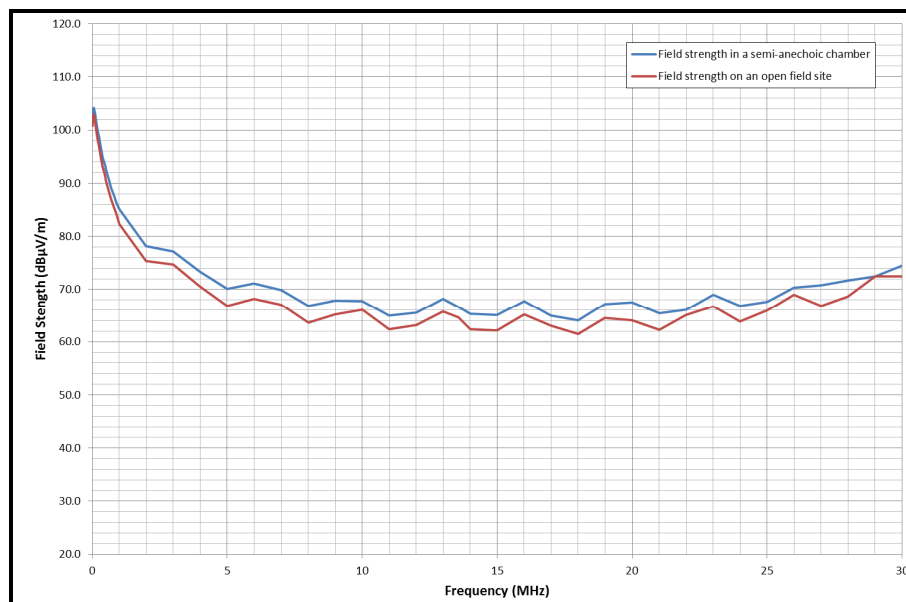
Initially, The EUT was rotated through 360 degrees in 60 degree steps at both measurement distances. The mag loop antenna was rotated through 90 degrees in 30 degree steps at every position the EUT was moved to. The EUT and mag loop antenna were then rotated in small increments in order to maximise emission levels.

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

Radiated measurements were performed on an open field test site and within a 5 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, unmodulated 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 RFID frequencies.

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

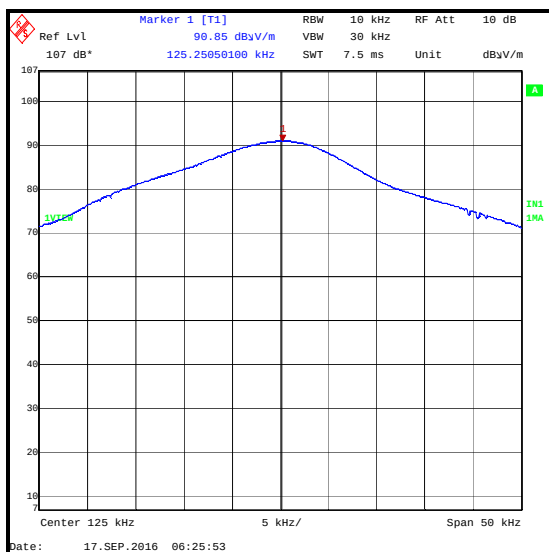
The centre of the magnetic loop antenna is placed exactly 3 metres from the reference unit. The reference unit is placed on a plastic table at a height of 0.8 metres above floor level and the centre of the mag loop antenna is 1 metre above the floor level. The mag loop antenna and reference unit are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

Each reference unit is connected to a 12 Volt battery 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.

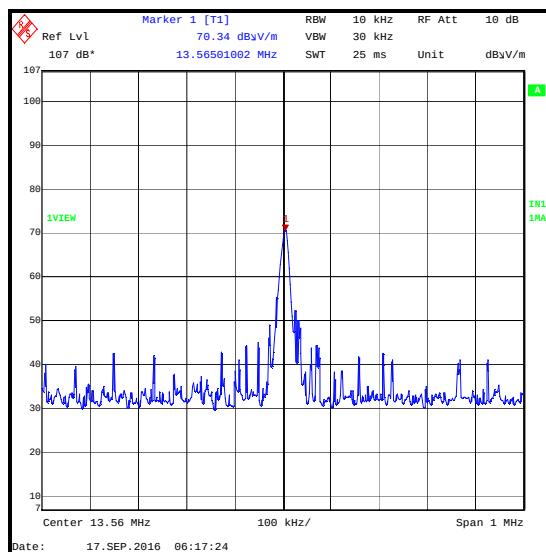
The internal verification procedure and verification plots are available for inspection on request.

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

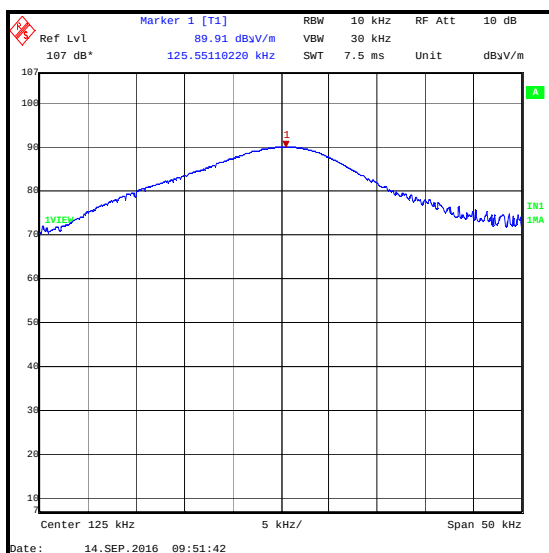
Verification plots of the two reference units at a measurement distance of 3 metres are shown on the following page. Plots were taken on an open field test site (14 September 2016) and in a semi-anechoic chamber (17 September 2016).



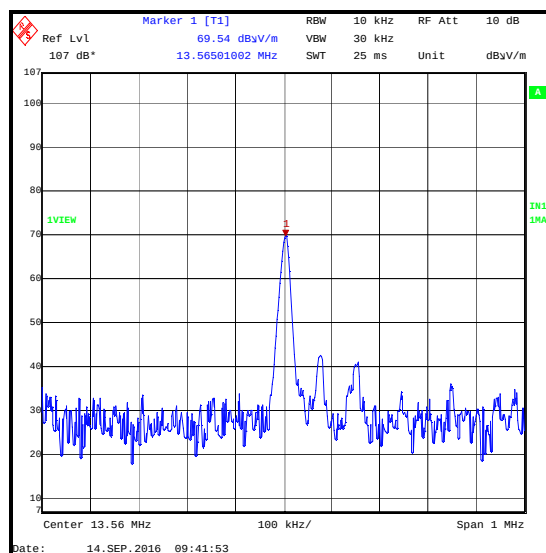
125 kHz reference unit signal at 3 metres in a semi-anechoic chamber on 17 September 2016



13.56 MHz reference unit signal at 3 metres in a semi-anechoic chamber on 17 September 2016



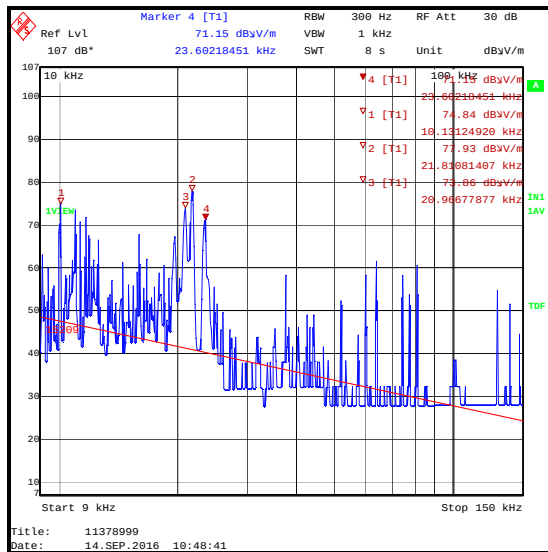
125 kHz reference unit signal at 3 metres on an open field test site on 14 September 2016



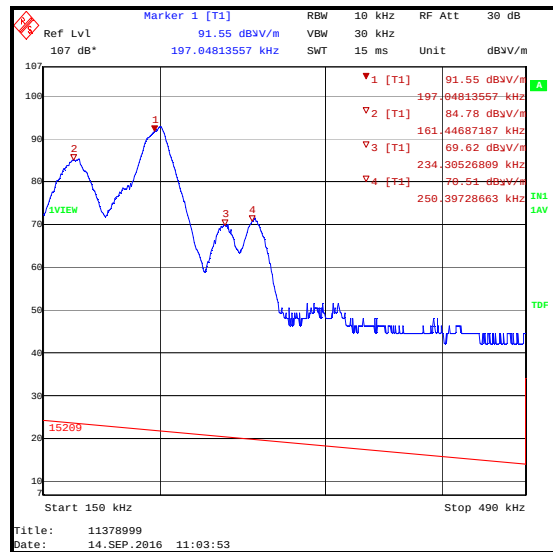
13.56 MHz reference unit signal at 3 metres on an open field test site on 14 September 2016

Note(s):

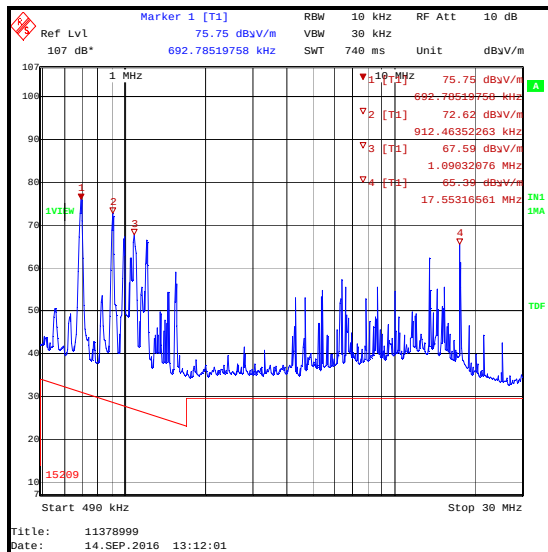
1. The above plots show comparable measurements of reference units on an open field test site and in a semi-anechoic chamber at spot frequencies.

Background scans of the open field test site

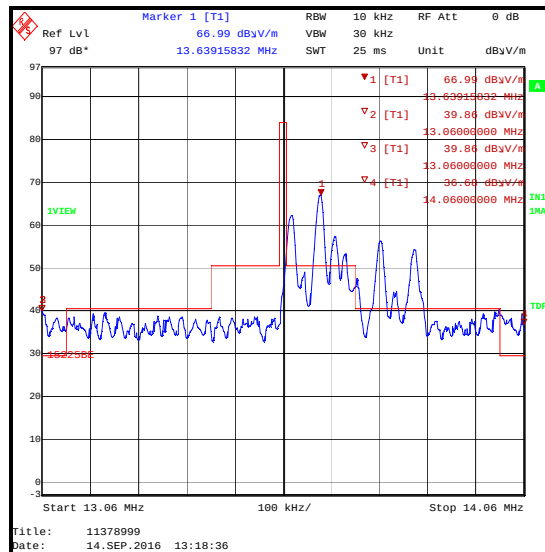
Frequency range: 9 kHz to 150 kHz
Average detector / background scan



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
Peak detector / background scan of the open field test site

Note(s):

- 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 ---