



TEST REPORT

Test Report No. : UL-RPT-RP11088562JD03A

Manufacturer : STid
Model No. : ARC-AC3
FCC ID : OVNAC3
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: 29 April 2016

Checked by:

Ian Watch
Senior Engineer, Radio Laboratory

Company Signatory:

Steven White
Service Lead, 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:	STid
Address:	20 Parc d'Activités des Pradeaux 13850 Gréasque France

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:	08 March 2016 to 31 March 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 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 174176 Date: June 3, 2015
Title:	AC Power-Line Conducted Emissions Frequently Asked Questions.
Reference:	FCC KDB Publication Number 937606 Date: 10/10/2014
Title:	Test Site Requirements for Part 15 and 18 Devices Operating Below 30 MHz

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:	ARC1
Model Name or Number:	ARC-AC3
Test Sample Serial Number:	G14180432 (<i>Standard unit</i>)
Hardware Version:	03
Software Version:	02
FCC ID:	OVNAC3

Brand Name:	ARC1
Model Name or Number:	ARC-AC3
Test Sample Serial Number:	G14180434 (<i>Modified antenna unit</i>)
Hardware Version:	03
Software Version:	02
FCC ID:	OVNAC3

3.2. Description of EUT

The Equipment Under Test was an RFID tag reader operating at 13.56 MHz.

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:	13.559833 MHz	
Power Supply Requirement:	Nominal	12 VDC
	Minimum	10.2 VDC
	Maximum	13.8 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:	12 Volt Battery
Brand Name:	OPTIMA Batteries
Model Name or Number:	8012-254
Serial Number:	Not marked or stated

Description:	100-240 VAC to 12 VDC Switch Mode Power Supply
Brand Name:	RS Pro
Model Name or Number:	SAW48-12.0-4000
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 when the EUT was powered.
- AC conducted emissions tests were performed with the EUT connected to an RS Pro SAW48-12.0-4000 power supply. The power supply was connected to a 120 VAC 60 Hz / 240 VDC 60 Hz single phase supply via a LISN.
- Testing at voltage extremes was performed with the EUT connected to a variable voltage, bench power supply.
- Radiated tests on an open field test site were performed with the EUT powered from a fully charged 12 Volt battery.
- For all other tests, EUT was powered from an off-the-shelf unmodified DC power supply.

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:	Georgios Vrezas	Test Date:	31 March 2016
Test Sample Serial Numbers:	G14180432 & G14180434		

FCC Reference:	Part 15.207
Test Method Used:	ANSI C63.10 Section 6.2

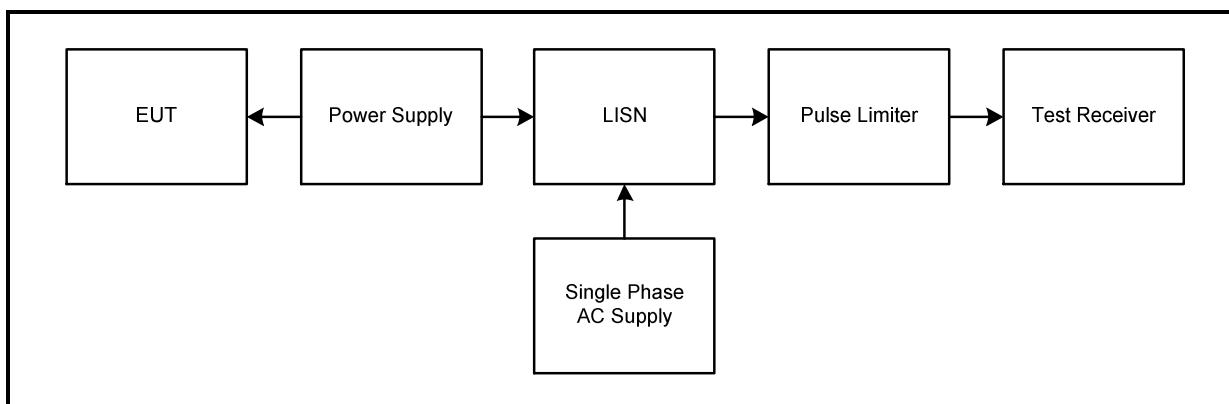
Environmental Conditions:

Temperature (°C):	23
Relative Humidity (%):	35

Note(s):

1. The EUT was connected to a power supply. The power supply was connected to 120 VAC 60 Hz single phase supply via a LISN.
2. In accordance with KDB 174176 Q4, tests were also performed with the power supply connected to a 240 VAC 60 Hz single phase supply via a LISN.
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.
5. * Test results prior to modification of the EUT (standard antenna).
6. ** Test results with modified sample Serial No. G14180434 (transmitter terminated into 50 Ohm load in accordance with KDB 174176 Q5)

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
0.182	Live	45.6*	64.4	18.8	Complied
0.240	Live	37.8*	62.1	24.3	Complied
0.303	Live	35.0*	60.2	25.2	Complied
0.425	Live	32.3*	57.4	25.1	Complied
13.560	Live	15.8**	60.0	44.2	Complied
27.119	Live	38.3*	60.0	21.7	Complied

Results: Live / Average / 120 VAC 60 Hz

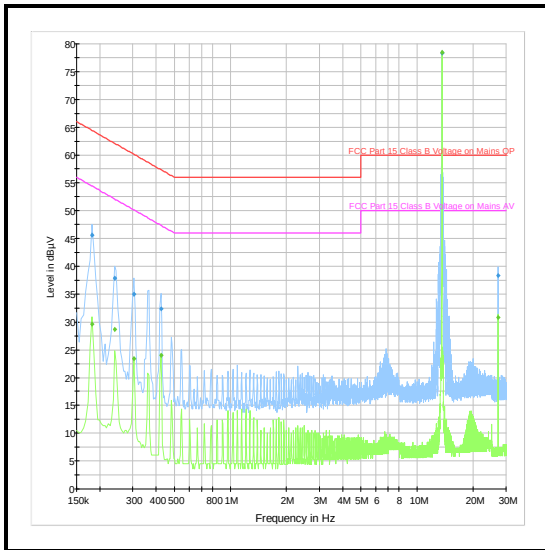
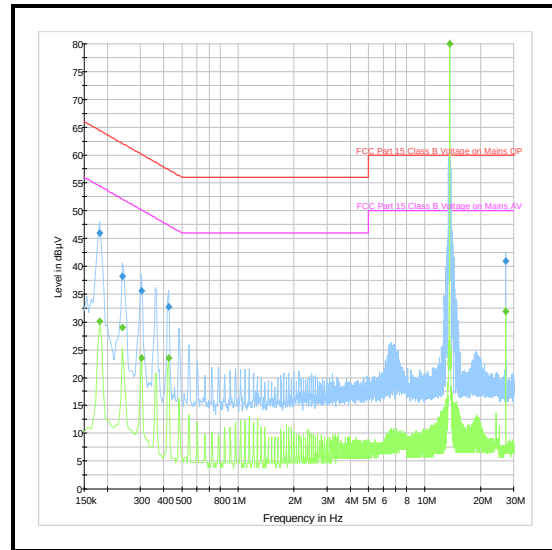
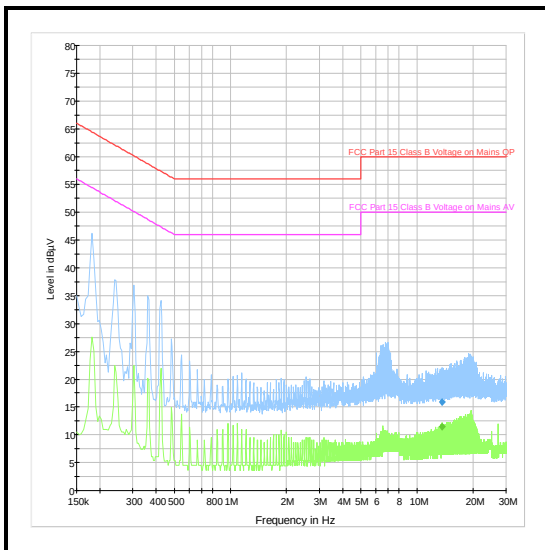
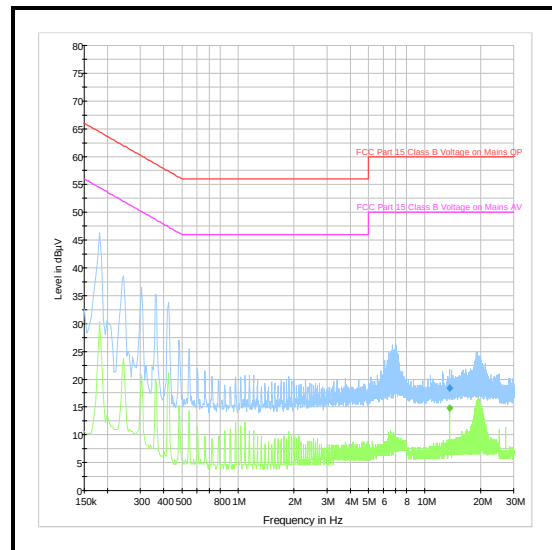
Frequency (MHz)	Line	Level (dBμV)	Limit (dBμV)	Margin (dB)	Result
0.182	Live	29.6*	54.4	24.8	Complied
0.240	Live	28.6*	52.1	23.5	Complied
0.303	Live	23.4*	50.2	26.8	Complied
0.425	Live	23.9*	47.4	23.5	Complied
13.560	Live	11.4**	50.0	38.6	Complied
27.119	Live	30.8*	50.0	19.2	Complied

Results: Neutral / Quasi Peak / 120 VAC 60 Hz

Frequency (MHz)	Line	Level (dBμV)	Limit (dBμV)	Margin (dB)	Result
0.182	Neutral	46.0*	64.4	18.4	Complied
0.240	Neutral	38.3*	62.1	23.8	Complied
0.303	Neutral	35.6*	60.2	24.6	Complied
0.425	Neutral	32.7*	57.4	24.7	Complied
13.560	Neutral	18.4**	60.0	41.6	Complied
27.119	Neutral	41.0*	60.0	19.0	Complied

Results: Neutral / Average / 120 VAC 60 Hz

Frequency (MHz)	Line	Level (dBμV)	Limit (dBμV)	Margin (dB)	Result
0.182	Neutral	30.1*	54.4	24.3	Complied
0.240	Neutral	29.1*	52.1	23.0	Complied
0.303	Neutral	23.6*	50.2	26.6	Complied
0.425	Neutral	23.5*	47.4	23.9	Complied
13.560	Neutral	14.8**	50.0	35.2	Complied
27.119	Neutral	31.9*	50.0	18.1	Complied

Transmitter AC Conducted Spurious Emissions (continued)**Live / 120 VAC 60 Hz****Neutral / 120 VAC 60 Hz****Test results prior to modification of the EUT (standard antenna)****Live / 120 VAC 60 Hz****Neutral / 120 VAC 60 Hz****Test results with modified sample (transmitter terminated into 50 Ohm load)***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
0.182	Live	40.4*	64.4	24.0	Complied
0.375	Live	46.1*	58.4	12.3	Complied
0.497	Live	33.3*	56.1	22.8	Complied
0.663	Live	32.3*	56.0	23.7	Complied
13.560	Live	17.2**	60.0	42.8	Complied
27.119	Live	38.7*	60.0	21.3	Complied

Results: Live / Average / 240 VAC 60 Hz

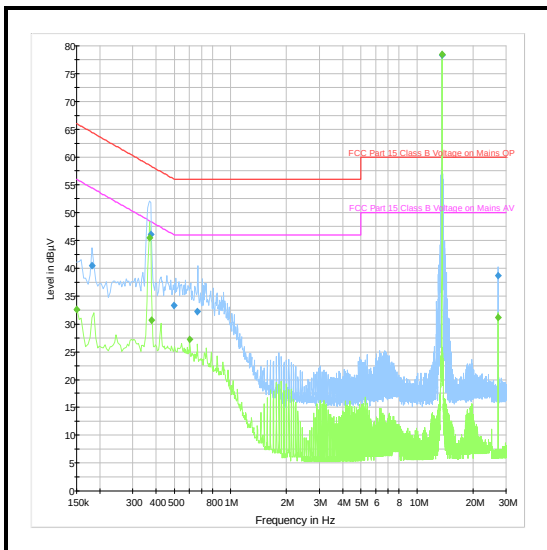
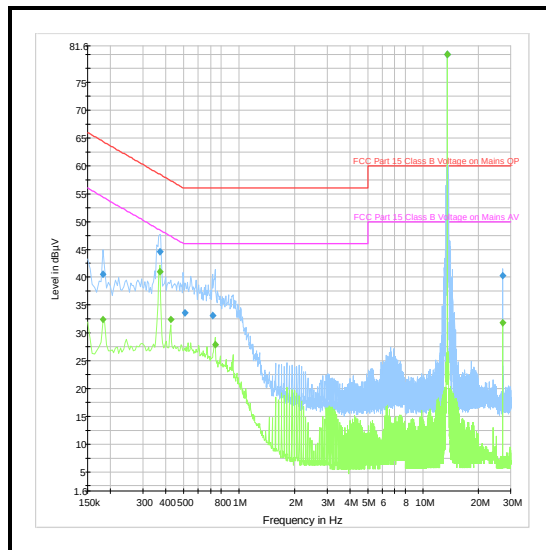
Frequency (MHz)	Line	Level (dBμV)	Limit (dBμV)	Margin (dB)	Result
0.150	Live	32.6*	56.0	23.4	Complied
0.371	Live	45.6*	48.5	2.9	Complied
0.380	Live	30.7*	48.3	17.6	Complied
0.605	Live	27.2*	46.0	18.8	Complied
13.560	Live	14.2**	50.0	35.8	Complied
27.119	Live	31.2*	50.0	18.8	Complied

Results: Neutral / Quasi Peak / 240 VAC 60 Hz

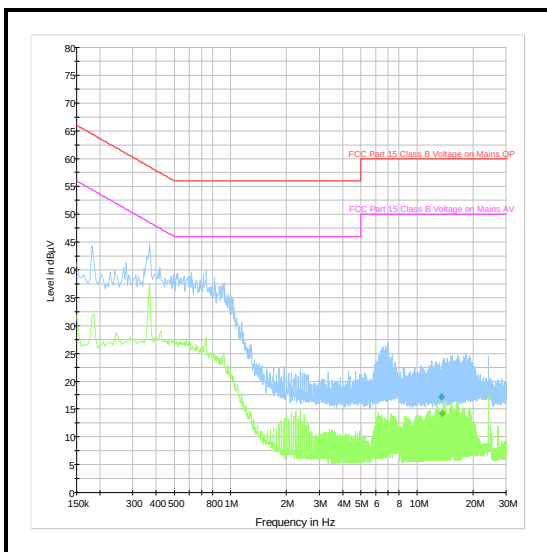
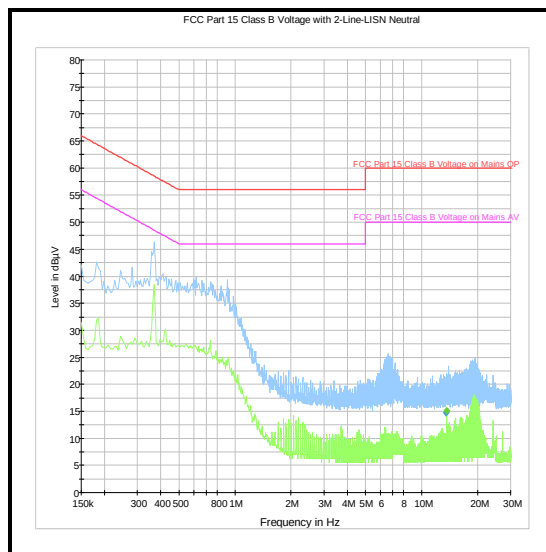
Frequency (MHz)	Line	Level (dBμV)	Limit (dBμV)	Margin (dB)	Result
0.182	Neutral	40.5*	64.4	23.9	Complied
0.371	Neutral	44.6*	58.5	13.9	Complied
0.506	Neutral	33.6*	56.0	22.4	Complied
0.717	Neutral	33.1*	56.0	22.9	Complied
13.560	Neutral	14.8**	60.0	45.2	Complied
27.119	Neutral	40.3*	60.0	19.7	Complied

Results: Neutral / Average / 240 VAC 60 Hz

Frequency (MHz)	Line	Level (dBμV)	Limit (dBμV)	Margin (dB)	Result
0.182	Neutral	32.4*	54.4	22.0	Complied
0.371	Neutral	41.0*	48.5	7.5	Complied
0.425	Neutral	32.4*	47.4	15.0	Complied
0.740	Neutral	27.9*	46.0	18.1	Complied
13.560	Neutral	15.1**	50.0	34.9	Complied
27.119	Neutral	31.9*	50.0	18.1	Complied

Transmitter AC Conducted Spurious Emissions (continued)**Live / 240 VAC 60 Hz****Neutral / 240 VAC 60 Hz**

Test results prior to modification of the EUT (standard antenna)

**Live / 240 VAC 60 Hz****Neutral / 240 VAC 60 Hz**

Test results with modified sample (transmitter terminated into 50 Ohm load)

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)
M1625	Thermohygrometer	JM Handelspunkt	890603/002	None stated	11 Jan 2017	12
A067	LISN	Rohde & Schwarz	ESH3-Z5	890603/002	27 Aug 2016	12
A1830	Pulse Limiter	Rohde & Schwarz	ESH3-Z2	100668	08 Mar 2017	12
M1263	Test Receiver	Rohde & Schwarz	ESIB7	100265	16 Oct 2016	12
S0539	Variable AC Power Supply	Kikusui	PCR 1000L	13010170	Calibrated before use	-
M1229	Multimeter	Fluke	179	87640015	23 Apr 2016	12

5.2.2. Transmitter Fundamental Field Strength

Test Summary:

Test Engineer:	Georgios Vrezas	Test Dates:	14 March 2016 & 15 March 2016
Test Sample Serial Number:	G14180432		

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

Environmental Conditions:

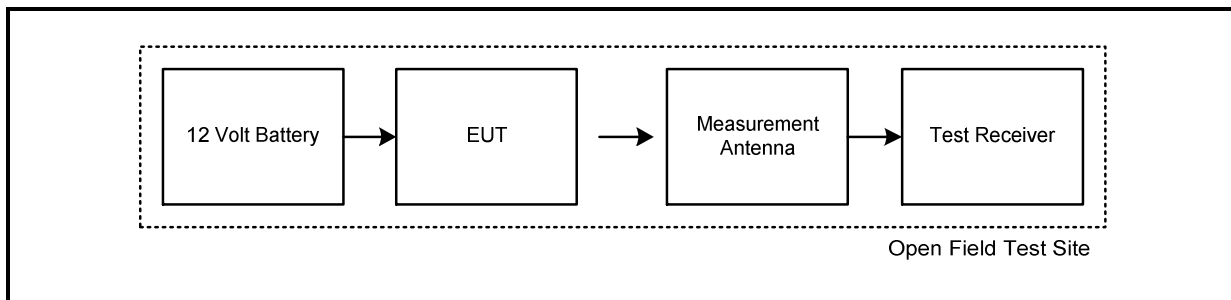
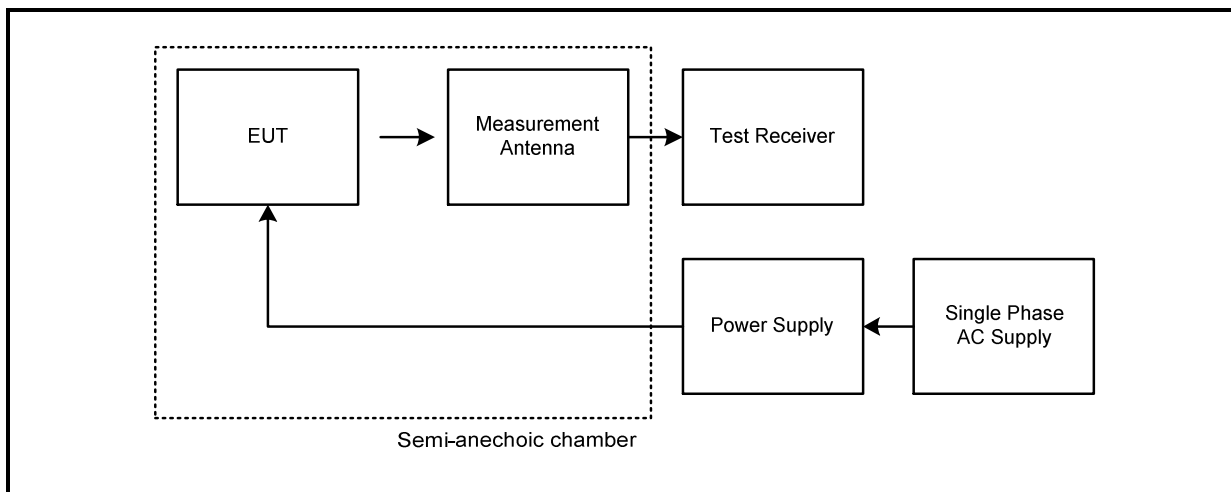
Temperature (°C):	12 to 21
Relative Humidity (%):	31 to 51

Note(s):

1. The limit is specified at a test distance of 30 metres. However, as specified by FCC Section 15.31 (f)(2), measurements may be performed at a closer distance and the measured level corrected to the specified measurement distance by using the square of an inverse linear distance extrapolation factor (40dB/decade).
2. 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 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 14 March 2016. Unfortunately, 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. Ambient emissions affected the fundamental field strength measurement, therefore the fundamental field strength measurement was repeated using a reduced bandwidth (resolution bandwidth 1 kHz and video bandwidth 3 kHz). The fundamental was visible with these measurement settings.
3. The fundamental field strength level was maximized by rotating the measurement antenna and EUT. A peak level of 67.7 dB μ V/m in a 1 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 15 March 2016. An RF level offset on the test receiver was used to correlate the field strength measurement made in the semi-anechoic chamber to the same measurement performed at 3 metres on the open field test site. Refer to result plot '*Fundamental field strength and spectrum mask / measured at 3 metres in a semi-anechoic chamber with reduced measurement bandwidth of 1 kHz*'. This illustrates that the value of the RF level offset is -4 dB, since the fundamental field strength is 67.7 dB μ V/m at a measurement distance of 3 metres.
4. Further measurements were performed in the semi-anechoic chamber using a spectrum analyser with a peak detector and measurement bandwidth of 10 kHz. An RF level offset of -44 dB was used on the spectrum analyser. This offset includes the -4 dB offset as explained in Note 3 above and a further -40 dB to extrapolate the level measured at 3 metres to the required distance of 30 metres (one decade). The fundamental field strength was maximized by rotating the measurement antenna and EUT. A peak level of 27.6 dB μ V/m at a measurement distance of 3 metres (extrapolated to 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 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 27.5 dB μ V/m was recorded.

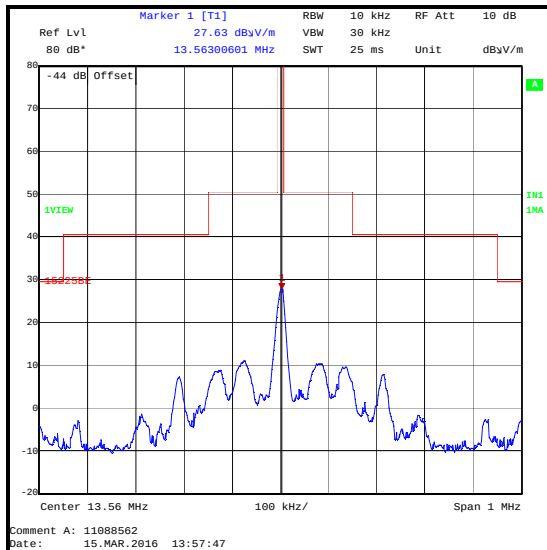
Transmitter Fundamental Field Strength (continued)**Note(s):**

5. 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.

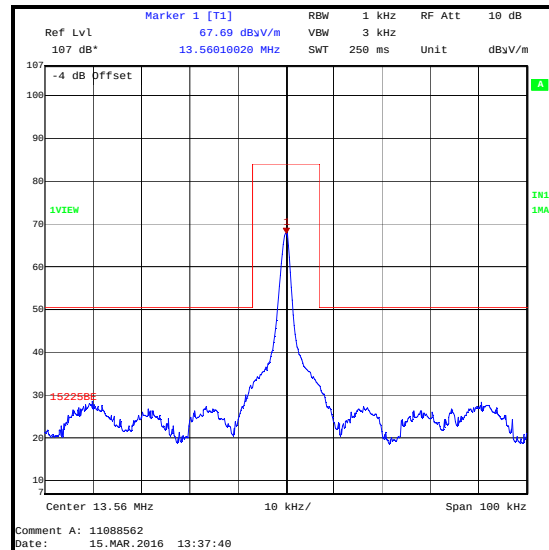
Transmitter Fundamental Field Strength (continued)**Test setup for fundamental field strength measurements:****Measurements on an open field test site****Measurements in a semi-anechoic chamber**

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

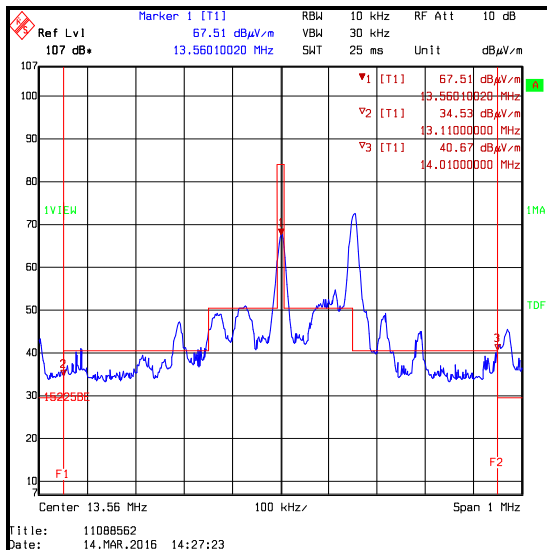
Frequency (MHz)	Measurement Antenna Position	Level (dB μ V/m)	Limit at 30 m (dB μ V/m)	Margin (dB)	Result
13.560100	Tip of antenna 30° from EUT	27.5	84.0	56.5	Complied



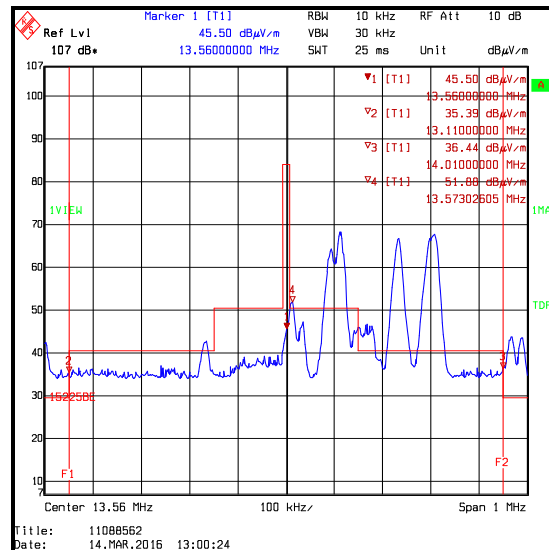
Fundamental field strength and spectrum mask / measured at 3 metres in a semi-anechoic chamber / extrapolated to 30 metres



Fundamental field strength and spectrum mask / measured at 3 metres in a semi-anechoic chamber with reduced measurement bandwidth of 1 kHz



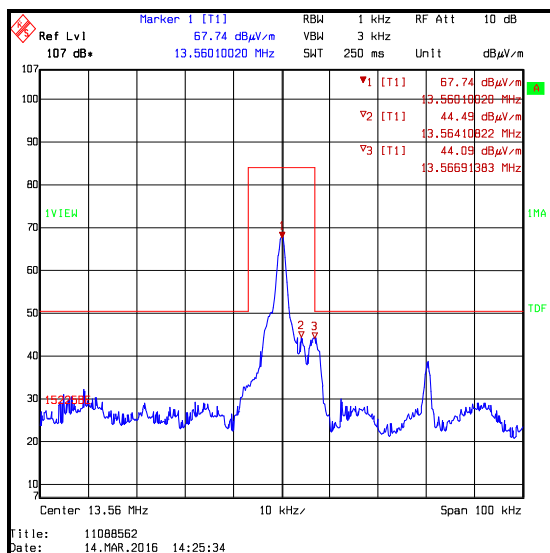
Fundamental field strength / EUT operating / measured at 3 metres / measured on an open field test site with 10 kHz measurement bandwidth (fundamental is affected by an ambient emission)



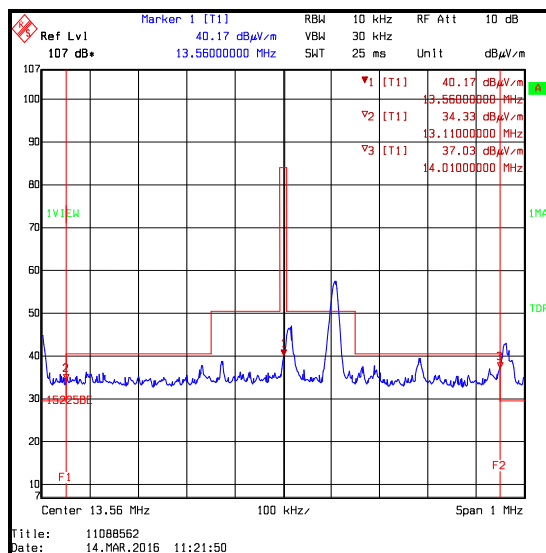
Fundamental field strength / EUT operating / measured at 30 metres / measured on an open field test site with 10 kHz measurement bandwidth (fundamental is below the noise floor / masked by an ambient emission)

Transmitter Fundamental Field Strength (continued)

Results:



Fundamental field strength / EUT operating / measured at 3 metres / measured on an open field test site with reduced measurement bandwidth of 1 kHz



EUT off / Background scan of the open field test site with a 10 kHz measurement bandwidth showing an unwanted ambient emission at approximately 13.56 MHz (Marker 1)

Test Equipment Used:

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1945	Thermohyrometer	JM Handelspunkt	30.5015.01	0112	23 Apr 2016	12
K0001	5m RSE Chamber	Rainford EMC	N/A	N/A	12 Jan 2017	12
M1273	Test Receiver	Rohde & Schwarz	ESIB 26	100275	19 Mar 2016	12
M127	Test Receiver	Rohde & Schwarz	FSEB30	842659/016	11 Aug 2016	12
M1785	Thermohyrometer	JM Handelspunkt	30.5015.13	None stated	23 Apr 2016	12
M1568	Magnetic Loop Antenna	Rohde & Schwarz	HFH2-Z2	879284/2	06 May 2016	12

5.2.3. Transmitter Radiated Spurious Emissions

Test Summary:

Test Engineer:	Georgios Vrezas	Test Dates:	08 March 2016 to 15 March 2016
Test Sample Serial Number:	G14180432		

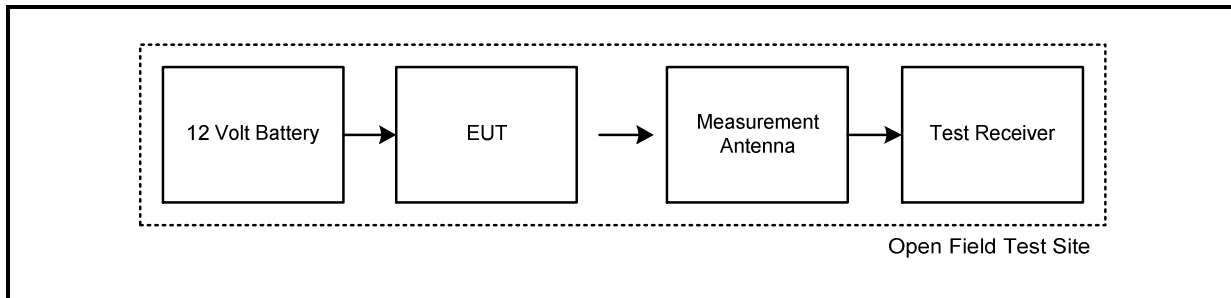
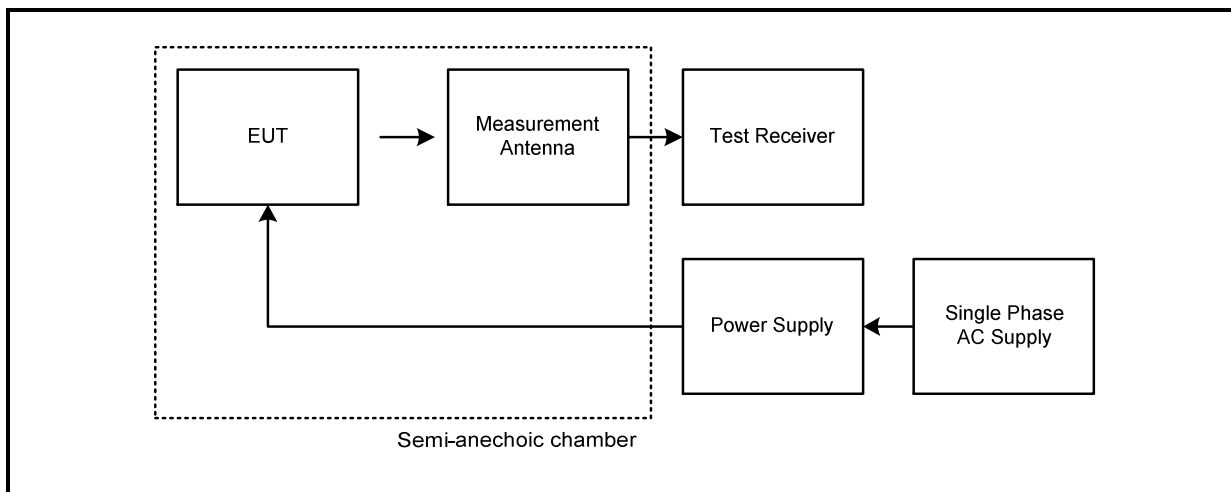
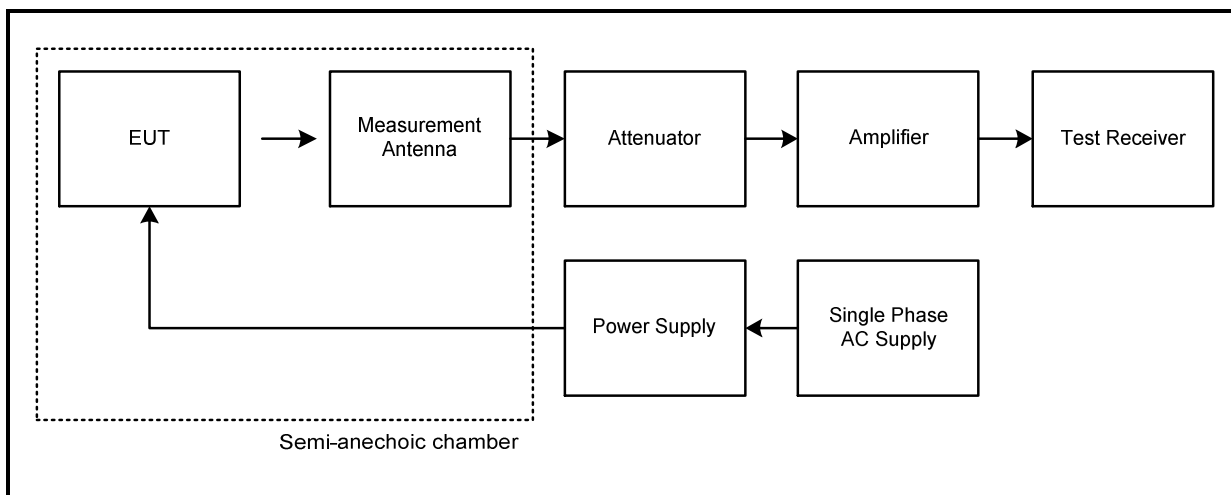
FCC Reference:	Parts 15.225(d) & 15.209(a)
Test Method Used:	ANSI C63.10 Sections 6.3, 6.4, 6.5 and Notes below
Frequency Range:	9 kHz to 1000 MHz

Environmental Conditions:

Temperature (°C):	12 to 21
Relative Humidity (%):	31 to 51

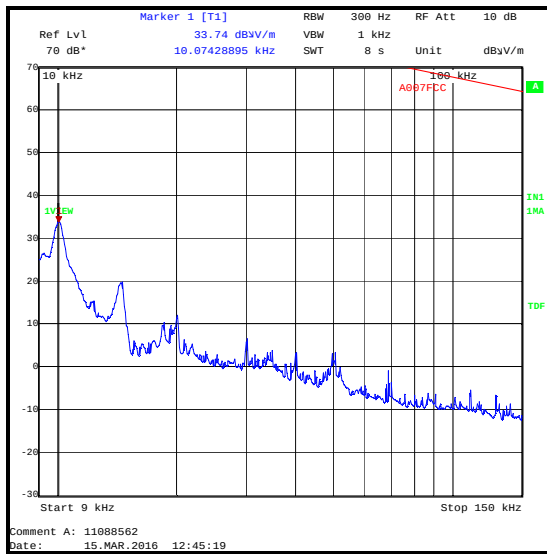
Note(s):

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 March 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 15 March 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 08 March 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. All emissions on the 9 kHz to 150 kHz plot were investigated and found to be radiating from the test site turntable.
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 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.

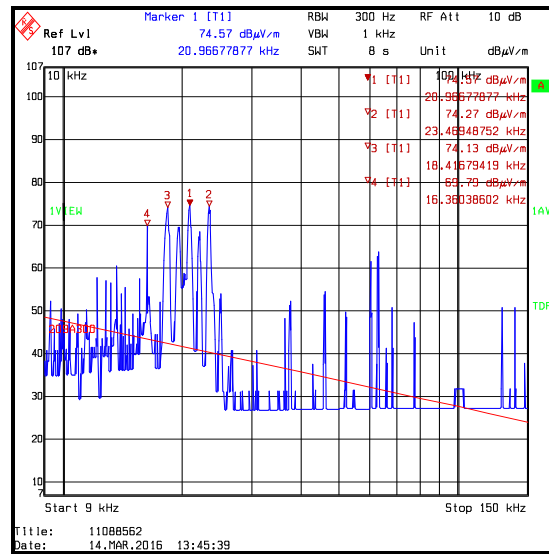
Transmitter Radiated Spurious Emissions (continued)**Test setup for radiated measurements:****Measurements below 30 MHz on an open field test site****Measurements below 30 MHz in a semi-anechoic chamber****Measurements above 30 MHz in a semi-anechoic chamber.**

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

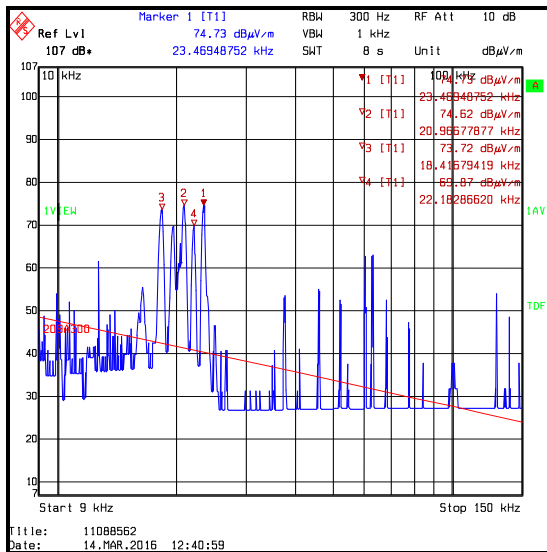
Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
108.460	Vertical	36.1	43.5	7.4	Complied
162.698	Vertical	34.3	43.5	9.2	Complied
244.057	Vertical	39.2	46.0	6.8	Complied
257.628	Vertical	35.6	46.0	10.4	Complied



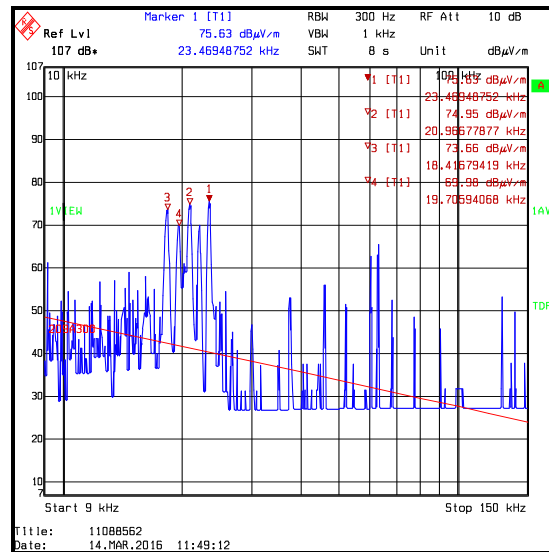
9 kHz to 150 kHz / peak detector / measured at 3 metres extrapolated to 30 metres / measured in a semi-anechoic chamber



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

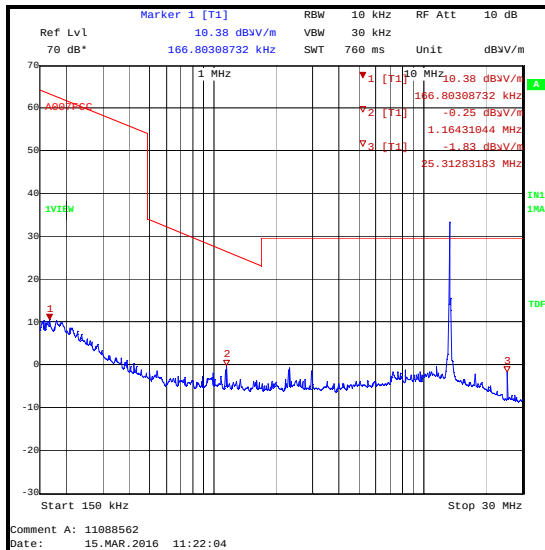


9 kHz to 150 kHz / average detector / EUT operating / measured at 30 metres on an open field test site



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

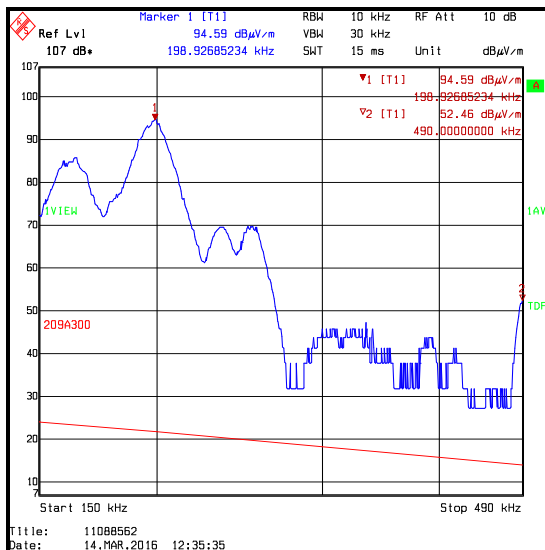
Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying table.

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

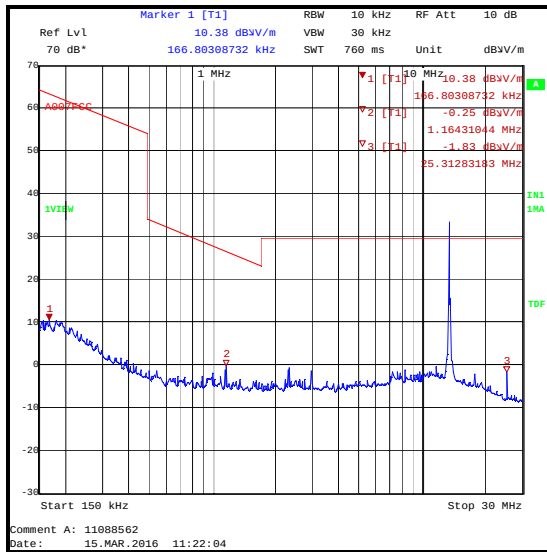


150 kHz to 490 kHz / average detector / EUT operating / measured at 30 metres on an open field test site

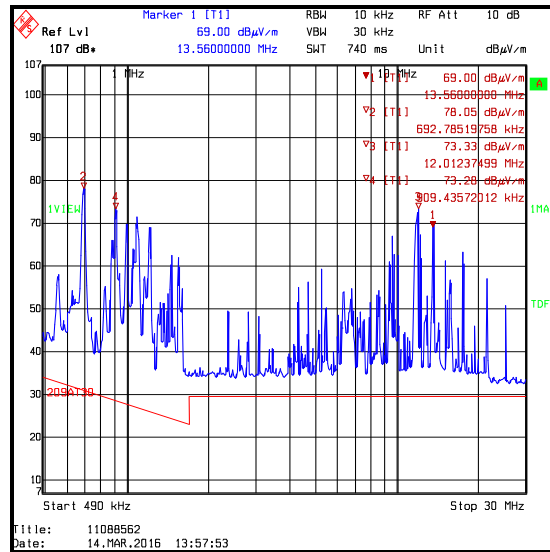


150 kHz to 490 kHz / average detector / EUT operating / measured at 300 metres on an open field test site

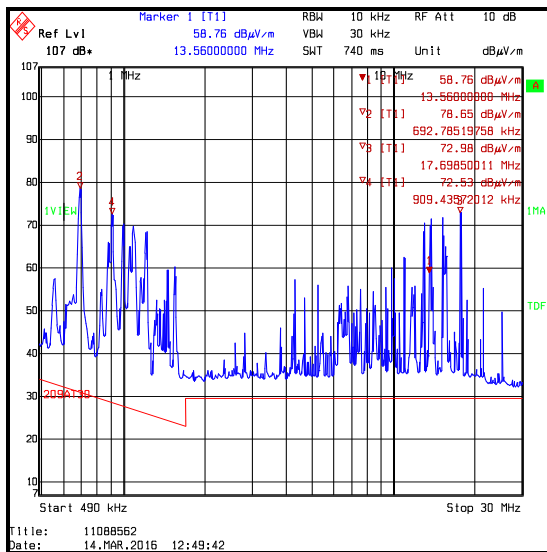
Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying table.

Transmitter Radiated Spurious Emissions (continued)

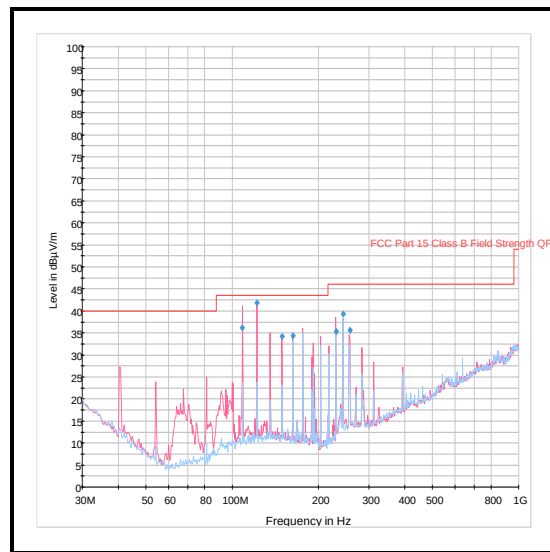
150 kHz to 30 MHz / peak detector / measured at 3 metres extrapolated to 30 metres / measured in a semi-anechoic chamber



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)
M1945	Thermohygrometer	JM Handelspunkt	30.5015.01	0112	23 Apr 2016	12
K0001	5m RSE Chamber	Rainford EMC	N/A	N/A	12 Jan 2017	12
M1273	Test Receiver	Rohde & Schwarz	ESIB 26	100275	19 Mar 2016	12
G0543	Amplifier	Sonoma	310N	230801	29 May 2016	3
A259	Antenna	Chase	CBL6111A	1513	09 Apr 2016	12
A1834	Attenuator	Hewlett Packard	8491B	10444	Calibrated before use	-
M1124	Test Receiver	Rohde & Schwarz	ESIB 26	100046	18 Nov 2016	12
M1252	Signal Generator	Hewlett Packard	83640A	3119A00489	26 Oct 2017	24
M127	Test Receiver	Rohde & Schwarz	FSEB30	842659/016	11 Aug 2016	12
M1785	Thermohygrometer	JM Handelspunkt	30.5015.13	None stated	23 Apr 2016	12
M1568	Magnetic Loop Antenna	Rohde & Schwarz	HFH2-Z2	879284/2	06 May 2016	12

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

Test Engineer:	Georgios Vrezas	Test Date:	15 March 2016
Test Sample Serial Number:	G14180432		

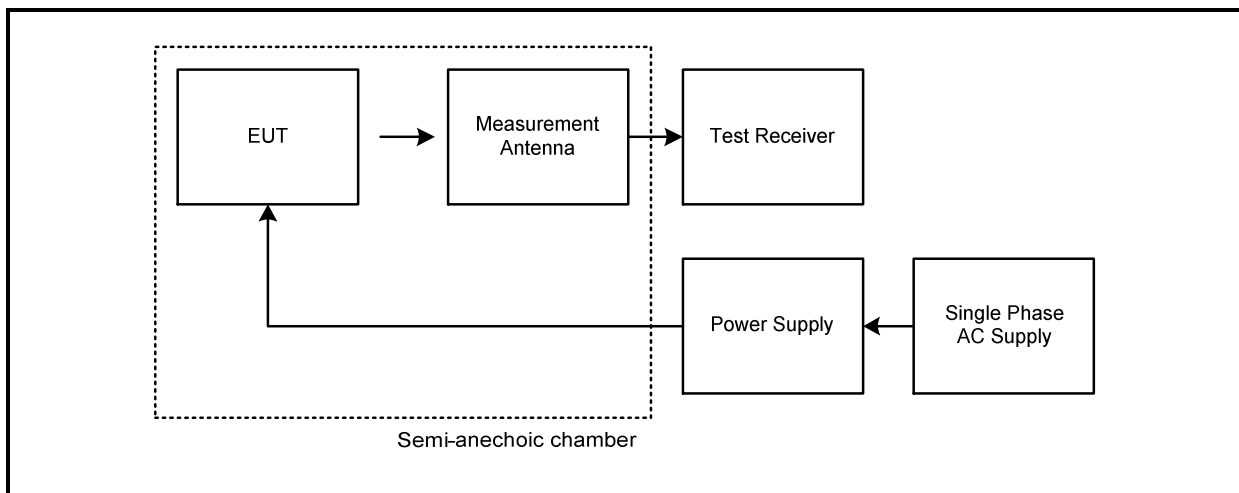
FCC Reference:	Parts 15.225(c)(d) & 15.209(a)
Test Method Used:	ANSI C63.10 Section 6.4 and Notes below

Environmental Conditions:

Temperature (°C):	21
Relative Humidity (%):	36

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 March 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 15 March 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. For the field strength measurements in a semi-anechoic chamber, an offset of -44 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.
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.

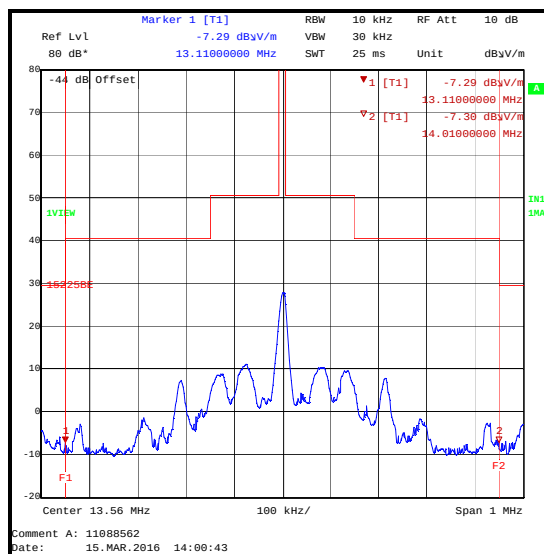
Test setup:

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	-7.3	29.5	36.8	Complied

Results: Peak / Upper Band Edge

Frequency (MHz)	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
14.01	-7.3	29.5	36.8	Complied

**Test Equipment Used:**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1945	Thermohygrometer	JM Handelspunkt	30.5015.01	0112	23 Apr 2016	12
K0001	5m RSE Chamber	Rainford EMC	N/A	N/A	12 Jan 2017	12
M1273	Test Receiver	Rohde & Schwarz	ESIB 26	100275	19 Mar 2016	12
M1568	Magnetic Loop Antenna	Rohde & Schwarz	HFH2-Z2	879284/2	06 May 2016	12

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

Test Engineer:	Georgios Vrezas	Test Date:	16 March 2016
Test Sample Serial Number:	G14180432		

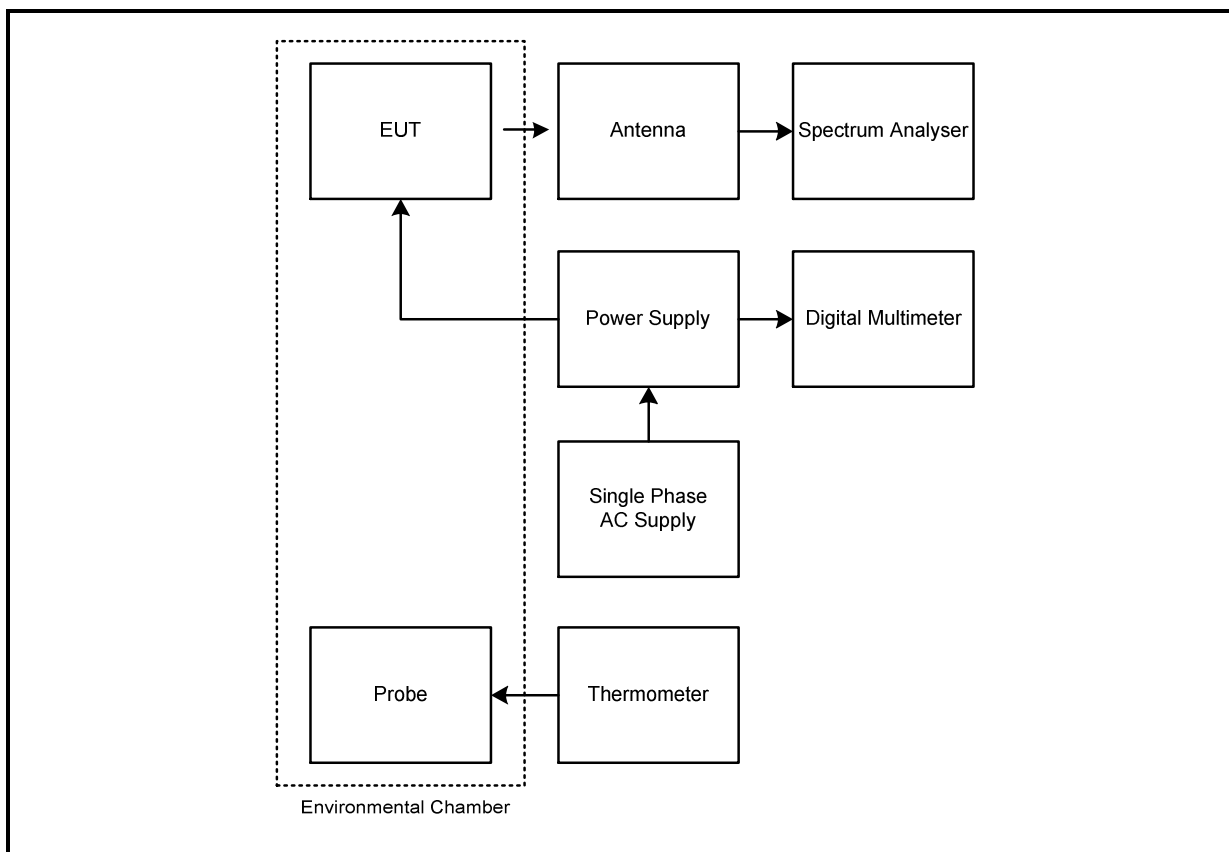
FCC Reference:	Part 15.225(e)
Test Method Used:	ANSI C63.10 Section 6.8.1 and 6.8.2

Environmental Conditions:

Ambient Temperature (°C):	20
Ambient Relative Humidity (%):	32

Note(s):

1. Testing at voltage extremes was performed with the EUT powered by an external DC power supply.
2. Frequency error was measured using a calibrated Rohde & Schwarz spectrum analyser.
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	13.559918 MHz	13.559923 MHz	13.559925 MHz	13.559925 MHz
20	13.559842 MHz	13.559834 MHz	13.559833 MHz	13.559833 MHz
50	13.559832 MHz	13.559840 MHz	13.559848 MHz	13.559852 MHz

Frequency with Worst Case Deviation (MHz)	Frequency Error (Hz)	Frequency Error (%)	Limit (%)	Margin (%)	Result
13.559925 MHz	92	0.000678	0.01	0.009322	Complied

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

Supply Voltage (VDC)	Nominal Frequency (MHz)	Measured Frequency (MHz)	Frequency Error (Hz)	Frequency Error (%)	Limit (%)	Margin (%)	Result
10.2	13.559833	13.559835	2	0.000015	0.01	0.009985	Complied
12.0	13.559833	13.559833	0	0.000000	0.01	0.010000	Complied
13.8	13.559833	13.559838	5	0.000037	0.01	0.009963	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	23 Apr 2016	12
M1674	Environmental Chamber	Espec Corporation	SU-241	92013139	Calibrated before use	-
M127	Test Receiver	Rohde & Schwarz	FSEB30	842659/016	11 Aug 2016	12
S0557	DC Power Supply	TTi	EL303R	395819	Calibrated before use	-
M1229	Multimeter	Fluke	179	87640015	23 Apr 2016	12
M1568	Magnetic Loop Antenna	Rohde & Schwarz	HFH2-Z2	879284/2	06 May 2016	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
Frequency Stability	13 MHz to 14 MHz	95%	±0.92 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

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'



Details of 3 metre and 30 metre open field test site used on 14 March 2016

Temperature: 12°C to 21°C

Relative Humidity: 31% to 51%

Ground conditions: Dry

Measurements at 3 and 30 metres

The test site was free from underground metal objects.

The EUT was powered at its nominal voltage from an external 12 VDC battery.

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 measurement 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.

Details of 300 metre open field test site used on 14 March 2016

Temperature: 12°C to 21°C

Relative Humidity: 31% to 51%

Ground conditions: Dry

Measurements at 300 metres

The test site was free from underground metal objects.

The EUT was powered at its nominal voltage from an external 12 VDC battery.

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 measurement 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.

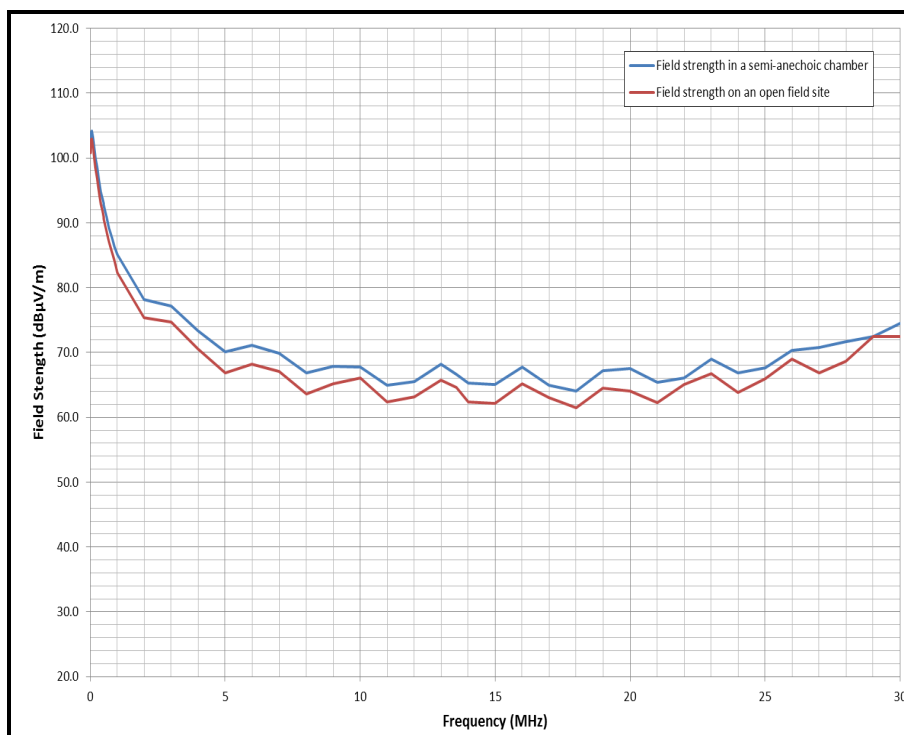
Initially, the EUT was rotated through 360 degrees in 60 degree steps at both measurement distances. The mag loop antenna was rotated through 90 degrees in 30 degree steps at every position the EUT was moved to. The EUT and mag loop antenna were then rotated in small increments in order to maximise emission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

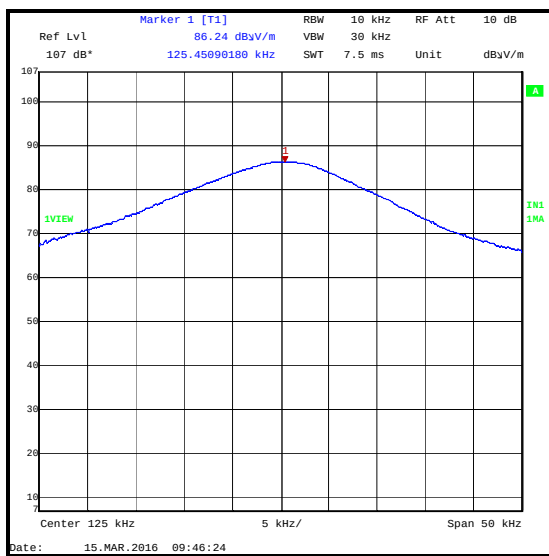
The centre of the magnetic loop antenna is placed exactly 3 metres from the reference unit. The reference unit is placed on a plastic table at a height of 0.8 metres above floor level and the centre of the mag loop antenna is 1 metre above the floor level. The mag loop antenna and reference unit are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

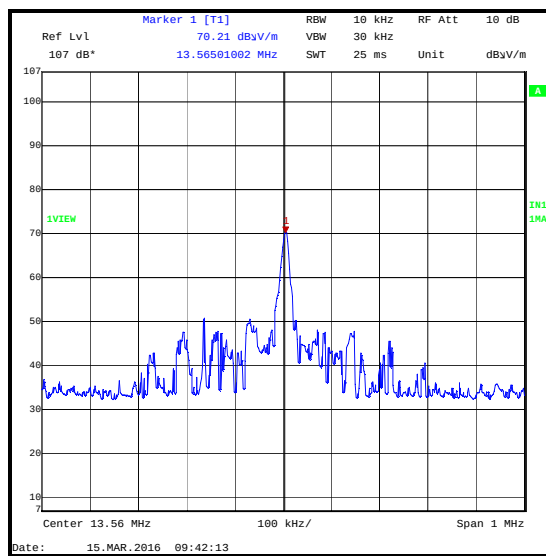
The internal verification procedure and verification plots are available for inspection on request.

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

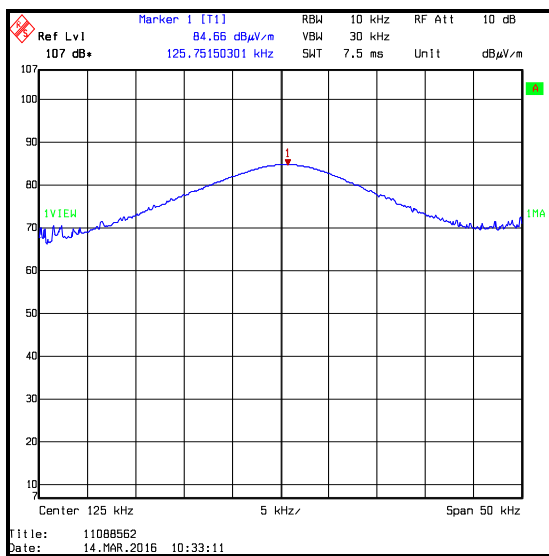
Verification plots of the two reference units at a measurement distance of 3 metres are shown on the following page. Plots were taken on an open field test site (14 March 2016) and in a semi-anechoic chamber (15 March 2016).



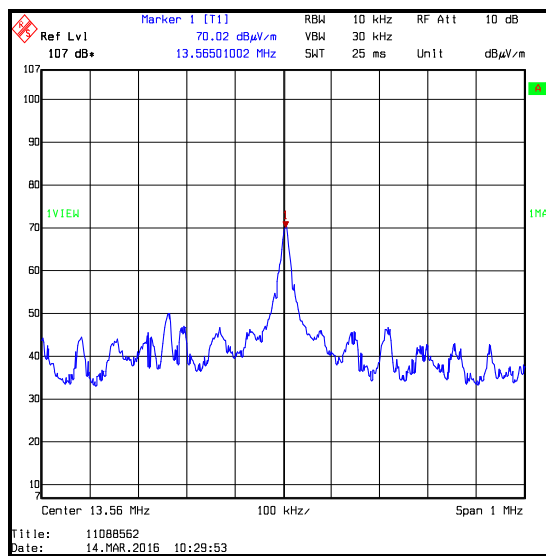
125 kHz reference unit signal at 3 metres in a semi-anechoic chamber on 15 March 2016



13.56 MHz reference unit signal at 3 metres in a semi-anechoic chamber on 15 March 2016



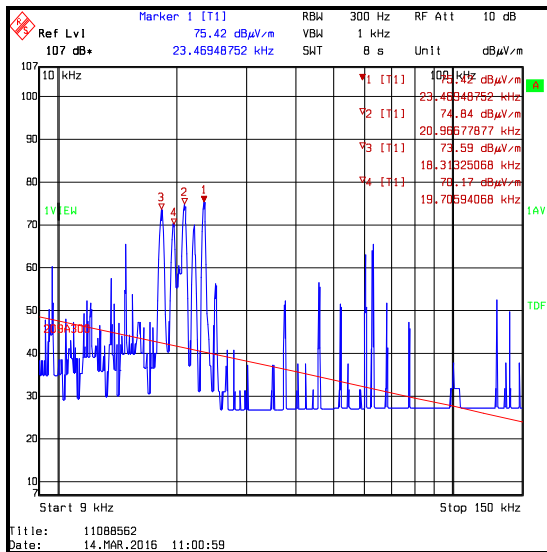
125 kHz reference unit signal at 3 metres on an open field test site on 14 March 2016



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

Note(s):

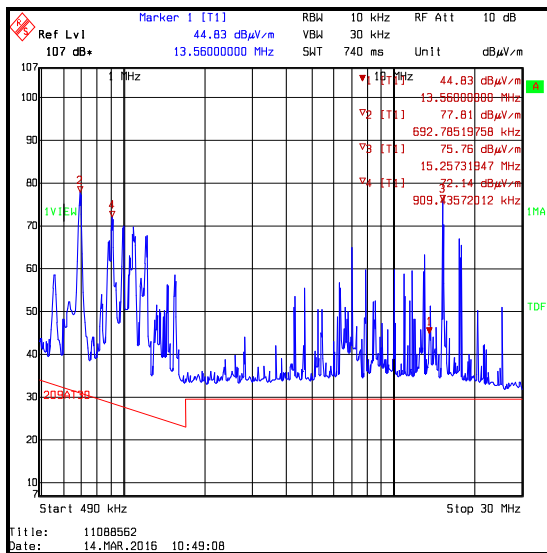
1. The above plots show comparable measurements of reference units on an open field test site and in a semi-anechoic chamber at spot frequencies.

Background scans of the open field test site

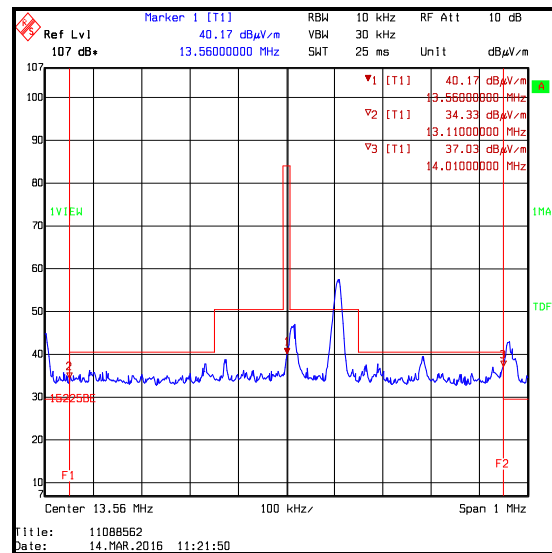
**Frequency range: 9 kHz to 150 kHz
Average detector / background scan**



**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
/ 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 was turned off when the background scans were performed.

--- END OF REPORT ---