TEST REPORT

Test Report No. : UL-RPT-RP11066287JD04A

Manufacturer	:	Flextronics International Sweden AB
Model No.	:	SR0020-W
FCC ID	:	2AIP8I
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: 22 August 2016

Checked by:

Steven White
Service Lead, Radio Laboratory

Company Signatory:

Sarah Williams
Senior Engineer, Radio Laboratory
UL VS LTD

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

UL VS LTD

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1. Customer/Manufacturer Information

1.1. Customer Information

Company Name:	Sirin Labs AG
Address:	Muhlentalstrasse 2 8200 Schaffhausen Switzerland

1.2. Manufacturer Information

Manufacturer Name:	Flextronics International Sweden AB
Address:	Datalinjen 3A SE – 583 30 Linkőping Sweden

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:	28 April 2016 to 20 August 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 937606 Date: 10/10/2014
Title:	Test Site Requirements for Part 15 and 18 Devices Operating Below 30 MHz
Reference:	FCC KDB 174176 D01 Line Conducted FAQ v01r01 June 3, 2015
Title:	AC Power-line Conducted Emissions Frequently asked questions.

2.4. Deviations from the Test Specification

For the measurements contained within this test report, there were no deviations from, additions to, or exclusions from the test specification identified above.

3. Equipment Under Test (EUT)

3.1. Identification of Equipment Under Test (EUT)

Brand Name:	SOLARIN
Model Name or Number:	SR0020-W
Test Sample IMEI:	357232070004146
Hardware Version:	TP1
Software Version:	LRC1TA.1.0.2.3
Handset Cover Material:	Technical leather with titanium coating
FCC ID:	2AIP8I

Brand Name:	SOLARIN
Model Name or Number:	SR0020-W
Test Sample Serial Number:	0067
Test Sample IMEI:	Not Marked or Stated
Hardware Version:	TP1
Software Version:	LRC1TA.1.0.2.3
Handset Cover Material:	Technical leather with titanium coating
FCC ID:	2AIP8I

3.2. Description of EUT

The equipment under test was a Mobile device supporting Cellular, WLAN, BT, BTLE, NFC & GPS Technologies.

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	3.9 V
	Minimum	3.5 V
	Maximum	4.4 V
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 cable (length 1.2 metres)
Brand Name:	Not stated
Model Name or Number:	Not stated
Serial Number:	Not stated

Description:	USB charger
Brand Name:	Ktec
Model Name or Number:	KSC15B1200150D5
Serial Number:	Not stated

Description:	Personal Hand-Free (PHF)
Brand Name:	Sirin
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 NFC test mode.

4.2. Configuration and Peripherals

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

- The RFID transmitter test mode was enabled by running a customer specific application on the handset. The application scans until an RFID tag is placed near the RFID antenna of the handset which enables a continuously modulated RFID mode.
- For transmitter radiated emissions testing, an RFID tag was used to perform measurements. The application scans until an RFID tag is placed near the RFID antenna of the handset which enables a continuously modulated RFID mode.
- Transmitter radiated spurious emissions tests were performed with the USB Charger, USB cable and PHF connected to the EUT as this was found to be the worst case during pre-scans.
- Testing for frequency stability and measurements at temperature and voltage extremes was performed using a sample supplied with short 4-wire DC flying leads connected internally to the device in place of the battery, and exited through a hole in the casing. These leads were then extended to a DC power supply for testing purposes.
- AC conducted emissions tests were performed with the EUT connected to a USB charger output via a USB cable. The power supply input was connected to a 120 VAC 60 Hz / 240 VAC 60 Hz single phase supply via a LISN.
- For AC conducted emissions, fundamental field strength, radiated spurious emissions and band edge radiated emissions tests, the EUT was connected to an AC charger via a USB cable. A pair of headphones were also connected to the EUT.
- 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 Engineers:	Ian Watch & Georgios Vrezas	**Test Dates:**	24 May 2016 & 20 August 2016
Test Sample IMEI Number:	357232070004146		

FCC Reference:	Part 15.207
Test Method Used:	ANSI C63.10 Section 6.2 / FCC KDB 174176 D01 and Notes below

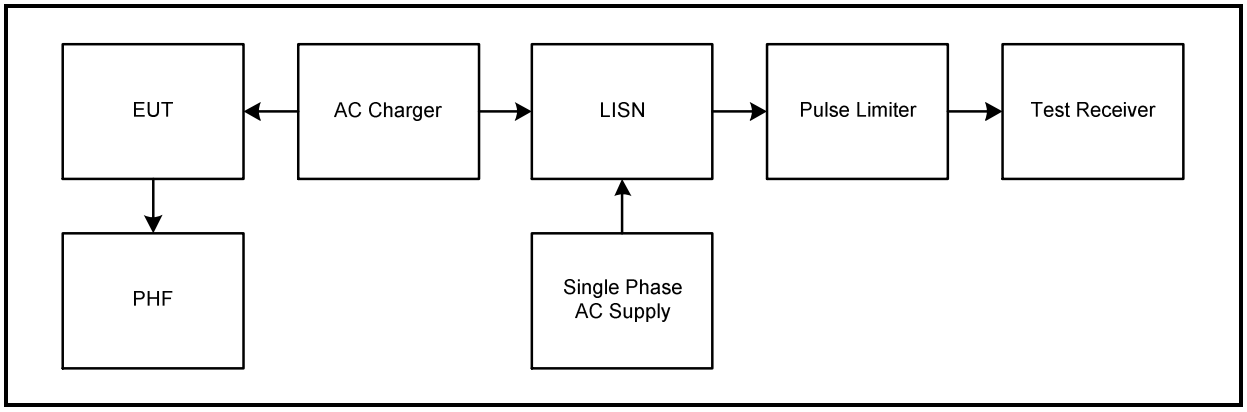
Environmental Conditions:

Temperature (°C):	23 to 26
Relative Humidity (%):	36 to 48

Note(s):

1. The EUT was plugged into a USB cable which is connected to an AC charger. The AC charger was connected to 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 AC charger.
3. Pre-scans were performed and markers placed on the highest live and neutral measured levels. Final measurements were performed on the marker frequencies and the results entered into the tables below.
4. A pulse limiter was fitted between the LISN and the test receiver.

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
0.195	Live	40.3	63.8	23.6	Complied
0.398	Live	33.5	57.9	24.4	Complied
0.569	Live	37.4	56.0	18.6	Complied
0.776	Live	31.3	56.0	24.7	Complied
1.163	Live	29.3	56.0	26.7	Complied
13.560	Live	35.0	60.0	25.0	Complied

Results: Live / Average / 120 VAC 60 Hz

Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.200	Live	26.2	53.6	27.4	Complied
0.299	Live	23.4	50.3	26.9	Complied
0.560	Live	24.0	46.0	22.0	Complied
1.068	Live	16.8	46.0	29.2	Complied
1.991	Live	21.4	46.0	24.6	Complied
13.560	Live	30.3	50.0	19.7	Complied

Results: Neutral / Quasi Peak / 120 VAC 60 Hz

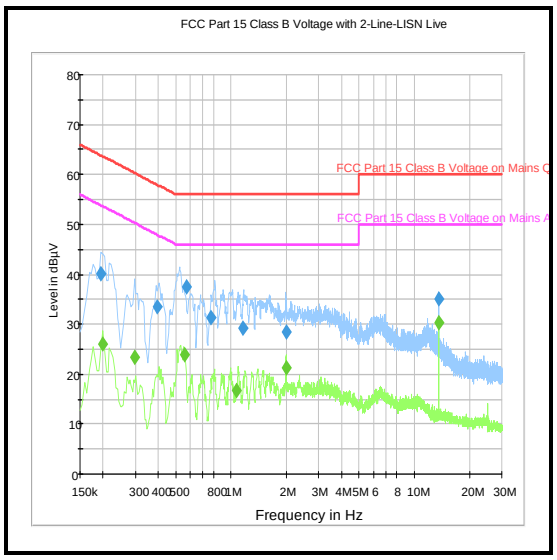
Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.173	Neutral	38.7	64.8	26.1	Complied
0.299	Neutral	35.0	60.3	25.3	Complied
0.533	Neutral	35.8	56.0	20.2	Complied
0.686	Neutral	33.4	56.0	22.6	Complied
1.194	Neutral	30.1	56.0	25.9	Complied
13.560	Neutral	35.7	60.0	24.3	Complied

Results: Neutral / Average / 120 VAC 60 Hz

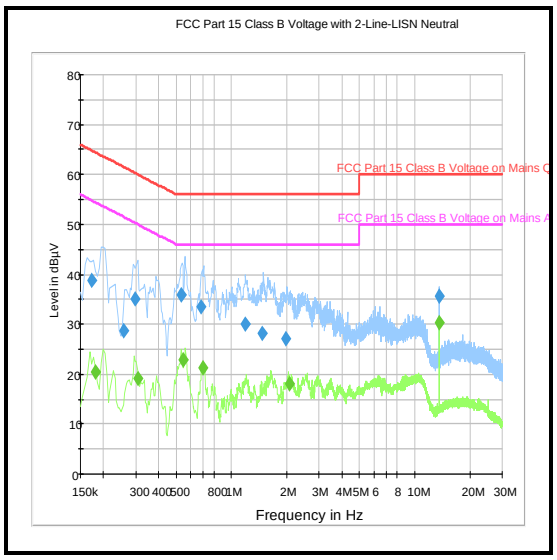
Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.182	Neutral	20.5	54.4	33.9	Complied
0.308	Neutral	19.2	50.0	30.8	Complied
0.542	Neutral	22.8	46.0	23.2	Complied
0.699	Neutral	21.2	46.0	24.8	Complied
2.063	Neutral	18.0	46.0	28.0	Complied
13.560	Neutral	30.3	50.0	19.7	Complied

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.

Transmitter AC Conducted Spurious Emissions (continued)

Results: Live / Quasi Peak / 240 VAC 60 Hz

Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.195	Live	43.6	63.8	20.2	Complied
0.285	Live	39.7	60.7	21.0	Complied
0.389	Live	36.8	58.1	21.3	Complied
0.573	Live	31.2	56.0	24.8	Complied
1.433	Live	27.1	56.0	28.9	Complied
13.560	Live	37.3	60.0	22.7	Complied

Results: Live / Average / 240 VAC 60 Hz

Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.195	Live	29.3	53.8	24.5	Complied
0.290	Live	25.2	50.5	25.3	Complied
0.384	Live	23.9	48.2	24.3	Complied
0.555	Live	25.5	46.0	20.5	Complied
2.076	Live	21.1	46.0	24.9	Complied
13.560	Live	35.4	50.0	14.6	Complied

Results: Neutral / Quasi Peak / 240 VAC 60 Hz

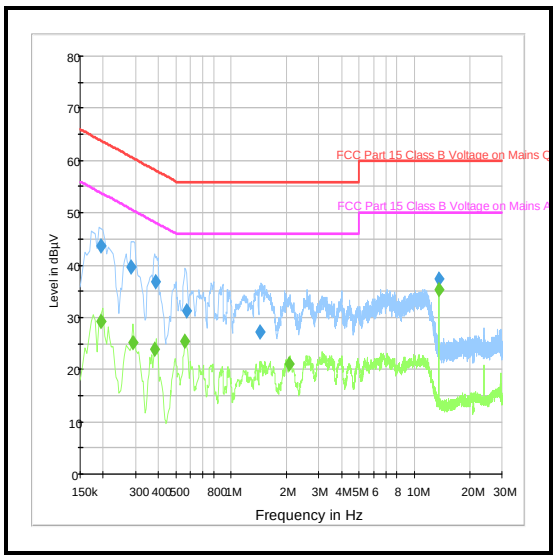
Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.191	Neutral	40.2	64.0	23.8	Complied
0.303	Neutral	35.0	60.2	25.2	Complied
0.389	Neutral	35.7	58.1	22.4	Complied
0.555	Neutral	34.6	56.0	21.4	Complied
2.333	Neutral	25.5	56.0	30.5	Complied
13.560	Neutral	38.1	60.0	21.9	Complied

Results: Neutral / Average / 240 VAC 60 Hz

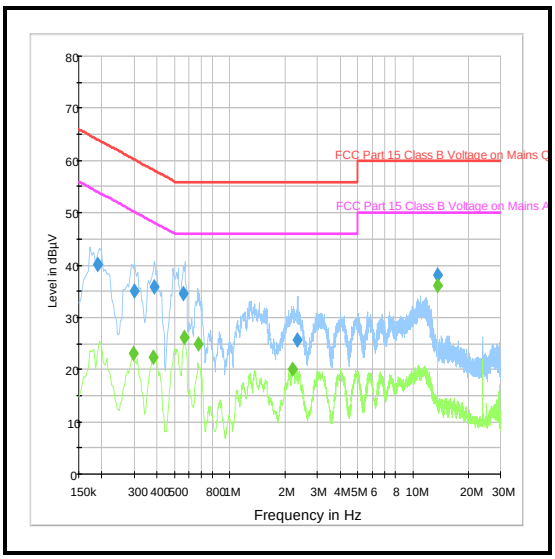
Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.299	Neutral	23.1	50.3	27.2	Complied
0.384	Neutral	22.4	48.2	25.8	Complied
0.564	Neutral	26.2	46.0	19.8	Complied
0.672	Neutral	24.8	46.0	21.2	Complied
2.198	Neutral	19.9	46.0	26.1	Complied
13.560	Neutral	36.1	50.0	13.9	Complied

Transmitter AC Conducted Spurious Emissions (continued)

Results: 240 VAC 60 Hz



Live



Neutral

Test Equipment Used:

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1623	Thermohygrometer	JM Handelspunkt	30.5015.13	None stated	11 Jan 2017	12
M2015	Thermohygrometer	Testo	608-H1	45046424	10 Jun 2017	12
A067	LISN	Rohde & Schwarz	ESH3-Z5	890603/002	27 Aug 2016	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-7	100265	16 Oct 2016	12

5.2.2. Transmitter Fundamental Field Strength

Test Summary:

Test Engineers:	Georgios Vrezas & Andrew Edwards	**Test Dates:**	01 June 2016 & 12 June 2016
Test Sample IMEI Number:	357232070004146		

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):	10 to 15
Relative Humidity (%):	52 to 69

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 01 June 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 48.5 dBµV/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 12 June 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 0.7 dB, since the fundamental field strength is 48.5 dBµV/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 0.7 dB was used on the test receiver. Refer to results plots '*Fundamental field strength and spectrum mask / measured at 3 metres in a semi-anechoic chamber.* This illustrates that the value of the RF level offset is 0.7 dB and the peak fundamental field strength is 49.4 dBµV/m at a measurement distance of 3 metres.
5. Final measurements were performed in the semi-anechoic chamber 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 level of 48.3 dBµV/m at a measurement distance of 3 metres was recorded. A further 40 dB was subtracted to extrapolate the level measured at 3 metres to the required distance of 30 metres:

Corrected level 48.3 – 40 = 8.3 dBµV/m at 30 metres.

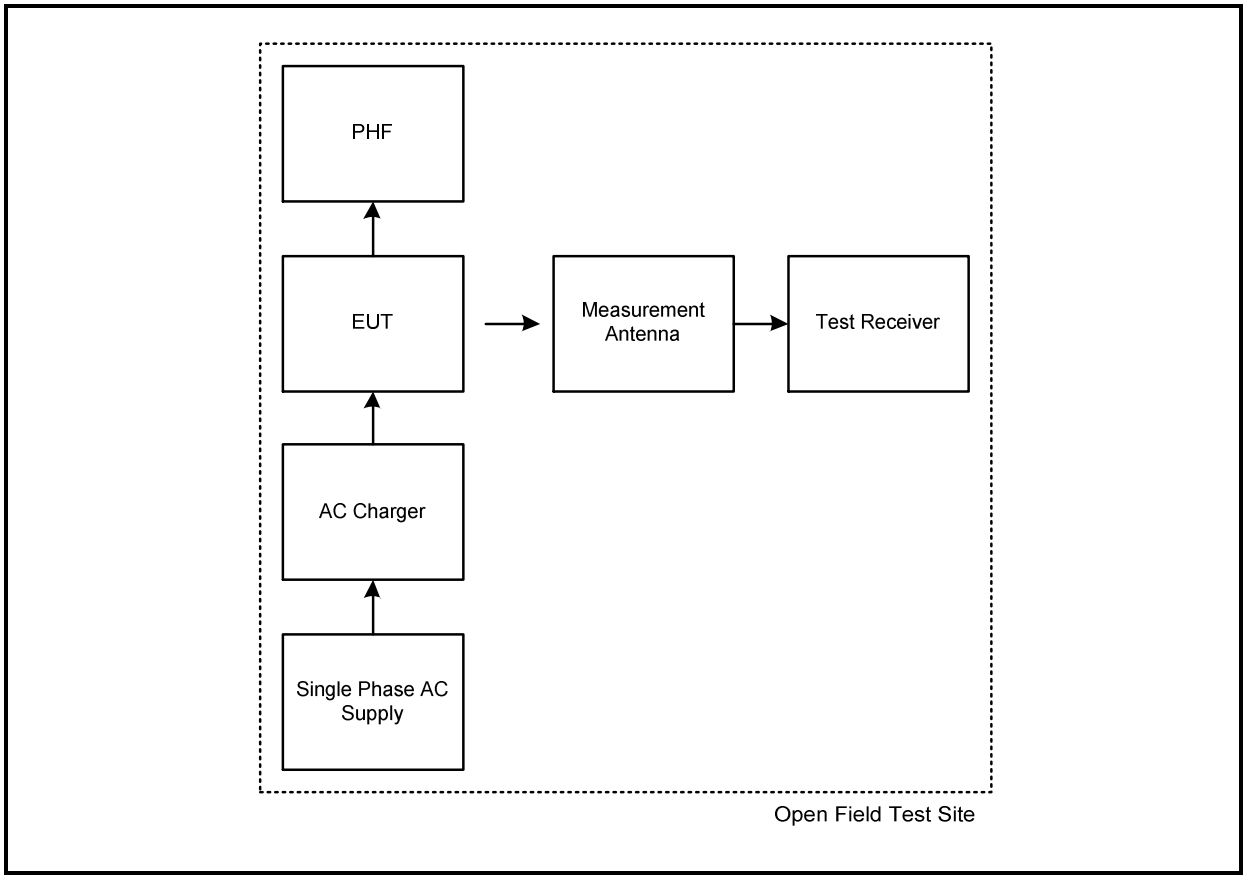
Transmitter Fundamental Field Strength (continued)

Note(s):

6. 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, an RF level offset was used to replicate the measurement 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.
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.
8. For compliance with the spectrum mask, refer to section 5.2.4 of this test report.
9. Assets M1956 Steel Rule, A2686 Measuring Wheel and A2955 Protractor, were used to support offsite measurements. The calibrated steel rule was used to verify the accuracy of the measuring wheel and the protractor used to ensure the accuracy of the EUT position during testing.

Test setup for fundamental field strength measurements:

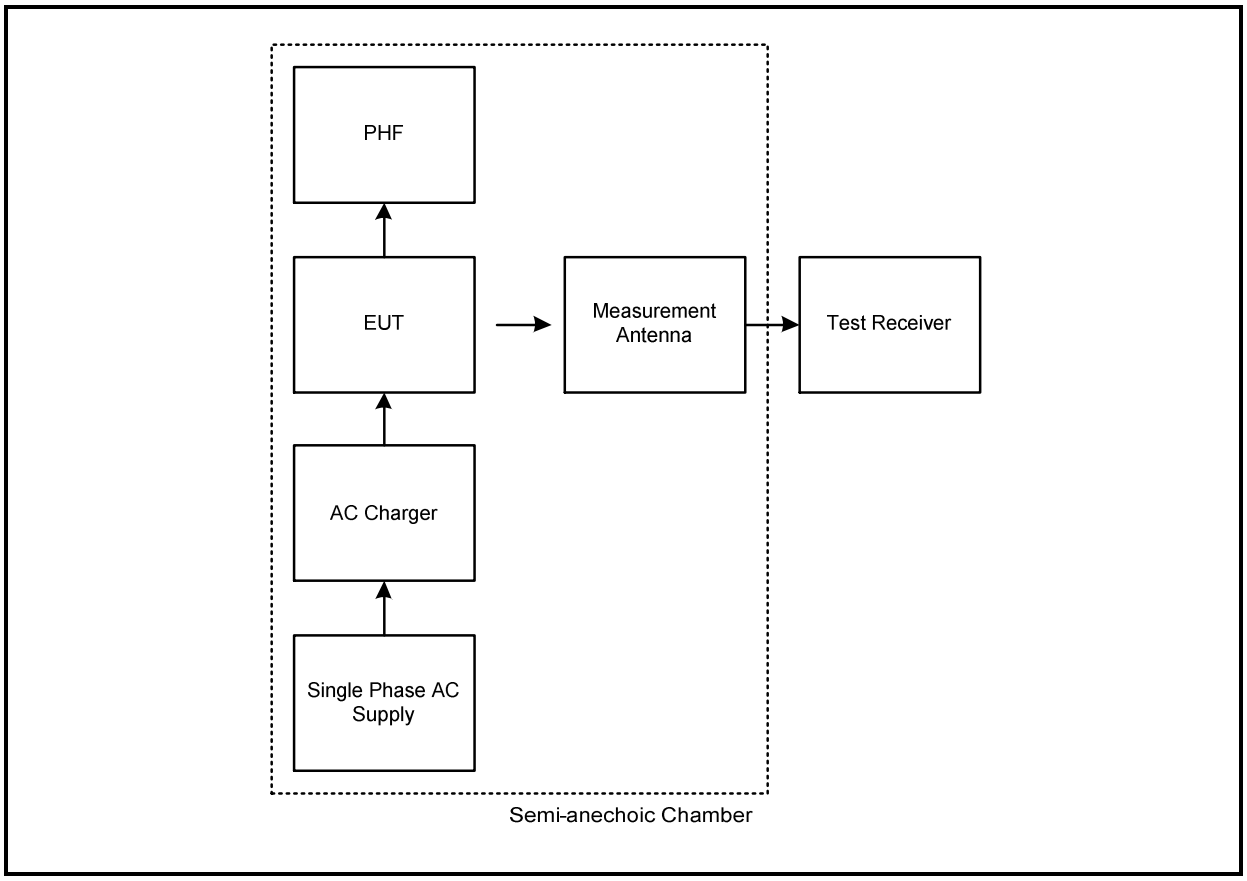
Measurements on an open field test site



Transmitter Fundamental Field Strength (continued)

Test setup for fundamental field strength measurements:

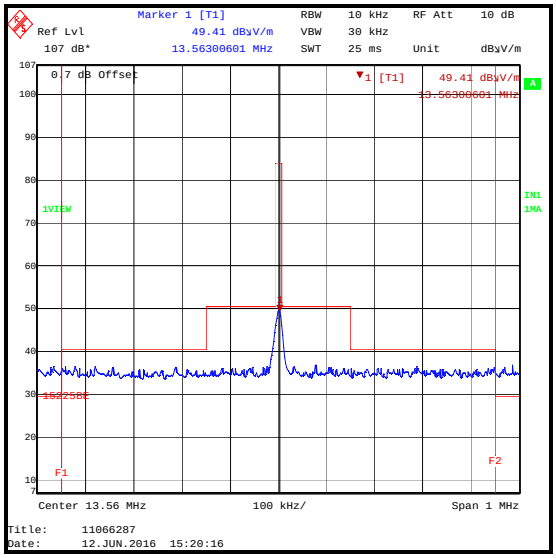
Measurements in a semi-anechoic chamber



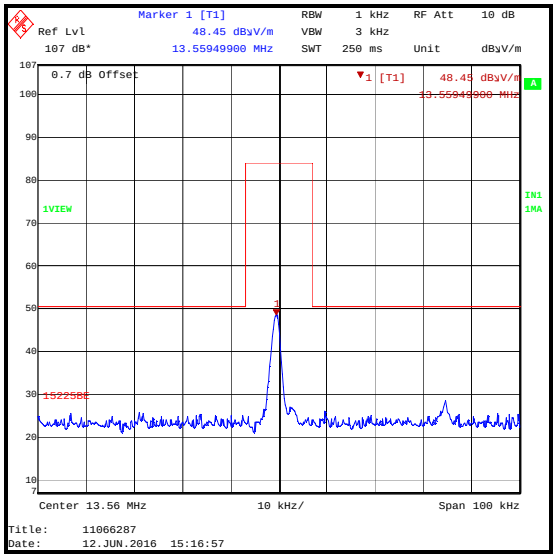
Transmitter Fundamental Field Strength (continued)

Results: Quasi Peak

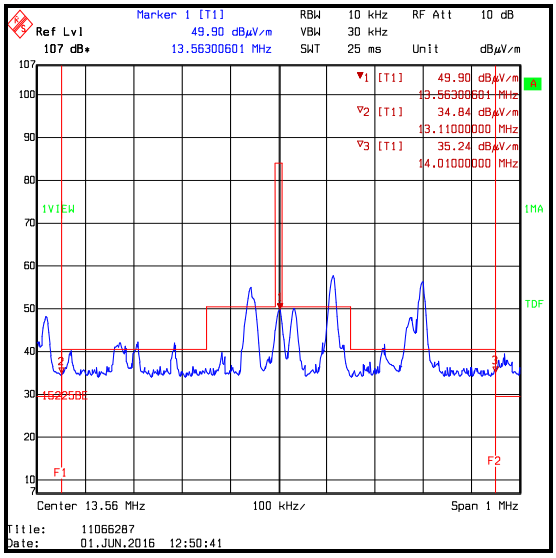
Frequency (MHz)	Antenna Polarity	Level (dBµV/m)	Limit at 30 m (dBµV/m)	Margin (dB)	Result
13.56	90°to EUT	8.3	84.0	75.7	Complied



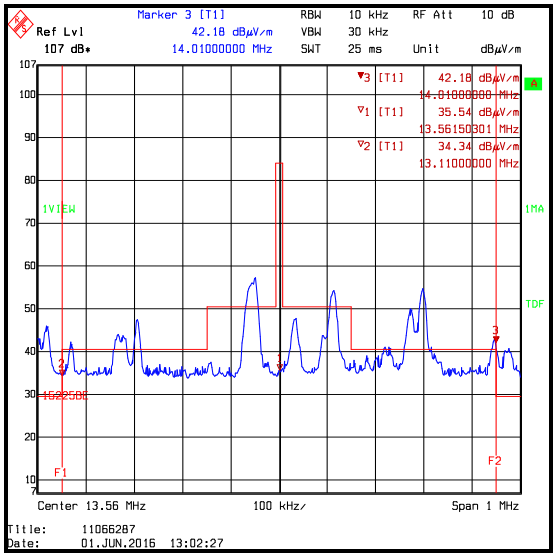
Fundamental field strength at 3 metres in a semi-anechoic chamber / extrapolated to 30 metres



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



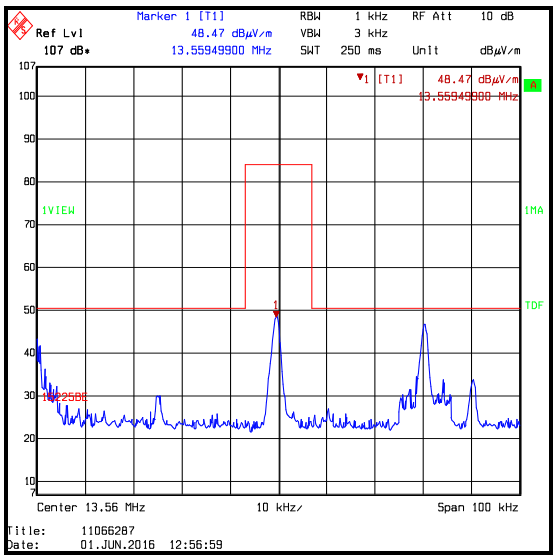
Fundamental field strength / EUT operating / measured at 3 metres / measured on an open field test site with 10 kHz measurement bandwidth (fundamental is affected by an ambient emission)



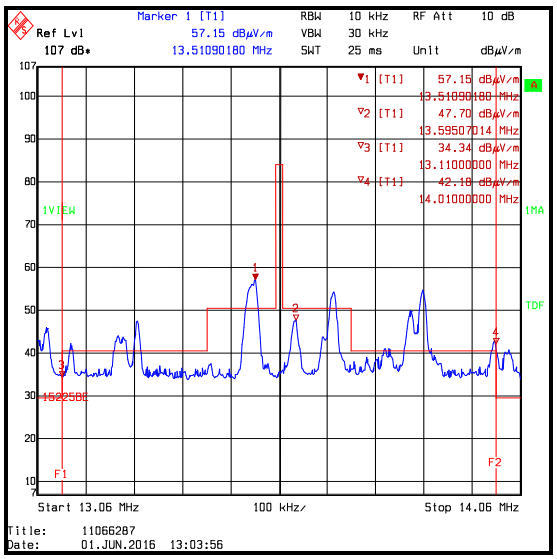
Fundamental field strength / EUT operating / measured at 30 metres / measured on an open field test site with 10 kHz measurement bandwidth (fundamental is below the noise floor)

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 ambient emissions

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
M1273	Test Receiver	Rohde & Schwarz	ESIB26	100275	11 Apr 2017	12
M127	Test Receiver	Rohde & Schwarz	FSEB30	842659/016	11 Aug 2016	12
M2014	Thermohygrometer	Testo	608-H1	45046246	10 Jun 2017	12
M2002	Thermohygrometer	Testo	608-H1	45041825	02 Apr 2017	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	9781907550980	#1	Calibration not required	-

5.2.3. Transmitter Radiated Spurious Emissions

Test Summary:

Test Engineers:	Ian Watch, Georgios Vrezas & Andrew Edwards	**Test Dates:**	03 May 2016, 01 June 2016 & 12 June 2016
Test Sample IMEI Number:	357232070004146		

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):	10 to 24
Relative Humidity (%):	31 to 69

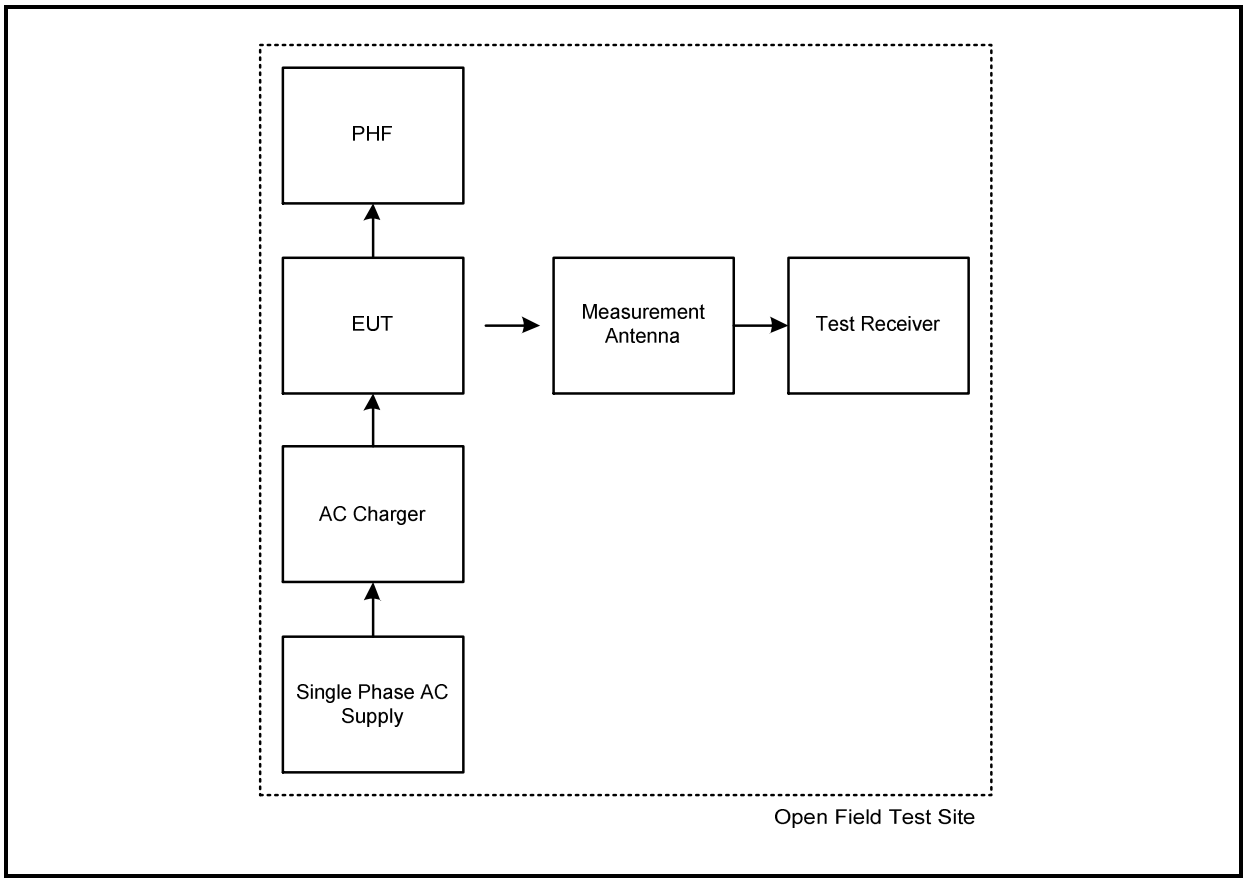
Note(s):

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 02 June 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 16 June 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 prescan 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 03 May 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. 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)

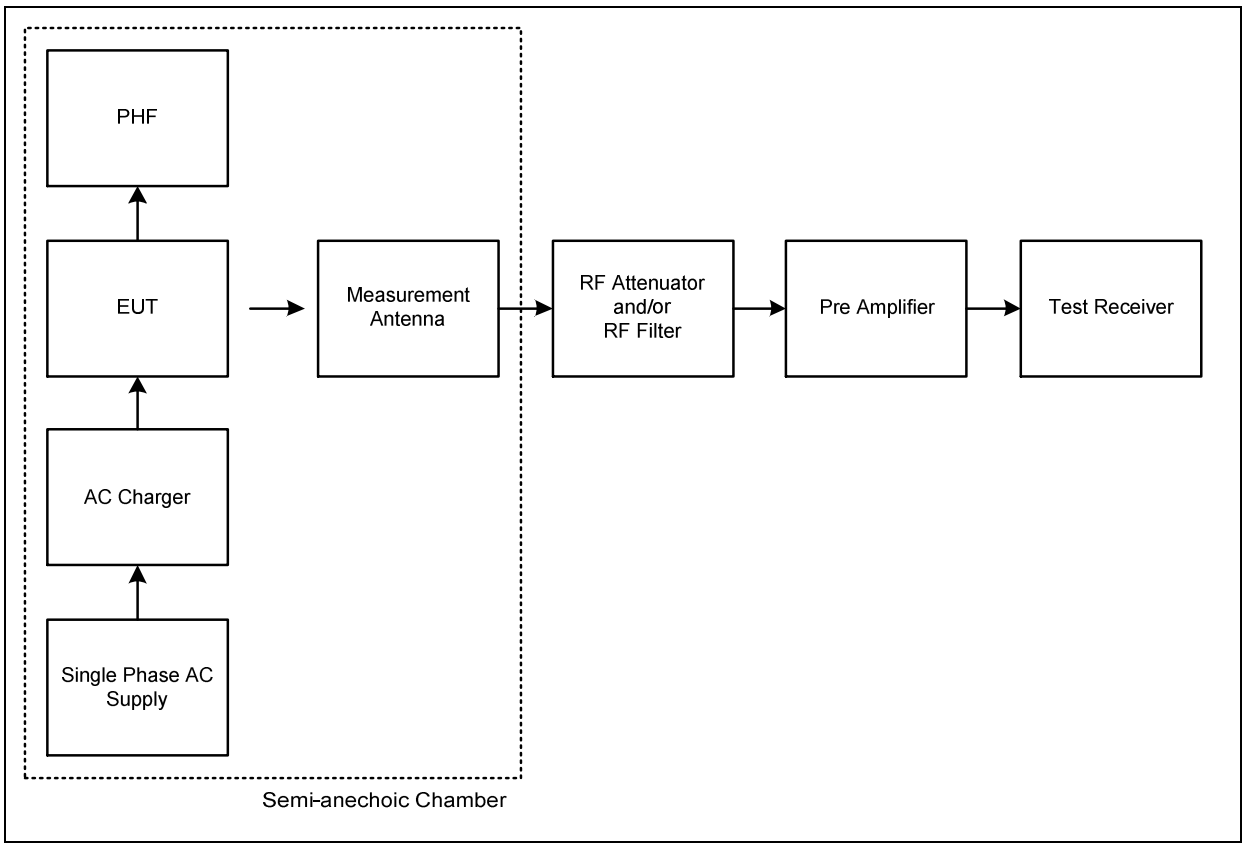
Test setup for Radiated Spurious Emissions measurements:

Measurements on an open field test site



Transmitter Radiated Spurious Emissions (continued)

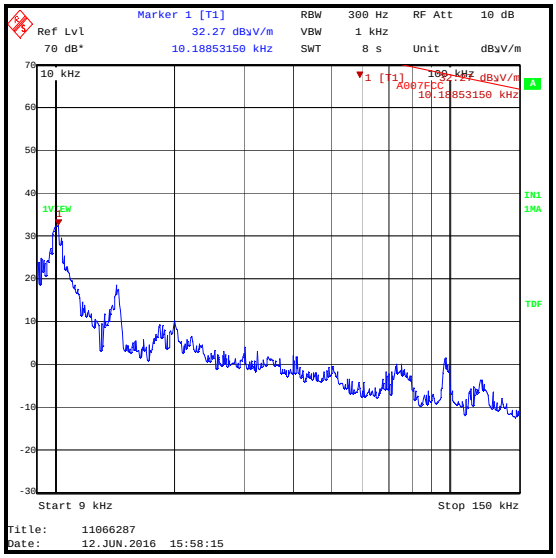
Test setup for radiated measurements:



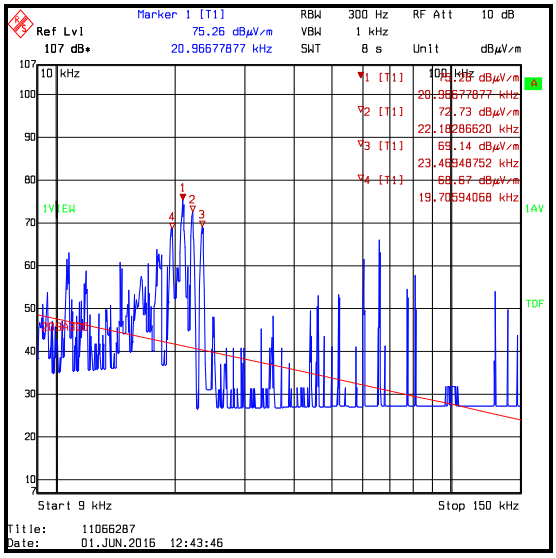
Transmitter Radiated Spurious Emissions (continued)

Results: Quasi Peak

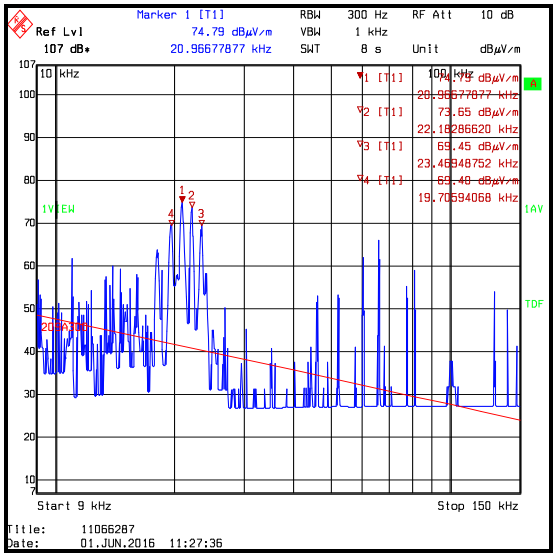
Frequency (MHz)	Antenna Polarity	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
40.677	Vertical	27.8	40.0	12.2	Complied



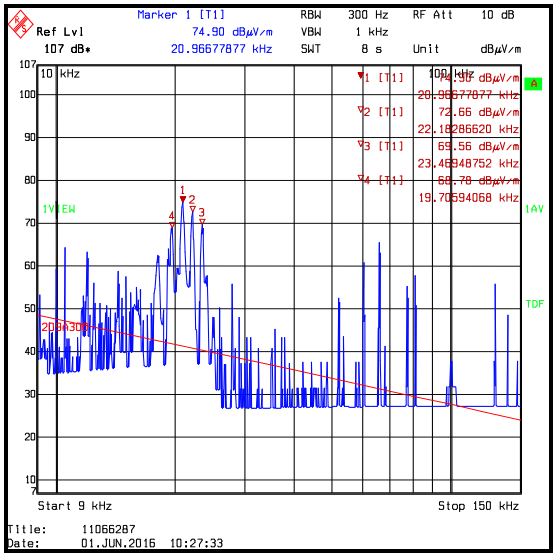
9 kHz to 150 kHz / peak detector / measured at 3 metres extrapolated to 30 metres / measured in a semi-anechoic chamber



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



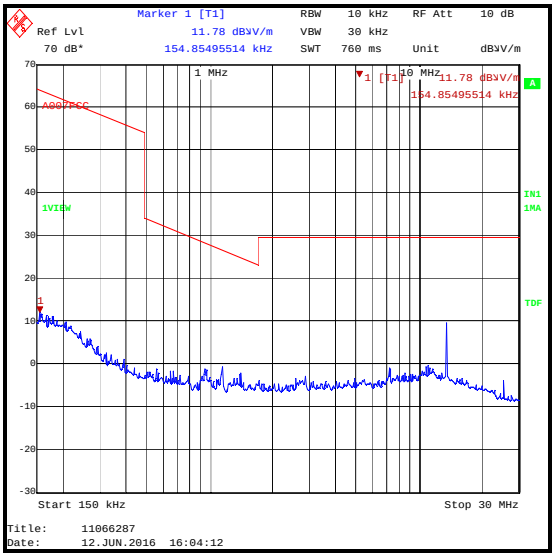
9 kHz to 150 kHz / average detector / EUT operating / measured at 30 metres on an open field test site



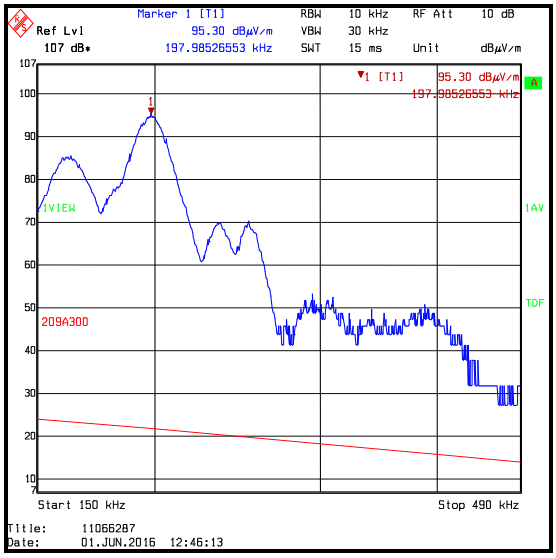
9 kHz to 150 kHz / average detector / EUT operating / measured at 300 metres on an open field test site

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

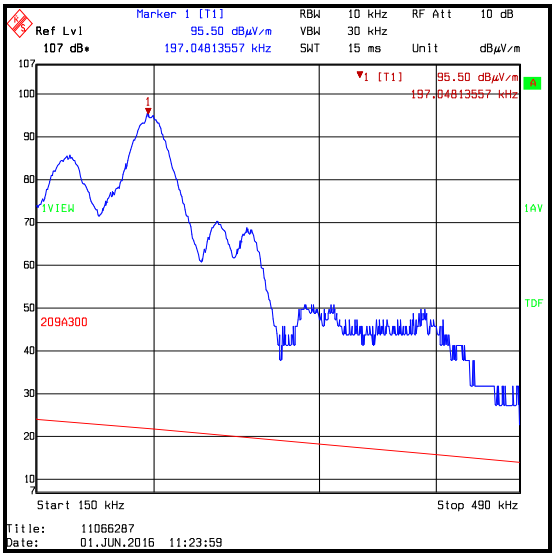
Transmitter Radiated Spurious Emissions (continued)



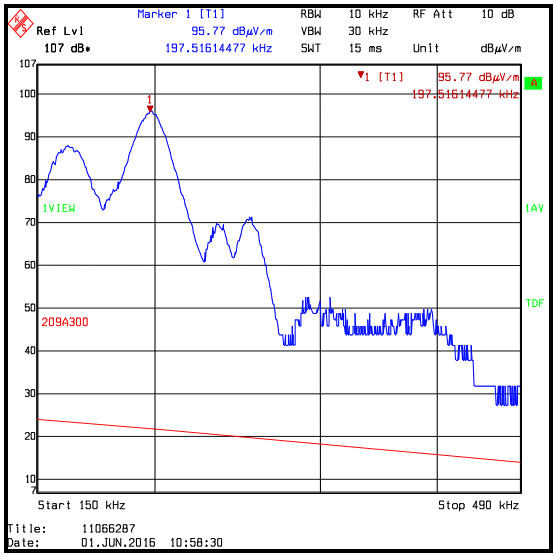
150 kHz to 30 MHz / peak detector (worst case) / EUT operating / measured at 3 metres extrapolated to 30 metres / measured in a semi-anechoic chamber



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



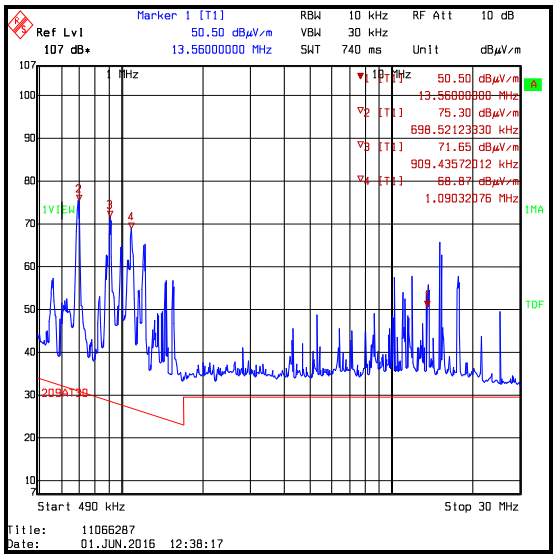
150 kHz to 490 kHz / average detector / EUT operating / measured at 30 metres on an open field test site



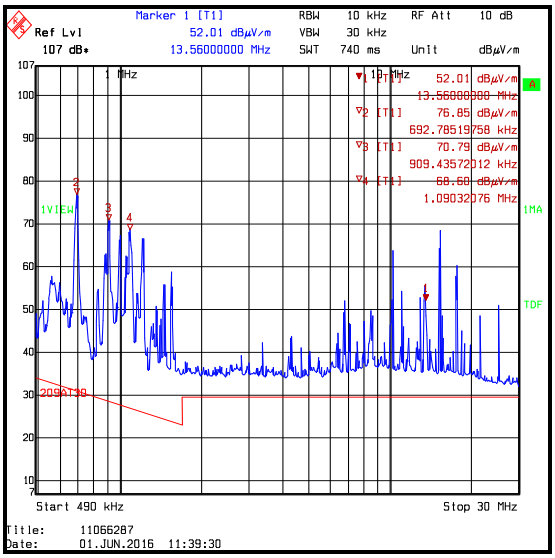
150 kHz to 490 kHz / average detector / EUT operating / measured at 300 metres on an open field test site

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

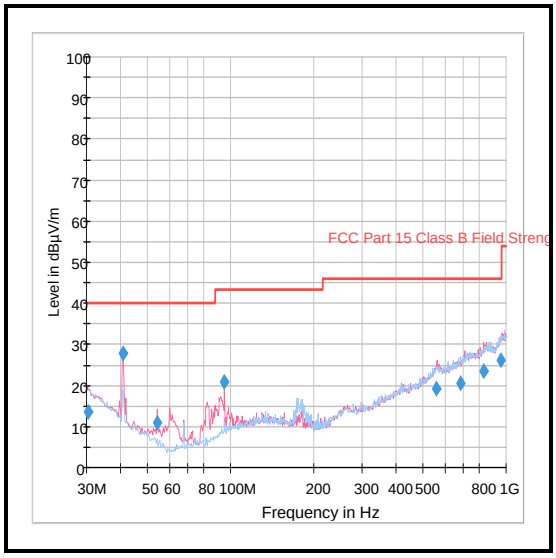
Transmitter Radiated Spurious Emissions (continued)



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	3
M1273	Test Receiver	Rohde & Schwarz	ESIB26	100275	11 Apr 2017	12
A259	Antenna	Chase	CBL6111A	1513	30 Mar 2017	12
M2014	Thermohygrometer	Testo	608-H1	45046246	10 Jun 2017	12
M2002	Thermohygrometer	Testo	608-H1	45041825	02 Apr 2017	12
M1273	Test Receiver	Rohde & Schwarz	ESIb26	100275	11 Apr 2017	12
M127	Test Receiver	Rohde & Schwarz	FSEB30	842659/016	11 Aug 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	9781907550980	#1	Calibration not required	-

5.2.4. Transmitter Band Edge Radiated Emissions

Test Summary:

Test Engineer:	Andrew Edwards	**Test Date:**	12 June 2016
Test Sample IMEI Number:	357232070004146		

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

Environmental Conditions:

Temperature (°C):	23
Relative Humidity (%):	43

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 01 June 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 12 Jun 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 RF level offset of -39.3 dB was used. The offset was calculate as:

   -40 dB + 0.7 dB = -39.3 dB,

   Where -40 dB is the extrapolation factor from 3 metres to 30 metres and +0.7 dB is the correlation factor between measurements in a semi-anechoic chamber and measurements on an open field test site at 13.56 MHz. For details on the calculations of the correlation factor, see Notes 3 and 4 in Section 5.2.2 of this test report.
3. The test receiver 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.

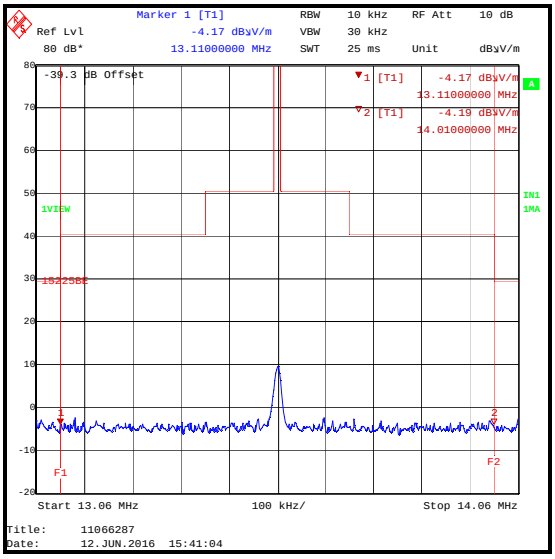
Transmitter Band Edge Radiated Emissions (continued)

Results: Peak / Lower Band Edge

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
13.11	-4.2	29.5	33.7	Complied

Results: Peak / Upper Band Edge

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
14.01	-4.2	29.5	33.7	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
M1273	Test Receiver	Rohde & Schwarz	ESIB26	100275	11 Apr 2017	12
M1568	Magnetic Loop Antenna	Rohde & Schwarz	HFH2-Z2	879284/2	23 May 2017	12

5.2.5. Transmitter Frequency Stability (Temperature & Voltage Variation)

Test Summary:

Test Engineer:	Stefan Ho	**Test Date:**	28 April 2016
Test Sample Used:	0067		

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

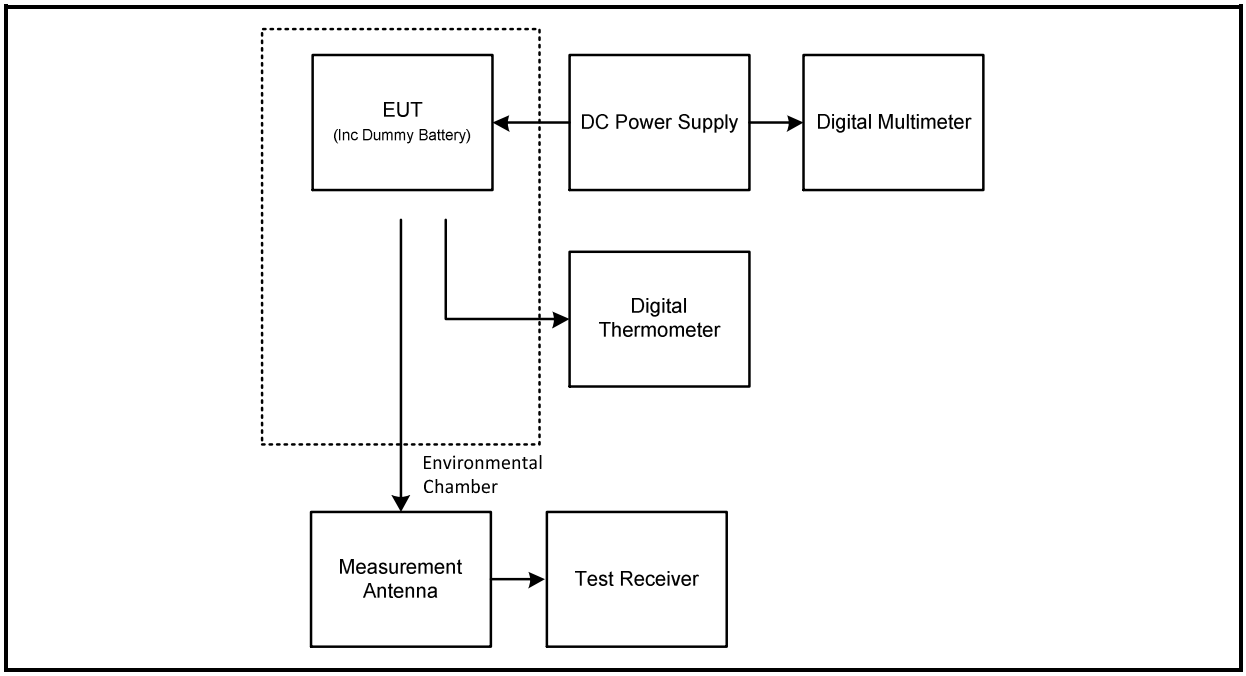
Environmental Conditions:

Ambient Temperature (℃):	22
Ambient Relative Humidity (%):	33

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 3.5 and 4.4 VDC.
2. Frequency error was measured using a 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	13.559670 MHz	13.559668 MHz	13.559683 MHz	13.559341 MHz
20	13.559676 MHz	13.559660 MHz	13.559683 MHz	13.559681 MHz
50	13.559649 MHz	13.559659 MHz	13.559659 MHz	13.559653 MHz

Frequency with Worst Case Deviation (MHz)	Frequency Error (Hz)	Frequency Error (%)	Limit (%)	Margin (%)	Result
13.559341	340	0.002507	0.01	0.007493	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
3.5	13.56	13.559325	675	0.0049	0.01	0.0051	Complied
3.9	13.56	13.559681	319	0.0023	0.01	0.0077	Complied
4.4	13.56	13.559670	330	0.0024	0.01	0.0076	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 Series 3	23900506	Calibrated before use	
M1249	Thermometer	Fluke	52II	88800049	27 May 2016	12
S021	Dual DC power supply	Thurlby Thandar Instruments	CPX200	061034	Calibrated before use	
M1251	Multimeter	Fluke	175	89170179	26 May 2016	12
M127	Spectrum Analyzer	Rohde & Schwarz	FSEB30	842659/016	11 Aug 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 01 June 2016

Temperature: 10℃ to 15℃ Relative Humidity: 52% t o 69%

Ground conditions: Wet

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 USB charger. The USB charger was connected to a single phase supply. A power cable was run across the site to the EUT via the USB charger 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 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 01 June 2016

Temperature: 10℃ to 15℃ Relative Humidity: 52% t o 69%

Ground conditions: Wet

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 USB charger. The USB charger was connected to a single phase supply from a portable generator. A power cable was run across the field to the USB charger. 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 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.

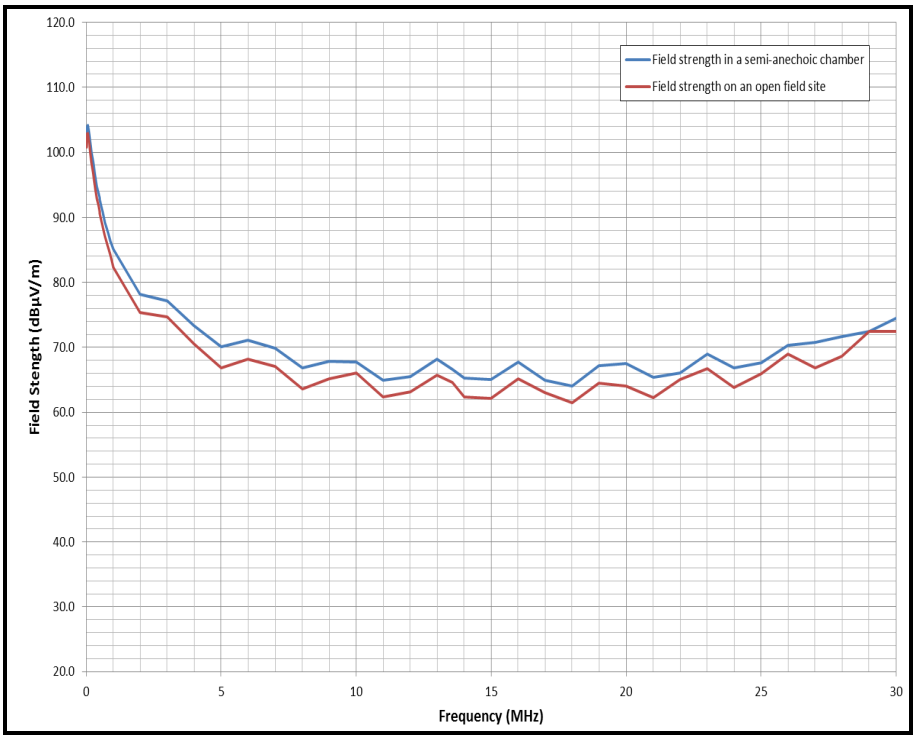
Initially, the EUT was rotated through 360 degrees in 60 degree steps at both measurement distances. The mag loop antenna was rotated through 90 degrees in 30 degree steps at every position the EUT was moved to. The EUT and mag loop antenna were then rotated in small increments in order to maximise emission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

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

Radiated measurements were performed 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, 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 RFID frequencies.

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

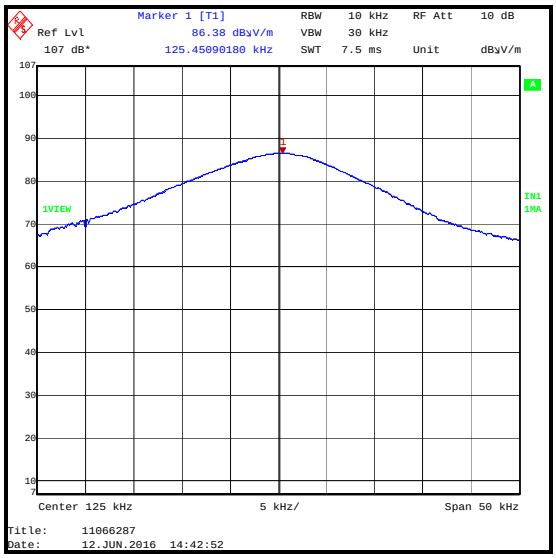
The centre of the magnetic loop antenna is placed exactly 3 metres from the reference unit. The reference unit is placed on a plastic table at a height of 0.8 metres above floor level and the centre of the mag loop antenna is 1 metre above the floor level. The mag loop antenna and reference unit are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

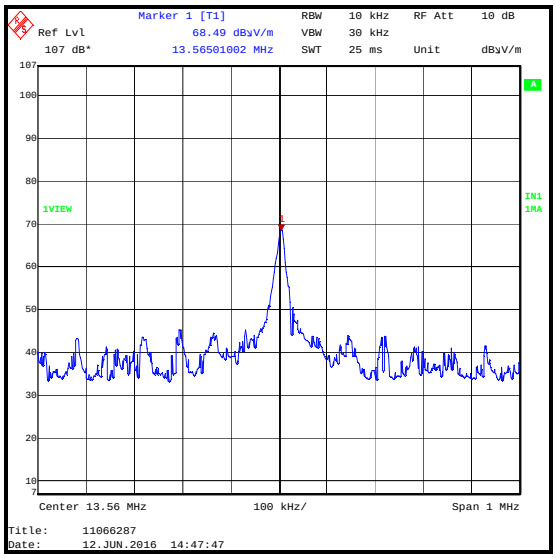
The internal verification procedure and verification plots are available for inspection on request.

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

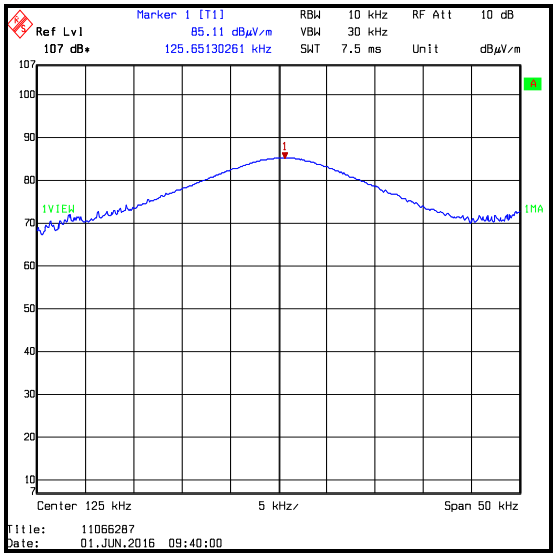
Verification plots of the two reference units at a measurement distance of 3 metres are shown on the following page. Plots were taken on an open field test site (01 June 2016) and in a semi-anechoic chamber (12 June 2016).



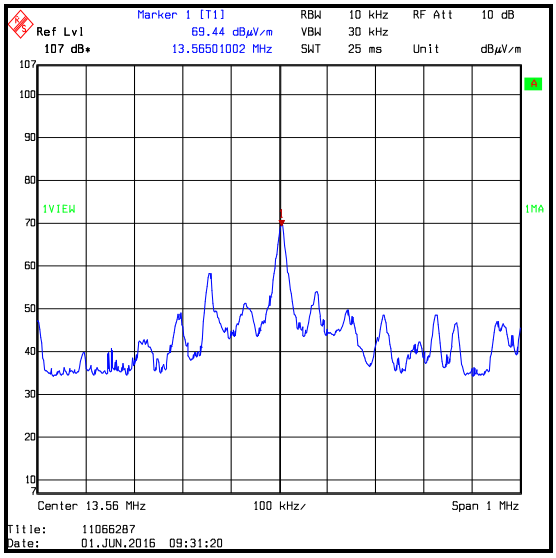
125 kHz reference unit signal at 3 metres in a semi-anechoic chamber on 12 June 2016



13.56 MHz reference unit signal at 3 metres in a semi-anechoic chamber on 12 June 2016



125 kHz reference unit signal at 3 metres on an open field test site on 01 June 2016

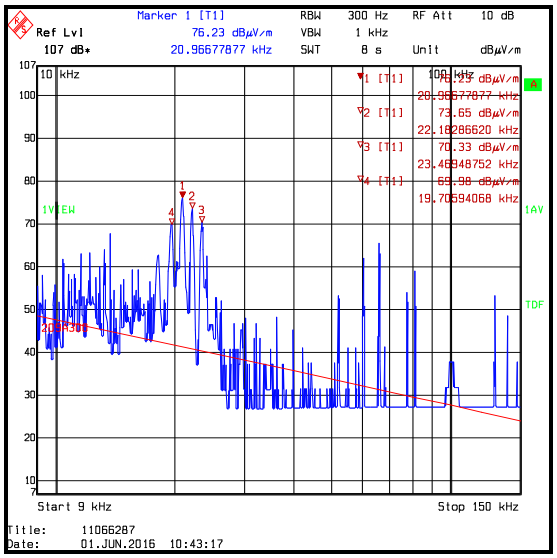


13.56 MHz reference unit signal at 3 metres on an open field test site on 01 June 2016

Note(s):

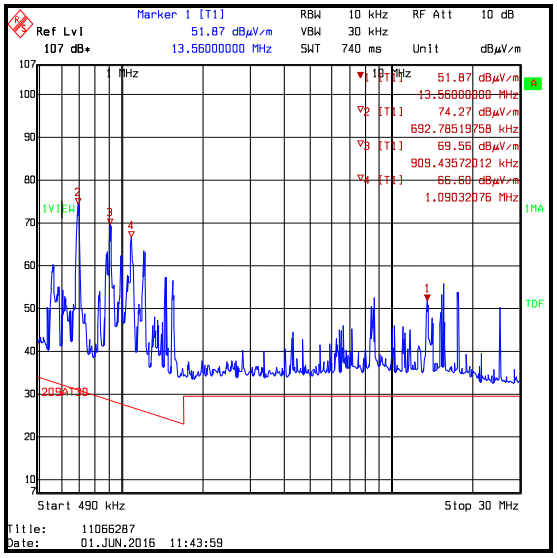
1. The above plots show comparable measurements of reference units on an open field test site and in a semi-anechoic chamber at spot frequencies.

Background scans of the open field test site

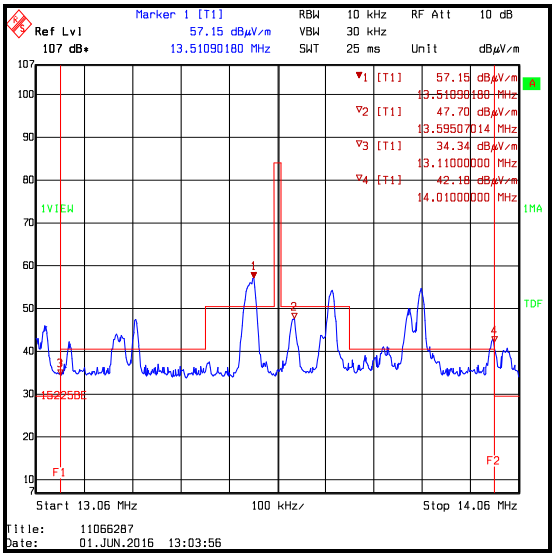


Frequency range: 9 kHz to 150 kHz
Average detector / background scan

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 ---