Report on the Radio Testing

For

Dyson Technology Ltd

on

360 Eye (Docking Station)

Report no. TRA-026979-03-47-00A

19th April 2016

Element Materials Technology Warwick Ltd.
Registered in England and Wales. Registered Office: 5 Fleet Place, London, EC4M 7RD
Company Reg No. 02536659

Report Number: TRA-026979-03-47-00A
Issue: A

REPORT ON THE RADIO TESTING OF A
Dyson Technology Ltd
360 Eye (Docking Station)
WITH RESPECT TO SPECIFICATION
FCC 47CFR 15.225 & IC RSS-210 Annex 2.6

TEST DATE: 26th Nov 2015 - 04th Dec 2015

Tested by: A Tosif

A Tosif
Radio Test Engineer

Approved by: John Charters

Digitally signed by John Charters
DN: cn=John Charters, o=Element Materials Technology, ou, email=john.charters@element.com, c=GB
Date: 2016.04.25 15:14:49 +01'00'

J Charters
Department Manager - Radio

Date: 19th April 2016

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1 Revision Record

Issue Number	*Issue Date*	*Revision History*
A	19th April 2016	Original

2 Summary

TEST REPORT NUMBER:	TRA-026979-03-47-00A
WORKS ORDER NUMBER:	TRA-026979-03
PURPOSE OF TEST:	Certification
TEST SPECIFICATION(S):	47CFR15.225 & RSS-210 Annex 2.6
EQUIPMENT UNDER TEST (EUT):	360 Eye (Docking Station)
FCC IDENTIFIER: CERTIFICATION NUMBER	QVHRB01DS001 7986A-RB01DS001
EUT SERIAL NUMBER:	0110152410047
MANUFACTURER/AGENT:	Dyson Technology Ltd
ADDRESS:	Tetbury Hill Malmesbury Wiltshire SN16 0RP United Kingdom
CLIENT CONTACT:	Nicholas Jordan ☎ 01666 827464 ✉ Nicholas.Jordan@dyson.com
ORDER NUMBER:	4500269678
TEST DATE:	26th Nov 2015 - 04th Dec 2015
TESTED BY:	A Tosif Element

2.1 Test Summary

Test Method and Description	*Requirement Clause*		*Applicable to this equipment*	*Result / Note*
	RSS	*47CFR15*		
Radiated spurious emissions, below 30 MHz	210, A2.6(d)	15.225(d)	☒	*Pass*
Radiated spurious emissions	Gen, 6.13	15.209	☒	*Pass*
AC power line conducted emissions	Gen, 8.8	15.207	☒	*Pass*
Occupied bandwidth	Gen, 6.6	15.215(c)	☒	*Pass*
Field strength of fundamental	210, A2.6(a), (b) and (c)	15.225(a), (b) and (c)	☒	*Pass*
Frequency stability	210, A2.6	15.225(e)	☒	*Pass*

Notes:

The results contained in this report relate only to the items tested, in the condition at time of test, and were obtained in the period between the date of initial receipt of samples and the date of issue of the report.

The apparatus was set up and exercised using the configurations, modes of operation and arrangements defined in this report only. Any modifications made are identified in Section 8 of this report.

Particular operating modes, apparatus monitoring methods and performance criteria required by the standards tested to have been performed except where identified in Section 5.2 of this test report (Deviations from Test Standards).

3 Contents

4 Introduction

This report TRA-026979-03-47-00A presents the results of the Radio testing on a Dyson Technology Ltd, 360 Eye (Docking Station) to specification 47CFR15 Radio Frequency Devices and RSS-210 Licence-exempt Radio Apparatus (All Frequency Bands): Category I Equipment.

The testing was carried out for Dyson Technology Ltd by Element, at the address(es) detailed below.

☐ Element Hull
Unit E
South Orbital Trading Park
Hedon Road
Hull
HU9 1NJ
UK

☒ Element North West
Unit 1
Pendle Place
Skemersdale
West Lancashire
WN8 9PN
UK

This report details the configuration of the equipment, the test methods used and any relevant modifications where appropriate.

All test and measurement equipment under the control of the laboratory and requiring calibration is subject to an established programme and procedures to control and maintain measurement standards. The quality management system meets the principles of ISO 9001, and has quality control procedures for monitoring the validity of tests undertaken. Records and sufficient detail are retained to establish an audit trail of calibration records relating to its test results for a defined period. Under control of the established calibration programme, key quantities or values of the test & measurement instrumentation are within specification and comply with the relevant traceable internationally recognised and appropriate standard specifications, which are UKAS calibrated as such where these properties have a significant effect on results. Participation in inter-laboratory comparisons and proficiency testing ensures satisfactory correlation of results conform to Elements own procedures, as well as statistical techniques for analysis of test data providing the appropriate confidence in measurements.

Throughout this report EUT denotes equipment under test.

FCC Site Listing:
Element is accredited for the above sites under the US-EU MRA, Designation number UK0009.

IC Registration Number(s):
Element North West 3930B-4

The test site requirements of ANSI C63.4-2014 are met up to 1 GHz.

The test site SVSWR requirements of CISPR 16-1-4:2010 are met over the frequency range 1 GHz to 18 GHz.

5 Test Specifications

5.1 Normative References

- FCC 47 CFR Ch. I – Part 15 – Radio Frequency Devices.
- ANSI C63.10-2013 – American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.
- ANSI C63.4-2014 – American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.
- Industry Canada RSS-210, Issue 8, December 2010 – Licence-exempt Radio Apparatus (All Frequency Bands): Category I Equipment.
- Industry Canada RSS-Gen, Issue 4, November 2014 – General Requirements for Compliance of Radio Apparatus

5.2 Deviations from Test Standards

There were no deviations from the test standard.

6 Glossary of Terms

§	denotes a section reference from the standard, not this document
AC	Alternating Current
ANSI	American National Standards Institute
BW	bandwidth
C	Celsius
CFR	Code of Federal Regulations
CW	Continuous Wave
dB	decibel
dBm	dB relative to 1 milliwatt
DC	Direct Current
DSSS	Direct Sequence Spread Spectrum
EIRP	Equivalent Isotropically Radiated Power
ERP	Effective Radiated Power
EUT	Equipment Under Test
FCC	Federal Communications Commission
FHSS	Frequency Hopping Spread Spectrum
Hz	hertz
IC	Industry Canada
ITU	International Telecommunication Union
LBT	Listen Before Talk
m	metre
max	maximum
MIMO	Multiple Input and Multiple Output
min	minimum
MRA	Mutual Recognition Agreement
N/A	Not Applicable
PCB	Printed Circuit Board
PDF	Portable Document Format
Pt-mpt	Point-to-multipoint
Pt-pt	Point-to-point
RF	Radio Frequency
RH	Relative Humidity
RMS	Root Mean Square
Rx	receiver
s	second
SVSWR	Site Voltage Standing Wave Ratio
Tx	transmitter
UKAS	United Kingdom Accreditation Service
V	volt
W	watt
Ω	ohm

7 Equipment under Test

7.1 EUT Identification

- Name: 360 Eye (Docking Station)
- Serial Number: 0110152410047
- Model Number: RB01
- Software Revision: 1.0.0.4
- Build Level / Revision Number: 65021-01/10

7.2 System Equipment

Equipment listed below forms part of the overall test setup and is required for equipment functionality and/or monitoring during testing. The compliance levels achieved in this report relate only to the EUT and not items given in the following list.

Power supply
Robotic Vacuum

7.3 EUT Mode of Operation

Test	Description of Operating Mode
All tests detailed in this report	EUT is actively transmitting either waiting for a tag to be presented or reading a tag as required.

7.4 EUT Description

The EUT is used for charging the robotic vacuum and contains a 13.56 MHz RFID module. It constantly pole to check if a robotic vacuum has docked. It will only energise the charging contacts if the correct tag is detected.

The radiated spurious emissions and power line testing were performed in following two configurations.

Configuration 1: Robotic vacuum charging on the X223 Docking Station (combined system)

Configuration 2: X223 Docking Station (Standalone)

8 EUT Test Setup

8.1 Block Diagram

The following diagrams show basic EUT interconnections:

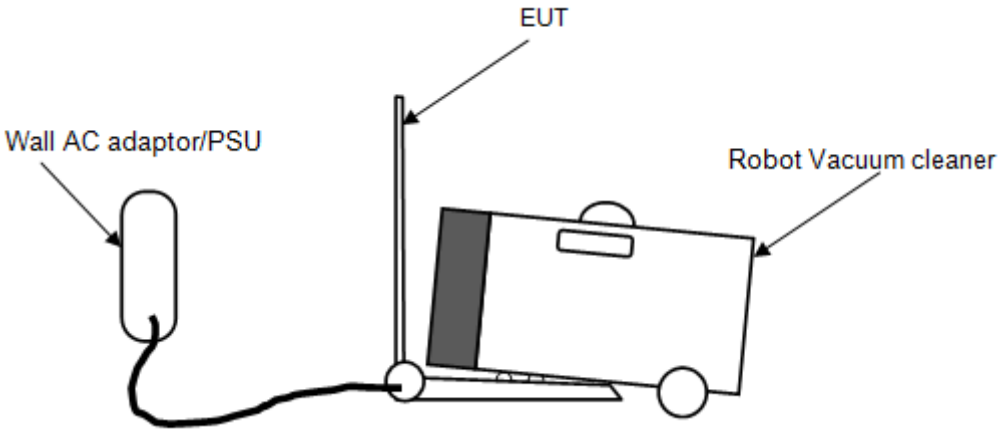


Figure 1 – Configuration 1

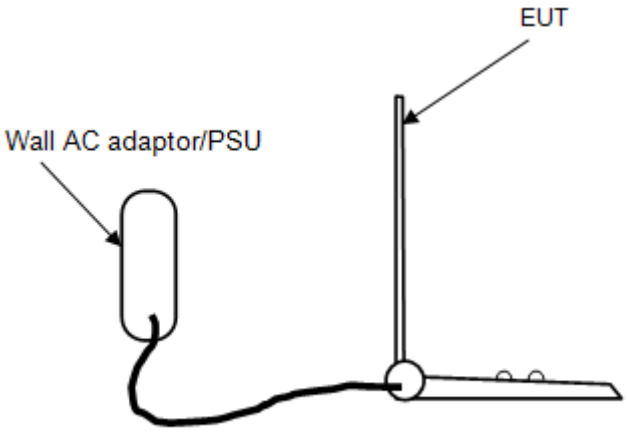
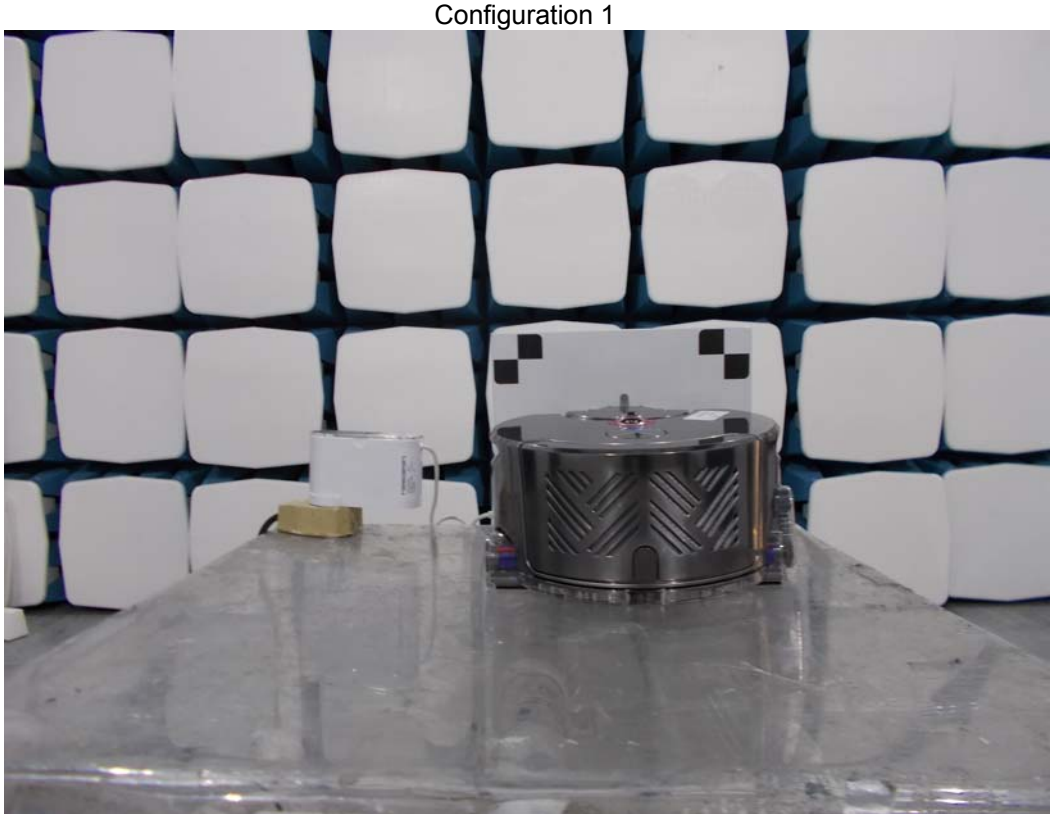


Figure 2 – Configuration 2

8.2 General Set-up Photograph

The following photograph shows basic EUT set-up:

Configuration 1



Configuration 2

9 Modifications

No modifications were performed during this assessment.

10 General Technical Parameters

10.1 Normal Conditions

The EUT was tested under the normal environmental conditions of the test laboratory, except where otherwise stated. The normal power source applied was 110 V ac, 60 Hz, from the mains.

10.2 Varying Test Conditions

Variation of temperature is required to ensure stability of the declared fundamental frequency. During frequency error testing the following variations were made:

	Category	***Variation***
☒	Standard	-20 to +50 C
☐	Extended	

Variation of supply voltage is required to ensure stability of the declared output power and frequency. During carrier power and frequency error testing the following variations were made:

	Category	***Nominal***	***Variation***
☒	Mains	110 V ac +/-2 %	85 % and 115 %
☐	Battery	New battery	N/A

11 Radiated emissions below 30 MHz

11.1 Definitions

Out-of-band emissions
Emissions on a frequency or frequencies immediately outside the necessary bandwidth which result from the modulation process, but exclude spurious emissions.

Spurious emissions
Emissions on a frequency or frequencies which are outside the necessary bandwidth and the level of which may be reduced without affecting the corresponding transmission of information. Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products and frequency conversion products, but exclude out-of-band emissions.

Restricted bands
A frequency band in which intentional radiators are permitted to radiate only spurious emissions but not fundamental signals.

11.2 Test Parameters

Test Location:	Element North West
Test Chamber:	REF940
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.4
EUT Channels / Frequencies Measured:	13.56 MHz
Deviations From Standard:	None
Measurement Distance and Site	3 m
EUT Height:	0.8 m
Measurement Antenna and Height:	60 cm shielded loop; 1 m
Measurement BW:	9 kHz to 150 kHz: 200 Hz; 150 kHz to 30 MHz: 9 kHz
Measurement Detector:	9 – 90 kHz and 110 – 490 kHz: Average, RMS Other frequencies below 30 MHz: Quasi-peak.

Environmental Conditions (Normal Environment)

Temperature: 22 °C	+15 ºC to +35 ºC (as declared)
Humidity: 35 % RH	20 % RH to 75 % RH (as declared)
Supply: 110 Vac	110 Vac ±10 % (as declared)

11.3 Test Limit

Emissions from license-exempt transmitters shall comply with the field strength limits shown in the table below. Additionally, the level of any transmitter emission shall not exceed the level of the transmitter's fundamental emission.

General Field Strength Limits for License-Exempt Transmitters at Frequencies below 30 MHz

Frequency, f (kHz)	*Field Strength*	*Measurement Distance (m)*
9 to 490	2,400 / 377.f (µA/m) 2,400 / f (µV/m)	300
490 to 1,750	24,000 / 377.f (µA/m) 24,000 / f (µV/m)	30
1,750 to 30,000	30 (µV/m)	30

n.b. Devices operated pursuant to §15.225 / RSS-210 A2.6 are exempt from complying with the restricted band requirements for the 13.36–13.41 MHz band only.

11.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure i, the EUT fundamental frequency was maximised by rotating the EUT through 360º, in three orthogonal planes, and adjusting the measurement antenna azimuth.

Radiated electromagnetic emissions from the EUT are checked first by preview scans. Preview scans for all spectrum and modulation characteristics are checked, using a peak detector and where applicable worst-case determined for function, operation, orientation, etc. for both vertical and horizontal polarisations. Pre-scan plots are shown with a peak detector and 9 kHz RBW.

If the EUT connects to auxiliary equipment and is table or floor standing, the configurations prescribed in ANSI C63.10 are followed. Alternatively, a layout closest to normal use (as declared by the provider) is employed, (see EUT setup photographs for more detail).

Emissions between 9 kHz and 30 MHz are measured using a calibrated 60cm active loop antenna. Pre-amplifiers and filters are used where required. Care is taken to ensure that test receiver resolution bandwidth, video bandwidth and detector type(s) meet the regulatory requirements.

Power values measured on the test receiver / analyzer are converted to field strength, FS, in µV/m at the regulatory distance, using:

$$FS = 10^{(PR - CF) / 20}$$

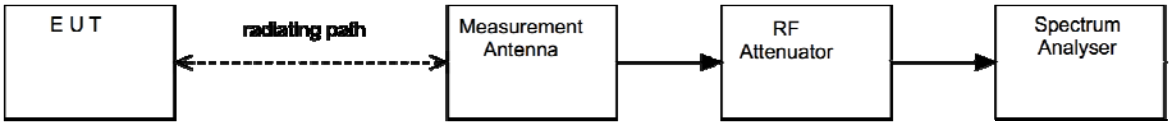
Where,

PR is the power recorded on the receiver / spectrum analyzer in dBµV and includes any cable loss, antenna factor and pre-amplifier gain;
CF is the distance extrapolation factor in dB (where measurement distance different to limit distance);

Per FCC 47CFR15.31(f)(2) / RSS-Gen 6.4, an extrapolation factor of 40 dB per decade was used for measurements at distances closer than specified.

This field strength value is then compared with the regulatory limit.

Figure i Test Setup



11.5 Test Equipment

Type of Equipment	Maker/Supplier	Model Number	Element Number	Calibration Due Date
Loop Antenna	R&S	hfh2	L007	10/04/2017
Receiver	R&S	ESHS10	UH003	25/06/2016

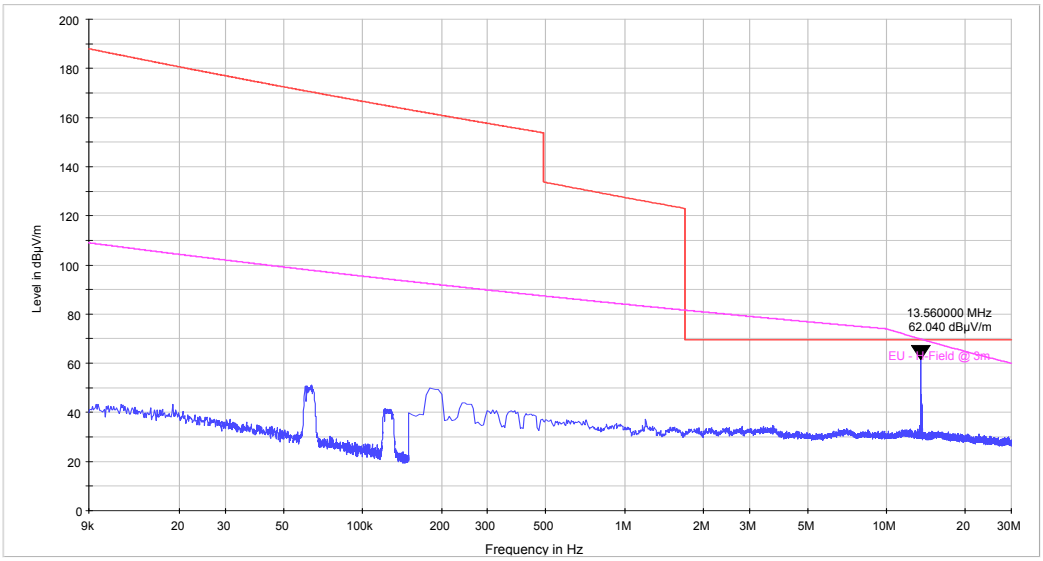
11.6 Test Set-up Photograph

Configuration 1

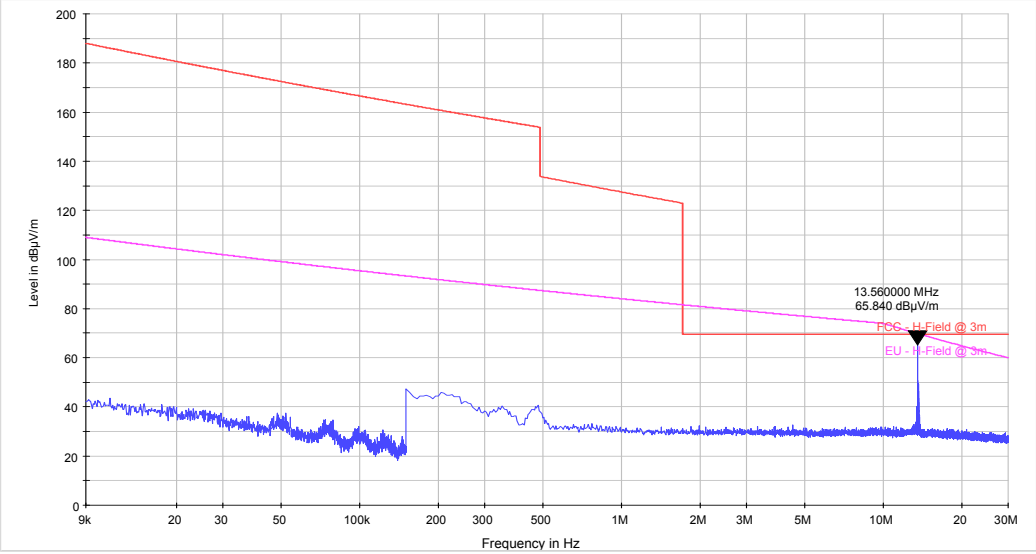
Configuration 2

11.7 Test Results

Configuration 1



Configuration 2



Configuration 1						
Emission Frequency (MHz)	Receiver Level (dBµV/m)	Measurement Distance (m)	Limit Distance (m)	Extrapolation Factor (dB)	Field Strength (µV/m)	Result
No emissions were detected within 20 dB of the limit						

Configuration 2						
Emission Frequency (MHz)	Receiver Level (dBµV/m)	Measurement Distance (m)	Limit Distance (m)	Extrapolation Factor (dB)	Field Strength (µV/m)	Result
No emissions were detected within 20 dB of the limit						

12 Radiated emissions

12.1 Definitions

Out-of-band emissions
Emissions on a frequency or frequencies immediately outside the necessary bandwidth which result from the modulation process, but exclude spurious emissions.

Spurious emissions
Emissions on a frequency or frequencies which are outside the necessary bandwidth and the level of which may be reduced without affecting the corresponding transmission of information. Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products and frequency conversion products, but exclude out-of-band emissions.

Restricted bands
A frequency band in which intentional radiators are permitted to radiate only spurious emissions but not fundamental signals.

12.2 Test Parameters

Test Location:	Element North West
Test Chamber:	REF940
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.5
EUT Channels / Frequencies Measured:	13.56 MHz
Deviations From Standard:	None
Measurement BW:	120 kHz
Measurement Detector:	Quasi-peak

Environmental Conditions (Normal Environment)

Temperature: 23 °C	+15 ºC to +35 ºC (as declared)
Humidity: 34 % RH	20 % RH to 75 % RH (as declared)
Supply: 110 Vac	110 Vac ±10 % (as declared)

12.3 Test Limit

Emissions from license-exempt transmitters shall comply with the field strength limits shown in the table below. Additionally, the level of any transmitter emission shall not exceed the level of the transmitter's fundamental emission.

General Field Strength Limits for License-Exempt Transmitters at Frequencies above 30 MHz

Frequency (MHz)	*Field Strength (µV/m at 3 m)*
30 to 88	100
88 to 216	150
216 to 960	200
Above 960	500

12.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure ii, the emissions from the EUT were measured on a spectrum analyzer / EMI receiver.

Radiated electromagnetic emissions from the EUT are checked first by preview scans. Preview scans for all spectrum and modulation characteristics are checked, using a peak detector and where applicable worst-case determined for function, operation, orientation, etc. for both vertical and horizontal polarisations. Pre-scan plots are shown with a peak detector and 100 kHz RBW.

If the EUT connects to auxiliary equipment and is table or floor standing, the configurations prescribed in ANSI C63.10 are followed. Alternatively, a layout closest to normal use (as declared by the provider) is employed, (see EUT setup photographs for more detail).

Emissions between 30 MHz and 1 GHz are measured using calibrated broadband antennas. Emissions above 1 GHz are characterized using standard gain horn antennas. Pre-amplifiers and filters are used where required. Care is taken to ensure that test receiver resolution bandwidth, video bandwidth and detector type(s) meet the regulatory requirements.

For both horizontal and vertical polarizations, the EUT is then rotated through 360 degrees in azimuth until the highest emission is detected. At the previously determined azimuth the test antenna is raised and lowered from 1 to 4 m in height until a maximum emission level is detected, this maximum value is recorded.

Power values measured on the test receiver / analyzer are converted to field strength, FS, in dBµV/m at the regulatory distance, using:

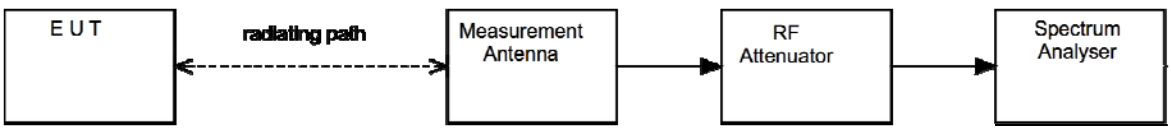
$$FS = PR + CL + AF – PA + DC – CF$$

Where,

PR is the power recorded on the receiver / spectrum analyzer in dBµV;
CL is the cable loss in dB;
AF is the test antenna factor in dB/m;
PA is the pre-amplifier gain in dB (where used);
DC is the duty correction factor in dB (where used, e.g. harmonics of pulsed fundamental);
CF is the distance factor in dB (where measurement distance is different to limit distance);

This field strength value is then compared with the regulatory limit.

Figure ii Test Setup

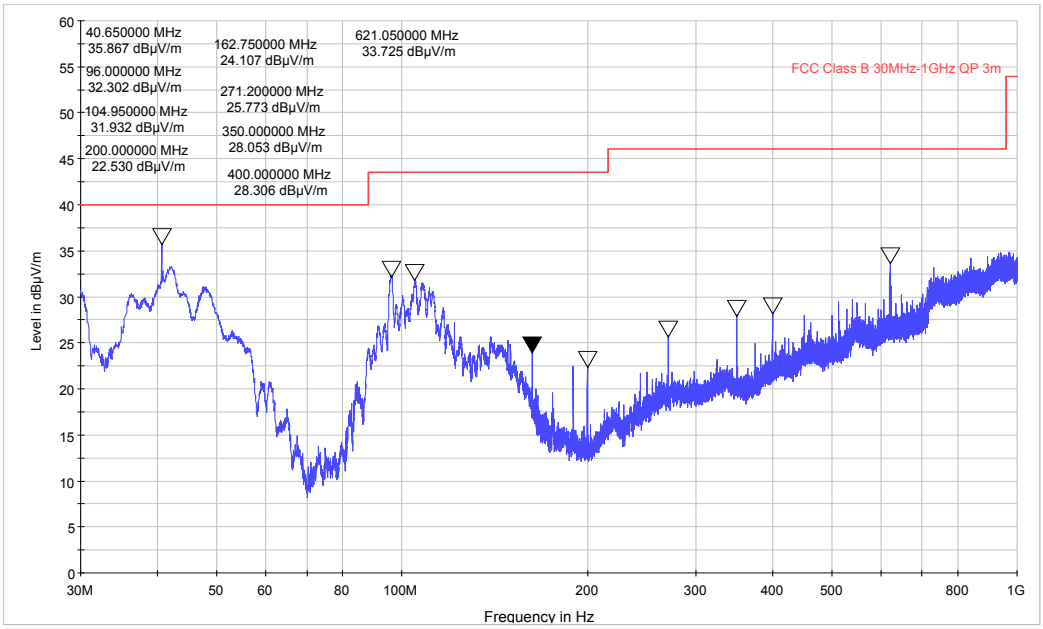


12.5 Test Equipment

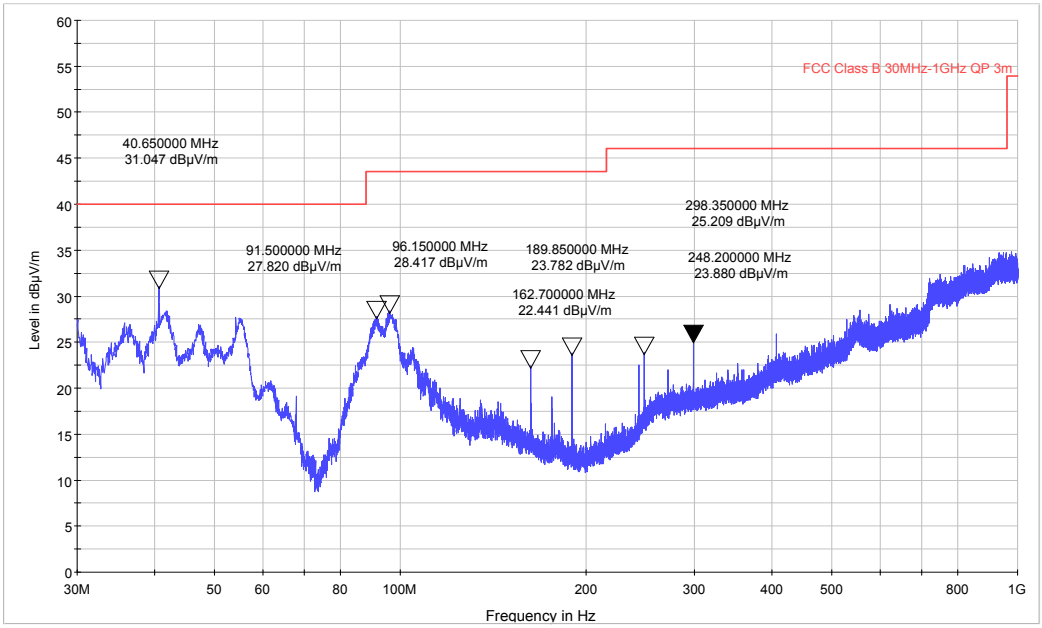
Type of Equipment	Maker/Supplier	Model Number	Element Number	Calibration Due Date
Radio Chamber - PP	Rainford EMC	ATS	REF940	08/09/2016
IC Reg Radio Chamber - PP	Rainford EMC	ATS	REF940	08/09/2017
Bilog	Chase	CBL611/A	UH191	26/02/2016
Receiver	R&S	ESVS10	L317	26/02/2016

12.6 Test Results

Configuration 1



Configuration 2



Configuration 1								
Detector	Freq. (MHz)	Meas'd Emission (dBuV)	Cable Loss (dB)	Antenna Factor (dB/m)	Pre-amp Gain (dB)	Field Strength (dBµV/m)	Field Strength (µV/m)	Limit (µV/m)
Qp	40.7	13.5	1.0	13.3	N/A	27.8	24.5	100.0
Qp	96.0	15.7	1.5	9.9	N/A	27.1	22.5	150.0
Qp	189.9	14.4	2.0	8.6	N/A	25.0	17.7	150.0
Qp	200.0	18.5	1.9	8.3	N/A	28.7	27.4	150.0
Qp	250.0	11.8	2.4	12.1	N/A	26.3	20.6	200.0
Qp	271.2	16.1	1.0	13.3	N/A	30.4	33.0	200.0
Qp	298.4	14.2	2.5	12.9	N/A	29.6	30.1	200.0
Qp	350.0	17.2	2.5	14.2	N/A	33.9	49.6	200.0
Qp	400.0	14.3	2.5	12.9	N/A	29.7	30.4	200.0
Qp	403.1	16.3	2.5	14.2	N/A	33.0	44.7	200.0
Qp	405.1	22.4	2.5	14.2	N/A	39.1	90.3	200.0
Qp	416.1	26.6	2.8	16.2	N/A	45.6	189.9	200.0
Qp	418.5	13.2	2.8	16.4	N/A	32.3	41.3	200.0
Qp	420.9	16.5	2.8	16.2	N/A	35.5	59.4	200.0
Qp	432.1	20.4	2.9	16.0	N/A	39.3	91.9	200.0

Configuration 2								
Detector	Freq. (MHz)	Meas'd Emission (dBuV)	Cable Loss (dB)	Antenna Factor (dB/m)	Pre-amp Gain (dB)	Field Strength (dBµV/m)	Field Strength (µV/m)	Limit (µV/m)
Qp	41.4	7.9	1.0	12.9	N/A	21.8	12.3	100.0
Qp	96.2	14.2	1.5	9.9	N/A	25.6	19.0	150.0
Qp	189.9	16.0	2.0	8.6	N/A	26.6	21.3	150.0
Qp	271.2	14.9	2.2	12.7	N/A	29.8	31.0	200.0
Qp	298.4	14.5	2.5	12.9	N/A	29.9	31.1	200.0
Qp	406.9	13.0	2.7	16.0	N/A	31.8	38.7	200.0
Qp	420.4	8.5	2.8	16.2	N/A	27.5	23.7	200.0
Qp	447.5	9.9	3.0	16.4	N/A	29.3	29.1	200.0

13 AC power-line conducted emissions

13.1 Definition

Line-to-ground radio-noise voltage that is conducted from all of the EUT current-carrying power input terminals that are directly (or indirectly via separate transformers or power supplies) connected to a public power network.

13.2 Test Parameters

Test Location:	Element North West
Test Chamber:	UH390
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.2
EUT Channels / Frequencies Measured:	13.56 MHz
Deviations From Standard:	None
Measurement BW:	10 kHz
Measurement Detectors:	Quasi-Peak and Average, RMS

Environmental Conditions (Normal Environment)

Temperature: 22 °C	+15 ºC to +35 ºC (as declared)
Humidity: 34 % RH	20 % RH to 75 % RH (as declared)
Supply: 110 Vac	110 Vac ±10 % (as declared)

13.3 Test Limit

A radio apparatus that is designed to be connected to the public utility (AC) power line shall ensure that the radio frequency voltage, which is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz, shall not exceed the limits in Table 3.

Table 3 – AC Power Line Conducted Emission Limits

Frequency (MHz)	***Conducted limit (dBµV)***	
	Quasi-Peak	***Average***
0.15 to 0.5	66 to 56*	56 to 46*
0.5 to 5	56	46
5 to 30	60	50

*The level decreases linearly with the logarithm of the frequency.
**A linear average detector is required.

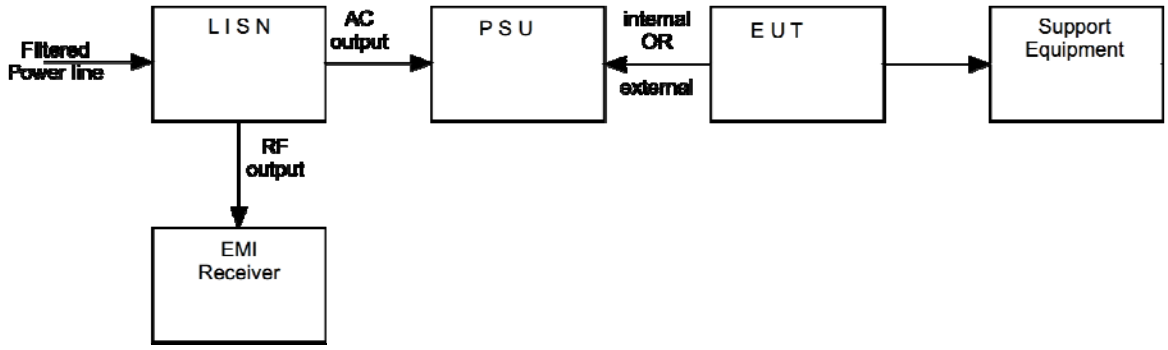
13.4 Test Method

With the EUT setup in a screened room, as per section 9 of this report and connected as per Figure iii, the power line emissions were measured on a spectrum analyzer / EMI receiver.

AC power line conducted emissions from the EUT are checked first by preview scans with peak and average detectors covering both live and neutral lines. A spectrum analyzer is used to determine if any periodic emissions are present.

Formal measurements using the correct detector(s) and bandwidth are made on frequencies identified from the preview scans. Final measurements were performed with EUT set at its maximum duty in transmit and receive modes.

Figure iii Test Setup



13.5 Test Equipment

Type of Equipment	*Maker/Supplier*	*Model Number*	*Element Number*	*Calibration Due Date*
Receiver	R&S	ESHS10	UH187	29/10/2016
Lisn	R&S	EN216	UH396	01/07/2016

13.6 Test Set-up Photograps

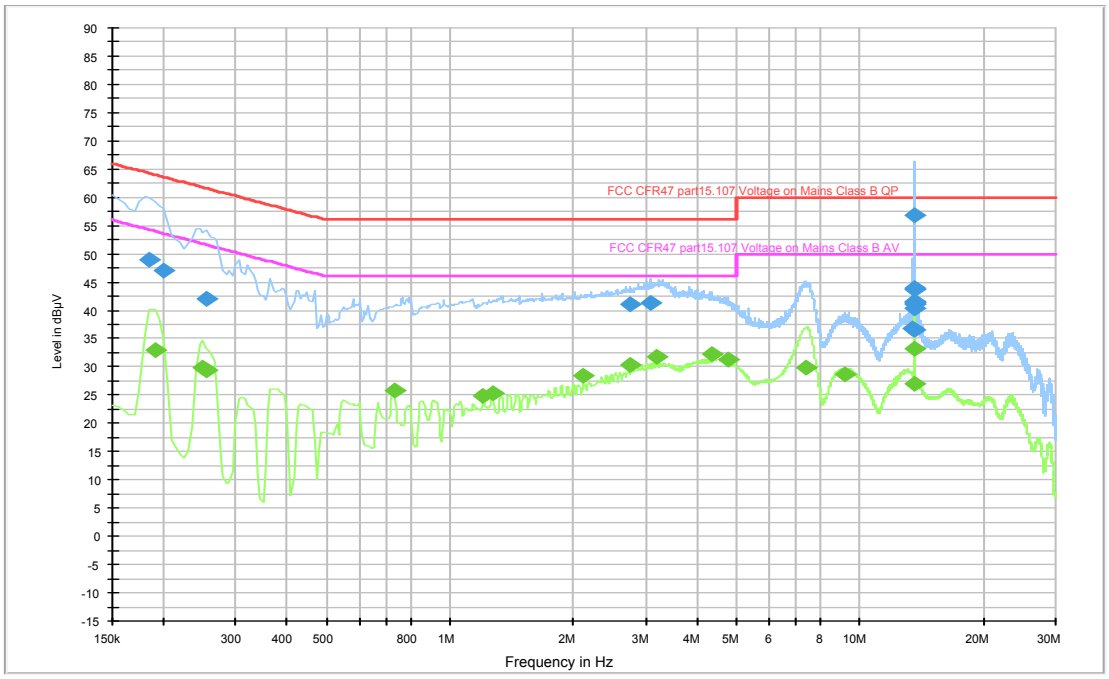
Configuration 1

Configuration 2

13.7 Test Results

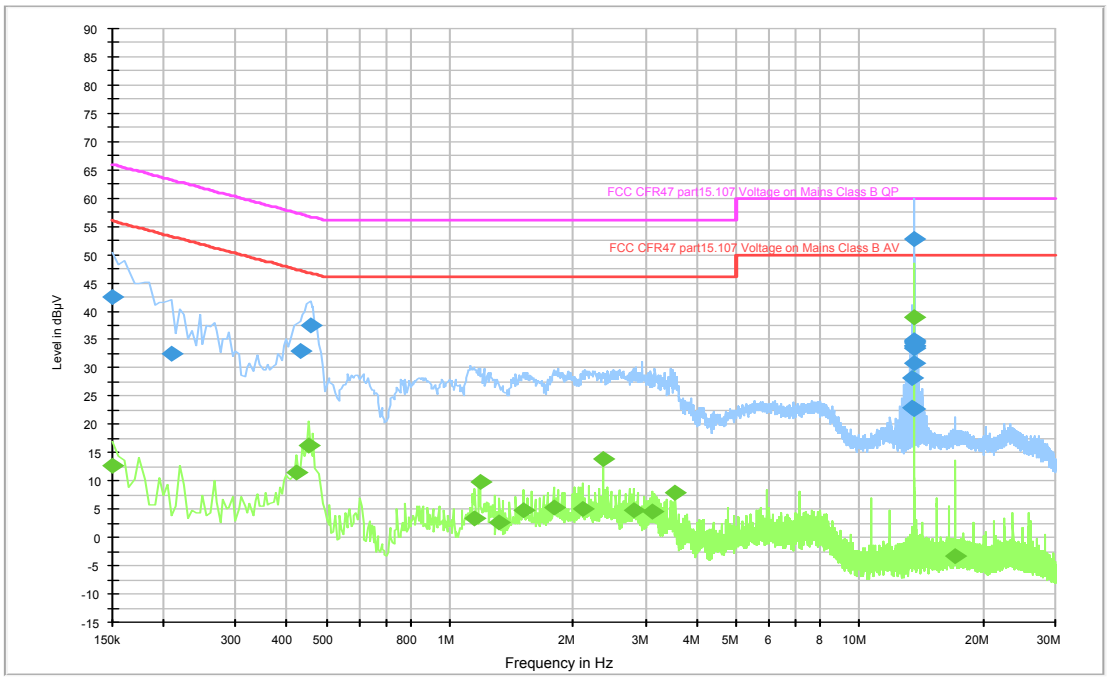
Configuration 1

Conducted emissions on Mains 9kHz-30MHz ESHS10 + UH396



Configuration 2

Conducted emissions on Mains 9kHz-30MHz ESHS10 + UH396



Configuration 1						
Results measured using the average detector						
Reference Number	Frequency (MHz)	Conductor	Result (dBuV)	Specification Limit (dBuV)	Margin (dB)	Result Summary
1.	2.115000	N	28.5	46.0	17.5	PASS
2.	2.735000	N	30.3	46.0	15.7	PASS
3.	3.205000	N	31.7	46.0	14.3	PASS
4.	4.335000	N	32.2	46.0	13.8	PASS
5.	4.755000	N	31.2	46.0	14.8	PASS
6.	13.565000	N	33.1	50.0	16.9	PASS
Results measured using the quasi-peak detector						
Reference Number	Frequency (MHz)	Conductor	Result (dBuV)	Specification Limit (dBuV)	Margin (dB)	Result Summary
1.	0.185000	L1	48.9	64.3	15.3	PASS
2.	0.200000	L1	47.1	63.6	16.5	PASS
3.	0.255000	L1	42.0	61.6	19.6	PASS
4.	2.750000	N	41.2	56.0	14.8	PASS
5.	3.085000	N	41.4	56.0	14.6	PASS
6.	13.510000	L1	40.3	60.0	19.7	PASS
7.	13.520000	L1	41.6	60.0	18.4	PASS
8.	13.540000	L1	41.3	60.0	18.7	PASS
9.	13.565000	N	56.9	60.0	3.1	PASS
10.	13.575000	N	43.7	60.0	16.3	PASS
11.	13.585000	L1	44.0	60.0	16.0	PASS
12.	13.595000	N	41.1	60.0	18.9	PASS
13.	13.610000	N	41.2	60.0	18.8	PASS

Configuration 2						
Results measured using the average detector						
Reference Number	Frequency (MHz)	Conductor	Result (dBuV)	Specification Limit (dBuV)	Margin (dB)	Result Summary
1.	13.565000	L1	39.0	50	11	PASS
Results measured using the quasi-peak detector						
Reference Number	Frequency (MHz)	Conductor	Result (dBuV)	Specification Limit (dBuV)	Margin (dB)	Result Summary
1.	0.455000	L1	37.4	56	18.6	PASS
2.	13.565000	N	52.7	56	3.3	PASS

14 Occupied Bandwidth

14.1 Definition

Occupied bandwidth
The width of a frequency band such that, below the lower and above the upper frequency limits, the mean powers emitted are each equal to 0.5 % of the emitted power. This is also known as the *99 % emission bandwidth*.

20 dB bandwidth
The emission bandwidth (x dB) is defined as the frequency range between two points, one above and one below the carrier frequency, at which the spectral density of the emission is attenuated x dB below the maximum in-band spectral density of the modulated signal.

14.2 Test Parameters

Test Location:	Element North West
Test Chamber:	Radio Lab
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.9
EUT Channels / Frequencies Measured:	13.56 MHz
Deviations From Standard:	None

Environmental Conditions (Normal Environment)

Temperature: 25 °C	+15 ºC to +35 ºC (as declared)
Humidity: 38 % RH	20 % RH to 75 % RH (as declared)
Supply: 110 Vac	110 Vac ±10 % (as declared)

14.3 Test Limit

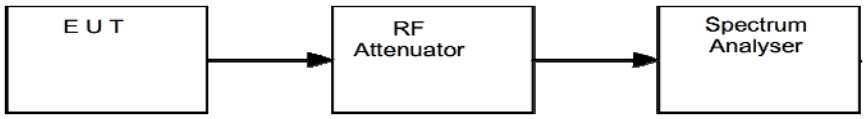
Industry Canada:
When the occupied bandwidth limit is not stated in the applicable RSS or reference measurement method, the transmitted signal bandwidth shall be reported as the 99 % emission bandwidth, as calculated or measured.

Federal Communications Commission:
Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§ 15.217 through 15.257 and in subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated.

14.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure iv, the bandwidth of the EUT was measured on a spectrum analyser. The measurements were performed with EUT set at its maximum duty. All modulation schemes, data rates and power settings were used to observe the worst-case configuration in each bandwidth.

Figure iv Test Setup

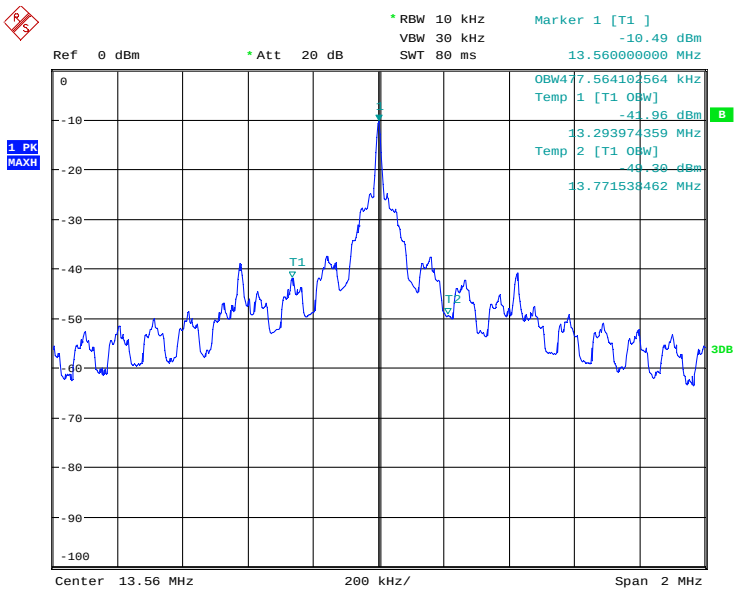


14.5 Test Equipment

Type of Equipment	Maker/Supplier	Model Number	Element Number	Calibration Due Date
Spectrum Analyser	R&S	FSU26	REF909	13/02/2016

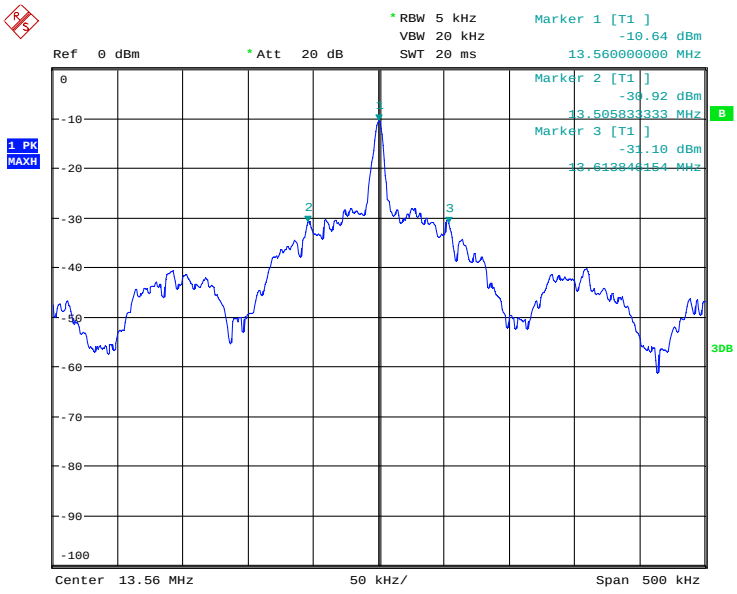
14.6 Test Results

RSS-210			
Channel Frequency (MHz)	F_L (MHz)	F_H (MHz)	99 % Bandwidth (kHz)
13.56	13.293974	13.771538	477.564



Date: 4.DEC.2015 16:40:11

15.225			
Channel Frequency (MHz)	F_L (MHz)	F_H (MHz)	20 dB Bandwidth (kHz)
13.56	13.505833	13.613846	108.013



Date: 4.DEC.2015 16:48:35

15 Transmitter output power (fundamental radiated emission)

15.1 Definition

The RF power dissipated in the standard output termination when operating under the rated duty cycle selected by the applicant for approval.

15.2 Test Parameters

Test Location:	Element North West
Test Chamber:	REF940
Test Antenna:	Active 60cm loop
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.3 / 6.4
EUT Channels / Frequencies Measured:	13.56 MHz
Deviations From Standard:	None
Measurement BW:	9 kHz
Measurement Detector:	Quasi-peak
Voltage Extreme Environment Test Range:	Mains Power = 85% and 115% of Nominal (FCC only requirement); Battery Power = new battery.

Environmental Conditions (Normal Environment)

Temperature: 20 °C	+15 ºC to +35 ºC (as declared)
Humidity: 34 % RH	20 % RH to 75 % RH (as declared)

15.3 Test Limit

The field strength measured at 30 m shall not exceed the limits in the following table:

Field Strength Limits for License-Exempt Transmitters for Any Application

Frequency range (MHz)	*Field strength (µV/m at 30m)*	*Field strength (dBµV/m at 30m)*
13.110 – 13.410	106	40.5
13.410 – 13.553	334	50.5
13.553 – 13.567	15,848	84.0
13.567 – 13.710	334	50.5
13.710 – 14.010	106	40.5

15.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure v, the resolution bandwidth of the spectrum analyser was increased above the EUT occupied bandwidth and the peak emission data noted.

The measurements were performed with EUT set at its maximum duty. All modulation schemes, data rates and power settings were used to observe the worst-case configuration in each bandwidth.

Power values measured on the test receiver / analyzer are converted to field strength, FS, in µV/m at the regulatory distance, using:

$$FS = 10^{(PR - CF) / 20}$$

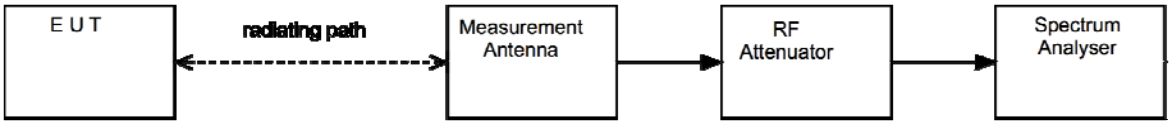
Where,

PR is the power recorded on the receiver / spectrum analyzer in dBµV and includes any cable loss, antenna factor and pre-amplifier gain;

CF is the distance extrapolation factor in dB (where measurement distance different to limit distance);

This field strength value is then compared with the regulatory limit.

Figure v Test Setup



15.5 Test Equipment

Type of Equipment	*Maker/Supplier*	*Model Number*	*Element Number*	*Calibration Due Date*
Loop Antenna	R&S	hfh2	L007	10/04/2017
Receiver	R&S	ESHS10	UH003	25/06/2016
Spectrum Analyser	R&S	FSU26	REF909	13/02/2016

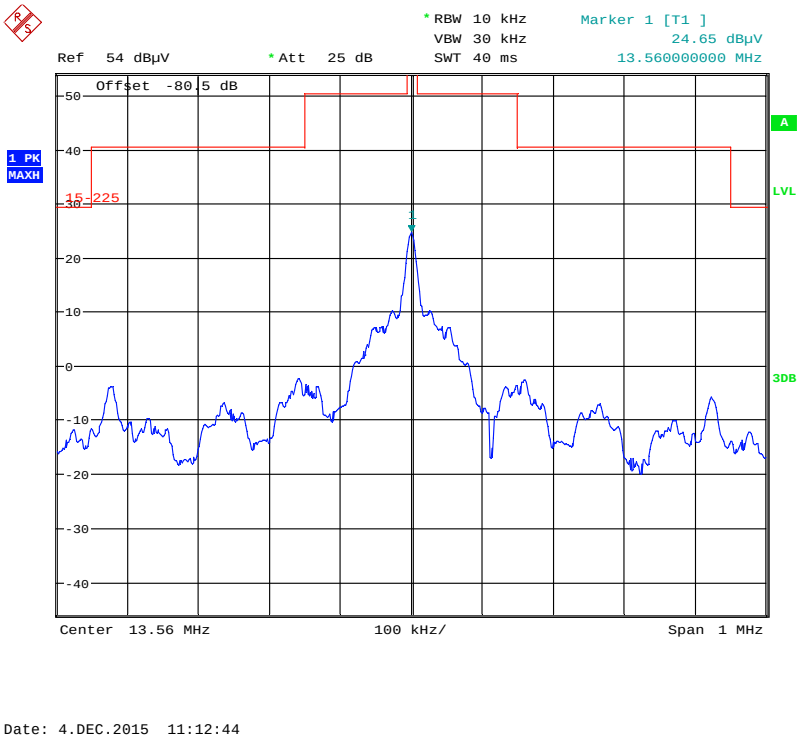
15.6 Test Results

Channel Freq. (MHz)	Receiver Level (dBµV/m)	Measurement Distance (m)	Limit Distance (m)	Extrapolation Factor (dB)	Field Strength (dBµV/m)	Field Strength (µV/m)	Result
13.56	62.30	3	30	37.88	24.42	16.63	PASS
13.56	43.50	10	30	19.08	24.42	16.63	PASS

Notes:

1. Results quoted are extrapolated as indicated
2. Extrapolation <30 MHz 40dB/decade as per 15.31(f)(2) & RSS-Gen 6.4
3. 10 – 30 metre extrapolation 19.08 dB (40dB/decade)
4. 3 – 10 metre extrapolation as measured (18.8 dB)
5. 3 – 30 metre extrapolation 37.88 dB

Emission Mask



16 Frequency stability

16.1 Definition

Frequency stability is a measure of frequency drift due to temperature and supply voltage variations, with reference to the frequency measured at an appropriate reference temperature and the rated supply voltage.

16.2 Test Parameters

Test Location:	Element North West
Test Chamber:	Radio Lab
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.8
Channels / Frequencies Measured:	13.56 MHz
Modulation:	Off
Deviations From Standard:	None
Temperature Extreme Environment Test Range:	-20 to +50 C
Voltage Extreme Environment Test Range:	Mains Power = ±15% of Nominal; IC: Battery: nominal and end point; FCC: Battery: new battery.

Environmental Conditions (Normal Environment)

Temperature: 20 °C	Standard Requirement: +20 ºC
Humidity: 38 %RH	20 % RH to 75 % RH (as declared)

16.3 Test Limit

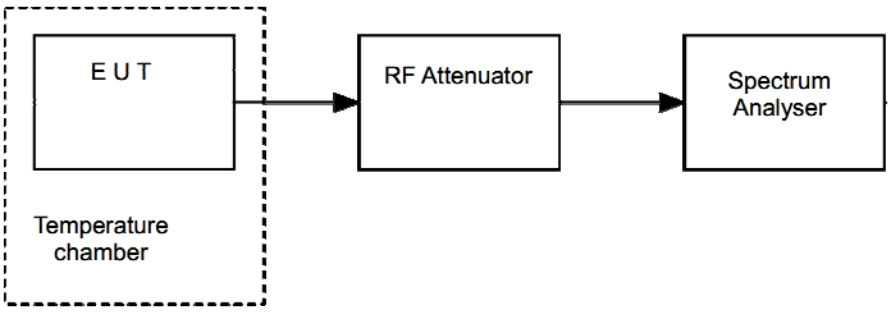
Carrier frequency stability shall be maintained to ±0.01% (±100 ppm) = ±1.356 kHz

16.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure v, the frequency was measured under varying conditions of temperature and supply voltage.

The measurements were performed with EUT set in a CW mode of operation.

Figure v Test Setup



16.5 Test Equipment

Type of Equipment	Maker/Supplier	Model Number	Element Number	Calibration Due Date
Spectrum Analyser	R&S	FSU26	REF909	13/02/2016
Multimeter	Agilent	34405a	REF976	03/06/2016
Temperature Indicator	Fluke	52 Series II	L426	30/05/2016
PSU	Thandar	-	UH100	Cal with REF976
Temp Chamber	Sharetree	-	L011	Cal with L426

16.6 Test Results

Test Conditions		Measured Frequency (MHz)	Drift (kHz)
T_{nom}	V_{nom}	13.560042	N/A
T_{nom}	V_{min}	13.560046	0.005
T_{nom}	V_{max}	13.560044	0.002
T_{max}	V_{nom}	13.559911	-0.131
T_{min}	V_{nom}	13.560069	0.027

17 Measurement Uncertainty

Calculated Measurement Uncertainties

All statements of uncertainty are expanded standard uncertainty using a coverage factor of 1.96 to give a 95 % confidence:

[1] Radiated emissions below 30 MHz

Uncertainty in test result (9 kHz to 30 MHz) = **2.3 dB**

[2] Spurious emissions

Uncertainty in test result (30 MHz to 1 GHz) = **4.6 dB**
Uncertainty in test result (1 GHz to 18 GHz) = **4.7 dB**

[3] AC power line conducted emissions

Uncertainty in test result = **3.4 dB**

[4] Occupied bandwidth

Uncertainty in test result = **15.5 %**

[5] Maximum frequency error

Uncertainty in test result (Power Meter) = **0.113 ppm**
Uncertainty in test result (Spectrum Analyser) = **0.265 ppm**

18 RF Exposure

Section 4.3 General SAR test reduction and exclusion guidance

For Standalone SAR exclusion consideration, when SAR Exclusion Threshold requirement in KDB 447498 is satisfied, standalone SAR evaluation for general population exposure conditions by measurement or numerical simulation is not required.

The SAR Test Exclusion Threshold for frequency range below 100 MHz will be determined as follows.

SAR Exclusion Threshold (SARET) = (Step 1 + Step 2) * Step 3

Step 1

$$NT = [(MP/TSD^{A}) * \sqrt{f_{GHz}}]$$

NT = Numeric Threshold (3.0 for 1-g SAR and 7.5 for 10-g SAR)

MP = Max Power of channel (mW) (including tune-up tolerance)

TSD^{A} = Min Test separation Distance or 50mm (whichever is lower) = 5mm (in this case)

We can transpose this formula to allow us to find the maximum power of a channel allowed and compare this to the measured maximum power.

$$= [(NT \times TSD^{A}) / \sqrt{f_{GHz}}]$$

For Distances Greater than 50 mm Step 2 applies

Step 2

$$(TSD^{B} – 50mm) * 10$$

Where:

TSD^{B} = Min Test separation Distance (mm) = 50

Note: Step 2 doesn't apply here as the TSD^{A} is less than 50 mm

Step 3

a) the power threshold at the corresponding test separation distance at 100 MHz in step 2 is multiplied by [1 + log (100/ f_{MHz}))] for test separation distances > 50 mm and < 200 mm

b) the power threshold determined by the equation in steps 1 for 50 mm and 100 MHz is multiplied by ½ for test separation distances ≤ 50 mm

SARET = $[(NT \times TSD^{A}) / \sqrt{f_{GHz}}] * {}^{1}/_{2}$
SARET = $[(3.0 \times 50) / \sqrt{0.1}] * {}^{1}/_{2}$
SARET = 474.34 mW

Channel Frequency (MHz)	EIRP (mW)	SAR Exclusion Threshold (mW)	SAR Evaluation
13.56	9.22×10^{-7}	474.34	Not Required

Therefore standalone SAR evaluation for general population exposure conditions by measurement or numerical simulation is not required.

Prediction of MPE limit at a given distance

$$S = \frac{EIRP}{4\pi R^2} \quad \text{re - arranged} \qquad R = \sqrt{\frac{EIRP}{S\ 4\pi}}$$

Where:

S = power density
R = distance to the centre of radiation of the antenna
EIRP = EUT Maximum power

Note: The EIRP value was calculated using the E-Field measurement.

FCC Result

Prediction Frequency (MHz)	Maximum EIRP (mW)	Power density limit (S) (mW/cm^2)	Distance (R) cm required to be less than 0.98 mW/cm^2
13.56	9.22×10^{-7}	0.98	0.00028

IC Result

Prediction Frequency (MHz)	Maximum EIRP (W)	Exemption limit (W)	RF Exposure calculation
13.56	9.22×10^{-10}	1.00	Not Required