

Report on the Radio Testing

For

SigFox SA

on

Mini Base Station

Report no. TRA-027724-47-01-A

10/03/2016

RF916 3.0



Report Number: TRA-027724-47-01-A  
Issue: A

REPORT ON THE RADIO TESTING OF A  
SigFox SA  
Mini Base Station SMBS-T  
WITH RESPECT TO SPECIFICATION  
FCC 47CFR 15.247 & IC RSS-247

TEST DATE: Test Date 10/01/2016

Written by: S Hodgkinson

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Approved by:

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Date:

10/03/2016

Disclaimers:

- [1] THIS DOCUMENT MAY BE REPRODUCED ONLY IN ITS ENTIRETY AND WITHOUT CHANGE
- [2] THE RESULTS CONTAINED IN THIS DOCUMENT RELATE ONLY TO THE ITEM(S) TESTED

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RF916 3.0



## 1 Revision Record

<b><i>Issue Number</i></b>	<b><i>Issue Date</i></b>	<b><i>Revision History</i></b>
A	10/03/2016	Original

## 2 Summary

TEST REPORT NUMBER: TRA-027724-47-01-A

WORKS ORDER NUMBER TRA-027724-01

PURPOSE OF TEST: USA: Testing of radio frequency equipment per the relevant authorization procedure of chapter 47 of CFR (code of federal regulations) Part 2, subpart J.  
Canada: Testing of radio apparatus for TAC (technical acceptance certificate) per subsections 4(2) of the Radio communication Act and 21(1) of the Radio communication Regulations.

TEST SPECIFICATION(S): 47CFR15.247 & RSS-247

EQUIPMENT UNDER TEST (EUT): Mini Base Station SMBS-T

FCC IDENTIFIER: 2ACK7SMBST

IC IDENTIFIER 12204A-SMBST

EUT SERIAL NUMBER: Sample 1

MANUFACTURER/AGENT: SigFox SA

ADDRESS: 425 Rue Jean Rostand  
Labège  
31670

CLIENT CONTACT: Patrick Antoine  
  
 patrick.antoine@sigfox.com

ORDER NUMBER: 20150802330

TEST DATE: Test Date 10/01/2016

TESTED BY: S Hodgkinson

## 2.1 Test Summary

<b>Test Method and Description</b>	<b>Requirement Clause</b>		<b>Applicable to this equipment</b>	<b>Result / Note</b>
	<b>RSS</b>	<b>47CFR15</b>		
Radiated spurious emissions (restricted bands of operation and cabinet radiation)	Gen, 8.10	15.205	<input checked="" type="checkbox"/>	Pass
AC power line conducted emissions	Gen, 8.8	15.207	<input checked="" type="checkbox"/>	Pass
Carrier frequency separation	247, 5.1 (2)	15.247(a)(1)	<input checked="" type="checkbox"/>	Pass
Number of hopping channels	247, 5.1 (3), (4) and (5)	15.247(a)(1) (i), (ii) and (iii)	<input checked="" type="checkbox"/>	Pass
Average time of occupancy	247, 5.1 (3), (4) and (5)	15.247(a)(1) (i), (ii) and (iii)	<input checked="" type="checkbox"/>	Pass
Maximum peak conducted output power	247, 5.4 (1), (2) and (3)	15.247 (a)(1), (b)(1) and (b)(2)	<input checked="" type="checkbox"/>	Pass
20dB emission bandwidth	247, 5.1 (1)	15.247(a)(1) (i) and (ii)	<input checked="" type="checkbox"/>	Pass
Out-of-band emissions	247, 5.5	15.247(d)	<input checked="" type="checkbox"/>	Pass
Unintentional Radiated Emissions	RSS-Gen issue 4(7.1)	15.107	<input checked="" type="checkbox"/>	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

1	Revision Record.....	3
2	Summary.....	4
2.1	Test Summary.....	5
3	Contents.....	6
4	Introduction .....	8
5	Test Specifications.....	9
5.1	Normative References .....	9
5.2	Deviations from Test Standards .....	9
6	Glossary of Terms.....	10
7	Equipment Under Test .....	11
7.1	EUT Identification.....	11
7.2	System Equipment.....	11
7.3	EUT Mode of Operation .....	11
7.3.1	Transmission.....	11
7.3.2	Reception .....	11
7.4	EUT Radio Parameters .....	12
7.4.1	General .....	12
7.4.2	Antennas .....	12
7.4.3	Product specific declarations.....	13
7.5	EUT Description .....	13
8	Modifications .....	14
9	EUT Test Setup .....	15
9.1	Block Diagram.....	15
9.2	General Set-up Photograph .....	16
10	General Technical Parameters.....	17
10.1	Normal Conditions.....	17
11	Radiated emissions.....	18
11.1	Definitions .....	18
11.2	Test Parameters.....	18
11.3	Test Limit.....	18
11.4	Test Method .....	19
11.5	Test Set-up Photograph .....	20
11.6	Test Equipment.....	21
11.7	Test Results .....	22
12	AC power-line conducted emissions .....	26
12.1	Definition .....	26
12.2	Test Parameters.....	26
12.3	Test Method .....	27
12.4	Test Set-up Photograph .....	27
12.5	Test Equipment.....	28
12.6	Test Results .....	29
13	Carrier frequency separation.....	33
13.1	Definition .....	33
13.2	Test Parameters.....	33
13.3	Test Limit.....	33
13.4	Test Method .....	34
13.5	Test Equipment.....	34
13.6	Test Results .....	35
14	Number of hopping frequencies .....	36
14.1	Definition .....	36
14.2	Test Parameters.....	36
14.3	Test Limit.....	36
14.4	Test Method .....	37
14.5	Test Equipment.....	37
14.6	Test Results .....	37
15	Average channel occupancy .....	39
15.1	Definition .....	39
15.2	Test Parameters.....	39
15.3	Test Limit.....	39
15.4	Test Method .....	40
15.5	Test Equipment.....	40
15.6	Test Results .....	40
16	Maximum peak conducted output power.....	42

16.1	Definition .....	42
16.2	Test Parameters.....	42
16.3	Test Limit.....	42
16.4	Test Method .....	43
16.5	Test Equipment.....	43
16.6	Test Results .....	43
17	Occupied Bandwidth .....	44
17.1	Definition .....	44
17.2	Test Parameters.....	44
17.3	Test Limit.....	44
17.4	Test Method .....	45
17.5	Test Equipment.....	45
17.6	Test Results .....	45
18	Out-of-band and conducted spurious emissions .....	47
18.1	Definition .....	47
18.2	Test Parameters.....	47
18.3	Test Limits.....	47
18.4	Test Method .....	48
18.5	Test Equipment.....	48
18.6	Test Results .....	53
19	Radiated emissions – unintentional radiation / receiver emissions .....	54
19.1	Definitions .....	54
19.2	Test Parameters.....	54
19.3	Test Limit.....	54
19.4	Test Method .....	55
19.5	Test Set-up Photograph.....	55
19.6	Test Equipment.....	56
19.7	Test Results .....	57
20	Measurement Uncertainty .....	61

## 4 Introduction

This report TRA-027724-47-01-A presents the results of the Radio testing on a SigFox SA, Mini Base Station to specification 47CFR15 Radio Frequency Devices and RSS-247 Licence-exempt Radio Apparatus (All Frequency Bands): Category I Equipment.

The testing was carried out for SigFox SA by Element, at the address(es) detailed below.

<input type="checkbox"/> Element Hull Unit E South Orbital Trading Park Hedon Road Hull HU9 1NJ UK	<input checked="" type="checkbox"/> Element North West Unit 1 Pendle Place Skemersdale West Lancashire WN8 9PN UK
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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 Hull	3483A
Element North West	3930B

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

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-247, Issue 1, May 2015 – Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices
- 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

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

## 7 Equipment Under Test

### 7.1 EUT Identification

- Name: Mini Base Station
- Serial Number: Sample1
- Model Number: SMBS-T
- Software Revision: 0.0.3
- Build Level / Revision Number: 1.0.0.A

### 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.

Sample No.	Description	Identification
S01	Vostro Laptop	N/A
S02	screened Ethernet cable	N/A
S04	Screened Ethernet Cable	N/A
S08	Screened Ethernet Cable	N/A
S09	POE +Gigabit	N/A
S15	Antenna CXL 900-3LW/H	N/A
S22	USB Memory Stick	N/A
S23	USB Memory Stick	N/A

### 7.3 EUT Mode of Operation

#### 7.3.1 Transmission

The mode of operation for Tx tests was as follows...

Test	Description of Operating Mode
All tests detailed in this report	EUT Transmitting a modulated carrier at top, middle or bottom frequency or hopping as required

Test	Description of Operating Mode:
PLCE	ETU hopping across all channels in either TX or RX mode.

#### 7.3.2 Reception

The mode of operation for Rx tests was as follows...

Test	Description of Operating Mode:
Receiver conducted and radiated (ERP) spurious emissions	EUT active but non-transmitting.

## 7.4 EUT Radio Parameters

### 7.4.1 General

<b>Frequency of operation:</b>	902MHz-928MHz
<b>Occupied channel bandwidth(s):</b>	178.044kHz
<b>Channel spacing:</b>	200kHz
<b>Modulation:</b>	DBPSK modulated
<b>ITU emission designator(s):</b>	180KB7D
<b>Simplex/Duplex</b>	Semi Duplex (TDD, No full duplex)
<b>Declared output power(s):</b>	Max +36 E.I.R.P
<b>Nominal Supply Voltage:</b>	40-45Vdc via POE
<b>Location of notice for license exempt use:</b>	Label / user manual / both.
<b>Duty cycle:</b>	2%

### 7.4.2 Antennas

<b>Type:</b>	CXL 900-3LW/h
<b>Frequency range:</b>	824-960MHz
<b>Impedance:</b>	50Ω
<b>SWR:</b>	≤1.5
<b>Gain:</b>	5 dBi
<b>Polarisation:</b>	Vertical
<b>Beam width:</b>	Half power beamwidth = 30°
<b>Connector type:</b>	N- Type
<b>Length:</b>	700mm
<b>Weight:</b>	660 g
<b>Environmental limits:</b>	-30°C - +70°C
<b>Mounting:</b>	On 16 to 54 mm dia mast tube

#### 7.4.3 Product specific declarations

<b>Multiple antenna configuration(s), e.g. MIMO:</b>	<b>N/A</b>
<b>Fixed pt-pt operations (yes/no):</b>	<b>N/A</b>
<b>Installation manual advice on pt-pt operational restrictions (yes/no):</b>	<b>N/A</b>
<b>Fixed pt-mpt operations (yes/no):</b>	<b>N/A</b>

#### 7.5 EUT Description

The EUT is a FHSS device operating in the 902-928MHz band. The hopping scheme can be selected with software, hopping set1 or hopping set 2.

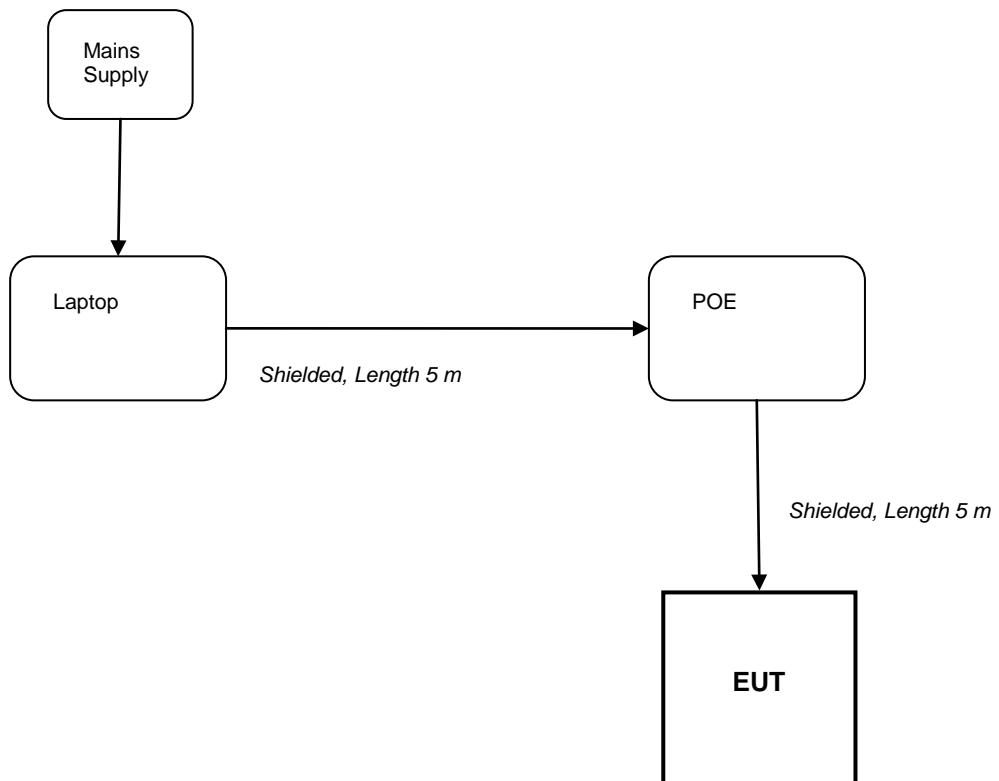
## **8 Modifications**

No modifications were performed during this assessment.

## 9 EUT Test Setup

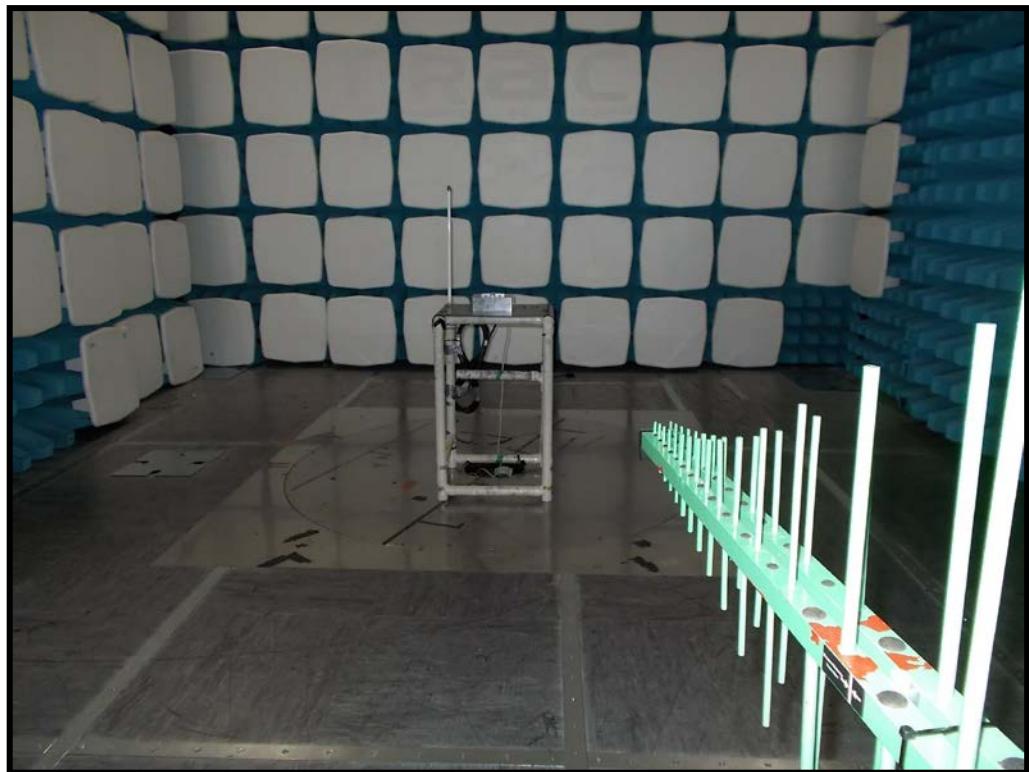
### 9.1 Block Diagram

The following diagram shows basic EUT interconnections with cable type and cable lengths identified:



## 9.2 General Set-up Photograph

The following photograph shows basic EUT set-up:



## 10 General Technical Parameters

### 10.1 *Normal Conditions*

The E U T was tested under the normal environmental conditions of the test laboratory, except where otherwise stated. The normal power source applied was approx. 40Vdc-45Vdc from the POE

There are no specific frequency stability requirements for the type of device. The results contained in this report demonstrate that the occupied bandwidth is contained within the authorised band and the manufacturer has declared sufficient frequency stability (refer to section 7.4).

## 11 Radiated emissions

### 11.1 Definitions

#### *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 / Element Hull
Test Chamber:	Radio Lab
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.5 and 6.6
EUT Channels / Frequencies Measured:	Low / Mid / High
EUT Channel Bandwidths:	178kHz
Deviations From Standard:	None
Measurement BW:	30 MHz to 1 GHz: 120 kHz Above 1 GHz: 1 MHz
Measurement Detector:	Up to 1 GHz: quasi-peak Above 1 GHz: RMS average and Peak

### Environmental Conditions (Normal Environment)

Temperature: 18 °C	+15 °C to +35 °C (as declared)
Humidity: 50 % RH	20 % RH to 75 % RH (as declared)
Supply: 45Vdc	Via POE (as declared)

### 11.3 Test Limit

Unwanted emissions that fall within the restricted frequency bands shall comply with the limits specified:

#### 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

#### 11.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure i, 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 dB $\mu$ V/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 dB $\mu$ V;

CL is the cable loss in dB;

AF is the test antenna factor in dB/m;

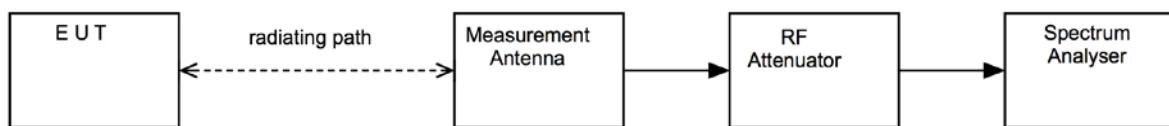
PA is the pre-amplifier gain in dB (where used);

DC is the duty correction factor in dB (where used, e.g. harmonics of pulsed fundamental);

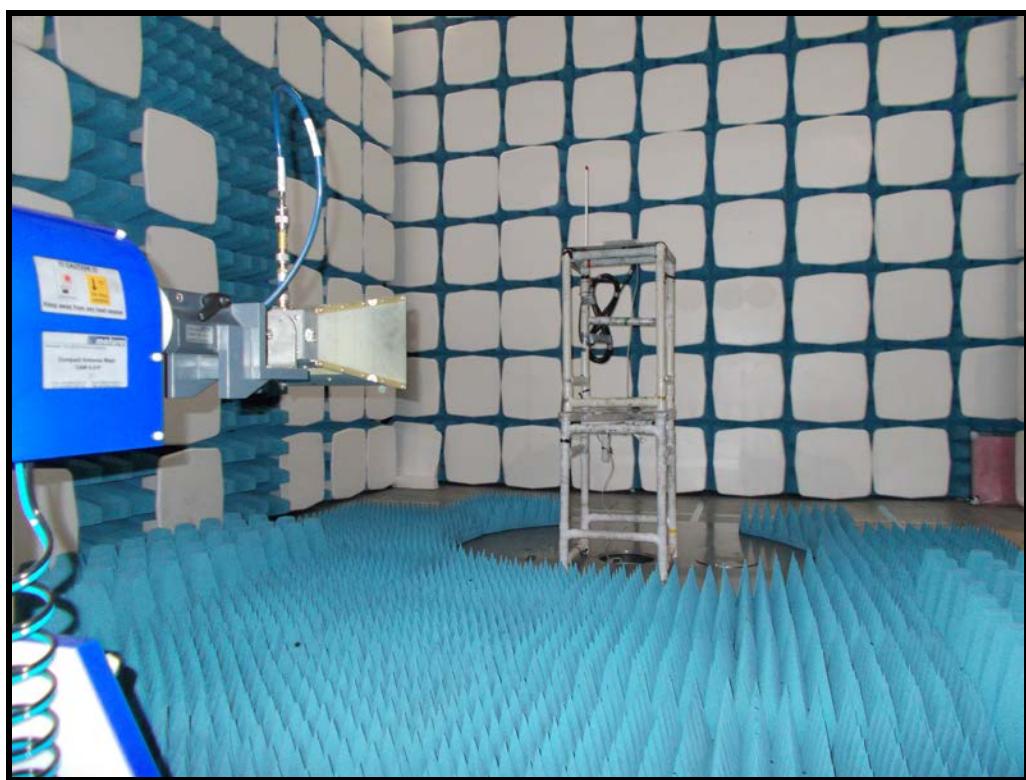
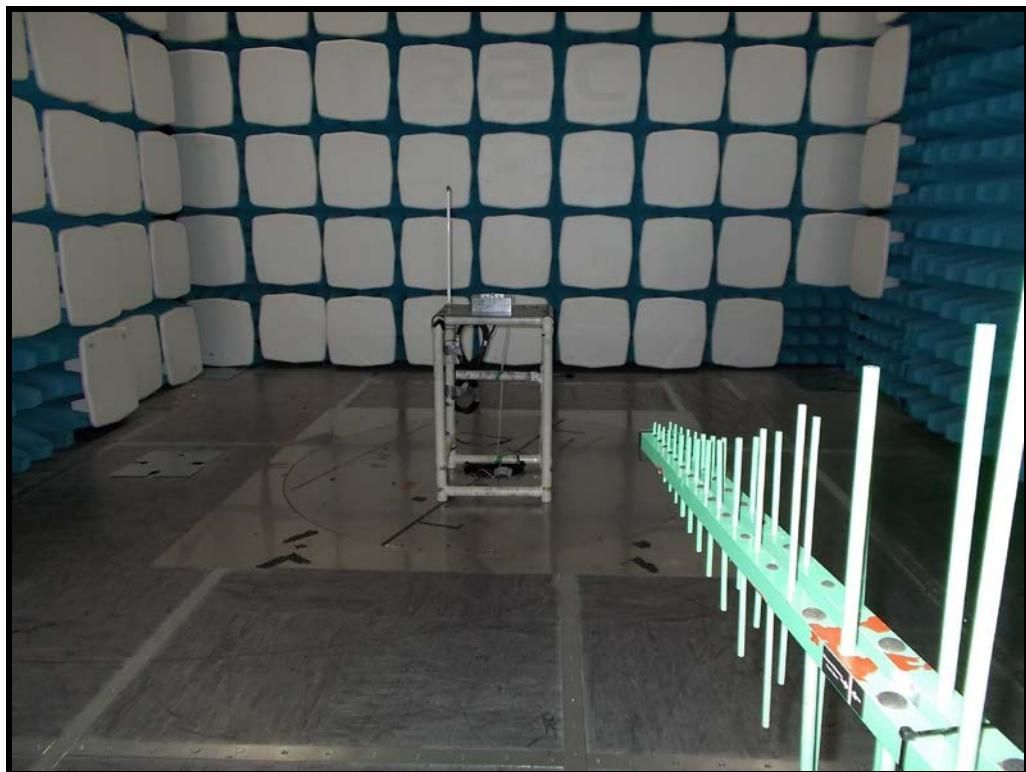
CF is the distance factor in dB (where measurement distance different to limit distance);

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

**Figure i Test Setup**



### 11.5 Test Set-up Photograph

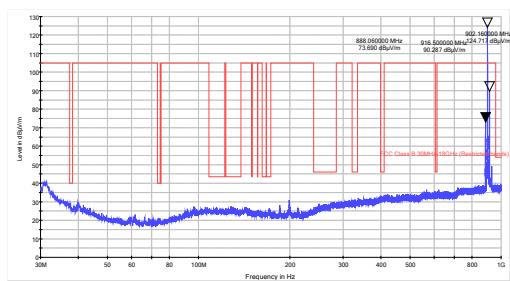




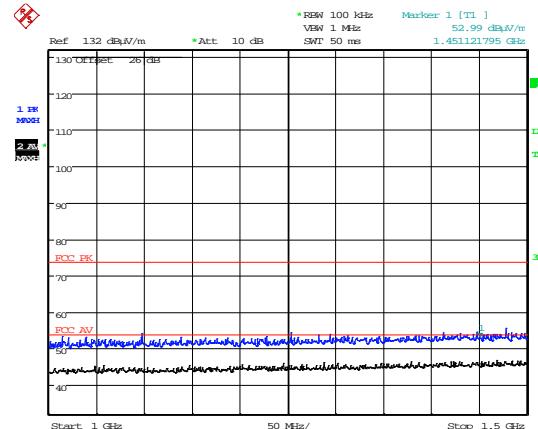
## 11.6 Test Equipment

Element No	Equipment Type	Equipment Description	Manufacturer	Last Cal Calibration	Calibration Period	Due For Calibration
L139	3115	1-18GHz Horn	EMCO	25/09/2015	24	25/09/2017
L352	ESVS10	Receiver	R&S	07/08/2015	12	07/08/2016
U093	CBL6112B	Bilog	Chase	17/06/2015	24	17/06/2017
U281	FSU46	Spectrum Analyser	R&S	24/04/2015	12	24/04/2016
REF940	ATS	Radio Chamber - PP	Rainford EMC	08/09/2014	24	08/09/2016
L572	8449B	Pre Amp	Agilent	16/02/2016	12	16/02/2017
U519	VHF-1500+	High Pass Filter	MiniCircuits	25/02/2015	24	25/02/2017

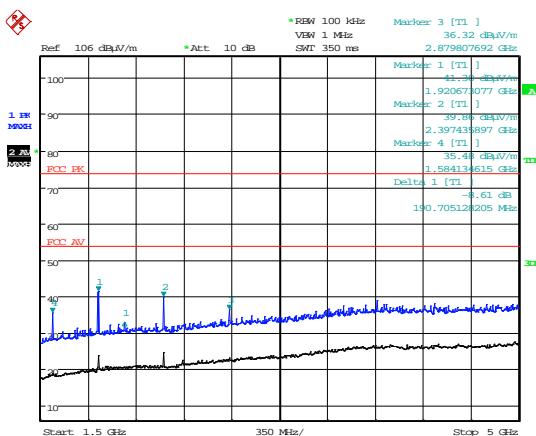
## 11.7 *Test Results*



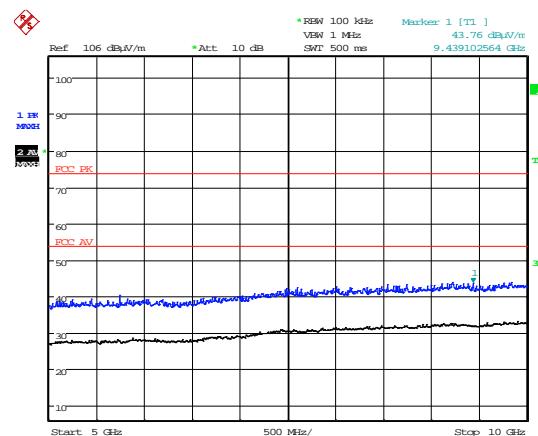
## 1 –Bottom Channel Radiated (30 MHz to 1 GHz).



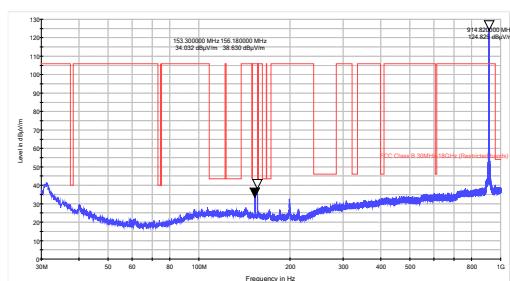
## 2 –Bottom Channel Radiated (1 GHz to 1.5 GHz).



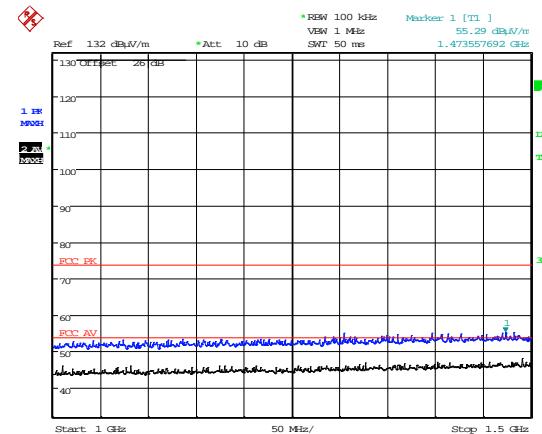
### 3 –Bottom Channel Radiated (1.5 GHz to 5 GHz).



#### 4 –Bottom Channel Radiated (5 GHz to 10 GHz).

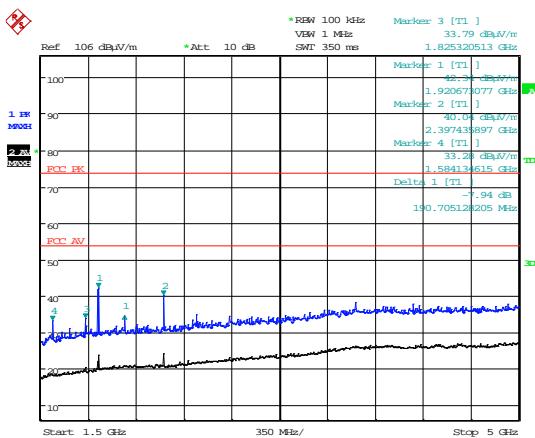


1 –Middle Channel Radiated (30 MHz to 1 GHz).



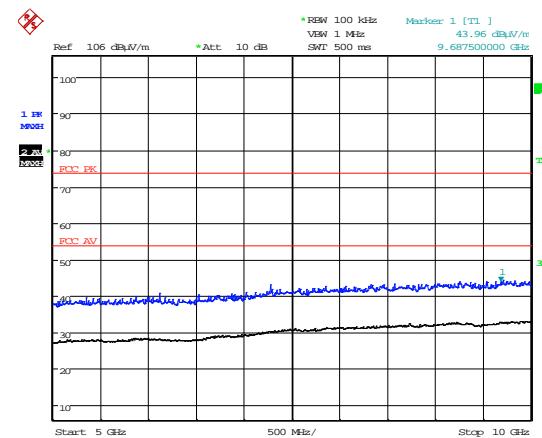
Date: 12.FEB.2016 15:18:17

2 –Middle Channel Radiated (1 GHz to 1.5 GHz).



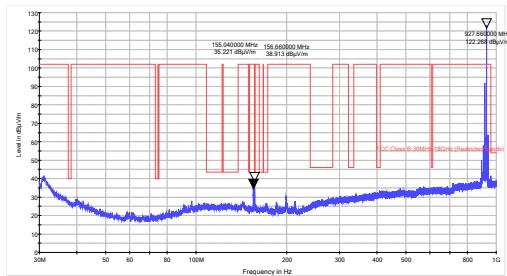
Date: 15.FEB.2016 08:51:13

3 –Middle Channel Radiated (1.5 GHz to 5 GHz).

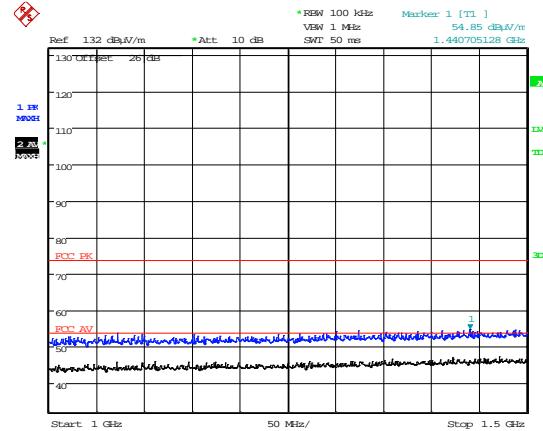


Date: 15.FEB.2016 09:01:30

4 –Middle Channel Radiated (5 GHz to 10 GHz).

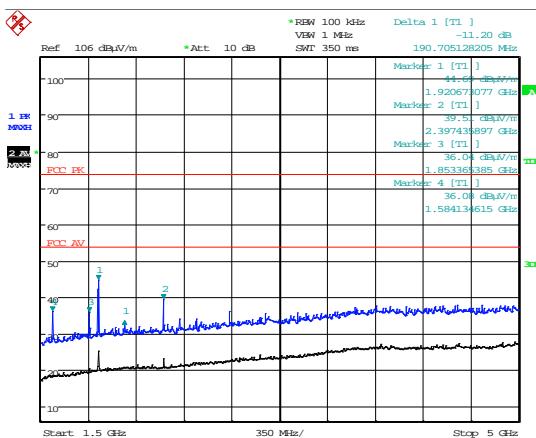


1 –Top Channel Radiated  
(30 MHz to 1 GHz).



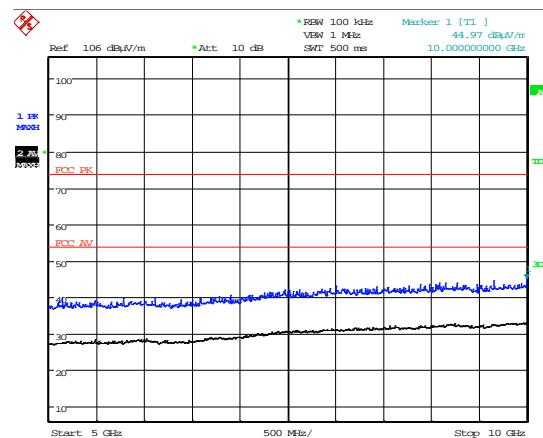
Date: 12.FEB.2016 15:23:19

2 –Top Channel Radiated  
(1 GHz to 1.5 GHz).



Date: 15.FEB.2016 08:49:38

3 –Top Channel Radiated  
(1.5 GHz to 5 GHz).



Date: 15.FEB.2016 09:02:59

4 –Top Channel Radiated  
(5 GHz to 10 GHz).

High Power; Channel: 902.2 MHz										
Detector	Freq. (MHz)	Meas'd Emission (dB $\mu$ V)	Cable Loss (dB)	Antenna Factor (dB/m)	Pre-amp Gain (dB)	Duty Cycle Corr'n (dB)	Distance Extrap'n Factor (dB)	Field Strength (dB $\mu$ V/m)	Field Strength ( $\mu$ V/m)	Limit ( $\mu$ V/m)
No Significant emissions.										
pk levels $\geq$ 1 GHz are below the average limit, therefore average values not measured										

High Power; Channel: 914.8 MHz										
Detector	Freq. (MHz)	Meas'd Emission (dB $\mu$ V)	Cable Loss (dB)	Antenna Factor (dB/m)	Pre-amp Gain (dB)	Duty Cycle Corr'n (dB)	Distance Extrap'n Factor (dB)	Field Strength (dB $\mu$ V/m)	Field Strength ( $\mu$ V/m)	Limit ( $\mu$ V/m)
No Significant emissions.										
pk levels $\geq$ 1 GHz are below the average limit, therefore average values not measured										

High Power; Channel: 927.7 MHz										
Detector	Freq. (MHz)	Meas'd Emission (dB $\mu$ V)	Cable Loss (dB)	Antenna Factor (dB/m)	Pre-amp Gain (dB)	Duty Cycle Corr'n (dB)	Distance Extrap'n Factor (dB)	Field Strength (dB $\mu$ V/m)	Field Strength ( $\mu$ V/m)	Limit ( $\mu$ V/m)
No Significant emissions.										
pk levels $\geq$ 1 GHz are below the average limit, therefore average values not measured										

## 12 AC power-line conducted emissions

### 12.1 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.

### 12.2 Test Parameters

Test Location:	Element North West / Element Hull
Test Chamber:	LF Lab
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.2
EUT Channels / Frequencies Measured:	Mid
EUT Channel Bandwidths:	200kHz
Deviations From Standard:	None
Measurement BW:	10kHz
Measurement Detectors:	Quasi-Peak and Average, RMS

### Environmental Conditions (Normal Environment)

Temperature: 23 °C	+15 °C to +35 °C (as declared)
Humidity: 32 % RH	20 % RH to 75 % RH (as declared)
Supply: 45Vdc	Via POE (as declared)

### 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 (dB $\mu$ V)	
	Quasi-Peak	Average <sup>**</sup>
0.15 to 0.5	66 to 56 <sup>*</sup>	56 to 46
0.5 to 5	56	46
5 to 30	60	50

<sup>\*</sup>The level decreases linearly with the logarithm of the frequency.

<sup>\*\*</sup>A linear average detector is required.

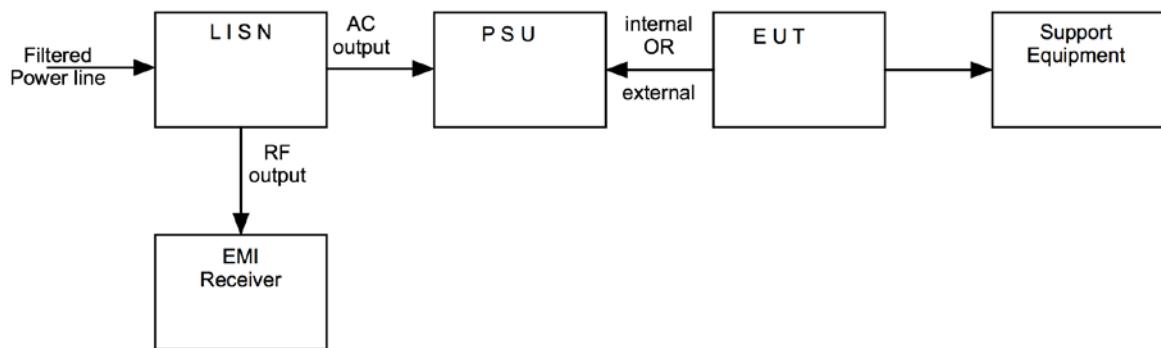
### 12.3 Test Method

With the EUT setup in a screened room, as per section 9 of this report and connected as per Figure ii, 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 ii Test Setup**



### 12.4 Test Set-up Photograph

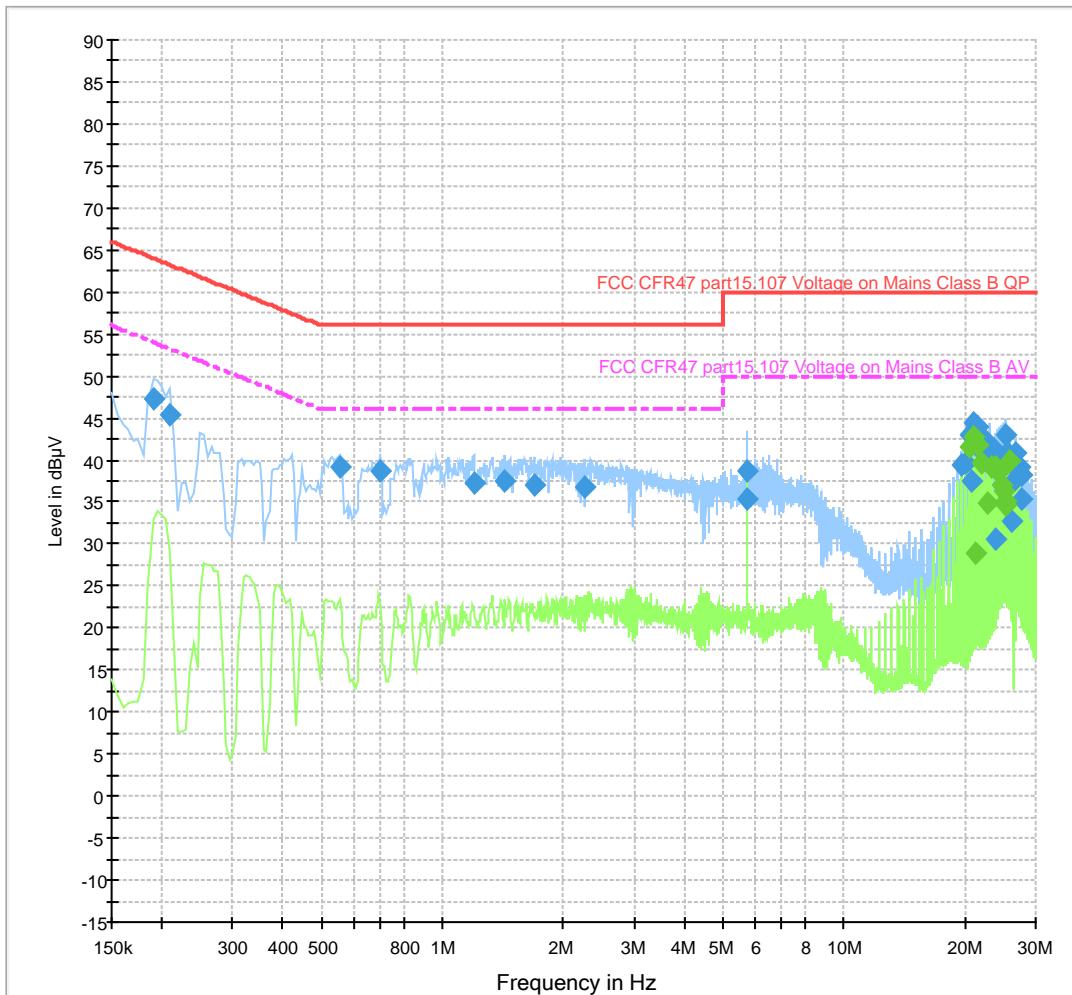


## 12.5 ***Test Equipment***

Element No	Equipment Type	Equipment Description	Manufacturer	Last Cal Calibration	Calibration Period	Due For Calibration
UH396	ENV216	Lisn	R&S	01/07/2015	12	01/07/2016
L352	ESVS10	Receiver	R&S	07/08/2015	12	07/08/2016

## 12.6 Test Results

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



### Transmitter Mode

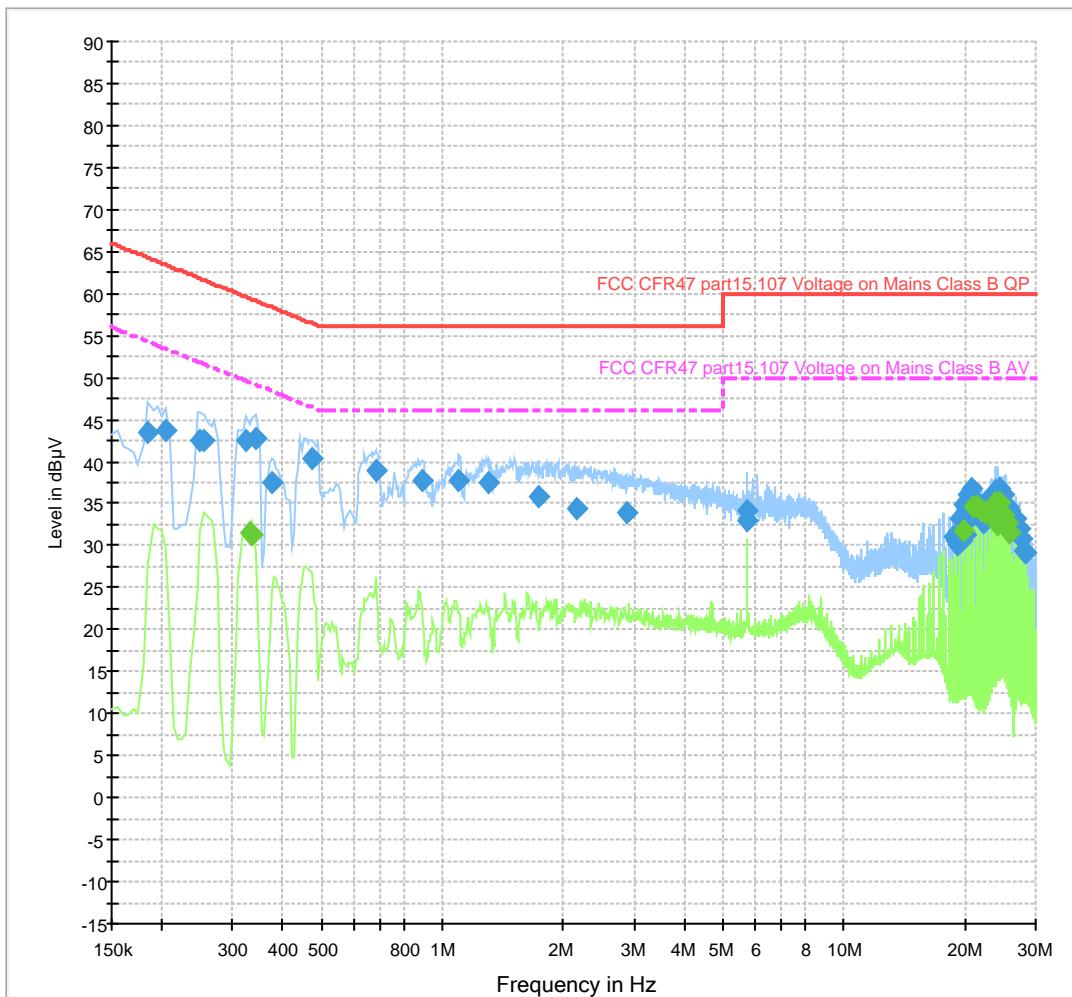
**Transmitter results measured using the quasi-peak detector compared to the quasi-peak limit**

Frequency (MHz)	QuasiPeak (dB $\mu$ V)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dB $\mu$ V)
0.190000	47.2	2000.0	10.000	L1	9.5	16.8	64.0
0.210000	45.3	2000.0	10.000	L1	9.5	17.9	63.2
0.555000	39.1	2000.0	10.000	L1	9.6	16.9	56.0
0.700000	38.7	2000.0	10.000	L1	9.6	17.3	56.0
1.195000	37.4	2000.0	10.000	L1	9.6	18.6	56.0
1.435000	37.4	2000.0	10.000	L1	9.6	18.6	56.0
1.690000	37.0	2000.0	10.000	L1	9.6	19.0	56.0
2.250000	36.8	2000.0	10.000	L1	9.6	19.2	56.0
20.595000	43.0	2000.0	10.000	N	9.8	17.0	60.0
20.595000	43.0	2000.0	10.000	N	9.8	17.0	60.0
21.075000	44.4	2000.0	10.000	N	9.8	15.6	60.0
21.555000	43.9	2000.0	10.000	N	9.9	16.1	60.0
21.795000	41.4	2000.0	10.000	N	9.9	18.6	60.0
22.035000	42.4	2000.0	10.000	N	9.9	17.6	60.0
22.270000	41.2	2000.0	10.000	N	9.9	18.8	60.0
22.510000	42.3	2000.0	10.000	N	9.9	17.7	60.0
22.990000	41.5	2000.0	10.000	N	9.9	18.5	60.0
23.470000	41.4	2000.0	10.000	N	9.9	18.6	60.0
24.910000	40.4	2000.0	10.000	N	9.9	19.6	60.0
25.385000	42.9	2000.0	10.000	N	9.9	17.1	60.0
25.625000	40.8	2000.0	10.000	N	9.9	19.2	60.0
26.825000	40.9	2000.0	10.000	N	9.9	19.1	60.0

**Transmitter results measured using the Average detector compared to the Average limit**

Frequency (MHz)	Average (dB $\mu$ V)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dB $\mu$ V)
20.595000	41.6	2000.0	10.000	N	9.8	8.4	50.0
21.075000	42.7	2000.0	10.000	N	9.8	7.3	50.0
21.555000	41.9	2000.0	10.000	N	9.9	8.1	50.0
22.035000	39.7	2000.0	10.000	N	9.9	10.3	50.0
22.755000	34.8	2000.0	10.000	L1	9.8	15.2	50.0
23.230000	39.2	2000.0	10.000	N	9.9	10.8	50.0
23.710000	39.1	2000.0	10.000	N	9.9	10.9	50.0
24.190000	38.8	2000.0	10.000	N	9.9	11.2	50.0
24.430000	38.6	2000.0	10.000	N	9.9	11.4	50.0
24.670000	37.1	2000.0	10.000	N	9.9	12.9	50.0
24.910000	36.2	2000.0	10.000	N	9.9	13.8	50.0
25.150000	35.0	2000.0	10.000	L1	9.8	15.0	50.0
25.390000	34.6	2000.0	10.000	L1	9.8	15.4	50.0
25.865000	39.8	2000.0	10.000	N	9.9	10.2	50.0

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

**Receive Mode**

**Receiver results measured using the quasi-peak detector compared to the quasi-peak limit**

Frequency (MHz)	QuasiPeak (dB $\mu$ V)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dB $\mu$ V)
0.205000	43.7	2000.0	10.000	L1	9.5	19.7	63.4
0.250000	42.6	2000.0	10.000	L1	9.5	19.2	61.8
0.255000	42.5	2000.0	10.000	L1	9.5	19.1	61.6
0.325000	42.5	2000.0	10.000	L1	9.5	17.1	59.6
0.345000	42.8	2000.0	10.000	L1	9.5	16.3	59.1
0.475000	40.4	2000.0	10.000	L1	9.5	16.0	56.4
0.680000	38.9	2000.0	10.000	L1	9.6	17.1	56.0
0.890000	37.8	2000.0	10.000	L1	9.6	18.2	56.0
1.100000	37.7	2000.0	10.000	L1	9.6	18.3	56.0
1.305000	37.4	2000.0	10.000	L1	9.6	18.6	56.0

**Receiver results measured using the Average detector compared to the Average limit**

Frequency (MHz)	Average (dB $\mu$ V)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dB $\mu$ V)
0.330000	31.4	2000.0	10.000	L1	9.5	18.0	49.5
0.335000	31.4	2000.0	10.000	L1	9.5	18.0	49.3
19.885000	31.7	2000.0	10.000	L1	9.8	18.3	50.0
21.085000	34.6	2000.0	10.000	N	9.8	15.4	50.0
21.565000	34.6	2000.0	10.000	N	9.9	15.4	50.0
22.045000	34.1	2000.0	10.000	N	9.9	15.9	50.0
22.520000	33.8	2000.0	10.000	N	9.9	16.2	50.0
23.000000	34.0	2000.0	10.000	N	9.9	16.0	50.0
23.480000	34.4	2000.0	10.000	N	9.9	15.6	50.0
23.960000	35.1	2000.0	10.000	N	9.9	14.9	50.0
24.200000	32.4	2000.0	10.000	N	9.9	17.6	50.0
24.440000	35.0	2000.0	10.000	N	9.9	15.0	50.0
24.920000	33.7	2000.0	10.000	N	9.9	16.3	50.0
25.400000	32.6	2000.0	10.000	N	9.9	17.4	50.0
25.875000	31.6	2000.0	10.000	N	9.9	18.4	50.0

## 13 Carrier frequency separation

### 13.1 Definition

The carrier frequency separation is the frequency separation between two adjacent hopping frequencies.

### 13.2 Test Parameters

Test Location:	Element North West / Element Hull
Test Chamber:	Radio Lab
Test Standard and Clause:	ANSI C63.10-2013, Clause 7.8.2
EUT Channels / Frequencies Measured:	All; 902 to 928MHz
EUT 20dB Bandwidth:	178kHz
EUT Test Modulations:	Internal pattern generation – hopping enabled
Deviations From Standard:	None
Measurement BW:	100kHz
Measurement Detector:	Peak

### Environmental Conditions (Normal Environment)

Temperature: 23 °C	+15 °C to +35 °C (as declared)
Humidity: 32 % RH	20 % RH to 75 % RH (as declared)
Supply: 45 Vdc	Via POE (as declared)

### 13.3 Test Limit

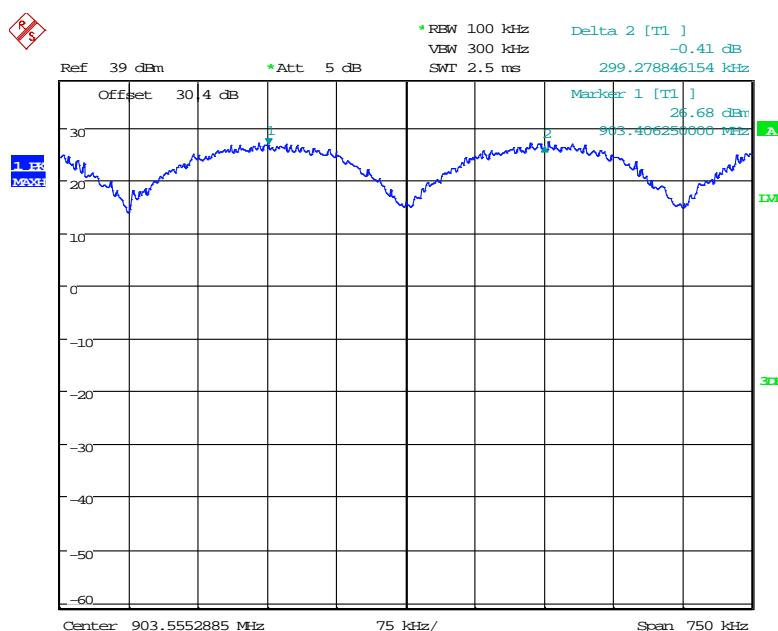
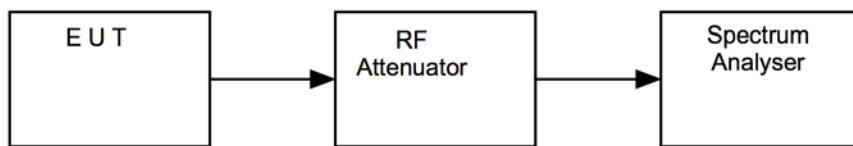
Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the -20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the band 2400 to 2483.5 MHz may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the -20 dB bandwidth of the hopping channel, whichever is greater, provided that the systems operate with an output power no greater than 0.125 W.

### 13.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure iii, the emissions of the EUT were 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 nominal bandwidth.

**Figure iii Test Setup**



Date: 12.JAN.2016 16:02:59

### 13.5 Test Equipment

Element No	Equipment Type	Equipment Description	Manufacturer	Last Cal Calibration	Calibration Period	Due For Calibration
U281	FSU46	Spectrum Analyser	R&S	24/04/2015	12	24/04/2016
UH274	Coax cable	2mtr N-Type	Trac		Cal in use	
TRLUH225	Attenuator	100W- 20dB	Spinner		Cal in use	
TRLUH112	Attenuator	75W-10dB	Bird		Cal in use	

### 13.6 Test Results

<b>Power setting: Max</b>			
<i>F1<sub>c</sub></i> (MHz)	<i>F2<sub>c</sub></i> (MHz)	<i>Channel Separation,</i> <i>F2<sub>c</sub> – F1<sub>c</sub></i> (kHz)	<i>Result</i>
903.1069712	903.406250	299.278846	PASS

## 14 Number of hopping frequencies

### 14.1 Definition

The total number of hopping frequencies (the centre frequencies defined within the hopping sequence of a FHSS equipment) which are randomly sequenced in order to spread the transmission.

### 14.2 Test Parameters

Test Location:	Element North West / Element Hull
Test Chamber:	Radio Lab
Test Standard and Clause:	ANSI C63.10-2013, Clause 7.8.3
EUT Channels / Frequencies Measured:	All; 902-928 MHz
EUT 20dB Bandwidth:	178kHz
EUT Test Modulations:	Internal pattern generation – hopping enabled
Deviations From Standard:	None
Measurement BW:	100kHz
Measurement Detector:	Peak

### Environmental Conditions (Normal Environment)

Temperature: 23 °C	+15 °C to +35 °C (as declared)
Humidity: 32 % RH	20 % RH to 75 % RH (as declared)
Supply: 45 Vdc	Via POE(as declared)

### 14.3 Test Limit

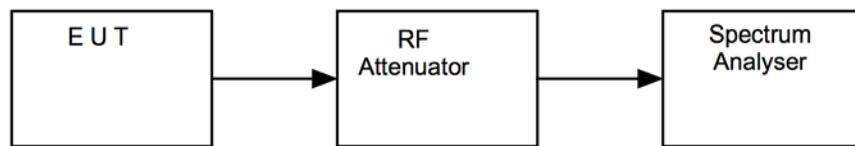
- For frequency hopping systems in the band 902 to 928 MHz: if the -20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping channels;  
If the -20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping channels;
- Frequency hopping systems operating in the band 2400 to 2483.5 MHz shall use at least 15 hopping channels;
- Frequency hopping systems operating in the band 5725 to 5850 MHz shall use at least 75 hopping channels.

#### 14.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure iv, the emissions of the EUT were 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 nominal bandwidth.

**Figure iv Test Setup**



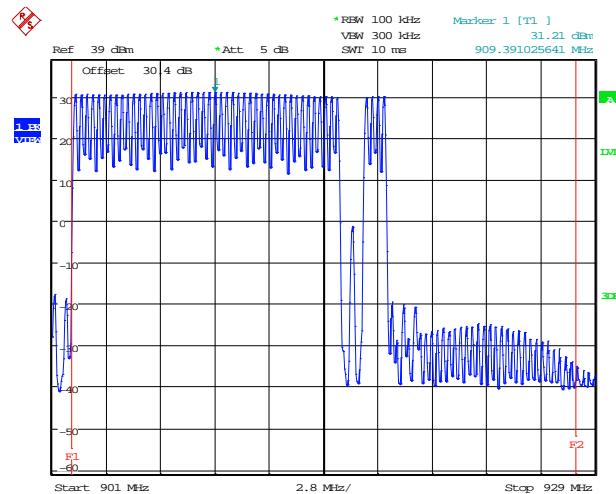
#### 14.5 Test Equipment

Element No	Equipment Type	Equipment Description	Manufacturer	Last Cal Calibration	Calibration Period	Due For Calibration
U281	FSU46	Spectrum Analyser	R&S	24/04/2015	12	24/04/2016
UH274	Coax cable	2mtr N-Type	Trac		Cal in use	
TRLUH225	Attenuator	100W- 20dB	Spinner		Cal in use	
TRLUH112	Attenuator	75W-10dB	Bird		Cal in use	

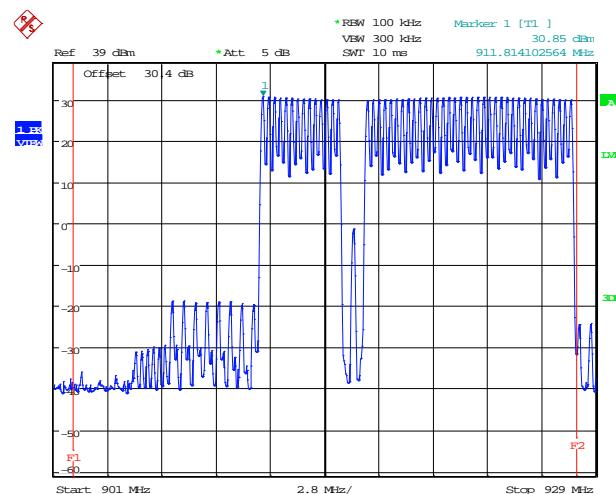
#### 14.6 Test Results

**The number of hopping channels observed = 50 channels in each of the hopping sets.**

## Hopping set 1



## Hopping set 2



## 15 Average channel occupancy

### 15.1 Definition

The channel occupancy is the total of the transmitter 'on' times, during an observation period, on a particular hopping frequency.

### 15.2 Test Parameters

Test Location:	Element North West / Element Hull
Test Chamber:	Radio Lab
Test Standard and Clause:	ANSI C63.10-2013, Clause 7.8.4
EUT Channels / Frequencies Measured:	Mid
EUT 20dB bandwidth:	178kHz
EUT Number of hopping channels:	50
EUT Test Modulations:	Internal pattern generation – hopping enabled
Deviations From Standard:	None
Measurement BW:	100kHz
Measurement Detector:	Peak

### Environmental Conditions (Normal Environment)

Temperature: 23 °C	+15 °C to +35 °C (as declared)
Humidity: 32% RH	20 % RH to 75 % RH (as declared)
Supply: 45Vdc	Via POE (as declared)

### 15.3 Test Limit

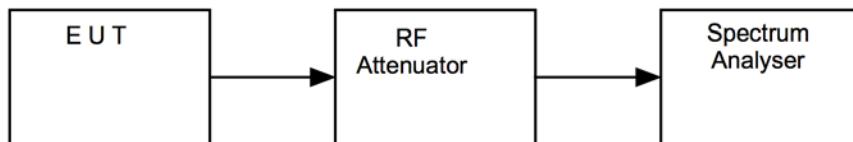
- For frequency hopping systems in the band 902 to 928 MHz: if the -20 dB bandwidth of the hopping channel is less than 250 kHz, the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 20 second period;  
If the -20 dB bandwidth of the hopping channel is 250 kHz or greater, the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 10 second period;
- Frequency hopping systems operating in the band 2400 to 2483.5 MHz: The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds, multiplied by the number of hopping channels employed;
- Frequency hopping systems operating in the band 5725 to 5850 MHz: The average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 30 second period.

#### 15.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure v, the emissions of the EUT were measured on a spectrum analyser.

The measurements were performed with EUT set at its maximum duty. A number of hops were observed to confirm consistency of the dwell time / observe the worst case. All modulation schemes, data rates and power settings were used to observe the worst-case configuration.

**Figure v Test Setup**

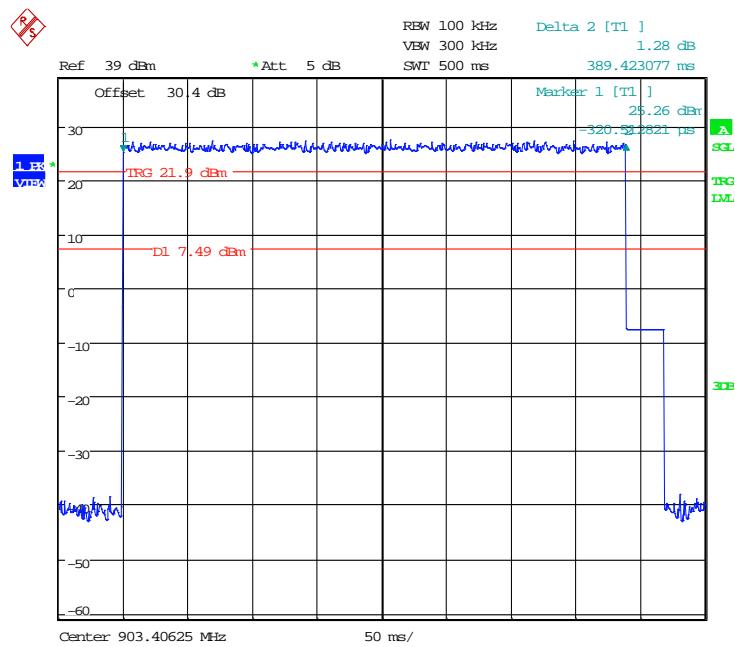


#### 15.5 Test Equipment

Element No	Equipment Type	Equipment Description	Manufacturer	Last Cal Calibration	Calibration Period	Due For Calibration
U281	FSU46	Spectrum Analyser	R&S	24/04/2015	12	24/04/2016
UH274	Coax cable	2mtr N-Type	Trac		Cal in use	
TRLUH225	Attenuator	100W- 20dB	Spinner		Cal in use	
TRLUH112	Attenuator	75W-10dB	Bird		Cal in use	

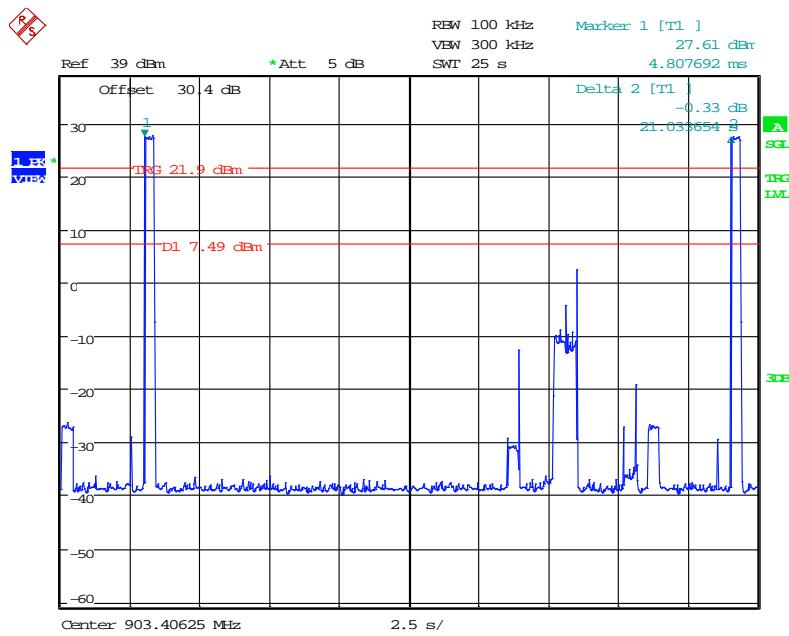
#### 15.6 Test Results

Modulation: ; Power setting: Max				
Individual occupancy time (ms)	Observation period (s)	Number of hops observed	Average time of occupancy (s)	Result
389.423	21	1	389.423	PASS



Date: 12.JAN.2016 16:10:15

### Channel occupancy Time



Date: 12.JAN.2016 16:13:48

### Channel repetition time

## 16 Maximum peak conducted output power

### 16.1 Definition

The maximum peak conducted output power is defined as the maximum power level measured with a peak detector using a filter with width and shape of which is sufficient to accept the signal bandwidth.

### 16.2 Test Parameters

Test Location:	Element North West / Element Hull
Test Chamber:	Radio Lab
Test Standard and Clause:	ANSI C63.10-2013, Clause 7.8.5
EUT Channels / Frequencies Measured:	Low / Mid / High – hopping disabled.
EUT Channel Bandwidths:	178kHz
Deviations From Standard:	None
Measurement BW:	1MHz
Spectrum Analyzer Video BW:	3MHz
Measurement Detector:	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: 24 °C	+15 °C to +35 °C (as declared)
Humidity: 23 % RH	20 % RH to 75 % RH (as declared)

### 16.3 Test Limit

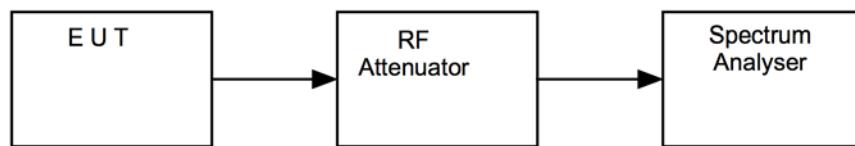
- For frequency hopping systems operating in the band 902 to 928 MHz, the maximum peak conducted output power shall not exceed 1 W, and the e.i.r.p. shall not exceed 4 W, if the hopset uses 50 or more hopping channels;  
the maximum peak conducted output power shall not exceed 0.25 W, and the e.i.r.p. shall not exceed 1 W, if the hopset uses less than 50 hopping channels.
- For frequency hopping systems operating in the band 2400 to 2483.5 MHz and employing at least 75 hopping channels, the maximum peak conducted output power shall not exceed 1 W;  
for all other frequency hopping systems in the band, the maximum peak conducted output power shall not exceed 0.125 W. The e.i.r.p. shall not exceed 4 W.
- For frequency hopping systems operating in the band 5725 to 5850 MHz, the maximum peak conducted output power shall not exceed 1 W. The e.i.r.p. shall not exceed 4 W.
- Point-to-point systems in the bands 2400-2483.5 MHz and 5725 to 5850 MHz are permitted to have an e.i.r.p. higher than 4 W provided that the higher e.i.r.p. is achieved by employing higher gain directional antennas and not higher transmitter output powers.

#### 16.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure vi, 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.

**Figure vi Test Setup**



#### 16.5 Test Equipment

Element No	Equipment Type	Equipment Description	Manufacturer	Last Cal Calibration	Calibration Period	Due For Calibration
U281	FSU46	Spectrum Analyser	R&S	24/04/2015	12	24/04/2016
UH273	Coax cable	2mtr N-Type	Element		Cal in use	
UH274	Coax cable	2mtr N-Type	Element		Cal in use	
TRLUH225	Attenuator	100W- 20dB	Spinner		Cal in use	
TRLUH112	Attenuator	75W-10dB	Bird		Cal in use	
RFG441	D-3000A	Singal Generator	Agilent	08/10/2014	24	08/10/2016

#### 16.6 Test Results

Channel Frequency (MHz)	Analyzer Level (dBm)	Maximum peak conducted output power (W)	Antenna gain (dBi)	E.I.R.P. (W)	Result
902.20	29.68	0.93	5	2.94	PASS
914.80	29.60	0.91	5	2.88	PASS
927.70	29.64	0.92	5	2.91	PASS

**Highest Gain of any antenna to be used = 5 dBi**

**Software values used for the attenuator settings (with noise selected).**

**902.2MHz = 4**

**914.8MHz = 3**

**927.7MHz = 3**

## 17 Occupied Bandwidth

### 17.1 Definition

The emission bandwidth (-20 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 20 dB below the maximum in-band spectral density of the modulated signal.

### 17.2 Test Parameters

Test Location:	Element North West / Element Hull
Test Chamber:	Radio IAB
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.9
EUT Channels / Frequencies Measured:	Low / Mid / High
EUT Channel Bandwidths:	178kHz
Modulation:	DBPSK modulated
Deviations From Standard:	None
Measurement BW: (requirement: 1 % to 5 % OBW)	2kHz
Spectrum Analyzer Video BW: (requirement at least 3x RBW)	5kHz
Measurement Span: (requirement 2 to 5 times OBW)	550kHz
Measurement Detector:	Peak

### Environmental Conditions (Normal Environment)

Temperature: 23 °C	+15 °C to +35 °C (as declared)
Humidity: 32 % RH	20 % RH to 75 % RH (as declared)
Supply: 45 Vdc	Via POE (as declared)

### 17.3 Test Limit

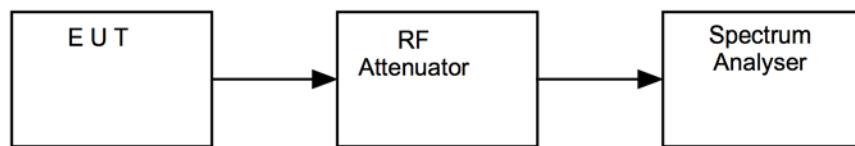
- For frequency hopping systems in the band 902 to 928 MHz: The maximum allowed -20 dB bandwidth of the hopping channel is 500 kHz.
- Frequency hopping systems operating in the band 5725 to 5850 MHz: The maximum -20 dB bandwidth of the hopping channel shall be 1 MHz

#### 17.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure vii, 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 vii Test Setup**



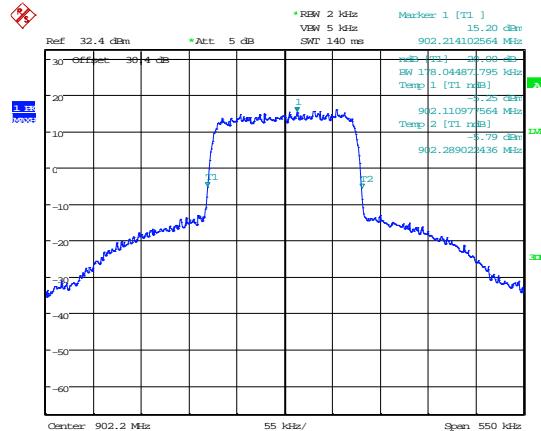
#### 17.5 Test Equipment

Element No	Equipment Type	Equipment Description	Manufacturer	Last Cal Calibration	Calibration Period	Due For Calibration
U281	FSU46	Spectrum Analyser	R&S	24/04/2015	12	24/04/2016
UH273	Coax cable	2mtr N-Type	Element		Cal in use	
TRLUH225	Attenuator	100W- 20dB	Spinner		Cal in use	
TRLUH112	Attenuator	75W-10dB	Bird		Cal in use	

#### 17.6 Test Results

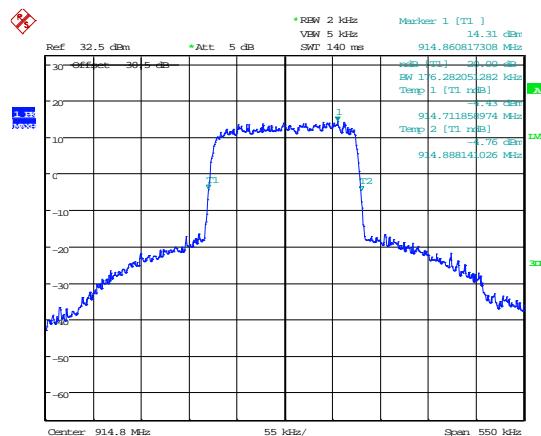
Modulation DBPSK modulated Power setting: Max				
Channel Frequency (MHz)	$F_L$ (MHz)	$F_H$ (MHz)	20dB Bandwidth (kHz)	Result
902.20	902.110977	902.289022	178.044	PASS
914.80	914.711856	914.88856	176.282	PASS
927.70	927.611856	927.788141	176.282	PASS

20dB Bandwidth – 902.20 MHz



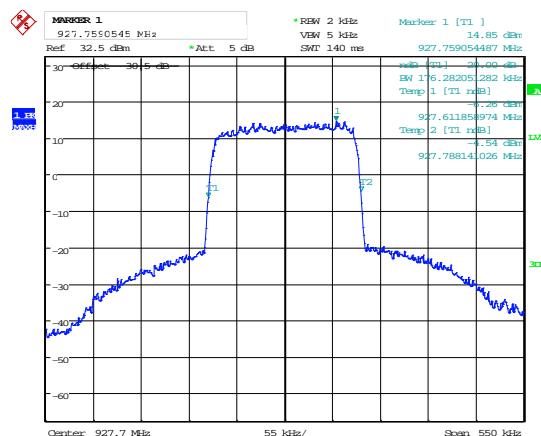
Date: 12.JAN.2016 15:30:54

20dB Bandwidth – 914.80 MHz



Date: 12.JAN.2016 15:06:22

20dB Bandwidth = 927.7 MHz



Date: 12.JAN.2016 15:05:16

## 18 Out-of-band and conducted spurious emissions

### 18.1 Definition

*Out-of-band emission.*

Emission on a frequency or frequencies immediately outside the necessary bandwidth that results from the modulation process but excluding spurious emissions.

*Spurious emission.*

Emission on a frequency or frequencies that 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.

### 18.2 Test Parameters

Test Location:	Element North West / Element Hull
Test Chamber:	Radio Lab
Test Standard and Clause:	ANSI C63.10-2013, Clause 7.8.8
EUT Channels / Frequencies Measured:	Low / Mid / High
EUT Channel Bandwidths:	178kHz
Deviations From Standard:	None
Measurement BW:	100 kHz
Spectrum Analyzer Video BW: (requirement at least 3x RBW)	300kHz
Measurement Detector:	Peak
Measurement Range:	30 MHz to 26.5 GHz

### Environmental Conditions (Normal Environment)

Temperature: 23 °C	+15 °C to +35 °C (as declared)
Humidity: 32 % RH	20 % RH to 75 % RH (as declared)
Supply: 45Vdc	Via POE (as declared)

### 18.3 Test Limits

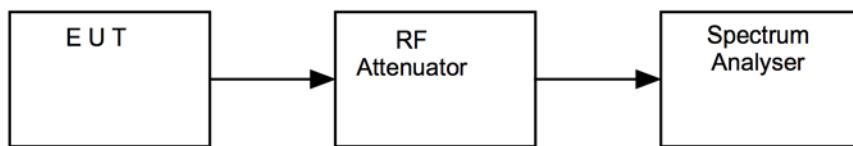
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in FCC 47CFR15.209(a) / RSS-Gen is not required.

#### 18.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure viii, the emissions from the EUT were 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 viii Test Setup**

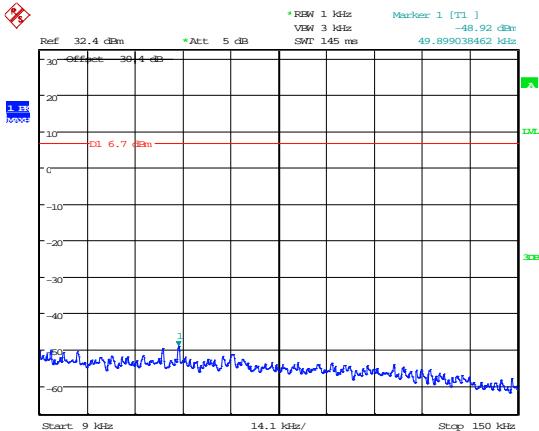


#### 18.5 Test Equipment

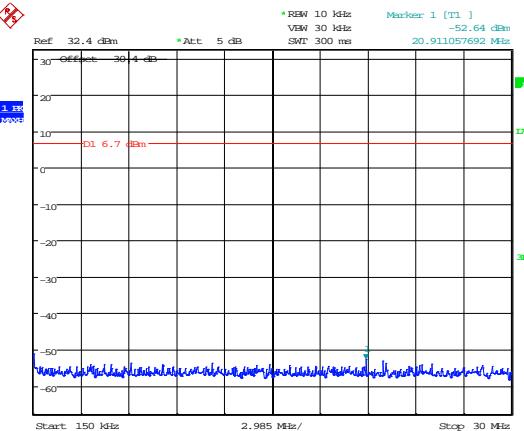
Element No	Equipment Type	Equipment Description	Manufacturer	Last Cal Calibration	Calibration Period	Due For Calibration
U281	FSU46	Spectrum Analyser	R&S	24/04/2015	12	24/04/2016
UH274	Coax cable	2mtr N-Type	Element		Cal in use	
TRLUH225	Attenuator	100W- 20dB	Spinner		Cal in use	
TRLUH112	Attenuator	75W-10dB	Bird		Cal in use	

## Conducted Spurious emissions 902.2MHz

## 9kHz – 150kHz



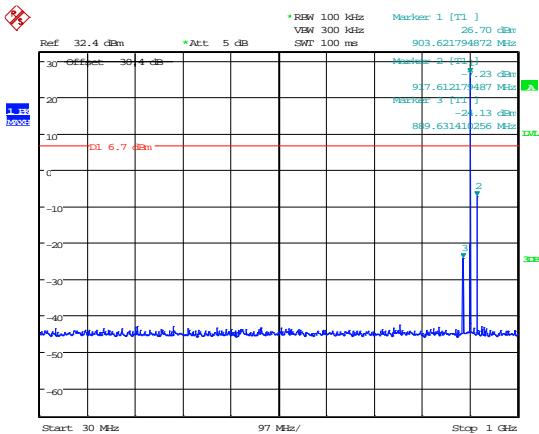
## 150kHz to 30 MHz



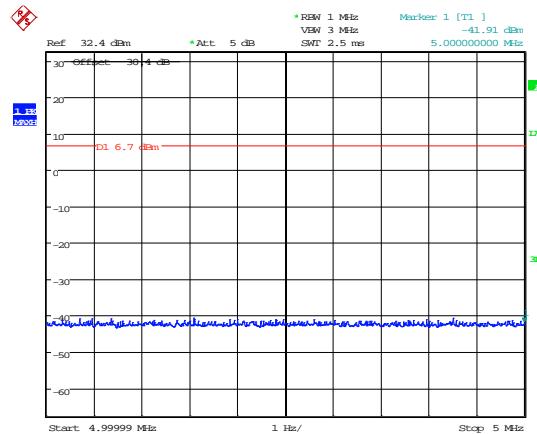
Date: 12.JAN.2016 14:30:22

Date: 12.JAN.2016 14:30:48

## 30 MHz to 1 GHz



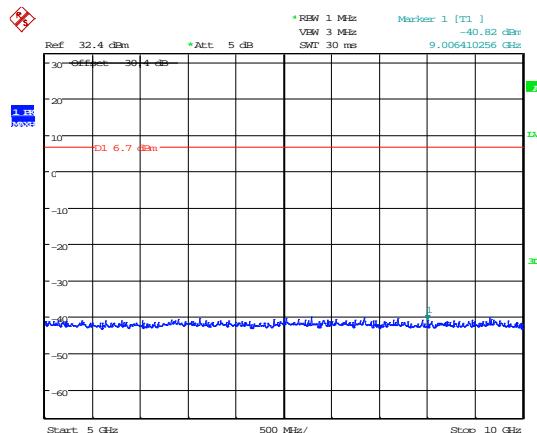
## 1 GHz to 5 GHz



Date: 12.JAN.2016 14:29:43

Date: 12.JAN.2016 14:32:17

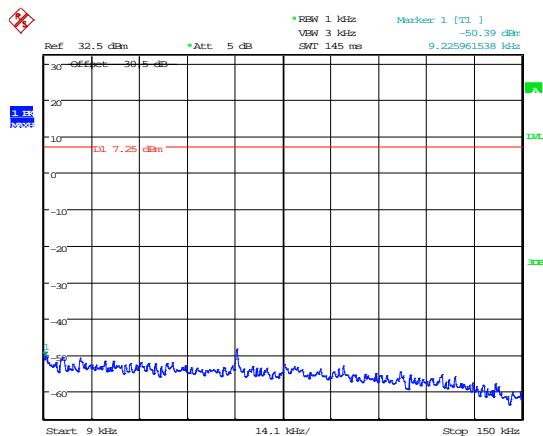
## 5 GHz to 10 GHz



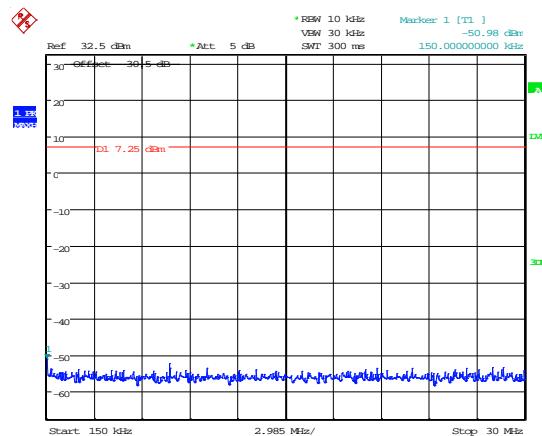
Date: 12.JAN.2016 14:32:37

## Conducted Spurious emissions 914.8MHz

## 9kHz – 150kHz



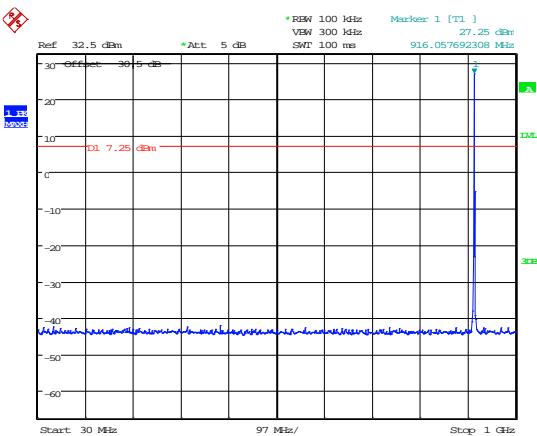
## 150kHz to 30 MHz



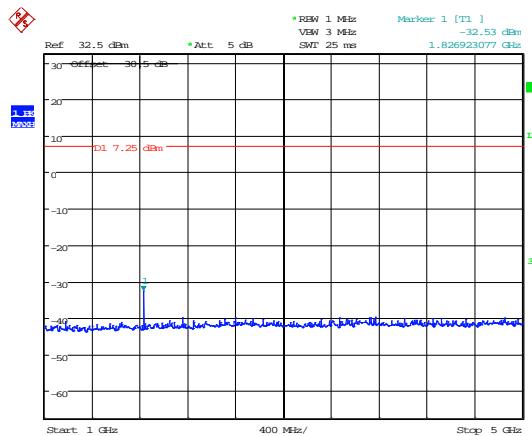
Date: 12.JAN.2016 14:43:29

Date: 12.JAN.2016 14:43:57

## 30 MHz to 1 GHz



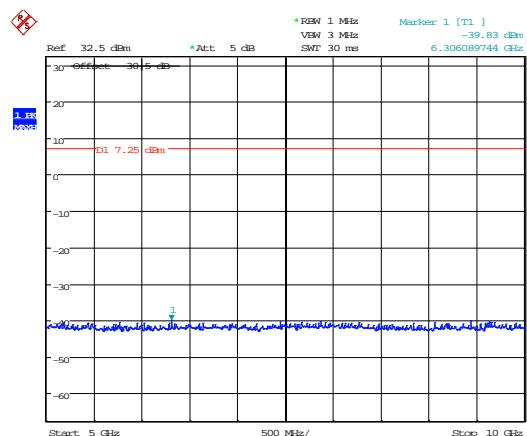
## 1 GHz to 5 GHz



Date: 12.JAN.2016 14:42:52

Date: 12.JAN.2016 14:44:23

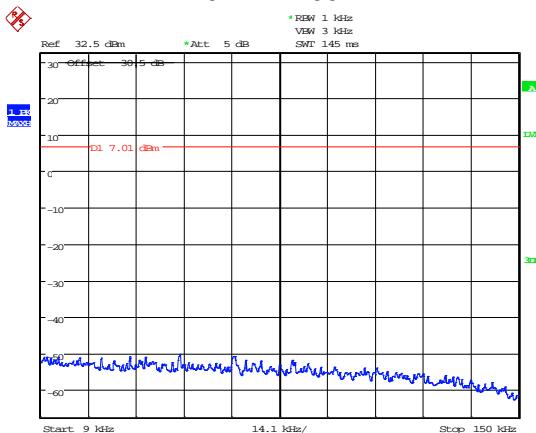
## 5 GHz to 10 GHz



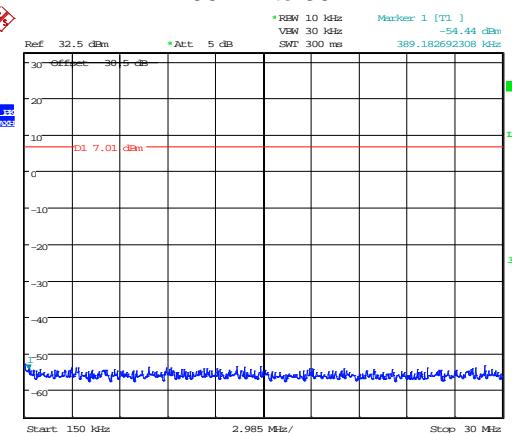
Date: 12.JAN.2016 14:44:46

## Conducted Spurious emissions 927.7MHz

## 9kHz – 150kHz



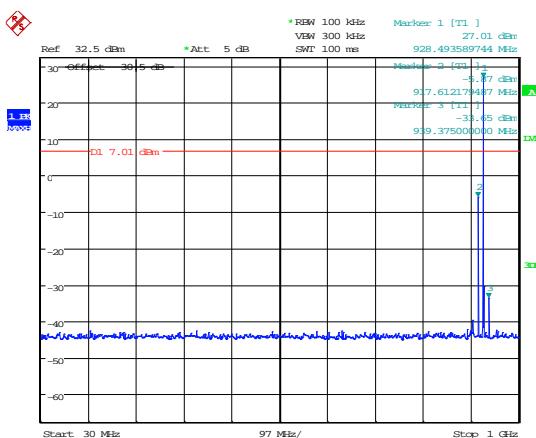
## 150kHz to 30 MHz



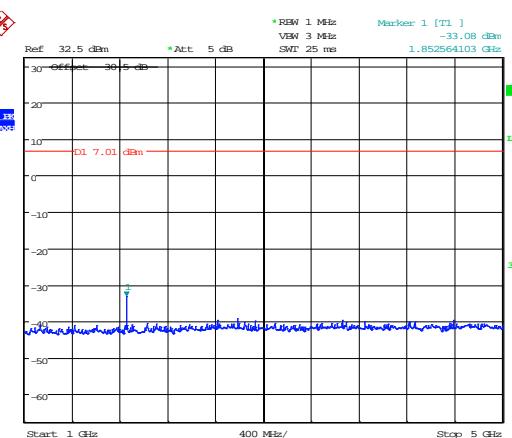
Date: 12.JAN.2016 14:26:17

Date: 12.JAN.2016 14:26:47

## 30 MHz to 1 GHz



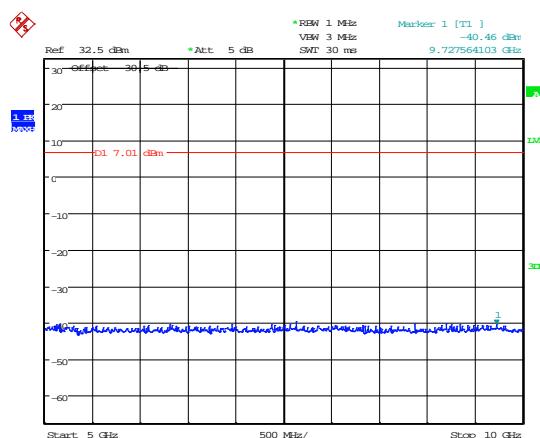
## 1 GHz to 5 GHz



Date: 12.JAN.2016 14:25:36

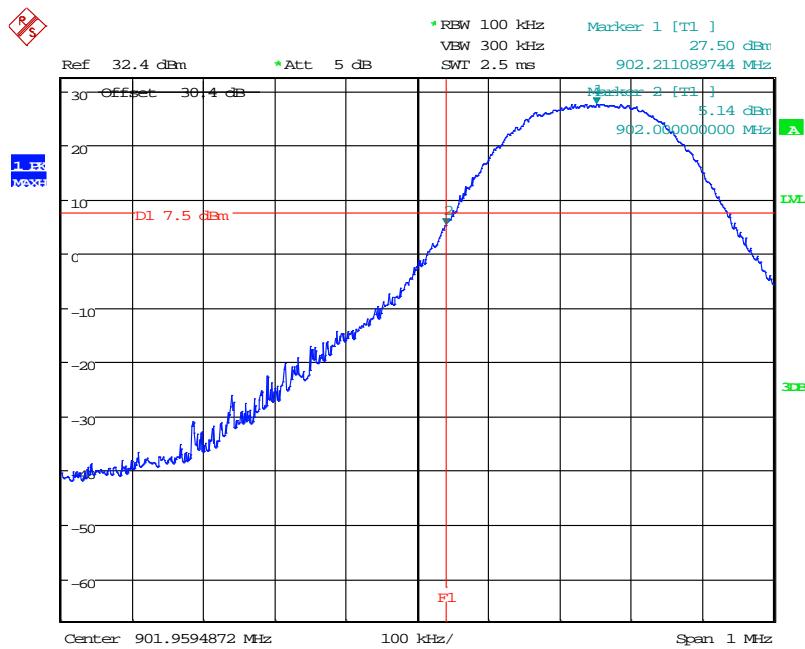
Date: 12.JAN.2016 14:27:09

## 5 GHz to 10 GHz



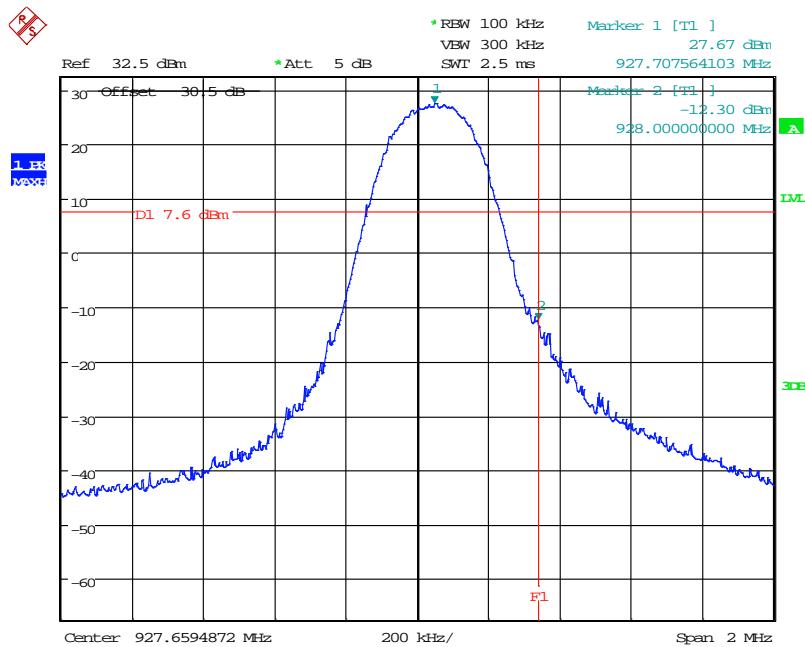
Date: 12.JAN.2016 14:27:27

## Conducted Bandedge Compliance



Date: 12.JAN.2016 14:54:57

## Lower Bandedge



Date: 12.JAN.2016 14:59:24

## Upper Bandedge

## 18.6 Test Results

The worst case conducted emission measurements at the antenna port are listed below:

902.2MHz

Ref No.	Measured Freq (MHz)	Det.	Within Restricted bands (Y/N)	Emission Level (dBc)	Limit (dBc)	Summary
1.	917.612179	Pk	N	33.93dBc	-20dBc	Pass

914.8MHz

Ref No.	Measured Freq (MHz)	Det.	Within Restricted bands (Y/N)	Emission Level (dBc)	Limit (dBc)	Summary
1.	No Emissions within 20dB				-20dBc	Pass

927.7MHz

Ref No.	Measured Freq (MHz)	Det.	Within Restricted bands (Y/N)	Emission Level (dBc)	Limit (dBc)	Summary
1.	917.612179	Pk	N	32.68dBc	-20dBc	Pass

## 19 Radiated emissions – unintentional radiation / receiver emissions

### 19.1 Definitions

#### *Receiver spurious emissions*

The radio frequency signals generated within the receiver, which may cause interference to other equipment. This includes the period during which the equipment is scanning or switching channels.

#### *Unintentional radiator*

A device that generates RF energy which is not intended to be radiated for reception by a radio receiver.

### 19.2 Test Parameters

Test Location:	Element North West / Element Hull
Test Chamber:	Radio
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.5 and 6.6
EUT Channels / Frequencies Measured:	Low / Mid / High
EUT Channel Bandwidths:	178kHz
Deviations From Standard:	None
Measurement BW:	30 MHz to 1 GHz: 120 kHz Above 1 GHz: 1 MHz
Measurement Detector:	Up to 1 GHz: quasi-peak Above 1 GHz: Peak

### Environmental Conditions (Normal Environment)

Temperature: 23 °C	+15 °C to +35 °C (as declared)
Humidity: 32 % RH	20 % RH to 75 % RH (as declared)
Supply: 45 Vdc	Via POE (as declared)

### 19.3 Test Limit

Note:

Only radio communication receivers operating in stand-alone mode within the band 30 to 960 MHz, as well as scanner receivers, are subject to requirements, as described above. All other receivers are exempted from any certification, testing, labelling and reporting requirements.

However, all receivers in all frequency bands shall comply with the limits set forth in FCC 47CFR15B / IC RSS-Gen even in cases where testing, reporting and/or certification are not required.

#### Receiver Radiated Limits

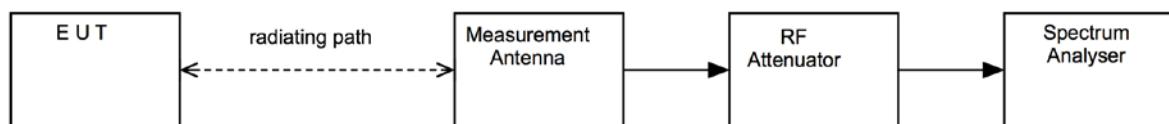
Frequency (MHz)	Field Strength (µV/m at 3 m)
30 to 88	100
88 to 216	150
216 to 960	200
Above 960	500

#### 19.4 Test Method

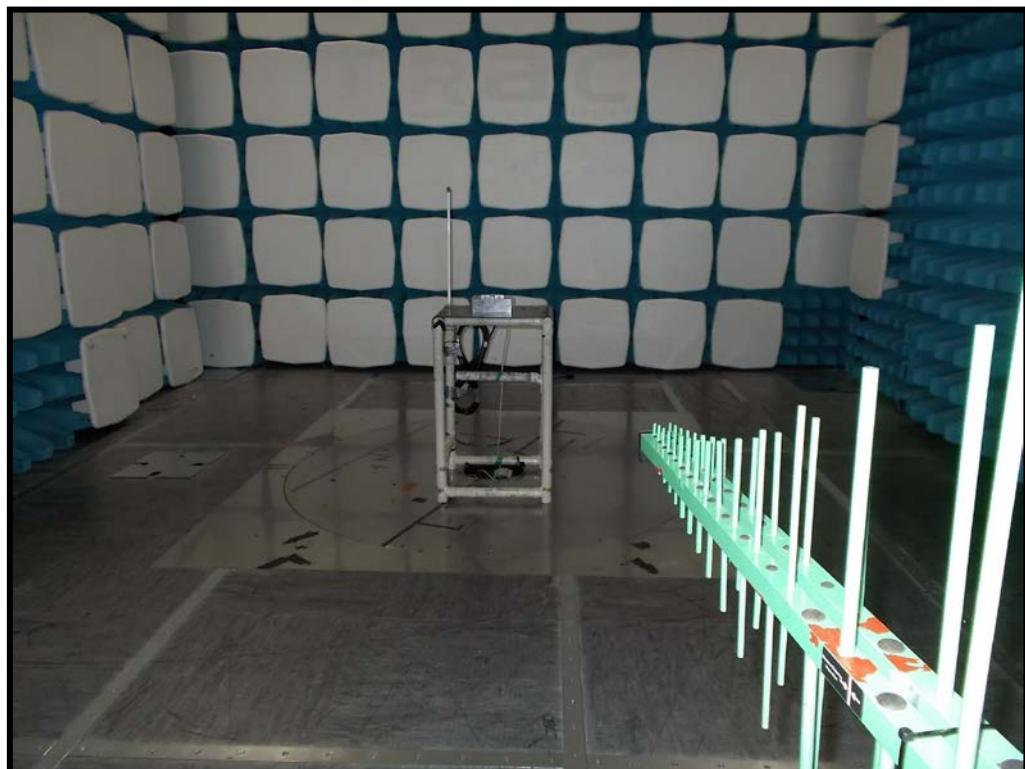
With the EUT setup as per section 9 of this report and connected as per Figure viii, the emissions from the EUT were measured on a spectrum analyzer / EMI receiver. The EUT was rotated in three orthogonal planes and the measurement antenna height scanned (below 1 GHz, from 1 to 4 m; above 1 GHz as necessary) in order to maximise emissions.

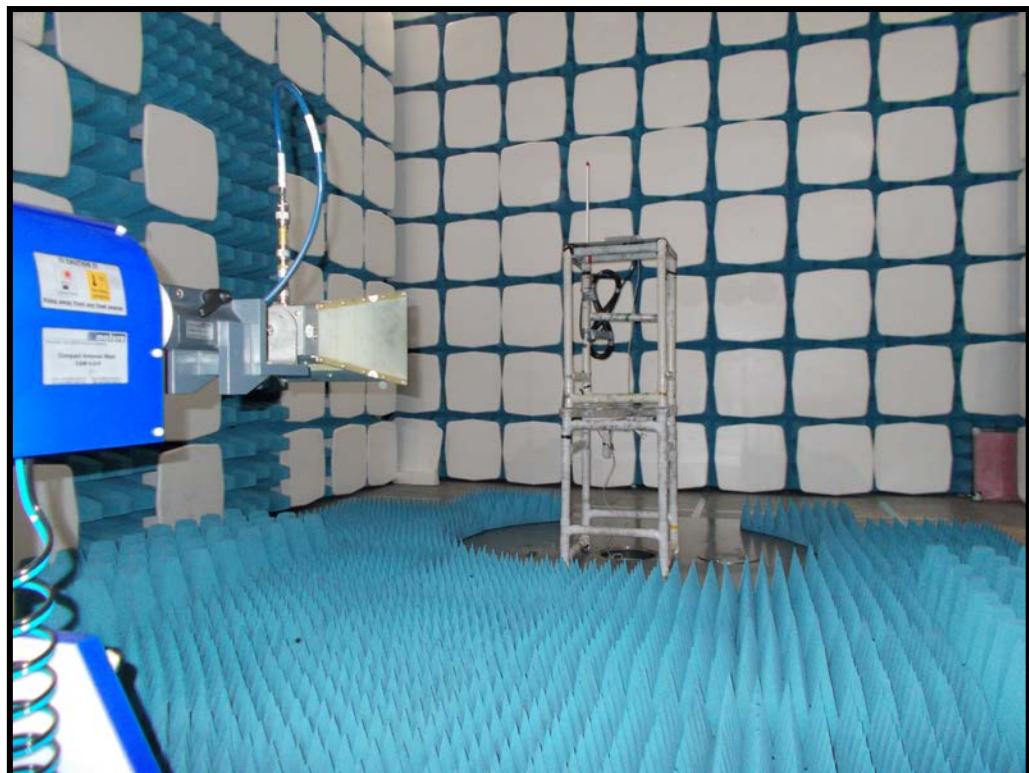
The measurements were performed with EUT set at its maximum duty. All modulation schemes, data rates and power settings were used to observe the worst-case configuration at each frequency. Pre-scan plots are shown with a peak detector and 100 kHz RBW.

**Figure viii Test Setup**



#### 19.5 Test Set-up Photograph



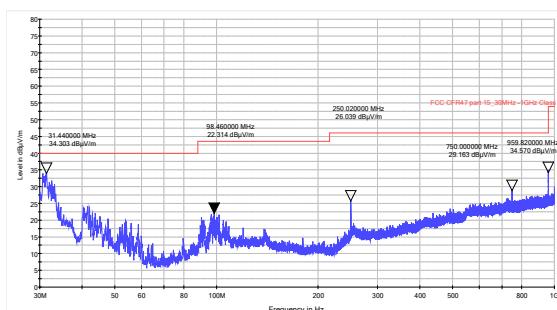


## 19.6 Test Equipment

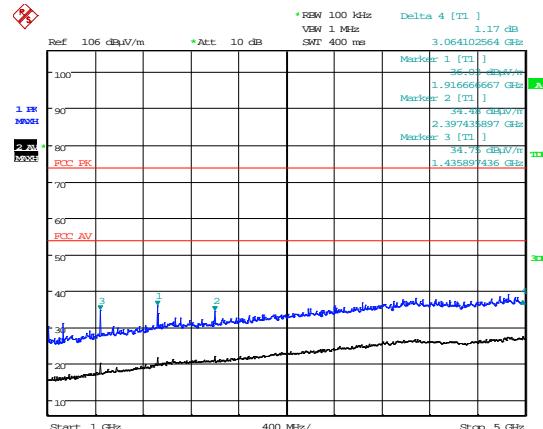
Element No	Equipment Type	Equipment Description	Manufacturer	Last Cal Calibration	Calibration Period	Due For Calibration
L139	3115	1-18GHz Horn	EMCO	25/09/2015	24	25/09/2017
L352	ESVS10	Receiver	R&S	07/08/2015	12	07/08/2016
U093	CBL6112B	Bilog	Chase	17/06/2015	24	17/06/2017
U281	FSU46	Spectrum Analyser	R&S	24/04/2015	12	24/04/2016
REF940	ATS	Radio Chamber - PP	Rainford EMC	08/09/2014	24	08/09/2016
L572	8449B	Pre Amp	Agilent	16/02/2016	12	16/02/2017

## 19.7 Test Results

### Unintentional Radiated Spurious emissions 902.2 MHz

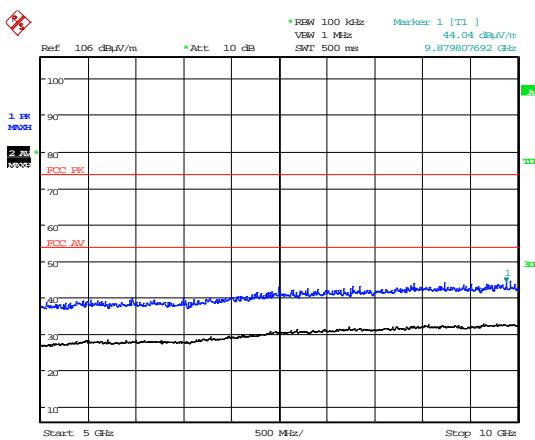


1 –Bottom Rx Channel Radiated  
(30 MHz to 1 GHz).



Date: 15.FEB.2016 10:41:01

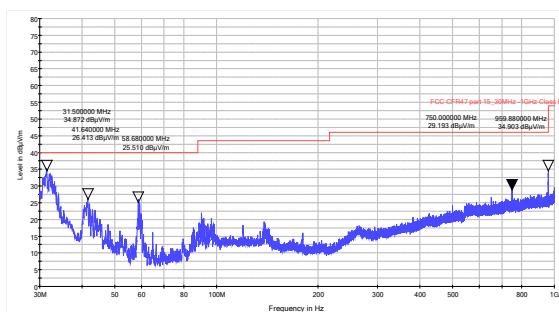
1 –Bottom Rx Channel Radiated  
2 (1 GHz to 5 GHz).



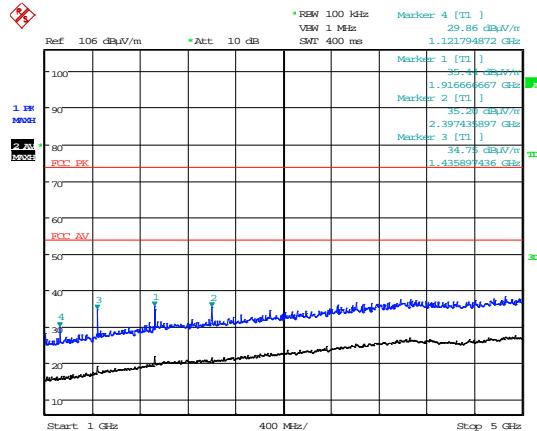
Date: 15.FEB.2016 10:42:54

3 –Bottom Rx Channel Radiated (5 GHz to 10 GHz).

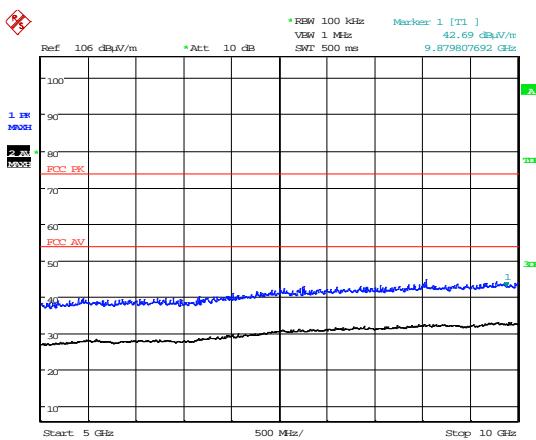
## Unintentional Radiated Spurious emissions 914.8 MHz



1 –Middle Rx Channel Radiated  
(30 MHz to 1 GHz).



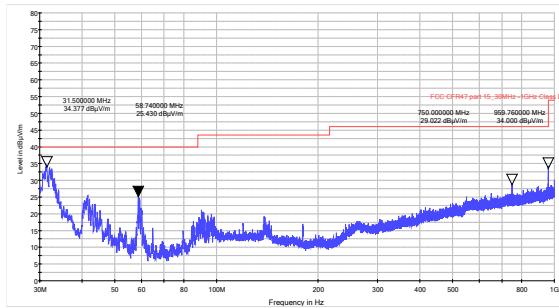
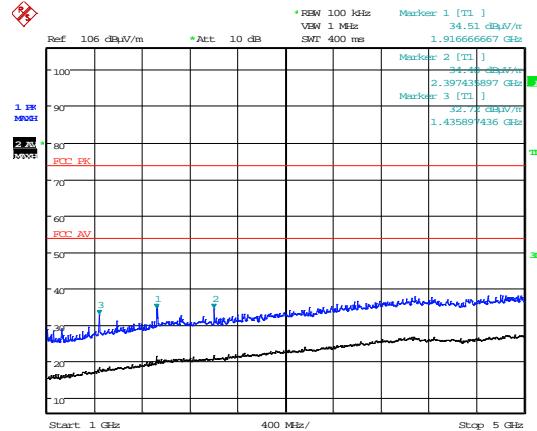
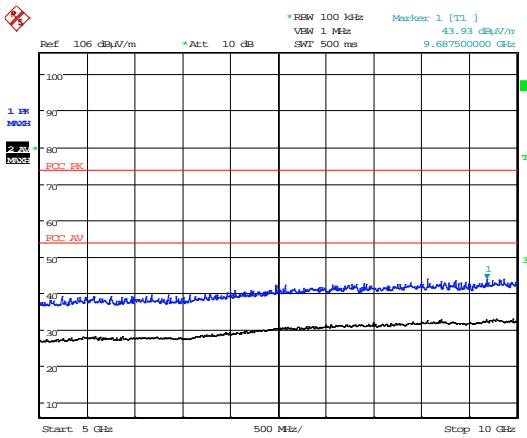
2 –Middle Rx Channel Radiated  
(1 GHz to 5 GHz).



Date: 15.FEB.2016 10:47:20

3 –Middle Rx Channel Radiated  
(5 GHz to 10 GHz).

## Unintentional Radiated Spurious emissions 927.7 MHz

1 –Top Rx Channel Radiated  
(30 MHz to 1 GHz).2 –Top Rx Channel Radiated  
(1 GHz to 5 GHz).3 –Top Rx Channel Radiated  
(5 GHz to 10 GHz).

Ref No.	FREQ. (MHz)	MEAS Rx (dB $\mu$ V)	CABLE LOSS (dB)	ANT FACT. (dB/m)	PRE AMP (dB)	HP Filter	FIELD ST'GH (dB $\mu$ V/m)	FIELD ST'GH ( $\mu$ V/m)	LIMIT ( $\mu$ V/m)
1	30.66	11.8	0.7	18.6	N	N	31.0	35.65	100
2	43.80	13.2	0.8	11.5	N	N	25.5	18.77	100
3	550.02	6.13	2.7	19.8	N	N	28.7	27.13	200
4	750.00	9.0	3.3	21.9	N	N	34.2	50.99	200
5	850.20	0.3	3.5	22.5	N	N	26.3	20.54	200
6	874.98	5.8	3.5	22.3	N	N	31.6	37.98	200
7	899.82	4.0	3.6	22.9	N	N	30.4	33.27	200
8	959.76	13.0	3.7	24.0	N	N	40.70	108.27	200
9	960.12	15.1	3.7	24.0	N	N	42.80	137.88	500
10	960.20	18.80	3.7	24.0	N	N	46.50	211.11	500
11	1583.96	55.72	2.5	26.0	35.30	-1.6	47.30pk	231.7	5011
12	1583.96	46.66	2.5	26.0	35.30	-1.6	38.24Av	81.70	500
13	1919.12	56.03	3.3	27.5	35.40	-0.7	50.77pk	345.5	5011
14	1919.12	46.82	3.3	27.5	35.4	-0.7	41.56Av	119.7	500
15	2400.18	54.14	3.0	28.2	35.5	-0.4	49.49pk	298.2	5011
16	2400.18	47.61	3.0	28.2	35.5	-0.4	45.65Av	140.6	500
17	2878.35	49.98	3.3	29.4	35.6	-0.4	46.73pk	217.0	5011
18	2878.35	37.66	3.3	29.4	35.6	-0.4	34.41Av	52.50	500

Radiated emissions listed above are worse case, all emissions  $\geq$ 1GHz are the same frequencies

1583.96MHz

1919.12MHz

2400.18MHz

2878.35MHz

Regardless of the selected receiver frequency.

## 20 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 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**

#### [2] AC power line conducted emissions

Uncertainty in test result = **3.4 dB**

#### [3] Occupied bandwidth

Uncertainty in test result = **15.5 %**

#### [4] Conducted carrier power

Uncertainty in test result (Power Meter) = **1.08 dB**

#### [5] Conducted / radiated RF power out-of-band

Uncertainty in test result – up to 8.1 GHz = **3.31 dB**  
 Uncertainty in test result – 8.1 GHz to 15.3 GHz = **4.43 dB**  
 Uncertainty in test result (30 MHz to 1 GHz) = **4.6 dB**  
 Uncertainty in test result (1 GHz to 18 GHz) = **4.7 dB**

#### [6] Frequency separation

Uncertainty in test result (Spectrum Analyser) = **3.6 kHz**

#### [7] Accumulated channel occupancy time

Uncertainty in test result = **7.98 %**