Report on the Radio Testing

For

IMC Group Limited

on

IceSpy Notion Pro

Report no. TRA-030757-47-00A

4th January 2017

Report Number: TRA-030757-47-00A
Issue: A

REPORT ON THE RADIO TESTING OF A
IMC Group Limited
IceSpy Notion Pro
WITH RESPECT TO SPECIFICATION
FCC 47CFR 15.247 & IC RSS-247

TEST DATE: 21st April - 6th June 2016

Written by: D Winstanley

D Winstanley
Senior Radio Test Engineer

Approved by:

Digitally signed by John Charters
DN: cn=John Charters, o=Element Materials Technology, ou, email=john.charters@element.com, c=GB
Date: 2017.05.26 13:09:52 +01'00'

J Charters
Department Manager - Radio

Date: 4th January 2017

Element Materials Technology Warwick Ltd.
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Company Reg No. 02536659

1 Revision Record

Issue Number	*Issue Date*	*Revision History*
A	4th January 2017	Original

2 Summary

TEST REPORT NUMBER:	TRA-030757-47-00A
WORKS ORDER NUMBER	TRA-030757-00
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):	IceSpy Notion Pro
FCC IDENTIFIER:	N2OIN-TH001F2
MANUFACTURER/AGENT:	IMC Group Limited
ADDRESS:	Suite 6 24 Swan Street Kingsclear Newbury United Kingdom
CLIENT CONTACT:	Neil Lundy ☎ 01635 291349 ✉ n.lundy@the-imcgroup.com
ORDER NUMBER:	Not Applicable
TEST DATE:	21st April - 6th June 2016
TESTED BY:	D Winstanley Element

2.1 Test Summary

Test Method and Description	*Requirement Clause*		*Applicable to this equipment*	*Result / Note*
	RSS	*47CFR15*		
Radiated spurious emissions (restricted bands of operation and cabinet radiation)	Gen, 8.10	15.205	☒	*Pass*
AC power line conducted emissions	Gen, 8.8	15.207	☐	*Note 1*
Carrier frequency separation	247, 5.1 (2)	15.247(a)(1)	☒	*Pass*
Number of hopping channels	247, 5.1 (3), (4) and (5)	15.247(a)(1) (i), (ii) and (iii)	☒	*Pass*
Average time of occupancy	247, 5.1 (3), (4) and (5)	15.247(a)(1) (i), (ii) and (iii)	☒	*Pass*
Maximum peak conducted output power	247, 5.4 (1), (2) and (3)	15.247 (a)(1), (b)(1) and (b)(2)	☒	*Pass*
20dB emission bandwidth	247, 5.1 (1)	15.247(a)(1) (i) and (ii)	☒	*Pass*
Out-of-band emissions	247, 5.5	15.247(d)	☒	*Pass*
Unintentional Radiated Spurious Emisisons	Gen, 8.10	15.109	X	*Pass*

Notes:

1. EUT is battery powered

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-030757-47-00A presents the results of the Radio testing on an IMC Group Limited, IceSpy Notion Pro 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 IMC Group Limited by Element, at the address(es) detailed below.

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

☒ Element Skelmersdale
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 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

§	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: IceSpy Notion Pro
- Serial Number: Not available
- Model Number: IN-TH001-F2
- Software Revision: Not Applicable
- Build Level / Revision Number: Not Applicable

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.

Not Applicable – No support/monitoring equipment required.

7.3 EUT Mode of Operation

7.3.1 Transmission

The mode of operation for transmitter tests was as follows…

EUT was set into transmit mode Via NotionRadioApproval software application V1.0 provided by the manufacturer.
The EUT was set to transmit on top, middle or bottom frequencies with the hopping stopped.
EUT was also set to transmit hopping over all channels following its normal operational parameters.

7.3.2 Reception

The mode of operation for receiver tests was as follows…

EUT was set into a permanent receive mode

7.4 EUT Radio Parameters

7.4.1 General

Frequency of operation:	902.1 MHz to 927.3 MHz
Modulation type(s):	FM
Occupied channel bandwidth(s):	25 kHz
Channel spacing:	200 kHz
ITU emission designator(s):	F1D
Declared output power(s):	10 dBm (max)
Warning against use of alternative antennas in user manual (yes/no):	Yes
Nominal Supply Voltage:	1.6 Vdc
Frequency stability:	±1 kHz
Location of notice for license exempt use:	Label / user manual / both.
Duty cycle:	19 ms in 100 ms period (19%)

7.4.2 Antennas

Type:	Integral
Frequency range:	902 – 928 MHz
Impedance:	50 Ohms
Connector type:	Not Applicable
Mounting:	PCB Trace

7.4.3 Product specific declarations

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

7.5 EUT Description

The IceSpy Notion Pro series of RH/T transmitter units are flexible, reliable and waterproof to IP65 except the RH sensor which requires exposure to the atmosphere. Each unit has been designed to offer a comprehensive range of temperature and humidity

8 Modifications

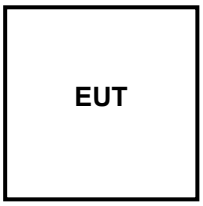
No modifications were performed during this assessment.

9 EUT Test Setup

9.1 Block Diagram

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

EUT is a standalone battery powered device



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. 1.6 V dc from batteries.

10.2 Varying Test Conditions

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).

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

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

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 Skelmersdale
Test Chamber:	Chambers 2 and 6
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.5 and 6.6
EUT Channels / Frequencies Measured:	902.1 MHz / 914.7 MHz / 927.3 MHz
EUT Channel Spacing:	200 kHz
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: 21 °C	+15 ºC to +35 ºC (as declared)
Humidity: 30 % RH	20 % RH to 75 % RH (as declared)
Supply: 1.6 V dc	

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 dBµV/m at the regulatory distance, using:

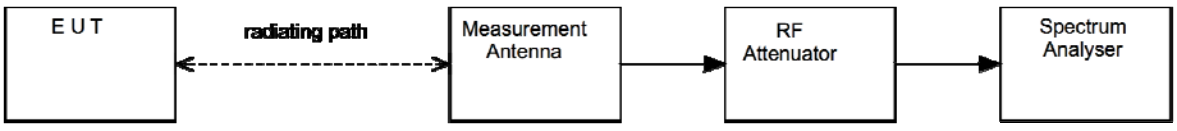
$$FS = PR + CL + AF – PA + DC – CF$$

Where,

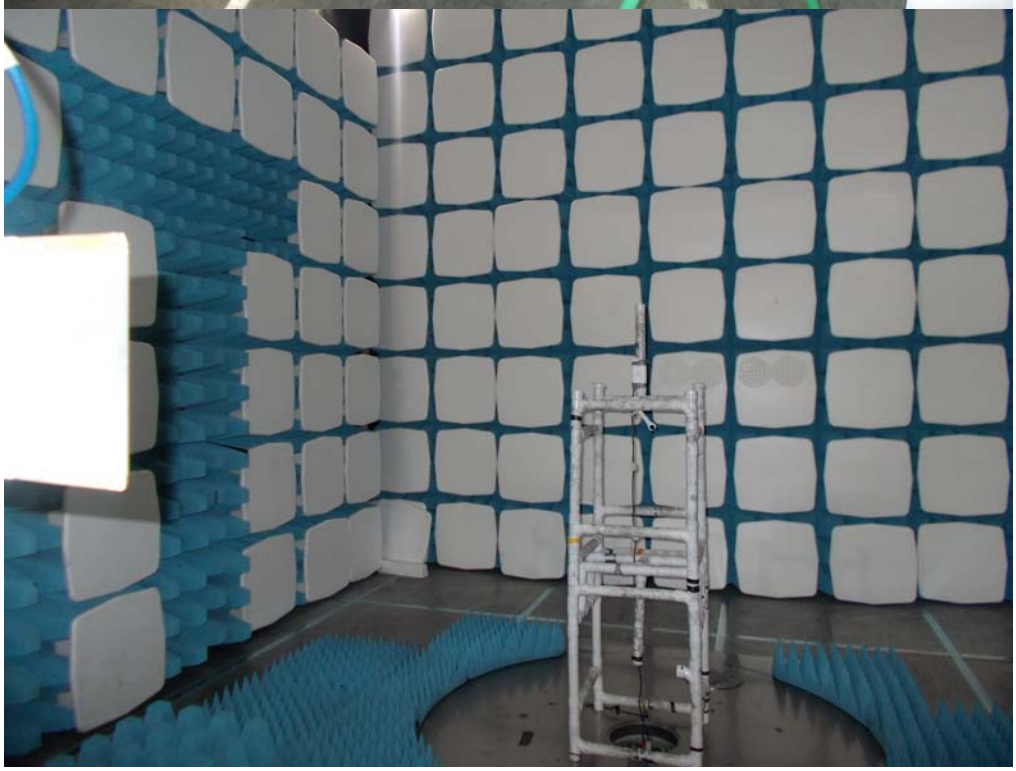
PR is the power recorded on the receiver / spectrum analyzer in dBµV;
CL is the cable loss in dB;
AF is the test antenna factor in dB/m;
PA is the pre-amplifier gain in dB (where used);
DC is the duty correction factor in dB (where used, e.g. harmonics of pulsed fundamental);
CF is the distance factor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



Test Equipment

Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration	Calibration Period
ESVS10	R&S	Receiver	L317	11/03/2017	12
FSU50	R&S	Spectrum Analyser	U544	16/03/2017	12
CBL6112B	Chase	Bilog	U093	17/06/2017	24
8449B	Agilent	Pre Amp	L572	16/02/2017	12
3115	EMCO	1-18GHz Horn	L139	25/09/2017	24

11.6 Test Results

High Power; Channel: 902.1 MHz										
Detector	***Freq. (MHz)***	***Meas'd Emission (dBµV)***	***Cable Loss (dB)***	***Antenna Factor (dB/m)***	***Pre-amp Gain (dB)***	***Duty Cycle Corr'n (dB)***	***Distance Extrap'n Factor (dB)***	***Field Strength (dBµV/m)***	***Field Strength (µV/m)***	***Limit (µV/m)***
Pk	2706.30	52.87	3.60	28.90	36.06	0.00	0.00	49.31	292.08	5012
Av	2706.30	52.87	3.60	28.90	36.06	-13.98	0.00	35.33	58.42	500
Pk	2706.30	52.87	3.60	28.90	36.06	0.00	0.00	49.31	292.08	5012
Av	2706.30	52.87	3.60	28.90	36.06	-13.98	0.00	35.33	58.42	500
Pk	3608.40	50.99	4.30	31.50	35.74	0.00	0.00	51.05	356.86	5012
Av	3608.40	50.99	4.30	31.50	35.74	-13.98	0.00	37.07	71.37	500
Pk	4510.50	49.94	5.30	32.30	35.73	0.00	0.00	51.81	389.49	5012
Av	4510.50	49.94	5.30	32.30	35.73	-13.98	0.00	37.83	77.90	500
Pk	5412.60	51.51	6.20	34.40	35.90	0.00	0.00	56.21	646.40	5012
Av	5412.60	51.51	6.20	34.40	35.90	-13.98	0.00	42.23	129.28	500
Pk	9021.00	51.27	9.50	37.70	36.40	0.00	0.00	62.07	1269.11	5012
Av	9021.00	51.27	9.50	37.70	36.40	-13.98	0.00	48.09	253.82	500

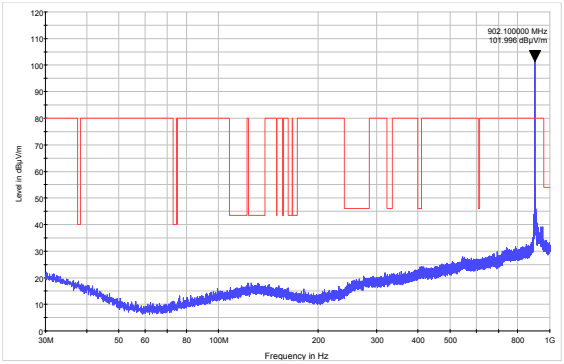


Figure 1 – Radiated Emissions Plot (30 MHz to 1 GHz); Channel Bottom; Vertical Polarization.

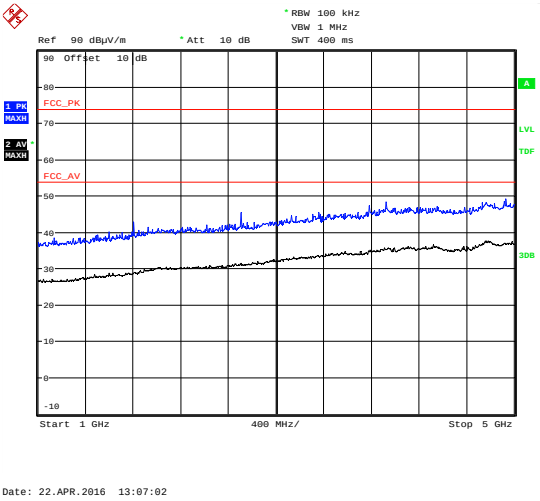


Figure 2 – Radiated Emissions Plot (1 GHz to 5 GHz); Channel Bottom; Vertical Polarization.

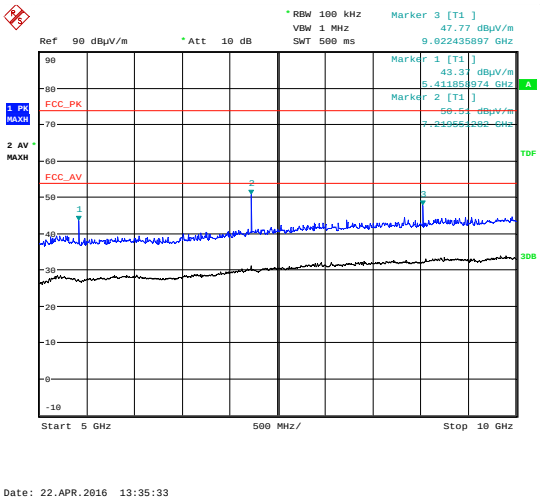


Figure 3 – Radiated Emissions Plot (5 GHz to 10 GHz); Channel Bottom; Vertical Polarization.

High Power; Channel: 914.7 MHz										
Detector	***Freq. (MHz)***	***Meas'd Emission (dBµV)***	***Cable Loss (dB)***	***Antenna Factor (dB/m)***	***Pre-amp Gain (dB)***	***Duty Cycle Corr'n (dB)***	***Distance Extrap'n Factor (dB)***	***Field Strength (dBµV/m)***	***Field Strength (µV/m)***	***Limit (µV/m)***
QP	966.70	7.70	5.73	21.54	N/A	0.00	0.00	34.97	56.04	500
Pk	2744.10	53.48	3.60	29.00	36.06	0.00	0.00	50.02	316.96	5012
Av	2744.10	53.48	3.60	29.00	36.06	-13.98	0.00	36.04	63.39	500
Pk	3658.80	50.89	4.30	31.70	35.71	0.00	0.00	51.18	362.24	5012
Av	3658.80	50.89	4.30	31.70	35.71	-13.98	0.00	37.20	72.45	500
Pk	4573.50	49.66	5.40	32.50	35.75	0.00	0.00	51.81	389.49	5012
Av	4573.50	49.66	5.40	32.50	35.75	-13.98	0.00	37.83	77.90	500
Pk	7317.60	52.18	8.80	36.40	36.06	0.00	0.00	61.32	1164.13	5012
Av	7317.60	52.18	8.80	36.40	36.06	-13.98	0.00	47.34	232.83	500
Pk	9147.00	51.43	10.10	37.80	36.47	0.00	0.00	62.86	1389.95	5012
Av	9147.00	51.43	10.10	37.80	36.47	-13.98	0.00	48.88	277.99	500

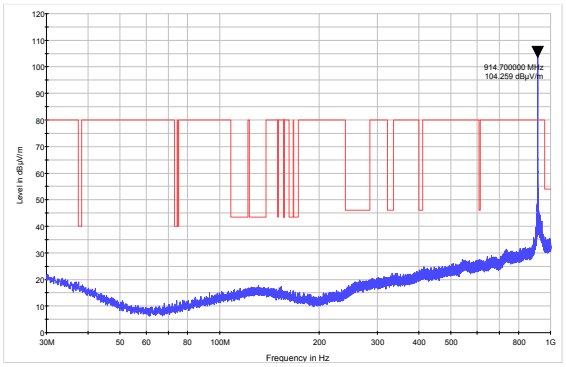


Figure 1 – Radiated Emissions Plot (30 MHz to 1 GHz); Channel Bottom; Vertical Polarization.

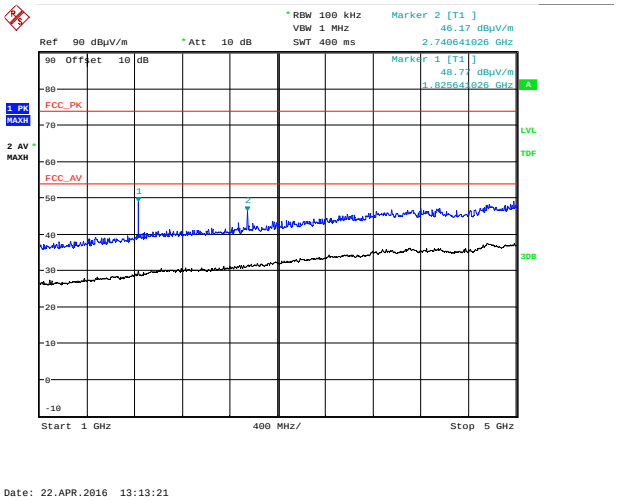


Figure 2 – Radiated Emissions Plot (1 GHz to 5 GHz); Channel Bottom; Vertical Polarization.

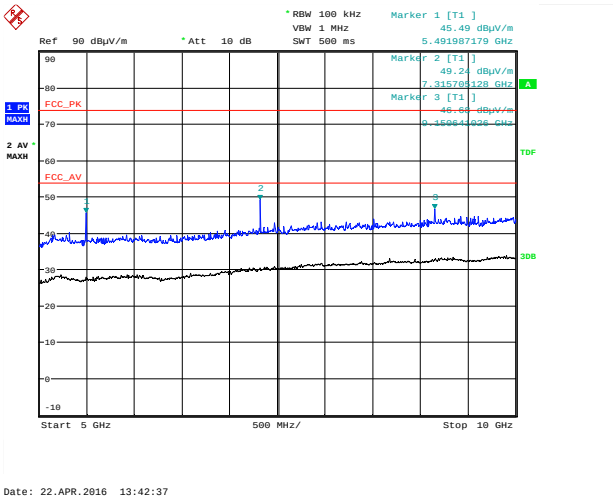


Figure 3 – Radiated Emissions Plot (5 GHz to 10 GHz); Channel Bottom; Vertical Polarization.

High Power; Channel: 927.3 MHz										
Detector	***Freq. (MHz)***	***Meas'd Emission (dBµV)***	***Cable Loss (dB)***	***Antenna Factor (dB/m)***	***Pre-amp Gain (dB)***	***Duty Cycle Corr'n (dB)***	***Distance Extrap'n Factor (dB)***	***Field Strength (dBµV/m)***	***Field Strength (µV/m)***	***Limit (µV/m)***
QP	966.30	9.10	5.73	21.52	N/A	0.00	0.00	36.35	65.69	500
QP	979.30	7.70	5.77	21.70	N/A	0.00	0.00	35.17	57.35	500
Pk	2781.90	53.12	3.70	29.10	36.07	0.00	0.00	49.85	310.81	5012
Av	2781.90	53.12	3.70	29.10	36.07	-13.98	0.00	35.87	62.16	500
Pk	3709.20	50.23	4.30	31.80	35.69	0.00	0.00	50.64	340.41	5012
Av	3709.20	50.23	4.30	31.80	35.69	-13.98	0.00	36.66	68.08	500
Pk	4636.50	47.31	5.60	32.60	35.78	0.00	0.00	49.73	306.55	5012
Av	4636.50	47.31	5.60	32.60	35.78	-13.98	0.00	35.75	61.31	500
Pk	7418.40	52.80	9.30	36.70	36.08	0.00	0.00	62.72	1367.73	5012
Av	7418.40	52.80	9.30	36.70	36.08	-13.98	0.00	48.74	273.55	500
Pk	8345.70	48.32	10.00	37.30	36.29	0.00	0.00	59.33	925.76	5012
Av	8345.70	48.32	10.00	37.30	36.29	-13.98	0.00	45.35	185.15	500

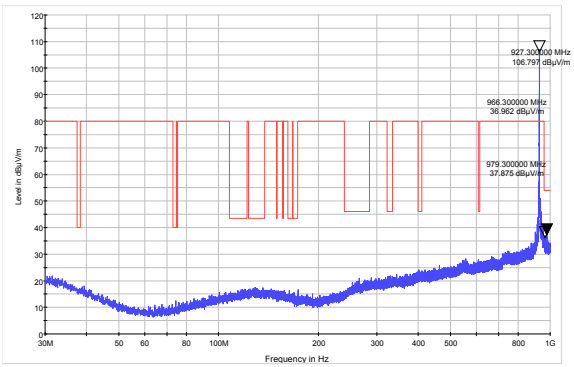


Figure 1 – Radiated Emissions Plot (30 MHz to 1 GHz); Channel Bottom; Vertical Polarization.

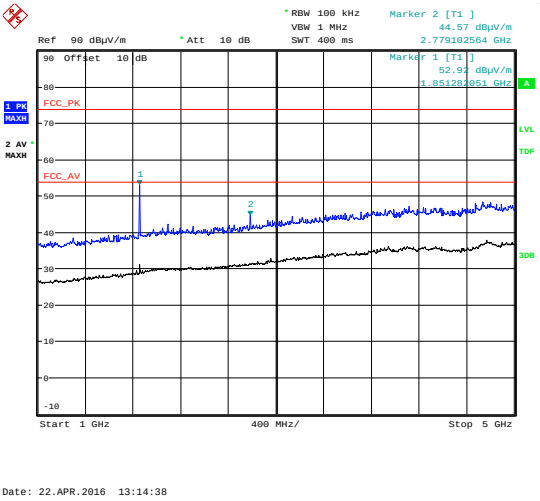


Figure 2 – Radiated Emissions Plot (1 GHz to 5 GHz); Channel Bottom; Vertical Polarization.

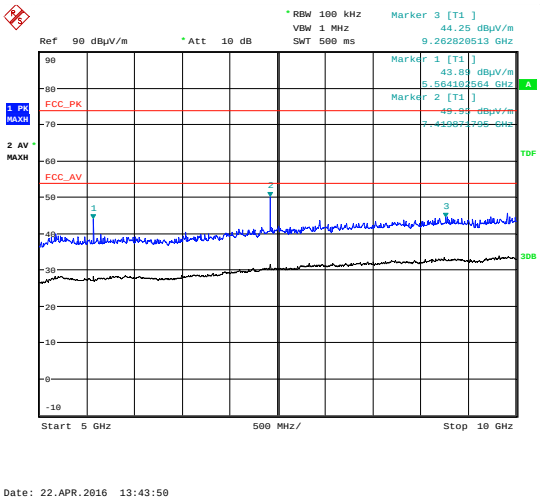


Figure 3 – Radiated Emissions Plot (5 GHz to 10 GHz); Channel Bottom; Vertical Polarization.

12 Carrier frequency separation

12.1 Definition

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

12.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Lab
Test Standard and Clause:	ANSI C63.10-2013, Clause 7.8.2
EUT Channels / Frequencies Measured:	All;
EUT 20dB Bandwidth:	24.2 kHz
EUT Test Modulations:	Internal pattern generation – hopping enabled
Deviations From Standard:	None
Measurement BW:	30 kHz
Measurement Detector:	Peak

Environmental Conditions (Normal Environment)

Temperature: 22 °C	+15 ºC to +35 ºC (as declared)
Humidity: 42 % RH	20 % RH to 75 % RH (as declared)
Supply: 1.6 V dc	

12.3 Test Limit

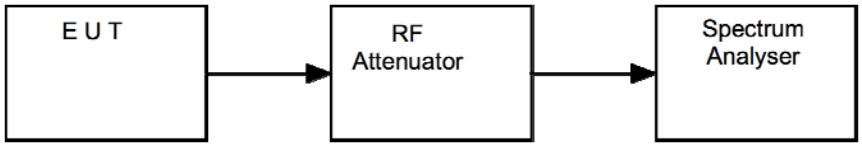
Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the -20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the band 2400 to 2483.5 MHz may have hopping channel carrier frequencies 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.

12.4 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

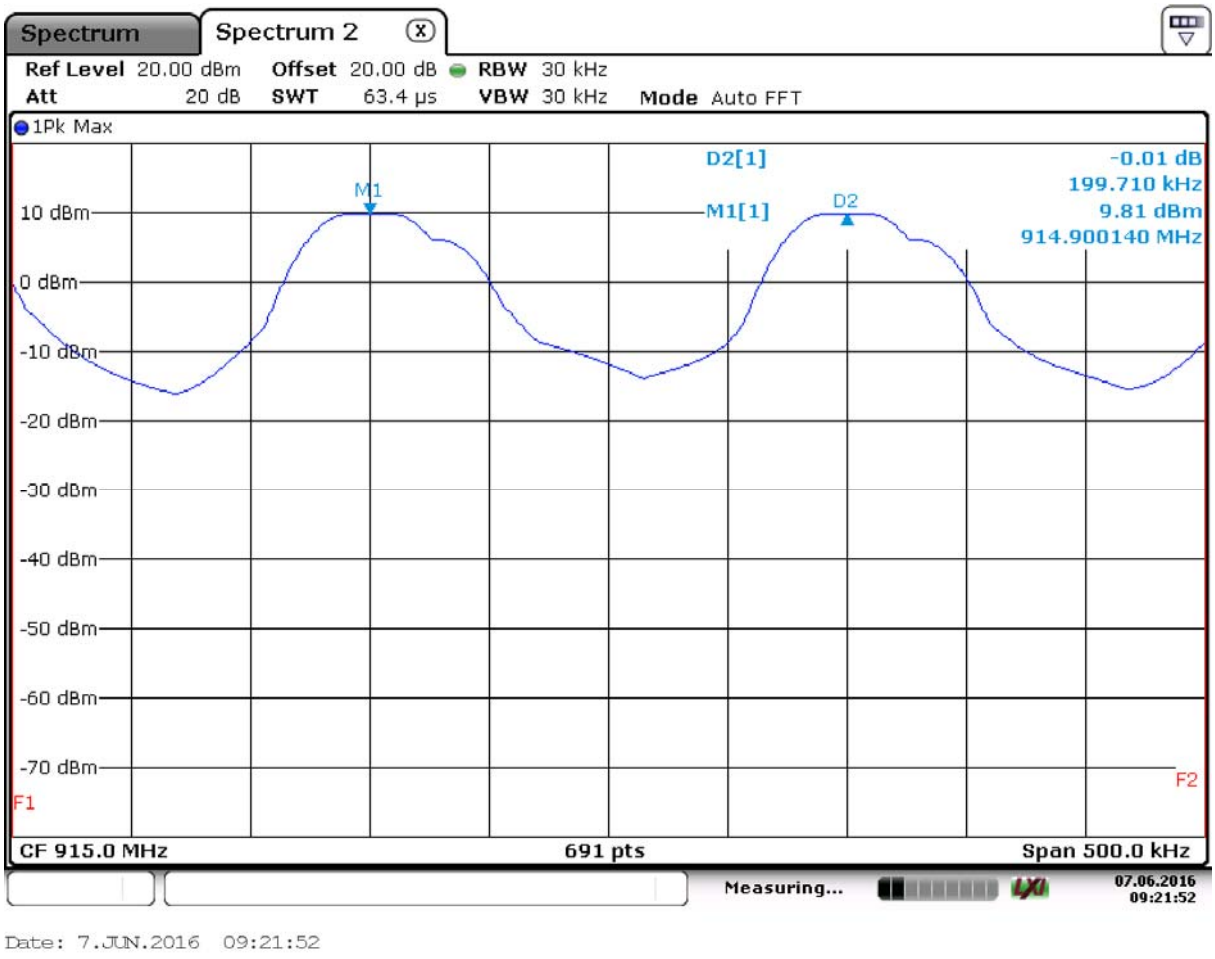


12.5 Test Equipment

Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
FSU50	R&S	Spectrum Analyser	U544	16/03/2017

12.6 Test Results

$F1_c$ (MHz)	***$F2_c$ (MHz)***	***Channel Separation, $F2_c - F1_c$ (kHz)***	***Result***
914.900140	915.09985	199.710	PASS



Date: 7.JUN.2016 09:21:52

13 Number of hopping frequencies

13.1 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.

13.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Lab
Test Standard and Clause:	ANSI C63.10-2013, Clause 7.8.3
EUT Channels / Frequencies Measured:	All;
EUT 20dB Bandwidth:	24.2 kHz
EUT Test Modulations:	Internal pattern generation – hopping enabled
Deviations From Standard:	None
Measurement BW:	30 kHz
Measurement Detector:	Peak

Environmental Conditions (Normal Environment)

Temperature: 22 °C	+15 ºC to +35 ºC (as declared)
Humidity: 42 % RH	20 % RH to 75 % RH (as declared)
Supply: 1.6 V dc	

13.3 Test Limit

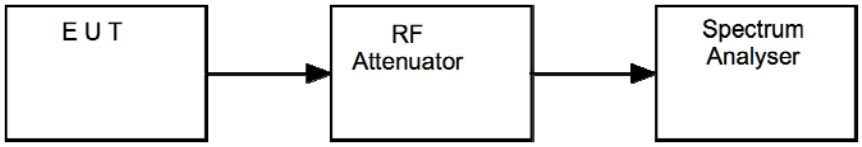
- For frequency hopping systems in the band 902 to 928 MHz: if the -20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping channels; If the -20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping channels;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

13.4 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

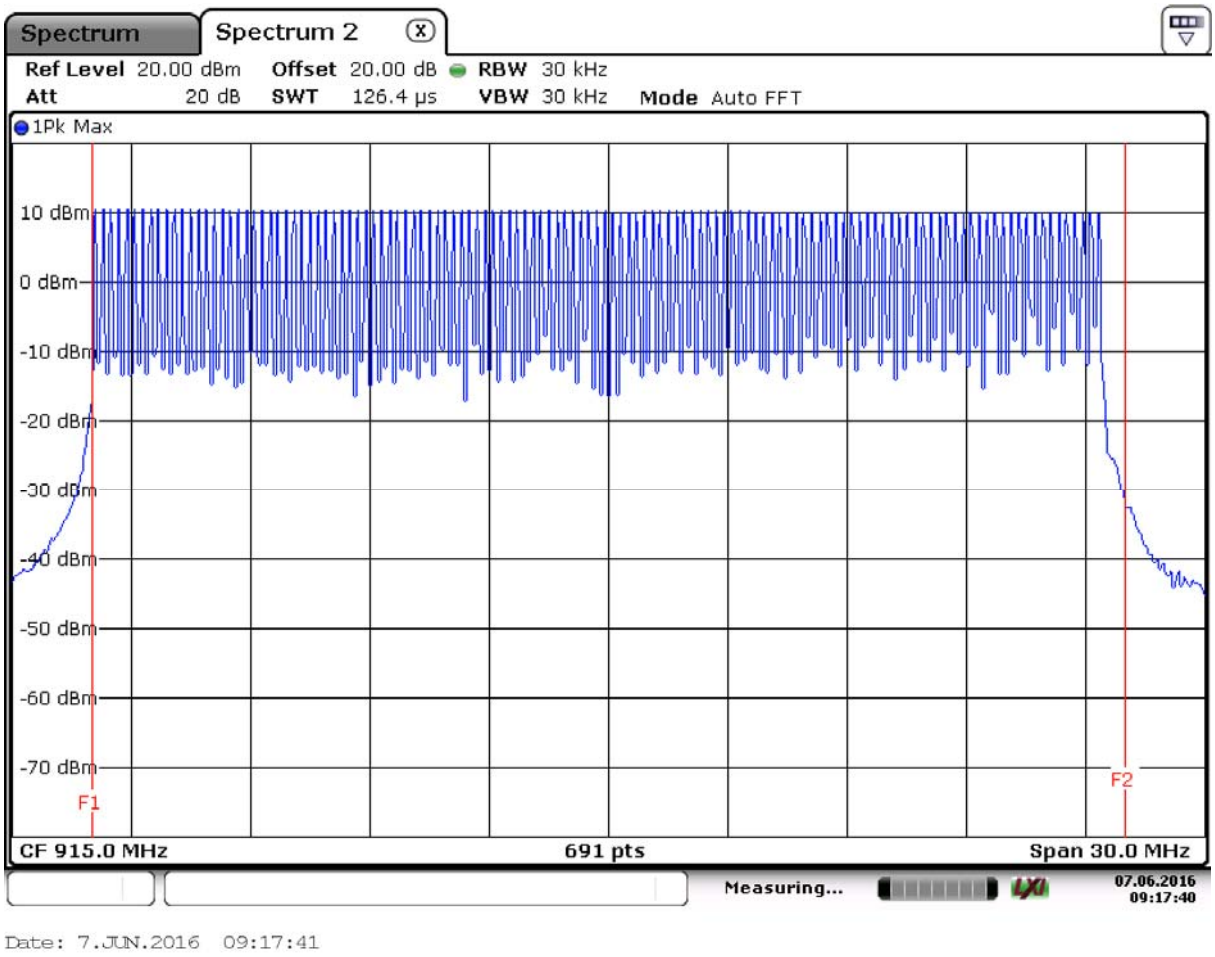


13.5 Test Equipment

Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
FSU50	R&S	Spectrum Analyser	U544	16/03/2017

13.6 Test Results

Lowest channel, F_{CL} (MHz)	***Highest channel, F_{CH} (MHz)***	***Number of channels observed***	***Result***
902.1	927.3	127	PASS



14 Average channel occupancy

14.1 Definition

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

14.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Lab
Test Standard and Clause:	ANSI C63.10-2013, Clause 7.8.4
EUT Channels / Frequencies Measured:	Mid
EUT 20dB bandwidth:	24.2 kHz
EUT Number of hopping channels:	127
EUT Test Modulations:	Internal pattern generation – hopping enabled
Deviations From Standard:	None
Measurement BW:	100 kHz
Measurement Detector:	Peak

Environmental Conditions (Normal Environment)

Temperature: 22 °C	+15 ºC to +35 ºC (as declared)
Humidity: 42 % RH	20 % RH to 75 % RH (as declared)
Supply: 1.6 V dc	1.6 V dc (as declared)

14.3 Test Limit

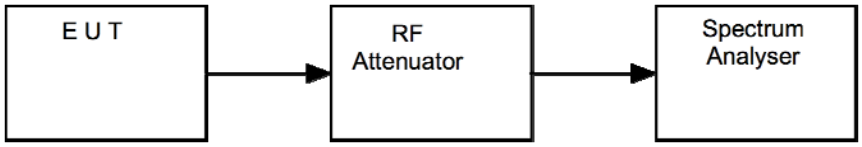
- For frequency hopping systems in the band 902 to 928 MHz: if the -20 dB bandwidth of the hopping channel is less than 250 kHz, the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 20 second period;
  If the -20 dB bandwidth of the hopping channel is 250 kHz or 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.

14.4 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

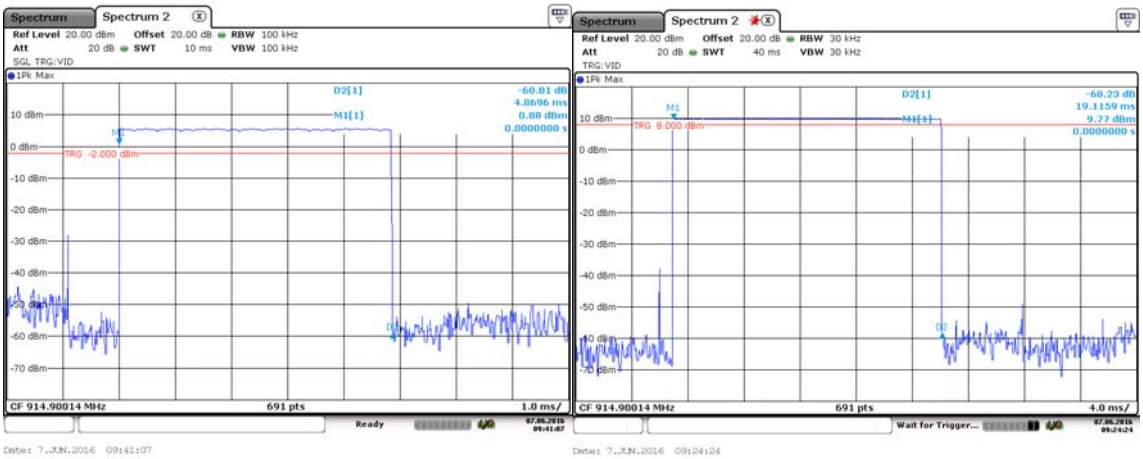


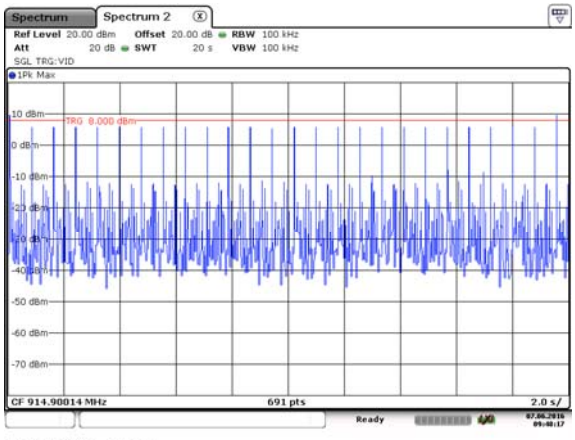
14.5 Test Equipment

Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
FSU50	R&S	Spectrum Analyser	U544	16/03/2017

14.6 Test Results

Individual occupancy time (ms)	***Observation period (s)***	***Number of hops observed***	***Average time of occupancy (s)***
19.1159	20	2	0.0382318
4.8696	20	24	0.1168704
Total On Time			0.1551022
Limit			0.4
Results			PASS





15 Maximum peak conducted output power

15.1 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.

15.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Lab
Test Standard and Clause:	ANSI C63.10-2013, Clause 7.8.5
EUT Channels / Frequencies Measured:	902.1 MHz / 914.7 MHz / 927.3 – hopping stopped.
EUT Channel Bandwidths:	200kHz
Deviations From Standard:	None
Measurement BW:	50 kHz
Spectrum Analyzer Video BW:	3 MHz
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: 22 °C	+15 ºC to +35 ºC (as declared)
Humidity: 42 % RH	20 % RH to 75 % RH (as declared)

15.3 Test Limit

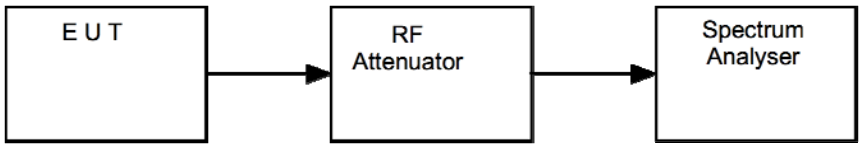
- For frequency hopping systems operating in the band 902 to 928 MHz, the maximum peak conducted output power shall not exceed 1 W, and the e.i.r.p. shall not exceed 4 W, if the hopset uses 50 or more hopping channels;
  the maximum peak conducted output power shall not exceed 0.25 W, and the e.i.r.p. 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.

15.4 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

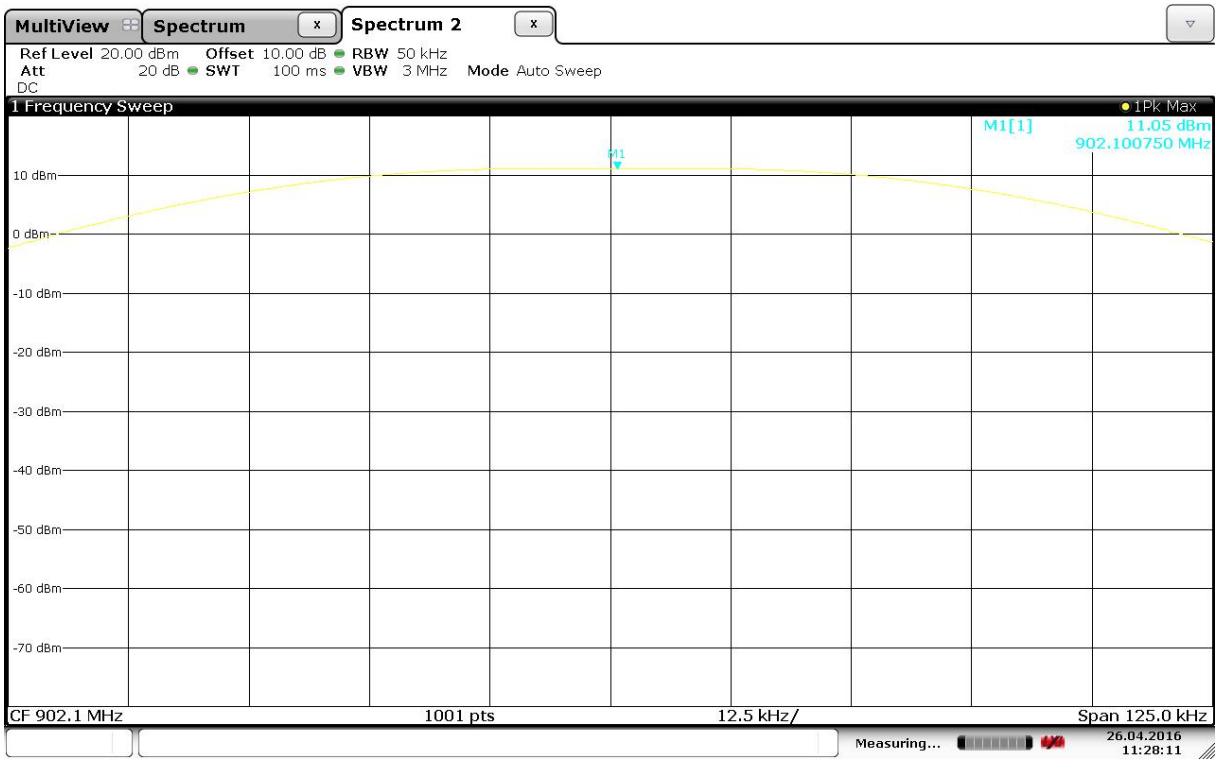


15.5 Test Equipment

Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
FSU50	R&S	Spectrum Analyser	U544	16/03/2017

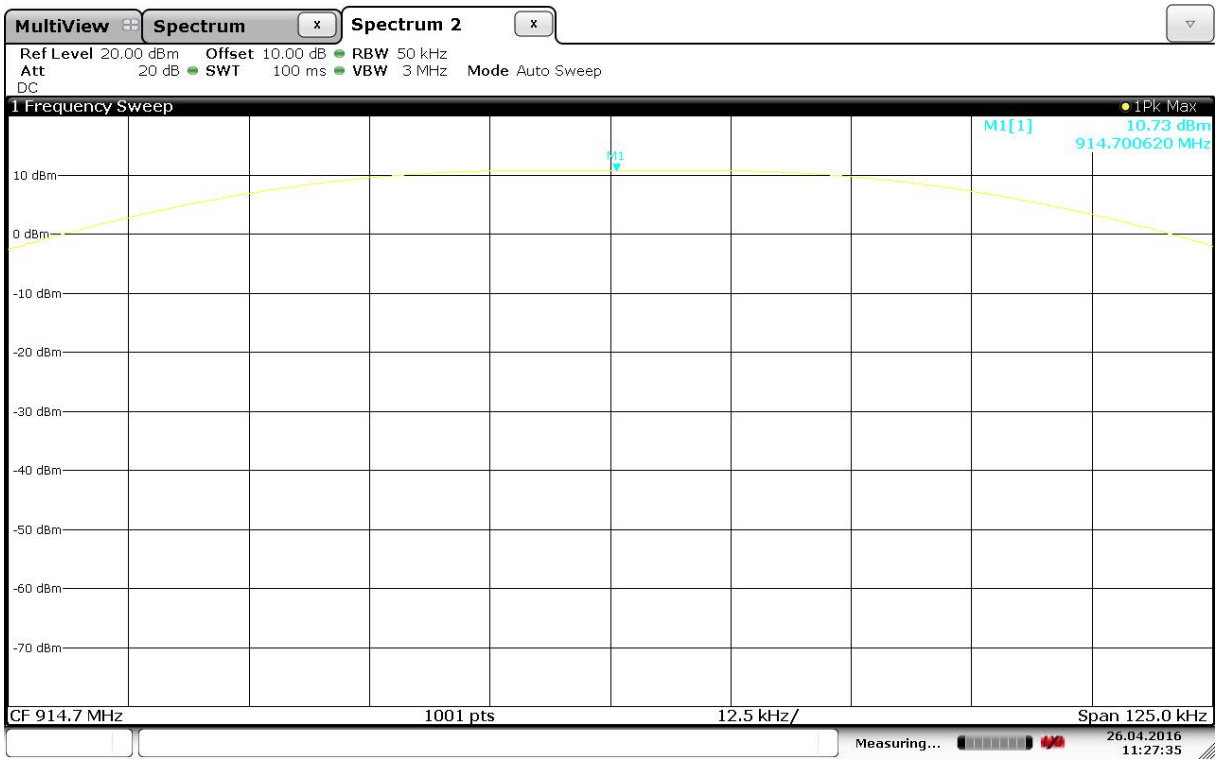
15.6 Test Results

Channel Frequency (MHz)	***Analyzer Level (dBm)***	***Maximum peak conducted output power (mW)***	***Result***
902.1	11.05	12.74	PASS
914.7	10.73	11.83	PASS
927.3	10.3	10.72	PASS



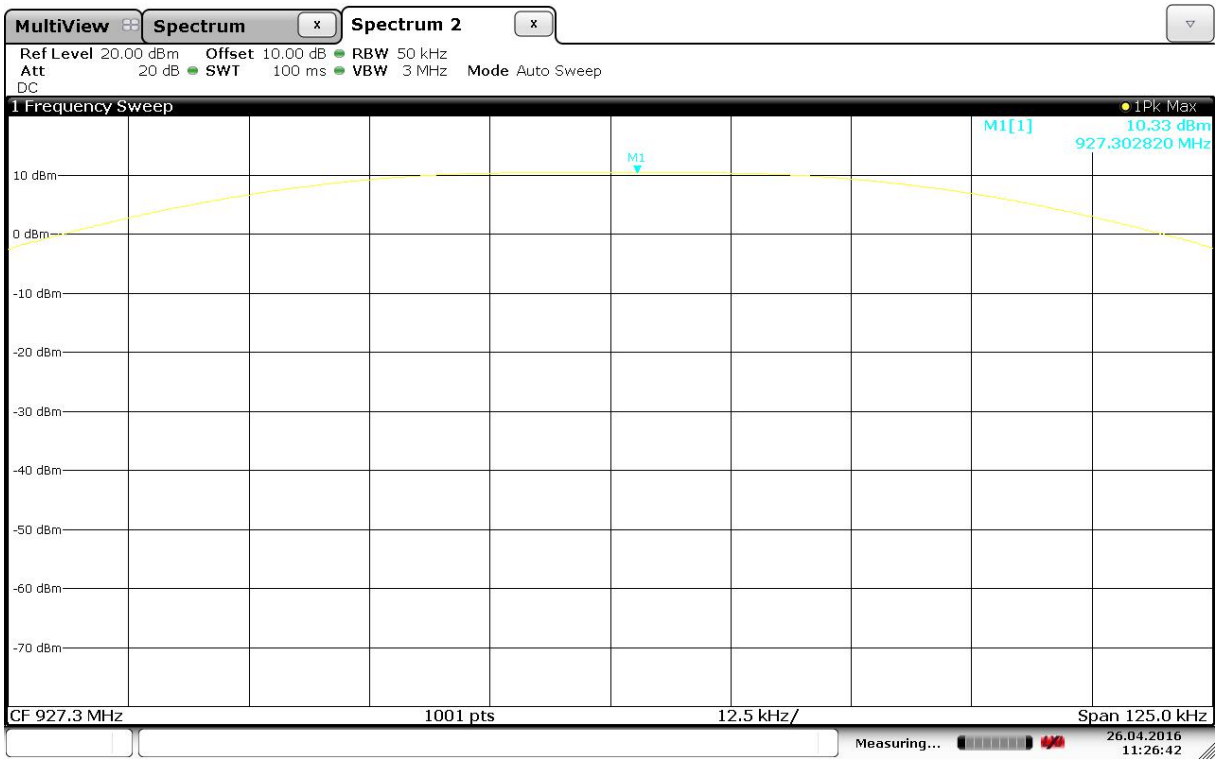
Date: 26.APR.2016 11:28:11

Operating Frequency - 902.1



Date: 26.APR.2016 11:27:35

Operating Frequency – 914.7



Operating Frequency – 927.3

16 Occupied Bandwidth

16.1 Definition

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.

16.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Lab
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.9
EUT Channels / Frequencies Measured:	902.1 MHz / 914.7 MHz / 927.3 – hopping stopped.
EUT Channel Bandwidths:	200kHz
EUT Test Modulations:	4.67kHz FSK
Deviations From Standard:	None
Measurement BW: (requirement: 1 % to 5 % OBW)	200 Hz
Spectrum Analyzer Video BW: (requirement at least 3x RBW)	3 MHz
Measurement Span: (requirement 2 to 5 times OBW)	2MHz
Measurement Detector:	Peak

Environmental Conditions (Normal Environment)

Temperature: 22 °C	+15 ºC to +35 ºC (as declared)
Humidity: 24 % RH	20 % RH to 75 % RH (as declared)
Supply: 1.6 Vdc	

16.3 Test Limit

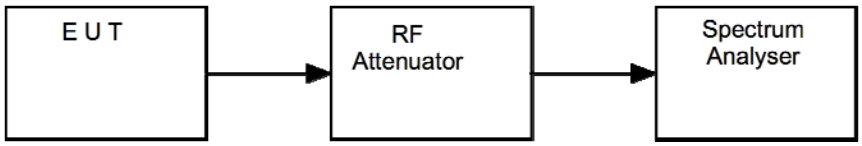
- For frequency hopping systems in the band 902 to 928 MHz: The maximum allowed -20 dB bandwidth of the hopping channel is 500 kHz.
- Frequency hopping systems operating in the band 5725 to 5850 MHz: The maximum -20 dB bandwidth of the hopping channel shall be 1 MHz

16.4 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

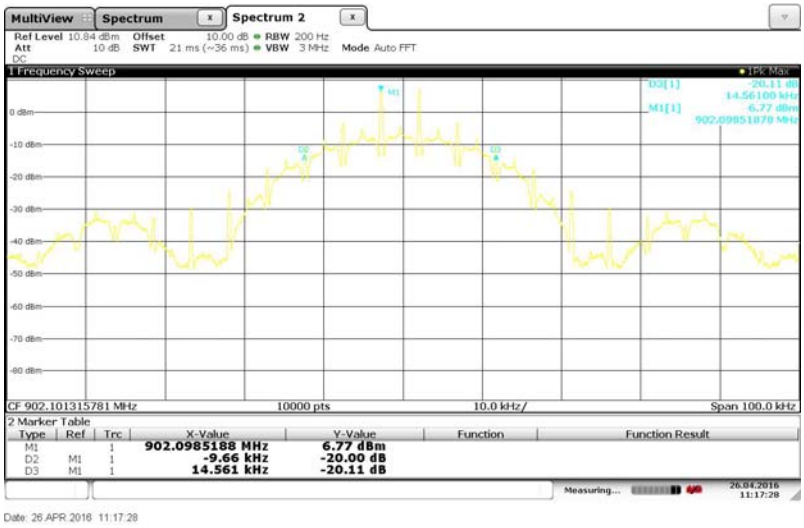


16.5 Test Equipment

Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
FSU50	R&S	Spectrum Analyser	U544	16/03/2017

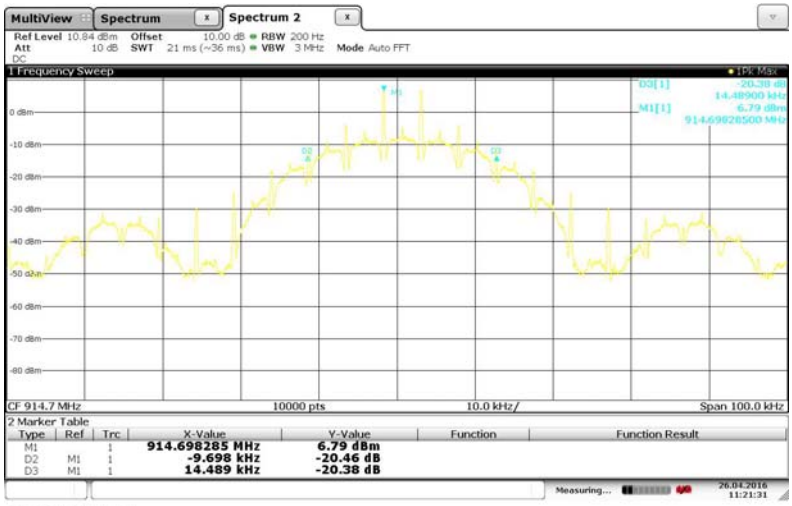
16.6 Test Results

Channel Frequency (MHz)	***F_L (MHz)***	***F_H (MHz)***	***20dB Bandwidth (kHz)***	***Result***
902.1	902.0888588	902.1130798	24.221	PASS
914.7	914.688587	914.712774	24.187	PASS
927.3	927.288326	927.312504	24.178	PASS



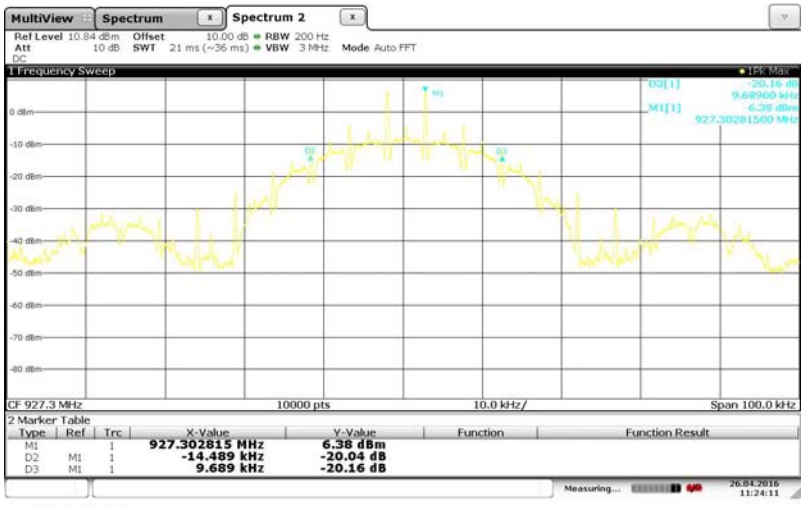
Date: 26.APR.2016 11:17:28

902.1 MHz



Date: 26.APR.2016 11:21:31

914.7 MHz



Date: 26.APR.2016 11:24:11

927.3 MHz

17 Out-of-band and conducted spurious emissions

17.1 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.

17.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Lab
Test Standard and Clause:	ANSI C63.10-2013, Clause 7.8.8
EUT Channels / Frequencies Measured:	902.1 MHz / 914.7 MHz / 927.3 – hopping stopped.
EUT Channel Bandwidths:	200kHz
Deviations From Standard:	None
Measurement BW:	100 kHz
Spectrum Analyzer Video BW: (requirement at least 3x RBW)	3 MHz
Measurement Detector:	Peak
Measurement Range:	30 MHz to 26.5 GHz

Environmental Conditions (Normal Environment)

Temperature: 22 °C	+15 ºC to +35 ºC (as declared)
Humidity: 42 % RH	20 % RH to 75 % RH (as declared)
Supply: 1.6 V dc	

17.3 Test Limits

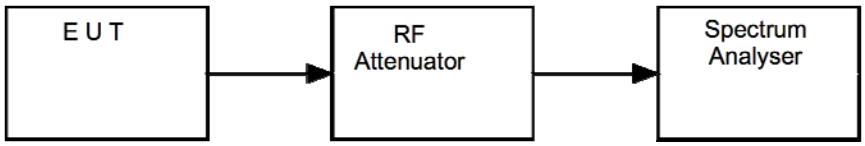
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either 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.

17.4 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

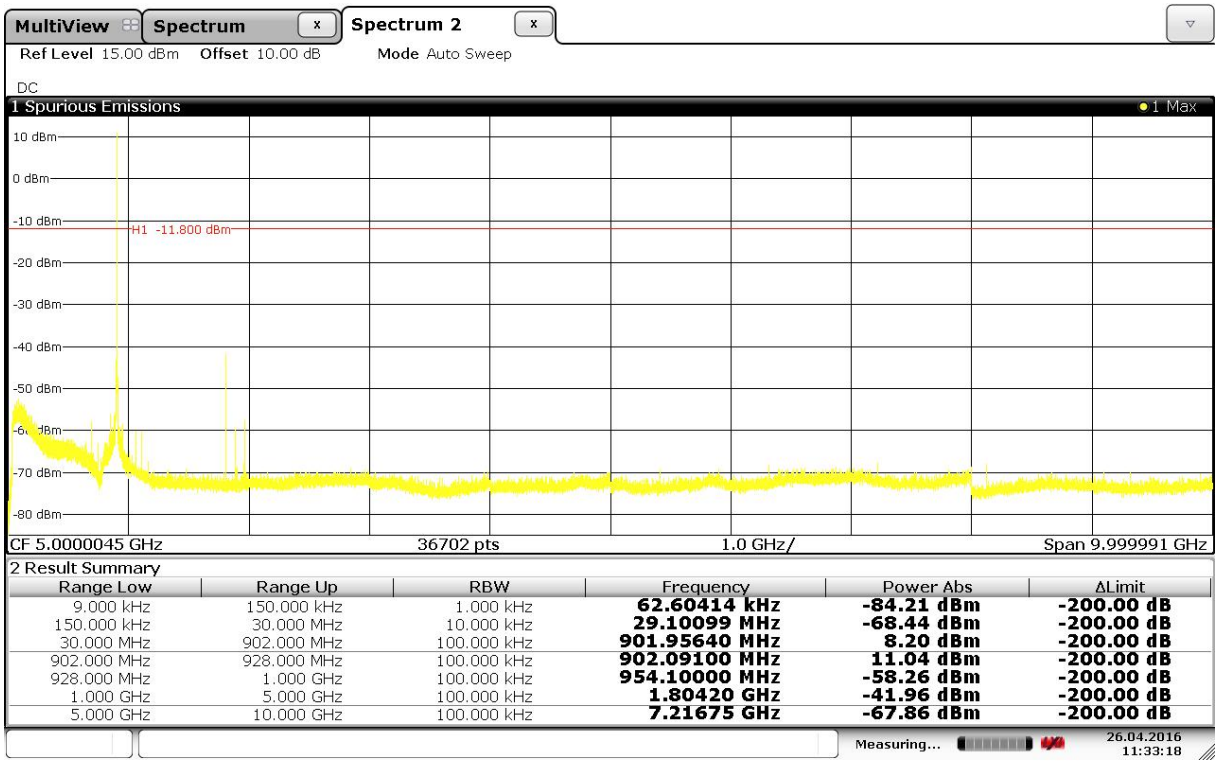


17.5 Test Equipment

Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
FSU50	R&S	Spectrum Analyser	U544	16/03/2017

17.6 Test Results

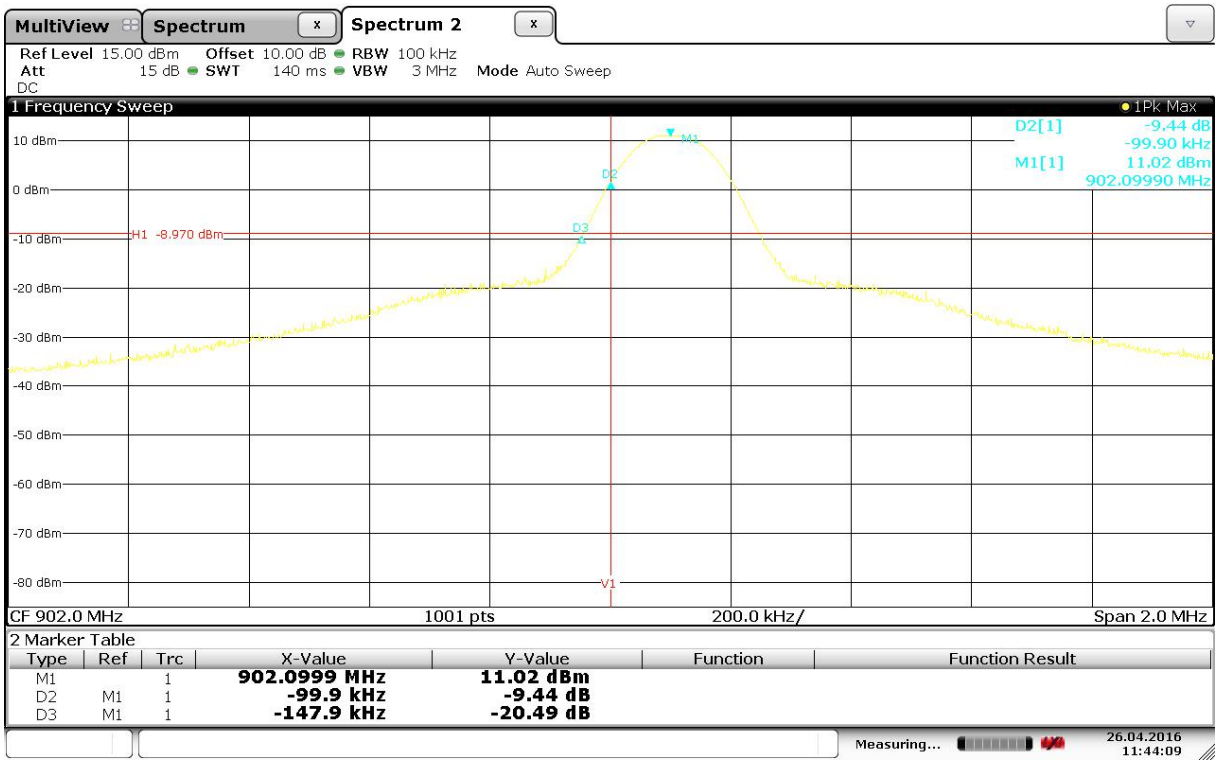
902.1 MHz						
Channel Frequency (MHz)	***Emission Frequency (MHz)***	***Peak Level (100kHz) (dBm)***	***Emission Level (dBm)***	***Limit (dBm)***	***Margin (dB)***	***Result***
No Significant Emissions Within 20 dB of the Limit						PASS



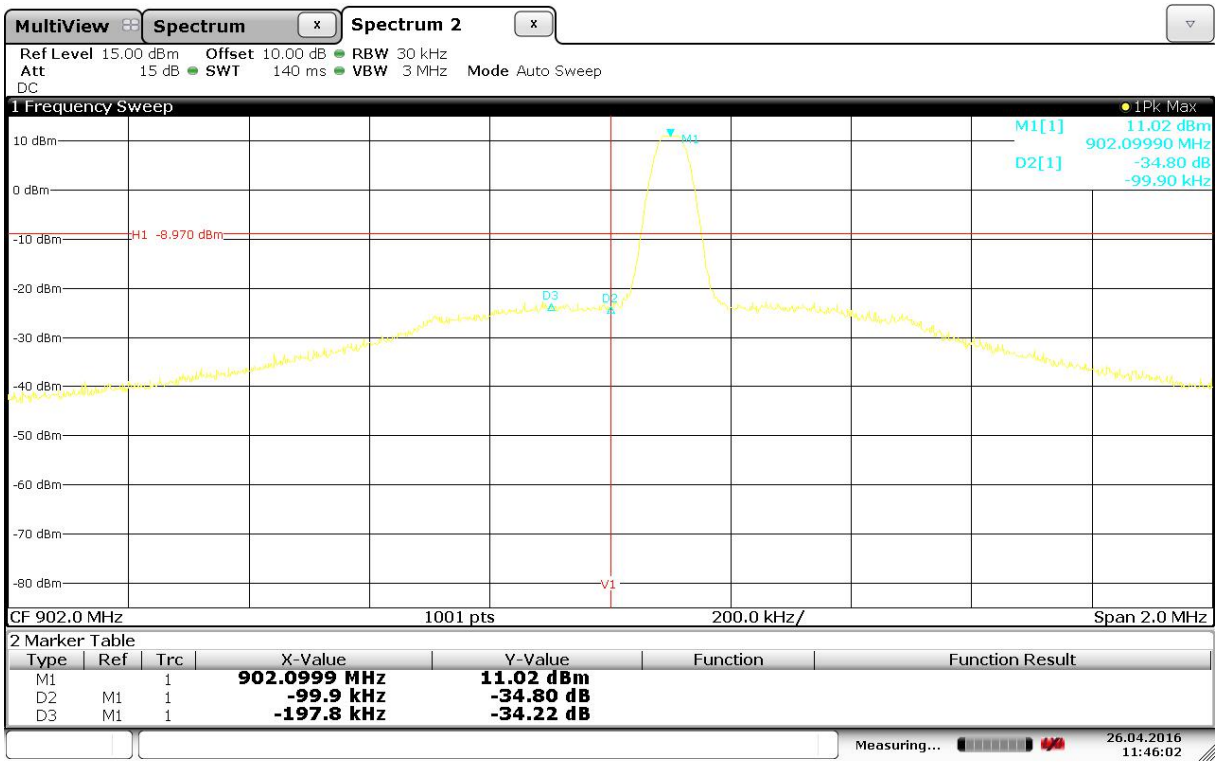
Date: 26.APR.2016 11:33:17

Band edge Compliance							
Channel Frequency (MHz)	***Peak Level (100kHz) (dBm)***	***Peak Level (30kHz) (dBm)***	***Emission Frequency (MHz)***	***Delta Marker (dB)***	***Limit (dB)***	***Margin (dB)***	***Result***
902.1	11.02	11.02	902	-34.80	-20	-14.8	PASS

As Peak Level in 100kHz and 30kHz are the same the delta level will apply directly to the limit

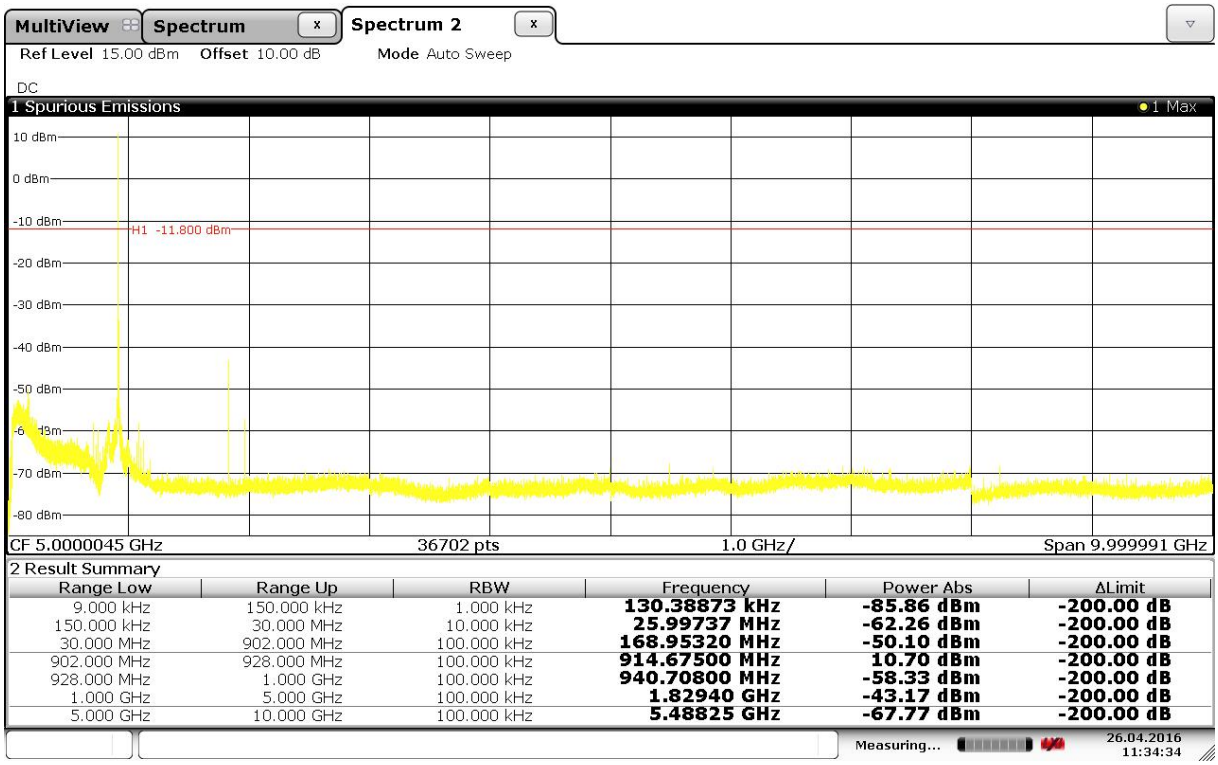


Date: 26.APR.2016 11:44:09



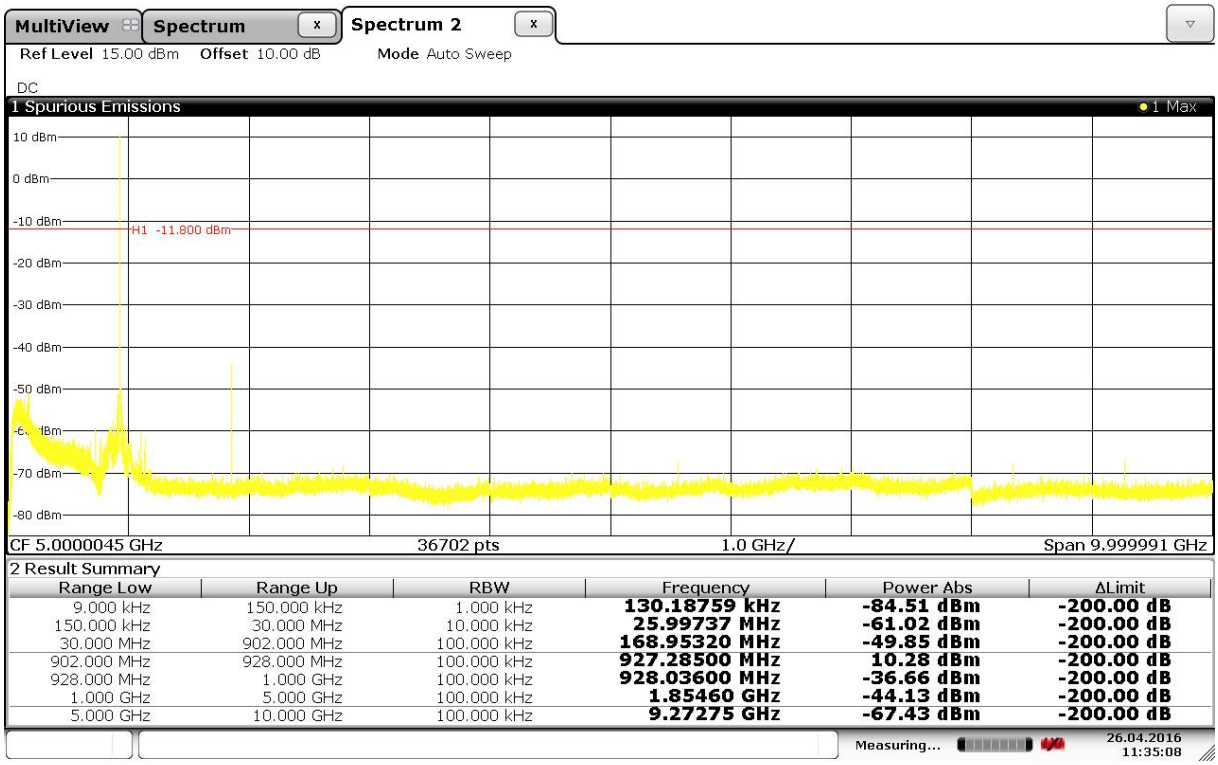
Date: 26.APR.2016 11:46:02

914.7 MHz						
Channel Frequency (MHz)	***Emission Frequency (MHz)***	***Analyzer Level (dBm)***	***Emission Level (dBm)***	***Limit (dBm)***	***Margin (dB)***	***Result***
No Significant Emissions Within 20 dB of the Limit						PASS



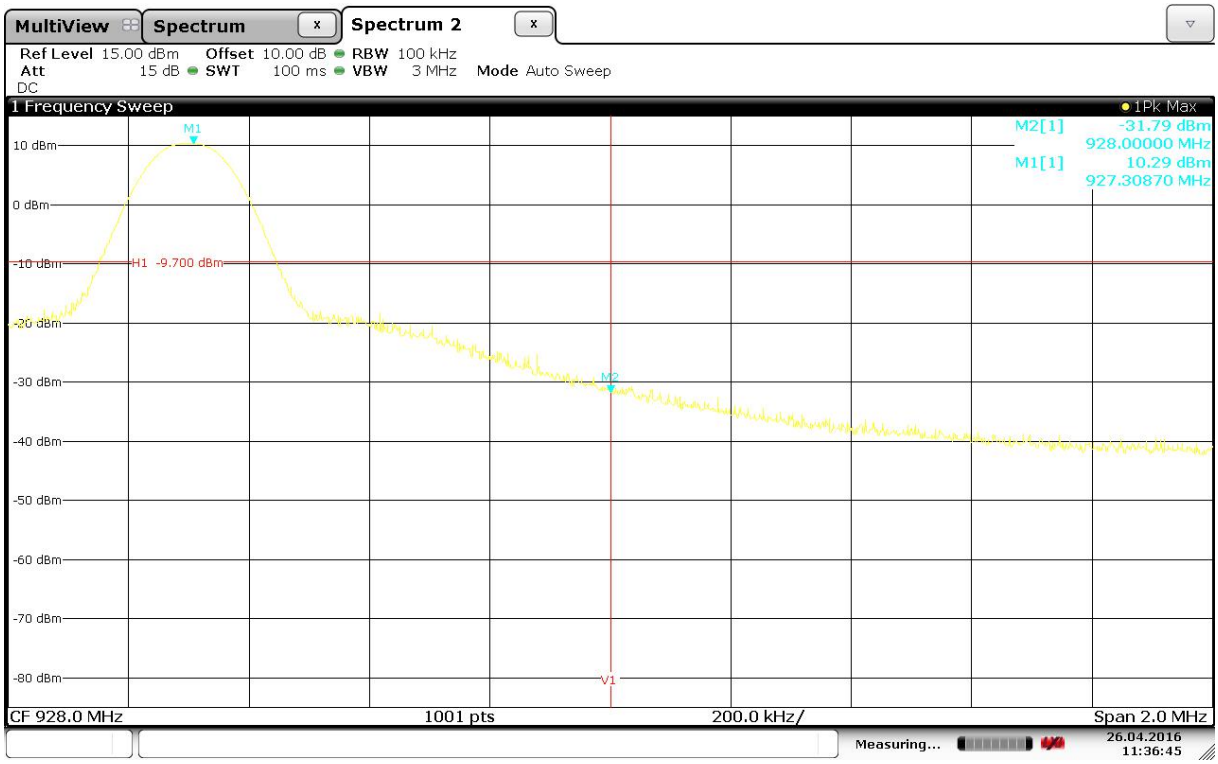
Date: 26.APR.2016 11:34:34

927.3 MHz						
Channel Frequency (MHz)	***Emission Frequency (MHz)***	***Analyzer Level (dBm)***	***Emission Level (dBm)***	***Limit (dBm)***	***Margin (dB)***	***Result***
No Significant Emissions Within 20 dB of the Limit						PASS



Date: 26.APR.2016 11:35:08

Band edge Compliance						
Channel Frequency (MHz)	***Emission Frequency (MHz)***	***Peak Level (100kHz) (dBm)***	***Emission Level (dBm)***	***Limit (dBm)***	***Margin (dB)***	***Result***
No Emissions Within 20 dB of the Limit						PASS



Date: 26.APR.2016 11:36:46

18 Radiated emissions – unintentional radiation / receiver emissions

18.1 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.

18.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Chambers 2 and 6
Test Standard and Clause:	ANSI C63.4-2014, Clause 8
EUT Channels / Frequencies Measured:	902.1 MHz / 914.7 MHz / 927.3 MHz
EUT Channel Bandwidths:	200 kHz
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: 21 °C	+15 ºC to +35 ºC (as declared)
Humidity: 30 % RH	20 % RH to 75 % RH (as declared)
Supply: 1.6 V dc	

18.3 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

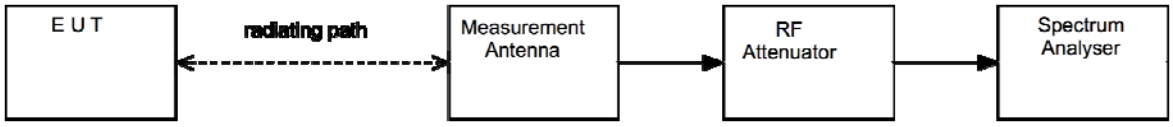
Frequency (MHz)	***Field Strength (µV/m at 3 m)***
30 to 88	100
88 to 216	150
216 to 960	200
Above 960	500

18.4 Test Method

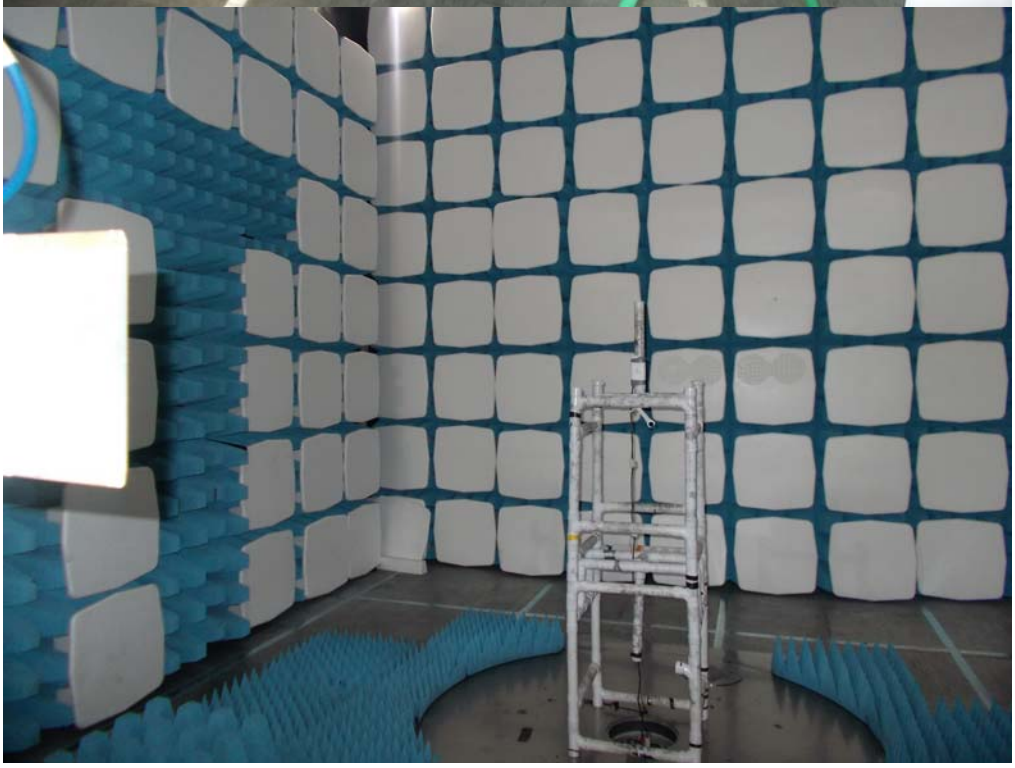
With the EUT setup as per section 9 of this report and connected as per Figure viii, the emissions from the EUT were measured on a spectrum analyzer / EMI receiver. The EUT was rotated in three orthogonal planes and the measurement antenna height scanned (below 1 GHz, from 1 to 4 m; above 1 GHz as necessary)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



18.5 Test Set-up Photograph



18.6 Test Equipment

Equipment Type	Manufacturer	Equipment Description	Element No	Due For Calibration
ESVS10	R&S	Receiver	L317	11/03/2017
FSU50	R&S	Spectrum Analyser	U544	16/03/2017
CBL6112B	Chase	Bilog	U093	17/06/2017
8449B	Agilent	Pre Amp	L572	16/02/2017
3115	EMCO	1-18GHz Horn	L139	25/09/2017

18.7 Test Results

Detector	*Freq. (MHz)*	*Measured Emission (dBµV/m)*	*Cable Loss (dB)*	*Antenna Factor (dB/m)*	*Pre-amp Gain (dB)*	*Field Strength (dBµV/m)*	*Extrap'n Factor (dB)*	*Field Strength (µV/m)*	*Limit (uV/m)*
No Significant Emissions									

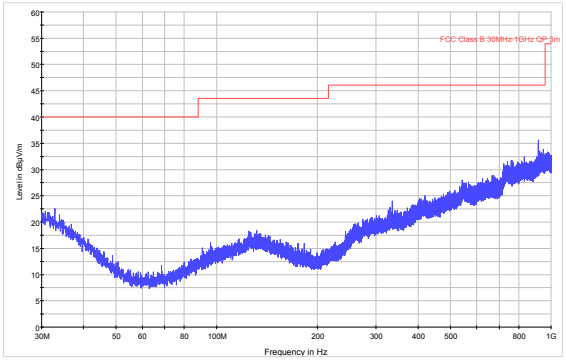


Figure 1 – Radiated Emissions Plot (30 MHz to 1 GHz); Vertical Polarization.

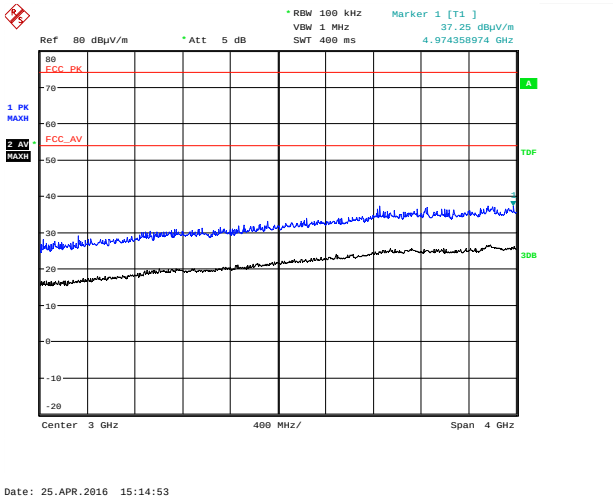


Figure 2 – Radiated Emissions Plot (1 GHz to 5 GHz); Vertical Polarization.

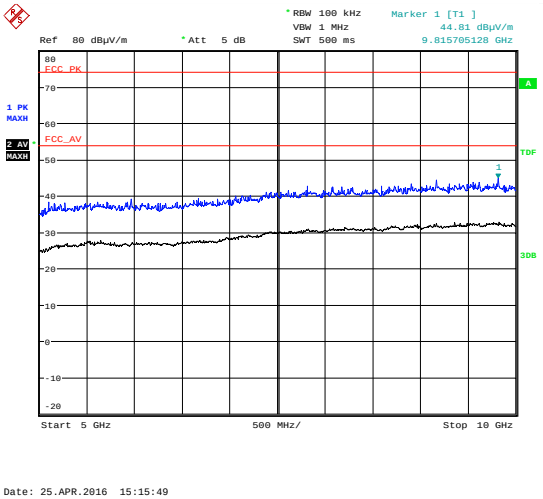


Figure 3 – Radiated Emissions Plot (5 GHz to 10 GHz); Vertical Polarization.

19 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 %**