Report on the Radio Testing

For

Cad-Capture Group Limited

on

OccupEye Base Station

Report no. TRA-029955-01-47-00A

16th February 2016

RF915 3.0

Report Number: TRA-029955-01-47-00A
Issue: A

REPORT ON THE RADIO TESTING OF A
Cad-Capture Group Limited
OccupEye Base Station
WITH RESPECT TO SPECIFICATION
FCC 47CFR 15.247

TEST DATE: 7th - 15th January 2016

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Date: 16th February 2016

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

1 Revision Record

Issue Number	*Issue Date*	*Revision History*
A	16th February 2016	Original

2 Summary

TEST REPORT NUMBER:	TRA-029955-01-47-00A
WORKS ORDER NUMBER	TRA-029955-01
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.
TEST SPECIFICATION(S):	47CFR15.247
EQUIPMENT UNDER TEST (EUT):	OccupEye Base Station
FCC IDENTIFIER:	2AHC7OEH01
EUT SERIAL NUMBER:	Not Applicable
MANUFACTURER/AGENT:	Cad-Capture Group Limited
ADDRESS:	Barnfield House Accrington Road Blackburn BB1 3NY United Kingdom
CLIENT CONTACT:	Simon Watts ☎ 01254 504400 ✉ simon.watts@cadcap.co.uk
ORDER NUMBER:	Not Applicable
TEST DATE:	7th - 15th January 2016
TESTED BY:	D Winstanley Element

2.1 Test Summary

Test Method and Description		***Requirement Clause*** ***47CFR15***	***Applicable to this equipment***	***Result / Note***
Radiated spurious emissions (restricted bands of operation and cabinet radiation)		15.205	☒	*Pass*
AC power line conducted emissions		15.207	☒	*Pass*
Occupied bandwidth		15.247(a)(2)	☒	*Pass*
Conducted carrier power	Peak	15.247(b)(3)	☐	*Pass*
	Max.		☒	
Conducted / radiated RF power out-of-band		15.247(d)	☒	*Pass*
Power spectral density, conducted		15.247(e)	☒	*Pass*
Calculation of duty correction		15.35(c)	☐	*N/A*
Radiated Emissions Unintentional Radiations / receiver emissions		15.109	☒	*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).

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4 Introduction

This report TRA-029955-01-47-00A presents the results of the Radio testing on a Cad-Capture Group Limited, OccupEye Base Station to specification 47CFR15 Radio Frequency Devices.

The testing was carried out for Cad-Capture 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.

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: OccupEye Base Station
- Serial Number: Not Applicable
- Model Number: Base Station
- 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.

S14 - EUT Power supply

S4 - Network Cable

S3 - Network Router (Remote from EUT)

S16 - Router PSU (Remote from EUT)

7.3 EUT Mode of Operation

7.3.1 Transmission

The mode of operation for Tx tests was as follows…

The EUT was set to the highest or lowest operating frequency transmitting a modulated carrier at maximum power.
The EUT was powered by and unfiltered +12Vdc Power supply and was connected to a remote network.

7.3.2 Reception

The mode of operation for Rx tests was as follows…

The EUT was set to receive mode on the highest and lowest operating frequency as required.
The EUT was powered by and unfiltered +12Vdc Power supply and was connected to a remote network.

7.4 EUT Radio Parameters

7.4.1 General

Frequency of operation:	910.5 MHz – 918.1 MHz
Modulation type(s):	FSK
Occupied channel bandwidth(s):	625 kHz
Channel spacing:	112.5 kHz
ITU emission designator(s):	F1D625k0
Declared output power(s):	5dBm (Conducted)
Nominal Supply Voltage:	+12Vdc
Duty cycle:	0.3

7.4.2 Antennas

Type:	1/2 Wave Centre-fed dipole with articulating base
Frequency range:	900-930 MHz
Impedance:	50 Ohms
SWR:	<2.0 typical at centre
Gain:	<1.2 dBi
Polarisation:	N/a
Beam width:	Not Stated
Connector type:	Part 15 compliant RP-SMA
Length:	142 mm
Weight:	Not stated
Environmental limits:	-30 to 80 Centigrade
Mounting:	Via RP-SMA connector mounted to host PCB

7.5 EUT Description

The EUT is part of an occupancy monitoring system. The EUT covered in this report is a base station operating on frequencies between 910.5 MHz - 918.1MHz in the 902 MHz - 928 MHz band.

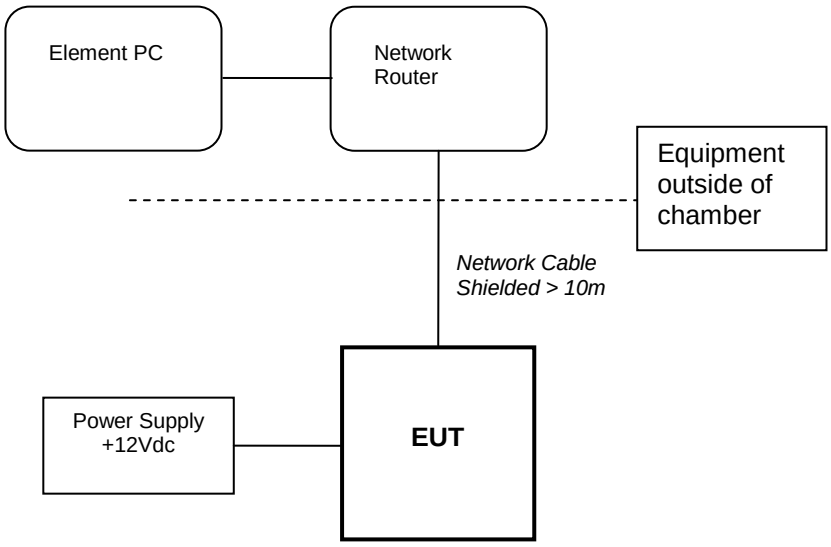
8 Modifications

No modifications were performed during this assessment.

9 EUT Test Setup

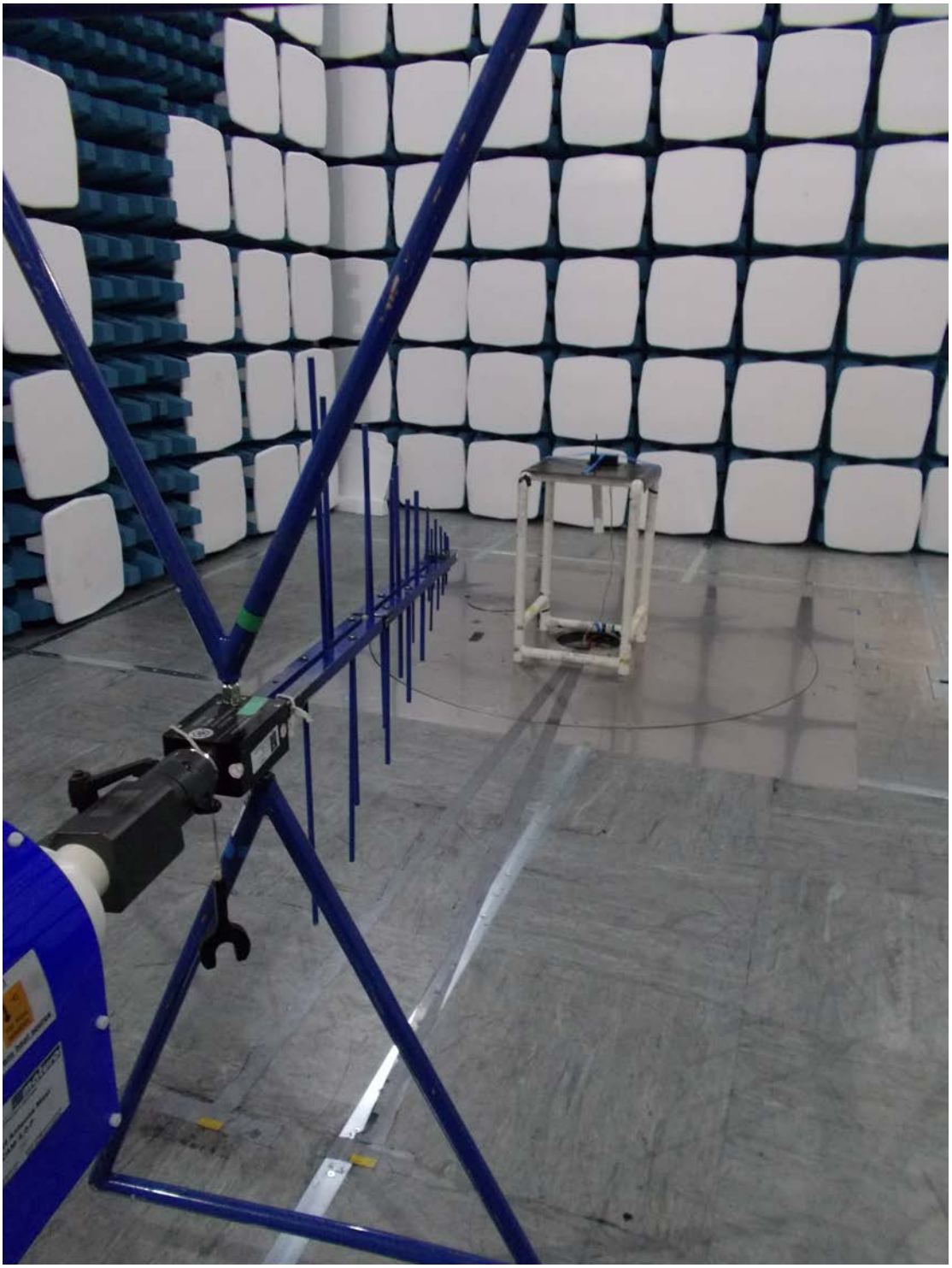
9.1 Block Diagram

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. 12 V dc from a power supply,

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	N/A
☒	Other	+12Vdc	N/A

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:	Radio Chamber (REF940)
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.5 and 6.6
EUT Channels / Frequencies Measured:	Low / High
EUT Channel Bandwidths:	> 500 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: 22 °C	+15 ºC to +35 ºC (as declared)
Humidity: 44 % RH	20 % RH to 75 % RH (as declared)
Supply: +12 Vdc	+10 Vdc to +14 Vdc (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 dBµV/m at the regulatory distance, using:

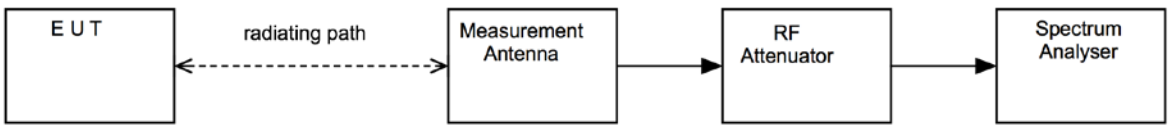
$$FS = PR + CL + AF - PA + DC - CF$$

Where,

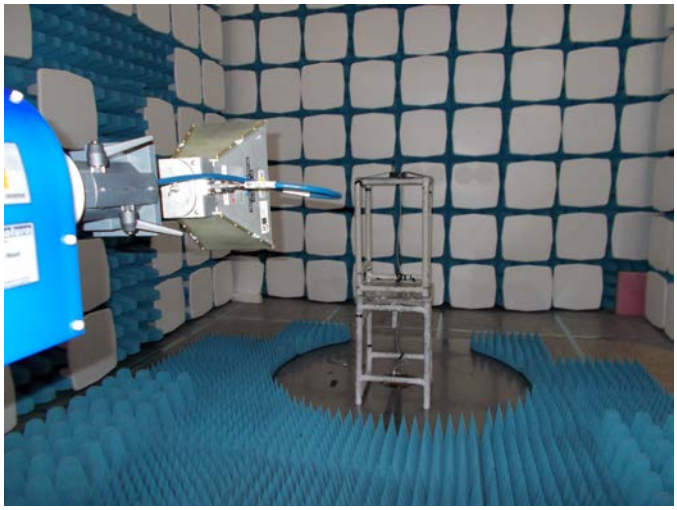
PR is the power recorded on the receiver / spectrum analyzer in dBµV;
CL is the cable loss in dB;
AF is the test antenna factor in dB/m;
PA is the pre-amplifier gain in dB (where used);
DC is the duty correction factor in dB (where used, e.g. harmonics of pulsed fundamental);
CF is the distance factor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

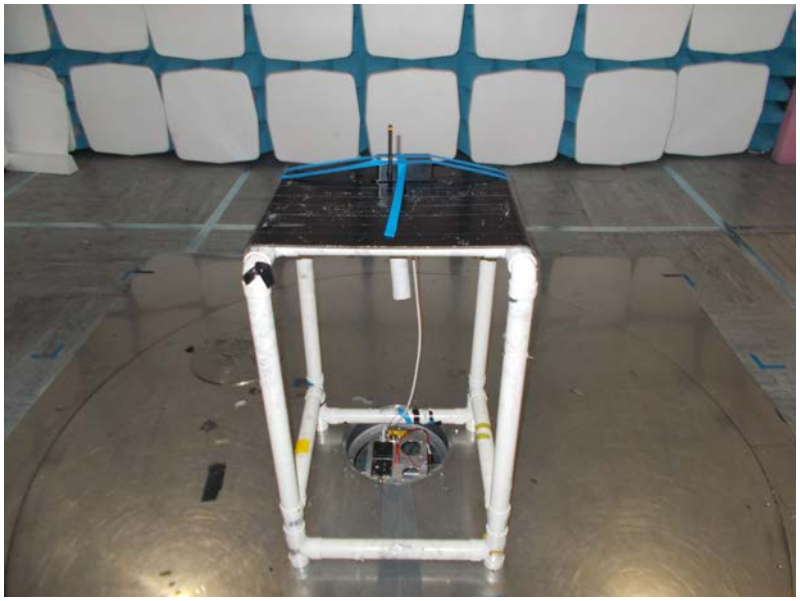
This field strength value is then compared with the regulatory limit.

Figure i Test Setup



11.5 Test Set-up Photograph



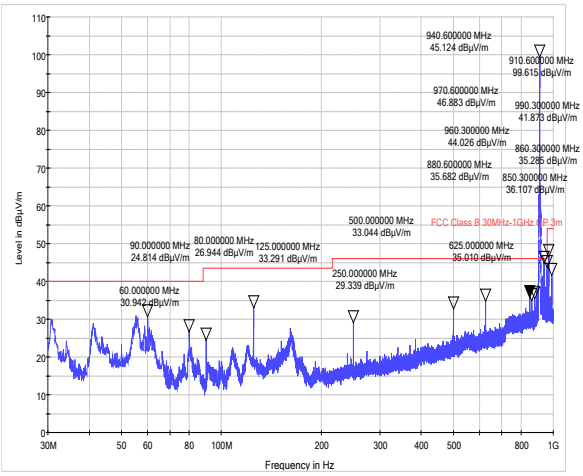


11.6 Test Equipment

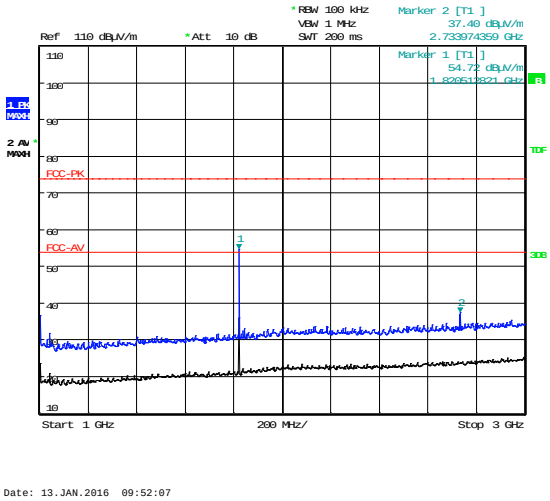
Type of Equipment	*Maker/Supplier*	*Model Number*	*Element Number*	*Calibration Due Date*	*Calibration Interval*
Spectrum Analyser	Rhode & Schwarz	FSU46	REF909	13/02/2016	12
Receiver	Rhode & Schwarz	ESVS10	TRL317	26/02/2016	12
Pre Amplifier	Agilent	8449B	L572	10/02/2016	12
Horn Antenna	EMCO	3115	L139	25/09/2017	24
Log Periodic Antenna	Chase	CBL611/A	UH191	26/02/2017	24

11.7 Test Results

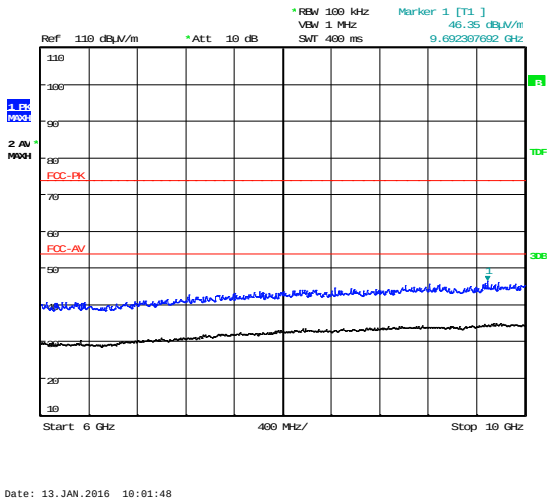
Low Channel										
Detector	***Freq. (MHz)***	***Meas'd Emission (dBµV)***	***Cable Loss (dB)***	***Antenna Factor (dB/m)***	***Pre-amp Gain (dB)***	***Duty Cycle Corr'n (dB)***	***Distance Extrap'n Factor (dB)***	***Field Strength (dBµV/m)***	***Field Strength (µV/m)***	***Limit (µV/m)***
QP	125.00	15.0	1.6	12.6	N/A	0.00	0.00	29.22	28.91	150
QP	960.60	15.1	4.3	24.0	N/A	0.00	0.00	43.39	147.74	500
QP	990.30	12.1	4.4	23.9	N/A	0.00	0.00	40.33	103.87	500
QP	250.00	11.2	2.4	12.1	N/A	0.00	0.00	25.68	19.23	200
QP	970.60	-1.4	4.3	24.2	N/A	0.00	0.00	27.05	22.52	500
Pk	2730.76	51.78	4.2	29	36.12	0.00	0.00	48.86	277.33	5012
Av	2730.76	39.81	4.2	29	36.12	0.00	0.00	36.89	69.90	500



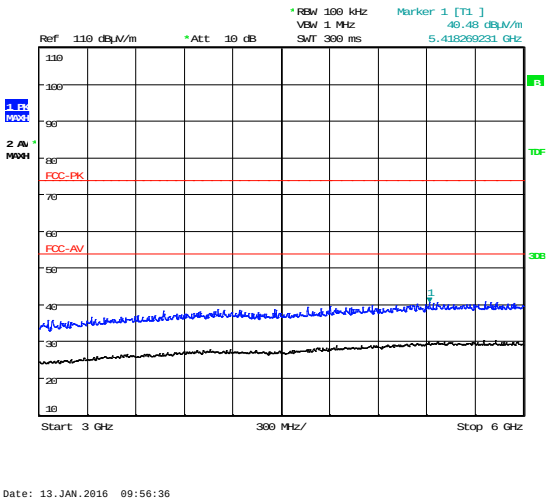
30MHz – 1GHz



1GHz – 3GHz

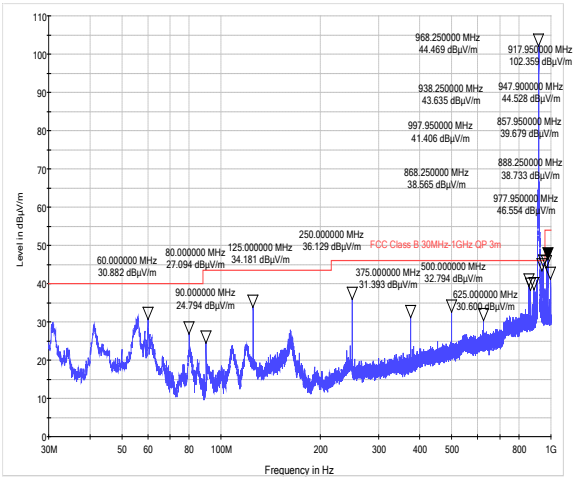


3GHz – 6GHz

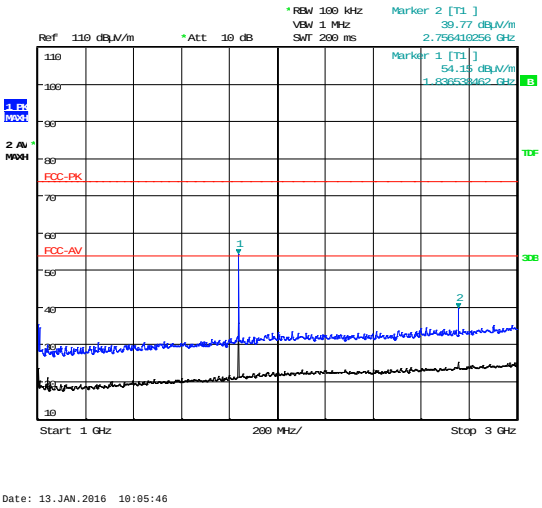


6GHz – 10GHz

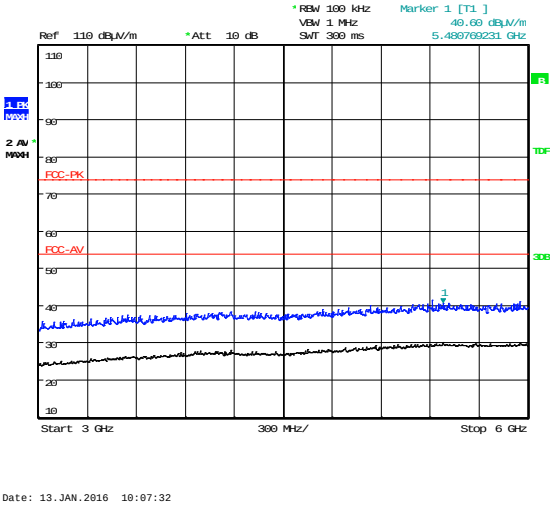
High Channel										
Detector	***Freq. (MHz)***	***Meas'd Emission (dBµV)***	***Cable Loss (dB)***	***Antenna Factor (dB/m)***	***Pre-amp Gain (dB)***	***Duty Cycle Corr'n (dB)***	***Distance Extrap'n Factor (dB)***	***Field Strength (dBµV/m)***	***Field Strength (µV/m)***	***Limit (µV/m)***
QP	108.05	15.0	1.5	11.1	N/A	0.00	0.00	27.64	24.10	150
QP	125.00	17.3	1.6	12.6	N/A	0.00	0.00	31.48	37.50	150
QP	273.60	14.8	2.2	12.6	N/A	0.00	0.00	29.64	30.34	200
QP	967.95	19.1	4.3	24.1	N/A	0.00	0.00	47.5	237.14	500
QP	978.25	21.0	4.3	24.1	N/A	0.00	0.00	49.39	294.78	500
QP	998.25	17.9	4.4	23.8	N/A	0.00	0.00	46.07	201.14	500
Pk	2753.75	52.03	3.9	29.1	36.11	0.00	0.00	48.92	279.25	5012
Av	2753.75	40.08	3.9	29.1	36.11	0.00	0.00	36.97	70.55	500



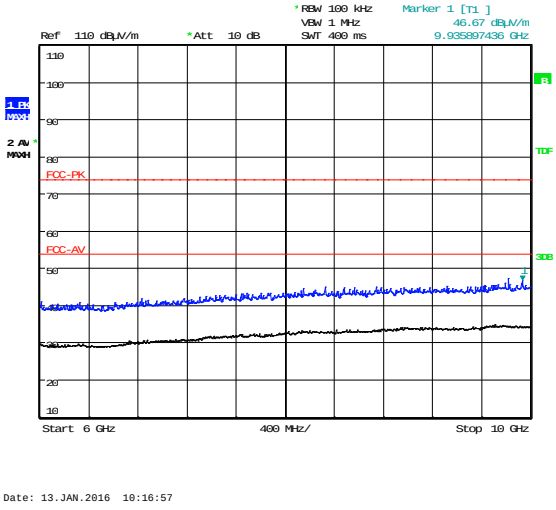
30MHz – 1GHz



1GHz – 3GHz



3GHz – 6GHz



6GHz – 10GHz

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 Skelmersdale
Test Chamber:	Transient Lab
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.2
EUT Channel Bandwidths:	> 500 kHz
Deviations From Standard:	None
Measurement BW:	10 kHz
Measurement Detectors:	Quasi-Peak and Average, RMS

Environmental Conditions (Normal Environment)

Temperature: 19 °C	+15 ºC to +35 ºC (as declared)
Humidity: 33 % RH	20 % RH to 75 % RH (as declared)
Supply: +12 Vdc	+10 Vdc to +14 Vdc (as declared)

12.3 Test Limit

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

Table 3 – AC Power Line Conducted Emission Limits

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

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

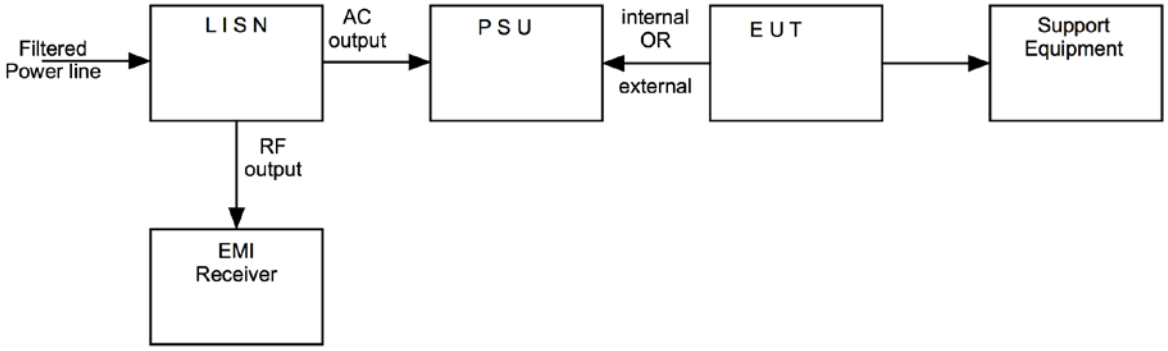
12.4 Test Method

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



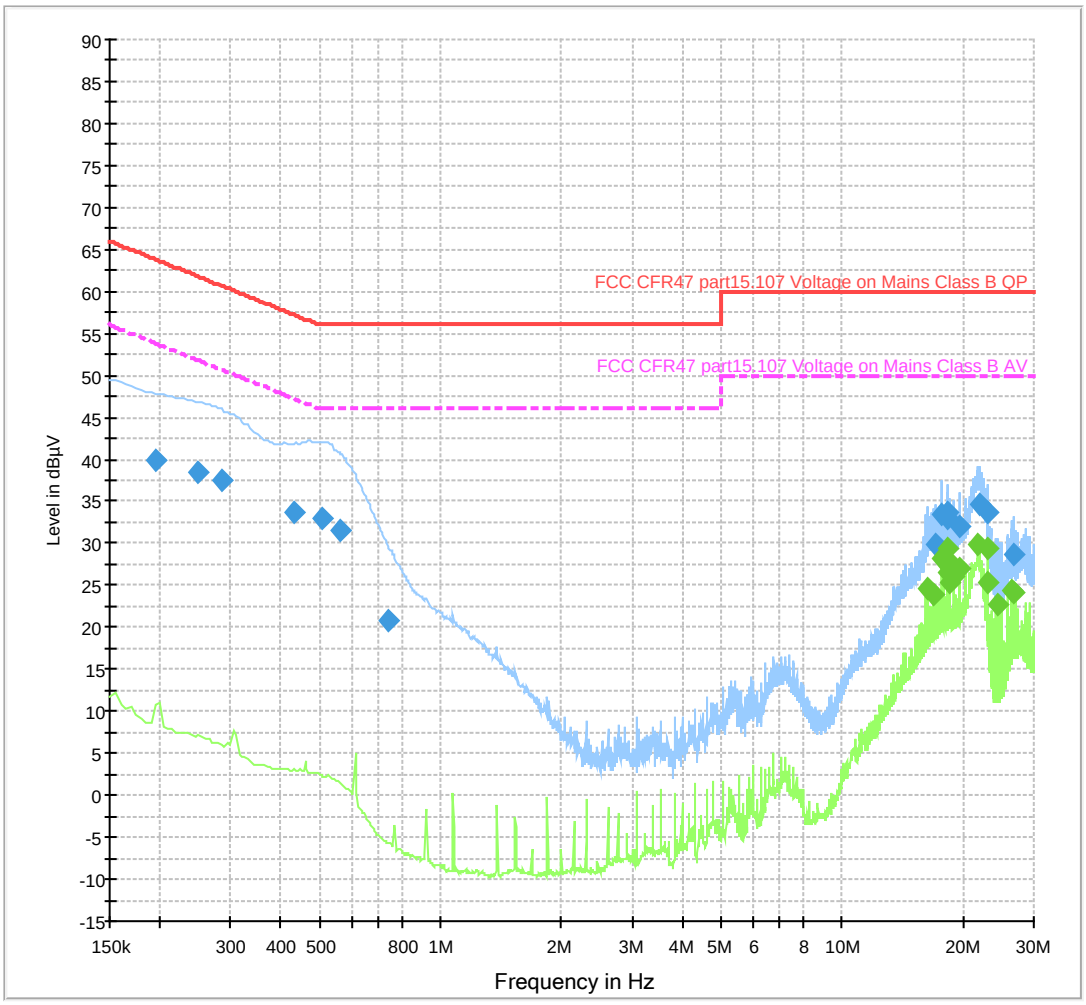
12.5 Test Set-up Photograph

12.6 Test Equipment

Type of Equipment	*Maker/Supplier*	*Model Number*	*Element Number*	*Calibration Due Date*	*Calibration Interval*
Receiver	Rhode & Schwarz	ESHS10	UH187	29/10/16	12
Lisn	Rhode & Schwarz	UH187	UH396	01/07/16	12

12.7 Test Results – Transmit Mode

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

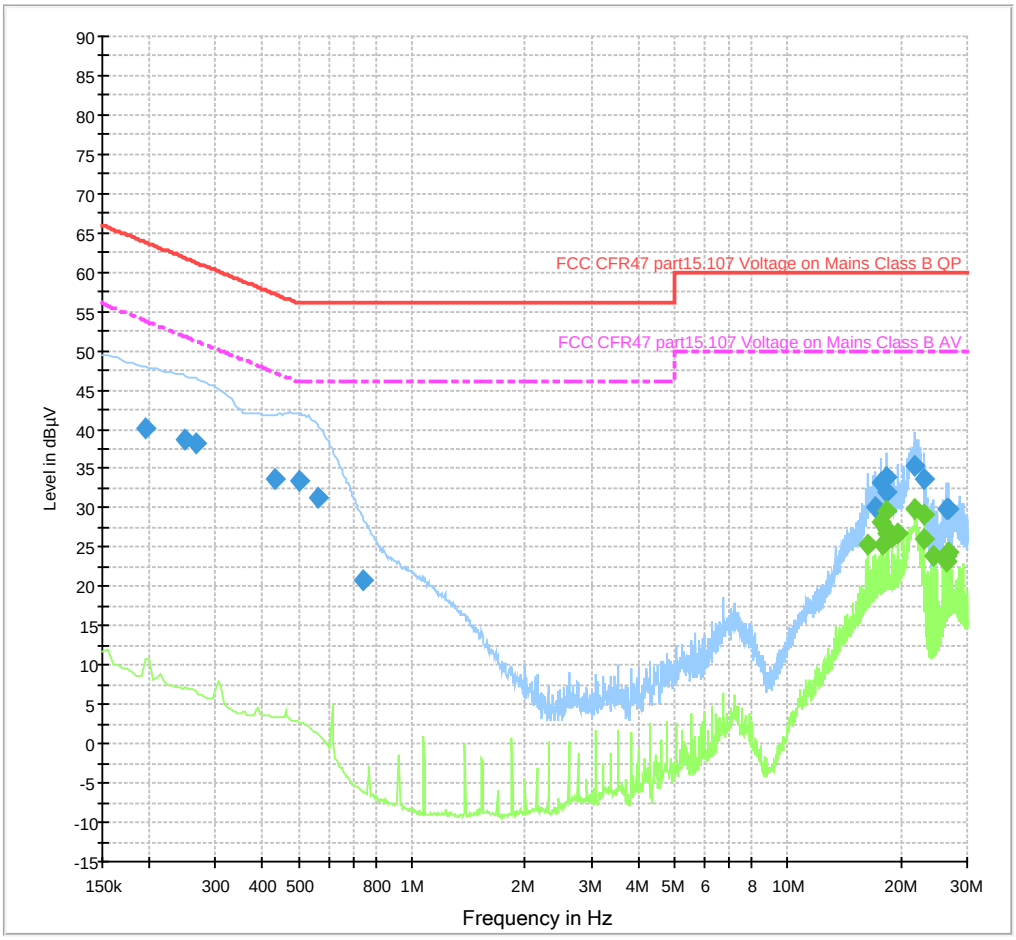


Results measured using the average detector						
Reference Number	***Frequency (MHz)***	***Conductor***	***Result (dBuV)***	***Specification Limit (dBuV)***	***Margin (dB)***	***Result Summary***
No Significant Emissions Within 20 dB of limit						PASS

Results measured using the quasi-peak detector						
Reference Number	***Frequency (MHz)***	***Conductor***	***Result (dBuV)***	***Specification Limit (dBuV)***	***Margin (dB)***	***Result Summary***
No Significant Emissions Within 20 dB of limit						PASS

12.8 Test Results – Receive Mode

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



Results measured using the average detector						
Reference Number	**Frequency (MHz)**	**Conductor**	**Result (dBuV)**	**Specification Limit (dBuV)**	**Margin (dB)**	**Result Summary**
No Significant Emissions Within 20 dB of limit						PASS

Results measured using the quasi-peak detector						
Reference Number	**Frequency (MHz)**	**Conductor**	**Result (dBuV)**	**Specification Limit (dBuV)**	**Margin (dB)**	**Result Summary**
No Significant Emissions Within 20 dB of limit						PASS

13 Occupied Bandwidth

13.1 Definition

The emission bandwidth (-6 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 6 dB below the maximum in-band spectral density of the modulated signal.

13.2 Test Parameters

Test Location:	Element North West
Test Chamber:	Radio Lab
Test Standard and Clause:	IC: ANSI C63.10-2013, Clause 6.9 FCC: ANSI C63.10-2013, Clause 11.8
EUT Channels / Frequencies Measured:	Low / High
EUT Channel Bandwidths:	> 500 kHz
EUT Test Modulations:	GFSK
Deviations From Standard:	None
Measurement BW: (IC requirement: 1% to 5% OBW; FCC requirement: 100 kHz)	100 kHz
Spectrum Analyzer Video BW: (requirement at least 3x RBW)	300 kHz
Measurement Span: (requirement 2 to 5 times OBW)	5 MHz
Measurement Detector:	Peak

Environmental Conditions (Normal Environment)

Temperature: 24 °C	+15 ºC to +35 ºC (as declared)
Humidity: 47 % RH	20 % RH to 75 % RH (as declared)
Supply: 12 V dc	+10 to +14 Vdc (as declared)

13.3 Test Limit

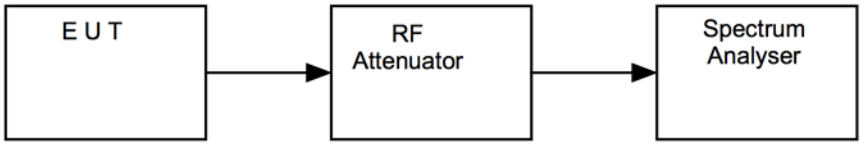
The minimum -6 dB bandwidth shall be at least 500 kHz.

13.4 Test Method

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

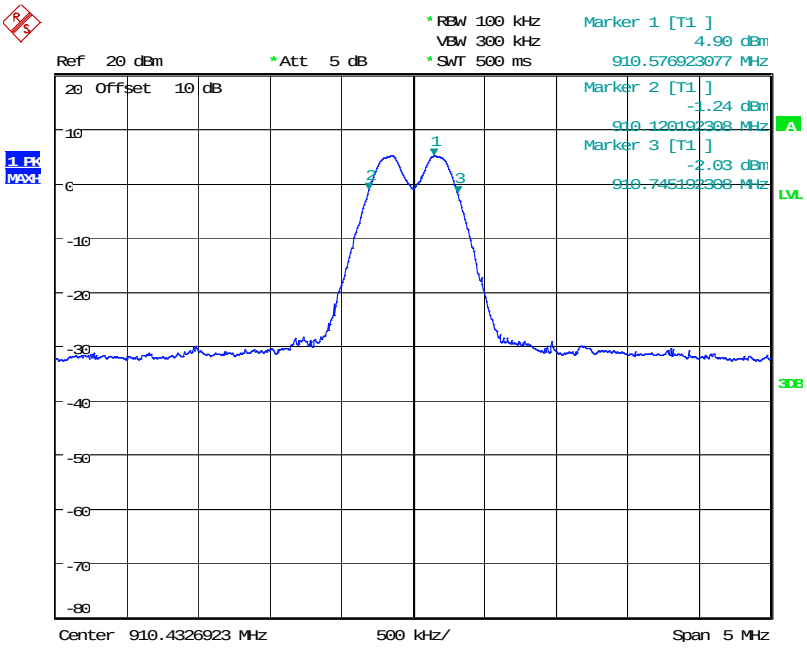


13.5 Test Equipment

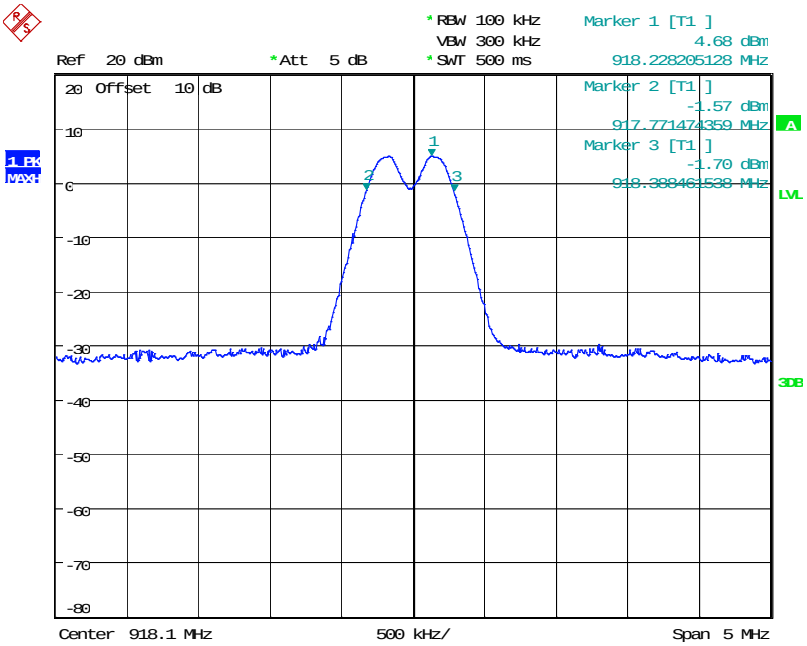
Type of Equipment	*Maker/Supplier*	*Model Number*	*Element Number*	*Calibration Due Date*	*Calibration Interval*
Spectrum Analyser	Rhode & Schwarz	FSU46	U281	24/04/2016	12

13.6 Test Results

Channel Frequency (MHz)	*F_L (MHz)*	*F_H (MHz)*	*6dB Bandwidth (kHz)*	*Result*
910.5	910.1201923	910.7451923	625.00	PASS
918.1	917.7714744	918.3884615	616.98	PASS



Date: 12.JAN.2004 13:26:09



Date: 12.JAN.2004 13:30:53

14 Maximum peak conducted output power

14.1 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.

The maximum conducted output power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level.

14.2 Test Parameters

Test Location:	Element North West
Test Chamber:	Radio Lab
Test Standard and Clause:	ANSI C63.10-2013, Clause 11.9.1
EUT Channels / Frequencies Measured:	Low / High
EUT Channel Bandwidths:	> 500 kHz
Deviations From Standard:	None
Measurement BW:	1 MHz
Spectrum Analyzer Video BW: (requirement at least 3x RBW)	3 MHz
Measurement Detector:	Peak
Voltage Extreme Environment Test Range:	+12Vdc

Environmental Conditions (Normal Environment)

Temperature: 24 °C	+15 ºC to +35 ºC (as declared)
Humidity: 47 % RH	20 % RH to 75 % RH (as declared)

14.3 Test Limit

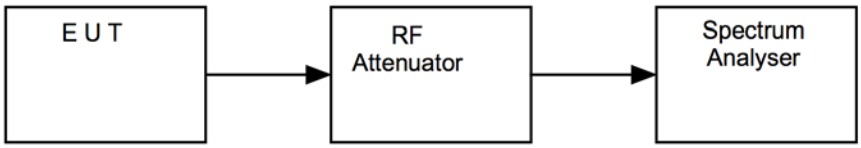
For systems employing digital modulation techniques operating in the bands 902 to 928 MHz, 2400 to 2483.5 MHz and 5725 to 5850 MHz, the maximum peak conducted output power shall not exceed 1 W.

14.4 Test Method

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



14.5 Test Equipment

Type of Equipment	*Maker/Supplier*	*Model Number*	*Element Number*	*Calibration Due Date*	*Calibration Interval*
Spectrum Analyser	Rhode & Schwarz	FSU46	U281	24/04/2016	12

14.6 Test Results

Channel Frequency (MHz)	*Analyzer Level (dBm)*	*Cable loss (dB)*	*Power (mW)*	*Result*
910.5	-5.18	10.00	3.03	PASS
918.1	-5.22	10.00	3.01	PASS

15 Out-of-band and conducted spurious emissions

15.1 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.

15.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Lab
Test Standard and Clause:	ANSI C63.10-2013, Clause 11.11
EUT Channels / Frequencies Measured:	Low / High
EUT Channel Bandwidths:	> 500 kHz
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: 24 °C	+15 ºC to +35 ºC (as declared)
Humidity: 48 % RH	20 % RH to 75 % RH (as declared)
Supply: +12 Vdc	+10Vdc to +14Vdc (as declared)

15.3 Test Limit

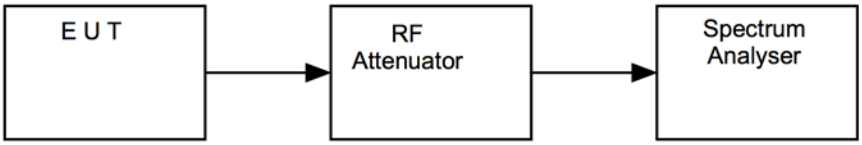
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either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

15.4 Test Method

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

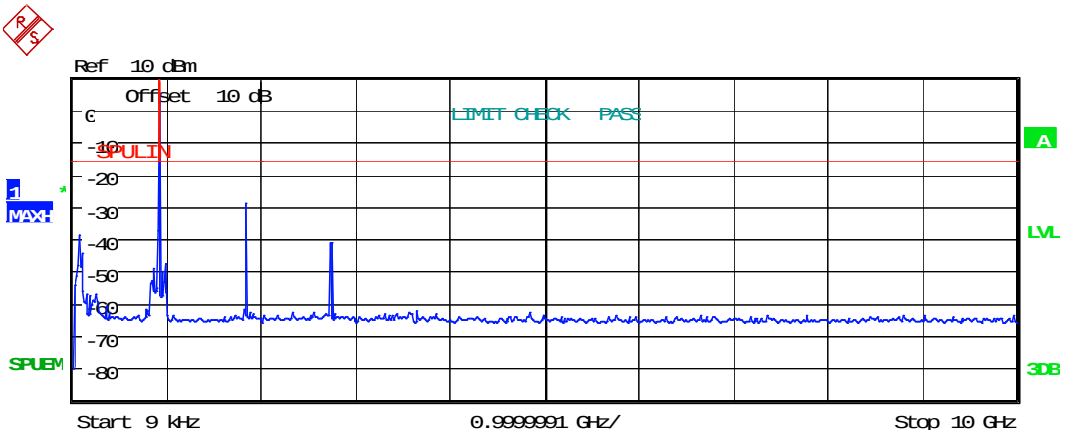


15.5 Test Equipment

Type of Equipment	*Maker/Supplier*	*Model Number*	*Element Number*	*Calibration Due Date*	*Calibration Interval*
Spectrum Analyser	Rhode & Schwarz	FSU46	U281	24/04/2016	12

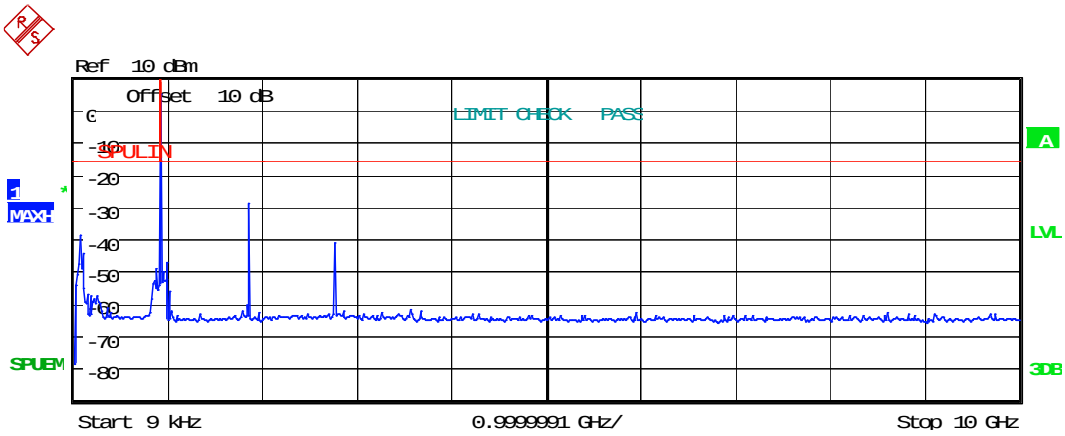
15.6 Test Results

Low Frequency						
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



Start [Hz]	Stop [Hz]	RBW [Hz]	Freq [Hz]	PwrAbs [dBm]	Δ Limit [dB]
9.000 k	150.000 k	1.00 k	11.485577 k	-80.17	-64.74
150.000 k	30.000 M	10.00 k	30.000000 M	-54.59	-39.16
30.000 M	902.000 M	100.00 k	59.996800 M	-39.12	-23.69
902.000 M	928.000 M	100.00 k	910.580000 M	4.63	-25.37
928.000 M	1.000 G	100.00 k	970.552000 M	-47.92	-32.49
1.000 G	2.000 G	100.00 k	1.821000 G	-28.98	-13.55
2.000 G	3.000 G	100.00 k	2.732000 G	-41.48	-26.05
3.000 G	5.000 G	100.00 k	3.642200 G	-62.55	-47.12
5.000 G	10.000 G	100.00 k	5.745000 G	-63.95	-48.52

Low Frequency						
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



Start [Hz]	Stop [Hz]	RBW [Hz]	Freq [Hz]	PwrAbs [dBm]	Δ Limit [dB]
9.000 k	150.000 k	1.00 k	22.105769 k	-78.99	-63.56
150.000 k	30.000 M	10.00 k	30.000000 M	-54.78	-39.35
30.000 M	902.000 M	100.00 k	59.996800 M	-38.96	-23.53
902.000 M	928.000 M	100.00 k	918.224000 M	4.54	-25.46
928.000 M	1.000 G	100.00 k	977.968000 M	-47.71	-32.28
1.000 G	2.000 G	100.00 k	1.837000 G	-29.27	-13.84
2.000 G	3.000 G	100.00 k	2.754000 G	-41.64	-26.21
3.000 G	5.000 G	100.00 k	3.563800 G	-62.26	-46.83
5.000 G	10.000 G	100.00 k	5.939500 G	-62.77	-47.34

16 Power spectral density

16.1 Definition

The power per unit bandwidth.

16.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Lab
Test Standard and Clause:	ANSI C63.10-2013, Clause 11.10
EUT Channels / Frequencies Measured:	Low / High
EUT Channel Bandwidths:	> 500kHz
Deviations From Standard:	None
Measurement BW:	100 kHz
Spectrum Analyzer Video BW: (requirement at least 3x RBW)	300 kHz
Measurement Span: (requirement 1.5 times Channel BW)	3 MHz
Measurement Detector:	Peak

Environmental Conditions (Normal Environment)

Temperature: 24 °C	+15 ºC to +35 ºC (as declared)
Humidity: 48 % RH	20 % RH to 75 % RH (as declared)
Supply: +12 Vdc	+10 Vdc to +14Vdc (as declared)

16.3 Test Limit

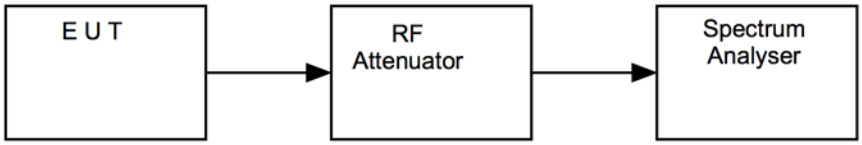
The transmitter power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

16.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure vi, the peak emission of the EUT was measured on a spectrum analyser, with path losses taken into account.

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

Type of Equipment	*Maker/Supplier*	*Model Number*	*Element Number*	*Calibration Due Date*	*Calibration Interval*
Spectrum Analyser	Rhode & Schwarz	FSU46	U281	24/04/2016	12

16.6 Test Results

Channel Frequency (MHz)	*Analyzer Level (dBm)*	*Cable loss (dB)*	*Power (dBm)*	*Result*
910.5	-5.43	10.00	4.57	PASS
918.1	-5.43	10.00	4.57	PASS

17 Radiated emissions – unintentional radiation / receiver emissions

17.1 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.

17.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Chamber (REF940)
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.5 and 6.6
EUT Channels / Frequencies Measured:	Low / High
EUT Channel Bandwidths:	> 500 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: Peak

Environmental Conditions (Normal Environment)

Temperature: 22 °C	+15 ºC to +35 ºC (as declared)
Humidity: 47 % RH	20 % RH to 75 % RH (as declared)
Supply: +12 V dc	+10 Vdc to +14 Vdc (as declared)

17.3 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

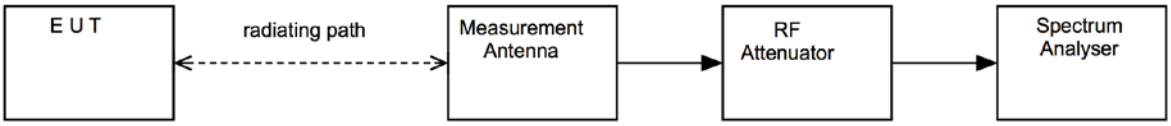
Frequency (MHz)	***Field Strength (µV/m at 3 m)***
30 to 88	100
88 to 216	150
216 to 960	200
Above 960	500

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 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



17.5 Test Equipment

Type of Equipment	*Maker/Supplier*	*Model Number*	*Element Number*	*Calibration Due Date*	*Calibration Interval*
Spectrum Analyser	Rhode & Schwarz	FSU46	REF909	13/02/2016	12
Receiver	Rhode & Schwarz	ESVS10	TRL317	26/02/2016	12
Pre Amplifier	Agilent	8449B	L572	10/02/2016	12
Horn Antenna	EMCO	3115	L139	25/09/2017	24
Log Periodic Antenna	Chase	CBL611/A	UH191	26/02/2017	24

17.6 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 (µV/m)
QP	30.15	4.2	0.8	18.8	N/A	-	-	23.84	15.56
QP	35.00	6.6	0.8	16.4	N/A	-	-	23.83	15.54
QP	39.55	13.0	0.9	13.9	N/A	-	-	27.79	24.52
QP	40.35	14.0	1.0	13.4	N/A	-	-	28.39	26.27
QP	55.30	25.1	1.0	6.6	N/A	-	-	32.7	43.15
QP	60.85	21.2	1.1	5.9	N/A	-	-	28.25	25.85
QP	80.00	17.8	1.3	7.8	N/A	-	-	26.87	22.05
QP	85.55	14.3	1.3	8.6	N/A	-	-	24.19	16.20
QP	107.30	15.0	1.5	11.0	N/A	-	-	27.46	23.60
QP	108.80	14.6	1.5	11.2	N/A	-	-	27.32	23.23
QP	125.00	17.0	1.6	12.6	N/A	-	-	31.15	36.10
QP	250.00	11.9	2.4	12.1	N/A	-	-	26.37	20.82
QP	375.00	16.0	2.8	14.7	N/A	-	-	33.42	46.88
QP	500.00	14.0	3.1	17.4	N/A	-	-	34.51	53.15
QP	625.05	14.8	3.7	19.5	N/A	-	-	37.95	78.98
QP	750.00	8.6	3.9	21.9	N/A	-	-	34.39	52.42

18 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] Power spectral density

Uncertainty in test result (Spectrum Analyser) = **2.48 dB**