Report on the Radio Testing

For

A-Safe UK Limited

on

RackEye

Report no. TRA-034535-47-00B

5th January 2018

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

ilac-MRA
UKAS TESTING
0026

Report Number: TRA-034535-47-00B
Issue: B

REPORT ON THE RADIO TESTING OF A
A-Safe UK Limited
RackEye
WITH RESPECT TO SPECIFICATION
FCC 47CFR 15D

TEST DATE: 20th September - 10th November 2017

Written by:	D Winstanley	D Winstanley
Tested by:	Digitally signed by Daniel Winstanley DN: cn=Daniel Winstanley, o=Element, ou, email=daniel.winstanley@element.com, c=GB Reason: I am the author of this document Date: 2018.01.08 14:05:56 Z	D Winstanley, A Wong Radio Test Engineers
Approved by:	Digitally signed by John Charters DN: cn=John Charters, o, ou=Element Materials Technology Ltd., email=john.charters@element.com, c=GB Reason: I am approving this document Date: 2018.01.05 15:35:30 Z	J Charters Department manager - Radio
Date:	5th January 2018	

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

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

ilac-MRA
UKAS TESTING
0026

1 Revision Record

Issue Number	*Issue Date*	*Revision History*
A	12th December 2017	Original
B	5th January 2018	Amendments

2 Summary

TEST REPORT NUMBER:	TRA-034535-47-00B
WORKS ORDER NUMBER	TRA-034535-01
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):	FCC 47CFR 15D
EQUIPMENT UNDER TEST (EUT):	RackEye
FCC IDENTIFIER:	2AMYT-RACKEYE001
EUT SERIAL NUMBER:	70410785
MANUFACTURER/AGENT:	A-Safe UK Limited
ADDRESS:	Habergham Works Ainleys Industrial Estate Elland HX5 9JP United Kingdom
CLIENT CONTACT:	Dean Cowan ☎ 01422 261619 ✉ Dean.Cowan@asafe.com
ORDER NUMBER:	PO005672
TEST DATE:	20th September - 10th November 2017
TESTED BY:	D Winstanley, A Wong Element

2.1 Test Summary

TEST/EXAMINATION	Part 15	Result
Coordination with Fixed Microwave Service	15.307 (b)	No Note 1
Antenna Requirement	15.317 15.203	Pass
Modulation Techniques	15.319 (b)	Pass
Conducted AC Powerline	15.315 15.207	No Note 2
Emission Bandwidth	15.323 (a)	Pass
Peak Transmit Power	15.319 (c)	Pass
Power Spectral Density	15.319 (d)	Pass
Antenna Gain	15.319 (e)	Pass
Automatic Discontinuation of Transmission	15.319 (f)	Pass
Radio Frequency Radiation Exposure	15.319 (i)	Pass
Monitoring Thresholds	15.323 (c)(2) 15.323 (c)(9)	Pass
Monitoring of Intended Transmit Window and Maximum Reaction Time	15.323 (c)(1)	Pass
Monitoring Bandwidth	15.323 (c)(7)	Pass
Access Criteria Functional Test	15.323 (c)(6)	Note 3
Duration of Transmission	15.323 (c)(3)	Pass
Connection Acknowledgement	15.323 (c)(4)	Pass
Lower threshold Selected Channel, Power Accuracy, Segment Occupancy	15.323 (c)(5)	Pass
Monitoring Antenna	15.323 (c)(8)	Pass
Duplex Connections	15.323 (c)(10)	Pass
Alternative Monitoring Interval for Co-located Devices	15.323 (c)(11)	Note 4
Fair Access to Spectrum Related to (c)(10) & (c)(11)	15.323 (c)(12)	Note 4
Emission Inside and Outside the Sub-band	15.323 (d)	Pass
Frame Period	15.323 (e)	Pass
Frequency Stability	15.323 (f)	Pass

Note:
1. Requirement removed April 4th 2005 see public notice DX 05-1005.
2. The portable part is battery powered only.
3. The EUT does not transmit control and signalling information.
4. The EUT does not utilise the provisions of 15.323 (c)(11)

Notes:

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

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

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

3 Contents

4 Introduction

This report TRA-034535-47-00B presents the results of the Radio testing on a A-Safe UK Limited, RackEye to specification 47CFR15 Radio Frequency Devices.

The testing was carried out for A-Safe UK Limited by Element, at the addresses detailed below.

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

☒ Element Skelmersdale
Unit 1
Pendle Place
Skelmersdale
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.

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

ISED Registration Number(s):

Element Skelmersdale	3930B
Element Hull	3483A

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

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

5 Test Specifications

5.1 Normative References

- FCC 47 CFR Ch. I – Part 15 – Radio Frequency Devices.
- ANSI C63.10-2013 – American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.
- ANSI C63.4-2014 – American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.
- ANSI C63.17-2013 - American National Standard Methods of Measurement of the Electromagnetic and Operational Compatibility of Unlicensed Personal Communications Services (UPCS) Devices
- Industry Canada RSS-213, Issue 3, March 2015 – 2 GHz Licence-Exempt Personal Communications Services (LE-PCS) 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 (now ISED)
ISED	Innovation, Science and Economic Development 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: RackEye
- Serial Number: 70410785
- Software Revision: Not Stated
- Build Level / Revision Number: Rev E

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.

The following Element support equipment was used

Type – Digital Radiocommunication Tester
Model – CMD60
Reference number – RFG433

The following support equipment was provided by the manufacturer

Type – DSPG Fixed Part Simulator
Serial – 766

Type – Laptop
Model – HP Elite Book

Type – Smart Phone
Model – Google Nexus

7.3 EUT Mode of Operation

7.3.1 Transmission

The mode of operation for transmitter tests was as follows…

The EUT was set into transmit mode via an over the air command sent from a fixed part connected to a PC running DSPG Test Application to enable a TDD test mode. The parameters selected for the TDD test mode are

Slot Type – 1-Full
Antenna – 0
Slot number – 12
Carrier - 23- 27 (as required)
Pattern – 5

Once in test mode the unit required a power down to change these settings.

For limited testing the device was also connected to a CMD60 test set

7.3.2 Reception / Unintentional emissions

The mode of operation for receive tests was as follows…
EUT was set to receive on the required channel

7.4 EUT Radio Parameters

7.4.1 General

Band of operation:	1920 MHz – 1930 MHz
Frequency range of operation:	1921.536 MHz – 1928.448 MHz
Modulation type(s):	GFSK
Occupied channel bandwidth(s):	1.4 MHz
Channel spacing:	1.728 MHz
ITU emission designator(s):	1M4F1D
Declared output power(s):	<112 mW
Warning against use of alternative antennas in user manual (yes/no):	Not Applicable
Nominal Supply Voltage:	3.0 Vdc
Location of notice for license exempt use:	Label / user manual / both.
Duty cycle:	4.1667 %

7.4.2 Antennas

Type:	Integral
Frequency range:	1880 – 1930 MHz
Impedance:	50 Ohms
Gain:	0 dBi
Polarisation:	Omni
Connector type:	Not Applicable
Weight:	Not Applicable
Environmental limits:	Not Applicable
Mounting:	PCB Trace

7.5 EUT Description

The EUT is a DECT Portable Part fitted to a PCB for the purposes of communicating data from impact sensors.

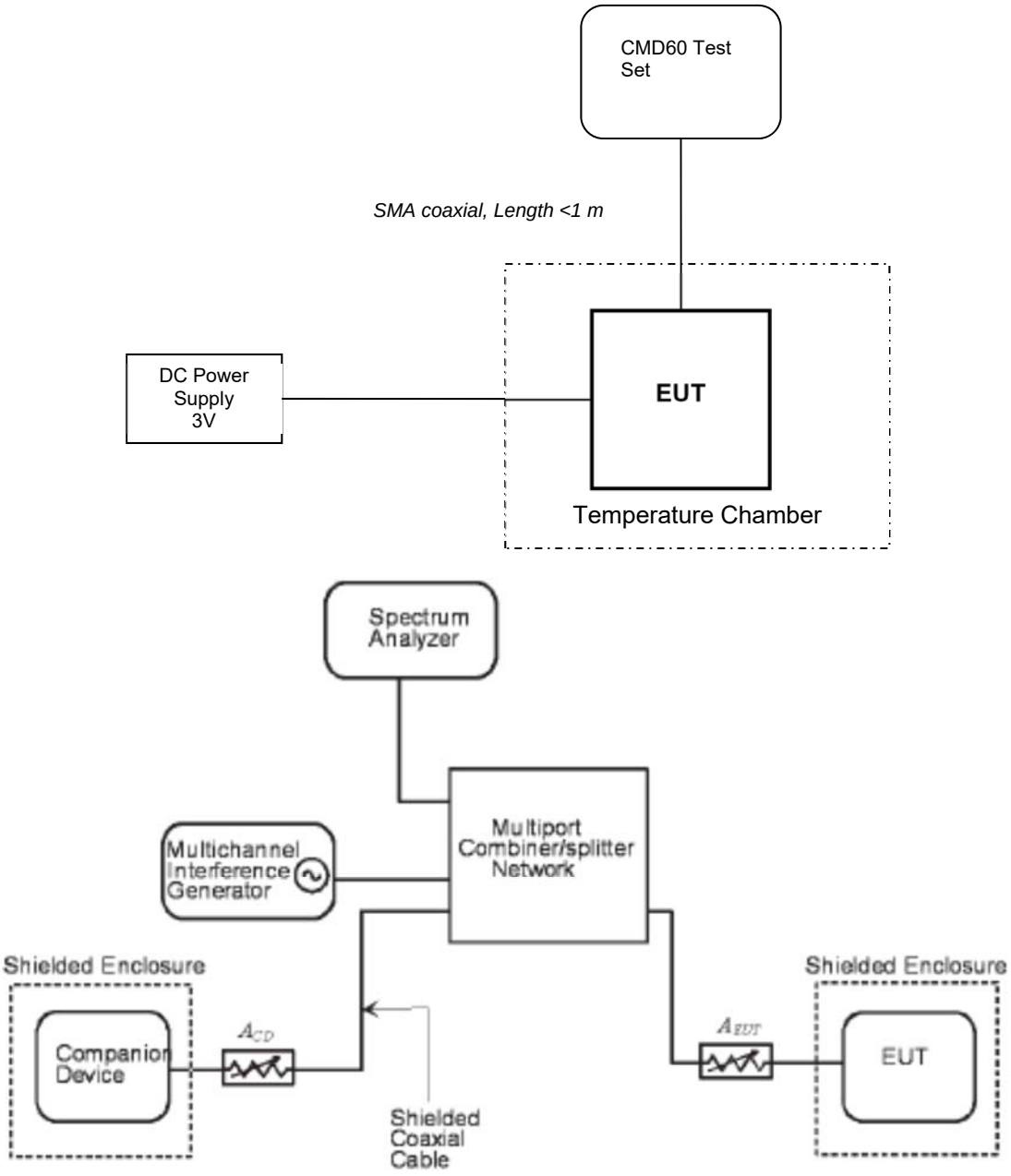
8 Modifications

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:



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 3 V dc from a PSU or 3 V dc from alkaline batteries.

10.2 Varying Test Conditions

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

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

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

	Category	***Nominal***	***Variation***
☐	Mains	110 V ac +/-2 %	85 % and 115 %
☒	Battery	New battery	Not Applicable

11 Antenna Requirements

11.1 Definition

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device

11.2 Test Limit

The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section.

11.3 Test Result (Attestation)

The unit employs an integral antenna arrangement.

12 Modulation Techniques

12.1 Definition

All transmissions must use only digital modulation techniques.

12.2 Test Limit

Attestation of compliance with the digital modulation requirement will be made in accordance with the disclosure statement required by the applicable equipment authorization procedures (see, e.g., 47CFR2).

12.3 Test Result (Attestation)

The A-Safe UK Limited RackEye is an isochronous device operating in the 1920 MHz – 1930 MHz frequency band.

The A-Safe UK Limited RackEye modulation technique is based on DECT technology as described in European standards EN 300 175-2 and EN 300 175-3.

The A-Safe UK Limited RackEye modulation techniques are MC/TDMA/TDD (Multi Carrier / Time Division Multiple Access / Time Division Duplex) using GFSK modulation.

13 Radio Frequency Radiation Exposure

13.1 KDB 447498 - General SAR test reduction and exclusion guidance

Section 4.3 General SAR test reduction and exclusion guidance

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

In the frequency range below 100 MHz to 6 GHz and test separation distance of 50mm, the SAR Test Exclusion Threshold for operation in the 2400 – 2483.5 MHz band will be determined as follows

SAR Exclusion Threshold (SARET)

SAR Exclusion Threshold = Step 1 + Step 2

Step 1

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

NT = Numeric Threshold (3.0 for 1-g SAR and 7.5 for 10-g SAR)
MP = Max Power of channel (mW) (inc tune up)
TSD^{A} = Min Test separation Distance or 50mm (whichever is lower) = 50

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

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

For Distances Greater than 50 mm Step 2 applies

Step 2

$$(TSD^{B} – 50mm) * 10\}$$

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

Operating Frequency 1.921536 GHz

SARET = [(3.0 x 50) / √1.921536] + { (50 – 50) * 10 }
SARET = [150 / 1.38] + (0 * 10 }
SARET = 108.21mW

Operating Frequency 1.928448 GHz

SARET = [(3.0 x 50) / √1.928448] + { (50 – 50) * 10 }
SARET = [150 / 1.39] + (0 * 10 }
SARET = 108.02mW

Channel Frequency (MHz)	EIRP (mW)	SAR Exclusion Threshold	SAR Evaluation
1921.536	102.56	108.21	Not Required
1928.448	103.51	107.02	Not Required

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

13.2 MPE Calculation

47 CFR §§1.1310

Prediction of MPE limit at a given distance

Equation from page 18 of OET Bulletin 65, Edition 97-01

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

where:

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

Note:

The EIRP was calculated by addition on the maximum conducted carrier power dBm and the maximum antenna gain.

Result

Prediction Frequency (MHz)	Conducted Carrier power (dBm)	Antenna Gain (dBi)	Maximum EIRP (mW)	Power density limit (S) (mW/cm^2)	Distance (R) cm Required to be less than 1 mW/cm^2
1921.536	20.11	0	102.56	1	2.9
1928.448	20.15	0	103.51	1	2.9

14 Transmitter Emission Bandwidth

14.1 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.

14.2 Test Parameters

Measurement standard	ANSI C63.17 sub-clause 6.1.3
Test Location:	Element Skelmersdale
Test Chamber:	Radio Laboratory
Measurement BW:	20 kHz
Spectrum Analyzer Video BW:	200 kHz
Measurement Span:	3 MHz
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: 3 V dc	

14.3 Test Limit

Operation shall be contained within the 1920 MHz to 1930 MHz band. The emission bandwidth shall be less than 2.5 MHz but in no event shall the emission bandwidth be less than 50 kHz.

The emission bandwidth shall be determined by measuring the width of the signal between two points, one below the carrier centre frequency and one above the carrier centre frequency, that are 26 dB own relative to the maximum level of the modulated carrier.

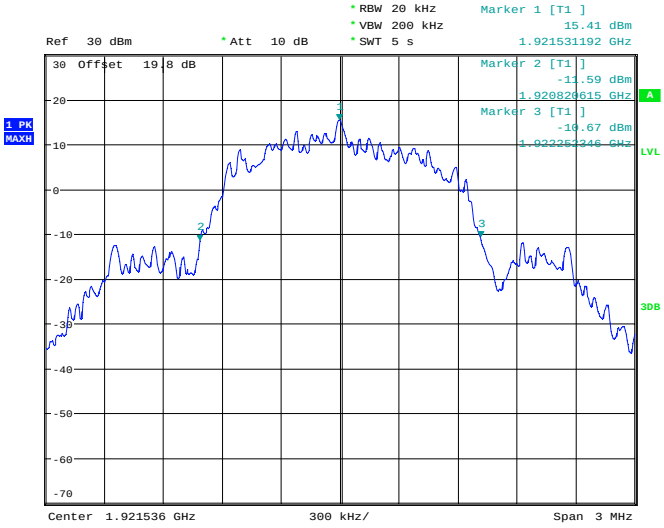
14.4 Test Results

Test Details: f_l = 1921.536 MHz				
∆ P (dBc)	fl (MHz)	fh (MHz)	∆f (MHz)	Limit
-26	1920.820615	1922.252346	1.432	50kHz> ∆f > 2.5MHz
-12	1920.947538	1922.137923	1.190	N/A
-6	1921.154269	1921.753308	0.599	N/A

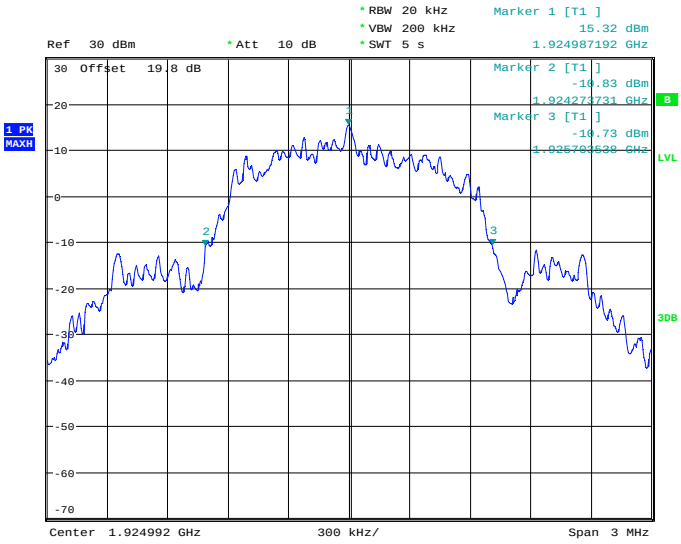
Test Details: f_c = 1924.992 MHz				
∆ P (dBc)	fl (MHz)	fh (MHz)	∆f (MHz)	Limit
-26	1924.273731	1925.703538	1.430	50kHz> ∆f > 2.5MHz
-12	1924.408346	1925.592962	1.185	N/A
-6	1924.615077	1925.204500	0.589	N/A

Test Details: f_h = 1928.448 MHz				
∆ P (dBc)	fl (MHz)	fh (MHz)	∆f (MHz)	Limit
-26	1927.737423	1929.164346	1.427	50kHz> ∆f > 2.5MHz
-12	1927.862423	1929.048962	1.187	N/A
-6	1928.073962	1928.659538	0.586	N/A

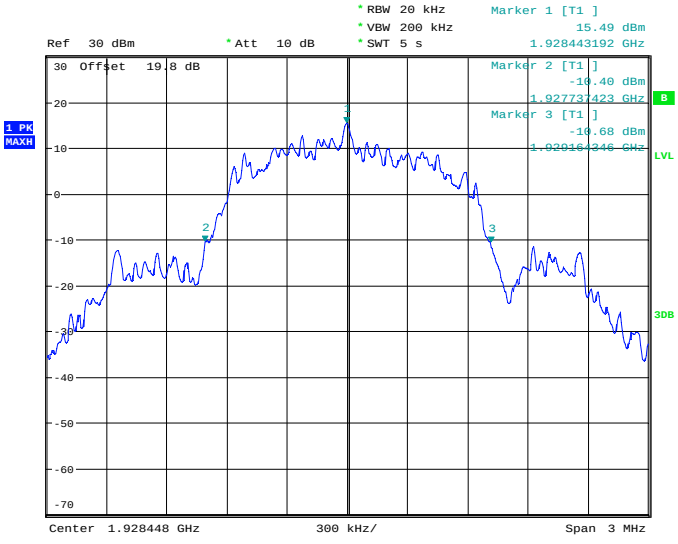
26 dB Emission Bandwidth



f_l



f_c



f_h

15 Peak Transmit Power

15.1 Definition

The peak transmit power is the maximum of the RMS power during a transmit burst

15.2 Test Parameters

Measurement standard	ANSI C63.17 sub-clause 6.1.2
Test Location:	Element Skelmersdale
Test Chamber:	Radio Lab
EUT Channels / Frequencies Measured:	Low / Mid / High
EUT Occupied Bandwidths:	1.4 MHz
Measurement BW:	3 MHz
Measurement Span:	Zero Span
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)

15.3 Test Limit

Peak transmit power shall not exceed 100 µW multiplied by the square root of the emission bandwidth in hertz

The limit for Peak Transmit Power (PTP) is calculated using the following formula:

$$PTP = 5 \text{ Log}_{10} \text{ EBW} - 10 \text{ dBm}$$

This limit must be corrected to take into account any gain of the antenna greater than 3dBi.
Where: EBW is the transmitter emission bandwidth in Hz as determined in the previous test.

$$EBW = 1.431\text{MHz}$$

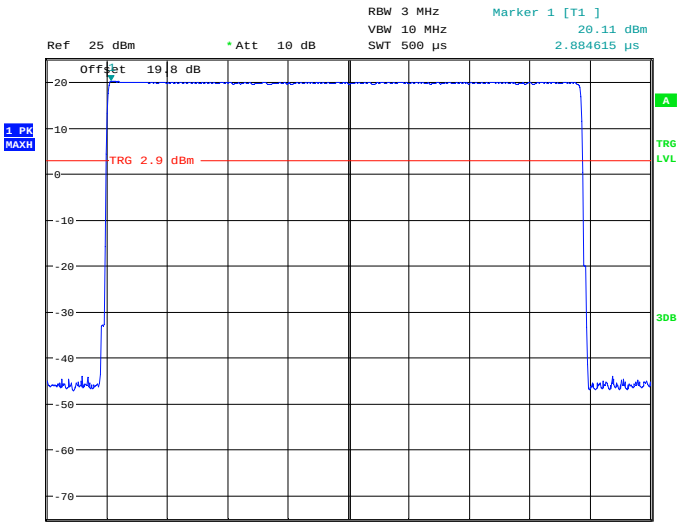
$$PTP = 5 \text{ Log}_{10} 1.431 - 10 \text{ dBm}$$

$$PTP = 20.78 \text{ dBm}$$

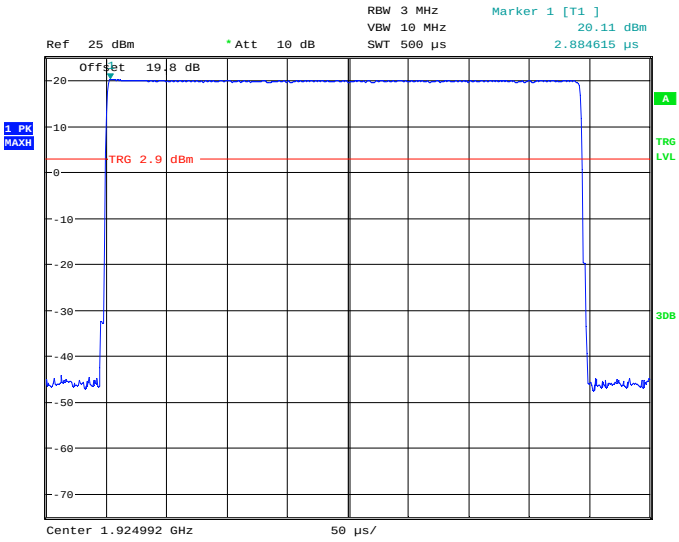
15.4 Test Results

Frequency (MHz)	Peak Transmit Power (dBm)	Limit (dBm)
1921.536	20.11	20.78
1924.992	20.11	20.78
1928.448	20.15	20.78

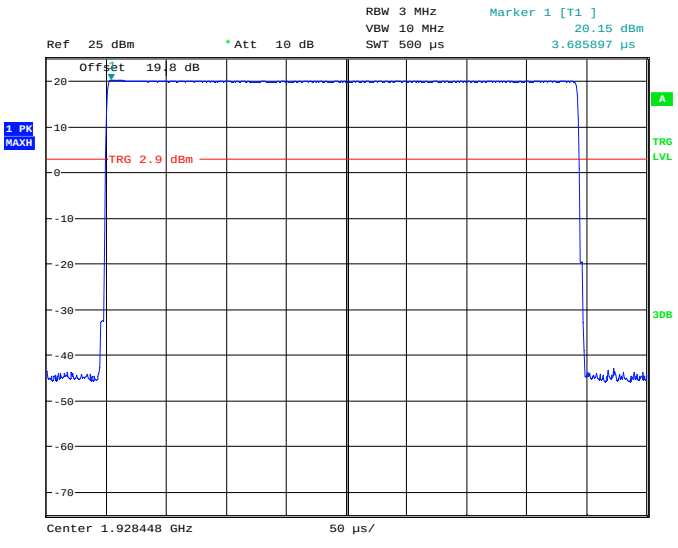
Note: 1. Permanent antenna was replaced with temporary antenna connector to enable conducted measurement.
2. Antenna gain < 3dBi and so correction of the limit is not required.


RBW 3 MHz
VBW 10 MHz
SWT 500 µs
Marker 1 [T1]
20.11 dBm
2.884615 µs
Ref 25 dBm
*Att 10 dB
Offset 19.8 dB
TRG 2.9 dBm
1 PK
MAXH
A
TRG
LVL
3DB
Center 1.921536 GHz
50 µs/

f_l


RBW 3 MHz
VBW 10 MHz
SWT 500 µs
Marker 1 [T1]
20.11 dBm
2.884615 µs
Ref 25 dBm
*Att 10 dB
Offset 19.8 dB
TRG 2.9 dBm
1 PK
MAXH
A
TRG
LVL
3DB
Center 1.924992 GHz
50 µs/

f_c


RBW 3 MHz
VBW 10 MHz
SWT 500 µs
Marker 1 [T1]
20.15 dBm
3.685897 µs
Ref 25 dBm
*Att 10 dB
Offset 19.8 dB
TRG 2.9 dBm
1 PK
MAXH
A
TRG
LVL
3DB
Center 1.928448 GHz
50 µs/

f_h

16 Power Spectral Density

16.1 Definition

The power per unit bandwidth.

16.2 Test Parameters

Measurement standard	ANSI C63.17 sub-clause 6.1.5
Test Location:	Element Skelmersdale
Test Chamber:	Radio Lab
EUT Channels / Frequencies Measured:	Low / Mid / High
EUT Occupied Bandwidths:	1.4 MHz
Measurement BW:	3 kHz
Measurement Span:	Zero Span
Measurement Detector:	Peak

Environmental Conditions (Normal Environment)

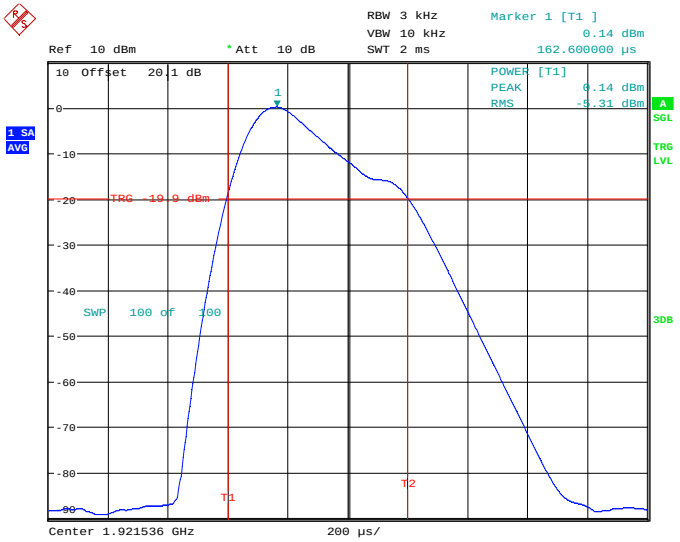
Temperature: 22 °C	+15 ºC to +35 ºC (as declared)
Humidity: 42 % RH	20 % RH to 75 % RH (as declared)

16.3 Test Limit

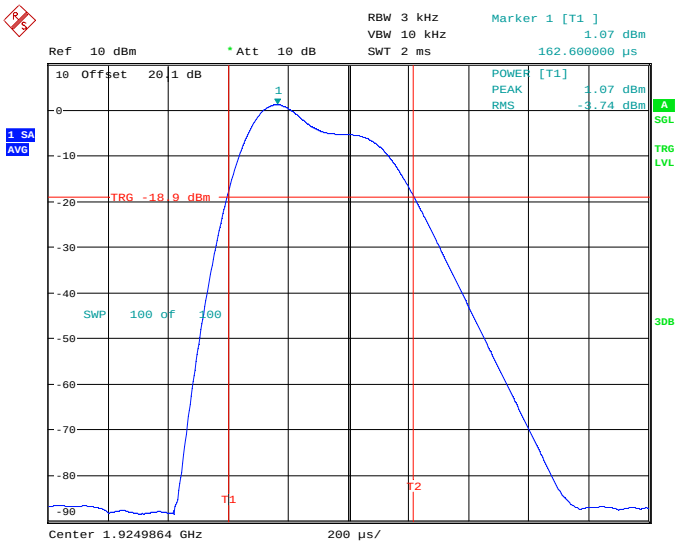
The power spectral density shall not exceed 3mW in any 3 kHz bandwidth as measured with a spectrum analyser having a resolution bandwidth of 3 kHz.

Frequency (MHz)	Power Spectral Density (mW/3kHz)	Limit (mW/3kHz)
1921.536	0.14	3
1924.992	1.07	3
1928.448	-0.09	3

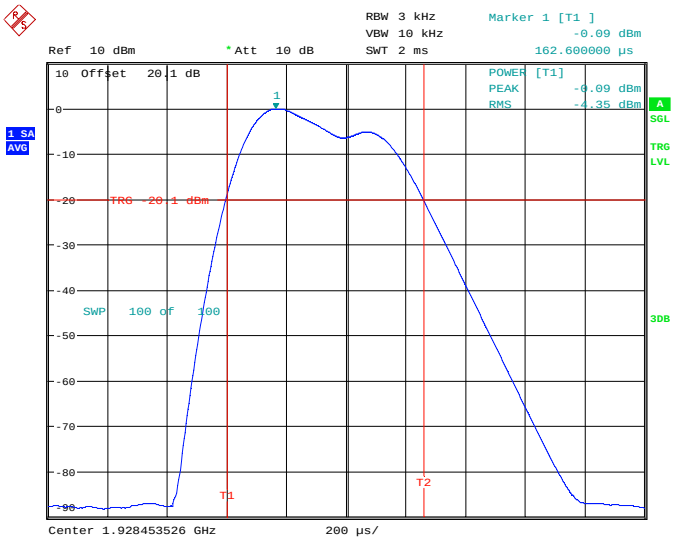
Note: 1. Permanent antenna was replaced with temporary antenna connector to enable conducted measurement.
2. Antenna gain < 3dBi and so correction of the limit is not required.


RBW 3 kHz
VBW 10 kHz
SWT 2 ms
Marker 1 [T1]
0.14 dBm
162.600000 µs
Ref 10 dBm
*Att 10 dB
10 Offset 20.1 dB
POWER [T1]
PEAK 0.14 dBm
RMS -5.31 dBm
1 SA
AVG
A
SGL
TRG
LVL
TRG -19.9 dBm
SWP 100 of 100
3DB
T1
T2
Center 1.921536 GHz
200 µs/

f_l


RBW 3 kHz
VBW 10 kHz
SWT 2 ms
Marker 1 [T1]
1.07 dBm
162.600000 µs
Ref 10 dBm
*Att 10 dB
10 Offset 20.1 dB
POWER [T1]
PEAK 1.07 dBm
RMS -3.74 dBm
1 SA
AVG
A
SGL
TRG
LVL
TRG -18.9 dBm
SWP 100 of 100
3DB
T1
T2
Center 1.9249864 GHz
200 µs/

f_c


RBW 3 kHz
VBW 10 kHz
SWT 2 ms
Marker 1 [T1]
-0.09 dBm
162.600000 µs
Ref 10 dBm
*Att 10 dB
10 Offset 20.1 dB
POWER [T1]
PEAK -0.09 dBm
RMS -4.35 dBm
1 SA
AVG
A
SGL
TRG
LVL
TRG -20.1 dBm
SWP 100 of 100
3DB
T1
T2
Center 1.928453526 GHz
200 µs/

f_h

17 Antenna Gain

17.1 Definition

Any directional gain of the antenna exceeding 3dBi has an effect on the limit applied to the measurements taken for the peak transmit power test. If the directional gain of the antenna is less than 3dBi it is not required to be taken into account.

17.2 Test Limit

The peak transmit power shall be reduced by the amount in decibels that the maximum directional gain of the antenna exceeds 3 dBi.

17.3 Test Result (Attestation)

Maximum Antenna Gain	Exceeds 3dBi by
0 dBi	N/A

Antenna Gain declared by Manufacturer

18 Automatic Discontinuation of Transmissions

18.1 Definition

Automatic discontinuation of transmission means break off of transmissions that are not control and signalling information.

18.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Lab
EUT Channels / Frequencies Measured:	Mid

Environmental Conditions (Normal Environment)

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

18.3 Test Limit

The device shall automatically discontinue transmission in case of either absence of information to transmit or operational failure. These provisions are not intended to preclude transmission of control and signalling information or use of repetitive codes used by certain digital technologies to complete frame or burst intervals.

18.4 Test Results

The RackEye is a Portable part and as such does not transmit control and signalling information the counterpart device is a fixed part device and does transmit control and signalling information.

Part	Transmits Control and Signalling Information	Equipment Under Test
Fixed Part	X	
Portable Part		X

The following tests were performed after a connection had been established with the counterpart device

Number	Test	Reaction of EUT	Pass / Fail
1	Batteries removed from EUT	A	Pass
2	Power removed from companion	C	Pass

A – Connection breakdown, Cease of all transmissions.
B – Connection breakdown, EUT transmits control and signalling information.
C – Connection breakdown, Counterpart transmits control and signalling information.

19 Monitoring Thresholds

19.1 Definition

The spectrum sharing rules require that EUTs monitor their intended channel (time and spectrum window) prior to transmission to sense RF energy in the channel. If there is RF energy above the monitoring limit threshold the EUT must either defer transmission until the channel is clear or select another clear channel.

19.2 Test Parameters

Measurement standard - Calculation	ANSI C63.17 sub-clause 7.2.1
Calculations	As laid out in ANSI C63.17 sub-clause 4.3.3
Measurement standard	ANSI C63.17 sub-clause 7.3
Test Location:	Element Skelmersdale
Test Chamber:	Radio Lab

19.3 Calculations

Calculation of monitoring threshold limits for isochronous devices:

Lower threshold: $T_L = -174 + 10Log_{10}B + M_U + P_{MAX} - P_{EUT}$ (dBm)

Upper threshold: $T_U = -174 + 10Log_{10}B + M_U + P_{MAX} - P_{EUT}$ (dBm)

Where:
B = Emission bandwidth (Hz)
M_U = dBs the threshold may exceed thermal noise (30 for T_L & 50 for T_U)
P_{MAX} = Output Power Limit (dBm)
P_{EUT} = Transmitted power (dBm)

Monitor Threshold	B (Hz)	M_U (dB)	P_{MAX} (dBm)	P_{EUT} (dBm)	Threshold (dBm)
T_L	1431731.00	30.00	20.78	20.15	-81.81
T_U	1431731.00	50.00	20.78	20.15	-61.81

Note: 1. Threshold levels rounded up/down

The threshold level was determined following the procedure as laid out in ANSI C63.17 sub-clause 7.3.2 (a) Frequency administration was used to allow operation on the carrier closest to the centre of the band.

19.4 Test Limit

The EUT must not transmit until the interference level is less than or equal to:

Measured Threshold Level ≤ $T_U + U_M$

Where:
T_U = Calculated Upper threshold level
T_L = Calculated Lower threshold level
U_M = Margin of uncertainty in threshold measurements (6dB)

Results

Monitor threshold	Measured Threshold Level	Limit	Pass/Fail
Upper threshold (dBm)	-68 dBm	-55.81 dBm	Pass

20 Monitoring of Intended Transmit Window & Maximum Reaction Time

20.1 Definition

The reaction time is the minimum duration of the interference present during the monitoring interval that must be detected by the EUT so as to determine that the monitored time and spectrum window is occupied.

20.2 Test Parameters

Measurement standard	ANSI C63.17 sub-clause 7.5
Test Location:	Element Skelmersdale
Test Chamber:	Radio Lab
EUT Channels / Frequencies Measured:	f1 - 1924.992 MHz ; f2 – 1926.720MHz

Environmental Conditions (Normal Environment)

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

20.3 Test Method

The EUT was restricted to operation on two channels. The interference generator was fed pulses from the function generator to produce a pulsed carrier of the specified time length and the output of the interference generator was set to the required level. The pulse generator and companion device were synchronized so the position of the pulses corresponded to the time-slot pattern in the frame of the EUT.

For each of the required tests the pulse width and interference level are as below:

Test c)

With the interference generator output set at the relevant calculated threshold level plus measurement uncertainty (U_M) and the width of the pulse interference exceeds the largest of 50µs and $50\sqrt{1.25/B}$ µs verify that the EUT does not establish a connection.

Test d)

With the interference generator output set at 6dB above the relevant calculated threshold level plus measurement uncertainty (U_M) and the width of the pulse interference exceeds the largest of 35µs and $35\sqrt{1.25/B}$ µs verify that the EUT does not establish a connection.

Where B = Emission bandwidth of the EUT in MHz

20.4 Test Results

Test Equation (µs)	Pulse Width (µs)	f_1 Interferer Level (dBm)	f_2 Interferer Level (dBm)	EUT transmission Frequency	Pass/Fail
$50\sqrt{1.25/B}$	50µs	$T_L + U_m$	T_L	f_2	Pass
$35\sqrt{1.25/B}$	35µs	$T_L + U_m + 6$	T_L	f_2	Pass

Notes:
1. T_L is the calculated Lower threshold.
2. U_M is Margin of uncertainty in threshold measurements (6dB).

21 Monitoring Bandwidth & Antenna

21.1 Definition

The methods implemented for checking whether the spectrum is occupied or not.

21.2 Test Limit

ANSI C63.17 sub-clause 7.4 states that if the monitoring is made through the radio receiver used by the EUT for communication the intended bandwidth requirements for the monitoring system are met.

21.3 Test Results

The monitoring bandwidth test was carried out in accordance with ANSI C63.17 sub-clause 7.4.

21.3.1 Monitoring Bandwidth

As declared by the manufacturer the EUT uses the radio receiver used for communication for monitoring therefore the intended bandwidth requirements for the monitoring system are met of ANSI C63.17 sub-clause 7.4 are met.

21.3.2 Monitoring Antenna

The antenna of the EUT used for transmitting is the same antenna that is used for monitoring.

22 Power Accuracy

22.1 Definition

Checks that a power level can be determined within a set margin.

22.2 Test Limit

The power measurement resolution for the previous comparison must be accurate to within 6dB.

22.3 Test Results

The monitoring threshold test covered in Part 15.323 (c)(2) automatically proves that this requirement is met.

23 Segment Occupancy

23.1 Definition

To ensure that any group of devices does not utilise more than a maximum amount of time / spectrum

23.2 Test Limit

No device or group of co-operating devices located within 1 m of each other shall, during any frame period, occupy more than 6 MHz of aggregate bandwidth, or alternatively, more than one third of the time and spectrum windows defined by the system.

23.3 Test Results (Declaration)

See manufacture Declaration

24 Duration Of Transmission

24.1 Definition

The amount of time a device uses a channel without repeating access criteria

24.2 Test Parameters

Measurement standard	ANSI C63.17 sub-clause 8.2.2
Test Location:	Element Skelmersdale
Test Chamber:	Radio Lab
EUT Channels / Frequencies Measured:	1924.992 MHz

Environmental Conditions (Normal Environment)

Temperature: 23 °C	+15 ºC to +35 ºC (as declared)
Humidity: 44 % RH	20 % RH to 75 % RH (as declared)

24.3 Test Limit

The EUT shall not continue to use the same channel without executing the access criteria at least as often as every 8 h.

24.4 Test Results

Repetition of Access Criteria	Maximum Transmission Time	Maximum Transmission Time Limit	Pass/Fail
Period	401.6 µS	<8 Hours	Pass

Note: 1. The portable part is the initiating device that repeats the access criteria
2. The EUT is a ULE device utilising 1 packet only

25 Connection Acknowledgement

25.1 Definition

To verifies that the two devices communicating over a duplex connection comply with the access criteria.

25.2 Test Parameters

Measurement standard	ANSI C63.17 sub-clause 8.2.1
Test Location:	Element Skelmersdale
Test Chamber:	Radio Lab
EUT Channels / Frequencies Measured:	1924.992 MHz

Environmental Conditions (Normal Environment)

Temperature: 23 °C	+15 ºC to +35 ºC (as declared)
Humidity: 44 % RH	20 % RH to 75 % RH (as declared)

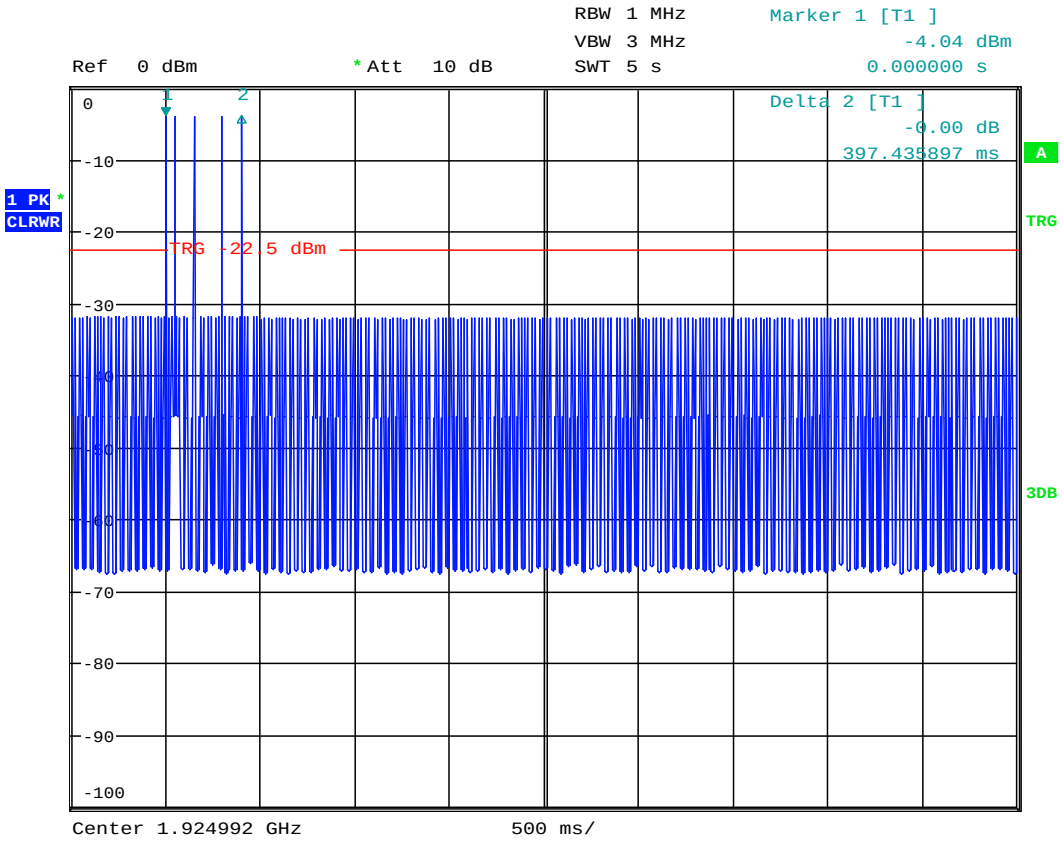
25.3 Test Method

The test was carried out in two parts. The first was to verify that with the companion device off (no initial acknowledgement received) the EUT does not transmit on the same time/spectrum window for more than the limit. The second was to verify that after a connection is broken the EUT terminates its transmission on the current communication channel within 30 seconds or less. As the device only transmits single packets this was tested by transmitting a single packet, blocking acknowledgements and trying to transmits single packet again.

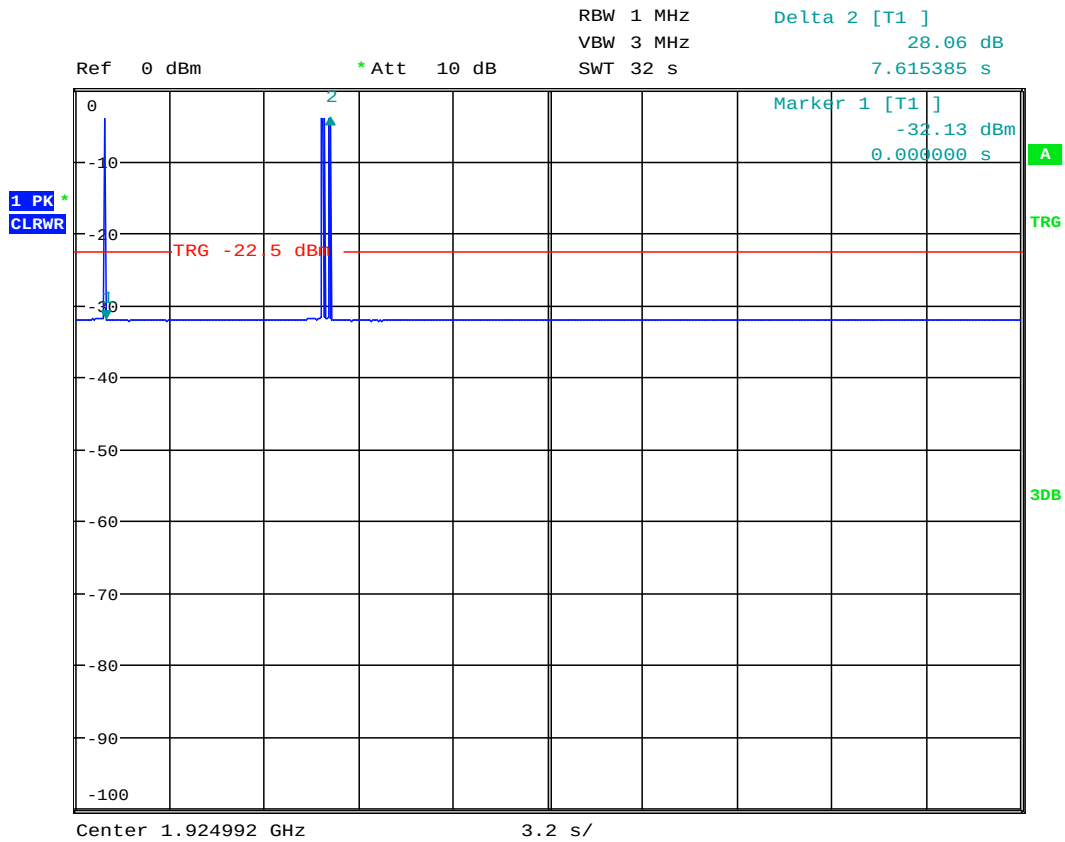
25.4 Test Results

Test	Time Taken (seconds)	Limit (seconds)	Pass/Fail
Transmission on communications channel no acknowledgement received (note 1)	0.397	1	Pass
Valid Packet , acknowledgement blocked , packet trasnmit (note 1)	<10 seconds	30	Pass

Note: 1. The companion device transmits a beacon signal when acknowledgements are blocked.
2. The EUT does not transmit a control channel.
3. The EUT is a ULE device utilising 1 packet only.



Transmissions on Communications Channel - Initial Acknowledgement Not Received



Valid packet - Acknowledgements Blocked – Packet transmit

26 Least Interfered Channel (LIC) Procedure

26.1 Definition

To determine that an EUT is operating in the LIC mode can properly select the channel with the lowest interference power, within a 6 dB resolution

26.2 Test Parameters

Measurement standard	ANSI C63.17 sub-clause 7.3.2
Test Location:	Element Skelmersdale
Test Chamber:	Radio Lab
EUT Channels / Frequencies Measured:	1924.992 MHz (f1) / 1926.720 MHz(f2)

Environmental Conditions (Normal Environment)

Temperature: 23 °C	+15 ºC to +35 ºC (as declared)
Humidity: 44 % RH	20 % RH to 75 % RH (as declared)

26.3 Test Method

The EUT utilizes more than 40 channels; therefore the least interfered channel testing is applicable.

The EUT was restricted to operating on two frequencies only, designated f1 and f2.

Test b)
Interference on f1 was set at $T_L + U_M + 7dB$ and at $T_L + U_M$ on f2. Initiate communication. The EUT should transmit on f2. Repeat 5 times. If the EUT transmits on f1 the test is failed.

Test c)
Interference on f1 was set at $T_L + U_M$ and at $T_L + U_M + 7dB$ on f2. Initiate communication. The EUT should transmit on f1. Repeat 5 times. If the EUT transmits on f2 the test is failed.

Test d)
Interference on f1 was set at $T_L + U_M + 1dB$ and at $T_L + U_M - 6dB$ on f2. Initiate communication. The EUT should transmit on f2. Repeat 5 times. If the EUT transmits on f1 the test is failed.

Test e)
Interference on f1 was set at $T_L + U_M - 6dB$ and at $T_L + U_M + 7dB$ on f2. Initiate communication. The EUT should transmit on f1. Repeat 5 times. If the EUT transmits on f2 the test is failed.

26.4 Test Results

Test	Transmit on f1	Transmit on f2	Wanted Transmit Channel	Pass/Fail
b	No	Yes	f2	Pass
c	Yes	No	f1	Pass
d	No	Yes	f2	Pass
e	Yes	No	f1	Pass

Note: 1. All tests were repeated 5 times.

27 Selected Channel Confirmation

27.1 Definition

To determine that an EUT monitors the selected channel immediately prior to transmission. The test described as follows is intended to verify that the EUT makes its channel selection decision on the basis of a recent power level reading

27.2 Test Parameters

Measurement standard	ANSI C63.17 sub-clause 7.3.3
Test Location:	Element Skelmersdale
Test Chamber:	Radio Lab
EUT Channels / Frequencies Measured:	1924.992 MHz (f1) / 1926.720 MHz (f2)

Environmental Conditions (Normal Environment)

Temperature: 23 °C	+15 ºC to +35 ºC (as declared)
Humidity: 44 % RH	20 % RH to 75 % RH (as declared)

27.3 Test Method

The EUT was Restricted to operating on two frequencies only, f1 and f2.

Test a)
Interference is applied on f1 at a level of T_U + U_M. Verify a connection is established on f2.

Any connection is terminated.

Test b)
Interference is applied on f2 at a level of T_U + U_M and immediately removed from f1 and the EUT is immediately caused to attempt transmission. In this case the EUT should transmit on f1

The test is applied in both single and long slot configurations.

27.4 Test Results

Test	Transmit on f1	Transmit on f2	Wanted Transmit Channel	Pass/Fail
a	No	Yes	f2	Pass
b	Yes	No	f1	Pass

Note: 1. Results in the above table are applicable for both single and long slot configurations.

28 Duplex Connections

28.1 Definition

To determine that an EUT monitors the selected channel immediately prior to transmission. The test described as follows is intended to verify that the EUT makes its channel selection decision on the basis of a recent power level reading

28.2 Test Parameters

Measurement standard	ANSI C63.17 sub-clause 8.3.2
Test Location:	Element Skelmersdale
Test Chamber:	Radio Lab
EUT Channels / Frequencies Measured:	1924.992 MHz
Interference Free Receive slot	3 (duplex mate – slot 15)
Interference Free Transmit Slot	5 (duplex mate – slot 17)

Environmental Conditions (Normal Environment)

Temperature: 23 °C	+15 ºC to +35 ºC (as declared)
Humidity: 44 % RH	20 % RH to 75 % RH (as declared)

28.3 Test Method

Before all tests are carried out any connection is terminated.

Test b)
The system is restricted to operation on one frequency (1924.992 MHz) using administration. Verify that a connection between the EUT and its companion device can be made.

Test c) & d)
Apply interference at a level $T_L + U_M$ to all transmit time slots except one which has interference at least 10dB below T_L. Apply interference at a level $T_L + U_M + 10dB$ to all receive time slots except one which has interference at least 10dB below T_L. The interference free receive timeslot should not be the duplex mate of the interference free transmit timeslot. The EUT should establish a connection on the interference free receive slot and its duplex mate.

Test e) & f)
Apply interference at a level $T_L + U_M$ to all receive time slots except one which has interference at least 10dB below T_L. Apply interference at a level $T_L + U_M + 10dB$ to all transmit time slots except one which has interference at least 10dB below T_L. The interference free transmit timeslot should not be the duplex mate of the interference free receive timeslot. The EUT should establish a connection on the interference free transmit slot and its duplex mate.

28.4 Test Results

Test	Connection Made	Time Slot Selected	Required Time Slot	Pass/Fail
b	Yes	8	Any	Pass
c & d	Yes	3	Interference Free Receive Slot and Duplex Mate	Pass
e & f	Yes	5	Interference Free Transmit Slot and Duplex Mate	Pass

29 Emissions Inside and Outside the Sub-Band - Conducted

29.1 Definition

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

Out-of-band emission.
Emission on a frequency or frequencies immediately outside the operating band 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 in-band and out-of-band emissions.

29.2 Test Parameters

Measurement standard	ANSI C63.17 sub-clause 6.1.6
Test Location:	Element Skelmersdale
Test Chamber:	Radio Lab
EUT Channels / Frequencies Measured:	1921.536 MHz / 1928.448 MHz

29.3 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.

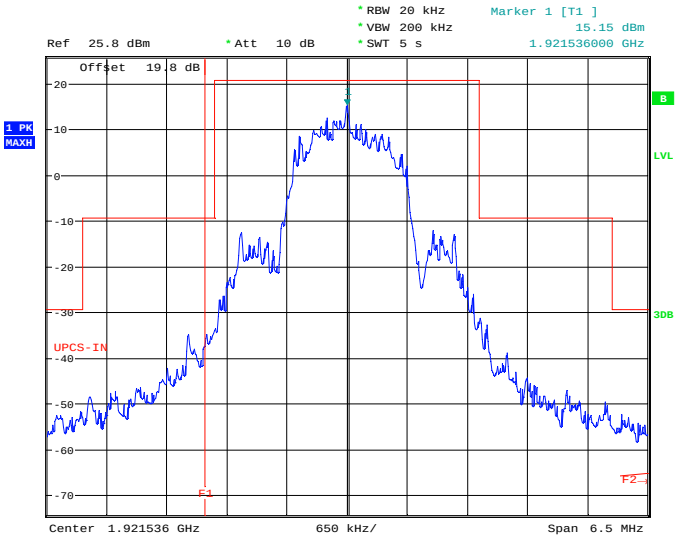
The measurements were performed with EUT set at its maximum duty. All modulation schemes, data rates and power settings were used to observe the worst case configuration in each bandwidth.

29.4 Test Results

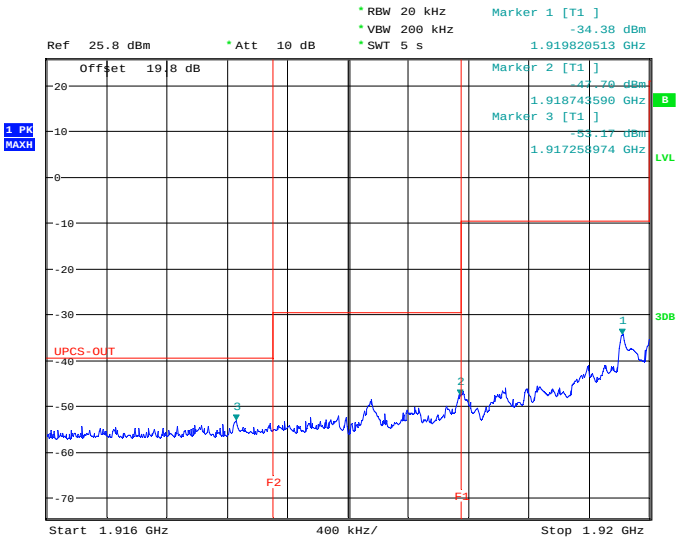
RF carrier set to the lowest carrier defined by the EUT					
Out-of-Band Emissions from UPCS bandedge	**FREQ. (MHz)**	**MEAS. Rx. (dBm)**	**CABLE & ATTEN. LOSS (dB)**	**EMISSION LEVEL (dBm)**	**LIMIT (dBm)**
> - 2.5MHz	Not Applicable – Radiated testing performed				
- 1.25 MHz – 2.5 MHz	1918.743590	-67.50	19.8	-47.70	-29.5
- 1.25 MHz	1919.820513	-54.18	19.8	-34.38	-9.5
In-band Emissions	See plot				
+ 1.25 MHz	1931.102564	-76.79	19.8	-56.99	-9.5
+ 1.25 MHz – 2.5 MHz	1932.384615	-75.30	19.8	-55.50	-29.5
> + 2.5MHz	Not Applicable – Radiated testing performed				

Limits	**Out-of-Band Emissions From UPCS bandedge**	**Attenuation (dB) required below Reference power of 112mW**
	± 1.25MHz	30
	±1.25 MHz – 2.5 MHz	50
	> ±2.5MHz	60
	In band Emissions from centre of emission bandwidth	**Attenuation (dB) required below permitted peak power for the EUT**
	1B – 2B	30
	2B – 3B	50
	3B – UPCS band edge	60

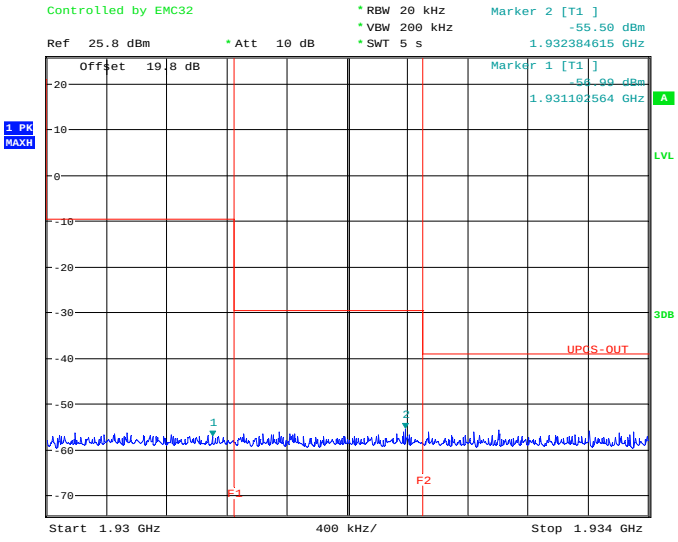
Emissions inside the Sub-Band RF carrier set to the lowest carrier defined by the EUT



Conducted Emissions outside the Sub-Band RF carrier set to the lowest carrier defined by the EUT



Lower Bandedge - > 2.5MHz

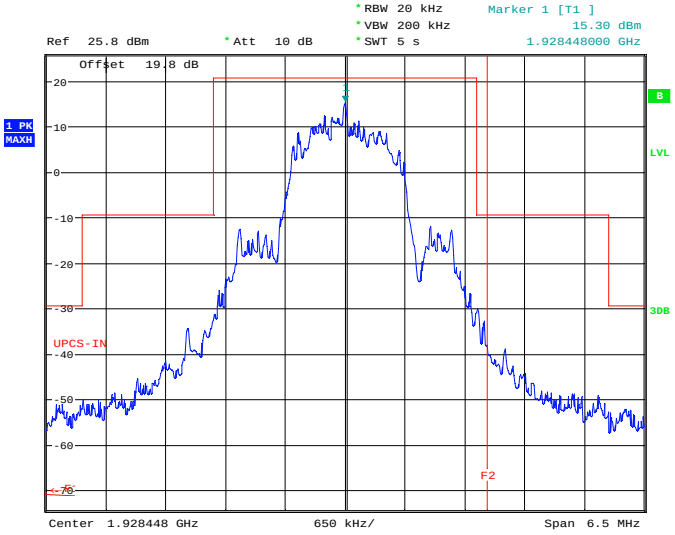


Upper Bandedge - > 2.5MHz

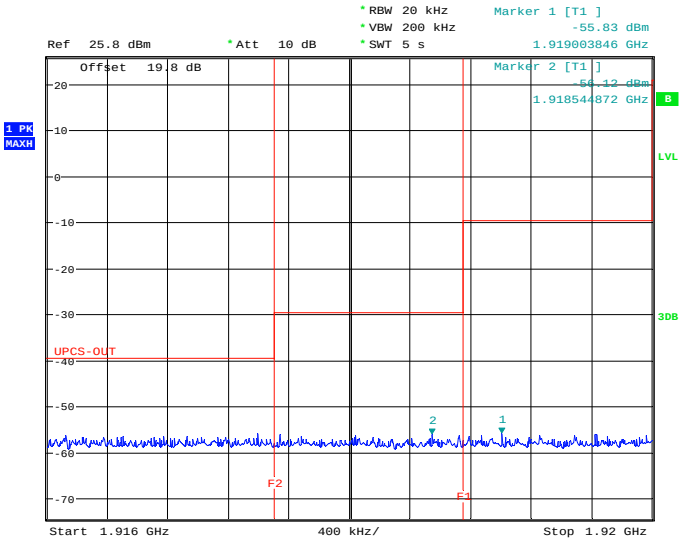
RF carrier set to the lowest carrier defined by the EUT					
Out-of-Band Emissions from UPCS bandedge	**FREQ. (MHz)**	**MEAS. Rx. (dBm)**	**CABLE & ATTEN. LOSS (dB)**	**EMISSION LEVEL (dBm)**	**LIMIT (dBm)**
> - 2.5MHz	Not Applicable – Radiated testing performed				
- 1.25 MHz – 2.5 MHz	1918.544872	-75.92	19.8	-56.12	-29.5
- 1.25 MHz	1919.003846	-75.63	19.8	-55.83	-9.5
In-band Emissions	See plot				
+ 1.25 MHz	1930.019231	-56.70	19.8	-36.90	-9.5
+ 1.25 MHz – 2.5 MHz	1931.474359	-71.03	19.8	-51.23	-29.5
> + 2.5MHz	Not Applicable – Radiated testing performed				

Limits		
	Out-of-Band Emissions From UPCS bandedge	**Attenuation (dB) required below Reference power of 112mW**
	± 1.25MHz	30
	±1.25 MHz – 2.5 MHz	50
	> ±2.5MHz	60
	In band Emissions from centre of emission bandwidth	**Attenuation (dB) required below permitted peak power for the EUT**
	1B – 2B	30
	2B – 3B	50
	3B – UPCS band edge	60

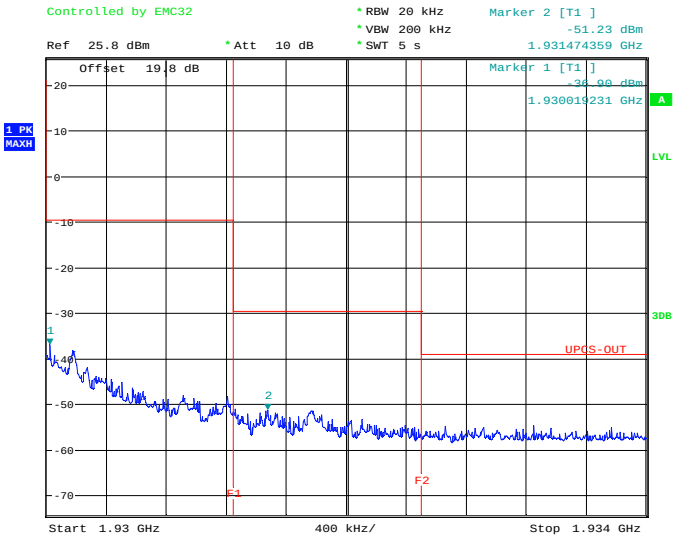
Emissions inside the Sub-Band RF carrier set to the highest carrier defined by the EUT



Conducted Emissions outside the Sub-Band RF carrier set to the highest carrier defined by the EUT



Lower Bandedge - > 2.5MHz



Upper Bandedge - > 2.5MHz

30 Emissions Inside and Outside the Sub-Band - Radiated

30.1 Definition

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

Out-of-band emission.
Emission on a frequency or frequencies immediately outside the operating band 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 in-band and out-of-band emissions.

30.2 Test Parameters

Test Standard and Clause:	ANSI C63.17 sub-clause 6.1.6. ANSI C63.10-2013, Clause 6.5 and 6.6
Test Location:	Element Skelmersdale / Hull
Test Chamber:	Radio Chamber
EUT Channels / Frequencies Measured:	Low / High
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: 32 % RH	20 % RH to 75 % RH (as declared)

30.3 Test Limit

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

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

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

30.4 Test Method

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

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

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

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

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

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

$$FS = PR + CL + AF – PA + DC – CF$$

Where,

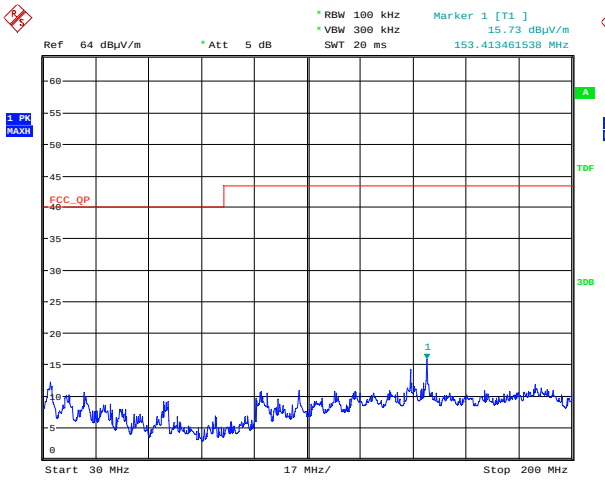
PR is the power recorded on the receiver / spectrum analyzer in dBµV;
CL is the cable loss in dB;
AF is the test antenna factor in dB/m;
PA is the pre-amplifier gain in dB (where used);
DC is the duty correction factor in dB (where used, e.g. harmonics of pulsed fundamental);
CF is the distance factor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

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

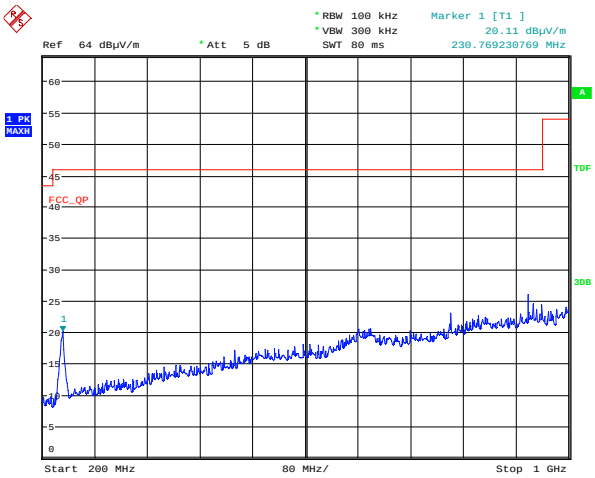
Figure ii Test Setup

30.5 Test Results

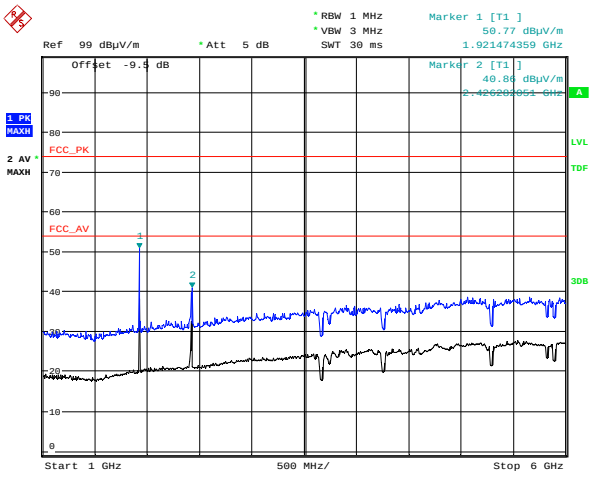
RF carrier set to the lowest carrier defined by the EUT										
Detector	***Freq. (MHz)***	***Meas'd Emission (dBµV)***	***Cable Loss (dB)***	***Antenna Factor (dB/m)***	***Pre-amp Gain (dB)***	***Duty Cycle Corr'n (dB)***	***Distance Extrap'n Factor (dB)***	***Field Strength (dBµV/m)***	***Field Strength (µV/m)***	***Limit (µV/m)***
Pk	3843.07	67.07	4.30	32.80	36.08	0.00	0.00	68.09	2538.05	5000
Av	3843.07	67.07	4.30	32.80	36.08	-27.96	0.00	40.13	101.52	500
Pk	5764.62	58.45	6.10	34.30	36.34	0.00	0.00	62.51	1335.06	5000
Av	5764.62	58.45	6.10	34.30	36.34	-27.96	0.00	34.55	53.40	500



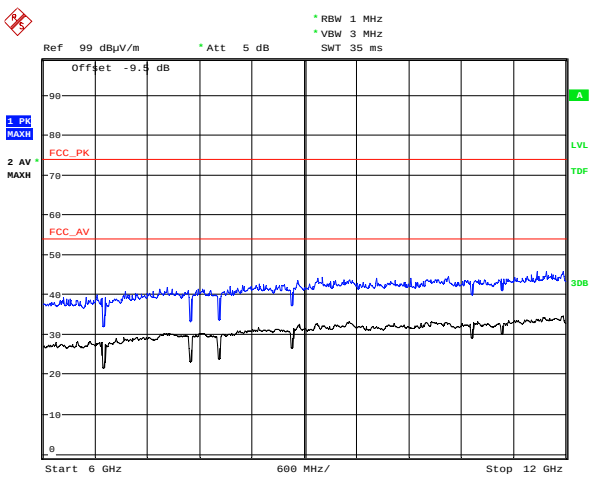
30MHz – 200 MHz



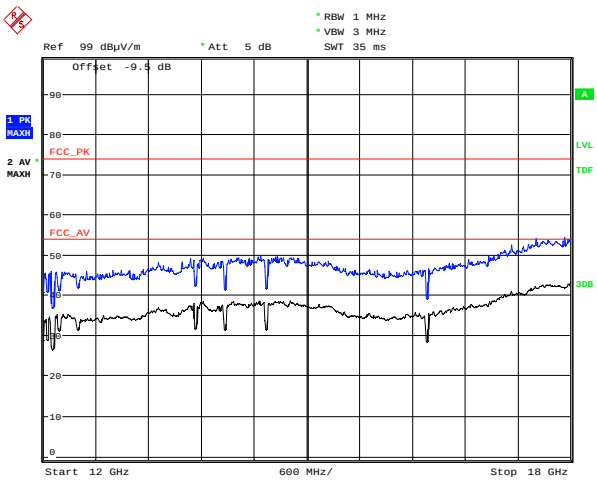
200 MHz – 1 GHz



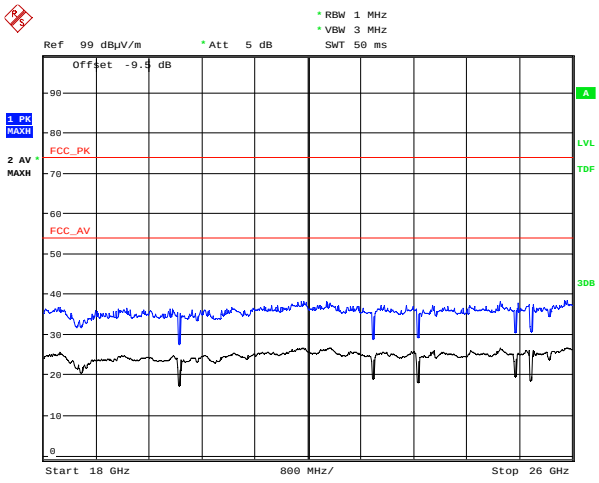
1GHz – 6GHz



6GHz – 12GHz

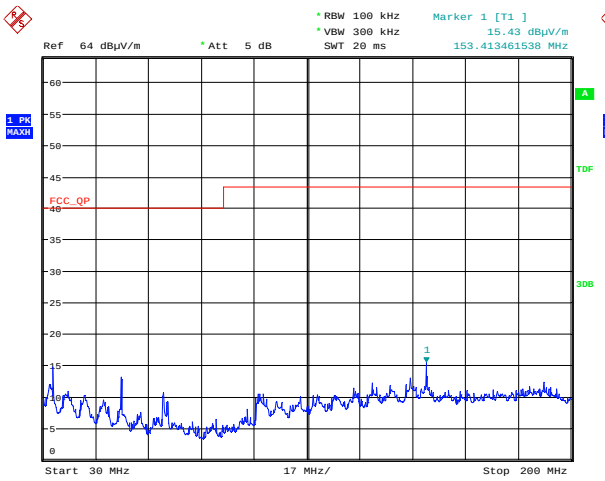


12 GHz – 18 GHz

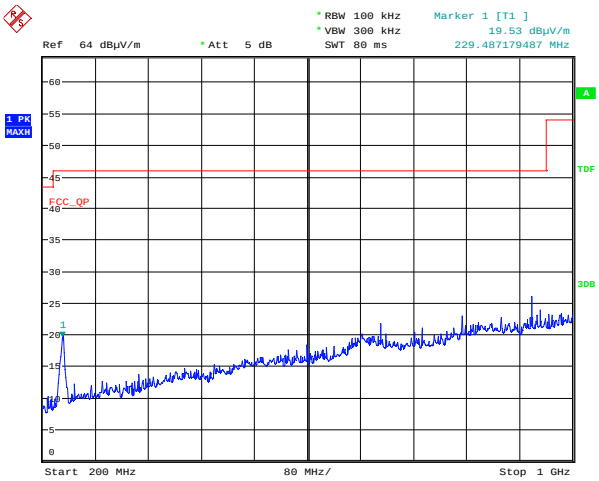


18 GHz – 20 GHz

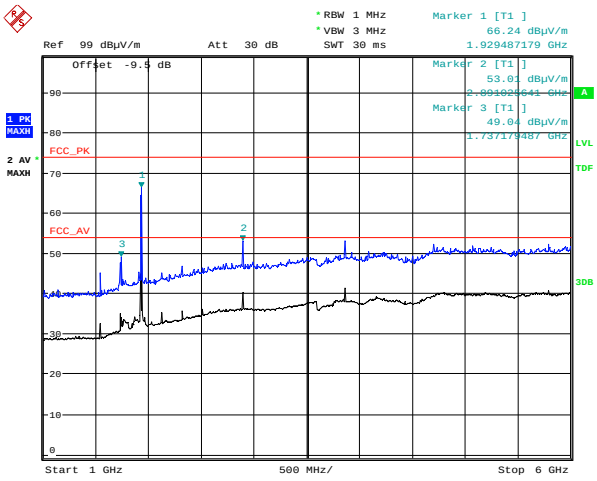
RF carrier set to the Highest carrier defined by the EUT										
Detector	***Freq. (MHz)***	***Meas'd Emission (dBµV)***	***Cable Loss (dB)***	***Antenna Factor (dB/m)***	***Pre-amp Gain (dB)***	***Duty Cycle Corr'n (dB)***	***Distance Extrap'n Factor (dB)***	***Field Strength (dBµV/m)***	***Field Strength (µV/m)***	***Limit (µV/m)***
Pk	3856.90	66.06	4.30	32.80	36.07	0.00	0.00	67.09	2262.04	5000
Av	3856.90	66.06	4.30	32.80	36.07	-27.96	0.00	39.13	90.48	500
Pk	5784.24	59.07	6.10	34.40	36.34	0.00	0.00	63.23	1450.44	5000
Av	5784.24	59.07	6.10	34.40	36.34	-27.96	0.00	35.27	58.02	500



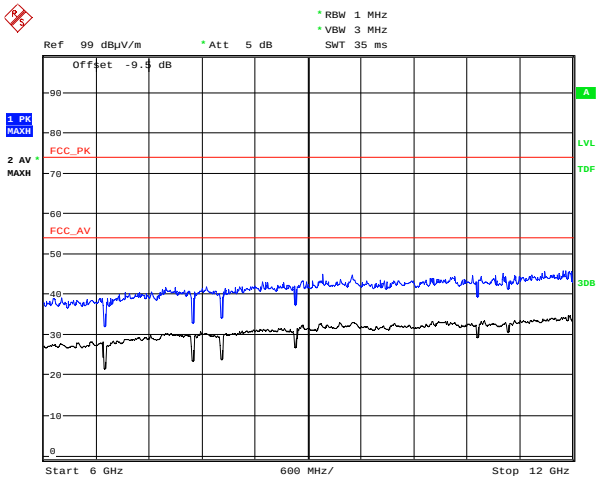
30MHz – 200 MHz



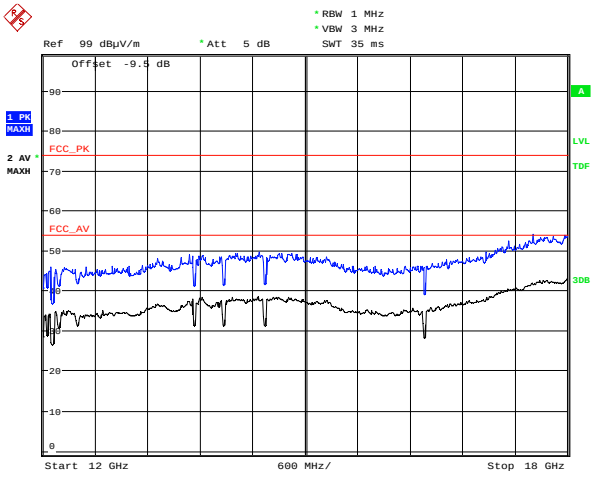
200 MHz – 1 GHz



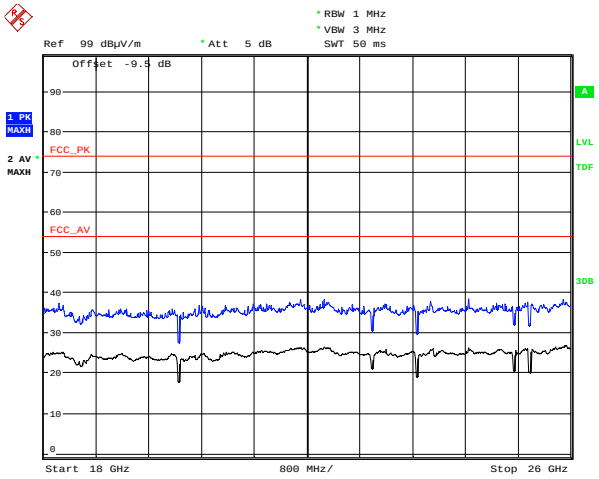
1GHz – 6GHz



6GHz – 12GHz



12 GHz – 18 GHz



18 GHz – 20 GHz

31 Frame Repetition Stability

31.1 Definition

This is the mean value of the frame repetition rate recorded over 1000 samples.

31.2 Test Parameters

Test Standard and Clause:	ANSI C63.17 sub-clause 6.2.2
Test Location:	Element Skelmersdale
Test Chamber:	Radio Lab
EUT Channels / Frequencies Measured:	1924.992 MHz
Deviations From Standard:	None

Environmental Conditions (Normal Environment)

Temperature: 22 °C	+15 ºC to +35 ºC (as declared)
Humidity: 32 % RH	20 % RH to 75 % RH (as declared)

31.3 Test Limit

Each device that implements time division for the purpose of maintaining a duplex connection on a given frequency carrier shall maintain a frame repetition rate with a frequency stability of at least 50 parts per million (ppm).

Each device that further divides access in time in order to support multiple communication links on a given frequency carrier shall maintain a frame repetition rate with a frequency stability of at least 10 ppm.

31.4 Test Result

Frame Repetition Stability (ppm)	Limit (ppm)	Pass/Fail
0	±10ppm	PASS

32 Frame Period and Jitter

32.1 Definition

Jitter is the difference in time between the rising edges of consecutive pulses occurring due to time-related, abrupt, spurious variations in the duration of the frame interval

32.2 Test Parameters

Test Standard and Clause:	ANSI C63.17 sub-clause 6.2.3
Test Location:	Element Skelmersdale
Test Chamber:	Radio Lab
EUT Channels / Frequencies Measured:	1924.992 MHz
Deviations From Standard:	None

Environmental Conditions (Normal Environment)

Temperature: 22 °C	+15 ºC to +35 ºC (as declared)
Humidity: 32 % RH	20 % RH to 75 % RH (as declared)

32.3 Test Limit

The jitter introduced at the 2 ends of a communication link shall not exceed 25 µs for any 2 consecutive transmissions.

32.4 Test Result

Maximum Jitter (µs)	3xSD Jitter (µs)	3xSD Jitter (µs)	Frame period (ms)	Limit (µs)		Pass/ Fail
				Frame Period (ms)	Jitter (µs)	
0.14	-0.08	0.42	10.00042	20 or 10/X	25	Pass

33 Frequency Stability

33.1 Definition

The accuracy of the transmitted signal, This testing is carried out with the following conditions over 1000 samples.

33.2 Test Paramters

Test Standard and Clause:	ANSI C63.17 sub-clause 6.2.1
Test Location:	Element Skelmersdale
Test Chamber:	Radio Chamber
EUT Channels / Frequencies Measured:	1924.992 MHz

Environmental Conditions (Normal Environment)

Temperature: 22 °C	+15 ºC to +35 ºC (as declared)
Humidity: 32 % RH	20 % RH to 75 % RH (as declared)

33.3 Test Limit

The carrier frequency stability shall be maintained within ±10 ppm (±0.001%).

33.4 Test Results

Temperature (°C)	Voltage (Vdc)	Fc (MHz)	offset (kHz)	offset (ppm)	Limit (ppm)
+20	Vnom	1924.992	5	2.60	±10ppm
-20	Vnom	1924.992	5	2.60	±10ppm
+55	Vnom	1924.992	6	3.12	±10ppm

Note: 1. The EUT is battery powered therefore voltage variations are not required.
2. Frequency variation relative to EUT operating Frequency.

35 Unintentional Radiated Emissions

35.1 Definition

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

Out-of-band emission.
Emission on a frequency or frequencies immediately outside the operating band 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 in-band and out-of-band emissions.

35.2 Test Parameters

Test Standard and Clause:	ANSI C63.17 sub-clause 6.1.6. ANSI C63.10-2013, Clause 6.5 and 6.6
Test Location:	Element Skelmersdale
Test Chamber:	Radio Chamber
EUT Channels / Frequencies Measured:	1921.536 MHz / 1928.448 MHz
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: 32 % RH	20 % RH to 75 % RH (as declared)

35.3 Test Limit

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

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

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

35.4 Test Method

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

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

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

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

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

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

$$FS = PR + CL + AF – PA + DC – CF$$

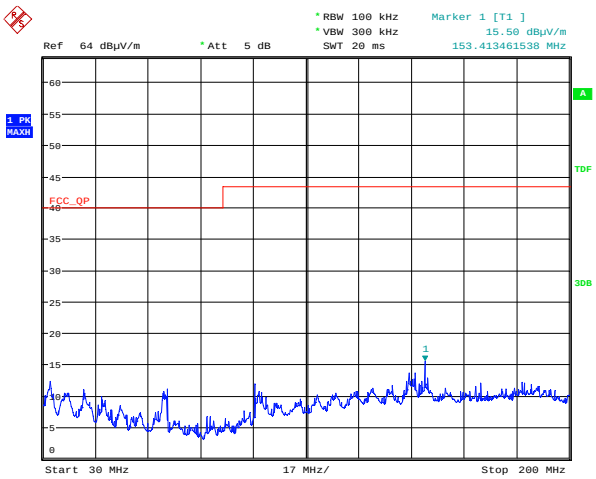
Where,

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

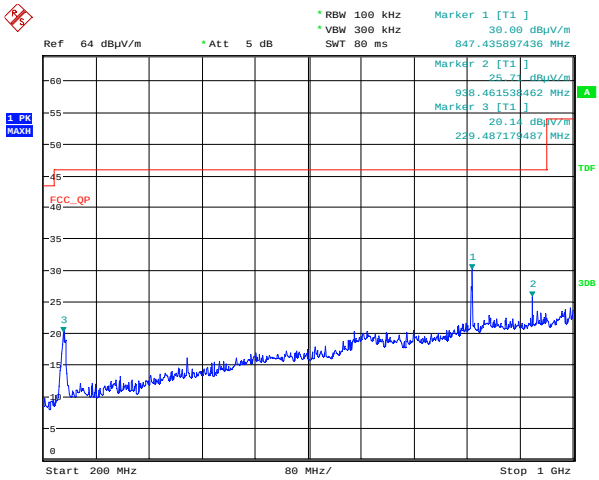
This field strength value is then compared with the regulatory limit.

Figure ii Test Setup

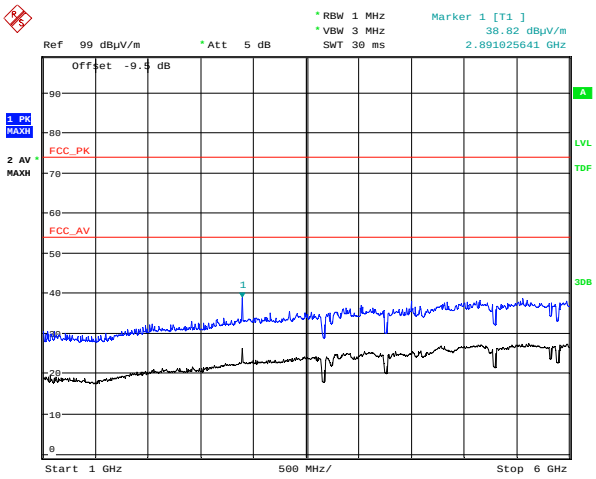
Det	Freq. (MHz)	Meas'd Emission (dBµV)	Cable Loss (dB)	Antenna Factor (dB/m)	Pre-amp Gain (dB)	Duty Cycle Corr'n (dB)	Distance Extrap'n Factor (dB)	Field Strength (dBµV/m)	Field Strength (µV/m)	Limit (µV/m)
No Significant Emission's Within 20 dB of the limit in receive mode.										



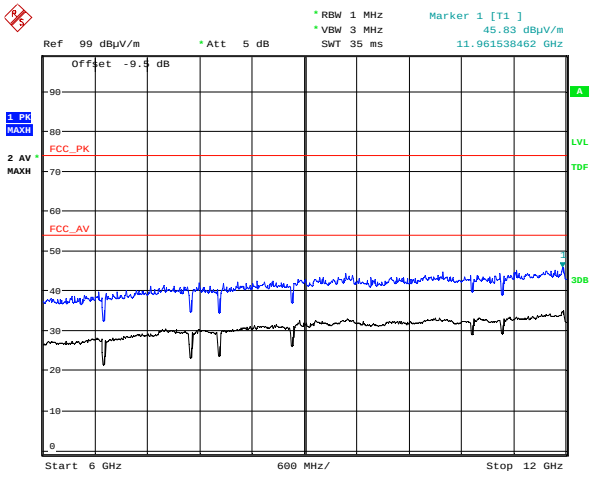
30MHz – 200 MHz



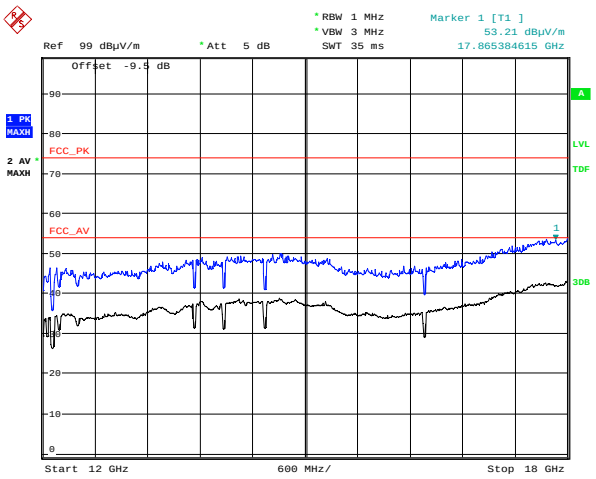
200 MHz – 1 GHz



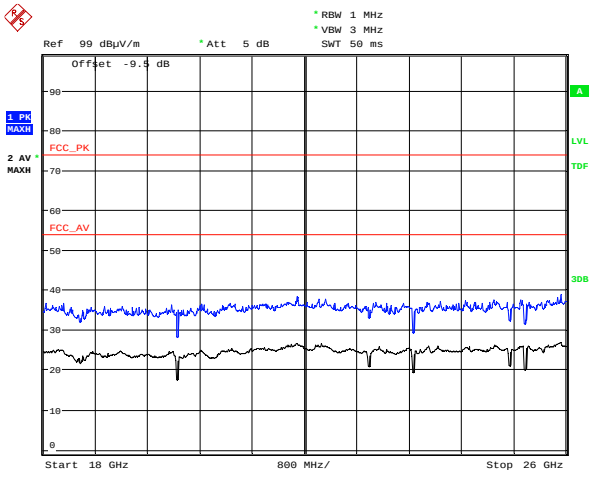
1GHz – 6GHz



6GHz – 12GHz



12 GHz – 18 GHz



18 GHz – 20 GHz

36 Test Equipment

Equipment Description	*Manufacturer*	*Equipment Type*	*Element No*	*Last Cal Calibration*	*Calibration Period*	*Due For Calibration*
Spectrum Analyser	R&S	FSU46	U281	19/06/2017	12	19/06/2018
Signal Generator	R&S	SMBV100A	REF916	09/06/2017	12	09/06/2018
Digital Signal Generator	Agilent	ESG D3000A	RFG441	28/11/2016	12	28/11/2017
Temperature Indicator	Fluke	52 Series II	L426	24/05/2017	12	24/05/2018
Temperature Chamber	Votsch	VT 4002	U521	Use L426		
Radiocommunication Tester	R&S	CMD 60	RFG433	24/05/2017	12	24/05/2018
1-18GHz Horn	EMCO	3115	L139	25/09/2017	24	25/09/2019
Pre Amp	Agilent	8449B	L572	07/02/2017	12	07/02/2018
Ferrite Lined Chamber	Rainford	ATS	REF886	24/07/2017	12	24/07/2018
Spectrum Analyser	R&S	FSU46	REF910	13/07/2017	12	13/07/2018
Biconical Antenna	EMCO	3109	RFG095	17/05/2016	36	17/05/2019
Log Periodic Antenna	EMCO	3146	RFG191	17/05/2016	36	17/05/2019
Horn Antenna	EMCO	3115	RFG129	09/02/2016	24	09/02/2018
Pre-Amp (1 – 26.5GHz)	Agilent	8449B	REF913	02/02/2016	24	02/02/2018
Pre-Amp (9kHz – 1GHz)	Sonoma	310	REF927	30/06/2016	24	30/06/2018
Short SMA RF Cable	AtlanTec RF	Cable	REF2165	09/12/2017	12	09/12/2017
Bandstop filter	Unknown	2.4 GHz Band Stop Filter	REF2158	Cal before use		
Attenuator	AtlanTec RF	AA20-xxH	-	Calibrate in use		
Combiners	-	-	-	Calibrate in use		

37 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] Adjacent Channel Power

Uncertainty in test result = **1.86dB**

[2] Carrier Power

Uncertainty in test result (Power Meter) = **1.08dB**
Uncertainty in test result (Spectrum Analyser) = **2.48dB**

[3] Effective Radiated Power

Uncertainty in test result = **4.71dB**

[4] Spurious Emissions

Uncertainty in test result = **4.75dB**

[5] Maximum frequency error

Uncertainty in test result (Frequency Counter) = **0.113ppm**
Uncertainty in test result (Spectrum Analyser) = **0.265ppm**

[6] Radiated Emissions, field strength OATS 14kHz-18GHz Electric Field

Uncertainty in test result (14kHz – 30MHz) = **4.8dB**,
Uncertainty in test result (30MHz – 1GHz) = **4.6dB**,
Uncertainty in test result (1GHz – 18GHz) = **4.7dB**

[7] Frequency deviation

Uncertainty in test result = **3.2%**

[8] Magnetic Field Emissions

Uncertainty in test result = **2.3dB**

[9] Conducted Spurious

Uncertainty in test result – Up to 8.1GHz = **3.31dB**
Uncertainty in test result – 8.1GHz – 15.3GHz = **4.43dB**
Uncertainty in test result – 15.3GHz – 21GHz = **5.34dB**
Uncertainty in test result – Up to 26GHz = **3.14dB**

[10] Channel Bandwidth

Uncertainty in test result = **15.5%**

[11] Amplitude and Time Measurement – Oscilloscope

Uncertainty in overall test level = **2.1dB**,
Uncertainty in time measurement = **0.59%,**
Uncertainty in Amplitude measurement = **0.82%**

[12] Power Line Conduction

Uncertainty in test result = **3.4dB**

[13] Spectrum Mask Measurements

Uncertainty in test result = **2.59% (frequency)**
Uncertainty in test result = **1.32dB (amplitude)**

[14] Adjacent Sub Band Selectivity

Uncertainty in test result = **1.24dB**

[15] Receiver Blocking – Listen Mode, Radiated

Uncertainty in test result = **3.42dB**

[16] Receiver Blocking – Talk Mode, Radiated

Uncertainty in test result = **3.36dB**

[17] Receiver Blocking – Talk Mode, Conducted

Uncertainty in test result = **1.24dB**

[18] Receiver Threshold

Uncertainty in test result = **3.23dB**

[19] Transmission Time Measurement

Uncertainty in test result = **7.98**