

Report on the Radio Testing

For

Pektron Group Ltd

on

Karma Key Fob

Report no. TRA-032712-05-47-00A

15th February 2017



Report Number: TRA-032712-05-47-00A
Issue: A

REPORT ON THE RADIO TESTING OF A
Pektron Group Ltd
Karma Key Fob
WITH RESPECT TO SPECIFICATION
FCC 47CFR 15.231 & IC RSS-210 Annex

TEST DATE: 9th - 13th February 2016

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Date: 15th February 2017

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



1 Revision Record

<i>Issue Number</i>	<i>Issue Date</i>	<i>Revision History</i>
A	15th February 2017	Original

2 Summary

TEST REPORT NUMBER:	TRA-032712-05-47-00A
WORKS ORDER NUMBER	TRA-032712-05
PURPOSE OF TEST:	USA: Testing of radio frequency equipment per the relevant authorization procedure of chapter 47 of CFR (code of federal regulations) Part 2, subpart J. Canada: Testing of radio apparatus for TAC (technical acceptance certificate) per subsections 4(2) of the Radio communication Act and 21(1) of the Radio communication Regulations.
TEST SPECIFICATION(S):	47CFR15.231 & IC RSS-210 Annex
EQUIPMENT UNDER TEST (EUT):	Karma Key Fob
FCC IDENTIFIER:	AQO005
ISED IDENTIFIER:	10176A-005
EUT SERIAL NUMBER:	Normal operation: WB00004 Continious tranmission: WB00002
MANUFACTURER/AGENT:	Pektron Group Ltd
ADDRESS:	Alfreton Road Derby Derbyshire United Kingdom
CLIENT CONTACT:	Dave Gowans ☎ 01332 832424 ✉ dgowans@pektron.co.uk
ORDER NUMBER:	PROJ-00000292
TEST DATE:	9th - 13th February 2016
TESTED BY:	D Moncayola Element

2.1 Test Summary

<i>Test Method and Description</i>	<i>Requirement Clause</i>			
	<i>47CFR15</i>	<i>RSS-210</i>	<i>Applicable to this equipment</i>	<i>Result / Note</i>
Radiated spurious emissions	15.231(b) 15.209	210 Annex A A.1.2	☒	Pass
AC power line conducted emissions	15.207	Gen, 8.8	☐	N/A
Occupied bandwidth	15.215(c)	210 Annex A A.1.3	☒	Pass
Field strength of fundamental	15.231(b)	210 Annex A A.1.2	☒	Pass
Transmitter Timings	15.231(a)	210 Annex A A.1.1.	☒	Pass

Notes:

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

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

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

3 Contents

1	Revision Record.....	3
2	Summary.....	4
2.1	Test Summary.....	5
3	Contents.....	6
4	Introduction	7
5	Test Specifications.....	8
5.1	Normative References	8
5.2	Deviations from Test Standards	8
6	Glossary of Terms.....	9
7	Equipment Under Test	10
7.1	EUT Identification.....	10
7.2	System Equipment.....	10
7.3	EUT Mode of Operation	10
7.3.1	Transmission.....	10
7.3.2	Reception.....	10
7.4	EUT Radio Parameters.....	11
7.4.1	General	11
7.4.2	Antennas.....	11
7.5	EUT Description	11
8	Modifications.....	12
9	EUT Test Setup	13
9.1	Block Diagram.....	13
9.2	General Set-up Photograph	14
10	General Technical Parameters.....	15
10.1	Normal Conditions.....	15
10.2	Varying Test Conditions	15
11	Radiated emissions.....	16
11.1	Definitions	16
11.2	Test Parameters.....	16
11.3	Test Limit.....	17
11.4	Test Method	18
11.5	Test Set-up Photograph	19
11.6	Test Equipment.....	19
11.7	Test Results	20
12	Occupied Bandwidth	22
12.1	Definitions	22
12.2	Test Parameters.....	22
12.3	Test Limit.....	22
12.4	Test Method	23
12.5	Test Equipment.....	23
12.6	Test Results	24
13	Transmitter output power (fundamental radiated emission)	25
13.1	Definition	25
13.2	Test Parameters.....	25
13.3	Test Limit.....	25
13.4	Test Method	26
13.5	Test Equipment.....	26
13.6	Test Results	26
14	Evaluation of certain unlicensed wireless devices with periodic emissions.....	27
14.1	Definition	27
14.2	Test Parameters.....	27
14.3	Test Limit.....	27
14.4	Test Method	28
14.5	Test Equipment.....	28
14.6	Test Results	28
15	Measurement Uncertainty.....	30

4 Introduction

This report TRA-032712-05-47-00A presents the results of the Radio testing on a Pektron Group Ltd, Karma Key Fob to specification 47CFR15 Radio Frequency Devices and RSS-210 Licence-exempt Radio Apparatus (All Frequency Bands): Category I Equipment.

The testing was carried out for Pektron Group Ltd 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 Skelmersdale West Lancashire WN8 9PN UK
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This report details the configuration of the equipment, the test methods used and any relevant modifications where appropriate.

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

Throughout this report EUT denotes equipment under test.

FCC Site Listing:

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

IC Registration Number(s):

Element Skelmersdale Chamber 6 3930B-4

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

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

5 Test Specifications

5.1 Normative References

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

5.2 Deviations from Test Standards

There were no deviations from the test standard.

6 Glossary of Terms

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

7 Equipment Under Test

7.1 EUT Identification

- Name: Karma Key Fob
- Model Number: A-0783G02
- Software Revision: Not Applicable
- Build Level / Revision Number: Production
- Serial Numbers
 - Normal Operation: WB00004
 - Constant Transmit: WB00002

7.2 System Equipment

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

Not Applicable – No support/monitoring equipment required.

7.3 EUT Mode of Operation

7.3.1 Transmission

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

EUT was set to permanent transmission using test software for Fundamental carrier power, spurious emissions and occupied bandwidth.

A unit operating in normal mode was utilised for measurement on transmission times

7.3.2 Reception

Not applicable

7.4 EUT Radio Parameters

7.4.1 General

Frequency of operation:	433.97 MHz
Modulation type(s):	ASK
Channel spacing:	Not Applicable
ITU emission designator(s):	A1D
Warning against use of alternative antennas in user manual (yes/no):	Not Applicable Integral PCB antenna
Nominal Supply Voltage:	3.0Vdc
Frequency stability:	Not Applicable
Location of notice for license exempt use:	Label / user manual / both.

7.4.2 Antennas

Type:	Integral PCB Track
Frequency range:	433.97 MHz
Impedance:	50 Ohms
Connector type:	Not Applicable
Mounting:	Not Applicable

7.5 EUT Description

The EUT is a car Key Fob transmitter operating at 433.97 MHz

8 Modifications

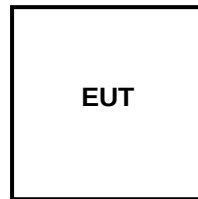
No modifications were performed during this assessment.

9 EUT Test Setup

9.1 Block Diagram

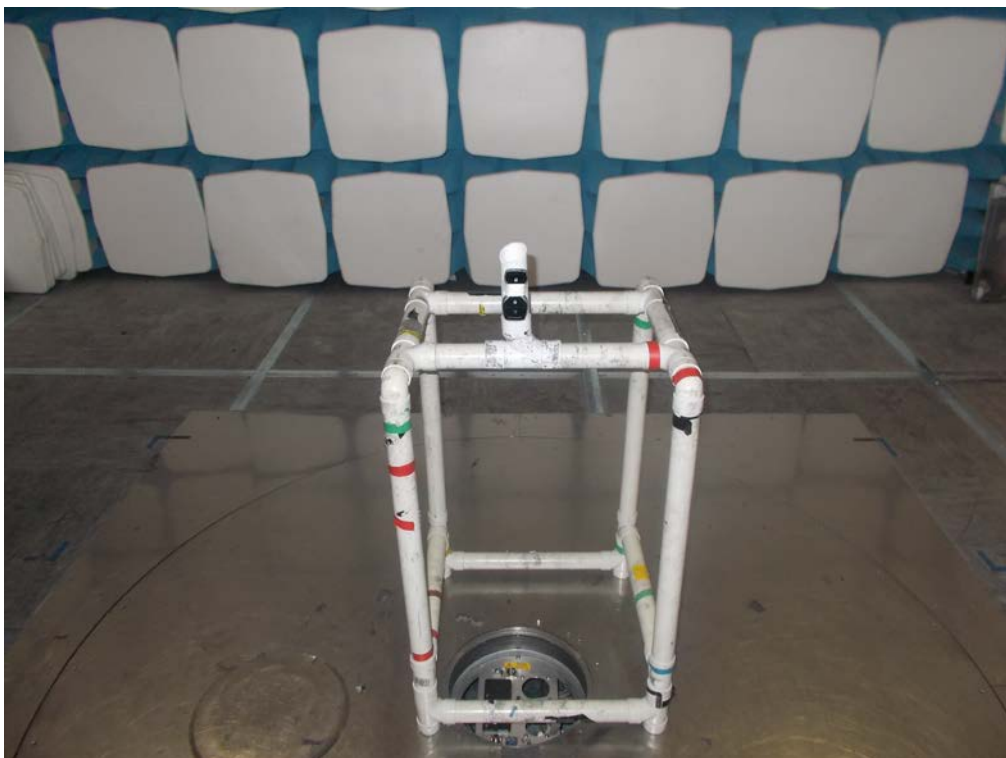
The following diagram shows basic EUT interconnections with cable type and cable lengths identified:

EUT is a battery powered device with no external connections



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. 3 V dc from alkaline batteries.

10.2 Varying Test Conditions

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

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

11 Radiated emissions

11.1 Definitions

Out-of-band emissions

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

Spurious emissions

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

Restricted bands

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

11.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio laboratory
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.5 and 6.6
EUT Channels / Frequencies Measured:	433.97 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 °C to +35 °C (as declared)
Humidity: 44 % RH	20 % RH to 75 % RH (as declared)
Supply: 3.0 V dc	3.0 V dc

11.3 Test Limit

In addition to the provisions of 15.205, the field strength of emissions from intentional radiators shall not exceed the following:

Fundamental Frequency (MHz)	Field Strength ($\mu\text{V/m}$ at 3 m)
40.66 – 40.70	225
70 – 130	125
130 – 174	125 to 375
174 – 260	375
260 – 470	375 to 1,250
Above 470	1,250

In addition to the provisions of RSS-210 issue 9 A.1.2, the field strength of emissions from intentional radiators shall not exceed the following:

Fundamental Frequency (MHz)	Field Strength ($\mu\text{V/m}$ at 3 m)
70 – 130	1,250
130 – 174	1,250 to 3750
174 – 260	3,750
260 – 470	3,750 to 12,500
Above 470	12,500

The limits on the field strength of the spurious emissions in the above table are based on the fundamental frequency of the intentional radiator. Spurious emissions shall be attenuated to the average (or, alternatively, CISPR quasi-peak) limits shown in this table or to the general limits shown in § 15.209 (below) and RSS-Gen 8.9 (below), whichever limit permits a higher field strength.

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

Frequency (MHz)	Field Strength ($\mu\text{V/m}$ at 3 m)
30 to 88	100
88 to 216	150
216 to 960	200
Above 960	500

n.b. per FCC 47CFR15.35(b) and RSS-Gen 8.9 peak limit is 20 dB above average.

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;

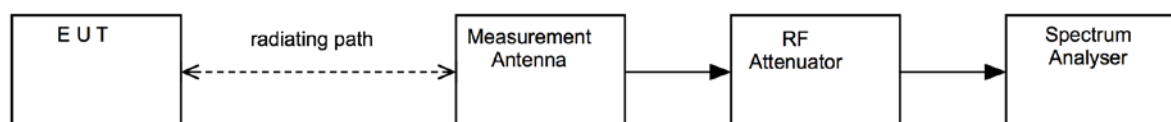
PA is the pre-amplifier gain in dB (where used);

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



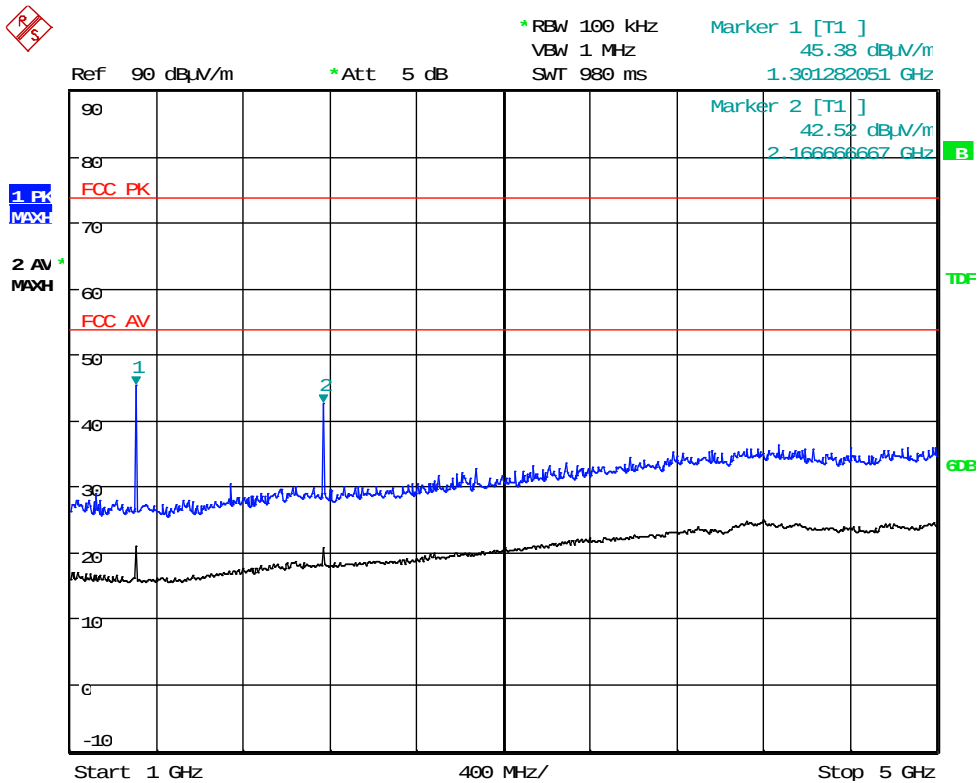
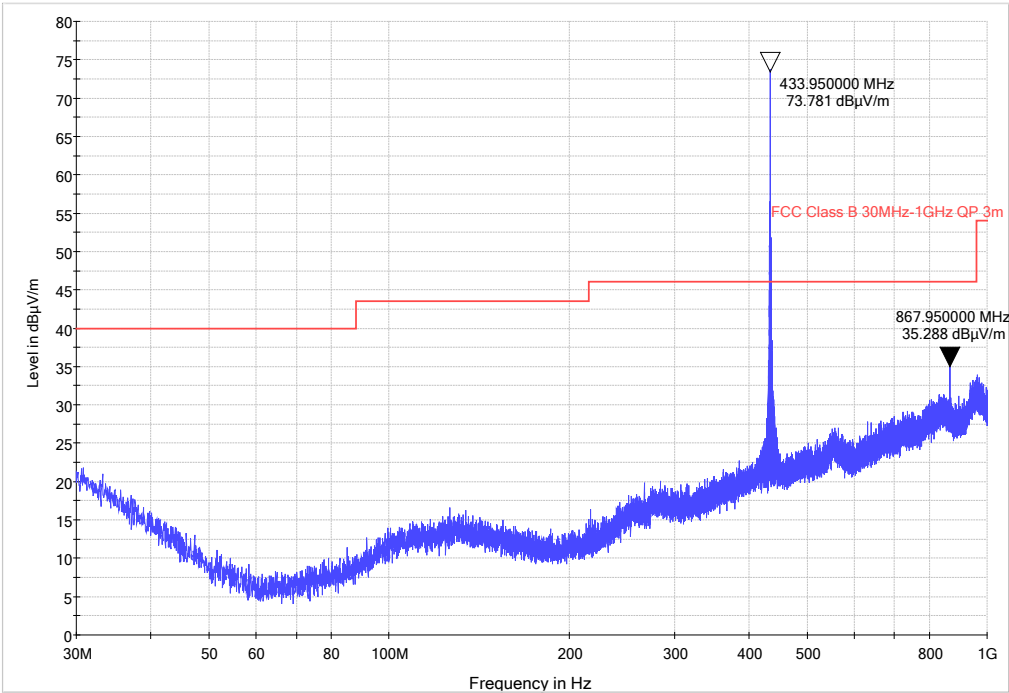
11.5 Test Set-up Photograph



11.6 Test Equipment

<i>Type of Equipment</i>	<i>Maker/Supplier</i>	<i>Model Number</i>	<i>Element Number</i>	<i>Calibration Due Date</i>
Bilog	Chase	CBL611/A	UH191	26/02/2017
ESVS10	R&S	ESVS10	L352	14/07/2017
Spectrum Analyser	R&S	FSU26	U405	02/06/2017
Horn Antenna	EMCO	3115	TRL139	25/09/2017
Pre-Amplifier	Agilent	8449B	TRL572	16/02/2017

11.7 Test Results



Date: 9.FEB.2017 16:50:35

<i>Detector</i>	<i>Freq. (MHz)</i>	<i>Meas'd Emission (dBμV)</i>	<i>Cable Loss (dB)</i>	<i>Antenna Factor (dB/m)</i>	<i>Pre-amp Gain (dB)</i>	<i>Duty Cycle Corr'n (dB)</i>	<i>Distance Extrap'n Factor (dB)</i>	<i>Field Strength (dBμV/m)</i>	<i>Field Strength (μV/m)</i>	<i>Limit (μV/m)</i>
QP	867.94	15.10	3.90	22.30	N/A	0.00	0.00	41.30	116.14	200
Pk	1301.85	56.88	2.10	25.50	36.40	0.00	0.00	48.08	253.51	5000
Av	1301.85	48.56	2.10	25.50	36.40	0.00	0.00	39.76	97.27	500
Pk	2169.78	52.93	2.80	28.00	36.15	0.00	0.00	47.58	239.33	5000
Av	2169.78	43.25	2.80	28.00	36.15	0.00	0.00	37.90	78.52	500

12 Occupied Bandwidth

12.1 Definitions

Occupied bandwidth

The width of a frequency band such that, below the lower and above the upper frequency limits, the mean powers emitted are each equal to 0.5 % of the emitted power. This is also known as the *99 % emission bandwidth*. For transmitters in which there are multiple carriers, contiguous or non-contiguous in frequency, the occupied bandwidth is to be the sum of the occupied bandwidths of the individual carriers.

20 dB bandwidth

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

12.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Laboratory
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.9
EUT Channels / Frequencies Measured:	433.97 MHz
Deviations From Standard:	None
Measurement BW: (requirement: 1 % to 5 % OBW)	500Hz
Spectrum Analyzer Video BW: (requirement at least 3x RBW)	2kHz
Measurement Span: (requirement 2 to 5 times OBW)	50 kHz
Measurement Detector:	Peak

Environmental Conditions (Normal Environment)

Temperature: 21 °C	+15 °C to +35 °C (as declared)
Humidity: 44 % RH	20 % RH to 75 % RH (as declared)
Supply: 3.0 V dc	(as declared)

12.3 Test Limit

Federal Communications Commission:

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

Industry Canada:

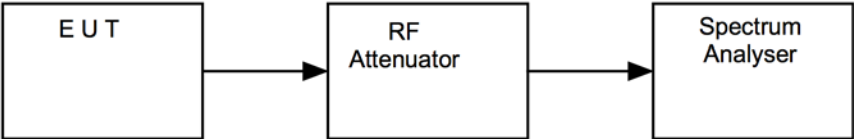
The 99% bandwidth of momentarily operated devices shall be less or equal to 0.25% of the centre frequency for devices operating between 70 MHz and 900 MHz. For devices operating above 900 MHz, the 99% bandwidth shall be less or equal to 0.5% of the centre frequency.

12.4 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

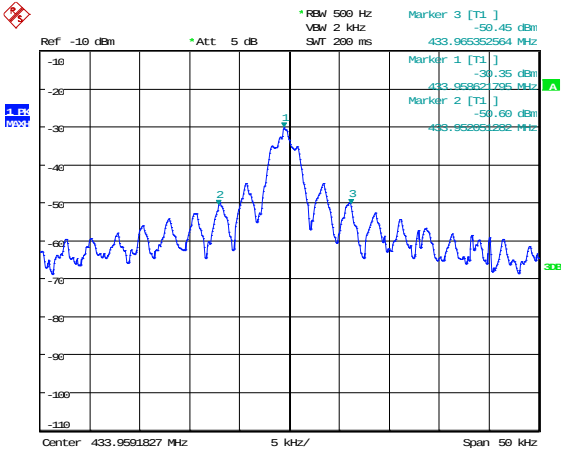


12.5 Test Equipment

Type of Equipment	Maker/Supplier	Model Number	Element Number	Calibration Due Date
Spectrum Analyser	R&S	FSU26	U405	02/06/2017

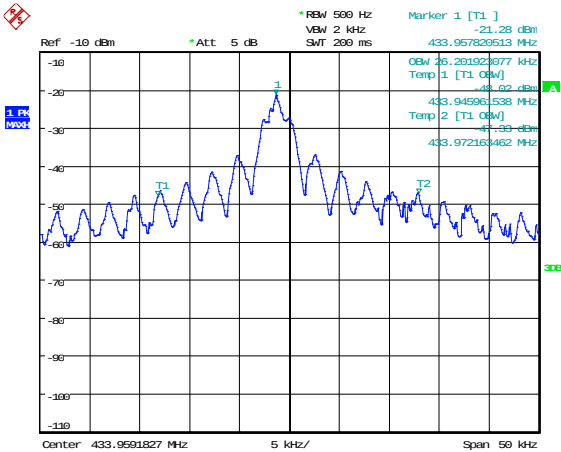
12.6 Test Results

20 dB Bandwidth				
Channel Frequency (MHz)	F_L (MHz)	F_H (MHz)	20dB Bandwidth (kHz)	Result
433.95	433.952	433.9653	13.3	PASS



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99 % Bandwidth				
Channel Frequency (MHz)	F_L (MHz)	F_H (MHz)	20dB Bandwidth (kHz)	Result
433.95	433.945900	433.9721	26.2	PASS



Date: 10.FEB.2017 11:12:14

13 Transmitter output power (fundamental radiated emission)

13.1 Definition

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

13.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Chamber (REF940)
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.5 / 6.6
EUT Channels / Frequencies Measured:	433.97 MHz
Deviations From Standard:	None
Measurement BW:	120 kHz
Spectrum Analyzer Video BW: (requirement at least 3x RBW)	Not Applicable
Measurement Detector:	Up to 1 GHz: Quasi-peak Above 1 GHz: Average RMS and Peak
Voltage Extreme Environment Test Range:	Mains Power = 85 % and 115 % of Nominal (FCC only requirement); Battery Power = new battery.

Environmental Conditions (Normal Environment)

Temperature: 22 °C	+15 °C to +35 °C (as declared)
Humidity: 44 % RH	20 % RH to 75 % RH (as declared)

13.3 Test Limit

The field strength measured at 3 metres shall not exceed the limits in the following table:

Field Strength Limits for License-Exempt Transmitters for Any Application

<i>Fundamental frequency (MHz)</i>	<i>Field strength of fundamental (μV/m at 3 m)</i>	<i>Detector</i>
260 - 470	3,750 – 12,500	Quasi-Peak

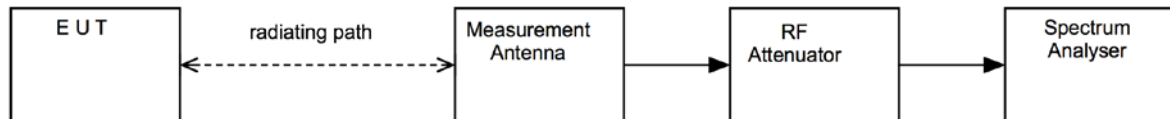
Linear Interpolation

13.4 Test Method

The EUT setup as per section 9 of this report and connected as per Figure iv.

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



13.5 Test Equipment

Type of Equipment	Maker/Supplier	Model Number	Element Number	Calibration Due Date
Bilog	Chase	CBL611/A	UH191	26/02/2017
ESVS10	R&S	ESVS10	L352	14/07/2017

13.6 Test Results

Detector	Freq. (MHz)	Meas'd Emission (dBμV)	Cable Loss (dB)	Antenna Factor (dB/m)	Pre-amp Gain (dB)	Field Strength (dBμV/m) @ 3m	Field Strength (μV/m) @ 3m	Limit (μV/m) @ 3m
QP	433.97	57.50	2.85	16.10	N/A	76.45	6645.08	10995.85

14 Evaluation of certain unlicensed wireless devices with periodic emissions

14.1 Definition

An unlicensed wireless device operating with periodic emissions shall address compliance with the applicable regulatory requirements

14.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio lab
Test Standard and Clause:	ANSI C63.10-2013, Clause 7.6.1
EUT Channels / Frequencies Measured:	433.97 MHz
Deviations From Standard:	None
Temperature Extreme Environment Test Range:	N/A
Voltage Extreme Environment Test Range:	N/A

Environmental Conditions (Normal Environment)

Temperature: 22 °C	+15 °C to +35 °C (as declared)
Humidity: 42 % RH	20 % RH to 75 % RH (as declared)
Supply: 3.0 V dc	3.0 V dc (as declared)

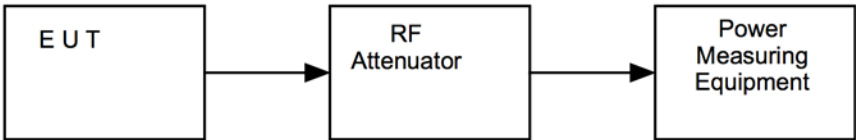
14.3 Test Limit

- 1) A manually operated transmitter shall employ a switch that will automatically deactivate the transmitter within not more than 5 seconds of being released.
- 2) A transmitter activated automatically shall cease transmission within 5 seconds after activation.
- 3) Periodic transmissions at regular predetermined intervals are not permitted. However, polling or supervision transmissions, including data, to determine system integrity of transmitters used in security or safety applications are allowed if the total duration of transmissions does not exceed more than two seconds per hour for each transmitter. There is no limit on the number of individual transmissions, provided the total transmission time does not exceed two seconds per hour.
- 4) Intentional radiators which are employed for radio control purposes during emergencies involving fire, security, and safety of life, when activated to signal an alarm, may operate during the pendency of the alarm condition

14.4 Test Method

EUT is triggered by all means available (manual / Automatic / Supervision). The length of transmission for each type of trigger is measured and compared to the relevant limit.

Figure vii Test Setup

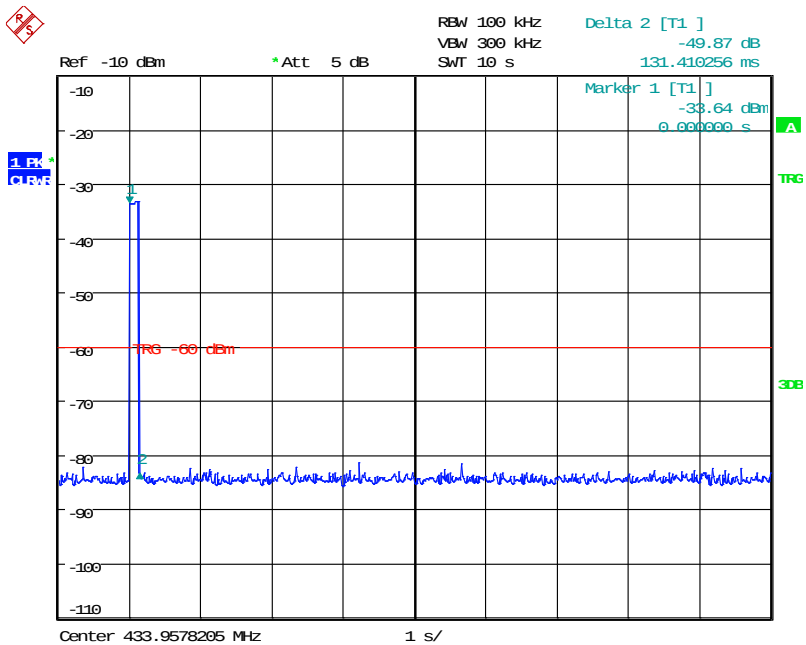


14.5 Test Equipment

Type of Equipment	Maker/Supplier	Model Number	Element Number	Calibration Due Date
Spectrum Analyser	R&S	FSU26	U405	02/06/2017

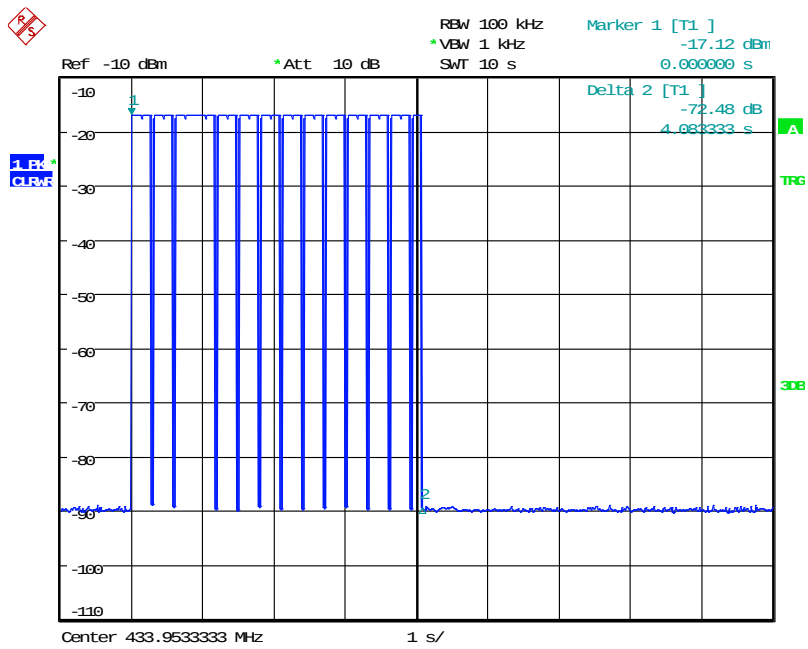
14.6 Test Results

Trigger Type	TxOn time (ms)	Limit (Seconds)	Results
Manual Short Button Press	131.41	<5	Pass
Manual Long Button Press	3850	<5	Pass
Automatic Transmission	Not Applicable, No Automatic Transmissions		
Supervision Transmission	Not Applicable, No Supervisions Transmissions		



Date: 10.FEB.2017 11:32:02

Single Button Press



Date: 20.OCT.2015 16:26:39

Hold Button Press

15 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] Carrier power

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

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

[2] Spurious emissions

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

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

[3] AC power line conducted emissions

Uncertainty in test result = **3.4 dB**

[4] Occupied bandwidth

Uncertainty in test result = **15.5 %**

[5] Maximum frequency error

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

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

[6] Duty cycle

Uncertainty in test result = **7.98 %**