

Report on the Radio Testing
For
Pektron Group Ltd
on
Karma 2.0 Key Fob
Report no. TRA-046711-45-03A
30 August 2019

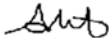
RF960 iss.1.0

Report Number: TRA-046711-45-03A
Issue: A

REPORT ON THE RADIO TESTING OF A
Pektron Group Ltd
Karma 2.0 Key Fob
WITH RESPECT TO SPECIFICATION
FCC 47CFR 15.231

TEST DATE: 2019-07-31 to 2019-08-13

Tested by: Atif Tosif, David Garvey & Ian Broadwell

Written by: 

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Date: 30 August 2019

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

RF960 iss.1.0

1 Revision Record

<i>Issue Number</i>	<i>Issue Date</i>	<i>Revision History</i>
A	30 August 2019	Original

2 Summary

TEST REPORT NUMBER: TRA-046711-45-03A

WORKS ORDER NUMBER: TRA-046711-01

PURPOSE OF TEST: Certification

TEST SPECIFICATION: 47CFR15.231

EQUIPMENT UNDER TEST (EUT): Karma 2.0 Key Fob

FCC IDENTIFIER: AQO010

MANUFACTURER/AGENT: Pektron Group Ltd

ADDRESS: Alfreton Road
Derby
Derbyshire
DE21 4AP
United Kingdom

CLIENT CONTACT: Richard Jones
☎ 01332832424 ext 382
✉ rjones@pektron.co.uk

ORDER NUMBER: PROJ-00000498

TEST DATE: 2019-07-31 to 2019-08-13

TESTED BY: Atif Tosif, David Garvey & Ian Broadwell
Element

2.1 Test Summary

Test Method and Description	Requirement Clause 47CFR15	Applicable to this equipment	Result / Note
Transmission Cessation Time	15.231 (a) (1)	<input checked="" type="checkbox"/>	<i>Pass</i>
Radiated Emissions (Field Strength of Fundamental and Spurious Emissions)	15.231 (b)	<input checked="" type="checkbox"/>	<i>Pass</i>
Occupied bandwidth	15.231 (c)	<input checked="" type="checkbox"/>	<i>Pass</i>
AC power line conducted emissions	15.207	<input type="checkbox"/>	<i>Note 1</i>

Specific Note:

1. The EUT is a battery powered device.

General Notes:

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

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

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

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4 Introduction

This report TRA-046711-45-03A presents the results of the Radio testing on a Pektron Group Ltd, Karma 2.0 Key Fob to specification 47CFR15 Radio Frequency Devices.

The testing was carried out for Pektron Group Ltd by Element, at the address detailed below.

<input checked="" type="checkbox"/>	Element Hull Unit E South Orbital Trading Park Hedon Road Hull HU9 1NJ UK	<input type="checkbox"/>	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.

FCC Site Listing:

The test laboratory is accredited for the above sites under the US-EU MRA, Designation numbers UK0007 & UK0020.

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.

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
CISPR	Comité International Spécial des Perturbations Radioélectriques
CW	Continuous Wave
dB	decibel
dBm	dB relative to 1 milliwatt
DC	Direct Current
EIRP	Equivalent Isotropically Radiated Power
ERP	Effective Radiated Power
EUT	Equipment Under Test
FCC	Federal Communications Commission
Hz	hertz
ITU	International Telecommunication Union
m	metre
max	maximum
min	minimum
MRA	Mutual Recognition Agreement
N/A	Not Applicable
PCB	Printed Circuit Board
PDF	Portable Document Format
QP	Quasi-Peak
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 2.0 Key Fob
- Model Number: A-0810G02
- Software Revision: P0810P01
- Build Level / Revision Number: 0810G02

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

The EUT was transmitting modulated carrier.

7.4 EUT Radio Parameters

Frequencies of operation:	433.96 MHz transmitter and 125 kHz receiver
Antenna type:	Integral
Nominal Supply Voltage:	3 Vdc

This report only covers 433.96 MHz transmitter.

7.5 EUT Description

The EUT is a battery powered key fob.

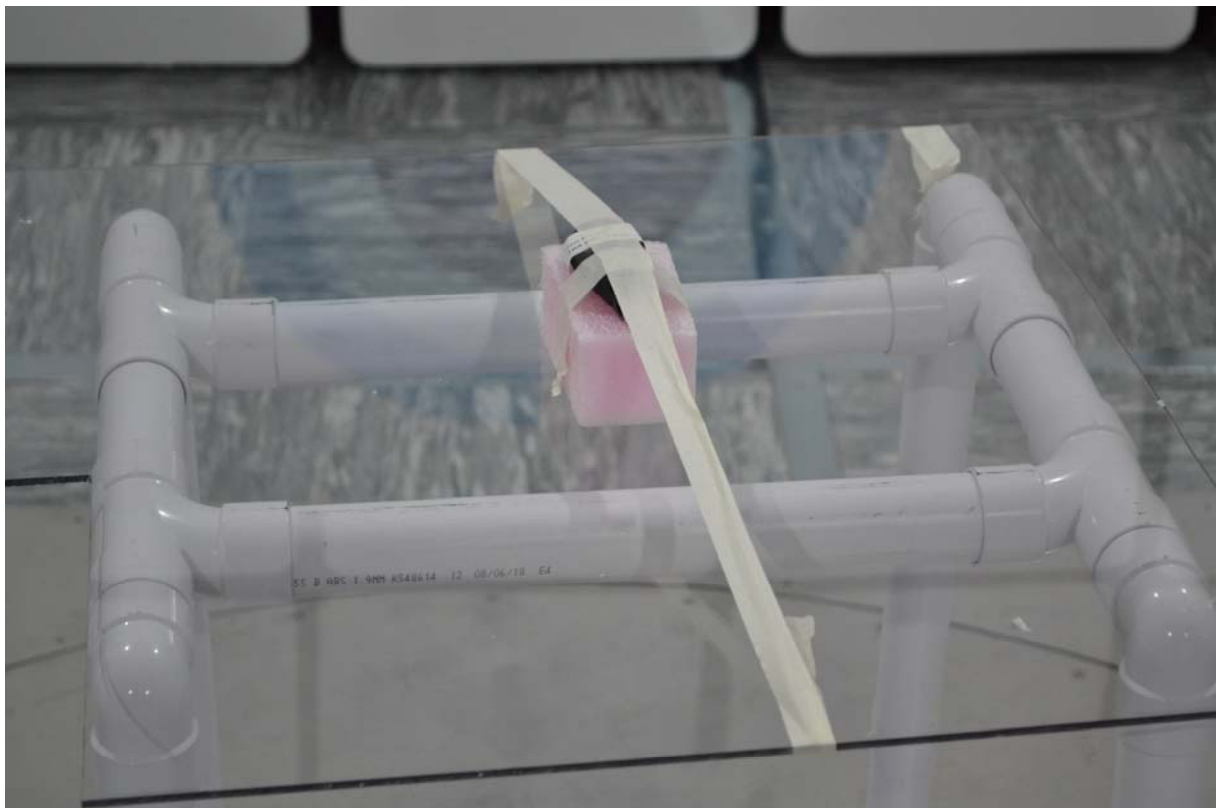
8 Modifications

No modifications were performed during this assessment.

9 EUT Test Setup

9.1 General Set-up Photograph

The following photograph shows basic EUT radiated set-up.



9.2 Measurement software

Where applicable, the following software was used to perform measurements contained within this report.

- Element Emissions R5

10 General Technical Parameters

10.1 Normal Conditions

The EUT was tested under the normal environmental conditions of the test laboratory, except where otherwise stated. The normal power source applied was 3 Vdc.

10.2 Varying Test Conditions

Not applicable.

11 Radiated emissions

11.1 Definitions

Fundamental emissions

Emissions on a frequency or frequencies which are within the necessary bandwidth.

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.

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.

11.2 Test Parameters

Test Location:	Element Hull
Test Chamber:	Wireless Lab 3
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.5 and 6.6
EUT Frequency Measured:	433.96 MHz
Deviations From Standard:	None
Measurement BW:	30 MHz to 1 GHz: 120 kHz; Above 1 GHz: 1 MHz

Environmental Conditions (Normal Environment)

Temperature: 21 °C	+15 °C to +35 °C (as declared)
Humidity: 48 %RH	20%RH to 75%RH (as declared)
Supply: 3 Vdc	As declared

Test Limits

The intentional radiators shall demonstrate compliance with the limits of field strength of emissions, as shown in table 1, based on the average value of the measured emissions. As an alternative, compliance with the limits in the table 1 may be based on the use of measurement instrumentation with a CISPR quasi-peak detector. The requirements of the pulsed operation section of 47CFR15.35 apply for averaging pulsed emissions and limiting peak emissions.

Table 1 – Field Strength Limits

Fundamental frequency (MHz)	Field strength of fundamental ($\mu\text{V/m}$ at 3m)	Field strength of Spurious Emissions ($\mu\text{V/m}$ at 3m)
40.66 – 40.70	2,250	225
70 – 130	1,250	125
130 – 174	1,250 to 3,750*	125 to 375
174 – 260	3,750	375
260 – 470	3,750 to 12,500*	375 to 1,250
Above 470	12,500	1,250

* Linear interpolation

The spurious emissions shall be attenuated to the average (or, alternatively, CISPR quasi-peak) limits shown in table 1 or to the general limits shown in table 2, whichever limit permits a higher field strength.

Table 2 – General Field Strength Limits at Frequencies above 30 MHz

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

n.b. per FCC 47CFR15.35(b), where an average measurement is specified, the peak limit is 20 dB above the average limit.

Devices may not meet the requirements in paragraph (a) of §15.231 and may be employed for any type of operation, provided the device complies with the requirements of paragraphs (b) through (d) of §15.231 and the field strength of emissions do not exceed the limits specified in Table 3.

Table 3 – Reduced Field Strength Limits

<i>Fundamental frequency (MHz)</i>	<i>Field strength of fundamental ($\mu\text{V/m at 3m}$)</i>	<i>Field strength of Spurious Emissions ($\mu\text{V/m at 3m}$)</i>
40.66 – 40.70	1,000	100
70 – 130	500	50
130 – 174	500 to 1,500*	50 to 150*
174 – 260	1,500	150
260 – 470	1,500 to 5,000*	150 to 500*
Above 470	5,000	500

* Linear interpolation

11.3 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 dB $\mu\text{V/m}$ at the regulatory distance, using:

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

Where,

PR is the power recorded on the receiver / spectrum analyzer in dB μV ;

CL is the cable loss in dB;

AF is the test antenna factor in dB/m;

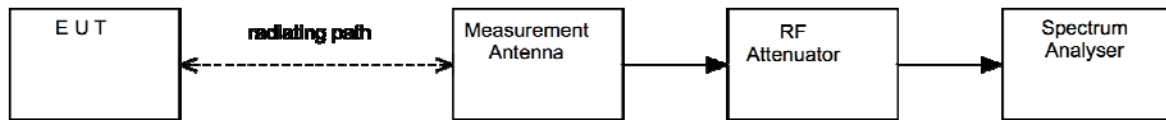
PA is the pre-amplifier gain in dB (where used);

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



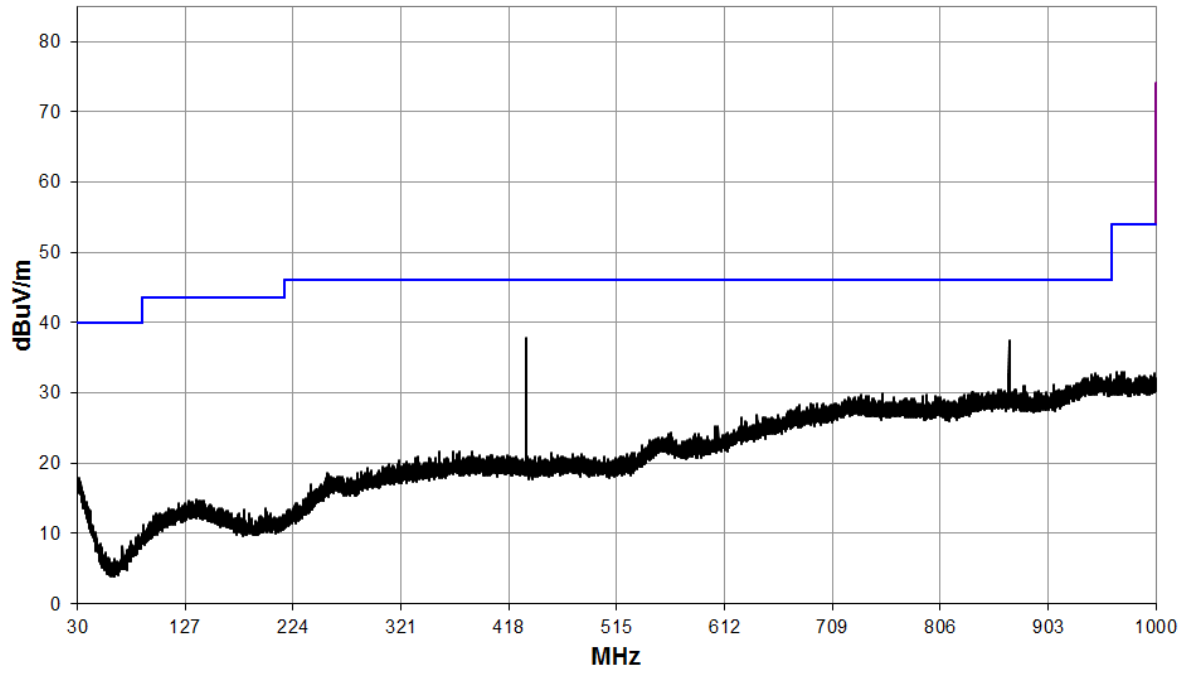
11.4 Test Equipment

<i>Equipment Description</i>	<i>Manufacturer</i>	<i>Equipment Type</i>	<i>Element No</i>	<i>Last Cal Calibration</i>	<i>Calibration Period</i>	<i>Due For Calibration</i>
Ferrite Lined Chamber	Rainford	Chamber	REF2259	2018-08-03	24	2020-08-03
EMI Test Receiver	R&S	ESW26	REF2235	2019-07-26	12	2020-07-26
Bilog Antenna	Chase	CBL6111B	REF2218	2018-11-06	12	2019-11-06
Horn Antenna	A Info Inc	LB-10180-NF	REF2241	2018-07-13	24	2020-07-13
Radiated Test Software	Element	Emissions R5	REF9000	N/A		

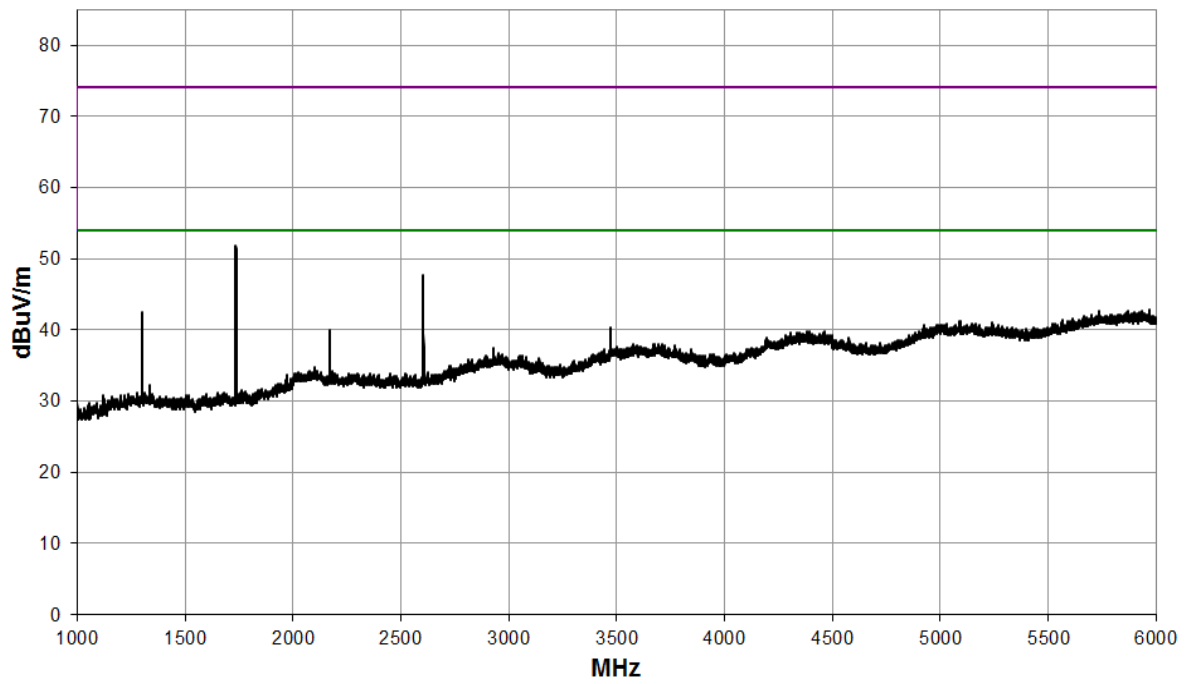
11.5 Test Results

<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>Field Strength (dBμV/m)</i>	<i>Field Strength (μV/m)</i>	<i>Limit (μV/m)</i>
AV	433.96	54.7	3.0	21.9	0.0	79.6	9549.9	10998.3
PK	433.96	60.7	3.0	21.9	0.0	85.6	19054.6	109983.3
QP	867.94	39.2	4.3	28.6	32.0	40.1	101.2	1250.0
AV	1301.87	44.9	3.8	25.1	34.0	39.8	97.7	500.0
AV	1735.79	50.1	4.1	25.5	34.0	45.7	192.8	1250.0
AV	2603.75	42.9	4.8	28.9	34.3	42.3	130.3	1250.0
AV	3471.75	41.7	5.5	30.5	34.3	43.4	147.9	1250.0

30 MHz to 1 GHz



1 GHz to 6 GHz



12 Occupied Bandwidth

12.1 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.

12.2 Test Parameters

Test Location:	Element Hull
Test Chamber:	Wireless Lab 2
Test Standard and Clause:	ANSI C63.10-2013, Clause 6.9
Frequency Measured:	433.96 MHz
Deviations From Standard:	None
Measurement Detector:	Peak

Environmental Conditions (Normal Environment)

Temperature: 23 °C	+15 °C to +35 °C (as declared)
Humidity: 54 %RH	20%RH to 75%RH (as declared)
Supply: 3 Vdc	As declared

Test Limits

The bandwidth of the emission shall be no wider than 0.25 % of the centre frequency for devices operating above 70 MHz and below 900 MHz. For devices operating above 900 MHz, the emission shall be no wider than 0.5 % of the centre frequency. Bandwidth is determined at the points 20 dB down from the modulated carrier.

12.3 Test Method

With the EUT connected as per Figure iv, 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 iv Test Setup

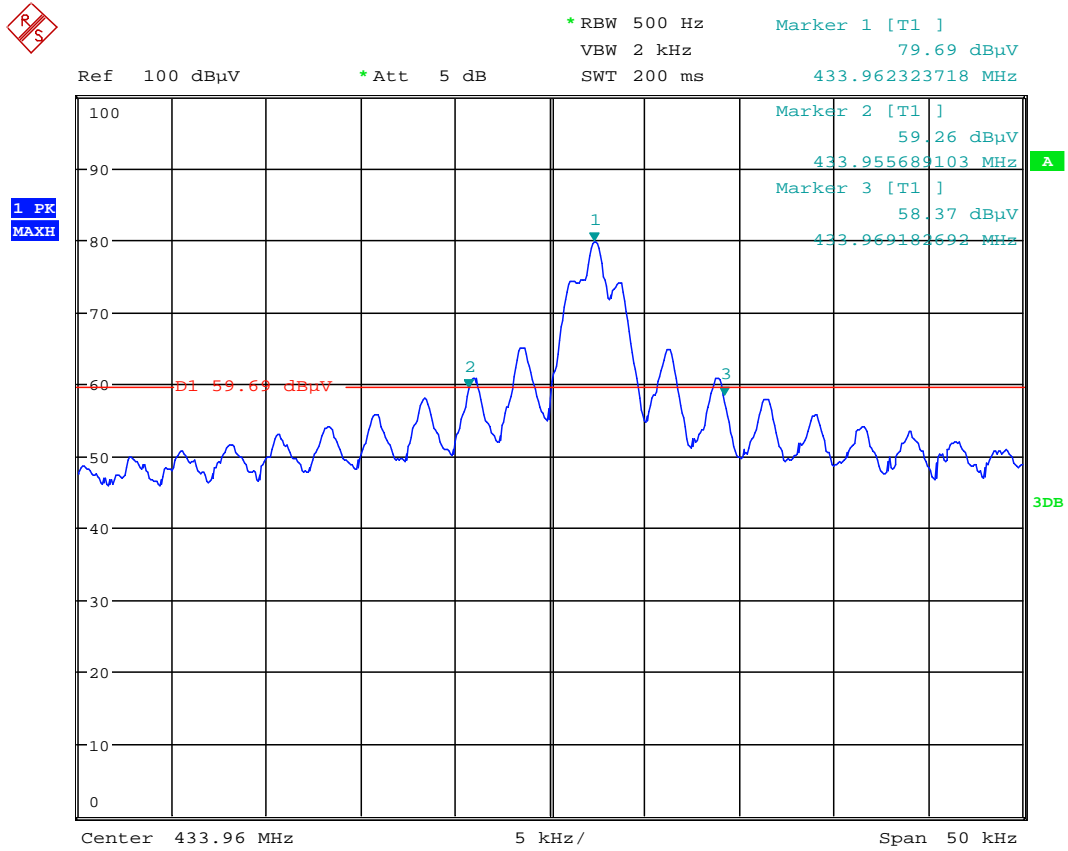


12.4 Test Equipment

Equipment Description	Manufacturer	Equipment Type	Element No	Last Cal Calibration	Calibration Period	Due For Calibration
Spectrum Analyser	R&S	FSU50	U544	2019-06-05	12	2020-06-05

12.5 Test Results

Channel Frequency (MHz)	F_L (MHz)	F_H (MHz)	20 dB Bandwidth (kHz)	Limit (kHz)
433.96	433.955689	433.969183	13.494	1084.9



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13 Transmission Cessation Time

13.1 Definition

The time it takes to cease a transmission.

13.2 Test Parameters

Test Location:	Element Hull
Test Chamber:	Wireless Lab 1
Test Standard and Clause:	ANSI C63.10-2013, Clause 7.4
Frequency Measured:	433.96 MHz
Deviations From Standard:	None

Environmental Conditions (Normal Environment)

Temperature: 25 °C	+15 °C to +35 °C (as declared)
Humidity: 40 %RH	20%RH to 75%RH (as declared)
Supply: 3 Vdc	As declared

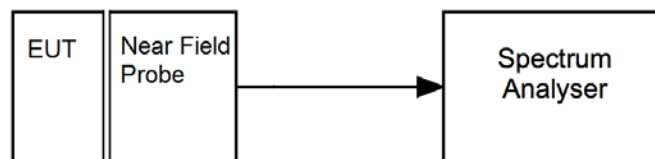
Test Limits

A manually operated transmitter shall be equipped with a push-to-operate switch and be under manual control at all times during transmission. When released, the transmitter shall cease transmission within no more than 5 seconds of being released.

13.3 Test Method

With the EUT connected as per Figure vii, the RF spectrum from the EUT was observed.

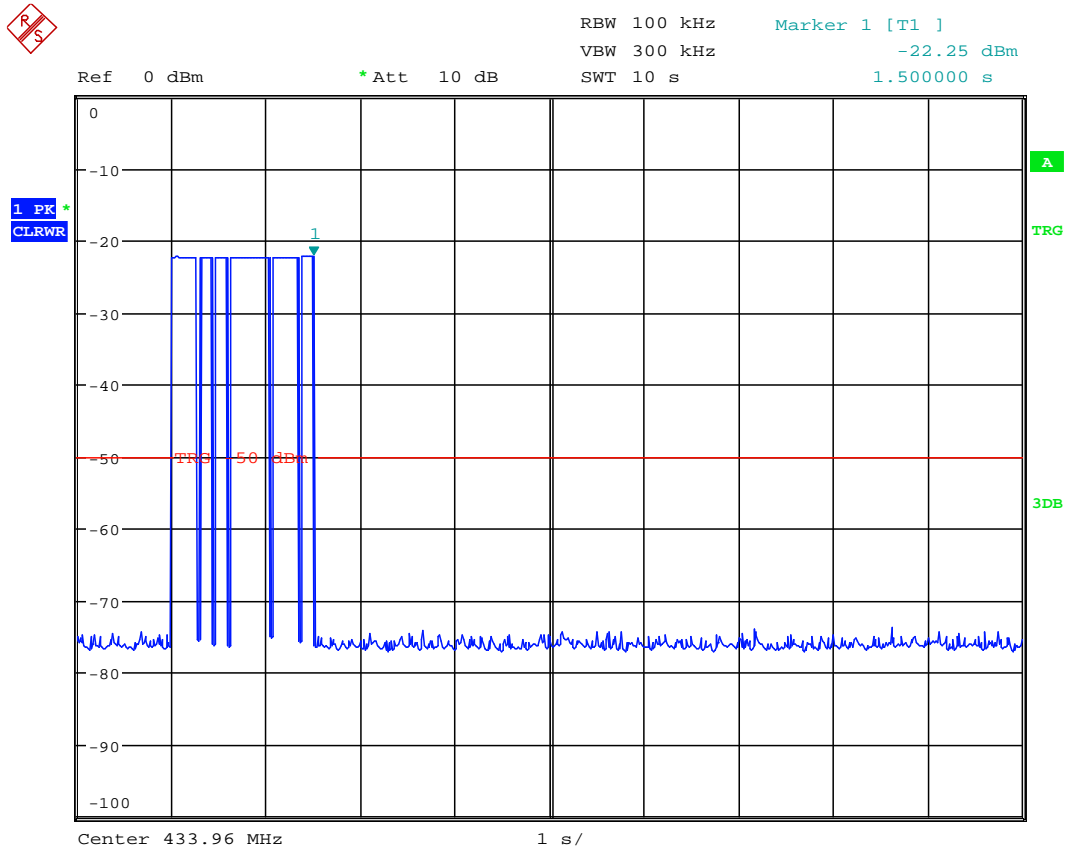
Figure vii Test Setup



13.4 Test Equipment

<i>Equipment Description</i>	<i>Manufacturer</i>	<i>Equipment Type</i>	<i>Element No</i>	<i>Due For Calibration</i>
Spectrum Analyser	R&S	FSU50	U544	2020-06-05

13.5 Test Results



The EUT stops transmitting as soon as the switch is released.

14 Measurement Uncertainty

Calculated Measurement Uncertainties

All statements of uncertainty are expanded standard uncertainty using a coverage factor of 1.96 to give a 95% confidence:

[1] Radiated emissions below 30MHz

Uncertainty in test result (9kHz – 30MHz) = **2.3dB**,

[2] Spurious emissions

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

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

[3] AC power line conducted emissions

Uncertainty in test result = **3.4dB**

[4] Occupied bandwidth

Uncertainty in test result = **15.5%**

[5] Maximum frequency error

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

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

[6] Transmission Time Measurement

Uncertainty in test result = **7.98%**