

Report on the Radio Testing  
For  
Pektron Group Limited  
on  
BTLE NFC Node  
Report no. TRA-051982-47-09B  
2021-05-18

RF914 6.0



Report Number: TRA-051982-47-09B  
Issue: B

REPORT ON THE RADIO TESTING OF A  
Pektron Group Limited  
BTLE NFC Node  
WITH RESPECT TO SPECIFICATION  
FCC 47CFR 15.209

TEST DATE: 2021-03-16 to 2021-03-25

Written by:



Steven Garwell  
Radio Test Engineer

Approved by:

Date: 2021-05-18

Daniel Winstanley  
Senior – Radio Test Engineer

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><b>Issue Number</b></i> | <i><b>Issue Date</b></i> | <i><b>Revision History</b></i> |
|----------------------------|--------------------------|--------------------------------|
| A                          | 2021-04-19               | Original                       |
| B                          | 2021-05-18               | General updates                |

## 2 Summary

|                             |                                                                                                                                                          |
|-----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| TEST REPORT NUMBER:         | TRA-051982-47-09B                                                                                                                                        |
| WORKS ORDER NUMBER:         | TRA-051982-02                                                                                                                                            |
| 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:         | 47CFR15.209                                                                                                                                              |
| EQUIPMENT UNDER TEST (EUT): | BTLE NFC Node                                                                                                                                            |
| FCC IDENTIFIER:             | AQO011                                                                                                                                                   |
| EUT SERIAL NUMBER(S):       | AB10001253 (Radiated)<br>AB10001263 (Conducted)                                                                                                          |
| MANUFACTURER/AGENT:         | Pektron Group Limited                                                                                                                                    |
| ADDRESS:                    | Alfreton Road<br>Derby<br>Derbyshire<br>DE21 4AP<br>United Kingdom                                                                                       |
| CLIENT CONTACT:             | Richard Jones<br>☎ 01332832424 ext 382<br>✉ rjones@pektron.co.uk                                                                                         |
| ORDER NUMBER:               | PROJ-00000632                                                                                                                                            |
| TEST DATE:                  | 2021-03-16 to 2021-03-25                                                                                                                                 |
| TESTED BY:                  | Steven Garwell, Michael Else<br>Element                                                                                                                  |

## 2.1 Test Summary

| <i>Test Method and Description</i>        | <i>Requirement Clause, 47CFR15</i> | <i>Applicable to this equipment</i> | <i>Result / Note</i> |
|-------------------------------------------|------------------------------------|-------------------------------------|----------------------|
| Radiated spurious emissions, below 30 MHz | 15.209                             | <input checked="" type="checkbox"/> | Pass                 |
| Radiated spurious emissions               | 15.209                             | <input checked="" type="checkbox"/> | Pass                 |
| AC power line conducted emissions         | 15.207                             | <input type="checkbox"/>            | Note 1               |
| Occupied bandwidth                        | 15.215(c)                          | <input checked="" type="checkbox"/> | Pass                 |
| Field strength of fundamental             | 15.209                             | <input checked="" type="checkbox"/> | Pass                 |

### Notes:

**Note 1:** The EUT is battery powered only.

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-051982-47-09B presents the results of the Radio testing on a Pektron Group Limited, BTLE NFC Node to specification 47CFR15 Radio Frequency Devices.

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

|                          |                                                                                             |                                     |                                                                                                    |
|--------------------------|---------------------------------------------------------------------------------------------|-------------------------------------|----------------------------------------------------------------------------------------------------|
| <input type="checkbox"/> | Element Hull<br>Unit E<br>South Orbital Trading Park<br>Hedon Road<br>Hull<br>HU9 1NJ<br>UK | <input checked="" type="checkbox"/> | Element Skelmersdale<br>Unit 1<br>Pendle Place<br>Skelmersdale<br>West Lancashire<br>WN8 9PN<br>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:

The test laboratory is accredited for the above sites under the US-UK MRA,

### Designation number(s):

|                      |        |
|----------------------|--------|
| Element Hull         | UK2007 |
| Element Skelmersdale | UK2020 |

### IC Registration Number(s):

|                      |       |
|----------------------|-------|
| Element Hull         | 3483A |
| Element Skelmersdale | 3930B |

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

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

## 7 Equipment Under Test

### 7.1 EUT Identification

- Name: BTLE NFC Node
- Serial Numbers: AB10001253 (Radiated), AB10001263 (Conducted)
- Model Number: A-0819G02
- Software Revision: Software Revision: Bootloader: P0819B1.0.4 / Application: P0819A2.1.2
- Build Level / Revision Number: Production

### 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.

1. Laptop Computer

### 7.3 EUT Mode of Operation

#### 7.3.1 Transmission

The mode of operation for transmitter tests was as follows:

The unit was tested in normal operation mode forcing the unit to read a card continuously.

### 7.4 EUT Radio Parameters

#### 7.4.1 General

|                                                                             |            |
|-----------------------------------------------------------------------------|------------|
| <b>Frequency of operation:</b>                                              | 125 kHz    |
| <b>Modulation type(s):</b>                                                  | ASK        |
| <b>Declared output power(s):</b>                                            | Not stated |
| <b>Warning against use of alternative antennas in user manual (yes/no):</b> | No         |
| <b>Nominal Supply Voltage:</b>                                              | 12 Vdc     |

### 7.5 EUT Description

The EUT is an ACM connected to node with LF antenna.ACM connected to node with LF antenna.

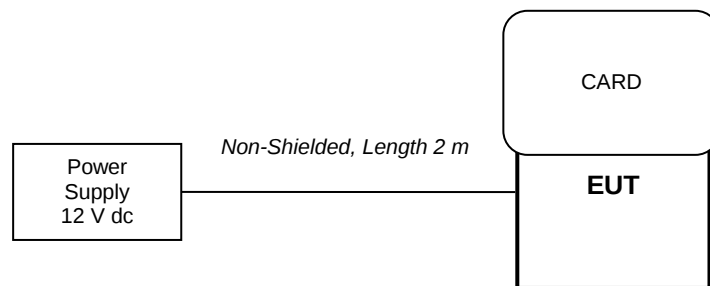
## 8 Modifications

No modifications were performed during this assessment.

## 9 EUT Test Setup

### 9.1 Block Diagram

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



## 9.2 General Set-up Photograph

The following photograph shows basic EUT set-up:



## 9.3 Measurement software

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

Element Emissions R5 (See Note)  
Element Transmitter Bench Test (See Note)  
ETS Lindgren EMPower V1.0.4.2

Note:

The version of the Element software used is recorded in the results sheets contained within this report.

## 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 12 Vdc from a power supply.

### 10.2 Varying Test Conditions

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:

|                                     | <b>Category</b> | <b>Nominal</b> | <b>Variation</b> |
|-------------------------------------|-----------------|----------------|------------------|
| <input checked="" type="checkbox"/> | Power supply    | 12 Vdc         | 85 % and 115 %   |
| <input type="checkbox"/>            | Battery         | New battery    | N/A              |

## 11 Radiated emissions below 30 MHz

### 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:                   | SK03 radio chamber                                                                                  |
| Test Standard and Clause:       | ANSI C63.10-2013, Clause 6.4                                                                        |
| EUT Frequency Measured:         | 125 kHz                                                                                             |
| Deviations From Standard:       | None                                                                                                |
| Measurement Distance and Site   | 3 m                                                                                                 |
| EUT Height:                     | 1 m                                                                                                 |
| Measurement Antenna and Height: | 60 cm shielded loop; 1 m                                                                            |
| Measurement BW:                 | 9 kHz to 150 kHz: 200 Hz;<br>150 kHz to 30 MHz: 9 kHz                                               |
| Measurement Detector:           | 9 kHz to 90 kHz and 110 kHz to 490 kHz: Average, RMS<br>Other frequencies below 30 MHz: Quasi-peak. |

### 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: 12 Vdc     | 12 Vdc (as declared)             |

### 11.3 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 Below 30 MHz

| <i>Frequency, f<br/>(kHz)</i> | <i>Field Strength</i>                      | <i>Measurement<br/>Distance<br/>(m)</i> |
|-------------------------------|--------------------------------------------|-----------------------------------------|
| 9 to 490                      | 2,400 / 377.f (μA/m)<br>2,400 / f (μV/m)   | 300                                     |
| 490 to 1,750                  | 24,000 / 377.f (μA/m)<br>24,000 / f (μV/m) | 30                                      |
| 1,750 to 30,000               | 30 (μV/m)                                  | 30                                      |

n.b. Devices operated pursuant to §15.225 / RSS-210 A2.6 are exempt from complying with the restricted band requirements for the 13.36–13.41 MHz band only.

### 11.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure i, the EUT fundamental frequency was maximised by rotating the EUT through 360°, in three orthogonal planes, and adjusting the measurement antenna azimuth.

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 9 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 9 kHz and 30 MHz are measured using a calibrated 60cm active loop antenna. 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.

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

$$FS = 10 (PR - CF) / 20$$

Where,

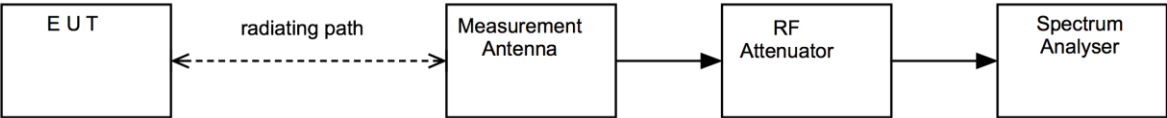
PR is the power recorded on the receiver / spectrum analyzer in dBμV and includes any cable loss, antenna factor and pre-amplifier gain;

CF is the distance extrapolation factor in dB (where measurement distance different to limit distance);

Per FCC 47CFR15.31(f)(2), an extrapolation factor of 40 dB per decade was used for extrapolation from 3 m to 300 m, and from 3 m to 30 m.

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

Figure i Test Setup



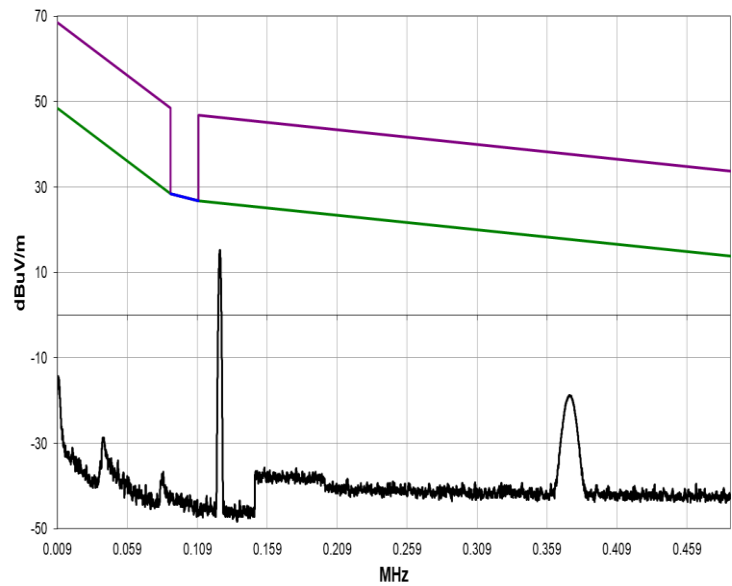
11.5 Test setup photograph



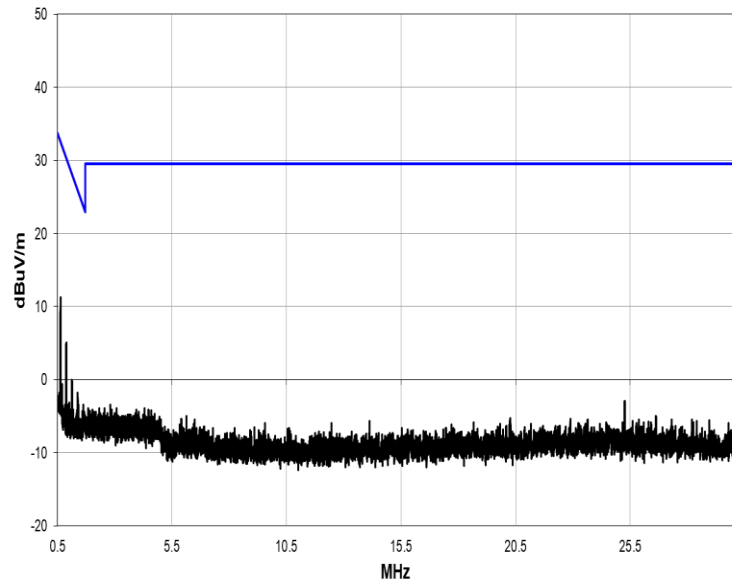
11.6 Test Equipment

| Equipment Type    | Manufacturer | Equipment Description | Element No | Due For Calibration |
|-------------------|--------------|-----------------------|------------|---------------------|
| Spectrum Analyser | R&S          | FSU46                 | REF910     | 2021-11-18          |
| Loop Antenna      | R&S          | hfh2                  | L007       | 2021-07-09          |
| ATS               | Rainford EMC | Radio Chamber - PP    | REF940     | 2021-12-09          |

11.7 Test Results



9 kHz to 490 kHz



490 kHz to 30 MHz

| Modulation: ASK; Frequency: 125 kHz                |                         |                          |                    |                           |                       |        |
|----------------------------------------------------|-------------------------|--------------------------|--------------------|---------------------------|-----------------------|--------|
| Emission Frequency (MHz)                           | Receiver Level (dBμV/m) | Measurement Distance (m) | Limit Distance (m) | Extrapolation Factor (dB) | Field Strength (μV/m) | Result |
| No significant emissions within 20 dB to the limit |                         |                          |                    |                           |                       | Pass   |

## 12 Radiated emissions

### 12.1 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.

### 12.2 Test Parameters

|                           |                              |
|---------------------------|------------------------------|
| Test Location:            | Element Skelmersdale         |
| Test Chamber:             | SK03 radio chamber           |
| Test Standard and Clause: | ANSI C63.10-2013, Clause 6.5 |
| EUT Frequency Measured:   | 125 kHz                      |
| Deviations From Standard: | None                         |
| Measurement BW:           | 30 MHz to 300 MHz: 120 kHz   |
| Measurement Detector:     | Quasi-peak                   |

### Environmental Conditions (Normal Environment)

|                    |                                  |
|--------------------|----------------------------------|
| Temperature: 22 °C | +15 °C to +35 °C (as declared)   |
| Humidity: 40 % RH  | 20 % RH to 75 % RH (as declared) |
| Supply: 12 Vdc     | 12 Vdc (as declared)             |

### 12.3 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

| <b>Frequency<br/>(MHz)</b> | <b>Field Strength<br/>(<math>\mu\text{V/m}</math> at 3 m)</b> |
|----------------------------|---------------------------------------------------------------|
| 30 to 88                   | 100                                                           |
| 88 to 216                  | 150                                                           |
| 216 to 960                 | 200                                                           |
| Above 960                  | 500                                                           |

## 12.4 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 dB $\mu$ V/m at the regulatory distance, using:

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

$$\text{Factor} = CL + AF - PA$$

Where,

PR is the power recorded on the receiver / spectrum analyzer in dB $\mu$ V;

CL is the cable loss in dB;

AF is the test antenna factor in dB/m;

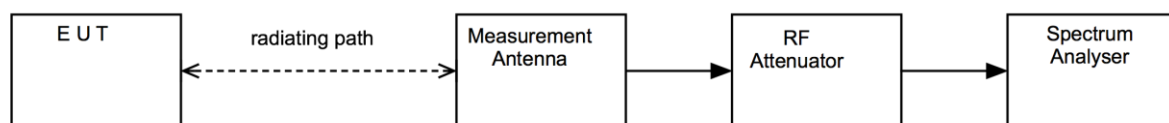
PA is the pre-amplifier gain in dB (where used);

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**



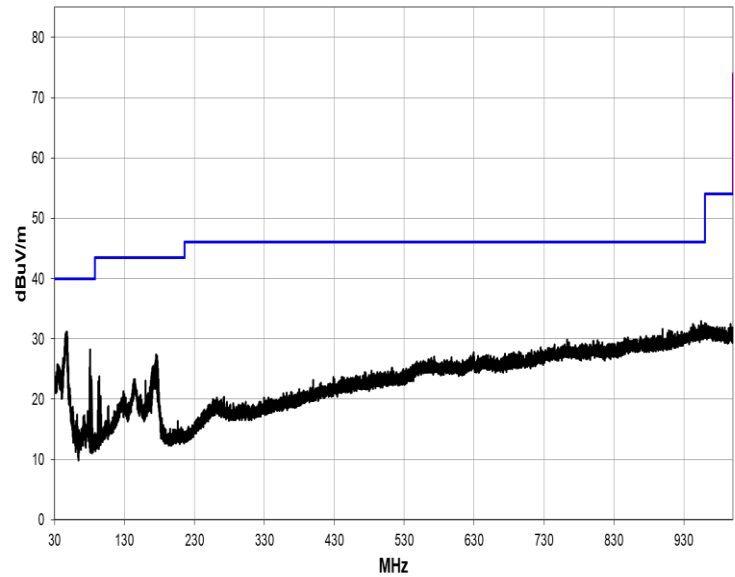
## 12.5 Test Set-up Photograph



## 12.6 Test Equipment

| <i>Equipment Type</i> | <i>Manufacturer</i> | <i>Equipment Description</i> | <i>Element No</i> | <i>Due For Calibration</i> |
|-----------------------|---------------------|------------------------------|-------------------|----------------------------|
| Spectrum Analyser     | R&S                 | FSU46                        | REF910            | 2021-11-18                 |
| Bilog                 | Chase               | CBL611/A                     | U573              | 2023-01-28                 |
| PreAmp                | Watkins Johnson     | 6201-69                      | U372              | 2022-03-01                 |
| Radio Chamber - PP    | Rainford EMC        | ATS                          | REF940            | 2021-12-09                 |

12.7 Test Results



30 MHz to 1 GHz

| Modulation: ASK; Frequency: 125 kHz                |                         |                          |                    |                           |                       |        |
|----------------------------------------------------|-------------------------|--------------------------|--------------------|---------------------------|-----------------------|--------|
| Emission Frequency (MHz)                           | Receiver Level (dBµV/m) | Measurement Distance (m) | Limit Distance (m) | Extrapolation Factor (dB) | Field Strength (µV/m) | Result |
| No significant emissions within 20 dB to the limit |                         |                          |                    |                           |                       | Pass   |

## 13 Occupied Bandwidth

### 13.1 Definition

#### 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.

### 13.2 Test Parameters

|                                                     |                              |
|-----------------------------------------------------|------------------------------|
| Test Location:                                      | Element Skelmersdale         |
| Test Chamber:                                       | Radio Laboratory             |
| Test Standard and Clause:                           | ANSI C63.10-2013, Clause 6.9 |
| EUT Frequency Measured:                             | 125 kHz                      |
| EUT Test Modulations:                               | ASK                          |
| Deviations From Standard:                           | None                         |
| Measurement BW:                                     | 500 Hz                       |
| Spectrum Analyzer Video BW:                         | 2 KHz                        |
| Measurement Span:<br>(requirement 2 to 5 times OBW) | 50 kHz                       |
| Measurement Detector:                               | Peak                         |

### Environmental Conditions (Normal Environment)

|                    |                                  |
|--------------------|----------------------------------|
| Temperature: 22 °C | +15 °C to +35 °C (as declared)   |
| Humidity: 40 % RH  | 20 % RH to 75 % RH (as declared) |
| Supply: 12 Vdc     | 12 Vdc (as declared)             |

### 13.3 Test Limit

Federal Communications Commission:

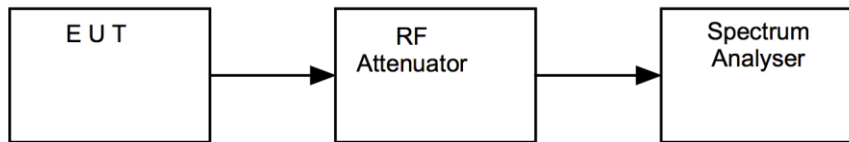
Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§ 15.217 through 15.257 and in subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific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

### 13.4 Test Method

With the EUT setup as per section 9 of this report and 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

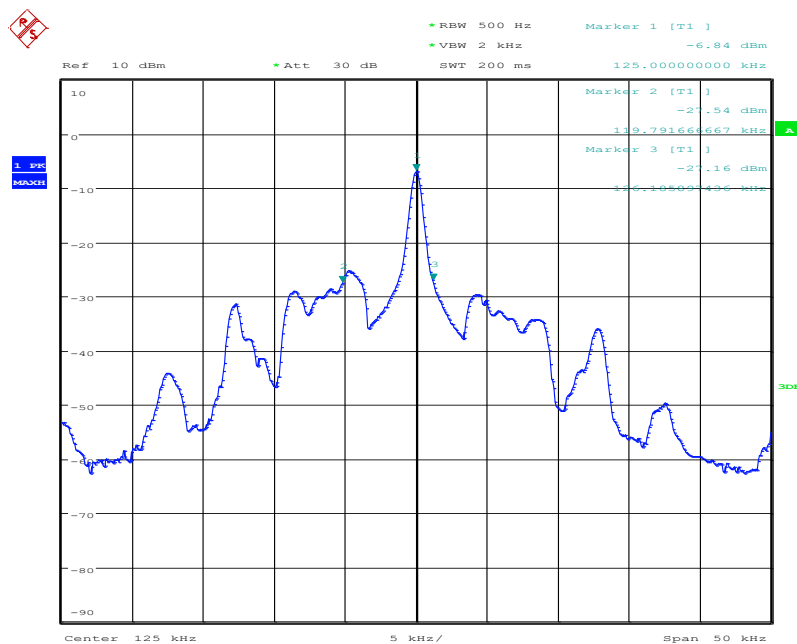


### 13.5 Test Equipment

| Equipment Type    | Manufacturer | Equipment Description | Element No | Due For Calibration |
|-------------------|--------------|-----------------------|------------|---------------------|
| Spectrum Analyser | R&S          | FSU46                 | REF910     | 2021-11-18          |

### 13.6 Test Results

| 15.225. Modulation: ASK; Frequency 125 kHz |             |             |                       |
|--------------------------------------------|-------------|-------------|-----------------------|
| Channel Frequency (kHz)                    | $F_L$ (kHz) | $F_H$ (kHz) | 20 dB Bandwidth (kHz) |
| 125                                        | 119.791667  | 126.185897  | 6.39423               |



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## 14 Transmitter output power (fundamental radiated emission)

### 14.1 Definition

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

### 14.2 Test Parameters

|                                                              |                                    |
|--------------------------------------------------------------|------------------------------------|
| Test Location:                                               | Element Skelmersdale               |
| Test Chamber:                                                | Radio Laboratory                   |
| Test Antenna:                                                | Active 60cm loop                   |
| Test Standard and Clause:                                    | ANSI C63.10-2013, Clause 6.3 / 6.4 |
| Frequency Measured:                                          | 125 kHz                            |
| Deviations From Standard:                                    | None                               |
| Measurement BW:                                              | 200 Hz                             |
| Spectrum Analyzer Video BW:<br>(requirement at least 3x RBW) | 1 KHz                              |
| Measurement Detector:                                        | Average                            |

### Environmental Conditions (Normal Environment)

|                    |                                  |
|--------------------|----------------------------------|
| Temperature: 24 °C | +15 °C to +35 °C (as declared)   |
| Humidity: 40 % RH  | 20 % RH to 75 % RH (as declared) |

### 14.3 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 Below 30 MHz

| <i>Frequency, f<br/>(kHz)</i> | <i>Field Strength</i>                          | <i>Measurement<br/>Distance<br/>(m)</i> |
|-------------------------------|------------------------------------------------|-----------------------------------------|
| 9 to 490                      | $2,400 / 377.f$ (μA/m)<br>$2,400 / f$ (μV/m)   | 300                                     |
| 490 to 1,750                  | $24,000 / 377.f$ (μA/m)<br>$24,000 / f$ (μV/m) | 30                                      |
| 1,750 to 30,000               | 30 (μV/m)                                      | 30                                      |

n.b. Devices operated pursuant to §15.225 / RSS-210 A2.6 are exempt from complying with the restricted band requirements for the 13.36–13.41 MHz band only.

### 14.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure v, the resolution bandwidth of the spectrum analyser was increased above the EUT occupied bandwidth and the peak emission data noted.

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

Power values measured on the test receiver / analyzer are converted to field strength, FS, in  $\mu\text{V/m}$  at the regulatory distance, using:

$$FS = 10 (PR - CF) / 20$$

Where,

PR is the power recorded on the receiver / spectrum analyzer in  $\text{dB}\mu\text{V}$  and includes any cable loss, antenna factor and pre-amplifier gain;

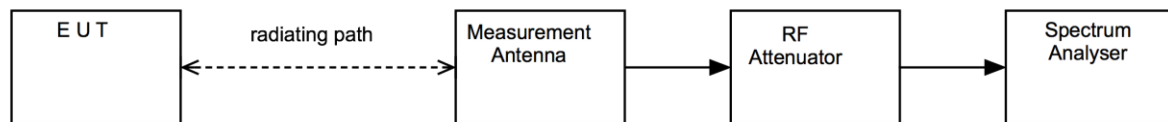
CF is the distance extrapolation factor in dB (where measurement distance different to limit distance);

Per FCC 47CFR15.31(f)(2) / RSS-Gen 6.4, an extrapolation factor of 40 dB per decade was used for extrapolation from 3 m to 300 m.

Per FCC 47CFR15.31(f)(2) / RSS-Gen 6.4, an extrapolation factor from 1 m to 3 m of 20.23 dB was determined from measurements at 1 and 3 metres.

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

#### Figure v Test Setup



#### 14.5 Test Equipment

| Equipment Type     | Manufacturer | Equipment Description | Element No | Due For Calibration |
|--------------------|--------------|-----------------------|------------|---------------------|
| Spectrum Analyser  | R&S          | FSU46                 | REF910     | 2021-11-18          |
| Loop Antenna       | R&S          | hfh2                  | L007       | 2021-07-09          |
| Radio Chamber - PP | Rainford EMC | ATS                   | REF940     | 2021-12-09          |

#### 14.6 Test Results

| Modulation: ASK; Frequency 125 kHz |                                      |                          |                    |                           |                                    |        |
|------------------------------------|--------------------------------------|--------------------------|--------------------|---------------------------|------------------------------------|--------|
| Channel Frequency (kHz)            | Receiver Level (dB $\mu\text{V/m}$ ) | Measurement Distance (m) | Limit Distance (m) | Extrapolation Factor (dB) | Field Strength ( $\mu\text{V/m}$ ) | Result |
| 125                                | 115.67                               | 1                        | 300                | 100.23                    | 5.916                              | Pass   |
| 125                                | 95.44                                | 3                        | 300                | 80.00                     | 5.916                              | Pass   |

## 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] Radiated emissions below 30 MHz

Uncertainty in test result (9 kHz to 30 MHz) = **2.3 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**