

Report on the Radio Testing

For

Magicard Ltd

on

Ultima

Report no. TRA-041439-47-00A

17 September 2018

---

RF914 4.0



Report Number: TRA-041439-47-00A  
Issue: A

REPORT ON THE RADIO TESTING OF A  
Magicard Ltd  
Ultima  
WITH RESPECT TO SPECIFICATION  
FCC 47CFR 15.225

TEST DATE: 11th July 2018

Tested by: D Moncayola  
Radio Test Engineer

Approved by: John Charters  
Date: 17 September 2018  
Department Manager- Radio

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

RF914 4.0

## 1 Revision Record

| <i>Issue Number</i> | <i>Issue Date</i> | <i>Revision History</i> |
|---------------------|-------------------|-------------------------|
| A                   | 17 September 2018 | Original                |
|                     |                   |                         |

## 2 Summary

|                             |  |
|-----------------------------|--|
| TEST REPORT NUMBER:         | TRA-041439-47-00A  |
| WORKS ORDER NUMBER:         | TRA-041439-01  |
| PURPOSE OF TEST:            | USA: Testing of radio frequency equipment per the relevant authorization procedure of chapter 47 of CFR (code of federal regulations) Part 2, subpart J. |
| TEST SPECIFICATION(S):      | 47CFR15.225 & RSS-210 Annex 2.6  |
| EQUIPMENT UNDER TEST (EUT): | Ultima   |
| FCC IDENTIFIER:             | XDW3680-0001   |
| EUT SERIAL NUMBER:          | 66801903   |
| MANUFACTURER/AGENT:         | Magicard Ltd   |
| ADDRESS:                    | Hampshire Road<br>Weymouth<br>Dorset<br>DT4 9XD<br>United Kingdom  |
| CLIENT CONTACT:             | Tim Last<br>☎ 01305 470263<br>✉ tim.last@magicard.com  |
| ORDER NUMBER:               | 689  |
| TEST DATE:                  | 11th July 2018   |
| TESTED BY:                  | D Moncayola<br>Element   |

## 2.1 Test Summary

| <b>Test Method and Description</b>        | <b>Requirement Clause</b> | <b>Applicable to this equipment</b> | <b>Result / Note</b> |
|---|---------------------------|-------------------------------------|----------------------|
|   | <b>47CFR15</b>            |                                     |                      |
| Radiated spurious emissions, below 30 MHz | 15.225(d)                 | <input checked="" type="checkbox"/> | Pass                 |
| Radiated spurious emissions               | 15.209                    | <input checked="" type="checkbox"/> | Pass                 |
| AC power line conducted emissions         | 15.207                    | <input checked="" type="checkbox"/> | Pass                 |
| Occupied bandwidth                        | 15.215(c)                 | <input checked="" type="checkbox"/> | Pass                 |
| Field strength of fundamental             | 15.225(a), (b) and (c)    | <input checked="" type="checkbox"/> | Pass                 |
| Frequency stability                       | 15.225(e)                 | <input checked="" type="checkbox"/> | 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 .....   | 8  |
| 5     | Test Specifications .....                                      | 9  |
| 5.1   | Normative References .....                                     | 9  |
| 5.2   | Deviations from Test Standards .....                           | 9  |
| 6     | Glossary of Terms .....  | 10 |
| 7     | Equipment Under Test .....                                     | 11 |
| 7.1   | EUT Identification .....                                       | 11 |
| 7.2   | System Equipment .....   | 11 |
| 7.3   | EUT Mode of Operation .....                                    | 11 |
| 7.3.1 | Transmission .....   | 11 |
| 7.4   | EUT Radio Parameters .....                                     | 11 |
| 7.4.1 | General .....  | 11 |
| 7.5   | EUT Description .....  | 12 |
| 8     | Modifications .....  | 13 |
| 9     | EUT Test Setup .....   | 14 |
| 9.1   | Block Diagram .....  | 14 |
| 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 below 30 MHz .....                          | 16 |
| 11.1  | Definitions .....  | 16 |
| 11.2  | Test Parameters .....  | 16 |
| 11.3  | Test Limit .....   | 17 |
| 11.4  | Test Method .....  | 17 |
| 11.5  | Test Set-up Photograph .....                                   | 18 |
| 11.6  | Test Equipment .....   | 19 |
| 11.7  | Test Results .....   | 20 |
| 12    | Radiated emissions .....                                       | 21 |
| 12.1  | Definitions .....  | 21 |
| 12.2  | Test Parameters .....  | 21 |
| 12.3  | Test Limit .....   | 21 |
| 12.4  | Test Method .....  | 22 |
| 12.5  | Test Set-up Photograph .....                                   | 23 |
| 12.6  | Test Equipment .....   | 24 |
| 12.7  | Test Results .....   | 25 |
| 13    | AC power-line conducted emissions .....                        | 26 |
| 13.1  | Definition .....   | 26 |
| 13.2  | Test Parameters .....  | 26 |
| 13.3  | Test Limit .....   | 26 |
| 13.4  | Test Method .....  | 27 |
| 13.5  | Test Set-up Photograph .....                                   | 28 |
| 13.6  | Test Equipment .....   | 29 |
| 13.7  | Test Results .....   | 30 |
| 14    | Occupied Bandwidth .....                                       | 32 |
| 14.1  | Definition .....   | 32 |
| 14.2  | Test Parameters .....  | 32 |
| 14.3  | Test Limit .....   | 32 |
| 14.4  | Test Method .....  | 33 |
| 14.5  | Test Equipment .....   | 34 |
| 14.6  | Test Results .....   | 35 |
| 15    | Transmitter output power (fundamental radiated emission) ..... | 36 |
| 15.1  | Definition .....   | 36 |
| 15.2  | Test Parameters .....  | 36 |
| 15.3  | Test Limit .....   | 36 |
| 15.4  | Test Method .....  | 37 |
| 15.5  | Test Equipment .....   | 38 |
| 15.6  | Test Results .....   | 39 |
| 16    | Frequency stability .....                                      | 40 |
| 16.1  | Definition .....   | 40 |
| 16.2  | Test Parameters .....  | 40 |

|      |                              |    |
|------|------------------------------|----|
| 16.3 | Test Limit.....              | 40 |
| 16.4 | Test Method.....             | 41 |
| 16.5 | Test Equipment .....         | 42 |
| 16.6 | Test Results.....            | 43 |
| 17   | Measurement Uncertainty..... | 44 |

## 4 Introduction

This report TRA-041439-47-00A presents the results of the Radio testing on a Magicard Ltd, Ultima to specification 47CFR15 Radio Frequency Devices.

The testing was carried out for Magicard Ltd 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:

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.

### 5.2 *Deviations from Test Standards*

The EUT was left powered on for the duration of the frequency stability tests.

## 6 Glossary of Terms

|               |  |
|---------------|--|
| <b>§</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: Ultima
- Serial Number: 66801903
- Model Number: 3680-0001
- Software Revision: v 1.0
- Build Level / Revision Number: Pre-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.

*Not Applicable – No support/monitoring equipment required.*

### 7.3 EUT Mode of Operation

#### 7.3.1 Transmission

The mode of operation for transmit tests was as follows:-

For ac power-line operation the device was transmitting in normal operational mode in worst case scenario (film door open). For all other tests the device was supplied with test firmware allowing a higher duty cycle to facilitate testing.

### 7.4 EUT Radio Parameters

#### 7.4.1 General

|                                    |                |
|------------------------------------|----------------|
| <b>Frequency of operation:</b>     | 13.56 MHz      |
| <b>Modulation type:</b>            | ASK            |
| <b>Occupied channel bandwidth:</b> | 5 kHz          |
| <b>Channel spacing:</b>            | Not Applicable |
| <b>ITU emission designator:</b>    | A1D            |
| <b>Declared output power:</b>      | 0.2 W          |
| <b>Nominal Supply Voltage:</b>     | 110 V, 60 Hz   |
| <b>Duty cycle:</b>                 | 2.1 %          |

### **7.5 *EUT Description***

The EUT is a thermal reverse-transfer ID card printer. A thermal print head is used to create an image on a piece of film, which is then transferred to a plastic card using a heated roller. The unit has a RFID system to control the status of the film.

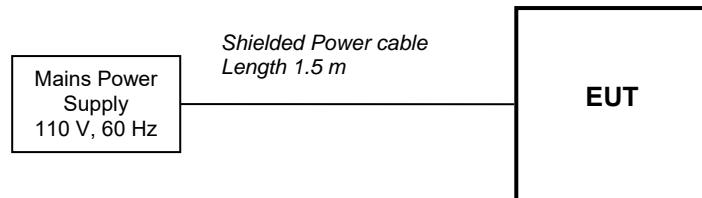
## **8 Modifications**

No modifications were performed during this assessment.

## 9 EUT Test Setup

### 9.1 Block Diagram

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



### 9.2 General Set-up Photograph

The following photograph shows basic EUT set-up.



## 10 General Technical Parameters

### 10.1 Normal Conditions

The EUT was tested under the normal environmental conditions of the test laboratory, except where otherwise stated. The normal power source applied was 110 V ac, 60 Hz, from the mains.

### 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:

|                                     | <b>Category</b> | <b>Variation</b>                |
|-------------------------------------|-----------------|---------------------------------|
| <input checked="" type="checkbox"/> | Standard        | -20 to +50 C in 10 degree steps |
| <input type="checkbox"/>            | 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:

|                                     | <b>Category</b> | <b>Nominal</b>  | <b>Variation</b> |
|-------------------------------------|-----------------|-----------------|------------------|
| <input checked="" type="checkbox"/> | Mains           | 110 V ac +/-2 % | 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:                   | Radio Chamber   |
| Test Standard and Clause:       | ANSI C63.10-2013, Clause 6.4  |
| EUT Frequency Measured:         | 13.56 MHz   |
| EUT Channel Bandwidth:          | 5 kHz   |
| Deviations From Standard:       | None  |
| Measurement Distance and Site:  | 3 m, OATS without ground plane.   |
| 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: 24 °C | +15 °C to +35 °C (as declared)   |
| Humidity: 45 % RH  | 20 % RH to 75 % RH (as declared) |
| Supply: 110 V ac   | 110 V ac (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

| Frequency, $f$ (kHz) | Field Strength  | Measurement Distance (m) |
|----------------------|---|--------------------------|
| 9 to 490             | 2,400 / 377. $f$ ( $\mu$ A/m)<br>2,400 / $f$ ( $\mu$ V/m)   | 300                      |
| 490 to 1,750         | 24,000 / 377. $f$ ( $\mu$ A/m)<br>24,000 / $f$ ( $\mu$ V/m) | 30                       |
| 1,750 to 30,000      | 30 ( $\mu$ V/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  $\mu$ V/m at the regulatory distance, using:

$$FS = 10^{(PR - CF) / 20}$$

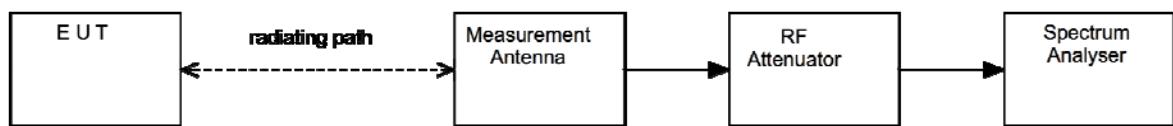
Where,

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 measurements at distances closer than specified.

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

**Figure i Test Setup**



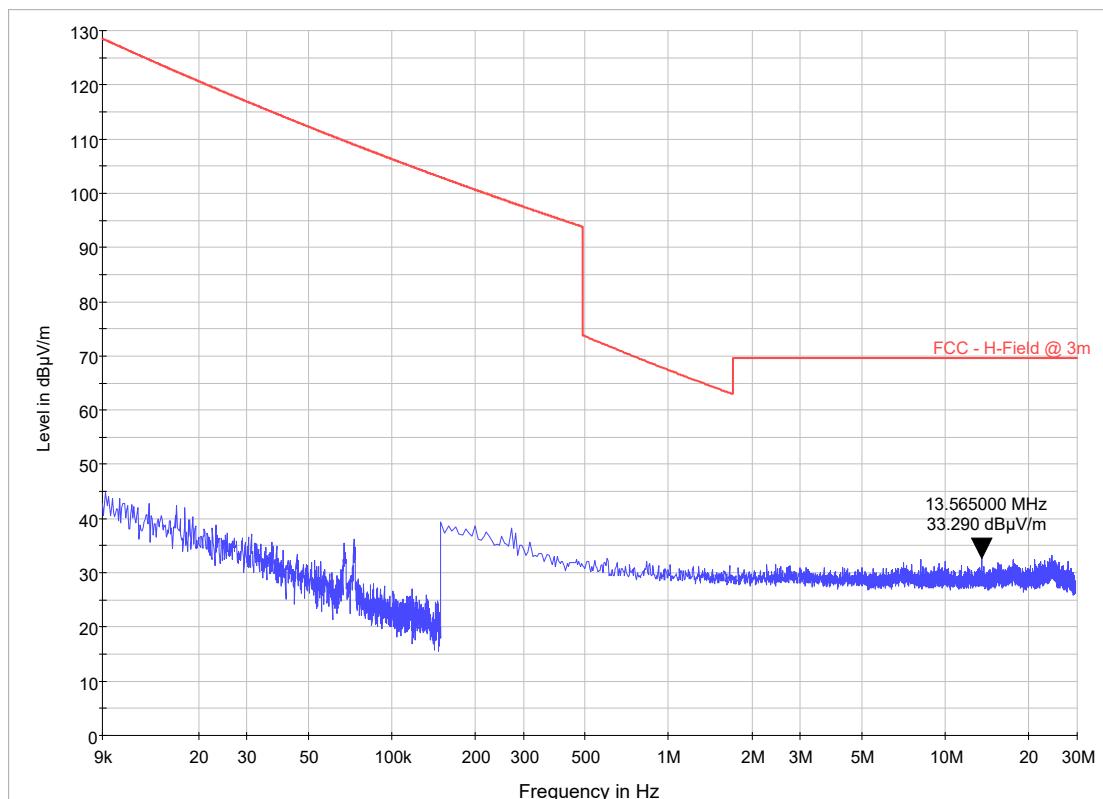
**11.5 Test Set-up Photograph**



**11.6 Test Equipment**

| <b>Equipment Type</b> | <b>Manufacturer</b> | <b>Equipment Description</b> | <b>Element No</b> | <b>Due For Calibration</b> |
|-----------------------|---------------------|------------------------------|-------------------|----------------------------|
| hfh2                  | R&S                 | Loop Antenna                 | L007              | 2019-05-10                 |
| ESHS10                | R&S                 | Receiver                     | U003              | 2018-08-29                 |

## 11.7 Test Results



| Modulation: ASK; Power setting: Highest power setting: |                               |                          |                    |                           |                             |        |
|--|-------------------------------|--------------------------|--------------------|---------------------------|-----------------------------|--------|
| Emission Frequency (MHz)                               | Receiver Level (dB $\mu$ V/m) | Measurement Distance (m) | Limit Distance (m) | Extrapolation Factor (dB) | Field Strength ( $\mu$ V/m) | Result |
| No emissions within 10 dB of 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:             | Radio Chamber                |
| Test Standard and Clause: | ANSI C63.10-2013, Clause 6.5 |
| EUT Frequency Measured:   | 13.56 MHz                    |
| EUT Channel Bandwidth:    | 5 kHz                        |
| Deviations From Standard: | None                         |
| Measurement BW:           | 30 MHz to 300 MHz: 120 kHz   |
| Measurement Detector:     | Quasi-peak                   |

### Environmental Conditions (Normal Environment)

|                    |                                  |
|--------------------|----------------------------------|
| Temperature: 24 °C | +15 °C to +35 °C (as declared)   |
| Humidity: 40 % RH  | 20 % RH to 75 % RH (as declared) |
| Supply: 110 V ac   | 110 V ac (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

| Frequency (MHz) | Field Strength (µV/m at 3 m) |
|-----------------|------------------------------|
| 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:

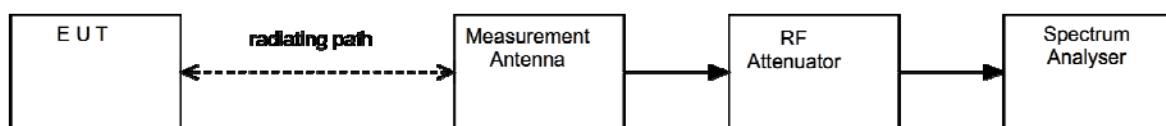
$$FS = PR + CL + AF - PA + DC - CF$$

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**



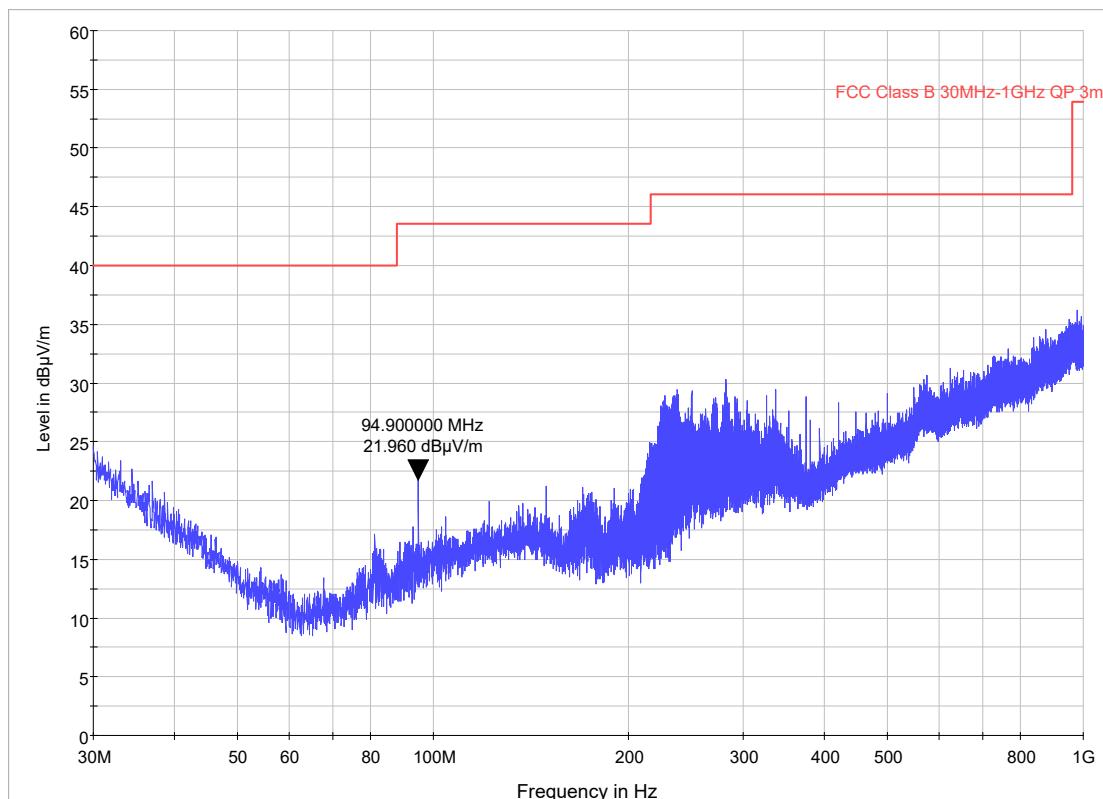
### 12.5 Test Set-up Photograph



**12.6 Test Equipment**

| <b>Equipment Type</b> | <b>Manufacturer</b> | <b>Equipment Description</b> | <b>Element No</b> | <b>Due For Calibration</b> |
|-----------------------|---------------------|------------------------------|-------------------|----------------------------|
| CBL611/A              | Chase               | Bilog                        | U573              | 2019-08-02                 |
| ESR7                  | R&S                 | EMI Receiver                 | U456              | 2018-09-12                 |

## 12.7 Test Results



| High Power; Frequency: 13.56 MHz:      |                |                                    |                       |                             |                         |                                 |  |                                     |                                   |                       |
|--|----------------|------------------------------------|-----------------------|-----------------------------|-------------------------|---------------------------------|--|-------------------------------------|-----------------------------------|-----------------------|
| Detector                               | Freq.<br>(MHz) | Meas'd<br>Emission<br>(dB $\mu$ V) | Cable<br>Loss<br>(dB) | Antenna<br>Factor<br>(dB/m) | Pre-amp<br>Gain<br>(dB) | Duty<br>Cycle<br>Corr'n<br>(dB) | Distance<br>Extrap'n<br>Factor<br>(dB) | Field<br>Strength<br>(dB $\mu$ V/m) | Field<br>Strength<br>( $\mu$ V/m) | Limit<br>( $\mu$ V/m) |
| No emissions within 10 dB of the limit |                |                                    |                       |                             |                         |                                 |  |                                     |                                   |                       |

## 13 AC power-line conducted emissions

### 13.1 Definition

Line-to-ground radio-noise voltage that is conducted from all of the EUT current-carrying power input terminals that are directly (or indirectly via separate transformers or power supplies) connected to a public power network.

### 13.2 Test Parameters

|                           |                              |
|---------------------------|------------------------------|
| Test Location:            | Element Skelmersdale         |
| Test Chamber:             | LF Laboratory                |
| Test Standard and Clause: | ANSI C63.10-2013, Clause 6.2 |
| EUT Frequency Measured:   | 13.56 MHz                    |
| EUT Channel Bandwidth:    | 5 kHz                        |
| EUT Modulation:           | ASK                          |
| Deviations From Standard: | None                         |
| Measurement BW:           | 10 kHz                       |
| Measurement Detectors:    | Quasi-Peak and Average       |

### Environmental Conditions (Normal Environment)

|                    |                                  |
|--------------------|----------------------------------|
| Temperature: 24 °C | +15 °C to +35 °C (as declared)   |
| Humidity: 45 % RH  | 20 % RH to 75 % RH (as declared) |
| Supply: 110 V ac   | 110 V ac (as declared)           |

### 13.3 Test Limit

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

**Table 3 – AC Power Line Conducted Emission Limits**

| Frequency<br>(MHz) | Conducted limit<br>(dB $\mu$ V) |           |
|--------------------|---------------------------------|-----------|
|                    | Quasi-Peak                      | Average** |
| 0.15 to 0.5        | 66 to 56*                       | 56 to 46* |
| 0.5 to 5           | 56                              | 46        |
| 5 to 30            | 60                              | 50        |

\*The level decreases linearly with the logarithm of the frequency.

\*\*A linear average detector is required.

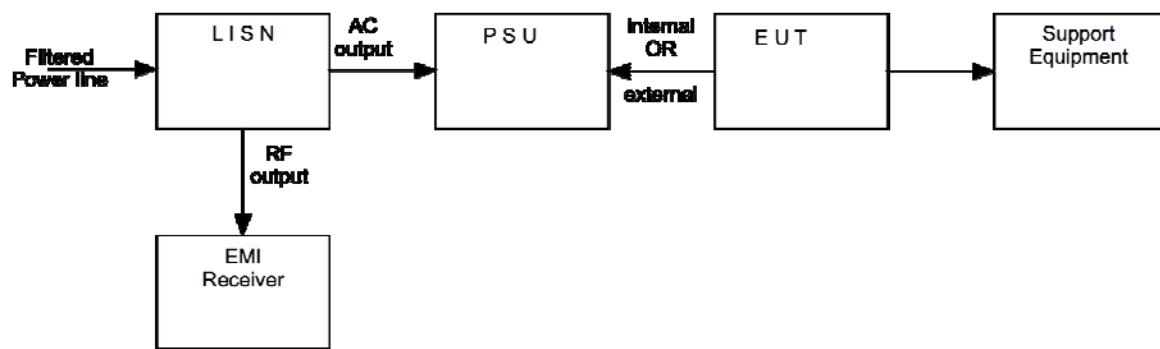
### 13.4 Test Method

With the EUT setup in a screened room, as per section 9 of this report and connected as per Figure iii, the power line emissions were measured on a spectrum analyzer / EMI receiver.

AC power line conducted emissions from the EUT are checked first by preview scans with peak and average detectors covering both live and neutral lines. A spectrum analyzer is used to determine if any periodic emissions are present.

Formal measurements using the correct detector(s) and bandwidth are made on frequencies identified from the preview scans. Final measurements were performed with EUT set at its maximum duty in transmit and receive modes.

**Figure iii Test Setup**



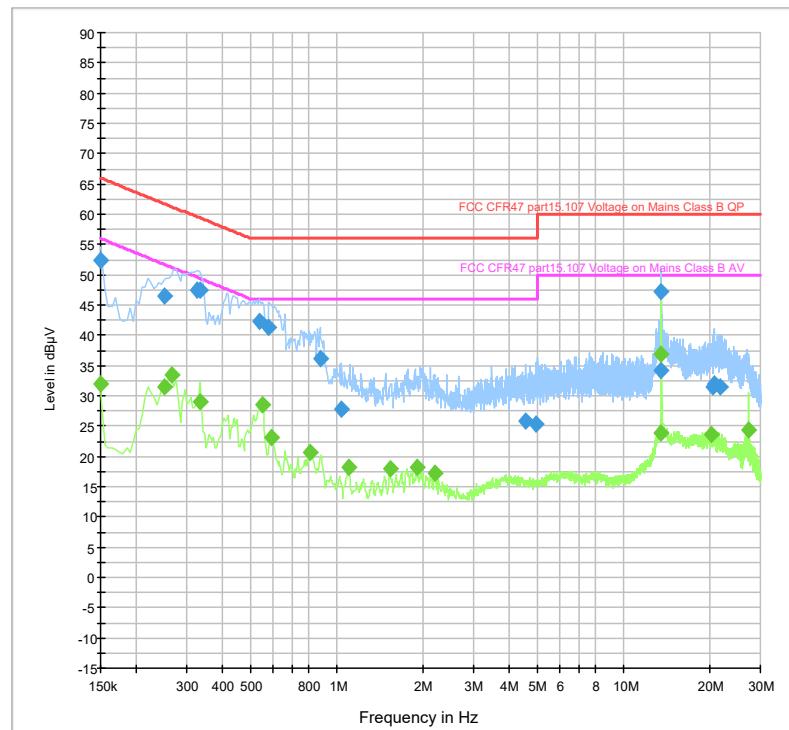
### 13.5 Test Set-up Photograph



### 13.6 Test Equipment

| Equipment Type | Manufacturer | Equipment Description | Element No | Due For Calibration |
|----------------|--------------|-----------------------|------------|---------------------|
| ESHS10         | R&S          | Receiver              | U003       | 2018-08-29          |
| ENV216         | R&S          | Lisn                  | U396       | 2018-07-05          |

### 13.7 Test Results



| AC power-line conducted emissions, Transmit mode: |                 |           |               |                            |             |                |
|---|-----------------|-----------|---------------|----------------------------|-------------|----------------|
| Results measured using the average detector       |                 |           |               |                            |             |                |
| Frequency (MHz)                                   | Bandwidth (kHz) | Conductor | Result (dBuV) | Specification Limit (dBuV) | Margin (dB) | Result Summary |
| 0.150000  | 10.000          | L1        | 31.9          | 56.0                       | 24.1        | PASS           |
| 0.250000  | 10.000          | N         | 31.5          | 51.8                       | 20.2        | PASS           |
| 0.265000  | 10.000          | N         | 33.4          | 51.3                       | 17.8        | PASS           |
| 0.335000  | 10.000          | N         | 29.1          | 49.3                       | 20.2        | PASS           |
| 0.550000  | 10.000          | N         | 28.5          | 46.0                       | 17.5        | PASS           |
| 0.590000  | 10.000          | N         | 23.1          | 46.0                       | 22.9        | PASS           |
| 0.810000  | 10.000          | N         | 20.8          | 46.0                       | 25.2        | PASS           |
| 1.095000  | 10.000          | N         | 18.1          | 46.0                       | 27.9        | PASS           |
| 1.535000  | 10.000          | N         | 17.8          | 46.0                       | 28.2        | PASS           |
| 1.895000  | 10.000          | N         | 18.3          | 46.0                       | 27.7        | PASS           |
| 2.200000  | 10.000          | N         | 17.1          | 46.0                       | 28.9        | PASS           |
| 13.530000   | 10.000          | N         | 23.9          | 50.0                       | 26.1        | PASS           |
| 13.565000   | 10.000          | L1        | 37.0          | 50.0                       | 13.0        | PASS           |
| 20.245000   | 10.000          | N         | 23.7          | 50.0                       | 26.3        | PASS           |
| 27.115000   | 10.000          | N         | 24.3          | 50.0                       | 25.7        | PASS           |

| <b>Results measured using the quasi-peak detector:</b> |                        |                  |                      |                                   |                    |                       |
|--|------------------------|------------------|----------------------|-----------------------------------|--------------------|-----------------------|
| <b>Frequency (MHz)</b>                                 | <b>Bandwidth (kHz)</b> | <b>Conductor</b> | <b>Result (dBuV)</b> | <b>Specification Limit (dBuV)</b> | <b>Margin (dB)</b> | <b>Result Summary</b> |
| 0.150000   | 10.000                 | L1               | 52.4                 | 66.0                              | 13.6               | PASS                  |
| 0.250000   | 10.000                 | N                | 46.6                 | 61.8                              | 15.2               | PASS                  |
| 0.325000   | 10.000                 | N                | 47.5                 | 59.6                              | 12.1               | PASS                  |
| 0.335000   | 10.000                 | N                | 47.5                 | 59.3                              | 11.8               | PASS                  |
| 0.535000   | 10.000                 | N                | 42.2                 | 56.0                              | 13.8               | PASS                  |
| 0.580000   | 10.000                 | N                | 41.3                 | 56.0                              | 14.7               | PASS                  |
| 0.875000   | 10.000                 | N                | 36.1                 | 56.0                              | 19.9               | PASS                  |
| 1.040000   | 10.000                 | N                | 27.8                 | 56.0                              | 28.2               | PASS                  |
| 4.565000   | 10.000                 | L1               | 25.8                 | 56.0                              | 30.2               | PASS                  |
| 4.970000   | 10.000                 | L1               | 25.4                 | 56.0                              | 30.6               | PASS                  |
| 13.475000  | 10.000                 | N                | 34.1                 | 60.0                              | 25.9               | PASS                  |
| 13.565000  | 10.000                 | L1               | 47.3                 | 60.0                              | 12.7               | PASS                  |
| 20.450000  | 10.000                 | N                | 31.6                 | 60.0                              | 28.4               | PASS                  |
| 20.690000  | 10.000                 | N                | 31.9                 | 60.0                              | 28.1               | PASS                  |
| 21.835000  | 10.000                 | N                | 31.5                 | 60.0                              | 28.5               | PASS                  |

## 14 Occupied Bandwidth

### 14.1 Definition

#### *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.

### 14.2 Test Parameters

|  |   |
|--|---|
| Test Location:   | Element Skelmersdale                                      |
| Test Chamber:  | Radio Laboratory  |
| Test Standard and Clause:                                    | ANSI C63.10-2013, Clause 6.9                              |
| EUT Frequency Measured:                                      | 13.56 MHz   |
| EUT Channel Bandwidth:                                       | 5 kHz   |
| EUT Test Modulations:  | ASK   |
| Deviations From Standard:                                    | Fix RBW used. 1% to 5% not achievable with ASK modulation |
| Measurement BW:<br>(requirement: 1% to 5% OBW)               | 1 kHz   |
| Spectrum Analyzer Video BW:<br>(requirement at least 3x RBW) | 3 kHz   |
| Measurement Span:<br>(requirement 2 to 5 times OBW)          | 20 kHz  |
| Measurement Detector:  | Peak  |

### Environmental Conditions (Normal Environment)

|                    |                                  |
|--------------------|----------------------------------|
| Temperature: 24 °C | +15 °C to +35 °C (as declared)   |
| Humidity: 45 % RH  | 20 % RH to 75 % RH (as declared) |
| Supply: 110 V ac   | 110 V ac (as declared)           |

### 14.3 Test Limit

#### Federal Communications Commission:

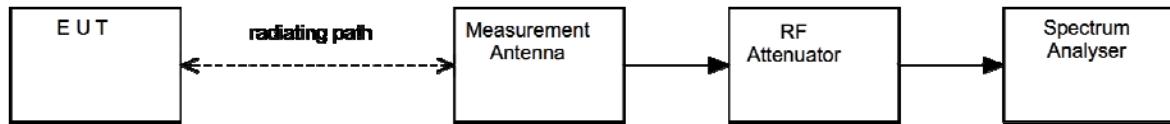
Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§ 15.217 through 15.257 and in subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific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

#### 14.4 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.

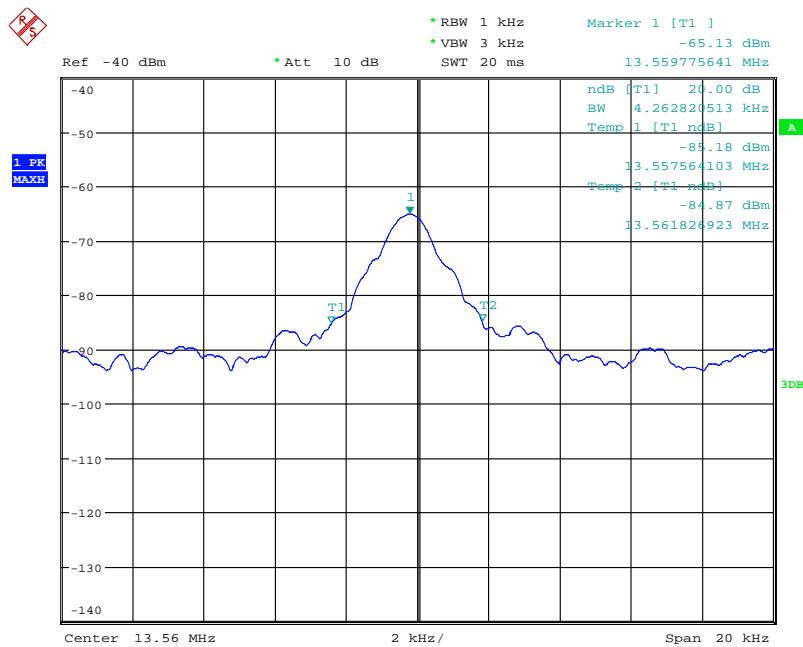
**Figure iv Test Setup**



**14.5 Test Equipment**

| <b>Equipment Type</b> | <b>Manufacturer</b> | <b>Equipment Description</b> | <b>Element No</b> | <b>Due For Calibration</b> |
|-----------------------|---------------------|------------------------------|-------------------|----------------------------|
| FSU50                 | R&S                 | Spectrum Analyser            | U544              | 2019-05-22                 |

## 14.6 Test Results



Date: 6.JUN.2018 15:38:30

### Modulation: ASK; Higher Power setting:

| Channel Frequency (MHz) | $F_L$ (MHz) | $F_H$ (MHz) | 20 dB Bandwidth (kHz) |
|-------------------------|-------------|-------------|-----------------------|
| 13.56                   | 13.5576     | 13.5618     | 4.2                   |

## 15 Transmitter output power (fundamental radiated emission)

### 15.1 Definition

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

### 15.2 Test Parameters

|   |   |
|---|---|
| Test Location:                          | Element Skelmersdale  |
| Test Chamber:                           | Far Field   |
| Test Antenna:                           | Active 60cm loop  |
| Test Standard and Clause:               | ANSI C63.10-2013, Clause 6.3 / 6.4  |
| EUT Frequencies Measured:               | 13.56 MHz   |
| EUT Channel Bandwidth:                  | 5 kHz   |
| Deviations From Standard:               | None  |
| Measurement BW:                         | 9 kHz   |
| Measurement Detector:                   | Quasi-peak  |
| Voltage Extreme Environment Test Range: | Mains Power = 85% and 115% of Nominal (FCC only requirement);<br>Battery Power = new battery. |

### Environmental Conditions (Normal Environment)

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

### 15.3 Test Limit

The field strength measured at 30 m shall not exceed the limits in the following table:

**Field Strength Limits for License-Exempt Transmitters for Any Application**

| <b>Frequency range (MHz)</b> | <b>Field strength (µV/m at 30m)</b> | <b>Field strength (dBµV/m at 30m)</b> |
|------------------------------|-------------------------------------|---------------------------------------|
| 13.110 – 13.410              | 106                                 | 40.5                                  |
| 13.410 – 13.553              | 334                                 | 50.5                                  |
| 13.553 – 13.567              | 15,848                              | 84.0                                  |
| 13.567 – 13.710              | 334                                 | 50.5                                  |
| 13.710 – 14.010              | 106                                 | 40.5                                  |

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

$$FS = 10^{(PR - CF) / 20}$$

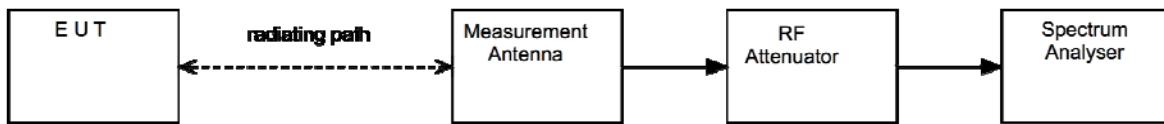
Where,

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 measurements at distances closer than specified.

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

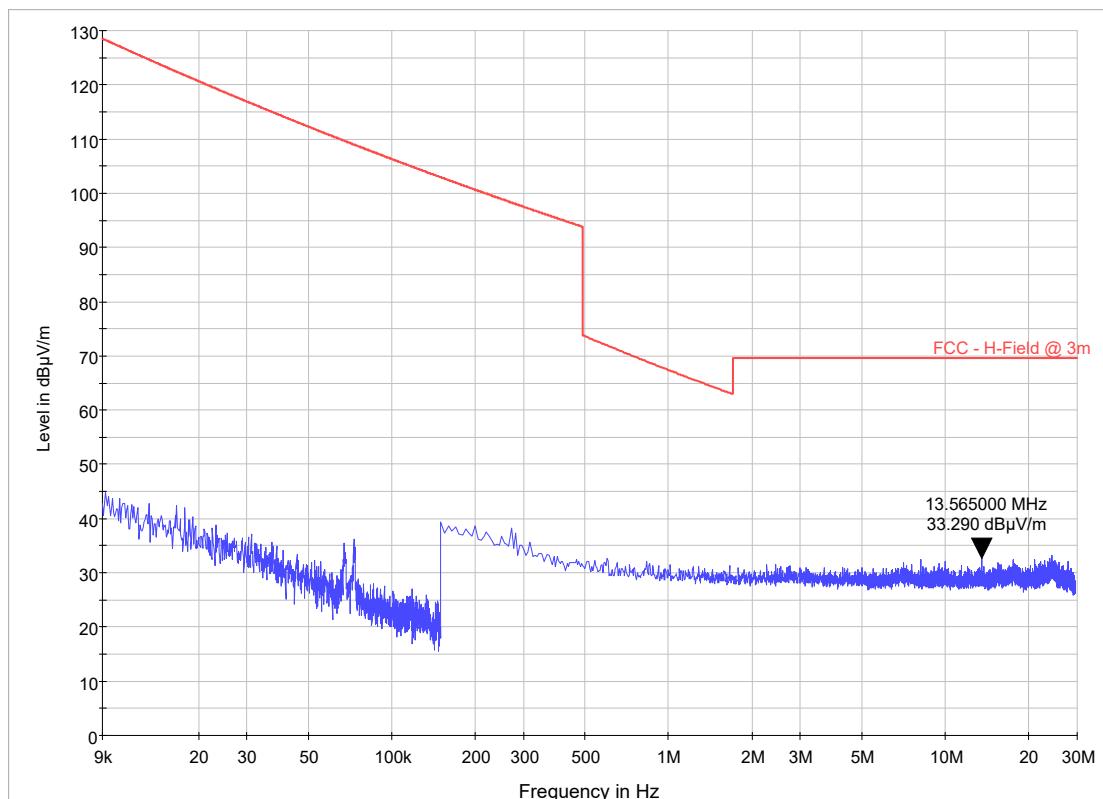
#### Figure v Test Setup



**15.5 Test Equipment**

| <b>Equipment Type</b> | <b>Manufacturer</b> | <b>Equipment Description</b> | <b>Element No</b> | <b>Due For Calibration</b> |
|-----------------------|---------------------|------------------------------|-------------------|----------------------------|
| hfh2                  | R&S                 | Loop Antenna                 | L007              | 2019-05-10                 |
| ESHS10                | R&S                 | Receiver                     | U003              | 2018-08-29                 |

## 15.6 Test Results



| Modulation: ASK; Power setting: Higher power setting: |                               |                          |                    |                           |                             |        |
|---|-------------------------------|--------------------------|--------------------|---------------------------|-----------------------------|--------|
| Channel Frequency (MHz)                               | Receiver Level (dB $\mu$ V/m) | Measurement Distance (m) | Limit Distance (m) | Extrapolation Factor (dB) | Field Strength ( $\mu$ V/m) | Result |
| 13.56   | 39.7                          | 3                        | 30                 | 40                        | 0.966                       | PASS   |

## 16 Frequency stability

### 16.1 Definition

Frequency stability is a measure of frequency drift due to temperature and supply voltage variations, with reference to the frequency measured at an appropriate reference temperature and the rated supply voltage.

### 16.2 Test Parameters

|   |   |
|---|---|
| Test Location:                              | Element Skelmersdale  |
| Test Chamber:                               | Radio Laboratory  |
| Test Standard and Clause:                   | ANSI C63.10-2013, Clause 6.8  |
| Frequency Measured:                         | 13.56 MHz   |
| Modulation:                                 | ASK   |
| Deviations From Standard:                   | EUT was left ON for the duration of the test.   |
| Temperature Extreme Environment Test Range: | -20 to +50 C  |
| Voltage Extreme Environment Test Range:     | Mains Power = $\pm 15\%$ of Nominal;<br>IC: Battery: nominal and end point;<br>FCC: Battery: new battery. |

### Environmental Conditions (Normal Environment)

|                    |                                  |
|--------------------|----------------------------------|
| Temperature: 20 °C | Standard Requirement: +20 °C     |
| Humidity: 45 %RH   | 20 % RH to 75 % RH (as declared) |

### 16.3 Test Limit

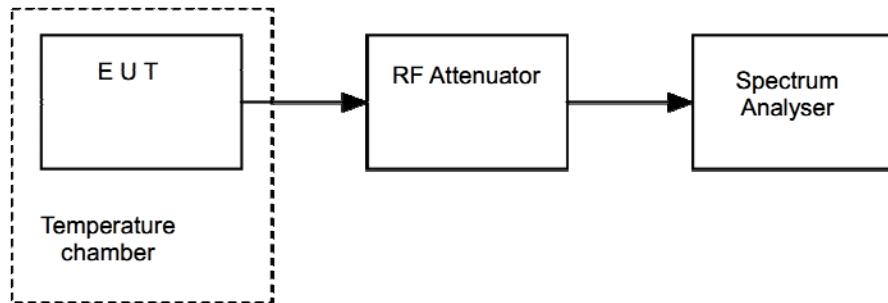
Carrier frequency stability shall be maintained to  $\pm 0.01\%$  ( $\pm 100$  ppm).

#### 16.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure v, the frequency was measured under varying conditions of temperature and supply voltage.

The measurements were performed with EUT set in a CW mode of operation.  
Measurements were made once temperature stability was achieved at each temperature.

**Figure v Test Setup**



### 16.5 Test Equipment

| Equipment Type | Manufacturer | Equipment Description | Element No | Due For Calibration |
|----------------|--------------|-----------------------|------------|---------------------|
| FSU50          | R&S          | Spectrum Analyser     | U544       | 2019-05-22          |
| 52 Series II   | Fluke        | Temperature Indicator | L426       | 2019-06-18          |
| 34405a         | Agilent      | Multimeter            | REF976     | 2019-01-17          |
| ETS            | ETS-S1000CHS | Temperature Chamber   | U522       | Use L426            |
| 8A             | RS           | Variable Transformer  | U034       | Use REF976          |

## 16.6 Test Results

| EUT Frequency: 13.56 MHz: |                      |                          |                       |                     |        |
|---------------------------|----------------------|--------------------------|-----------------------|---------------------|--------|
| Test Environment          |                      | Measured Frequency (MHz) | Frequency error (kHz) | Frequency error (%) | Result |
| -20 C                     | V <sub>nominal</sub> | 13.55975962              | 0.0000                | 0                   | PASS   |
| -10 C                     | V <sub>nominal</sub> | 13.55983974              | 0.0801                | 0.0006              | PASS   |
| 0 C                       | V <sub>nominal</sub> | 13.55983974              | 0.0801                | 0.0006              | PASS   |
| +10 C                     | V <sub>nominal</sub> | 13.55983974              | 0.0801                | 0.0006              | PASS   |
| +20 C                     | V <sub>minimum</sub> | 13.55975962              | 0.0000                | 0                   | PASS   |
|                           | V <sub>nominal</sub> | 13.55975962              | N/A                   | N/A                 | N/A    |
|                           | V <sub>maximum</sub> | 13.55975962              | 0.0000                | 0                   | PASS   |
| +30 C                     | V <sub>nominal</sub> | 13.55975962              | 0.0000                | 0                   | PASS   |
| +40 C                     | V <sub>nominal</sub> | 13.55975962              | 0.0000                | 0                   | PASS   |
| +50 C                     | V <sub>nominal</sub> | 13.55975962              | 0.0000                | 0                   | PASS   |

## 17 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**