

Report on the Radio Testing  
For  
Inova Design Solutions Ltd (Bodytrak)  
on  
Bodytrak I  
Report no. TRA-054222-47-13A  
17<sup>th</sup> August 2022

RF915 8.0



Report Number: TRA-054222-47-13A  
Issue: A

REPORT ON THE RADIO TESTING OF A  
Inova Design Solutions Ltd (Bodytrak)  
Bodytrak I  
WITH RESPECT TO SELECTED CLAUSES OF SPECIFICATION  
FCC 47CFR 15.247 & KDB 996369 D04 v02

TEST DATE: 09-08-2022 to 12-08-2022

Tested by: Michael Else

Written by:

Michael Else  
Radio Test Engineer

Approved by:

Dan Winstanley  
Senior Radio Test Engineer

Date: 17<sup>th</sup> August 2022

Disclaimers:

- [1] THIS DOCUMENT MAY BE REPRODUCED ONLY IN ITS ENTIRETY AND WITHOUT CHANGE  
[2] THE RESULTS CONTAINED IN THIS DOCUMENT RELATE ONLY TO THE ITEM(S) TESTED

## 1 Revision Record

| <i>Issue Number</i> | <i>Issue Date</i>            | <i>Revision History</i> |
|---------------------|------------------------------|-------------------------|
| A                   | 17 <sup>th</sup> August 2022 | Original                |
|                     |                              |                         |

## 2 Summary

|                             |                                                                  |
|-----------------------------|------------------------------------------------------------------|
| TEST REPORT NUMBER:         | TRA-054222-47-13A                                                |
| WORKS ORDER NUMBER:         | TRA-054222-08                                                    |
| PURPOSE OF TEST:            | Permissive change class investigation                            |
| TEST SPECIFICATION:         | 47CFR15.247 / KDB 996369 D04 v02                                 |
| EQUIPMENT UNDER TEST (EUT): | Bodytrak I                                                       |
| FCC IDENTIFIER:             | 2A3CVA                                                           |
| Contains FCCID (BLE):       | T7V1326C2                                                        |
| Contains FCCID (LTE):       | XPY1EIQ24NN                                                      |
| EUT SERIAL NUMBER:          | Conducted: BCP1N-A0146<br>Radiated: BCP1N-A0140                  |
| MANUFACTURER/AGENT:         | Inova Design Solutions Ltd (Bodytrak)                            |
| ADDRESS:                    | 86-90 Paul Street.<br>London<br>EC2A 4NE<br>United Kingdom       |
| CLIENT CONTACT:             | Leon Marsh<br>☎ +44 (0) 203 432 5439<br>✉ regulatory@bodytrak.co |
| ORDER NUMBER:               | PO-0290                                                          |
| TEST DATE:                  | 09-08-2022 to 12-08-2022                                         |
| TESTED BY:                  | Michael Else<br>Element                                          |

## 2.1 Test Summary

| Test Method and Description                                                       |      | Requirement Clause 47CFR15 | Applicable to this equipment        | Result / Note |
|-----------------------------------------------------------------------------------|------|----------------------------|-------------------------------------|---------------|
| Radiated spurious emissions (restricted bands of operation and cabinet radiation) |      | 15.247 (d)                 | <input checked="" type="checkbox"/> | Pass          |
| AC power line conducted emissions                                                 |      | 15.207                     | <input type="checkbox"/>            | Note 1        |
| Occupied bandwidth                                                                |      | 15.247 (a) (2)             | <input checked="" type="checkbox"/> | Pass          |
| Conducted carrier power                                                           | Peak | 15.247 (b) (3)             | <input checked="" type="checkbox"/> | Pass          |
|                                                                                   | Max. |                            | <input type="checkbox"/>            |               |
| Out of band emissions                                                             |      | 15.247 (d)                 | <input type="checkbox"/>            | Note 1        |
| Power spectral density                                                            |      | 15.247 (e)                 | <input type="checkbox"/>            | Note 1        |
| Calculation of duty correction                                                    |      | -                          | <input type="checkbox"/>            | -             |
| TX Radiated spurious emissions (Full Operation)                                   |      | KDB 996369 D04 v02         | <input checked="" type="checkbox"/> | Pass          |

### Specific Note:

1. Limited testing performed to selected clauses of FCC 47CFR 15.247 & KDB 996369 D04 v02 to facilitate permissive class change investigation.

### General Notes:

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

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

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

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## 4 Introduction

This report TRA-054222-47-13A presents the results of the Radio testing on a Inova Design Solutions Ltd ( Bodytrak), Bodytrak lto specification 47CFR15 Radio Frequency Devices & KDB 996369 D04 v02.

The testing was carried out for Inova Design Solutions Ltd ( Bodytrak) 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.

Throughout this report EUT denotes equipment under test.

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

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

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.
- KDB 996369 D04 Module Integration Guide v02 - Modular transmitter integration guide - Guidance for host product manufacturers.

### **5.2 Deviations from Test Standards**

Limited testing performed to selected clauses of FCC 47CFR 15.247 & KDB 996369 D04 v02 to facilitate permissive class change investigation.

## 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                                                  |
| <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: Bodytrak I
- Serial Number: BCP1N
- Model Number: Bodytral I
- Software Revision: 4120
- Build Level / Revision Number: B3 (Build 3)

### **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.

*Texas Instruments CC31XXEMUBOOST*  
*HP Probook 4540s Laptop*

### **7.3 EUT Mode of Operation**

#### **Radiated**

The EUT was programmed with test modes that when enabled caused the unit to transmit on the required channel with the detailed operating mode.

#### **Conducted**

The EUT was programmed to transmit on the required frequencies using a Texas instruments CC31XXEMUBOOST dev board and CC31XX/CC32XX Radio tool software (Version1.03.18) Via a test laptop.

## 7.4 EUT Radio Parameters

### 7.4.1 General

#### WiFi

|                                                                             |                             |
|-----------------------------------------------------------------------------|-----------------------------|
| <b>Frequency of operation:</b>                                              | 2412 MHz -2462 MHz          |
| <b>Modulation type(s):</b>                                                  | DSSS, OFDM                  |
| <b>Occupied channel bandwidth(s):</b>                                       | 20 MHz                      |
| <b>Channel spacing:</b>                                                     | 5 MHz                       |
| <b>ITU emission designator(s):</b>                                          | GXW                         |
| <b>Declared output power(s):</b>                                            | <20 dBm                     |
| <b>Warning against use of alternative antennas in user manual (yes/no):</b> | N/A integral antenna        |
| <b>Nominal Supply Voltage:</b>                                              | 3.7 Vdc                     |
| <b>Location of notice for license exempt use:</b>                           | Label / user manual / both. |

#### BLE

|                                       |                                         |
|---------------------------------------|-----------------------------------------|
| <b>Frequency of operation:</b>        | 2402 to 2480 MHz                        |
| <b>Modulation type(s):</b>            | GFSK                                    |
| <b>Occupied channel bandwidth(s):</b> | 2 MHz                                   |
| <b>Channel spacing:</b>               | 2 MHz                                   |
| <b>ITU emission designator(s):</b>    | F1D                                     |
| <b>Declared output power setting:</b> | -3 dBm                                  |
| <b>Nominal Supply Voltage:</b>        | 3.7 Vdc From Li-Po rechargeable battery |
| <b>Duty cycle:</b>                    | 100% for test                           |

#### LTE

| <b>Radio:</b>                    | <b>LTE</b> |
|----------------------------------|------------|
| <b>Band(s) of operation:</b>     | 12         |
| <b>Frequencies of operation:</b> | 707.5 MHz  |
| <b>Modulation type(s):</b>       | OFDM       |
| <b>Channel bandwidth(s):</b>     | 10 MHz     |
| <b>Nominal Supply Voltage:</b>   | 3.7 Vdc    |

## 7.4.2 Antennas

## WiFi

|                              |                   |
|------------------------------|-------------------|
| <b>Type:</b>                 | Antennova SR4W035 |
| <b>Frequency range:</b>      | 2.4 – 2.5 (GHz)   |
| <b>Impedance:</b>            | 50 $\Omega$       |
| <b>VSWR:</b>                 | 1.85:1            |
| <b>Gain:</b>                 | 3.5 dBi Peak      |
| <b>Polarisation:</b>         | Linear            |
| <b>Beam width:</b>           | Wideband          |
| <b>Connector type:</b>       | SMD               |
| <b>Length:</b>               | 6.0mm             |
| <b>Weight:</b>               | 4.0mm             |
| <b>Environmental limits:</b> | -40°C to 140°C    |
| <b>Mounting:</b>             | Soldered          |

## BLE

|                         |                              |
|-------------------------|------------------------------|
| <b>Type:</b>            | Component Multilayer Antenna |
| <b>Make/Model</b>       | TDK ANT016008LCS2442MA1      |
| <b>Frequency range:</b> | 2400 MHz to 2484 MHz         |
| <b>Gain:</b>            | 1.6 dBi                      |
| <b>Connector type:</b>  | Integral                     |

## LTE

|                       |                                 |
|-----------------------|---------------------------------|
| <b>Manufacturer:</b>  | Bodytrak (Low Band)             |
| <b>Bands covered:</b> | 5 (LTE 850/UMTS) & 12 (LTE 700) |
| <b>Type:</b>          | PCB trace and Flex PCB patch    |
| <b>Gain:</b>          | -0.9 dBi                        |
| <b>Model number:</b>  | N/A                             |

## **7.5 EUT Description**

The EUT is a personal wearable device and is comprised of a miniature earpiece with integrated sensors connected to a torso-worn communication pack. The normal power source applied was 3.7 Vdc from internal Li-Po Rechargeable battery.

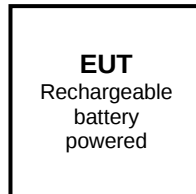
## **8 Modifications**

No modifications were performed during this assessment.

## 9 EUT Test Setup

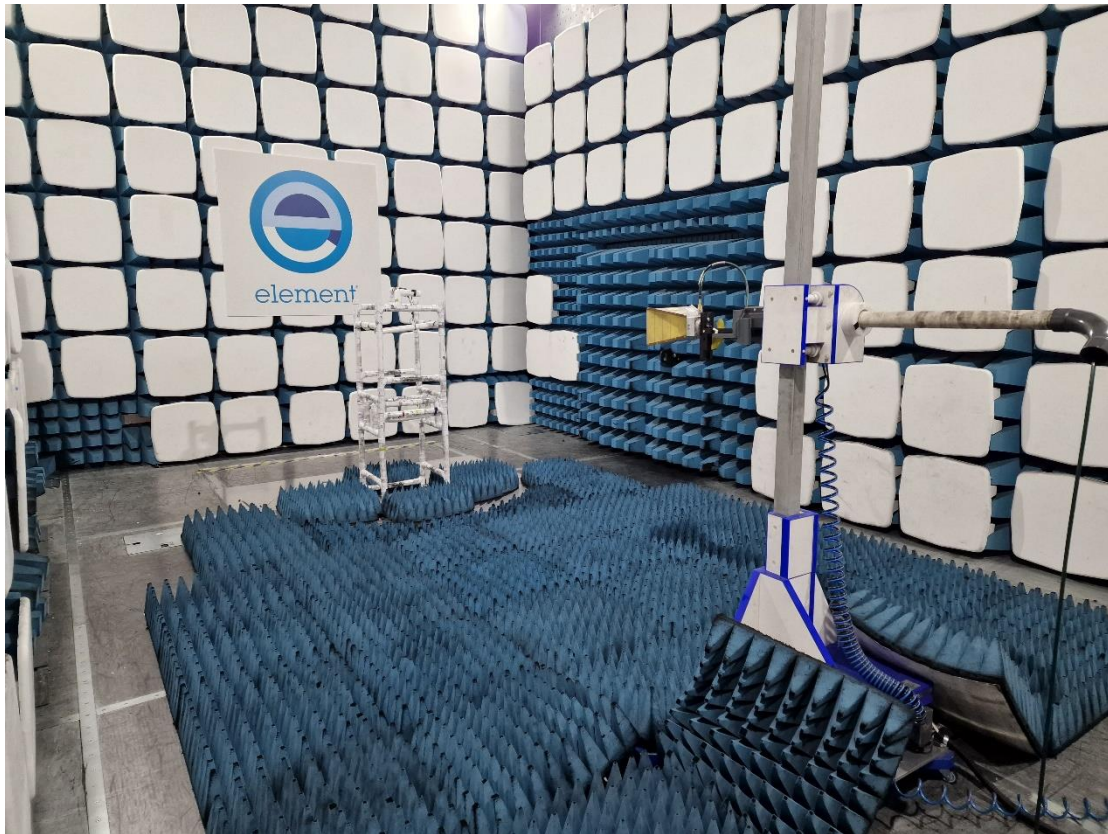
### 9.1 Block Diagram

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 2022.07.06.0  
Element Transmitter Bench Test  
ETS Lindgren EMPower V1.0.4.2

## 10 Radiated emissions, WiFi

### 10.1 Definitions

#### *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.

### 10.2 Test Parameters

|                           |                                                            |
|---------------------------|------------------------------------------------------------|
| Test Location:            | Element Skelmersdale                                       |
| Test Chamber:             | Chamber 03                                                 |
| Test Standard and Clause: | ANSI C63.10-2013, Clause 6.5 and 6.6                       |
| EUT Frequencies Measured: | 2412 MHz & 2462 MHz                                        |
| Deviations from Standard: | None                                                       |
| Measurement BW:           | 30 MHz to 1 GHz: 120 kHz; Above 1 GHz: 1 MHz               |
| Measurement Detector:     | Up to 1 GHz: quasi-peak; Above 1 GHz: RMS average and Peak |

#### Environmental Conditions (Normal Environment)

|                    |                                  |
|--------------------|----------------------------------|
| Temperature: 20 °C | +15 °C to +35 °C (as declared)   |
| Humidity: 53 % RH  | 20 % RH to 75 % RH (as declared) |
| Supply: 3.7 Vdc    | As declared                      |

### 10.3 Test Limit

Unwanted emissions that fall within the restricted frequency bands shall comply with the limits specified:

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

| <i>Frequency (MHz)</i> | <i>Field Strength (µV/m at 3 m)</i> | <i>Field Strength (dBµV/m at 3 m)</i> |
|------------------------|-------------------------------------|---------------------------------------|
| 30 to 88               | 100                                 | 40.0                                  |
| 88 to 216              | 150                                 | 43.5                                  |
| 216 to 960             | 200                                 | 46.0                                  |
| Above 960              | 500                                 | 54.0                                  |

On frequencies below or equal to 1000 MHz, the limits shown are based on measuring equipment employing a CISPR quasi-peak detector function. On frequencies above 1000 MHz, the radiated emission limits are based on the use of measurement instrumentation employing an average detector function. The limit on peak radio frequency emissions is 20 dB above the maximum permitted average emission limit.

#### 10.4 Test Method

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

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

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

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

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

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

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

Where,

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

CL is the cable loss in dB;

AF is the test antenna factor in dB/m;

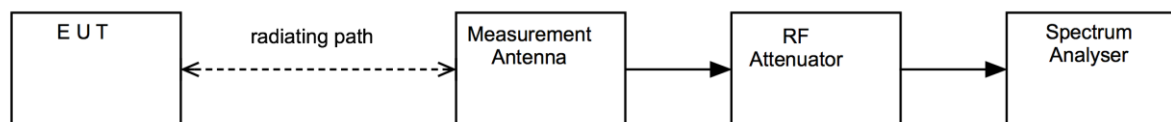
PA is the pre-amplifier gain in dB (where used);

DC is the duty correction factor in dB (where used, e.g. harmonics of pulsed fundamental);

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

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

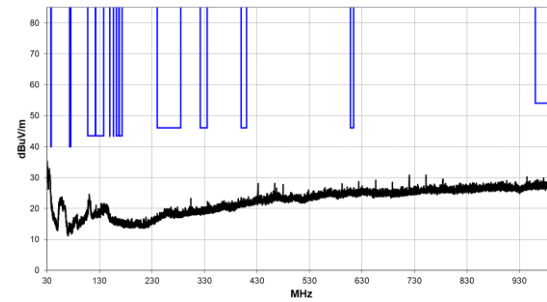
**Figure i Test Setup**



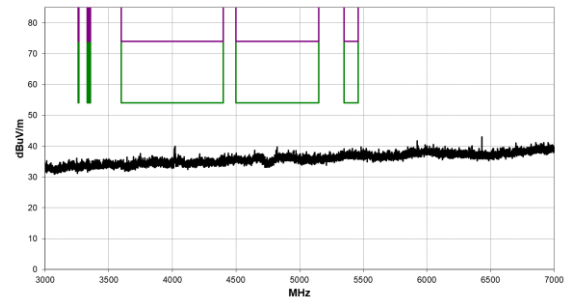
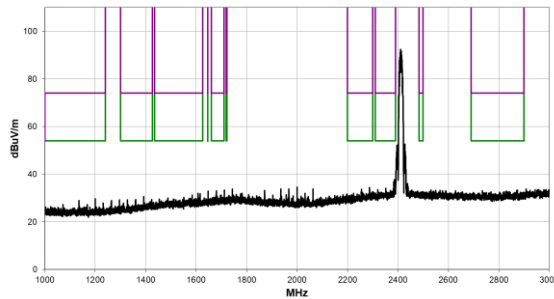
**10.5 Test Equipment**

| Equipment Type              | Manufacturer | Equipment Description  | Element No | Due For Calibration |
|-----------------------------|--------------|------------------------|------------|---------------------|
| Emissions R5 – 2022.07.06.0 | Element      | Radiated Test Software | REF9000    | Cal not required    |
| ATS                         | Rainford EMC | Chamber 1              | U387       | 2023-10-24          |
| FSU46                       | R&S          | Spectrum Analyser      | REF910     | 2022-12-22          |
| LNA6901                     | AMETEK       | Pre Amp                | U711       | 2023-03-14          |
| CBL6112                     | Chase        | Bilog                  | U420       | 2023-01-28          |
| 8449B                       | Agilent      | Pre Amp                | L572       | 2022-10-29          |
| 3115                        | EMCO         | 1-18GHz Horn           | U223       | 2023-12-13          |
| 3115                        | EMCO         | 1-18GHz Horn           | L139       | 2024-07-01          |
| SN 4478                     | BSC          | 2.4G Band Stop Filter  | U543       | 2023-02-03          |
| 20240-20                    | Flann        | Horn 18-26GHz (&U330)  | L263A      | 2024-06-23          |

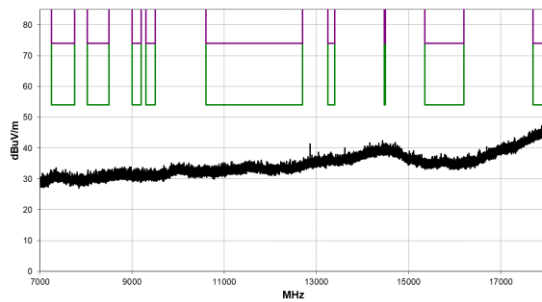
## 10.6 Test Results



30 MHz to 1 GHz

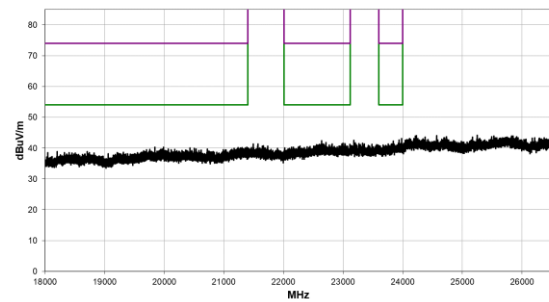


1 GHz to 3 GHz



7 GHz to 18 GHz

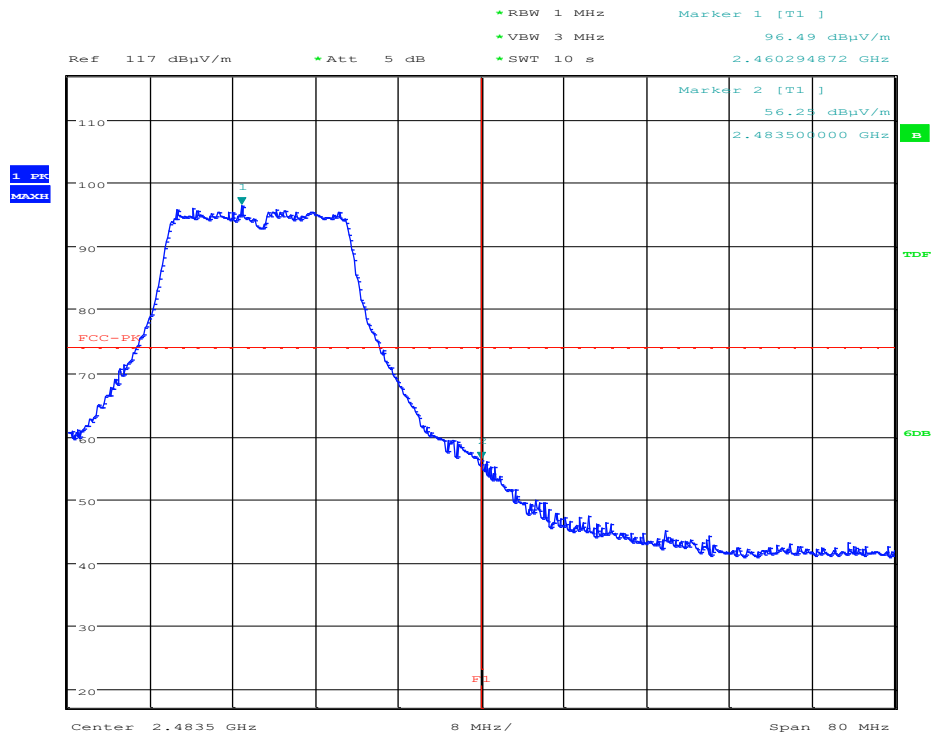
3 GHz to 7 GHz



18 GHz to 26.5 GHz

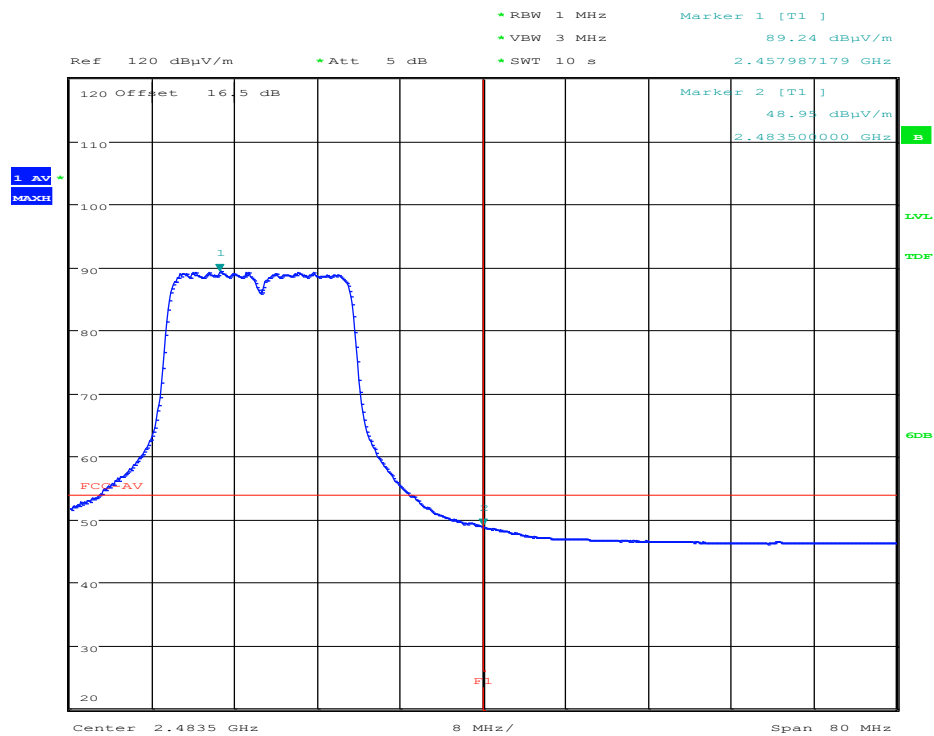
| Frequency: 2412 MHz; Channel: 1; DSSS1;             |             |                        |             |                        |                               |                         |                |             |
|-----------------------------------------------------|-------------|------------------------|-------------|------------------------|-------------------------------|-------------------------|----------------|-------------|
| Detector                                            | Freq. (MHz) | Meas'd Emission (dBμV) | Factor (dB) | Duty Cycle Corr'n (dB) | Distance Extrap'n Factor (dB) | Field Strength (dBμV/m) | Limit (dBμV/m) | Margin (dB) |
| No significant emissions within 20 dB of the limit. |             |                        |             |                        |                               |                         |                |             |

## Upper Radiated Band Edge Peak



Date: 10.AUG.2022 15:04:03

## Upper Radiated Band Edge Average



Date: 10.AUG.2022 15:05:52

## 11 Radiated emissions, Full Operation (FCC)

### 11.1 Definitions

#### *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:                    | Chamber 03                                     |
| Test Standard and Clause:        | TIA 603-D, clause 2.2.12                       |
| Channels / Frequencies Measured: | BLE: 2402 MHz; WiFi: 2462 MHz; LTE: 707.5 MHz; |
| Deviations From Standard:        | None                                           |
| Measurement BW:                  | 30 MHz to 1 GHz: 120 kHz; Above 1 GHz: 1 MHz   |
| Measurement Detector:            | Below 1 GHz: Peak<br>Above 1 GHz: Peak         |

### Environmental Conditions (Normal Environment)

#### **Radiated**

Temperature: 21 °C

Humidity: 56 %RH

Supply: 3.7 Vdc

### 11.3 Test Limits

#### *Part 15*

Unwanted emissions that fall within the restricted frequency bands shall comply with the limits specified:

#### **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                                                           |

#### *Part 22, Part 24 & Part 27*

At least  $43 + 10 \log P$  dB

$(10 \log P_{\text{watts}}) - (43 + 10 \log (P_{\text{watts}} * 1000)) = \text{LIMIT} = -13 \text{ dBm}$

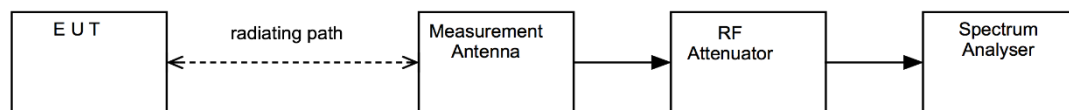
### 11.3.1 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure viii the emissions from the EUT were measured on a spectrum analyzer / EMI receiver. The EUT was rotated in three orthogonal planes and the measurement antenna height scanned (below 1GHz, from 1 to 4 m; above 1GHz as necessary) in order to maximise emissions. The measurements were performed with EUT set at its maximum gain. All modulation schemes, data rates and power settings were used to observe the worst-case configuration at each frequency.

The EUT was substituted with a known generator and antenna and for the same level achieved at the analyser, the effective radiated power was recorded.

Pre-scan plots are shown with a peak detector and 100kHz RBW.

**Figure i-b Test Setup**

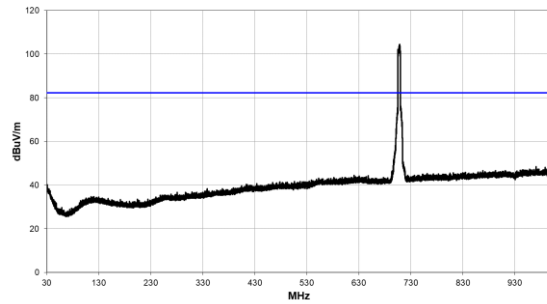


### 11.3.2 Test Equipment

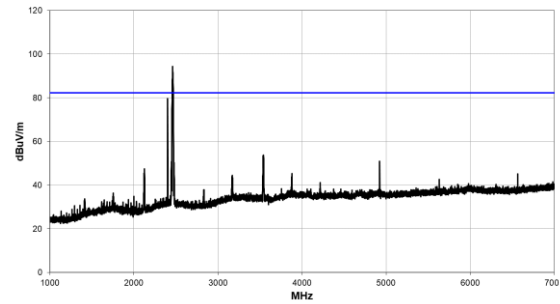
| <b>Equipment Description</b> | <b>Manufacturer</b> | <b>Equipment Type</b>        | <b>Element No</b> | <b>Due For Calibration</b> |
|------------------------------|---------------------|------------------------------|-------------------|----------------------------|
| Radiated Test Software       | Element             | Emissions R5<br>2022.07.06.0 | REF9000           | Cal not required           |
| Chamber 1                    | Rainford EMC        | ATS                          | U387              | 2023-10-24                 |
| Spectrum Analyser            | R&S                 | FSU46                        | REF910            | 2022-12-22                 |
| Pre Amp                      | AMETEK              | LNA6901                      | U711              | 2023-03-14                 |
| Bilog                        | Chase               | CBL6112                      | U420              | 2023-01-28                 |
| Pre Amp                      | Agilent             | 8449B                        | L572              | 2022-10-29                 |
| 1-18GHz Horn                 | EMCO                | 3115                         | U223              | 2023-12-13                 |
| 1-18GHz Horn                 | EMCO                | 3115                         | L139              | 2024-07-01                 |
| 2.4G Band Stop Filter        | BSC                 | SN 4478                      | U543              | 2023-02-03                 |
| Horn 18-26GHz (&U330)        | Flann               | 20240-20                     | L263A             | 2024-06-23                 |

### 11.3.3 Test Results

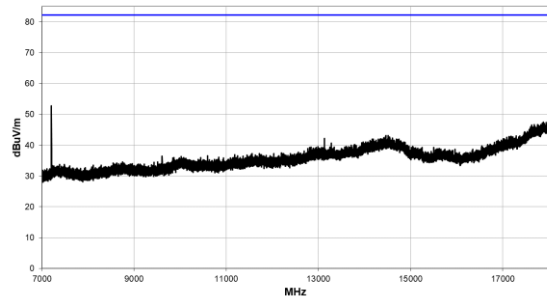
| <b>Radio 1: Bluetooth LE; Frequency: 2402 MHz; Power Setting: 0 dBm; Data Rate: 1 Mbps</b><br><b>Radio 2: 2.4 GHz WiFi; Frequency: 2462 MHz; Power Setting: Fixed; Data Rate: 11b 1M;</b><br><b>Radio 3: Band 12; ARFCN: 123095; Frequency: 707.5 MHz; Power Setting: High;</b> |                        |                    |                    |                    |               |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|--------------------|--------------------|--------------------|---------------|
| <b>Emission</b>                                                                                                                                                                                                                                                                 | <b>Frequency (MHz)</b> | <b>Level (dBm)</b> | <b>Limit (dBm)</b> | <b>Margin (dB)</b> | <b>Result</b> |
| No Intermodulation emissions were detected within 10 dB of the limit.                                                                                                                                                                                                           |                        |                    |                    |                    |               |



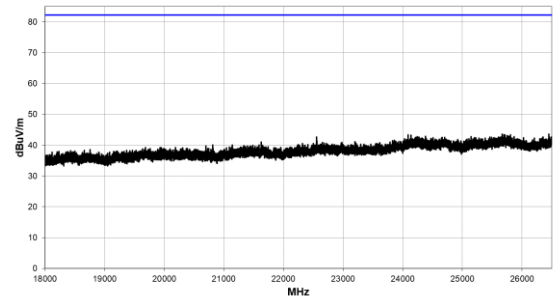
30 MHz to 1 GHz



1 GHz to 7 GHz



7 GHz to 18 GHz



18 GHz to 26.5 GHz

## 12 Maximum peak conducted output power

### 12.1 Definition

The maximum peak conducted output power is defined as the maximum power level measured with a peak detector using a filter with width and shape of which is sufficient to accept the signal bandwidth.

### 12.2 Test Parameters

|                                                              |                                              |
|--------------------------------------------------------------|----------------------------------------------|
| Test Location:                                               | Element Skelmersdale                         |
| Test Chamber:                                                | Chamber 03                                   |
| Test Standard and Clause:                                    | ANSI C63.10-2013, Clause 11.9.1              |
| EUT Channels / Frequencies Measured:                         | 2412 MHz                                     |
| EUT Channel Bandwidths:                                      | 20 MHz                                       |
| Deviations From Standard:                                    | None                                         |
| Measurement BW:                                              | N/A, Wideband Peak Power Meter               |
| Spectrum Analyzer Video BW:<br>(requirement at least 3x RBW) | 30 MHz                                       |
| Measurement Detector:                                        | Peak                                         |
| Voltage Extreme Environment Test Range:                      | Battery Power = new / fully charged battery. |

### Environmental Conditions (Normal Environment)

|                    |                                  |
|--------------------|----------------------------------|
| Temperature: 24 °C | +15 °C to +35 °C (as declared)   |
| Humidity: 53 % RH  | 20 % RH to 75 % RH (as declared) |

### 12.3 Test Limit

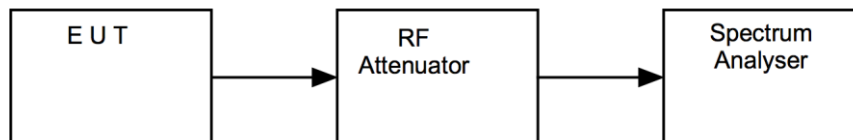
For systems employing digital modulation techniques operating in the bands 902 to 928 MHz, 2400 to 2483.5 MHz and 5725 to 5850 MHz, the maximum peak conducted output power shall not exceed 1 W.

## 12.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure iv, 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.

**Figure iv Test Setup**



## 12.5 Test Equipment

| Equipment Type       | Manufacturer       | Equipment Description | Element No | Due For Calibration |
|----------------------|--------------------|-----------------------|------------|---------------------|
| FSU26                | R&S                | Spectrum Analyser     | U405       | 2023-04-21          |
| SMB100A              | R&S                | Signal Generator      | U677       | 2023-01-26          |
| 7002-006             | ETS Lindgren       | Power Meter           | REF2286    | 2022-11-02          |
| ATT20KXP-483001-S4S5 | Atlantec Microwave | 20 dB attenuator      | N/A        | In Use              |

## 12.6 Test Results

| <i>Modulation: 802.11b; Data rate: 1mbps</i> |                                            |             |               |
|----------------------------------------------|--------------------------------------------|-------------|---------------|
| <i>Frequency (MHz)</i>                       | <i>Maximum peak conducted output power</i> |             | <i>Result</i> |
|                                              | <i>(dBm)</i>                               | <i>(mW)</i> |               |
| 2412                                         | 11.93                                      | 15.60       | Pass          |

## 13 Occupied Bandwidth

### 13.1 Definition

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

The 99% emission bandwidth is defined as the frequency range between two points, one above and the other below the carrier frequency, within which 99% of the total transmitted power of the fundamental transmitted emission is contained.

### 13.2 Test Parameters

|                                                     |                                               |
|-----------------------------------------------------|-----------------------------------------------|
| Test Location:                                      | Element Skelmersdale                          |
| Test Chamber:                                       | Radio Laboratory                              |
| Test Standard and Clause:                           | 6 dB Bandwidth: ANSI C63.10-2013, Clause 11.8 |
| EUT Channels / Frequencies Measured:                | 2412 MHz                                      |
| EUT Channel Bandwidths:                             | 20 MHz                                        |
| EUT Test Modulations:                               | DSSS                                          |
| Deviations From Standard:                           | None                                          |
| Measurement BW:                                     | 100 kHz                                       |
| Measurement Span:<br>(requirement 2 to 5 times OBW) | 50 MHz                                        |
| Measurement Detector:                               | Peak                                          |

### Environmental Conditions (Normal Environment)

|                    |                                  |
|--------------------|----------------------------------|
| Temperature: 25 °C | +15 °C to +35 °C (as declared)   |
| Humidity: 52 % RH  | 20 % RH to 75 % RH (as declared) |
| Supply: 3.7 Vdc    | 3.7 Vdc ±10 % (as declared)      |

### 13.3 Test Limit

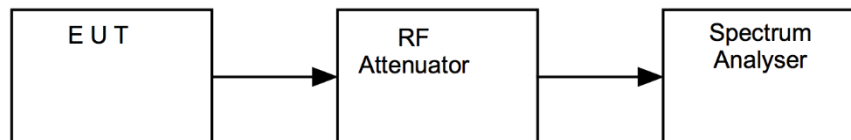
The minimum -6 dB bandwidth shall be at least 500 kHz.

### 13.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure iii, the bandwidth of the EUT was measured on a spectrum analyser.

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

**Figure iii Test Setup**



### 13.5 Test Equipment

| Equipment Type       | Manufacturer       | Equipment Description | Element No | Due For Calibration |
|----------------------|--------------------|-----------------------|------------|---------------------|
| FSW 43               | R&S                | Spectrum Analyser     | U728       | 2023-04-26          |
| ATT20KXP-483001-S4S5 | Atlantec Microwave | 20 dB attenuator      | N/A        | In Use              |

### 13.6 Test Results

| Bandwidth Type: 6 dB; Modulation: 802.11b; Data rate: 1mbps |             |             |                 |        |
|-------------------------------------------------------------|-------------|-------------|-----------------|--------|
| Frequency (MHz)                                             | $F_L$ (MHz) | $F_H$ (MHz) | Bandwidth (MHz) | Result |
| 2412                                                        | 2406.955000 | 2416.545000 | 9.590           | PASS   |



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## 14 Duty Cycle

### 14.1 Definition

The ratio of the sum of all pulse durations to the total period, during a specified period of operation.

### 14.2 Test Parameters

|                                             |                               |
|---------------------------------------------|-------------------------------|
| Test Location:                              | Element Skelmersdale          |
| Test Chamber:                               | Chamber 03                    |
| Test Standard and Clause:                   | ANSI C63.10-2013, Clause 11.6 |
| Deviations From Standard:                   | None                          |
| Temperature Extreme Environment Test Range: | N/A                           |
| Voltage Extreme Environment Test Range:     | N/A                           |

### Environmental Conditions (Normal Environment)

|                    |                                  |
|--------------------|----------------------------------|
| Temperature: 20 °C | +15 °C to +35 °C (as declared)   |
| Humidity: 53 % RH  | 20 % RH to 75 % RH (as declared) |
| Supply: 3.7 Vdc    | 3.7 Vdc (as declared)            |

### 14.3 Test Limit

N/A.

Note, the maximum duty cycle correction factor which may be used is 20 dB.

#### 14.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure vii, the duty of the EUT was calculated from the sum of total on and off times over the observation period.

The measurements were performed with EUT set at its maximum duty. WiFi 802.11.b 1Mb/s; DSSS1 was Measured.

[1] Single antenna output devices

Duty was measured at the antenna port / at a distance of 3 m.

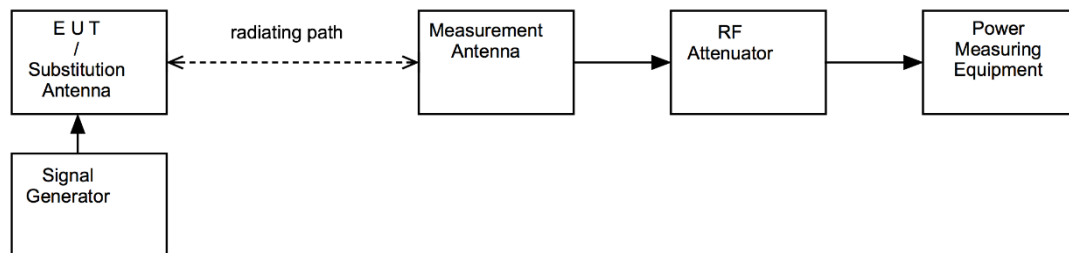
[2] Multiple antenna output devices

Duty was measured as the combination of all ports simultaneously / at a distance of 3 m.

The duty cycle correction factor, DC, shall be added to the measurement results prior to comparing with the emission limit to compute the emission level that would have been measured had the test been performed at 100% duty cycle. The correction factor is computed as:

- 1) If power averaging (rms) mode was used in step f), then the applicable correction factor is  $[10 \log (1 / D)]$ , where D is the duty cycle.
- 2) If linear voltage averaging mode was used in step f), then the applicable correction factor is  $[20 \log (1 / D)]$ , where D is the duty cycle.
- 3) If a specific emission is demonstrated to be continuous ( $D \geq 98\%$ ) rather than turning ON and OFF with the transmit cycle, then no duty cycle correction is required for that emission.

**Figure vii Test Setup**



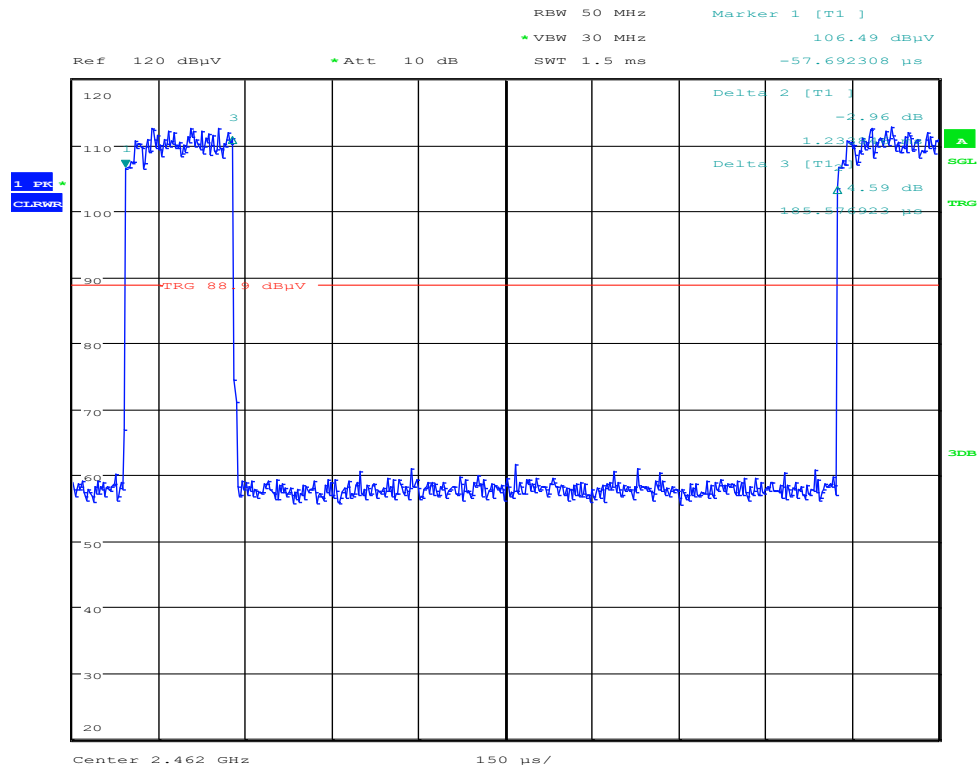
#### 14.5 Test Equipment

| Equipment Type | Manufacturer | Equipment Description  | Element No | Due For Calibration |
|----------------|--------------|------------------------|------------|---------------------|
| Emissions R5   | Element      | Radiated Test Software | REF9000    | Cal not required    |
| FSU46          | R&S          | Spectrum Analyser      | REF910     | 2022-12-22          |
| 8449B          | Agilent      | Pre Amp                | L572       | 2022-10-29          |
| 3115           | EMCO         | 1-18GHz Horn           | L139       | 2024-07-01          |

## 14.6 Test Results

WiFi 802.11.b 1Mb/s

| WiFi; 802.11.b 1Mb/s; DSSS1; |                      |                |                   |                        |
|------------------------------|----------------------|----------------|-------------------|------------------------|
| Test Environment             |                      | TxOn time (ms) | Frame Period (ms) | Calculated Factor (dB) |
| V <sub>nominal</sub>         | T <sub>nominal</sub> | 0.185576       | 1.233846          | 16.5                   |



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## 15 Measurement Uncertainty

### Radio Testing – General Uncertainty Schedule

All statements of uncertainty are expanded standard uncertainty using a coverage factor of 1.96 to give a 95 % confidence where no required test level exists.

| Test/Measurement                                                                                 | Budget Number | MU          |
|--------------------------------------------------------------------------------------------------|---------------|-------------|
| <b>Conducted RF Power, Power Spectral Density, Adjacent Channel Power and Spurious emissions</b> |               |             |
| Absolute RF power (via antenna connector) Dare RPR3006W Power Head                               | MU4001        | 0.9 dB      |
| Carrier Power and PSD - Spectrum Analysers                                                       | MU4004        | 0.9 dB      |
| Adjacent Channel Power                                                                           | MU4002        | 1.9 dB      |
| Transmitter conducted spurious emissions                                                         | MU4041        | 0.9 dB      |
| Conducted power and spurious emissions 40 GHz to 50 GHz                                          | MU4042        | 2.4 dB      |
| Conducted power and spurious emissions 50 GHz to 75 GHz                                          | MU4043        | 2.5 dB      |
| Conducted power and spurious emissions 75 GHz to 110 GHz                                         | MU4044        | 2.4 dB      |
|                                                                                                  |               |             |
| <b>Radiated RF Power and Spurious emissions ERP and EIRP</b>                                     |               |             |
| Effective Radiated Power Reverb Chamber                                                          | MU4020        | 3.7 dB      |
| Effective Radiated Power                                                                         | MU4021        | 4.7 dB      |
| TRP Emissions 30 MHz to 1 GHz using CBL6111 or CBL6112 Bilog Antenna                             | MU4046        | 5.3 dB      |
| TRP Emissions 1 GHz to 18 GHz using HL050 Log Periodic Antenna                                   | MU4047        | 5.1 dB      |
| TRP Emissions 18 GHz to 26.5 GHz using Standard Gain Horn                                        | MU4048        | 2.7 dB      |
| TRP Emissions 26.5 GHz to 40 GHz using Standard Gain Horn                                        | MU4049        | 2.7 dB      |
|                                                                                                  |               |             |
| <b>Spurious Emissions Electric and Magnetic Field</b>                                            |               |             |
| Radiated Spurious Emissions 30 MHz to 1 GHz                                                      | MU4037        | 4.7 dB      |
| Radiated Spurious Emissions 1-18 GHz                                                             | MU4032        | 4.5 dB      |
| E Field Emissions 18GHz to 26 GHz                                                                | MU4024        | 3.2 dB      |
| E Field Emissions 26GHz to 40 GHz                                                                | MU4025        | 3.3 dB      |
| E Field Emissions 40GHz to 50 GHz                                                                | MU4026        | 3.5 dB      |
| E Field Emissions 50GHz to 75 GHz                                                                | MU4027        | 3.6 dB      |
| E Field Emissions 75GHz to 110 GHz                                                               | MU4028        | 3.6 dB      |
| Radiated Magnetic Field Emissions                                                                | MU4031        | 2.3 dB      |
|                                                                                                  |               |             |
| <b>Frequency Measurements</b>                                                                    |               |             |
| Frequency Deviation                                                                              | MU4022        | 0.316 kHz   |
| Frequency error using CMTA test set                                                              | MU4023        | 113.441 Hz  |
| Frequency error using GPS locked frequency source                                                | MU4045        | 0.0413 ppm  |
|                                                                                                  |               |             |
| <b>Bandwidth/Spectral Mask Measurements</b>                                                      |               |             |
| Channel Bandwidth                                                                                | MU4005        | 3.87 %      |
| Transmitter Mask Amplitude                                                                       | MU4039        | 1.3 dB      |
| Transmitter Mask Frequency                                                                       | MU4040        | 2.59 %      |
|                                                                                                  |               |             |
| <b>Time Domain Measurements</b>                                                                  |               |             |
| Transmission Time                                                                                | MU4038        | 4.40 %      |
|                                                                                                  |               |             |
| <b>Dynamic Frequency Selection (DFS) Parameters)</b>                                             |               |             |
| DFS Analyser - Measurement Time                                                                  | MU4006        | 679 $\mu$ s |
| DFS Generator - Frequency Error                                                                  | MU4007        | 92 Hz       |
| DFS Threshold Conducted                                                                          | MU4008        | 1.3 dB      |
| DFS Threshold Radiated                                                                           | MU4009        | 3.2 dB      |
|                                                                                                  |               |             |

| Test/Measurement                                         | Budget Number | MU            |
|----------------------------------------------------------|---------------|---------------|
| <b>Receiver Parameters</b>                               |               |               |
| EN300328 Receiver Blocking                               | MU4010        | <b>1.1 dB</b> |
| EN301893 Receiver Blocking                               | MU4011        | <b>1.1 dB</b> |
| EN303340 Adjacent Channel Selectivity                    | MU4012        | <b>1.1 dB</b> |
| EN303340 Overloading                                     | MU4013        | <b>1.1 dB</b> |
| EN303340 Receiver Blocking                               | MU4014        | <b>1.1 dB</b> |
| EN303340 Receiver Sensitivity                            | MU4015        | <b>0.9 dB</b> |
| EN303372-1 Image Rejection                               | MU4016        | <b>1.4 dB</b> |
| EN303372-1 Receiver Blocking                             | MU4017        | <b>1.1 dB</b> |
| EN303372-2 Adjacent Channel Selectivity                  | MU4018        | <b>1.1 dB</b> |
| EN303372-2 Dynamic Range                                 | MU4019        | <b>0.9 dB</b> |
| Receiver Blocking Talk Mode Conducted                    | MU4033        | <b>1.2 dB</b> |
| Receiver Blocking Talk Mode- radiated                    | MU4034        | <b>3.4 dB</b> |
| Rx Blocking, listen mode, blocking level                 | MU4035        | <b>3.2 dB</b> |
| Rx Blocking, listen mode, radiated Threshold Measurement | MU4036        | <b>3.4 dB</b> |
| Adjacent Sub Band Selectivity                            | MU4003        | <b>4.2 dB</b> |