



EMC Technologies (NZ) Ltd  
47 Mackelvie St, Newton  
Auckland 1021  
New Zealand  
Phone 09 360 0862  
E-Mail Address: [aucklab@emctech.co.nz](mailto:aucklab@emctech.co.nz)  
Web Site: [www.emctech.co.nz](http://www.emctech.co.nz)

## **TEST REPORT**

### **TPG-IS Model TPGHKB UHF Portable Transceiver with WiFi / Bluetooth Module**

*tested to the*

**Code of Federal Regulations (CFR) 47**

**Part 15 – Radio Frequency Devices,  
Subpart C – Intentional Radiators**

**Section 15.247 – Operation in the band 2400 – 2483.5 MHz**

*for*

**Tait International Ltd**

This Test Report is issued with the authority of:

A handwritten signature in black ink that reads "Andrew Cutler".

**Andrew Cutler - General Manager**



All tests reported herein  
have been performed in  
accordance with the  
laboratory's scope of  
accreditation

## Table of Contents

<b>1. STATEMENT OF COMPLIANCE</b>	<b>3</b>
<b>2. RESULTS SUMMARY</b>	<b>3</b>
<b>3. CLIENT INFORMATION</b>	<b>4</b>
<b>4. DESCRIPTION OF TEST SAMPLE</b>	<b>4</b>
<b>5. ATTESTATION</b>	<b>5</b>
<b>6. TEST RESULTS</b>	<b>6</b>
<b>7. TEST EQUIPMENT USED</b>	<b>28</b>
<b>8. ACCREDITATIONS</b>	<b>28</b>
<b>9. PHOTOGRAPHS</b>	<b>29</b>

**EMC**  
Technologies

Global Product Certification

## 1. STATEMENT OF COMPLIANCE

The **TPGIS Model TPGHKB UHF Portable Transceiver with WiFi / Bluetooth Module** complies with FCC Part 15 Section 15.247 as an Intentional Radiator when the methods as described in ANSI C63.10 - 2013 and those defined in FCC KDB558074 D01 V04 are applied based on FCC KDB 996369 D04 Module Integration Guide.

## 2. RESULTS SUMMARY

The results of testing carried out in August and October 2024 are detailed below.

Clause	Parameter	Result
15.103	Exempted devices.	Device is not exempt.
15.201	Equipment authorisation Requirement	FCC compliant modular transmitter utilised that is co-located in a Land Mobile Portable Transceiver.
15.203	Antenna requirement	Complies. Internal antenna utilised.
15.204	External PA and antenna modifications	Complies.
15.205	Restricted bands of operation	Complies.
15.207	Conducted limits	Not applicable. Internal battery powered device.
15.209	Radiated emission limits	See 15.247(d)
15.247		
(a)(2)	Minimum bandwidth	Not tested
(b)(3)	Peak output power	Complies.
(b)(4)	Antenna gain less than 6 dBi	Complies.
(c)	Operation with directional antenna	Not applicable
(d)	Out of band emissions	Complies
(e)	Power spectral density	Not tested
(f)	Hybrid systems	Not applicable
(g)	Use of all channels	Not applicable
(h)	Intelligent frequency hopping	Not applicable
(i)	Radio frequency hazards	Not tested SAR testing will be required.

### 3. CLIENT INFORMATION

<b>Company Name</b>	Tait International Limited
<b>Address</b>	245 Wooldridge Road Harewood
<b>City</b>	Christchurch 8051
<b>Country</b>	New Zealand
<b>Contact</b>	Rayna Zhang

### 4. DESCRIPTION OF TEST SAMPLE

<b>Brand Name</b>	TPG-IS
<b>Model Number</b>	TPGHKB
<b>Product Code</b>	T03-25007-EBAZ
<b>Product</b>	UHF Portable Transceiver with WiFi / Bluetooth module
<b>Manufacturer</b>	Tait International Ltd
<b>Country of Origin</b>	New Zealand
<b>Portable Serial Number</b>	26966391, 26966382
<b>Module Manufacturer</b>	Texas Instruments
<b>Module FCC ID</b>	WL18MODGB
<b>Portable FCC ID</b>	CASTPGHKB

The device that was tested is a portable transceiver that can operate in the 378 – 470 MHz UHF land mobile bands that has a WiFi / Bluetooth module that has been installed in accordance with the module manufacturer's installation instructions.

The module operates in the 2400.0 – 2483.5 MHz band with verification measurements being made to ensure continued compliance of the module and the portable transceiver.

It is not possible for the WiFi and Bluetooth to operate simultaneously.

Co-location measurements were carried out with either the WiFi or Bluetooth were operating when the Portable Transceiver was operating continuously on 424.000 MHz.

Testing was carried out when the WiFi / Bluetooth module was configured for a maximum power output of +18 dBm.

## 5. ATTESTATION

This report describes the tests and measurements performed for the purpose of determining compliance with the specification with the following conditions:

**The client selected the test sample.**

**The report relates only to the sample tested.**

**Any corrections or erasures in this report are detailed in the revision table below.**

Measurement uncertainties with statistical confidence intervals of 95% are shown below test results. Both Class A and Class B uncertainties have been accounted for, as well as influence uncertainties where appropriate.

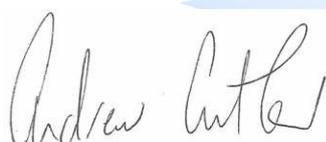
All compliance statements have been made with respect of the specification limit with no reference to the measurement uncertainty.

All testing was carried out as per the standard in the worst-case configuration with no deviations being applied.

In addition this equipment has been tested in accordance with the requirements contained in the appropriate Commission regulations.

To the best of my knowledge, these tests were performed using measurement procedures that are consistent with industry or Commission standards and demonstrate that the equipment complies with the appropriate standards.

I further certify that the necessary measurements were made by EMC Technologies NZ Ltd, 47 MacKelvie Street, Grey Lynn, Auckland, New Zealand.



Andrew Cutler  
General Manager  
EMC Technologies NZ Ltd

### Report Revision Table

Version	Change Made	Date
240801.1	Final version	22 Oct 2024

## 6. TEST RESULTS

### Standard

The sample was tested in accordance with 47 CFR Part 15 Subpart C Section 15.247.

### Methods and Procedures

The following measurement methods and procedures have been applied:

ANSI C63.10 – 2013

ANSI C63.10 – 2020

FCC KDB558074 D01 V004

### Section 15.201: Equipment authorisation requirement

Certification of the WiFi / Bluetooth module, as detailed in Subpart J of Part 2, is not required for this device as it is a FCC certified module transmitter with FCC ID: WL18MODGB that has been installed in accordance with the module manufacturer's installation instructions.

### Section 15.203: Antenna requirement

The WiFi / Bluetooth module has an internal antenna.

**Result:** Complies.

### Section 15.204: External radio frequency power amplifiers and antenna modifications

An external power amplifier is NOT provided for use with this transmitter.

Suitable warnings will be placed in the user manual regarding the modification of the device.

**Result:** Complies.

**Section 15.205: Restricted bands of operation**

The module operating in this device transmit on various frequencies in the 2.4 GHz band.

Section 15.247 allows this between 2400.0 – 2483.5 MHz

**Result:** Complies.

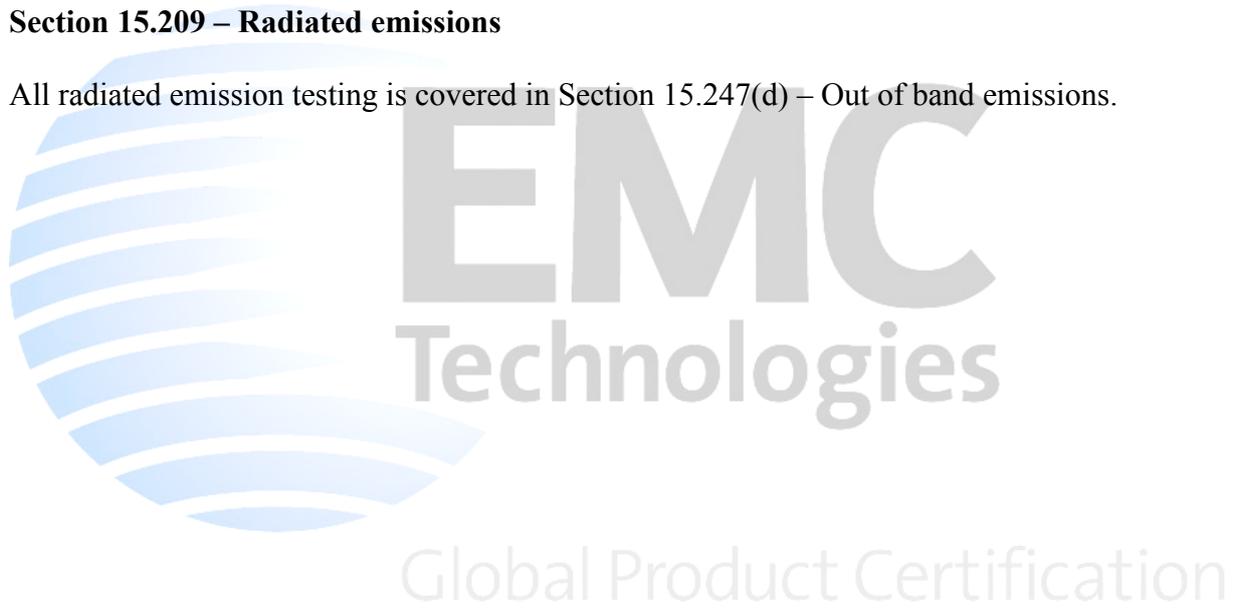
**Section 15.107: Conducted limits**

Device is battery powered and it is not possible to directly or indirectly power it from the public AC mains supply.

**Result:** Not applicable.

**Section 15.209 – Radiated emissions**

All radiated emission testing is covered in Section 15.247(d) – Out of band emissions.



### Section 15.247 (b) (3) – Peak Power Output

Testing for peak power output was carried out using a test sample that was supplied with an antenna output port that was connected to the WiFi / Bluetooth module using test software supplied by the client.

The transmitter power was set with the software supplied.

Bluetooth testing was carried out as configured at maximum power.

No changes were made to the supplied software except for defining the transmission frequency, modulation type (DSSS, CCK, OFDM or MCS), bandwidth of operation (20 MHz or 40 MHz) and ensuring that the power output was set to +18.0 dBm.

Testing was carried out using a spectrum analyser that was attached to the device using a power attenuator and short length of sucoflex cable.

All measurements were made using peak detector with a 1 MHz that was operating in peak hold mode.

#### Bluetooth:

Bluetooth mode testing was carried out when operating in Constant Transmit Mode on 2402, 2440 and 2480 MHz with the following results recorded

Frequency (MHz)	Level (dBm)	Limit (dBm)
2402.000	+10.6	+30.0
2440.000	+9.7	+30.0
2480.000	+9.1	+30.0

A conducted power limit of 1 watt (+30 dBm) has been applied

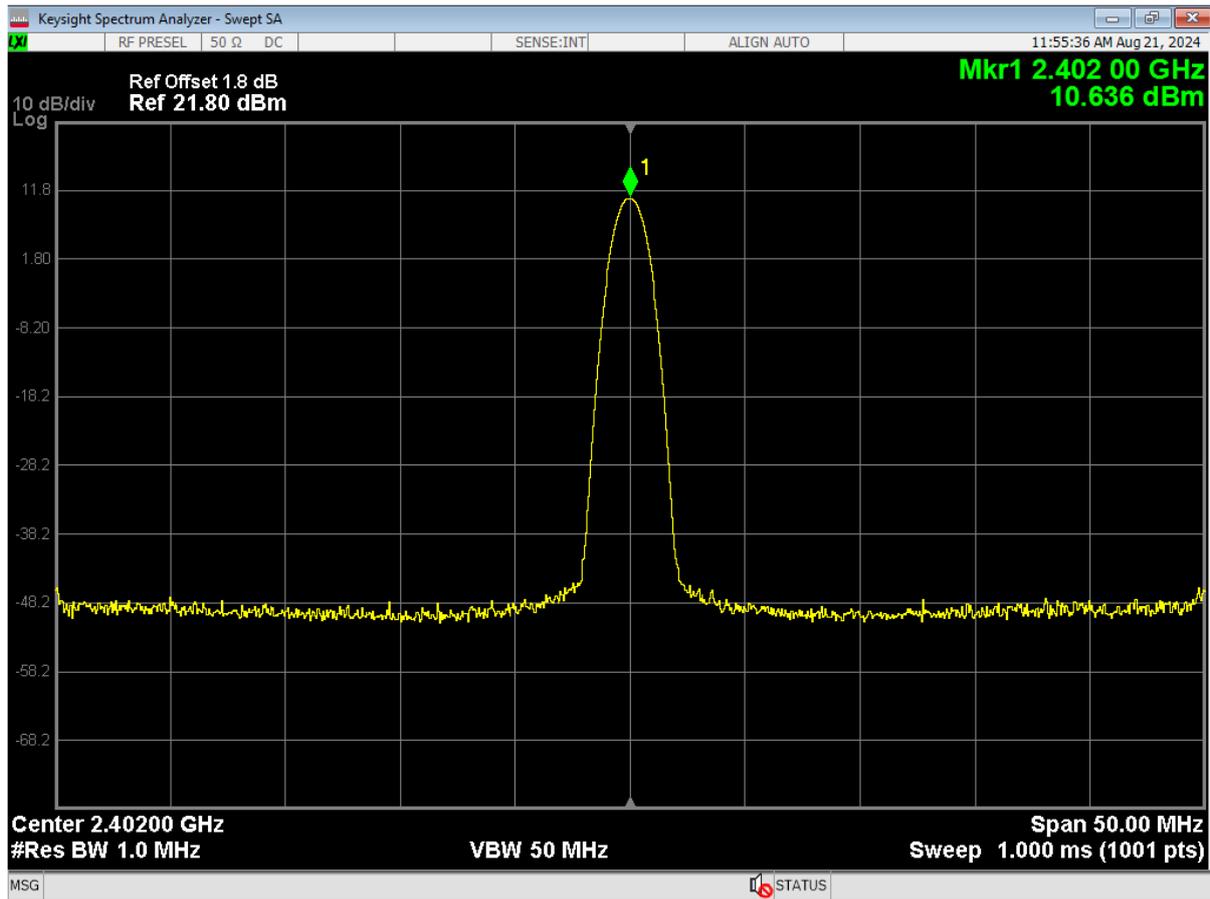
**Result:** Complies

Measurement uncertainty with a confidence interval of 95% is:

- Conducted power (30 – 25000 MHz)  $\pm$  2.1 dB

### Section 15.247 (b) (3) – Peak Power Output (continued)

## Bluetooth operating on 2402 MHz



Technologies

Global Product Certification

**Section 15.247 (b) (3) – Peak Power Output (continued)**

**WiFi (20 MHz):**

The module was tested when it was configured in 20 MHz channel bandwidth mode.

The spectrum analyser was configured to measure the band power.

Based upon previous testing of this identical the following modulation types were tested when operating on 2412 MHz.

20 MHz bandwidth on 2412 MHz

Modulation Type	Level (dBm)	Limit (dBm)
2 MHz DSSS	+16.2	+30.0
11CCK	+18.2	+30.0
18OFDM	+20.7	+30.0
MCS3	+20.9	+30.0

**Plot of the worst case power level measured**

**2412 MHz, 20 MHz, MCS3**



## Section 15.247 (b )(3) – Peak Power Output (continued)

### WiFi (40 MHz):

The module was also tested when configured in 40 MHz channel bandwidth mode.

The spectrum analyser was configured to measure the band power.

40 MHz bandwidth on 2422 MHz

Modulation Type	Level (dBm)	Limit (dBm)
2 MHz DSSS	+13.3	+30.0
11CCK	+15.3	+30.0
18OFDM	+18.2	+30.0
MCS3	+20.3	+30.0

### Plot of the highest power level observed

2422 MHz, 40 MHz, MCS3



**Result:** Complies.

Measurement uncertainty with a confidence interval of 95% is:

- Conducted power (30 – 25000 MHz)  $\pm$  2.1 dB

## Section 15.247 (b) (4) – Antenna gain not exceeding 6 dBi (WiFi)

Radiated power measurements were made at the test site to ensure that the internal antenna fitted to the WiFi module does not exceed 6 dBi.

Radiated measurements were made using the modulation type which gave the highest conducted power measurements in the laboratory.

Based upon previous test result measurements were made in the X, Y and Z planes, as the device is portable, using the worst case polarisation, as the device is portable, with the worst case plane for each polarisation being used for all subsequent measurements.

### 20 MHz Channel Bandwidth – MCS3

Device (Axis)	Frequency (MHz)	Level (dBm)	Antenna (dBi)	Coax (dB)	Path Loss (dB)	EIRP (dBm)	Antenna	Limit (dBm)
X	2412.0	-35.1	9.0	14.3	49.6	19.8	Horizontal	30.0
-	-	-	-	-	-	-	-	-
Y	2412.0	-32.1	9.0	14.3	49.6	22.8	Horizontal	30.0
-	-	-	-	-	-	-	-	-
Z	2412.0	-35.1	9.0	14.3	49.6	19.8	Vertical	30.0

### 40 MHz Channel Bandwidth – MCS3

Device Axis	Frequency MHz	Level dBm	Antenna dBi	Coax dB	Path Loss dB	EIRP dBm	Antenna	Limit dBm
Z	2422.0	-34.9	9.0	14.3	49.7	20.1	Vertical	30.0
-	-	-	-	-	-	-	-	-
Y	2422.0	-32.1	9.0	14.3	49.7	22.9	Vertical	30.0

The transmitter EIRP (dBm) was calculated using the following

Channel power on spectrum analyser (dBm) – Receive Antenna gain (dBi) + Coax loss between the receive antenna and the spectrum analyser (dB) – Path loss between the transmitter and the receive antenna over a distance of 3 metres (dB)

These factors were determined as follows:

Antenna gain dBi: Antenna calibration certificate  
Coax loss dB: Laboratory bench measurements  
Path loss dB: Formula =  $32.45 + 20 * \log(f \text{ MHz}) + 20 * \log(d \text{ km})$

The antenna gain can therefore be determined to be:

Channel BW	Modulation	Frequency (MHz)	Conducted (dBm)	Radiated (dBm)	Gain/Loss (dB)
20 MHz	MCS3	2412	20.9	22.8	+1.9
40 MHz	MCS3	2412	20.3	22.9	+2.6

It can be seen that the antenna gain is less than +6 dBi.

**Result:** Complies.

### Section 15.247 (b) (4) – Antenna gain not exceeding 6 dBi (Bluetooth)

Radiated power measurements were made at the test site to ensure that the internal antenna fitted to the Bluetooth module does not exceed 6 dBi.

Measurements were made using a measurements receiver with a peak detector with a 1 MHz bandwidth using a measurement distance of 3 metres.

Device Axis	Frequency MHz	Level dBuV/m	EIRP dBm	Limit dBm	Antenna	Margin dB
Z	2402.000	101.1	5.9	30.0	Vertical	24.1
X	2402.000	101.3	6.1	30.0	Horizontal	23.9
-	-	-	-	-	-	-
X	2440.000	101.1	5.9	30.0	Horizontal	24.1
-	-	-	-	-	-	-
X	2480.000	99.4	4.2	30.0	Horizontal	25.8

The EIRP level was calculated using the formula:

Field strength (V/m) = (square root (30 \* power (watts))) / distance (metres)

The antenna gain can therefore be determined to be:

Channel BW	Modulation	Frequency (MHz)	Conducted (dBm)	Radiated (dBm)	Gain / Loss (dB)
1 MHz	Bluetooth	2402	10.8	6.1	-4.7
-	-	2440	10.4	5.9	-4.5
-	-	2480	10.4	4.2	-6.2

The antenna gain is less than +6 dBi

Analysis of the results shows that the antenna loss would be in the range of approximately -4.5 dBi to -6.2 dBi across the frequency range of 2402 – 2480 MHz when operating in Bluetooth mode.

**Result:** Complies.

Measurement uncertainty with a confidence interval of 95% is:

- Free radiation tests (30 – 25000 MHz) ± 4.1 dB

### Section 15.247(d) – Out of band emissions – Band edges (Conducted)

The WiFi and Bluetooth emissions from this module are required to remain within the 2400.0 – 2483.5 MHz band.

When conducted measurements are made at the band edges of 2400.0 MHz and 2483.5 MHz using a peak detector with a 100 kHz resolution bandwidth the emission levels are required to be attenuated by at least 20 dB compared to highest emission level observed in the band of operation.

The device was operated in Bluetooth mode at 2402 MHz and 2480 MHz

The device was also operated in WiFi mode using a channel bandwidth of 20 MHz centred on 2412 MHz and 2472 MHz.

In addition the device was operated in WiFi mode using a channel bandwidth of 40 MHz that was centred on 2422 MHz and 2452 MHz.

In WiFi mode testing was carried out using 2M DSSS, 11CCK, 18OFDM and MCS3 modulation types for both 20 MHz and 40 MHz channel bandwidths.

The following measurements were recorded:

Bluetooth on 2402 MHz and 2480 MHz

Modulation Type	F Low (MHz)	F High (MHz)
Bluetooth	2401.850	2480.150

20 MHz on 2412 MHz and 2472 MHz

Modulation Type	F Low (MHz)	F High (MHz)
2 MHz DSSS	2403.400	2480.500
11CCK	2403.800	2480.500
18OFDM	2403.100	2481.900
MCS3	2402.600	2481.600

40 MHz on 2422 MHz and 2462 MHz

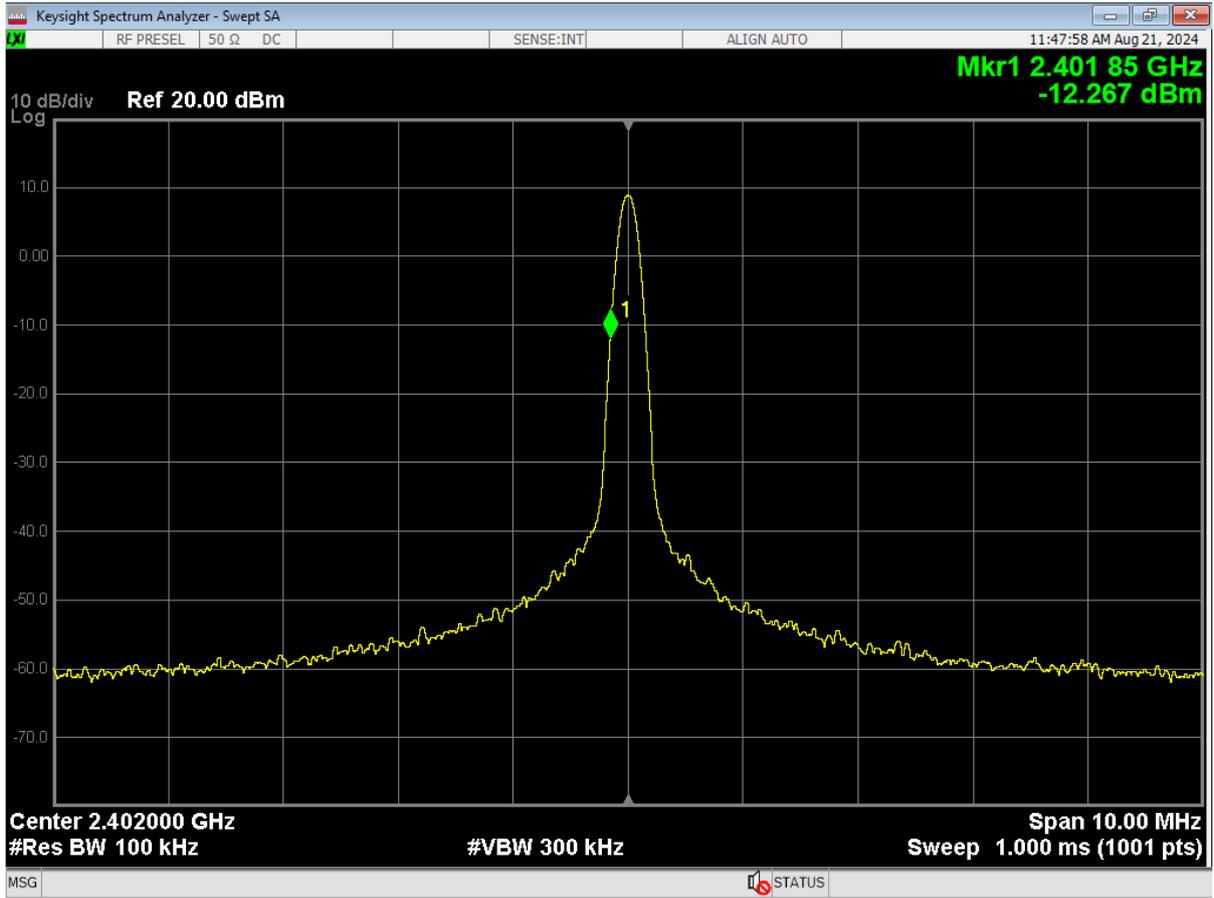
Modulation Type	F Low (MHz)	F High (MHz)
2 MHz DSSS	2403.800	2480.400
11CCK	2403.900	2480.400
18OFDM	2403.400	2480.600
MCS3	2403.400	2480.800

**Result:** Complies.

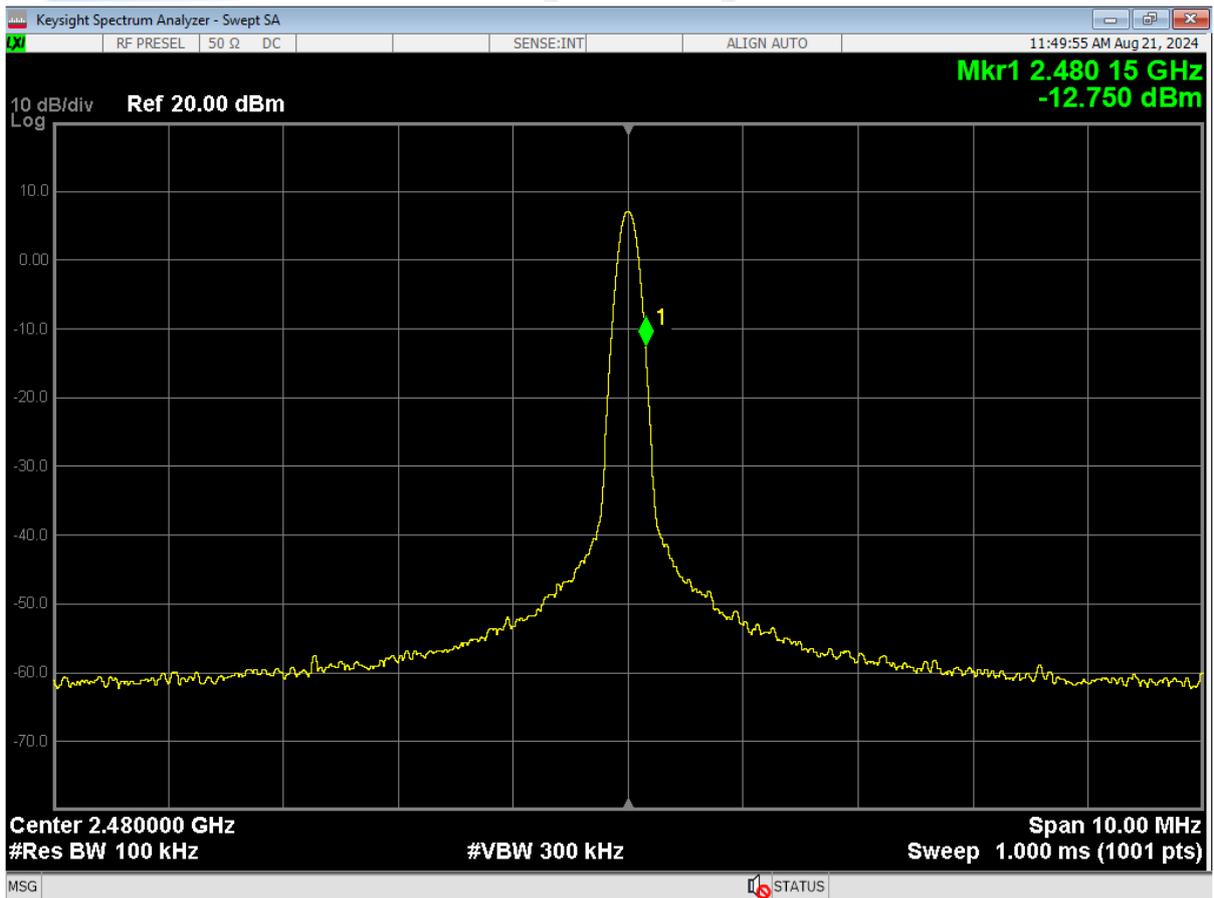
Measurement uncertainty with a confidence interval of 95% is:

- Conducted power (30 – 25000 MHz)  $\pm$  2.1 dB

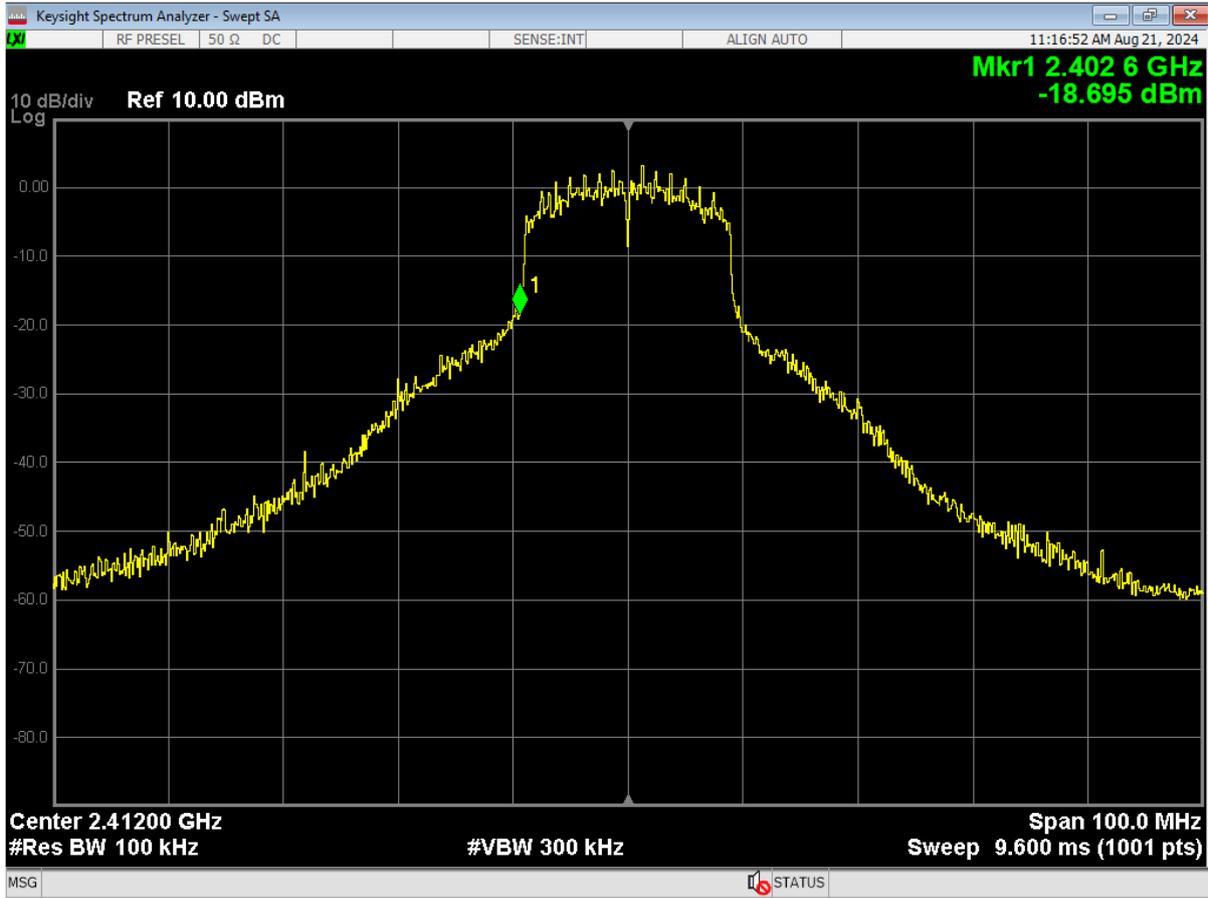
# Bluetooth: 2402 MHz



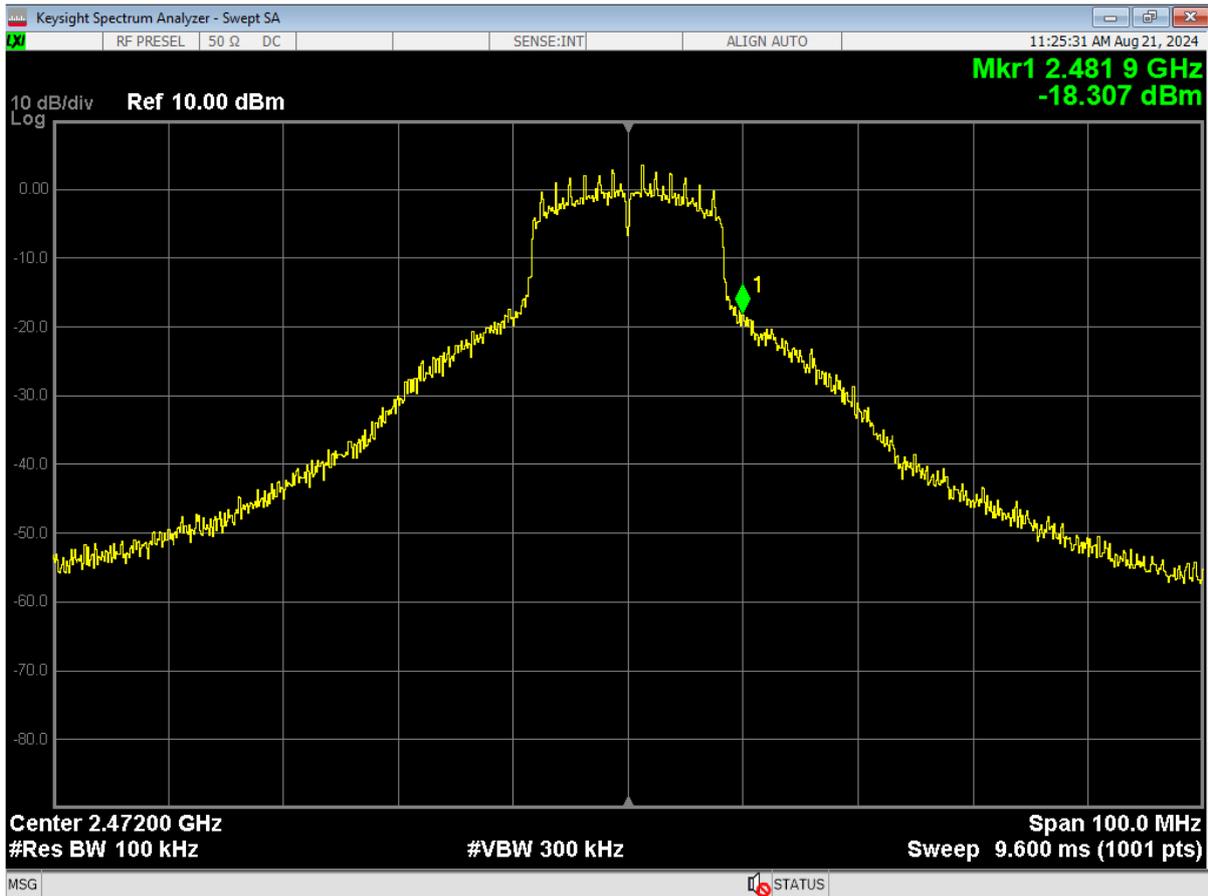
# Bluetooth: 2480 MHz



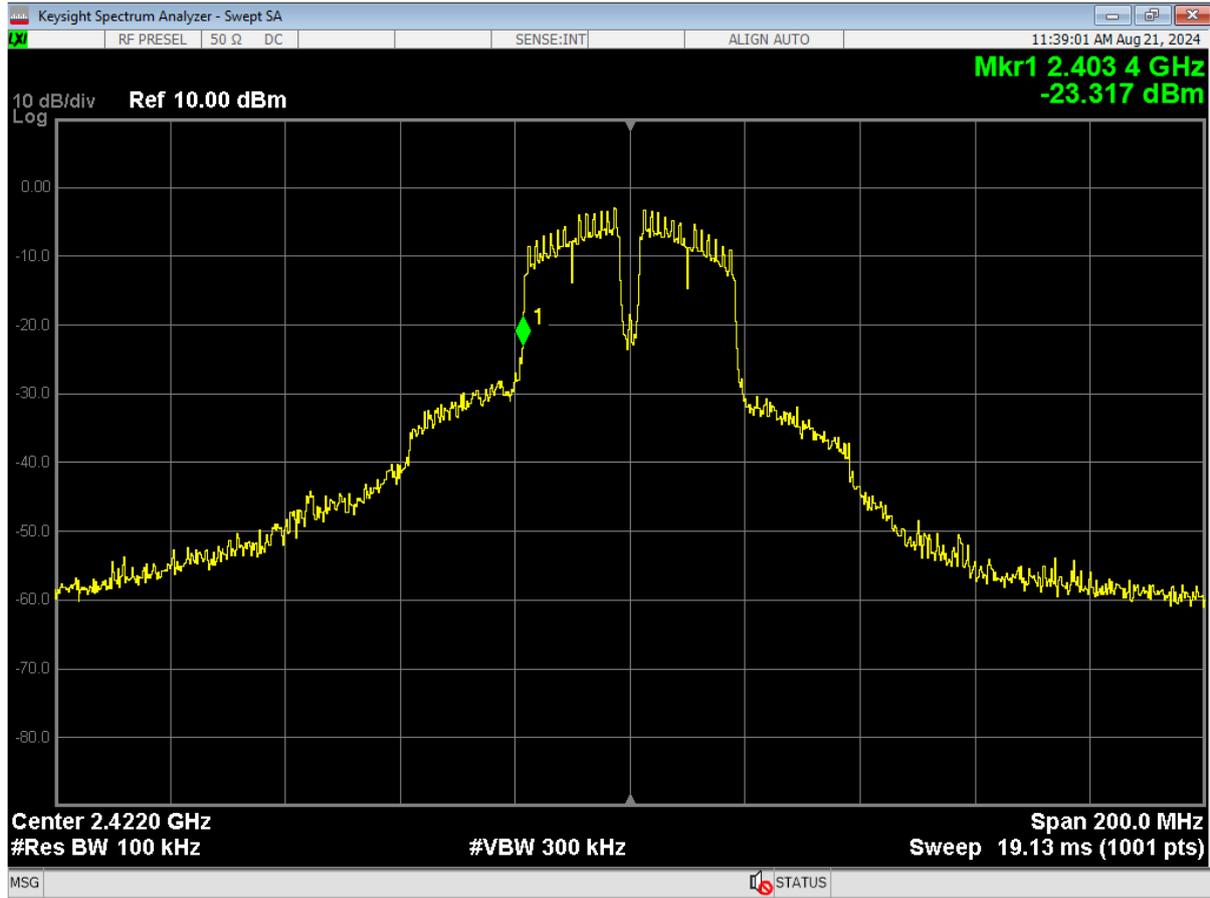
# WiFi 20 MHz – MCS3– 2412 MHz



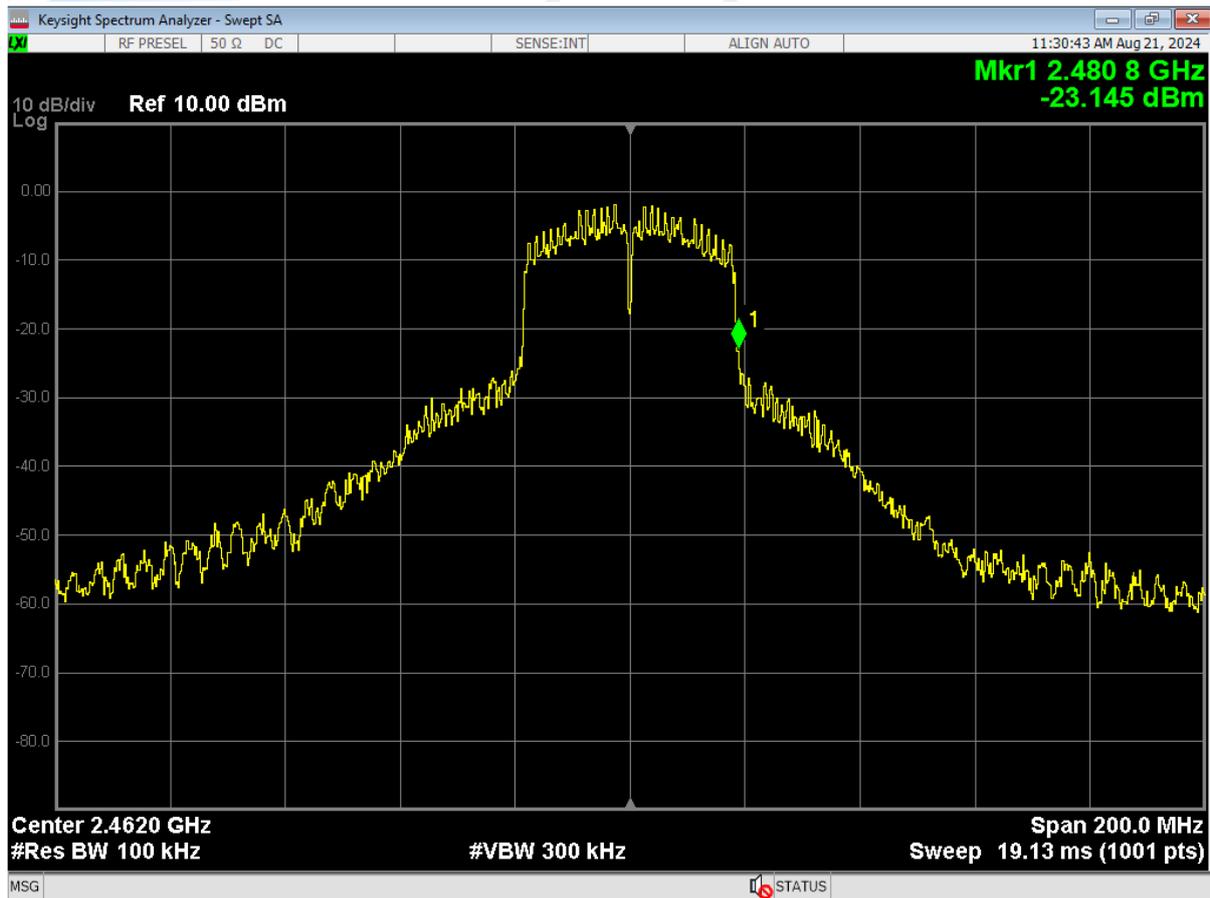
# WiFi 20 MHz – 18OFDM - 2472 MHz



# WiFi 40 MHz – 18OFDM + MCS3 – 2422 MHz



# WiFi 40 MHz – MCS3 – 2462 MHz



## Section 15.247(d) – Out of band emissions – Band edges (Radiated)

The WiFi and Bluetooth emissions from this module are required to remain within the 2400.0 – 2483.5 MHz band.

When radiated measurements are made at the band edges of 2400.0 MHz and 2483.5 MHz using a peak detector with a 100 kHz resolution bandwidth the emission levels are required to be attenuated by at least 20 dB compared to highest emission level observed in the band of operation.

The device was operated in Bluetooth mode at 2402 MHz and 2480 MHz

The device was also operated in WiFi mode using a channel bandwidth of 20 MHz and 40 MHz using MCS3 modulation.

At the 2483.5 MHz band edge the device is required to meet the general emission limits as defined in FCC part 15 section 15.209 due a restricted band extending from 2483.5 – 2500.0 MHz.

At the 2400.0 MHz band edge the general emission limits as defined in FCC part 15 section 15.209 need to be applied due a restricted band extending from 2310.0 – 2390.0 MHz.

The results below will show that the frequency of operation will need to be modified due to restricted band non compliance

Using a measuring receiver with a peak detector and an average detector with a 1 MHz resolution bandwidth the following measurements were recorded at the test site.

### Bluetooth

#### 2402 MHz

Frequency (MHz)	Vertical (dBuV/m)	Horizontal (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Result	Antenna	Detector
2390.000	48.5	48.5	74.0	25.5	Pass	Vertical	Peak
2390.000	35.5	35.5	54.0	18.0	Pass	Vertical	Average

#### 2480 MHz

Frequency (MHz)	Vertical (dBuV/m)	Horizontal (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Result	Antenna	Detector
2483.5	49.9	49.9	74.0	24.1	Pass	Vertical	Peak
2483.5	37.8	37.8	54.0	12.2	Pass	Vertical	Average

No Bluetooth emissions detected. Noise floor has been recorded.

Radiated -20 dBc 100 kHz band edge measurements were also made between 2390 – 2400 MHz with no Bluetooth emissions being observed.

## 20 MHz Channel bandwidth – MCS3

The device will be configured to operate using 20 MHz channels with centre frequencies of 2412 MHz – 2462 MHz.

2412 MHz

Frequency (MHz)	Vertical (dBuV/m)	Horizontal (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Result	Antenna	Detector
2390.000	66.3	67.1	74.0	6.9	Pass	Horizontal	Peak
2390.000	43.2	43.3	54.0	10.7	Pass	Horizontal	Average

2462 MHz

Frequency (MHz)	Vertical (dBmV/m)	Horizontal (dBmV/m)	Limit (dBmV/m)	Margin (dB)	Result	Antenna	Detector
2483.500	68.8	68.2	74.0	5.2	Pass	Vertical	Peak
2483.500	43.5	43.1	54.0	10.5	Pass	Vertical	Average
2484.300	68.1	-	74.0	5.9	Pass	Vertical	Peak
2484.300	43.0	-	54.0	11.0	Pass	Vertical	Average

## 40 MHz Channel bandwidth – MCS3

The device will be configured to operate using 40 MHz channels with centre frequencies of 2422 MHz – 2462 MHz

2422 MHz

Frequency (MHz)	Vertical (dBuV/m)	Horizontal (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Result	Antenna	Detector
2390.000	71.1	68.3	74.0	2.9	Pass	Vertical	Peak
2390.000	46.9	45.9	54.0	7.1	Pass	Vertical	Average
2386.400	71.5	69.2	74.0	2.5	Pass	Vertical	Peak
2386.400	46.5	45.2	54.0	7.5	Pass	Vertical	Average

2462 MHz

Frequency (MHz)	Vertical (dBmV/m)	Horizontal (dBmV/m)	Limit (dBmV/m)	Margin (dB)	Result	Antenna	Detector
2483.500	72.8	72.5	74.0	1.2	Pass	Vertical	Peak
2483.500	47.1	47.1	54.0	6.9	Pass	Vertical	Average
2485.900	72.4	72.4	74.0	1.6	Pass	Vertical	Peak
2485.900	46.1	46.1	54.0	7.9	Pass	Vertical	Average

**Result:** Complies.

Measurement uncertainty with a confidence interval of 95% is:

- Free radiation tests (30 – 25000 MHz) ± 4.1 dB

## Section 15.247(d) – Out of band emissions – Conducted Spurious Emissions

As the sample was supplied with an antenna port conducted spurious emissions measurements were made at this port using a spectrum analyser over the range of 100 kHz up to 25 GHz.

A peak detector with a 100 kHz resolution bandwidth was used to make these measurements

All levels are required to be attenuated by at least 20 dB compared to highest emission levels observed in the band of operation.

The device was operated in Bluetooth mode at 2402 MHz.

The device was also operated in WiFi mode using MCS3 modulation with a channel bandwidth of 20 MHz and 40 MHz on 2412 MHz

Full testing was not carried out based upon previous testing carried out on an identical module that was installed in a different Portable.

The following measurements were recorded:

### Bluetooth: 2402 MHz

Frequency (MHz)	Level (dBm)	Limit (dBm)
2402.0	+9.9	-
4804.0	-45.8	-10.1
7206.0	-64.0	-10.1
9608.0	-63.6	-10.1
12010.0	less than -70	-10.1
14412.0	-56.8	-10.1
16814.0	less than -70	-10.1
19216.0	less than -70	-10.1
21618.0	less than -70	-10.1
24020.0	less than -70	-10.1
Other emissions		
800.670	-58.8	-10.9
1601.340	-56.4	-10.9
3202.670	-54.9	-10.9
4003.340	-55.2	-10.9
5604.680	-73.1	-10.9
13611.370	-66.4	-10.9

All other emissions observed were observed to less than -60 dBm and were not recorded.

Harmonic emissions less than -60 dBm have been recorded for completeness.

**Section 15.247(d) – Out of band emissions – Conducted Spurious Emissions (continued)**

**WiFi 20 MHz 18OFDM: 2422 MHz**

Frequency (MHz)	Level (dBm)	Limit (dBm)
2412.0	+5.1	-
4824.0	less than -60	-14.9
7236.0	less than -60	-14.9
9648.0	less than -60	-14.9
12060.0	less than -60	-14.9
14472.0	less than -60	-14.9
16884.0	less than -60	-14.9
19296.0	less than -60	-14.9
21708.0	less than -60	-14.9
24120.0	less than -60	-14.9

**WiFi 40 MHz 18OFDM: 2412 MHz**

Frequency (MHz)	Level (dBm)	Limit (dBm)
2412.0	-2.1	-
4824.0	less than -60	-22.1
7236.0	less than -60	-22.1
9648.0	less than -60	-22.1
12060.0	less than -60	-22.1
14472.0	less than -60	-22.1
16884.0	less than -60	-22.1
19296.0	less than -60	-22.1
21708.0	less than -60	-22.1
24120.0	less than -60	-22.1

All other emissions observed were observed to less than -60 dBm and were not recorded.

**Result:** Complies.

Measurement uncertainty with a confidence interval of 95% is:

- Conducted power (30 – 25000 MHz)  $\pm$  2.1 dB

## **Section 15.247(d) – Out of band emissions - Radiated Emissions above 30 MHz**

Testing for radiated emissions was carried out over the frequency range of 30 MHz to 25 GHz as the WiFi / Bluetooth module operates at various frequencies between 2400.0 – 2483.5 MHz

Testing was carried out at the laboratory's open area test site - located at Driving Creek, Orere Point, Auckland, New Zealand.

An enclosure containing absorber material, Panashield HYB-NF-12, has been placed between the turntable and the measurement antenna for when measurements are made above 1 GHz.

This material has no absorbing affect below 1 GHz with site verification measurements.

Below 1000 MHz the transmitter was placed on the test table top which was a total of 0.8 m above the test site ground plane.

Above 1000 MHz the transmitter was placed on the test table top which was a total of 1.5 m above the test site ground plane.

Measurements of the radiated field were made 3 metres from the transmitting antenna.

When an emission is located, it is positively identified and its maximum level is found by rotating the automated turntable, and by varying the antenna height with an automated antenna tower.

All emissions were measured in both vertical and horizontal antenna polarisations with no measurements made above the 10<sup>th</sup> harmonic.

Testing was carried out with the device being placed in the centre of the test table standing vertically upright.

The module was installed into a UHF portable transceiver that was powered using an internal battery pack that was fully charged.

Testing was carried out when the RF module was programed using supplied software in various modes of operation.

Below 1000 MHz a Quasi Peak detector with a 120 kHz bandwidth was used.

Above 1000 MHz the restricted band emission measurements were made using an Average detector and a Peak detector with a bandwidth of 1.0 MHz.

In the non-restricted bands measurements were made using a peak detector with a 100 kHz bandwidth.

The general limits that are defined in Section 15.209(a) were applied to the restricted bands frequencies that are defined Section 15.205(a).

## Radiated Emissions above 30 MHz cont.

All other frequencies not listed in Section 15.205(a) are defined as non-restricted frequencies where a limit of -20 dBc relative to field strength of the highest level in the band operation when measured using a Peak detector with a 100 kHz bandwidth as defined in Section 15.247(d).

The emission level was determined in field strength by taking the following into consideration:

Level (dB $\mu$ V/m) = Receiver Reading (dB $\mu$ V) + Antenna Factor (dB/m) + Coax Loss (dB)

For example, if an emission of 30 dB $\mu$ V was observed at 30 MHz.

$$45.5 \text{ dB}\mu\text{V/m} = 30.0 \text{ dB}\mu\text{V} + 14 \text{ dB/m} + 1.5 \text{ dB}$$

### Results:

#### General Emissions: 30 MHz – 2700 MHz

Testing was carried out when the device was transmitting in

- WiFi mode at 2412 MHz when operating with a 20 MHz channel bandwidth with MCS3 modulation

Frequency (MHz)	Vertical (dB $\mu$ V/m)	Horizontal (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Antenna Polarisation	Detector	BW
55.320	14.8	-	40.0	25.2	Pass	Vertical	QP
344.000	24.7	-	46.0	21.3	Pass	Vertical	QP

and

- Bluetooth mode at 2402 MHz

Frequency (MHz)	Vertical (dB $\mu$ V/m)	Horizontal (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Antenna Polarisation	Detector	BW
55.280	15.1	-	40.0	24.9	Pass	Vertical	QP
344.000	24.1	-	46.0	21.9	Pass	Vertical	QP

No further emissions were detected from the device when measurements were made between 30 – 2700 MHz when vertical and horizontal antenna polarisations were used except for the fundamental emissions which were observed at 2412 MHz and 2402 MHz depending upon the mode of operation

**Result:** Complies.

Measurement uncertainty with a confidence interval of 95% is:

- Free radiation tests (30 – 2700 MHz)  $\pm$  4.1 dB

## Harmonic Spurious Emissions

Testing was carried out when the WiFi module was operating on 2412 MHz with a 20 MHz channel bandwidth with MCS3 modulation applied.

### Transmitting on 2412 MHz

Frequency (MHz)	Vertical (dBuV/m)	Horizontal (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Antenna	BW
4824.000	< 59	< 59	74.0	> 15	Peak	Vert/Horiz	1 MHz
4824.000	< 46	< 46	54.0	> 8	Average	Vert/Horiz	1 MHz
-	-	-	-	-	-	-	-
7236.000	< 59	< 59	74.0	> 15	Peak	Vert/Horiz	1 MHz
7236.000	< 46	< 46	54.0	> 8	Average	Vert/Horiz	1 MHz
-	-	-	-	-	-	-	-
9648.000	< 59	< 59	74.0	> 15	Peak	Vert/Horiz	1 MHz
9648.000	< 46	< 46	54.0	> 8	Average	Vert/Horiz	1 MHz
-	-	-	-	-	-	-	-
12060.000	< 59	< 59	74.0	> 15	Peak	Vert/Horiz	1 MHz
12060.000	< 46	< 46	54.0	> 8	Average	Vert/Horiz	1 MHz
-	-	-	-	-	-	-	-
14472.000	< 59	< 59	74.0	> 15	Peak	Vert/Horiz	1 MHz
14472.000	< 46	< 46	54.0	> 8	Average	Vert/Horiz	1 MHz
-	-	-	-	-	-	-	-
16884.000	< 59	< 59	74.0	> 15	Peak	Vert/Horiz	1 MHz
16884.000	< 46	< 46	54.0	> 8	Average	Vert/Horiz	1 MHz
-	-	-	-	-	-	-	-
19296.000	< 59	< 59	74.0	> 15	Peak	Vert/Horiz	1 MHz
19296.000	< 46	< 46	54.0	> 8	Average	Vert/Horiz	1 MHz
-	-	-	-	-	-	-	-
21708.000	< 59	< 59	74.0	> 15	Peak	Vert/Horiz	1 MHz
21708.000	< 46	< 46	54.0	> 8	Average	Vert/Horiz	1 MHz
-	-	-	-	-	-	-	-
24120.000	< 59	< 59	74.0	> 15	Peak	Vert/Horiz	1 MHz
24120.000	< 46	< 46	54.0	> 8	Average	Vert/Horiz	1 MHz

The general limits were applied to all frequencies.

No further emissions were detected from the device when measurements were made between 30 – 25000 MHz when vertical and horizontal antenna polarisations were used.

**Result:** Complies.

Measurement uncertainty with a confidence interval of 95% is:

- Free radiation tests (30 – 25000 MHz) ± 4.1 dB

## Harmonic Spurious Emissions

Testing was carried out when the WiFi module was operating on 2422 MHz with a 40 MHz channel bandwidth with MCS3 modulation applied.

### Transmitting on 2422 MHz

Frequency (MHz)	Vertical (dBuV/m)	Horizontal (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Antenna	BW
4844.000	< 59	< 59	74.0	> 15	Peak	Vert/Horiz	1 MHz
4844.000	< 46	< 46	54.0	> 8	Average	Vert/Horiz	1 MHz
	-	-	-	-	-	-	-
7266.000	< 59	< 59	74.0	> 15	Peak	Vert/Horiz	1 MHz
7266.000	< 46	< 46	54.0	> 8	Average	Vert/Horiz	1 MHz
	-	-	-	-	-	-	-
9688.000	< 59	< 59	74.0	> 15	Peak	Vert/Horiz	1 MHz
9688.000	< 46	< 46	54.0	> 8	Average	Vert/Horiz	1 MHz
	-	-	-	-	-	-	-
12110.000	< 59	< 59	74.0	> 15	Peak	Vert/Horiz	1 MHz
12110.000	< 46	< 46	54.0	> 8	Average	Vert/Horiz	1 MHz
	-	-	-	-	-	-	-
14532.000	< 59	< 59	74.0	> 15	Peak	Vert/Horiz	1 MHz
14532.000	< 46	< 46	54.0	> 8	Average	Vert/Horiz	1 MHz
	-	-	-	-	-	-	-
16954.000	< 59	< 59	74.0	> 15	Peak	Vert/Horiz	1 MHz
16954.000	< 46	< 46	54.0	> 8	Average	Vert/Horiz	1 MHz
	-	-	-	-	-	-	-
19376.000	< 59	< 59	74.0	> 15	Peak	Vert/Horiz	1 MHz
19376.000	< 46	< 46	54.0	> 8	Average	Vert/Horiz	1 MHz
	-	-	-	-	-	-	-
21798.000	< 59	< 59	74.0	> 15	Peak	Vert/Horiz	1 MHz
21798.000	< 46	< 46	54.0	> 8	Average	Vert/Horiz	1 MHz
	-	-	-	-	-	-	-
24220.000	< 59	< 59	74.0	> 15	Peak	Vert/Horiz	1 MHz
24220.000	< 46	< 46	54.0	> 8	Average	Vert/Horiz	1 MHz

The general limits were applied to all frequencies.

No further emissions were detected from the device when measurements were made between 30 – 25000 MHz when vertical and horizontal antenna polarisations were used.

**Result:** Complies.

Measurement uncertainty with a confidence interval of 95% is:

- Free radiation tests (30 – 25000 MHz) ± 4.1 dB

## Harmonic Spurious Emissions

Testing was carried out when the Bluetooth module was operating on 2402 MHz.

### Transmitting on 2402 MHz

Frequency (MHz)	Vertical (dBuV/m)	Horizontal (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Antenna	BW
4804.000	< 59	< 59	74.0	> 15	Peak	Vert/Horiz	1 MHz
4804.000	< 46	< 46	54.0	> 8	Average	Vert/Horiz	1 MHz
-	-	-	-	-	-	-	-
7206.000	< 59	< 59	74.0	> 15	Peak	Vert/Horiz	1 MHz
7206.000	< 46	< 46	54.0	> 8	Average	Vert/Horiz	1 MHz
-	-	-	-	-	-	-	-
9608.000	< 59	< 59	74.0	> 15	Peak	Vert/Horiz	1 MHz
9608.000	< 46	< 46	54.0	> 8	Average	Vert/Horiz	1 MHz
-	-	-	-	-	-	-	-
12010.000	< 59	< 59	74.0	> 15	Peak	Vert/Horiz	1 MHz
12010.000	< 46	< 46	54.0	> 8	Average	Vert/Horiz	1 MHz
-	-	-	-	-	-	-	-
14412.000	< 59	< 59	74.0	> 15	Peak	Vert/Horiz	1 MHz
14412.000	< 46	< 46	54.0	> 8	Average	Vert/Horiz	1 MHz
-	-	-	-	-	-	-	-
16814.000	< 59	< 59	74.0	> 15	Peak	Vert/Horiz	1 MHz
16814.000	< 46	< 46	54.0	> 8	Average	Vert/Horiz	1 MHz
-	-	-	-	-	-	-	-
19216.000	< 59	< 59	74.0	> 15	Peak	Vert/Horiz	1 MHz
19216.000	< 46	< 46	54.0	> 8	Average	Vert/Horiz	1 MHz
-	-	-	-	-	-	-	-
21618.000	< 59	< 59	74.0	> 15	Peak	Vert/Horiz	1 MHz
21618.000	< 46	< 46	54.0	> 8	Average	Vert/Horiz	1 MHz
-	-	-	-	-	-	-	-
24020.000	< 59	< 59	74.0	> 15	Peak	Vert/Horiz	1 MHz
24020.000	< 46	< 46	54.0	> 8	Average	Vert/Horiz	1 MHz

The general limits were applied to all frequencies.

No further emissions were detected from the device when measurements were made between 30 – 25000 MHz when vertical and horizontal antenna polarisations were used.

**Result:** Complies.

Measurement uncertainty with a confidence interval of 95% is:

- Free radiation tests (30 – 25000 MHz) ± 4.1 dB

## Co-Location Measurements

It is not possible for the Bluetooth transmitter and the WiFi transmitter to operate simultaneously.

It is possible for the UHF portable transmitter to operate simultaneously when either the Bluetooth or the WiFi transmitter were operating.

Testing was carried out when the WiFi transmitter was operating on 2412 MHz with a 20 MHz channel bandwidth with MCS3 modulation when the portable was operating on 424.000 MHz.

Testing was carried out when the WiFi transmitter was operating on 2422 MHz with a 40 MHz channel bandwidth with MCS3 modulation when the portable was operating on 424.000 MHz.

Testing was also carried out when the Bluetooth transmitter was operating on 2402 MHz when the portable was operating on 424.000 MHz.

The WiFi and Bluetooth transmitters were operating on high power (+18 dBm for WiFi) as set by the supplied software.

The portable was operating with a UHF whip antenna attached and the power as configured by the client (assumed to be set to high).

The device was made to transmit continuously on 424.000 MHz with the programming cable removed.

Observations were made between 30 MHz – 12.5 GHz with close observations being made between 1500 MHz – 5000 MHz using a spectrum analyser operating in peak hold mode at a distance of 3 metres and also at closer distances up to 0.5 metres.

At each distance the device was rotated and height scanned using both vertical and horizontal polarisations.

No Co-Location spurious emissions were detected.

The FCC part 15 section 15.209 general limits were applied

**Result:** Complies.

Measurement uncertainty with a confidence interval of 95% is:

- Free radiation tests (30 – 12500 MHz)  $\pm$  4.1 dB

## 7. TEST EQUIPMENT USED

Instrument	Manufacturer	Model	Serial No	Asset Ref	Cal Due	Period
Aerial Controller	EMCO	1090	9112-1062	RFS 3710	N/A	N/A
Aerial Mast	EMCO	1070-1	9203-1661	RFS 3708	N/A	N/A
Biconical Antenna	Schwarzbeck	BBA 9106	11042021A	3698	22 Nov 2024	3 years
Heliacx cable	Andrews	L6PNM-RPD	22869	Oats Cable	22 Dec 2024	1 year
10 m Coax Cable	Sucoflex	104PA	2546/49A	-	19 Dec 2024	1 year
Log Periodic Receiver	Schwarzbeck	VUSLP 9111	9111-112	EMC4025	15 Nov 2024	3 years
Spectrum Analyser	R & S	ESIB-40	100295	EMC4030	06 Oct 2024	3 years
Turntable	Keysght	N9038A	MY57290153	EMC4033	21 Nov 2024	1 year
VHF Balun	EMCO	1080-1-2.1	9109-1578	RFS 3709	N/A	N/A
Horn Antenna	Schwarzbeck	VHA 9103	9594	3697	22 Nov 2024	3 years
Horn Antenna	EMCO	3115	9511-4629	E1526	6 Mar 2026	3 years
Horn Antenna	EMCO	3116	92035	E1527	21 Sept 2026	3 years

## 8. ACCREDITATIONS

Testing was carried out in accordance with EMC Technologies NZ Ltd designation as a FCC Accredited Laboratory by International Accreditation New Zealand, designation number: NZ0002 under the APEC TEL MRA.

In addition testing was carried out in accordance with the terms of EMC Technologies (NZ) Ltd's International Accreditation New Zealand (IANZ) Accreditation to NZS/IEC/ISO 17025.

All measurement equipment has been calibrated in accordance with the terms of EMC Technologies (NZ) Ltd's International Accreditation New Zealand (IANZ) Accreditation to NZS/IEC/ISO 17025.

International Accreditation New Zealand has International Laboratory Accreditation Council (ILAC) Mutual Recognition Arrangements for testing and calibration with various accreditation bodies in a number of economies.

This includes NATA (Australia), UKAS (UK), SANAS (South Africa), NVLAP (USA), A2LA (USA), SWEDAC (Sweden).

Further details can be supplied on request.

## 9. PHOTOGRAPHS

Test Samples – Serial Numbers



Test Sample – Front View



Test Sample – Rear view



Test Sample – Rear view with battery inserted



Test Setup below 1000 MHz. Test table 80 cm high.



Test Setup above 1000 MHz. Test table 150 cm high.



Test sample with UHF antenna attached: X Plane – Standing Upright



Test sample with UHF antenna attached: Y - Plane Laying Flat



Global Product Certification

Test sample with UHF antenna attached: Z Plane – Laying on its Side

