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

TEST REPORT

TPG-IS Model TPGB1B
VHF 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:

Andrew Cutler - General Manager

ACCREDITED
IANZ
TESTING LABORATORY

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

Table of Contents

1. STATEMENT OF COMPLIANCE

The **TPGIS Model TPGB1B VHF 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 KBD 996369 D04 Module Integration Guide.

2. RESULTS SUMMARY

The results of testing carried out in July 2023 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 if restricted to operating on 20 MHz channels between 2412 MHz and 2467 MHz.and restricted to operating on 40 MHz channels between 2422 MHz and 2462 MHz.
(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

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

4. DESCRIPTION OF TEST SAMPLE

Brand Name	TPG-IS
Model Number	TPGB1B
Product Code	T03-25007-BAAA
Product	VHF Portable Transceiver with WiFi / Bluetooth module
Manufacturer	Tait International Ltd
Country of Origin	New Zealand
Portable Serial Number	26908406, 26908405
Module Manufacturer	Texas Instruments
Module FCC ID	WL18MODGB
Portable FCC ID	CASTPGB1B

The device that was tested is a portable transceiver that can operate in the 136 – 174 MHz VHF land mobile bands which 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 155.100 MHz.

Testing carried out with the WiFi / Bluetooth module configured by the client.

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.

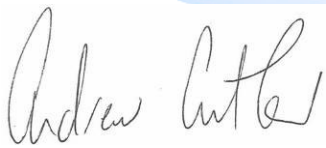
All compliance statements have been made with respect of the specification limit with no reference to the measurement uncertainty.

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
24509.1	Final version	31 July 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.

For the WiFi testing test software had to be used rather than the Standard User Mode as programmed in the transceiver firmware as the fireware cannot handle test modes.

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) and bandwidth of operation (20 MHz or 40 MHz).

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:

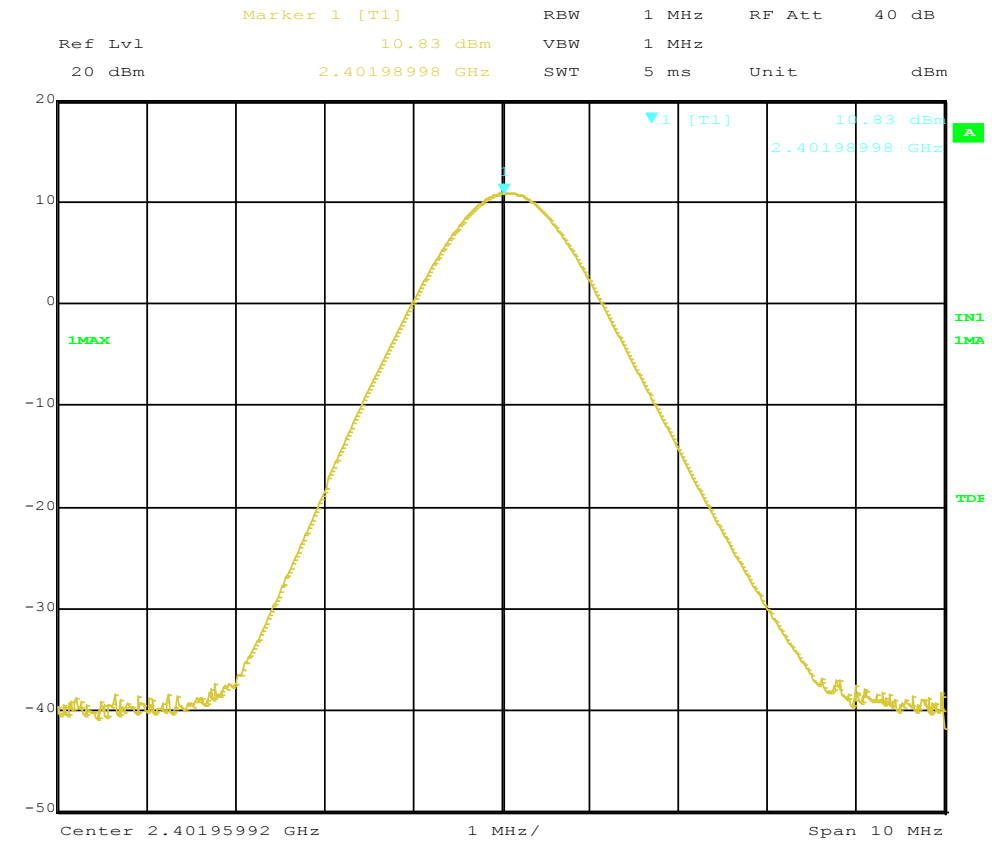
Bluetooth mode testing was carried out when operating in Constant Transmit Mode on 2402, 2440 and 2480 MHz with the following results recorded

Frequency (MHz)	Level (dBm)	Limit (dBm)
2402.000	+10.8	+30.0
2440.000	+10.4	+30.0
2480.000	+10.4	+30.0

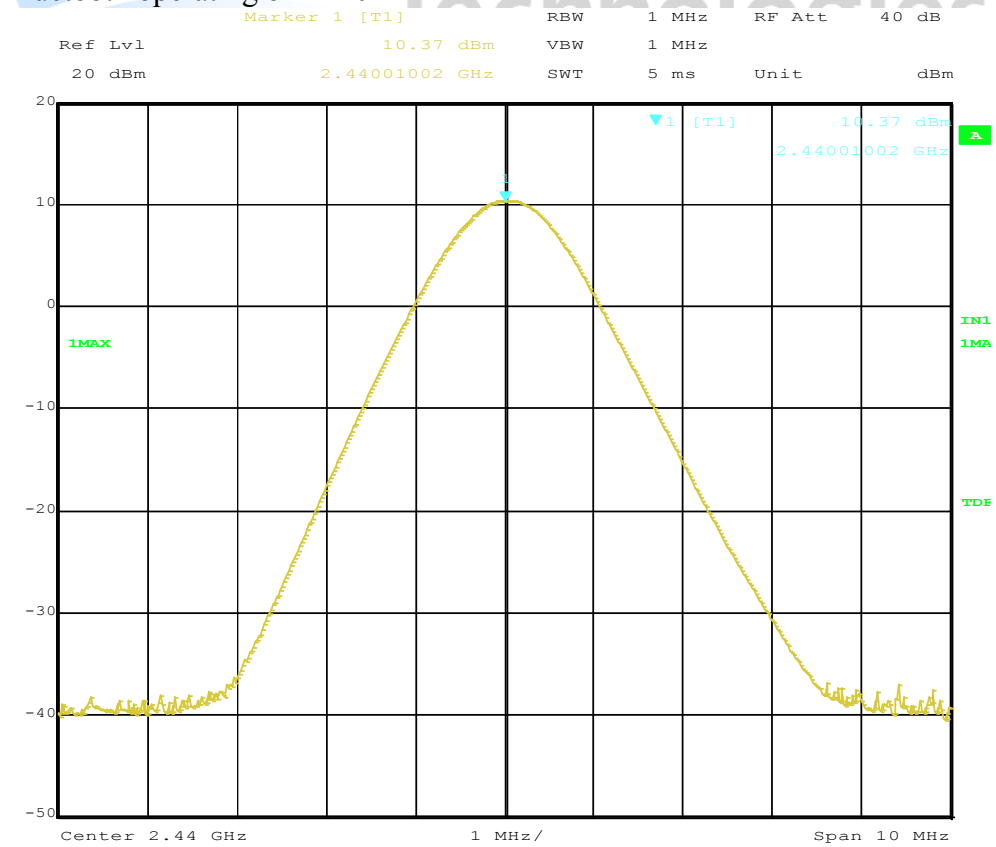
A conducted power limit of 1 watt (+30 dBm) has been applied

Result: Complies
Measurement uncertainty with a confidence interval of 95% is:
- Conducted power (30 – 25000 MHz) ± 2.1 dB

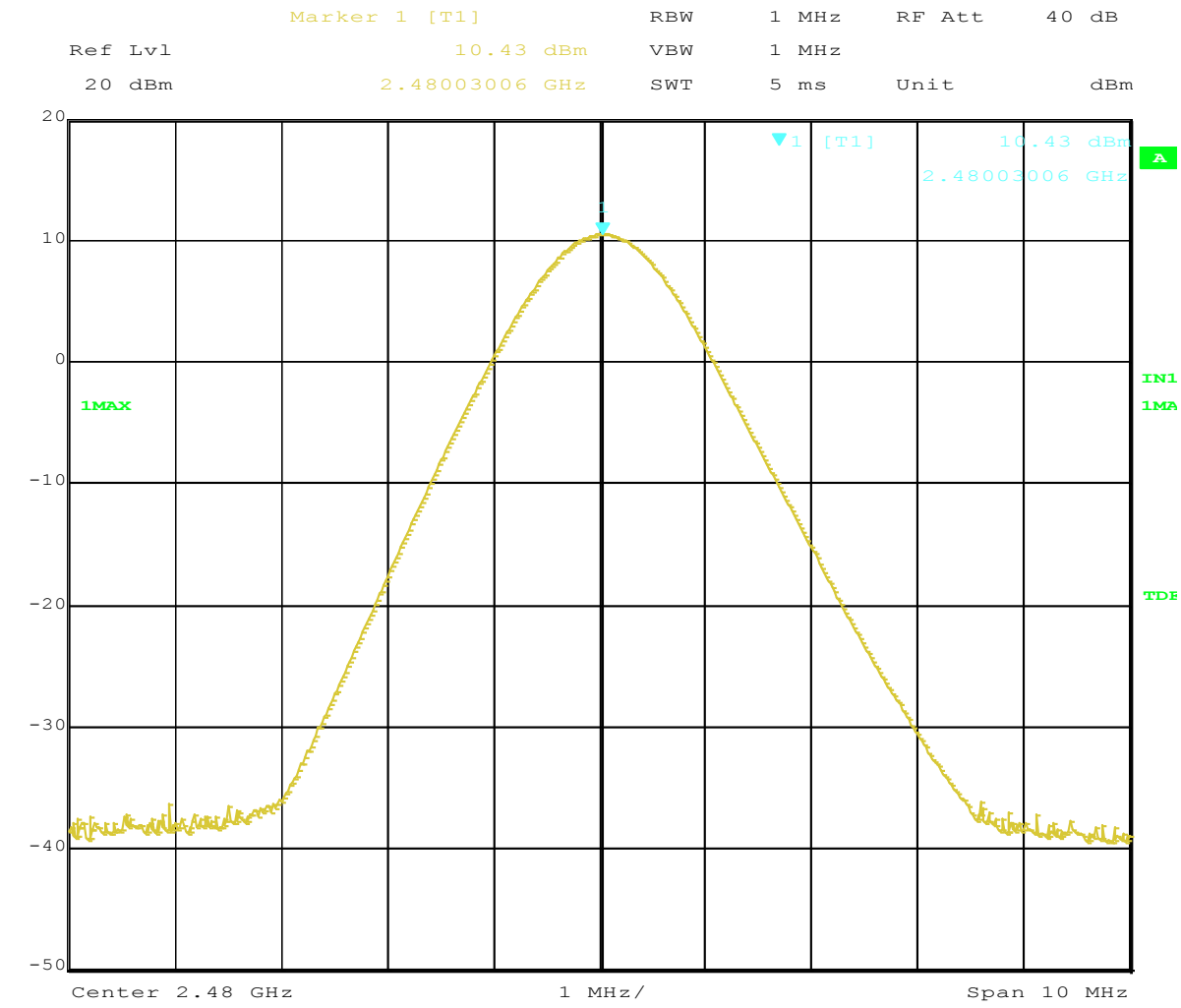
Bluetooth operating on 2402 MHz



Bluetooth operating on 2440 MHz



Bluetooth operating on 2480 MHz



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.

The module can operate using a number of modulation types.

All modulation types were tested when operating on 2442 MHz which is in the centre of the 2400 – 2483.5 MHz band.

Additional measurements were then made on 2412 MHz and 2472 MHz using the worst case modulation mode.

20 MHz bandwidth on 2442 MHz

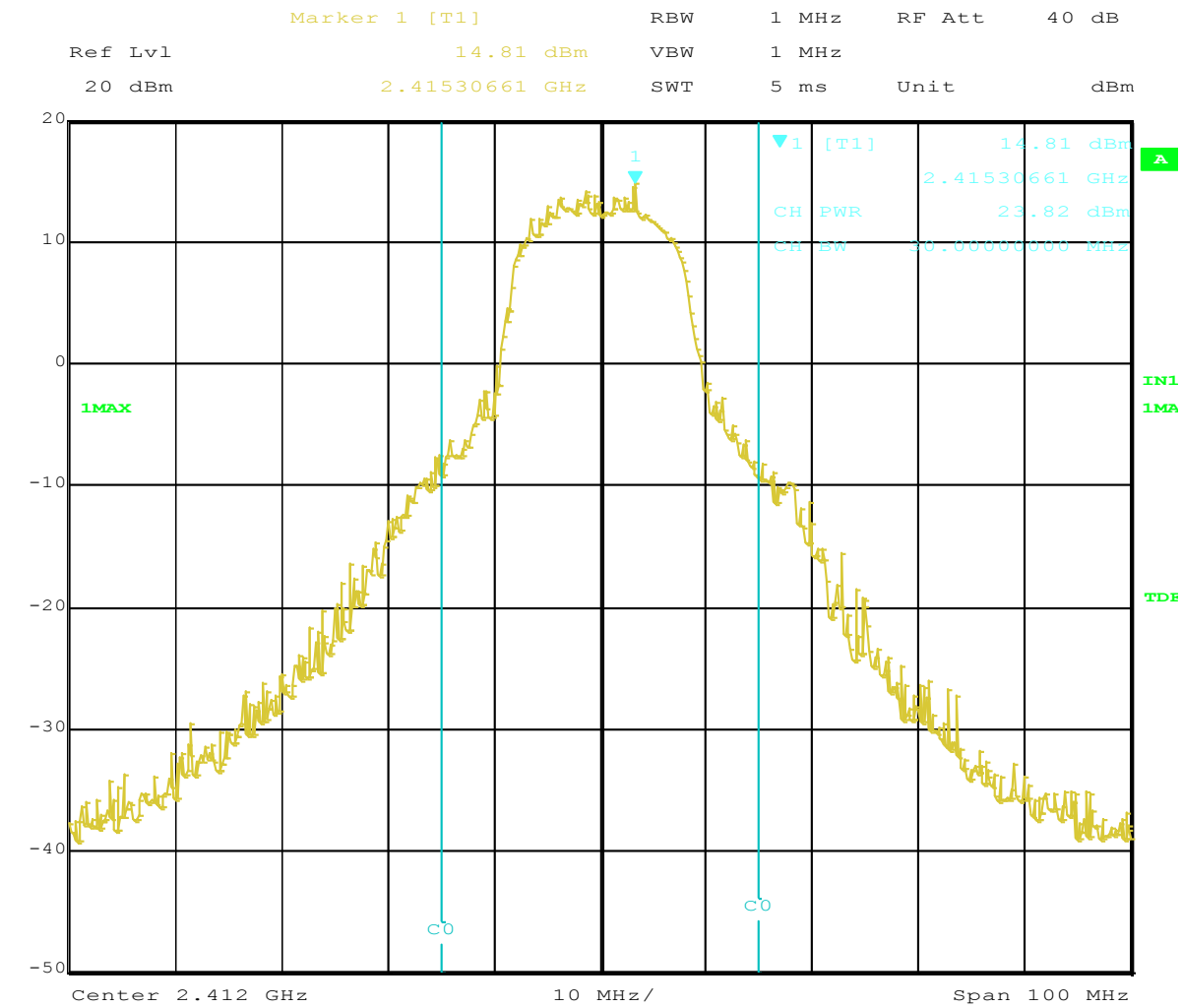
Modulation Type	Level (dBm)	Limit (dBm)
1 MHz DSSS	+18.6	+30.0
2 MHz DSSS	+19.1	+30.0
-	-	-
5CCK	+20.8	+30.0
11CCK	+22.0	+30.0
-	-	-
6OFDM	+23.5	+30.0
9OFDM	+23.5	+30.0
12OFDM	+23.5	+30.0
18OFDM	+23.5	+30.0
24OFDM	+23.0	+30.0
36OFDM	+22.1	+30.0
48OFDM	+21.2	+30.0
54OFDM	+21.1	+30.0
-	-	-
MCS0	+23.3	+30.0
MCS1	+23.1	+30.0
MCS2	+23.0	+30.0
MCS3	+23.4	+30.0
MCS4	+22.2	+30.0
MCS5	+22.3	+30.0
MCS6	+21.6	+30.0
MCS7	+19.9	+30.0

20 MHz on 2412 MHz and 2472 MHz

Modulation Type	2412 MHz Level (dBm)	2472 MHz Level (dBm)	Limit (dBm)
2 MHz DSSS	+19.3	+19.9	+30.0
11CCK	+22.4	+22.0	+30.0
18OFDM	+23.8	+23.6	+30.0
MCS3	+23.6	+23.1	+30.0

Plot of the worst case power level measured

2412 MHz, 20 MHz, 18OFDM



Result: Complies

Measurement uncertainty with a confidence interval of 95% is:

- Free radiation tests (30 – 25000 MHz) ± 2.1 dB

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.

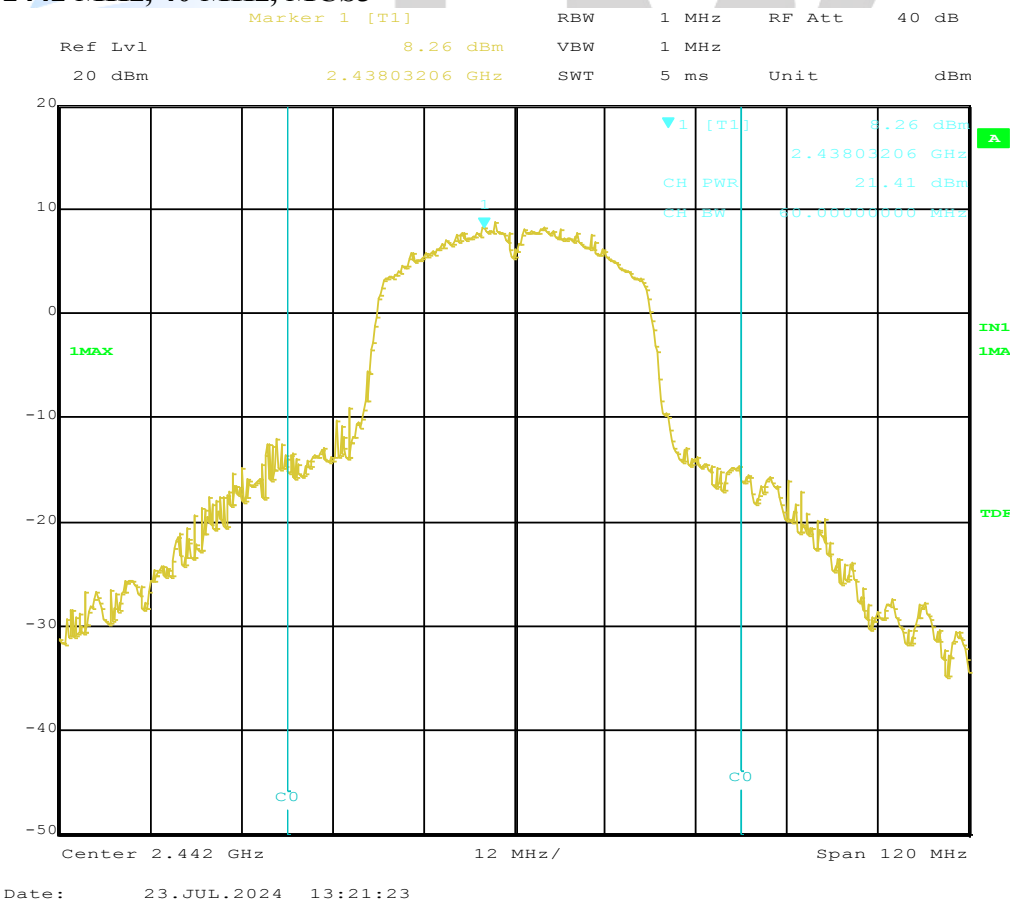
Using the worst case 20 MHz modulation modes measurements were made when the module was operating on a centre frequency of 2442 MHz.

40 MHz bandwidth on 2442 MHz

Modulation Type	Level (dBm)	Limit (dBm)
2 MHz DSSS	+15.5	+30.0
11CCK	+18.5	+30.0
18OFDM	+19.4	+30.0
MCS3	+21.4	+30.0

Plot of the highest power level observed

2442 MHz, 40 MHz, MCS3



Result: Complies

Measurement uncertainty with a confidence interval of 95% is:

- Conducted power (30 – 25000 MHz) ± 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.

Measurements were made using each of the modulation types which gave the highest conducted power measurements in the laboratory.

Initial measurements were made in the X, Y and Z planes using both vertical and horizontal polarisations, as the device is portable, with the worst case plane for each polarisation being used for all subsequent measurements.

20 MHz Channel Bandwidth

18OFDM

Device Axis	Frequency (MHz)	Level (dBm)	Antenna (dBi)	Coax (dB)	Path Loss (dB)	EIRP (dBm)	Antenna	Limit (dBm)
X	2412.0	-36.0	9.2	9.6	49.6	14.0	Vertical	30.0
X	2412.0	-34.1	9.1	9.6	49.6	16.0	Horizontal	30.0
-	-	-	-	-	-	-	-	-
Y	2412.0	-35.2	9.2	9.6	49.6	14.8	Vertical	30.0
Y	2412.0	-36.8	9.1	9.6	49.6	13.3	Horizontal	30.0
-	-	-	-	-	-	-	-	-
Z	2412.0	-32.3	9.2	9.6	49.6	17.7	Vertical	30.0
Z	2412.0	-41.3	9.1	9.6	49.6	8.8	Horizontal	30.0
-	-	-	-	-	-	-	-	
Z	2442.0	-34.3	9.2	9.6	49.7	15.8	Vertical	30.0
X	2442.0	-32.8	9.1	9.6	49.7	17.4	Horizontal	30.0
-	-	-	-	-	-	-	-	-
Z	2472.0	-38.1	9.2	9.6	49.9	12.2	Vertical	30.0
X	2472.0	-35.5	9.1	9.6	49.9	14.9	Horizontal	30.0

MCS3

Device (Axis)	Frequency (MHz)	Level (dBm)	Antenna (dBi)	Coax (dB)	Path Loss (dB)	EIRP (dBm)	Antenna	Limit (dBm)
Z	2412.0	-31.5	9.2	9.6	49.6	18.5	Vertical	30.0
-	-	-	-	-	-	-	-	-
Z	2442.0	-34.4	9.2	9.6	49.7	15.7	Vertical	30.0
X	2442.0	-31.7	9.1	9.6	49.7	18.5	Horizontal	30.0
-	-	-	-	-	-	-	-	-
Z	2472.0	-37.3	9.2	9.6	49.9	13.0	Vertical	30.0

2MDSS

Device (Axis)	Frequency (MHz)	Level (dBm)	Antenna (dBi)	Coax (dB)	Path Loss (dB)	EIRP (dBm)	Antenna	Limit (dBm)
Z	2412.0	-36.2	9.2	9.6	49.6	13.8	Vertical	30.0
-	-	-	-	-	-	-	-	-
Z	2442.0	-38.3	9.2	9.6	49.7	11.8	Vertical	30.0
X	2442.0	-36.3	9.1	9.6	49.7	13.9	Horizontal	30.0
-	-	-	-	-	-	-	-	-
Z	2472.0	-41.3	9.2	9.6	49.9	9.0	Vertical	30.0

20 MHz Channel Bandwidth cont.

11CCK

Device Axis	Frequency (MHz)	Level (dBm)	Antenna (dBi)	Coax (dB)	Path Loss (dB)	EIRP (dBm)	Antenna	Limit (dBm)
Z	2412.0	-32.9	9.2	9.6	49.6	17.1	Vertical	30.0
-	-	-	-	-	-	-	-	-
Z	2442.0	-36.1	9.2	9.6	49.7	14.0	Vertical	30.0
X	2442.0	-32.8	9.1	9.6	49.7	17.4	Horizontal	30.0
-	-	-	-	-	-	-	-	-
Z	2472.0	-38.2	9.2	9.6	49.9	12.1	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	-34.7	9.2	9.6	49.7	15.4	Vertical	30.0
-	-	-	-	-	-	-	-	-
Z	2452.0	-36.2	9.2	5.0	49.8	9.4	Vertical	30.0
-	-	-	-	-	-	-	-	-
Z	2462.0	-36.5	9.2	9.6	49.8	13.7	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 MHz) + 20 * log (d km)

The antenna gain can therefore be determined to be:

Channel BW	Modulation	Frequency (MHz)	Conducted (dBm)	Radiated (dBm)	Gain/Loss (dB)
20 MHz	18OFDM	2412	23.8	17.7	-6.1
		2442	23.5	17.4	-6.1
		2472	23.6	14.9	-8.7
20 MHz	MCS3	2412	23.6	18.5	-5.1
		2442	23.4	18.5	-4.9
		2472	23.1	13.0	-10.1
20 MHz	2MDSS	2412	19.3	13.8	-5.5
		2442	19.1	13.9	-5.2
		2472	19.9	9.0	-9.9

40 MHz Channel Bandwidth

Channel BW	Modulation	Frequency (MHz)	Conducted (dBm)	Radiated (dBm)	Gain/Loss (dB)
20 MHz	11CCK	2412	22.4	17.1	-5.3
		2442	22.0	17.4	-4.6
		2472	22.0	12.1	-9.9
40 MHz	MCS3	2452	21.4	15.4	-6.0

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

Analysis of the results shows that the antenna loss would be in the range of approximately -4.6 dBi to -10.1 dBi across the frequency range of 2412 – 2472 MHz when operating in WiFi mode.

Result: Complies
Measurement uncertainty with a confidence interval of 95% is:
- Free radiation tests (30 – 25000 MHz) ± 4.1 dB

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

It can be seen that 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 2MDSS, 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	2401.875	2480.145

20 MHz on 2412 MHz and 2472 MHz

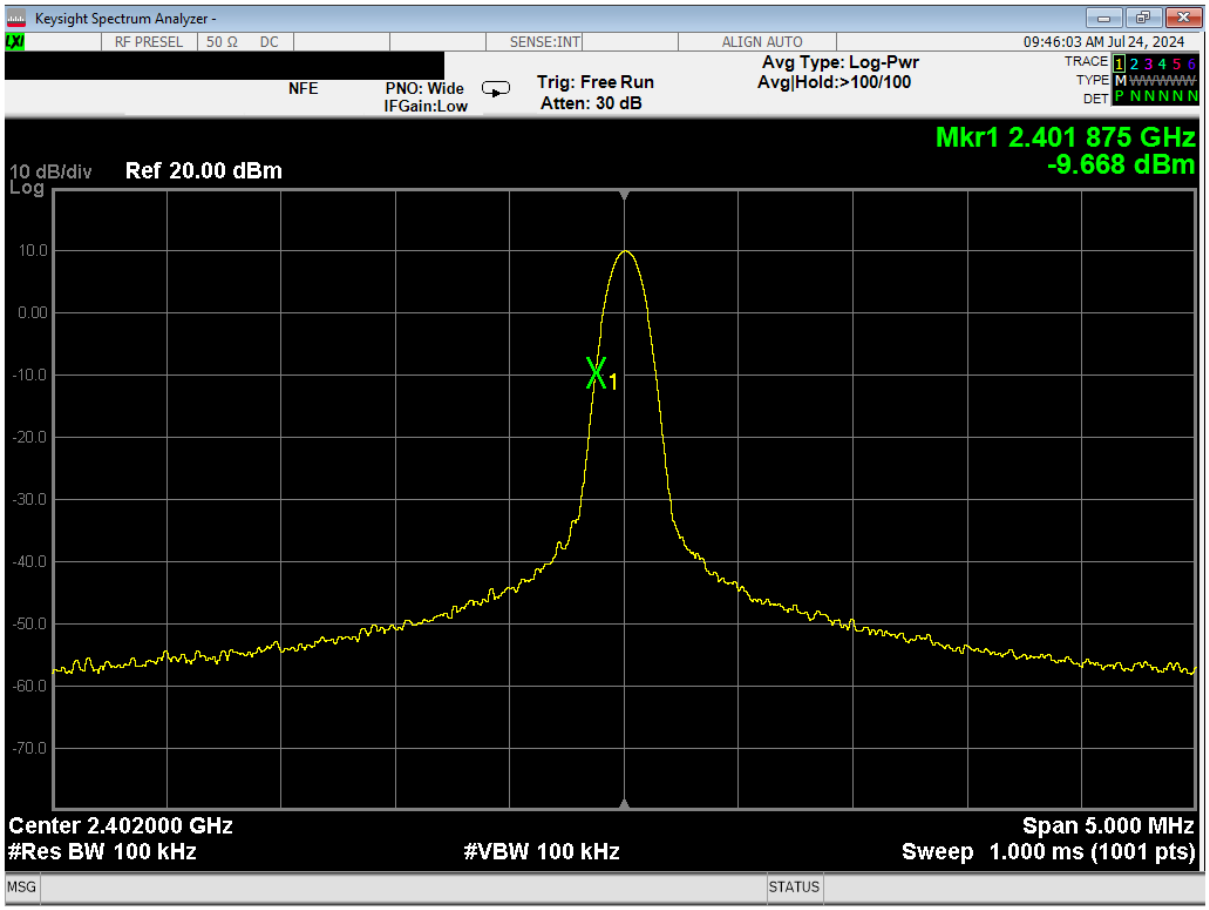
Modulation Type	F Low (MHz)	F High (MHz)
2 MHz DSSS	2403.500	2480.400
11CCK	2403.800	2480.500
18OFDM	2402.300	2481.300
MCS3	2402.400	2481.700

40 MHz on 2422 MHz and 2462 MHz

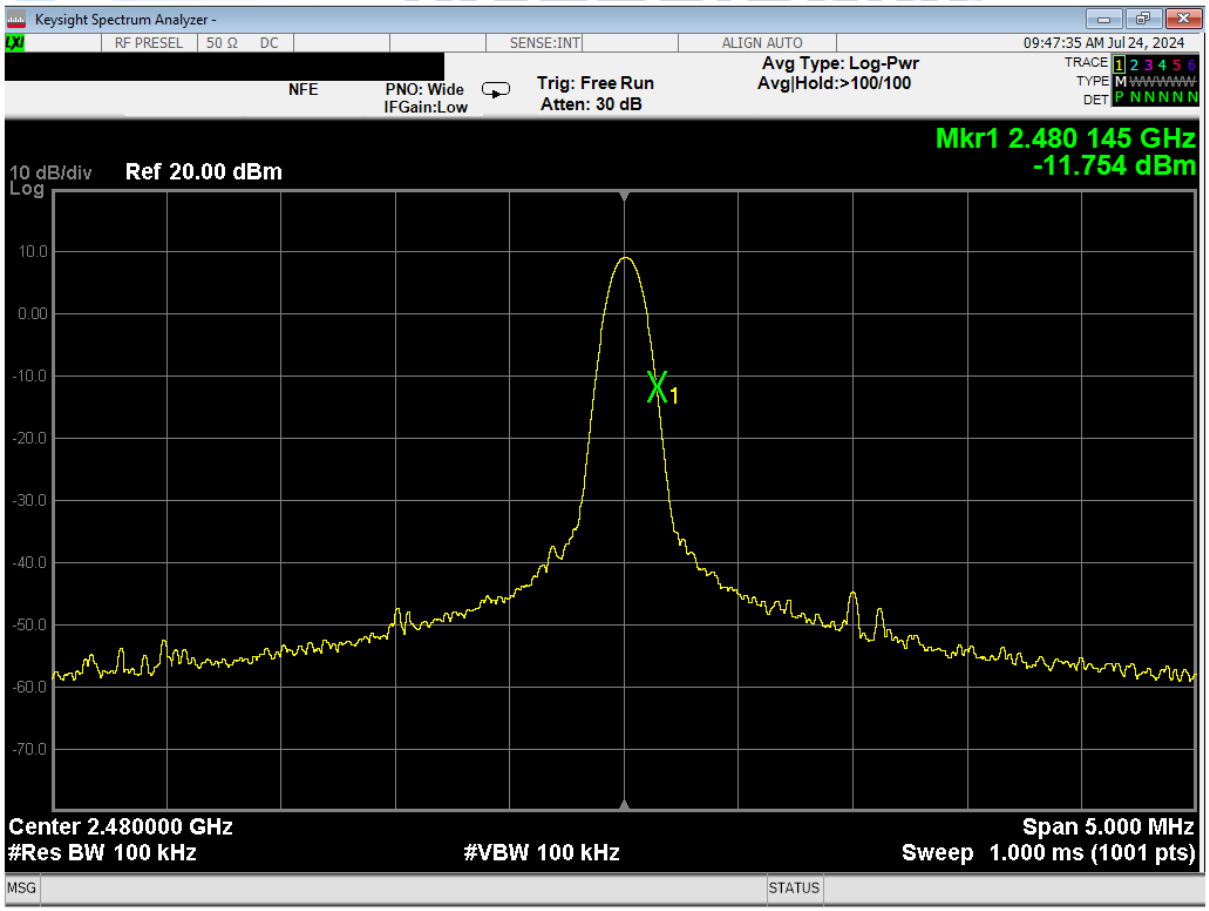
Modulation Type	F Low (MHz)	F High (MHz)
2 MHz DSSS	2403.800	2480.300
11CCK	2403.900	2480.300
18OFDM	2403.500	2480.600
MCS3	2403.400	2480.500

Result: Complies
Measurement uncertainty with a confidence interval of 95% is:
- Conducted power (30 – 25000 MHz) ± 2.1 dB

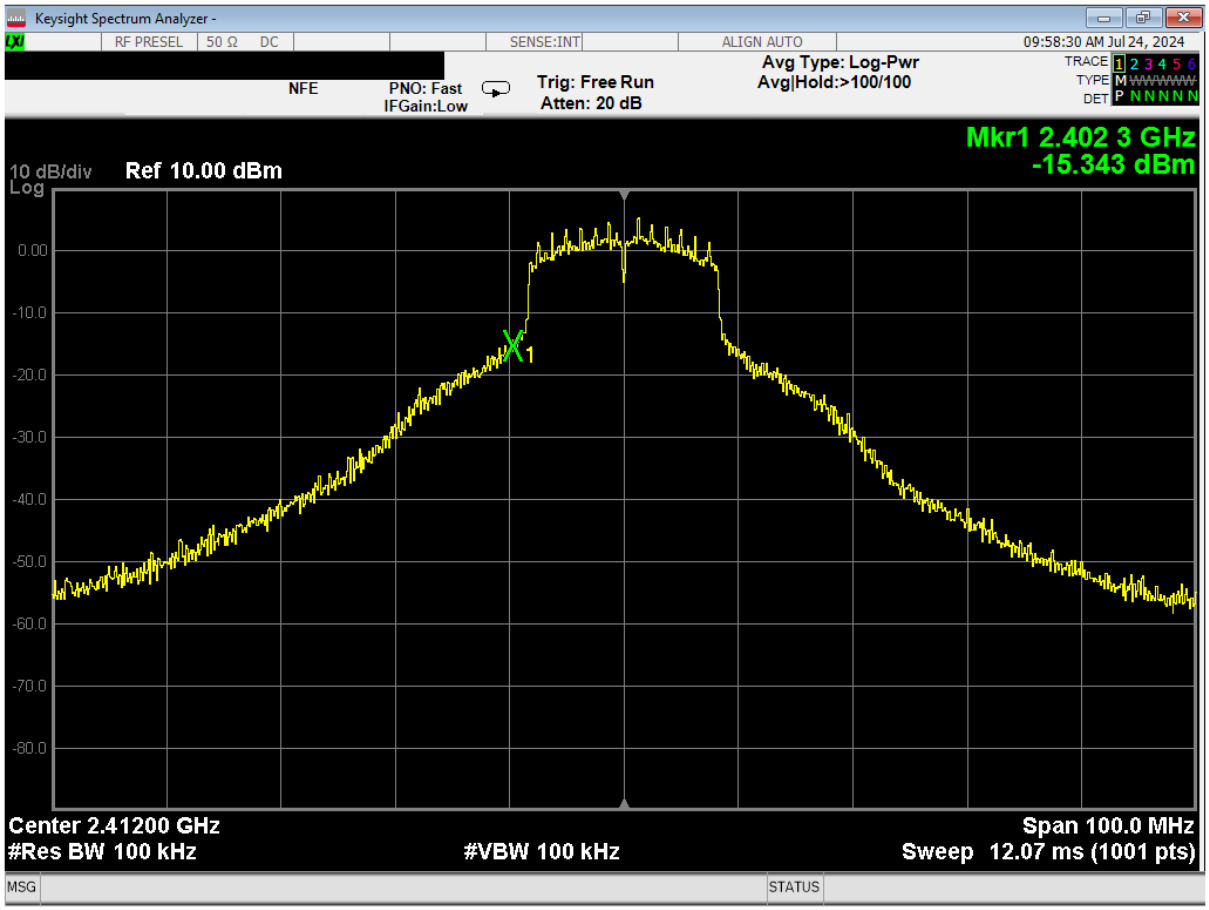
Bluetooth: 2402 MHz



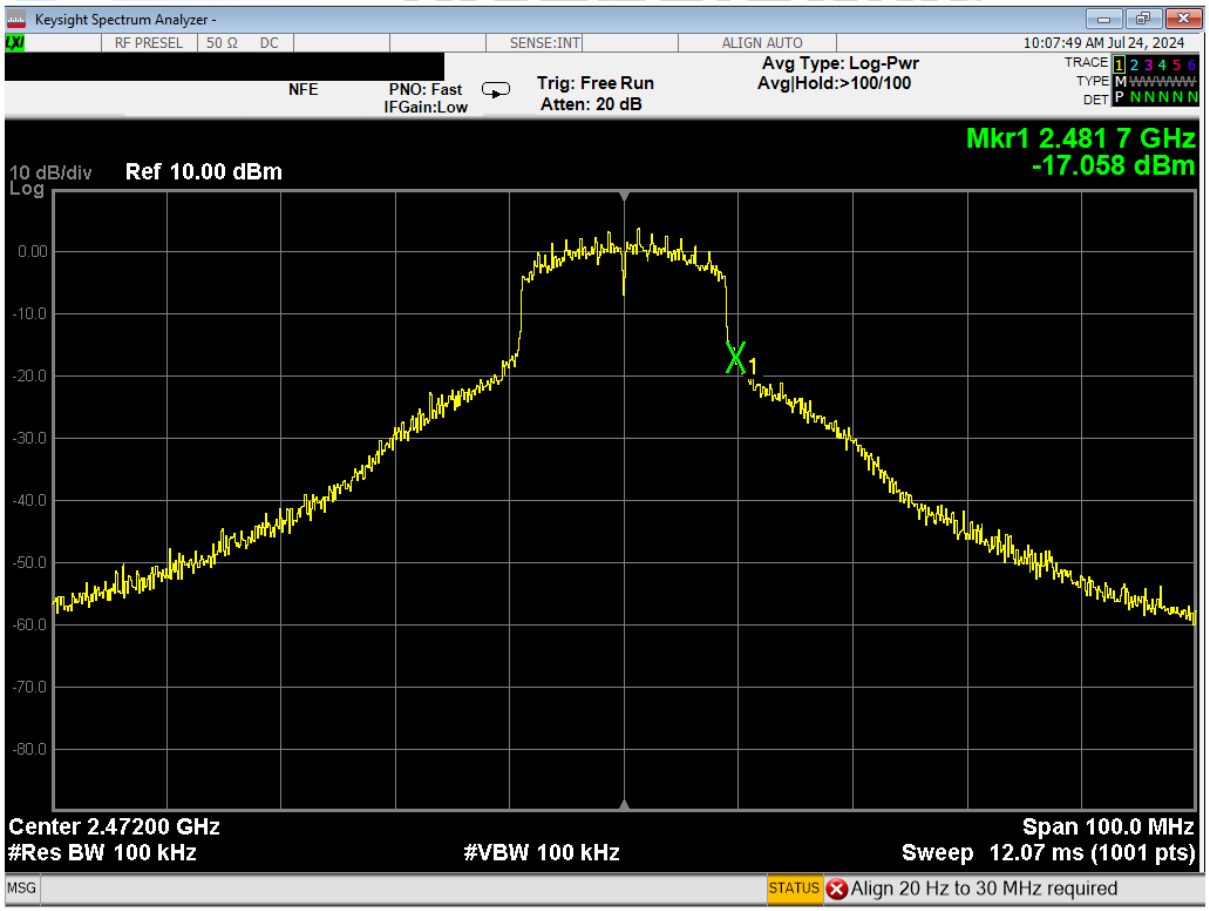
Bluetooth: 2480 MHz



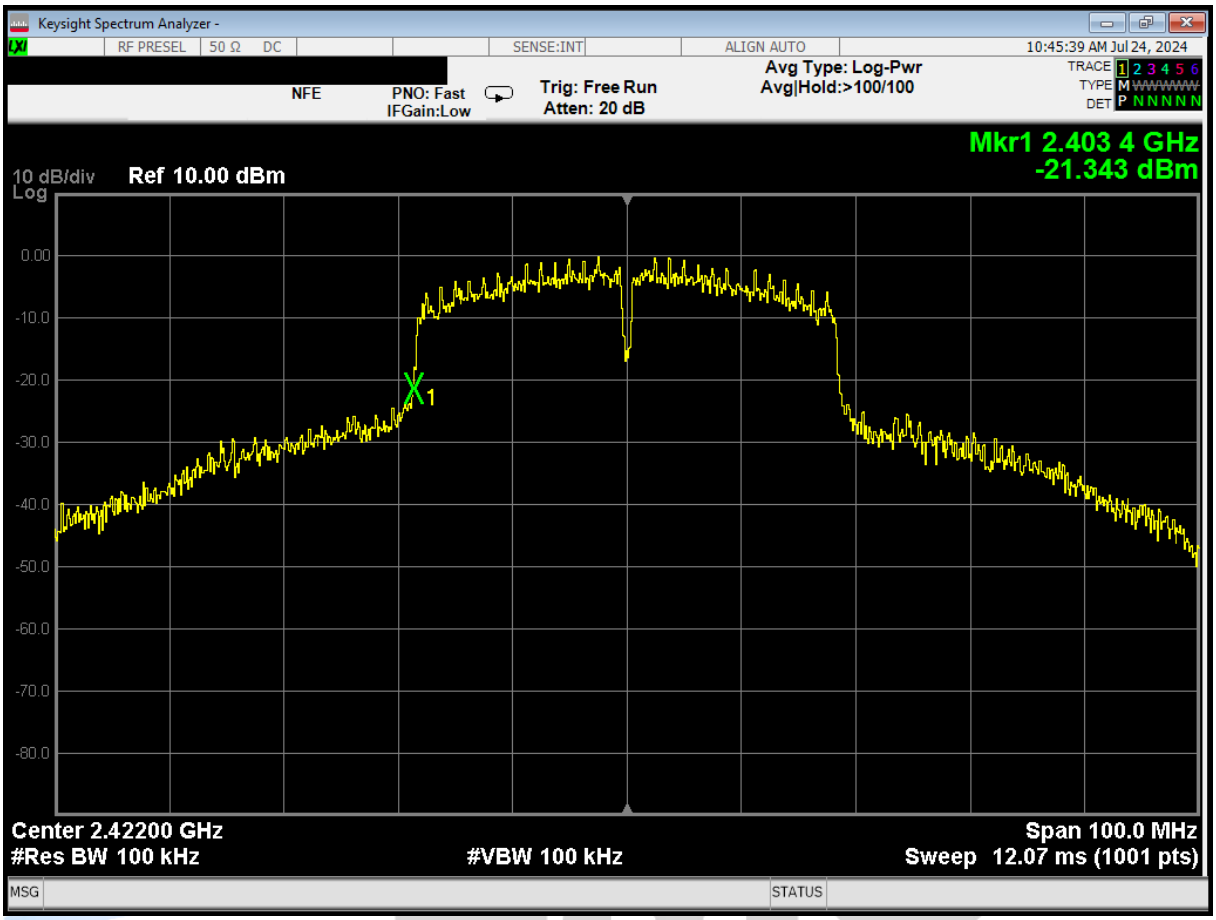
WiFi 20 MHz – 18OFDM– 2412 MHz



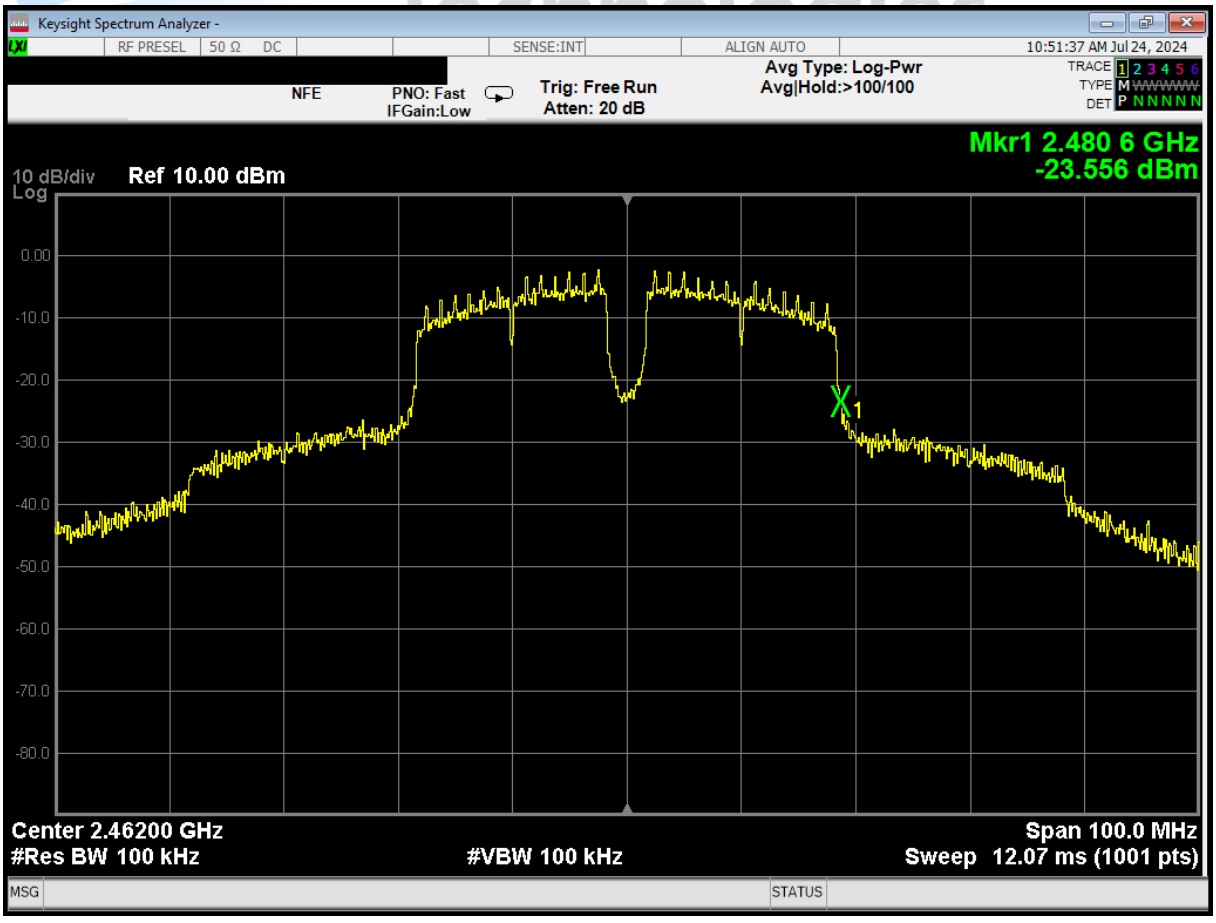
WiFi 20 MHz – MCS3– 2472 MHz



WiFi 40 MHz – MCS3 – 2422 MHz



WiFi 40 MHz – 18OFDM – 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

2412 MHz

Frequency (MHz)	Vertical (dBuV/m)	Horizontal (dBuV/m)	Limit (dBuV/m)	Margin dB	Result	Antenna	Detector
2390.000	69.1	69.8	74.0	4.2	Pass	Horizontal	Peak
2390.000	42.9	42.3	54.0	11.1	Pass	Vertical	Average

2467 MHz

Frequency (MHz)	Vertical (dBmV/m)	Horizontal (dBmV/m)	Limit (dBmV/m)	Margin (dB)	Result	Antenna	Detector
2483.500	68.9	70.7	74.0	3.3	Pass	Horizontal	Peak
2483.500	45.2	45.2	54.0	8.8	Pass	Vertical	Average

2472 MHz

Frequency (MHz)	Vertical (dBmV/m)	Horizontal (dBmV/m)	Limit (dBmV/m)	Margin (dB)	Result	Antenna	Detector
2483.500	76.8	70.7	74.0	-2.8	*Fail	Vertical	Peak
2483.500	49.2	45.2	54.0	4.8	Pass	Vertical	Average

*In order to comply the module will need to be restricted to operating on 20 MHz channels between 2412 MHz and 2467 MHz.

40 MHz Channel bandwidth – MCS3

2422 MHz

Frequency (MHz)	Vertical (dBuV/m)	Horizontal (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Result	Antenna	Detector
2386.400	68.3	65.3	74.0	5.7	Pass	Vertical	Peak
2386.400	44.3	42.1	54.0	9.7	Pass	Vertical	Average
2390.000	68.3	64.5	74.0	5.7	Pass	Vertical	Peak
2390.000	44.3	43.3	54.0	9.7	Pass	Vertical	Average

2462 MHz

Frequency (MHz)	Vertical (dBmV/m)	Horizontal (dBmV/m)	Limit (dBmV/m)	Margin (dB)	Result	Antenna	Detector
2483.500	69.5	70.8	74.0	3.2	Pass	Horizontal	Peak
2483.500	44.6	45.1	54.0	8.9	Pass	Horizontal	Average
2486.000	-	72.1	74.0	1.9	Pass	Horizontal	Peak
2486.000	-	45.5	54.0	8.5	Pass	Horizontal	Average
2486.400	70.5	-	74.0	3.5	Pass	Vertical	Peak
2486.400	46.6	-	54.0	7.4	Pass	Vertical	Average

40 MHz Channel bandwidth – MCS3 cont.

2472 MHz

Frequency (MHz)	Vertical (dBmV/m)	Horizontal (dBmV/m)	Limit (dBmV/m)	Margin (dB)	Result	Antenna	Detector
2483.500	79.5	-	74.0	-5.5	*Fail	Vertical	Peak
2483.500	53.4	-	54.0	0.6	Pass	Vertical	Average

*In order to comply the module will need to be restricted to operating on 40 MHz channels between 2422 MHz and 2462 MHz.

Result: Complies when the module frequency of operations is contained as detailed above.
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, 2440 MHz and 2480 MHz

The device was also operated in WiFi mode using a channel bandwidth of 20 MHz on 2412 MHz, 2440 MHz and 2472 MHz.

The device was also operated in WiFi mode using a channel bandwidth of 40 MHz on 2422 MHz and 2452 MHz.

In WiFi mode testing was carried out using 18OFDM modulation type for both 20 MHz and 40 MHz channel bandwidths.

The following measurements were recorded:

Bluetooth: 2402 MHz

Frequency (MHz)	Level (dBm)	Limit (dBm)
2402.0	+9.9	-
4804.0	-39.6	-10.1
7206.0	-57.4	-10.1
9608.0	-58.2	-10.1
12010.0	-69.9	-10.1
14412.0	-48.8	-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	-60.3	-10.9
1601.340	-58.6	-10.9
3202.670	-54.2	-10.9
4003.340	-55.5	-10.9
5604.680	-65.8	-10.9
13611.370	-64.3	-10.9

Bluetooth: 2440 MHz

Frequency (MHz)	Level (dBm)	Limit (dBm)
2440.0	+9.2	-
4880.0	-39.8	-10.8
7320.0	-60.8	-10.8
9760.0	-64.0	-10.8
12200.0	less than -70	-10.8
14640.0	-51.2	-10.8
17080.0	less than -70	-10.8
19520.0	less than -70	-10.8
21960.0	less than -70	-10.8
24400.0	less than -70	-10.8
Other emissions		
813.340	-60.3	-10.8
1626.670	-60.3	-10.8
3253.340	-56.2	-10.8
4066.680	-56.7	-10.8
13826.680	-62.8	-10.8

Bluetooth: 2480 MHz

Frequency (MHz)	Level (dBm)	Limit (dBm)
2480.0	+9.1	-
4960.0	-42.3	-10.9
7440.0	-62.8	-10.9
9920.0	-68.5	-10.9
12400.0	less than -70	-10.9
14880.0	-60.2	-10.9
17360.0	less than -70	-10.9
19840.0	less than -70	-10.9
22320.0	less than -70	-10.9
24800.0	less than -70	-10.9
Other emissions		
826.670	-59.3	-10.9
1653.340	-56.5	-10.9
3306.670	-56.6	-10.9
4133.340	-56.3	-10.9
14053.360	-55.1	-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.

Result: Complies
Measurement uncertainty with a confidence interval of 95% is:
- Conducted power (30 – 25000 MHz) ± 2.1 dB

WiFi 20 MHz 18OFDM: 2422 MHz

Frequency (MHz)	Level (dBm)	Limit (dBm)
2412.0	+5.1	-
4824.0	-66.3	-14.9
7236.0	-67.3	-14.9
9648.0	less than -70	-14.9
12060.0	less than -70	-14.9
14472.0	less than -70	-14.9
16884.0	less than -70	-14.9
19296.0	less than -70	-14.9
21708.0	less than -70	-14.9
24120.0	less than -70	-14.9

WiFi 20 MHz 18OFDM: 2442 MHz

Frequency (MHz)	Level (dBm)	Limit (dBm)
2442.0	+5.0	-
4884.0	less than -70	-15.0
7326.0	-66.7	-15.0
9768.0	less than -70	-15.0
12210.0	less than -70	-15.0
14652.0	less than -70	-15.0
17094.0	less than -70	-15.0
19536.0	less than -70	-15.0
21978.0	less than -70	-15.0
24420.0	less than -70	-15.0

WiFi 20 MHz 18OFDM: 2462 MHz

Frequency (MHz)	Level (dBm)	Limit (dBm)
2472.0	+4.8	-
4944.0	less than -70	-15.2
7416.0	-69.3	-15.2
9888.0	less than -70	-15.2
12360.0	less than -70	-15.2
14832.0	less than -70	-15.2
17304.0	less than -70	-15.2
19776.0	less than -70	-15.2
22248.0	less than -70	-15.2
24720.0	less than -70	-15.2

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.

Result: Complies
Measurement uncertainty with a confidence interval of 95% is:
- Conducted power (30 – 25000 MHz) ± 2.1 dB

WiFi 40 MHz 18OFDM: 2412 MHz

Frequency (MHz)	Level (dBm)	Limit (dBm)
2412.0	-2.1	-
4824.0	less than -70	-22.1
7236.0	less than -70	-22.1
9648.0	less than -70	-22.1
12060.0	less than -70	-22.1
14472.0	less than -70	-22.1
16884.0	less than -70	-22.1
19296.0	less than -70	-22.1
21708.0	less than -70	-22.1
24120.0	less than -70	-22.1

WiFi 40 MHz 18OFDM: 2442 MHz

Frequency (MHz)	Level (dBm)	Limit (dBm)
2442.0	-2.6	-
4884.0	less than -70	-22.6
7326.0	less than -70	-22.6
9768.0	less than -70	-22.6
12210.0	less than -70	-22.6
14652.0	less than -70	-22.6
17094.0	less than -70	-22.6
19536.0	less than -70	-22.6
21978.0	less than -70	-22.6
24420.0	less than -70	-22.6

WiFi 40 MHz 18OFDM: 2472 MHz

Frequency (MHz)	Level (dBm)	Limit (dBm)
2472.0	-2.4	-
4944.0	less than -70	-22.4
7416.0	less than -70	-22.4
9888.0	less than -70	-22.4
12360.0	less than -70	-22.4
14832.0	less than -70	-22.4
17304.0	less than -70	-22.4
19776.0	less than -70	-22.4
22248.0	less than -70	-22.4
24720.0	less than -70	-22.4

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.

Result: Complies
Measurement uncertainty with a confidence interval of 95% is:
- Conducted power (30 – 25000 MHz) ± 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 10th 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 multi band VHF / 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 (dBµV/m) = Receiver Reading (dBµV) + Antenna Factor (dB/m) + Coax Loss (dB)
For example, if an emission of 30 dBµV was observed at 30 MHz.

45.5 dBµV/m = 30.0 dBµV + 14 dB/m + 1.5 dB

Results:

General Emissions: 30 MHz – 2700 MHz

Testing was carried out when the device was transmitting in

- WiFi mode at 2432 MHz when operating with a 20 MHz channel bandwidth with 18OFDM modulation

Frequency (MHz)	Vertical (dBuV/m)	Horizontal (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Polarisation	Detector	BW
55.320	21.4	-	40.0	18.6	Pass	QP	120 kHz

and

- Bluetooth mode at 2402 MHz

Frequency (MHz)	Vertical (dBuV/m)	Horizontal (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Polarisation	Detector	BW
55.280	17.9	-	40.0	22.1	Pass	QP	120 kHz

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 2432 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) ± 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 18OFDM modulation applied.

Measurements were made on the channel which was measured to the highest radiated power.

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 2442 MHz with a 40 MHz channel bandwidth with 18OFDM modulation applied.

Measurements were made on the channel which was measured to the highest radiated power.

Transmitting on 2442 MHz

Frequency (MHz)	Vertical (dBuV/m)	Horizontal (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Antenna	BW
4884.000	< 59	< 59	74.0	> 15	Peak	Vert/Horiz	1 MHz
4884.000	< 46	< 46	54.0	> 8	Average	Vert/Horiz	1 MHz
	-	-	-	-	-	-	-
7326.000	< 59	< 59	74.0	> 15	Peak	Vert/Horiz	1 MHz
7326.000	< 46	< 46	54.0	> 8	Average	Vert/Horiz	1 MHz
	-	-	-	-	-	-	-
9768.000	< 59	< 59	74.0	> 15	Peak	Vert/Horiz	1 MHz
9768.000	< 46	< 46	54.0	> 8	Average	Vert/Horiz	1 MHz
	-	-	-	-	-	-	-
12210.000	< 59	< 59	74.0	> 15	Peak	Vert/Horiz	1 MHz
12210.000	< 46	< 46	54.0	> 8	Average	Vert/Horiz	1 MHz
	-	-	-	-	-	-	-
14652.000	< 59	< 59	74.0	> 15	Peak	Vert/Horiz	1 MHz
14652.000	< 46	< 46	54.0	> 8	Average	Vert/Horiz	1 MHz
	-	-	-	-	-	-	-
17094.000	< 59	< 59	74.0	> 15	Peak	Vert/Horiz	1 MHz
17094.000	< 46	< 46	54.0	> 8	Average	Vert/Horiz	1 MHz
	-	-	-	-	-	-	-
19536.000	< 59	< 59	74.0	> 15	Peak	Vert/Horiz	1 MHz
19536.000	< 46	< 46	54.0	> 8	Average	Vert/Horiz	1 MHz
	-	-	-	-	-	-	-
21978.000	< 59	< 59	74.0	> 15	Peak	Vert/Horiz	1 MHz
21978.000	< 46	< 46	54.0	> 8	Average	Vert/Horiz	1 MHz
	-	-	-	-	-	-	-
24420.000	< 59	< 59	74.0	> 15	Peak	Vert/Horiz	1 MHz
24420.000	< 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.

Measurements were made on the channel which was measured to the highest radiated power.

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 VHF 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 18OFDM modulation when the portable was operating on 155.100 MHz.

Testing was carried out when the WiFi transmitter was operating on 2422 MHz with a 40 MHz channel bandwidth with 18OFDM modulation when the portable was operating on 155.100 MHz.

Testing was also carried out when the Bluetooth transmitter was operating on 2402 MHz when the portable was operating on 155.100 MHz.

The WiFi and Bluetooth transmitters were operating on high power as set by the supplied software.

The portable was operating with a VHF 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 155.100 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) ± 4.1 dB

8. 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
Heliax 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	Schwarzbeck	VUSLP 9111	9111-112	EMC4025	15 Nov 2024	3 years
Receiver	R & S	ESIB-40	100295	EMC4030	06 Oct 2024	3 years
Spectrum Analyser	Keysght	N9038A	MY57290153	EMC4033	21 Nov 2024	1 year
Turntable	EMCO	1080-1-2.1	9109-1578	RFS 3709	N/A	N/A
VHF Balun	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

9. 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.

10. PHOTOGRAPHS

Test Samples – Serial Numbers

Test Sample – Front View

Test Sample – Rear view with battery removed

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

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

Test sample with VHF antenna attached

X Plane Test Setup (standing up right)

X Plane Test Setup (standing upright)

Y Plane Setup (laying flat)

Y Plane Setup (laying flat)

Z Plane Setup (laying flat on edge)

Z Plane Setup (laying flat on edge)