EMC Technologies (NZ) Ltd
47 MacKelvie Street
Grey Lynn, Auckland 1021
New Zealand
Phone 09 360 0862
Fax 09 360 0861
E-Mail Address: aucklab@ihug.co.nz
Web Site: www.emctech.com.au

TEST REPORT

Define Instruments IoT Bridge IoT Communications Device

tested to

47 Code of Federal Regulations

Part 15 - Radio Frequency Devices

Subpart C – Intentional Radiators

including

Section 15.247 - Operation in the band 2400 – 2483.5 MHz

for

Define Instruments Ltd

This Test Report is issued with the authority of:

Andrew Cutler - General Manager

IANZ ACCREDITED LABORATORY

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

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1. STATEMENT OF COMPLIANCE

The **Define Instruments IoT Bridge IoT Communications Device** complies with FCC Part 15 Subpart C including 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.

2. RESULTS SUMMARY

The results of testing carried out between the 5th May and 6th July 2017 are detailed below:

Clause	Parameter	Result
15.201	Equipment authorisation requirement	Certification required as two single use modules have been used in the same device and operate simultaneously
15.203	Antenna requirement	Complies. A reverse SMA connector has been utilised.
15.204	External PA and antenna modifications	Noted.
15.205	Restricted bands of operation	Complies.
15.207	Conducted limits	Complies.
15.209	Radiated emission limits	Complies.
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	Complies

3. INTRODUCTION

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.

This report contains no corrections.

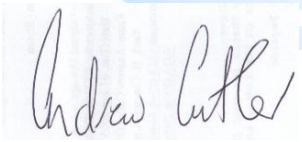
Measurement uncertainties with statistical confidence intervals of 95% are shown below test results. Both Class A and Class B uncertainties have been accounted for, as well as influence uncertainties where appropriate.

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

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

4. CLIENT INFORMATION

Company Name	Define Instruments Ltd
Address	10B Vega Place Mairangi Bay
City	Auckland
Country	New Zealand.
Contact	Mr Anthony Glucina

5. DESCRIPTION OF TEST SYSTEM

Brand Name	Define Instruments
Model Number	IoT (Internet of Things) Bridge
Product	IoT Communications Device
Manufacturer	Define Instruments Ltd
Country of Origin	New Zealand
Serial Number	Not serialised
Module FCC ID's	2ACTT-WGM110, 2ACTT-BGM111

The device has the following specifications:

FCC Band:	2400.0 MHz – 2483.5 MHz
Test Frequencies:	WiFi 2412 MHz, 2462 MHz
	Bluetooth: 2402 MHz, 2426 MHz, 2480 MHz
Antenna Type:	WiFi External whip antenna
	Bluetooth PCB antenna internal to the device
Power Supply:	24 Vdc from external power supply

This device is used within a host device that enables the connection of legacy standalone equipment (PLC's or other discrete control systems) to the Cloud.

This is achieved using two single use module transmitters operating in the 2.4 GHz band using WiFi and Bluetooth technologies.

6. RESULTS

Standard

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

Methods and Procedures

The following measurement methods and procedures have been applied:

ANSI C63.10 – 2013

FCC KDB558074 D01 V004

Section 15.201: Equipment authorisation requirement

Certification as detailed in Subpart J of Part 2 is required for this device in one form or another as two standalone certified modules have been incorporated onto a single circuit board.

Verification testing of the two single use modules on this board has been carried out to ensure that the overall device complies with one module not degrading the performance of the other module and vice versa.

Reference has been made to KDB 996369 D01 v02

Section 15.203: Antenna requirement

An external whip antenna is used for the WiFi transmitter.

This antenna has a reverse SMA connector that is a unique antenna connector.

An internal chip antenna is used for the Bluetooth transmitter

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

Result: Complies.

Section 15.205: Restricted bands of operation

The modules 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

Conducted emission testing has been carried out when the device was powered at 24 Vdc using a representative power supply.

The representative power supply was powered at 120 Vac 60 Hz.

Conducted emission testing was carried out over the frequency range of 150 kHz to 30 MHz at the Laboratory's MacKelvie Street premises in a 2.4 m x 2.4 m x 2.4 m screened room.

Testing was carried out in accordance with section 15.207(a) using a measuring receiver and a 50 uH / 50 ohm artificial mains network which is also known as a line impedance stabilisation network (LISN).

Measurements on both the phase and neutral lines were made using either a Quasi Peak or an Average detector with a 9 kHz bandwidth.

The supplied conducted emission plot is a combined plot showing the worst case of the Peak, Quasi Peak and Average levels for both phase and neutral.

The Class B conducted limits have been applied.

Testing was carried out with a laptop computer attached to the serial port on the device.

When installed this device would not normally be attached to a laptop computer but it would be attached the host device electronics.

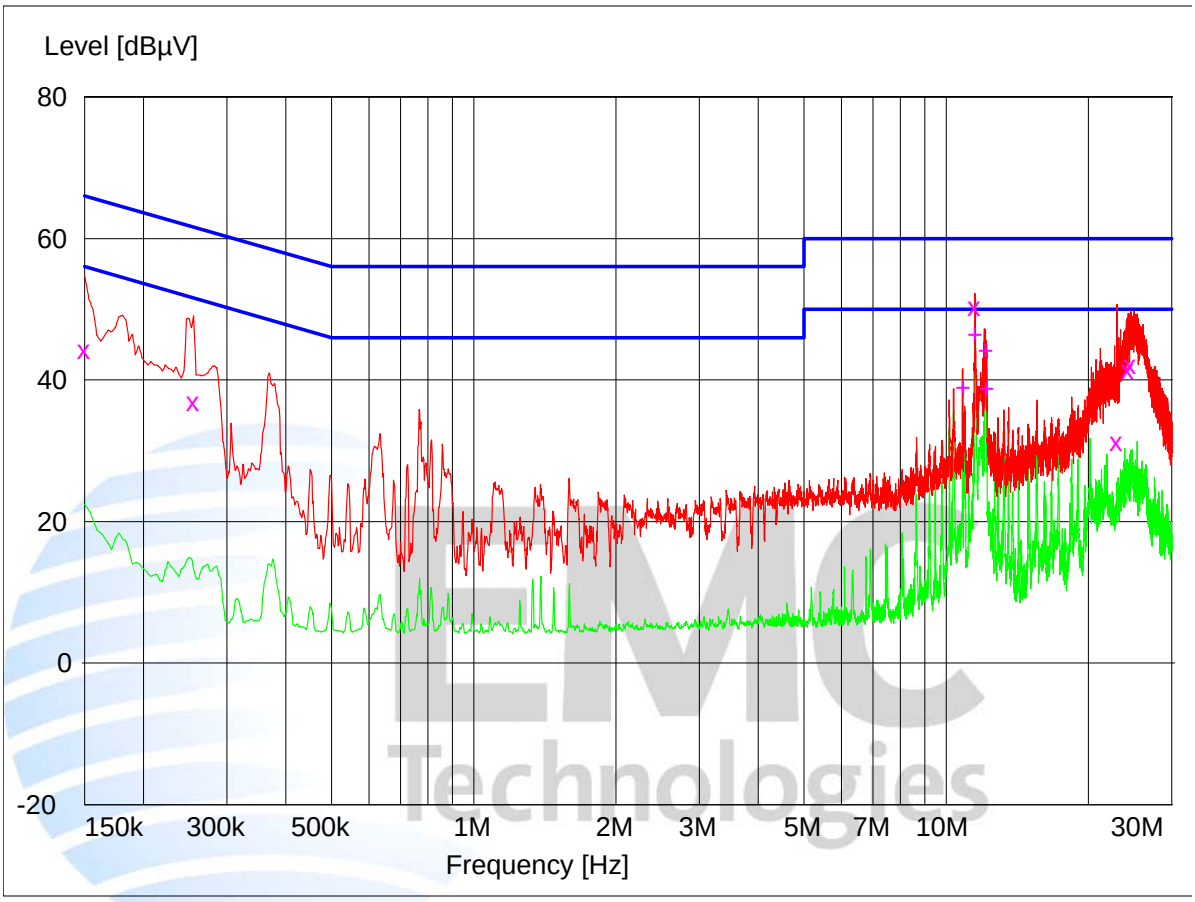
Result: Complies.

Measurement uncertainty with a confidence interval of 95% is:
Conducted emissions tests (0.15 - 30 MHz) ± 2.2 dB

Conducted Emissions – AC Input Power Port

Setup:	Device tested when powered at 24 Vdc using a 120 Vac 60 Hz representative AC power supply while the WiFi and Bluetooth transmitters were transmitting continuously.

Peak ---	Average --	Quasi Peak X	Average +



Final Quasi-Peak Measurements

Frequency MHz	Level dBµV	Limit dBµV	Margin dB	Phase	Rechecks dBµV
0.150000	44.30	66.0	21.7	L1	
0.255000	36.90	61.6	24.7	N	
11.504000	50.30	60.0	9.7	N	
22.947500	31.30	60.0	28.7	N	
24.284000	41.50	60.0	18.5	L1	
24.531500	42.20	60.0	17.8	L1	

Final Average Measurements

Frequency MHz	Level dBµV	Limit dBµV	Margin dB	Phase	Rechecks dBµV
10.829000	38.90	50.0	11.1	N	
11.504000	46.50	50.0	3.5	N	
12.093500	44.20	50.0	5.8	N	
12.179000	38.80	50.0	11.2	L1	

Section 15.209 – Radiated emissions

As this device contains digital devices that operate using frequencies below 30 MHz, low frequency measurements were attempted between 9 kHz – 30 MHz at the open area test site over a distance of 10 metres using a loop antenna the centre of which was 1 metre above the ground.

Details of the general test set up are provided in the photograph section of this report.

The general limits described in 15.209 have been applied with the 300 metre and 30 metre limits being extrapolated by a factor of 40 dB per decade as allowed for in section 15.31(d)(2).

Between 9 – 90 kHz and between 110 – 490 kHz an Average detector and a Peak detector were used.

Where a peak detector was used the limit was increased by +20 dB.

Between 90 kHz and 110 kHz band between 490 kHz and 30 MHz a Quasi Peak detector was used.

No emissions were detected on these frequencies of interest and no other emissions were detected from this device over the range of 9 kHz – 30 MHz

Result: Complies
Measurement uncertainty with a confidence interval of 95% is:
- Free radiation tests (9 kHz – 30 MHz) ± 4.8 dB

Section 15.247(b)(3)– Peak output power

The device being placed in the centre of the test table at a height of 150 cm above the ground plane with the transmit antenna vertical.

Testing was carried out when the WiFi transmitter was transmitting on 2412 MHz and when the Bluetooth Transmitter was continuously advertising on 2402, 2426 and 2480 MHz.

The measured results are recorded below.

The radiated power level in dBm was determined by formula from the field strength using the formula Field strength (V/m) = (square root of (30 x transmitter power (watts))) / distance (metres)

Bluetooth transmitter

Frequency (MHz)	Level (dBuV/m)	Level (dBm)	Limit (dBm)	Polarity	Margin (dB)	Result
2402.0000	85.0	-12.4	30.0	Vertical	42.4	Pass
	82.6	-14.8	30.0	Horizontal	44.8	Pass
2426.0000	85.9	-11.5	30.0	Vertical	41.5	Pass
	82.9	-14.5	30.0	Horizontal	44.5	Pass
2480.0000	85.4	-12.0	30.0	Vertical	42.0	Pass
	83.1	-14.3	30.0	Horizontal	44.3	Pass

Measurements were made using a peak detector with a 1 MHz bandwidth.

WiFi transmitter (Horizontal) - 2412 MHz

Frequency (MHz)	Level (dBuV/m)	Level (dBm)	Level (watt)	Summed (watts)	Power (dBm)	Limit (dBm)
2403.0000	82.6	-14.8	0.0000	0.0097	9.9	30.0
2406.0000	97.4	0.0	0.0010			
2409.0000	99.2	1.8	0.0015			
2412.0000	103.3	5.9	0.0039			
2415.0000	99.2	1.8	0.0015			
2418.0000	96.8	-0.6	0.0009			
2421.0000	96.6	-0.8	0.0008			
2424.0000	80.9	-16.5	0.0000			

WiFi transmitter (Vertical) - 2412 MHz

Frequency (MHz)	Level (dBuV/m)	Level (dBm)	Level (watt)	Summed (watts)	Power (dBm)	Limit (dBm)
2403.0000	92.4	-5.0	0.0003	0.0244	13.9	30.0
2406.0000	101.4	4.0	0.0025			
2409.0000	103.2	5.8	0.0038			
2412.0000	107.6	10.2	0.0105			
2415.0000	103.8	6.4	0.0044			
2418.0000	101.3	3.9	0.0025			
2421.0000	92.5	-4.9	0.0003			

WiFi transmitter (Vertical) – 2462 MHz

Frequency (MHz)	Level (dBuV/m)	Level (dBm)	Level (watt)	Summed (watts)	Power (dBm)	Limit (dBm)
2453.0000	93.8	-3.6	0.0004	0.0273	14.4	30.0
2456.0000	100.2	2.8	0.0019			
2459.0000	103.5	6.1	0.0041			
2462.0000	108.4	11.0	0.0127			
2465.0000	104.1	6.7	0.0047			
2468.0000	102.4	5.0	0.0032			
2471.0000	92.3	-5.1	0.0003			

Measurements were made in peak using a resolution bandwidth of 3 MHz and summed

Testing was carried out at EMC Technologies NZ Ltd Open Area Test Site, which is located at Orere Point, Auckland.

The FCC grant for the WiFi transmitter lists a maximum conducted power of 0.343 watts (+15.3 dBm).

This compares favourably with a radiated power measurement of +14.4 dBm especially as the antenna gain / loss has not been considered as the client has not supplied this information.

The FCC grant for the Bluetooth transmitter lists a maximum conducted power of 0.0068 watts (+8.3 dBm).

This does not compare favourably with the a maximum radiated power measurement of +11.5 dBm however the antenna gain / loss has not been considered as the client has not supplied this information.

However for both transmitters the power level measured complies with the FCC limit for this type of equipment in this band and the radiated power measured does not exceed the FCC grant conducted power levels.

Result: Complies.
Measurement Uncertainty: ± 4.1 dB

Section 15.247 (d) – Out of band emissions

Spurious emissions and restricted band radiated emission measurements

Testing was carried out at EMC Technologies NZ Ltd Open Area Test Site, which is located at Driving Creek, Orere Point, Auckland.

Radiated emission measurements were carried out with the limits as per section 15.209 applied when these emissions fell within the restricted bands.

Measurements below 1000 MHz were made using a Quasi Peak Detector with a bandwidth of 120 kHz.

The transmitter was placed on the test table top which was a total of 1.5 m above the test site ground plane as the device was being measured above 1000 MHz.

Measurements above 1000 MHz were made using an average detector with a bandwidth of 1.0 MHz and also a peak detector with a bandwidth of 1.0 MHz.

Observations were made of the harmonic emissions generated by the WiFi and Bluetooth transmitters.

Additional observations were band around the band edges when the transmitters were transmitting simultaneously and also to determine if any inter-modulation products were being generated as a result of the interaction between the two transmitter modules.

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.

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

Level (dBμV/m) = Receiver Reading (dBμV) + Antenna Factor (dB/m) + Coax Loss (dB) – Amplifier Gain (dB)

Result: Complies
Measurement uncertainty: ± 4.1 dB

Results:

General emissions

Measurements below 1000 MHz were made with a laptop computer attached to the serial serial port on the device using a USB adaptor.

When installed this device would not normally be attached to a laptop computer but it would be attached the host device electronics.

Above 1000 MHz measurements were made with the serial cable terminated with a resistive load and the computer was not attached.

Frequency (MHz)	Vertical (dBuV/m)	Horizontal (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Result	Detector	Antenna Polarisation
30.929	30.7	28.2	40.0	9.3	Pass	QP	Vertical
59.755	37.7	19.6	40.0	2.3	Pass	QP	Vertical
71.000	35.1	18.0	40.0	4.9	Pass	QP	Vertical
189.619		27.6	43.5	15.9	Pass	QP	Horizontal
265.370		28.0	46.0	18.0	Pass	QP	Horizontal

All other general emissions above 265 MHz were observed to have a margin to the limit that exceeded at least 20 dB when measurements attempted using both vertical and horizontal polarisations.

Bluetooth Transmitter Harmonic Emissions

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/Hort	1 MHz
	< 46	< 46	54.0	> 8	Average	Vert/Hort	1 MHz
7206.000	< 59	< 59	74.0	> 15	Peak	Vert/Hort	1 MHz
	< 46	< 46	54.0	> 8	Average	Vert/Hort	1 MHz
9608.000	< 59	< 59	74.0	> 15	Peak	Vert/Hort	1 MHz
	< 46	< 46	54.0	> 8	Average	Vert/Hort	1 MHz
12010.000	< 59	< 59	74.0	> 15	Peak	Vert/Hort	1 MHz
	< 46	< 46	54.0	> 8	Average	Vert/Hort	1 MHz
14413.000	< 59	< 59	74.0	> 15	Peak	Vert/Hort	1 MHz
	< 46	< 46	54.0	> 8	Average	Vert/Hort	1 MHz
16814.000	< 59	< 59	74.0	> 15	Peak	Vert/Hort	1 MHz
	< 46	< 46	54.0	> 8	Average	Vert/Hort	1 MHz
19216.000	< 59	< 59	74.0	> 15	Peak	Vert/Hort	1 MHz
	< 46	< 46	54.0	> 8	Average	Vert/Hort	1 MHz
21618.000	< 59	< 59	74.0	> 15	Peak	Vert/Hort	1 MHz
	< 46	< 46	54.0	> 8	Average	Vert/Hort	1 MHz
24020.000	< 59	< 59	74.0	> 15	Peak	Vert/Hort	1 MHz
	< 46	< 46	54.0	> 8	Average	Vert/Hort	1 MHz

Bluetooth Transmitter Harmonic Emissions

Transmitting on 2426 MHz

Frequency (MHz)	Vertical (dBuV/m)	Horizontal (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Antenna	BW
4852.000	< 59	< 59	74.0	> 15	Peak	Vert/Hort	1 MHz
	< 46	< 46	54.0	> 8	Average	Vert/Hort	1 MHz
7278.000	< 59	< 59	74.0	> 15	Peak	Vert/Hort	1 MHz
	< 46	< 46	54.0	> 8	Average	Vert/Hort	1 MHz
9704.000	< 59	< 59	74.0	> 15	Peak	Vert/Hort	1 MHz
	< 46	< 46	54.0	> 8	Average	Vert/Hort	1 MHz
12130.000	< 59	< 59	74.0	> 15	Peak	Vert/Hort	1 MHz
	< 46	< 46	54.0	> 8	Average	Vert/Hort	1 MHz
14556.000	< 59	< 59	74.0	> 15	Peak	Vert/Hort	1 MHz
	< 46	< 46	54.0	> 8	Average	Vert/Hort	1 MHz
16982.000	< 59	< 59	74.0	> 15	Peak	Vert/Hort	1 MHz
	< 46	< 46	54.0	> 8	Average	Vert/Hort	1 MHz
19408.000	< 59	< 59	74.0	> 15	Peak	Vert/Hort	1 MHz
	< 46	< 46	54.0	> 8	Average	Vert/Hort	1 MHz
21834.000	< 59	< 59	74.0	> 15	Peak	Vert/Hort	1 MHz
	< 46	< 46	54.0	> 8	Average	Vert/Hort	1 MHz
24260.000	< 59	< 59	74.0	> 15	Peak	Vert/Hort	1 MHz
	< 46	< 46	54.0	> 8	Average	Vert/Hort	1 MHz

Bluetooth Transmitter Harmonic Emissions

Transmitting on 2480 MHz

Frequency (MHz)	Vertical (dBuV/m)	Horizontal (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Antenna	BW
4960.000	< 59	< 59	74.0	> 15	Peak	Vert/Hort	1 MHz
	< 46	< 46	54.0	> 8	Average	Vert/Hort	1 MHz
7440.000	< 59	< 59	74.0	> 15	Peak	Vert/Hort	1 MHz
	< 46	< 46	54.0	> 8	Average	Vert/Hort	1 MHz
9920.000	< 59	< 59	74.0	> 15	Peak	Vert/Hort	1 MHz
	< 46	< 46	54.0	> 8	Average	Vert/Hort	1 MHz
12400.000	< 59	< 59	74.0	> 15	Peak	Vert/Hort	1 MHz
	< 46	< 46	54.0	> 8	Average	Vert/Hort	1 MHz
14880.000	< 59	< 59	74.0	> 15	Peak	Vert/Hort	1 MHz
	< 46	< 46	54.0	> 8	Average	Vert/Hort	1 MHz
17360.000	< 59	< 59	74.0	> 15	Peak	Vert/Hort	1 MHz
	< 46	< 46	54.0	> 8	Average	Vert/Hort	1 MHz
19840.000	< 59	< 59	74.0	> 15	Peak	Vert/Hort	1 MHz
	< 46	< 46	54.0	> 8	Average	Vert/Hort	1 MHz
22320.000	< 59	< 59	74.0	> 15	Peak	Vert/Hort	1 MHz
	< 46	< 46	54.0	> 8	Average	Vert/Hort	1 MHz
24800.000	< 59	< 59	74.0	> 15	Peak	Vert/Hort	1 MHz
	< 46	< 46	54.0	> 8	Average	Vert/Hort	1 MHz

WiFi Transmitter

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/Hort	1 MHz
	< 46	< 46	54.0	> 8	Average	Vert/Hort	1 MHz
7236.000	< 59	< 59	74.0	> 15	Peak	Vert/Hort	1 MHz
	< 46	< 46	54.0	> 8	Average	Vert/Hort	1 MHz
9648.000	< 59	< 59	74.0	> 15	Peak	Vert/Hort	1 MHz
	< 46	< 46	54.0	> 8	Average	Vert/Hort	1 MHz
12060.000	< 59	< 59	74.0	> 15	Peak	Vert/Hort	1 MHz
	< 46	< 46	54.0	> 8	Average	Vert/Hort	1 MHz
14472.000	< 59	< 59	74.0	> 15	Peak	Vert/Hort	1 MHz
	< 46	< 46	54.0	> 8	Average	Vert/Hort	1 MHz
16884.000	< 59	< 59	74.0	> 15	Peak	Vert/Hort	1 MHz
	< 46	< 46	54.0	> 8	Average	Vert/Hort	1 MHz
19296.000	< 59	< 59	74.0	> 15	Peak	Vert/Hort	1 MHz
	< 46	< 46	54.0	> 8	Average	Vert/Hort	1 MHz
21708.000	< 59	< 59	74.0	> 15	Peak	Vert/Hort	1 MHz
	< 46	< 46	54.0	> 8	Average	Vert/Hort	1 MHz
24120.000	< 59	< 59	74.0	> 15	Peak	Vert/Hort	1 MHz
	< 46	< 46	54.0	> 8	Average	Vert/Hort	1 MHz

WiFi Transmitter

Transmitting on 2462 MHz

Frequency (MHz)	Vertical (dBuV/m)	Horizontal (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Antenna	BW
4924.000	< 59	< 59	74.0	> 15	Peak	Vert/Hort	1 MHz
	< 46	< 46	54.0	> 8	Average	Vert/Hort	1 MHz
7386.000	< 59	< 59	74.0	> 15	Peak	Vert/Hort	1 MHz
	< 46	< 46	54.0	> 8	Average	Vert/Hort	1 MHz
9848.000	< 59	< 59	74.0	> 15	Peak	Vert/Hort	1 MHz
	< 46	< 46	54.0	> 8	Average	Vert/Hort	1 MHz
12310.000	< 59	< 59	74.0	> 15	Peak	Vert/Hort	1 MHz
	< 46	< 46	54.0	> 8	Average	Vert/Hort	1 MHz
14772.000	< 59	< 59	74.0	> 15	Peak	Vert/Hort	1 MHz
	< 46	< 46	54.0	> 8	Average	Vert/Hort	1 MHz
17234.000	< 59	< 59	74.0	> 15	Peak	Vert/Hort	1 MHz
	< 46	< 46	54.0	> 8	Average	Vert/Hort	1 MHz
19696.000	< 59	< 59	74.0	> 15	Peak	Vert/Hort	1 MHz
	< 46	< 46	54.0	> 8	Average	Vert/Hort	1 MHz
22158.000	< 59	< 59	74.0	> 15	Peak	Vert/Hort	1 MHz
	< 46	< 46	54.0	> 8	Average	Vert/Hort	1 MHz
24620.000	< 59	< 59	74.0	> 15	Peak	Vert/Hort	1 MHz
	< 46	< 46	54.0	> 8	Average	Vert/Hort	1 MHz

Inter-modulation emissions

No inter-modulation emissions were observed when the Bluetooth and WiFi transmitter modules were transmitting continuously.

Observations were made between 30 MHz - 25 GHz using either a Quasi Peak or a Peak and an Average detector with a measurement antenna in either horizontal of vertical polarisation when the Bluetooth transmitter was continuously advertising on 2402, 2426 and 2480 MHz continuously when the WiFi transmitter was manually made to transmit on 2412 MHz,

Bandedge Measurements

Measurements were made in the laboratory to ensure that the -20 dBc band edge requirements were met by the Bluetooth device when transmitting on 2402 MHz and 2480 MHz and when the WiFi device was operating on 2412 MHz and 2462 MHz.

The -20 dB bandwidth of both devices are required to be contained within the band of 2400.0 - 2483.5 MHz

Relative Bluetooth measurements were made using radiated techniques.

Measurements on the WiFi transmitter were made directly at the antenna port.

Measurements were made using a peak detector with a 100 kHz bandwidth

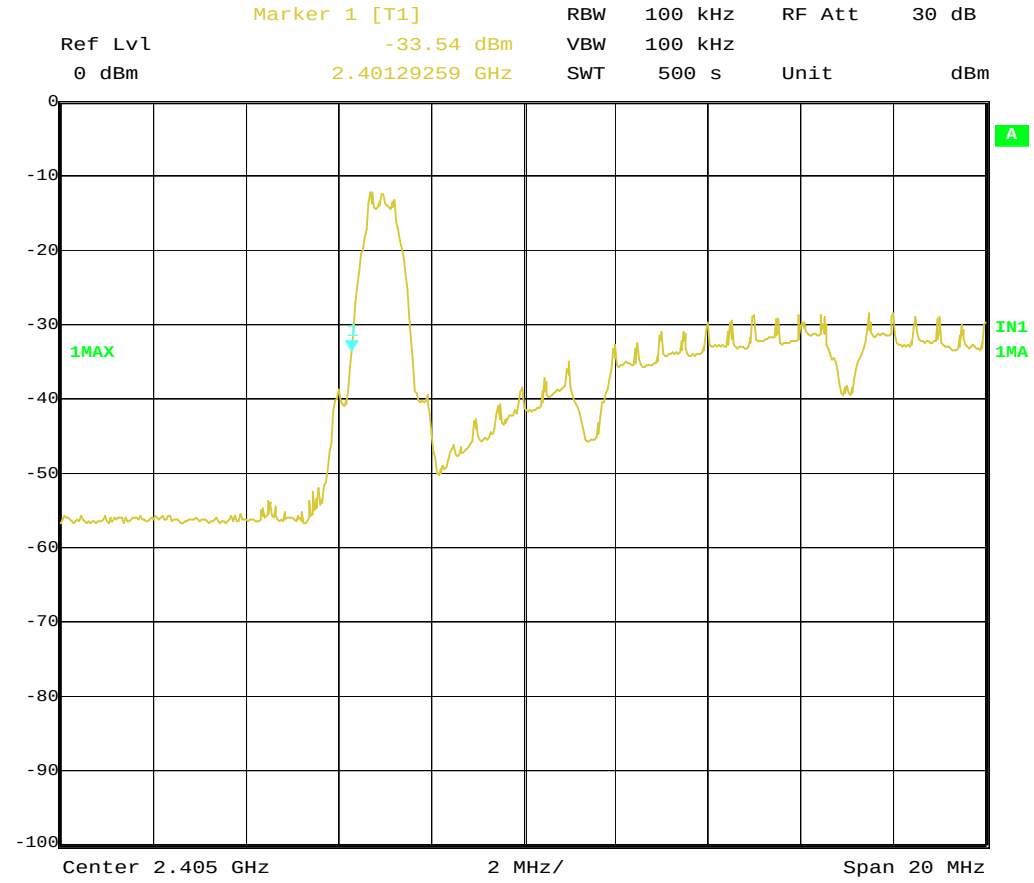
The following results were recorded

Bluetooth Tx	2402 MHz	2480 MHz
Bandedge	2401.293 MHz	2480.611 MHz
Limit	2400.000 MHz	2483.500 MHz

WiFi Tx	2412 MHz	2462 MHz
Bandedge	2402.982 MHz	2470.938 MHz
Limit	2400.000 MHz	2483.500 MHz

Result: Complies

Bluetooth transmitter on 2402 MHz



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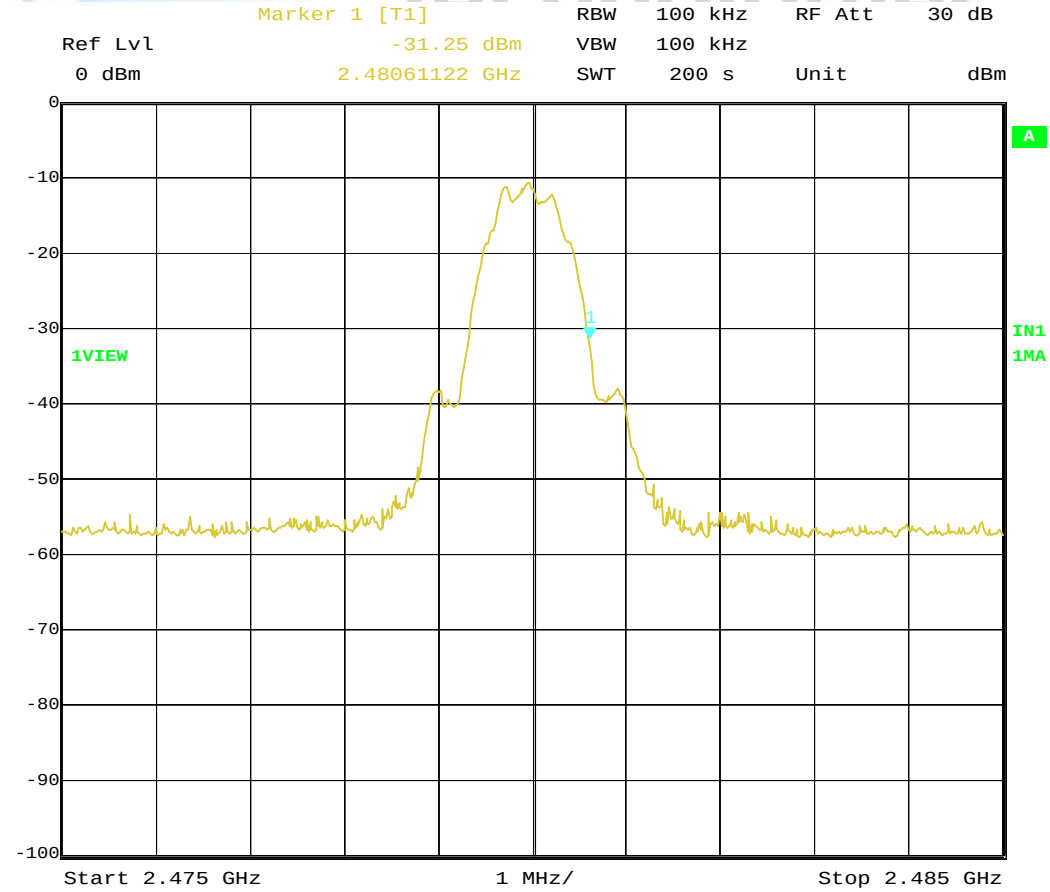
Bluetooth transmitter on 2480 MHz



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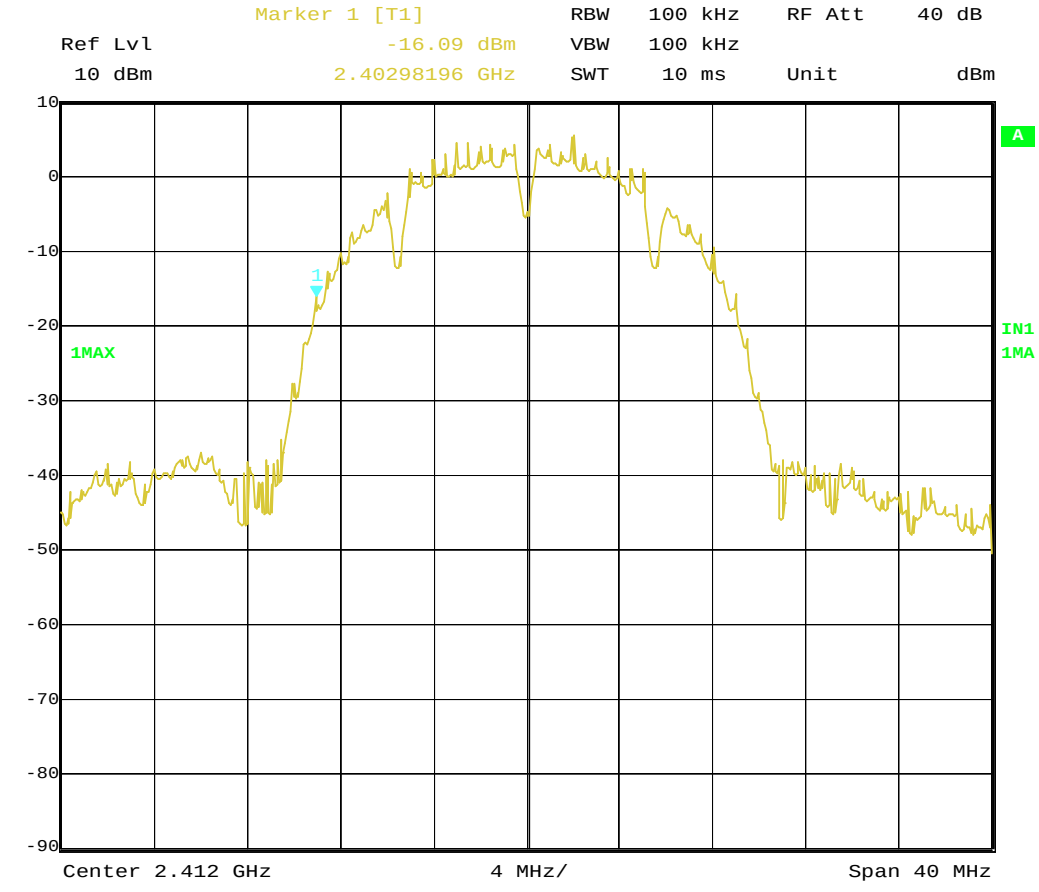
WiFi transmitter on 2412 MHz



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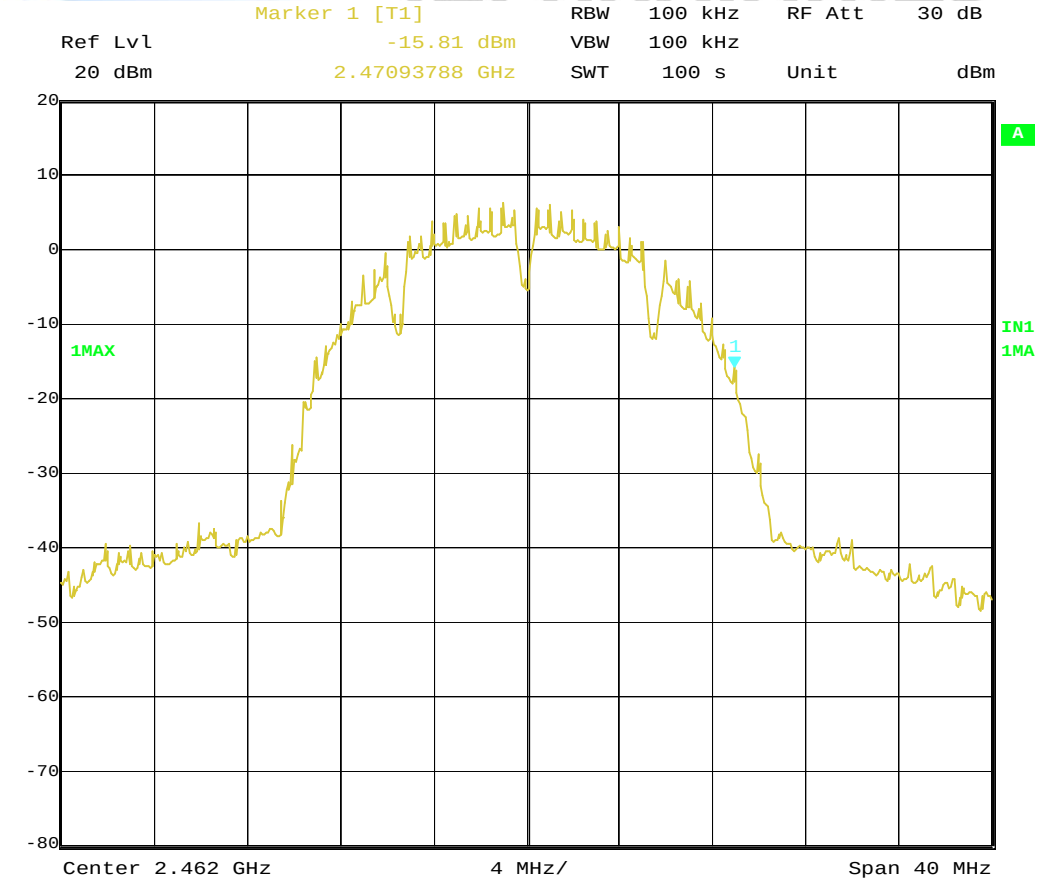
WiFi transmitter on 2462 MHz



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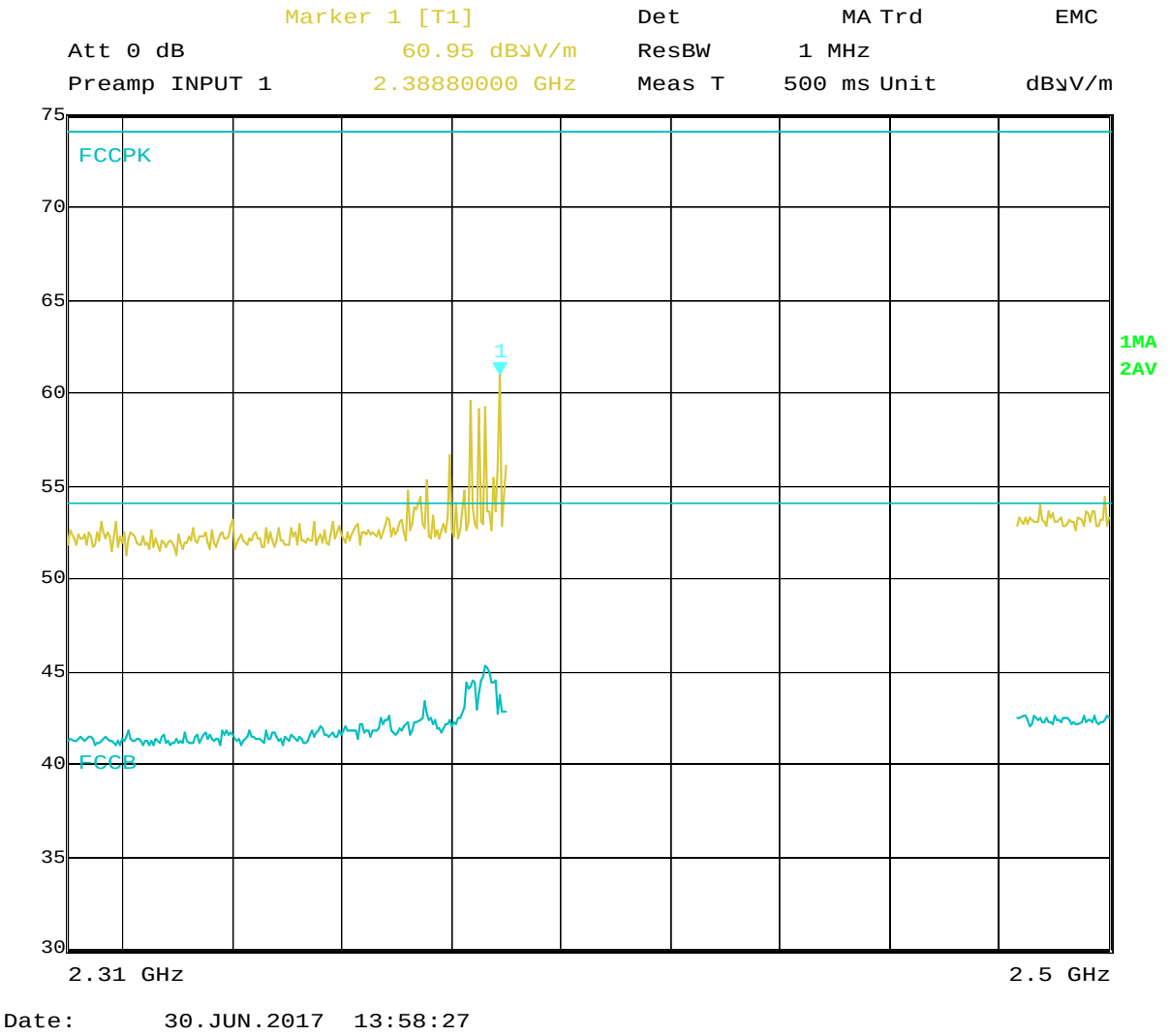
2310 - 2390 MHz and 2483.5 – 2500.0 MHz Restricted Band Measurements

When the Bluetooth device was transmitting alternately on 2402, 2426 and 2480 MHz and the WiFi device was transmitting on 2412 MHz radiated emission measurements were made at the open area test site in the 2310 - 2390 MHz restricted band and in the 2483.5 – 2500 MHz restricted band to determine compliance.

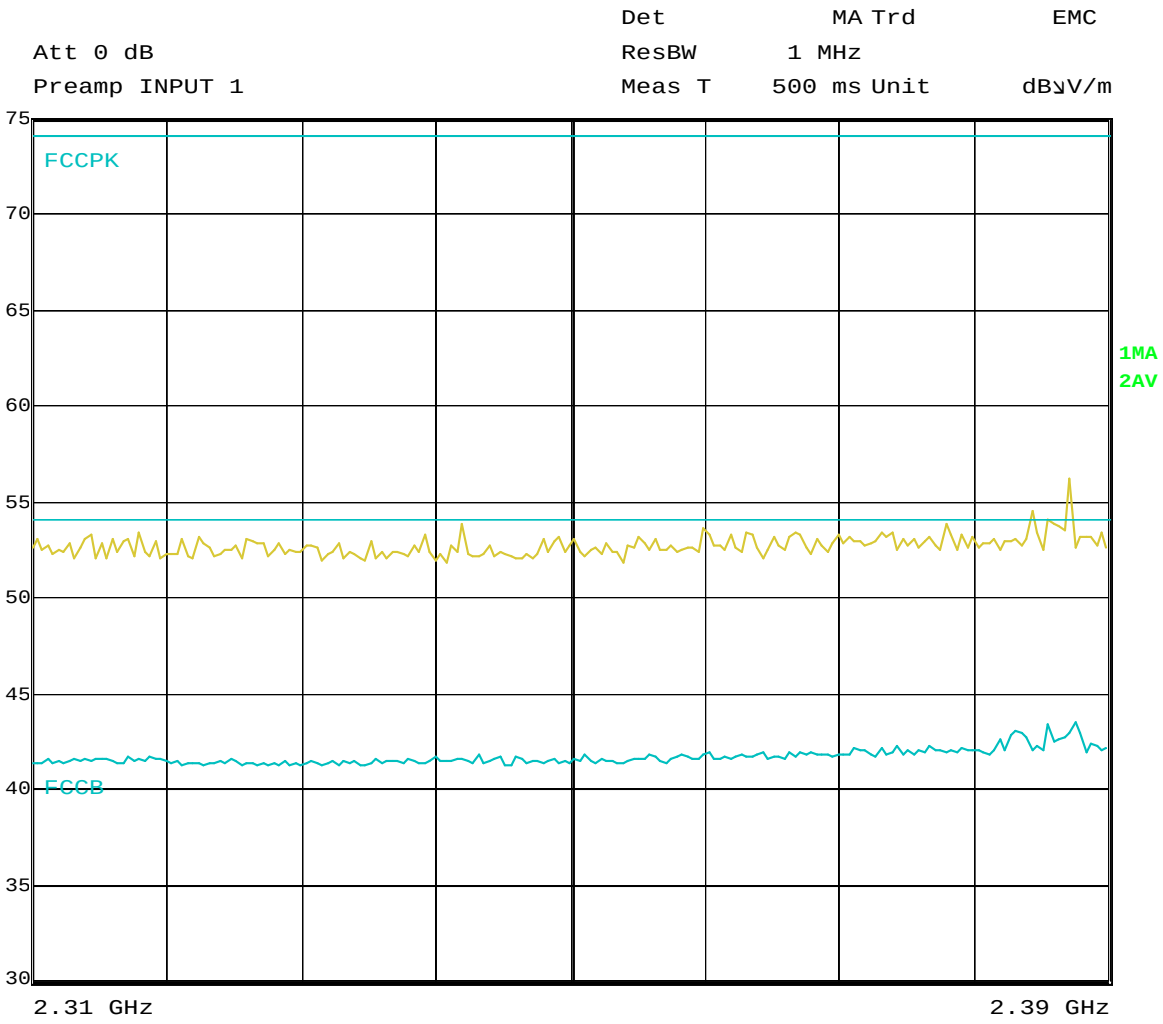
Measurements were made using a scanning measuring receiver that scanned between 2310 - 2390 MHz and between 2483.5 - 2500.0 MHz using both an Average and a Peak detector with a 1 MHz bandwidth in peak hold mode when the device was rotated and height scanned.

2310 - 2390 MHz and 2483.5 - 2500.0 MHz. Vertical polarisation



Frequency (MHz)	Vertical (dBuV/m)	Horizontal (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Antenna	BW
2386.000	45.3		54.0	9.7	Average	Vertical	1 MHz
2388.800	61.0		74.0	13.0	Peak	Vertical	1 MHz

2310 - 2390 MHz Horizontal polarisation.



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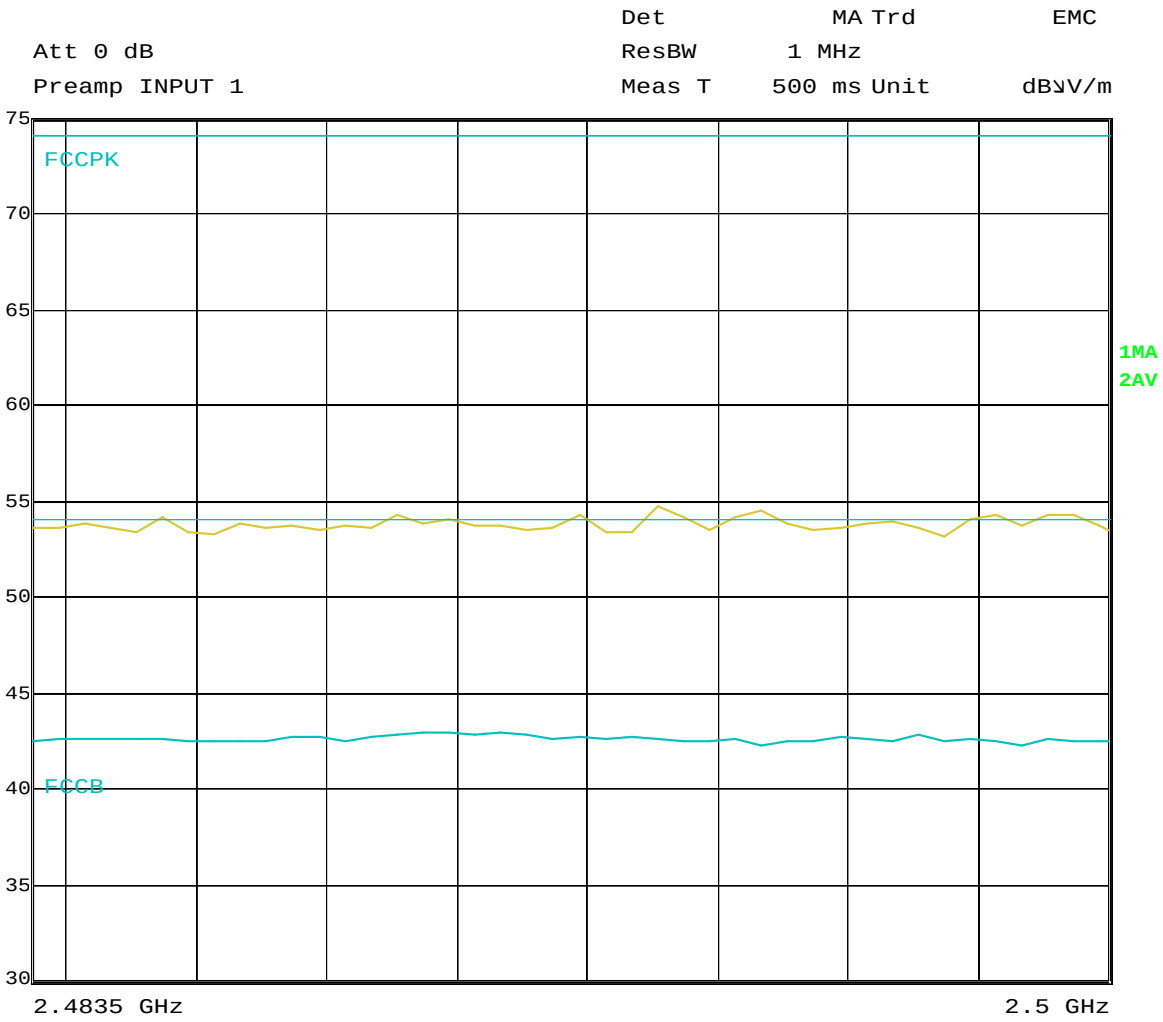
2483.5 - 2500 MHz Horizontal polarisation.



All measurements were attempted at a distance of 3 metres using vertical and horizontal polarisations with a peak and an average detector with a 1 MHz bandwidth was used.

As per section 15.209 a limit of 500 uV/m applies to the restricted band emissions when an average detector is used.

This limit has been converted to dBuV/m using the formula 20 * (log 500) with a factor of + 20 dB being added to determine the peak limit.

Result: Complies.

Measurement uncertainty with a confidence interval of 95% is:

- Free radiation tests (30 – 25,000 MHz) ± 4.1 dB

Section 15.247(i) – Radio Frequency Hazard Information

As per Section 15.247 (i) spread spectrum transmitters operating in the 2400.0 – 2483.5 MHz band are required to be operated in a manner that ensures that the public is not exposed to RF energy levels in accordance with CFR 47, Section 1.1307(b)(1).

The device when in operation is fixed inside a host device and a safe distance could be maintained when it is operated as a IoT Bridge.

In accordance with Section 1.1310 the Maximum Permissible Exposure (MPE) limits for the General Population / Uncontrolled Exposure of 1.0 mW/cm^2 has been applied.

Power density, $mW/cm^2 = E^2/3770$
E for MPE: $0.615 = E^2/3770$

$E = \sqrt{1.0*3770}$

$E = 61.4$ V/m

The maximum distance from the antenna at which the MPE is met or exceeded is calculated from the equation relating field strength in V/m, transmit power in watts, transmit antenna gain and separation distance in metres.

The highest radiated power has been measured to be +14.4 dBm or 0.0275 watts (27.5 mW) EIRP from the WiFi transmitter.

The power output of the Bluetooth transmitter was not considered as the measured radiated power of -11.5 dBm (0.07 mW) is not significant and would not make a significant contribution to the overall power output of the device.

Therefore:

$E = \sqrt{(30 * P * G) / d}$

$d = \sqrt{(30 * P * G) / E}$

$d = \sqrt{(30 * 0.0245) / 61.4}$

$d = 0.0148$ m or 1.5 cm

Result: Complies if a minimum safe distance of 20 cm is specified in the set up instructions for this system.

7. TEST EQUIPMENT USED

Instrument	Manufacturer	Model	Serial No	Asset Ref	Cal Due	Period
Aerial Controller	EMCO	1090	9112-1062	RFS 3710	Not applic	Not applic
Aerial Mast	EMCO	1070-1	9203-1661	RFS 3708	Not applic	Not applic
Biconical Antenna	Schwarzbeck	BBA 9106	-	3680	3 Feb 2018	3 years
Horn Antenna	EMCO	3115	9511-4629	E1526	4 June 2018	3 years
Horn Antenna	EMCO	3116	92035	E1527	10 June 2019	3 years
Log Periodic	Schwarzbeck	VUSLP 9111	9111-228	3785	1 Dec 2017	3 years
Loop Antenna	EMCO	6502	9003-2485	3798	4 July 2018	1 year
Mains Network	R & S	ESH2-Z5	881362/032	3628	2 Oct 2017	2 years
Receiver	R & S	ESHS 10	828404/005	3728	9 June 2018	2 years
Receiver	R & S	ESIB 40	100295	INV0818	28 Aug 2018	1 year
Turntable	EMCO	1080-1-2.1	9109-1578	RFS 3709	Not applic	Not applic
VHF Balun	Schwarzbeck	VHA 9103	9594	3696	3 Feb 2018	3 years

At the time of testing all test equipment was within calibration

8. ACCREDITATIONS

Testing was carried out in accordance with EMC Technologies Ltd registration with the Federal Communications Commission as a listed facility, registration number: 90838, which was last updated on September 30th 2016.

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

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

International Accreditation New Zealand has 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.

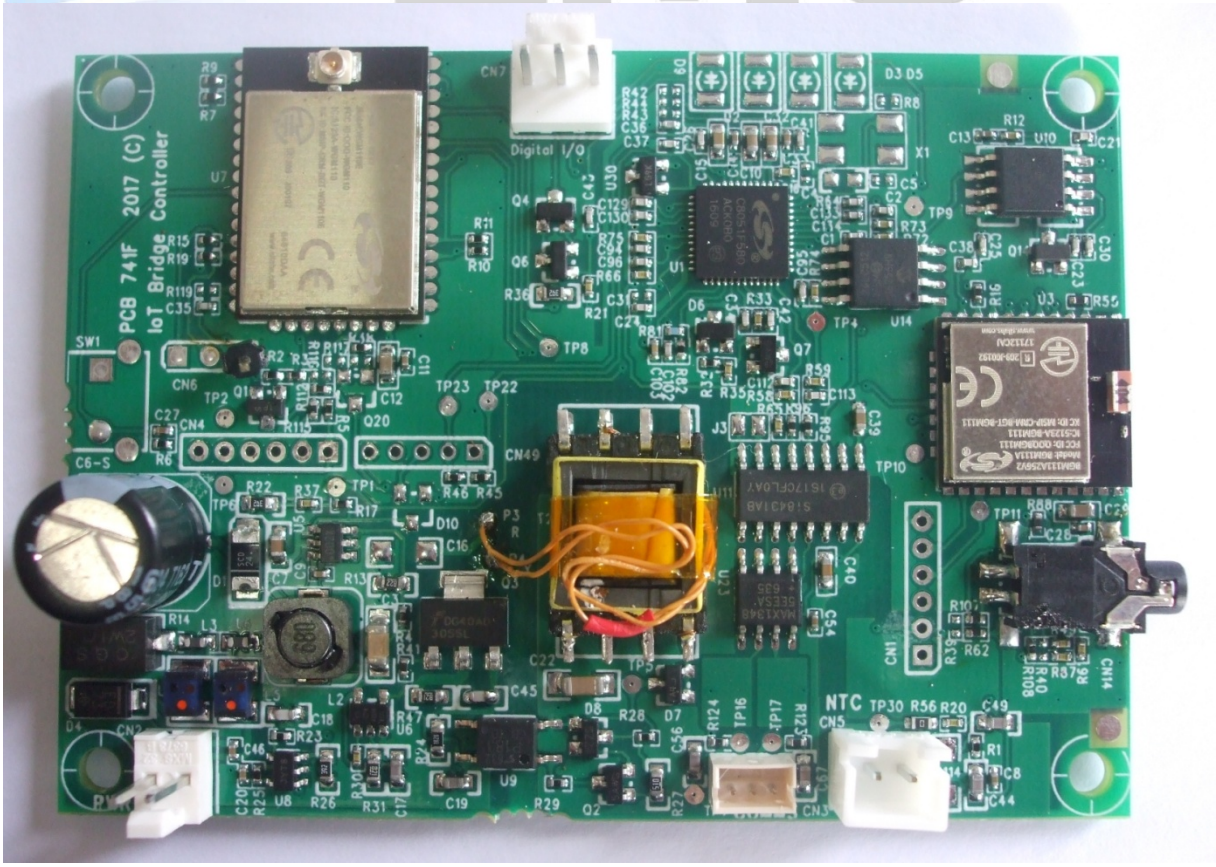
9. PHOTOGRAPHS

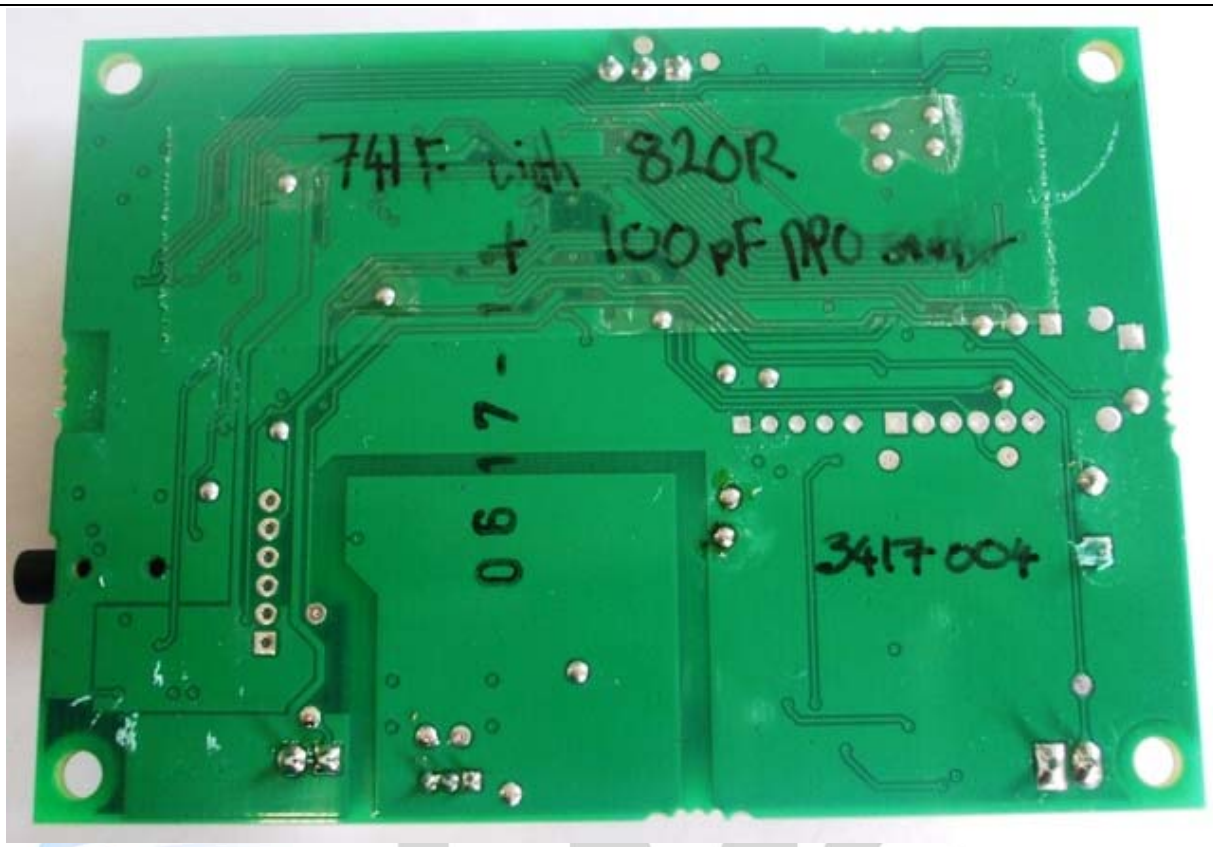
External Photos

Antenna details

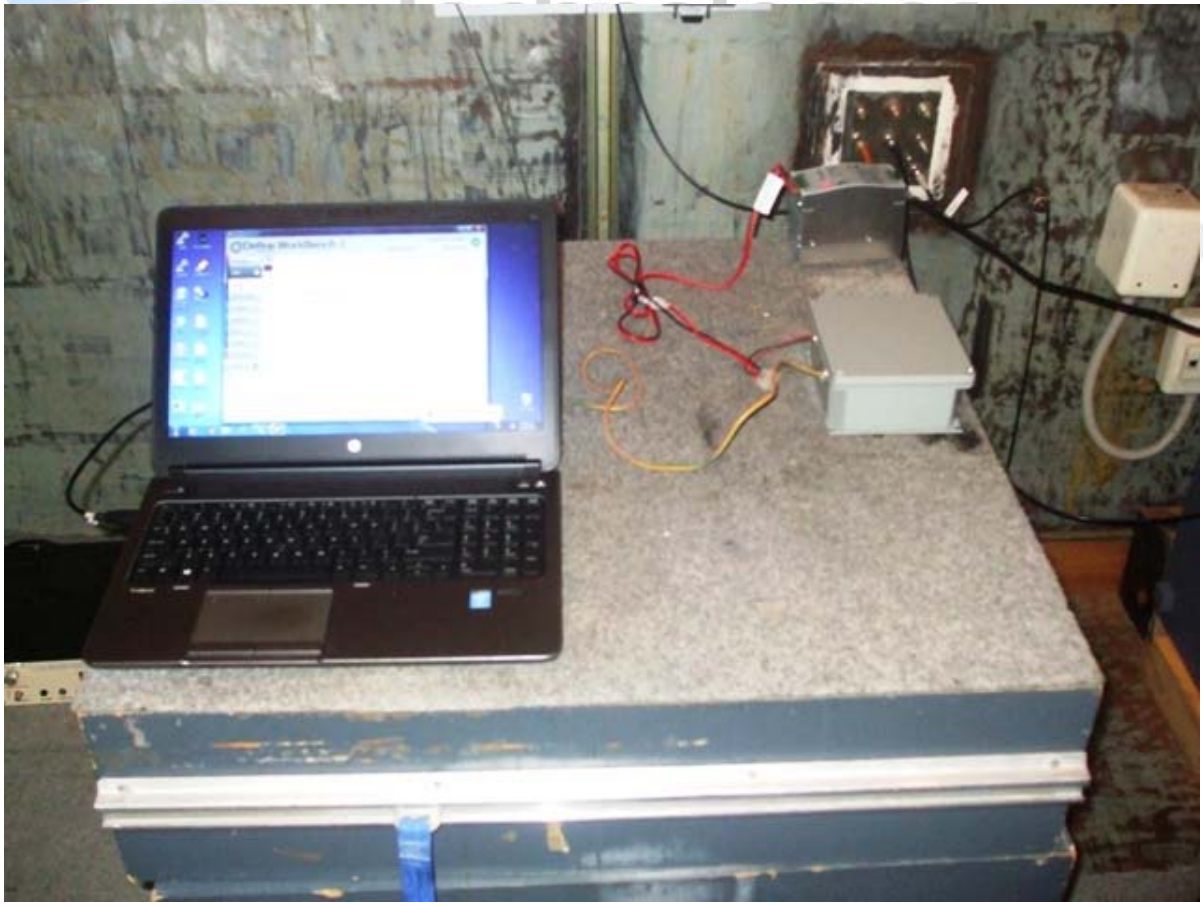
Reverse SMA antenna Connector

Internal Photo





Conducted emissions test set up



Radiated emissions test set up – Below 1000 MHz (80 cm test height)

Radiated emissions test set up – Above 1000 MHz (150 cm test height)