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TEST REPORT

Define Point 2 Point Remote Monitoring Transceiver

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

A handwritten signature in black ink, appearing to read "Andrew Cutler", is placed over a light blue rectangular background.

This Test Report is issued with the authority of:

Andrew Cutler - General Manager



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 Point 2 Point (P2P) Remote Monitoring Transceiver** complies with FCC Part 15 Subpart C including Section 15.247 as an Intentional Radiator when the methods as described in ANSI C63.4 - 2003 and those defined in FCC KDB 558074 D01 v03r02.

2. RESULTS SUMMARY

The results of testing carried out during April 2014 are detailed below:

Clause	Parameter	Result
15.201	Equipment authorisation requirement	Certification required.
15.203	Antenna requirement	Complies.
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	Complies
(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	Complies
(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.

The client selected the test sample.

This report relates only to the sample tested.

This report contains no corrections or erasures.

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.

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
Model Number	Point 2 Point (P2)
Product	Remote Monitoring Transceiver
Manufacturer	Define Instruments Ltd
Country of Origin	New Zealand
Serial Number	Sample not serialized
FCC ID	2ACTT-1409

Product Description

The transceiver tested would typically have an environmental sensor attached to it, for example a temperature probe, that collects various data which is then periodically sent to an identical transceiver which would be attached to a recording / indicating / storage device of some sort.

Testing was carried out with one transceiver that was marked as the receiver and the other transceiver was marked as the transmitter.

The only difference between the test configurations was the input and output port configurations.

The device can be configured to operate on one of 15 channels using configuration software.

Band of Operation: 2400-2483.5 MHz

Number of channels: 15

Operating frequencies: 2405 – 2475 MHz

Channel spacing: 5 MHz

Rated Conducted Power: +20 dBm

Antenna Type: Omni-directional whip with unique standard SMA connector

Power Supply: External dc supply between 9 - 36 Vdc.
Typically a 12 or 24 Vdc battery

Ports: No specific ports however provision was made for the attachment of either a temperature sensor or a temperature recording / indicating / storage device.

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 C63.4 – 2003
- FCC KDB 558074 D01 v03r02

Section 15.201: Equipment authorisation requirement

Certification as detailed in Subpart J of Part 2 is required for this device.

Section 15.203: Antenna requirement

The base station uses a detachable dipole with a reverse SMA connector which meets the definition of a unique connector.

Result: Complies.

Section 15.204: External radio frequency power amplifiers and antenna modifications

An external power amplifier is 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 device tested transmits on 15 channels between 2405 MHz and 2475 MHz using digital modulation spread spectrum techniques.

Section 15.247 allows this between 2400 – 2483.5 MHz

Result: Complies.

Section 15.107: Conducted limits

Conducted emission testing has been carried out when the device was powered at 120 Vac 60 Hz using a representative AC power supply.

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 μ H / 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.

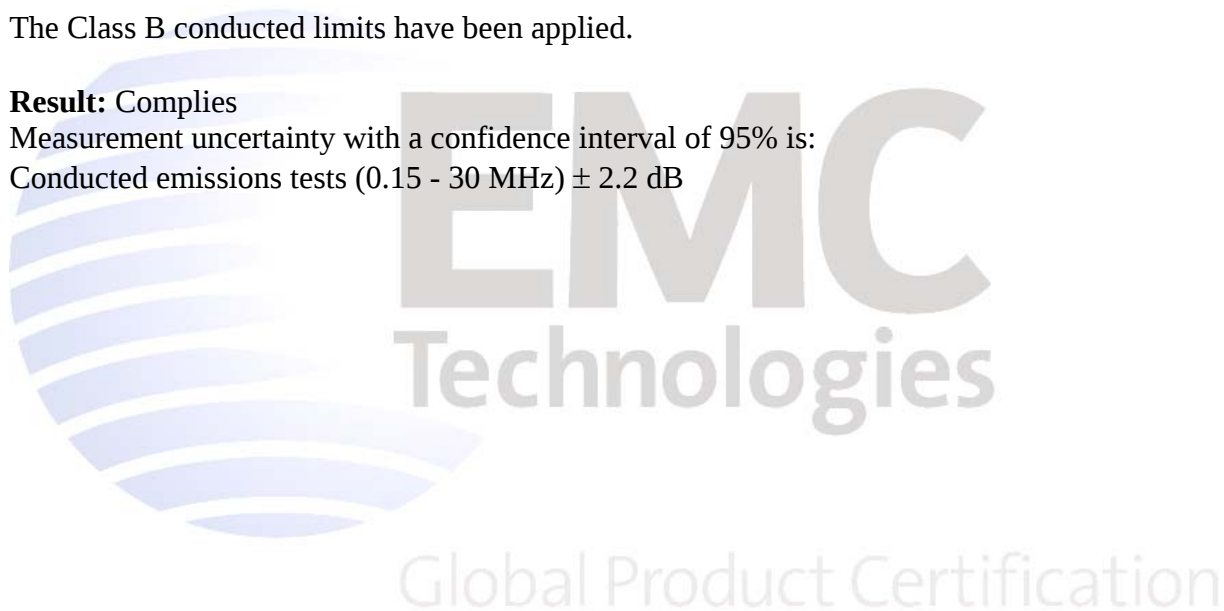
The supplied conducted emission plot is a combined plot showing the worst case of the Peak, Quasi Peak and Average levels for both phase and neutral.

The Class B conducted limits have been applied.

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

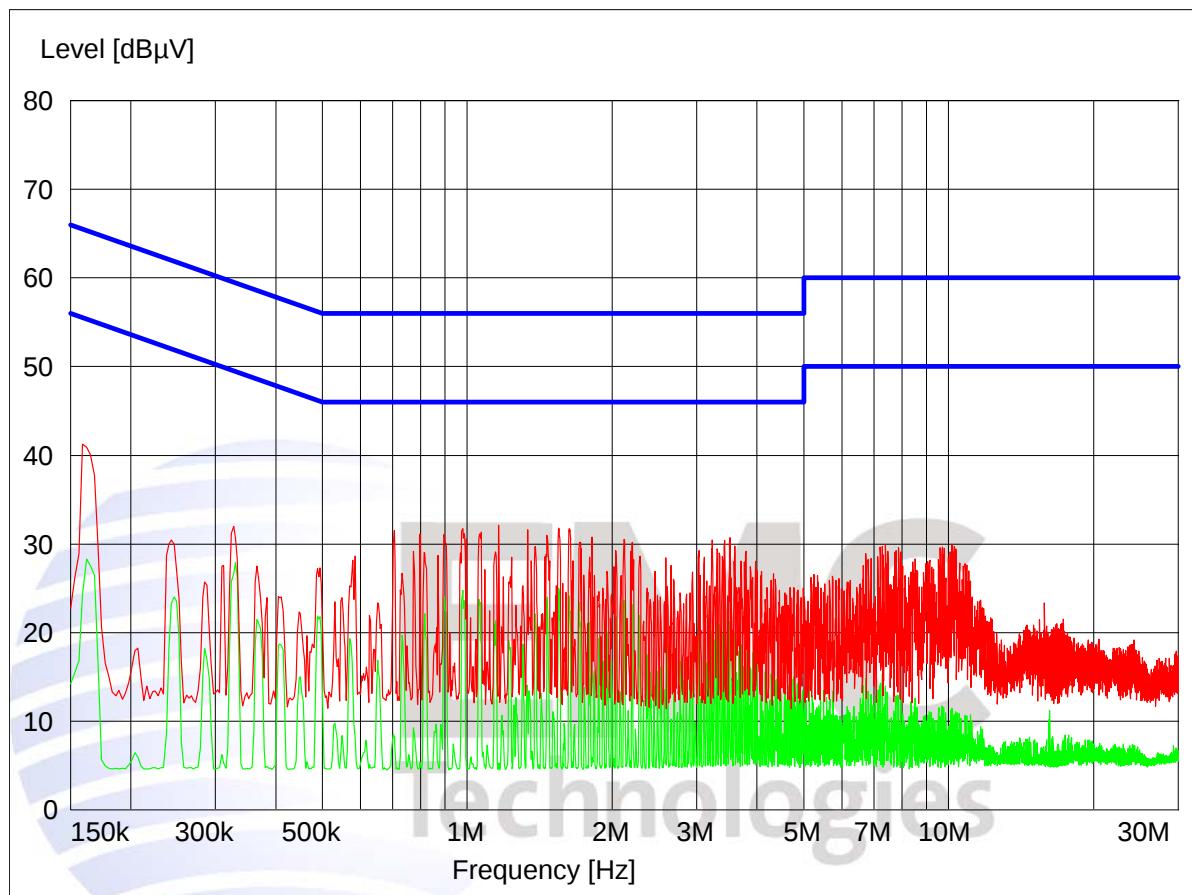
Setup: Transceiver was tested when powered at 12 Vdc using a representative AC power supply that was powered at 120 Vac 60 Hz. The transceiver was transmitting and receiving periodically on 2475 MHz.

Peak ---

Average --

Quasi Peak X

Average +



Final Quasi-Peak Measurements

Frequency MHz	Level dBμV	Limit dBμV	Margin dB	Phase	Rechecks dBμV
	No measurements recorded				

Final Average Measurements

Frequency MHz	Level dBμV	Limit dBμV	Margin dB	Phase	Rechecks dBμV
	No measurements recorded				

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(a)(2) - Minimum bandwidth

Digital devices operating in the 2400 - 2483.5 MHz band are required to have a minimum 6 dB bandwidth of 500 kHz.

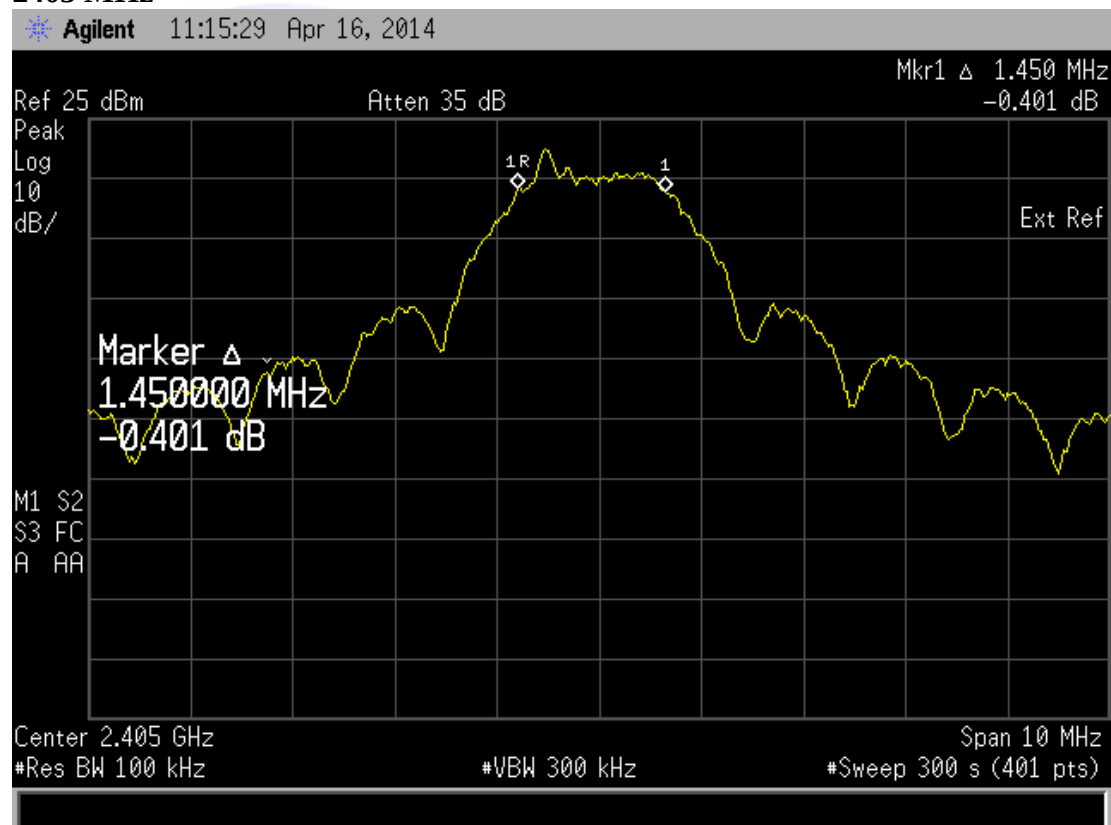
Measurements were made using a spectrum analyser operating in peak hold with a resolution bandwidth of 100 kHz.

The results are summarised as follows:

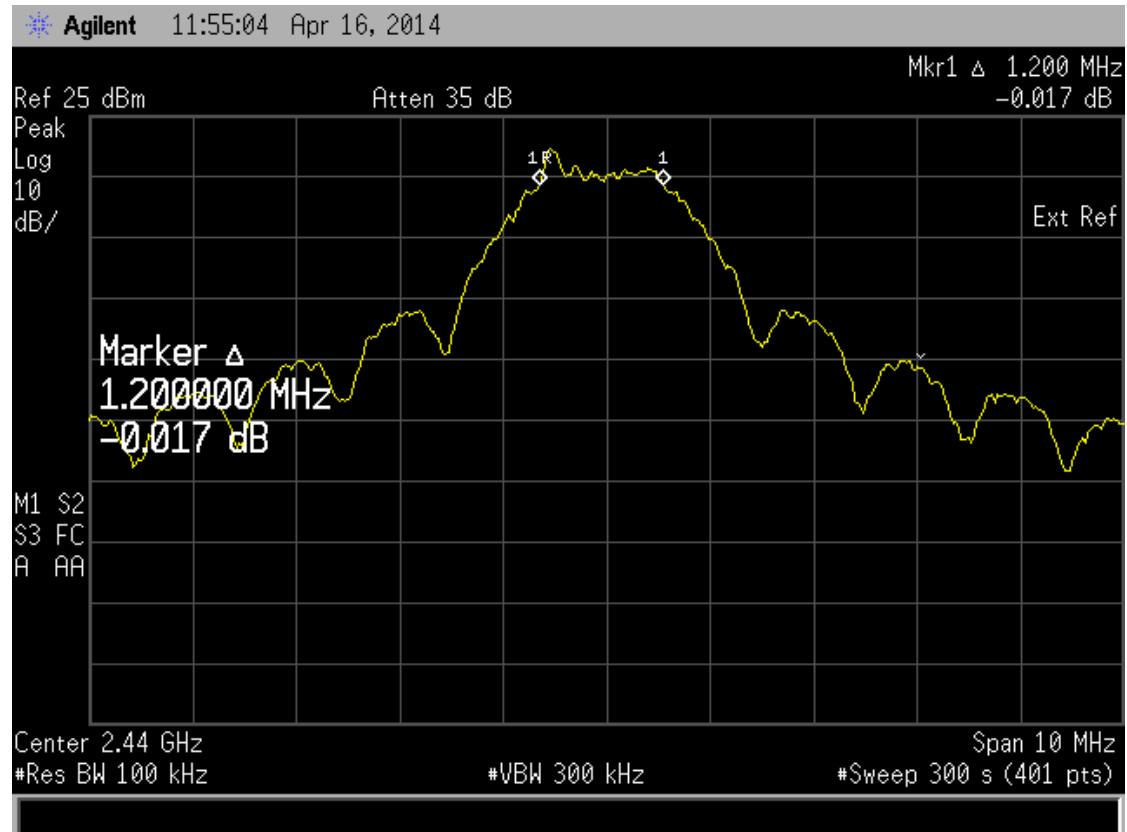
Frequency (MHz)	Bandwidth (kHz)
2405.000	1450
2440.000	1200
2475.000	1225

Result: Complies

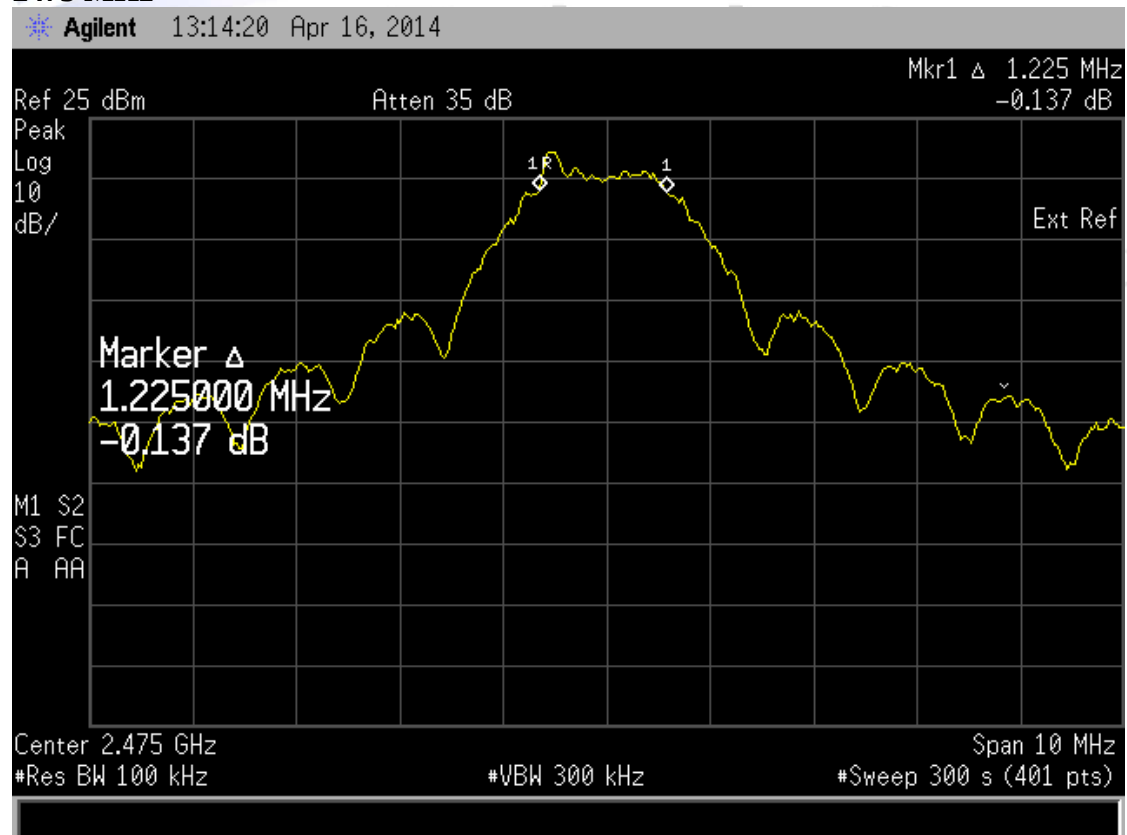
2405 MHz



2440 MHz



2475 MHz



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

Measurements were made at the antenna port using a measuring receiver with a peak detector and a resolution bandwidth of 3 MHz.

Frequency (MHz)	Level (dBm)	Power (Watts)	Limit (Watts)
2405.000	20.6	0.115	1.000
2440.000	20.1	0.102	1.000
2475.000	20.0	0.100	1.000

A conducted limit of 1.0 watt (+30 dBm) has been applied.

Radiated power measurements were also made using the supplied whip antenna on the lowest, middle and highest frequency channel using both vertical and horizontal polarisations.

Only vertical emissions have been recorded as this polarisation gave the worst case result.

Frequency (MHz)	Field Strength (dB μ V/m)	Radiated Power (dBm)	Conducted Power (dBm)	Antenna Gain (dB)
2405.000	118.3	23.1	20.6	2.5
2440.000	118.4	23.2	20.1	3.1
2475.000	118.3	23.1	20.0	3.1

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)

These calculations have been included to determine the gain / loss due to the antenna and cabling.

Testing was carried out at EMC Technologies NZ Ltd Open Area Test Site, which is located at Orere Point, Auckland, with the device being placed in the centre of the test table at a height of 80 cm above the ground plane.

Result: Complies.

Measurement Uncertainty: ± 4.1 dB

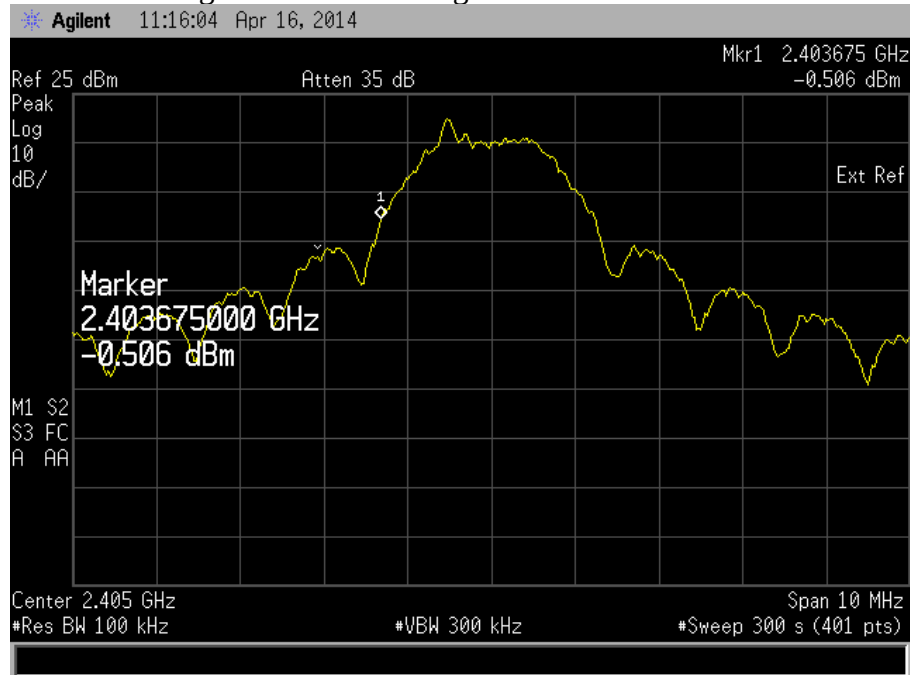
Section 15.247 (d) – Out of band emissions

Band edge measurements:

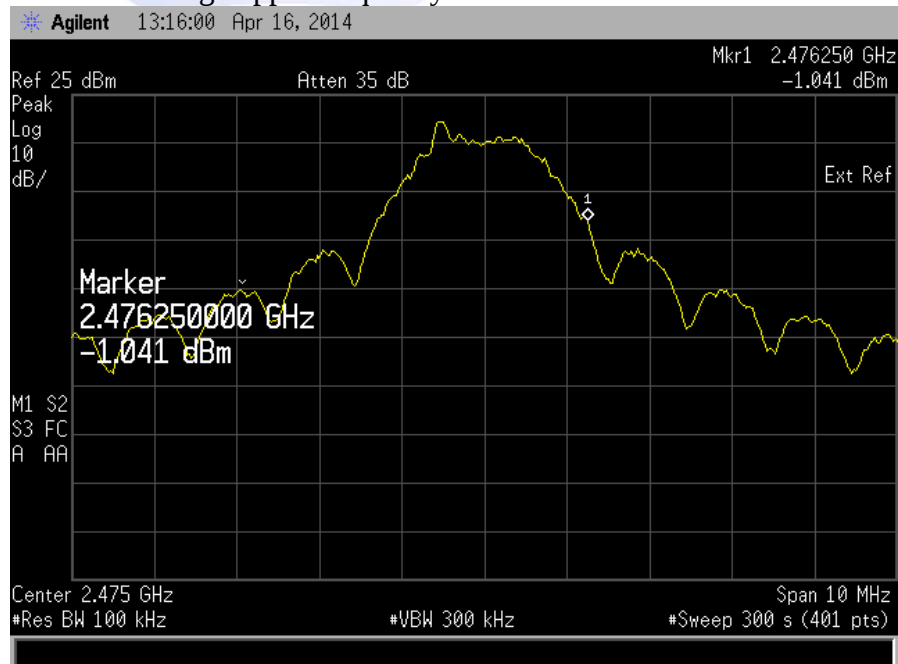
Testing was initially carried out at the antenna port with the -20 dB band-edge points being determined using a spectrum analyser with a 100 kHz resolution bandwidth when transmitting on 2405 MHz and 2475 MHz

The -20 dB band edge points were determined to be 2403.675 MHz and 2476.250 MHz

20 dB band-edge when transmitting on 2405 MHz



-20 dB bandedge upper frequency on 2475 MHz



The device is required to remain within the band of 2400 – 2483.5 MHz.

In addition radiated measurements were made in the restricted bands of 2310 – 2390 MHz and between 2483.5 – 2500 MHz where the limits as defined in section 15.209 were applied.

The following emissions were detected at the band edges when measured at a distance of three metres

The highest emission observed was on 2440 MHz using vertical polarisation with a level of 118.4 dBuV/m being recorded when a 100 kHz bandwidth peak detector was used

Transmitting on 2405 MHz

Observations made in the 2200 – 2300 MHz and 2310 – 2390 MHz restricted bands.

Frequency MHz	Vertical dBuV/m	Horizontal dBuV/m	Limit dBuV/m	Margin dB	Result	Antenna	Detector
2400.000	71.3	57.1	98.4	27.1	Pass	Vertical	Peak
2395.000	68.8	57.7	74.0	5.2	Pass	Vertical	Peak
	43.5	43.1	54.0	10.5	Pass	Vertical	Average
2320.000	64.1	55.3	74.0	9.9	Pass	Vertical	Peak
	41.9	41.9	54.0	12.1	Pass	Vertical	Average
2310.000	62.5	55.1	74.0	11.5	Pass	Vertical	Peak
	41.8	41.7	54.0	12.2	Pass	Vertical	Average

Transmitting on 2475 MHz

Observations made in the 2483.5 – 2500 MHz restricted band.

Frequency MHz	Vertical dBuV/m	Horizontal dBuV/m	Limit dBuV/m	Margin dB	Result	Antenna	Detector
2483.500	68.5	62.9	74.0	5.5	Pass	Vertical	Peak
	46.1	46.3	54.0	7.7	Pass	Horizontal	Average
2484.000	65.8	60.7	74.0	8.2	Pass	Vertical	Peak
	46.1	46.3	54.0	7.7	Pass	Horizontal	Average
2485.000	61.3	55.6	74.0	12.7	Pass	Vertical	Peak
	46.1	46.3	54.0	7.7	Pass	Horizontal	Average
2487.000	55.1		74.0	18.9	Pass	Vertical	Peak
	46.1		54.0	7.9	Pass	Vertical	Average
2500.000	43.8		74.0	30.2	Pass	Vertical	Peak
	43.5		54.0	10.5	Pass	Vertical	Average

Testing was carried out at EMC Technologies NZ Ltd Open Area Test Site, which is located at 670 Kawakawa Orere Road, Orere Point, Auckland.

Result: Complies.

Measurement Uncertainty: ± 4.1 dB

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.

All other emissions are required to meet a limit of -20 dBc with relation to the highest in band emission.

The highest emission observed was on 2440 MHz using vertical polarisation with a level of 118.4 dBuV/m recorded being recorded when a 100 kHz bandwidth peak detector was used

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

Measurements of the radiated field were attempted at 3 metres from the device with no emission being detected.

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

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.

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

Transmitting continuously on 2405 MHz

Frequency MHz	Vertical dBuV/m	Horizontal dBuV/m	Limit dBuV/m	Margin dB	Result	Antenna	Detector
4808.920	61.3	59.2	74.0	12.7	Pass	Vertical	Peak
	44.0	42.1	54.0	10.0	Pass	Vertical	Average
7213.380	58.0	58.2	74.0	15.8	Pass	Horizontal	Peak
	43.0	43.0	54.0	11.0	Pass	Vertical	Average
9617.840	59.2	61.3	98.3	37.0	Pass	Horizontal	Peak
12022.300	< 59.0	< 59.0	74.0	> 15.0	Pass	Vert/Hort	Peak
	< 46.0	< 46.0	54.0	> 8.0	Pass	Vert/Hort	Average
14426.760	< 59.0	< 59.0	98.3	> 39.3	Pass	Vert/Hort	Peak
16831.220	< 59.0	< 59.0	98.3	> 39.3	Pass	Vert/Hort	Peak
19235.680	< 59.0	< 59.0	74.0	> 15.0	Pass	Vert/Hort	Peak
	< 46.0	< 46.0	54.0	> 8.0	Pass	Vert/Hort	Average
21640.140	< 59.0	< 59.0	98.3	> 39.3	Pass	Vert/Hort	Peak
24044.600	< 59.0	< 59.0	74.0	> 15.0	Pass	Vert/Hort	Peak
	< 46.0	< 46.0	54.0	> 8.0	Pass	Vert/Hort	Average

Transmitting continuously on 2440 MHz

Frequency MHz	Vertical dBuV/m	Horizontal dBuV/m	Limit dBuV/m	Margin dB	Result	Antenna	Detector
4878.920	63.5	62.6	74.0	10.5	Pass	Vertical	Peak
	44.0	42.1	54.0	10.0	Pass	Vertical	Average
7318.380	61.5	61.3	74.0	12.5	Pass	Vertical	Peak
	43.0	43.0	54.0	11.0	Pass	Vertical	Average
9757.840	63.3	64.1	98.3	34.2	Pass	Horizontal	Peak
12197.300	< 59.0	< 59.0	74.0	> 15.0	Pass	Vert/Hort	Peak
	< 46.0	< 46.0	54.0	> 8.0	Pass	Vert/Hort	Average
14636.760	< 59.0	< 59.0	98.3	> 39.3	Pass	Vert/Hort	Peak
17076.220	< 59.0	< 59.0	98.3	> 39.3	Pass	Vert/Hort	Peak
19515.680	< 59.0	< 59.0	74.0	> 15.0	Pass	Vert/Hort	Peak
	< 46.0	< 46.0	54.0	> 8.0	Pass	Vert/Hort	Average
21955.140	< 59.0	< 59.0	98.3	> 39.3	Pass	Vert/Hort	Peak
24394.600	< 59.0	< 59.0	74.0	> 15.0	Pass	Vert/Hort	Peak
	< 46.0	< 46.0	54.0	> 8.0	Pass	Vert/Hort	Average

Transmitting continuously on 2475 MHz

Frequency MHz	Vertical dBuV/m	Horizontal dBuV/m	Limit dBuV/m	Margin dB	Result	Antenna	Detector
4948.920	62.7	62.6	74.0	11.3	Pass	Vertical	Peak
	44.0	42.1	54.0	10.0	Pass	Vertical	Average
7423.380	61.5	61.3	74.0	12.5	Pass	Vertical	Peak
	43.0	43.0	54.0	11.0	Pass	Vertical	Average
9897.840	61.9	64.1	98.3	34.2	Pass	Horizontal	Peak
12372.300	< 59.0	< 59.0	74.0	> 15.0	Pass	Vert/Hort	Peak
	< 46.0	< 46.0	54.0	> 8.0	Pass	Vert/Hort	Average
14846.760	< 59.0	< 59.0	98.3	> 39.3	Pass	Vert/Hort	Peak
17321.220	< 59.0	< 59.0	98.3	> 39.3	Pass	Vert/Hort	Peak
19795.680	< 59.0	< 59.0	74.0	> 15.0	Pass	Vert/Hort	Peak
	< 46.0	< 46.0	54.0	> 8.0	Pass	Vert/Hort	Average
22270.140	< 59.0	< 59.0	74.0	> 15.0	Pass	Vert/Hort	Peak
	< 46.0	< 46.0	54.0	> 8.0	Pass	Vert/Hort	Average
24744.600	< 59.0	< 59.0	74.0	> 15.0	Pass	Vert/Hort	Peak
	< 46.0	< 46.0	54.0	> 8.0	Pass	Vert/Hort	Average

Section 15.247(e) – Power Spectral Density

Power spectral density measurements were made at the antenna port of this transmitter.

The frequency of the highest emission was determined using a spectrum analyser with a resolution bandwidth that was slowly decreased from 1 MHz down to 3 kHz.

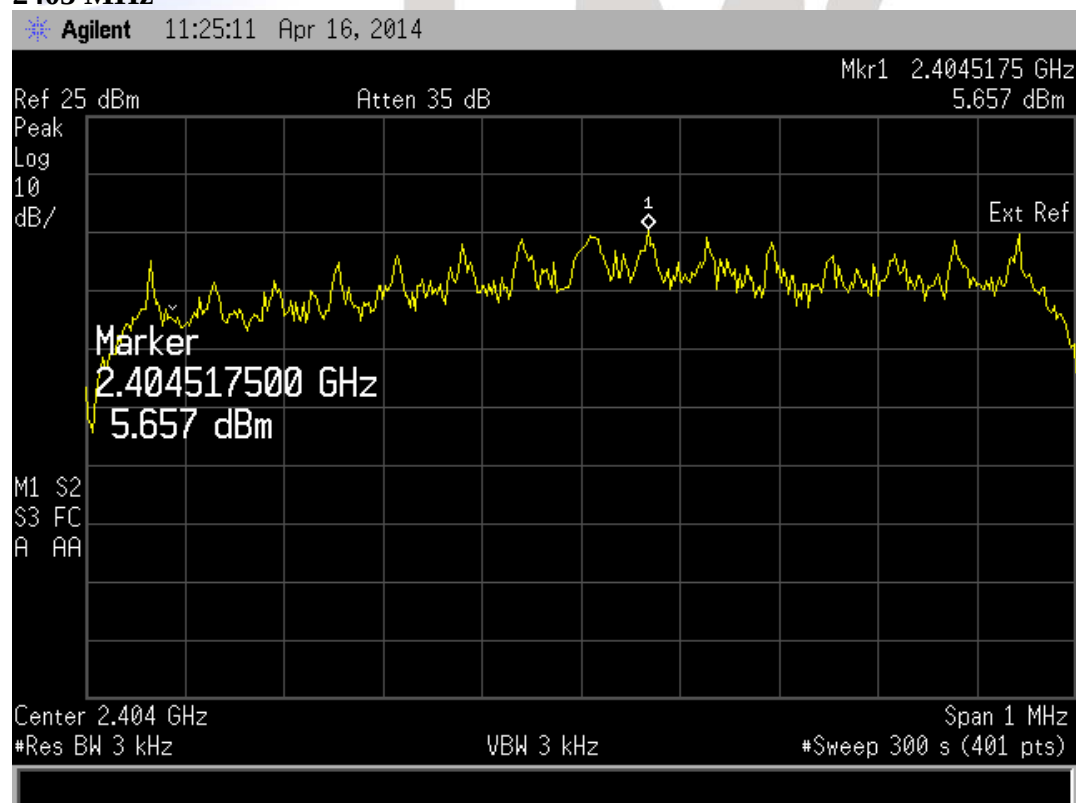
The power of the highest emission level was determined using a spectrum analyser with a resolution bandwidth of 3 kHz.

Transmit Frequency (MHz)	Emission Frequency (MHz)	Power (dBm)	Limit (dBm)
2405.000	2404.5175	5.7	8.0
2440.000	2439.4600	6.5	8.0
2475.000	2474.5225	5.1	8.0

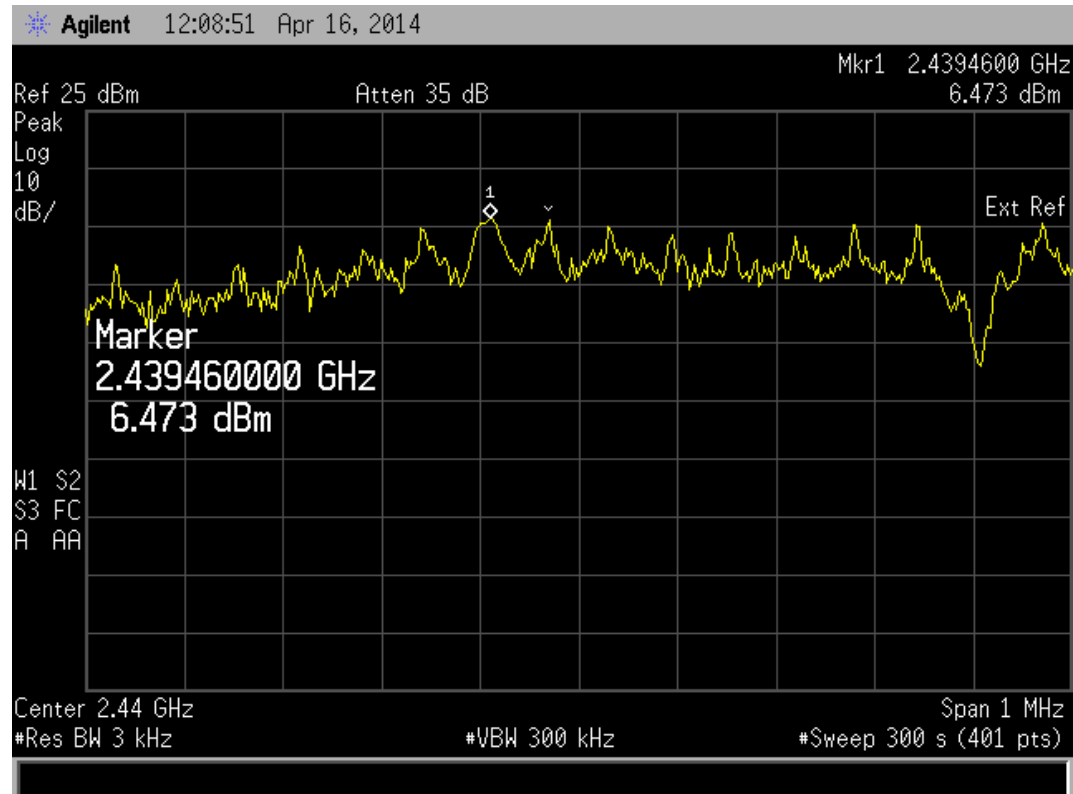
Result: Complies.

Measurement uncertainty with a confidence interval of 95% is: ± 1.5 dB.

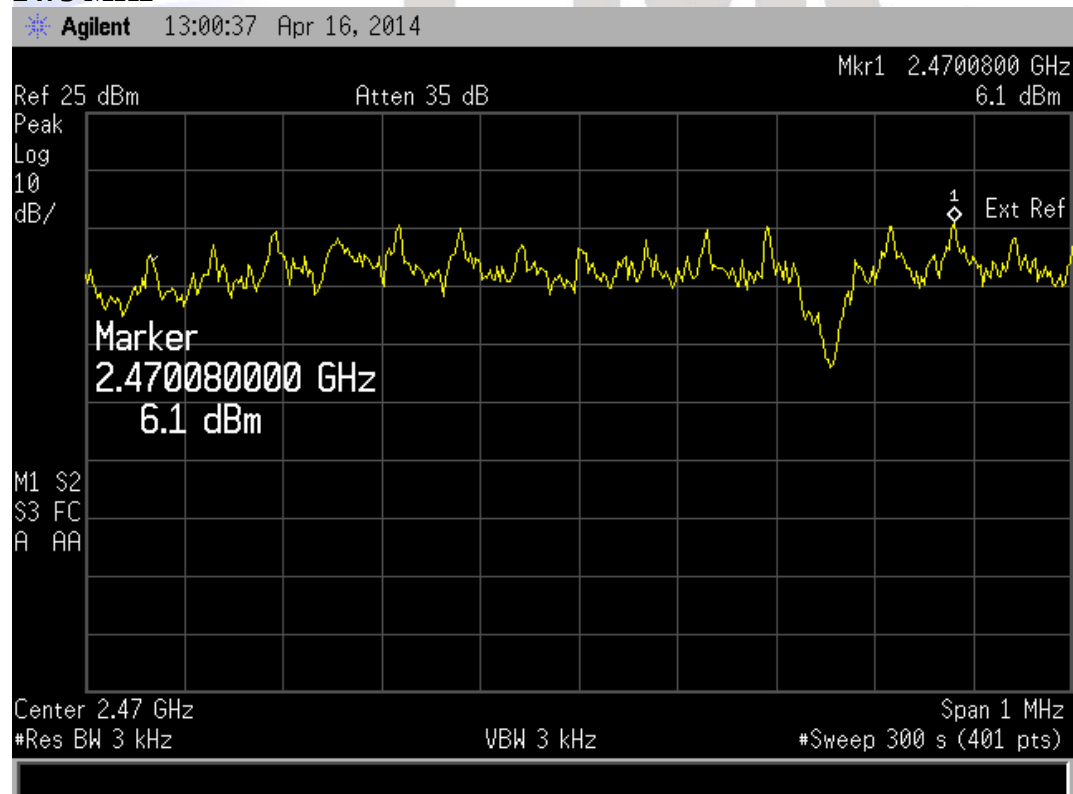
2405 MHz



2440 MHz



2475 MHz



Section 15.247(i) – Radio Frequency Hazard Information

As per Section 15.247 (i) spread spectrum transmitters operating in the 2400 – 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 and a safe distance could be maintained when events are undertaken.

In accordance with Section 1.1310 the Maximum Permissible Exposure (MPE) limits for the General Population / Uncontrolled Exposure of 1 mW/cm^2 has been applied.

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:

$$E, \text{ V/m} = (\sqrt{30 * P * G}) / d$$

$$\text{Power density, mW/cm}^2 = E^2 / 3770$$

$$E \text{ for MPE: } 1 = E^2 / 3770$$

$$E = \sqrt{1 * 3770}$$

$$E = 61.4 \text{ V/m}$$

The highest radiated power has been measured to be +23.3 dBm or 0.2089 watts EIRP.

Therefore:

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

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

$$d = \sqrt{30 * 0.2089} / 61.4$$

$$d = 0.041 \text{ m or } 4.1 \text{ cm}$$

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	Interval
Aerial Controller	EMCO	1090	9112-1062	RFS 3710	N/A	-
Aerial Mast	EMCO	1070-1	9203-1661	RFS 3708	N/A	-
Turntable	EMCO	1080-1-2.1	9109-1578	RFS 3709	N/A	-
Receiver	R & S	ESHS 10	828404/005	3728	21 Aug 2014	1 year
Mains Network	R & S	ESH2-Z5	881362/032	3628	21 Aug 2014	1 year
Receiver	R & S	ESIB 40	100171	R-27-1	29 Jan 2015	1 year
Spectrum Analyser	Hewlett Packard	E7405A	US39150142	3771	26 May 2014	1 year
VHF Balun	Schwarzbeck	VHA 9103	-	RFS 3603	7 Feb 2015	1 year
Biconical Antenna	Schwarzbeck	BBA 9106	-	RFS 3612	7 Feb 2015	1 year
Log Periodic	Schwarzbeck	VUSLP 9111	9111-228	3785	7 Feb 2015	1 year
Horn Antenna	EMCO	3115	9511-4629	E1526	10 May 2015	1 year
SG Horn Antenna	EMCO	3160-04	00224819	-	11 Sept 2015	3 years
SG Horn Antenna	EMCO	3160-05	00114635	-	11 Sept 2015	3 years
SG Horn Antenna	EMCO	3160-06	00114821	-	11 Sept 2015	3 years
SG Horn Antenna	EMCO	3160-07	00144919	-	11 Sept 2015	3 years
SG Horn Antenna	EMCO	3160-08	00114637	-	11 Sept 2015	3 years
Horn Antenna	EMCO	3116	92035	-	10 May 2015	1 year
Loop Antenna	EMCO	6502	9003-2485	3798	12 Dec 2014	1 year

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 updated in July, 2013.

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

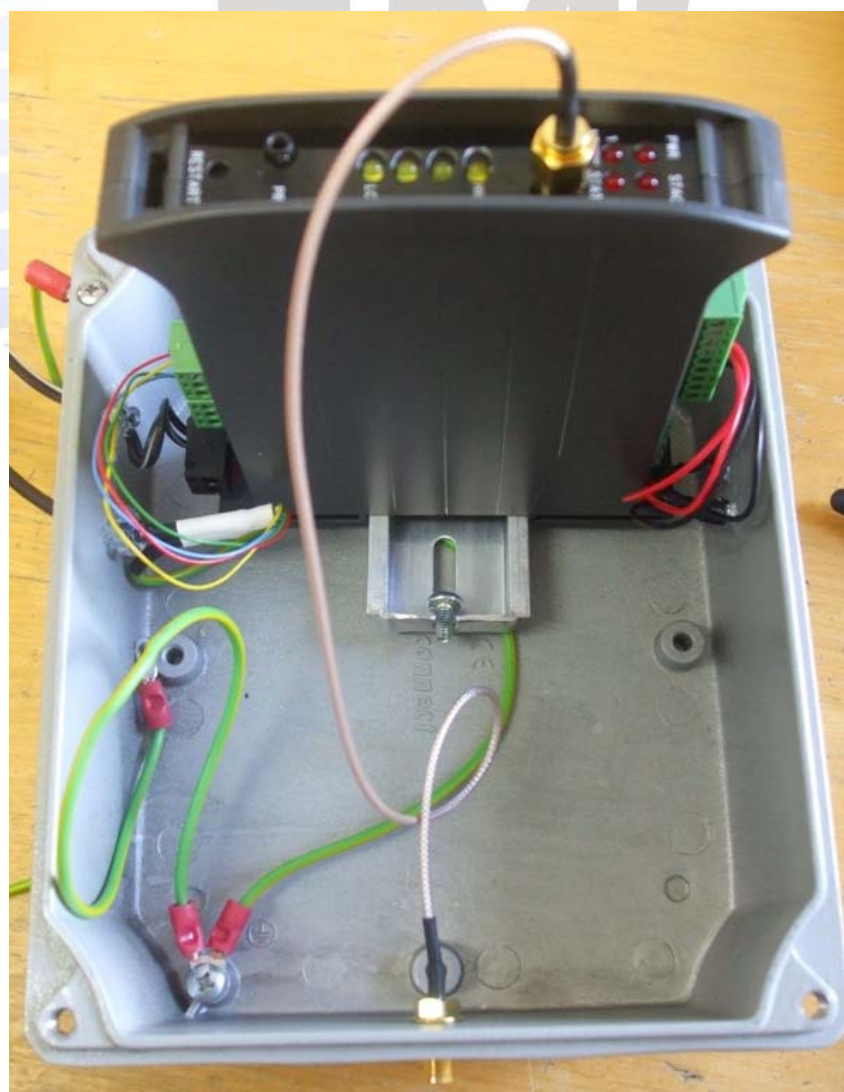
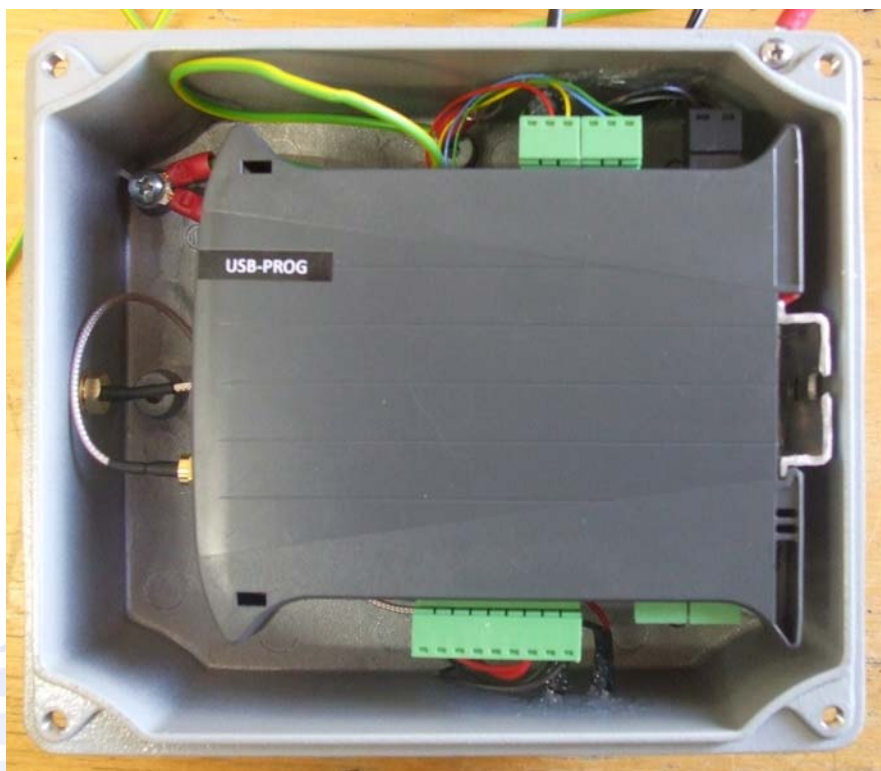
External Photos

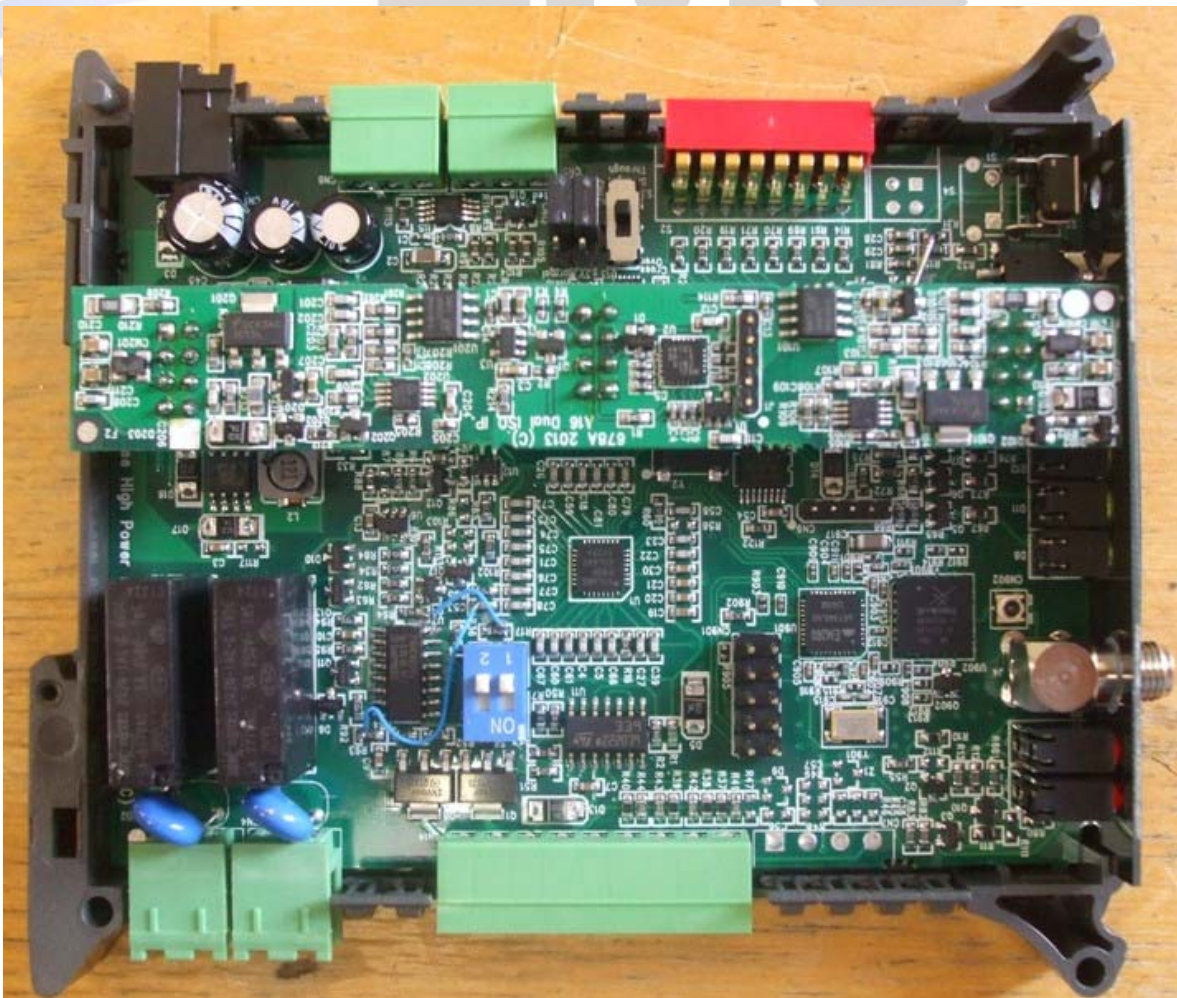
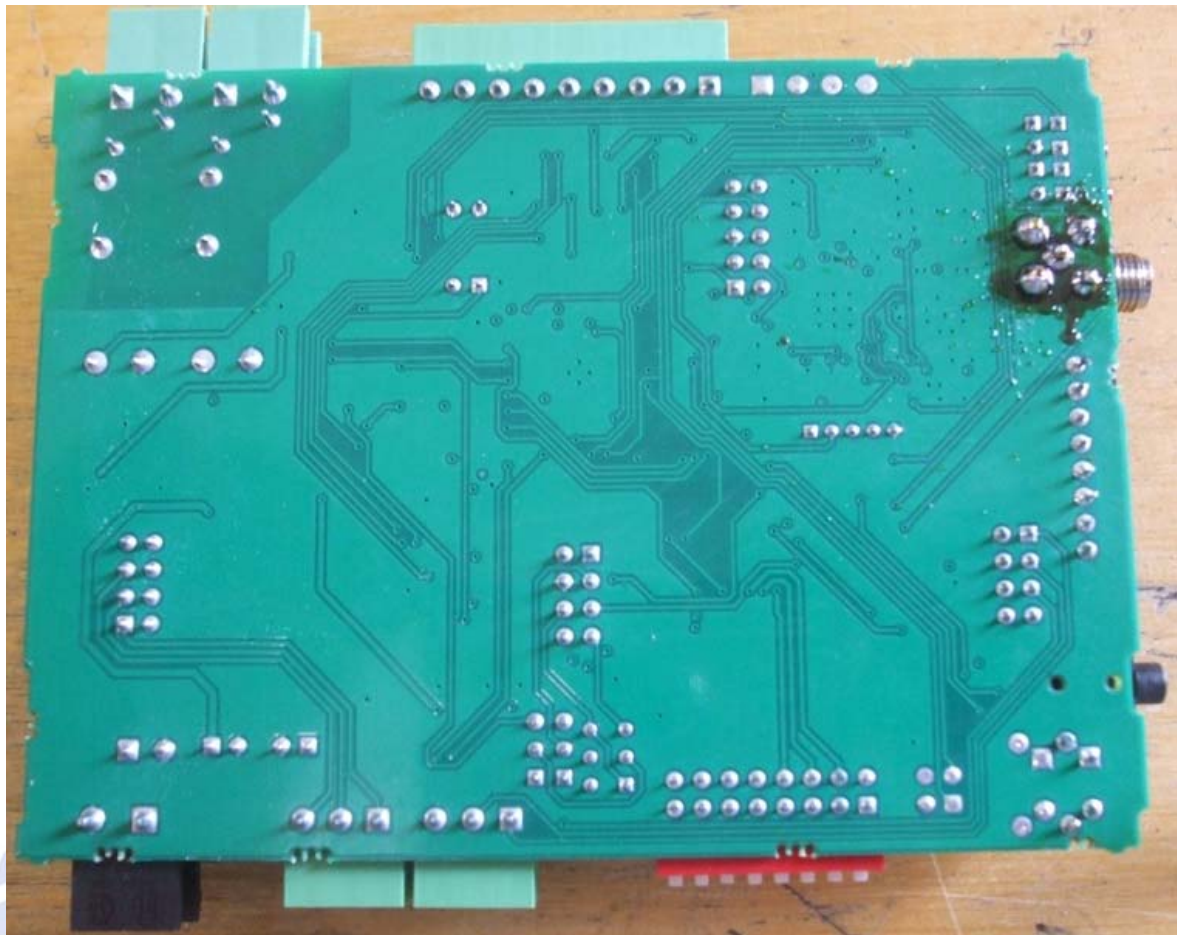


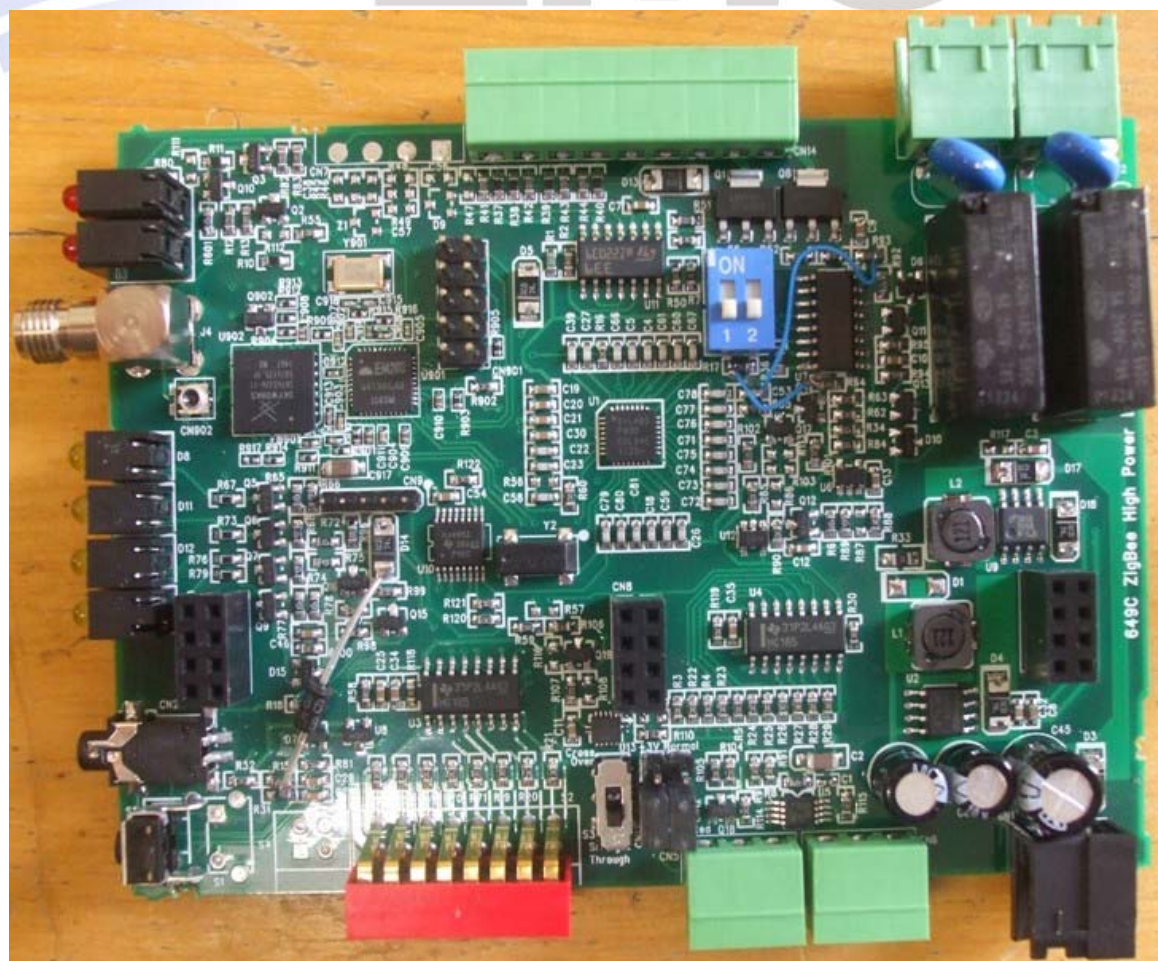
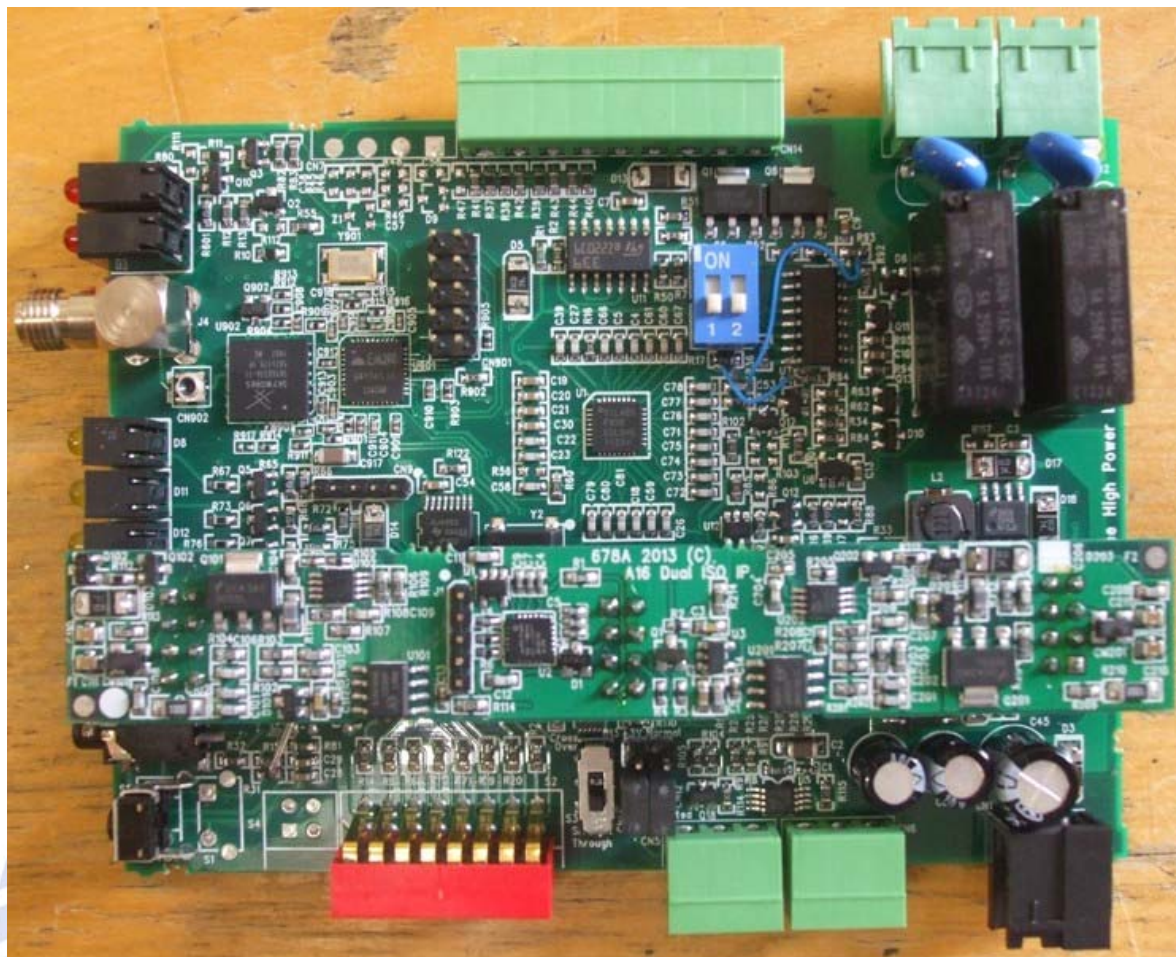
Antenna connector

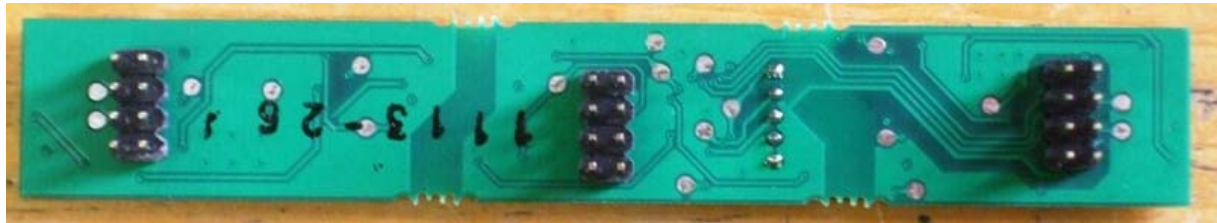


Internal photos







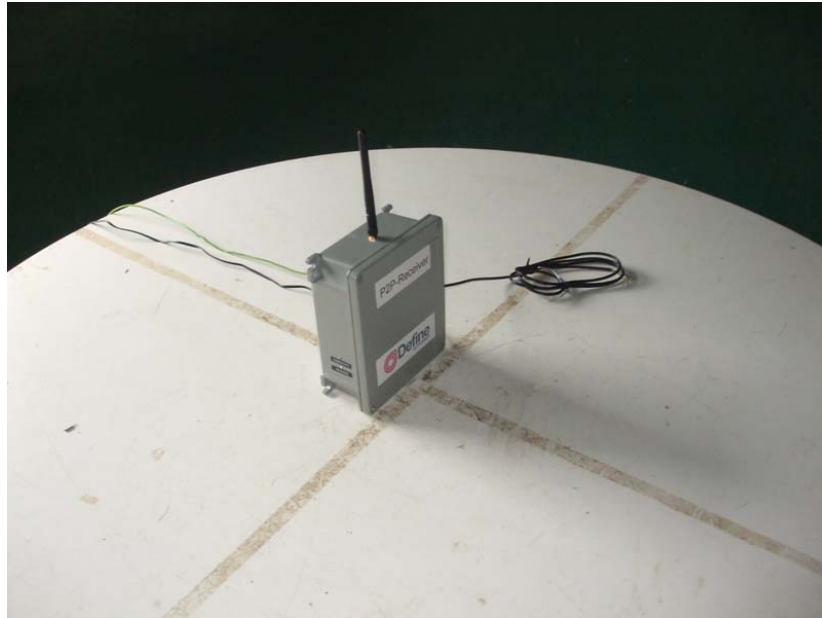


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Technologies

Global Product Certification

Radiated emissions test set up photos









Radiated emissions test set up photos – Below 30 MHz



Radiated emissions test set up photos – Above 30 MHz





