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TEST REPORT

Wireless Copilot Safe2Fly 900 MHz Transmitter

tested to

47 Code of Federal Regulations

Part 15 - Radio Frequency Devices

Subpart C – Intentional Radiators

Section 15.247 – Operation in the band 902 – 928 MHz

for

Nanoquip Ltd

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 **Wireless Copilot Safe2Fly 900 MHz Transmitter** 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 Public Notice DA 00-705 are applied.

2. RESULTS SUMMARY

The results from testing carried out between the 12th – 17th November 2012 and the 11th – 22nd February 2013 are summarised in the following table:

Clause	Parameter	Result
15.201	Equipment authorisation requirement	Certification required
15.203	Antenna requirement	Complies.
15.204	External PA and antenna modifications	Complies.
15.205	Restricted bands of operation	Complies
15.207	Conducted limits	Not applicable.
15.209	Radiated emission limits	Complies
15.247		
(a)(1)	Frequency hopping requirements	Complies
(b)(2)	Peak output power	Complies
(b)(4)	Antenna gains greater than 6 dBi	Not applicable
(c)	Directional antenna gains greater than 6 dBi	Not applicable
(d)	Out of band emissions	Complies
(e)	Power spectral density	Not applicable
(f)	Hybrid systems	Not applicable
(g)	Use of all channels	Noted
(h)	Intelligent frequency hopping	Noted
(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.

This report replaces report number 130114.1 to include references to FCC Public Notice DA 00-0705 and to correct and incorrect calibration date.

4. CLIENT INFORMATION

Company Name Nanoquip Ltd

Address 9 Dorchester Place
Orewa 0931

City Auckland

Country New Zealand

Contact Mr Ross Purdy

5. DESCRIPTION OF TEST SAMPLE

Brand Name	Wireless Copilot
Model	Safe2Fly
Product	900 MHz Transmitter
Manufacturer	Nanoquip Ltd
Country of Origin	New Zealand
Serial Number	Sample not serialised
FCC ID	RV5WCPTX02

The device tested consists is a remote telemetry transmitter that is installed in a model aircraft and monitors the voltage level of the on board battery.

This transmitter periodically transmits this voltage level periodically to a handheld receiver which gives an audible readout.

This device that was tested and has the following specifications:

Rated output power:	10 mW (+10.0 dBm)
Antennas:	Integral wire antenna
FCC band:	902 – 928 MHz
Test frequencies:	904.600 MHz, 915.000 MHz, 925.400 MHz
Number of channels:	53
Channel spacing:	400 kHz
Modulation type:	Frequency hopping spread spectrum - GFSK
Hopping sequence:	Pseudo random sequence.
Power Supply:	Internal 4.8 Vdc battery
Ports:	Model aircraft supply voltage monitoring

6. SETUPS AND PROCEDURES

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 Public Notice DA 00-0705

Section 15.201: Equipment authorisation requirement

Certification as detailed in Subpart J of Part 2 is required for this device as it contains a transmitter.

Section 15.203: Antenna requirement

The antenna for this device is a permanently attached wire antenna that will be internal to the device when the transmitter is installed inside a model aircraft.

Result: Complies

Section 15.204: External radio frequency power amplifiers and antenna modifications

An external power amplifier is not supplied with this device.

The equipment manual contains a warning about modifications to the device including the antennas.

Result: Complies.

Section 15.205: Restricted bands of operation

The transmitters contained within this device operate in the 902 - 928 MHz band which is covered by Section 15.247.

Result: Complies.

Section 15.207: Conducted emissions testing

Not applicable. This transmitter is powered using 4.8 Vdc battery.

Provision has not been made to enable charging of this battery.

The battery will need to be removed from the model aircraft in order to be charged.

Result: Complies

Section 15.209: Radiated emission limits, general requirements

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

This site conforms to the requirements of CISPR 16 and ANSI C63.4 - 2003.

Radiated emissions testing was carried out over the frequency range of 10 kHz to 10 GHz as the device operates in the 900 MHz band and it contains a 16 MHz clock oscillator.

Below 30 MHz:

As the device contains an oscillator that operates below 30 MHz measurements were made 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.

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 $(10 \text{ kHz} - 30 \text{ MHz}) \pm 4.8 \text{ dB}$

Above 30 MHz:

Above 30 MHz measurements were attempted at a distance of 3 metres.

A receiver with a quasi peak detector with a 120 kHz bandwidth was used between 30 – 1000 MHz and between 1000 – 10,000 MHz a peak detector and an average detector were used with a 1 MHz bandwidth.

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, where appropriate, with an automated antenna tower.

Measurements were attempted in both vertical and horizontal antenna polarisations.

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

Level (dB μ V/m) = Receiver Reading (dB μ V) + Antenna Factor (dB) + Coax Loss (dB)

No specific general emissions were detected from the device between 30 – 24000 MHz.

The only emissions observed were from the transmitter.

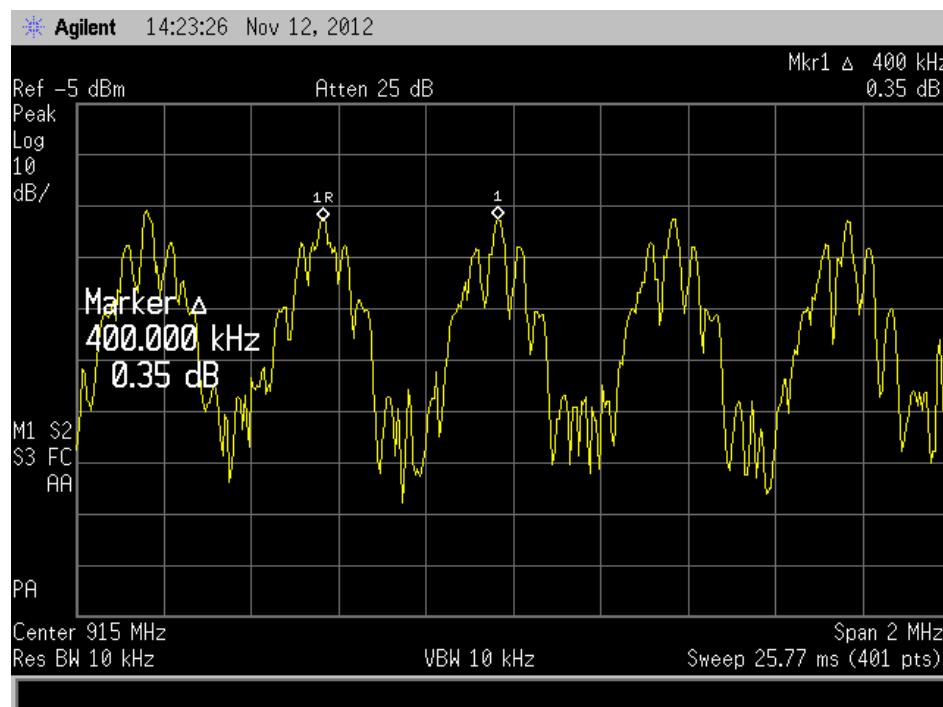
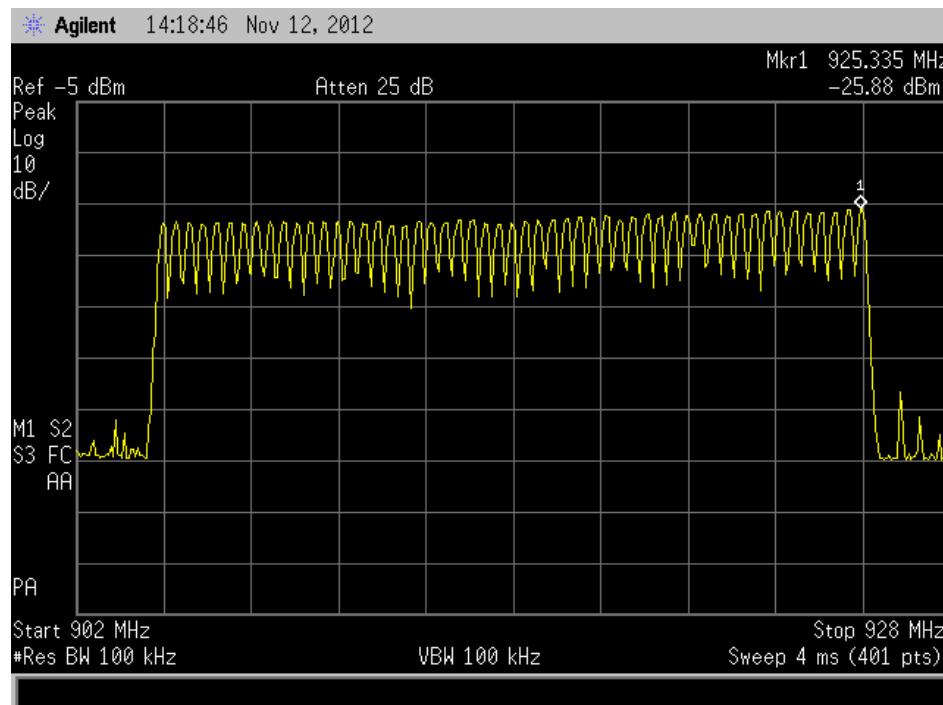
Result: Complies.

Measurement uncertainty with a confidence interval of 95% is:

- Free radiation tests (30 MHz – 24000 MHz) \pm 4.1 dB

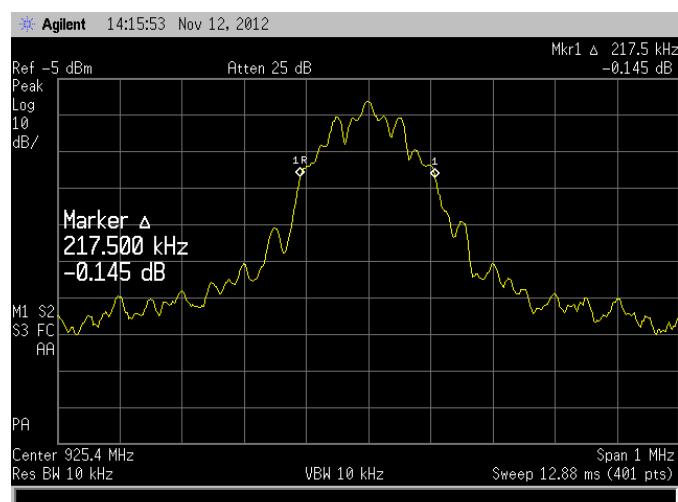
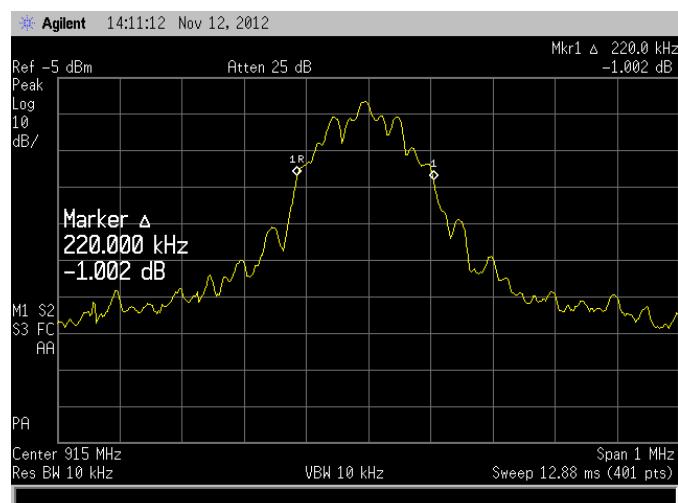
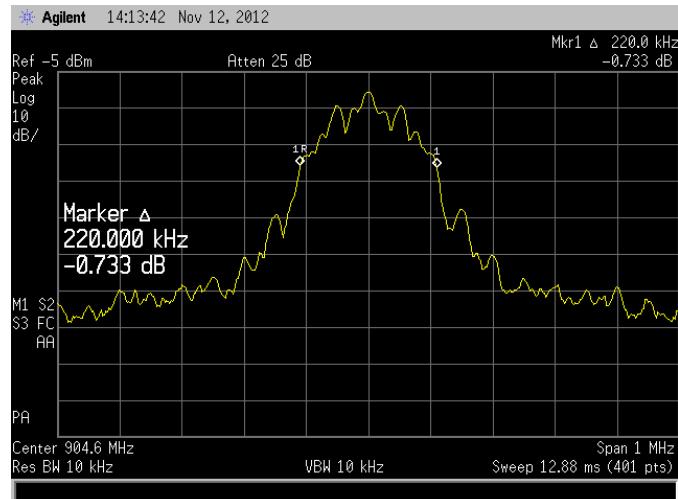
Section 15.247 (a) (1) (i) - Channel occupancy / bandwidth

This device has been configured to operate using 53 channels spaced at 400 kHz between 904.6 MHz and 925.6 MHz as detailed below.



The hopping carrier frequencies shall be separated by a minimum of 25 kHz or the 20 dB bandwidth.

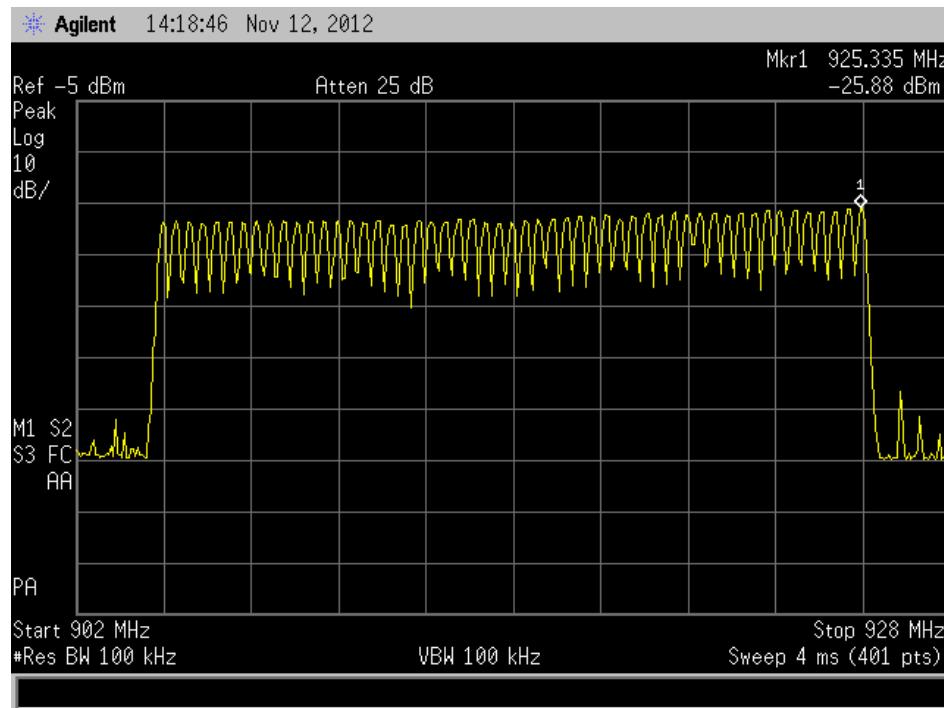
The 20 dB bandwidth has been determined to be 220 kHz:



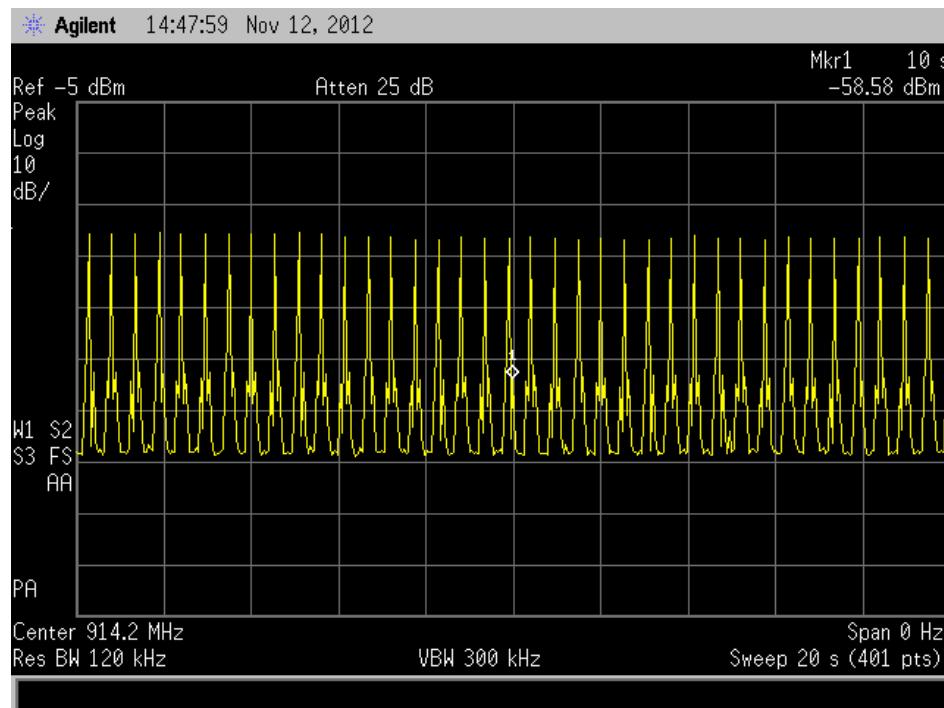
This system will meet the requirement of the 20 dB bandwidth being less than the hopping frequency as the 20 dB bandwidth is approximately 220 kHz and hopping channel interval is 400 kHz.

As the 20 dB bandwidth is less than 250 kHz the system is required to use at least 50 hopping frequencies and the average time of occupancy shall not be greater than 400 ms in any 20 second period

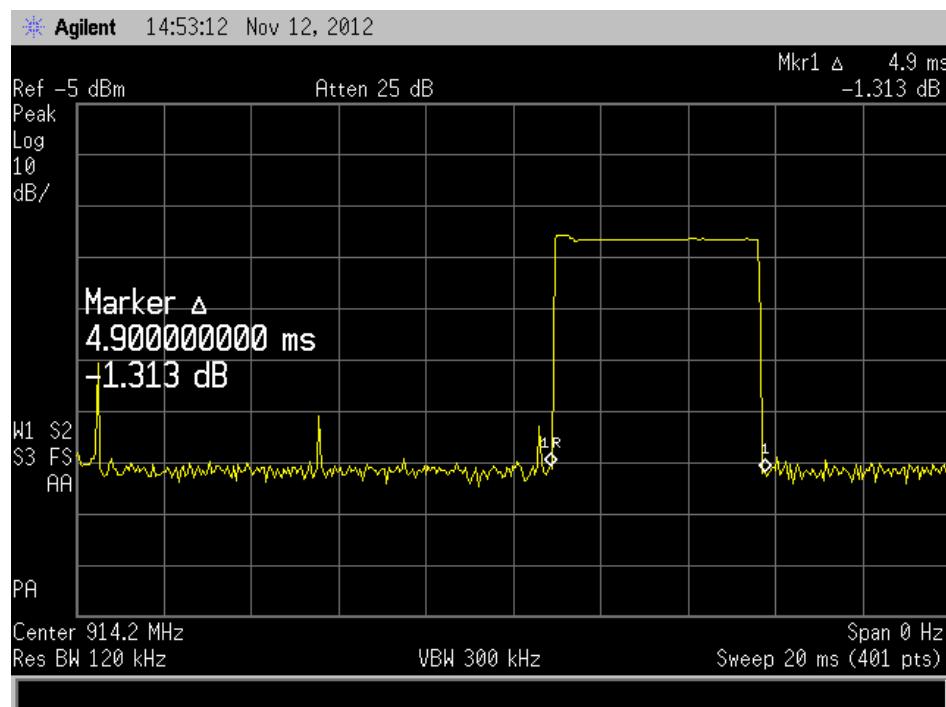
53 hopping frequencies were observed between 904.6 MHz and 925.4 MHz



38 transmissions were observed in a 20 second period



Each transmission was observed to have an on time of 4.9 ms which approximates to 5.0 ms



38 transmissions x 5 ms gives an occupancy time of 190 ms in any 20 second periods

Result: Complies

Section 15.247 (b) (2)– Peak output power

Radiated peak power measurements were made as the antenna port could not be accessed.

Testing was carried out on three channels being 904.6 MHz, 915.0 MHz and 925.4 MHz.

Measurements were made using a spectrum analyser with a resolution bandwidth of 1.0 MHz when the transmitter was setup to operate on discrete frequencies.

As the device is portable in nature, measurements were made in all 3 axis (X, Y and Z) with the axis with highest reading being used for all subsequent tests

Axis	Frequency (MHz)	Field Strength (dBuV/m)	Power (dBm)	Power (watts)	Limit (watts)	Antenna
X	904.600	99.1	3.9	0.0024	1.0000	Horizontal
Y	904.600	101.8	6.6	0.0045	1.0000	Vertical
Z	904.600	102.8	7.6	0.0057	1.0000	Vertical
Z	915.000	102.5	7.3	0.0053	1.0000	Vertical
Z	925.400	102.3	7.1	0.0051	1.0000	Vertical

The client advises that the antenna gain is approximately 1 or 0 dBi.

Radiated measurements were made using vertical and horizontal polarisations.

The power level in watts 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)

The transmitter itself was placed in the centre of the test table at a height of 80 cm above the ground plane.

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

Limits:

The maximum peak output power for frequency hopping systems operating in the 902 – 928 MHz band shall not exceed 1 watt (+30 dBm) for systems employing at least 50 channels.

Result: Complies

Measurement Uncertainty: ± 4.1 dB

Section 15.247 (c) – Out of band emissions

As this system does not have an antenna port radiated emission measurements were carried out.

A number of out of band emissions have been shown to fall within the restricted bands of operation as defined in section 15.205(a).

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

Testing was carried out at EMC Technologies NZ Ltd Open Area Test Site, which is located at Driving Creek, Orere Point, Auckland. Details of this site have been filed with the Commission, Registration Number: 90838, which was last updated in Feb 2011

The device 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 made with the antenna located at a 3 m horizontal distance from the boundary of the device under test.

Measurements below 1000 MHz were made using an 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.

The emission is measured in both vertical and horizontal antenna polarisations.

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

Level (dB μ V/m) = Receiver Reading (dB μ V) + Antenna Factor (dB) + Coax Loss (dB)

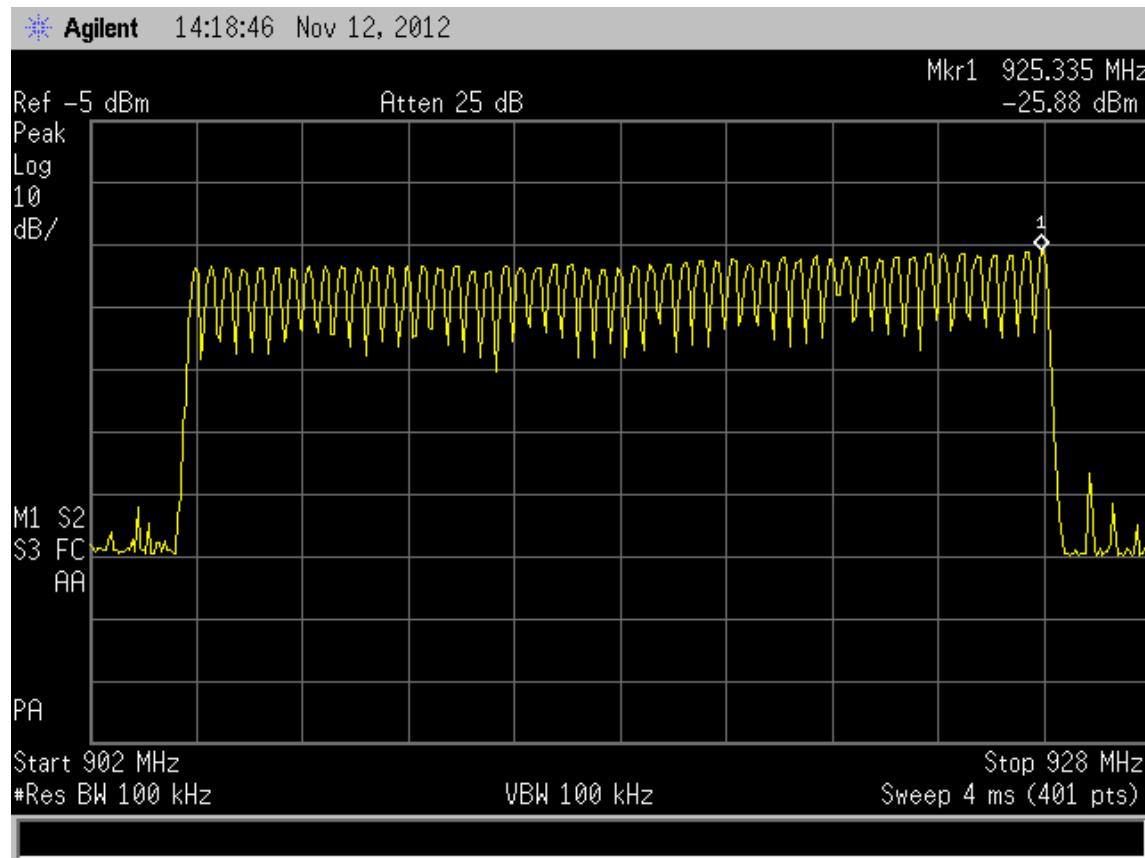
Where an emission falls outside of the restricted bands a limit being -20 dB below the fundamental emission level for the Z axis has been applied (vertical or horizontal).

The general limits as per section 15.209(a) have been applied to those emissions falling within the restricted bands.

Result: Complies

Band edge emissions

At the band edges of 902.000 MHz and 928.00 MHz all emissions were observed to attenuated by more than 20 dB when measured with a resolution bandwidth of 100 kHz as can be seen from the plot detailed below.



This was confirmed at the test site when radiated emission measurements were attempted at 902 MHz and 928 MHz in both vertical and horizontal polarisations using a resolution bandwidth of 100 kHz.

No emissions were detected within 20 dB of the applicable limit.

Result: Complies

Radiated spurious emissions

904.600 MHz

Frequency MHz	Vertical dBuV/m	Horizontal dBuV/m	Limit dBuV/m	Margin dB	Antenna Polarity	Detector
113.000	15.1	26.5	43.5	17.0	Horizontal	QP
452.293	47.5	55.7	82.8	27.1	Horizontal	QP
678.389	41.1	46.3	82.8	36.5	Horizontal	QP
1809.200	62.1	62.4	82.8	20.4	Horizontal	Peak
2713.800	52.1	53.5	74.0	20.5	Horizontal	Peak
	42.5	45.4	54.0	8.6	Horizontal	Average
3618.400	57.5	54.1	74.0	16.5	Vertical	Peak
	49.5	47.5	54.0	4.5	Vertical	Average
4523.000	49.1	49.5	74.0	24.5	Horizontal	Peak
	35.5	36.5	54.0	17.5	Horizontal	Average
5427.600	52.1	52.1	74.0	21.9	Vertical	Peak
	40.4	41.5	54.0	12.5	Horizontal	Average
6332.200	58.1	58.3	82.8	24.5	Horizontal	Peak
7236.800	51.5	51.6	82.8	31.2	Horizontal	Peak
8141.400	50.5	53.5	74.0	20.5	Horizontal	Peak
	38.8	42.2	54.0	11.8	Horizontal	Average
9046.000	53.1	53.1	74.0	20.9	Vertical	Peak
	39.5	39.5	54.0	14.5	Vertical	Average

915.000 MHz

Frequency MHz	Vertical dBuV/m	Horizontal dBuV/m	Limit dBuV/m	Margin dB	Antenna Polarity	Detector
113.000	15.1	26.5	43.5	17.0	Horizontal	QP
457.471	46.6	56.2	82.5	26.3	Horizontal	QP
686.162	39.1	43.5	82.5	39.0	Horizontal	QP
1830.000	63.3	66.2	82.5	16.3	Horizontal	Peak
2745.000	48.8	48.8	74.0	25.2	Vertical	Peak
	43.1	41.3	54.0	10.9	Vertical	Average
3660.000	55.1	53.1	74.0	18.9	Vertical	Peak
	51.3	46.3	54.0	2.7	Vertical	Average
4575.000	48.9	50.1	74.0	23.9	Horizontal	Peak
	35.5	36.9	54.0	17.1	Horizontal	Average
5490.000	52.1	52.1	73.3	21.2	Vertical	Peak
6405.000	58.2	57.1	73.3	15.1	Vertical	Peak
7320.000	51.3	50.1	74.0	22.7	Vertical	Peak
	39.9	38.5	54.0	14.1	Vertical	Average
8235.000	54.5	54.0	74.0	19.5	Vertical	Peak
	41.1	42.5	54.0	11.5	Horizontal	Average
9150.000	53.1	53.1	74.0	20.9	Vertical	Peak
	39.4	39.5	54.0	14.5	Horizontal	Average

925.400 MHz

Frequency MHz	Vertical dBuV/m	Horizontal dBuV/m	Limit dBuV/m	Margin dB	Antenna Polarity	Detector
113.000	15.1	26.5	43.5	17.0	Horizontal	QP
462.695	48.7	57.7	82.3	24.6	Horizontal	QP
694.000	49.1	42.7	74.1	25.0	Vertical	QP
1850.800	64.5	66.4	82.3	15.9	Horizontal	Peak
2776.200	49.1	48.6	74.0	24.9	Vertical	Peak
	43.3	42.1	54.0	10.7	Vertical	Average
3701.600	51.9	54.1	74.0	19.9	Horizontal	Peak
	46.4	50.5	54.0	3.5	Horizontal	Average
4627.000	48.9	49.5	74.0	24.5	Horizontal	Peak
	35.5	36.5	54.0	17.5	Horizontal	Average
5552.400	52.1	52.1	74.1	22.0	Vertical	Peak
6477.800	59.3	59.7	74.1	14.4	Horizontal	Peak
7403.200	50.1	50.1	74.0	23.9	Vertical	Peak
	38.1	38.6	54.0	15.9	Horizontal	Average
8328.600	53.3	53.5	74.0	20.7	Horizontal	Peak
	40.6	41.4	54.0	13.4	Horizontal	Average
9254.000	53.3	53.1	74.1	20.8	Vertical	Peak

Section 15.247 (i) – Radio Frequency Hazard Information

As per Section 15.247 (i) Spread spectrum transmitters operating in the 902 – 928 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).

In accordance with this section, and also Section 2.1091, this device has been defined as a mobile device whereby a distance of 20 cm or greater can normally be maintained between the user and the device.

In accordance with Section 1.1310 the Maximum Permissible Exposure (MPE) limits for the General Population / Uncontrolled Exposure of f/1500 have 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:

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

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

$$E \text{ for MPE: (902/1500)} = E^2/3770$$

$$E = \sqrt{902/1500} * 3770$$

$$E = \underline{47.6 \text{ V/m}}$$

The maximum radiated power measured was +7.6 dBm or 0.0057 watts.

Therefore:

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

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

$$d = \sqrt{30 * 0.0057} / 47.6$$

$$d = \underline{0.0087 \text{ m or } 0.87 \text{ cm}}$$

In order to meet the MPE requirement for mobile devices a minimum safe of 20 cm will need to be specified in the user manual for this system.

Result: Complies

7. TEST EQUIPMENT USED

Instrument	Manufacturer	Model	Serial No	Asset Ref	Cal Due
Aerial Controller	EMCO	1090	9112-1062	RFS 3710	N/a
Aerial Mast	EMCO	1070-1	9203-1661	RFS 3708	N/a
Biconical Antenna	Schwarzbeck	BBA 9106	-	RFS 3613	30 Jan 2014
Receiver	R & S	ESIB-40	100171	R-27-1	10 Oct 2013
Spectrum Analyser	Hewlett Packard	E7405A	US39150142	3776	14 Dec 2013
Log Periodic	Schwarzbeck	VUSLP 9111	9111-228	3785	30 Jan 2014
Horn Antenna	EMCO	3115	9511-4629	E1526	3 May 2013
Turntable	EMCO	1080-1-2.1	9109-1578	RFS 3709	N/a
VHF Balun	Schwarzbeck	VHA 9103	-	RFS 3613	30 Jan 2014

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 February 2011.

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, 2005.

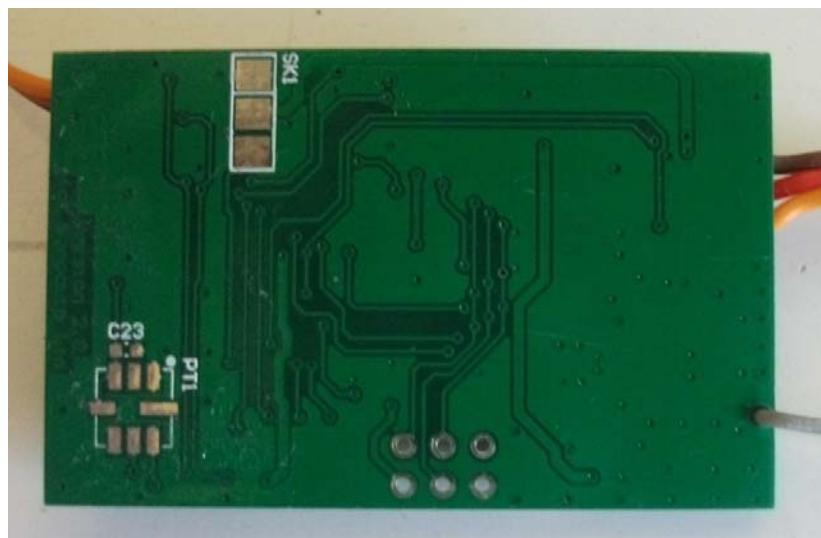
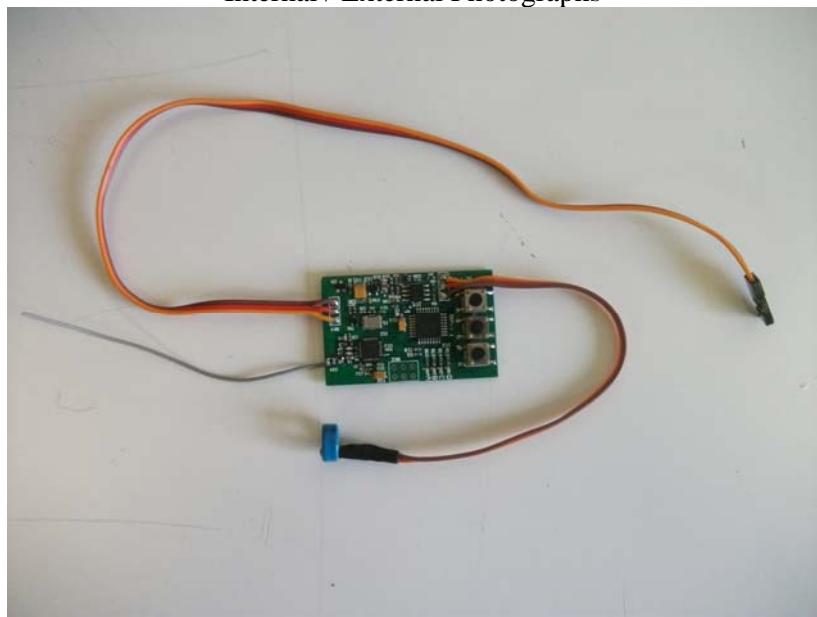
All measurement equipment has been calibrated in accordance with the terms of the EMC Technologies (NZ) Ltd International Accreditation New Zealand (IANZ) Accreditation to NZS/ISO/IEC 17025, 2005

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.

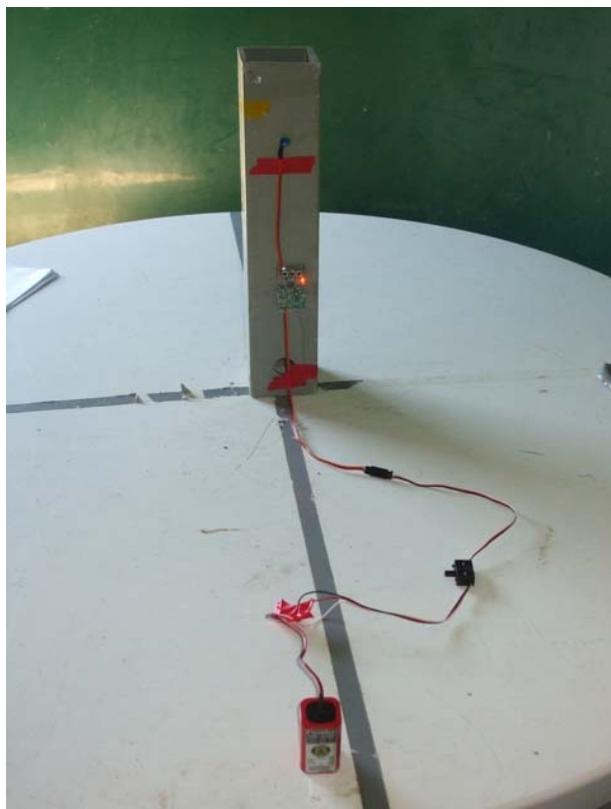
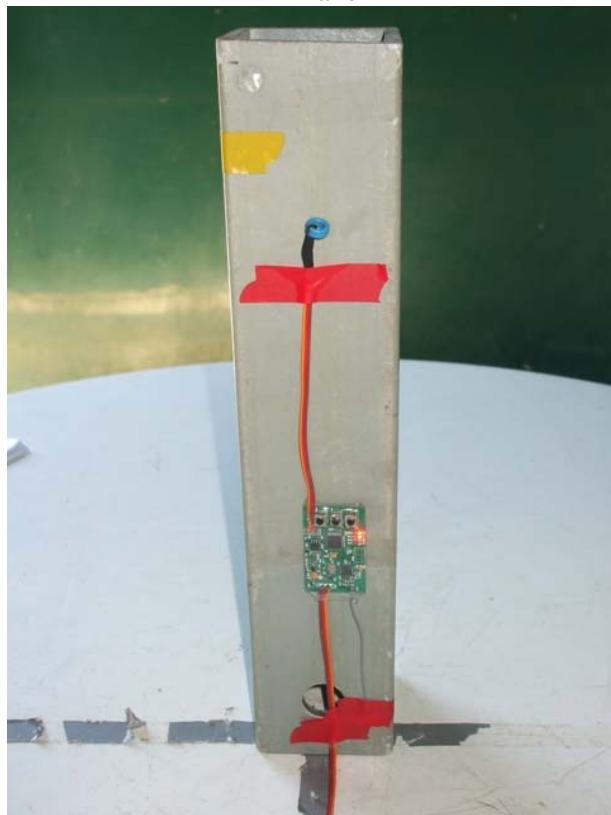
9. PHOTOGRAPHS

Internal / External Photographs

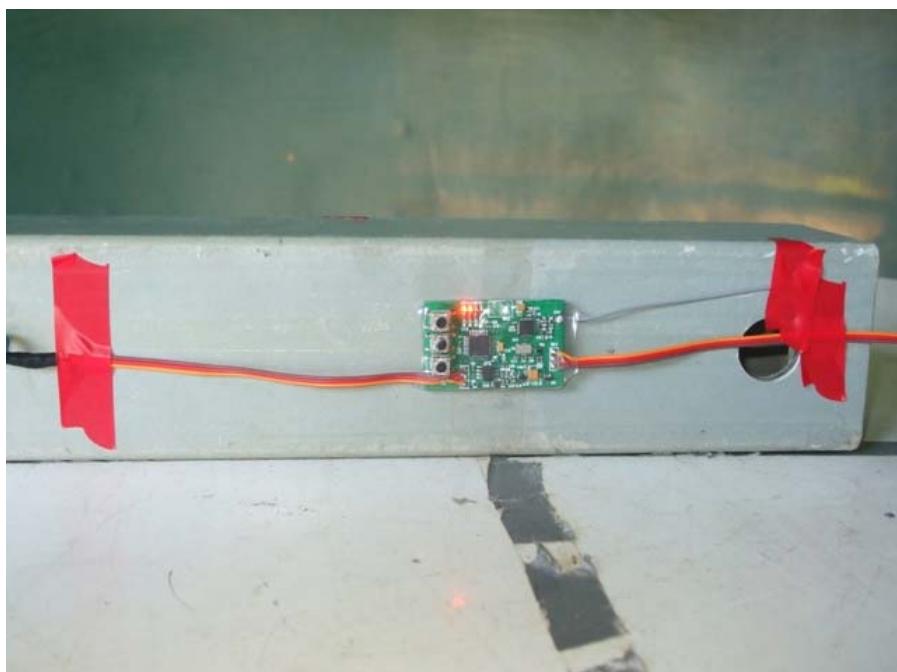
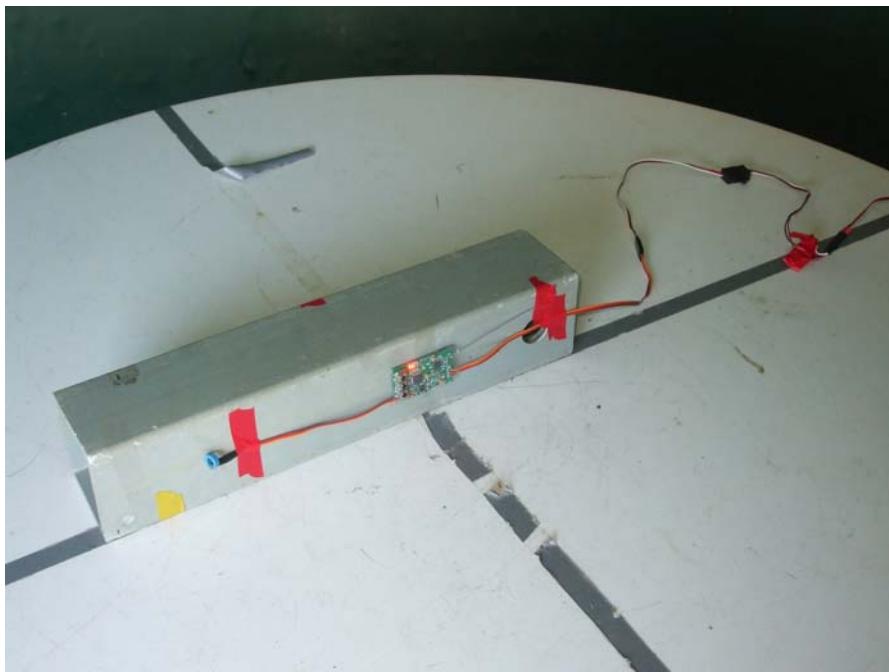


Radiated emissions test set up photos

X Plane



Z Plane



Y Plane

