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TEST REPORT

Frogparking V1.1 Wireless Link

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

Frogparking 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 **Frogparking V1.1 Wireless Link** complies with FCC Part 15 Subpart C Section 15.247 as an Intentional Radiator when the methods as described in ANSI C63.4 - 2003 are applied along with the methods defined in FCC Public Notice DA 00-705.

2. RESULTS SUMMARY

The results of testing carried out between October 1st and October 25th 2013 are detailed below:

Clause	Parameter	Result
15.201	Equipment authorisation requirement	Certification required.
15.203	Antenna requirement	Complies. This device uses an external antenna which uses a reverse SMA unique connector.
15.204	External PA and antenna modifications	Noted.
15.205	Restricted bands of operation	Complies.
15.207	Conducted limits	Not applicable. Device cannot be directly or indirectly powered from the Public AC mains supply.
15.209	Radiated emission limits	Noted. See 15.247 requirements.
15.247		
(a)(1)	Hopping channel separation	Complies
(a)(1)(i)(iii)	Channel occupancy / Bandwidth	Complies
(b)(1)(2)	Peak output power	Complies
(b)(4)	Antenna gain less than 6 dBi	Complies
(d)	Out of band emissions	Complies
(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	Frogparking Ltd
Address	36 Victoria Avenue
City	Palmerston North 4410
Country	New Zealand
Contact	Mr Kahu Swanson

5. DESCRIPTION OF TEST SYSTEM

Brand Name	Frogparking
Model Number	V1.1
Product	Wireless Link
Manufacturer	Gallagher Group Ltd
Country of Origin	New Zealand
Serial Number	Sample not serialized
FCC ID	Not yet determined

Product Description

The system tested is a parking space management system that consists of a Parking Space Sensor (Battery Frog) , which is a sealed road mounted sensor, and a Wireless Link, which collects the data transmitted by the parking space sensors and forwards it to a distant web served.

The Parking Space Sensor and the Wireless Link communicate using low power frequency hopping spread spectrum transceivers operating in the 900 MHz band.

The Wireless Link transceiver communicates with the web server using a cellular modem.

Band of Operation:	902 – 928 MHz
Modulation:	Frequency hopping spread spectrum
No of channels used:	50
No of channels available:	64
Hopping sequence:	Pseudo Random
Operating frequencies:	921.780 – 927.540 MHz
Channel spacing:	90 kHz
Rated Conducted Power:	+20 dBm (100 mW)
Data Rate:	38,400 bps
Modulation Description:	2 level GFSK
Modulation Designator:	F7D
Antenna Type:	EAD external quarter wave whip. Part number W915-RS with a peak gain of 3 dBi
Power Supply:	3.7 Vdc internal lithium polymer battery pack that is re-charged using an external solar panel
External Ports:	Reverse SMA antenna port
RF Module	Si4463 radio IC
Frequencies in use:	32.768 kHz, 30 MHz and 48 MHz

6. RESULTS

Standard

The sample was tested in accordance with 47 CFR Part 15 Subpart C and in particular section 15.247

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.

Section 15.203: Antenna requirement

The device uses an EAD external quarter wave whip. Part number W915-RS with a peak gain of 3 dBi. The antenna port uses a reverse SMA connector which is unique.

Result: Complies

Section 15.204: External radio frequency power amplifiers and antenna modifications

It is not possible to attach an external power amplifier to this transmitter.

Result: Complies.

Section 15.205: Restricted bands of operation

The device tested transmits on 50 channels between approximately 921 MHz and 928 MHz using frequency hopping spread spectrum techniques.

Section 15.247 allows this between 902 – 928 MHz

The requirements of the restricted bands have been noted

Result: Complies.

Section 15.209: Radiated emission limits, general requirements

As this device contains digital devices that are likely to operate using frequencies below 30 MHz, low frequency radiated emission measurements were attempted between 10 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 100 – 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 490 kHz and 30 MHz a Quasi Peak detector was used.

No emissions were detected from this device over the range of 10 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)(1) - Channel occupancy / bandwidth

The results are summarised as follows:

Parameter	Limit	Observation	Result
Number of channels	Minimum of 50 channels	64 channels available to be used. 50 channels observed in operation pseudo randomly.	Pass
20 dB bandwidth	Less than the channel spacing	A worst case bandwidth of 82.500 kHz was measured	Pass
Hop interval	Greater than 20 dB bandwidth	90 kHz	Pass
Dwell time	Not to exceed 400 ms in any 20 second period	43.2 ms	Pass

Result: Complies.

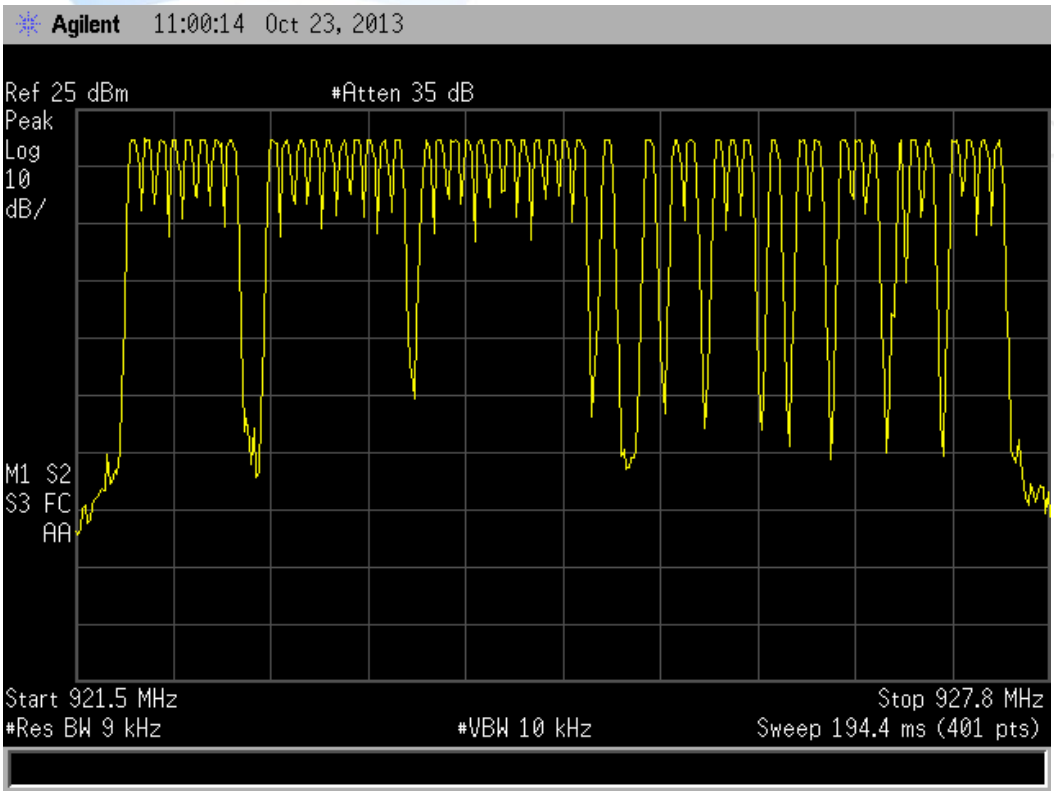
This device operates using Frequency Hopping Spread Spectrum techniques in the 902 – 928 MHz band.

A low channel of 921.870 MHz was observed and a high channel of 927.540 MHz was observed.

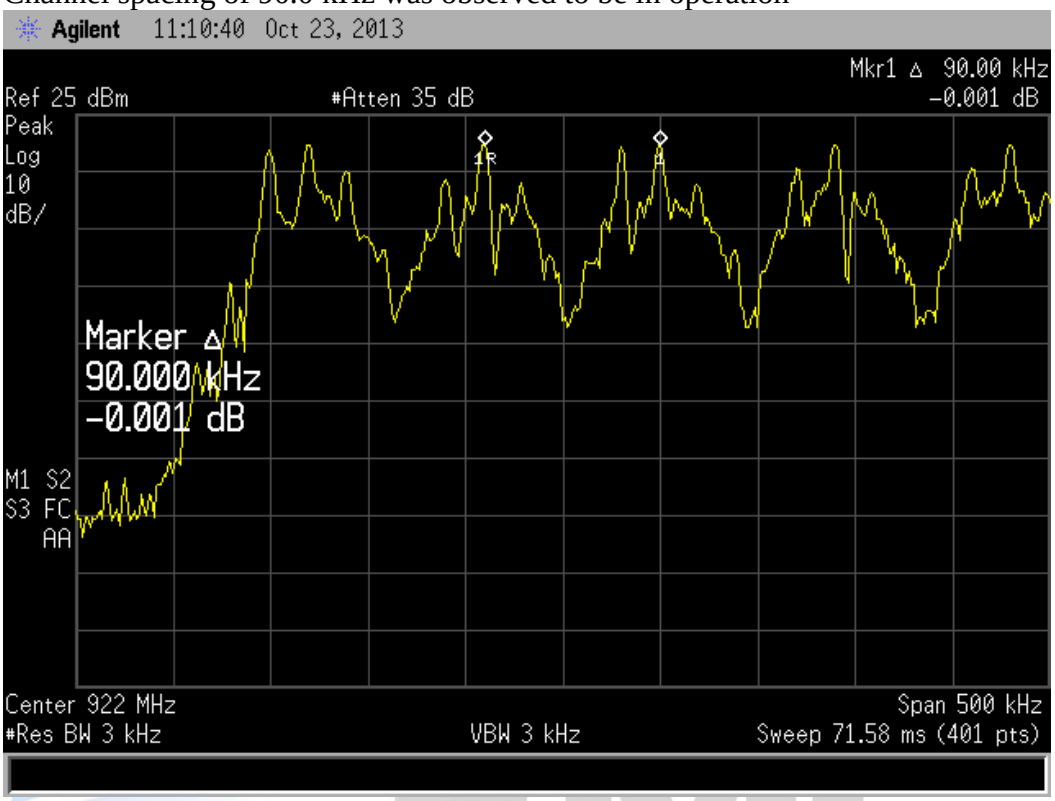
The client has advised that 64 channels are available to be used with only 50 channels being used on a pseudo random basis.

927.540 – 921.870 / 90 kHz = 63 + 1 = 64 channels

As can be seen below 50 channels out of the 64 available are in use on a pseudo random basis

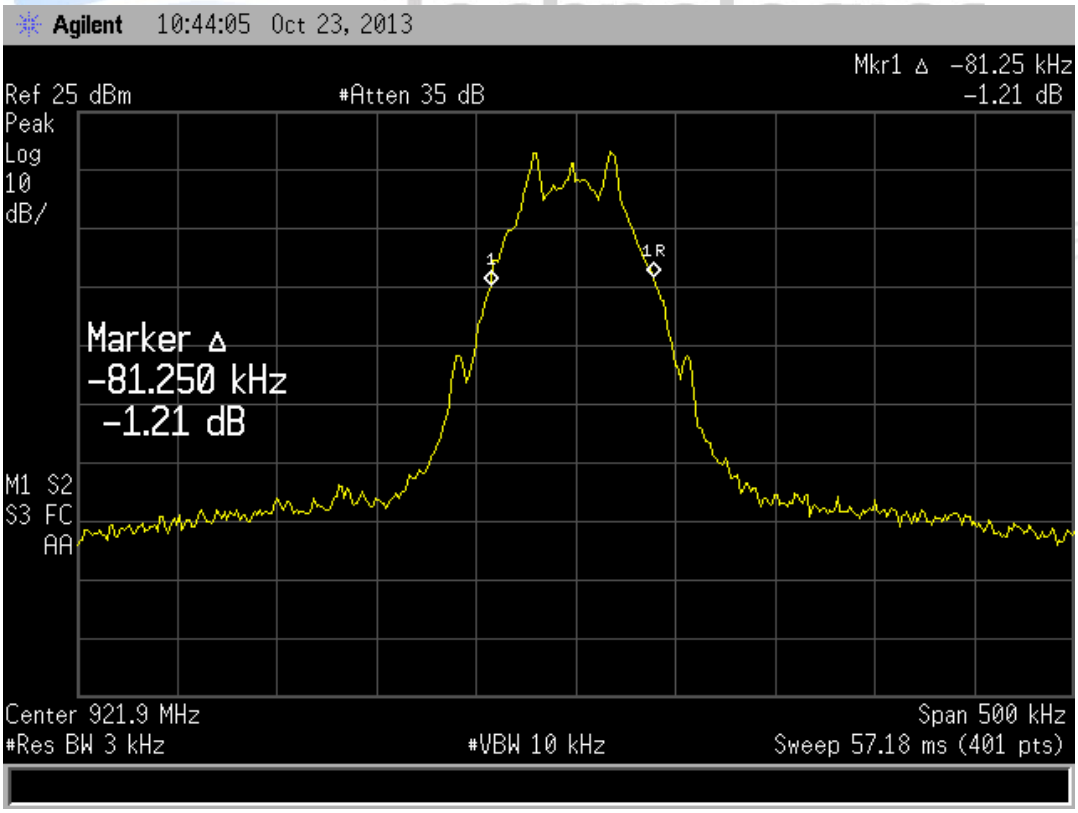


Channel spacing of 90.0 kHz was observed to be in operation

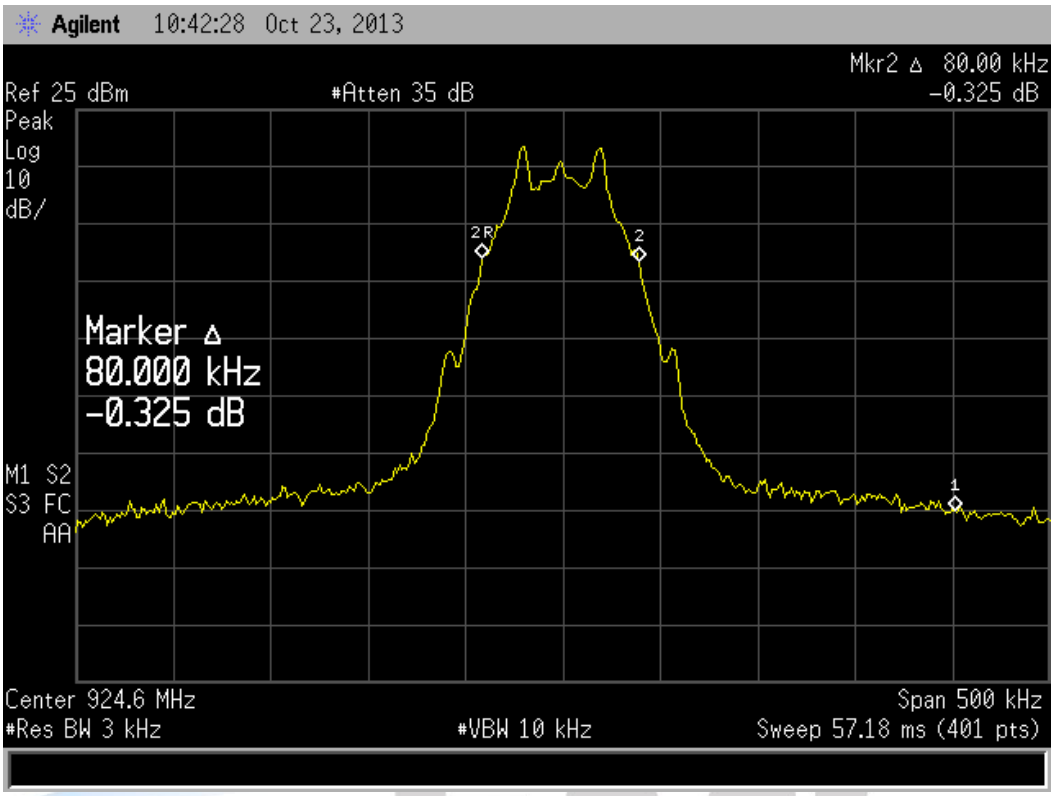


The -20 dB bandwidth for each device has been determined below

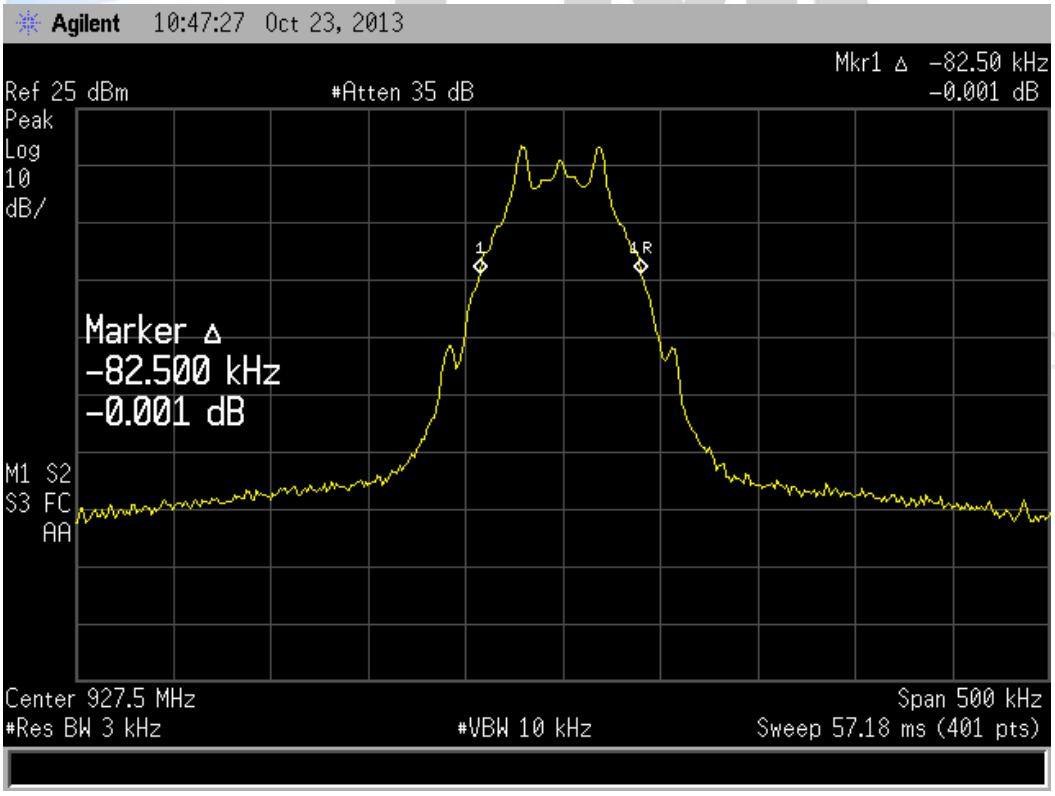
921.870 MHz



924.570 MHz

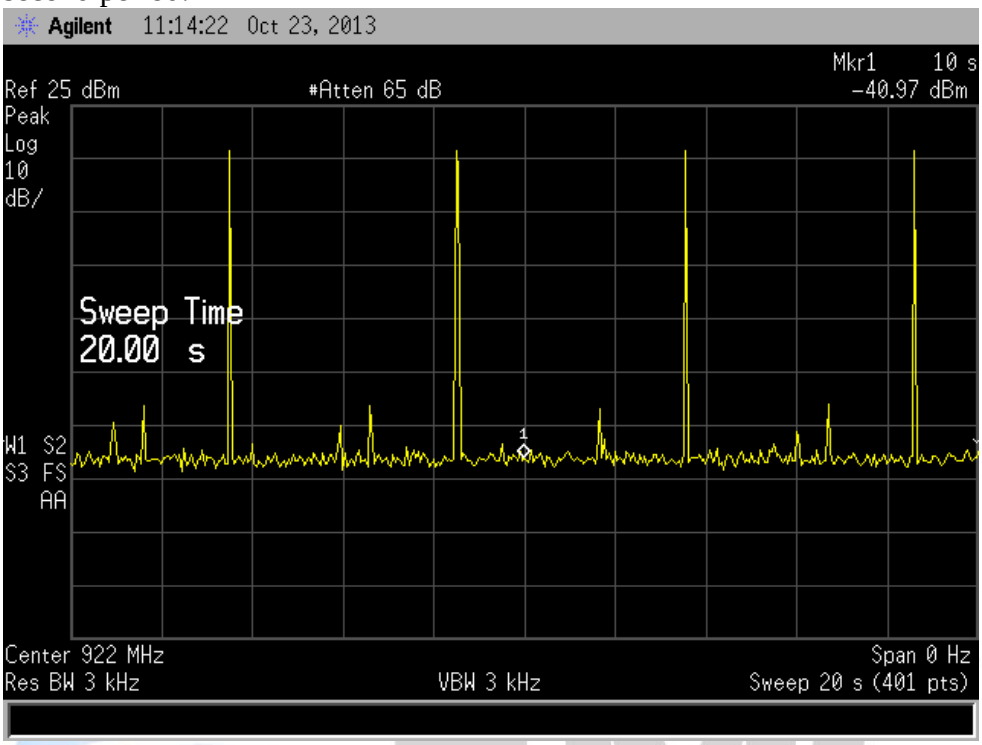


927.540 MHz

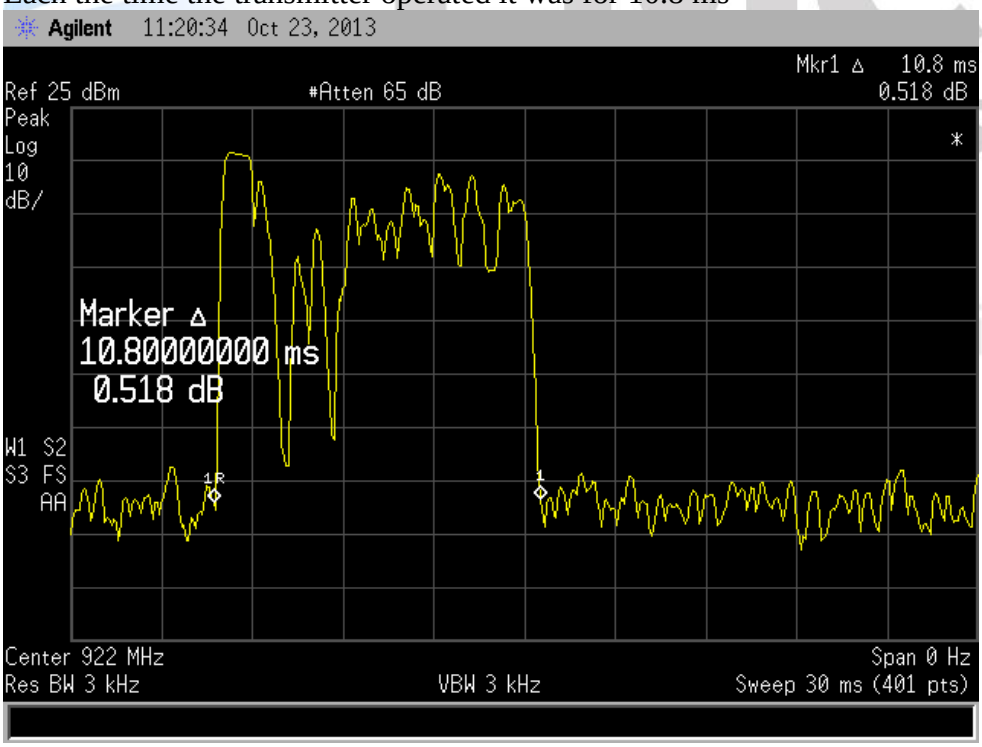


A worst case 20 dB bandwidth of 82.500 kHz was measured which is less than the step size of 90 kHz.

When operating in packet test transmission mode, which is a test mode developed by the client to simulate typical operating conditions, the device was observed to operate 4 times in a 20 second period.



Each the time the transmitter operated it was for 10.8 ms



Therefore the dwell time will be 4 x 10.8 ms = 43.2 ms

In any 20 second period the transmitter dwell time cannot exceed 400 ms

Result: Complies

Section 15.247(b)(1)+(2)– Peak output power

Conducted Power

Conducted power measurements were made on the low, mid and high frequency using a spectrum analyser with a 1 MHz resolution bandwidth that was connected to the antenna port

The following levels were recorded.

Frequency (MHz)	Level (dBm)	Limit (dBm)
921.870	19.9	30.0
924.560	19.8	30.0
927.540	19.7	30.0

A conducted power limit of 1 watt (+30 dBm) is specified for this device

Radiated Power

Radiated power measurements were made at the test site

The client advises that antenna uses has a gain of approximately 3 dBi

The conducted power output from the device was measured at the antenna port as described above.

Testing was carried out when the antenna vertical and with the solar panel on an angle as this is how the device would be positioned when operating.

Measurements were made in both vertical and horizontal polarisations with the worst field strength level being recorded at each frequency.

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).

The antenna gain is the difference between the measured output power and the calculated radiated power.

Frequency (MHz)	Field Strength (dBµV/m)	Calculated Radiated Power (dBm)	Measured Conducted Power (dBm)	Calculated Antenna Gain (dBi)	Antenna Polarisation
921.870	117.0	21.8	19.9	1.9	Horizontal
924.560	117.1	21.9	19.8	2.1	Horizontal
927.540	117.1	21.9	19.7	2.2	Horizontal

A conducted limit of 1.0 watt (+30 dBm) has been applied and the calculated antenna gain approximates the specified antenna gain.

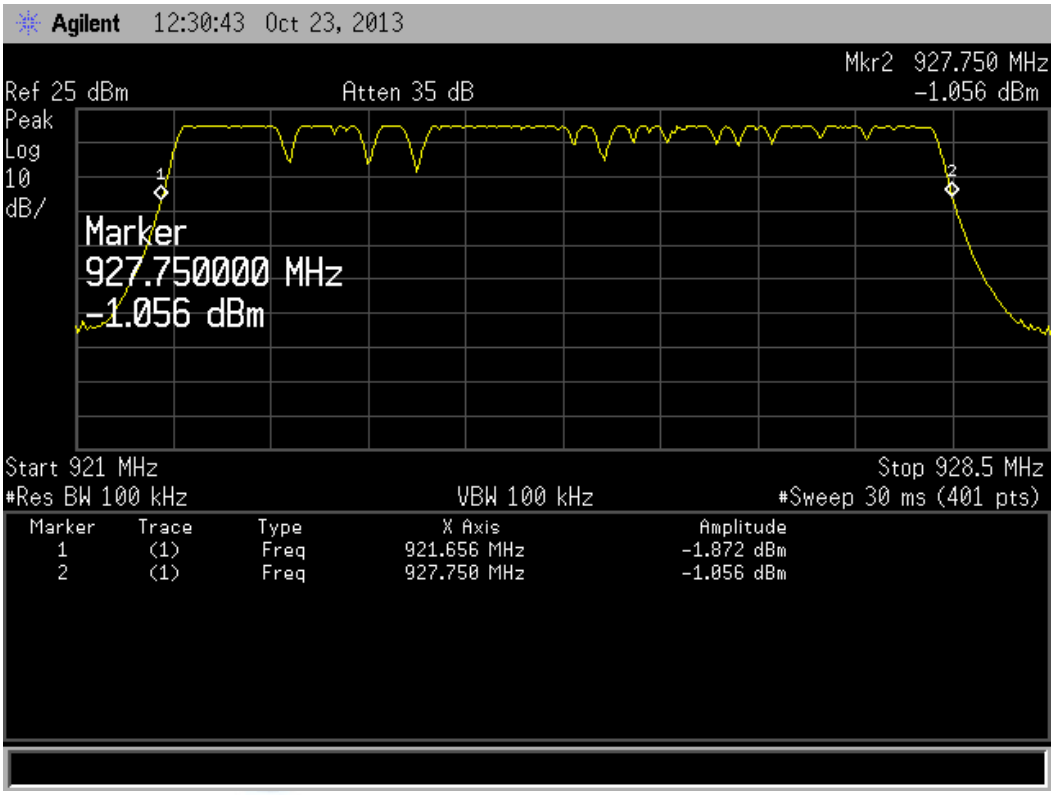
Result: Complies.
Measurement Uncertainty: ± 4.1 dB

Section 15.247 (d) – Out of band emissions

Band edge measurements:

At the band edges of 902 and 928 MHz all emissions are required to be attenuated by more than 20 dB relative to the highest 100 kHz resolution bandwidth emission level observed in the band of operation.

Measurements were at the antenna port showing that the -20 dBc points remain within the 902 – 928 MHz band.



Radiated measurements were made at 902 and 928 MHz with the following levels being recorded

Frequency MHz	Vertical dBuV/m	Horizontal dBuV/m	Limit dBuV/m	Margin dB	Result	Antenna
902.000	43.1		97.1	54.0	Pass	Vertical
902.000		43.1	86.8	43.7	Pass	Horizontal
928.000	67.4		97.1	29.7	Pass	Vertical
928.000		55.1	86.8	31.7	Pass	Horizontal

Testing was carried out at EMC Technologies NZ Ltd Open Area Test Site, which is located at Driving Creek, 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 however this limit was not applied as the sample complied with the more extreme limits in section 15.209 for all frequencies, except at 2Fc where the -20 dBc limit was applied.

Testing was carried out on two frequencies being one near the top and one near the bottom of the frequency of operation as the frequency span is less than 10 MHz.

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

Testing was carried out when the antenna vertical and with the solar panel on an angle as this is how the device would be positioned when operating.

All emissions were measured in both vertical and horizontal antenna polarisations.

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.

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 on 921.780 MHz

Frequency MHz	Vertical dBuV/m	Hort dBuV/m	Limit dBuV/m	Margin dB	Antenna	Detector
193.518		27.5	43.5	16.0	Horizontal	Quasi Peak
372.950	20.1		46.0	25.9	Vertical	Quasi Peak
1843.740		46.2	86.8	40.6	Horizontal	Peak
1843.740	48.5		91.7	43.2	Vertical	Peak
2765.610	60.1	60.8	74.0	13.2	Horizontal	Peak
	47.3	48.6	54.0	5.4	Horizontal	Average
3687.480	52.1	52.1	74.0	21.9	Vertical	Peak
	38.9	38.9	54.0	15.1	Vertical	Average
4609.350	54.1	54.1	74.0	19.9	Vertical	Peak
	41.1	41.1	54.0	12.9	Vertical	Average
5531.220	56.9	56.9	74.0	17.1	Vertical	Peak
	44.1	44.1	54.0	9.9	Vertical	Average
6453.090	59.7	59.7	74.0	14.3	Vertical	Peak
	46.8	46.8	54.0	7.2	Vertical	Average
7374.960	55.1	55.1	74.0	18.9	Vertical	Peak
	42.8	41.7	54.0	11.2	Vertical	Average
8296.830	55.3	55.3	74.0	18.7	Vertical	Peak
	42.8	42.8	54.0	11.2	Vertical	Average
9218.700	56.4	56.4	74.0	17.6	Vertical	Peak
	43.5	43.5	54.0	10.5	Vertical	Average

The general emission limit has been applied to all frequencies except for the harmonic observed at 2Fc where the -20 dBc limit has been applied

Transmitting continuously on 927.540 MHz

Frequency MHz	Vertical dBuV/m	Hort dBuV/m	Limit dBuV/m	Margin dB	Antenna	Detector
193.518		27.5	43.5	16.0	Horizontal	Quasi Peak
372.950	20.1		46.0	25.9	Vertical	Quasi Peak
1855.080		46.5	86.6	40.1	Horizontal	Peak
1855.080	49.5		91.7	42.2	Vertical	Peak
2782.620	60.1	61.1	74.0	12.9	Horizontal	Peak
	48.7	48.5	54.0	5.3	Vertical	Average
3710.160	52.1	52.1	74.0	21.9	Vertical	Peak
	38.9	38.9	54.0	15.1	Vertical	Average
4637.700	54.1	54.1	74.0	19.9	Vertical	Peak
	41.1	41.1	54.0	12.9	Vertical	Average
5565.240	56.9	56.9	74.0	17.1	Vertical	Peak
	44.1	44.1	54.0	9.9	Vertical	Average
6492.780	59.7	59.7	74.0	14.3	Vertical	Peak
	46.8	46.8	54.0	7.2	Vertical	Average
7420.320	55.1	55.1	74.0	18.9	Vertical	Peak
	41.7	41.7	54.0	12.3	Vertical	Average
8347.860	55.3	55.3	74.0	18.7	Vertical	Peak
	42.8	42.8	54.0	11.2	Vertical	Average
9275.400	56.4	56.4	74.0	17.6	Vertical	Peak
	43.5	43.5	54.0	10.5	Vertical	Average

The general emission limit has been applied to all frequencies except for the harmonic observed at 2Fc where the -20 dBc limit has been applied.

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.

This transmitter would normally be pole mounted high above the ground.

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

Power density, $mW/cm^2 = E^2/3770$

E for MPE: $(921/1500) = E^2/3770$

$E = \sqrt{}(921/1500)*3770$

$E = \underline{48.1\ V/m}$

The maximum radiated power measured was +21.9 dBm or 0.154 Watts

Therefore:

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

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

$d = \sqrt{}(30 * 0.154) / 48.1$

$d = \underline{0.045\ m \text{ or } 4.5\ cm}$

In order to meet the MPE requirement for mobile devices a minimum safe distance of at least 20 cm will be required.

Result: Complies

7. TEST EQUIPMENT USED

Instrument	Manufacturer	Model	Serial No	Asset Ref	Cal Due
Aerial Controller	EMCO	1090	9112-1062	RFS 3710	Not applic
Aerial Mast	EMCO	1070-1	9203-1661	RFS 3708	Not applic
Turntable	EMCO	1080-1-2.1	9109-1578	RFS 3709	Not applic
Receiver	R & S	ESIB 40	100171	R-27-1	10 Apr 2014
Receiver	R & S	ESHS 10	828404/005	RFS 3728	2 Feb 2014
Mains Network	R & S	ESH2-Z5	881362/034	3628	29 Jul 2014
VHF Balun	Schwarzbeck	VHA 9103	-	RFS 3603	30 Jan 2014
Biconical	Schwarzbeck	BBA 9106	-	RFS 3612	30 Jan 2014
Log Periodic	Schwarzbeck	VUSLP 9111	9111-228	3785	30 Jan 2014
Horn Antenna	EMCO	3115	9511-4629	E1526	3 May 2014
Horn Antenna	EMCO	3116	92035	-	16 Jun 2014
Loop Antenna	EMCO	6502	9003-2485	3798	9 May 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 last 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, 2005.

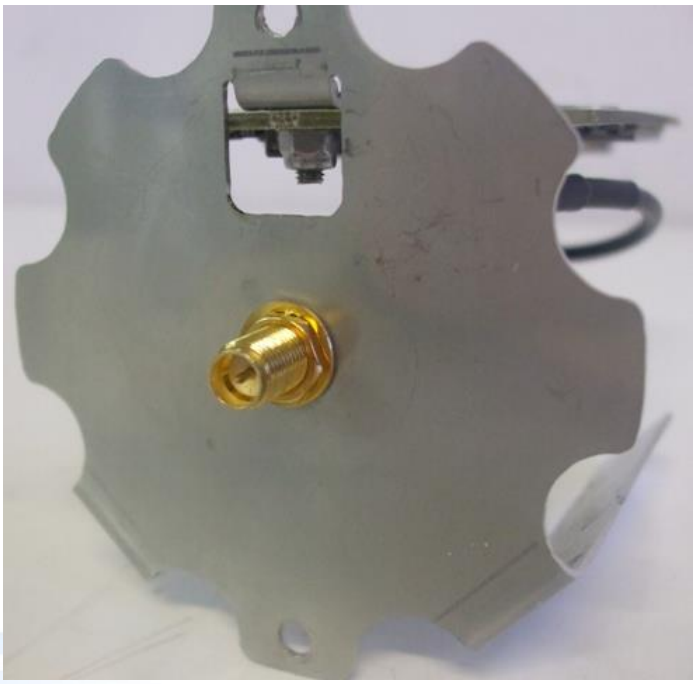
All measurement equipment has been calibrated in accordance with the terms of the EMC Technologies (NZ) Ltd International Accreditation New Zealand (IANZ) Accreditation to NZS/ISO/IEC 17025, 2005.

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.

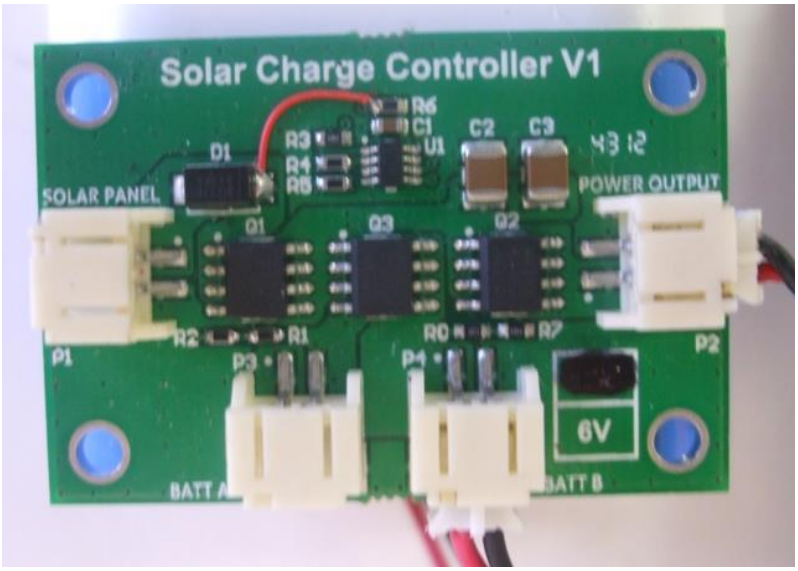
9. PHOTOGRAPHS

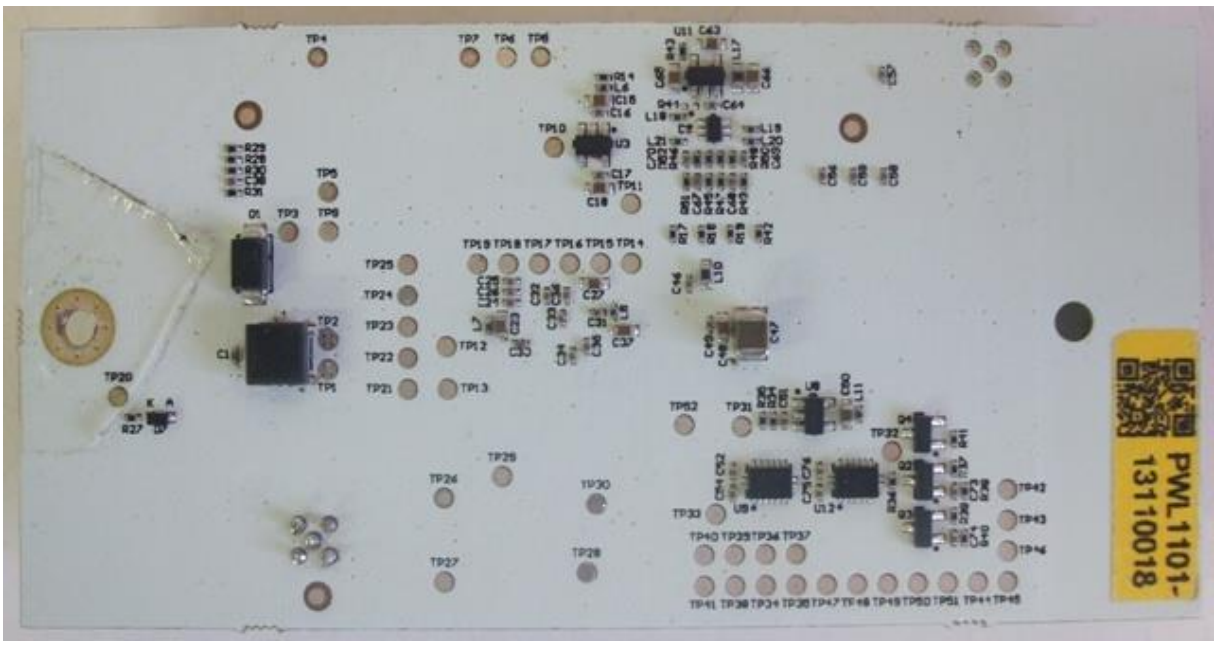
External photos

Antenna Port – Reverse SMA connector

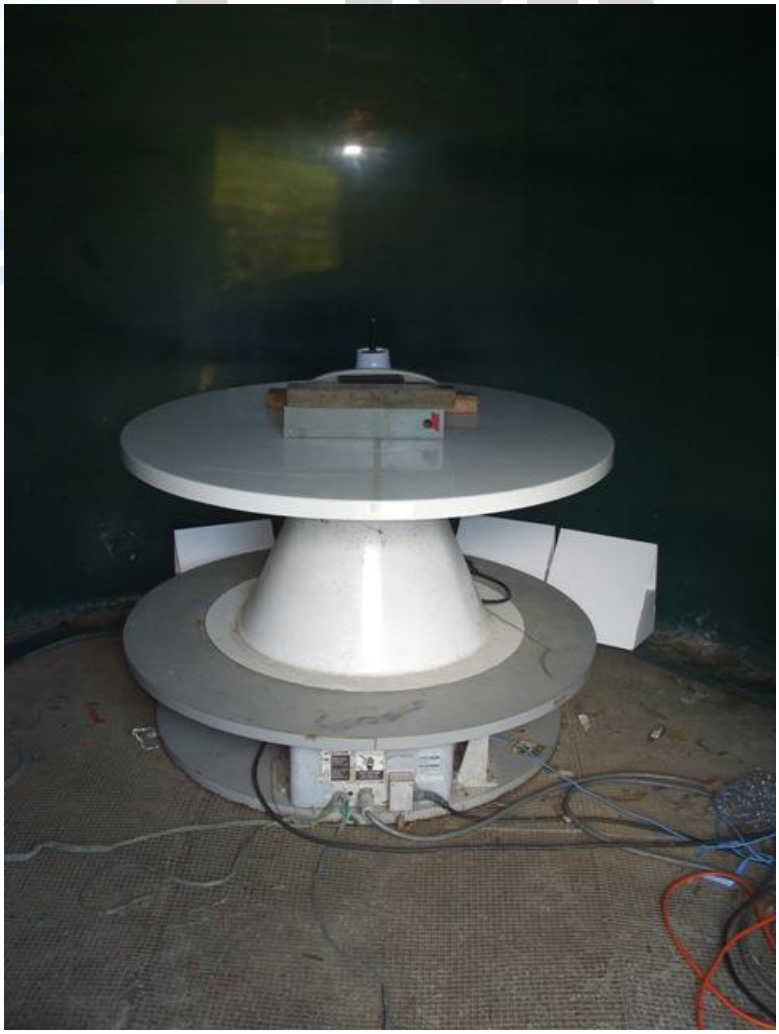


Internal Photos





Radiated Emission Test Set Up



Radiated emissions test set up photos – Below 30 MHz

Radiated emissions test set up photos – Above 30 MHz