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TEST REPORT

Kruse GO Tour Master Transmitter

tested to

47 Code of Federal Regulations

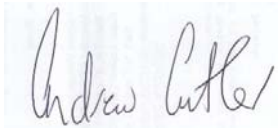
Part 15 - Radio Frequency Devices

Subpart C – Intentional Radiators

Section 15.247 - Operation in the band 902 – 928 MHz

for

Kruse Multilingual Systems 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

Table of Contents

1. STATEMENT OF COMPLIANCE

The **Kruse GO Tour Master Transmitter** 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 September 12th and September 17th 2013 are detailed below:

Clause	Parameter	Result
15.201	Equipment authorisation requirement	Certification required.
15.203	Antenna requirement	Complies. An external whip with a unique connector has been used.
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	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	Kruse Multilingual Systems Ltd
Address	PO Box 41169 St Lukes
City	Auckland 1346
Country	New Zealand
Contact	Mr Shaun O'Donnell

5. DESCRIPTION OF TEST SYSTEM

Brand Name	Kruse
Model Number	GO
Product	Tour Master Transmitter
Manufacturer	Kruse Multilingual Systems Ltd
Country of Origin	New Zealand
Serial Number	Sample not serialized
FCC ID	2AE66-KGTM24

Product Description

The system tested consists of one master unit, the unit under test, and one or many receiver units.

Both the master unit and the receiver are powered using re-chargable lithium polymer battery packs at 3.7 Vdc.

The playing of audio commentaries held on the receivers is triggered by a pulse from the master unit.

This pulse can be generated automatically by the master unit assessing its location using a GPS receiver or manually by the operator using the keypad on the master unit.

When a pulse is activated it consists of 100 messages which are approximately 7 ms long which gives a total transmission time of approximately 700 ms.

Testing was carried out in a test mode with a pulse being transmitted automatically once every 2 seconds to give a worst case scenario.

Band of Operation:	902 – 928 MHz	
Modulation:	Frequency hopping spread spectrum	
Number of channels:	50	
Operating frequencies:	922.000 – 926.900 MHz	
Channel spacing:	100 kHz	
Rated Conducted Power:	+10 dBm (10 mW)	
Frequencies in use:	Microcontroller	16.000 MHz,
	Audio Decoder	12.288 MHz
	RF Module	30.000 MHz
	LCD power supply	4.000 MHz
	Main power supply	850.0 kHz
Antenna Type:	Half wave dipole	
Power Supply:	3.7 Vdc internal lithium polymer battery pack	
Ports:	Battery charging port Antenna port	
RF Module	Hope RF RFM22B Transceiver	

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 transceiver uses an external half wave dipole that is attached using a reverse SMA connector which is unique.

Photos at the rear of this report show the use of this connector

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 15.207: Conducted limits

Conducted Emissions testing was carried out over the frequency range of 150 kHz to 30 MHz which was carried out 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 using a representative AC power supply system that was powered at 120 Vac 60 Hz which was used to charge the batteries that operate this device and was connected to the charging port on the device.

Testing was carried out with the device transmitting continuously.

The device was placed on top of the emissions table, which is 1 m x 1.5 m, 80 cm above the screened room floor which acts as the horizontal ground plane.

In addition the device was positioned 40 cm away from the screened room wall which acts as the vertical ground plane.

The artificial mains network was bonded to the screened room floor.

At all times the device was kept more than 80 cm from the artificial mains network.

The Class B limits have been applied.

The supplied plot is combined plot showing the worst case quasi peak and average results of both the phase and neutral lines to the representative AC power supply.

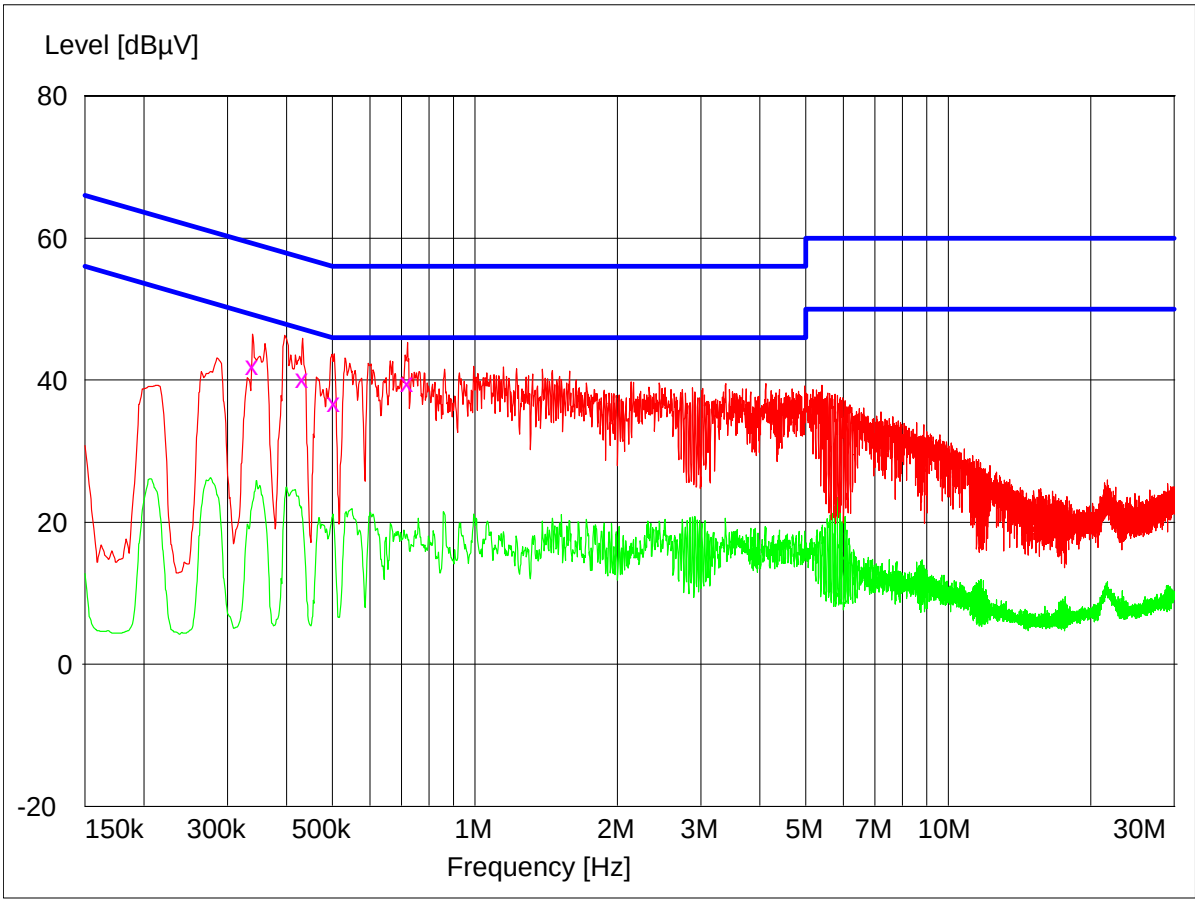
Quasi peak and average detectors have been used with resolution bandwidths of 9 kHz.

Measurement uncertainty with a confidence interval of 95% is:
- AC Mains port (0.15-30 MHz) ± 2.8 dB

Conducted Emissions – AC Input Power Port

Setup:	Device tested when powered at 115 Vac while transmitting once every 2 seconds in a test mode with the antenna attached. Testing was carried out using a representative power supply.

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



Final Quasi-Peak Measurements

Frequency MHz	Level dBµV	Limit dBµV	Margin dB	Phase	Rechecks dBµV
0.339000	42.10	59.2	17.1	L1	
0.432000	40.30	57.2	16.9	L1	
0.504000	36.80	56.0	19.3	L1	
0.720000	39.70	56.0	16.3	L1	

Final Average Measurements

Frequency MHz	Level dBµV	Limit dBµV	Margin dB	Phase	Rechecks dBµV
	No emissions detected within 15 dB of the limit				

Section 15.209: Radiated emission limits, general requirements

As this device contains digital devices that operate using frequencies below 30 MHz (16.0 MHz, 12.288 MHz, 30.0 MHz, 4.0 MHz and 850.0 kHz), low frequency measurements were attempted between 150 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 150 – 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 on the frequencies of interest listed above and no other emissions were detected from this device over the range of 150 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

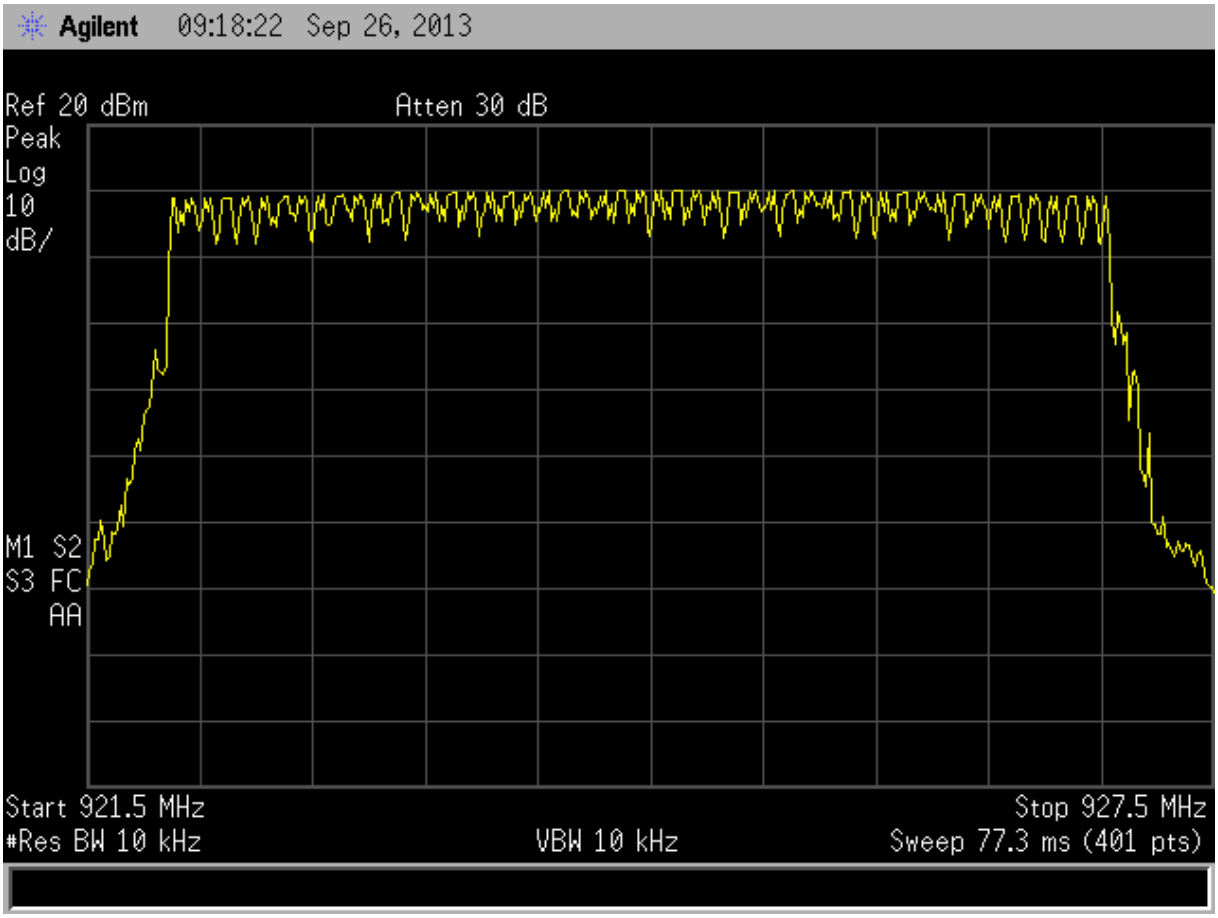
The results are summarised as follows:

Parameter	Limit	Observation	Result
Number of channels	Minimum of 50 channels	50 channels with 100 kHz spacing observed	
20 dB bandwidth	Less than the channel spacing	A worst case bandwidth of 85 kHz was measured	Pass
Hop interval	Greater than 20 dB bandwidth	99.750 kHz	Pass
Dwell time	Not to exceed 400 ms in any 20 second period	225 ms	Pass

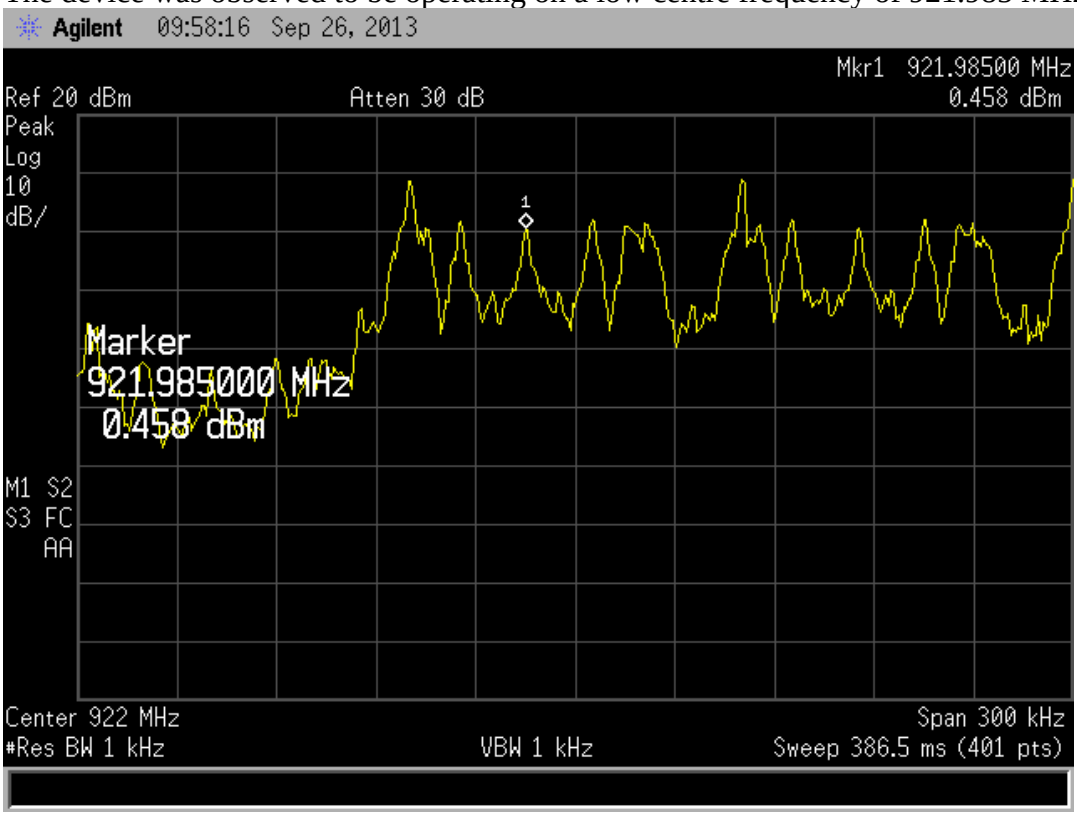
Result: Complies.

This device operates using Frequency Hopping Spread Spectrum techniques.

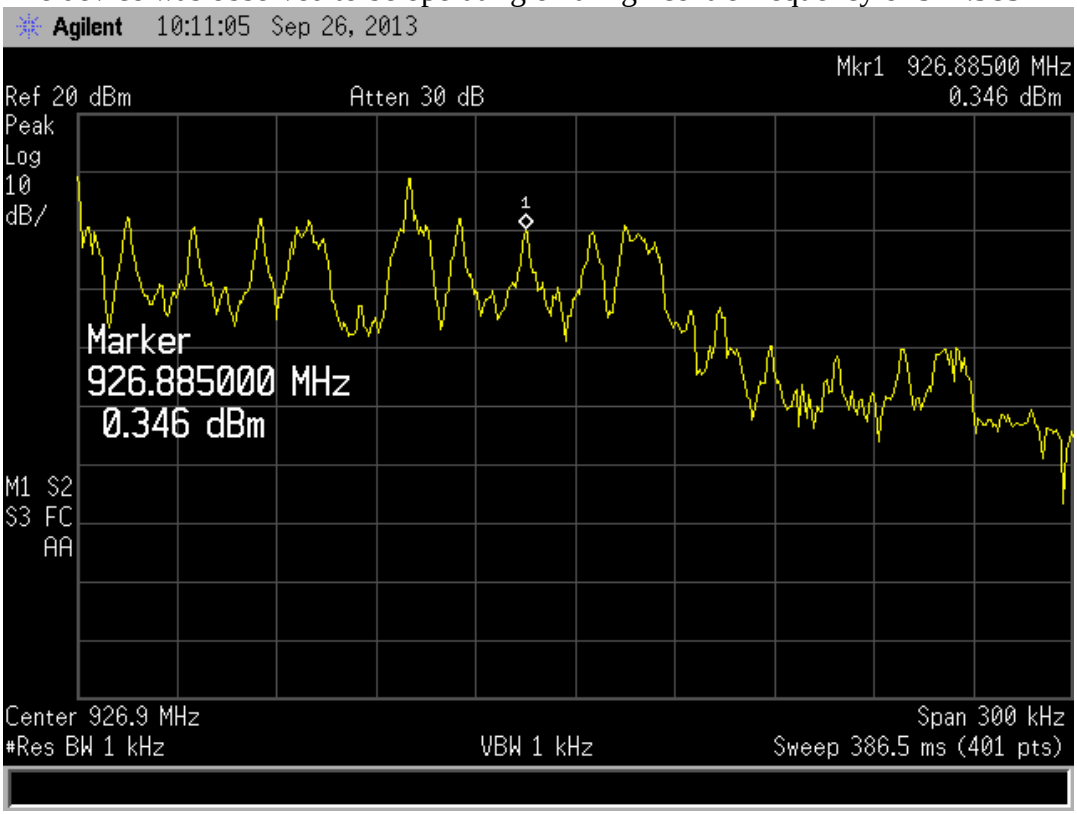
50 channels were observed between 922.000 – 926.900 MHz



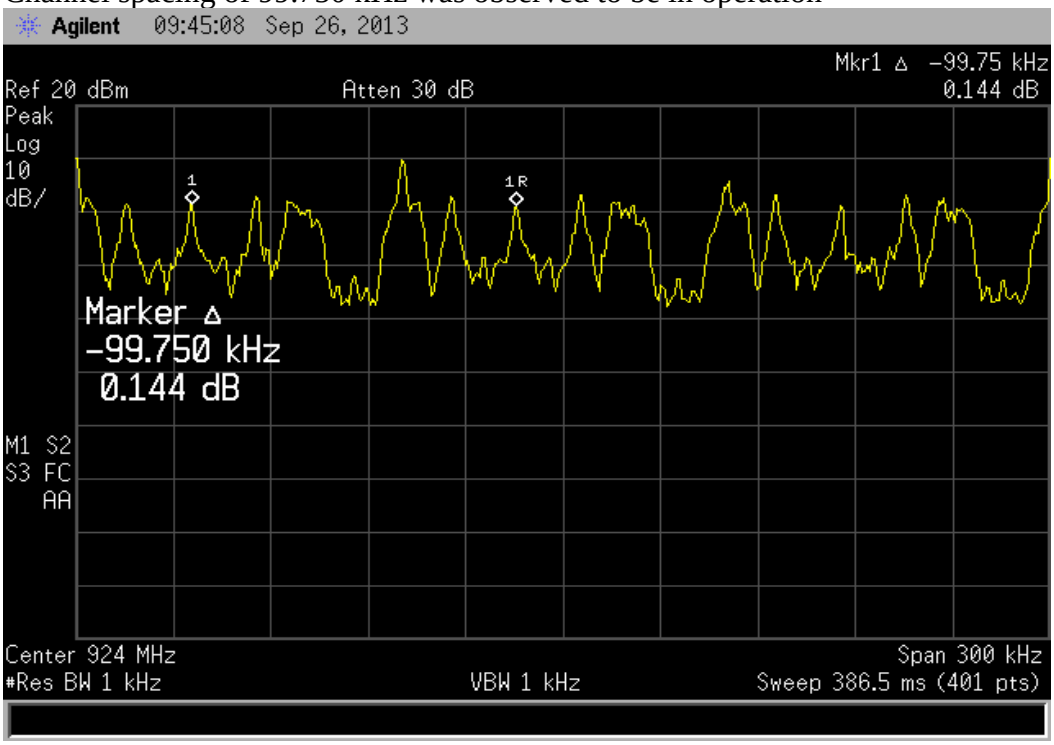
The device was observed to be operating on a low centre frequency of 921.985 MHz



The device was observed to be operating on a high centre frequency of 921.985 MHz



Channel spacing of 99.750 kHz was observed to be in operation



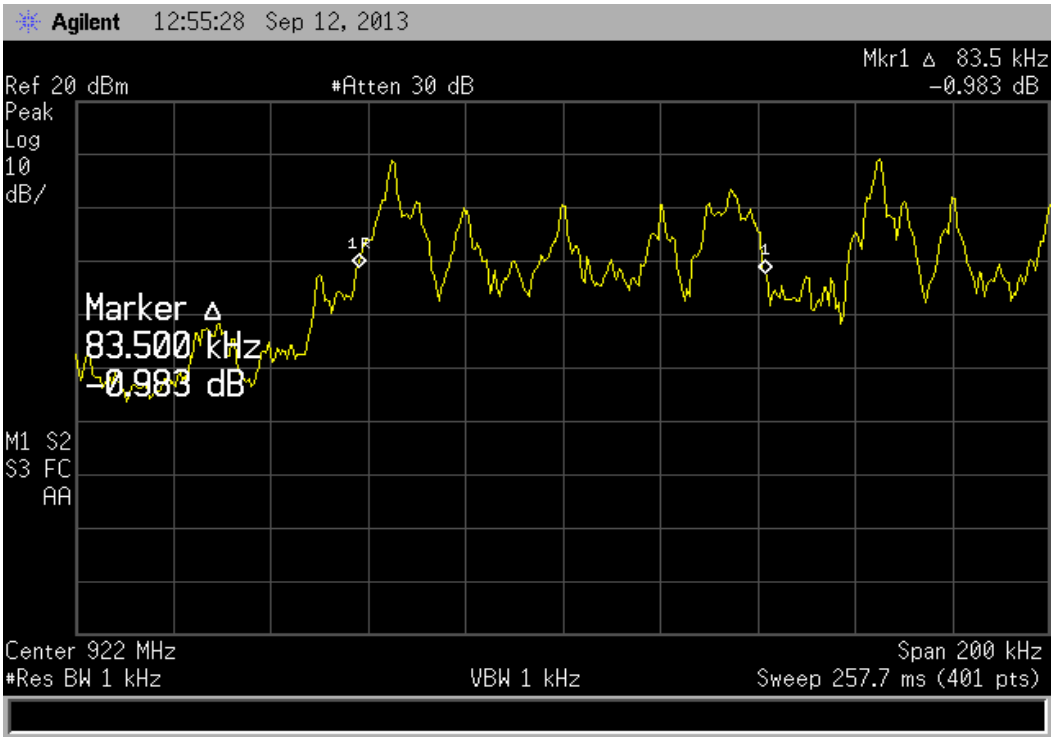
Therefore the number of channels in use will be:

926.885 MHz – 921.985 MHz = 4.9 MHz

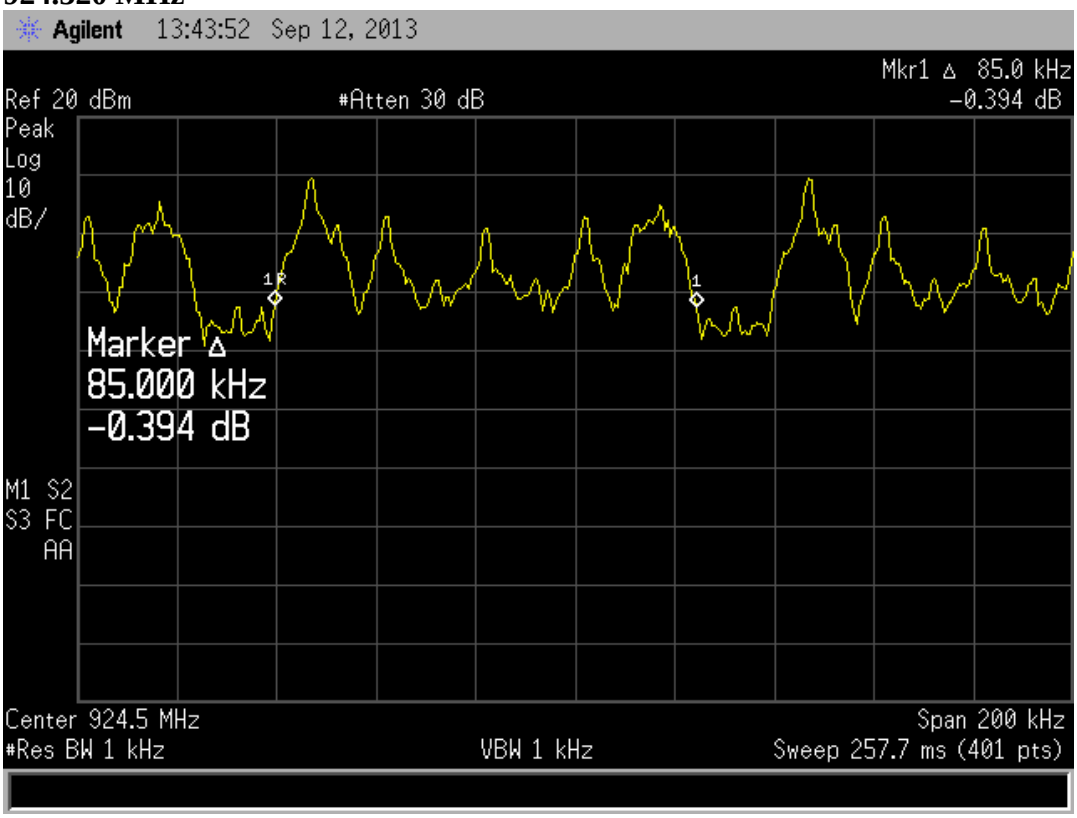
4.9 MHz / 100 kHz = 49 + 1 = 50 channels in use

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

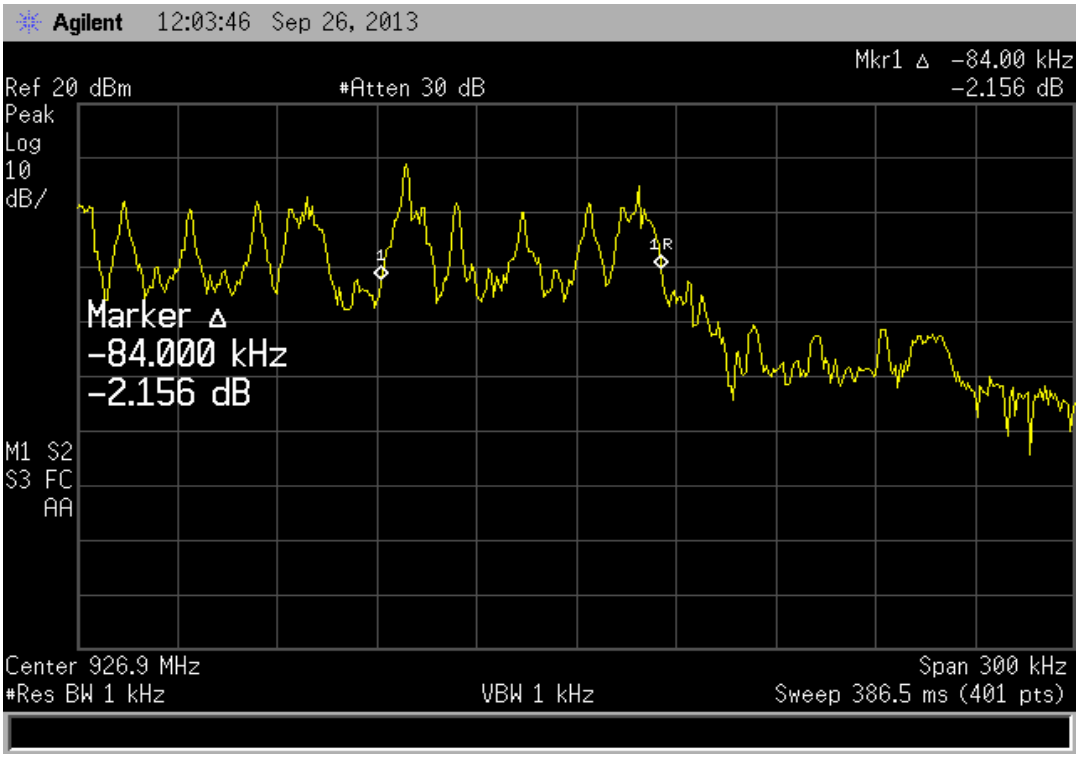
922 MHz



924.320 MHz



926.900 MHz

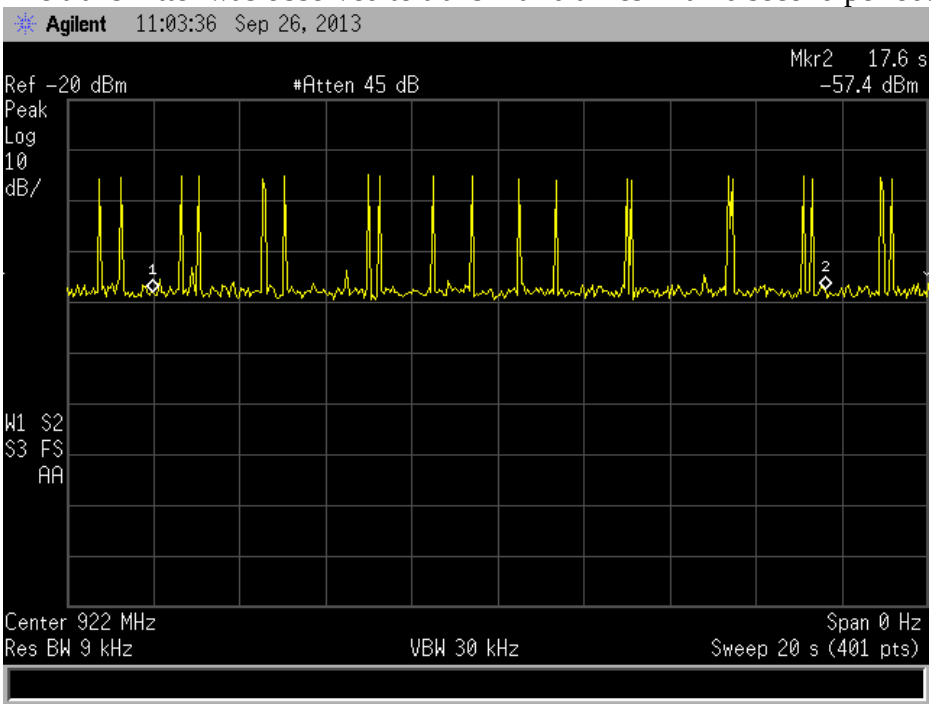


A worst case 20 dB bandwidth of 85.0 kHz was measured.

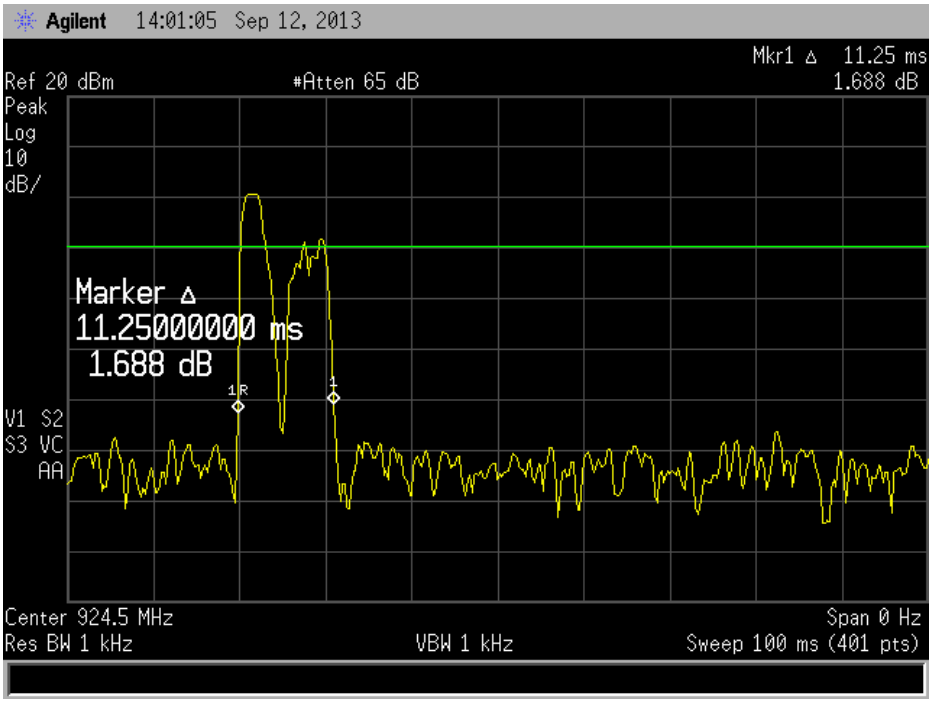
The client advises that when the transmitter pulse is activated it sends out 100 messages with each message being approximately 7 ms in duration.

When operating in test mode the device transmitted a pulse every 2 seconds in a simulated worst case.

The transmitter was observed to transmit 20 times in a 20 second period.



Each time the transmitter transmitted it did so for 11.25 ms.



The dwell time will therefore be 20 transmissions x 11.25 ms = 225 ms.

Result: Complies

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

Conducted Power

Conducted power measurements were made on the highest low, mid and high frequency with a power meter being connected directly to the antenna terminal.

Measurements were made using a measuring receiver with a Peak detector with a resolution bandwidth of 100 kHz.

The following levels were recorded.

Frequency (MHz)	Level (dBm)	Limit (dBm)
922.000	9.3	30.0
924.000	10.0	30.0
926.800	9.1	30.0

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

Result: Complies
Measurement Uncertainty: ± 1.5 dB

Radiated Power

In addition radiated power measurements were made at the test site

The antenna has a gain of approximately 1 (0 dB)

Using the measured conducted power and the conducted power calculated from radiated power measurements the antenna gain was determined

Testing was carried out with the device orientated in 3 planes (X, Y and Z) and in both vertical and horizontal polarisations with the worst case level being recorded at each frequency.

Frequency (MHz)	Field Strength (dBµV/m)	Calculated Conducted (dBm)	Measured Conducted (dBm)	Antenna Gain (dB)	Antenna Polarisation
922.000	103.3	8.1	9.3	-1.2	Horizontal
924.000	104.3	9.1	10.0	-0.9	Horizontal
926.800	104.7	9.5	9.1	+0.4	Horizontal

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

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).

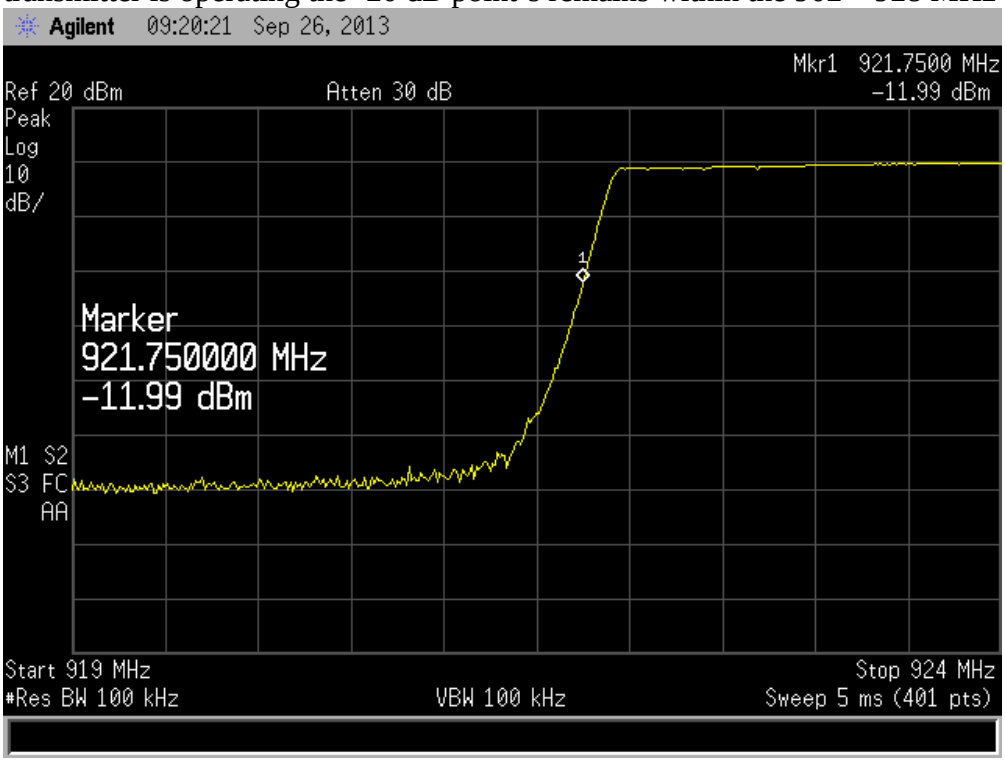
Result: Complies.
Measurement Uncertainty: ± 4.1 dB

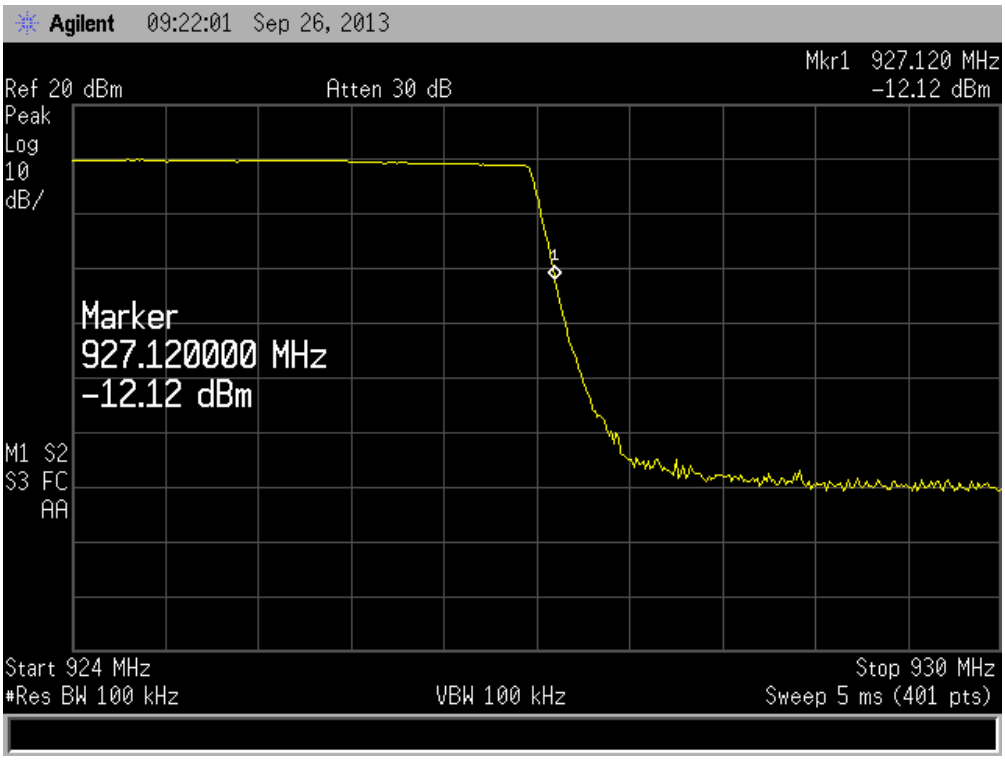
Section 15.247 (d) – Out of band emissions

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.

A relative radiated emission measurement has been made which shows that when the transmitter is operating the -20 dB point's remains within the 902 – 928 MHz band.





In addition 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		31.8	84.7	52.9	Pass	Horizontal
902.000	32.1		84.7	52.6	Pass	Vertical
928.000		49.1	84.7	35.6	Pass	Horizontal
928.000	48.4		84.7	36.3	Pass	Vertical

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.

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.

Measurements of the radiated field were attempted at 3 metres from the device when it was orientated in three axis (X, Y and Z) with 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 continuously on 922.0 MHz

Frequency MHz	Vertical dBuV/m	Hort dBuV/m	Limit dBuV/m	Margin dB	Antenna	Detector	Worst Plane
34.068	23.5		40.0	16.5	Vertical	QP	Flat
54.060	20.7		40.0	19.3	Vertical	QP	Flat
74.100	15.1		40.0	24.9	Vertical	QP	Flat
3144.804	47.1	49.2	74.0	24.8	Horizontal	Peak	Side
3144.804	42.6	45.6	54.0	8.4	Horizontal	Average	Side
1844.000	57.3		74.0	16.7	Vertical	Peak	Upright
	40.1		54.0	13.9	Vertical	Average	Upright
1844.000		62.0	74.0	12.0	Horizontal	Peak	Flat
		44.3	54.0	9.7	Horizontal	Average	Flat
2766.000	51.5		74.0	22.5	Vertical	Peak	Upright
	34.0		54.0	22.0	Vertical	Average	Upright
2766.000		51.2	74.0	22.8	Horizontal	Peak	On edge
		33.1	54.0	20.9	Horizontal	Average	On edge
3688.000	53.5		74.0	20.5	Vertical	Peak	Flat
	32.5		54.0	21.5	Vertical	Average	Flat
3688.000		53.7	74.0	20.3	Horizontal	Peak	Upright
		30.9	54.0	23.1	Horizontal	Average	Upright
4610.000	62.3		74.0	11.7	Vertical	Peak	Flat
	44.5		54.0	9.5	Vertical	Average	Flat
4610.000		66.0	74.0	8.0	Horizontal	Peak	Upright
		45.0	54.0	9.0	Horizontal	Average	Upright
5532.000	56.7		74.0	17.3	Vertical	Peak	Flat
	33.7		54.0	20.3	Vertical	Average	Flat
5532.000		58.6	74.0	15.4	Horizontal	Peak	Upright
		35.1	54.0	18.9	Horizontal	Average	Upright
6454.000	< 50.0	< 50.0	74.0	> 24.0	Vertical	Peak	All
	< 40.0	< 40.0	54.0	> 14.0	Vertical	Average	All
7376.000	47.8		74.0	26.2	Vertical	Peak	On edge
	33.1		54.0	20.9	Vertical	Average	On edge
7376.000		49.8	74.0	24.2	Horizontal	Peak	Upright
		33.1	54.0	20.9	Horizontal	Average	Upright
8298.000	< 50.0	< 50.0	74.0	> 24.0	Vertical	Peak	All
	< 40.0	< 40.0	54.0	> 14.0	Vertical	Average	All
9220.000	< 50.0	< 50.0	74.0	> 24.0	Vertical	Peak	All
	< 40.0	< 40.0	54.0	> 14.0	Vertical	Average	All

Transmitting continuously on 926.8 MHz

Frequency MHz	Vertical dBuV/m	Hort dBuV/m	Limit dBuV/m	Margin dB	Antenna	Detector	Worst Plane
34.068	23.5		40.0	16.5	Vertical	QP	Flat
54.060	20.7		40.0	19.3	Vertical	QP	Flat
74.100	15.1		40.0	24.9	Vertical	QP	Flat
3144.804	47.1	49.2	74.0	24.8	Horizontal	Peak	Side
3144.804	42.6	45.6	54.0	8.4	Horizontal	Average	Side
1853.600	57.3		74.0	16.7	Vertical	Peak	Upright
	40.1		54.0	13.9	Vertical	Average	Upright
1853.600		62.1	74.0	11.9	Horizontal	Peak	Flat
		45.3	54.0	8.7	Horizontal	Average	Flat
2780.400	51.6		74.0	22.4	Vertical	Peak	Upright
	33.5		54.0	20.5	Vertical	Average	Upright
2780.400		51.2	74.0	22.8	Horizontal	Peak	On edge
		33.1	54.0	20.9	Horizontal	Average	On edge
3707.200	53.5		74.0	20.5	Vertical	Peak	Flat
	32.5		54.0	21.5	Vertical	Average	Flat
3707.200		53.7	74.0	20.3	Horizontal	Peak	Upright
		30.9	54.0	23.1	Horizontal	Average	Upright
4634.000	63.3		74.0	10.7	Vertical	Peak	Flat
	45.1		54.0	8.9	Vertical	Average	Flat
4634.000		67.9	74.0	6.1	Horizontal	Peak	Upright
		48.0	54.0	6.0	Horizontal	Average	Upright
5560.800	56.7		74.0	17.3	Vertical	Peak	Flat
	33.7		54.0	20.3	Vertical	Average	Flat
5560.800		58.6	74.0	15.4	Horizontal	Peak	Upright
		35.1	54.0	18.9	Horizontal	Average	Upright
6487.600	< 50.0	< 50.0	74.0	> 24.0	Vertical	Peak	All
	< 40.0	< 40.0	54.0	> 14.0	Vertical	Average	All
7414.400	47.8		74.0	26.2	Vertical	Peak	On edge
	33.1		54.0	20.9	Vertical	Average	On edge
7414.400		49.8	74.0	24.2	Horizontal	Peak	Upright
		33.1	54.0	20.9	Horizontal	Average	Upright
8341.200	< 50.0	< 50.0	74.0	> 24.0	Vertical	Peak	All
	< 40.0	< 40.0	54.0	> 14.0	Vertical	Average	All
9268.000	< 50.0	< 50.0	74.0	> 24.0	Vertical	Peak	All
	< 40.0	< 40.0	54.0	> 14.0	Vertical	Average	All

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).

In accordance with Section 1.1310 this device would be classed as a portable device and therefore Section 2.1093 will apply.

Section 2.1093 requires SAR measurements to be carried out.

A SAR evaluation has been carried out in accordance with KDB Publication 447498 D01 General RF Exposure Guidance v05 dated October 24, 2012.

Clause 4.3.1 1 has been applied to this device as the power output is very low.

The highest output power observed from this device was +9.5 dBm or 8.91 mW when transmitting on 926.800 MHz.

The 1-g SAR threshold level was calculated using a safe distance of 5 mm

1-g SAR = (8.91 mW / 5 mm) * (√ 0.9268 GHz) = 1.72

The 1-g SAR threshold level, for distances < 50 mm, is < 3.0.

The device will therefore meet the requirements of Section 2.1093 without any further testing falling below the 1-g SAR threshold level.

Result: Complies.

7. TEST EQUIPMENT USED

Instrument	Manufacturer	Model	Serial No	Asset Ref	Cal Due	Interval
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
Turntable	EMCO	1080-1-2.1	9109-1578	RFS 3709	Not applic	Not applic
Receiver	R & S	ESIB 40	100171	R-27-1	10 Oct 2013	1 year
Receiver	R & S	ESHS 10	828404/005	RFS 3728	2 Feb 2014	1 year
Mains Network	R & S	ESH2-Z5	881362/034	3628	29 Jul 2014	1 year
VHF Balun	Schwarzbeck	VHA 9103	-	RFS 3603	30 Jan 2014	3 years
Biconical Antenna	Schwarzbeck	BBA 9106	-	RFS 3612	30 Jan 2014	3 years
Log Periodic	Schwarzbeck	VUSLP 9111	9111-228	3785	30 Jan 2014	3 years
Horn Antenna	EMCO	3115	9511-4629	E1526	3 May 2014	3 years
Horn Antenna	EMCO	3116	92035	-	16 Jun 2014	3 years
Loop Antenna	EMCO	6502	9003-2485	3798	9 May 2014	3 years

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.

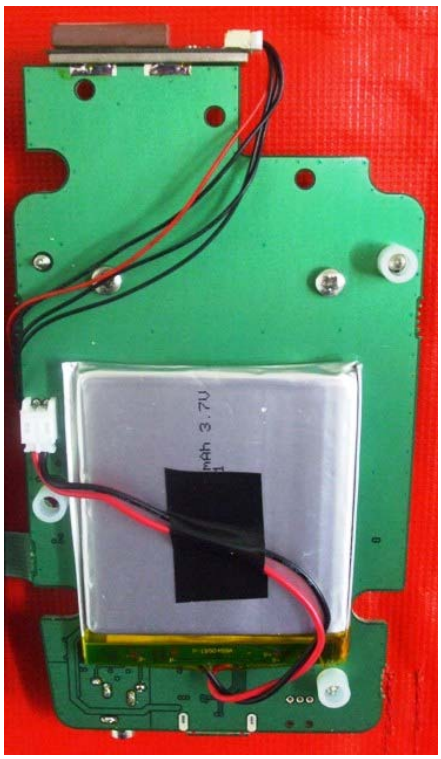
International Accreditation New Zealand has Mutual Recognition Arrangements for testing and calibration with various accreditation bodies in a number of economies. This includes NATA (Australia), UKAS (UK), SANAS (South Africa), NVLAP (USA), A2LA (USA), SWEDAC (Sweden). Further details can be supplied on request.

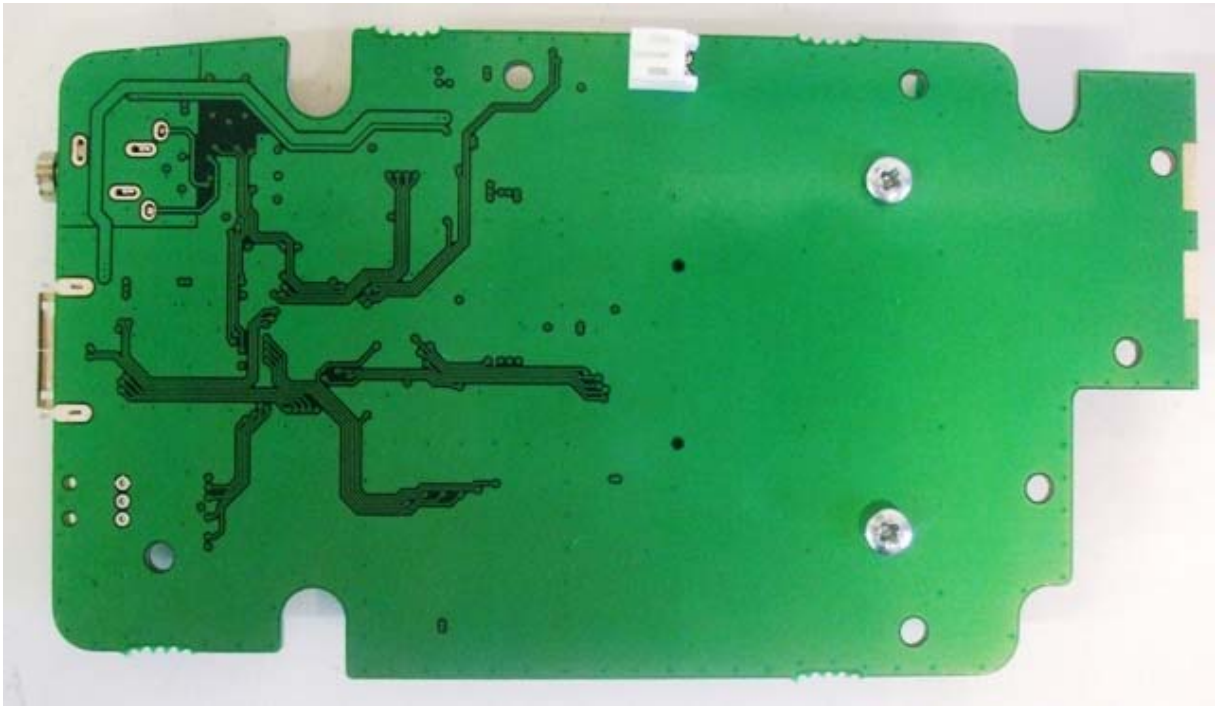
9. PHOTOGRAPHS

External photos

Unique antenna connector – Reverse SMA connector

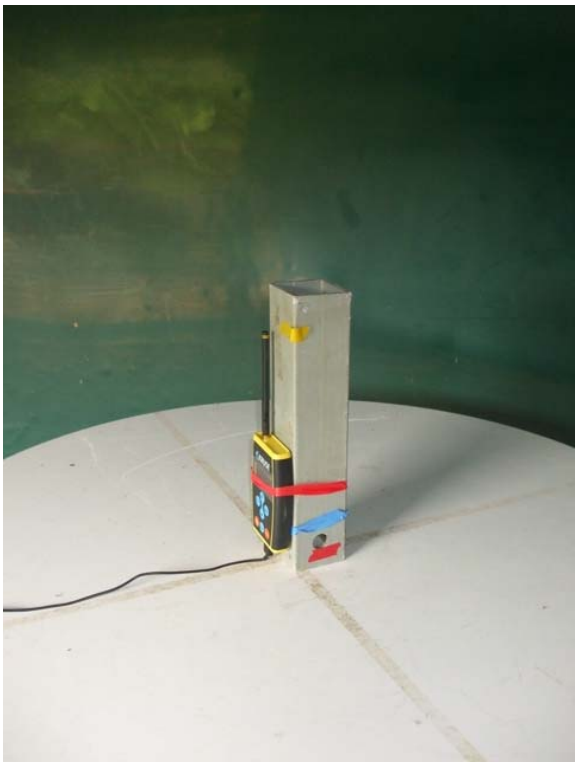
Internal Photos



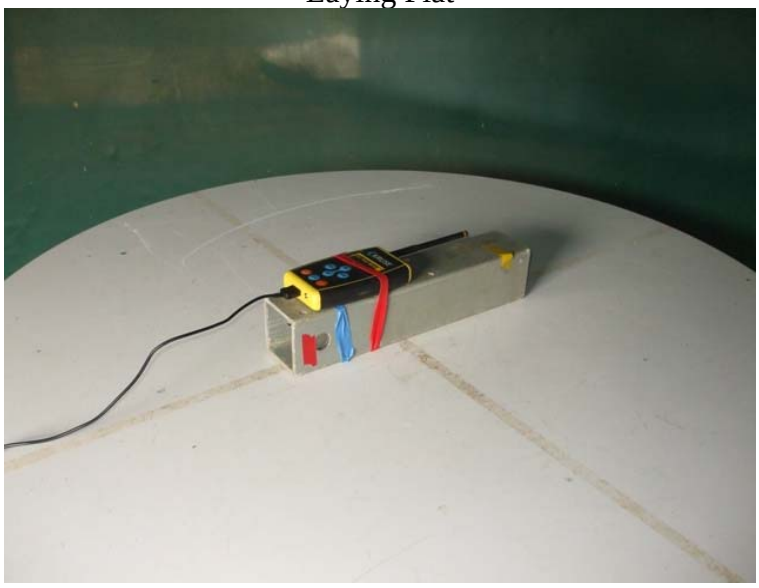


Radiated Emission Test Set Up

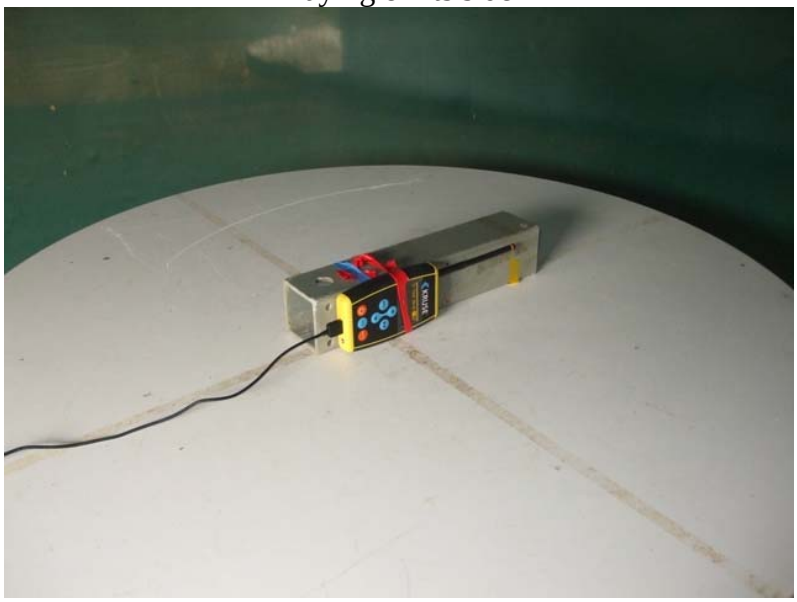
Standing up right

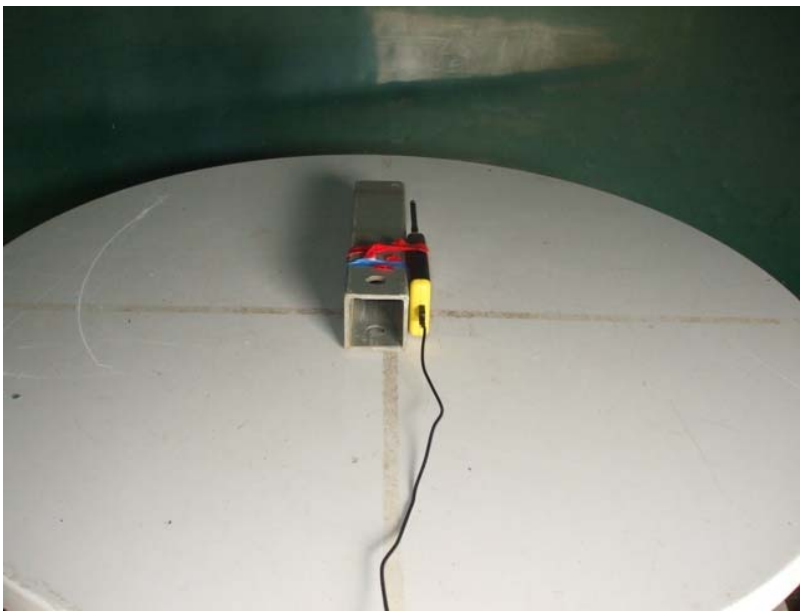


Laying Flat



Laying on its side





Radiated emissions test set up photos – Below 30 MHz

Radiated emissions test set up photos – Above 30 MHz

Conducted Emissions Test Set Up