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TEST REPORT

Heyrex Collar Biosensor Capsule v6
Animal Biometrics Monitoring Device

tested to

47 Code of Federal Regulations

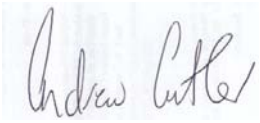
Part 15 - Radio Frequency Devices

Subpart C – Intentional Radiators

Section 15.247 - Operation in the band 2400 – 2483.5 MHz

for

Say Systems



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 **Heyrex Collar Biosensor Capsule v6 Animal Biometrics Monitoring Device** complies with FCC Part 15 Subpart C 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 of testing carried out between September 2012 and December 2012 are detailed below:

Clause	Parameter	Result
15.201	Equipment authorisation requirement	Certification required.
15.203	Antenna requirement	Complies. Antenna is integral to the device.
15.204	External PA and antenna modifications	Noted.
15.205	Restricted bands of operation	Complies.
15.207	Conducted limits	Not applicable
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	Say Systems
Address	Level 1, 236-256 Karori Rd, Karori
City	Wellington
Country	New Zealand
Contact	Mr Mark Solly

5. DESCRIPTION OF TEST SYSTEM

Brand Name	Heyrex
Model Number	Collar Biosensor Capsule v6
Product	Animal Biometrics Monitoring Device
Manufacturer	Say Systems
Country of Origin	New Zealand
Serial Number	Sample not serialized
Band of Operation:	2400 to 2483.5 MHz
FCC ID	RGZ-C6

Product Description

The Heyrex animal biometrics and telemetry system consists of a battery powered sensor module (Collar Biosensor Capsule v6) and a fixed base station (Rex net v3).

The sensor is attached to animals and communicates using the 2.4 GHz ISM band to a fixed base station.

The base station stores and relays data from the sensor module to an Ethernet network via an RJ45 outlet.

Band of Operation:	2400-2483.5 MHz
Number of channels:	21
Operating frequencies:	2402 MHz – 2462 MHz
Channel spacing:	3 MHz
Rated Conducted Power:	approximately 0 dBm
Modulation Type:	Proprietary 2 Mbps GFSK Frequency Hopping, Using Nordic Enhanced Shock burst Protocol
Antenna Type:	Omni-directional integrated antenna on board
Power Supply:	3 Vdc internal lithium cell batteries
Ports:	Device has no external ports

The device was tested removed from the plastic case that it was supplied with.

It was tested in a naked state with an external battery pack attached.

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 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 collar sensor transceiver uses an integral 2.4 GHz antenna.

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 21 channels between 2402 MHz and 2480 MHz using frequency hopping spread spectrum techniques.

Section 15.247 allows this between 2400 – 2483.5 MHz

The requirements of the restricted bands have been noted

Result: Complies.

Section 15.107: Conducted limits

Not applicable

The Collar Sensor device is powered using an internal dc battery.

This device cannot be connected directly or indirectly to the public AC mains supply.

Result: Complies

Section 15.209: Radiated emission limits, general requirements

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

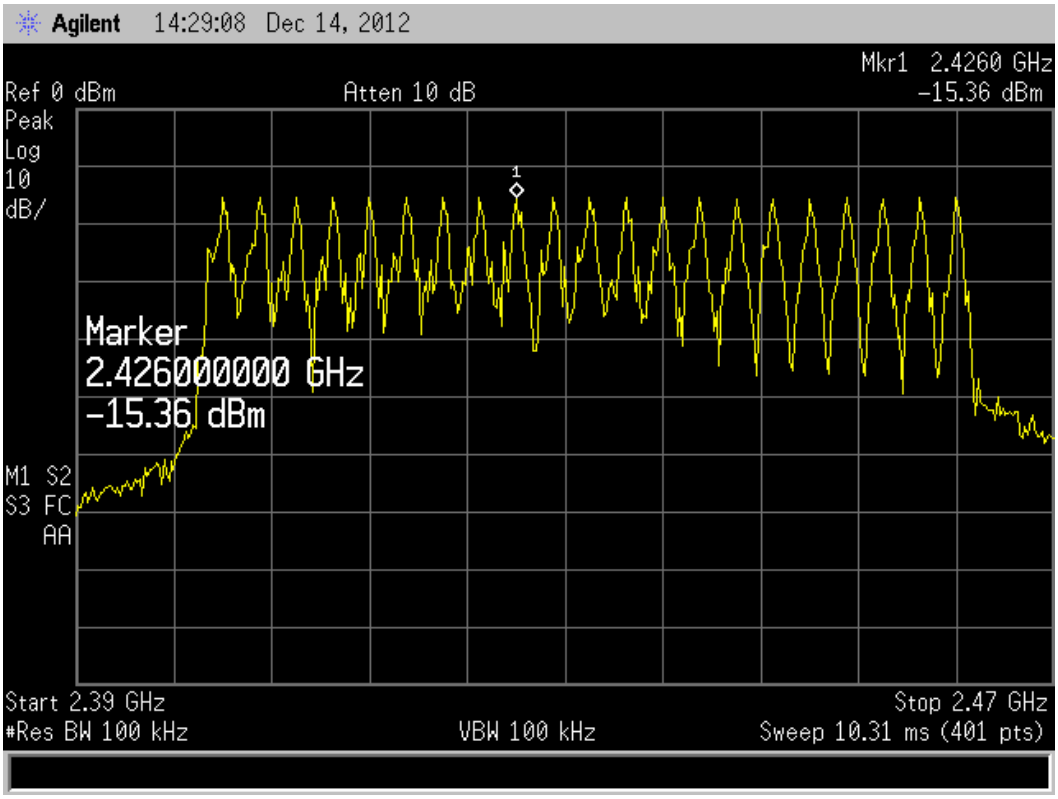
The results are summarised as follows:

Parameter	Limit	Observation	Result
Number of channels	Minimum of 15 channels	21 channels with 3 MHz spacing	Pass
20 dB bandwidth	Less than the channel spacing	A worst case bandwidth of 2.0625 MHz was measured	Pass
Hop interval	Greater than 20 dB bandwidth	3 MHz	Pass
Dwell time	Not to exceed 400 ms in any 8.4 second period	394.875 ms	Pass

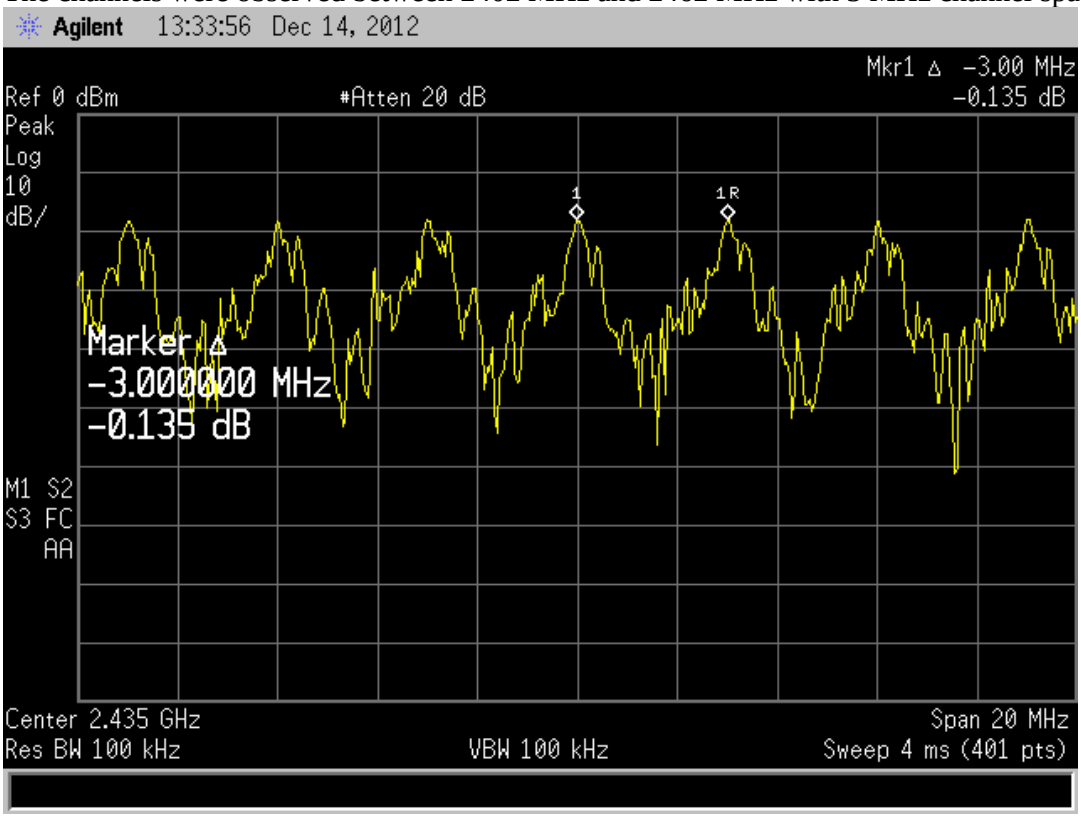
Result: Complies

This device operates using Frequency Hopping Spread Spectrum techniques.

21 channels were observed between 2402 – 2480 MHz

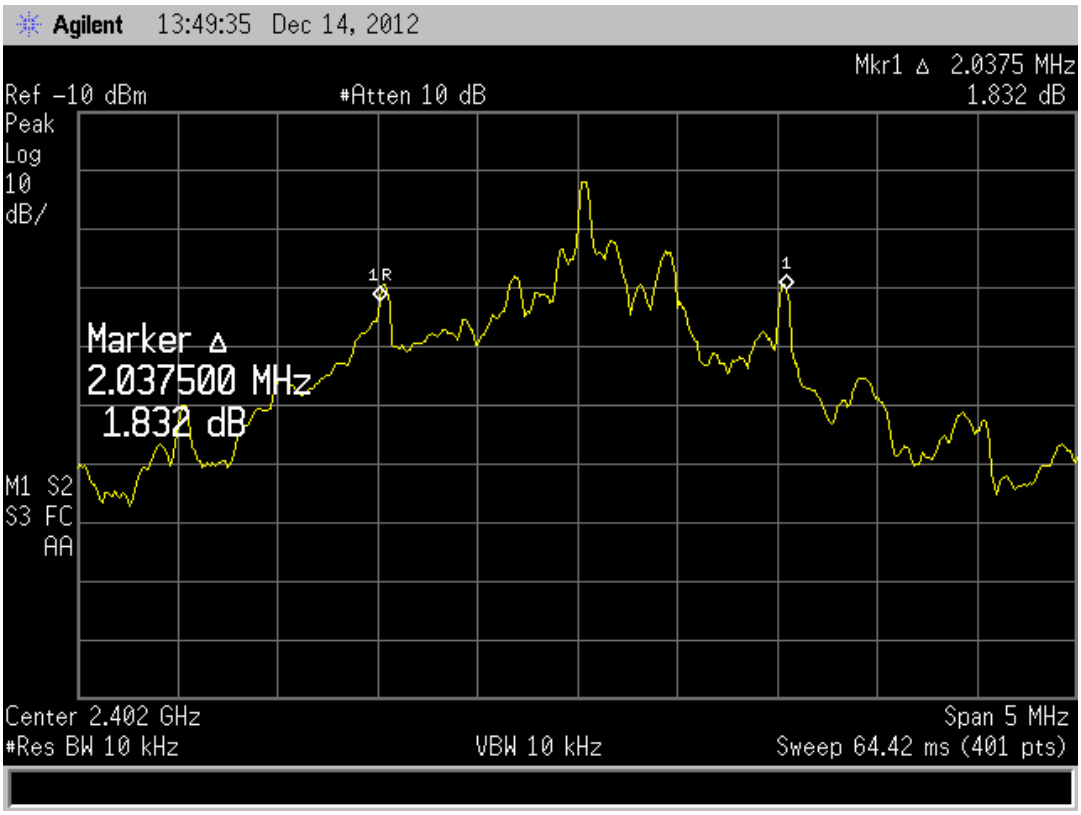


The channels were observed between 2402 MHz and 2462 MHz with 3 MHz channel spacing

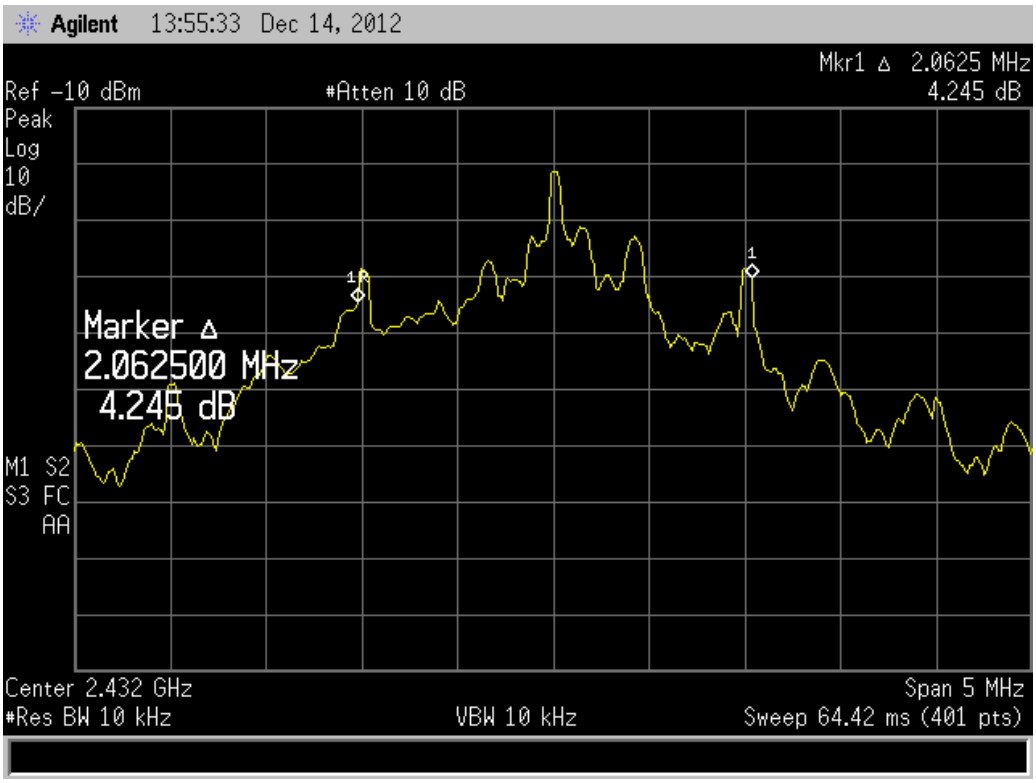


The -20 dB bandwidth for each device has been determined below

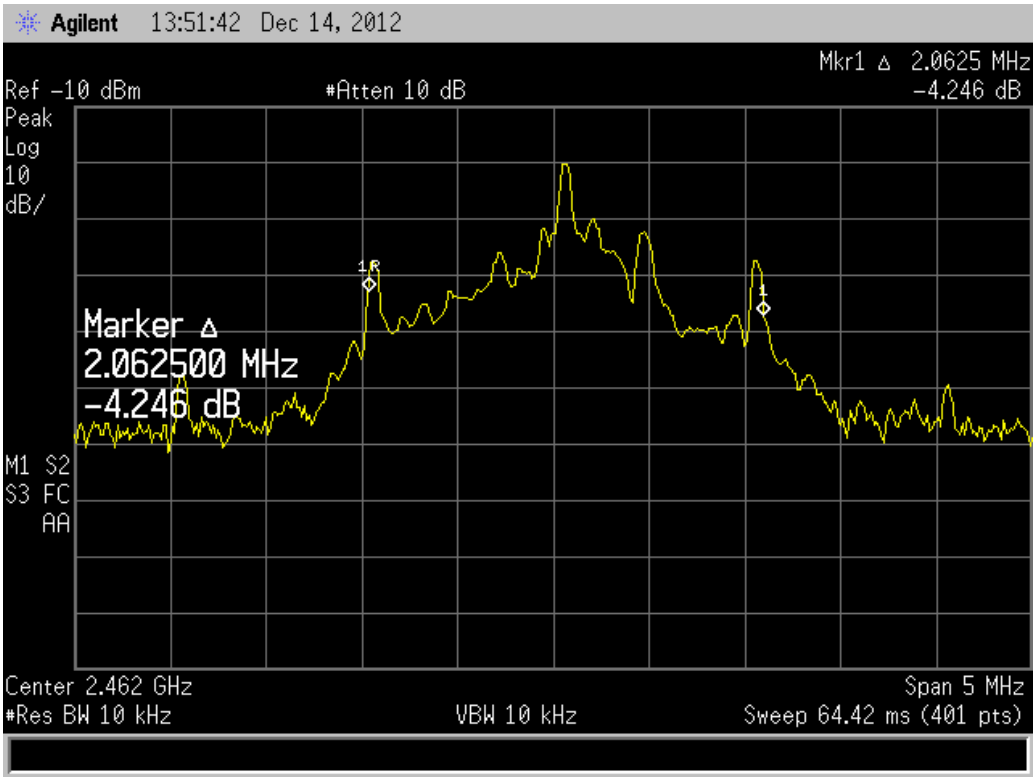
2402 MHz



2432 MHz

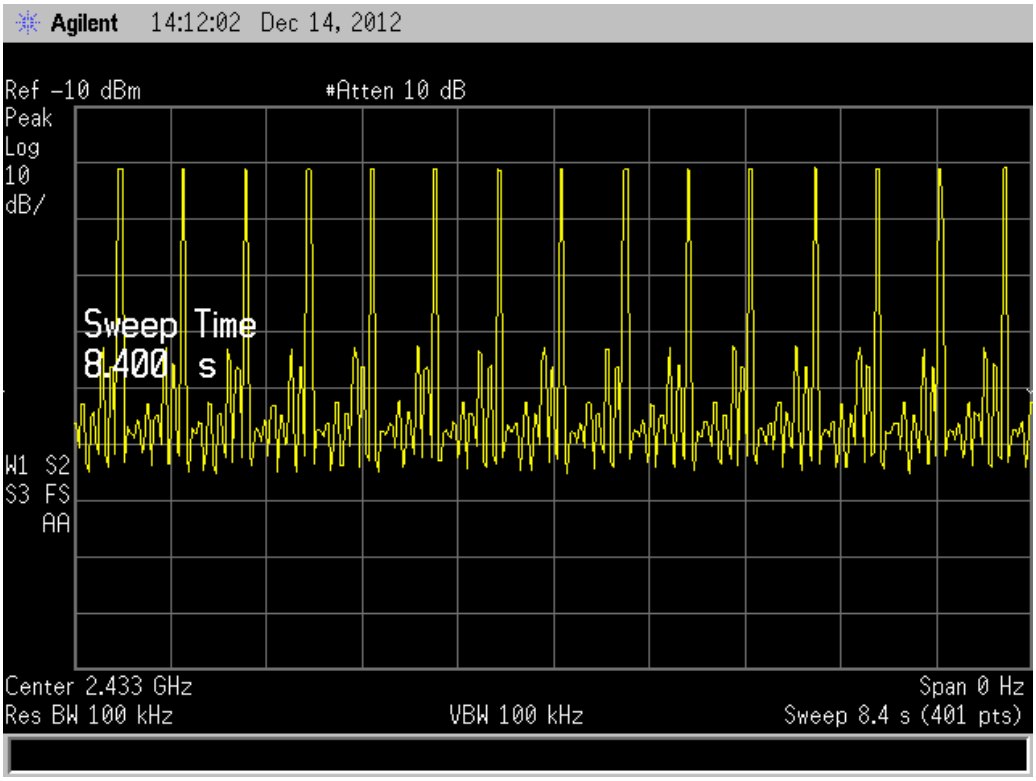


2462 MHz

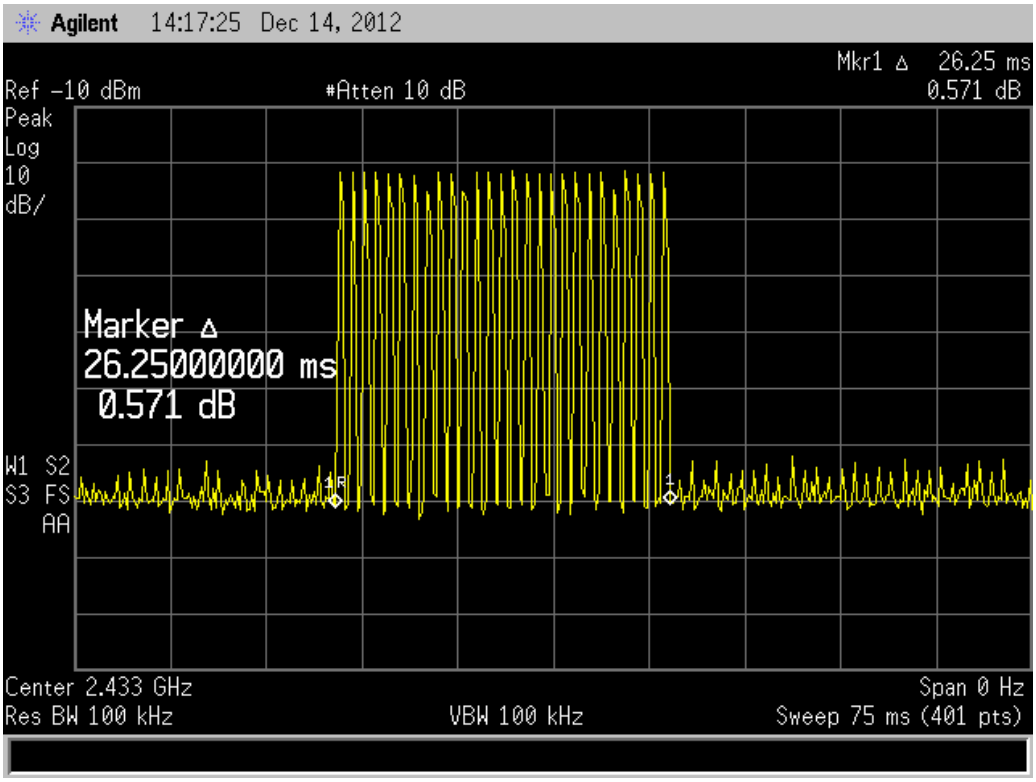


A worst case 20 dB bandwidth of 2.0625 MHz was measured.

In a period of 8.4 seconds (0.4 seconds x 21 channels) the transmitter was observed to transmit 15 times.



Each time the transmitter transmitted it did so for 26.250 ms.



The dwell time will therefore be 15 transmissions x 26.250 ms = 393.750 ms.

Result: Complies

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

Radiated power measurements were made on the highest low, mid and high frequency channel using both vertical and horizontal polarisations as this device does not have an antenna port.

Measurements were made using a measuring receiver with a Peak detector with a resolution bandwidth of 1 MHz.

The conducted output power could not be measured directly as the device does not have an antenna port.

Using an assumed antenna gain of 1 (0 dB) the conducted power has been calculated from the radiated power measurements.

Testing was carried out with the device orientated in 3 planes (X, Y and Z) and in both vertical and horizontal polarisations.

Frequency (MHz)	Field Strength (dBµV/m)	Radiated Power (dBm)	Antenna Gain (dB)	Conducted Power (dBm)	Conducted Power (W)	Antenna Polarisation
2402.000	96.0	0.8	0.0	0.8	0.001194	Vertical
2441.000	95.0	-0.2	0.0	-0.2	0.000949	Horizontal
2462.000	96.2	1.0	0.0	1.0	0.001251	Horizontal

A conducted limit of 0.125 watt (+20 dBm) has been applied as less than 75 channels are in use.

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)

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

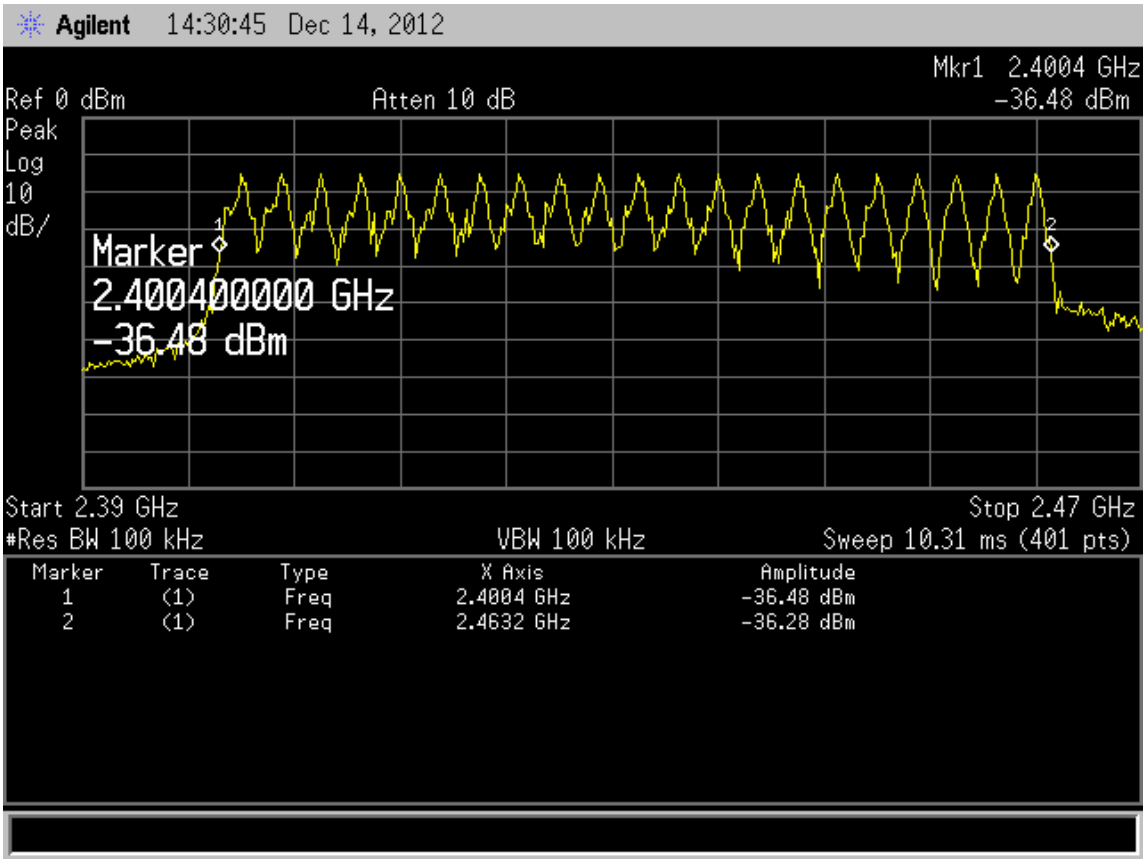
Result: Complies
Measurement Uncertainty: ± 4.1 dB

Section 15.247 (d) – Out of band emissions

Band edge measurements:

At the band edges of 2400 MHz and 2483.5 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 the transmitter is operating the -20 dB point's remains within the 2400 – 2483.5 MHz band.



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.

No emissions were detected in these bands with in 20 dB of the applicable general limits when measurements were attempted using either a peak or average detector with a 1 MHz bandwidth.

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.

The highest emission observed was on 2462 MHz using horizontal polarisation with a level of 95.8 dBuV/m being recorded when a 100 kHz bandwidth peak detector was used

A -20 dBc limit of 75.8 dBuV/m will therefore apply.

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) + Coax Loss (dB) – Amplifier Gain (dB)

Result: Complies
Measurement uncertainty: ± 4.1 dB

Transmitting continuously on 2402 MHz

Frequency MHz	Vertical dBuV/m	Horizontal dBuV/m	Limit dBuV/m	Margin dB	Result	Antenna	Detector
4804.000	< 59.0	< 59.0	74.0	> 15.0	Pass	Vert/Hort	Peak
	< 46.0	< 46.0	54.0	> 8.0	Pass	Vert/Hort	Average
7206.000	< 59.0	< 59.0	75.8	> 16.8	Pass	Vert/Hort	Peak
9608.000	< 59.0	< 59.0	75.8	> 16.8	Pass	Vert/Hort	Peak
12010.000	< 59.0	< 59.0	74.0	> 15.0	Pass	Vert/Hort	Peak
	< 46.0	< 46.0	54.0	> 8.0	Pass	Vert/Hort	Average
14412.000	< 59.0	< 59.0	75.8	> 16.8	Pass	Vert/Hort	Peak
16814.000	< 59.0	< 59.0	75.8	> 16.8	Pass	Vert/Hort	Peak
19216.000	< 59.0	< 59.0	74.0	> 15.0	Pass	Vert/Hort	Peak
	< 46.0	< 46.0	54.0	> 8.0	Pass	Vert/Hort	Average
21618.000	< 59.0	< 59.0	74.0	> 15.0	Pass	Vert/Hort	Peak
	< 46.0	< 46.0	54.0	> 8.0	Pass	Vert/Hort	Average
24020.000	< 59.0	< 59.0	74.0	> 15.0	Pass	Vert/Hort	Peak
	< 46.0	< 46.0	54.0	> 8.0	Pass	Vert/Hort	Average

The device was then observed when hopping continuously with all average emissions levels observed to drop with continue to comply.

Transmitting continuously on 2441 MHz

Frequency MHz	Vertical dBuV/m	Horizontal dBuV/m	Limit dBuV/m	Margin dB	Result	Antenna	Detector
4880.000	< 59.0	< 59.0	74.0	> 15.0	Pass	Vert/Hort	Peak
	< 46.0	< 46.0	54.0	> 8.0	Pass	Vert/Hort	Average
7320.000	< 59.0	< 59.0	74.0	> 15.0	Pass	Vert/Hort	Peak
	< 46.0	< 46.0	54.0	> 8.0	Pass	Vert/Hort	Average
9760.000	< 59.0	< 59.0	75.8	> 16.8	Pass	Vert/Hort	Peak
12200.000	< 59.0	< 59.0	74.0	> 15.0	Pass	Vert/Hort	Peak
	< 46.0	< 46.0	54.0	> 8.0	Pass	Vert/Hort	Average
14640.000	< 59.0	< 59.0	75.8	> 16.8	Pass	Vert/Hort	Peak
17080.000	< 59.0	< 59.0	75.8	> 16.8	Pass	Vert/Hort	Peak
19520.000	< 59.0	< 59.0	74.0	> 15.0	Pass	Vert/Hort	Peak
	< 46.0	< 46.0	54.0	> 8.0	Pass	Vert/Hort	Average
21960.000	< 59.0	< 59.0	74.0	> 15.0	Pass	Vert/Hort	Peak
	< 46.0	< 46.0	54.0	> 8.0	Pass	Vert/Hort	Average
24400.000	< 59.0	< 59.0	74.0	> 15.0	Pass	Vert/Hort	Peak
	< 46.0	< 46.0	54.0	> 8.0	Pass	Vert/Hort	Average

The device was then observed when hopping continuously with all average emissions levels observed to drop with continue to comply.

Transmitting continuously on 2462 MHz

Frequency MHz	Vertical dBuV/m	Horizontal dBuV/m	Limit dBuV/m	Margin dB	Result	Antenna	Detector
4924.000	< 59.0	< 59.0	74.0	> 15.0	Pass	Vert/Hort	Peak
	< 46.0	< 46.0	54.0	> 8.0	Pass	Vert/Hort	Average
7386.000	< 59.0	< 59.0	74.0	> 15.0	Pass	Vert/Hort	Peak
	< 46.0	< 46.0	54.0	> 8.0	Pass	Vert/Hort	Average
9848.000	< 59.0	< 59.0	75.8	> 16.8	Pass	Vertical	Peak
12310.000	< 59.0	< 59.0	74.0	> 15.0	Pass	Vert/Hort	Peak
	< 46.0	< 46.0	54.0	> 8.0	Pass	Vert/Hort	Average
14772.000	< 59.0	< 59.0	75.8	> 16.8	Pass	Vert/Hort	Peak
17234.000	< 59.0	< 59.0	75.8	> 16.8	Pass	Vert/Hort	Peak
19696.000	< 59.0	< 59.0	74.0	> 15.0	Pass	Vert/Hort	Peak
	< 46.0	< 46.0	54.0	> 8.0	Pass	Vert/Hort	Average
22158.000	< 59.0	< 59.0	74.0	> 15.0	Pass	Vert/Hort	Peak
	< 46.0	< 46.0	54.0	> 8.0	Pass	Vert/Hort	Average
24620.000	< 59.0	< 59.0	75.8	> 16.8	Pass	Vert/Hort	Peak

The device was then observed when hopping continuously with all average emissions levels observed to drop with continue to comply.

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.

No SAR requirements will apply when the transmitter is attached to the dog.

However the transmitter may come into close contact with humans so 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.

At 2462 MHz the conducted transmitter output power was determined to be 1.251 mW

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

1-g SAR = (1.251 mW / 5 mm) * (√ 2.462 GHz) = 0.39

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 by falling below the 1-g SAR threshold level.

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 Oct 2013
Receiver	R & S	ESHS 10	828404/005	RFS 3728	2 Feb 2013
Mains Network	R & S	ESH2-Z5	881362/034	3628	29 Jul 2013
VHF Balun	Schwarzbeck	VHA 9103	-	RFS 3603	30 Jan 2013
Biconical Antenna	Schwarzbeck	BBA 9106	-	RFS 3612	30 Jan 2013
Log Periodic	Schwarzbeck	VUSLP 9111	9111-228	3785	30 Jan 2013
Horn Antenna	EMCO	3115	9511-4629	E1526	3 May 2013
Horn Antenna	EMCO	3116	92035	-	16 Jun 2013
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 on 15 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.

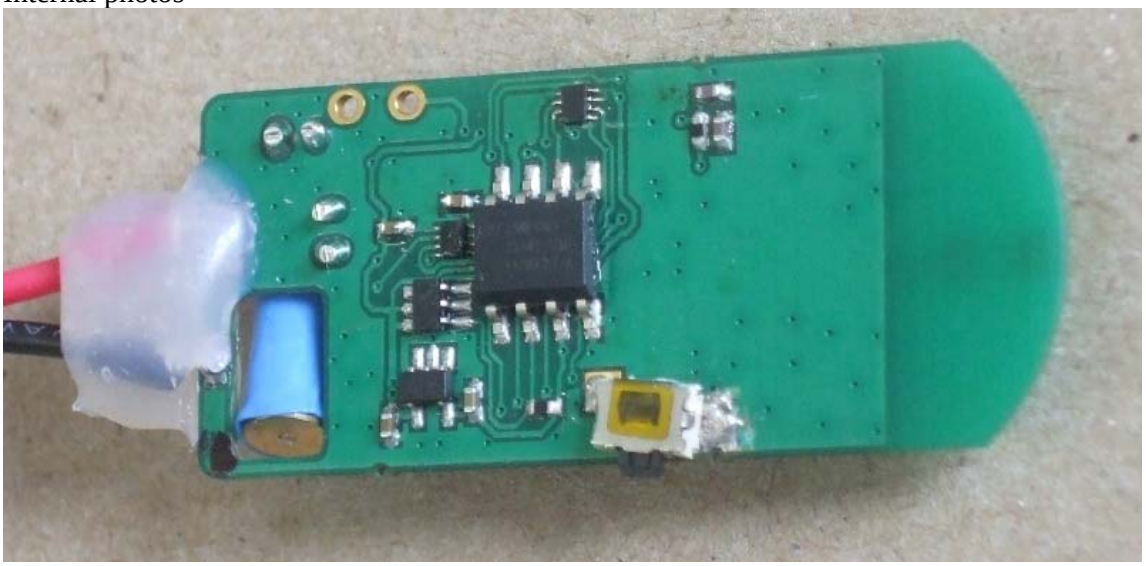
9. PHOTOGRAPHS

External photos – The complete system

The finish collar external view

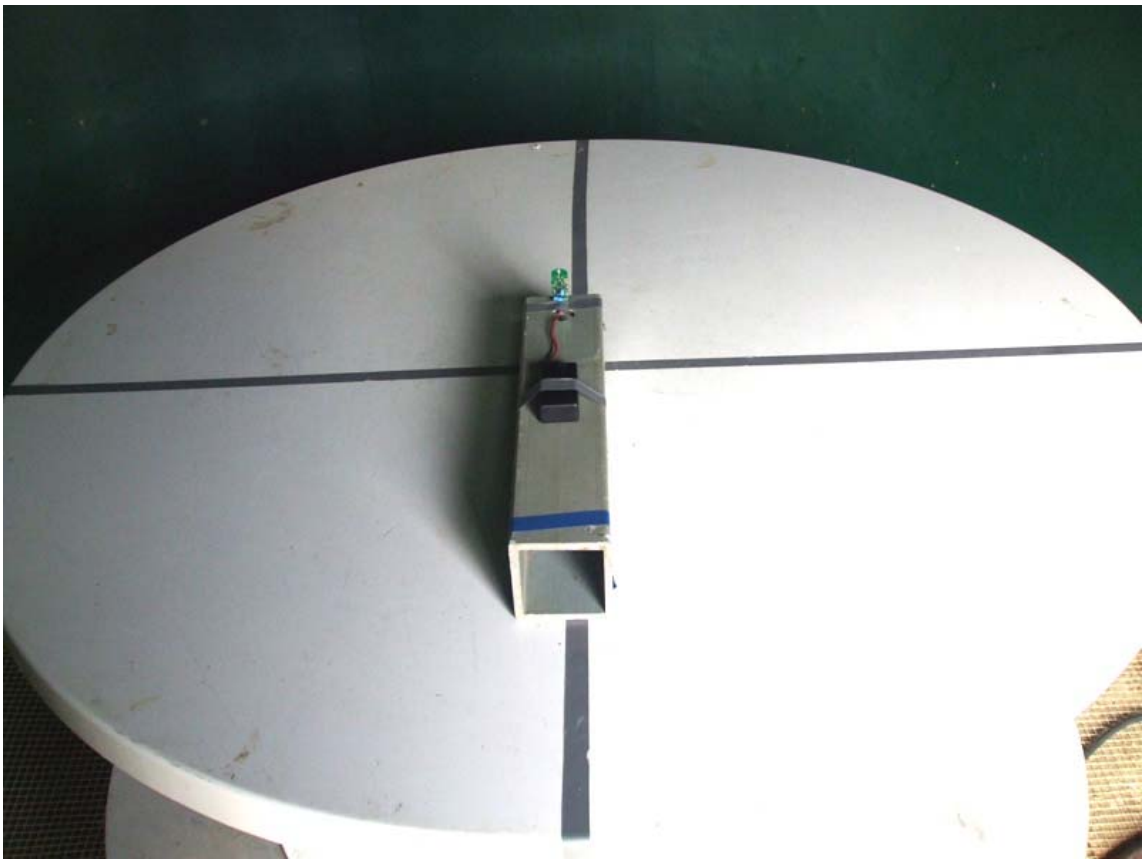
The naked test sample that was tested

Internal photos



Radiated emissions tests set up photos – Y Plane

Z Plane



X Plane