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TEST REPORT

Zephyr Technology BioHarness 3 Vital Signs Monitoring Device

tested to the

Code of Federal Regulations (CFR) 47

Part 15 – Radio Frequency Devices, Subpart C – Intentional Radiators

Section 15.249 – Operation in the band 2400.000 – 2483.500 MHz

for

Zephyr Technology

This Test Report is issued with the authority of:

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

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 **Zephyr Technology BioHarness 3 Vital Signs Monitoring Device** complies with 47 CFR Part 15 and in particular Sections, 15.205, 15.207, 15.209, 15.215 and 15.249 as detailed below when tested in accordance with ANSI C63.4 – 2003.

2. RESULTS SUMMARY

The results of testing, carried out in May and June 2012, are listed below

Clause	Description	Result
15.201	Equipment authorisation requirement	Applied
15.203	Antenna requirement	Complies
15.204	External power amplifiers	Not applicable
15.205	Operation in restricted bands	Complies
15.207	Conducted emissions	Not applicable
15.209	Radiated emissions	See below
15.215	Additional provisions	Complies
15.249 (a)	Field strength of fundamental	Complies
15.249 (a)	Field strength of harmonics	Complies
15.249 (b)	Fixed, point to point operations	Not applicable
15.249 (c)	3 metre measurement distance	Noted
15.249 (d)	Spurious emission levels except harmonics	Complies
15.249 (e)	Detectors above 1000 MHz	Noted
15.249 (f)	Reference to section 15.37(d)	Noted

3. CLIENT INFORMATION

Company Name Zephyr Technologies

Address 503 Mount Wellington Highway
Mount Wellington

City Auckland

Country New Zealand

Contact Ms Celine Courtaud

4. DESCRIPTION OF TEST SAMPLE

Brand Name	Zephyr Technology
Model Number	BioHarness 3
Product	Vital Signs Monitoring Device
Manufacturer	Zephyr Technology
Country of Origin	United States of America
Serial Number	Sample not serialized
802.15.4 FCC ID	TFB-PROFLEX1
BT Module FCC ID	T7V1315
New FCC ID	VZ6-BH3
Band of Operation:	2400 to 2483.5 MHz
802.15.4 Band:	2405 to 2475 MHz. 15 channels with 5 MHz spacing
Test Frequencies:	2405, 2440, 2475 MHz
Rated Conducted Power:	0.003 W (+15 dBm)
Modulation Type:	GFSK, 2 Mbps data rate
Bluetooth:	2402 to 2480 MHz. 79 channels with 1 MHz spacing
Rated Conducted Power:	Not known
Antenna Type:	Integral antenna
Power Supply:	Internal 3 Vdc battery
Ports:	Portable device has no external ports

A Bluetooth module was utilised which has previous been tested and found to be compliant.

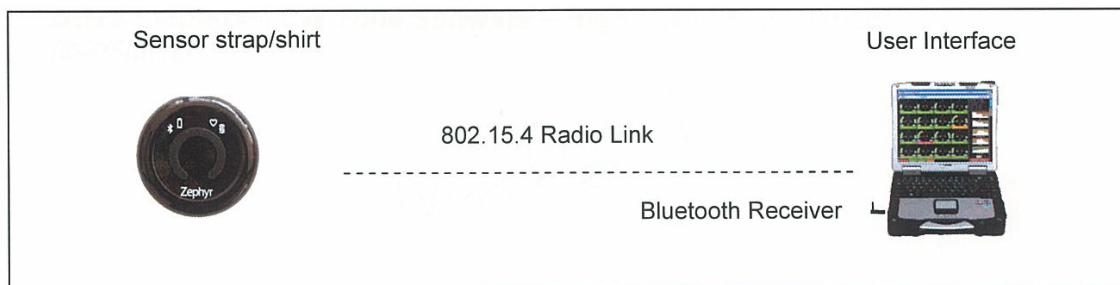
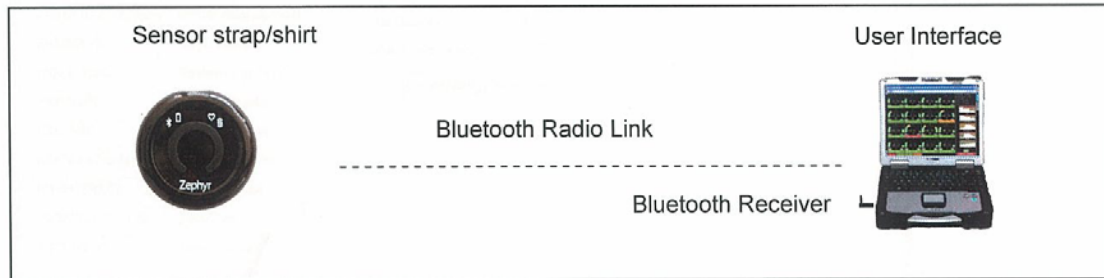
A 802.15.4 module has been used but it has been modified by the client.

The client advises that the BioHarness 802.15.4 transmitter transmits 2.5 ms of data every 2.5 seconds approximately.

The Zephyr Technologies BioHarness 3 system allows users to remotely monitor the physiological status of multiple subjects.

Subjects wear a BioHarness on their torso using a special garment strap that allows the devices to measure heart rate and respiration rate.

The BioHarness then transmits this physiological data via Bluetooth and / or 802.15.4 to a PC.



The system is designed to allow users to make real-time assessments about the health and safety of teams working under strenuous and potentially hazardous conditions.

The systems have applications in emergency response and defence.

5. ATTESTATION

This report describes the tests and measurements performed for the purpose of determining compliance with the specification with the following conditions:

The client selected the test sample.

The report relates only to the sample tested.

This report does not contain corrections or erasures.

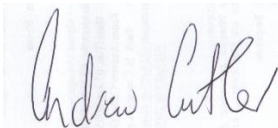
Measurement uncertainties with statistical confidence intervals of 95% are shown below test results. Both Class A and Class B uncertainties have been accounted for, as well as influence uncertainties where appropriate.

In addition this equipment has been tested in accordance with the requirements contained in the appropriate Commission regulations.

As the two transmitters in this device can operate simultaneously verification measurements were made during the course of the testing process to confirm that each device continued to comply with all the pertinent sections of FCC part 15 subparts A, B and C while operating simultaneously as well as standalone devices.

To the best of my knowledge, these tests were performed using measurement procedures that are consistent with industry or Commission standards and demonstrate that the equipment complies with the appropriate standards.

I further certify that the necessary measurements were made by EMC Technologies NZ Ltd, 47 MacKelvie Street, Grey Lynn, Auckland, New Zealand.



Andrew Cutler
General Manager
EMC Technologies NZ Ltd

6. TEST RESULTS

Section 15.201: Equipment authorisation requirement

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

The Bluetooth transmitter is a FCC compliant module. FCC ID: T7V1315.

The 802.15.5 transmitter also has modular compliance with FCC ID: TFB-PROFLEX1 however the client advises that the module has been modified and therefore it needs to be re-certified.

Section 15.203 – Antenna requirement

The transmitters in this device use a 2.4 GHz antenna that is integral to the device

Result: Complies

Section 15.204: External radio frequency power amplifiers and antenna modifications

An external power amplifier is not supplied with this device and it is not possible to attach an external power amplifier.

Result: Complies.

Section 15.205 – Restricted bands of operation

Refer to measurements made with reference to Section 15.249 (a).

This device operates in the 2400 – 2483.5 MHz which is not a restricted band.

Result: Complies

Section 15.207 – Conducted emissions

Not applicable.

This device is powered using an internal dc battery.

This device cannot be directly or indirectly powered using the public AC mains supply.

Result: Complies

Section 15.209 – Radiated emissions

In accordance with section 15.249 (d) the general emission limits specified in Section 15.209 (a) have been applied to all emissions except the transmitter harmonics.

See Section 15.249 (a) for further details.

In addition as the device contains a number of clock oscillators (32.768 kHz, 16 MHz and 32 MHz) general emission measurements were made at the test site to ensure that any emissions due to these oscillators were compliant.

Measurements were made at the test site between 10 kHz and 1000 MHz.

Further specific test set up details can be located in Section 15.249(a) of this report.

In summary between 10 kHz and 30 MHz measurements were made using a loop antenna that was positioned 10 metres from the device and the general emission limits as per section 15.209 were applied.

No emissions were detected.

In summary between 30 MHz – 1000 MHz measurements were made in vertical and horizontal polarisations at a distance of 3 metres from the device and the general emission limits as per section 15.209 were applied.

No emissions were detected.

Result: Complies

Section 15.215 (c) – Additional provisions to the general radiated emission limitations

The device operates in the 2400 – 2483.5 MHz band.

Spectrum mask measurements have been made at 2405 and 2475 MHz to ensure that the 20 dB bandwidth of the modulated signal is contained within the assigned frequency band.

Measurements show compliance with the -20 dB requirements

Frequency (MHz)	F low (MHz)	F high (MHz)
2405.000	2402.575	Not applicable
2475.000	Not applicable	2477.250

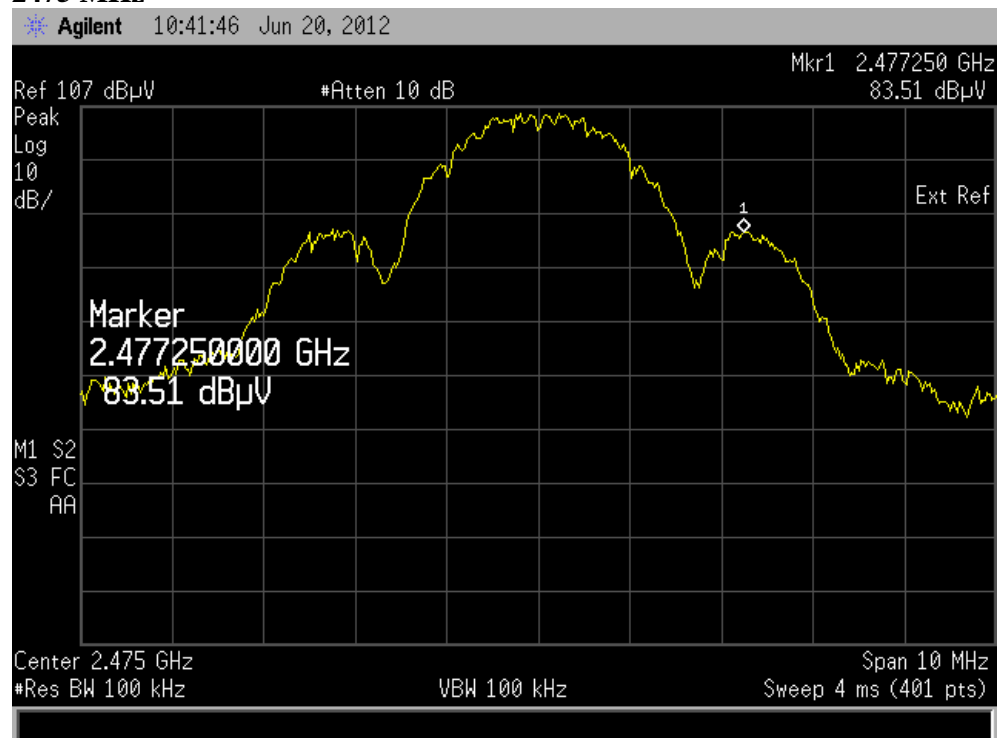
The device can be seen to stay within the band of 2400 – 2483.5 MHz at the -20 dB points

The actual measurement plots are detailed below

2405 MHz



2475 MHz



Results: Complies

Section 15.249 (a) – Field strength of the Fundamental and Harmonics

Radiated emission measurements were carried out with the limits as per section 15.249 (a) being applied to the Fundamental and Harmonics of each transmitter.

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

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 made 3 metres from the transmitting antenna.

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.

The limit as specified section 15.249 was applied to the average detector levels with a factor of 20 dB being applied to these levels when they were then measured using a peak detector.

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 is measured in both vertical and horizontal antenna polarisations with no measurements were made above the 10th harmonic

The client modified the devices in order that the transmitter could transmit continuously on a low, middle and top frequency of operation.

As the device is portable testing was carried out in the X, Y and Z planes.

Measurements were not specifically made on the Bluetooth transmitter as this module has been certified previously and has not been modified and has been installed as per the manufacturer's instructions.

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

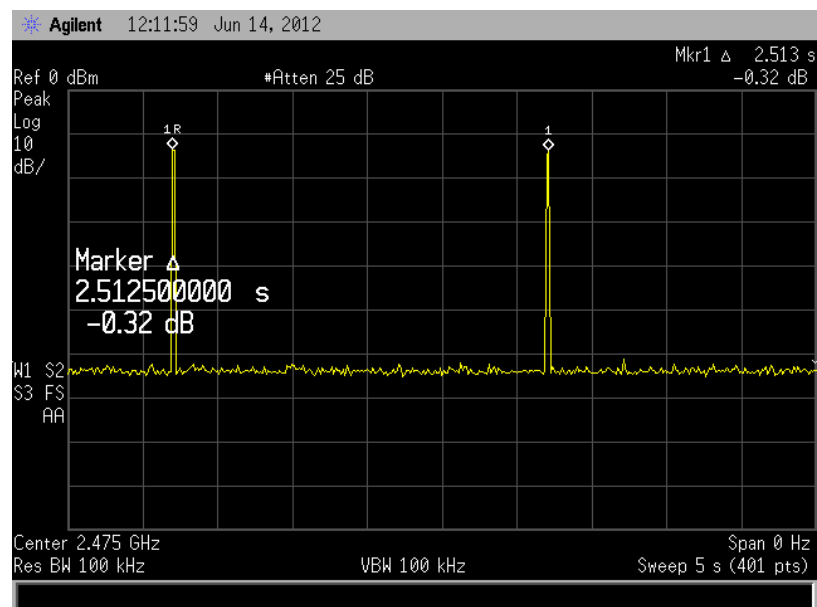
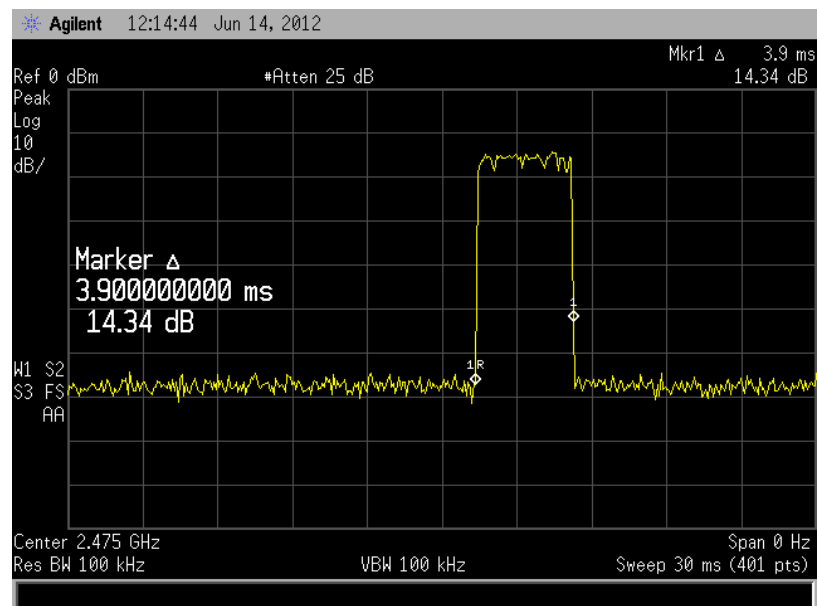
Level (dBµV/m) = Receiver Reading (dBµV) + Antenna Factor (dB) + Coax Loss (dB) – Amplifier Gain (dB)

Duty cycle

This device does not operate continuously but sends a 3.9 ms burst of data every 2.5 seconds.

Therefore the requirements of Section 15.35 (c) have been applied as the limit for this band is specified as an average limit and the pulse train does not exceed 0.1 seconds (100 ms).

The following measurements were made when the transmitter was operating normally.



The duty cycle in log terms will therefore be $20 * \log (3.9 \text{ ms} / 100 \text{ ms}) = -28.2 \text{ dB}$

Therefore the recorded peak measurements have been corrected using the above factor and compared with against the average limit for this band (50 mV/m or 94 dBuV/m).

Fundamental emission

Peak measurements

Frequency (MHz)	Vertical (dBuV/m)	Horizontal (dBuV/m)	Limit (dBuV/m)	Orientation	Margin (dB)	Detector Antenna
2405.000	111.0	110.4	114.0	Laying flat	3.0	Peak
2405.000	105.2	100.3	114.0	Upright	8.8	Peak
2405.000	111.4	102.5	114.0	On edge	2.6	Peak
2440.000	110.1	109.3	114.0	Laying flat	3.9	Peak
2440.000	103.4	98.4	114.0	Upright	10.6	Peak
2440.000	110.1	101.2	114.0	On edge	3.9	Peak
2475.000	110.1	110.0	114.0	Laying flat	3.9	Peak
2475.000	103.8	99.3	114.0	Upright	10.2	Peak
2475.000	111.2	100.6	114.0	On edge	2.8	Peak

Peak measurements corrected using duty cycle factor and compared against the average limit

Frequency (MHz)	Vertical (dBuV/m)	Horizontal (dBuV/m)	Limit (dBuV/m)	Orientation	Margin (dB)
2405.000	82.8	82.2	94.0	Laying flat	11.2
2405.000	77.0	72.1	94.0	Upright	17.0
2405.000	83.2	74.3	94.0	On edge	10.8
2440.000	79.9	81.1	94.0	Laying flat	12.1
2440.000	75.2	70.2	94.0	Upright	18.8
2440.000	81.9	73.0	94.0	On edge	12.1
2475.000	81.9	81.8	94.0	Laying flat	12.1
2475.000	75.6	71.1	94.0	Upright	18.4
2475.000	83.0	72.4	94.0	On edge	11.0

Section 15.249 specifies a limit of 50 mV/m when an average detector is used for devices operating the band 2400 – 2483.5 MHz.

Peak measurements were made using a detector with a 1 MHz RBW.

This limit has been converted to dBuV/m using the formula $20 * (\log 0.050 / 0.000001)$

Result: Complies

Measurement uncertainty with a confidence interval of 95% is:

- Free radiation tests (30 – 25,000 MHz) ± 4.1 dB

Spurious emissions

Device was tested transmitting a 3 ms burst every 2.5 seconds with the average determined using the previously calculated duty cycle.

Testing was carried out with the Bluetooth transmitter activated and operating continuously.

Transmitting on 2405 MHz

Frequency (MHz)	Vertical (dBuV/m)	Horizontal (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
4810.0000	67.3	72.2	74.0	1.8	Measured Peak
4810.0000	39.1	44.0	54.0	10.0	Calculated Average
4810.0000	43.7	44.6	54.0	9.4	Measured Average
7215.0000	-	-	74.0	-	Measured Peak
7215.0000	-	-	54.0	-	Measured Average
9620.0000	-	-	74.0	-	Measured Peak
9620.0000	-	-	54.0	-	Measured Average
12025.0000	-	-	74.0	-	Measured Peak
12025.0000	-	-	54.0	-	Measured Average
14430.0000	-	-	74.0	-	Measured Peak
14430.0000	-	-	54.0	-	Measured Average
16835.0000	-	-	74.0	-	Measured Peak
16835.0000	-	-	54.0	-	Measured Average
19240.0000	-	-	74.0	-	Measured Peak
19240.0000	-	-	54.0	-	Measured Average
21645.0000	-	-	74.0	-	Measured Peak
21645.0000	-	-	54.0	-	Measured Average
24050.0000	-	-	74.0	-	Measured Peak
24050.0000	-	-	54.0	-	Measured Average

When the device was transmitting on 2405 MHz additional measurements were made from the band edge of 2400 MHz down to 2300 MHz in order to determine if there were any band edge spurious emissions and whether there were any emissions from this device or the Bluetooth transmitter in the restricted band of 2310 MHz – 2390 MHz.

No emissions were detected when measurements were attempted over this frequency range when using an average or peak detector with a 1 MHz resolution bandwidth in either vertical or horizontal polarisations.

A dash indicates that no emissions were detected within at least 10 dB of the applicable limit.

Transmitting on 2440 MHz

Frequency (MHz)	Vertical (dBuV/m)	Horizontal (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
4880.0000	70.5	66.5	74.0	3.5	Measured Peak
4880.0000	42.3	38.3	54.0	11.7	Calculated Average
4880.0000	43.3	44.1	54.0	9.9	Measured Average
7320.0000	-	-	74.0	-	Measured Peak
7320.0000	-	-	54.0	-	Measured Average
9760.0000	-	-	74.0	-	Measured Peak
9760.0000	-	-	54.0	-	Measured Average
12200.0000	-	-	74.0	-	Measured Peak
12200.0000	-	-	54.0	-	Measured Average
14640.0000	-	-	74.0	-	Measured Peak
14640.0000	-	-	54.0	-	Measured Average
17080.0000	-	-	74.0	-	Measured Peak
17080.0000	-	-	54.0	-	Measured Average
19520.0000	-	-	74.0	-	Measured Peak
19520.0000	-	-	54.0	-	Measured Average
21960.0000	-	-	74.0	-	Measured Peak
21960.0000	-	-	54.0	-	Measured Average
24400.0000	-	-	74.0	-	Measured Peak
24400.0000	-	-	54.0	-	Measured Average

A dash indicates that no emissions were detected within at least 10 dB of the applicable limit.

Transmitting on 2475 MHz

Frequency (MHz)	Vertical (dBuV/m)	Horizontal (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
4950.0000	66.1	73.0	74.0	1.0	Measured Peak
4950.0000	37.9	44.8	54.0	9.2	Calculated Average
4950.0000	43.5	44.9	54.0	9.1	Measured Average
7425.0000	-	-	74.0	-	Measured Peak
7425.0000	-	-	54.0	-	Measured Average
9900.0000	-	-	74.0	-	Measured Peak
9900.0000	-	-	54.0	-	Measured Average
12375.0000	-	-	74.0	-	Measured Peak
12375.0000	-	-	54.0	-	Measured Average
14850.0000	-	-	74.0	-	Measured Peak
14850.0000	-	-	54.0	-	Measured Average
17325.0000	-	-	74.0	-	Measured Peak
17325.0000	-	-	54.0	-	Measured Average
19800.0000	-	-	74.0	-	Measured Peak
19800.0000	-	-	54.0	-	Measured Average
22275.0000	-	-	74.0	-	Measured Peak
22275.0000	-	-	54.0	-	Measured Average
24750.0000	-	-	74.0	-	Measured Peak
24750.0000	-	-	54.0	-	Measured Average

When the device was transmitting on 2475 MHz additional measurements were made in the upper band edge restricted band from 2483.5 MHz up to 2500 MHz.

No emissions were detected from this device or from the Bluetooth transmitter when measurements were attempted over this frequency range when using an average or peak detector with a 1 MHz resolution bandwidth in either vertical or horizontal polarisations.

A dash indicates that no emissions were detected within at least 10 dB of the applicable limit.

No other spurious emissions were detected from the device (802.15.4 transmitter, Bluetooth transmitter or the support electronics).

Measurements were attempted at a distance of 3 metres using vertical and horizontal polarisations using both an average and peak detector with a bandwidth of 1 MHz.

Above 5 GHz where no emissions were detected the measurement antenna was moved to a distance of 50 cm but no emissions were detected at this distance as well.

As per section 15.249 a limit of 500 uV/m has been applied to the harmonic emissions when an average detector was used and a factor of +20 dB has been applied with a peak detector was used.

In addition as per Section 15.35(c) a duty cycle correction factor has been calculated and applied to the measured peak levels which show a similar level to the average levels that were measured.

This limit has been converted to dBuV/m using the formula $20 * (\log 500)$

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) – Microwave Preamplifier Gain (dB)

Result: Complies

Measurement uncertainty with a confidence interval of 95% is:

- Free radiation tests (30 – 25,000 MHz) ± 4.1 dB

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 2012
Spectrum Analyser	Hewlett Packard	E7405A	US39150142	3771	14 Dec 2012
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 June 2013
Loop Antenna	EMCO	6502	9003-2485	3798	9 May 2014

8. ACCREDITATIONS

Testing was carried out in accordance with EMC Technologies NZ Ltd registration with the Federal Communications Commission as a listed facility, Registration Number: 90838, which was updated in February 2011.

In addition testing was carried out in accordance with the terms of EMC Technologies (NZ) Ltd's International Accreditation New Zealand (IANZ) Accreditation to NZS/IEC/ISO 17025:2005.

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

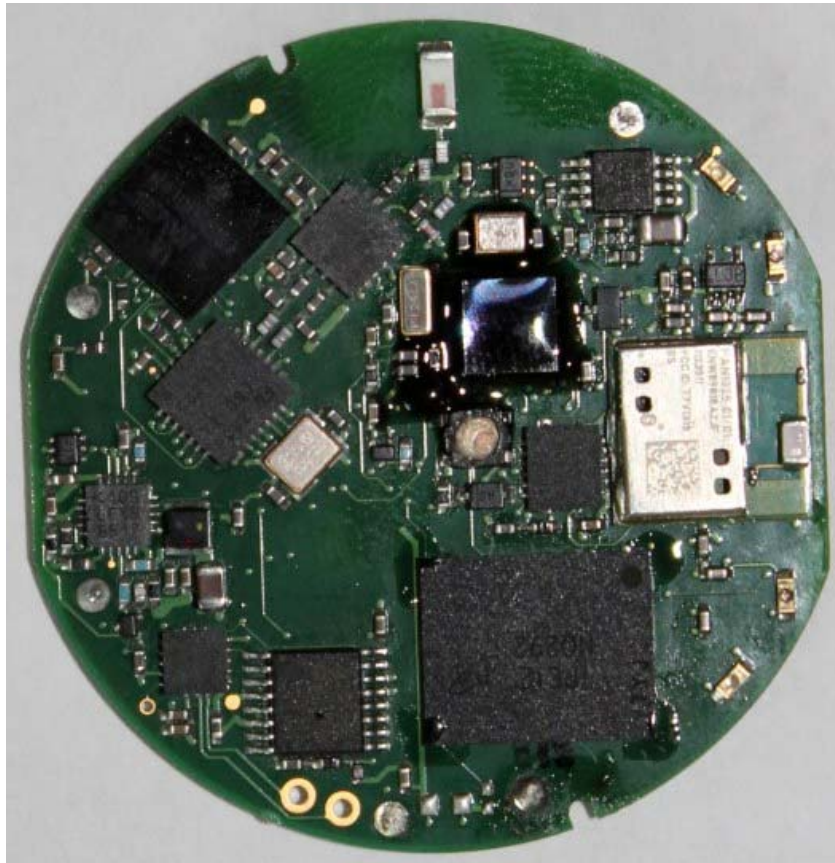
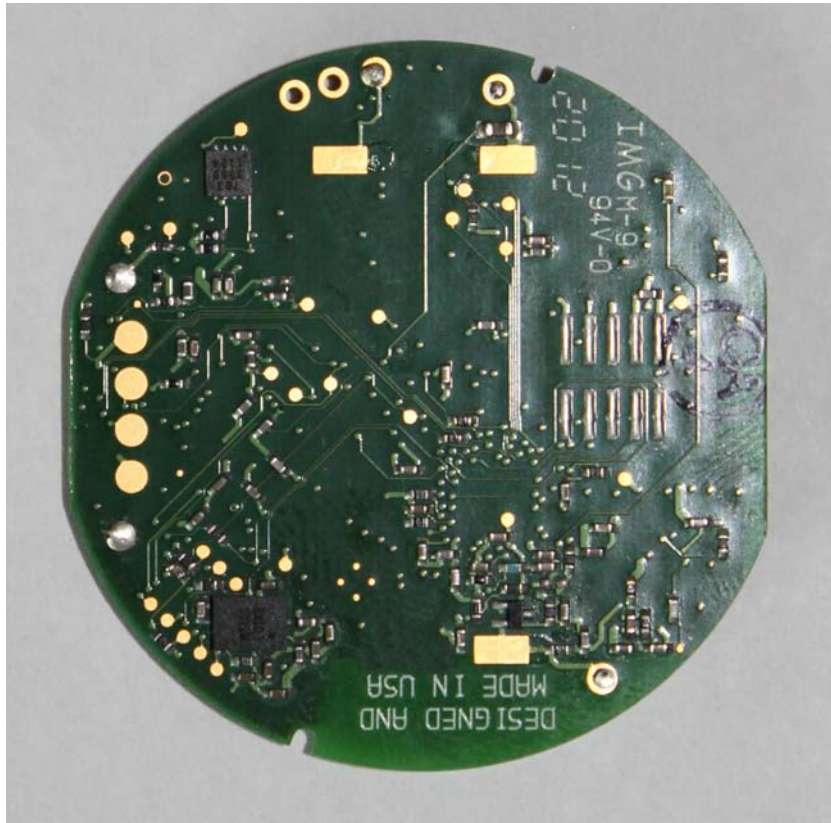
International Accreditation New Zealand has Mutual Recognition Arrangements for testing and calibration with a number of accreditation bodies in various economies. This includes NATA (Australia), UKAS (UK), SANAS (South Africa), NVLAP (USA), A2LA (USA), SWEDAC (Sweden). Further details can be supplied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

9. PHOTOGRAPHS

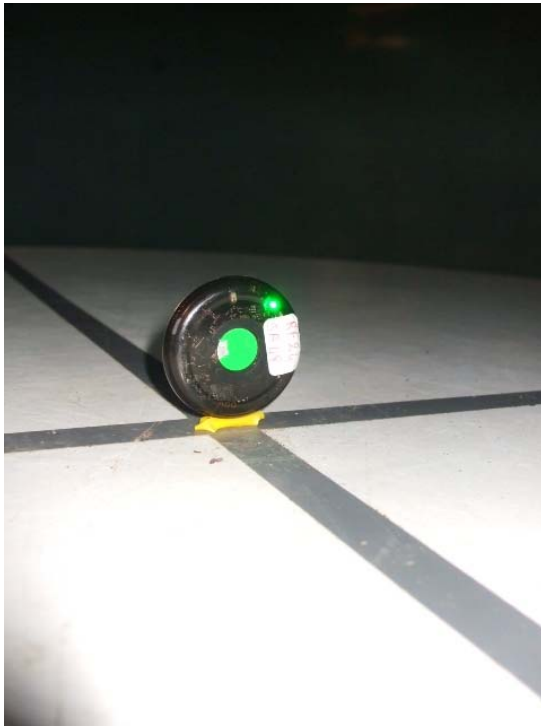
External photos



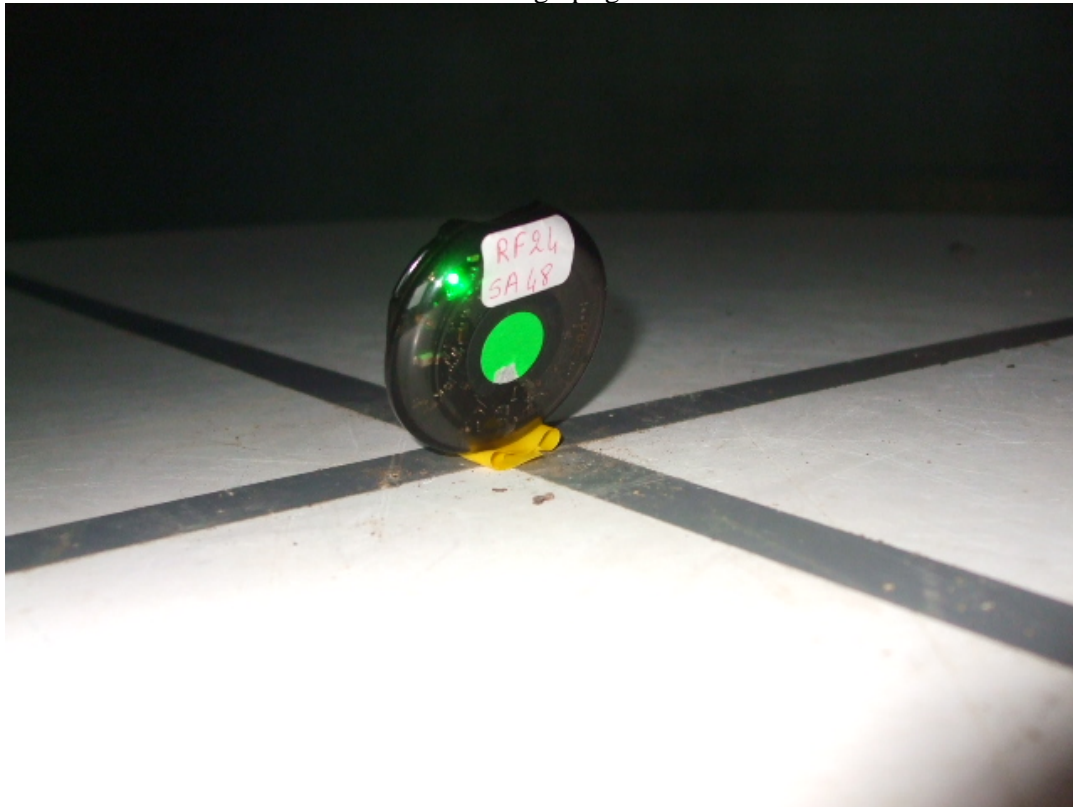
Internal Photos



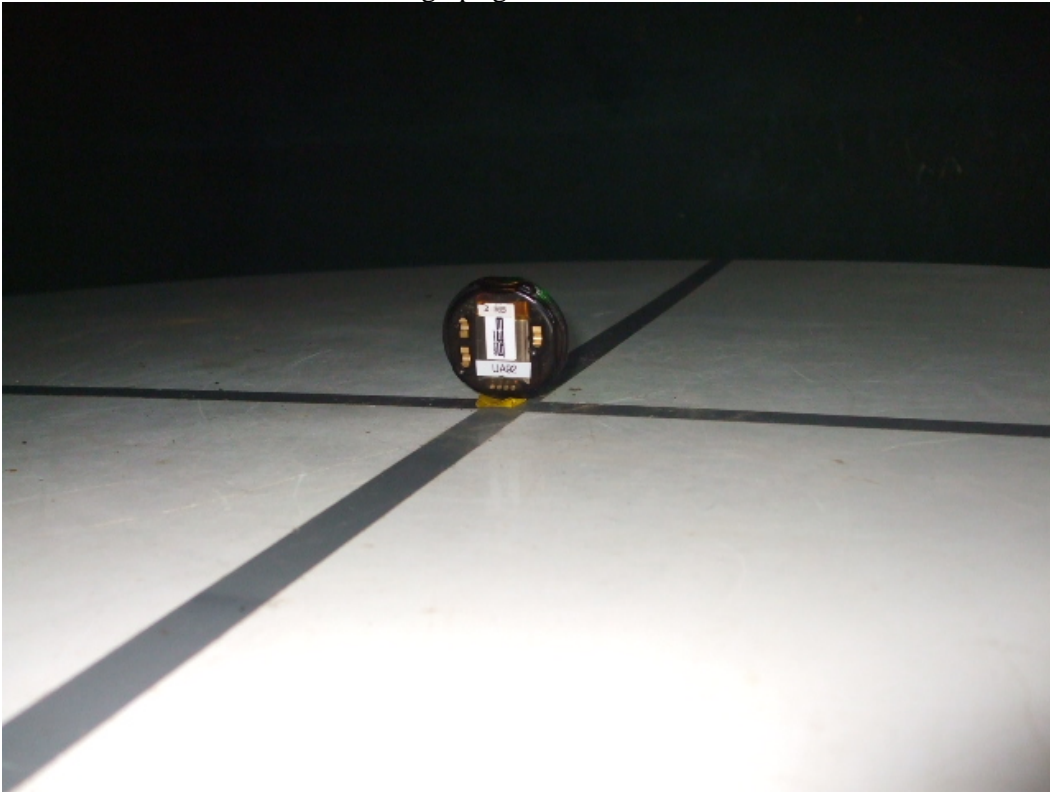
Radiated emissions test set up photos – Standing on edge



Standing upright



Standing upright – Another view



Laying flat on the test table

