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TEST REPORT

Millar MT10B Telemeter

tested to the

Code of Federal Regulations (CFR) 47

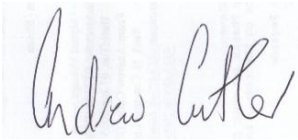
Part 15 – Radio Frequency Devices, Subpart C – Intentional Radiators

Section 15.249 – Operation in the band 2400 – 2483.5 MHz

for

Millar Instruments Ltd

This Test Report is issued with the authority of:



Andrew Cutler - General Manager

IANZ ACCREDITED LABORATORY

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 **Millar MT10B Telemeter** 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 C63.10 – 2013.

2. RESULTS SUMMARY

The results of testing carried out in November 2016 are detailed below.

Clause	Description	Result
15.201	Equipment authorisation requirement	New equipment. Certification process 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. Internally powered device.
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 Millar Instruments Ltd

Address Level 1, Uniservices
70 Symonds Street

City Auckland 1010

Country New Zealand

Contact Mr David Budget

4. DESCRIPTION OF TEST SAMPLE

Brand Name	Millar Instruments
Model	MT10B
Product	Telemeter
Manufacturer	Millar Ltd
Country of Origin	New Zealand
Serial Number	10561
FCC ID	V58HU10

5. EQUIPMENT PARAMETERS

The 2.4 GHz transceiver in this device has the following RF specifications:

FCC Band:	2400 MHz – 2483.5 MHz
Test Frequencies:	2402, 2440, 2480 MHz
Operating Range:	2402 – 2480 MHz
Rated Power:	1.00 mW (+0 dBm)
Modulation Type:	0.358 ms GFSK packet sent every 7.7 ms
Antenna Type:	Permanently attached wire whip antenna
Power Supply:	Internal battery

The device tested is a 2.4 GHz transceiver that is used to measure various physiological parameters within animals and then transmit them to a remote monitoring location.

Typically the device would be used in a laboratory environment and would be attached to rats and mice.

The device is powered using an internal battery that is charged using a wireless charger that operates on 614 kHz.

6. 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.

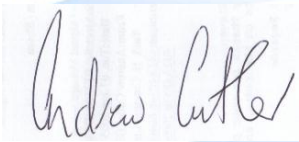
This report does not contain corrections or erasures.

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.

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

7. TEST RESULTS

Section 15.201: Equipment authorisation requirement

Certification as detailed in Subpart J of Part 2 is being sought for this device which is a low power 2.4 GHz band transmitter.

Section 15.203 – Antenna requirement

This device uses a 2.4 GHz external wire whip antenna that is permanently attached 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 limits

Not applicable as this device does not directly or indirectly connect to that public AC mains supply.

The device is powered wirelessly using a smart pad wireless transfer power device that operates on 614 kHz which has been tested separately.

Section 15.209 – Radiated emissions below 30 MHz

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.

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.

Testing was carried out using when the device powered using a temporary external battery which allowed testing without the operation of the wireless power transfer device.

Testing was carried out when the device was placed in the centre of the test table and it was tested in the X, Y and Z planes.

The device was tested transmitting continuously on 2402 MHz.

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

Section 15.209 – Radiated emissions above 30 MHz

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.

Testing for general radiated emissions was carried out over the frequency range of 30 MHz to 25000 MHz as the device contains a 2.4 GHz transmitter.

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

An enclosure containing absorber material, Panashield HYB-NF-12, has been placed between the turntable and the measurement antenna for when measurements are made above 1 GHz.

This material has no absorbing affect below 1 GHz with site verification measurements.

Testing was carried out using when the device powered using a temporary external battery which allowed testing without the operation of the wireless power transfer device.

Testing was carried out when the device was placed in the centre of the test table and it was tested in the X, Y and Z planes.

Above 1000 MHz the transmitter was placed on the test table top which was a total of 1.5 m above the test site ground plane.

Below 1000 MHz the transmitter was placed on the test table top which was a total of 0.8 m above the test site ground plane.

The device was tested transmitting continuously on 2402 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, where appropriate, with an automated antenna tower.

No general emissions were detected from this device

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

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

Result: Complies

Measurement uncertainty with a confidence interval of 95% is:
- Free radiation tests (30 – 1000 MHz) ± 4.1 dB

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

The device operates in the 2400 – 2483.5 MHz band.

Testing was carried out using when the device powered using a temporary external battery which allowed testing without the operation of the wireless power transfer device.

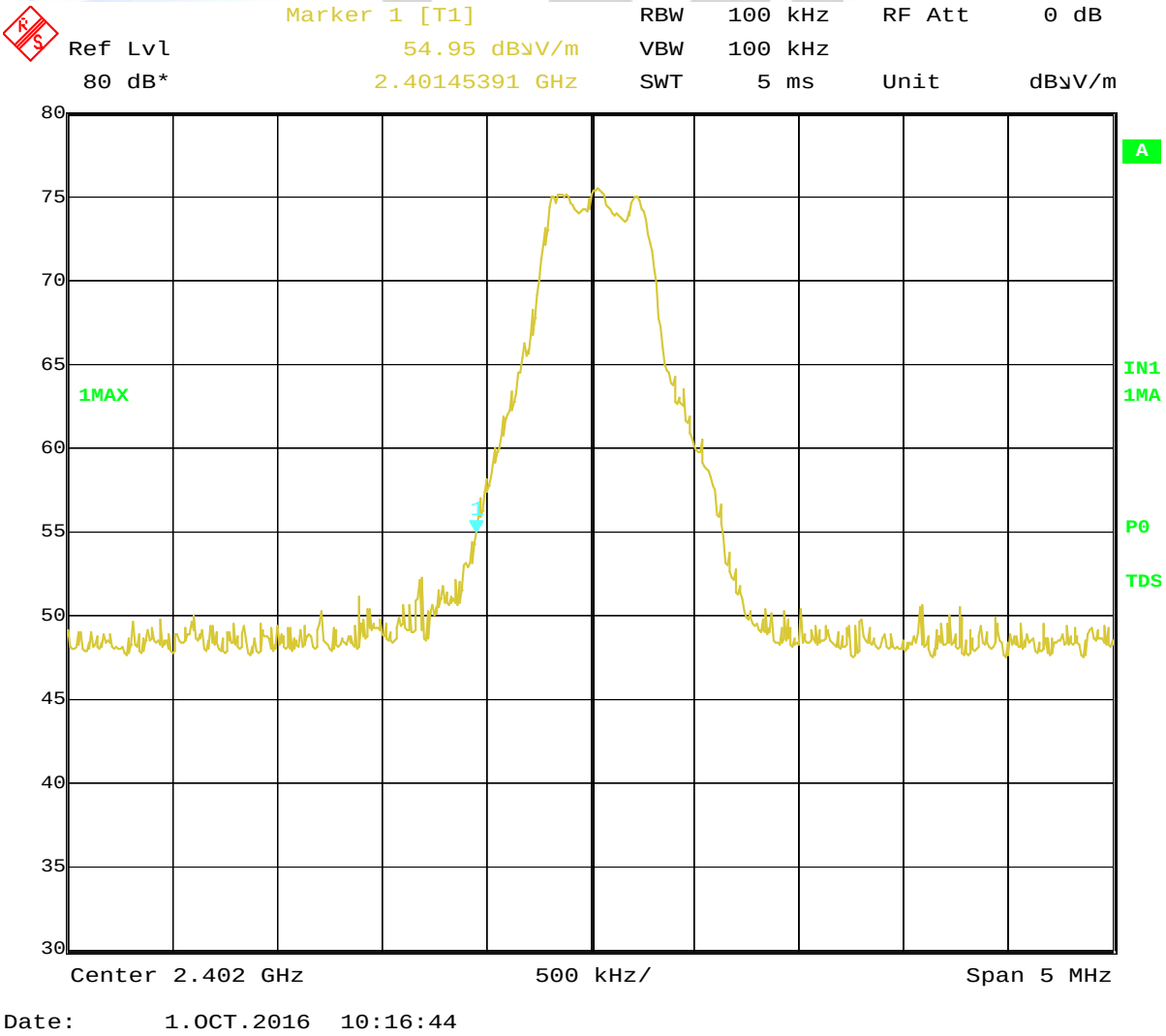
Spectrum mask measurements have been made when the device was operating on 2402 MHz and 2480 MHz.

Measurements have been made at the -20 dB points.

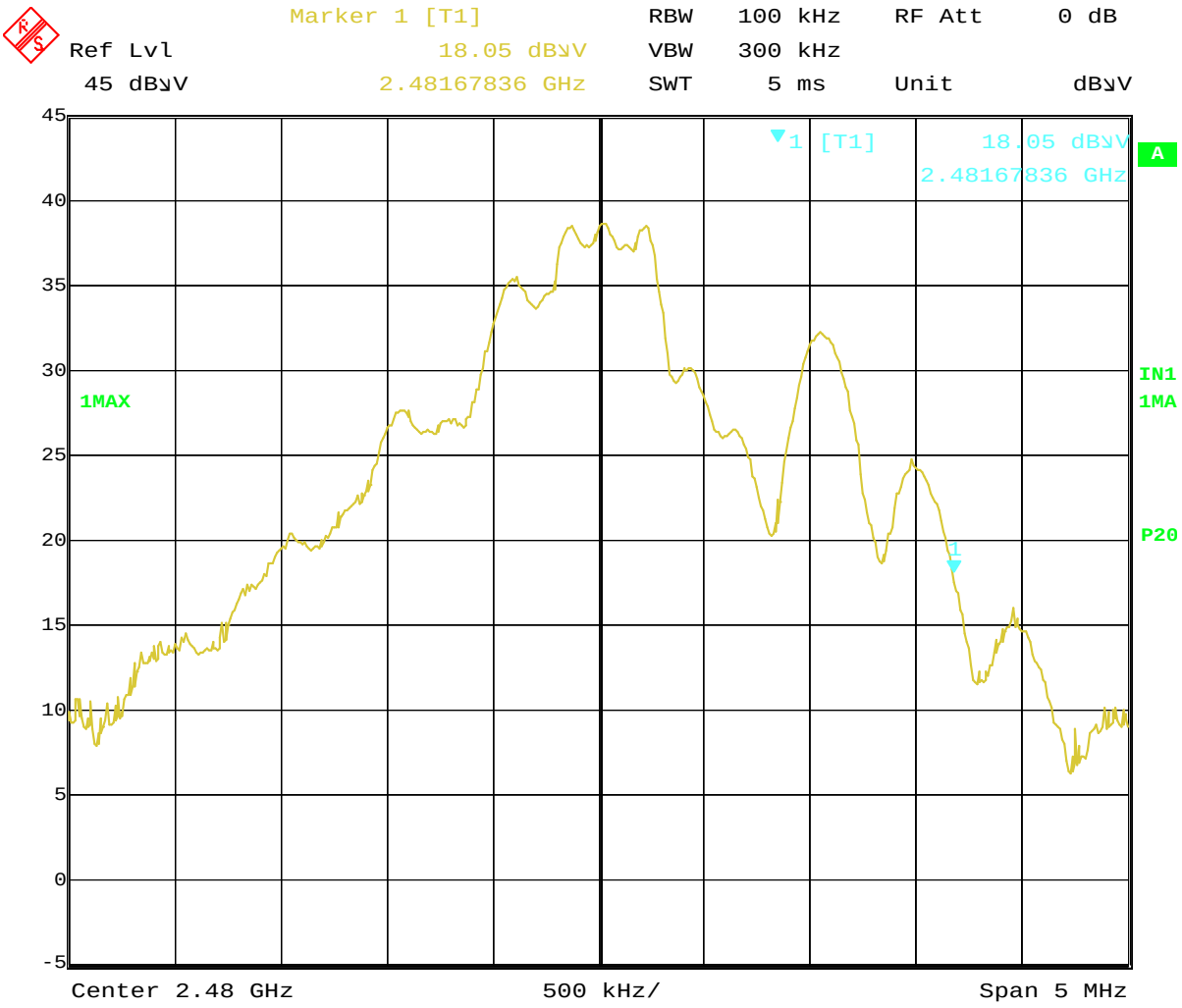
Frequency (MHz)	F low (MHz)	F high (MHz)
2402.000	2401.453	-
2480.000	-	2481.678

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

2402 MHz



2480 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.

An enclosure containing absorber material, Panashield HYB-NF-12, has been placed between the turntable and the measurement antenna for when measurements are made above 1 GHz.

This material has no absorbing affect below 1 GHz with site verification measurements.

Above 1000 MHz the transmitter was placed on the test table top which was a total of 1.5 m above the test site ground plane.

Below 1000 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 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.

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 10^{th} harmonic

Testing was carried out using when the device powered using a temporary external battery which allowed testing without the operation of the wireless power transfer device.

Testing was carried out when the device was placed in the centre of the test table and it was tested in the X, Y and Z planes.

The transmitter was tested individually when transmitting continuously on 2402, 2440 and 2480 MHz.

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).

Fundamental emission

Testing was carried out as detailed below

2402 MHz

Plane	Vertical (dBuV/m)	Horizontal (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Antenna	BW
X	81.6	77.9	114.0	32.4	Peak	Vertical	1 MHz
X	72.1	67.3	94.0	21.9	Average	Vertical	1 MHz
Y	77.7	83.1	114.0	30.9	Peak	Horizontal	1 MHz
Y	66.8	73.2	94.0	20.8	Average	Horizontal	1 MHz
Z	77.7	75.1	114.0	36.3	Peak	Vertical	1 MHz
Z	66.9	64.3	94.0	27.1	Average	Vertical	1 MHz

2440 MHz

Plane	Vertical (dBuV/m)	Horizontal (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Antenna	BW
X	75.2	78.5	114.0	35.5	Peak	Horizontal	1 MHz
X	63.8	67.7	94.0	26.3	Average	Horizontal	1 MHz
Y	81.6	78.1	114.0	32.4	Peak	Vertical	1 MHz
Y	71.3	67.3	94.0	22.7	Average	Vertical	1 MHz
Z	81.9	75.1	114.0	32.1	Peak	Vertical	1 MHz
Z	72.1	64.3	94.0	21.9	Average	Vertical	1 MHz

2480 MHz

Plane	Vertical (dBuV/m)	Horizontal (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Antenna	BW
X	82.1	76.1	114.0	31.9	Peak	Vertical	1 MHz
X	71.9	65.0	94.0	22.1	Average	Vertical	1 MHz
Y	75.8	78.8	114.0	35.2	Peak	Horizontal	1 MHz
Y	63.9	68.1	94.0	25.9	Average	Horizontal	1 MHz
Z	81.4	74.5	114.0	32.6	Peak	Vertical	1 MHz
Z	71.2	63.7	94.0	22.8	Average	Vertical	1 MHz

Section 15.249 specifies a limit of 50 mV/m (94 dBuV/m) when an average detector is used for devices operating in the band of 2400 – 2483.5 MHz.

A peak limit of 114 dBuV/m has also been applied.

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

Transmitting on 2402 MHz

Frequency (MHz)	Vertical (dBuV/m)	Horizontal (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna	Detector	BW
4804.000	< 59	< 59	74.0	> 15	Horizontal	Peak	1 MHz
	< 46	< 46	54.0	> 8	Horizontal	Average	1 MHz
7206.000	< 59	< 59	74.0	> 15	Horizontal	Peak	1 MHz
	< 46	< 46	54.0	> 8	Horizontal	Average	1 MHz
9608.000	< 59	< 59	74.0	> 15	Vert/Hort	Peak	1 MHz
	< 46	< 46	54.0	> 8	Vert/Hort	Average	1 MHz
12010.000	< 59	< 59	74.0	> 15	Vert/Hort	Peak	1 MHz
	< 46	< 46	54.0	> 8	Vert/Hort	Average	1 MHz
14413.000	< 59	< 59	74.0	> 15	Vert/Hort	Peak	1 MHz
	< 46	< 46	54.0	> 8	Vert/Hort	Average	1 MHz
16814.000	< 59	< 59	74.0	> 15	Vert/Hort	Peak	1 MHz
	< 46	< 46	54.0	> 8	Vert/Hort	Average	1 MHz
19216.000	< 59	< 59	74.0	> 15	Vert/Hort	Peak	1 MHz
	< 46	< 46	54.0	> 8	Vert/Hort	Average	1 MHz
21618.000	< 59	< 59	74.0	> 15	Vert/Hort	Peak	1 MHz
	< 46	< 46	54.0	> 8	Vert/Hort	Average	1 MHz
24020.000	< 59	< 59	74.0	> 15	Vert/Hort	Peak	1 MHz
	< 46	< 46	54.0	> 8	Vert/Hort	Average	1 MHz

Transmitting on 2440 MHz

Frequency (MHz)	Vertical (dBuV/m)	Horizontal (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna	Detector	BW
4880.000	< 59	< 59	74.0	> 15	Vert/Hort	Peak	1 MHz
	< 46	< 46	54.0	> 8	Vert/Hort	Average	1 MHz
7320.000	< 59	< 59	74.0	> 15	Vert/Hort	Peak	1 MHz
	< 46	< 46	54.0	> 8	Vert/Hort	Average	1 MHz
9760.000	< 59	< 59	74.0	> 15	Vert/Hort	Peak	1 MHz
	< 46	< 46	54.0	> 8	Vert/Hort	Average	1 MHz
12200.000	< 59	< 59	74.0	> 15	Vert/Hort	Peak	1 MHz
	< 46	< 46	54.0	> 8	Vert/Hort	Average	1 MHz
14640.000	< 59	< 59	74.0	> 15	Vert/Hort	Peak	1 MHz
	< 46	< 46	54.0	> 8	Vert/Hort	Average	1 MHz
17080.000	< 59	< 59	74.0	> 15	Vert/Hort	Peak	1 MHz
	< 46	< 46	54.0	> 8	Vert/Hort	Average	1 MHz
19520.000	< 59	< 59	74.0	> 15	Vert/Hort	Peak	1 MHz
	< 46	< 46	54.0	> 8	Vert/Hort	Average	1 MHz
21960.000	< 59	< 59	74.0	> 15	Vert/Hort	Peak	1 MHz
	< 46	< 46	54.0	> 8	Vert/Hort	Average	1 MHz
24400.000	< 59	< 59	74.0	> 15	Vert/Hort	Peak	1 MHz
	< 46	< 46	54.0	> 8	Vert/Hort	Average	1 MHz

Transmitting on 2480 MHz

Frequency (MHz)	Vertical (dBuV/m)	Horizontal (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna	Detector	BW
4960.000	< 59	< 59	74.0	> 15	Vert/Hort	Peak	1 MHz
	< 46	< 46	54.0	> 8	Vert/Hort	Average	1 MHz
7440.000	< 59	< 59	74.0	> 15	Vert/Hort	Peak	1 MHz
	< 46	< 46	54.0	> 8	Vert/Hort	Average	1 MHz
9920.000	< 59	< 59	74.0	> 15	Vert/Hort	Peak	1 MHz
	< 46	< 46	54.0	> 8	Vert/Hort	Average	1 MHz
12400.000	< 59	< 59	74.0	> 15	Vert/Hort	Peak	1 MHz
	< 46	< 46	54.0	> 8	Vert/Hort	Average	1 MHz
14880.000	< 59	< 59	74.0	> 15	Vert/Hort	Peak	1 MHz
	< 46	< 46	54.0	> 8	Vert/Hort	Average	1 MHz
17360.000	< 59	< 59	74.0	> 15	Vert/Hort	Peak	1 MHz
	< 46	< 46	54.0	> 8	Vert/Hort	Average	1 MHz
19840.000	< 59	< 59	74.0	> 15	Vert/Hort	Peak	1 MHz
	< 46	< 46	54.0	> 8	Vert/Hort	Average	1 MHz
22320.000	< 59	< 59	74.0	> 15	Vert/Hort	Peak	1 MHz
	< 46	< 46	54.0	> 8	Vert/Hort	Average	1 MHz
24800.000	< 59	< 59	74.0	> 15	Vert/Hort	Peak	1 MHz
	< 46	< 46	54.0	> 8	Vert/Hort	Average	1 MHz

* Measurements on 2405 MHz, 2440 MHz and 2480 MHz were carried out in March 2013.

No emissions were detected when testing was attempted in the X, Y or Z planes.

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

As per section 15.249 a limit of 500 uV/m applies to the harmonic emissions when an average detector is used.

This limit has been converted to dBuV/m using the formula 20 * (log 500) with a factor of + 20 dB being added to determine the peak limit.

Result: Complies.

Measurement uncertainty with a confidence interval of 95% is:
- Free radiation tests (30 – 25,000 MHz) ± 4.1 dB

2310 - 2390 MHz and 2483.5 – 2500.0 MHz Restricted Band Measurements

When the device was transmitting alternately on 2402, 2440 and 2480 MHz radiated emission measurements were made at the open area test site in the 2310 - 2390 MHz restricted band and in the 2483.5 – 2500 MHz restricted band to determine compliance.

2310 - 2390 MHz Restricted Band

Frequency (MHz)	Vertical (dBuV/m)	Hort (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	BW	Antenna
2390.000	49.8	49.8	74.0	24.2	Peak	Vertical	1 MHz
2390.000	33.6	33.6	54.0	20.4	Average	Vertical	1 MHz

The highest emission observed at 2390 MHz occurred when the transmitter was operating on 2402 MHz

Only the highest emission level has been reported when testing was carried out in X, Y and Z planes.

2483.5 – 2500.0 MHz Restricted Band

Frequency (MHz)	Vertical (dBuV/m)	Hort (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	BW	Antenna
2483.500	55.9	49.1	74.0	18.1	Peak	Vertical	1 MHz
2480.000	34.1	34.2	54.0	19.8	Average	Horizontal	1 MHz

The highest emission observed at 2483.5 MHz occurred when the transmitter was operating on 2480 MHz.

Only the highest emission level has been reported when testing was carried out in X, Y and Z planes.

All measurements were attempted at a distance of 3 metres using vertical and horizontal polarisations with a peak and an average detector with a 1 MHz bandwidth was used.

As per section 15.249 a limit of 500 uV/m applies to the harmonic emissions when an average detector is used.

This limit has been converted to dBuV/m using the formula 20 * (log 500) with a factor of + 20 dB being added to determine the peak limit.

Result: Complies.

Measurement uncertainty with a confidence interval of 95% is:
- Free radiation tests (30 – 25,000 MHz) ± 4.1 dB

8. TEST EQUIPMENT USED

Instrument	Manufacturer	Model	Serial No	Asset Ref	Cal Due	Period
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
Biconical Antenna	Schwarzbeck	BBA 9106	-	3680	3 Feb 2018	3 years
Horn Antenna	EMCO	3115	9511-4629	E1526	4 June 2017	3 years
Horn Antenna	EMCO	3116	92035	E1527	10 June 2019	3 years
Log Periodic	Schwarzbeck	VUSLP 9111	9111-228	3785	1 Dec 2017	3 years
Loop Antenna	EMCO	6502	9003-2485	3798	4 July 2017	3 years
Mains Network	R & S	ESH2-Z5	881362/032	3628	2 Oct 2017	2 years
Receiver	R & S	ESHS 10	828404/005	3728	27 June 2017	2 years
Receiver	R & S	ESIB 40	100171	EMC4003	15 Feb 2017	1 year
SG Horn Antenna	EMCO	3160-04	00224819	-	11 Sept 2018	3 years
SG Horn Antenna	EMCO	3160-05	00114635	-	11 Sept 2018	3 years
SG Horn Antenna	EMCO	3160-06	00114821	-	11 Sept 2018	3 years
SG Horn Antenna	EMCO	3160-07	00144919	-	11 Sept 2018	3 years
SG Horn Antenna	EMCO	3160-08	00114637	-	11 Sept 2018	3 years
Spectrum Analyser	Hewlett Packard	E7405A	US39150142	3776	8 Sept 2017	1 year
Turntable	EMCO	1080-1-2.1	9109-1578	RFS 3709	Not applic	Not applic
VHF Balun	Schwarzbeck	VHA 9103	9594	3696	3 Feb 2018	3 years

9. 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 2014.

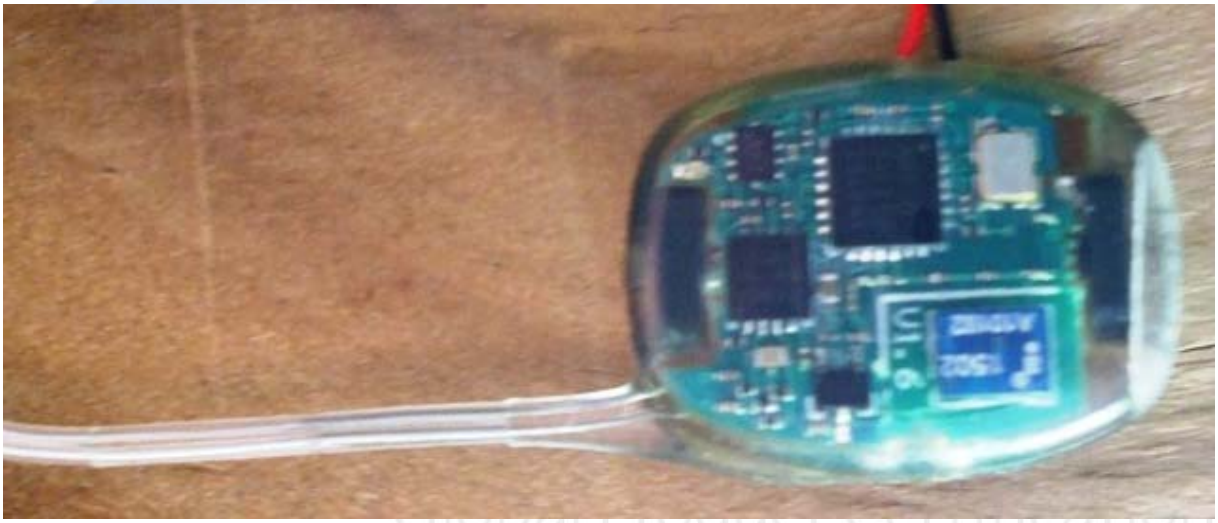
In addition testing was carried out in accordance with the terms of EMC Technologies (NZ) Ltd's International Accreditation New Zealand (IANZ) Accreditation to NZS/IEC/ISO 17025.

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.

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.

10. PHOTOGRAPHS

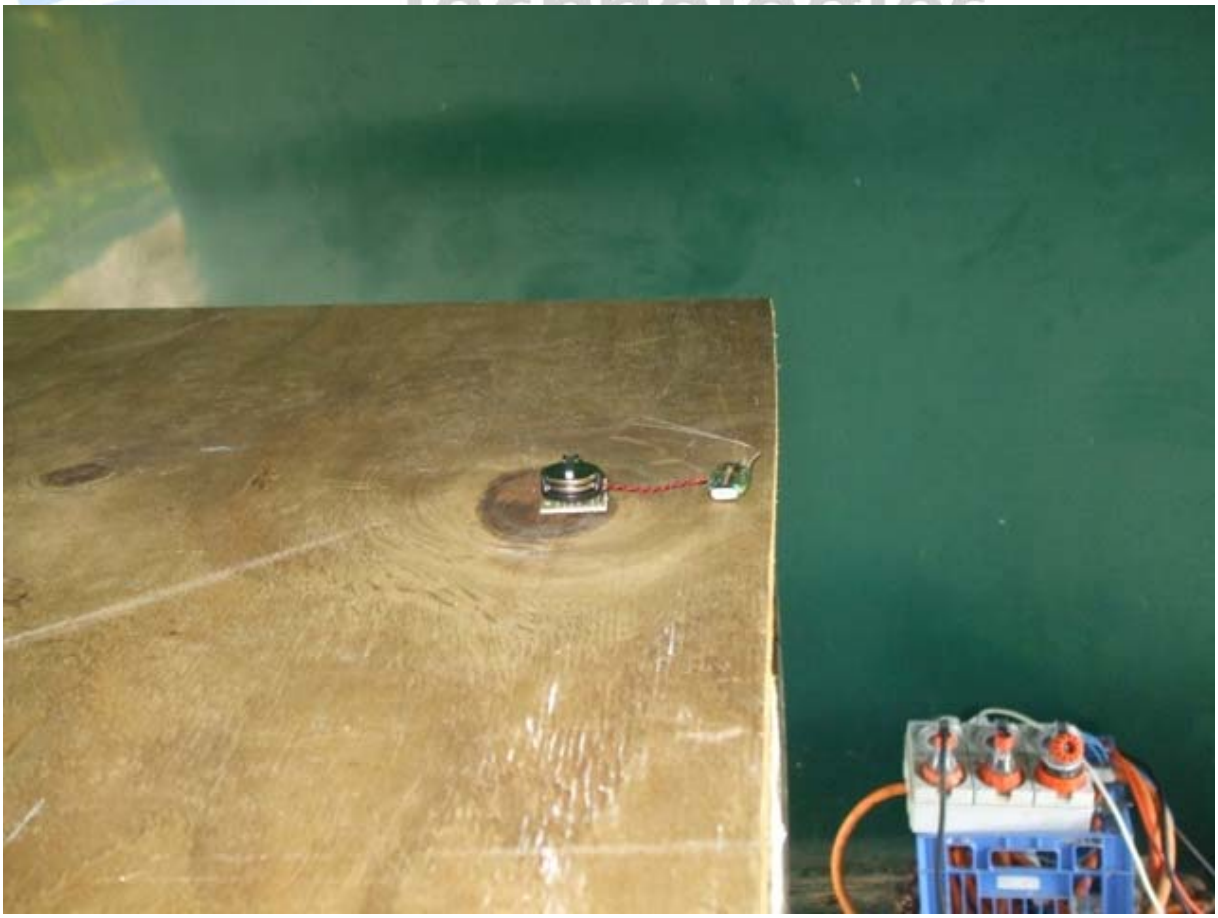
External photos

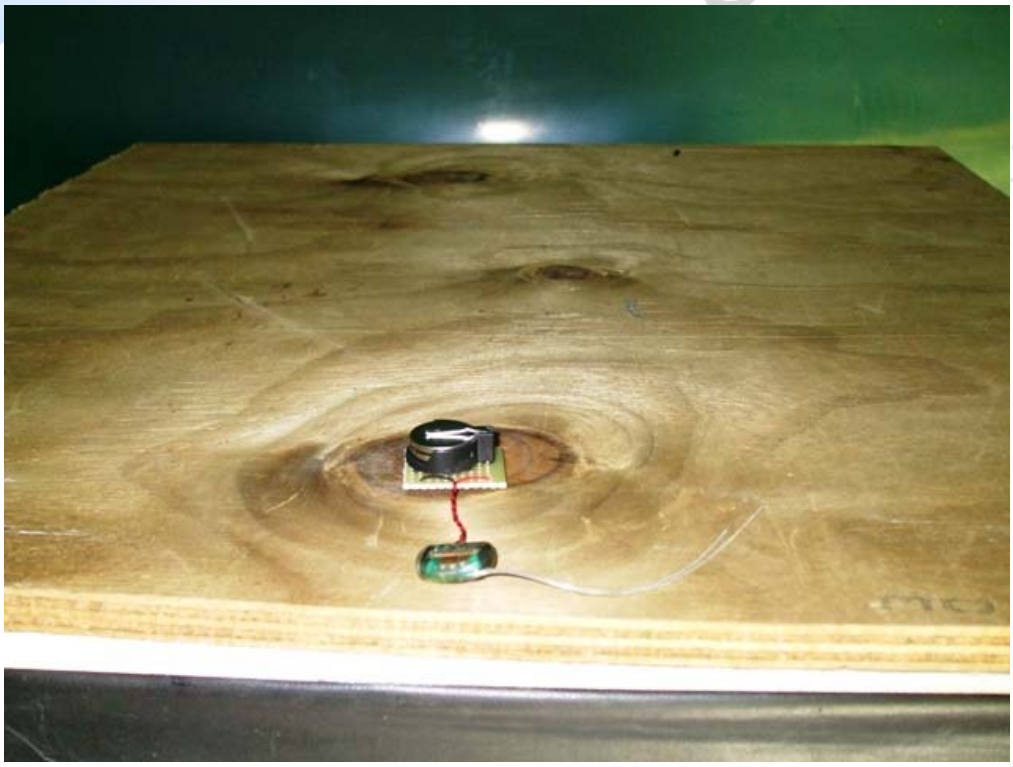


Device tested at 1.5 metres above the ground plane above 1000 MHz

X Plane

Y Plane





Z Plane