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TEST REPORT

Millar TRM54P 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:

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

Table of Contents

1.	STATEMENT OF COMPLIANCE	3
2.	RESULTS SUMMARY	3
3.	CLIENT INFORMATION	3
4.	DESCRIPTION OF TEST SAMPLE	4
5.	EQUIPMENT PARAMETERS	4
6.	ATTESTATION	5
7.	TEST RESULTS	6
8.	TEST EQUIPMENT USED	18
9.	ACCREDITATIONS	18
10.	PHOTOGRAPHS	19

1. STATEMENT OF COMPLIANCE

The **Millar TRM54P 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 May 2016 are detailed below.

Clause	Description	Result
15.201	Equipment authorisation requirement	Class 2 permissive change 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, 70 Symonds Street
Grafton

City Auckland 1010

Country New Zealand

Contact Mr Daniel McCormick

4. DESCRIPTION OF TEST SAMPLE

Brand Name	Millar Instruments / Telemetry Research
Model	TRM54P
Product	Telemeter
Manufacturer	Millar Ltd
Country of Origin	New Zealand
Serial Number	10846
FCC ID	V58HU70

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 MHz
Operating Range:	2402 – 2480 MHz
Rated Power:	1.00 mW (+0 dBm)
Modulation Type:	38 ms GFSK packet sent every 66 ms
Antenna Type:	Permanently attached wire whip antenna
Power Supply:	Internal battery
Clock Frequencies	16 MHz clock for microcontroller

This device has previously been tested and certified with 2405 MHz being the lowest operating frequency.

Re-testing has been carried out with 2402 MHz now being the lowest operating frequency.

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.

In addition that device has the ability to be charged using a wireless charger that operates on 198 kHz.

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

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.

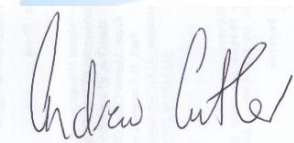
This report does not contain corrections or erasures.

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

EMC
Technologies

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7. TEST RESULTS

Section 15.201: Equipment authorisation requirement

Certification as detailed in Subpart J of Part 2 has previously been granted for this device as it contains a 2.4 GHz transmitter.

The lowest frequency of operation has been changed from 2405 MHz to 2402 MHz hence a Class 2 permissive change will be required.

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 can be charged wirelessly using a smart pad wireless charger that operates on 198 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 (16 MHz clock), 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 an internal battery supply.

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 1000 MHz as the highest frequency in use by the digital device in this device is less than 108 MHz (16 MHz clock).

Testing was carried out at the laboratory's open area test site - located at Driving Creek, Orere Point, Auckland, New Zealand. This site conforms to the requirements of CISPR 16 and ANSI C63.4 - 2003.

Testing was carried out using when the device powered using an internal battery supply.

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.

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.

Above 30 MHz the emission is measured in both vertical and horizontal antenna polarisations, where appropriate, using a quasi peak detector.

No general emissions were detected from this device

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

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

Result: Complies

Measurement uncertainty with a confidence interval of 95% is:

- Free radiation tests (30 – 1000 MHz) $\pm$ 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.

Relative spectrum mask measurements have been made when the device was operating on 2402 MHz, 2405 MHz and 2480 MHz.

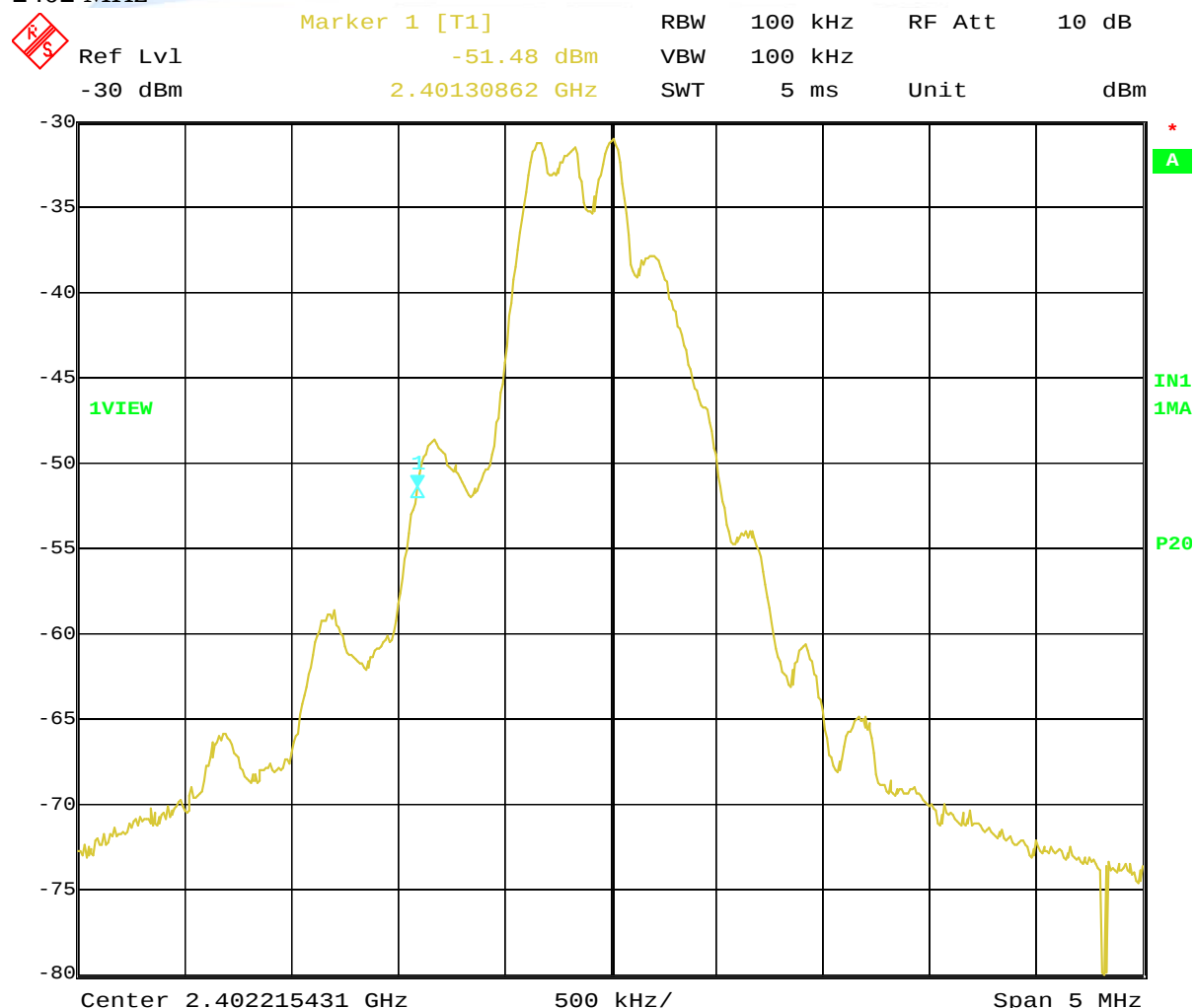
Measurements have actually been made at the -20 dB points.

Frequency (MHz)	F low (MHz)	F high (MHz)
2402.000	2401.30862	
*2405.000	2404.52500	-
*2480.000	-	2480.82500

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

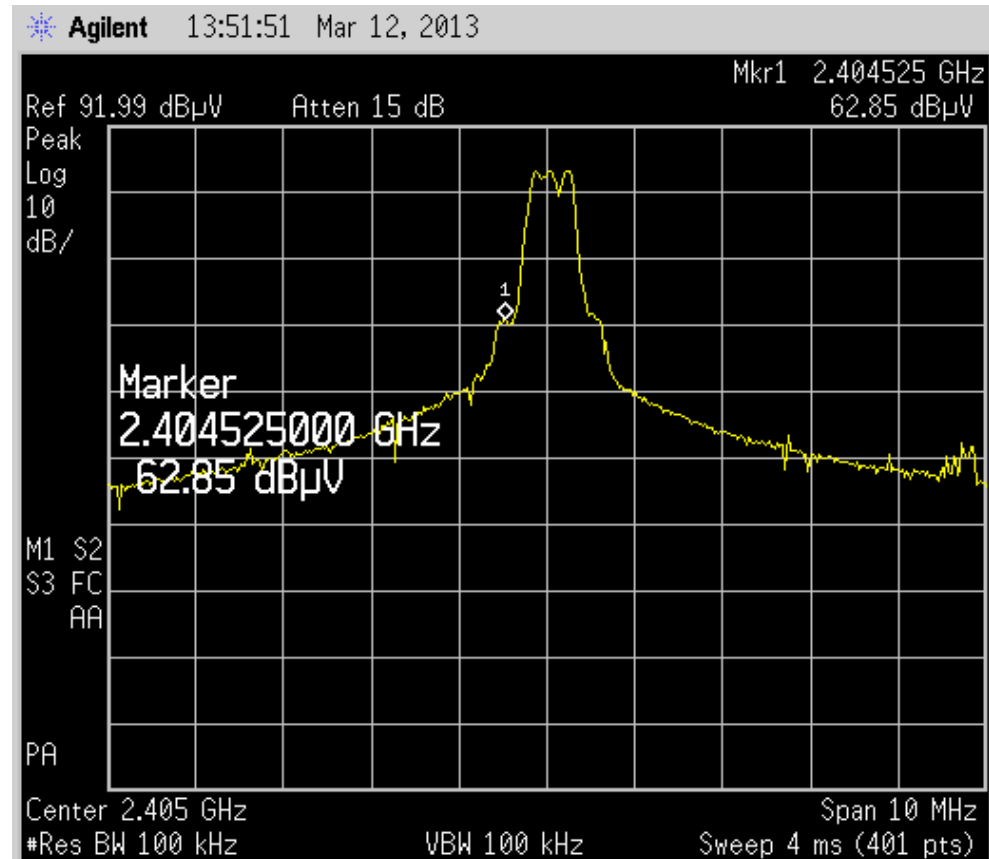
The device can be seen to stay within the band of 2400 – 2483.5 MHz at the -20 dB points

2402 MHz

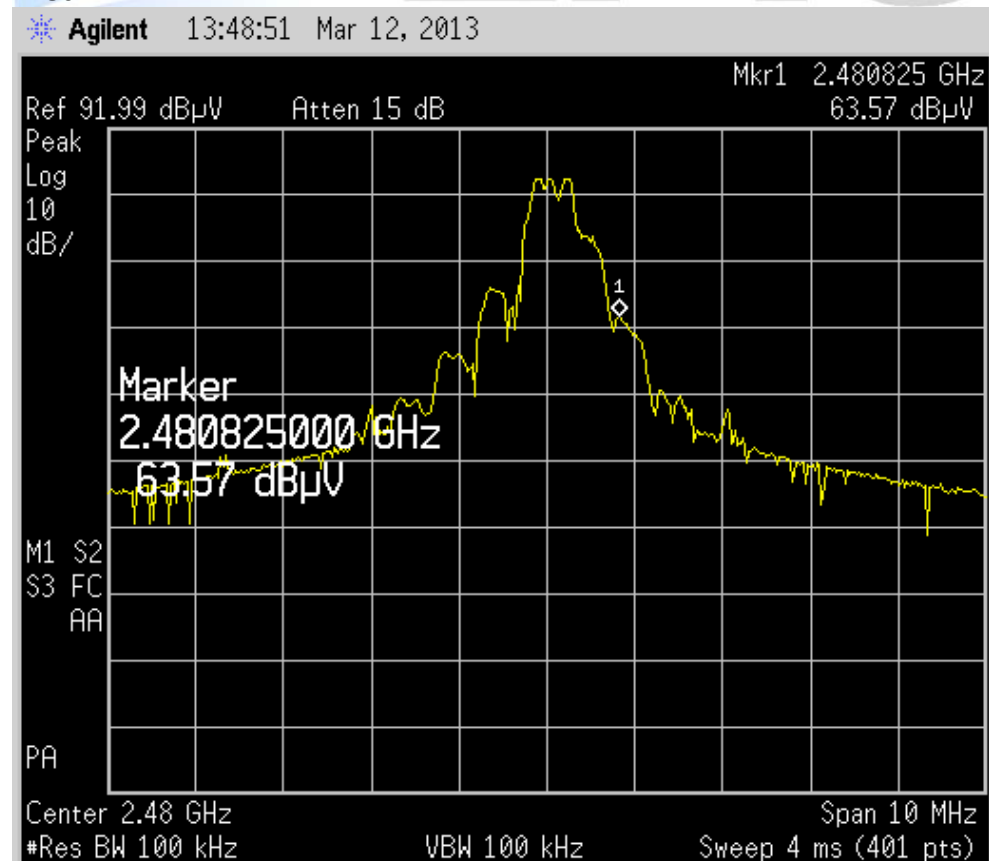


Date: 1. JAN. 1997 01:12:56

2405 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.

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 10th harmonic

Testing was carried out using when the device powered using an internal battery supply.

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 MHz.

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

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

Level (dB μ V/m) = Receiver Reading (dB μ V) + 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)	Antenna	Detector	BW
X	93.6	87.8	114.0	20.4	Vertical	Peak	1 MHz
	77.2	72.1	94.0	16.8	Vertical	Average	1 MHz
Y	87.3	90.5	114.0	23.5	Horizontal	Peak	1 MHz
	73.7	75.1	94.0	18.9	Horizontal	Average	1 MHz
Z	91.4	84.3	114.0	22.6	Vertical	Peak	1 MHz
	73.1	73.2	94.0	20.8	Horizontal	Average	1 MHz

2405 MHz

Plane	Vertical (dBuV/m)	Horizontal (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna	Detector	BW
X	95.1	88.3	114.0	18.9	Vertical	Peak	1 MHz
	78.6	75.2	94.0	15.4	Vertical	Average	1 MHz
Z	93.1	89.0	114.0	20.9	Vertical	Peak	1 MHz
	84.5	73.8	94.0	9.5	Vertical	Average	1 MHz

2440 MHz

Plane	Vertical (dBuV/m)	Horizontal (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna	Detector	BW
Z	95.4	90.2	114.0	18.6	Vertical	Peak	1 MHz
	87.3	74.1	94.0	6.7	Vertical	Average	1 MHz

2480 MHz

Plane	Vertical (dBuV/m)	Horizontal (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna	Detector	BW
Y	87.3	92.3	114.0	21.7	Horizontal	Peak	1 MHz
	71.1	75.5	94.0	18.5	Horizontal	Average	1 MHz
X	94.2	90.1	114.0	19.8	Vertical	Peak	1 MHz
	77.7	73.6	94.0	16.3	Vertical	Average	1 MHz
Z	89.5	94.4	114.0	19.6	Horizontal	Peak	1 MHz
	73.1	77.9	94.0	16.1	Horizontal	Average	1 MHz

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

All planes were tested when the device was operating on 2402 MHz and 2480 MHz.

Limited testing was carried out on the other frequencies in the plane with gave highest observed emissions at 2480 MHz (Z Plane. Standing on edge).

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 2405 MHz**

Frequency (MHz)	Vertical (dBuV/m)	Horizontal (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna	Detector	BW
4810.000	< 59	< 59	74.0	> 15	Vert/Hort	Peak	1 MHz
	< 46	< 46	54.0	> 8	Vert/Hort	Average	1 MHz
7215.000	< 59	< 59	74.0	> 15	Vert/Hort	Peak	1 MHz
	< 46	< 46	54.0	> 8	Vert/Hort	Average	1 MHz
9620.000	< 59	< 59	74.0	> 15	Vert/Hort	Peak	1 MHz
	< 46	< 46	54.0	> 8	Vert/Hort	Average	1 MHz
12025.000	< 59	< 59	74.0	> 15	Vert/Hort	Peak	1 MHz
	< 46	< 46	54.0	> 8	Vert/Hort	Average	1 MHz
14430.000	< 59	< 59	74.0	> 15	Vert/Hort	Peak	1 MHz
	< 46	< 46	54.0	> 8	Vert/Hort	Average	1 MHz
16835.000	< 59	< 59	74.0	> 15	Vert/Hort	Peak	1 MHz
	< 46	< 46	54.0	> 8	Vert/Hort	Average	1 MHz
19240.000	< 59	< 59	74.0	> 15	Vert/Hort	Peak	1 MHz
	< 46	< 46	54.0	> 8	Vert/Hort	Average	1 MHz
21645.000	< 59	< 59	74.0	> 15	Vert/Hort	Peak	1 MHz
	< 46	< 46	54.0	> 8	Vert/Hort	Average	1 MHz
24050.000	< 59	< 59	74.0	> 15	Vert/Hort	Peak	1 MHz
	< 46	< 46	54.0	> 8	Vert/Hort	Average	1 MHz

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*** 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

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*** 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

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 2016	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 2016	2 years
Receiver	R & S	ESHS 10	828404/005	3728	27 June 2016	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	1 Dec 2016	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



Radiated emissions test set up.

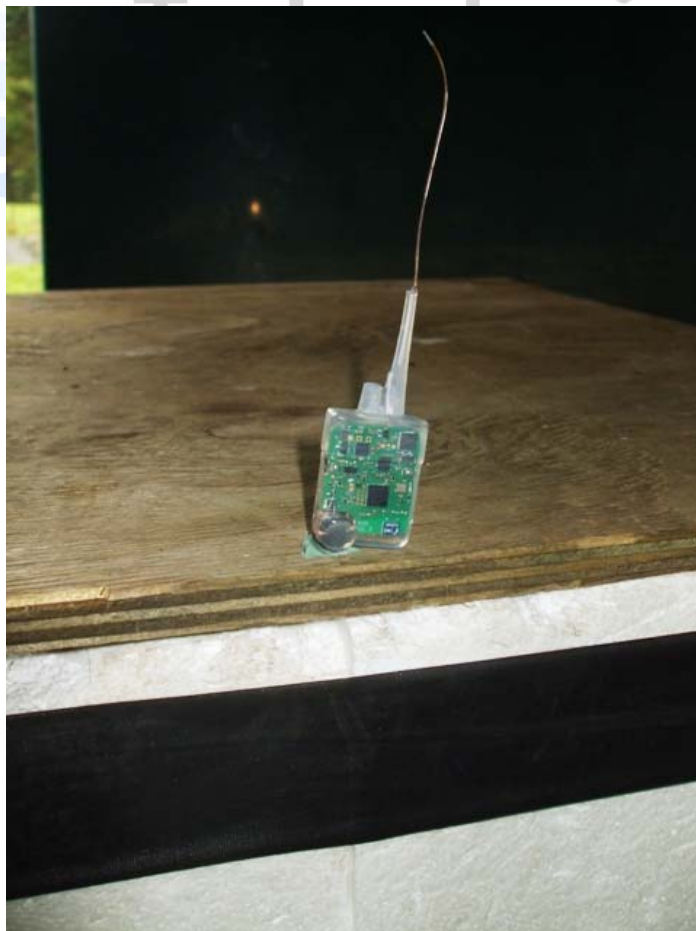
General set up



X Plane



Y Plane



Z Plane

