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## **TEST REPORT**

**Millar Instruments / Telemetry Research  
TRM54 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 / Telemetry Research Ltd**

This Test Report is issued with the authority of:

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

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**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 **Millar Instruments / Telemetry Research TRM54 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 C63.4 – 2003.

## 2. RESULTS SUMMARY

The results of testing carried out in December 2012 and March 2013 are detailed 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. 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 / Telemetry Research Ltd

**Address** Level 1, 70 Symonds Street  
Grafton

**City** Auckland 1010

**Country** New Zealand

**Contact** Mr David Budgett

## 4. DESCRIPTION OF TEST SAMPLE

<b>Brand Name</b>	Millar Instruments / Telemetry Research
<b>Model</b>	TRM54
<b>Product</b>	Telemeter
<b>Manufacturer</b>	Telemetry Research Ltd
<b>Country of Origin</b>	New Zealand
<b>Serial Number</b>	6770, 6808, 6810
<b>FCC ID</b>	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:	2405, 2440, 2480 MHz
Operating Frequencies:	16 channels between 2405 – 2480 MHz in 5 MHz steps
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

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.**

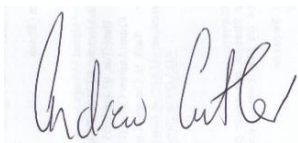
**This report does not contain corrections or erasures.**

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

## **7. 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 a 2.4 GHz 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 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 2440 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)  $\pm$  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 2440 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 $\mu$ V/m) = Receiver Reading (dB $\mu$ V) + Antenna Factor (dB) + 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.

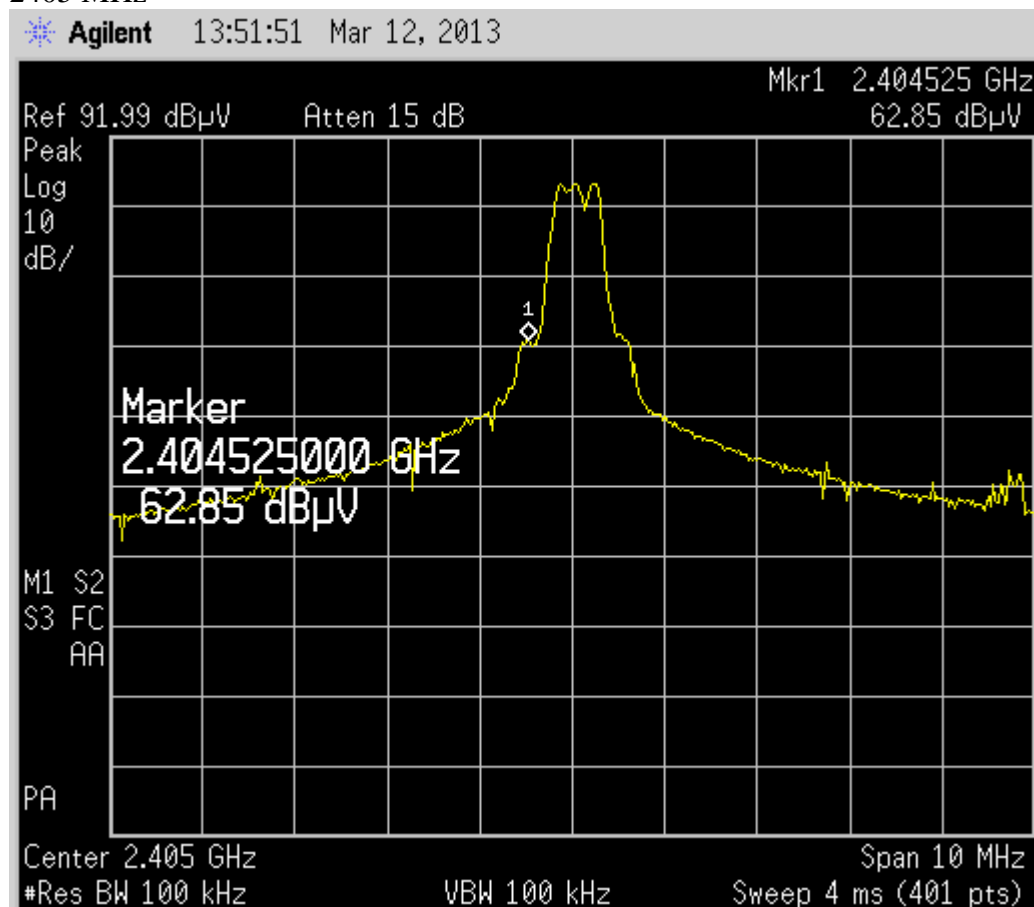
Relative spectrum mask measurements have been made when the device was operating on Channel 1 – 2405 MHz and Channel 16 – 2480 MHz.

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

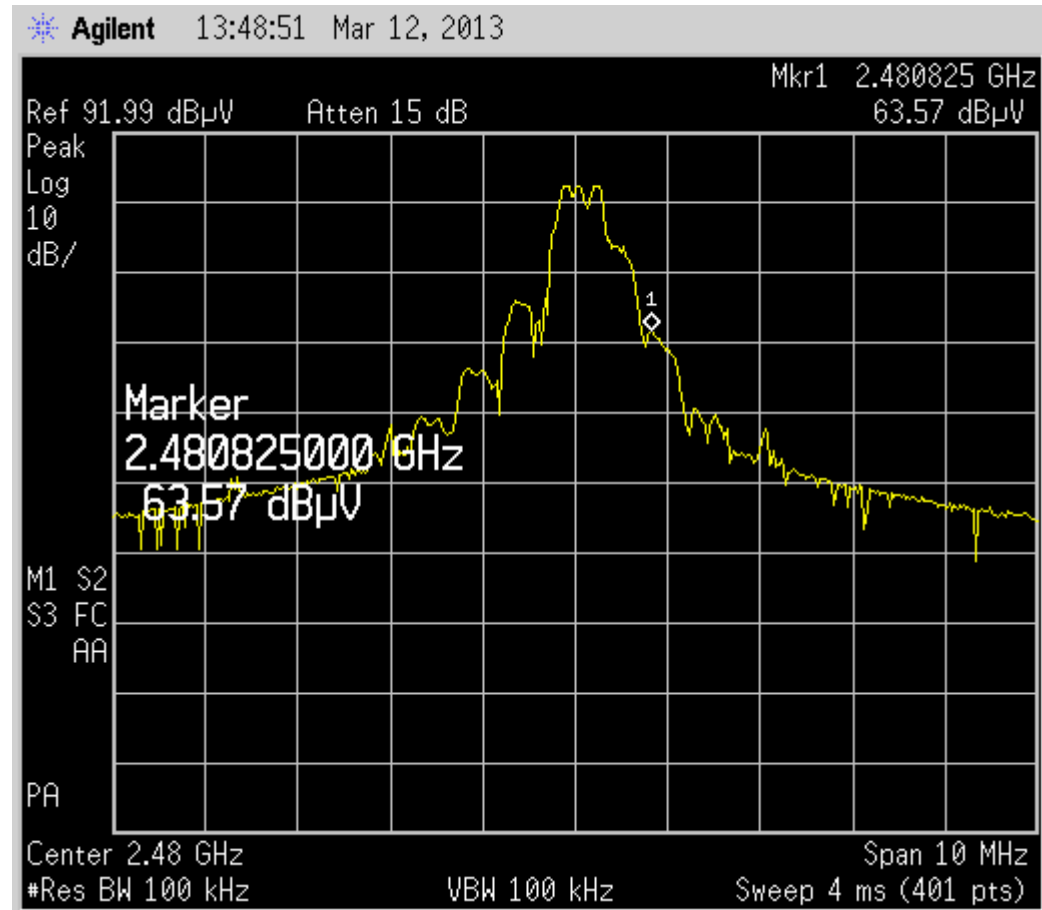
Frequency (MHz)	F low (MHz)	F high (MHz)
2405.000	2404.525	-
2480.000	-	2480.825

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

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 10<sup>th</sup> 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.

Three transmitters were tested individually when transmitting continuously on 2405, 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) + Coax Loss (dB) – Amplifier Gain (dB)

## Fundamental emission

Testing was carried out as detailed below

Frequency (MHz)	Vertical (dBuV/m)	Horizontal (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna	Detector	BW
Y Plane							
2480.000	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 Plane							
2480.000	94.2	90.1	114.0	19.8	Vertical	Peak	1 MHz
	77.7	73.6	94.0	16.3	Vertical	Average	1 MHz
2405.000	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 Plane							
2480.000	89.5	94.4	114.0	19.6	Horizontal	Peak	1 MHz
	73.1	77.9	94.0	16.1	Horizontal	Average	1 MHz
2440.000	95.4	90.2	114.0	18.6	Vertical	Peak	1 MHz
	87.3	74.1	94.0	6.7	Vertical	Average	1 MHz
2405.000	93.1	89.0	114.0	20.9	Vertical	Peak	1 MHz
	84.5	73.8	94.0	9.5	Vertical	Average	1 MHz

All planes were tested when the device was operating on 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)  $\pm 4.1$  dB

## Spurious emissions

### 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

## 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

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)  $\pm 4.1$  dB

## 8. TEST EQUIPMENT USED

Instrument	Manufacturer	Model	Serial No	Asset Ref	Cal Due	Interval
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	ESHS 10	828404/005	3728	21 Aug 2013	1 year
Mains Network	R & S	ESH2-Z5	881362/032	3628	21 Aug 2013	1 year
Receiver	R & S	ESIB 40	100171	R-27-1	21 Oct 2013	1 year
Spectrum Analyser	Hewlett Packard	E7405A	US39150142	3771	20 Mar 2013	1 year
VHF Balun	Schwarzbeck	VHA 9103	-	RFS 3603	7 Feb 2014	1 year
Biconical Antenna	Schwarzbeck	BBA 9106	-	RFS 3612	7 Feb 2014	1 year
Log Periodic	Schwarzbeck	VUSLP 9111	9111-228	3785	7 Feb 2014	1 year
Horn Antenna	EMCO	3115	9511-4629	E1526	10 May 2013	1 year
SG Horn Antenna	EMCO	3160-04	00224819	-	11 Sept 2015	3 years
SG Horn Antenna	EMCO	3160-05	00114635	-	11 Sept 2015	3 years
SG Horn Antenna	EMCO	3160-06	00114821	-	11 Sept 2015	3 years
SG Horn Antenna	EMCO	3160-07	00144919	-	11 Sept 2015	3 years
SG Horn Antenna	EMCO	3160-08	00114637	-	11 Sept 2015	3 years
Horn Antenna	EMCO	3116	92035	-	10 May 2013	1 year
Loop Antenna	EMCO	6502	9003-2485	3798	12 Dec 2013	1 year

## 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 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.

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

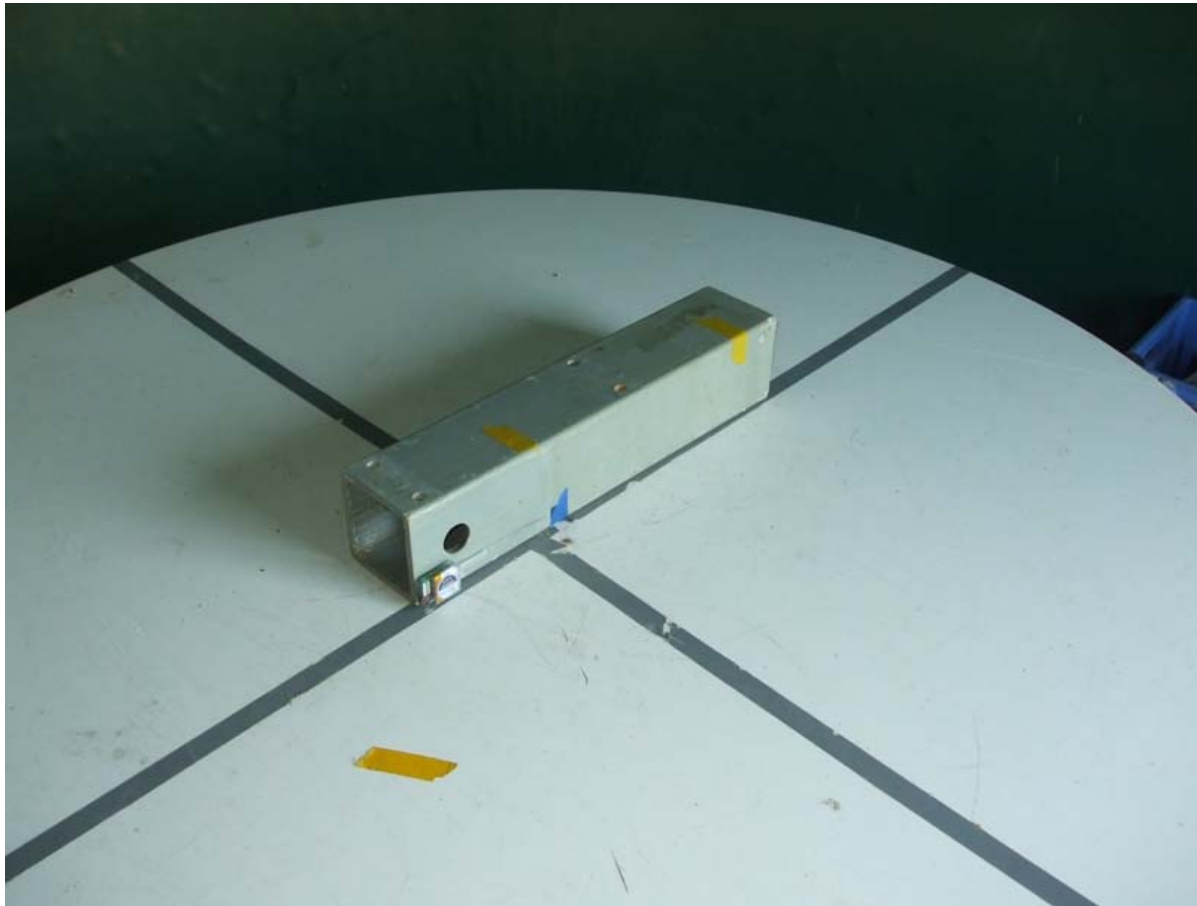


## Radiated emissions test set up photos

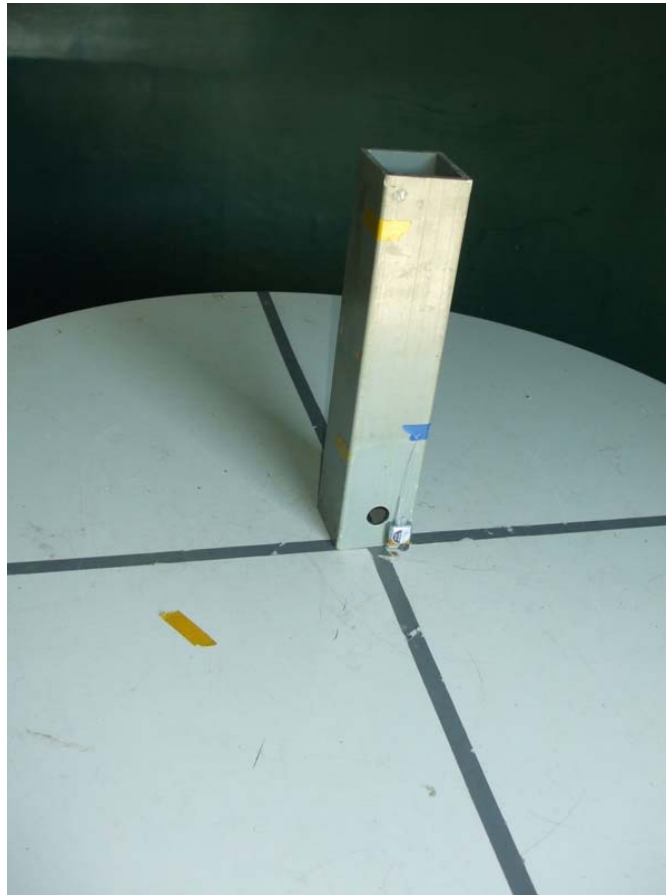
General set up



## Z Plane



X Plane





## Y Plane

