

# EMC Technologies (NZ) Ltd

Test Report No 101207.1

Report date: 14<sup>th</sup> December 2010

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## TEST REPORT

### **CAS / CAM PROD0295 Collision Avoidance System Transmitter**

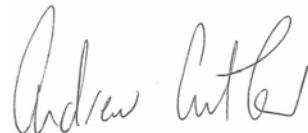
*tested for compliance with the*

**Code of Federal Regulations (CFR) 47**

**Part 90 –Private Land Mobile Services**

*for*

**Advanced Mining Technologies PTY Ltd**



Test Report issued by:

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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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Page 1 of 25

# **EMC Technologies (NZ) Ltd**

Test Report No **101207.1**

Report date: 14<sup>th</sup> December 2010

---

## **Table of Contents**

<b>1. CLIENT INFORMATION</b>	<b>3</b>
<b>2. DESCRIPTION OF TEST SAMPLE</b>	<b>3</b>
<b>3. COMPLIANCE STATEMENT &amp; TEST RESULTS</b>	<b>5</b>
<b>4. TEST SAMPLE DESCRIPTION</b>	<b>6</b>
<b>5. TEST CONDITIONS</b>	<b>7</b>
<b>6. ATTESTATION</b>	<b>8</b>
<b>7. TRANSMITTER TEST RESULTS</b>	<b>9</b>
<b>8. TEST EQUIPMENT USED</b>	<b>21</b>
<b>9. ACCREDITATIONS</b>	<b>21</b>
<b>10. PHOTOGRAPH(S)</b>	<b>22</b>

# EMC Technologies (NZ) Ltd

Test Report No 101207.1

Report date: 14<sup>th</sup> December 2010

---

## 1. CLIENT INFORMATION

**Company Name** Advanced Mining Technologies PTY Ltd  
**Address** PO Box 5107  
Chittaway Bay  
**State** New South Wales 2261  
**Country** Australia  
**Contact** Mr Dmitri Fechine

## 2. DESCRIPTION OF TEST SAMPLE

**Brand Name** CAS / CAM  
**Model Number** PROD0295  
**Product** Collision Avoidance System Transmitter  
**Manufacturer** AMT PTY Ltd  
**Designed in** Australia  
**Manufactured in** Australia  
**Serial number** 2953 0904 0185  
**FCC ID** YIY-AMTCASG1

Testing has been carried out as this device has been modified as detailed below:

1. The junction board and the transceiver board were merged together (see the original CAS CAM RF block diagram).
2. MCU board has been insignificantly changed, namely some control lines were connected to different microcontroller pins.

# EMC Technologies (NZ) Ltd

Test Report No 101207.1

Report date: 14<sup>th</sup> December 2010

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The system was powered at 13.8 Vdc using an external lead acid battery.

Section 90.217 of the FCC rules has been applied to this transmitter as the power output does not exceed 120 mW.

The RF module in the system is operated using a whip antenna with a 5 dBi gain.

Testing was therefore carried out with a dummy load for the spurious emission case radiation tests.

This report can also be applied to the following devices which are identical to the units tested except for variations in the dip switch settings that result in different unit ID numbers being transmitted and as a result different part numbers.

Mainstream units:

PROD0169 CAS Heavy Vehicle REAR RF UNIT  
PROD0239 CAS Heavy Vehicle FRONT RF UNIT  
PROD0307 CAS Heavy Vehicle RIGHT RF UNIT  
PROD0308 CAS Heavy Vehicle LEFT RF UNIT

Special cases:

PROD0193 (CAS CALIBRATION UNIT))  
PROD0580 (CAS LVV RF UNIT)  
PROD0595 (CAS TEST STATION RF UNIT)  
PROD0596 (STATIONARY OBJECT RF UNIT)  
PROD0598 (MOBILE PLANT & EQUIPMENT RF UNIT)  
PROD0650 (CAS BATTERY LV RF UNIT)  
PROD0655 (CAS HV RF INTERLOCK UNIT)

# EMC Technologies (NZ) Ltd

Test Report No 101207.1

Report date: 14<sup>th</sup> December 2010

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## 3. COMPLIANCE STATEMENT & TEST RESULTS

The **CAS / CAM PROD0295 Collision Avoidance System Transmitter** complies with 47 CFR Part 90, section 90.217.

Testing was carried out in accordance with the test methods defined in 47 CFR Part 2 and 90.

Listed below are the relevant Part 2 test methods and the Part 90 limits.

Clause	Parameter	Result
2.1041	Measurement procedures	Noted
2.1046	RF power output	Complies
2.1049	Occupied bandwidth	Complies
2.1051	Spurious emissions at antenna terminals	Complies
2.1053	Field strength of spurious radiation	Complies
2.1055	Frequency stability	Complies
2.1057	Frequency spectrum to be investigated	Noted
90.217	Exemption from technical standards	Complies

# EMC Technologies (NZ) Ltd

Test Report No 101207.1

Report date: 14<sup>th</sup> December 2010

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## 4. TEST SAMPLE DESCRIPTION

The sample tested has the following specifications:

### **Rated Transmitter Output Power**

Maximum output power: 20 mW (+13.0 dBm)

Minimum output power: 0.01 mW(-10.0 dBm)

### **Test Frequencies**

428.0000 MHz, 452.7000 MHz

### **Transmitter operating range**

421 MHz to 454 MHz

### **FCC Bands**

421 MHz to 512 MHz

### **Modes of operation**

Raised cosine 2 FSK modulation (RC2FSK) with a 1 kHz frequency deviation.

Data rate is stated to be 7.2 k baud and the RC alpha is 0.5.

### **Emission designator**

F2D

### **Power Supply**

External DC voltage supply. Typically 13.8 Vdc

# EMC Technologies (NZ) Ltd

Test Report No 101207.1

Report date: 14<sup>th</sup> December 2010

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## 5. TEST CONDITIONS

### Standard Temperature and Humidity

Temperature Range: 15°C - 30°C  
Humidity Range: 40% - 75%

### Standard Test Power Source

Standard Test Voltage: 13.8 Vdc.

### Extreme Temperature

High Temperature: + 50°C maintained.  
Low Temperature: - 30 °C maintained.

### Extreme Test Voltages

Low Voltage: 11.7 Vdc  
High Voltage: 15.9 Vdc

# EMC Technologies (NZ) Ltd

Test Report No 101207.1

Report date: 14<sup>th</sup> December 2010

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## 6. ATTESTATION

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

**The test sample was selected by the client.**

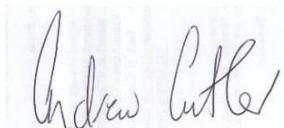
**The report relates only to the sample tested.**

**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

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Test Report No 101207.1

Report date: 14<sup>th</sup> December 2010

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## 7. TRANSMITTER TEST RESULTS

### Introduction

This transmitter has been tested in accordance with the requirements of 47 CFR Section 90.217 – Exemption from technical standards.

- are exempt from the technical requirements set out in this subpart but must instead comply with the following.

In order for this section to apply the following needs to be demonstrated:

- The frequency of operation could be used at stations licensed below 800 MHz on any frequency listed in Subpart B and C of 47 CFR Part 90.

This transmitter can operate in the FCC band 421 – 521 MHz over the range of 421 – 454 MHz.

For testing purposes it has been configured to operate on 428.000 MHz and 452.700 MHz.

# EMC Technologies (NZ) Ltd

Test Report No 101207.1

Report date: 14<sup>th</sup> December 2010

---

## RF Conducted Power Output

Section 90.217 specifies that the output power of the transmitter shall not exceed 120 mW (20.8 dBm).

The manufacturer states that the transmitter can be operated over the range of -10 dBm (0.01 mW) to +13 dBm (20.0 mW) with a whip antenna with a gain of 5 dBi.

20 mW setting (+13 dBm)

Frequency (MHz)	Voltage (Vdc)	Rated (dBm)	Measured (dBm)
428.000	11.7	13.0	12.3
428.000	13.8	13.0	12.3
428.000	15.9	13.0	12.6

0.01 mW setting (-10 dBm)

Frequency (MHz)	Voltage (Vdc)	Rated (dBm)	Measured (dBm)
428.000	11.7	-10.0	-9.8
428.000	13.8	-10.0	-9.9
428.000	15.9	-10.0	-9.8

20 mW setting (+13 dBm)

Frequency (MHz)	Voltage (Vdc)	Rated (dBm)	Measured (dBm)
452.700	11.7	13.0	12.5
452.700	13.8	13.0	12.1
452.700	15.9	13.0	12.3

0.01 mW setting (-10 dBm)

Frequency (MHz)	Voltage (Vdc)	Rated (dBm)	Measured (dBm)
452.700	11.7	-10.0	-9.0
452.700	13.8	-10.0	-9.0
452.700	15.9	-10.0	-9.1

### Limits:

The output power shall be within +/- 1 dB of the manufacturers rated power.

In accordance with Section 90.217 the output power cannot exceed 120 mW (+20.8 dBm).

**Result:** Complies

**Measurement Uncertainty:**  $\pm 0.5$  dB

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Page 10 of 25

## EMC Technologies (NZ) Ltd

Test Report No **101207.1**  
Report date: 14<sup>th</sup> December 2010

## Occupied bandwidth

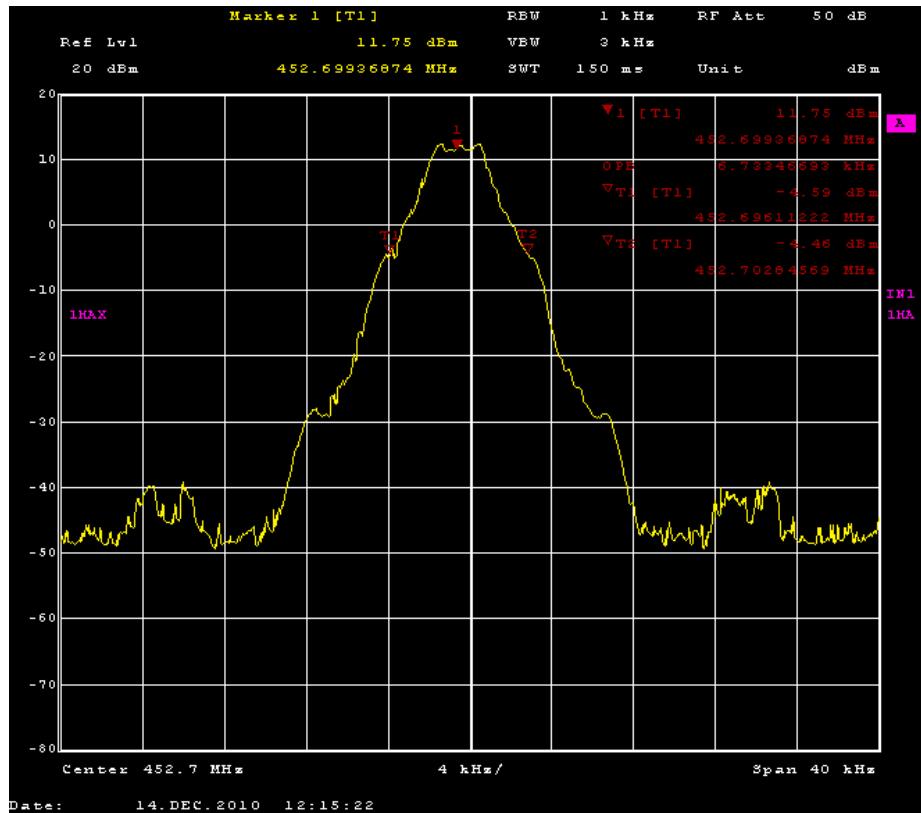
This transmitter transmits data using F2D.

The occupied bandwidth has been measured and compared against the occupied bandwidth declared by the client.

Measurements have been made using a spectrum analyser operating occupied bandwidth measurement function, in peak hold mode.

The (99% power) absolute bandwidth points determined using the occupied bandwidth measurement function.

Emission	Channel Spacing	Measured	Designation
F2D	12.5 kHz	6.7 kHz	8k50F2D



# EMC Technologies (NZ) Ltd

Test Report No 101207.1

Report date: 14<sup>th</sup> December 2010

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## Transmitter spurious emissions at the antenna terminals

The spectrum analyser bandwidth was set to 100 kHz for measurements below 1 GHz and 1 MHz for measurements above 1 GHz.

**Frequency:** 428.000 MHz

Spurious emission (MHz)	+13 dBm levels (dBm)	-10 dBm levels (dBm)
856.000	-39.4	-64.6
1284.000	-33.1	-54.0
1712.000	-45.2	-67.6
2140.000	-40.0	-57.3
2568.000	-48.9	-67.5
3000.000	-43.3	-63.7
3424.000	-57.0	-75.2
3852.000	-48.0	-75.6
4280.000	-61.0	-77.4

**Frequency:** 452.700 MHz

Spurious emission (MHz)	+13 dBm levels (dBm)	-10 dBm levels (dBm)
905.4000	-41.0	-74.0
1358.1000	-50.0	-63.5
1810.7750	-43.0	-72.6
2263.5000	-43.6	-65.0
2716.2250	-56.2	-75.7
3168.9000	-47.1	-70.0
3621.6000	-59.5	-75.0
4074.3000	-48.6	-71.4
4527.0000	-66.0	-75.6

Spectrum plots have been provided at the carrier frequencies of 428.000 MHz, 452.100 MHz and 452.7000 MHz.

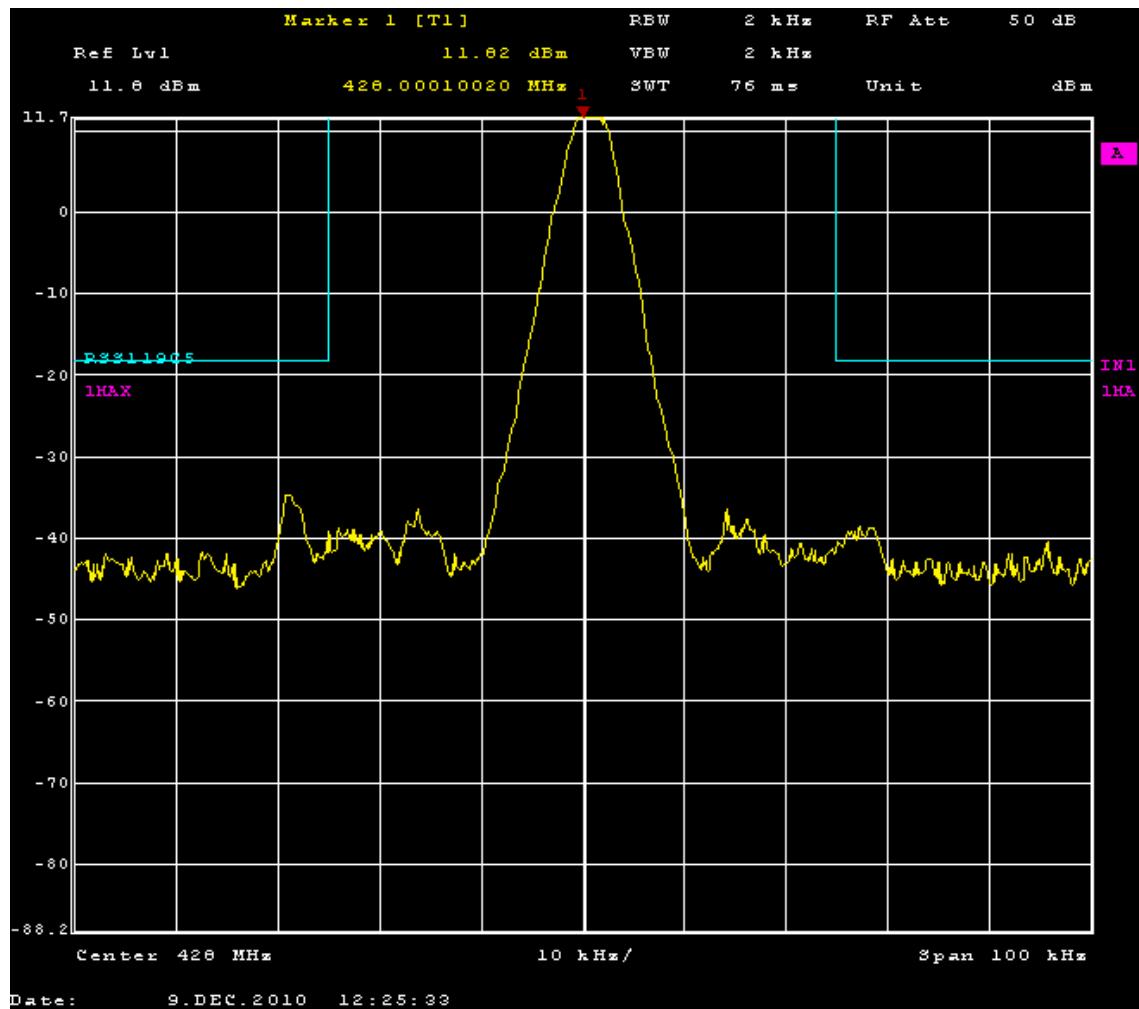
As the device operates with 12.5 kHz channel spacings a displacement frequency of 25 kHz has been applied.

A resolution bandwidth of 300 Hz has been applied a limit of -30 dBc has been utilised.

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Test Report No 101207.1  
Report date: 14<sup>th</sup> December 2010

+13.0 dBm at 428.0000 MHz



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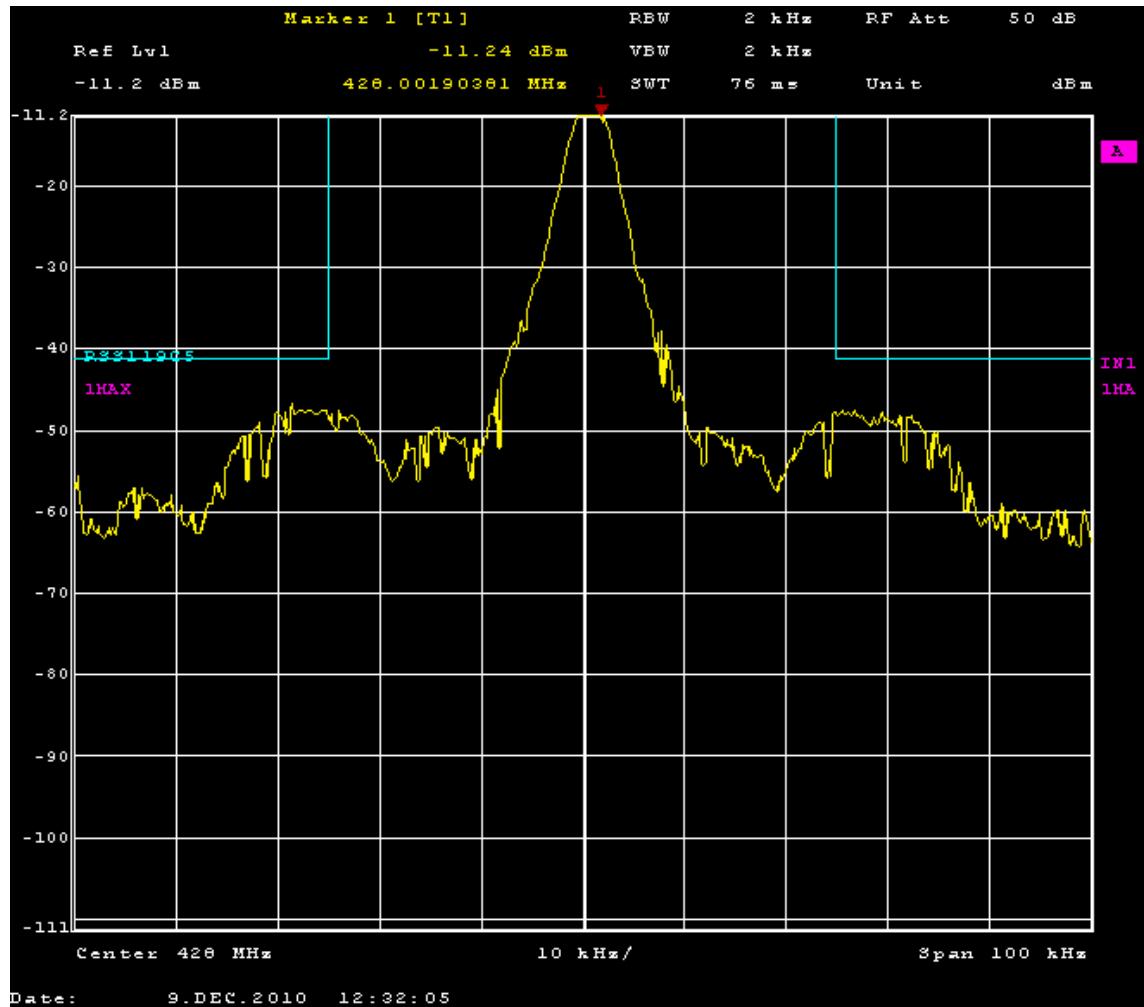
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Page 13 of 25

# EMC Technologies (NZ) Ltd

Test Report No 101207.1  
Report date: 14<sup>th</sup> December 2010

**-10.0 dBm at 428.0000 MHz**



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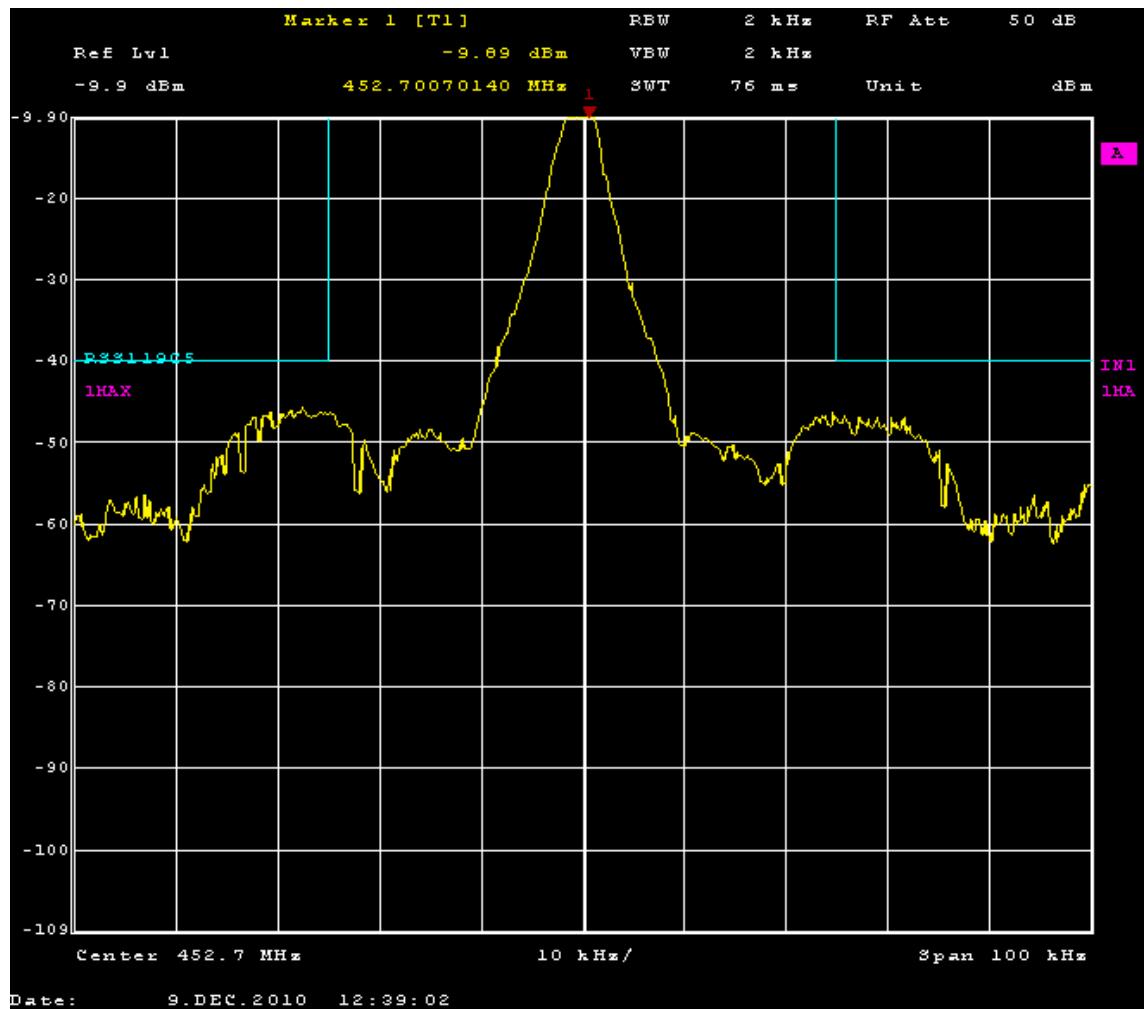
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Page 14 of 25

## EMC Technologies (NZ) Ltd

Test Report No **101207.1**  
Report date: 14<sup>th</sup> December 2010

+13.0 dBm at 452.700 MHz



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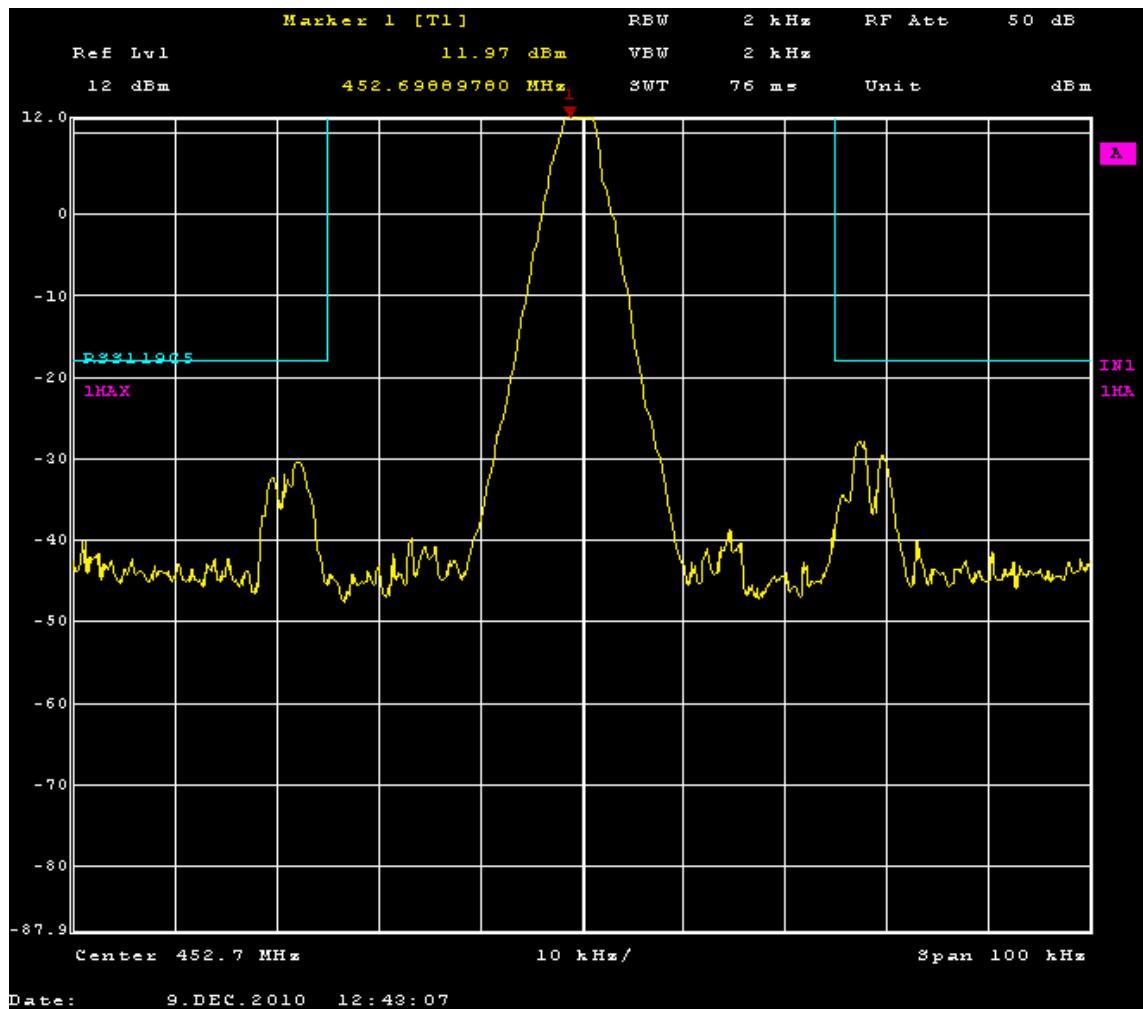
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Page 15 of 25

# EMC Technologies (NZ) Ltd

Test Report No 101207.1  
Report date: 14<sup>th</sup> December 2010

## -10.0 dBm at 452.700 MHz



### Limit:

90.217 (a) states that for equipment designed to operate with a 12.5 kHz channel bandwidth, any emission appearing on a frequency more than 25 kHz from the assigned frequency, shall be attenuated by at least 30 dB below the unmodulated carrier.

A transmitter output power of +13.0 dBm gives a limit of -17.0 dBm and a transmitter output power of -10.0 dBm gives a limit of -40.0 dBm

**Result:** Complies

**Measurement Uncertainty:**  $\pm 3.3$  dB

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Page 16 of 25

# EMC Technologies (NZ) Ltd

Test Report No 101207.1  
Report date: 14<sup>th</sup> December 2010

## Field strength of the transmitter spurious emissions

**Frequency:** 428.000 MHz at +13.0 dBm

Frequency (MHz)	Level (dBuV/m)	Level (dBm)	Limit (dBm)	Polarity	Margin (dB)
856.000	40.6	-54.6	-20.0	Vertical	34.6
856.000	38.0	-57.2	-20.0	Horizontal	37.2
1284.000	52.0	-43.2	-20.0	Vertical	23.2
1284.000	54.0	-41.2	-20.0	Horizontal	21.2
1712.000	35.0	-60.2	-20.0	Vertical	40.2
1712.000	36.5	-58.7	-20.0	Horizontal	38.7
2140.000	43.7	-51.5	-20.0	Vertical	31.5
2140.000	44.5	-50.7	-20.0	Horizontal	30.7
2568.000	-	-	-20.0	Vertical	-
2568.000	-	-	-20.0	Horizontal	-
2996.000	-	-	-20.0	Vertical	-
2996.000	-	-	-20.0	Horizontal	-
3424.000	-	-	-20.0	Vertical	-
3424.000	-	-	-20.0	Horizontal	-
3852.000	-	-	-20.0	Vertical	-
3852.000	-	-	-20.0	Horizontal	-
4280.000	-	-	-20.0	Vertical	-
4280.000	-	-	-20.0	Horizontal	-

**Frequency:** 428.000 MHz at -10.0 dBm

Frequency (MHz)	Level (dBuV/m)	Level (dBm)	Limit (dBm)	Polarity	Margin (dB)
856.000	25.8	-69.4	-40.0	Vertical	29.4
856.000	25.6	-69.6	-40.0	Horizontal	29.6
1284.000	34.2	-61.0	-40.0	Vertical	21.0
1284.000	34.6	-60.6	-40.0	Horizontal	20.6
1712.000	-	-	-40.0	Vertical	-
1712.000	-	-	-40.0	Horizontal	-
2140.000	-	-	-40.0	Vertical	-
2140.000	-	-	-40.0	Horizontal	-
2568.000	-	-	-40.0	Vertical	-
2568.000	-	-	-40.0	Horizontal	-
2996.000	-	-	-40.0	Vertical	-
2996.000	-	-	-40.0	Horizontal	-
3424.000	-	-	-40.0	Vertical	-
3424.000	-	-	-40.0	Horizontal	-
3852.000	-	-	-40.0	Vertical	-
3852.000	-	-	-40.0	Horizontal	-
4280.000	-	-	-40.0	Vertical	-
4280.000	-	-	-40.0	Horizontal	-

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Page 17 of 25

# EMC Technologies (NZ) Ltd

Test Report No 101207.1

Report date: 14<sup>th</sup> December 2010

---

**Frequency:** 452.7000 MHz at +13.0 dBm

Frequency (MHz)	Level (dBuV/m)	Level (dBm)	Limit (dBm)	Polarity	Margin (dB)
905.400	33.8	-61.4	-20.0	Vertical	41.4
905.400	36.3	-58.9	-20.0	Horizontal	38.9
1358.100	60.1	-35.1	-20.0	Vertical	15.1
1358.100	59.1	-36.1	-20.0	Horizontal	16.1
1810.800	40.3	-54.9	-20.0	Vertical	34.9
1810.800	40.6	-54.6	-20.0	Horizontal	34.6
2263.500	46.5	-48.7	-20.0	Vertical	28.7
2263.500	47.0	-48.2	-20.0	Horizontal	28.2
2716.200	44.0	-51.2	-20.0	Vertical	31.2
2716.200	45.3	-49.9	-20.0	Horizontal	29.9
3168.900	-	-	-20.0	Vertical	-
3168.900	-	-	-20.0	Horizontal	-
3621.600	-	-	-20.0	Vertical	-
3621.600	-	-	-20.0	Horizontal	-
4074.300	-	-	-20.0	Vertical	-
4074.300	-	-	-20.0	Horizontal	-
4527.000	-	-	-20.0	Vertical	-
4527.000	-	-	-20.0	Horizontal	-

**Frequency:** 452.7000 MHz at -10.0 dBm

Frequency (MHz)	Level (dBuV/m)	Level (dBm)	Limit (dBm)	Polarity	Margin (dB)
905.400	29.0	-66.2	-40.0	Vertical	26.2
905.400	26.4	-68.8	-40.0	Horizontal	28.8
1358.100	38.1	-57.1	-40.0	Vertical	17.1
1358.100	33.4	-61.8	-40.0	Horizontal	21.8
1810.800	36.0	-59.2	-40.0	Vertical	19.2
1810.800	35.8	-59.4	-40.0	Horizontal	19.4
2263.500	-	-	-40.0	Vertical	-
2263.500	-	-	-40.0	Horizontal	-
2716.200	-	-	-40.0	Vertical	-
2716.200	-	-	-40.0	Horizontal	-
3168.900	-	-	-40.0	Vertical	-
3168.900	-	-	-40.0	Horizontal	-
3621.600	-	-	-40.0	Vertical	-
3621.600	-	-	-40.0	Horizontal	-
4074.300	-	-	-40.0	Vertical	-
4074.300	-	-	-40.0	Horizontal	-
4527.000	-	-	-40.0	Vertical	-
4527.000	-	-	-40.0	Horizontal	-

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Page 18 of 25

# EMC Technologies (NZ) Ltd

Test Report No 101207.1

Report date: 14<sup>th</sup> December 2010

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No other radiated emissions were observed.

When operating in transmit mode no other emissions were detected between the harmonic emissions.

The device was tested on an open area test site at a distance of 3 metres.

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 tested while transmitting continuously into an attached dummy load.

The level recorded is the signal generator output level in dBm less any gains / losses due to the coax cable and the dipole antenna.

**Limit:**

90.217 (a) states that for equipment designed to operate with a 12.5 kHz channel bandwidth, any emission appearing on a frequency more than 25 kHz from the assigned frequency, shall be attenuated by at least 30 dB below the unmodulated carrier.

A transmitter output power of +13.0 dBm gives a limit of -17.0 dBm and a transmitter output power of -10.0 dBm gives a limit of -40.0 dBm

The spectrum was investigated up to the 10<sup>th</sup> harmonic of the transmitter.

**Result:** Complies

**Measurement Uncertainty:** ±4.1 dB

# EMC Technologies (NZ) Ltd

Test Report No 101207.1

Report date: 14<sup>th</sup> December 2010

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## Frequency Stability

Frequency stability measurements were between - 30 °C and + 50°C in 10°C increments.

At each temperature the transmitter was given a period of 30 minutes to stabilise. The transmitter was then turned on and the frequency error measured after a period of 1 minute.

Measurements were made with the supply varied between 115% and 85% of the nominal supply voltage (13.8 Vdc).

Frequency Error (Hz) – 452.700 MHz			
Temp.	11.7 Vdc	13.8 Vdc	15.9 Vdc
+50°C	-89.0	-89.0	-88.0
+40°C	-185.0	-188.0	-188.0
+30°C	-163.0	-168.0	-163.0
+20°C	-190.0	-188.0	-190.0
+10°C	-230.0	-230.0	-230.0
0°C	-230.0	-230.0	-230.0
-10°C	+10.0	+10.0	+10.0
-20°C	+30.0	+30.0	+30.0
-30°C	+100.0	+100.0	+100.0

Frequency Error (Hz) – 428.000 MHz			
Temp.	11.7 Vdc	13.8 Vdc	15.9 Vdc
+50°C	-50.0	-50.0	-50.0
+40°C	-180.0	-180.0	-180.0
+30°C	-261.0	-261.0	-261.0
+20°C	-321.0	-321.0	-321.0
+10°C	-180.0	-180.0	-180.0
0°C	-190.0	-190.0	-190.0
-10°C	+10.0	+10.0	+10.0
-20°C	+50.0	+50.0	+50.0
-30°C	+90.0	+90.0	+90.0

### Limit:

In the absence of a specified limit the stability for mobile stations less than 2 watts operating in a 12.5 kHz band plan as per Part 90.213 has been applied where the frequency stability between 421 – 512 MHz is 2.5 ppm.

Testing was carried out on 428.000 MHz. 2.5 ppm = 2.5 x 428 MHz = 1070 Hz (worst case).

**Result:** Complies

**Measurement Uncertainty:** ±30 Hz

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**EMC Technologies (NZ) Ltd**

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Page 20 of 25

# EMC Technologies (NZ) Ltd

Test Report No 101207.1

Report date: 14<sup>th</sup> December 2010

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## 8. 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	21 Dec 2011
Spectrum Analyser	R & S	ESIB 40	100171	R-27-1	21 Dec 2011
VHF Balun	Schwarzbeck	VHA 9103	-	RFS 3603	7 Feb 2011
Biconical Antenna	Schwarzbeck	BBA 9106	-	RFS 3612	7 Feb 2011
Log Periodic	Schwarzbeck	VUSLP 9111	9111-228	3785	7 Feb 2011
Horn Antenna	Electrometrics	RGA-60	6234	E1492	10 May 2011

## 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 last up dated on January, 2010.

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

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## 10. PHOTOGRAPH(S)

External views of items tested



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Page 22 of 25

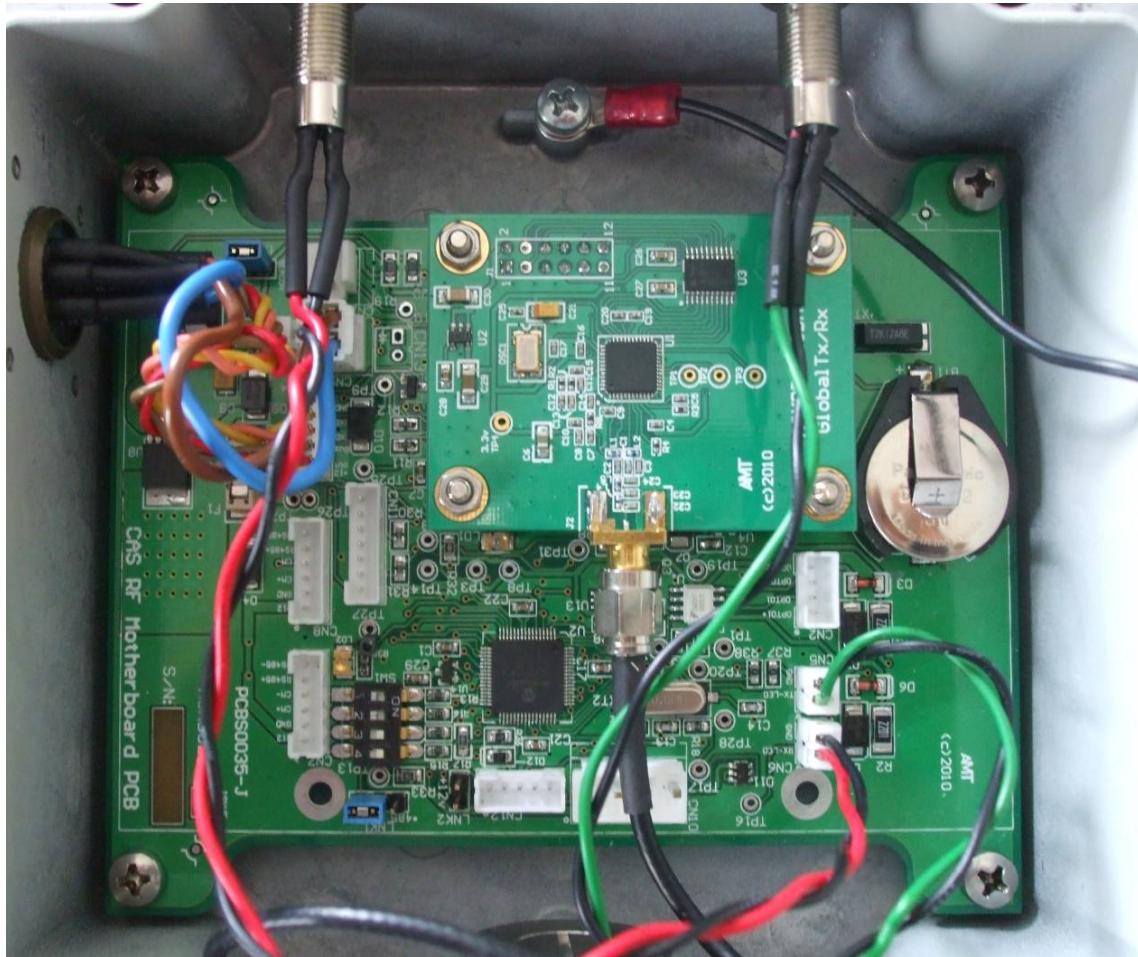
# EMC Technologies (NZ) Ltd

Test Report No 101207.1

Report date: 14<sup>th</sup> December 2010

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Internal view



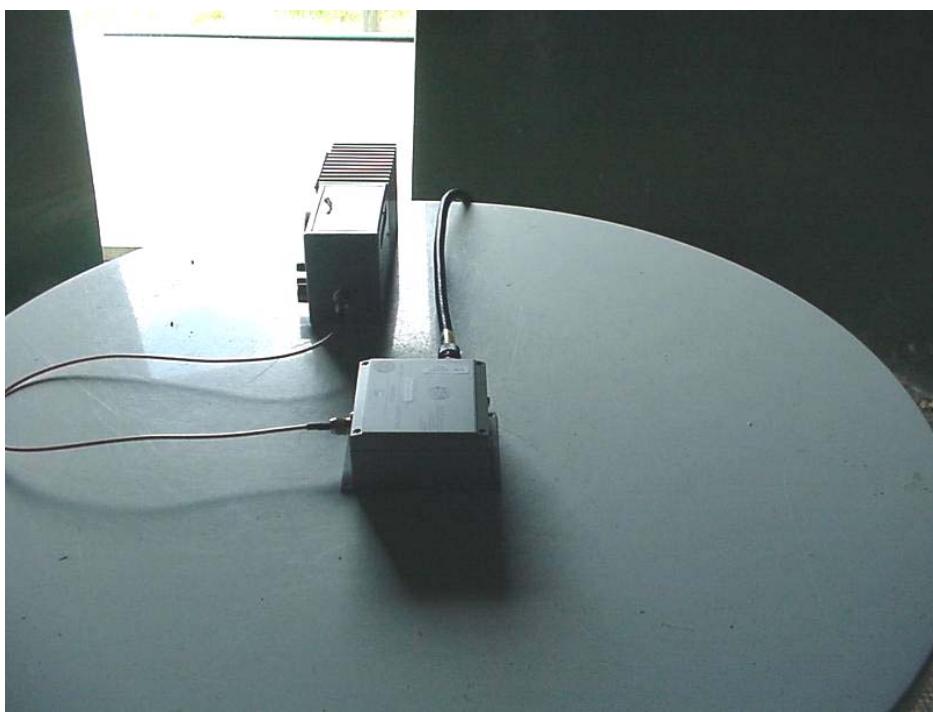
# EMC Technologies (NZ) Ltd

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Radiated emissions test set up – Dummy load on output

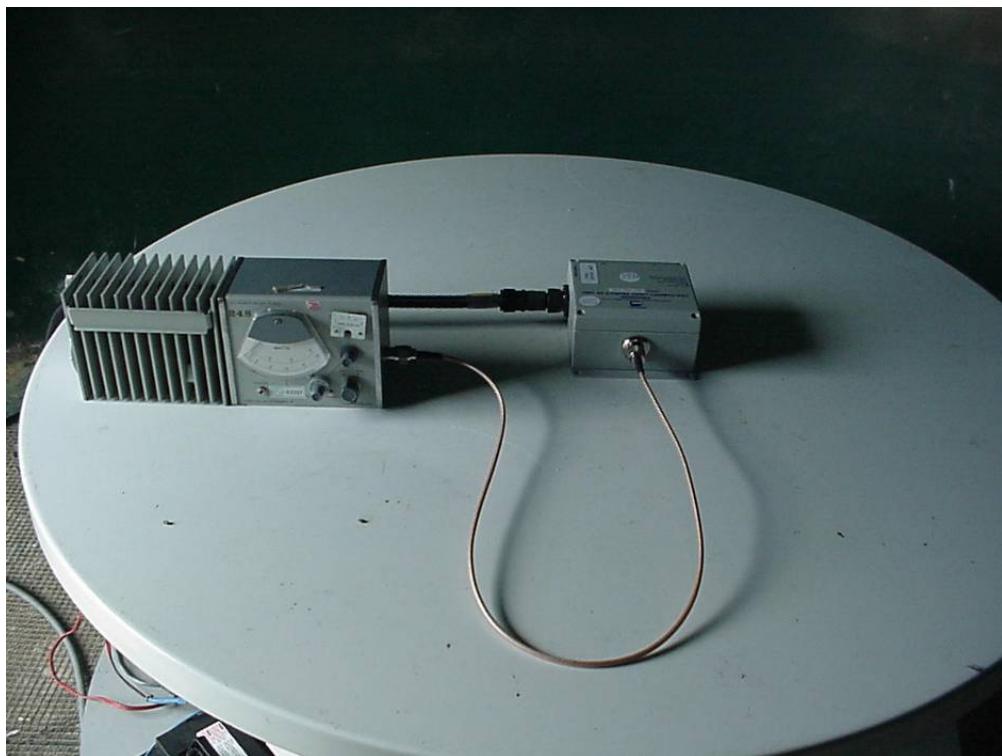


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Page 25 of 25