

EMC Technologies (NZ) Ltd

Test Report No 100526.1

Report date: 10 June 2010

TEST REPORT

CAS / CAM Global RF Collision Avoidance System Transmitter

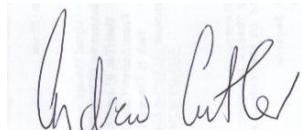
tested for compliance with the

Code of Federal Regulations (CFR) 47

Part 90 –Private Land Mobile Services

for

Advanced Mining Technologies PTY Ltd



Test Report issued by:

Andrew Cutler - General Manager



EMC Technologies (NZ) Ltd

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Page 1 of 33

EMC Technologies (NZ) Ltd

Test Report No **100526.1**

Report date: 10 June 2010

Table of Contents

1. CLIENT INFORMATION	3
2. DESCRIPTION OF TEST SAMPLE	3
3. COMPLIANCE STATEMENT & TEST RESULTS	5
4. TEST SAMPLE DESCRIPTION	6
5. TEST CONDITIONS	7
6. ATTESTATION	8
7. TRANSMITTER TEST RESULTS	9
8. TEST EQUIPMENT USED	23
9. ACCREDITATIONS	23
10. PHOTOGRAPH(S)	24

EMC Technologies (NZ) Ltd

Test Report No 100526.1

Report date: 10 June 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 Global RF
Product Collision Avoidance System Transmitter
Manufacturer AMT PTY Ltd
Designed in Australia
Manufactured in Australia
FCC ID YIY-AMTCASG1

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.

Two versions of this transmitter were tested with identical transmitter results obtained.

The versions of the transmitter tested were identified as follows:

EMC Technologies (NZ) Ltd

Test Report No **100526.1**

Report date: 10 June 2010

- AMT CAS Heavy Vehicle System that consisted of the following
 - 6 x PROD0118 Colour Camera Units
 - PROD0119 Colour LCD Display
 - PROD0161 CAS Expansion Unit
 - PROD0169 Heavy Vehicle Rear RF Unit. Serial no# 1694 1002 0171
- AMT CAS Light Vehicle System that consisted of the following
 - PROD0711 Light Vehicle Dash Alarm
 - PROD0295 Light Vehicle RF Unit. Serial no# 2963 0904 0185

The transmitter module in each of this RF units is identical with the main difference between the samples being the type and number of ports provided with the device.

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 and with the antenna connected to confirm the radiated power from the system.

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:

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 100526.1

Report date: 10 June 2010

3. COMPLIANCE STATEMENT & TEST RESULTS

The **CAS / CAM Global RF Collision Avoidance System** 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.

<u>CLAUSE</u>	<u>TEST PERFORMED</u>	<u>RESULT</u>
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 **100526.1**

Report date: 10 June 2010

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, 452.1250 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 kbaud and the RC alpha is 0.5.

Emission designator

F2D

Power Supply

External DC voltage supply. Typically 13.8 Vdc

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EMC Technologies (NZ) Ltd

Test Report No **100526.1**

Report date: 10 June 2010

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

High Voltage: 11.7 Vdc
Low Voltage: 15.9 Vdc

EMC Technologies (NZ) Ltd

Test Report No 100526.1

Report date: 10 June 2010

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.

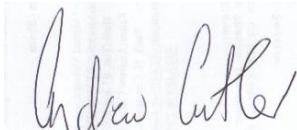
The report relates only to the sample tested.

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 **100526.1**

Report date: 10 June 2010

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 100526.1

Report date: 10 June 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	12.1
428.000	13.8	13.0	12.1
428.000	15.9	13.0	12.1

0.01 mW setting (-10 dBm)

Frequency (MHz)	Voltage (Vdc)	Rated (dBm)	Measured (dBm)
428.000	11.7	-10.0	-10.5
428.000	13.8	-10.0	-10.5
428.000	15.9	-10.0	-10.5

20 mW setting (+13 dBm)

Frequency (MHz)	Voltage (Vdc)	Rated (dBm)	Measured (dBm)
452.700	11.7	13.0	12.4
452.700	13.8	13.0	12.4
452.700	15.9	13.0	12.4

0.01 mW setting (-10 dBm)

Frequency (MHz)	Voltage (Vdc)	Rated (dBm)	Measured (dBm)
452.700	11.7	-10.0	-10.1
452.700	13.8	-10.0	-10.1
452.700	15.9	-10.0	-10.1

Measurements were made to confirm that the radiated power was less than 120 mW (+20.8 dBm) when the whip antenna, which has a gain of 5 dBi, was attached.

Measurements were made at the open area test site over a distance of 3 metres.

EMC Technologies (NZ) Ltd

Test Report No 100526.1

Report date: 10 June 2010

+13.0 dBm power output setting

Frequency (MHz)	Level (dBuV/m)	Level (dBm)	Limit (dBm)	Antenna	Margin (dB)
428.0000	112.6	17.4	20.8	Vertical	3.4
428.0000	102.4	7.2	20.8	Horizontal	13.6
452.7000	111.4	16.2	20.8	Vertical	4.6
452.7000	101.1	5.9	20.8	Horizontal	14.9

-10.0 dBm power output setting

Frequency (MHz)	Level (dBuV/m)	Level (dBm)	Limit (dBm)	Antenna	Margin (dB)
428.0000	91.6	-3.6	20.8	Vertical	24.4
428.0000	81.1	-14.1	20.8	Horizontal	34.9
452.7000	90.0	-5.2	20.8	Vertical	26.0
452.7000	77.3	-17.9	20.8	Horizontal	38.7

Testing was carried out using a spectrum analyser operating in peak hold mode using a resolution bandwidth of 1 MHz.

The spectrum analyser was connected directly to the output of the transmitter with a correction factor being applied to the observed levels to allow for the loss in the coax cable.

The transmitter was operated continuously with modulation applied.

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: ±0.5 dB

EMC Technologies (NZ) Ltd

Test Report No 100526.1

Report date: 10 June 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 in peak hold mode.

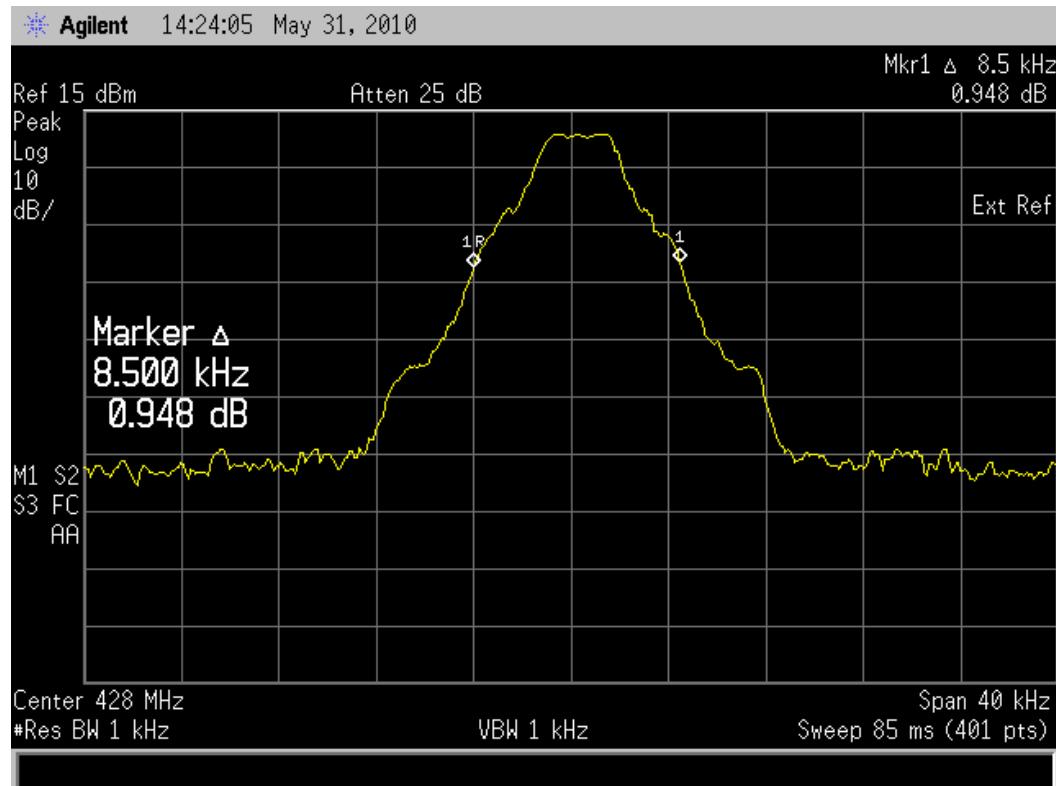
Initially power measurements are made using a resolution bandwidth of 120 kHz.

This level is used as a reference level on the spectrum analyser.

The resolution bandwidth is then changed to 1 kHz and the reference level minus 23 dB (99%) absolute bandwidth points determined.

It was found that the power level at 120 kHz and at 1 kHz were the same hence 1 kHz has been used.

Emission	Channel Spacing	Measured	Designation
F2D	12.5 kHz	8.500 kHz	8k50F2D



EMC Technologies (NZ) Ltd

Test Report No 100526.1

Report date: 10 June 2010

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	-52.1	-63.5
1284.000	-43.3	-59.9
1712.000	-54.0	-69.4
2140.000	-46.0	-62.3
2568.000	-57.5	-74.9
3000.000	-57.2	-75.0
3424.000	-58.3	-78.3
3852.000	-54.0	-84.0
4280.000	-65.4	-78.0

Frequency: 452.700 MHz

Spurious emission (MHz)	+13 dBm levels (dBm)	-10 dBm levels (dBm)
905.4000	-44.5	-68.7
1358.1000	-43.1	-61.4
1810.7750	-54.9	-75.7
2263.5000	-46.2	-63.3
2716.2250	-59.6	-74.7
3168.9000	-56.2	-74.1
3621.6000	-69.2	-80.8
4074.3000	-56.8	-74.8
4527.0000	-66.4	-80.9

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.

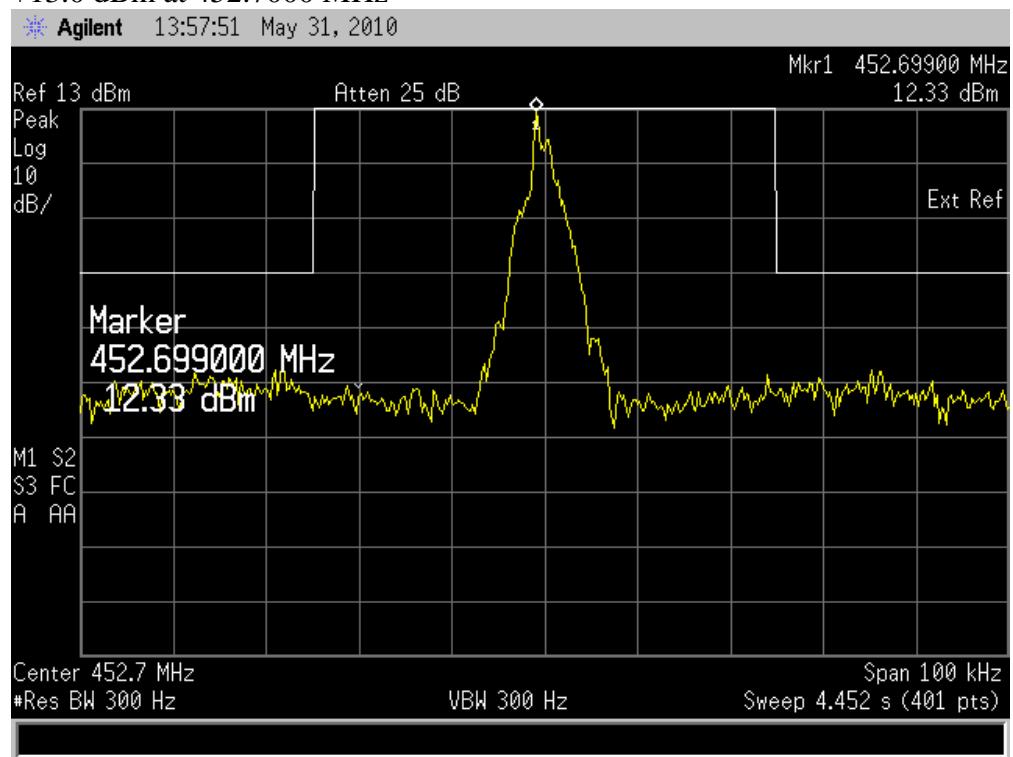
A resolution bandwidth of 300 Hz has been applied a limit of -30 dBc has been utilised.

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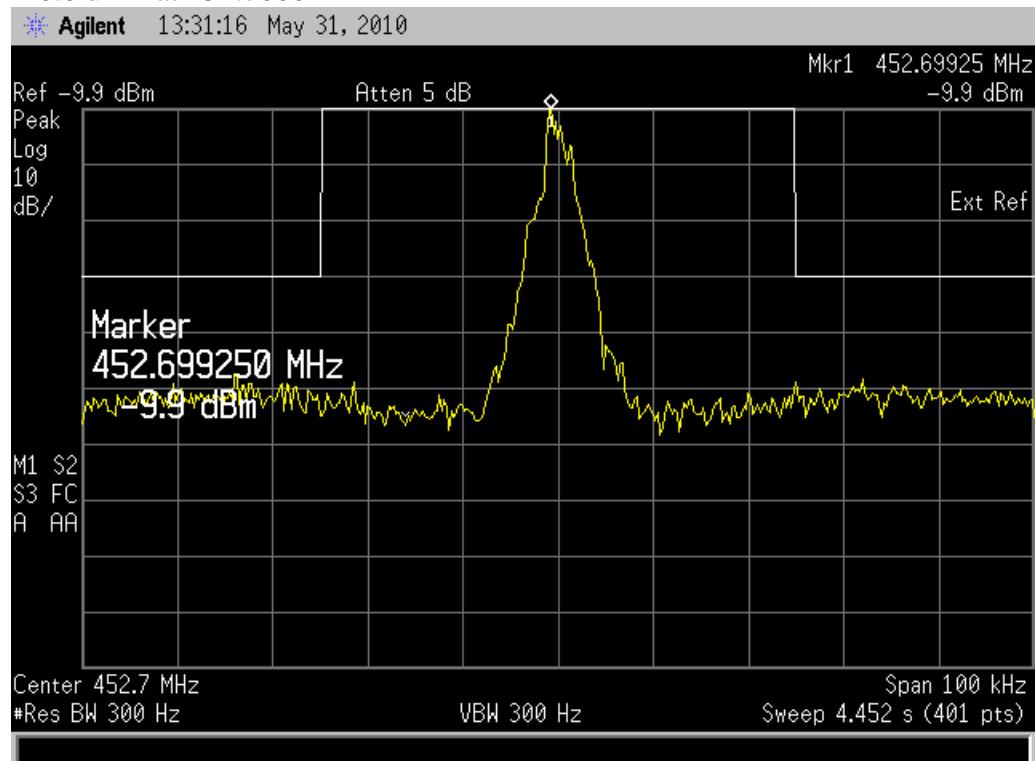
Test Report No 100526.1

Report date: 10 June 2010

+13.0 dBm at 452.7000 MHz



-10.0 dBm at 452.7000 MHz

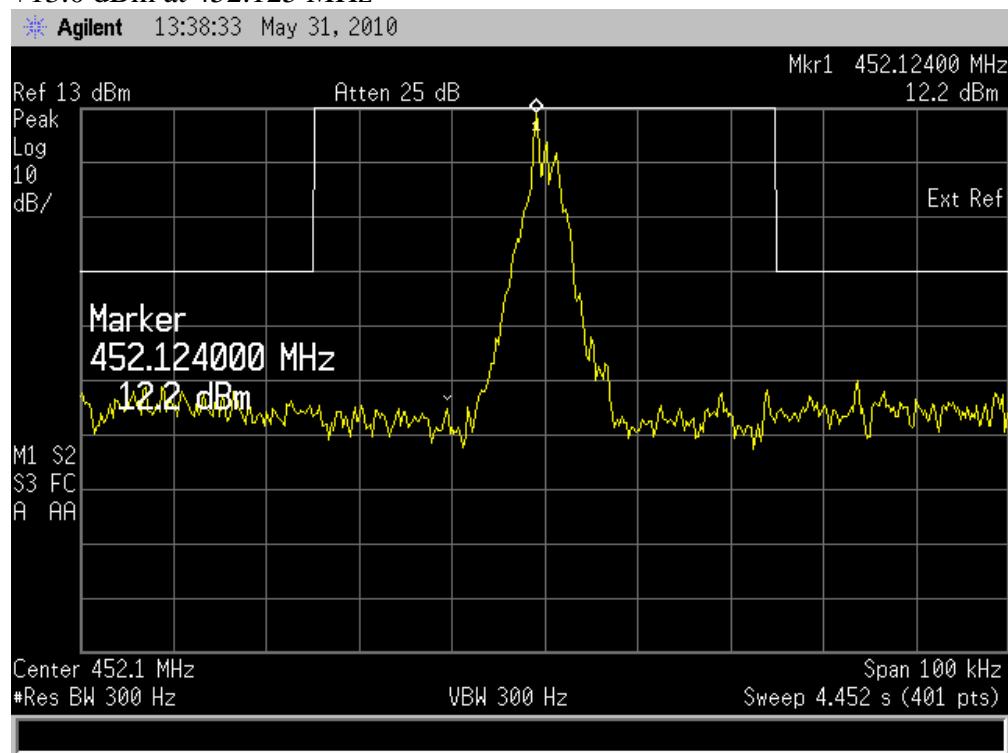


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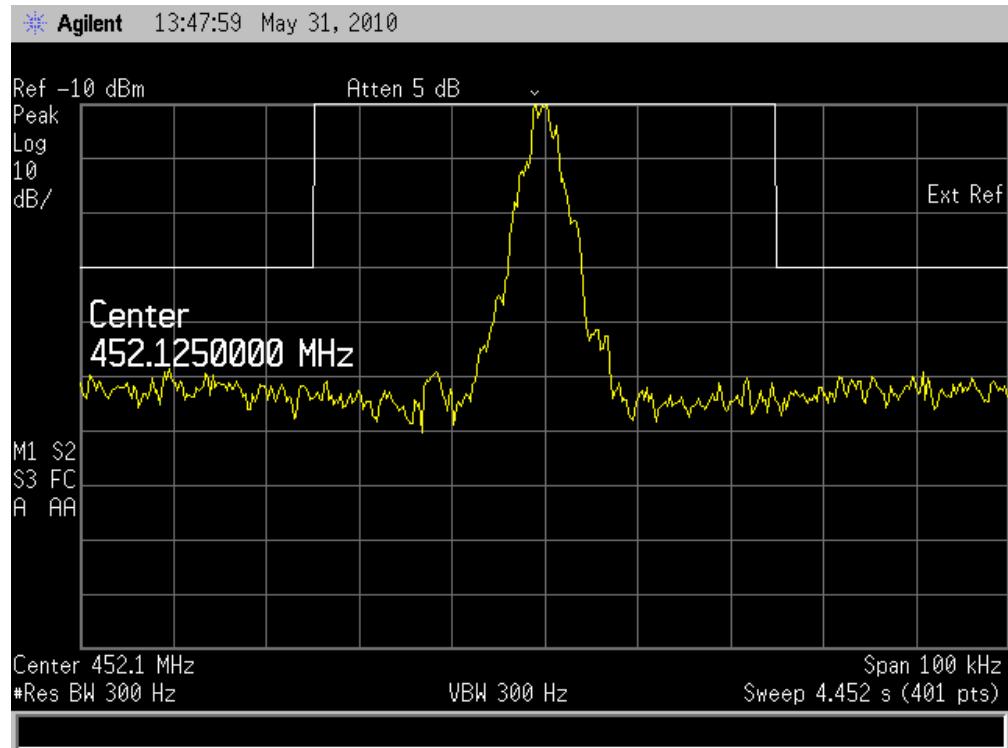
Test Report No 100526.1

Report date: 10 June 2010

+13.0 dBm at 452.125 MHz



-10 dBm at 452.125 MHz

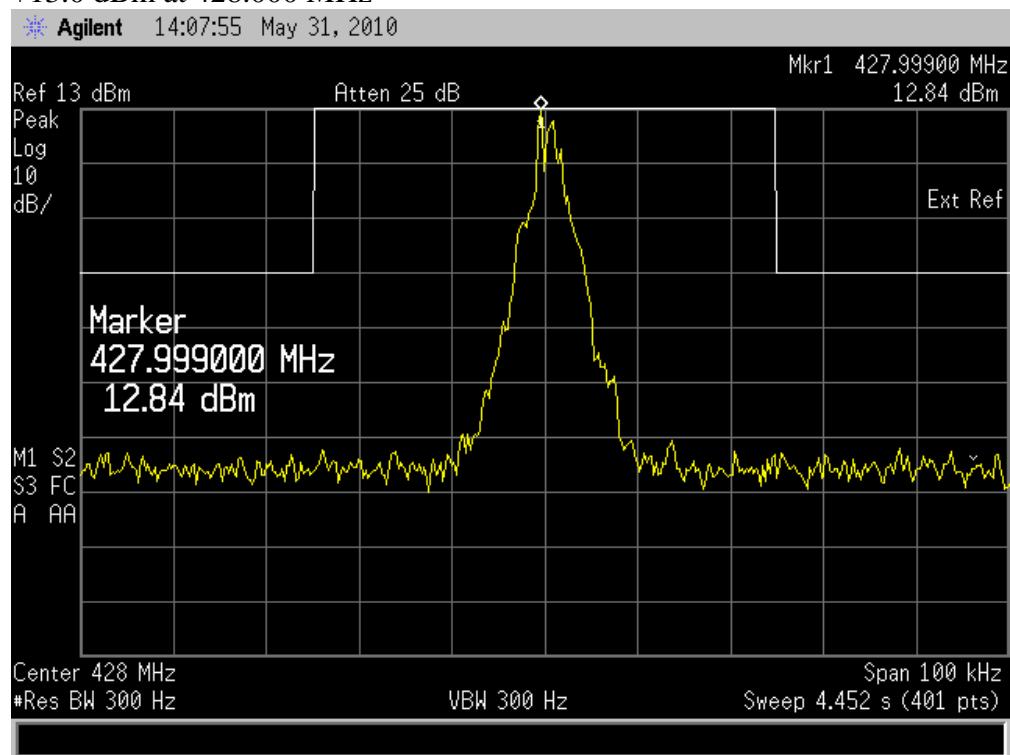


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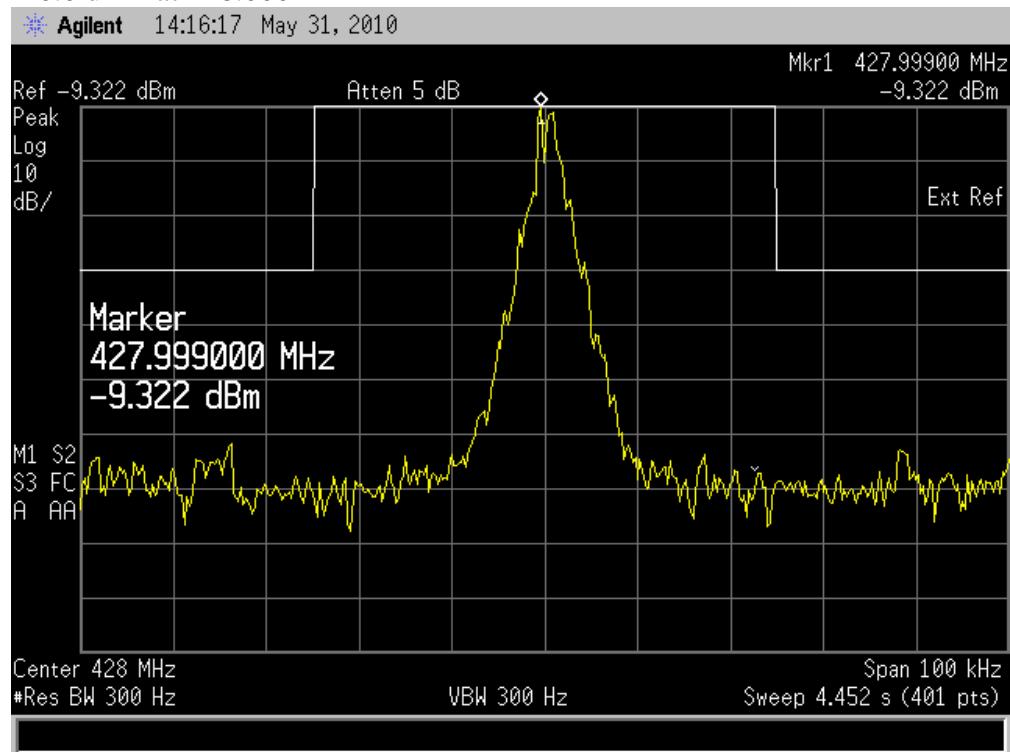
Test Report No 100526.1

Report date: 10 June 2010

+13.0 dBm at 428.000 MHz



-10.0 dBm at 428.000 MHz



EMC Technologies (NZ) Ltd

Test Report No **100526.1**

Report date: 10 June 2010

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: ± 3.3 dB

EMC Technologies (NZ) Ltd

Test Report No 100526.1

Report date: 10 June 2010

Field strength of the transmitter spurious emissions

Frequency: 428.000 MHz at +13.0 dBm

Frequency (MHz)	Level (dBuV/m)	Power (dBm)	Limit (dBm)	Polarity	Margin (dB)
856.0000	30.6	-64.6	-17.0	Vertical	47.6
856.0000	29.2	-66.0	-17.0	Horizontal	49.0
1284.0000	52.7	-42.5	-17.0	Vertical	25.5
1284.0000	54.5	-40.7	-17.0	Horizontal	23.7
1712.0000	33.9	-61.3	-17.0	Vertical	44.3
1712.0000	31.6	-63.6	-17.0	Horizontal	46.6
2140.0000	37.4	-57.8	-17.0	Vertical	40.8
2140.0000	36.9	-58.3	-17.0	Horizontal	41.3
2568.0000	-	-	-17.0	Vertical	-
2568.0000	-	-	-17.0	Horizontal	-
2996.0000	-	-	-17.0	Vertical	-
2996.0000	-	-	-17.0	Horizontal	-
3424.0000	-	-	-17.0	Vertical	-
3424.0000	-	-	-17.0	Horizontal	-
3852.0000	-	-	-17.0	Vertical	-
3852.0000	-	-	-17.0	Horizontal	-
4280.0000	-	-	-17.0	Vertical	-
4280.0000	-	-	-17.0	Horizontal	-

Frequency: 428.000 MHz at -10.0 dBm

Frequency (MHz)	Level (dBuV/m)	Power (dBm)	Limit (dBm)	Polarity	Margin (dB)
856.0000	21.2	-74.0	-40.0	Vertical	34.0
856.0000	20.8	-74.4	-40.0	Horizontal	34.4
1284.0000	33.8	-61.4	-40.0	Vertical	21.4
1284.0000	32.5	-62.7	-40.0	Horizontal	22.7
1712.0000	29.6	-65.6	-40.0	Vertical	25.6
1712.0000	28.7	-66.5	-40.0	Horizontal	26.5
2140.0000	35.9	-59.3	-40.0	Vertical	19.3
2140.0000	38.1	-57.1	-40.0	Horizontal	17.1
2568.0000	-	-	-40.0	Vertical	-
2568.0000	-	-	-40.0	Horizontal	-
2996.0000	-	-	-40.0	Vertical	-
2996.0000	-	-	-40.0	Horizontal	-
3424.0000	-	-	-40.0	Vertical	-
3424.0000	-	-	-40.0	Horizontal	-
3852.0000	-	-	-40.0	Vertical	-
3852.0000	-	-	-40.0	Horizontal	-
4280.0000	-	-	-40.0	Vertical	-
4280.0000	-	-	-40.0	Horizontal	-

EMC Technologies (NZ) Ltd

Test Report No 100526.1

Report date: 10 June 2010

Frequency: 452.7000 MHz at +13.0 dBm

Frequency (MHz)	Level (dBuV/m)	Power (dBm)	Limit (dBm)	Polarity	Margin (dB)
905.4000	33.1	-62.1	-17.0	Vertical	45.1
905.4000	30.3	-64.9	-17.0	Horizontal	47.9
1358.1000	54.8	-40.4	-17.0	Vertical	23.4
1358.1000	54.5	-40.7	-17.0	Horizontal	23.7
1810.8000	36.5	-58.7	-17.0	Vertical	41.7
1810.8000	40.8	-54.4	-17.0	Horizontal	37.4
2263.5000	39.6	-55.6	-17.0	Vertical	38.6
2263.5000	39.5	-55.7	-17.0	Horizontal	38.7
2716.2000	38.5	-56.7	-17.0	Vertical	39.7
2716.2000	39.9	-55.3	-17.0	Horizontal	38.3
3168.9000	-	-	-17.0	Vertical	-
3168.9000	-	-	-17.0	Horizontal	-
3621.6000	-	-	-17.0	Vertical	-
3621.6000	-	-	-17.0	Horizontal	-
4074.3000	-	-	-17.0	Vertical	-
4074.3000	-	-	-17.0	Horizontal	-
4527.0000	-	-	-17.0	Vertical	-
4527.0000	-	-	-17.0	Horizontal	-

Frequency: 452.7000 MHz at -10.0 dBm

Frequency (MHz)	Level (dBuV/m)	Power (dBm)	Limit (dBm)	Polarity	Margin (dB)
905.4000	24.7	-70.5	-40.0	Vertical	30.5
905.4000	25.4	-69.8	-40.0	Horizontal	29.8
1358.1000	33.6	-61.6	-40.0	Vertical	21.6
1358.1000	33.4	-61.8	-40.0	Horizontal	21.8
1810.8000	31.9	-63.3	-40.0	Vertical	23.3
1810.8000	31.5	-63.7	-40.0	Horizontal	23.7
2263.5000	39.3	-55.9	-40.0	Vertical	15.9
2263.5000	39.2	-56.0	-40.0	Horizontal	16.0
2716.2000	39.3	-55.9	-40.0	Vertical	15.9
2716.2000	38.5	-56.7	-40.0	Horizontal	16.7
3168.9000	-	-	-40.0	Vertical	-
3168.9000	-	-	-40.0	Horizontal	-
3621.6000	-	-	-40.0	Vertical	-
3621.6000	-	-	-40.0	Horizontal	-
4074.3000	-	-	-40.0	Vertical	-
4074.3000	-	-	-40.0	Horizontal	-
4527.0000	-	-	-40.0	Vertical	-
4527.0000	-	-	-40.0	Horizontal	-

EMC Technologies (NZ) Ltd

Test Report No 100526.1

Report date: 10 June 2010

Other radiated emissions observed.

Frequency (MHz)	Level (dBuV/m)	Power (dBm)	Limit (dBm)	Polarity	Margin (dB)
54.035	34.5	-60.7	-40.0	Vertical	20.7
54.035	28.1	-67.1	-40.0	Horizontal	27.1
60.000	26.7	-68.5	-40.0	Vertical	28.5
141.150	25.0	-70.2	-40.0	Horizontal	30.2
567.352	32.5	-62.7	-40.0	Horizontal	22.7
567.352	34.3	-60.9	-40.0	Horizontal	20.9
621.388	42.1	-53.1	-40.0	Vertical	13.1
621.388	32.8	-62.4	-40.0	Horizontal	22.4
675.422	38.1	-57.1	-40.0	Vertical	17.1
675.422	31.9	-63.3	-40.0	Horizontal	23.3
729.453	33.4	-61.8	-40.0	Vertical	21.8
783.489	34.7	-60.5	-40.0	Vertical	20.5
837.525	36.3	-58.9	-40.0	Vertical	18.9
891.554	36.9	-58.3	-40.0	Vertical	18.3
891.554	32.7	-62.5	-40.0	Horizontal	22.5
945.590	36.7	-58.5	-40.0	Vertical	18.5
945.590	38.3	-56.9	-40.0	Horizontal	16.9
999.626	40.1	-55.1	-40.0	Horizontal	15.1

The level of these emissions was the same regardless of whether the transmitter was operating at +13 dBm or -10 dBm.

Therefore the -40.0 dBm lower limit has been applied as the transmitter is operating continuously.

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

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 power level of each emission was determined by replacing the transmitter with a dipole antenna that was connected to a signal generator.

EMC Technologies (NZ) Ltd

Test Report No **100526.1**

Report date: 10 June 2010

The signal generator output level was increased until the same field strength level was observed at each emission frequency.

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 10th harmonic of the transmitter.

Result: Complies

Measurement Uncertainty: ± 4.1 dB

EMC Technologies (NZ) Ltd

Test Report No 100526.1

Report date: 10 June 2010

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).

Temp.	Frequency Error (Hz) – 452.700 MHz		
	11.7 Vdc	13.8 Vdc	15.9 Vdc
+50°C	-88.0	-88.0	-88.0
+40°C	-188.0	-188.0	-188.0
+30°C	-163.0	-163.0	-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

Temp.	Frequency Error (Hz) – 428.000 MHz		
	11.7 Vdc	13.8 Vdc	15.9 Vdc
+50°C	-50.0	-50.0	-50.0
+40°C	-180	-180	-180
+30°C	-261	-261	-261
+20°C	-321	-321	-321
+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

EMC Technologies (NZ) Ltd

Test Report No 100526.1

Report date: 10 June 2010

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	ESHS 10	828404/005	3728	21 Aug 2010
Mains Network	R & S	ESH2-Z5	881362/032	3628	21 Aug 2010
Receiver	R & S	ESCS 30	847124/020	E1595	21 Feb 2011
Receiver	R & S	ESIB 40	100171	R-27-1	21 Aug 2010
Spectrum Analyser	Hewlett Packard	E7405A	US39150142	3771	20 April 2011
Microwave Preamp	Hewlett Packard	8349B	2644A01659	-	20 April 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 updated 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.

EMC Technologies (NZ) Ltd

Test Report No 100526.1

Report date: 10 June 2010

10. PHOTOGRAPH(S)

External views of items tested



EMC Technologies (NZ) Ltd

Test Report No 100526.1

Report date: 10 June 2010



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Page 25 of 33

EMC Technologies (NZ) Ltd

Test Report No 100526.1

Report date: 10 June 2010



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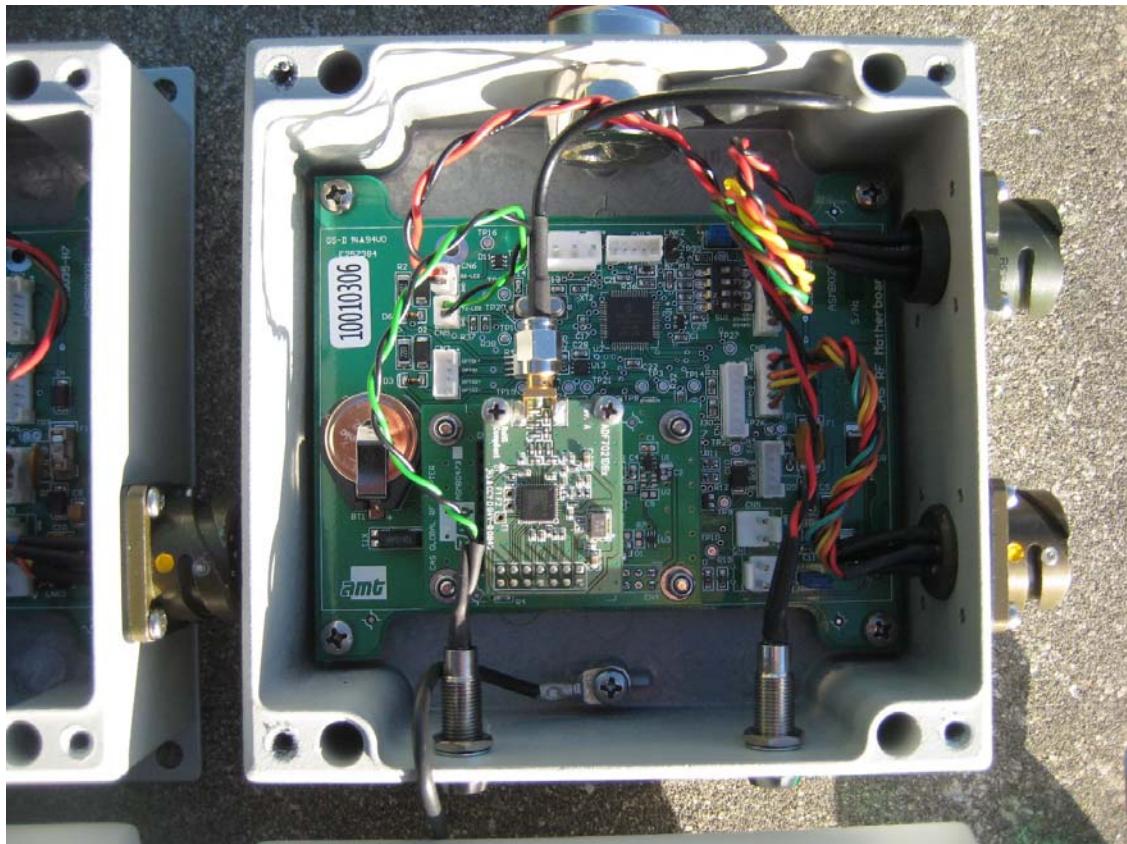
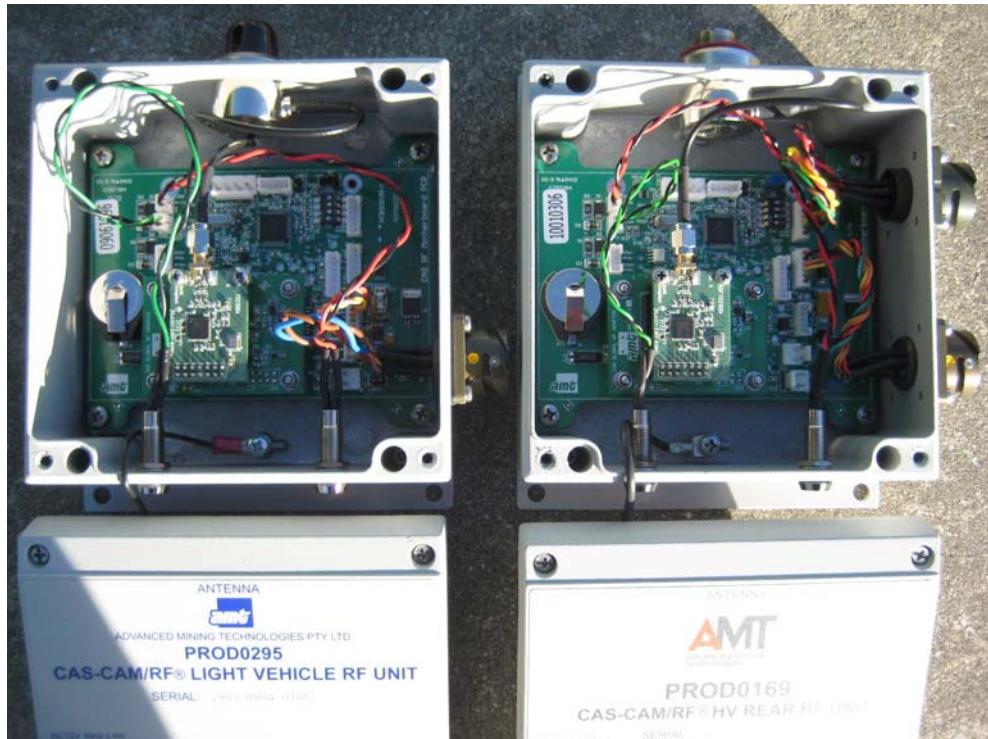
Page 26 of 33

EMC Technologies (NZ) Ltd

Test Report No 100526.1

Report date: 10 June 2010

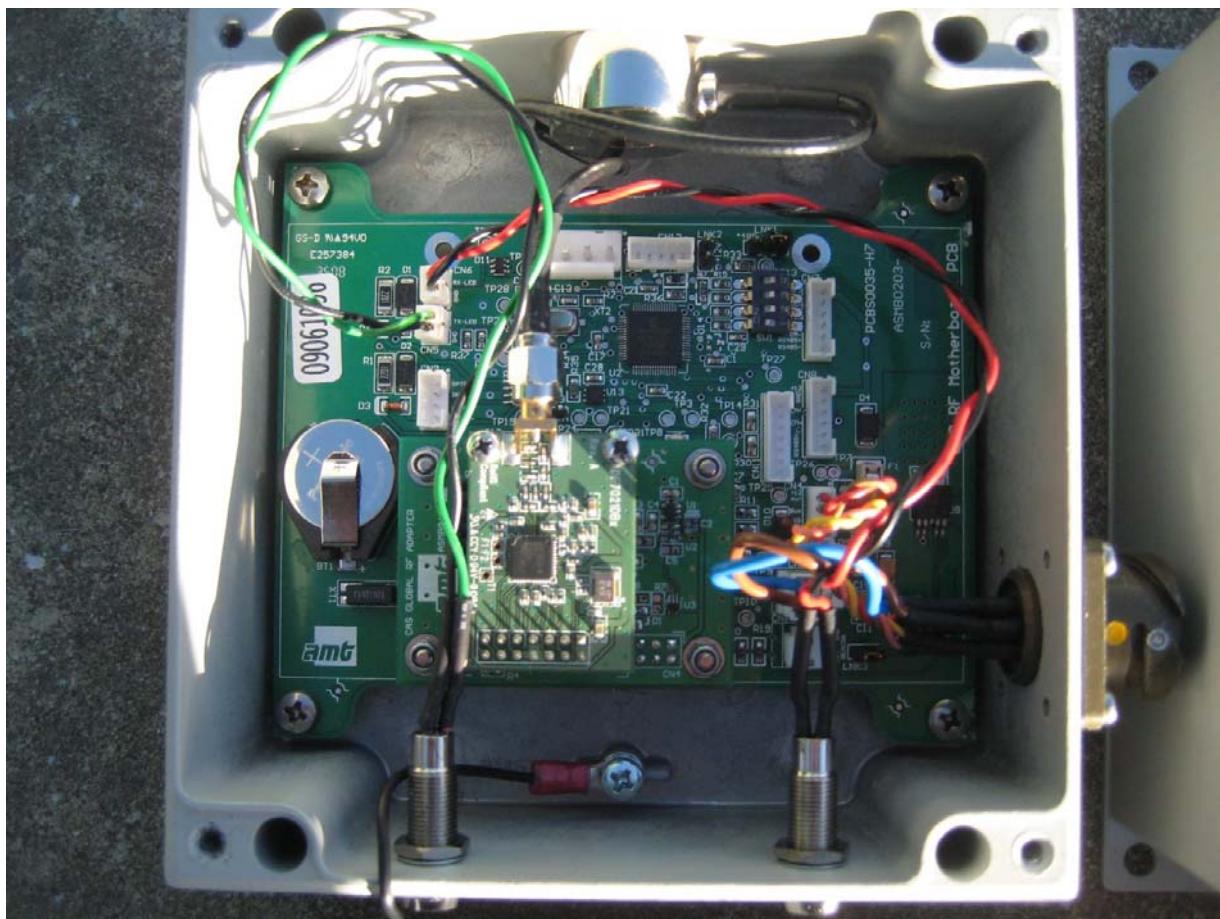
Internal views



EMC Technologies (NZ) Ltd

Test Report No 100526.1

Report date: 10 June 2010

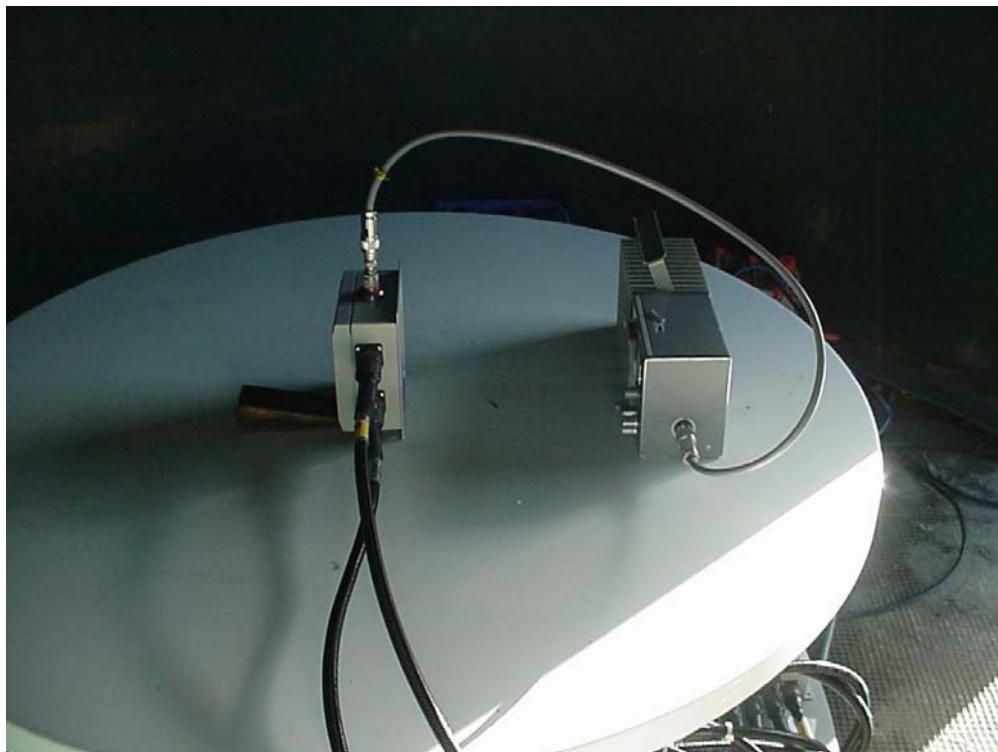
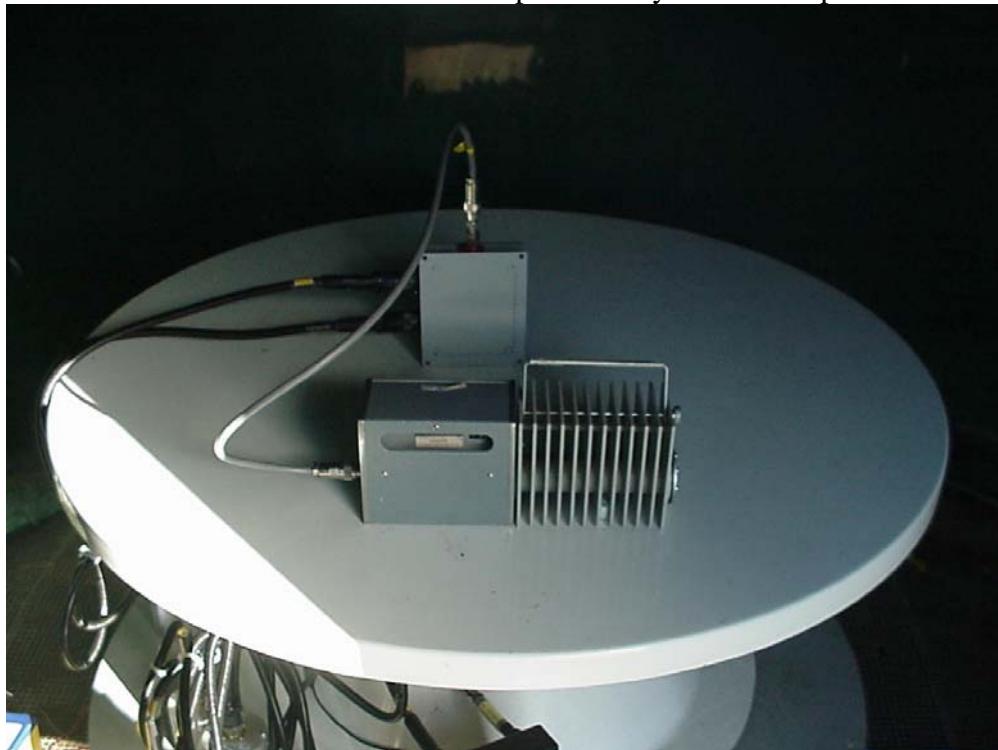


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Test Report No 100526.1

Report date: 10 June 2010

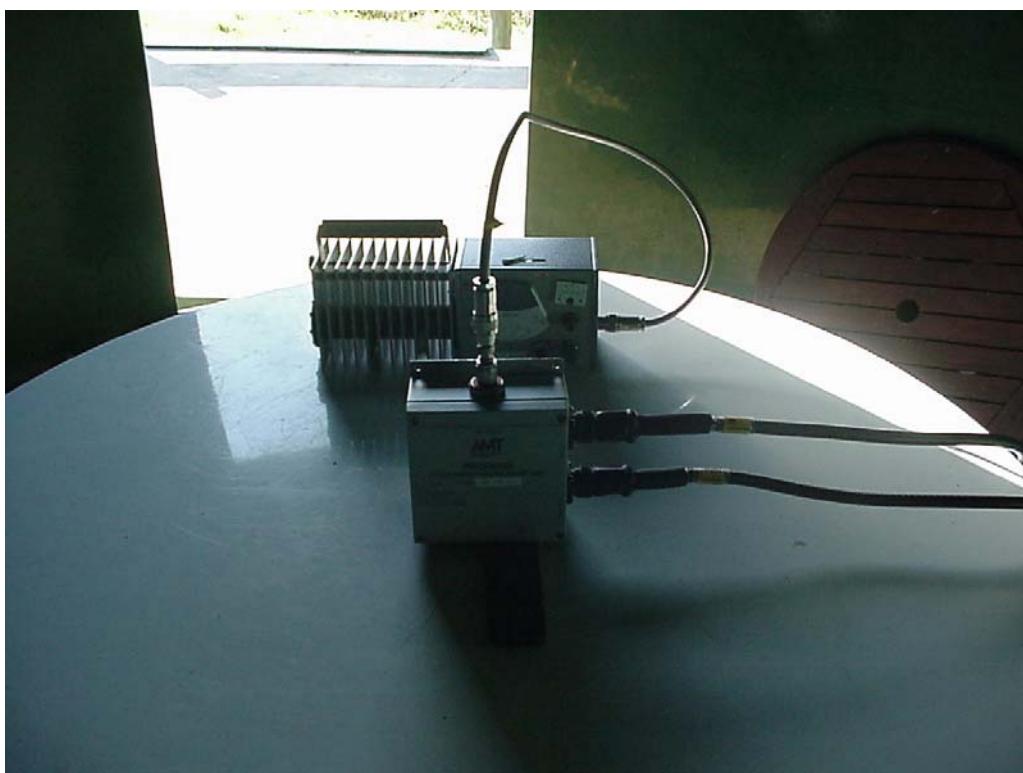
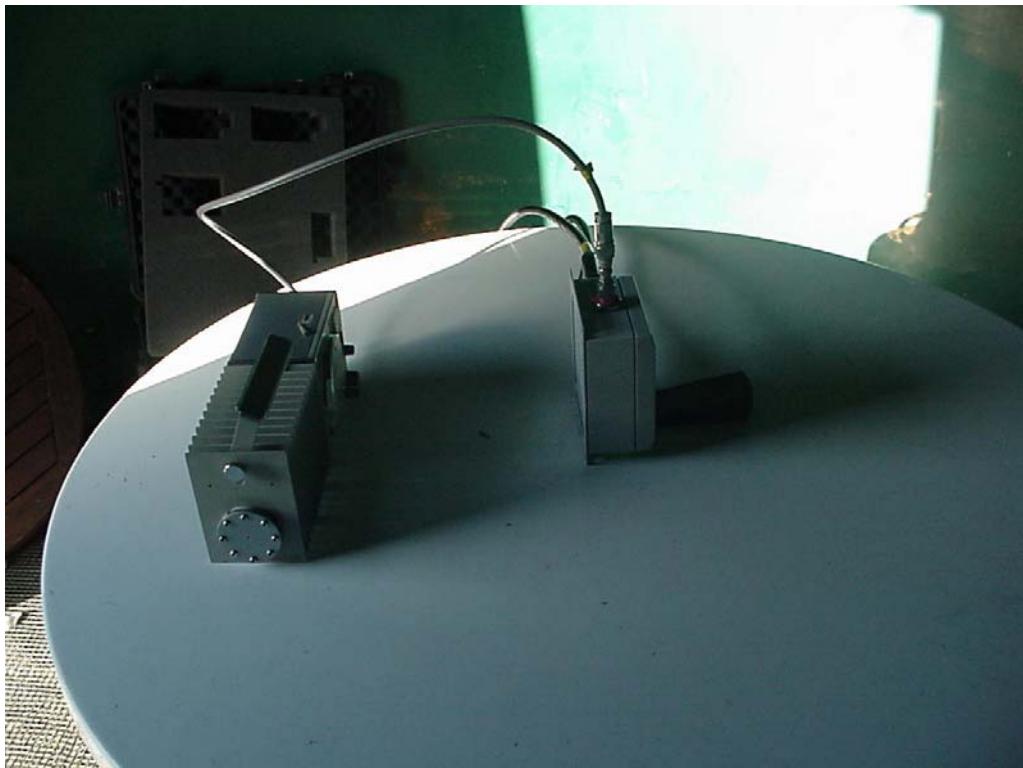
Radiated emissions test set up – Dummy load on output



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Test Report No 100526.1

Report date: 10 June 2010



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Report date: 10 June 2010

Radiated emissions test set up – Whip antenna on output



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Page 31 of 33

EMC Technologies (NZ) Ltd

Test Report No 100526.1

Report date: 10 June 2010



EMC Technologies (NZ) Ltd

Test Report No 100526.1

Report date: 10 June 2010

