

# EMC Technologies (NZ) Ltd

Test Report No **100901.1**  
Report date: 5 October 2010

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## TEST REPORT

**ELPRO 315-WH-GT-G 802.15.4 Radio  
with bridge to 802.3 and 802.11b/g or 802.11a**

*tested to*

**47 Code of Federal Regulations**

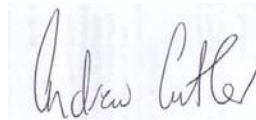
**Part 15 - Radio Frequency Devices**

**Subpart C – Intentional Radiators**

**Section 15.247 – Operation in the band 2400 – 2483.5 MHz**

*for*

**ELPRO Technologies PTY Ltd**



This Test Report is issued with the authority of:

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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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**EMC Technologies (NZ) Ltd**

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## 1. STATEMENT OF COMPLIANCE

The **ELPRO 315-WH-GT-G 802.15.4 Radio with bridge to 802.3 and 802.11b/g or 802.11a** complies with FCC Part 15 Subpart C as an Intentional Radiator when the methods as described in ANSI C63.4 - 2003 are applied.

## 2. RESULTS SUMMARY

The results from testing are summarised in the following table:

Clause	Parameter	Result
15.109	Digital device radiated emission limits	Complies
15.201	Equipment authorisation requirement	Certification required
15.203	Antenna requirement	Complies
15.204	External PA and antenna modifications	Complies
15.205	Restricted bands of operation	Complies
15.207	Conducted limits	Complies
15.209	Radiated emission limits	Complies
15.247		
(a)(2)	Minimum 6 dB bandwidth	Complies
(b)(3)	Peak output power	Complies
(c)	Directional antenna gains greater than 6 dBi	Not applicable
(d)	Out of band emissions	Complies
(e)	Power spectral density	Complies
(f)	Hybrid systems	Not applicable
(g)	Use of all channels	Not applicable
(h)	Intelligent frequency hopping	Not applicable
(i)	Radio frequency hazards	Complies

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## 3. INTRODUCTION

This report describes the tests and measurements performed for the purpose of determining compliance with the specification.

**The client selected the test sample.**

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

**This report contains no 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.

## 4. CLIENT INFORMATION

<b>Company Name</b>	ELPRO Technologies PTY Ltd
<b>Address</b>	9/12 Billabong Street Stafford
<b>State</b>	Queensland
<b>Country</b>	Australia
<b>Contact</b>	Mr Scott Bowman

## 5. DESCRIPTION OF TEST SAMPLE

<b>Brand Name</b>	ELPRO
<b>Model Number</b>	315-WH-GT-G
<b>Product</b>	802.15.4 Radio with bridge to 802.3 and 802.11b/g or 802.11a
<b>Manufacturer</b>	ELPRO Technologies PTY Ltd
<b>Country of Origin</b>	Australia
<b>Serial Number</b>	06101090721
<b>FCC ID</b>	O9P-315WH

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## Device description

The 315-WH-GT is a stand alone unit designed for industrial applications.

Its primary function is to act as a router or bridge between 802.15.4 (Wi-HART) and 802.11b/g (WiFi) or 802.11a (WiFi) and 802.3 (cable) Ethernet networks.

It is powered from a 12-24VDC supply or from AC mains using a plug pack.

It has a single digital IO. The product also provides a method for connecting to RS-485 devices remotely.

The product consists of a microcontroller core, and a secondary microcontroller board providing the 802.15.4 communication function.

The main microcontroller core provides four (4) communications ports and one discrete I/O port as follows:

1 Ethernet (802.3) port (Max 3m Cable)

1 RS-232 serial port (Max 3m Cable)

1 RS-485 port (Communication)

1 mini-PCI port using Ubiquiti-Networks 802.11 LAN card (two antenna connectors).

1 Discrete I/O port (Single wire connection to ground Max 3m Cable)

The secondary microcontroller board provides a single 802.15.4 antenna connection port.

The product is housed in a metal enclosure approximately 150mm(H) x 120mm(W) x 60mm(D).

Connectors for power and 802.3, RS485 and RS232 ports are on one end.

LED Indicators are on the top of the product, on the 802.3 connector and two on the antenna end.

Two SMA connectors on one end edge provide connection for the 802.11 antennas.

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The Wireless LAN card is housed inside the product.

Two different models of 802.11 (Ubiquiti-Networks) Wireless LAN cards will be offered, depending on the RF band to be used.

These will be designated 315-WH-GT-A for the 802.11a model and 315-WH-GT-G for the 802.11b/g model.

Both of these devices have FCC modular approval as identified by FCC ID: SWX-SR2 (2 GHz version) and FCC ID: SWX-SR5 (5 GHz version).

A further SMA connector provides connection to the 802.15.4 module (Wi-Hart).

This device also has FCC modular certification as identified by FCC ID: SJC-M2140 however the client is using an antenna set up that was not certified hence the testing that has been carried out.

This device that was tested and has the following specifications:

Modulation type:	Wi Hart:	OQPSK using 802.15.4 protocols
Operating voltage:		24 Vdc
Rated output power:		6.0 mW (+8.0 dBm approximately)
Antennas:		Z2400-EL 10 dBi collinear with 3 metres of CC3-SMA coax cable. Overall gain 6 dBi.
		Y2400-EL 18 dBi Yagi antenna with 3 metres of CC3-SMA coax cable. Overall gain 14 dBi.
FCC band:		2400 – 2483.5 MHz
Operating channels:		15 channels with 5 MHz spacing between 2405 MHz and 2475 MHz
Operating frequencies:		25 MHz, 33 MHz, 44 MHz and 256 MHz in the LAN card
Digital device classification:		Class A – Commercial, industrial or business use

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## 6. SETUPS AND PROCEDURES

### Standard

The sample was tested in accordance with 47 CFR Part 15 Subpart C and in particular section 15.247

### Methods and Procedures

The measurement methods and procedures as described in ANSI C63.4 - 2003 were used.

### Section 15.107: Conducted emissions

The device contains a digital device. Refer to Section 15.207 for the conducted measurements that have been carried out.

### Section 15.109: Radiated emission limits

The device contains a Class A digital device.

A number of specific digital device emissions were observed.

Digital device radiated emissions testing was carried out over the frequency range of 30 MHz to 2000 MHz as the client has declared that the highest digital device operates above 108 MHz but below 500 MHz.

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

Testing was carried out when the device was operating continuously with measurements being made at a distance of 10 metres.

A receiver with a quasi peak detector with a 120 kHz bandwidth was used between 30 – 1000 MHz and between 1000 – 2,000 MHz a peak detector and an average detector were used with a 1 MHz resolution bandwidth.

The limits as described in Section 15.109 have been applied.

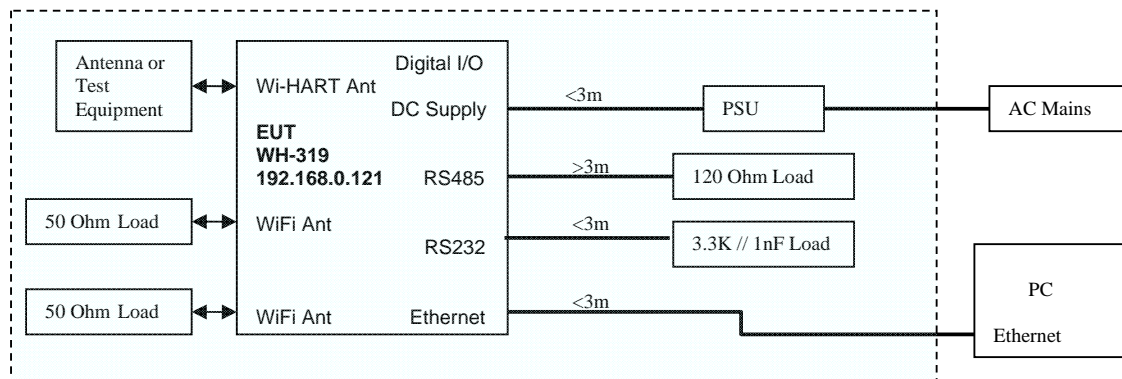
This site conforms to the requirements of CISPR 16 and ANSI C63.4 - 2003.

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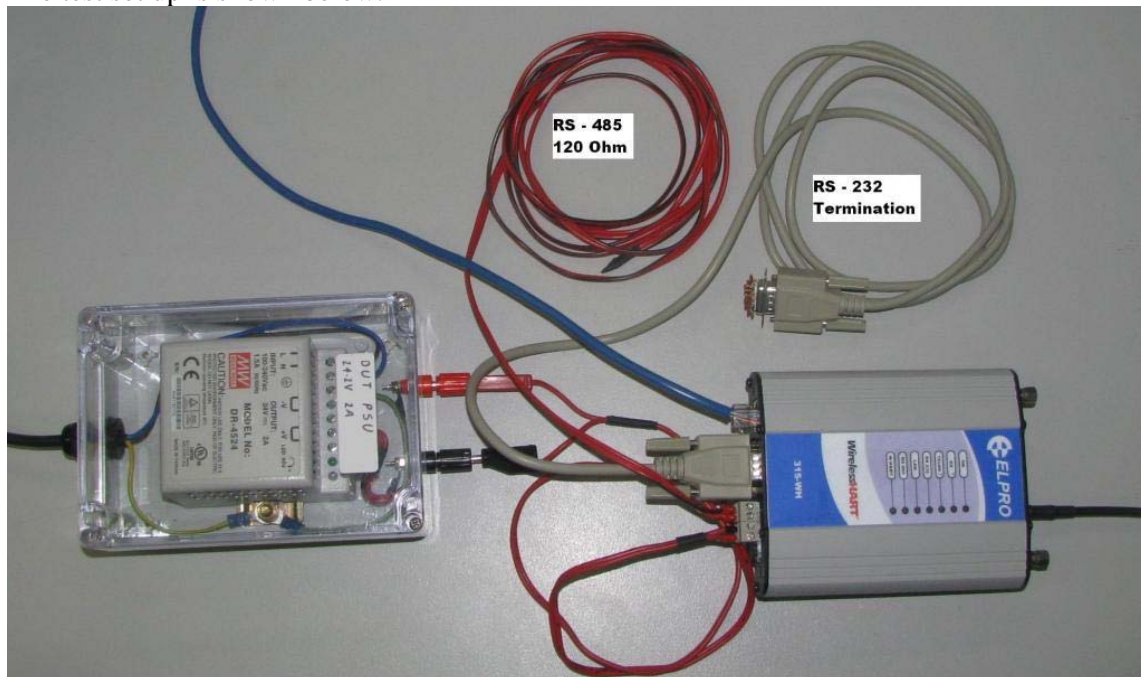
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When an emission is located, it is positively identified and its maximum level is found by rotating the automated turntable, and by varying the antenna height, where appropriate, with an automated antenna tower with measurements being made in both vertical and horizontal antenna polarisations.

Testing was carried out with the device configured as follows:



The test set up is shown below.



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

$$\text{Level (dB}\mu\text{V/m)} = \text{Receiver Reading (dB}\mu\text{V)} + \text{Antenna Factor (dB)} + \text{Coax Loss (dB)}$$

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## Results:

Frequency MHz	Vertical dBuV/m	Horizontal dBuV/m	Limit dBuV/m	Margin dB	Detector	Antenna
30.580	18.1		39.0	20.9	Quasi Peak	Vertical
47.802	24.1		39.0	14.9	Quasi Peak	Vertical
50.431	23.2		39.0	15.8	Quasi Peak	Vertical
64.804	17.4		39.0	21.6	Quasi Peak	Vertical
71.432	16.7		39.0	22.3	Quasi Peak	Vertical
81.174		24.6	39.0	14.4	Quasi Peak	Horizontal
141.000		28.3	43.5	15.2	Quasi Peak	Horizontal
143.367	26.5		43.5	17.0	Quasi Peak	Vertical
150.000	20.6		43.5	22.9	Quasi Peak	Vertical
200.000	20.5		43.5	23.0	Quasi Peak	Vertical
225.000	28.4	30.1	46.4	16.3	Quasi Peak	Horizontal
233.908		28.2	46.4	18.2	Quasi Peak	Horizontal
250.000	30.7	37.8	46.4	8.6	Quasi Peak	Horizontal
264.000		28.6	46.4	17.8	Quasi Peak	Horizontal
325.000		29.6	46.4	16.8	Quasi Peak	Horizontal
374.996	33.7		46.4	12.7	Quasi Peak	Vertical
375.000		36.6	46.4	9.8	Quasi Peak	Horizontal
400.000		32.5	46.4	13.9	Quasi Peak	Horizontal
401.000	34.1		46.4	12.3	Quasi Peak	Vertical
524.994	36.2	33.4	46.4	10.2	Quasi Peak	Vertical
549.996	35.1	35.2	46.4	11.2	Quasi Peak	Horizontal
600.000	34.9		46.4	11.5	Quasi Peak	Vertical
660.521	32.8	34.8	46.4	11.6	Quasi Peak	Horizontal
699.995	38.5	35.9	46.4	7.9	Quasi Peak	Vertical
999.920	39.3	38.6	49.5	10.2	Quasi Peak	Vertical
1125.000		43.7	69.5	25.8	Peak	Horizontal
1125.000		34.0	49.5	15.5	Average	Horizontal

**Result:** Complies

Measurement uncertainty with a confidence interval of 95% is:

Free radiation tests (30 – 2,000 MHz)  $\pm 4.1$  dB

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## **Section 15.201: Equipment authorisation requirement**

Certification as detailed in Subpart J of Part 2 is required for this device as it contains a transmitter.

The 802.15.4 transmitter has limited modular approval using FCC ID: SJC-M2140 with certification being sought by the client for the antenna combination that is to be used.

The Ubiquiti-Networks 802.11b/g and 802.11a transmitters have full modular certification using FCC ID: SWX-SR2 and FCC ID: SWX-SR5

## **Section 15.203: Antenna requirement**

The 802.15.4 device has an antenna port with a standard SMA type connector which is not unique.

Given the type of device the user manual will state that this device must be installed by an experienced radio and antenna installer using only antennas that are supplied by the manufacturer.

Device was tested with the following antennas:

- Z2400-EL 10 dBi collinear with 3 metres of CC3-SMA coax cable.
- Y2400-EL 18 dBi Yagi antenna with 3 metres of CC3-SMA coax cable.

**Result:** Complies

## **Section 15.204: External radio frequency power amplifiers and antenna modifications**

An external power amplifier is not supplied with this device.

The equipment manual contains a warning about modifications to the device including the antennas.

**Result:** Complies.

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## **Section 15.205: Restricted bands of operation**

The transmitters contained within this device operate in the 2400 – 2483.5 MHz band which is covered by Section 15.247.

**Result:** Complies.

## **Section 15.207 + Section 15.107: Conducted emissions testing**

Conducted Emissions testing was carried out over the frequency range of 150 kHz to 30 MHz which was carried out at the laboratory's MacKelvie Street premises in a 2.4 m x 2.4 m x 2.4 m screened room

Testing was carried out using a representative external 120 Vac to 24 Vdc power supply.

The device can operate over a power supply range of 9 – 30 Vdc.

Testing was carried out using a 24 Vdc supply as this was deemed to be the worst case set up.

The transmitter in this device operates in the 2400 – 2483.5 MHz band.

Testing was carried out when the device was transmitting and receiving continuously.

The device was placed on top of the emissions table, which is 1 m x 1.5 m, 80 cm above the screened room floor which acts as the horizontal ground plane.

In addition the device was positioned 40 cm away from the screened room wall which acts as the vertical ground plane.

The artificial mains network was bonded to the screened room floor.

At all times the device was kept more than 80 cm from the artificial mains network.

The Class B limits have been applied.

**Result:** Complies

Measurement uncertainty with a confidence interval of 95% is:

- AC Mains port (0.15-30 MHz)  $\pm$  2.8 dB

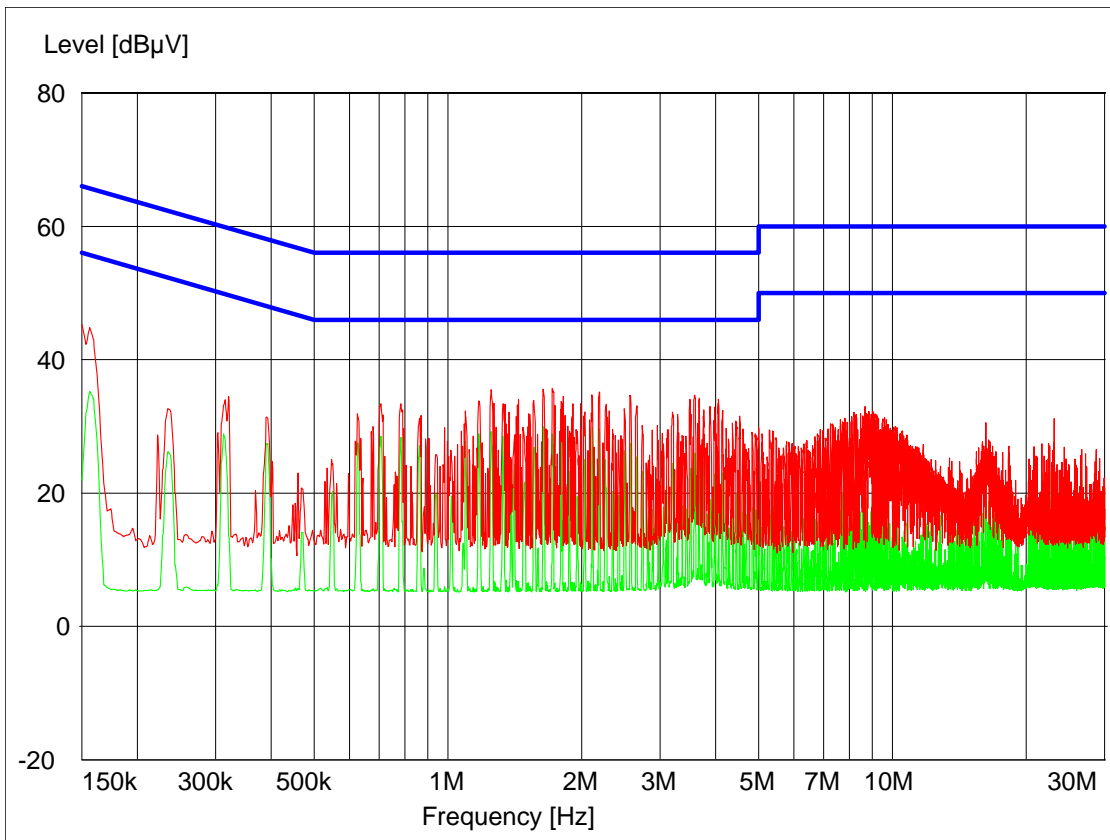
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## Conducted Emissions – AC Mains Port – Phase Line

<b>Setup:</b>	Device tested when using a representative 120 Vac to 24 Vdc power supply while the device was transmitting and receiving continuously.
---------------	--

Peak ---   
  Average --   
  Quasi Peak X   
  Average +



### Final Quasi-Peak Measurements

Frequency MHz	Level dBµV	Limit dBµV	Margin dB	Phase	Rechecks dBµV
No results recorded					

### Final Average Measurements

Frequency MHz	Level dBµV	Limit dBµV	Margin dB	Phase	Rechecks dBµV
No results recorded					

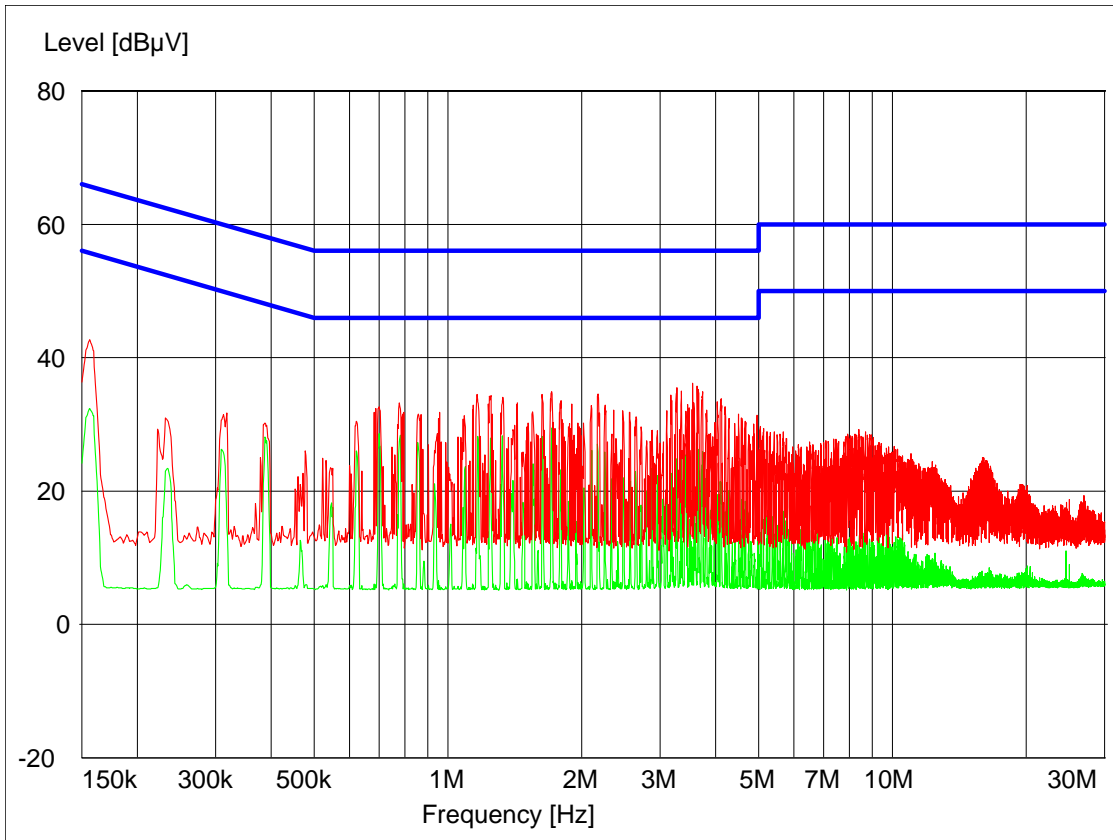
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## Conducted Emissions – AC Mains Port – Neutral Line

<b>Setup:</b>	Device tested when using a representative 120 Vac to 24 Vdc power supply while the device was transmitting and receiving continuously
---------------	---

Peak ---   
  Average --   
  Quasi Peak X   
  Average +



### Final Quasi-Peak Measurements

Frequency MHz	Level dBµV	Limit dBµV	Margin dB	Phase	Rechecks dBµV
No results recorded					

### Final Average Measurements

Frequency MHz	Level dBµV	Limit dBµV	Margin dB	Phase	Rechecks dBµV
No results recorded					

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## **Section 15.209: Radiated emission limits, general requirements**

Refer to Section 15.109 Radiated emissions testing.

Between 30 MHz – 2000 MHz no transmitter emissions were observed.

The only emissions observed over this frequency band were from the digital device to which the Class A limit was applied.

**Result:** Complies

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## Section 15.247(a)(2): Minimum bandwidth

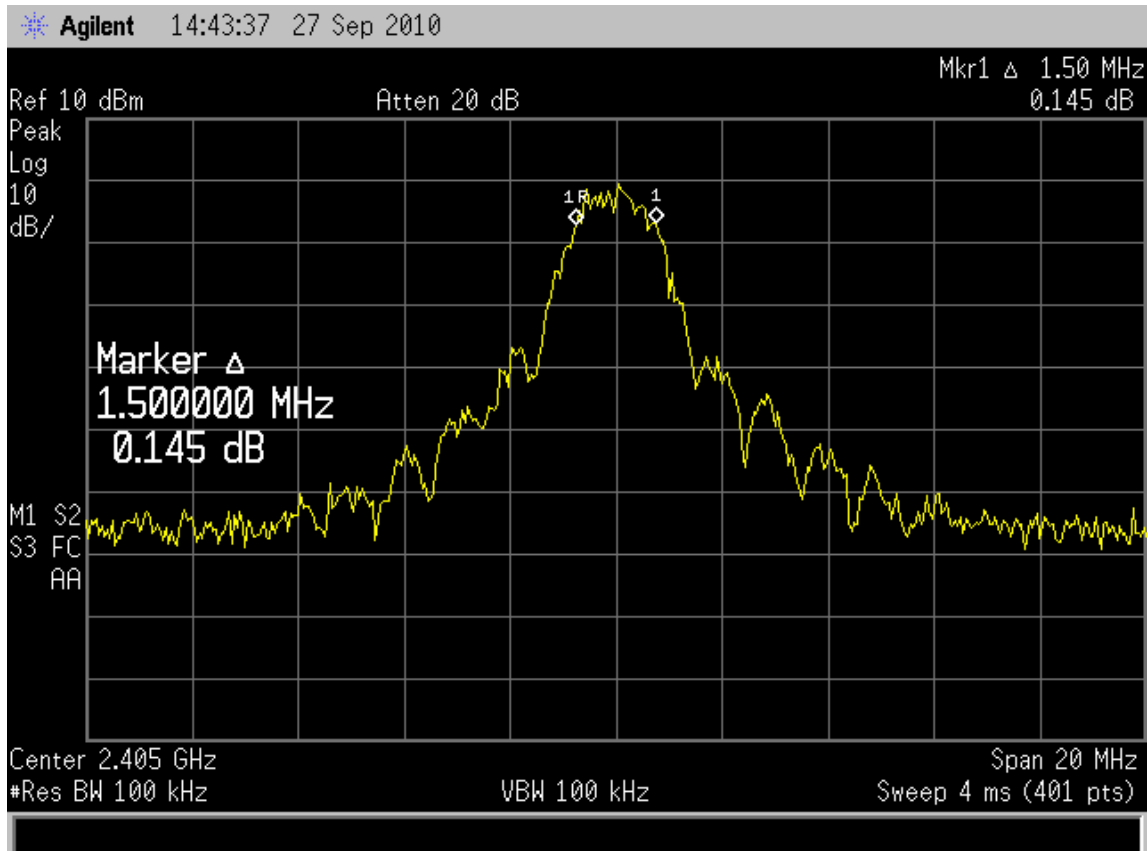
This systems using digital modulation techniques shall have a minimum 6 dB bandwidth of 500 kHz

Testing was carried on 2405 MHz, 2440 MHz and 2475 MHz with the following results:

Frequency (MHz)	6 dB bandwidth (MHz)
2405.000	1.5000
2440.000	1.5000
2475.000	1.5000

**Result:** Complies

2405 MHz



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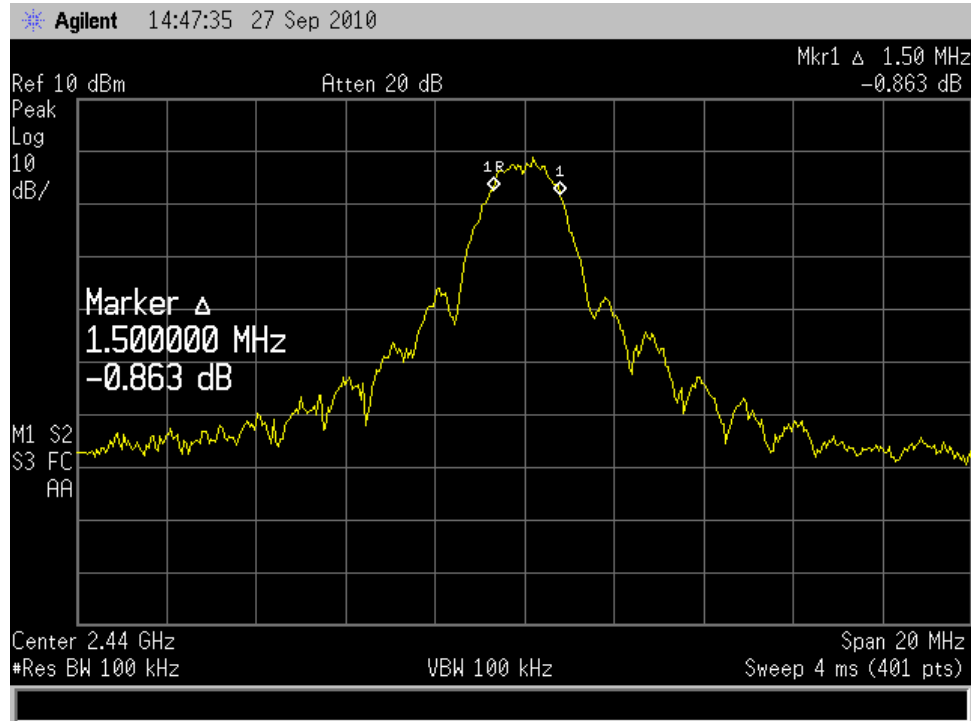
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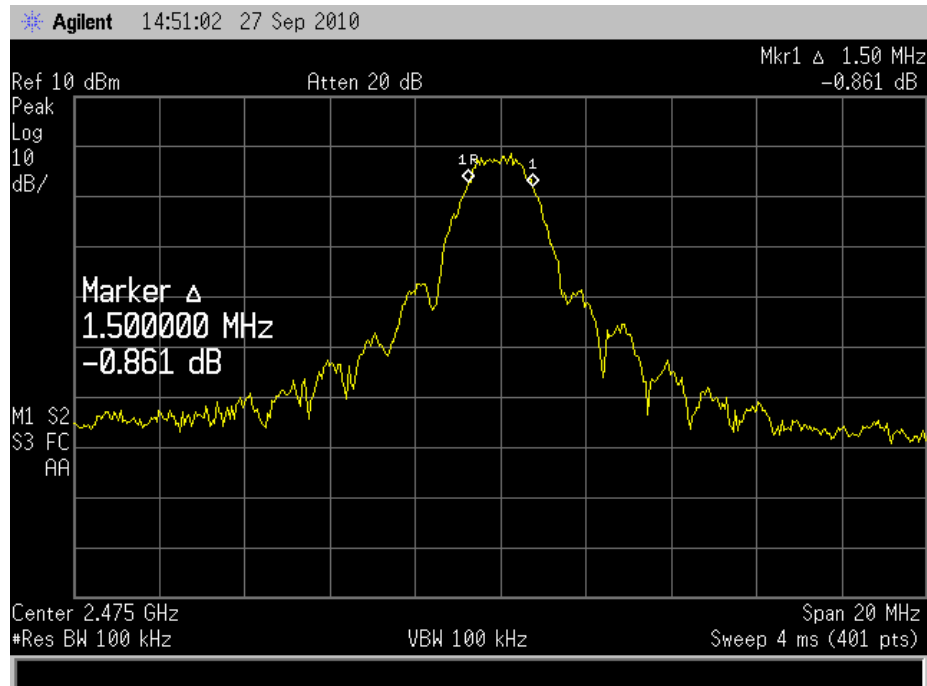
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2440 MHz



2475 MHz



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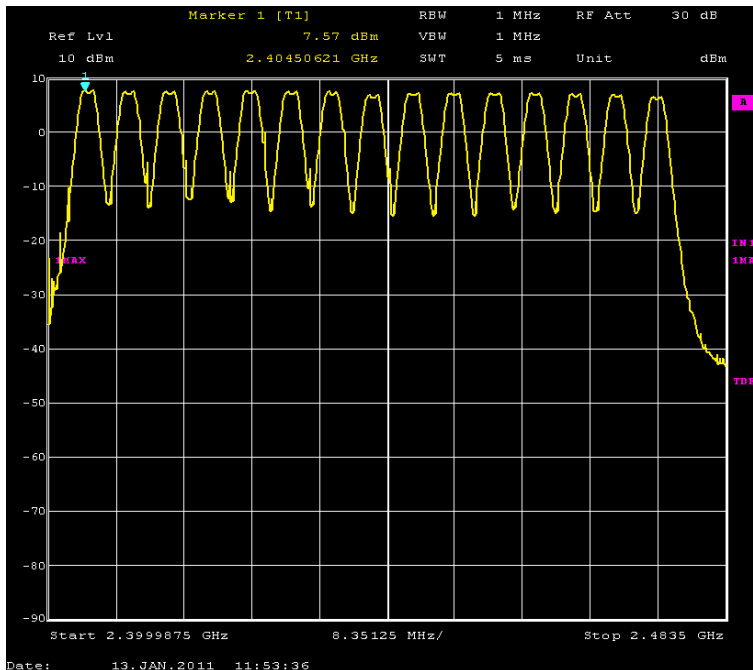
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## Section 15.247(b)(3)– Peak output power

Conducted peak power measurements were made as the antenna port using a spectrum analyser operating in peak hold with a resolution bandwidth of 1 MHz with the transmitter set up to operate on discrete frequencies.

Frequency (MHz)	Power (dBm)	Power (watts)	Grant Limit (watts)	FCC Limit (watts)
2405.000	7.57	0.0057	0.0060	1.000
2410.000	7.41	0.0055	0.0060	1.000
2415.000	7.32	0.0054	0.0060	1.000
2420.000	7.47	0.0056	0.0060	1.000
2425.000	7.52	0.0056	0.0060	1.000
2430.000	7.36	0.0054	0.0060	1.000
2435.000	7.30	0.0054	0.0060	1.000
2440.000	6.57	0.0045	0.0060	1.000
2445.000	7.07	0.0051	0.0060	1.000
2450.000	7.07	0.0051	0.0060	1.000
2455.000	7.11	0.0051	0.0060	1.000
2460.000	7.11	0.0051	0.0060	1.000
2465.000	7.00	0.0050	0.0060	1.000
2470.000	6.76	0.0047	0.0060	1.000
2475.000	6.46	0.0044	0.0060	1.000



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The input dc voltage to the device was varied between 9 Vdc – 30 Vdc which showed no variation in output power.

The above results show that the device is being operated in accordance with the power listed on the FCC equipment grant (6 mW or + 7.78 dBm) for this module.

Gain antennas are to be connected to this transmitter with overall gains of 6 dBi and 14 dBi will be attached.

The loss in the supplied coax was measured to be 4 dB in the 2400 – 2483.5 MHz band.

Section 15.247(b)(4) states that when the gain of the antenna used exceeds 6 dBi then the conducted power output needs to be reduced by an amount in dB in excess of 6 dBi.

In this case this equates to 0 dB for the collinear antenna and 8 dB for the yagi antenna.

Therefore the conducted limit has been reduced from 1 watt (+30 dBm) to +22 dBm when the yagi antenna was used.

Testing was carried out at the test site using the antennas supplied by the client to confirm this as detailed below.

Testing was carried out on three channels being 2405.000 MHz, 2440.000 MHz and 2475.000 MHz.

Measurements were made using a spectrum analyser with a resolution bandwidth of 3 MHz when the transmitter was setup to operate on discrete frequencies.

## Z2400-EL 10 dBi collinear with 3 metres of CC3-SMA coax cable

Frequency (MHz)	Field Strength (dBuV/m)	Radiated Power (dBm)	Antenna Gain (dBi)	Transmitter Power (dBm)	Limit (dBm)
2405.000	108.4	13.2	6.0	7.2	30.0
2440.000	107.5	12.3	6.0	6.3	30.0
2475.000	107.2	12.0	6.0	6.0	30.0

## Y2400-EL 18 dBi Yagi antenna with 3 metres of CC3-SMA coax cable

Frequency (MHz)	Field Strength (dBuV/m)	Radiated Power (dBm)	Antenna Gain (dBi)	Transmitter Power (dBm)	Limit (dBm)
2405.000	109.5	14.3	14.0	0.3	22.0
2440.000	113.3	18.1	14.0	4.1	22.0
2475.000	112.6	17.4	14.0	3.4	22.0

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There is a relatively good correlation between the radiated transmitter power and the measured conducted transmitter power when the co-linear antenna is used however there is not a good correlation when the log periodic antenna is used.

The calculated power less than the conducted power which would indicate that the antenna gain maybe overstated.

Radiated measurements were made using vertical and horizontal polarisations.

The power level in watts was determined by formula from the field strength using the formula  
Field strength (V/m) = (square root of (30 x transmitter power (watts))) / distance (metres)

The transmitter itself was placed in the centre of the test table at a height of 80 cm above the ground plane.

Testing was carried out at EMC Technologies NZ Ltd Open Area Test Site, which is located at Driving Creek, Orere Point, Auckland.

**Result:** Complies

**Measurement Uncertainty:** ±4.1 dB

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## Section 15.247 (d) – Out of band emissions

### Band edge measurements:

At the band edges of 2400 MHz and 2483.5 MHz all emissions are required to be attenuated by more than 20 dB relative to the highest 100 kHz resolution bandwidth emission level observed in the band of operation.

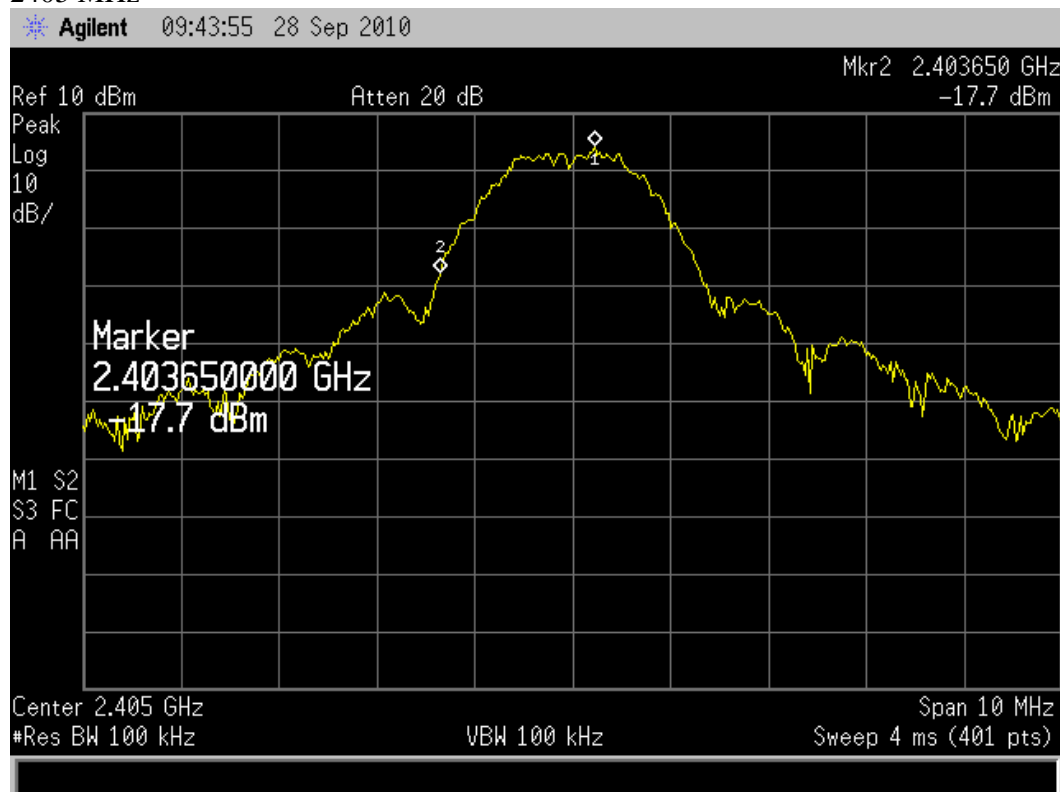
Testing was carried out when the device was transmitting on 2405 MHz and 2475 MHz with the -20 dB points determined as below.

### 20 dB bandwidth points

Frequency (MHz)	F low (MHz)	F high (MHz)
2405.000	2403.6500	-
2475.000	-	2476.3250

Spectrum plots showing these measurements is detailed below

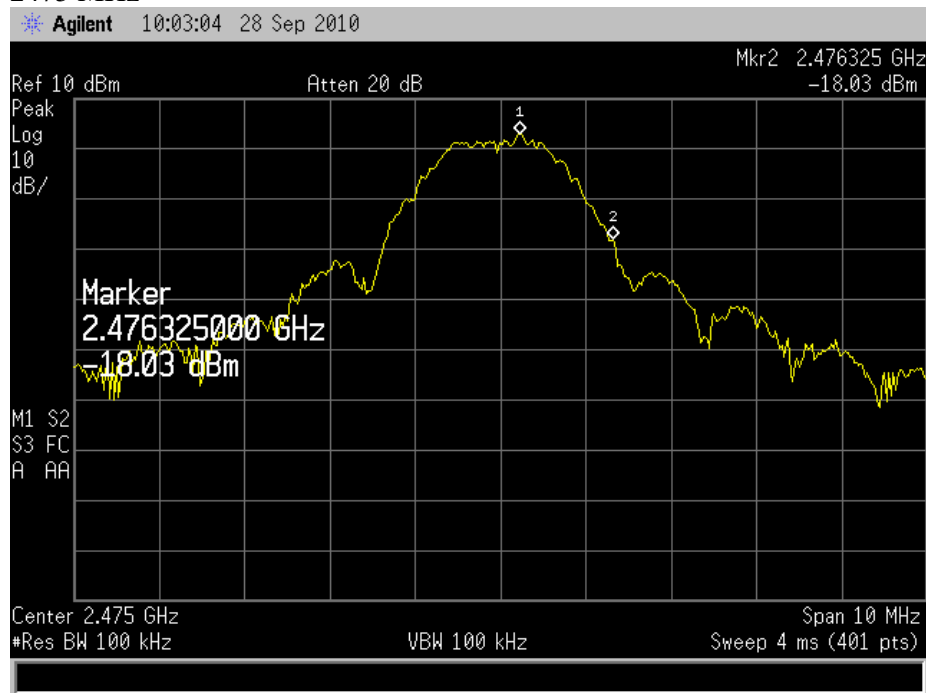
### 2405 MHz



# EMC Technologies (NZ) Ltd

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2475 MHz



Radiated emission measurements were made at the open area test site to confirm these levels.

Z2400-EL 10 dBi collinear with 3 metres of CC3-SMA coax cable

Frequency MHz	Vertical dBuV/m	Horizontal dBuV/m	Limit dBuV/m	Margin dB	Detector	RBW	Antenna
2405.000	103.2	93.1	-	-	Peak	100 kHz	Vertical
2400.000	61.0		83.2	22.2	Peak	100 kHz	Vertical
2400.000		52.1	73.1	41.0	Peak	100 kHz	Horizontal
2390.000	61.0	52.0	74.0	13.0	Peak	1 MHz	Vertical
2390.000	45.0	44.0	54.0	9.0	Average	1 MHz	Vertical
2475.000	104.6	95.2	-	-	Peak	100 kHz	Vertical
2483.500	60.5	57.0	74.0	13.5	Peak	1 MHz	Vertical
2483.500	45.1	44.0	54.0	8.9	Average	1 MHz	Vertical

**EMC Technologies (NZ) Ltd**

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# EMC Technologies (NZ) Ltd

Test Report No **100901.1**  
Report date: 5 October 2010

Y2400-EL 18 dBi Yagi antenna with 3 metres of CC3-SMA coax cable

Frequency MHz	Vertical dBuV/m	Horizontal dBuV/m	Limit dBuV/m	Margin dB	Detector	RBW	Antenna
2405.000	104.1	92.4	-	-	Peak	100 kHz	Vertical
2400.000	60.0		84.1	24.1	Peak	100 kHz	Vertical
2400.000		49.5	72.4	22.9	Peak	100 kHz	Horizontal
2390.000	56.0	47.0	74.0	18.0	Peak	1 MHz	Vertical
2390.000	44.0	35.0	54.0	10.0	Average	1 MHz	Vertical
2475.000	105.1	91.4	-	-	Peak	100 kHz	Vertical
2483.500	58.1	63.5	74.0	10.5	Peak	1 MHz	Horizontal
2483.500	44.9	49.1	54.0	4.9	Average	1 MHz	Vertical

When operating on 2405 MHz emissions at the band edge of 2400 MHz were attenuated by more than 20 dBc.

When operating on 2405 MHz the highest emissions observed in the 2310 MHz – 2390 MHz restricted band are recorded above and were observed to comply with the limits for this band.

When operating on 2475 MHz the highest emissions observed in the 2483.5 MHz – 2500 MHz restricted band are recorded above and were observed to comply with the limits for this band.

The device did not comply with this requirement when operating on 2480 MHz.

**Result:** Complies

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## Spurious emissions and restricted band radiated emission measurements

Conducted spurious emission measurements were made at the antenna port using a spectrum analyser with a 100 kHz resolution bandwidth on the three frequencies described below.

A limit of -20 dBc has been applied relative to the fundamental transmit frequency.

All other emissions observed had a margin to the limit that exceeded 20 dB.

### Transmitting on 2405 MHz

Frequency (MHz)	Level (dBm)	Limit (dBm)
2405.000	8.1	-
4810.000	-41.8	-11.9
7215.000	-37.6	-11.9
9620.000	-61.6	-11.9
12025.000	< -70.0	-11.9
14430.000	< -70.0	-11.9
16835.000	< -70.0	-11.9
19240.000	-69.2	-11.9
21645.000	< -70.0	-11.9
24050.000	< -70.0	-11.9

### Transmitting on 2420 MHz

Frequency (MHz)	Level (dBm)	Limit (dBm)
2420.000	7.9	-
4840.000	-45.7	-12.1
7260.000	-38.6	-12.1
9680.000	-62.6	-12.1
12100.000	< -70.0	-12.1
14520.000	< -70.0	-12.1
16940.000	< -70.0	-12.1
19360.000	< -70.0	-12.1
21780.000	< -70.0	-12.1
24200.000	< -70.0	-12.1

# EMC Technologies (NZ) Ltd

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## Transmitting on 2460 MHz

Frequency (MHz)	Level (dBm)	Limit (dBm)
2460.000	7.6	
4920.000	-48.3	-12.4
7380.000	-38.5	-12.4
9840.000	-59.7	-12.4
12300.000	< -70.0	-12.4
14760.000	< -70.0	-12.4
17220.000	< -70.0	-12.4
19680.000	< -70.0	-12.4
22140.000	< -70.0	-12.4
24600.000	< -70.0	-12.4

## Transmitting on 2475 MHz

Frequency (MHz)	Level (dBm)	Limit (dBm)
2475.000	7.6	
4950.000	-47.3	-12.4
7425.000	-40.3	-12.4
9900.000	-60.8	-12.4
12375.000	< -70.0	-12.4
14850.000	< -70.0	-12.4
17325.000	< -70.0	-12.4
19800.000	< -70.0	-12.4
22275.000	< -70.0	-12.4
24750.000	< -70.0	-12.4

Radiated measurements were also made as a number of out of band emissions have been shown to fall within the restricted bands of operation as defined in section 15.205(a).

Radiated emission measurements were carried out with the limits as per section 15.209 applied when these emissions fell within the restricted bands.

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.



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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 in both vertical and horizontal antenna polarisations.

The emission level is 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)

A dash in the result column indicates that a measurement was attempted on a frequency but no emissions were observed.

Other emissions were observed from the transmitter between 480 – 500 MHz and 1920 – 1990 MHz which were dependent upon the transmitter frequency.

As these emissions do not fall within the restricted frequency bands the -20 dB limit has been applied relative to the lowest emission level observed

When either antenna was used this occurred at 2405 MHz with a level of 103.2 dB $\mu$ V/m being observed when the collinear antenna was used and 104.1 dB $\mu$ V/m when the yagi antenna was used when measured using a 100 kHz bandwidth

**Result:** Complies

**Measurement uncertainty:**  $\pm 4.1$  dB

# EMC Technologies (NZ) Ltd

Test Report No **100901.1**  
Report date: 5 October 2010

2405.000 MHz harmonic emissions observed when the Z2400-EL 10 dBi collinear with 3 metres of CC3-SMA coax cable was attached

Frequency MHz	Vertical dBuV/m	Horizontal dBuV/m	Limit dBuV/m	Margin dB	Detector	Antenna
481.000	43.5		83.2	39.7	Peak	Vertical
1924.000	60.2		83.2	23.0	Peak	Vertical
4810.0000	59.1	47.0	74.0	14.9	Peak	Vertical
4810.0000	43.1	40.1	54.0	10.9	Average	Vertical
7215.0000	63.1	56.0	74.0	10.9	Peak	Vertical
7215.0000	45.7	42.0	54.0	8.3	Average	Vertical
9620.000	-	-	74.0	-	Peak	Vert/Hort
9620.000	-	-	54.0	-	Average	Vert/Hort
12025.000	-	-	74.0	-	Peak	Vert/Hort
12025.000	-	-	54.0	-	Average	Vert/Hort
14430.000	-	-	74.0	-	Peak	Vert/Hort
14430.000	-	-	54.0	-	Average	Vert/Hort
16835.000	-	-	74.0	-	Peak	Vert/Hort
16835.000	-	-	54.0	-	Average	Vert/Hort
19240.000	-	-	74.0	-	Peak	Vert/Hort
19240.000	-	-	54.0	-	Average	Vert/Hort
21645.000	-	-	74.0	-	Peak	Vert/Hort
21645.000	-	-	54.0	-	Average	Vert/Hort
24050.000	-	-	74.0	-	Peak	Vert/Hort
24050.000	-	-	54.0	-	Average	Vert/Hort

# EMC Technologies (NZ) Ltd

Test Report No **100901.1**  
Report date: 5 October 2010

2440.000 MHz harmonic emissions observed when the Z2400-EL 10 dBi collinear with 3 metres of CC3-SMA coax cable was attached.

Frequency MHz	Vertical dBuV/m	Horizontal dBuV/m	Limit dBuV/m	Margin dB	Detector	Antenna
488.000	48.3		83.2	34.9	Peak	Vertical
1952.000	60.3		83.2	22.9	Peak	Vertical
4880.000	53.1	47.0	74.0	20.9	Peak	Vertical
4880.000	42.1	40.1	54.0	11.9	Average	Vertical
7320.000	64.4	56.0	74.0	9.6	Peak	Vertical
7320.000	48.1	42.0	54.0	5.9	Average	Vertical
9760.000	-	-	74.0	-	Peak	Vert/Hort
9760.000	-	-	54.0	-	Average	Vert/Hort
12200.000	-	-	74.0	-	Peak	Vert/Hort
12200.000	-	-	54.0	-	Average	Vert/Hort
14640.000	-	-	74.0	-	Peak	Vert/Hort
14640.000	-	-	54.0	-	Average	Vert/Hort
17080.000	-	-	74.0	-	Peak	Vert/Hort
17080.000	-	-	54.0	-	Average	Vert/Hort
19520.000	-	-	74.0	-	Peak	Vert/Hort
19520.000	-	-	54.0	-	Average	Vert/Hort
21960.000	-	-	74.0	-	Peak	Vert/Hort
21960.000	-	-	54.0	-	Average	Vert/Hort
24400.000	-	-	74.0	-	Peak	Vert/Hort
24400.000	-	-	54.0	-	Average	Vert/Hort

# EMC Technologies (NZ) Ltd

Test Report No **100901.1**  
Report date: 5 October 2010

2475.000 harmonic emissions observed when the Z2400-EL 10 dBi collinear with 3 metres of CC3-SMA coax cable was attached.

Frequency MHz	Vertical dBuV/m	Horizontal dBuV/m	Limit dBuV/m	Margin dB	Detector	Antenna
495.000	44.6		83.2	38.6	Peak	Vertical
1980.000	57.1		83.2	26.1	Peak	Vertical
4880.0000	57.3	47.0	74.0	16.7	Peak	Vertical
4880.0000	43.7	40.1	54.0	10.3	Average	Horizontal
7320.0000	59.4	56.0	74.0	14.6	Peak	Vertical
7320.0000	44.1	42.0	54.0	9.9	Average	Vertical
9840.000	-	-	74.0	-	Peak	Vert/Hort
9840.000	-	-	54.0	-	Average	Vert/Hort
12300.000	-	-	74.0	-	Peak	Vert/Hort
12300.000	-	-	54.0	-	Average	Vert/Hort
14760.000	-	-	74.0	-	Peak	Vert/Hort
14760.000	-	-	54.0	-	Average	Vert/Hort
17220.000	-	-	74.0	-	Peak	Vert/Hort
17220.000	-	-	54.0	-	Average	Vert/Hort
19680.000	-	-	74.0	-	Peak	Vert/Hort
19680.000	-	-	54.0	-	Average	Vert/Hort
22140.000	-	-	74.0	-	Peak	Vert/Hort
22140.000	-	-	54.0	-	Average	Vert/Hort
24750.000	-	-	74.0	-	Peak	Vert/Hort
24750.000	-	-	54.0	-	Average	Vert/Hort

# EMC Technologies (NZ) Ltd

Test Report No **100901.1**  
Report date: 5 October 2010

2405.000 MHz harmonic emissions observed when the Y2400-EL 18 dBi Yagi antenna with 3 metres of CC3-SMA coax cable was attached

Frequency MHz	Vertical dBuV/m	Horizontal dBuV/m	Limit dBuV/m	Margin dB	Detector	Antenna
481.000	40.1		84.1	43.8	Peak	Vertical
1924.000	61.3		84.1	22.7	Peak	Vertical
4810.000	58.5	51.8	74.0	15.5	Peak	Vertical
4810.000	43.0	38.5	54.0	11.0	Average	Vertical
7215.000	67.3	63.3	74.0	6.7	Peak	Vertical
7215.000	48.2	46.6	54.0	5.8	Average	Vertical
9620.000	59.0	58.0	74.0	15.0	Peak	Vertical
9620.000	46.0	46.0	54.0	8.0	Average	Horizontal
12025.000	-	-	74.0	-	Peak	Vert/Hort
12025.000	-	-	54.0	-	Average	Vert/Hort
14430.000	-	-	74.0	-	Peak	Vert/Hort
14430.000	-	-	54.0	-	Average	Vert/Hort
16835.000	-	-	74.0	-	Peak	Vert/Hort
16835.000	-	-	54.0	-	Average	Vert/Hort
19240.000	-	-	74.0	-	Peak	Vert/Hort
19240.000	-	-	54.0	-	Average	Vert/Hort
21645.000	-	-	74.0	-	Peak	Vert/Hort
21645.000	-	-	54.0	-	Average	Vert/Hort
24050.000	-	-	74.0	-	Peak	Vert/Hort
24050.000	-	-	54.0	-	Average	Vert/Hort

# EMC Technologies (NZ) Ltd

Test Report No **100901.1**  
Report date: 5 October 2010

2440.000 MHz harmonic emissions observed when the Y2400-EL 18 dBi Yagi antenna with 3 metres of CC3-SMA coax cable was attached

Frequency MHz	Vertical dBuV/m	Horizontal dBuV/m	Limit dBuV/m	Margin dB	Detector	Antenna
488.000	36.1		84.1	48.0	Peak	Vertical
1952.000	60.2		84.1	23.9	Peak	Vertical
4880.0000	58.8	47.0	74.0	15.2	Peak	Vertical
4880.0000	44.1	40.1	54.0	9.9	Average	Vertical
7320.0000	65.2	56.0	74.0	8.8	Peak	Vertical
7320.0000	47.1	42.0	54.0	6.9	Average	Vertical
9760.000	-	-	74.0	-	Peak	Vert/Hort
9760.000	-	-	54.0	-	Average	Vert/Hort
12200.000	-	-	74.0	-	Peak	Vert/Hort
12200.000	-	-	54.0	-	Average	Vert/Hort
14640.000	-	-	74.0	-	Peak	Vert/Hort
14640.000	-	-	54.0	-	Average	Vert/Hort
17080.000	-	-	74.0	-	Peak	Vert/Hort
17080.000	-	-	54.0	-	Average	Vert/Hort
19520.000	-	-	74.0	-	Peak	Vert/Hort
19520.000	-	-	54.0	-	Average	Vert/Hort
21960.000	-	-	74.0	-	Peak	Vert/Hort
21960.000	-	-	54.0	-	Average	Vert/Hort
24400.000	-	-	74.0	-	Peak	Vert/Hort
24400.000	-	-	54.0	-	Average	Vert/Hort

# EMC Technologies (NZ) Ltd

Test Report No **100901.1**  
Report date: 5 October 2010

2475.000 MHz harmonic emissions observed when the Y2400-EL 18 dBi Yagi antenna with 3 metres of CC3-SMA coax cable was attached

Frequency MHz	Vertical dBuV/m	Horizontal dBuV/m	Limit dBuV/m	Margin dB	Detector	Antenna
495.000	36.7		84.1	47.4	Peak	Vertical
1980.000	58.3		84.1	25.8	Peak	Vertical
4880.0000	54.2	47.0	74.0	19.8	Peak	Vertical
4880.0000	41.4	40.1	54.0	12.6	Average	Horizontal
7320.0000	67.5	56.0	74.0	6.5	Peak	Vertical
7320.0000	45.4	42.0	54.0	8.6	Average	Vertical
9840.000	-	-	74.0	-	Peak	Vert/Hort
9840.000	-	-	54.0	-	Average	Vert/Hort
12300.000	-	-	74.0	-	Peak	Vert/Hort
12300.000	-	-	54.0	-	Average	Vert/Hort
14760.000	-	-	74.0	-	Peak	Vert/Hort
14760.000	-	-	54.0	-	Average	Vert/Hort
17220.000	-	-	74.0	-	Peak	Vert/Hort
17220.000	-	-	54.0	-	Average	Vert/Hort
19680.000	-	-	74.0	-	Peak	Vert/Hort
19680.000	-	-	54.0	-	Average	Vert/Hort
22140.000	-	-	74.0	-	Peak	Vert/Hort
22140.000	-	-	54.0	-	Average	Vert/Hort
24750.000	-	-	74.0	-	Peak	Vert/Hort
24750.000	-	-	54.0	-	Average	Vert/Hort

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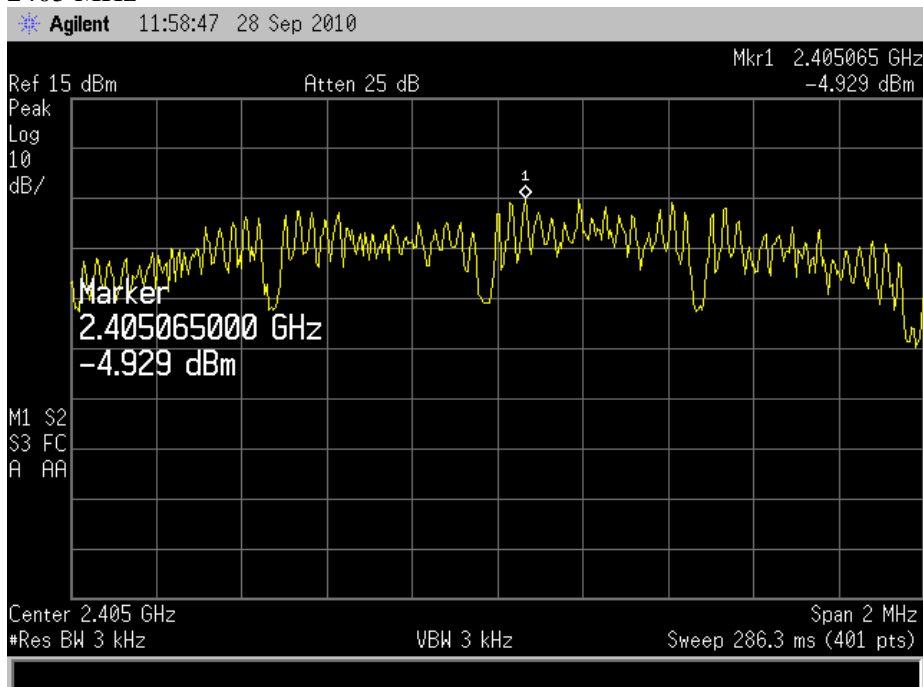
## Section 15.247 (e) – Power Spectral Density

For digitally modulated systems the power spectral density conducted from the intentional radiator to the antenna shall not exceed 8 dBm in any 3 kHz band.

Conducted measurements have been made at the antenna port using a spectrum analyser with a resolution bandwidth of 3 kHz as detailed below.

Frequency (MHz)	Density (dBm)	Limit (dBm)
2405.0650	-4.9	8.0
2440.0700	-5.7	8.0
2475.0750	-5.8	8.0

2405 MHz

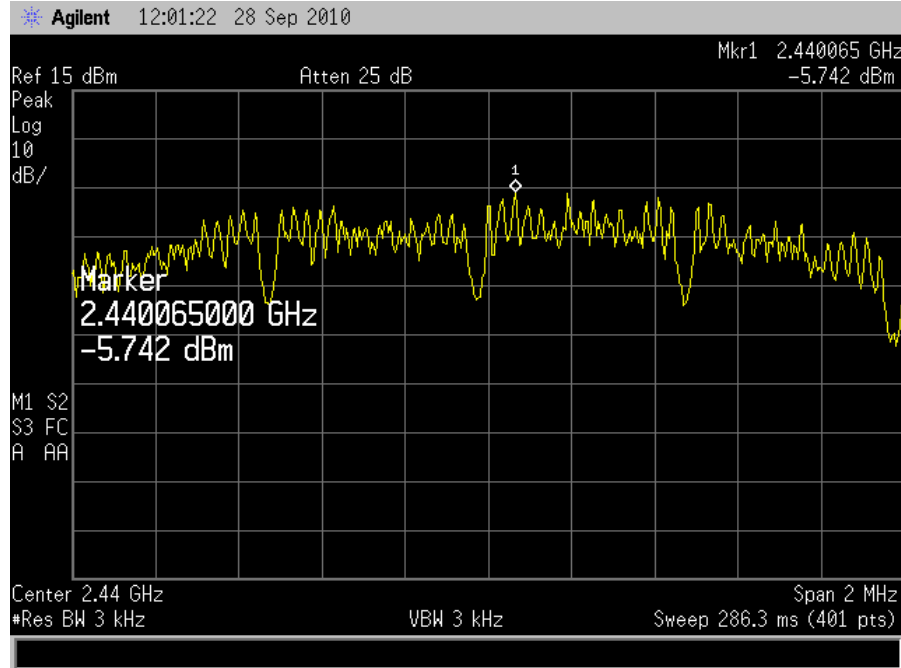




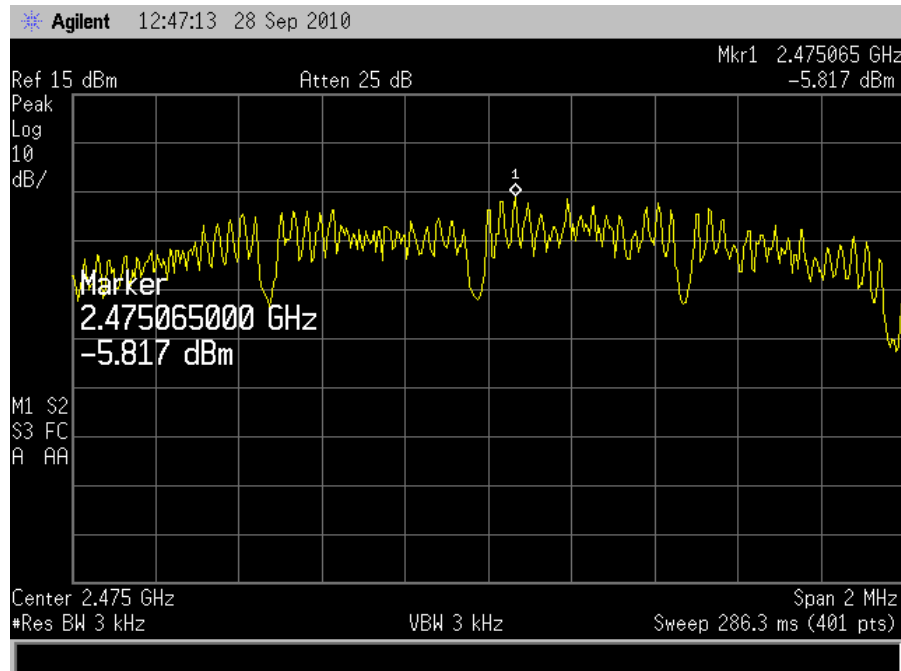
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## 2440 MHz



## 2475 MHz



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# EMC Technologies (NZ) Ltd

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Report date: 5 October 2010

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## Section 15.247(i) – Radio Frequency Hazard Information

As per Section 15.247 (b) (4) spread spectrum transmitters operating in the 2400 – 2483.5 MHz band are required to be operated in a manner that ensures that the public is not exposed to RF energy levels in accordance with CFR 47, Section 1.1307(b)(1).

The device when in operation is fixed and a safe distance could be maintained when events are undertaken.

In accordance with Section 1.1310 the Maximum Permissible Exposure (MPE) limits for the General Population / Uncontrolled Exposure of 1 mW/cm<sup>2</sup> has been applied.

The maximum distance from the antenna at which the MPE is met or exceeded is calculated from the equation relating field strength in V/m, transmit power in watts, transmit antenna gain and separation distance in metres:

$$E, \text{ V/m} = (\sqrt{30 * P * G}) / d$$
$$\text{Power density, mW/cm}^2 = E^2/3770$$
$$E \text{ for MPE: } 1 = E^2/3770$$
$$E = \sqrt{1*3770}$$
$$E = 61.4 \text{ V/m}$$

The highest conducted power has been measured to be +7.57 dBm or 0.0057 watts.

Attached to the transmitter will be a variety of antennas however the antenna with the highest gain will be the Y2400-EL 18 dBi Yagi antenna with 3 metres of CC3-SMA coax cable that has a loss of 4 dB. This gives an overall gain of 25.1 or 14 dBi.

Therefore:

$$E = \sqrt{30 * P * G} / d$$
$$d = \sqrt{30 * P * G} / E$$
$$d = \sqrt{30 * 0.0057 * 25.1} / 61.4$$
$$d = 0.034 \text{ m or } 3.4 \text{ cm}$$

**Result:** Complies if a minimum safe distance of 20 cm is specified in the set up instructions for this system.

# EMC Technologies (NZ) Ltd

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## 7. TEST EQUIPMENT USED

Instrument	Manufacturer	Model	Serial No	Asset Ref	Cal Due
Aerial Controller	EMCO	1090	9112-1062	RFS 3710	N/a
Aerial Mast	EMCO	1070-1	9203-1661	RFS 3708	N/a
Biconical Antenna	Schwarzbeck	BBA 9106	-	RFS 3613	30 Jan 2011
Receiver	R & S	ESCS 30	847124/020	E1595	7 Apr 2011
Receiver	R & S	ESIB-40	100171	R-27-1	10 Jun 2011
Receiver	R & S	ESHS 10	828404/005	RFS 3728	2 Dec 2010
Spectrum Analyser	Hewlett Packard	E7405A	US39150142	3776	14 Dec 2010
Log Periodic	Schwarzbeck	VUSLP 9111	9111-228	3785	30 Jan 2011
Horn Antenna	EMCO	3115	9511-4629	E1526	3 May 2011
Horn Antenna	EMCO	3116	92035	-	16 Jun 2011
Mains Network	R & S	ESH2-Z5	881362/034	3628	29 Jul 2012
Variac	General Radio	1592	-	RFS 3690	N/a
Turntable	EMCO	1080-1-2.1	9109-1578	RFS 3709	N/a
VHF Balun	Schwarzbeck	VHA 9103	-	RFS 3613	30 Jan 2011

## 8. ACCREDITATIONS

Testing was carried out in accordance with EMC Technologies Ltd registration with the Federal Communications Commission as a listed facility, registration number: 90838, which was updated on January 23<sup>rd</sup>, 2010.

All testing was carried out in accordance with the terms of EMC Technologies (NZ) Ltd International Accreditation New Zealand (IANZ) Accreditation to NZS/ISO/IEC 17025, 2005.

All measurement equipment has been calibrated in accordance with the terms of the EMC Technologies (NZ) Ltd International Accreditation New Zealand (IANZ) Accreditation to NZS/ISO/IEC 17025, 2005

International Accreditation New Zealand has Mutual Recognition Arrangements for testing and calibration with various accreditation bodies in a number of economies.

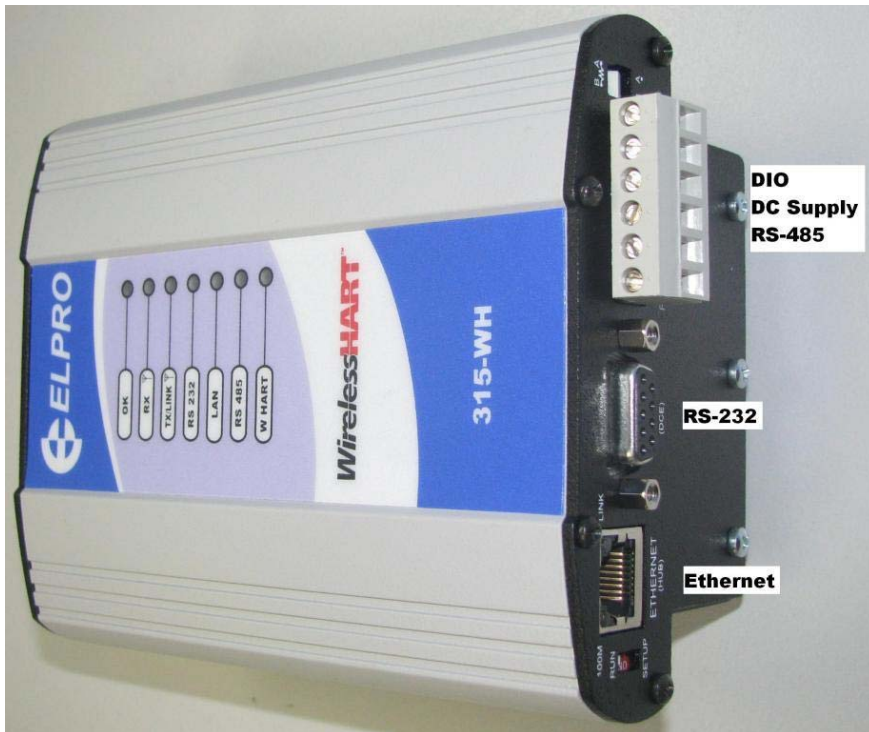
This includes NATA (Australia), UKAS (UK), SANAS (South Africa), NVLAP (USA), A2LA (USA), SWEDAC (Sweden). Further details can be supplied on request.

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## 9. PHOTOGRAPHS

External photos



EMC Technologies (NZ) Ltd

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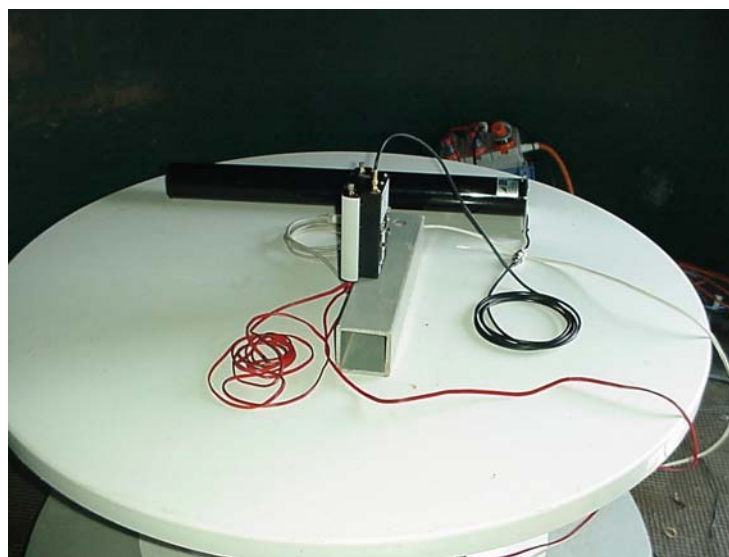
Web Site: [www.emctech.com.au](http://www.emctech.com.au)

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Outside test set ups:



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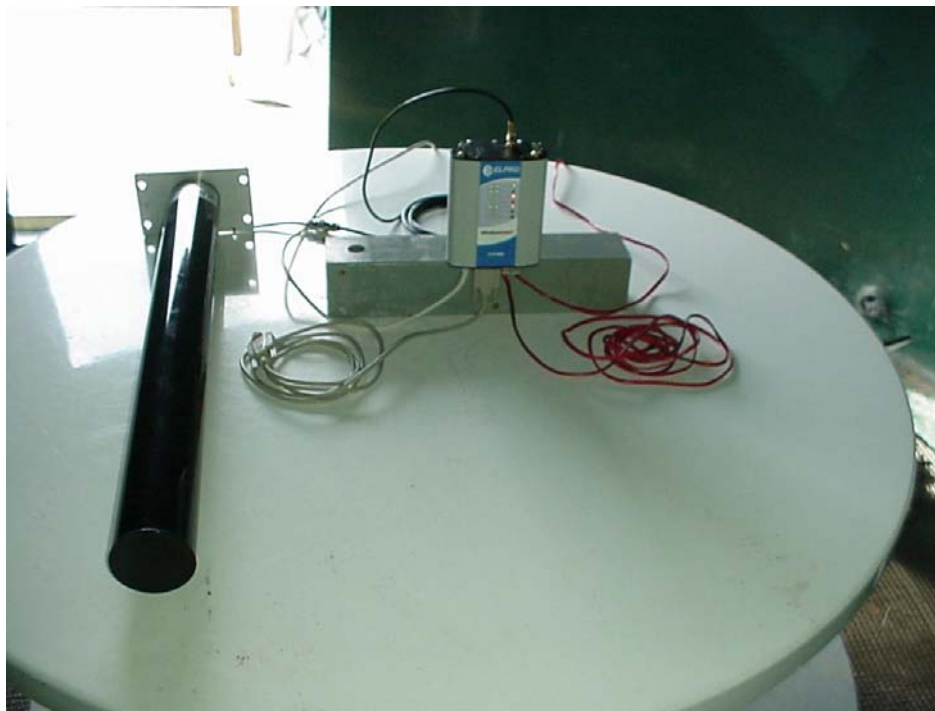
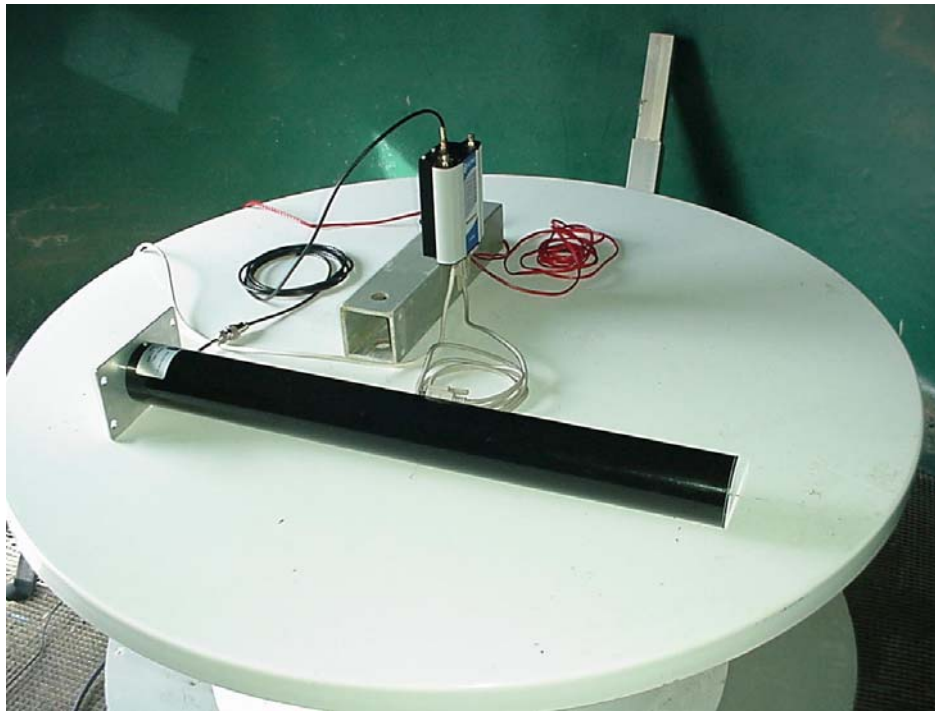
E-mail: [aucklab@ihug.co.nz](mailto:aucklab@ihug.co.nz)

Web Site: [www.emctech.com.au](http://www.emctech.com.au)

# EMC Technologies (NZ) Ltd

Test Report No 100901.1  
Report date: 5 October 2010

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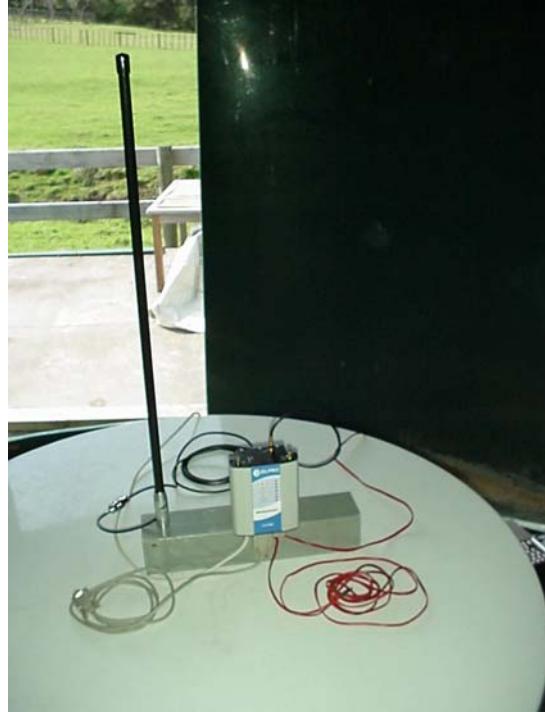
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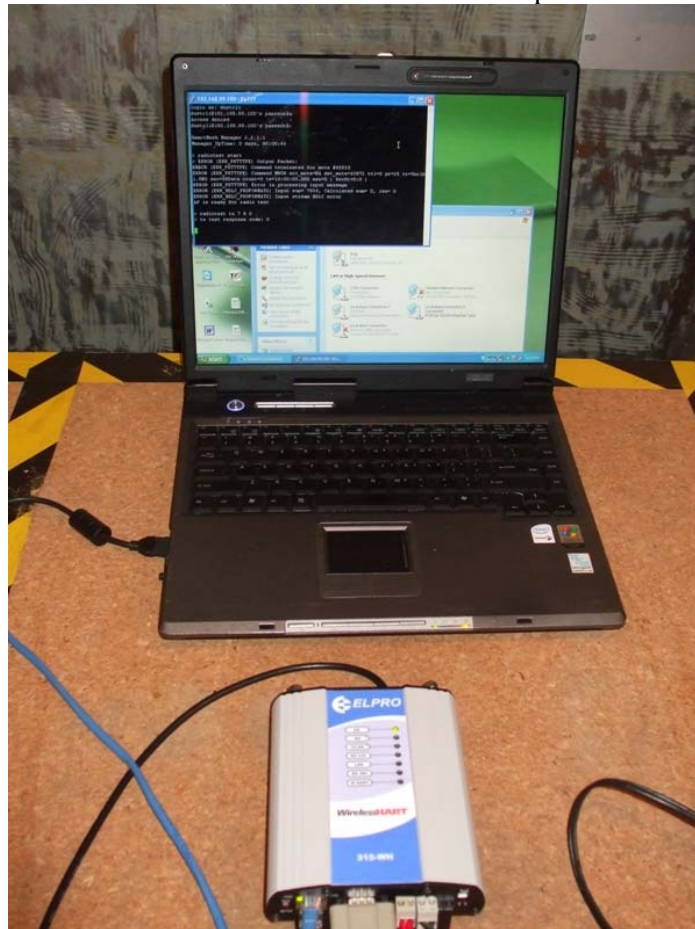
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## Conducted emissions test set up



A close up view of the display on the computer screen

```
192.168.99.100 - PuTTY
login as: dustcli
dustcli@192.168.99.100's password:

SmartMesh Manager 2.2.1.1
Manager UpTime: 0 days, 00:03:36

> radiotest start
> ERROR (ERR_PKTTYPE) Output Packet:
ERROR (ERR_PKTTYPE) Command terminated for mote #65535
ERROR (ERR_PKTTYPE) Command MNGR src_mote=NA dst_mote=
1.U#0 sec=SKData count=0 ts=16:00:00.000 asn=0 | DevSt
ERROR (ERR_PKTTYPE) Error in processing input message
ERROR (ERR_HDLC_PKGFORMAT2) Input sum= 7936, Calculated
ERROR (ERR_HDLC_PKGFORMAT2) Input stream HDLC error
AP is ready for radio test

>
> radiotest tx 7 8 0
> tx test response code: 0
```



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