EMC Technologies (NZ) Ltd

Test Report No **091216.20**
Report date: 14 April 2010

TEST REPORT

Commtest Ranger Booster Transmitter

tested for compliance with the

Code of Federal Regulations (CFR) 47

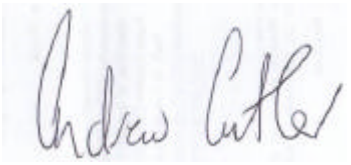
Part 15 – Radio Frequency Devices, Subpart C – Intentional Radiators

Section 15.247 – Operation in the band 2400 – 2483.5 MHz

for

Commtest Instruments Ltd

This Test Report is issued with the authority of:



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. CLIENT INFORMATION

Company Name Commtest Instruments Ltd

Address PO Box 9297

City Christchurch

Country New Zealand

Contact Mr Brian Wood

2. DESCRIPTION OF TEST SAMPLE

Brand Name Commtest

Model Number Ranger Booster

Product Transmitter

Manufacturer Commtest Instruments Ltd

Country of Origin New Zealand

Serial Number 80030

FCC ID V92RGBO

3. RESULT SUMMARY AND COMPLIANCE STATEMENT

The **Commtest Sensor Router** complies with 47 CFR Part 15 when the methods and procedures described in ANSI C63.4 – 2003 were applied

The results from testing are summarised in the following table:

Clause	Parameter	Result
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

4. TEST SAMPLE DESCRIPTION

Device Operational Description

The router forms part of a wireless sensor system.

It creates a link between a wireless sensor and a base station (central Ethernet enabled access point).

The device forwards any RF packets received on to the appropriate network node, which can be a sensor, a base station or another router.

The RF communications are driven by the CC2430 microprocessor.

Under normal operation the device will send a MAC acknowledgement response to any packets received.

A low noise amplifier (LNA) and power amplifier stages are included within the device to ensure maximum range is achieved.

The LNA is driven by a MAX2644, the PA by a MAX2242.

Testing was carried out using a supplied EMC tester programme which established a link between a supplied sensor and a computer.

For testing purposes a representative AC power supply was used to supply 12 Vdc to the device.

The device is capable of operating between 2400 – 2460 MHz in 5 MHz steps.

Testing has therefore been carried out at 2405 MHz, 2440 MHz and 2460 MHz.

IEEE 802.15.4 using Direct Sequence Spread Spectrum (DSSS) with CSMA and OQPSK modulation is used.

5. 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.

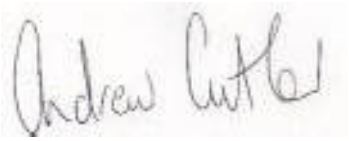
This report does not contain corrections or erasures.

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

6. RESULTS

Section 15.203 – Antenna requirement

This device has uses an internal antenna that is permanently mounted to the circuit board

Result: Complies

Section 15.205 – Restricted bands of operation

Refer to measurements made with reference to Section 15.247 (d).

Section 15.207 – Conducted emissions

Pre-testing was carried out using a representative power supply at 12 Vdc and 24 Vdc with final testing being carried out at 24 Vdc which showed the worst case results.

Conducted emissions testing was carried out over the frequency range of 150 kHz to 30 MHz using a 50 ohms / 50 microhenry artificial mains network.

Testing was carried out at the laboratory's MacKelvie Street screened room.

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

In addition the device was positioned 40cm 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 80cm from the artificial mains network.

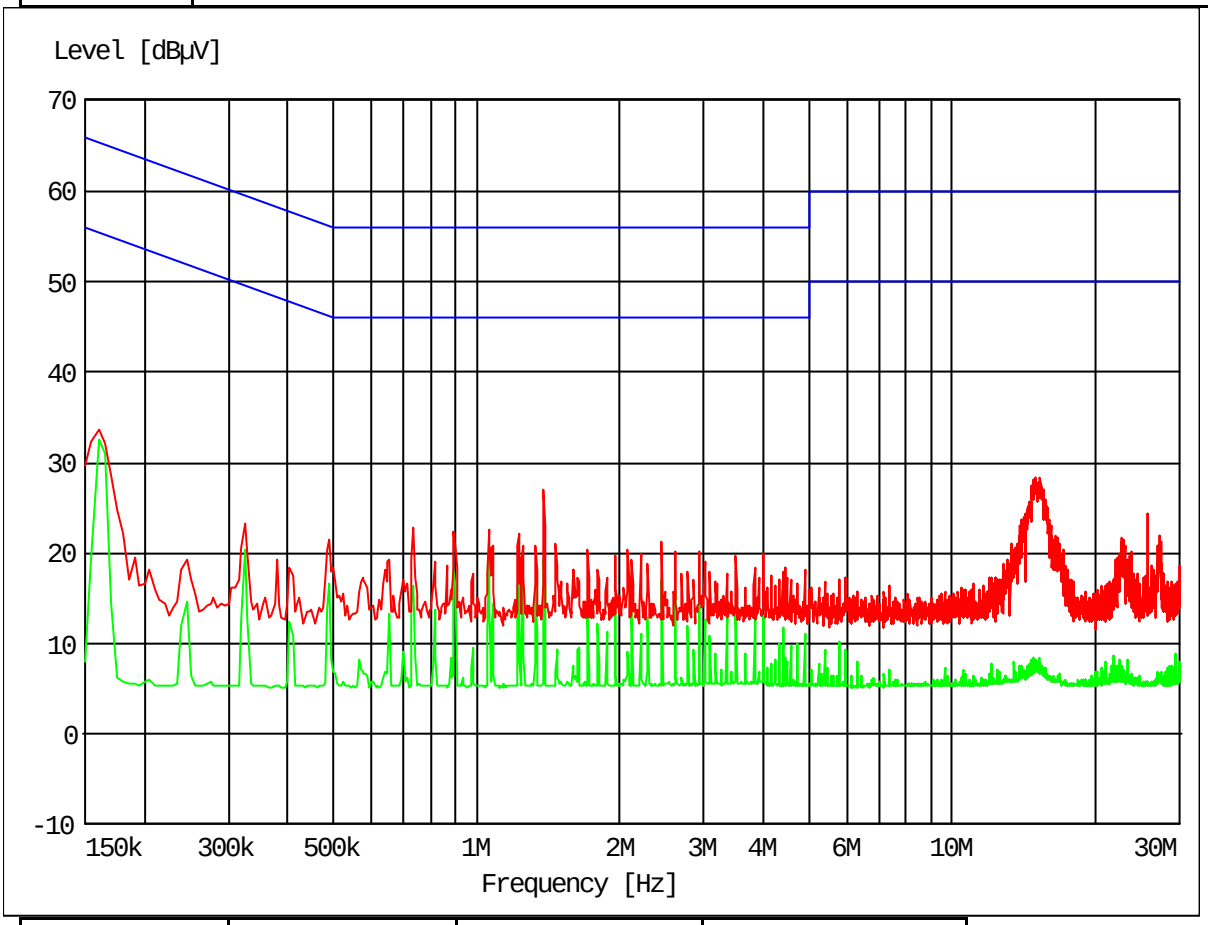
Quasi peak measurements were made with a receiver bandwidth of 9 kHz with a combined plot being produced showing the results of testing on the phase and neutral AC supply lines as a combined plot.

Measurement uncertainty with a confidence interval of 95% is:
- Mains terminal tests (0.15 - 30 MHz) ± 2.2 dB

Result: Complies with no emissions being detected within 20 dB of the applicable limit.

Conducted emissions

Comments:	Device tested transmitting continuously when powered using a representative 110 Vac to 24 Vdc power supply



Quasi-Peak Measurements

Frequency MHz	Level dBmV	Limit dBmV	Margin dB	Phase	Rechecks dBmV
No results within 20 dB of the limit					

Average Measurements

Frequency MHz	Level dBmV	Limit dBmV	Margin dB	Phase	Rechecks dBmV
No results within 20 dB of the limit					

Section 15.209 – Radiated emissions

In accordance with section 15.247(c) attenuation below the general limits specified in Section 15.209(a) except those emissions that fall within the restricted bands defined in Section 15.205(a).

Section 15.247(a)(2): Minimum bandwidth

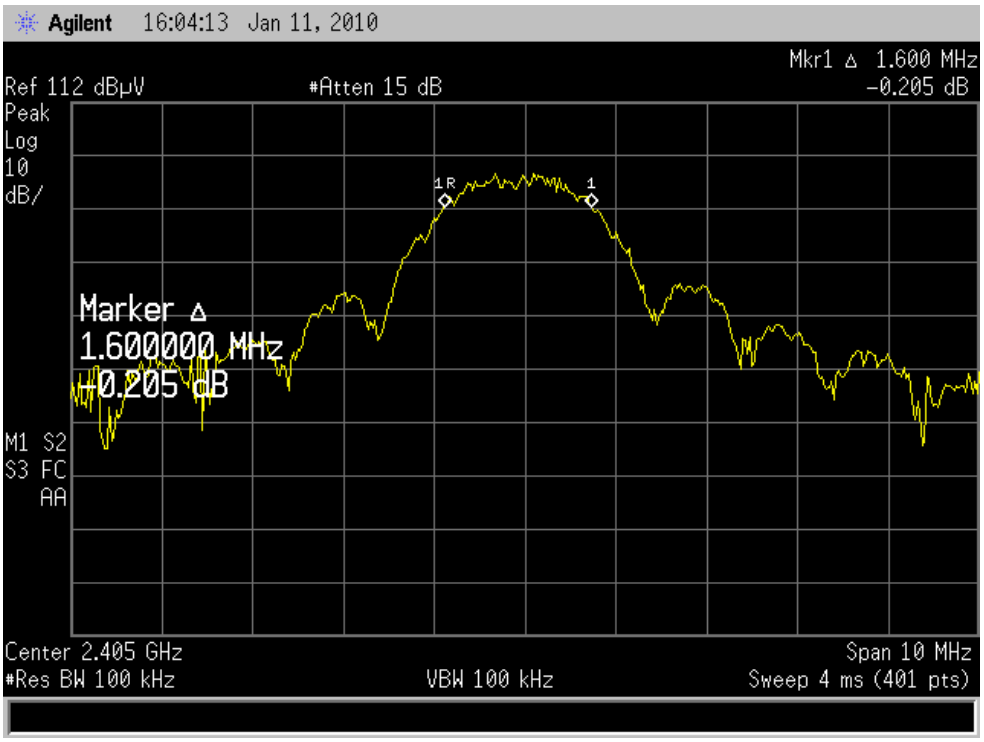
Systems using digital modulation techniques shall have a minimum 6 dB bandwidth of 500 kHz

Testing was carried on 2405 MHz, 2440 MHz and 2480 MHz with the following results:

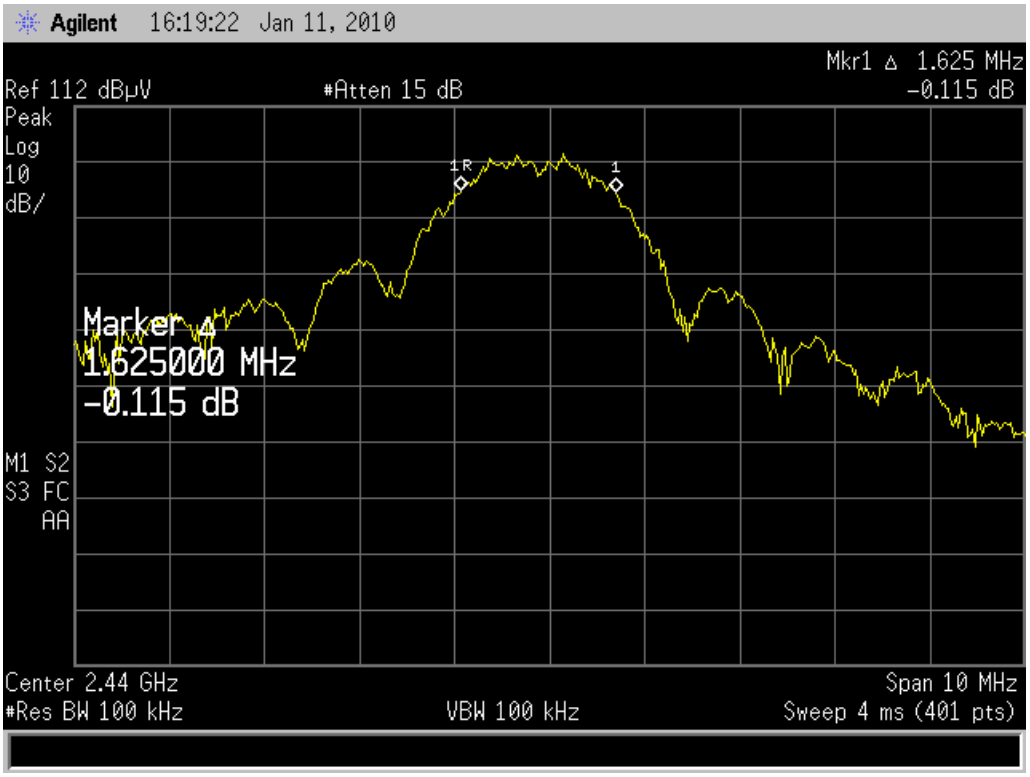
Frequency (MHz)	6 dB bandwidth (MHz)
2405.000	1.6000
2440.000	1.6250
2480.000	1.5500

Result: Complies

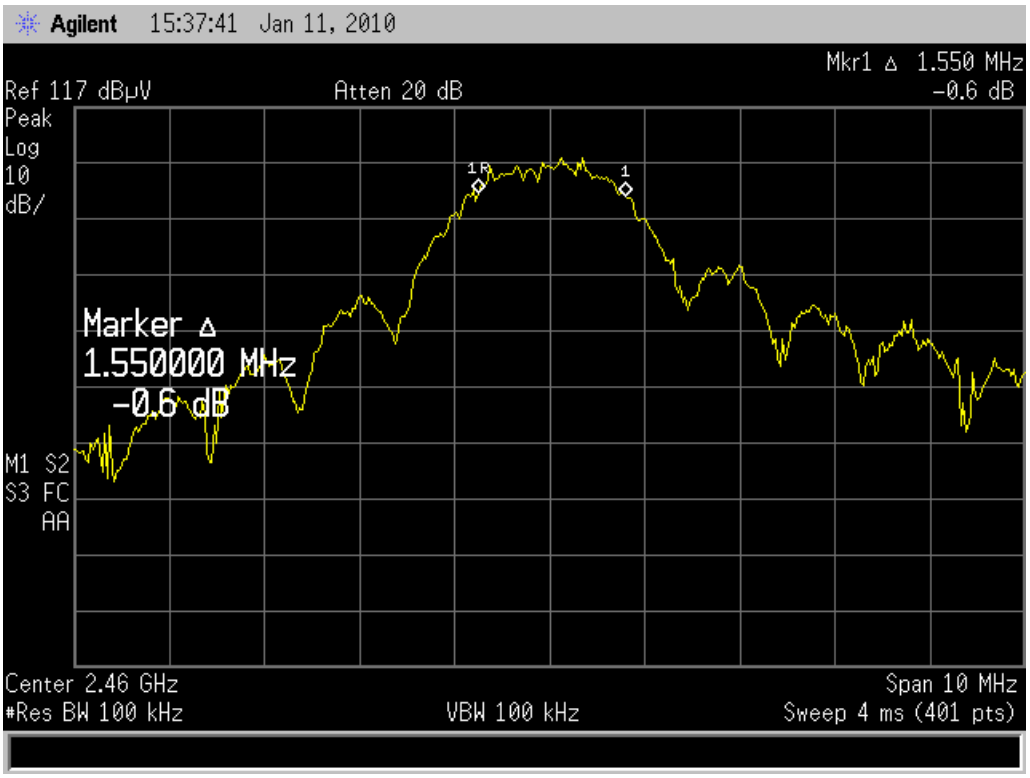
2405 MHz



2440 MHz



2480 MHz



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

Radiated peak power measurements were made as the antenna port could not be easily accessed.

Testing was carried out with a link established between a Sensor and a Ranger Station using the Booster half way along the transmission path as the Sensor could not communicate with the Ranger Station directly.

Testing was carried out on three channels being 2405.000 MHz, 2440.000 MHz and 2460.000 MHz as the module has the ability to operate on one of 12 channels with a 5 MHz separation from 2405 – 2460 MHz

Measurements were made using a spectrum analyser with a resolution bandwidth of 1 MHz when the transmitter was setup to operate on discrete frequencies.

Frequency (MHz)	Field Strength (dBuV/m)	Power (dBm)	Power (watts)	Limit (watts)
2405.000	110.4	13.0	0.020	1.0
2440.000	110.4	13.0	0.020	1.0
2460.000	109.8	12.4	0.017	1.0

The client advises that the coax connection to the module transmitter and the antenna gain approximate to a gain of 1 or 0 dBi.

Therefore the conducted limit of 1 watt (+30 dBm) has been applied.

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

Section 15.247 (c) – 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.

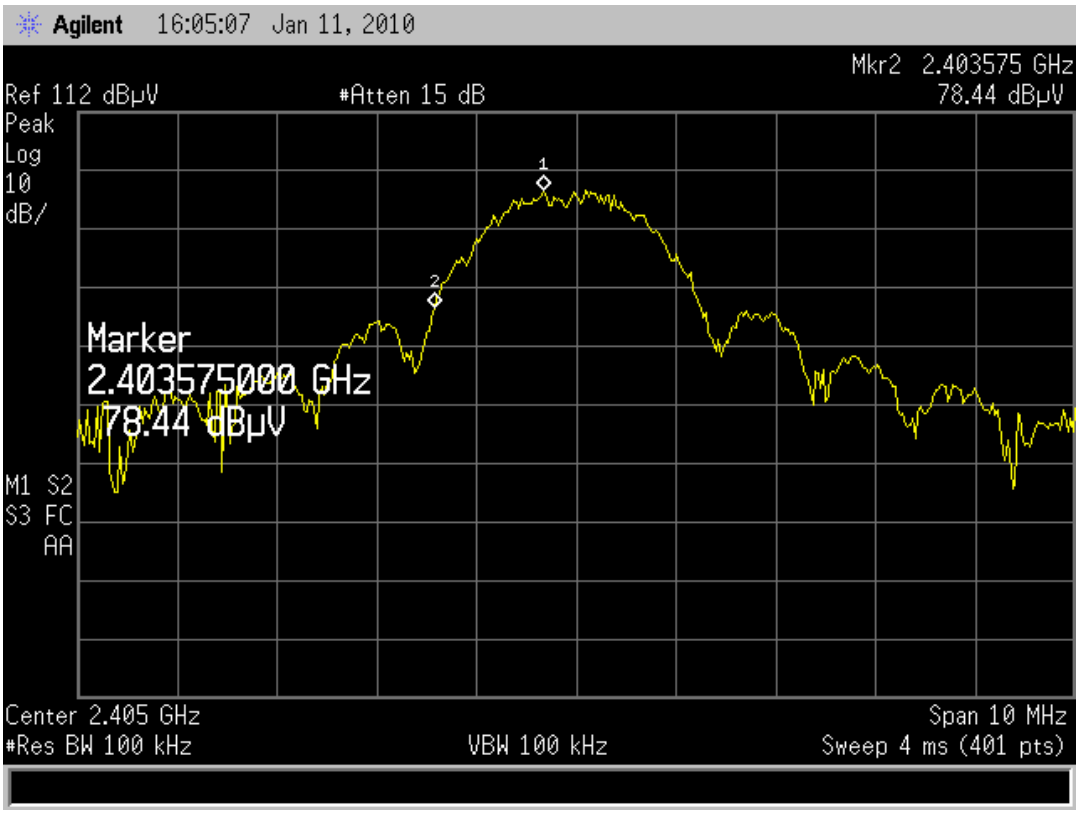
Testing was carried out when the device was transmitting on 2405 MHz and 2460 MHz with the -20 dB points determined as below.

20 dB bandwidth points

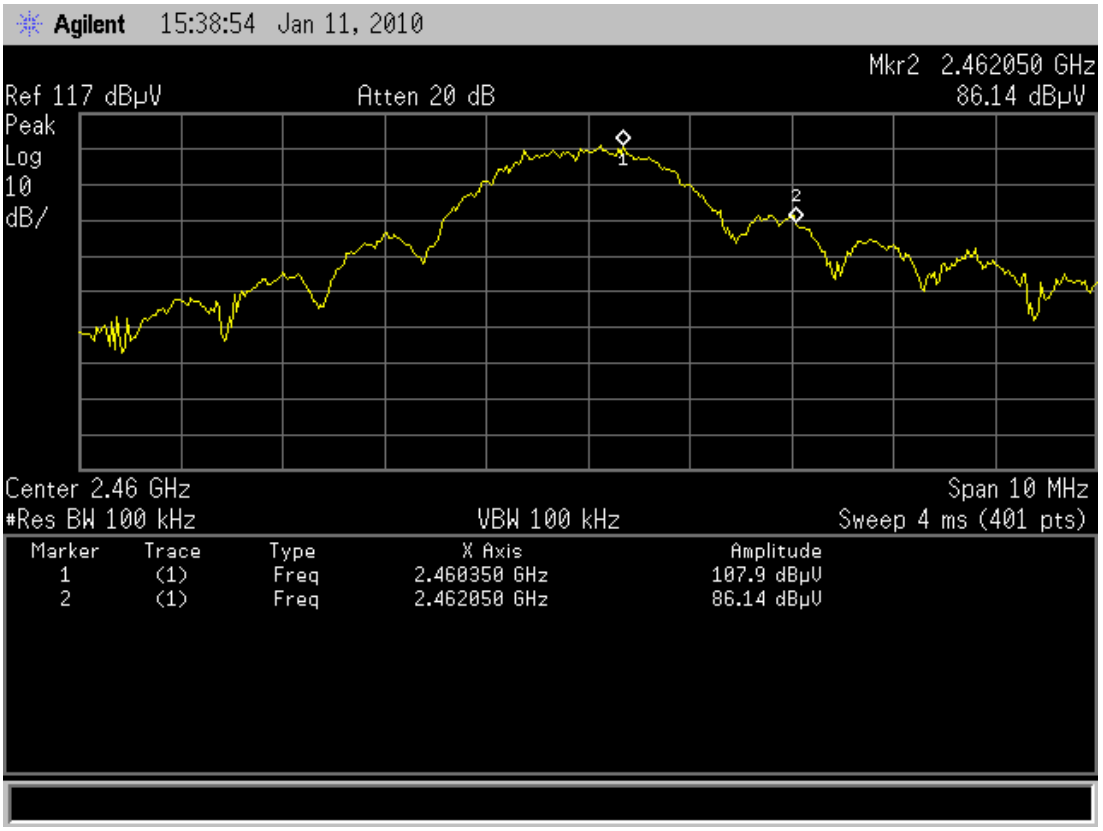
Frequency (MHz)	F low (MHz)	F high (MHz)
2405.000	2403.5750	-
2480.000	-	2462.0500

Spectrum plots showing these measurements is detailed below

2405 MHz



2460 MHz



Radiated emission measurements were made at the open area test site to confirm these levels at the band edges and in the nearby restricted bands of 2310 – 2390 MHz and 2483.5 – 2500 MHz.

Frequency MHz	Vertical dBuV/m	Horizontal dBuV/m	Limit dBuV/m	Margin dB	Detector	Antenna
2405.000	110.4	96.6			Peak	Vertical
2400.000	84.2		90.4	6.2	Peak	Vertical
2400.000		76.1	76.6	0.5	Peak	Horizontal
2390.000	65.2	54.4	74.0	8.8	Peak	Vertical
2390.000	46.5	40.4	54.0	7.5	Peak	Horizontal

Frequency MHz	Vertical dBuV/m	Horizontal dBuV/m	Limit dBuV/m	Margin dB	Detector	Antenna
2460.000	109.8	99.2			Peak	Vertical
2483.500	55.3	53.7	74.0	18.7	Peak	Vertical
2483.500	42.3	42.1	54.0	11.7	Average	Vertical

Result: Complies

Radiated emission measurements

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. Details of this site have been filed with the Commission, Registration Number: 90838, which was last updated in Jan 2010.

The device 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 with the antenna located at a 3 m horizontal distance from the boundary of the device under test.

Measurements below 1000 MHz were made using an 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. The emission is measured in both vertical and horizontal antenna polarisations.

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)

General emissions observed when the device was transmitting.

Frequency MHz	Vertical dBuV/m	Horizontal dBuV/m	Limit dBuV/m	Margin dB	Antenna Polarity
352.000	25.1	27.4	46.0	18.6	Horizontal
384.000	39.1	37.1	46.0	6.9	Vertical
416.000	39.1	37.3	46.0	6.9	Vertical
448.000	35.5	29.9	46.0	10.5	Vertical

The general limits as per section 15.209 have been applied as these emissions were present when the transmitter was not transmitting and therefore could be classed as standby emissions.

All other general emissions detected had a margin to the limit exceeding 25 dB when measurements were attempted up to 2.4 GHz using both vertical and horizontal polarisations.

Radiated transmitter spurious emission testing was carried out at a distance of 3 metres.

In the restricted bands measurements were made with a peak and an average detector with a 1 MHz bandwidth with an average limit of 54 dBuV/m being applied and a peak limit of 74 dBuV/m being applied.

In the non restricted bands measurements were made with a peak detector with a 100 kHz bandwidth with a -20 dBc limit being applied.

Measurements were attempted up to 24 GHz.

Measurements were made at a distance of 3 metres.

Measurements were made in vertical and horizontal polarisations.

Result: Complies
Measurement Uncertainty: ± 4.1 dB

Transmitting on 2405.000 MHz

Frequency MHz	Vertical dBuV/m	Horizontal dBuV/m	Limit dBuV/m	Margin dB	Detector	Antenna
4810.000	63.6	51.8	74.0	10.4	Peak	Vertical
4810.000	38.7	38.5	54.0	15.3	Average	Vertical
7215.000	63.3	69.9	74.0	4.1	Peak	Horizontal
7215.000	46.8	46.6	54.0	7.2	Average	Vertical
9620.000	62.9	53.6	74.0	11.1	Peak	Vertical
9620.000	39.5	40.3	54.0	13.7	Average	Horizontal
12025.000	66.2	58.2	74.0	7.8	Peak	Vertical
12025.000	44.1	44.1	54.0	9.9	Average	Vertical
14430.000	61.6	60.7	74.0	12.4	Peak	Vertical
14430.000	47.6	47.6	54.0	6.4	Average	Vertical
16835.000	57.8	57.6	74.0	16.2	Peak	Vertical
16835.000	44.8	44.7	54.0	9.2	Average	Vertical
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

Transmitting on 2440.000 MHz

Frequency MHz	Vertical dBuV/m	Horizontal dBuV/m	Limit dBuV/m	Margin dB	Detector	Antenna
4880.000	65.5	51.8	74.0	8.5	Peak	Vertical
4880.000	38.7	38.7	54.0	15.3	Average	Vertical
7320.000	73.8	64.3	74.0	0.2	Peak	Vertical
7320.000	47.3	47.2	54.0	6.7	Average	Vertical
9760.000	62.9	53.1	74.0	11.1	Peak	Vertical
9760.000	39.7	39.6	54.0	14.3	Average	Vertical
12200.000	69.4	57.4	74.0	4.6	Peak	Vertical
12200.000	43.5	43.5	54.0	10.5	Average	Vertical
14640.000	61.3	60.2	74.0	12.7	Peak	Vertical
14640.000	46.5	46.5	54.0	7.5	Average	Vertical
17080.000	60.3	60.2	74.0	13.7	Peak	Vertical
17080.000	47.1	47.0	54.0	6.9	Average	Vertical
19520.000	-	-	74.0	-	Peak	Vertical
19520.000	-	-	54.0	-	Average	Vertical
21960.000	-	-	74.0	-	Peak	Vertical
21960.000	-	-	54.0	-	Average	Vertical

Transmitting on 2460.000 MHz

Frequency MHz	Vertical dBuV/m	Horizontal dBuV/m	Limit dBuV/m	Margin dB	Detector	Antenna
4920.000	52.1	64.0	74.0	10.0	Peak	Horizontal
4920.000	39.0	39.1	54.0	14.9	Average	Horizontal
7380.000	67.3	72.1	74.0	1.9	Peak	Horizontal
7380.000	49.0	37.6	54.0	5.0	Average	Vertical
9840.000	63.7	63.1	74.0	10.3	Peak	Vertical
9840.000	40.3	40.4	54.0	13.6	Average	Horizontal
12300.000	67.3	57.5	74.0	6.7	Peak	Vertical
12300.000	43.7	43.5	54.0	10.3	Average	Vertical
14760.000	62.1	58.8	74.0	11.9	Peak	Vertical
14760.000	45.3	45.3	54.0	8.7	Average	Vertical
17220.000	61.6	60.7	74.0	12.4	Peak	Vertical
17220.000	47.6	47.6	54.0	6.4	Average	Vertical
19680.000	-	-	74.0	-	Peak	Vertical
19680.000	-	-	54.0	-	Average	Vertical
22140.000	-	-	74.0	-	Peak	Vertical
22140.000	-	-	54.0	-	Average	Vertical

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.

As this device as no antenna terminals measurements have been made using radiated test methods with the conducted power being derived.

It has been assumed that the integral antenna has unity gain (0 dB).

Measurements were made using 12 and 24 Vdc however this variation in DC supply voltage did not vary the observed output power.

The radiated power was derived from the field strength using the formula:
Power (watts) = (Field Strength (V/m)* Distance (m))^2) / 30 * Antenna Gain.

Frequency (MHz)	Level (dBuV/m)	Density (dBm)	Limit (dBm)	Antenna Polarisation
2405.0250	88.4	-6.8	8.0	Vertical
2440.0205	86.7	-8.5	8.0	Vertical
2460.2224	87.1	-8.1	8.0	Vertical

Measurements were made at the test site over a distance of 3 metres in both vertical and horizontal polarisations.

Result: Complies
Measurement Uncertainty: ± 4.1 dB

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).

In accordance with this section, and also Section 2.1091, this device has been defined as a mobile device whereby a distance of 20 cm can normally be maintained between the user and the device.

In accordance with Section 1.1310 the Maximum Permissible Exposure (MPE) limits for the General Population / Uncontrolled Exposure of 1.0 mW/cm^2 have 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:

$E, V/m = (\sqrt{} (30 * P * G)) / d$

Power density, $mW/cm^2 = E^2/3770$

E for MPE: $1 = E^2/3770$

$E = \sqrt{}1*3770$

$E = \underline{61.4\ V/m}$

The highest radiated power measured was 13.0 dBm = 20 mW

Therefore:

$E = \sqrt{} (30 * P * G) / d$

$d = \sqrt{} (30 * P * G) / E$

$d = \sqrt{} (30*0.020) / 61.4$

$d = \underline{0.013\ m\ or\ 1.3\ cm}$

This device will comply providing a safe distance of 20.0 cm is specified.

Result: Complies

7. TEST EQUIPMENT USED

Instrument	Manufacturer	Model	Serial No	Asset Ref	Cal Due
Aerial Controller	EMCO	1090	9112-1062	RFS 3710	Not applicable
Aerial Mast	EMCO	1070-1	9203-1661	RFS 3708	Not applicable
Turntable	EMCO	1080-1-2.1	9109-1578	RFS 3709	Not applicable
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 2010
Microwave Preamp	Hewlett Packard	8349B	2644A01659	-	20 April 2010
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 2010
Horn Antenna	EMCO	3116	2276	-	10 May 2010

8. ACCREDITATIONS

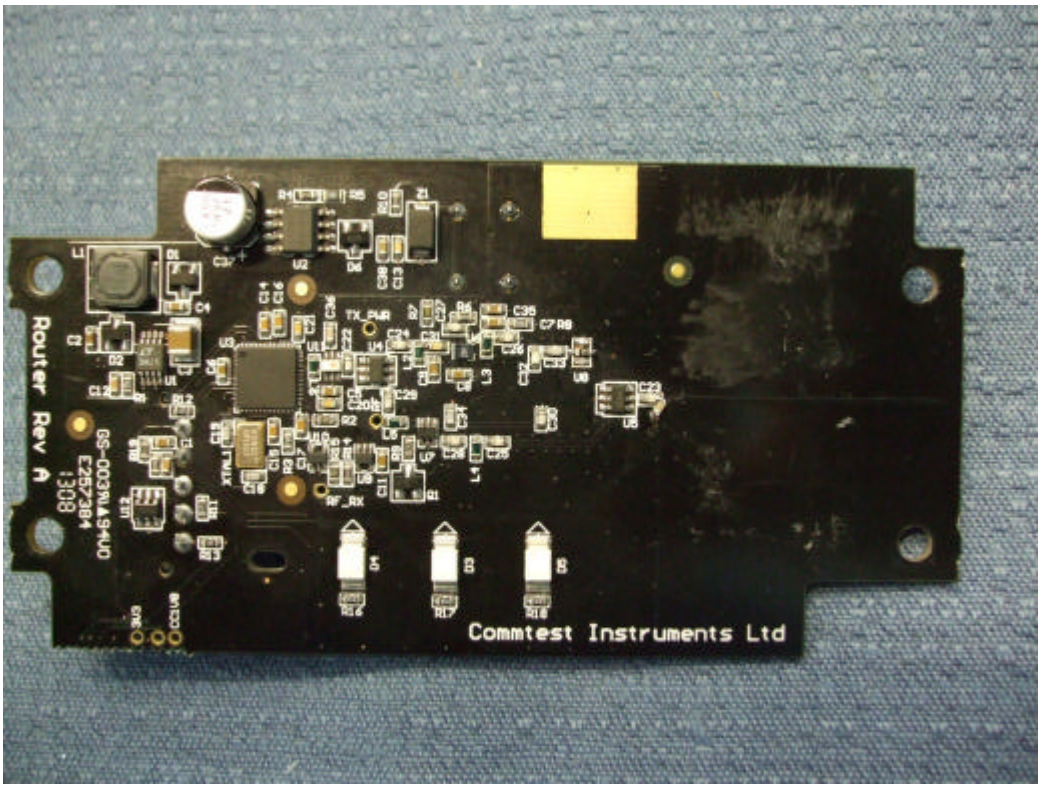
Testing was carried out at EMC Technologies NZ Ltd Open Area Test Site, which is located at Driving Creek, Orere Point, Auckland. Details of this site have been filed with the Commission, Registration Number: 90838, which was last updated in January 2010.

The tests were carried out in accordance with the terms of EMC Technologies (NZ) Ltd's International Accreditation New Zealand (IANZ) Accreditation to NZS/ISO/IEC 17025: 2005.

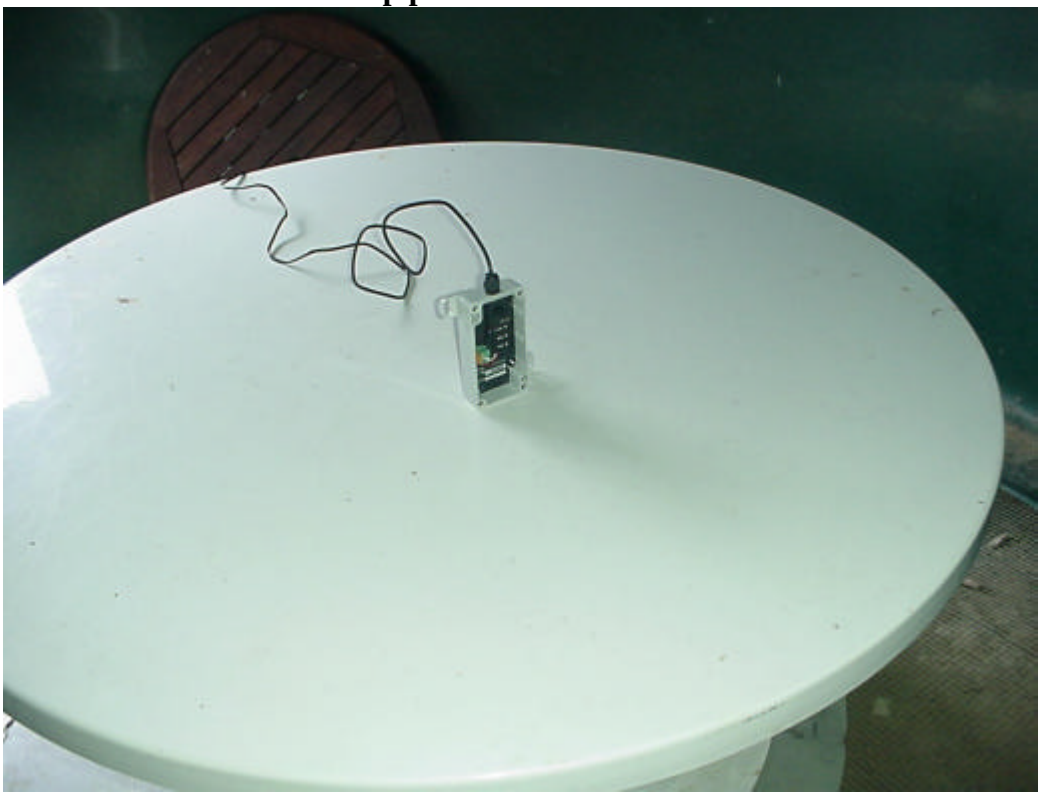
All measurement equipment has been calibrated in accordance with the terms of EMC Technologies (NZ) Ltd's International Accreditation New Zealand (IANZ) Accreditation to NZS/ISO/IEC 17025: 2005.

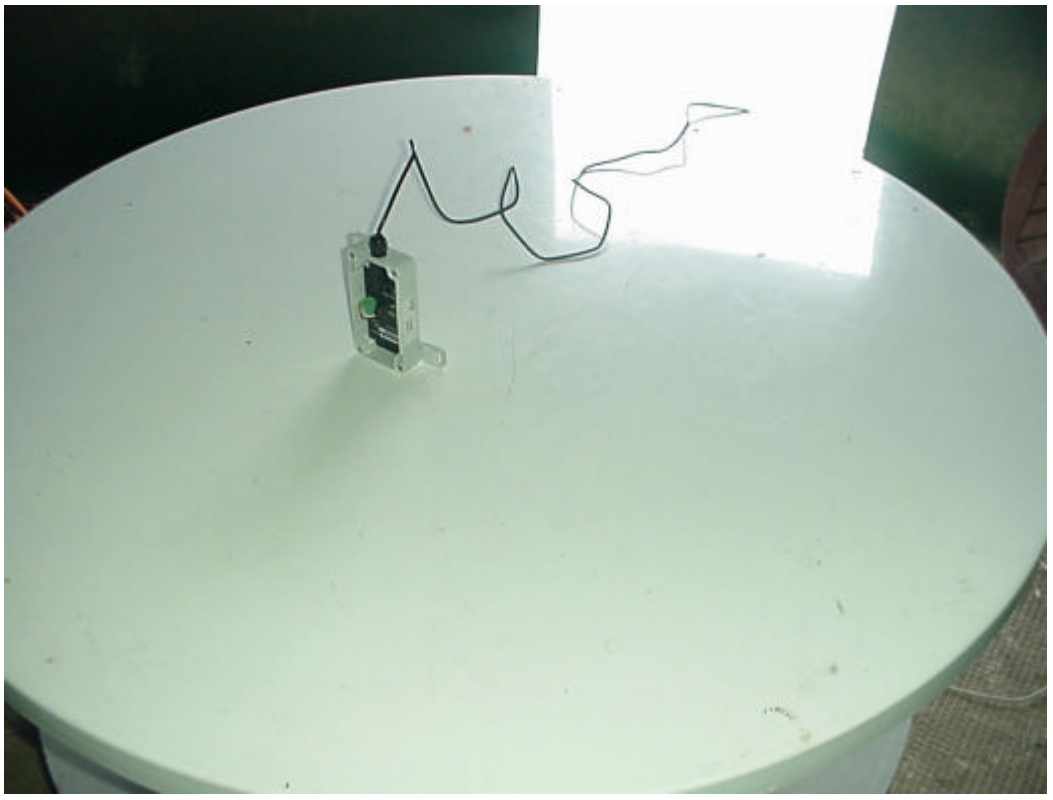
9. PHOTOGRAPH (S)


12-24V DC
Power
PAN
Status
Reset
Program


Router Rev A
Commtest Instruments Ltd

Test set up photos – Radiated emissions





Conducted emissions using the 24 Vdc power supply