



EMC Technologies (NZ) Ltd
PO Box 68-307
Newton, Auckland
Phone 09 360 0862
Fax 09 360 0861
E-Mail Address: aucklab@ihug.co.nz
Web Site: www.emctech.com.au

TEST REPORT

Fisher and Paykel Dishdrawer Transceiver

tested to the

Code of Federal Regulations (CFR) 47

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

Section 15.249 – Operation in the band 2400 – 2483.5 MHz

for

Fisher and Paykel Appliances 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. STATEMENT OF COMPLIANCE

The **Fisher and Paykel Dishdrawer Transceiver** complies with 47 CFR Part 15 and in particular Sections, 15.205, 15.207, 15.209, 15.215 and 15.249 as detailed below when tested in accordance with ANSI C63.4 – 2003.

2. RESULTS SUMMARY

Clause	Description	Result
15.201	Equipment authorisation requirement	Applied
15.203	Antenna requirement	Complies
15.204	External power amplifiers	Not applicable
15.205	Operation in restricted bands	Complies
15.207	Conducted emissions	Not applicable
15.209	Radiated emissions	See below
15.215	Additional provisions	Complies
15.249 (a)	Field strength of fundamental	Complies
15.249 (a)	Field strength of harmonics	Complies
15.249 (b)	Fixed, point to point operations	Not applicable
15.249 (c)	3 metre measurement distance	Noted
15.249 (d)	Spurious emission levels except harmonics	Complies
15.249 (e)	Detectors above 1000 MHz	Noted
15.249 (f)	Reference to section 15.37(d)	Noted

3. CLIENT INFORMATION

Company Name Fisher and Paykel Appliances Ltd

Address Level 2, Wall Street Mall
211 George Street

City Dunedin 9016

Country New Zealand

Contact Mr Craig Boon

4. DESCRIPTION OF TEST SAMPLE

Brand Name	Fisher and Paykel
Model	Dish drawer
Model Number	523469
Product	Transceiver
Manufacturer	Fisher and Paykel Appliances Ltd
Country of Origin	New Zealand
Serial Number	523469000022
FCC ID	ZQG-DD7INTRX

5. EQUIPMENT PARAMETERS

The remote tested has the following RF specifications:

FCC Band:	2400 MHz – 2483.5 MHz
Test Frequencies:	2404, 2441, 2477 MHz
Operating Frequencies:	2404, 2425, 2442, 2463, 2477 MHz
Rated Power:	1.00 mW (+0 dBm)
Modulation Type:	GFSK, 2 Mbps data rate
Antenna Type:	Integral
Power Supply:	External 120 Vac from the Dish drawer
Radio Module Type:	Nordic nRF24LE01

An overview of the system is as follows:

The system is event based using the radio component of the Nordic nRF24LE01 chip and that is driven by library code from Nordic and also Fisher and Paykel developed code.

Testing was carried out on the transceiver contained within the Dish drawer.

The Dish drawer transceiver cannot be directly activated by the user however it is activated when an external remote control transceiver is used.

When the user presses a button on the remote device the transmitter sends a “button event” message and then waits for the Dish drawer to return an acknowledge message.

In normal use there would be two “button event” messages every time a user runs a wash cycle which for most would be once or twice a day

The transmitter will always transmit on the last known good channel.

If an acknowledge message is not received from the Dish drawer after two attempts (with a delay before each) then the transmitter will select another channel from the list programmed list of frequencies at random and it then tries again.

The transmitter will then cycle through the list of frequencies up to seven times before giving up.

When the transmitter gives up, the remote device transceiver flashes a LED as an “out of range” indicator to the user.

The user can retry at their discretion.

The receiver scans each channel in the frequency list on a timed basis until it gets a valid message.

When the receiver sends the acknowledge message before restarting the scan it pauses on each channel for 3ms.

When the receiver is scanning there is some latency and it can be expected that the transmitter will retry several times before the receiver channel matches the transmit channel.

The transmit data rate is 2Mb/s.

A total of 45 bytes are transferred in the “button event” and acknowledge messages.

The message transfer time (including retries) is around 5 ms or less. When a dish wash is started the transmitter would be on for about 10ms for a duty of less than 0.1% in a given hour.

The Dish drawer transceiver is contained within the Dish drawer and is powered at the AC mains supply which in this case was 120 Vac.

As the Dish drawer transceiver is externally activated and has no user controls a sample of this transceiver was removed from the Dish drawer and was tested using an external 5 Vdc power supply in a “naked state” with this being determined to be a worst case configuration.

Additional testing was carried out with the Dish drawer transceiver being installed into a fully functioning Dish drawer.

The results of these tests gave results that were very similar or less than the results obtained when the device was tested in a “naked state”.

The results obtained were certainly no higher or worse than the naked state results.

6. ATTESTATION

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

The client selected the test sample.

The report relates only to the sample tested.

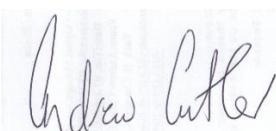
This report does not contain corrections or erasures.

Measurement uncertainties with statistical confidence intervals of 95% are shown below test results. Both Class A and Class B uncertainties have been accounted for, as well as influence uncertainties where appropriate.

In addition this equipment has been tested in accordance with the requirements contained in the appropriate Commission regulations.

To the best of my knowledge, these tests were performed using measurement procedures that are consistent with industry or Commission standards and demonstrate that the equipment complies with the appropriate standards.

I further certify that the necessary measurements were made by EMC Technologies NZ Ltd, 47 MacKelvie Street, Grey Lynn, Auckland, New Zealand.



Andrew Cutler
General Manager
EMC Technologies NZ Ltd

7. TRANSMITTER TEST RESULTS

Section 15.201: Equipment authorisation requirement

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

Section 15.203 – Antenna requirement

The transmitter and receiver in this device uses a 2.4 GHz antenna that is integral to the device

Result: Complies

Section 15.204: External radio frequency power amplifiers and antenna modifications

An external power amplifier is not supplied with this device and it is not possible to attach an external power amplifier to the mouse.

Result: Complies.

Section 15.205 – Restricted bands of operation

Refer to measurements made with reference to Section 15.249 (a).

This device operates in the 2400 – 2483.5 MHz which is not a restricted band.

Result: Complies

Section 15.207 – Conducted emissions

Conducted emission testing has been carried out when the device was powered at 120 Vac using the supplied Dish drawer.

Testing was carried out while the device was in standby awaiting an activation from a remote control device and while it was being continuously activated using a remote control (an audible beep was heard after each transmission).

Conducted emissions testing was carried out over the frequency range of 150 kHz to 30 MHz 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 in accordance with section 15.207(a) using a measuring receiver and a 50 uH / 50 ohm artificial mains network which is also known as a line impedance stabilisation network (LISN).

Measurements on both the phase and neutral lines were made using either a Quasi Peak or an Average detector with a 9 kHz bandwidth.

The supplied conducted emission plot is a combined plot showing the worst case of the Peak, Quasi Peak and Average levels for both phase and neutral.

The Class B conducted limits have been applied

Result: Complies

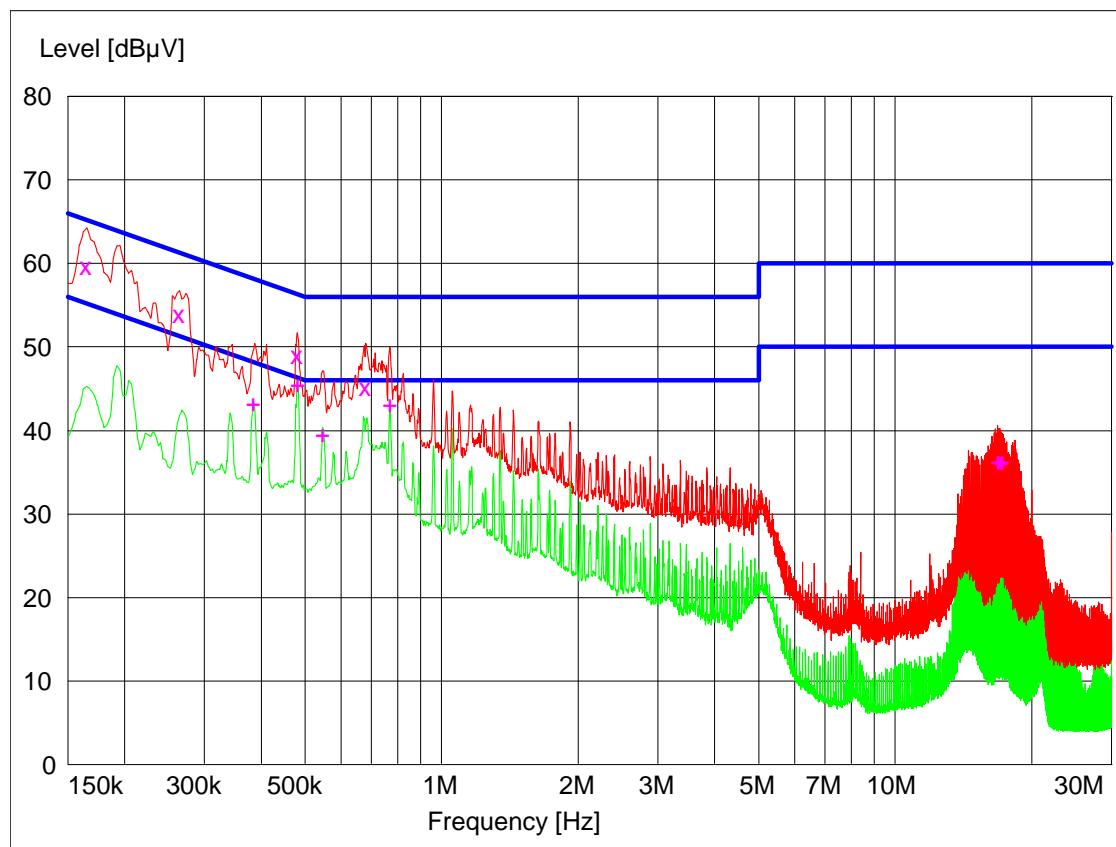
Measurement uncertainty with a confidence interval of 95% is:

Conducted emissions tests (0.15 - 30 MHz) \pm 2.2 dB

Conducted Emissions – AC Input Power Port

Setup:	Device tested when operating in receive mode awaiting a signal from a remote control transmitter when the dish drawer was powered at 120 Vac.
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Peak --- Average -- Quasi Peak X Average +



Final Quasi-Peak Measurements

Frequency MHz	Level dB μ V	Limit dB μ V	Margin dB	Phase	Rechecks dB μ V
0.165000	59.70	65.2	5.5	L1	
0.264000	53.90	61.3	7.4	L1	
0.480000	49.10	56.3	7.2	N	
0.681000	45.20	56.0	10.8	N	

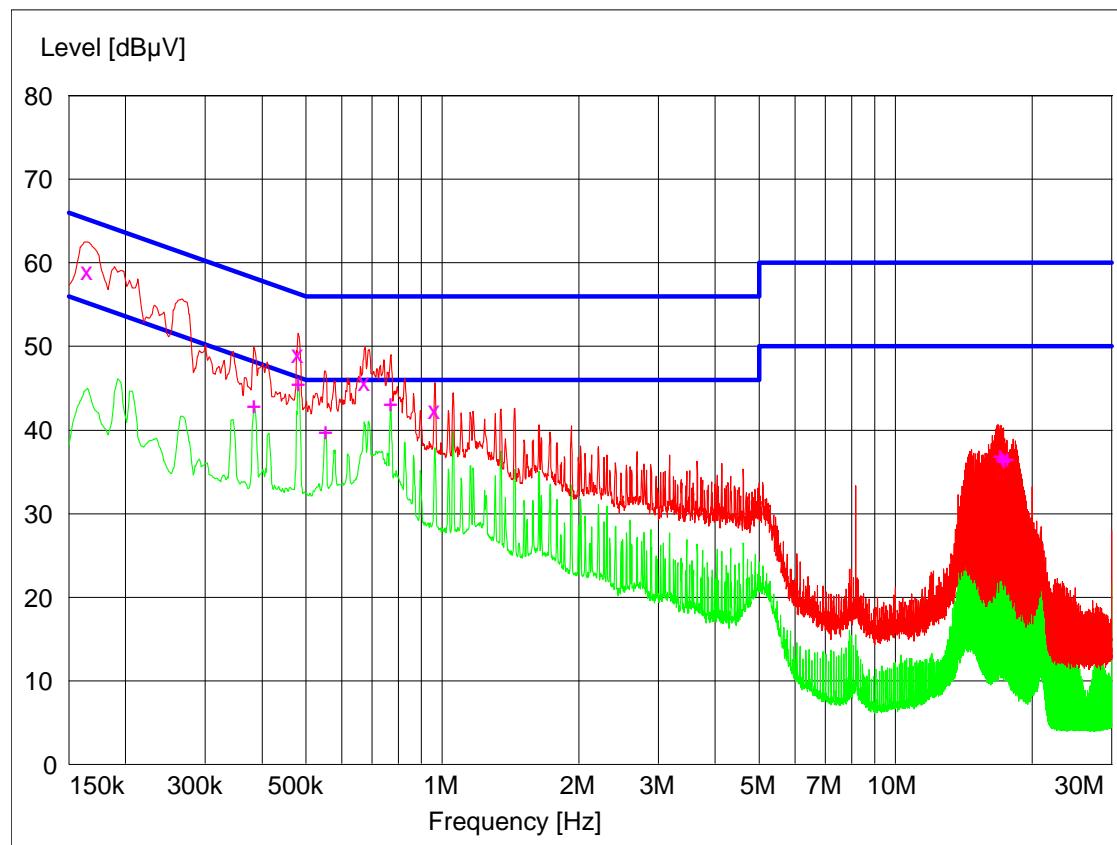
Final Average Measurements

Frequency MHz	Level dB μ V	Limit dB μ V	Margin dB	Phase	Rechecks dB μ V
0.384000	43.30	48.2	4.9	N	
0.480000	45.60	46.3	0.7	N	45.8
0.546000	39.60	46.0	6.4	N	
0.768000	43.20	46.0	2.8	N	
16.827500	36.40	50.0	13.6	L1	
16.922000	36.40	50.0	13.6	L1	
17.115500	36.20	50.0	13.8	N	
17.214500	36.40	50.0	13.6	L1	

Conducted Emissions – AC Input Power Port

Setup:	Device tested when operating in transmit mode when receiving a periodic signal, every 1 second, from a remote control transmitter when the dish drawer was powered at 120 Vac.
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Peak --- Average -- Quasi Peak X Average +



Final Quasi-Peak Measurements

Frequency MHz	Level dB μ V	Limit dB μ V	Margin dB	Phase	Rechecks dB μ V
0.165000	59.10	65.1	6.1	N	
0.480000	49.10	56.4	7.3	N	
0.675000	45.80	56.0	10.2	L1	
0.963000	42.40	56.0	13.6	N	

Final Average Measurements

Frequency MHz	Level dB μ V	Limit dB μ V	Margin dB	Phase	Rechecks dB μ V
0.384000	43.00	48.2	5.2	N	
0.480000	45.60	46.4	0.8	N	
0.552000	39.90	46.0	6.1	N	
0.768000	43.20	46.0	2.8	L1	
17.021000	37.00	50.0	13.0	L1	
17.214500	36.60	50.0	13.4	L1	
17.309000	36.50	50.0	13.5	N	
17.597000	36.70	50.0	13.3	L1	

Section 15.209 – Radiated emissions

In accordance with section 15.249 (d) the general emission limits specified in Section 15.209 (a) have been applied to all emissions except the transmitter harmonics.

See Section 15.249 (a) for further details.

Section 15.215 (c) – Additional provisions to the general radiated emission limitations

The device operates in the 2400 – 2483.5 MHz band.

Spectrum mask measurements have been made at 2404 and 2477 MHz to ensure that the 20 dB bandwidth of the modulated signal is contained within the assigned frequency band.

Measurements have actually been made at the -23 dB which show compliance with the -20 dB requirements

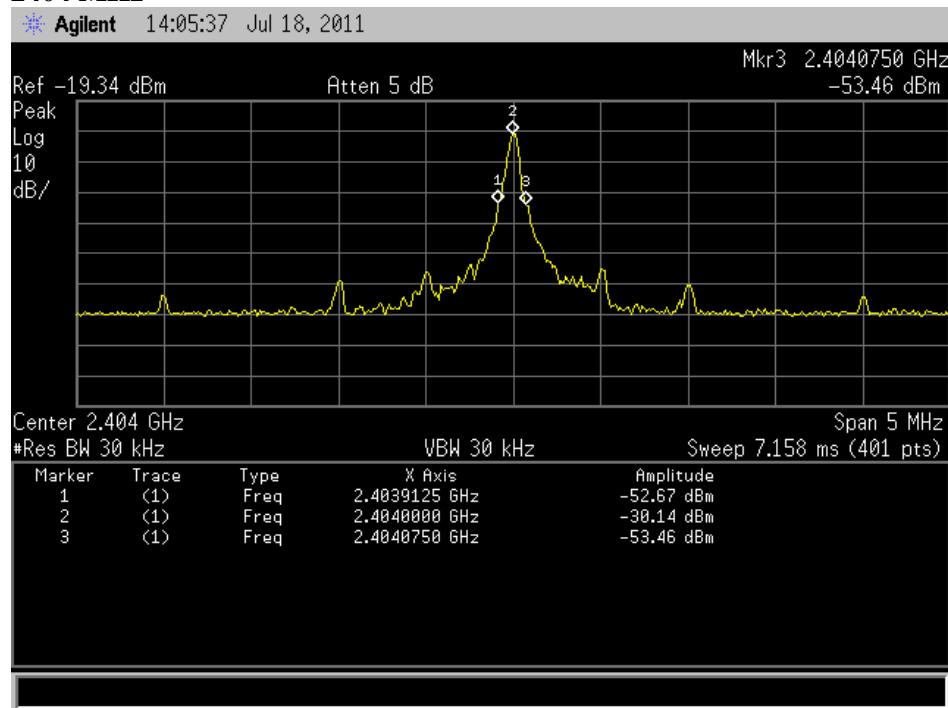
Frequency (MHz)	F low (MHz)	F high (MHz)
2404.000	2403.9125	Not applicable
2477.000	Not applicable	2477.1000

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

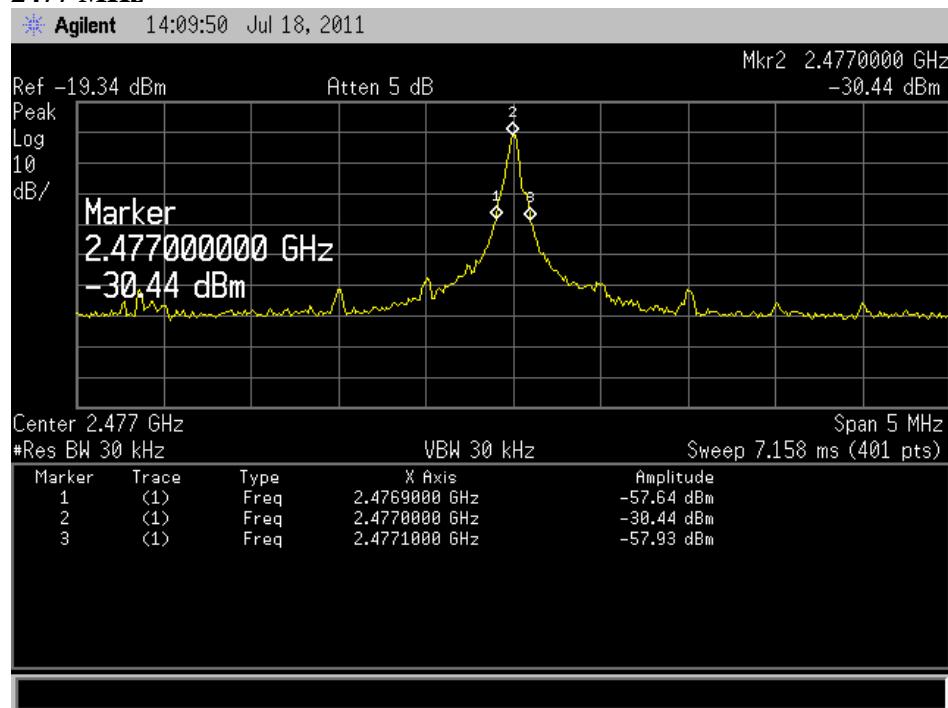
The actual measurement plots are detailed below

Results: Complies

2404 MHz



2477 MHz



Section 15.249 (a) – Field strength of the Fundamental and Harmonics

Radiated emission measurements were carried out with the limits as per section 15.249 (a) being applied to the Fundamental and Harmonics of each transmitter.

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

The transmitter was placed on the test table top which was a total of 0.8 m above the test site ground plane.

Measurements of the radiated field were made 3 metres from the transmitting antenna.

Measurements below 1000 MHz were made using a Quasi Peak Detector with a bandwidth of 120 kHz.

Measurements above 1000 MHz were made using an average detector with a bandwidth of 1.0 MHz and also a peak detector with a bandwidth of 1.0 MHz.

The limit as specified section 15.249 was applied to the average detector levels with a factor of 20 dB being applied to these levels when they were then measured using a peak detector.

When an emission is located, it is positively identified and its maximum level is found by rotating the automated turntable, and by varying the antenna height with an automated antenna tower.

All emissions were measured in both vertical and horizontal antenna polarisations.

The emission is measured in both vertical and horizontal antenna polarisations with no measurements were made above the 10th harmonic

The client modified the devices in order that the transmitter could transmit continuously on a low, middle and top frequency of operation.

As the device is portable testing was carried out in the X, Y and Z planes.

The emission level is determined in field strength by taking the following into consideration:

Level (dB μ V/m) = Receiver Reading (dB μ V) + Antenna Factor (dB) + Coax Loss (dB) – Amplifier Gain (dB)

Fundamental emission

Frequency (MHz)	Vertical (dBuV/m)	Horizontal (dBuV/m)	Limit (dBuV/m)	Antenna	Margin (dB)	Detector Antenna
Upright						
2477.0000	81.5	84.7	94.0	Horizontal	9.3	Peak
2440.0000	79.9	83.9	94.0	Horizontal	10.1	Peak
2404.0000	72.5	85.9	94.0	Horizontal	8.1	Peak
Laying Flat						
2477.0000	81.2	87.9	94.0	Horizontal	6.1	Peak
2440.0000	74.5	87.1	94.0	Horizontal	6.9	Peak
2404.0000	73.5	87.5	94.0	Horizontal	6.5	Peak
Left edge						
2477.0000	89.4	87.2	94.0	Vertical	4.6	Peak
2440.0000	85.9	82.6	94.0	Vertical	8.1	Peak
2404.0000	81.2	83.6	94.0	Horizontal	10.4	Peak

Testing was carried out in the X, Y and Z planes when it was transmitting continuously in a naked state.

Section 15.249 specifies a limit of 50 mV/m when an average detector is used for devices operating the band 2400 – 2483.5 MHz.

As the measurements showed that the device would comply when a peak detector with a 1 MHz RBW was used, average detector measurements were not carried out.

This limit has been converted to dBuV/m using the formula $20 * (\log 0.050 / 0.000001)$

Result: Complies

Measurement uncertainty with a confidence interval of 95% is:

- Free radiation tests (30 – 25,000 MHz) ± 4.1 dB

Spurious emissions

Transmitting on 2404 MHz

Frequency (MHz)	Vertical (dBuV/m)	Horizontal (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna	Detector
4808.000	-	-	74.0	-	Vert/Hort	Peak
4808.000	-	-	54.0	-	Vert/Hort	Average
7212.000	-	-	74.0	-	Vert/Hort	Peak
7212.000	-	-	54.0	-	Vert/Hort	Average
9616.000	-	-	74.0	-	Vert/Hort	Peak
9616.000	-	-	54.0	-	Vert/Hort	Average
12020.000	-	-	74.0	-	Vert/Hort	Peak
12020.000	-	-	54.0	-	Vert/Hort	Average
14424.000	-	-	74.0	-	Vert/Hort	Peak
14424.000	-	-	54.0	-	Vert/Hort	Average
16828.000	-	-	74.0	-	Vert/Hort	Peak
16828.000	-	-	54.0	-	Vert/Hort	Average
19232.000	-	-	74.0	-	Vert/Hort	Peak
19232.000	-	-	54.0	-	Vert/Hort	Average
21636.000	-	-	74.0	-	Vert/Hort	Peak
21636.000	-	-	54.0	-	Vert/Hort	Average
24040.000	-	-	74.0	-	Vert/Hort	Peak
24040.000	-	-	54.0	-	Vert/Hort	Average

Transmitting on 2441 MHz

Frequency (MHz)	Vertical (dBuV/m)	Horizontal (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna	Detector
4882.000	-	-	74.0	-	Vert/Hort	Peak
4882.000	-	-	54.0	-	Vert/Hort	Average
7323.000	-	-	74.0	-	Vert/Hort	Peak
7323.000	-	-	54.0	-	Vert/Hort	Average
9764.000	-	-	74.0	-	Vert/Hort	Peak
9764.000	-	-	54.0	-	Vert/Hort	Average
12205.000	-	-	74.0	-	Vert/Hort	Peak
12205.000	-	-	54.0	-	Vert/Hort	Average
14646.000	-	-	74.0	-	Vert/Hort	Peak
14646.000	-	-	54.0	-	Vert/Hort	Average
17087.000	-	-	74.0	-	Vert/Hort	Peak
17087.000	-	-	54.0	-	Vert/Hort	Average
19528.000	-	-	74.0	-	Vert/Hort	Peak
19528.000	-	-	54.0	-	Vert/Hort	Average
21969.000	-	-	74.0	-	Vert/Hort	Peak
21969.000	-	-	54.0	-	Vert/Hort	Average
24410.000	-	-	74.0	-	Vert/Hort	Peak
24410.000	-	-	54.0	-	Vert/Hort	Average

Transmitting on 2477 MHz

Frequency (MHz)	Vertical (dBuV/m)	Horizontal (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna	Detector
4954.000	-	-	74.0	-	Vert/Hort	Peak
4954.000	-	-	54.0	-	Vert/Hort	Average
7431.000	-	-	74.0	-	Vert/Hort	Peak
7431.000	-	-	54.0	-	Vert/Hort	Average
9908.000	-	-	74.0	-	Vert/Hort	Peak
9908.000	-	-	54.0	-	Vert/Hort	Average
12385.000	-	-	74.0	-	Vert/Hort	Peak
12385.000	-	-	54.0	-	Vert/Hort	Average
14862.000	-	-	74.0	-	Vert/Hort	Peak
14862.000	-	-	54.0	-	Vert/Hort	Average
17339.000	-	-	74.0	-	Vert/Hort	Peak
17339.000	-	-	54.0	-	Vert/Hort	Average
19816.000	-	-	74.0	-	Vert/Hort	Peak
19816.000	-	-	54.0	-	Vert/Hort	Average
22293.000	-	-	74.0	-	Vert/Hort	Peak
22293.000	-	-	54.0	-	Vert/Hort	Average
24770.000	-	-	74.0	-	Vert/Hort	Peak
24770.000	-	-	54.0	-	Vert/Hort	Average

No emissions were detected from the device when measurements were attempted at a distance of 3 metres using vertical and horizontal polarisations using both an average and peak detector with a bandwidth of 1 MHz.

As per section 15.249 a limit of 500 μ V/m has been applied to the harmonic emissions when an average detector and a factor of +20 dB has been applied with a peak detector was used.

This limit has been converted to dB μ V/m using the formula $20 * (\log 500)$

The emission level is determined in field strength by taking the following into consideration:

Level (dB μ V/m) = Receiver Reading (dB μ V) + Antenna Factor (dB) + Coax Loss (dB) – Microwave Preamplifier Gain (dB)

Result: Complies

Measurement uncertainty with a confidence interval of 95% is:

- Free radiation tests $(30 - 25,000 \text{ MHz}) \pm 4.1 \text{ dB}$

7. 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 2011
Mains Network	R & S	ESH2-Z5	881362/032	3628	21 Aug 2011
Receiver	R & S	ESCS 30	847124/020	E1595	21 Feb 2012
Receiver	R & S	ESIB 40	100171	R-27-1	21 Aug 2012
Spectrum Analyser	Hewlett Packard	E7405A	US39150142	3771	20 April 2012
VHF Balun	Schwarzbeck	VHA 9103	-	RFS 3603	7 Feb 2012
Biconical Antenna	Schwarzbeck	BBA 9106	-	RFS 3612	7 Feb 2012
Log Periodic	Schwarzbeck	VUSLP 9111	9111-228	3785	7 Feb 2012
Horn Antenna	EMCO	3115	9511-4629	E1526	10 May 2013
Horn Antenna	EMCO	3116	92035	-	10 May 2013

8. ACCREDITATIONS

Testing was carried out in accordance with EMC Technologies NZ Ltd registration with the Federal Communications Commission as a listed facility, Registration Number: 90838, which was updated in February 2011.

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

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/IEC/ISO 17025: 2005.

International Accreditation New Zealand has Mutual Recognition Arrangements for testing and calibration with a number of accreditation bodies in various economies. This includes NATA (Australia), UKAS (UK), SANAS (South Africa), NVLAP (USA), A2LA (USA), SWEDAC (Sweden). Further details can be supplied on request.

9. PHOTOGRAPHS

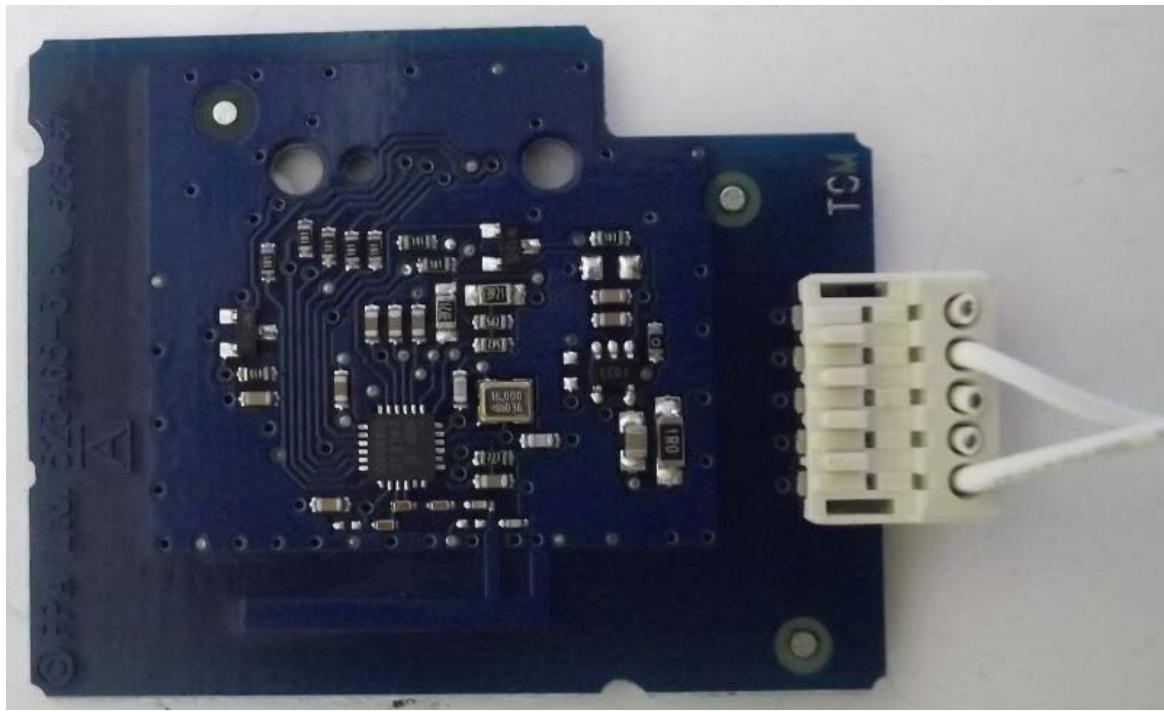
External Photos





Internal photos





Radiated emissions re test set ups





Conducted emissions test set up



