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TEST REPORT

Fusion MS-AL300
Audio Receiver / Processor / Amplifier

tested to

47 Code of Federal Regulations

Part 15 - Radio Frequency Devices

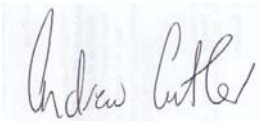
Subpart C – Intentional Radiators

including

Section 15.247 - Operation in the band 2400 – 2483.5 MHz

for

Fusion Electronics 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 **Fusion MS-AL300 Audio Receiver / Processor / Amplifier** complies with FCC Part 15 Subpart C including Section 15.247 as an Intentional Radiator when the methods as described in ANSI C63.4 - 2003 are applied along with the methods defined in FCC Public Notice DA 00-705.

2. RESULTS SUMMARY

The results of testing carried out in July and August 2013 are summarised below.

Clause	Parameter	Result
15.201	Equipment authorisation requirement	Certification required.
15.203	Antenna requirement	Complies. Antenna is integral to the device.
15.204	External PA and antenna modifications	Noted.
15.205	Restricted bands of operation	Complies.
15.207	Conducted limits	Not applicable
15.209	Radiated emission limits	Complies
15.247		
(a)(1)	Hopping channel separation	Complies
(a)(1)(i)(iii)	Channel occupancy / Bandwidth	Complies
(b)(1)(2)	Peak output power	Complies
(b)(4)	Antenna gain less than 6 dBi	Complies
(d)	Out of band emissions	Complies
(g)	Use of all channels	Not applicable
(h)	Intelligent frequency hopping	Not applicable
(i)	Radio frequency hazards	Complies

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

Company Name	Fusion Electronics Ltd
Address	Level 1, 111 Franklin Road Freemans Bay, 1011
City	Auckland
Country	New Zealand
Contact	Mr Phill Cauty

5. DESCRIPTION OF TEST SYSTEM

Brand Name	Fusion
Model Number	MS-AL300
Product	Audio receiver, processor, amplifier
Manufacturer	Forth Corporation Public Company Ltd
Country of Origin	Thailand
Serial Number	Sample not serialized
FCC ID	V5TMS-AL300

Product Description

Brand Name	Fusion
Model Number	MS-AL300
Product	Audio receiver, processor, amplifier
Manufacturer	Forth Corporation Public Company Ltd
Country of Origin	Thailand
Band of Operation:	2400-2483.5 MHz
Number of channels:	79 channels
Channel spacing:	1 MHz.
Rated transmit power:	1 mW (+0.0 dBm)
Modulation Type:	Bluetooth FSK
Operating Frequencies:	2402 -2480 MHz (2402 MHz = n * 1 MHz ; n (ch) = 0~78)
Test Frequencies:	2402, 2439, 2480 MHz
Antenna Type:	Integral
Antenna Gain:	0 dBi
Power Supply:	12.0 Vdc
Frequencies in use:	16 MHz, 26 MHz

6. RESULTS

Standard

The sample was tested in accordance with 47 CFR Part 15 Subpart C.

Methods and Procedures

The following measurement methods and procedures have been applied:

- ANSI C63.4 – 2003

- FCC Public Notice DA 00-0705

Section 15.201: Equipment authorisation requirement

Certification as detailed in Subpart J of Part 2 is required for this device.

Section 15.203: Antenna requirement

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

Result: Complies.

Section 15.204: External radio frequency power amplifiers and antenna modifications

It is not possible to attach an external power amplifier to this transmitter.

Result: Complies.

Section 15.205: Restricted bands of operation

The device tested transmits on 79 channels between 2402 MHz and 2480 MHz using adaptive frequency hopping spread spectrum techniques.

Section 15.247 allows this between 2400 – 2483.5 MHz

Result: Complies.

Section 15.207: Conducted limits

The device is powered using an external dc supply which is typically a 12 Vdc lead acid battery.

This device cannot be directly or indirectly connected to the public AC mains power supply in normal operations.

Typically this device would be used on board a boat.

Result: Complies.

Section 15.209: Radiated emission limits, general requirements

Below 30 MHz

As this device contains digital devices that operate using frequencies below 30 MHz (16 and 26 MHz), low frequency measurements were attempted between 150 kHz – 30 MHz at the open area test site over a distance of 10 metres using a loop antenna the centre of which was 1 metre above the ground.

The general limits described in 15.209 have been applied with the 300 metre and 30 metre limits being extrapolated by a factor of 40 dB per decade as allowed for in section 15.31(d)(2).

Between 150 – 490 kHz an Average detector and a Peak detector were used.

Where a peak detector was used the limit was increased by +20 dB

Between 490 kHz and 30 MHz a Quasi Peak detector was used.

No emissions were detected on these frequencies of interest and no other emissions were detected from this device over the range of 150 kHz – 30 MHz

Result: Complies.
Measurement uncertainty: ± 4.8 dB

Section 15.209: Radiated emission limits, general requirements

Above 30 MHz

General radiated emission measurements were carried out over the range of 30 MHz – 24 GHz to determine compliance.

The limits as per section 15.209 were applied

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

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 attempted at a distance of 3 metres.

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.

Pre testing of the device was carried out with the device positioned in all three axis (X, Y and Z) with the cables locations being varied to give the worst case emission levels.

Final testing was carried out when the device was placed horizontally (Y axis) as shown in the photos and the results recorded and reported in this test report.

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 measurements were made 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) – Amplifier Gain (dB)

No emissions other than the transmitter spurious emissions were observed.

Result: Complies.
Measurement uncertainty ± 4.1 dB

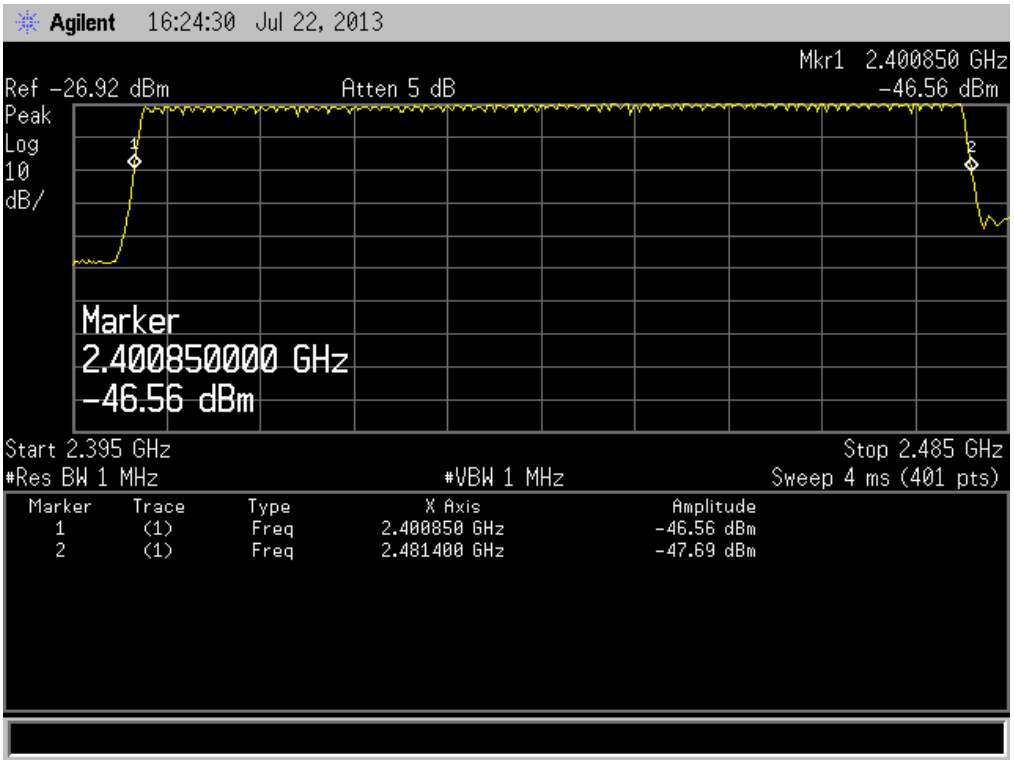
Section 15.247(a)(1)(i) - Channel occupancy / bandwidth

The results are summarised as follows:

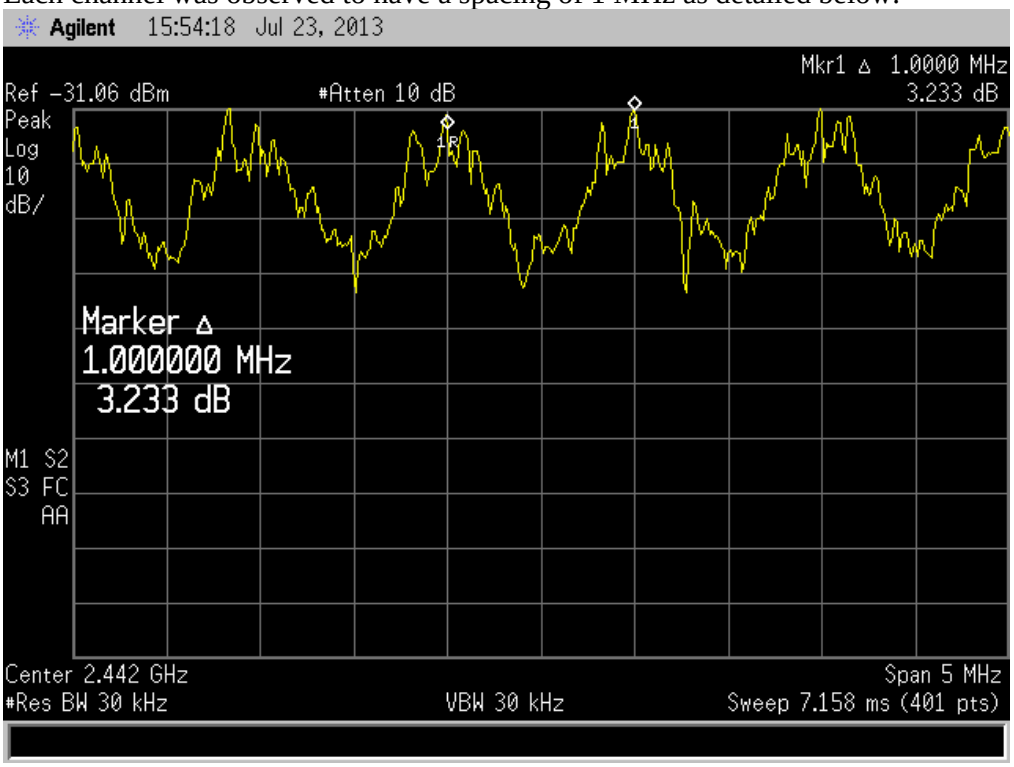
Parameter	Limit	Observation	Result
Number of channels	Minimum of 15 channels	79	Pass
20 dB bandwidth	Greater than 500 kHz	745 kHz	Pass
Hop interval	Greater than 20 dB bandwidth	1 MHz	Pass
Dwell time	Not to exceed 400 ms in any 31.6 second period	50 ms	Pass

Result: Complies

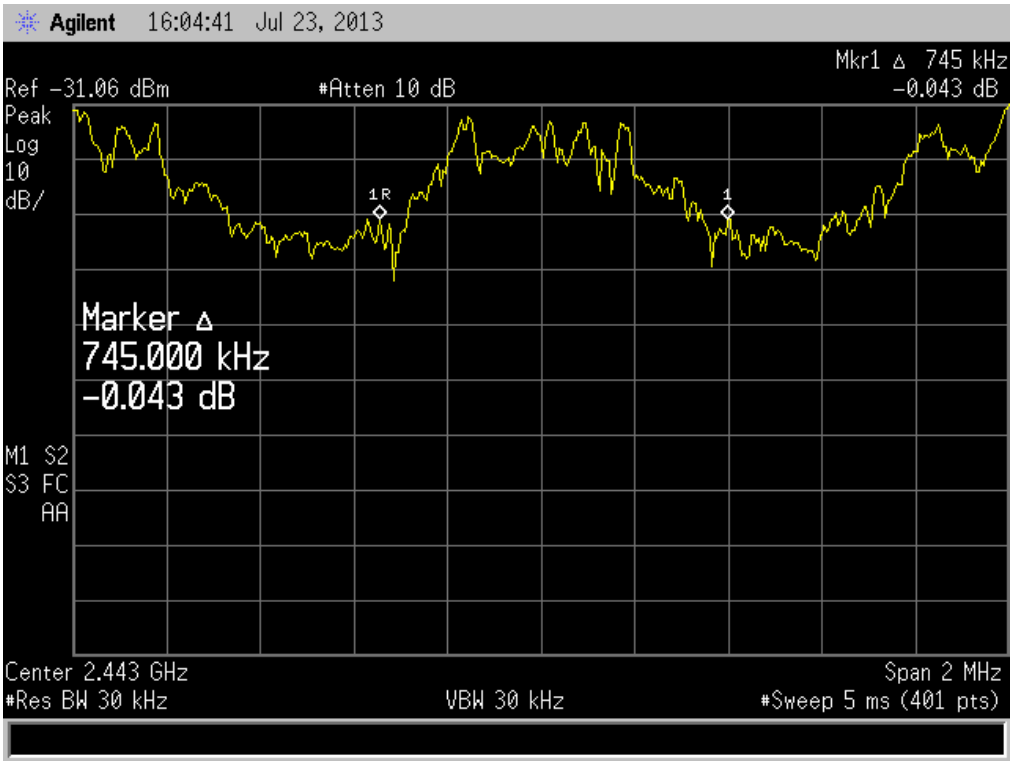
This device operates using Adaptive Frequency Hopping Spread Spectrum techniques.
79 channels were observed between 2402 – 2480 MHz as shown below:



Each channel was observed to have a spacing of 1 MHz as detailed below:

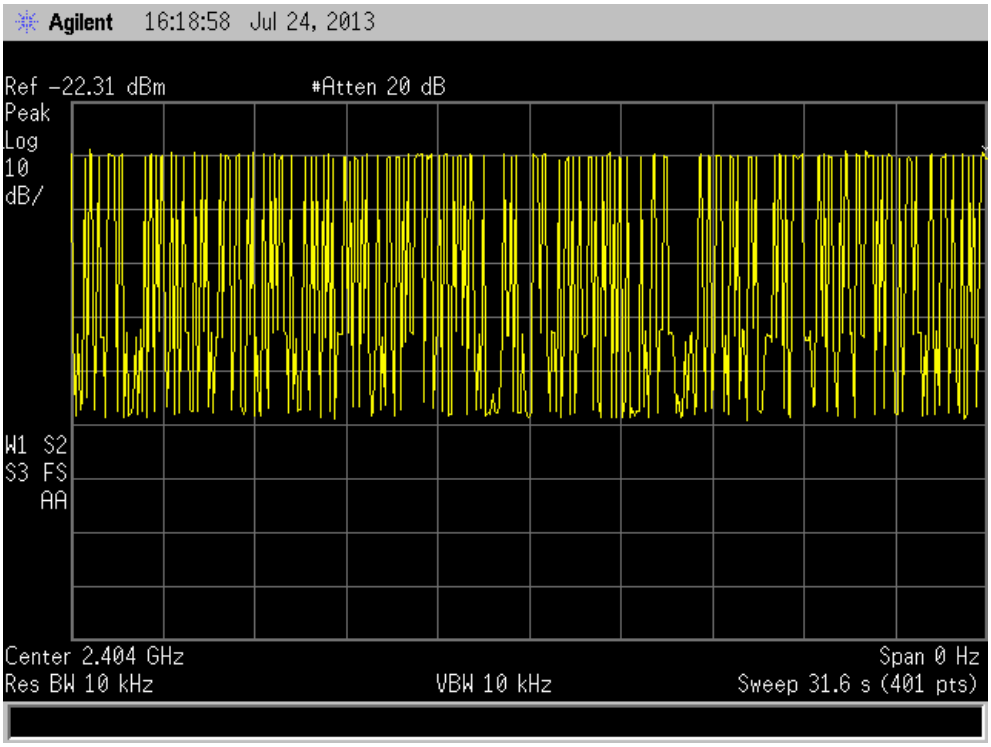


The -20 dB bandwidth for the device has been determined below



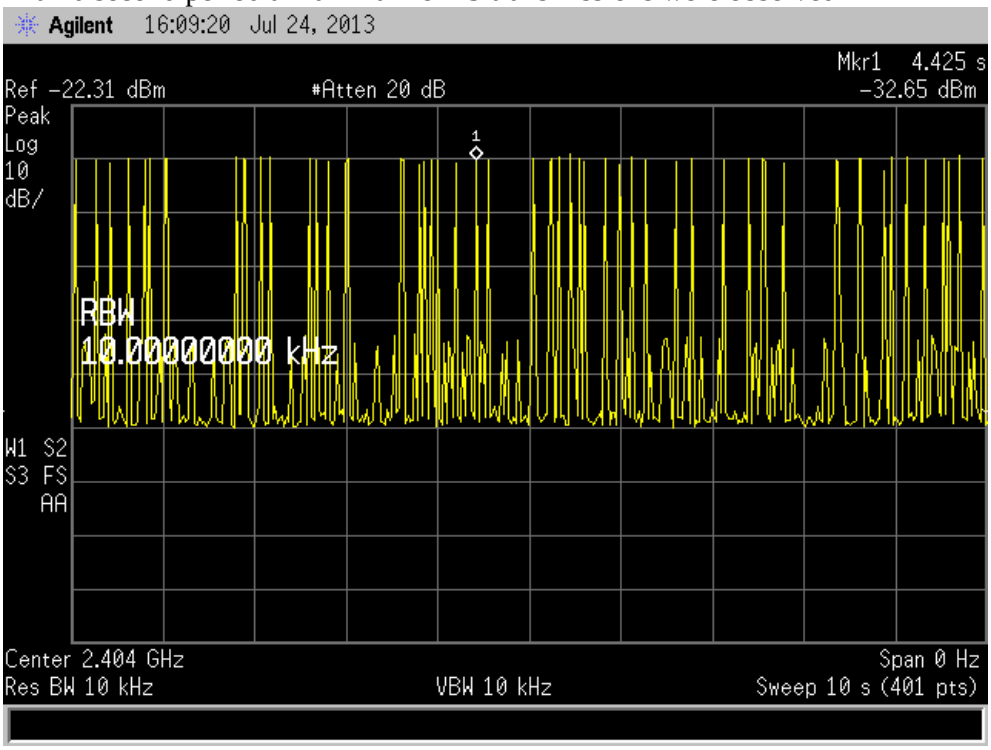
The 20 dB bandwidth is therefore less than the 1 MHz channel spacing.

During a period of 31.6 seconds (0.4 seconds x 79 channels) the transmitter was observed to transmit as shown below which did not allow an accurate measurement to be made.



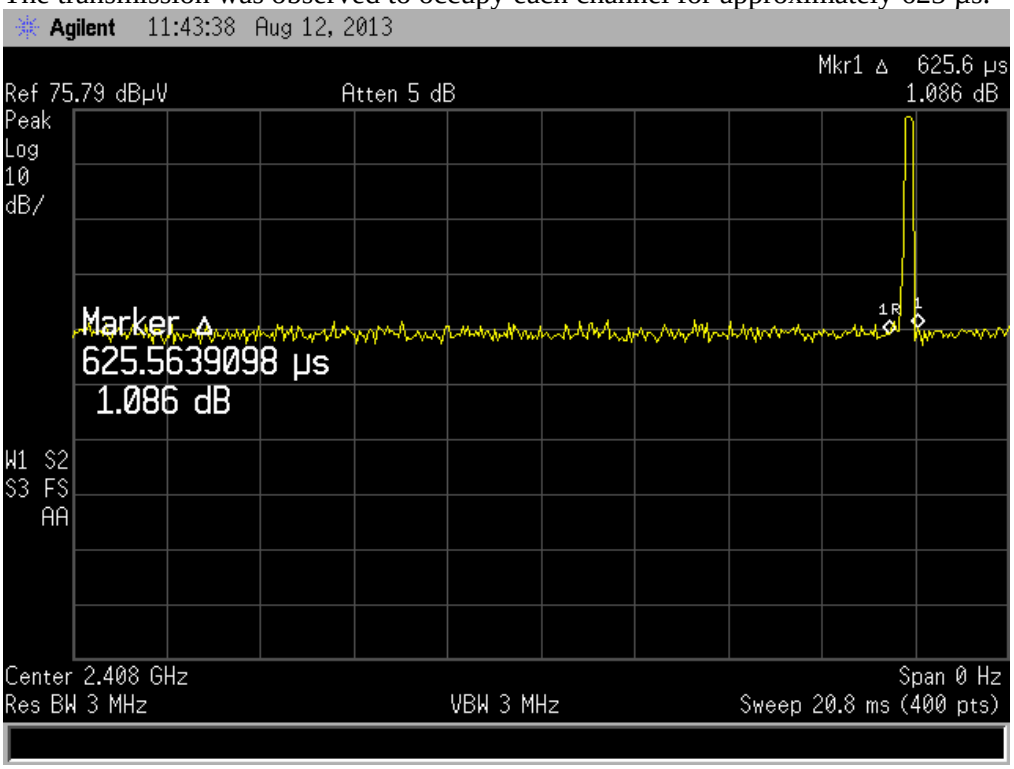
Several tests were then carried out using a 10 second measurement period with the maximum number of transmissions being used to determine the number of transmissions in 31.6 seconds.

In a 10 second period a maximum of 49 transmissions were observed



This gives 155 transmissions in a 31.6 second period

The transmission was observed to occupy each channel for approximately 625 µs.



Therefore in any 31.6 second period the occupancy time will be 155 transmissions x 625.0 µs = 0.096875 s or 96.9 ms.

Result: Complies.

Section 15.247(b)(1)+(2)– Peak output power

Pre testing of the device was carried out with the device positioned in all three axis (X, Y and Z) with the cables locations being varied to give the worst case emission levels.

Final testing was carried out when the device was placed horizontally (Y axis) in the centre of the test table at a height of 80 cm above the ground plane as shown in the photos and the results recorded and reported in this test report.

Radiated power measurements were made on the highest low, mid and high frequency channel using both vertical and horizontal polarisations.

Measurements were made using a measuring receiver with a Peak detector with a resolution bandwidth of 1 MHz.

Frequency (MHz)	Level (dBµV/m)	Level (dBm)	Limit (dBm)	Polarity	Margin (dB)	Result
2402.000	95.7	-1.7	30.0	Vertical	31.7	Pass
2440.000	97.6	0.2	30.0	Vertical	29.8	Pass
2480.000	93.5	-3.9	30.0	Vertical	33.9	Pass
2402.000	93.0	-4.4	30.0	Horizontal	34.4	Pass
2440.000	95.3	-2.1	30.0	Horizontal	32.1	Pass
2480.000	92.7	-4.7	30.0	Horizontal	34.7	Pass

The conducted output power could not be measured directly as the device does not have an antenna port.

Using an assumed antenna gain of 1 (0 dB) the conducted power has been calculated from the radiated power measurements.

A conducted limit of 1.0 watt (+30 dBm) has been applied as more than 75 channels are in use.

Frequency (MHz)	Field Strength (dBµV/m)	Radiated Power (dBm)	Antenna Gain (dB)	Conducted Power (dBm)	Conducted Power (W)	Antenna Polarisation
2402.0000	95.7	-1.7	0.0	-1.7	0.00111	Vertical
2440.0000	97.6	0.2	0.0	0.2	0.00173	Vertical
2480.0000	93.5	-3.9	0.0	-3.9	0.00067	Vertical
2402.0000	93.0	-4.4	0.0	-4.4	0.00060	Horizontal
2440.0000	95.3	-2.1	0.0	-2.1	0.00102	Horizontal
2480.0000	92.7	-4.7	0.0	-4.7	0.00056	Horizontal

The radiated power level in dBm 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)

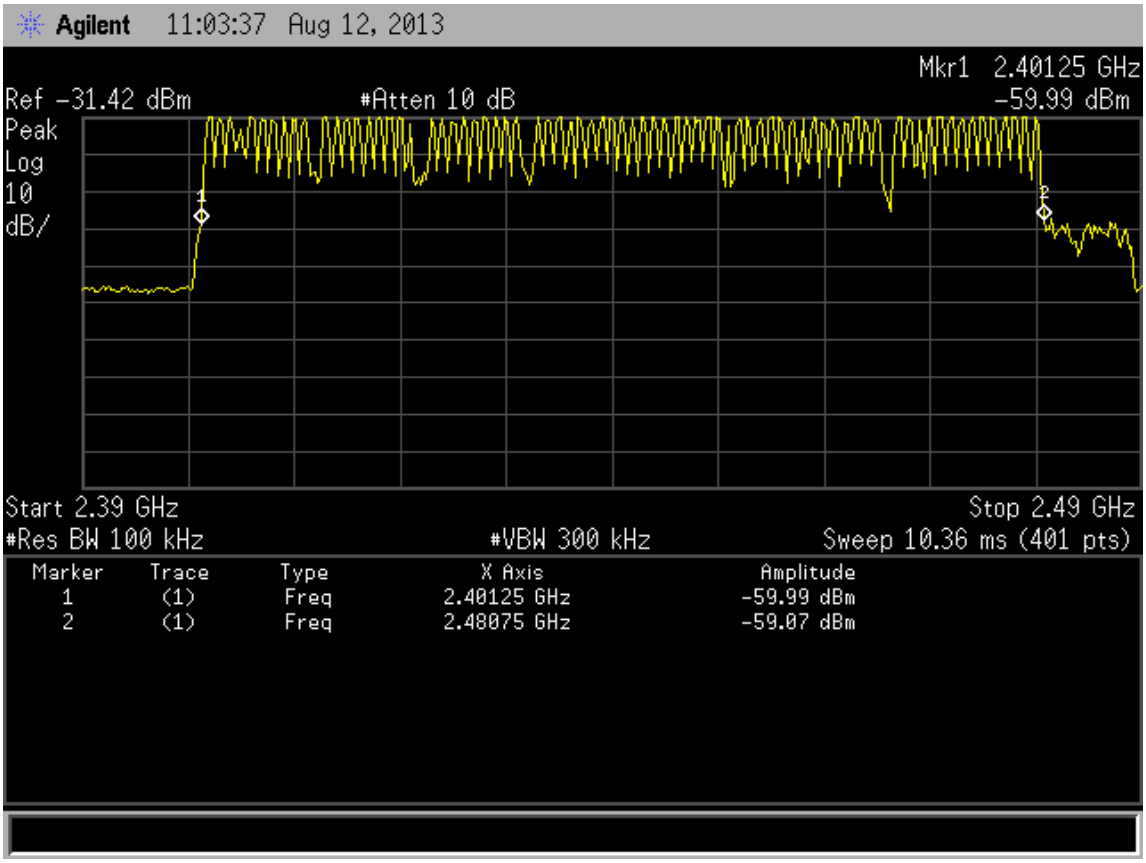
Result: Complies.
Measurement Uncertainty: ± 4.1 dB

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.

A radiated measurement has been made which shows that the transmitter is operating the -20 dB point's remains within the 2400 – 2483.5 MHz band.



F low (MHz)	F high (MHz)
2401.250	2480.750

In addition radiated measurements were made in the restricted bands of 2310 – 2390 MHz and between 2483.5 – 2500 MHz where the limits as defined in section 15.209 were applied.

No emissions were detected in this band when measurements were attempted using either a peak or average detector with a 1 MHz bandwidth.

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

Transmitter Spurious Emissions:

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

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

The restricted band limits have been applied to un-restricted band frequencies as all frequencies comply with the more stringent restricted band limits.

Pre testing of the device was carried out with the device positioned in all three axis (X, Y and Z) with the cables locations being varied to give the worst case emission levels.

Final testing was carried out when the device was placed horizontally (Y axis) in the centre of the test table at a height of 80 cm above the ground plane as shown in the photos and the results recorded and reported in this test report.

Measurements of the radiated field were attempted at 3 metres from the device with no emission being detected.

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.

All emissions were 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) – Amplifier Gain (dB)

Result: Complies.
Measurement uncertainty: ± 4.1 dB

Low frequency: 2402 MHz

Frequency (MHz)	Vertical (dBµV/m)	Horizontal (dBµV/m)	Limit (dBµV/m)	Margin	Detector
4804.000	< 50.0	< 50.0	74.0	-	Peak
4804.000	< 45.0	< 45.0	54.0	-	Average
7206.000	< 50.0	< 50.0	74.0	-	Peak
7206.000	< 45.0	< 45.0	54.0	-	Average
9608.000	< 50.0	< 50.0	74.0	-	Peak
9608.000	< 45.0	< 45.0	54.0	-	Average
12010.000	< 50.0	< 50.0	74.0	-	Peak
12010.000	< 45.0	< 45.0	54.0	-	Average
14412.000	< 50.0	< 50.0	74.0	-	Peak
14412.000	< 45.0	< 45.0	54.0	-	Average
16814.000	< 50.0	< 50.0	74.0	-	Peak
16814.000	< 45.0	< 45.0	54.0	-	Average
19216.000	< 50.0	< 50.0	74.0	-	Peak
19216.000	< 45.0	< 45.0	54.0	-	Average
					Average
21618.000	< 50.0	< 50.0	74.0	-	Peak
21618.000	< 45.0	< 45.0	54.0	-	Average
24020.000	< 50.0	< 50.0	74.0	-	Peak
24020.000	< 45.0	< 45.0	54.0	-	Average

Mid frequency: 2439 MHz

Frequency (MHz)	Vertical (dBµV/m)	Horizontal (dBµV/m)	Limit (dBµV/m)	Margin	Detector
4878.000	< 50.0	< 50.0	74.0	-	Peak
4878.000	< 45.0	< 45.0	54.0	-	Average
7317.000	< 50.0	< 50.0	74.0	-	Peak
7317.000	< 45.0	< 45.0	54.0	-	Average
9756.000	< 50.0	< 50.0	74.0	-	Peak
9756.000	< 45.0	< 45.0	54.0	-	Average
12195.000	< 50.0	< 50.0	74.0	-	Peak
12195.000	< 45.0	< 45.0	54.0	-	Average
14634.000	< 50.0	< 50.0	74.0	-	Peak
14634.000	< 45.0	< 45.0	54.0	-	Average
17073.000	< 50.0	< 50.0	74.0	-	Peak
17073.000	< 45.0	< 45.0	54.0	-	Average
19512.000	< 50.0	< 50.0	74.0	-	Peak
19512.000	< 45.0	< 45.0	54.0	-	Average
					Average
21951.000	< 50.0	< 50.0	74.0	-	Peak
21951.000	< 45.0	< 45.0	54.0	-	Average
24390.000	< 50.0	< 50.0	74.0	-	Peak
24390.000	< 45.0	< 45.0	54.0	-	Average

High frequency: 2480 MHz

Frequency (MHz)	Vertical (dBµV/m)	Horizontal (dBµV/m)	Limit (dBµV/m)	Margin	Detector
4960.000	< 50.0	< 50.0	74.0	-	Peak
4960.000	< 45.0	< 45.0	54.0	-	Average
7440.000	< 50.0	< 50.0	74.0	-	Peak
7440.000	< 45.0	< 45.0	54.0	-	Average
9920.000	< 50.0	< 50.0	74.0	-	Peak
9920.000	< 45.0	< 45.0	54.0	-	Average
12400.000	< 50.0	< 50.0	74.0	-	Peak
12400.000	< 45.0	< 45.0	54.0	-	Average
14880.000	< 50.0	< 50.0	74.0	-	Peak
14880.000	< 45.0	< 45.0	54.0	-	Average
17360.000	< 50.0	< 50.0	74.0	-	Peak
17360.000	< 45.0	< 45.0	54.0	-	Average
19840.000	< 50.0	< 50.0	74.0	-	Peak
19840.000	< 45.0	< 45.0	54.0	-	Average
					Average
22320.000	< 50.0	< 50.0	74.0	-	Peak
22320.000	< 45.0	< 45.0	54.0	-	Average
24800.000	< 50.0	< 50.0	74.0	-	Peak
24800.000	< 45.0	< 45.0	54.0	-	Average

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 highest radiated power has been measured to be 0.2 dBm or 0.00173 watts ERP when operating on 2440 MHz.

As the output power is well below the threshold for SAT Test Exclusion as per KDB 628591 D01 v14 no testing is required.

Result: Complies.

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	ESIB 40	100171	R-27-1	10 Oct 2013
VHF Balun	Schwarzbeck	VHA 9103	-	RFS 3603	30 Jan 2014
Biconical Antenna	Schwarzbeck	BBA 9106	-	RFS 3612	30 Jan 2014
Log Periodic	Schwarzbeck	VUSLP 9111	9111-228	3785	30 Jan 2014
Horn Antenna	EMCO	3115	9511-4629	E1526	3 May 2014
Horn Antenna	EMCO	3116	92035	-	16 Jun 2014
Loop Antenna	EMCO	6502	9003-2485	3798	9 May 2014

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 in July 2013.

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.

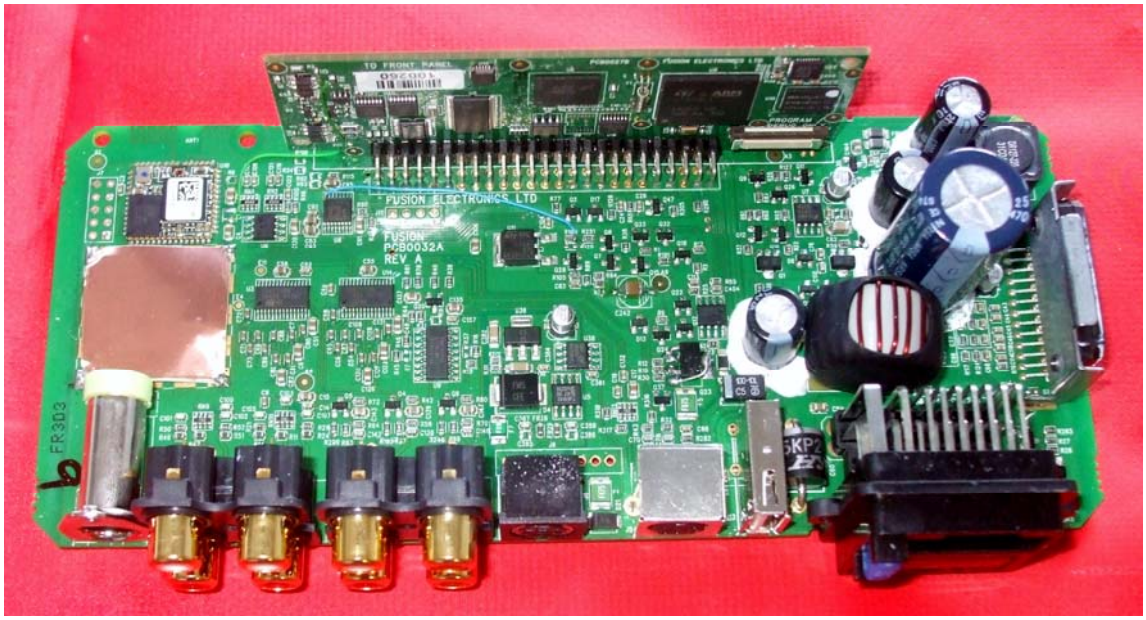
All measurement equipment has been calibrated in accordance with the terms of the EMC Technologies (NZ) Ltd International Accreditation New Zealand (IANZ) Accreditation to NZS/ISO/IEC 17025, 2005.

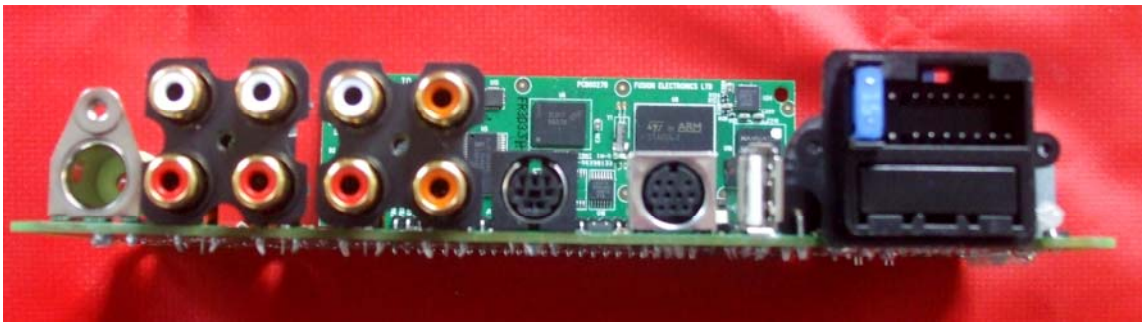
International Accreditation New Zealand has Mutual Recognition Arrangements for testing and calibration with various accreditation bodies in a number of economies. This includes NATA (Australia), UKAS (UK), SANAS (South Africa), NVLAP (USA), A2LA (USA), SWEDAC (Sweden). Further details can be supplied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

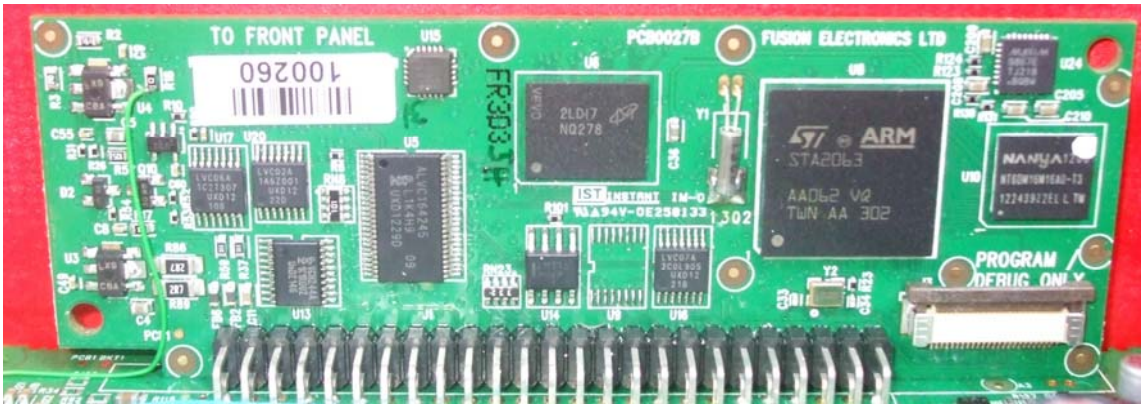
9. PHOTOGRAPHS

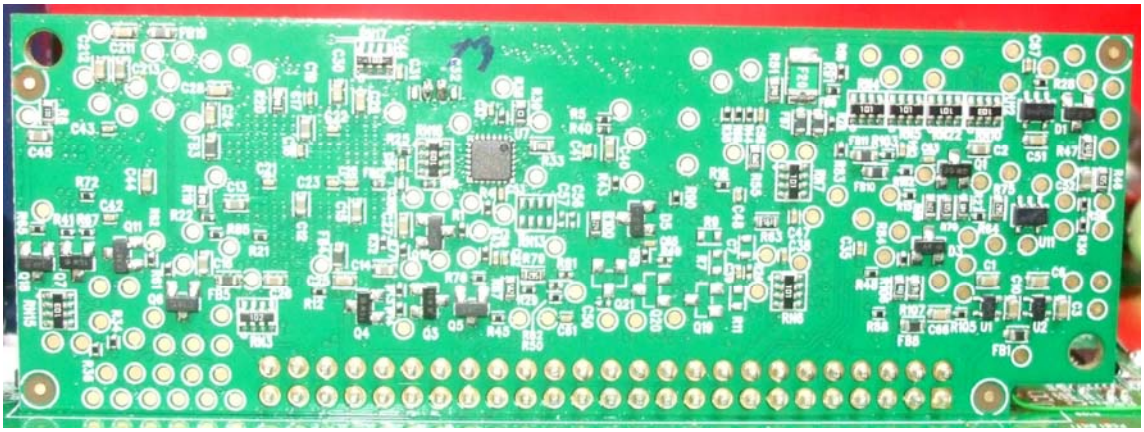
External Views

Internal views









Radiated emissions – Worst case test set up