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TEST REPORT

MiMOMax MWL-RADIOUNIT-P/Q* Fixed Digital Transceiver**

tested to the

Code of Federal Regulations (CFR) 47

Part 101 –Fixed Microwave Services

for

MiMOMax Wireless Ltd

This Test Report is issued with the authority of:

A handwritten signature in black ink, appearing to read "Andrew Cutler".

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 MiMOMax MWL-RADIOUNIT-**P/Q* Fixed Digital Transceiver complies with the Code of Federal Regulations (CFR) 47 Part 101 – Fixed Microwave Services.

2. RESULTS SUMMARY

The results of testing carried out between the 20th October and the 5th December 2012 are summarised below.

Clause	Description	Result
101.107	Frequency tolerance	Complies
101.109	Bandwidth	Complies
101.111	Emission limitations Spurious emission at antenna port Spurious emissions field strength	Complies Complies Complies
101.113	Transmitter power limitations	Complies
1.1310	Radio frequency exposure limits	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 MiMOMax Wireless Ltd
Address 540 Wairakei Road
Christchurch
Country New Zealand
Contact Mr Kok Heng - Loh

5. DESCRIPTION OF TEST SAMPLE

Brand Name MiMOMax
Model Number MWL-RADIOUNIT-**P/Q*
Product Fixed Digital Transceiver (928-960 MHz)
Manufacturer MiMOMAX Wireless Ltd
Manufactured in New Zealand
Designed in New Zealand
Serial Numbers 26900834
FCC ID XMK-MMXRUPRX003

The sample tested has the following specifications:

Rated Transmitter Output Power

Two transmitters each outputting +30 dBm (1 Watt) average

Transmitter FCC Frequency Bands

928.0 – 929.0 MHz,
932.0 – 932.5 MHz,
932.5 – 935.0 MHz,
941.0 – 941.5 MHz
941.5 – 944.0 MHz,
952.0 – 958.0 MHz,
958.0 – 960.0 MHz

Test frequencies

Frequency MHz	Mode	Power Watts	Bandwidth kHz
928.9875	Transmit	1.0	12.5
928.9875	Transmit	1.0	25.0

Testing was carried out on a single frequency that is representative of the performance of the radio over the frequency range of 928 – 960 MHz as a result of pre-testing that was carried out.

Emission Designators / Modes of operation

10k0W1W – digital speech and data

20k0W1W – digital speech and data

Modulation Modes:

QPSK,

16QAM,

64QAM,

256QAM

Standard Temperature and Humidity

Temperature: +15°C to + 30° maintained.

Relative Humidity: 20% to 75% observed.

Standard Test Power Source

Standard Test Voltage: 13.8 Vdc

Extreme Temperature

High Temperature: + 50°C maintained.

Low Temperature: - 30 °C maintained.

Extreme Test Voltages

High Voltage: 27.6 Vdc

Low Voltage: 10.8 Vdc

6. ATTESTATION

The **MiMOMax MWL-RADIOUNIT-**P/Q* Fixed Digital Transceiver** complies with the Code of Federal Regulations (CFR) 47 Part 101 – Fixed Microwave Services.

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.

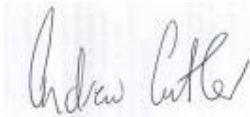
This report does not contain corrections or erasures.

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. TEST RESULTS

Part 101.107 Frequency Tolerance

Frequency tolerance measurements were between - 30 °C and + 50°C in 10°C increments.

At each temperature the transmitter was given a period of 30 minutes to stabilise. The transmitter was then turned on and the frequency error measured after a period of 1 minute.

Measurements were made with the input voltage set to 13.8 Vdc and when decreased to 10.8 Vdc and increased to 27.6 Vdc.

Frequency: 928.9875 MHz

Temperature	Voltage 10.8 Vdc	Voltage 13.8 Vdc	Voltage 27.6 Vdc
+50°C	-250.0	-250.0	-250.0
+40°C	-230.0	-200.0	-200.0
+30°C	-100.0	-110.0	-110.0
+20°C	-50.0	-50.0	-55.0
+10°C	+90.0	+90.0	+90.0
0°C	+140.0	+140.0	+140.0
-10°C	+160.0	+160.0	+160.0
-20°C	+180.0	+180.0	+180.0
-30°C	+30.0	+30.0	+30.0

Limit:

Part 101.107 (a) states that for multiple address master stations a frequency tolerance of +/- 0.00015 % will apply.

Transmitter was tested on 928.9875 MHz: +/- 0.00015 % = +/- 1393 Hz.

Result: Complies

Measurement Uncertainty: ±30 Hz

Part 101.109 Bandwidth limitations:

The transmitter tested has been designed to operate using four modulation types: QPSK, 16QAM, 64QAM and 256QAM.

An emission designator of W1W has been applied by the client with the transmitter being capable of operating with declared bandwidths of 10.0 kHz and 20.0 kHz.

The authorised bandwidth that would apply to this transmitter would be 12.5 kHz and 25 kHz respectively.

Measurements were made when the transmitter was operating on 928.9875 MHz.

The occupied bandwidth has been measured and compared against the occupied bandwidth declared by the client.

Measurements have been made of each modulation type using a spectrum analyser operating in peak hold mode and an external 20 dB attenuator applied which has been accounted for in the spectrum plots below.

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

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

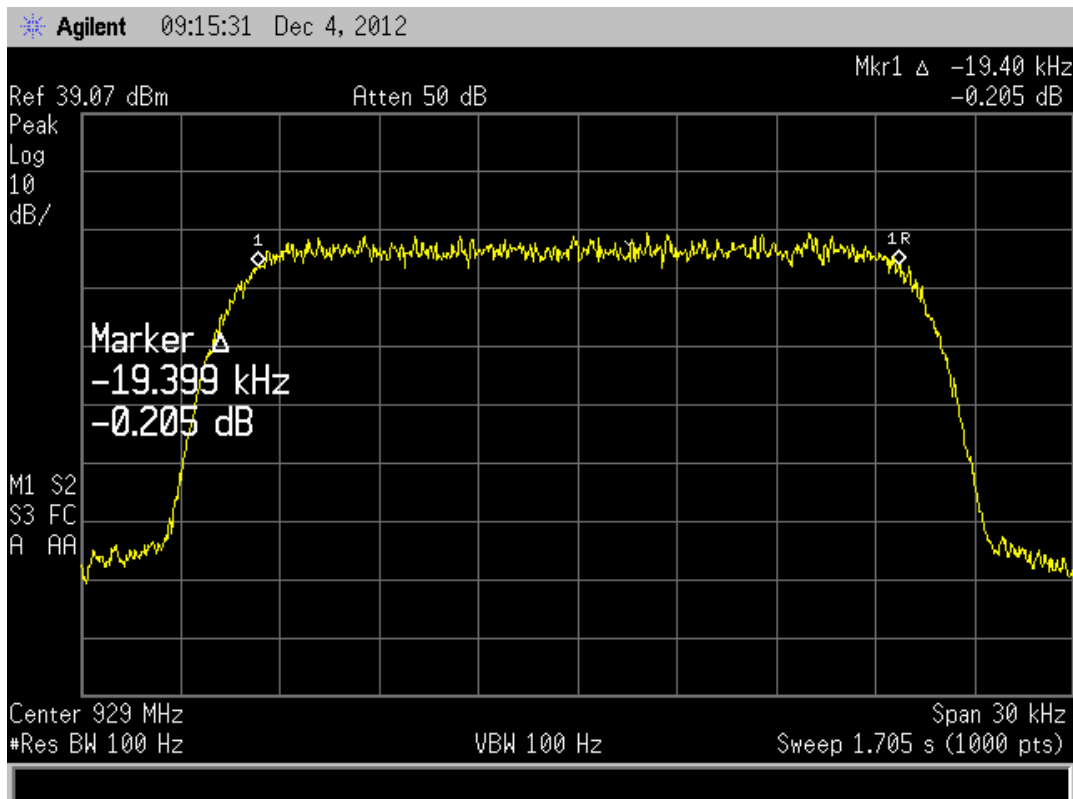
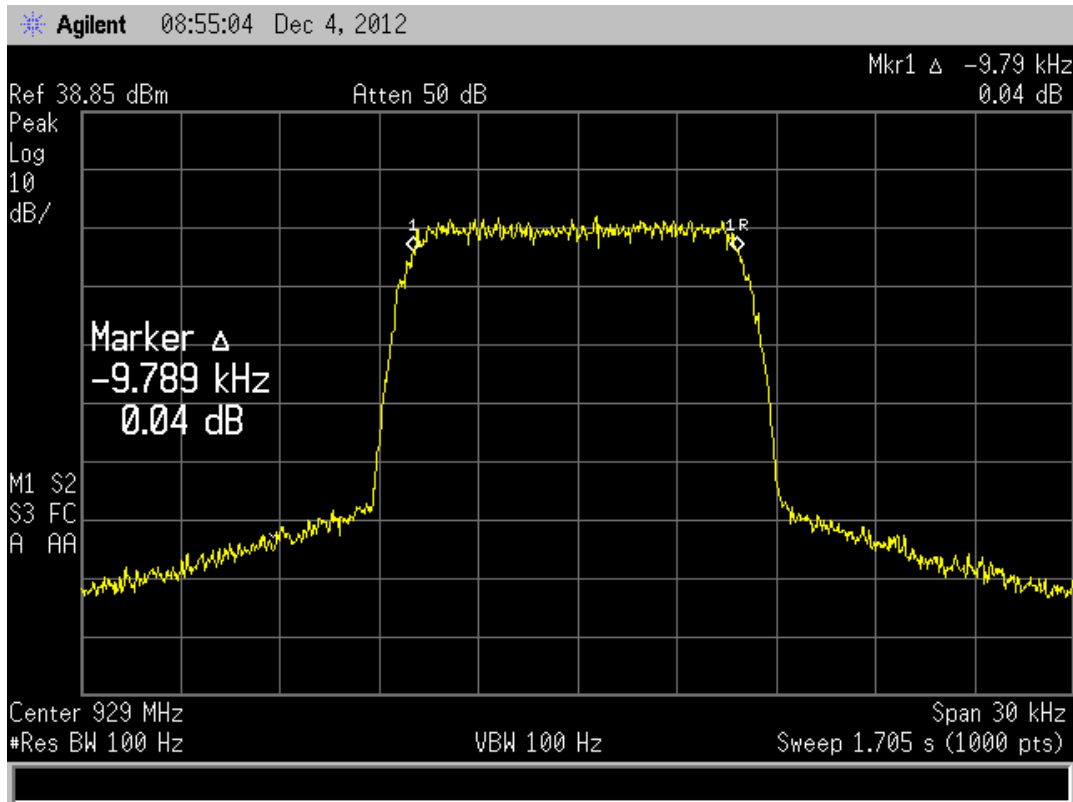
The resolution bandwidth is then changed to 100 Hz and the reference level minus 26 dB (99%) absolute bandwidth points determined

Pre testing showed that 256QAM modulation mode gave the worst case result which has been reported.

Result: Complies

256 QAM

Emission	Measured	Designated	Authorised
W1W	9.789 kHz	10.0 kHz	12.5 kHz
W1W	19.399 kHz	20.0 kHz	25.0 kHz



101.111 Emission limitations

As this transmitter uses digital modulation in the 900 MHz multiple address frequencies with 12.5 kHz and 25.0 kHz authorised bandwidths the emission masks as per section 101.111 (a) (5) and (6) have been applied.

The reference level for the following emission mask measurements has been determined using a resolution bandwidth of 120 kHz using an average detector when the transmitter was operating in each of the modulation modes.

This gave an average reference level of +30 dBm.

All measurements have been made using spectrum analyser operating in average mode with the transmitter operating on 928.9875 MHz.

The transmitter was modulated using modulation sources internal to the transmitter as supplied by the client.

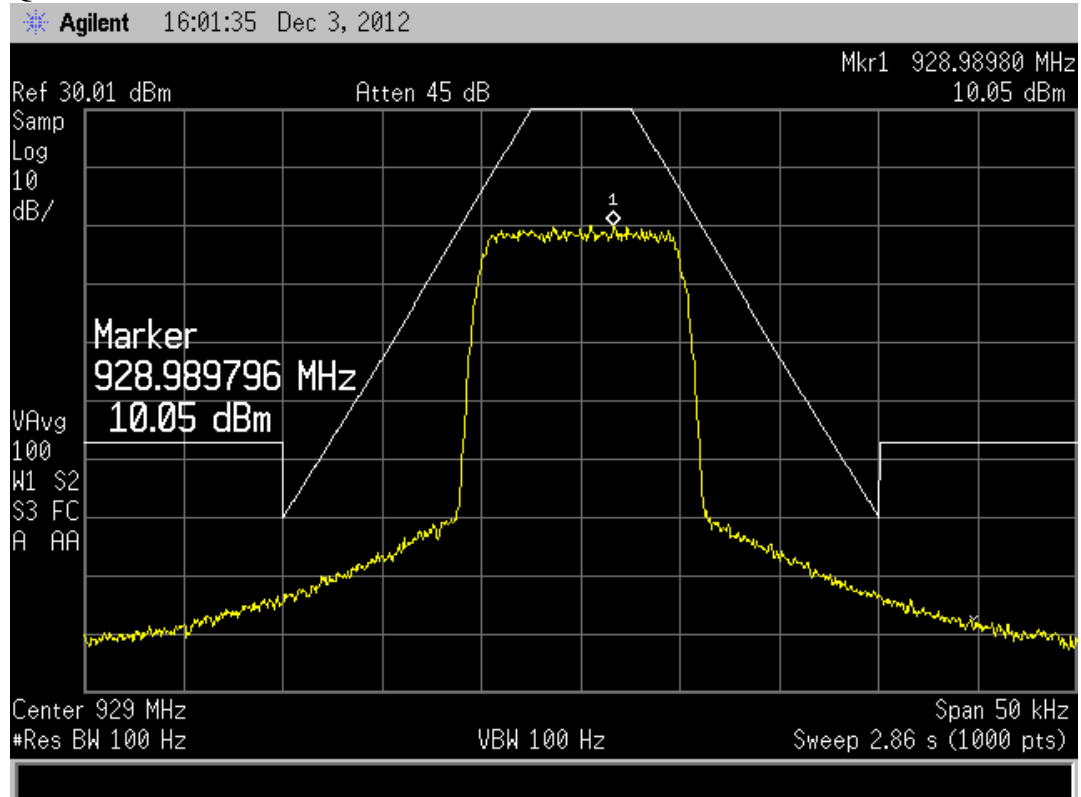
When the 12.5 kHz bandwidth mask (a)(5) was applied measurements were made using a resolution bandwidth of 100 Hz.

When the 25.0 kHz bandwidth mask (a)(6) was applied measurements were made using a resolution bandwidth of 200 Hz.

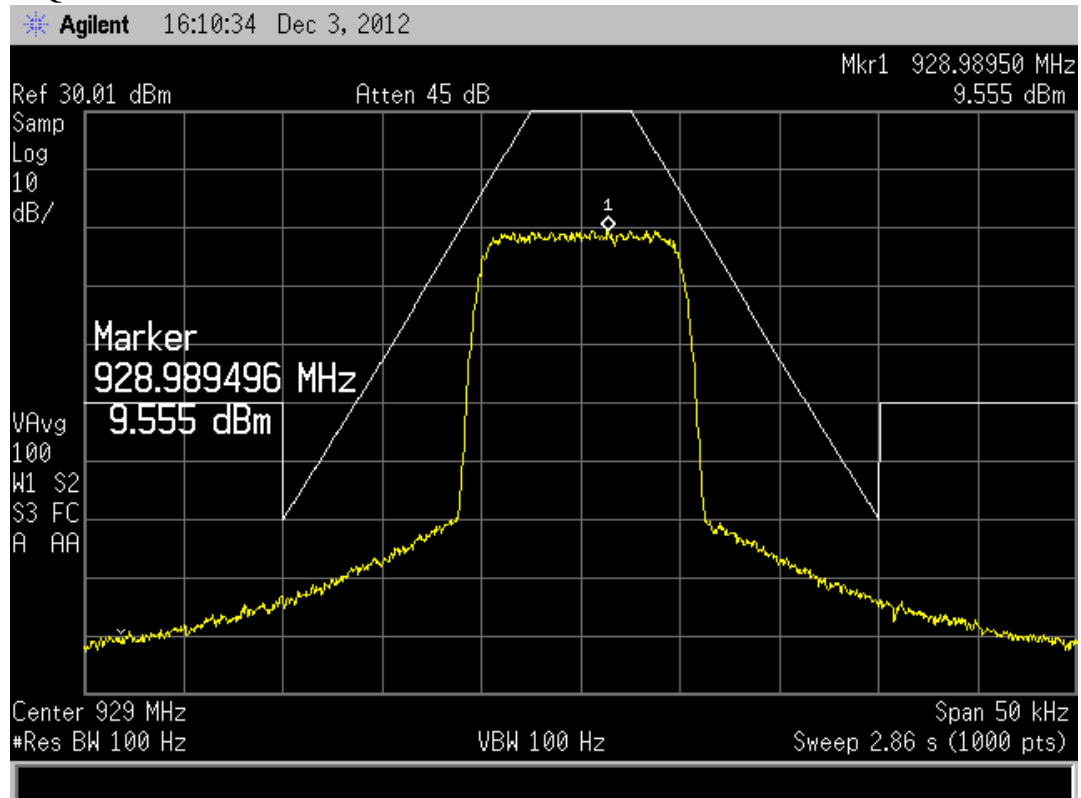
In the absence of a resolution bandwidth being specified, measurements were made with a resolution bandwidth of 1% of the declared bandwidths (1% of 10 kHz = 100 Hz, 1% of 20 kHz = 200 Hz).

Result: Complies.

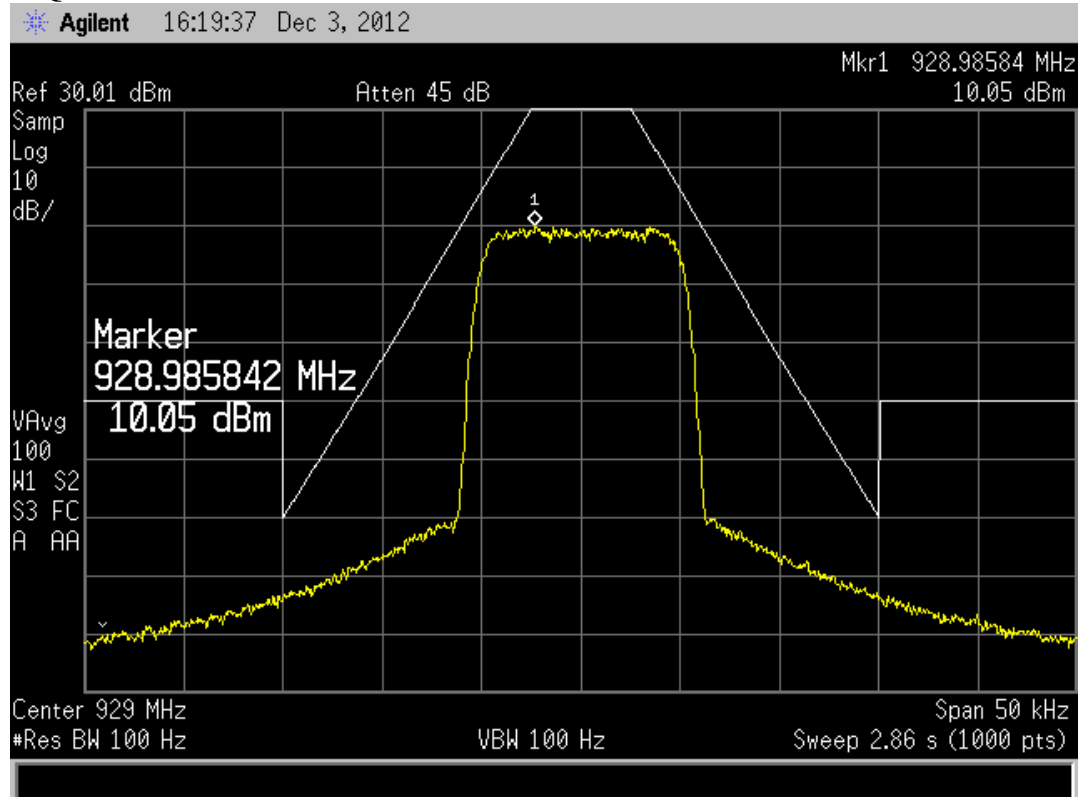
QPSK 12.5 kHz



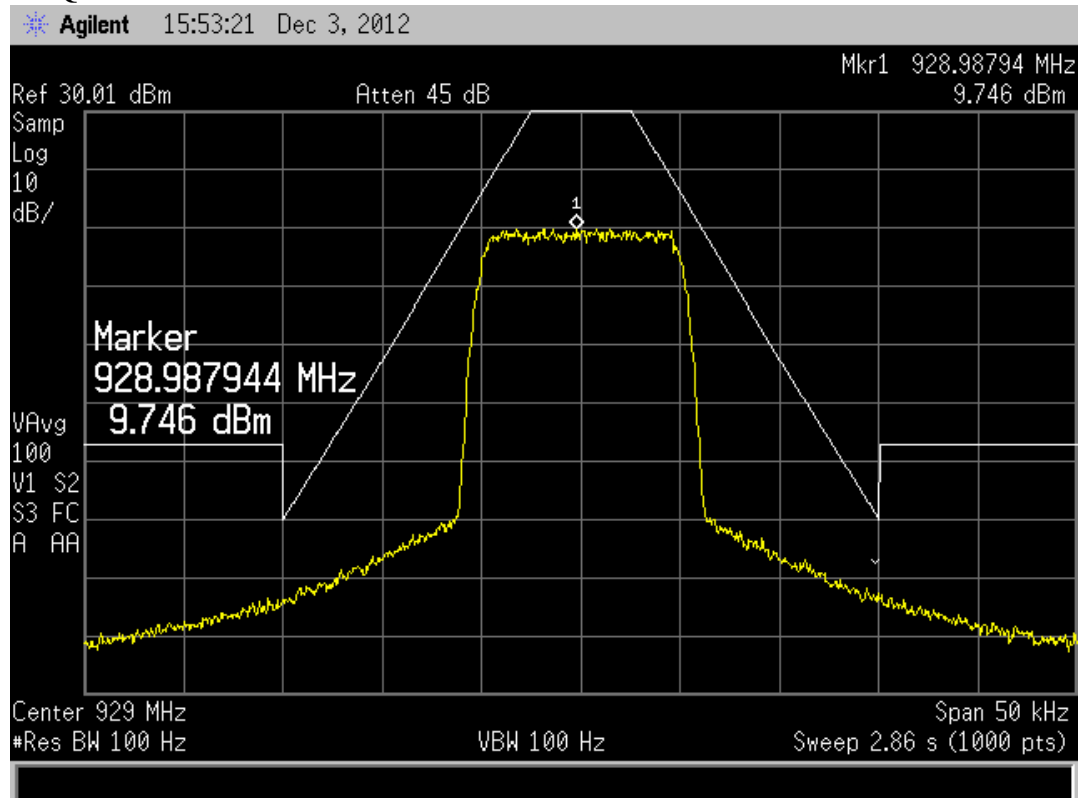
16QAM 12.5 kHz



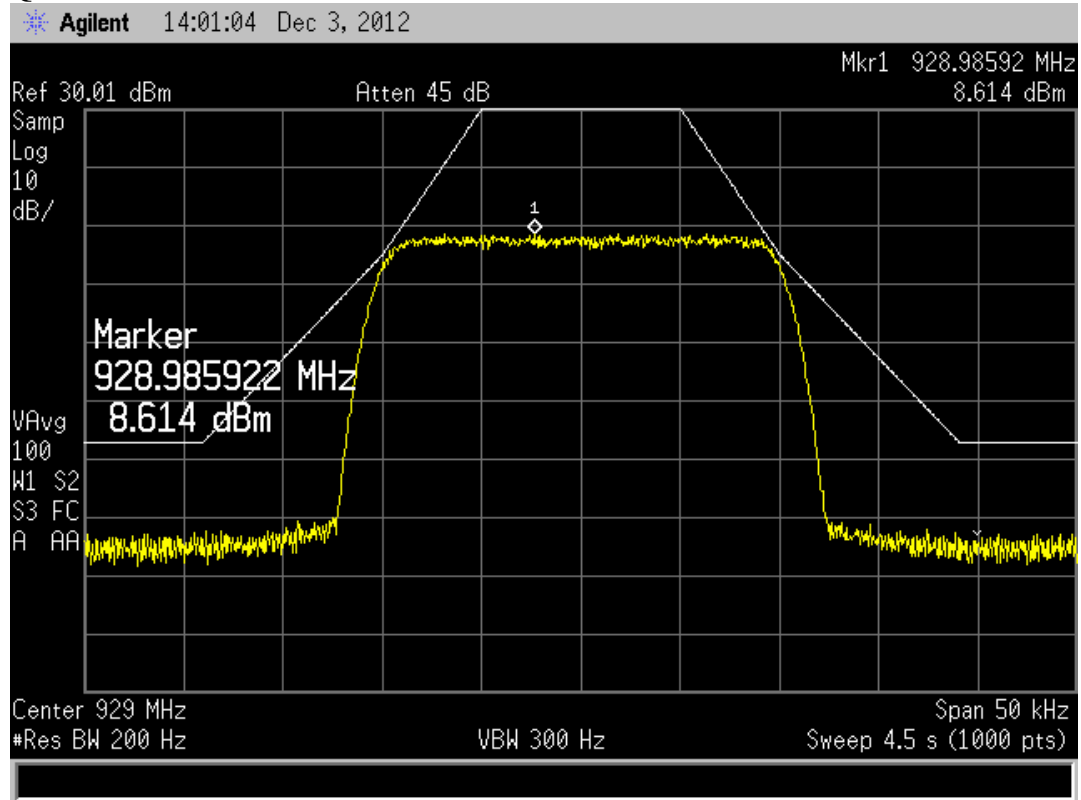
64QAM 12.5 kHz



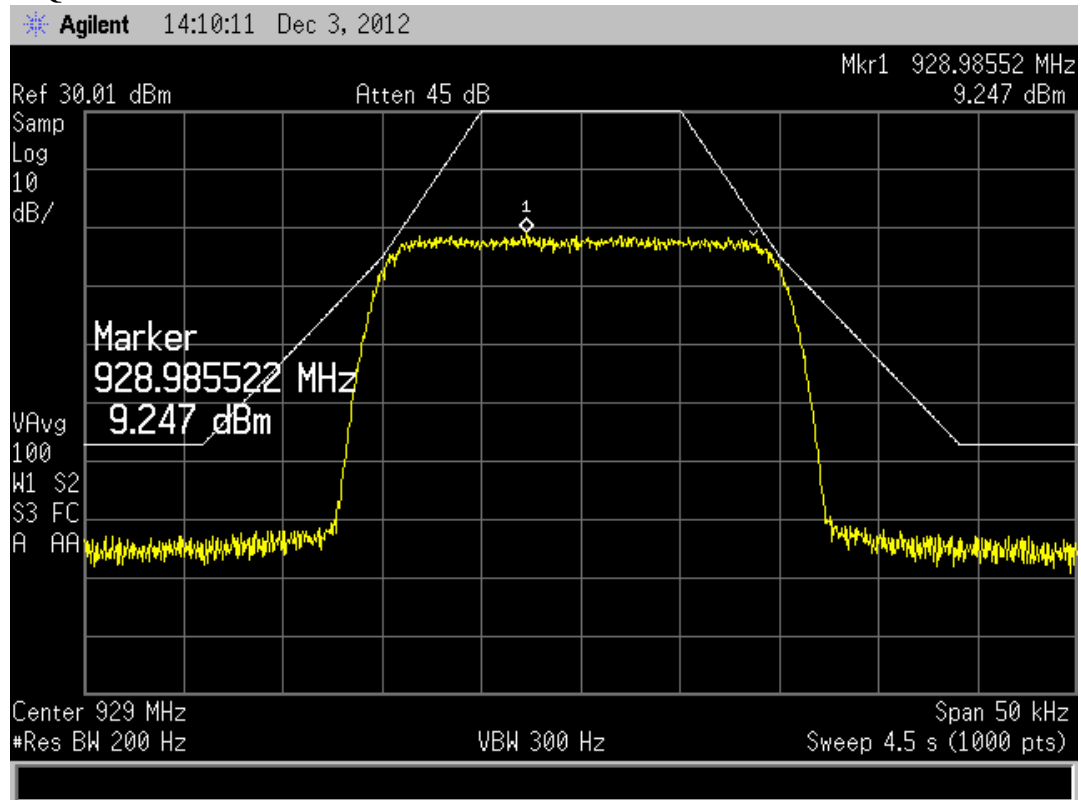
256QAM 12.5 kHz



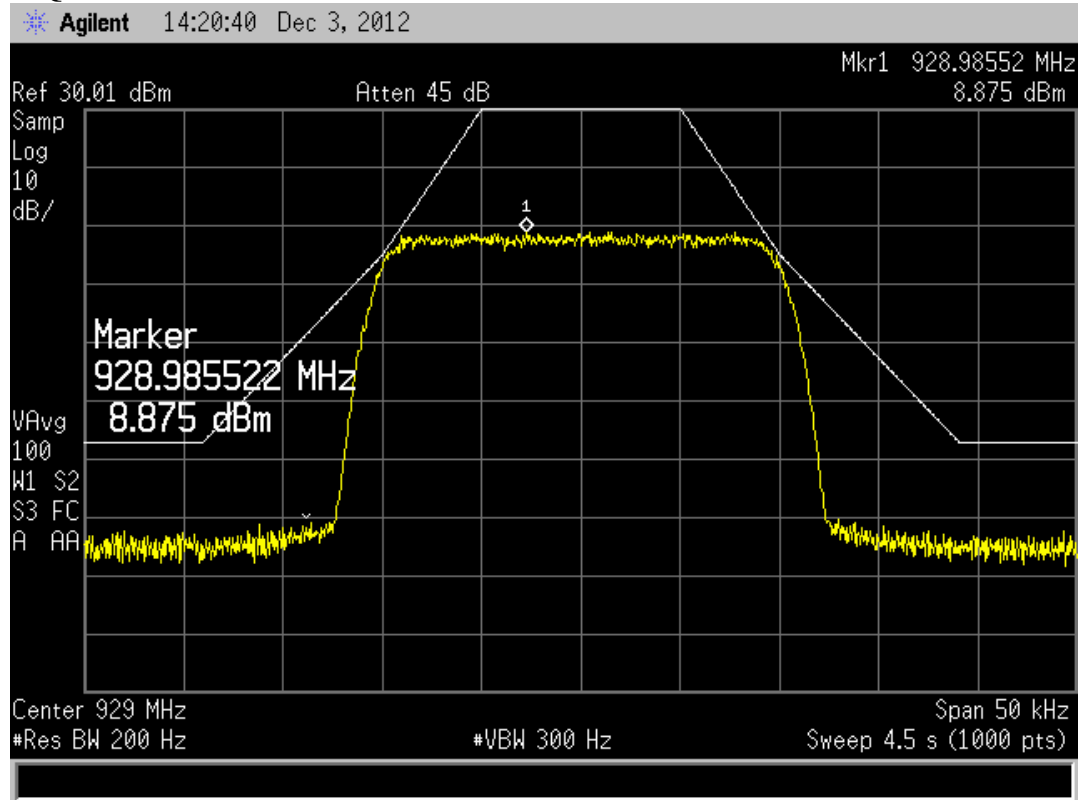
QPSK 25.0 kHz



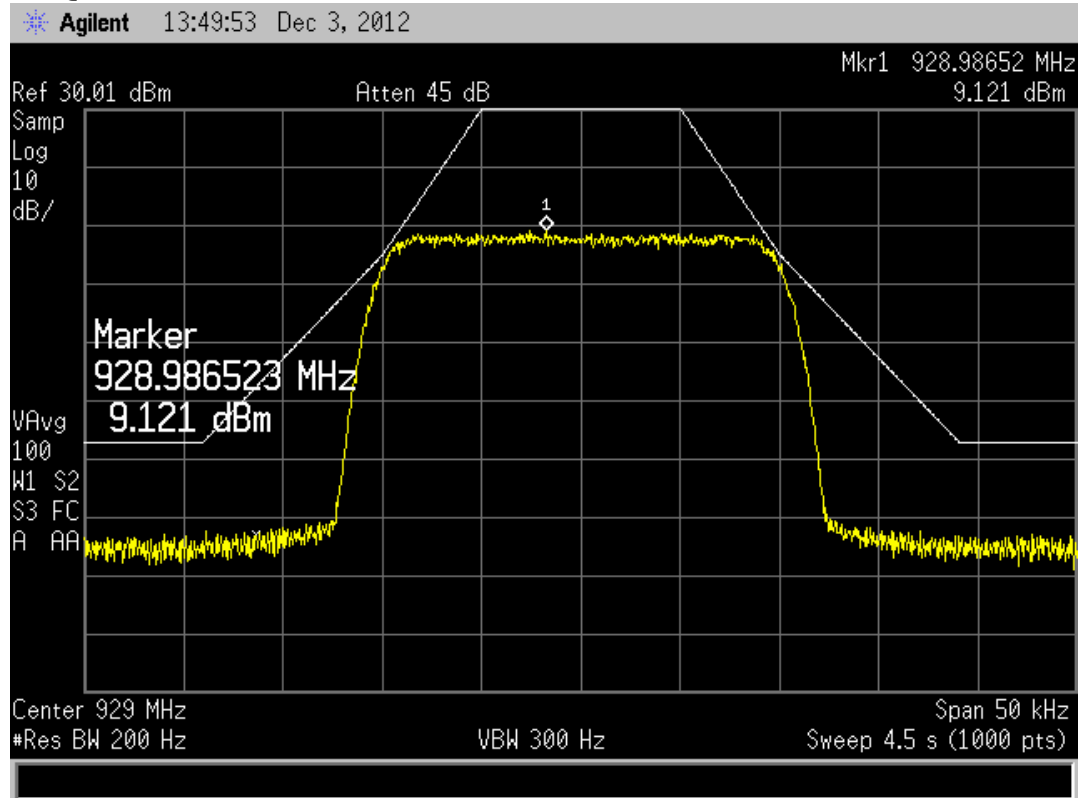
16QAM 25.0 kHz



64QAM 25.0 kHz



256QAM 25.0 kHz



Transmitter unwanted emissions – antenna terminal

As per section 2.1051 spurious emission measurements were made at the antenna port of the transmitter.

The spectrum analyser bandwidth was set to 100 kHz for measurements below 1 GHz and 1 MHz for measurements above 1 GHz.

Frequency: 928.9875 MHz

Spurious emission (MHz)	Emission level (dBm)	Limit (dBm)
1857.975	<-50 dBm	-20.0
2786.962	<-50 dBm	-20.0
3715.950	<-50 dBm	-20.0
4677.937	<-50 dBm	-20.0
5573.925	<-50 dBm	-20.0
6502.912	<-50 dBm	-20.0
7431.900	<-50 dBm	-20.0
8360.887	<-50 dBm	-20.0
9289.875	<-50 dBm	-20.0

Limit:

Section 101.111 (a)(5) states that on any frequency removed from the centre of the authorised bandwidth by a displacement frequency of more than 12.5 kHz shall be attenuated by at least $50 + 10 \log (P)$ or 70 dB whichever is the lesser attenuation.

An average rated power of 1.0 watt and a peak measured power of 5 watts gives a limit of -20 dBm.

The spectrum has been investigated up to the 10th harmonic of the transmitter.

Result: Complies

Measurement Uncertainty: ± 3.3 dB

Field strength of the transmitter spurious emissions

Frequency: 928.9875 MHz

Frequency (MHz)	Level (dB μ V/m)	Level (dBm)	Limit (dBm)	Polarity	Margin (dB)
1857.9750	46.5	-50.9	-20.0	Vertical	30.9
1857.9750	46.0	-51.4	-20.0	Horizontal	31.4
2786.9625	42.0	-55.4	-20.0	Vertical	35.4
2786.9625	41.8	-55.6	-20.0	Horizontal	35.6
3715.9500	-	-	-20.0	Vertical	-
3715.9500	-	-	-20.0	Horizontal	-
4644.9375	-	-	-20.0	Vertical	-
4644.9375	-	-	-20.0	Horizontal	-
5573.9250	-	-	-20.0	Vertical	-
5573.9250	-	-	-20.0	Horizontal	-
6502.9125	-	-	-20.0	Vertical	-
6502.9125	-	-	-20.0	Horizontal	-
7431.9000	-	-	-20.0	Vertical	-
7431.9000	-	-	-20.0	Horizontal	-
8360.8875	-	-	-20.0	Vertical	-
8360.8875	-	-	-20.0	Horizontal	-
9289.8750	-	-	-20.0	Vertical	-
9289.8750	-	-	-20.0	Horizontal	-

A “-” indicates that no emissions were observed within at least 20 dB of the limit.

Testing was carried out then the transmitter was transmitting continuously with a dummy load attached to each of the transmitter output ports.

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

Device was tested on an open area test site at a distance of 3 metres.

Testing was carried out at EMC Technologies NZ Ltd Open Area Test Site which has been filed with the Commission, Registration Number: 90838.

The level recorded is the signal generator output level in dBm less any gains / losses due to the coax cable and the dipole antenna.

Limit:

All spurious emissions are to be attenuated by at least $50 + 10 \log (P)$. The average rated power of 1 watts and the measured peak power of 5 watts gives a limit of -20 dBm.

No measurements were made above the 10th harmonic.

Result: Complies

Measurement Uncertainty: ± 4.1 dB

101.113 Transmitter power limitations

Measurements were carried out at the RF output terminals of the transmitter using spectrum analyser with measurements made using an average and a peak detector when the transmitter was modulated using the various modulation modes.

The rated output power is 1 Watt (30 dBm) average to each of the transmitter output ports.

Testing was carried out on both output ports and also when the supply voltage was varied.

Vertical output port: QPSK in Average

Frequency (MHz)	Voltage (Vdc)	Rated (dBm)	Measured (dBm)
928.9875	13.8	30.0	29.9
928.9875	10.8	30.0	29.9
928.9875	27.6	30.0	29.9

Horizontal output port: QPSK in Average

Frequency (MHz)	Voltage (Vdc)	Rated (dBm)	Measured (dBm)
928.9875	13.8	30.0	30.1
928.9875	10.8	30.0	30.1
928.9875	27.6	30.0	30.1

The above results show that a variation in supply voltage does not vary the output power.

Measurements were then made at each port in peak and average at 13.8 Vdc when the modulation type was varied.

Port	Mode	12.5 kHz	25.0 kHz
		Average (dBm)	Average (dBm)
Horizontal	QPSK	30.1	30.1
Horizontal	16QAM	30.1	30.1
Horizontal	64QAM	30.0	30.0
Horizontal	256QAM	30.0	30.0
Vertical	QPSK	29.9	29.9
Vertical	16QAM	30.0	30.0
Vertical	64QAM	29.9	29.9
Vertical	256QAM	29.9	29.9

Measurements were made to show that the declared power output of the transmitter measured power was within +/- 1 dB of the measured output power.

Result: Complies

Measurement Uncertainty: ± 0.5 dB

Radio Frequency Hazard Information

As per Section 1.1310 and Section 2.1091 certification of this transmitter is sought using the Controlled / Occupational exposure limits as detailed in OST/OET Bulletin Number 65.

This transmitter is a fixed digital transmitter that uses two transmitters that transmit identical modulation with one transmitter transmitting using a horizontally polarised antenna and the other transmitter transmits using a vertically polarised antenna.

Radio Frequency Hazard measurements and calculations were made using the antenna with the highest gain supplied by the client for this device.

The Radio Frequency Hazard assessment has been carried out using a peak detector as this gave the worst case result.

The transmitters have a rated average output power of 1 watt (+30.0 dBm) with the highest power measured being 1.02 watts (+30.1 dBm).

The supplied antenna has a gain of 2 x 16 dBi (2 x 39.8) however no coax loss has been accounted for.

The theoretical average radiated power, without any coax attenuation accounted for, would be of +46.1 dBm (40.7 watts peak).

As this transmitter uses MIMO techniques with digital modulation measurements were made at the test site at a distance of 10 metres to determine the peak radiated power when transmitting on 928.9875 MHz.

A peak detector was used as this would give the worst case levels as digital modulation has been used.

Two identical 10 metre lengths of coax cable were used to attach the antenna to the transmitter

The following results were recorded.

Frequency (MHz)	Level (dBuV/m)	Level (dBm)	Power (watts)	Polarity	Detector
928.9875	138.0	53.2	210.3	Vertical	Peak
928.9875	138.3	53.5	225.4	Horizontal	Peak

The worst case EIRP power of the transmitter was measured in horizontal polarization to be +53.5 dBm or 225.4 watts peak.

Calculations have also been made using the General Public/Uncontrolled Exposure limits.

The minimum distance from the antenna at which the MPE is met is calculated from the equation relating field strength in V/m, measured maximum radiated transmit power in watts and the separation distance in metres.

The maximum radiated transmitter measured was = 225.4 watts.

Power density, $\text{mW}/\text{cm}^2 = E^2/3770$

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

Transmitting on 928.9875 MHz

Occupational limit: $3.10 \text{ mW}/\text{cm}^2 (f/300 = 929 \text{ MHz}/300)$

General Population: $0.62 \text{ mW}/\text{cm}^2 (f/1500 = 929 \text{ MHz}/1500)$

Occupational

$E = 3.10 \text{ mW}/\text{cm}^2 = E^2/3770$

$E = \sqrt{3.10 * 3770}$

$E = 108.1 \text{ V}/\text{m}$

General Public

$E = 0.62 \text{ mW}/\text{cm}^2 = E^2/3770$

$E = \sqrt{0.62 * 3770}$

$E = 48.3 \text{ V}/\text{m}$

Occupational

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

$d = \sqrt{(30 * 225.4)} / 108.1$

$d = 0.76 \text{ metres}$

General Public

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

$d = \sqrt{(30 * 225.4)} / 48.3$

$d = 1.7 \text{ metres}$

Result: Complies if the user is advised of the above safe distances in the appropriate

8. TEST EQUIPMENT USED

Instrument	Manufacturer	Model	Serial #	Asset	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	9594	RFS 3680	12/01/15
Log Periodic	Schwarzbeck	VUSLP9111	9111-228	RFS 3785	12/12/15
Horn Antenna	EMCO	3115	9511-4629	E1526	21/02/14
Power Attenuator	Weinschel	49-20-43	GC104	E1308	N/a
Power Supply	Hewlett Packard	6032A	2743A-02859	E1069	N/a
RF Power Meter	Hewlett Packard	HP 436A	2512A22439	E1198	09/07/14
Spectrum Analyser	Hewlett Packard	E7405A	US39150142	RFS 3776	14/12/13
Measuring Receiver	Rhode & Schwarz	ESIB-40	100171	EMC4003	20/10/13
Thermal chamber	Contherm	M180F	86025	E1129	01/06/13
Thermometer	DSIR	RT200	035	E1049	01/06/13
Turntable	EMCO	1080-1-2.1	9109-1578	RFS 3709	N/a

9. 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 15 February, 2011.

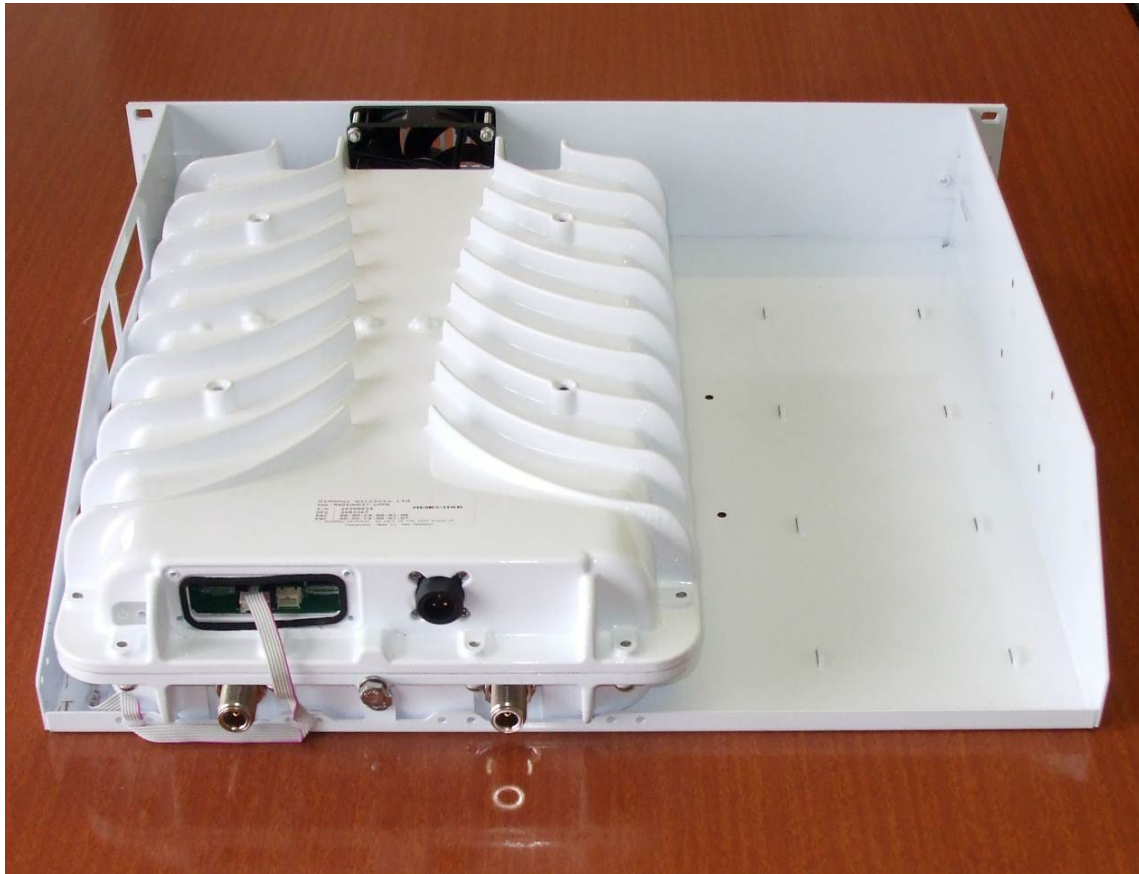
All testing was carried out in accordance with the terms of EMC Technologies (NZ) Ltd International Accreditation New Zealand (IANZ) Accreditation to NZS/ISO/IEC 17025, 2005.

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.

10. PHOTOGRAPHS

External views



Ports



Label

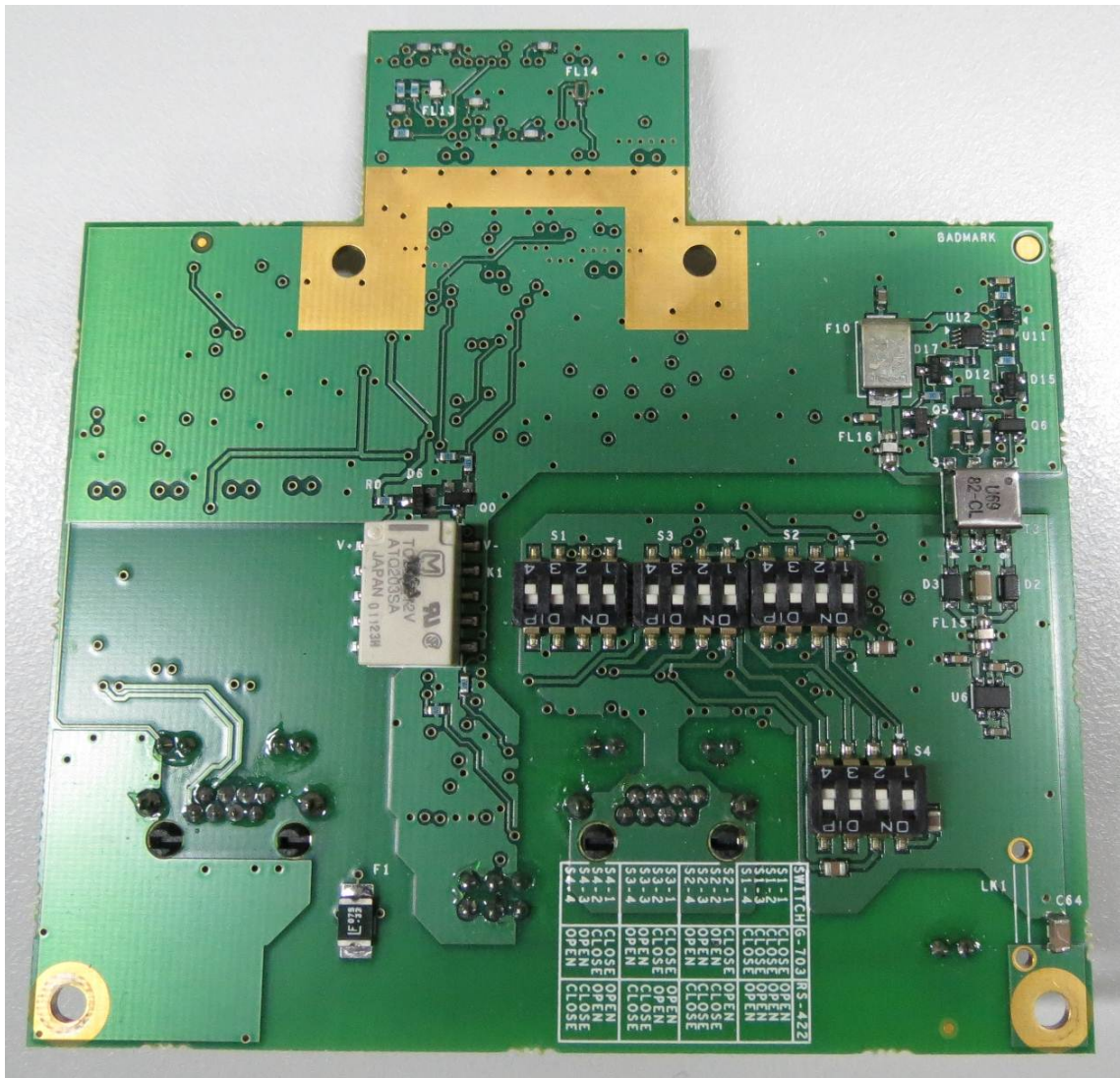


Internal Views

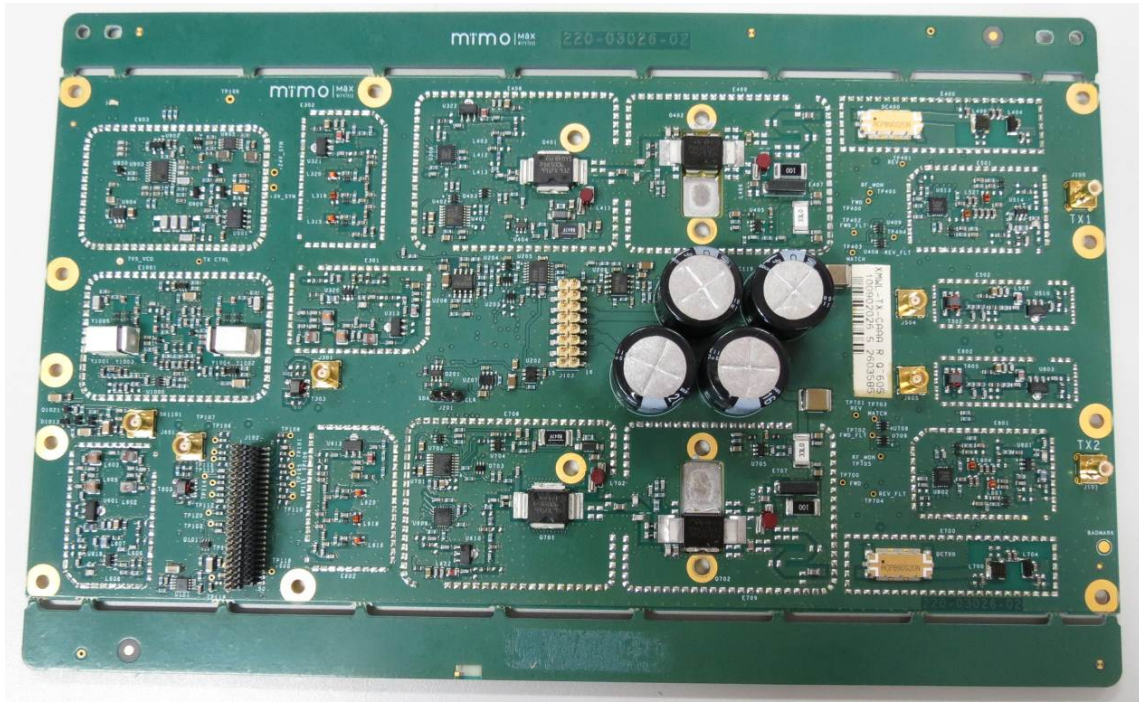
Main PCB



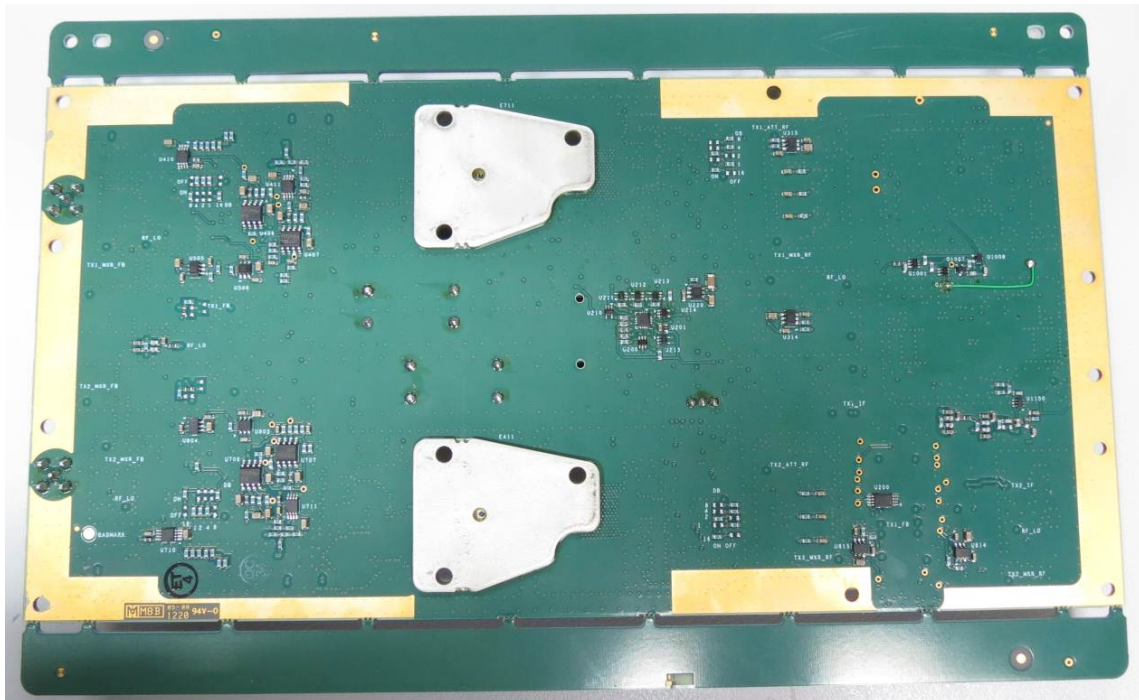
Main PCB



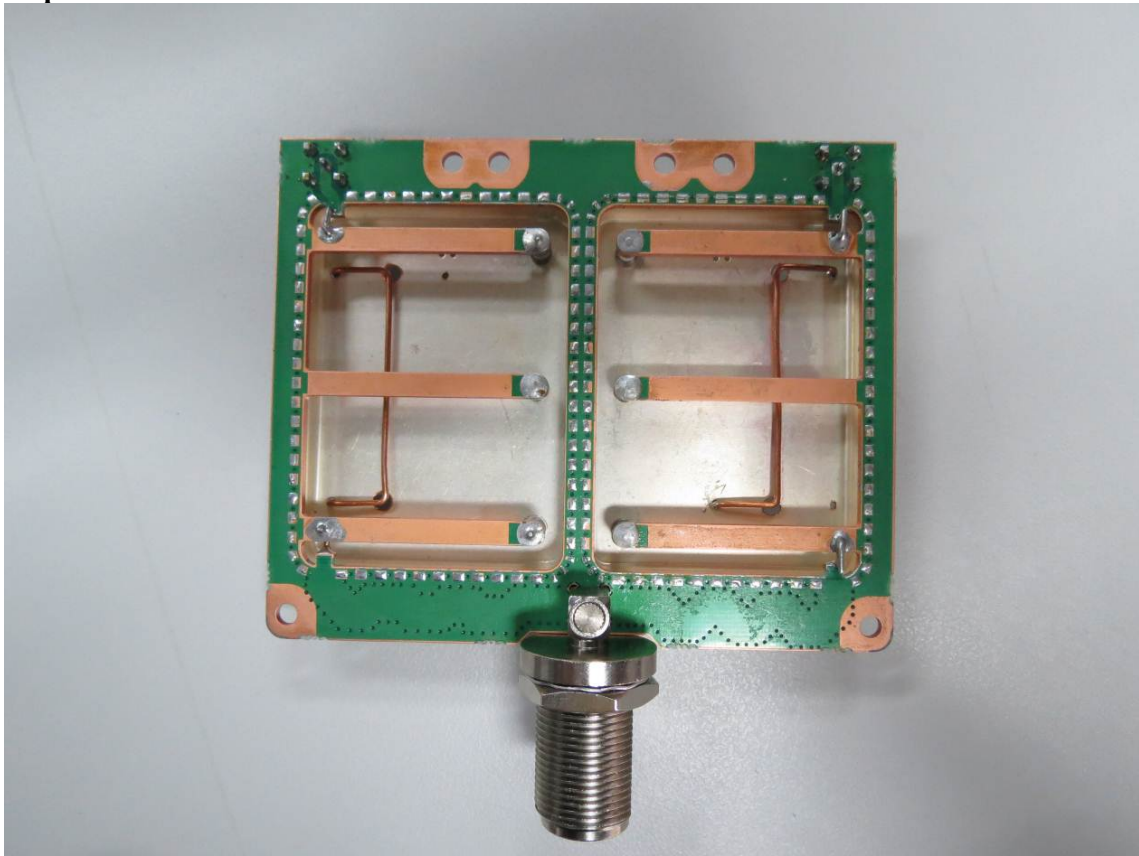
TX PCB



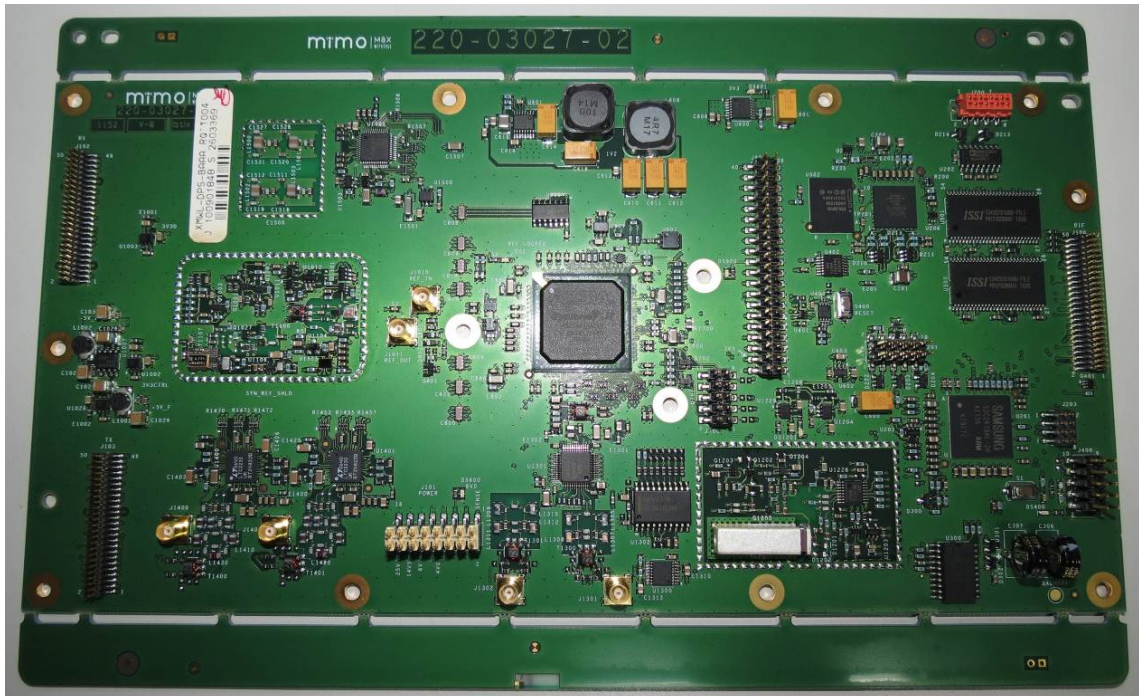
TX PCB



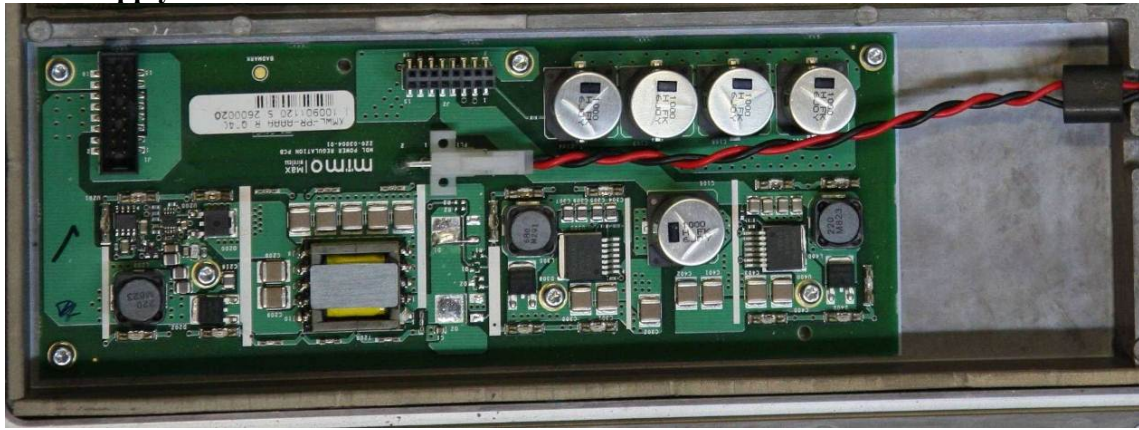
Duplexer



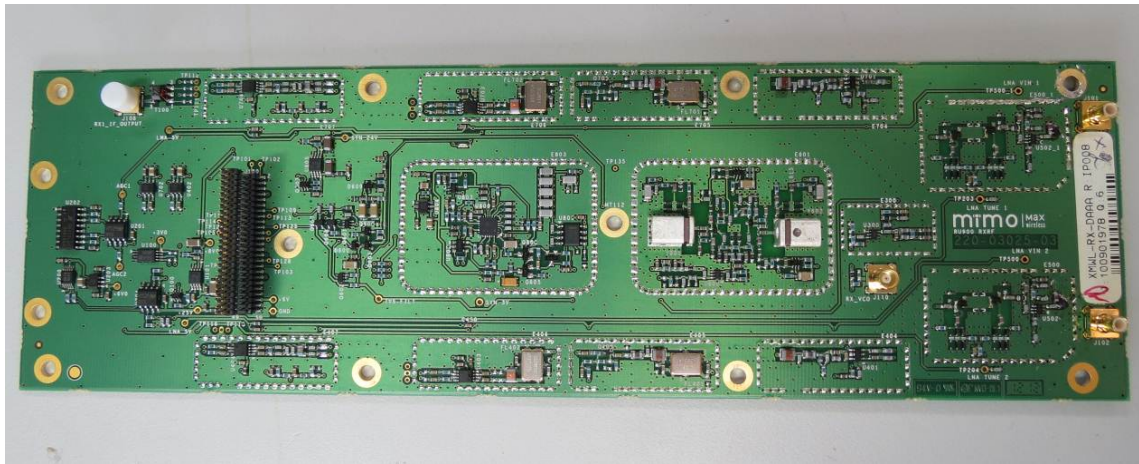
DPS PCB



PWR Supply



RX PCB



Open Air Test Site Setup



