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## **TEST REPORT**

### **4RF SR+ SQ928M140 Point to Multi-point Digital Radio**

*tested to the*

**Code of Federal Regulations (CFR) 47**

**Part 24 –Personal Communications Services  
Subpart D – Narrowband PCS**

*for*

**4RF Limited**

This Test Report is issued with the authority of:

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

**Andrew Cutler - General Manager**



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**EMC**  
Technologies

## 1. COMPLIANCE STATEMENT

The **4RF SR+ SQ928M140 Point to Multi-point Digital Radio** complies with the limits defined in 47 CFR Part 24, Subpart D – Narrowband PCS and 47 CFR Part 2 when tested in accordance with the test methods described in 47 CFR Part 2 and ANSI C63.4, 2002.

## 2. RESULT SUMMARY

The results of testing, carried out between 31<sup>st</sup> March and 10<sup>th</sup> April 2014, are summarised below.

| Clause            | Description                             | Result   |
|-------------------|-----------------------------------------|----------|
| 90.203            | Certification required                  | Noted    |
| 2.1046            | RF power output                         | Noted    |
| 24.132 (b)        | Power and antenna height limits         | Noted    |
| 2.1049            | Occupied bandwidth                      | Noted    |
| 2.202             | Bandwidths                              | Noted    |
| 24.131            | Authorised bandwidth                    | Complies |
| 24.133 (a)        | Emission Limits                         | Complies |
| 24.133 (a)(1),(2) | Emission masks                          | Complies |
| 2.1051            | Spurious emissions at antenna terminals | Complies |
| 2.1053            | Field strength of spurious radiation    | Complies |
| 2.1055            | Frequency stability                     | Noted    |
| 24.135            | Frequency stability                     | Complies |

### 3. 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.

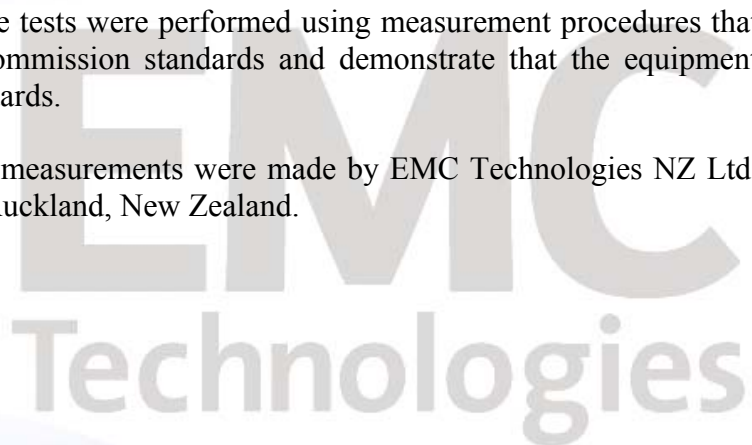
In addition this equipment has been tested in accordance with the requirements contained in the appropriate Commission regulations.

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



## 4. CLIENT INFORMATION

**Company Name** 4RF Limited

**Address** 26 Glover Street  
Ngauranga  
Wellington

**Country** New Zealand

**Contact** Mr Paul Young

## 5. TEST SAMPLE DESCRIPTION

**Brand Name** Aprisa SR+

**Model Number** SQ928M140

**Product** Point to Multi Point Digital Radio

**Manufacturer** 4RF Limited

**Manufactured in** New Zealand

**Designed in** New Zealand

**Serial Numbers** -

**FCC ID** UIPSQ928M140

The sample tested has the following specifications:

### Rated Transmitter Output Power

5.0 Watts (37.0 dBm)

### Transmitter FCC frequency range

930-931 MHz and 940-941 MHz

### Test frequencies

| Frequency (MHz) | Power (Watts) | Spacing (kHz)    |
|-----------------|---------------|------------------|
| 930.525         | 5.0           | 12.5, 25.0, 50.0 |
| 940.525         | 5.0           | 12.5, 25.0, 50.0 |

## **Emission Designators / Modes of operation**

G1D and D1D emissions designators have been applied when the transmitter uses 12.5, 25.0 and 50.0 kHz channel spacing.

G1D emission designator is applied when QPSK modulation is utilised

D1D emission designator is applied when 16QAM and 64QAM modulation is utilised

## **Power Supply**

The equipment is powered using an external DC supply.

## **Standard Temperature and Humidity**

Temperature: +15°C to + 30°C maintained.  
Relative Humidity: 20% to 75% observed.

## **Standard Test Power Source**

Nominal Voltage: 13.8 V dc.  
Standard Test Voltage: 13.8 V dc.

## **Extreme Temperature**

High Temperature: + 50°C maintained.  
Low Temperature: - 30°C maintained.

## **Extreme Test Voltages**

High Voltage: 30.0 Vdc  
Low Voltage: 10.0 Vdc

## 6. TEST RESULTS

### RF power output

Measurements were carried out at the RF output terminals of the transmitter using a 30 dB power attenuator and a 50  $\Omega$  dummy load.

Measurements were carried out when the transmitter was not being modulated.

Testing was carried out at maximum rated power output of 5 watts (37 dBm).

**Nominal Frequency:** 930.525 MHz

| Frequency (MHz) | Voltage (Vdc) | Rated (dBm) | Measured (dBm) |
|-----------------|---------------|-------------|----------------|
| 930.525         | 10.0          | 37.0        | 36.1           |
| 930.525         | 13.8          | 37.0        | 36.1           |
| 930.525         | 30.0          | 37.0        | 36.1           |

**Nominal Frequency:** 940.525 MHz

| Frequency (MHz) | Voltage (Vdc) | Rated (dBm) | Measured (dBm) |
|-----------------|---------------|-------------|----------------|
| 940.525         | 10.0          | 37.0        | 36.1           |
| 940.525         | 13.8          | 37.0        | 36.1           |
| 940.525         | 30.0          | 37.0        | 36.1           |

### Limits:

The output power shall be within +/- 1 dB of the manufacturers rated power.

**Result:** Complies.

**Measurement Uncertainty:**  $\pm 0.5$  dB

**Emission types:**

The following emission types are used:

- G1D digital data when QPSK modulation is utilised
- D1D digital data when 16QAM or 64QAM modulation is utilised

**Part 24.131 – Authorised Bandwidth:**

The authorized bandwidth of narrowband PCS channels will be 10 kHz for 12.5 kHz channels and 45 kHz for 50 kHz channels. For aggregated adjacent channels, a maximum authorized bandwidth of 5 kHz less than the total aggregated channel width is permitted.

Measurements have been made to verify the declared bandwidth.

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 a 30 dB attenuator.

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 23 dB (99%) absolute bandwidth points determined.

**Nominal Frequency:** 940.525 MHz

| Emission | Channel (kHz) | Measured (kHz) | Authorised Bandwidth (kHz) |
|----------|---------------|----------------|----------------------------|
| QPSK     | 12.5          | 9.560          | 10.0                       |
| 16QAM    | 12.5          | 8.588          | 10.0                       |
| 64 QAM   | 12.5          | 8.475          | 10.0                       |
|          |               |                |                            |
| QPSK     | 25.0          | 19.050         | 20.0                       |
| 16QAM    | 25.0          | 18.525         | 20.0                       |
| 64 QAM   | 25.0          | 18.300         | 20.0                       |
|          |               |                |                            |
| QPSK     | 50.0          | 40.750         | 45.0                       |
| 16QAM    | 50.0          | 38.750         | 45.0                       |
| 64 QAM   | 50.0          | 37.375         | 45.0                       |

**Result:** Complies.

## 24.133 Emission Limits

Part 24.133 (a) states the power of any emission shall be attenuated below the transmitter power in accordance with the following:

(1) For transmitters authorized a bandwidth greater than 10 kHz:

(i) On any frequency outside the authorized bandwidth and removed from the edge of the authorized bandwidth by a displacement frequency ( $f_d$  in kHz) of up to and including 40 kHz: at least  $116 \log_{10} ((f_d+10)/6.1)$  decibels or  $50 + 10 \log_{10} (P)$  decibels or 70 decibels, whichever is the lesser attenuation;

(ii) On any frequency outside the authorized bandwidth and removed from the edge of the authorized bandwidth by a displacement frequency ( $f_d$  in kHz) of more than 40 kHz: at least  $43 + 10 \log_{10} (P)$  decibels or 80 decibels, whichever is the lesser attenuation.

(2) For transmitters authorized a bandwidth of 10 kHz:

(i) On any frequency outside the authorized bandwidth and removed from the edge of the authorized bandwidth by a displacement frequency ( $f_d$  in kHz) of up to and including 20 kHz: at least  $116 \times \log_{10} ((f_d+5)/3.05)$  decibels or  $50 + 10 \times \log_{10} (P)$  decibels or 70 decibels, whichever is the lesser attenuation;

(ii) On any frequency outside the authorized bandwidth and removed from the edge of the authorized bandwidth by a displacement frequency ( $f_d$  in kHz) of more than 20 kHz: at least  $43 + 10 \log_{10} (P)$  decibels or 80 decibels, whichever is the lesser attenuation.

The transmitter can operate in the band 930-931 and 940-941 using an authorised bandwidth of 10 kHz and channel spacing of 12.5 kHz and an authorised bandwidth of 45 kHz and a channel spacing of 50 kHz.

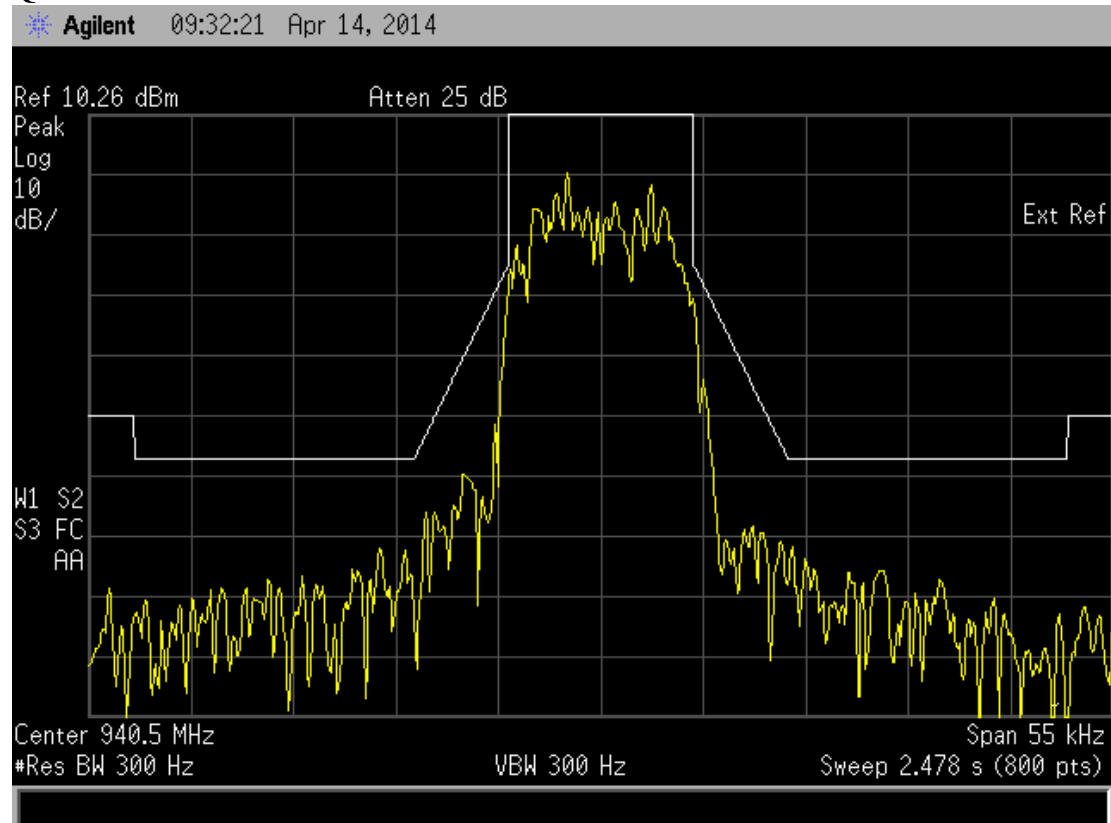
Measurements have been made of each modulation type using a spectrum analyser operating in peak hold mode and a 30 dB attenuator.

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

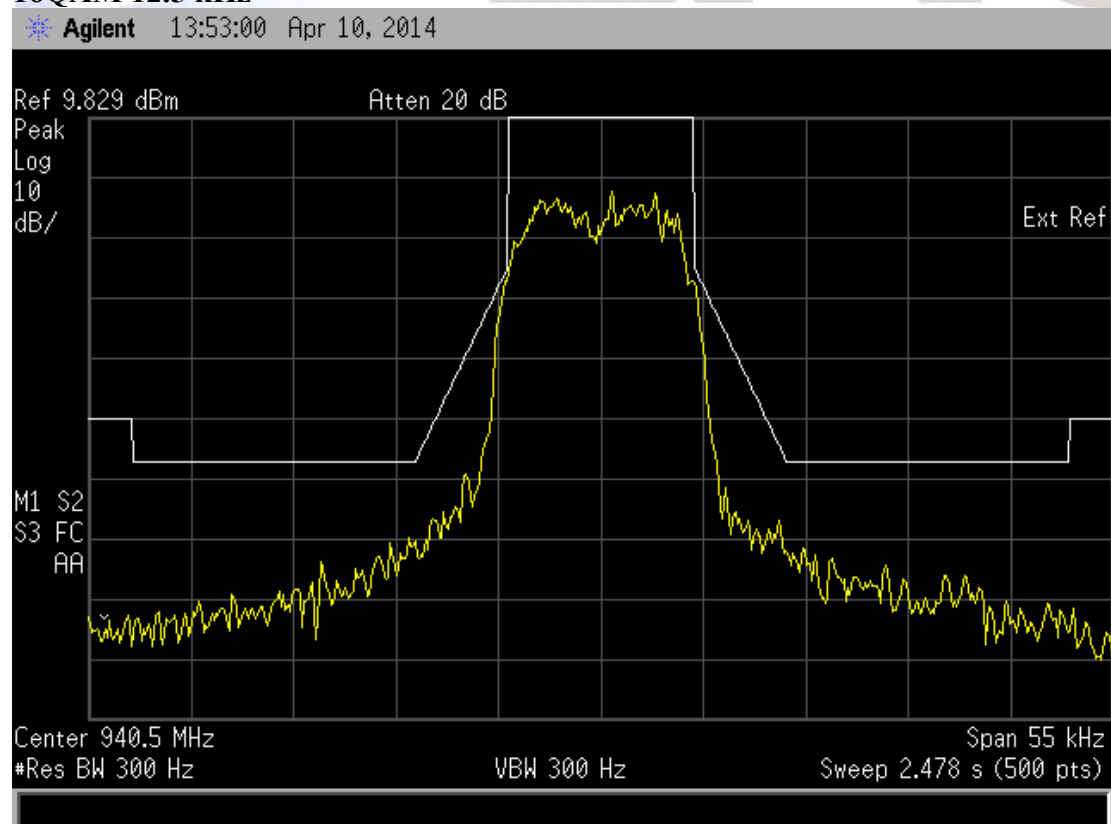
This level is used as a reference level on the spectrum analyser.

Nominal Frequency: 940.525 MHz

### QPSK 12.5 kHz

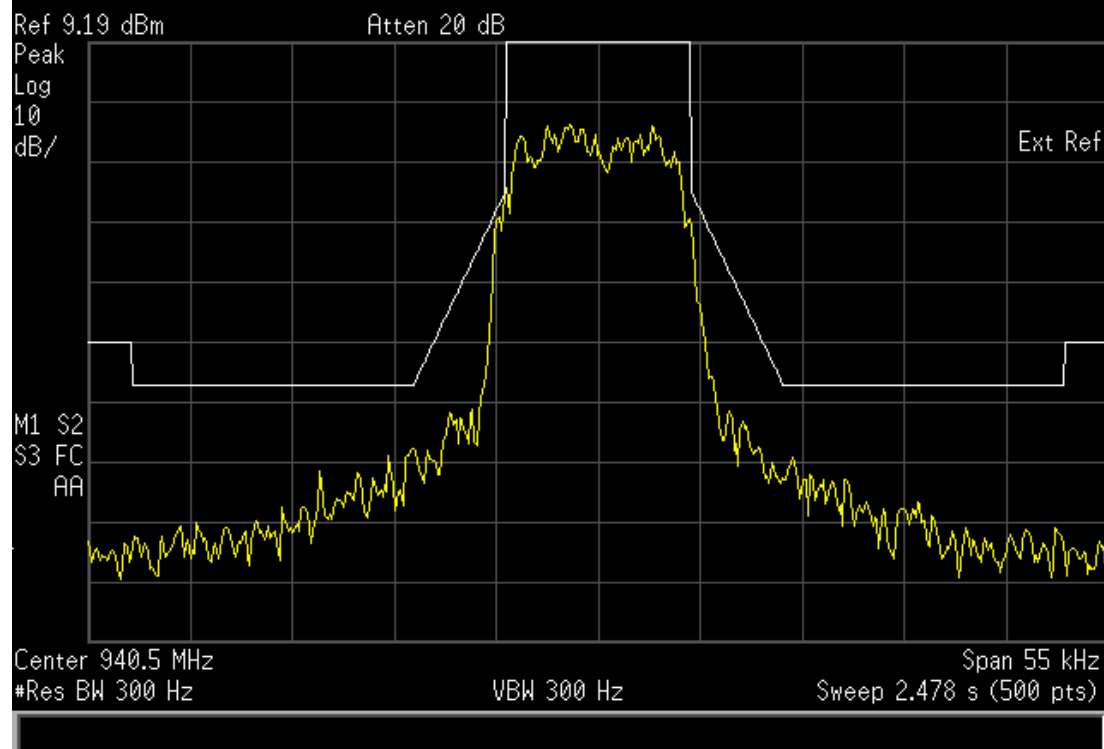


### 16QAM 12.5 kHz



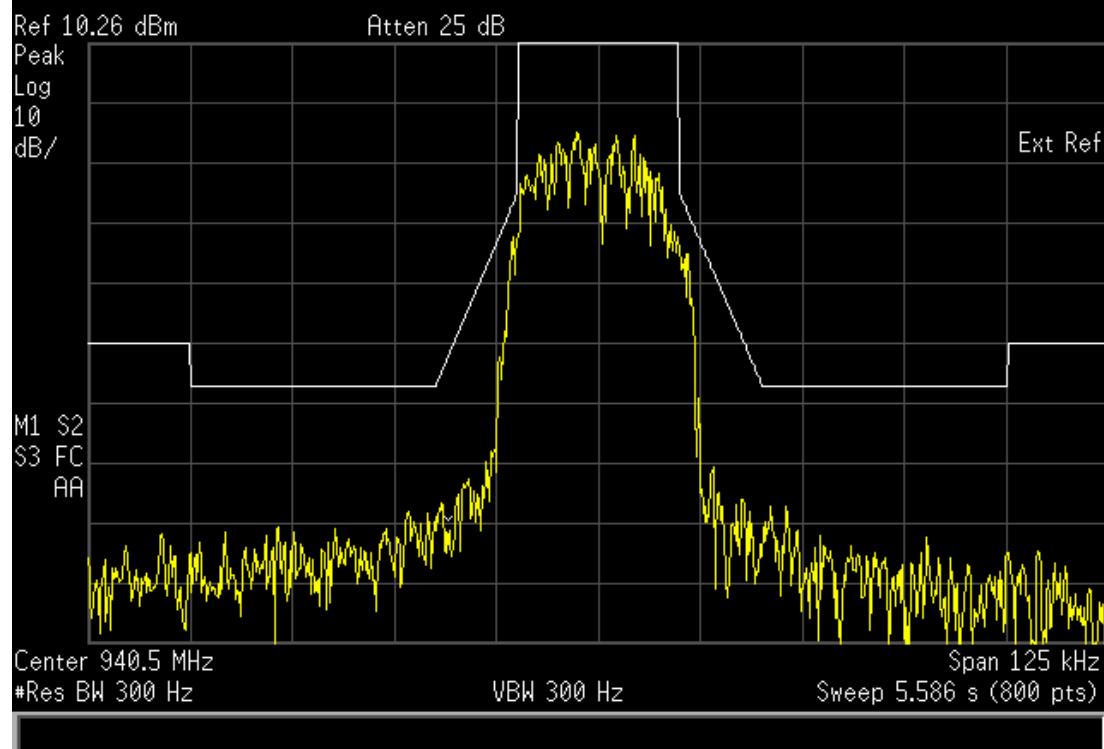
## 64 QAM 12.5 kHz

Agilent 13:56:36 Apr 10, 2014



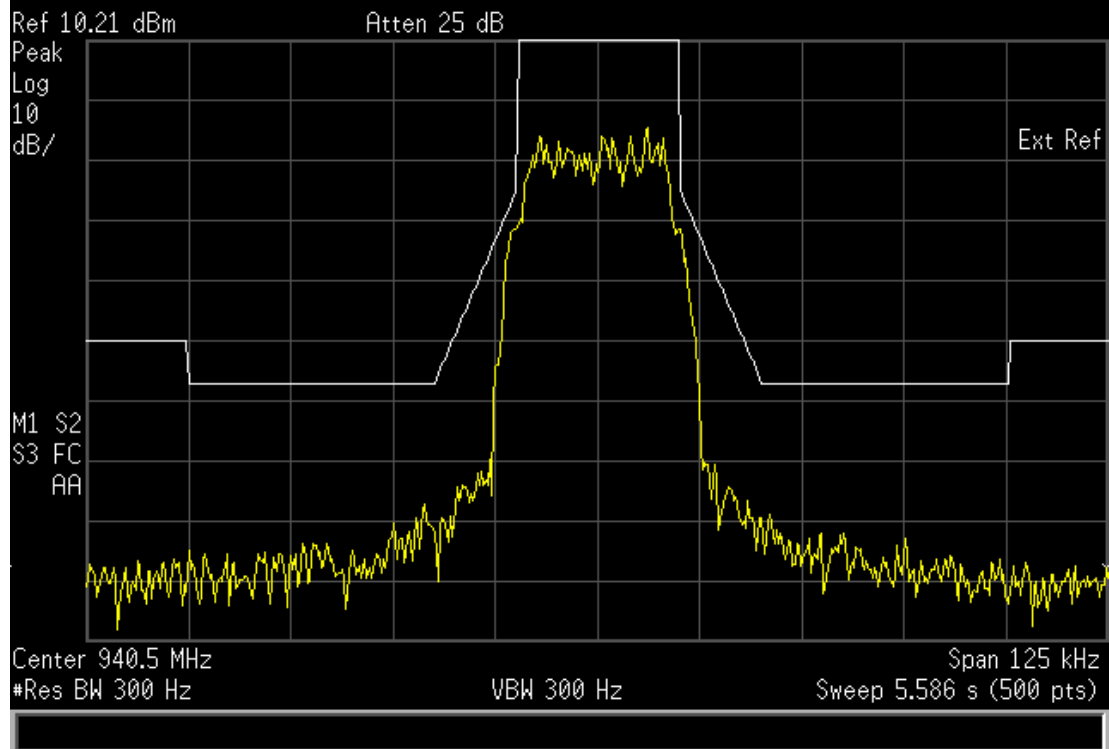
## QPSK 25.0 kHz

Agilent 09:49:33 Apr 14, 2014



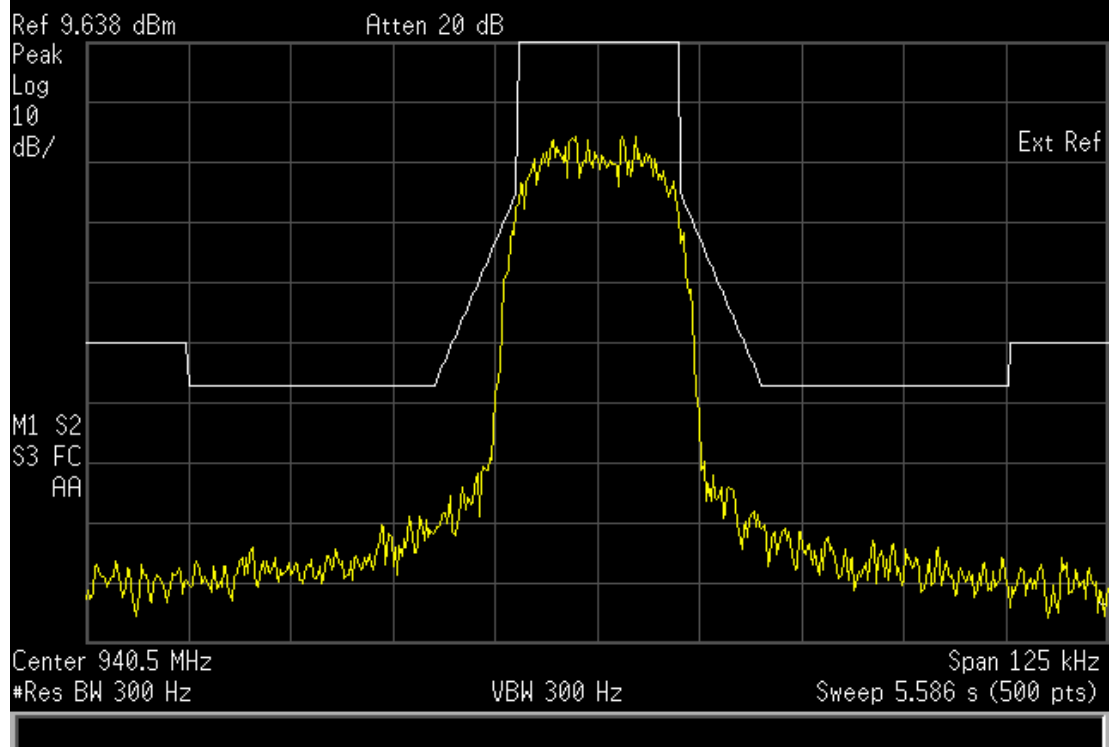
## 16QAM 25.0 kHz

Agilent 14:17:31 Apr 10, 2014

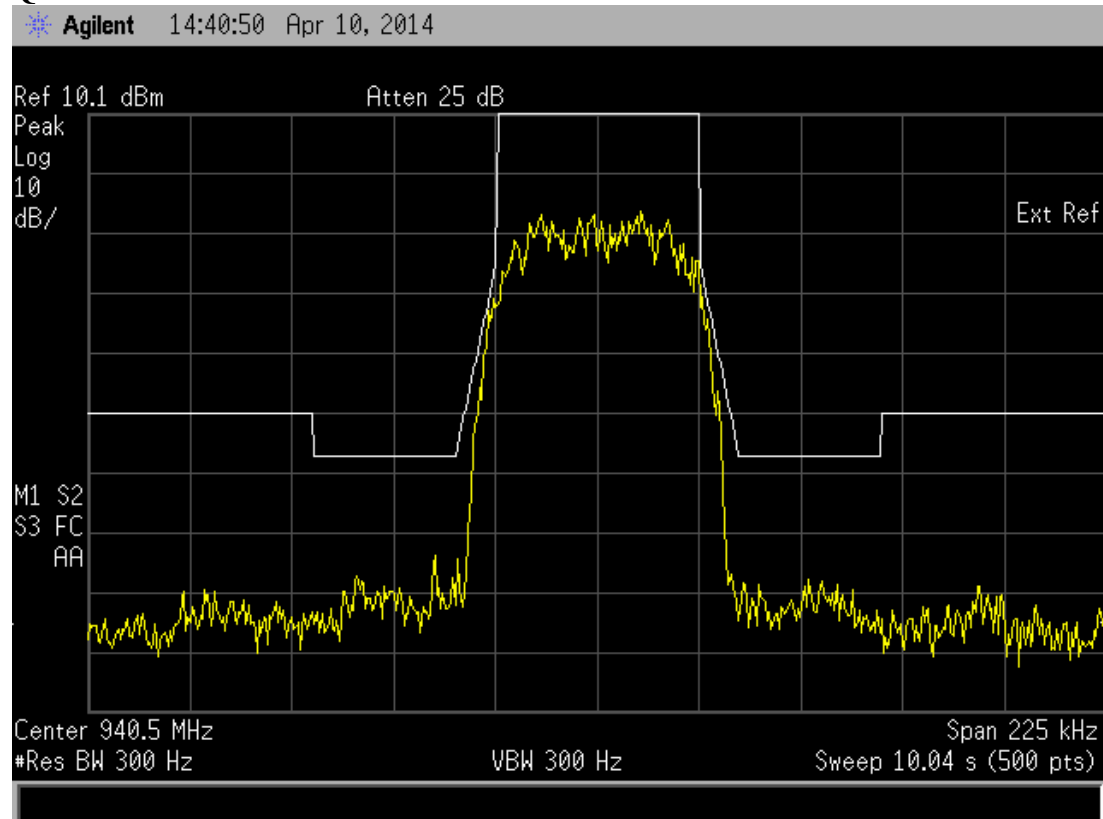


## 64 QAM 25.0 kHz

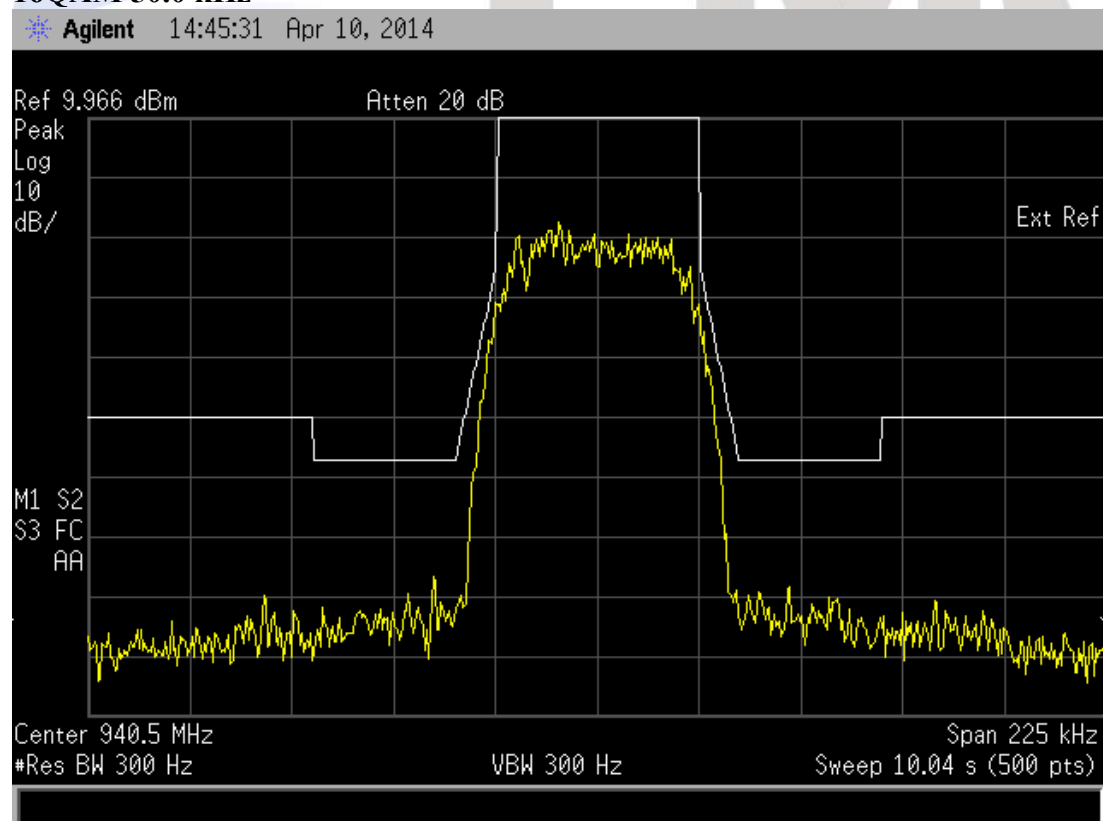
Agilent 14:25:55 Apr 10, 2014



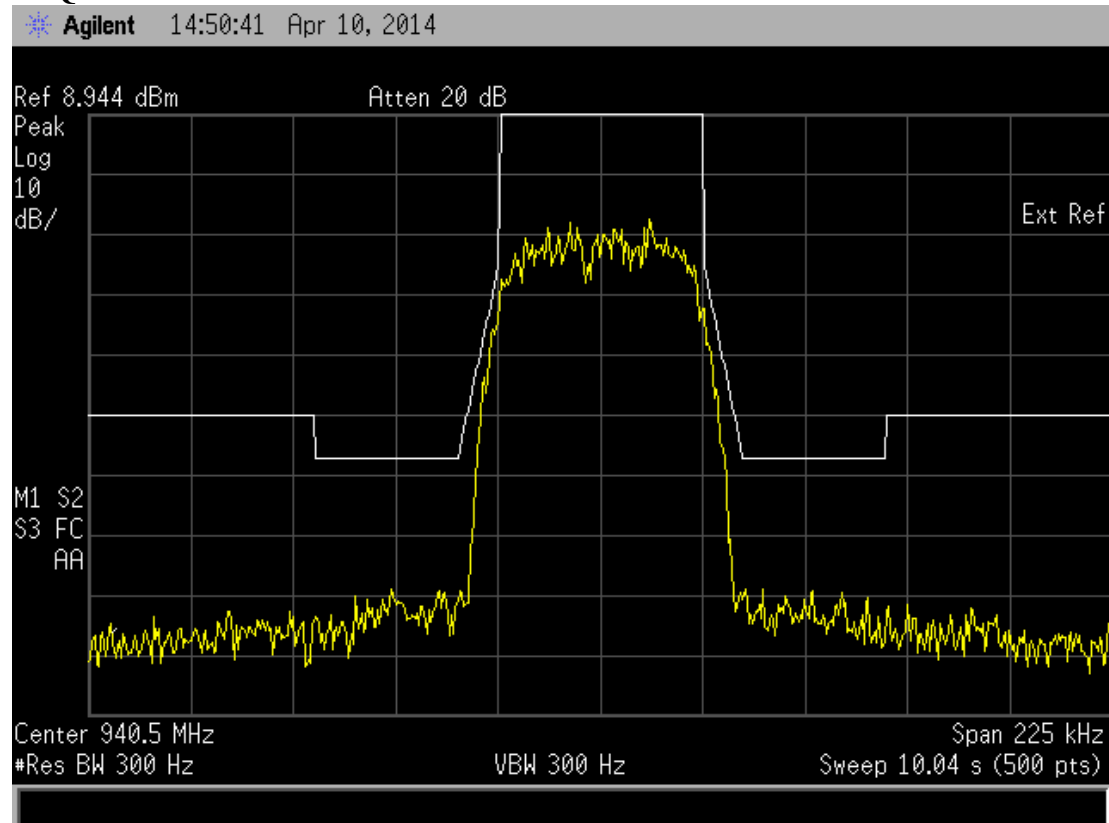
## QPSK 50.0 kHz



## 16QAM 50.0 kHz



## 64 QAM 50.0 kHz



**Result:** Complies

## Transmitter spurious emissions at the antenna terminals

Nominal Frequency: 930.525 MHz

| Spurious emission<br>(MHz) | Emission level<br>(dBm) | Limit<br>(dBm) |
|----------------------------|-------------------------|----------------|
| 1861.050                   | -65.0                   | -13.0          |
| 2791.575                   | <-65.0                  | -13.0          |
| 3722.100                   | < -70.0                 | -13.0          |
| 4652.625                   | < -70.0                 | -13.0          |
| 5583.150                   | < -70.0                 | -13.0          |
| 6513.675                   | < -70.0                 | -13.0          |
| 7444.200                   | < -70.0                 | -13.0          |
| 8374.725                   | < -70.0                 | -13.0          |
| 9305.250                   | < -70.0                 | -13.0          |

Nominal Frequency: 940.525 MHz

| Spurious emission<br>(MHz) | Emission level<br>(dBm) | Limit<br>(dBm) |
|----------------------------|-------------------------|----------------|
| 1881.050                   | -65.0                   | -13.0          |
| 2821.575                   | <-65.0                  | -13.0          |
| 3762.100                   | < -70.0                 | -13.0          |
| 4702.625                   | < -70.0                 | -13.0          |
| 5643.150                   | < -70.0                 | -13.0          |
| 6583.675                   | < -70.0                 | -13.0          |
| 7524.200                   | < -70.0                 | -13.0          |
| 8464.725                   | < -70.0                 | -13.0          |
| 9405.250                   | < -70.0                 | -13.0          |

### Limit:

Applied emission limitations, on any frequency removed from the centre of the authorised bandwidth by a displacement frequency of more than 20 kHz shall be attenuated by at least  $43 + 10 \log (P)$ .

A rated power of 5.0 watts (37.0 dBm) gives a limit of -13 dBm.

The spectrum has been investigated up to the 10<sup>th</sup> harmonic of the transmitter.

Part 2.1051 states that emissions greater than 20 dB below the limit need not be specified.

Part 2.1057 states that the spectrum should be investigated up to the 10<sup>th</sup> harmonic if the transmitter operates below 10 GHz.

**Result:** Complies.

**Measurement Uncertainty:**  $\pm 3.3$  dB

## Field strength of the transmitter spurious emissions

Nominal Frequency: 930.525 MHz

| Frequency (MHz) | Level (dBμV/m) | Level (dBm) | Limit (dBm) | Polarity   | Margin (dB) | Result |
|-----------------|----------------|-------------|-------------|------------|-------------|--------|
| 1861.0500       | 48.0           | -49.4       | -20.0       | Vertical   | 29.4        | Pass   |
| 1861.0500       | 46.8           | -50.6       | -20.0       | Horizontal | 30.6        | Pass   |
| 2791.5750       | 41.0           | -56.4       | -20.0       | Vertical   | 36.4        | Pass   |
| 2791.5750       | 41.0           | -56.4       | -20.0       | Horizontal | 36.4        | Pass   |
| 3722.1000       | 44.0           | -53.4       | -20.0       | Vertical   | 33.4        | Pass   |
| 3722.1000       | 44.0           | -53.4       | -20.0       | Horizontal | 33.4        | Pass   |
| 4652.6250       | 46.0           | -51.4       | -20.0       | Vertical   | 31.4        | Pass   |
| 4652.6250       | 46.0           | -51.4       | -20.0       | Horizontal | 31.4        | Pass   |
| 5583.1500       | 48.0           | -49.4       | -20.0       | Vertical   | 29.4        | Pass   |
| 5583.1500       | 48.0           | -49.4       | -20.0       | Horizontal | 29.4        | Pass   |
| 6513.6750       | 51.0           | -46.4       | -20.0       | Vertical   | 26.4        | Pass   |
| 6513.6750       | 51.0           | -46.4       | -20.0       | Horizontal | 26.4        | Pass   |
| 7444.2000       | 47.0           | -50.4       | -20.0       | Vertical   | 30.4        | Pass   |
| 7444.2000       | 47.0           | -50.4       | -20.0       | Horizontal | 30.4        | Pass   |
| 8374.7250       | 48.0           | -49.4       | -20.0       | Vertical   | 29.4        | Pass   |
| 8374.7250       | 48.0           | -49.4       | -20.0       | Horizontal | 29.4        | Pass   |
| 9305.2500       | 51.0           | -46.4       | -20.0       | Vertical   | 26.4        | Pass   |
| 9305.2500       | 51.0           | -46.4       | -20.0       | Horizontal | 26.4        | Pass   |

Nominal Frequency: 940.525 MHz

| Frequency (MHz) | Level (dBμV/m) | Level (dBm) | Limit (dBm) | Polarity   | Margin (dB) | Result |
|-----------------|----------------|-------------|-------------|------------|-------------|--------|
| 1881.0500       | 48.1           | -49.3       | -20.0       | Vertical   | 29.3        | Pass   |
| 1881.0500       | 46.6           | -50.8       | -20.0       | Horizontal | 30.8        | Pass   |
| 2821.5750       | 41.0           | -56.4       | -20.0       | Vertical   | 36.4        | Pass   |
| 2821.5750       | 41.0           | -56.4       | -20.0       | Horizontal | 36.4        | Pass   |
| 3762.1000       | 44.0           | -53.4       | -20.0       | Vertical   | 33.4        | Pass   |
| 3762.1000       | 44.0           | -53.4       | -20.0       | Horizontal | 33.4        | Pass   |
| 4702.6250       | 46.0           | -51.4       | -20.0       | Vertical   | 31.4        | Pass   |
| 4702.6250       | 46.0           | -51.4       | -20.0       | Horizontal | 31.4        | Pass   |
| 5643.1500       | 48.0           | -49.4       | -20.0       | Vertical   | 29.4        | Pass   |
| 5643.1500       | 48.0           | -49.4       | -20.0       | Horizontal | 29.4        | Pass   |
| 6583.6750       | 51.0           | -46.4       | -20.0       | Vertical   | 26.4        | Pass   |
| 6583.6750       | 51.0           | -46.4       | -20.0       | Horizontal | 26.4        | Pass   |
| 7524.2000       | 47.0           | -50.4       | -20.0       | Vertical   | 30.4        | Pass   |
| 7524.2000       | 47.0           | -50.4       | -20.0       | Horizontal | 30.4        | Pass   |
| 8464.7250       | 48.0           | -49.4       | -20.0       | Vertical   | 29.4        | Pass   |
| 8464.7250       | 48.0           | -49.4       | -20.0       | Horizontal | 29.4        | Pass   |
| 9405.2500       | 51.0           | -46.4       | -20.0       | Vertical   | 26.4        | Pass   |
| 9405.2500       | 51.0           | -46.4       | -20.0       | Horizontal | 26.4        | Pass   |

In transmit mode the transmitter was tested while transmitting continuously while attached to a dummy load.

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 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 July 2013

**Limit:**

All spurious emissions are to be attenuated by at least  $50 + 10 \log (P)$ .

The rated power of 5.0 watts (37.0 dBm) gives a limit of  $-20$  dBm.

No measurements were made above the 10<sup>th</sup> harmonic.

**Result:** Complies.

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



## Frequency Stability

Frequency stability 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.

**Nominal Frequency:** 940.525 MHz

| Temperature<br>(°C) | Voltage<br>(10.8 Vdc) | Voltage<br>(13.8 Vdc) | Voltage<br>(15.6 Vdc) |
|---------------------|-----------------------|-----------------------|-----------------------|
| +50                 | -34.0 Hz              | -38.0 Hz              | -38.0 Hz              |
| +40                 | -36.0 Hz              | -37.0 Hz              | -36.0 Hz              |
| +30                 | +35.0 Hz              | +36.0 Hz              | +38.0 Hz              |
| +20                 | +28.0 Hz              | +27.0 Hz              | +27.0 Hz              |
| +10                 | +115.0 Hz             | +113.0 Hz             | +115.0 Hz             |
| 0                   | +108.0 Hz             | +108.0 Hz             | +109.0 Hz             |
| -10                 | +97.0 Hz              | +99.0 Hz              | +99.0 Hz              |
| -20                 | +208.0 Hz             | +209.0 Hz             | +209.0 Hz             |
| -30                 | +221.0 Hz             | +222.0 Hz             | +223.0 Hz             |

### Limit:

Part 24.135 states that transmitters are required to have a frequency tolerance of 1.0 ppm.

This transmitter was tested on 940.525 MHz.

$$1.0 \text{ ppm} = 1.0 \times 940.5 \text{ Hz}.$$

Worst case observed was +223 Hz = 0.24 ppm

**Result:** Complies.

**Measurement Uncertainty:**  $\pm 30 \text{ Hz}$ .

## Exposure of humans to RF fields

Transmit Frequency 930.525 MHz

Minimum safe distances have been calculated below.

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

- Occupational / Controlled Exposure limit will be  $3.10 \text{ mW}/\text{cm}^2$   
( $f/300 = 930.5 \text{ MHz}/300$ )

- General Population / Uncontrolled exposure limit will be  $0.62 \text{ mW}/\text{cm}^2$   
( $f/1500 = 930.5 \text{ MHz}/1500$ )

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

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

### Controlled

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

$$E = \sqrt{3.1 * 3770}$$

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

### Uncontrolled

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

$$E = \sqrt{0.62 * 3770}$$

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

The rated maximum transmitter power (P) = 5 watts.

Transmitter is operated using an antenna with a gain (G) of up to 28 dBi which equals 631.

The client has declared a duty cycle (DC) of 100% (1)

### Controlled

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

$$d = \sqrt{30 * 5 * 631 * 1} / 108.1$$

$$d = 2.85 \text{ metres or } 285 \text{ cm}$$

### Uncontrolled

$$d = \sqrt{30 * 5 * 631 * 1} / 48.3$$

$$d = 6.37 \text{ metres or } 637 \text{ cm}$$

**Result:** Complies if the safe distances defined for each environment are applied.

## 7. TEST EQUIPMENT USED

| Instrument          | Manufacturer    | Model       | Serial #    | Asset    | Cal Due    | Interval |
|---------------------|-----------------|-------------|-------------|----------|------------|----------|
| Aerial Controller   | EMCO            | 1090        | 9112-1062   | 3710     | N/a        | N/a      |
| Aerial Mast         | EMCO            | 1070-1      | 9203-1661   | 3708     | N/a        | N/a      |
| Turntable           | EMCO            | 1080-1-2.1  | 9109-1578   | 3709     | N/a        | N/a      |
| VHF Balun           | Schwarzbeck     | VHA9103     | -           | 3603     | 12/01/2015 | 1 year   |
| Biconical Antenna   | Schwarzbeck     | BBA 9106    | -           | 3612     | 12/01/2015 | 1 year   |
| Log Periodic        | Schwarzbeck     | VUSLP 91111 | 9111-228    | 3785     | 12/01/2015 | 1 year   |
| Horn Antenna        | Electrometrics  | RGA-60      | 6234        | E1494    | 04/07/2014 | 1 year   |
| Measuring receiver  | Rohde & Schwarz | ESIB-40     | 100171      | EMC4003  | 29/01/2015 | 1 year   |
| Modulation Analyzer | Rohde & Schwarz | FMA         | 837807/020  | E1552    | 15/01/2015 | 1 year   |
| Oscilloscope        | Tektronics      | 745A        | B010643     | E1569    | 15/01/2015 | 1 year   |
| Power Attenuator    | Weinschel       | 49-20-43    | GC104       | E1308    | N/a        | N/a      |
| Power Supply        | Hewlett Packard | 6032A       | 2743A-02859 | E1069    | N/a        | N/a      |
| Signal Generator    | Rohde & Schwarz | SMHU        | 838923/028  | E1493    | 22/01/2015 | 1 year   |
| Spectrum Analyzer   | Hewlett Packard | E7405A      | US39150142  | RFS 3776 | 26/05/2014 | 1 year   |
| Thermal chamber     | Contherm        | M180F       | 86025       | E1129    | 01/06/2014 | 1 year   |
| Thermometer         | DSIR            | RT200       | 035         | E1049    | 01/06/2014 | 1 year   |

## 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 last updated in July 2013.

All testing has been carried out in accordance with the terms of EMC Technologies (NZ) Ltd's International Accreditation New Zealand (IANZ) Accreditation to ISO/IEC 17025.

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

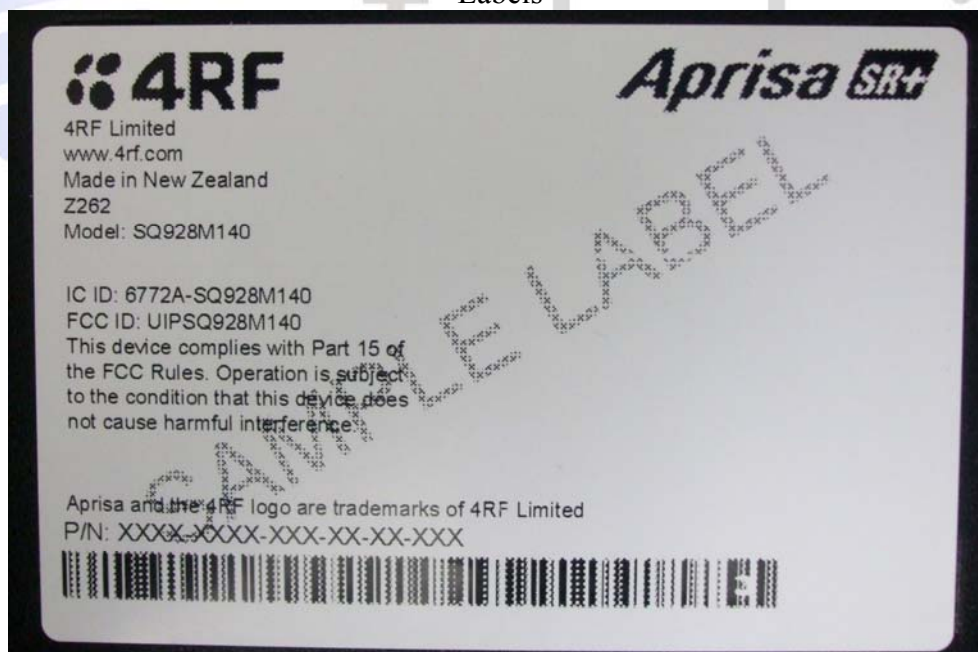
International Accreditation New Zealand has Mutual Recognition Arrangements for testing and calibration with various accreditation bodies in a number of economies. This includes NATA (Australia), UKAS (UK), SANAS (South Africa), NVLAP (USA), A2LA (USA), SWEDAC (Sweden). Further details can be supplied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

## 9. PHOTOGRAPHS

External photos of the device tested



Labels



## Radiated emissions test set up photos



