



EMC Technologies (NZ) Ltd
PO Box 68-307, Newton
Auckland 1145
New Zealand
Phone 09 360 0862
Fax 09 360 0861
E-Mail Address: aucklab@ihug.co.nz
Web Site: www.emctech.com.au

TEST REPORT

4RF SR+ SQ215M140 Point to Multi-point Digital Radio

tested to the

Code of Federal Regulations (CFR) 47

Part 90 –Private Land Mobile Services

for

4RF Limited

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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EMC
Technologies

1. COMPLIANCE STATEMENT

The **4RF SR+ SQ215M140 Point to Multi-point Digital Radio** complies with the limits defined in 47 CFR Part 90 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 27th March and 8th April 2014, are summarised below.

Clause	Description	Result
90.203	Certification required	Noted
2.1046 90.259 (a)	RF power output Power and antenna height limits	Noted Noted
2.1049 2.202	Occupied bandwidth Bandwidths	Noted Noted
90.207 90.209 90.210	Types of emissions Bandwidth limitations Emission masks	Complies Complies Complies
2.1051	Spurious emissions at antenna terminals	Complies
2.1053	Field strength of spurious radiation	Complies
2.1055 90.213	Frequency stability Frequency stability	Noted Complies
1.1310	Radio frequency exposure limits	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.

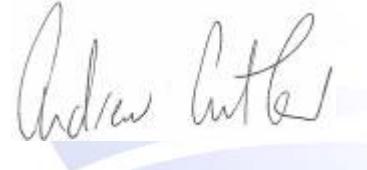
This report does not contain corrections or erasures.

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 SQ215M140

Product Point to Multi Point Digital Radio

Manufacturer 4RF Limited

Manufactured in New Zealand

Designed in New Zealand

Serial Numbers -

FCC ID UIPSQ215M140

The sample tested has the following specifications:

Rated Transmitter Output Power

Between 216 – 217 MHz: 5 watts (+37 dBm)
Between 217 – 220 MHz: 2 watts (+33 dBm)

Transmitter FCC frequency range

Part 90: 216 - 217 MHz and 217 - 220 MHz

Test frequencies

Channel	Frequency (MHz)	Power (Watts)	Spacing (kHz)
1	216.575	5.0	12.5, 25.0 & 50.0
2	217.575	2.0	12.5, 25.0 & 50.0
3	219.575	2.0	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 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 5 watts (37 dBm) for the band 216 – 217 MHz.

Frequency (MHz)	Voltage (Vdc)	Rated (dBm)	Measured (dBm)
216.575	10.0	37.0	36.5
216.575	13.8	37.0	36.5
216.575	30.0	37.0	36.5

Testing was carried out at 2 watts (33 dBm) for the band 217 – 220 MHz

Frequency (MHz)	Voltage (Vdc)	Rated (dBm)	Measured (dBm)
217.575	10.0	33.0	32.9
217.575	13.8	33.0	32.9
217.575	30.0	33.0	32.9

Limit:

90.259 (a) (4) In the 217-220 MHz band, the maximum transmitter output power is 2 watts.

The maximum antenna height above average terrain (HAAT) is 152 m (500 feet).

Result: Complies

Measurement Uncertainty: ± 0.5 dB

Part 90.207 – 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 90.209 – Bandwidth limitations:

The authorised bandwidth is taken to be the necessary bandwidth.

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: 217.575 MHz

Emission	Channel (kHz)	Measured (kHz)	Authorised Bandwidth (kHz)
QPSK	12.5	9.750	11.25
16QAM	12.5	9.700	11.25
64QAM	12.5	9.650	11.25
QPSK	25.0	17.000	20.0
16QAM	25.0	16.250	20.0
64QAM	25.0	15.495	20.0
QPSK	50.0	38.721	45.0
16QAM	50.0	38.095	45.0
64QAM	50.0	36.716	45.0

Result: Complies.

Spectrum Masks

Part 90.210 states all equipment operating in other bands equipment designed to operate with a must meet the requirements of Emission Mask B or C, as applicable.

Mask B has been applied as the transmitter has an audio low pass filter.

The transmitter can operate in the band 217-220 MHz using an authorised bandwidth of 11.25 kHz and channel spacing of 12.5 kHz and an authorised bandwidth of 20 kHz and a channel spacing of 25 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.

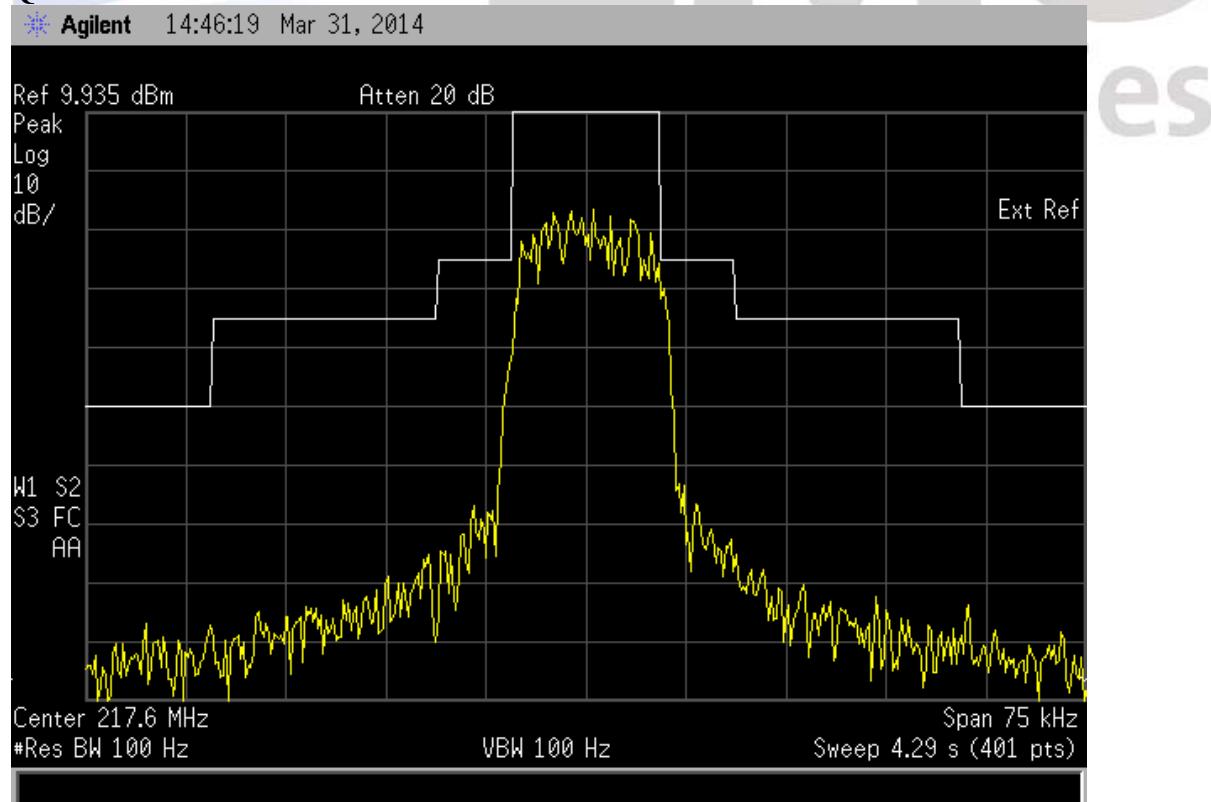
This level is used as a reference level on the spectrum analyser.

The resolution bandwidth is then changed and the reference level minus 23 dB (99%) absolute bandwidth points determined.

Measurements were made with the spectrum analyser operating in peak hold centred on the allocated frequency.

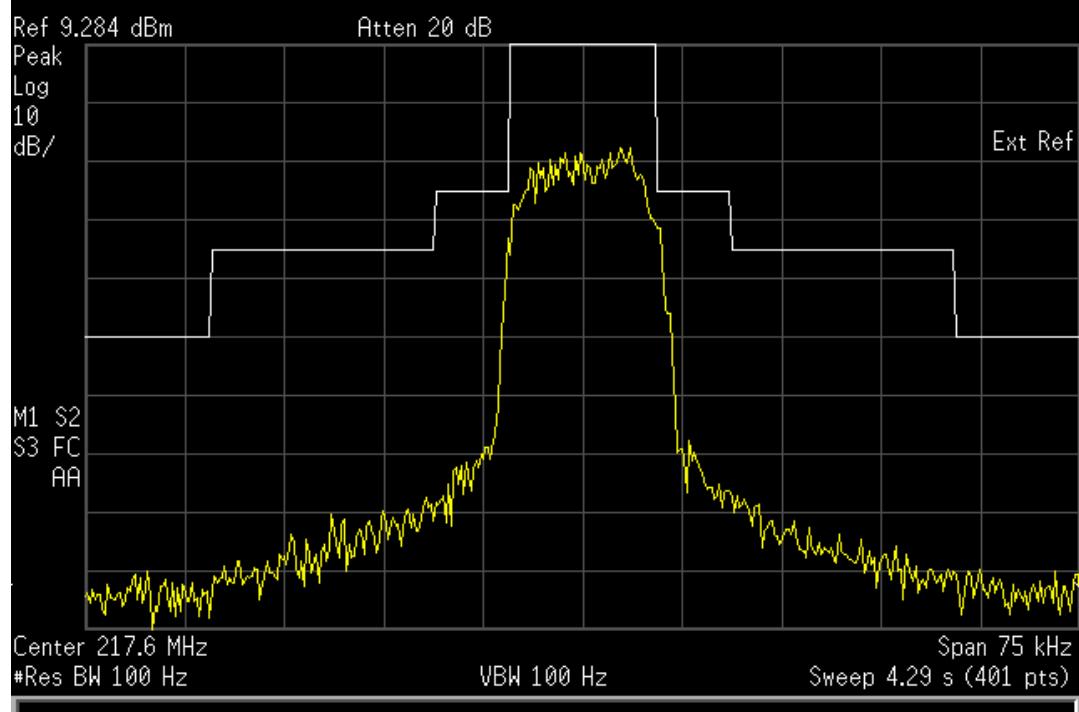
Nominal Frequency: 217.575 MHz

QPSK 12.5 kHz



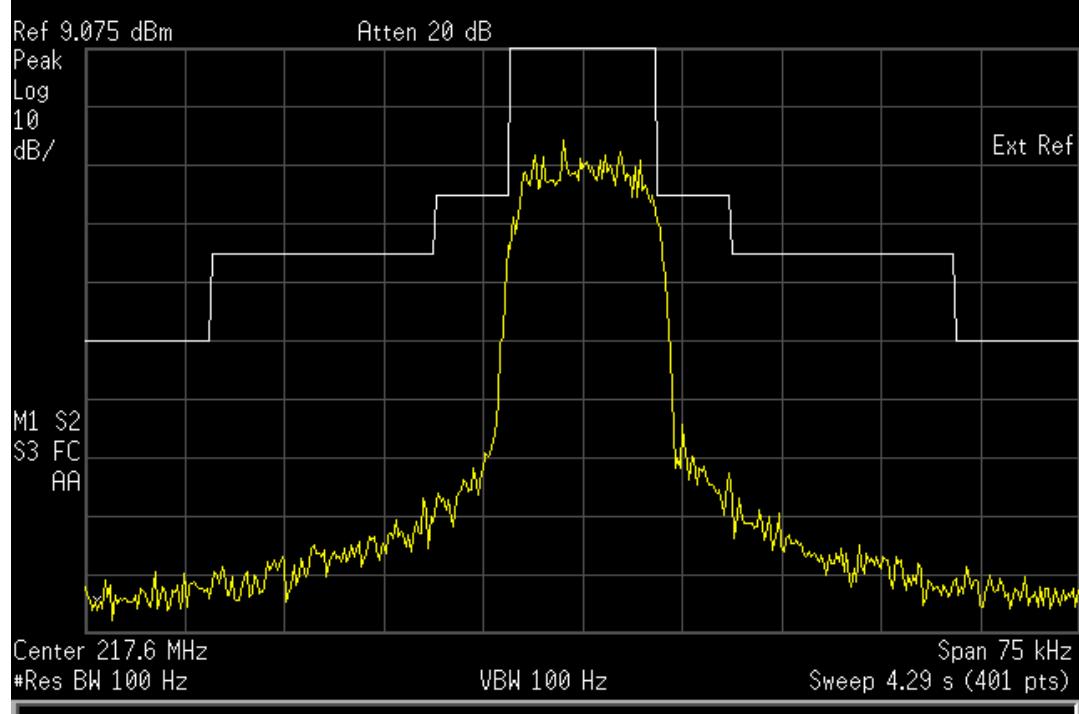
16QAM 12.5 kHz

Agilent 14:49:22 Mar 31, 2014



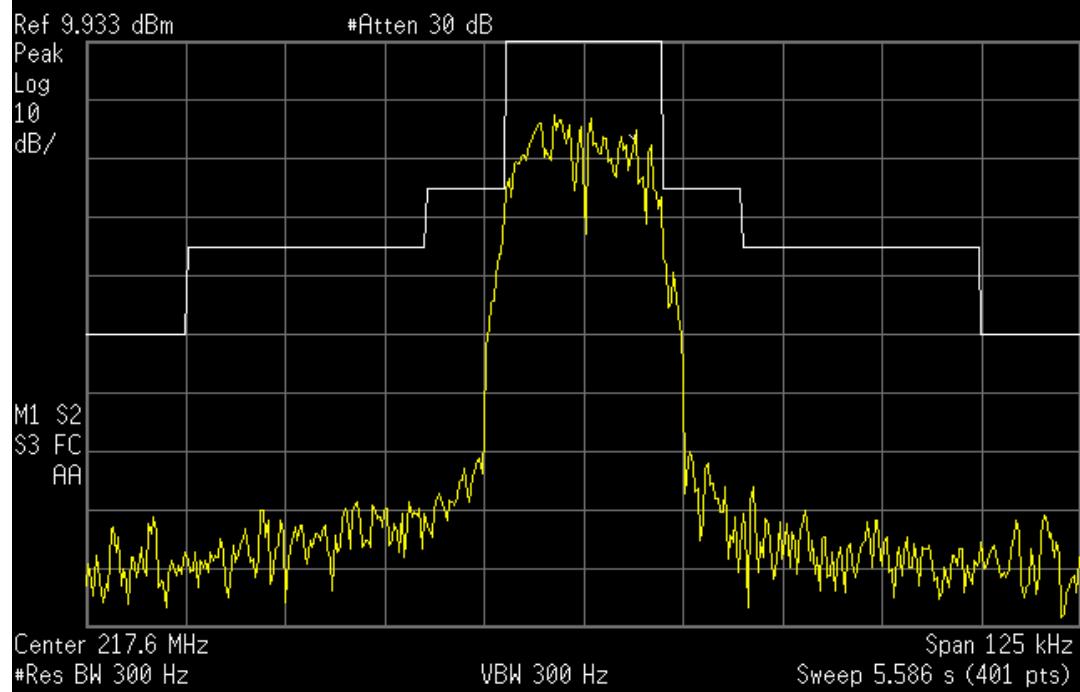
64 QAM 12.5 kHz

Agilent 14:51:37 Mar 31, 2014



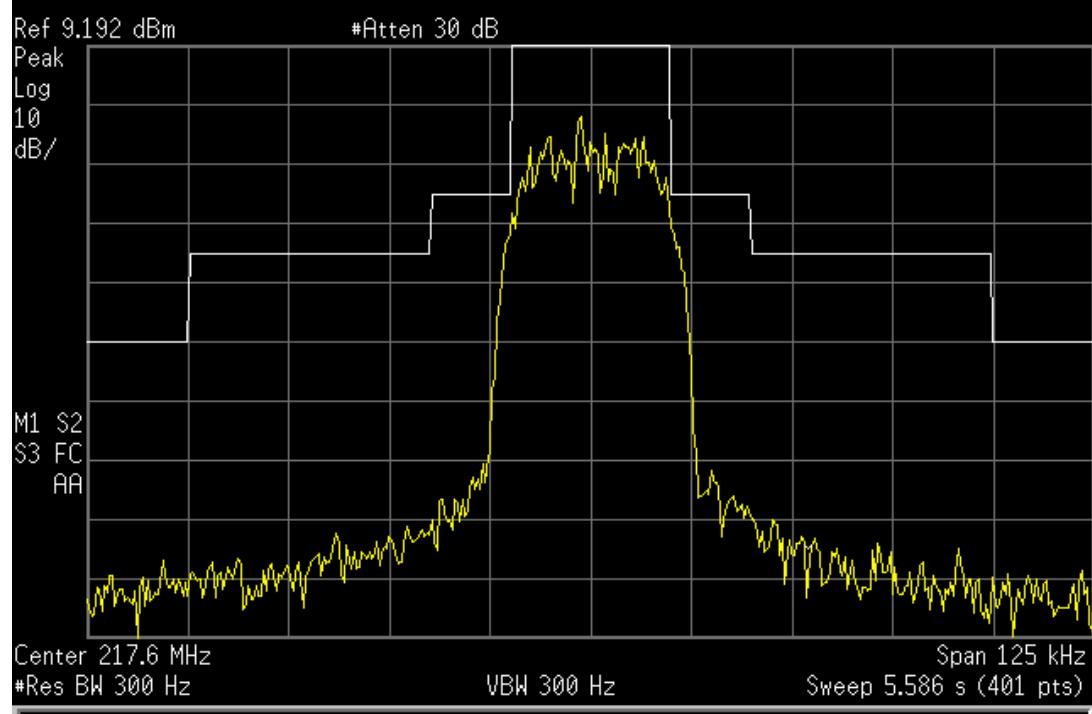
QPSK 25.0 kHz

Agilent 09:31:13 Mar 27, 2014



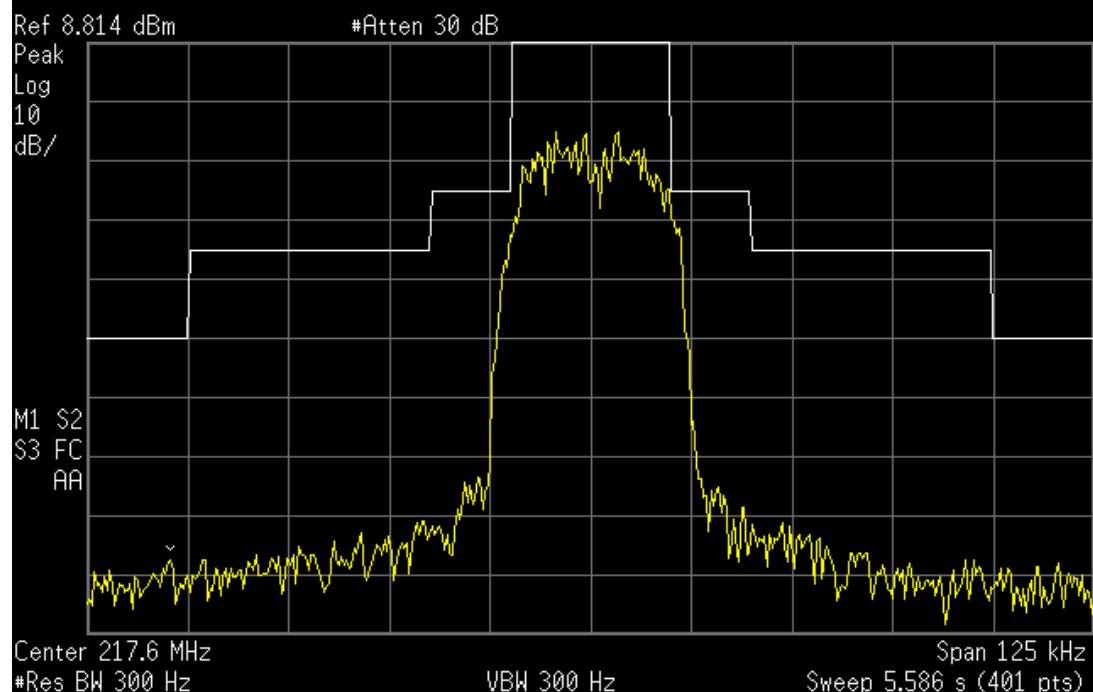
16QAM 25.0 kHz

Agilent 09:33:27 Mar 27, 2014



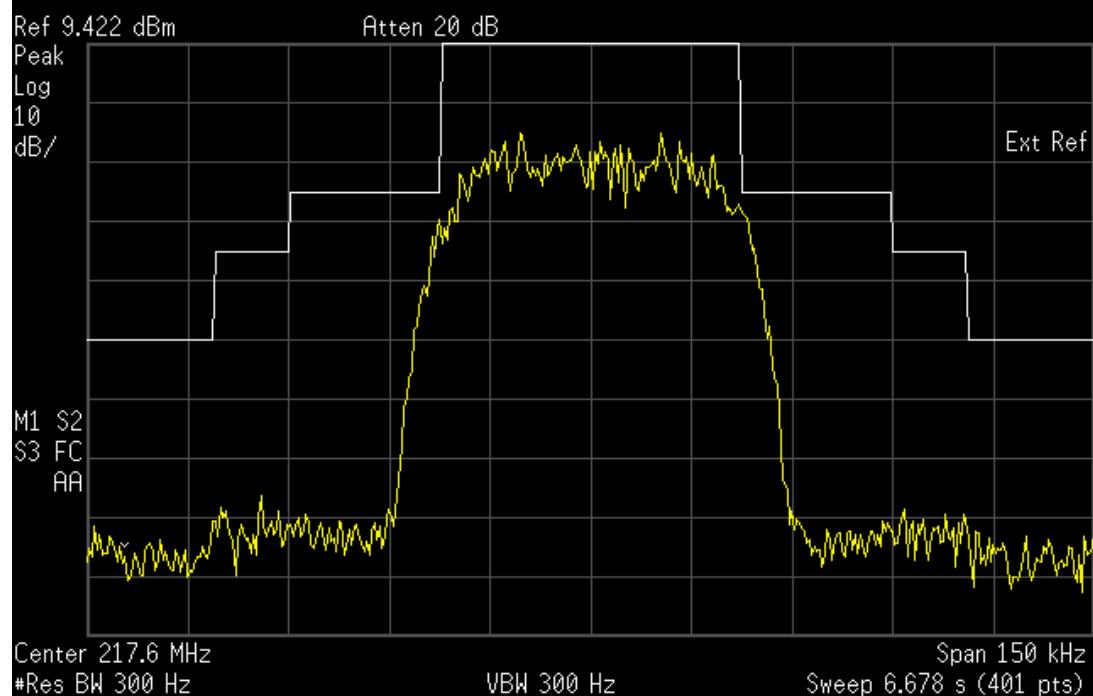
64 QAM 25.0 kHz

Agilent 09:35:19 Mar 27, 2014



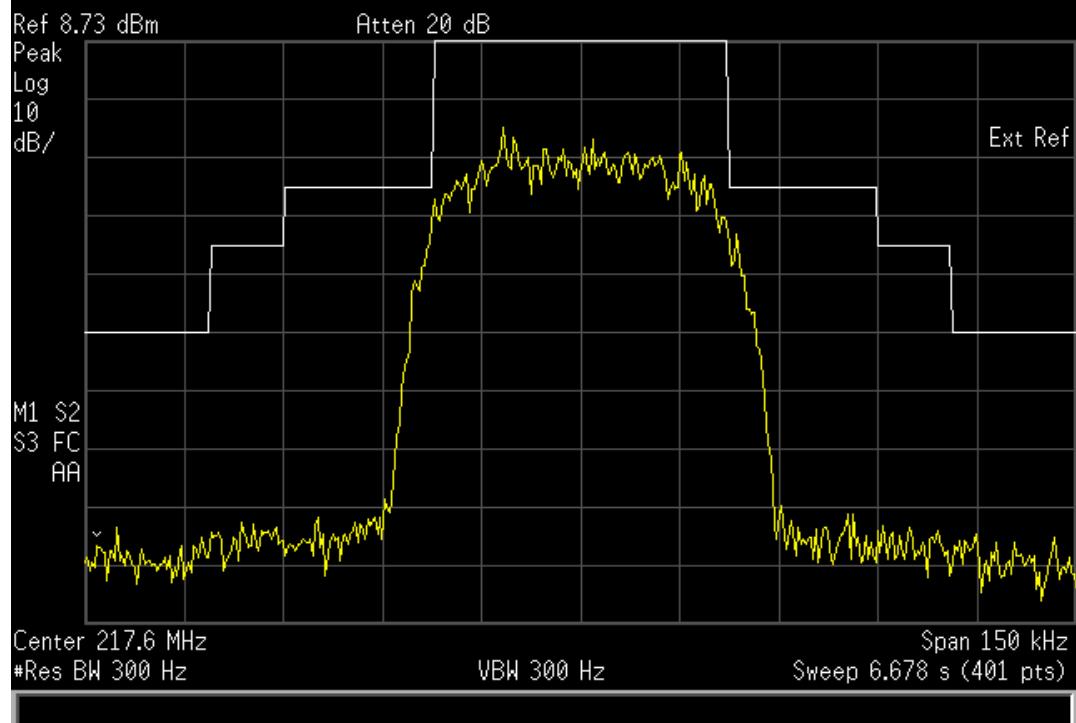
QPSK 50.0 kHz

Agilent 15:15:27 Mar 31, 2014



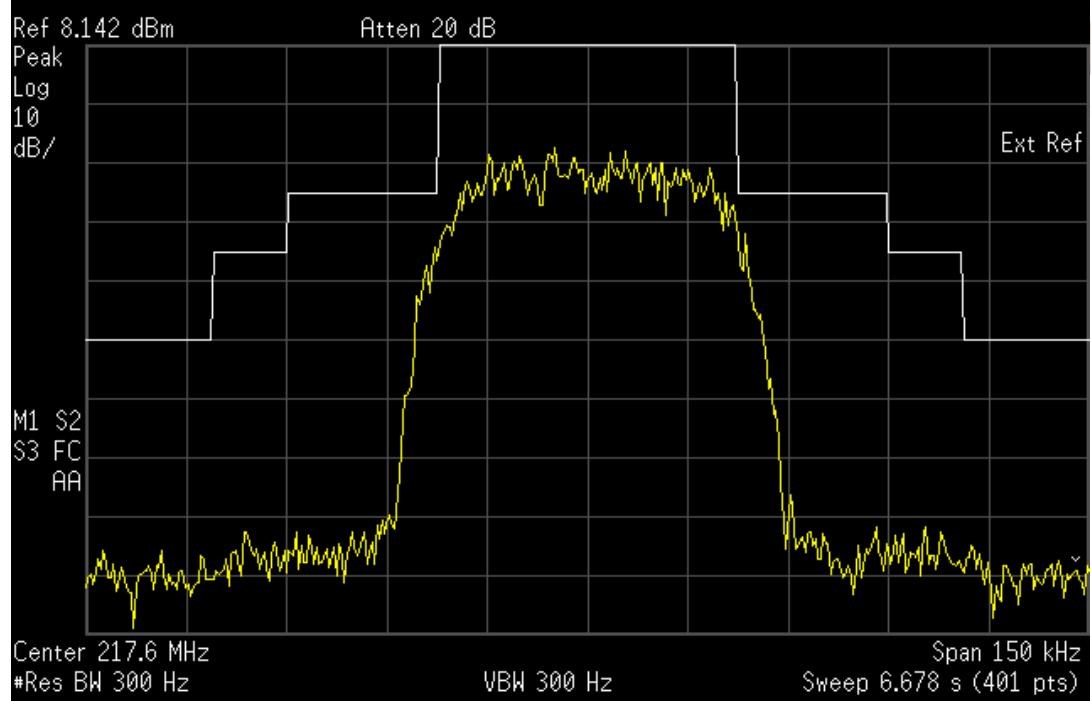
16QAM 50.0 kHz

Agilent 15:17:08 Mar 31, 2014



64 QAM 50.0 kHz

Agilent 15:19:37 Mar 31, 2014



Result: Complies

Transmitter spurious emissions at the antenna terminals

Nominal Frequency: 216.575 MHz

Spurious emission (MHz)	Emission level (dBm)	Limit (dBm)
433.150	-30.2	-13.0
649.725	-67.2	-13.0
866.300	< -70.0	-13.0
1082.875	< -70.0	-13.0
1299.450	< -70.0	-13.0
1516.025	< -70.0	-13.0
1732.600	< -70.0	-13.0
1949.175	< -70.0	-13.0
2165.750	< -70.0	-13.0

Nominal Frequency: 217.575 MHz

Spurious emission (MHz)	Emission level (dBm)	Limit (dBm)
435.150	-30.3	-13.0
652.725	-68.3	-13.0
870.300	< -70.0	-13.0
1087.875	< -70.0	-13.0
1305.450	< -70.0	-13.0
1523.025	< -70.0	-13.0
1740.600	< -70.0	-13.0
1958.175	< -70.0	-13.0
2175.750	< -70.0	-13.0

Nominal Frequency: 219.575 MHz

Spurious emission (MHz)	Emission level (dBm)	Limit (dBm)
439.150	-31.9	-13.0
658.725	-66.3	-13.0
878.300	< -70.0	-13.0
1097.875	< -70.0	-13.0
1317.450	< -70.0	-13.0
1537.025	< -70.0	-13.0
1756.600	< -70.0	-13.0
1976.175	< -70.0	-13.0
2195.750	< -70.0	-13.0

Limit:

Applied mask B, 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 $43 + 10 \log (P)$.

A rated power of 2.0 watts (33.0 dBm) and of 5.0 watts (37.0 dBm) gives a limit of –13 dBm.

The spectrum has been investigated up to the 10th 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 10th harmonic if the transmitter operates below 10 GHz.

Result: Complies.

Measurement Uncertainty: ± 3.3 dB



Field strength of the transmitter spurious emissions

Nominal Frequency: 216.075 MHz

Frequency (MHz)	Level (dB μ V/m)	Level (dBm)	Limit (dBm)	Polarity	Margin (dB)
433.1500	27.5	-69.9	-20.0	Vertical	49.9
433.1500	27.5	-69.9	-20.0	Horizontal	49.9
649.7250	31.5	-65.9	-20.0	Vertical	45.9
649.7250	31.6	-65.8	-20.0	Horizontal	45.8
866.3000	35.3	-62.1	-20.0	Vertical	42.1
866.3000	35.4	-62.0	-20.0	Horizontal	42.0
1082.8750	45.0	-52.4	-20.0	Vertical	32.4
1082.8750	44.8	-52.6	-20.0	Horizontal	32.6
1299.4500	46.3	-51.1	-20.0	Vertical	31.1
1299.4500	47.0	-50.4	-20.0	Horizontal	30.4
1516.0250	48.1	-49.3	-20.0	Vertical	29.3
1516.0250	49.1	-48.3	-20.0	Horizontal	28.3
1732.6000	50.2	-47.2	-20.0	Vertical	27.2
1732.6000	50.0	-47.4	-20.0	Horizontal	27.4
1949.1750	53.3	-44.1	-20.0	Vertical	24.1
1949.1750	53.2	-44.2	-20.0	Horizontal	24.2
2165.7500	55.1	-42.3	-20.0	Vertical	22.3
2165.7500	54.8	-42.6	-20.0	Horizontal	22.6

Nominal Frequency: 217.575 MHz

Frequency (MHz)	Level (dB μ V/m)	Level (dBm)	Limit (dBm)	Polarity	Margin (dB)
435.1500	27.5	-69.9	-20.0	Vertical	49.9
435.1500	27.6	-69.8	-20.0	Horizontal	49.8
652.7250	31.5	-65.9	-20.0	Vertical	45.9
652.7250	31.7	-65.7	-20.0	Horizontal	45.7
870.3000	35.0	-62.4	-20.0	Vertical	42.4
870.3000	35.4	-62.0	-20.0	Horizontal	42.0
1087.8750	45.0	-52.4	-20.0	Vertical	32.4
1087.8750	44.8	-52.6	-20.0	Horizontal	32.6
1305.4500	46.4	-51.0	-20.0	Vertical	31.0
1305.4500	47.0	-50.4	-20.0	Horizontal	30.4
1523.0250	48.0	-49.4	-20.0	Vertical	29.4
1523.0250	49.0	-48.4	-20.0	Horizontal	28.4
1740.6000	50.5	-46.9	-20.0	Vertical	26.9
1740.6000	50.0	-47.4	-20.0	Horizontal	27.4
1958.1750	53.2	-44.2	-20.0	Vertical	24.2
1958.1750	53.2	-44.2	-20.0	Horizontal	24.2
2175.7500	55.1	-42.3	-20.0	Vertical	22.3
2175.7500	55.0	-42.4	-20.0	Horizontal	22.4

Nominal Frequency: 219.575 MHz

Frequency (MHz)	Level (dB μ V/m)	Level (dBm)	Limit (dBm)	Polarity	Margin (dB)
439.1500	27.4	-70.0	-20.0	Vertical	50.0
439.1500	27.5	-69.9	-20.0	Horizontal	49.9
658.7250	31.5	-65.9	-20.0	Vertical	45.9
658.7250	31.8	-65.6	-20.0	Horizontal	45.6
878.3000	35.2	-62.2	-20.0	Vertical	42.2
878.3000	35.5	-61.9	-20.0	Horizontal	41.9
1097.8750	45.0	-52.4	-20.0	Vertical	32.4
1097.8750	44.8	-52.6	-20.0	Horizontal	32.6
1317.4500	46.2	-51.2	-20.0	Vertical	31.2
1317.4500	47.0	-50.4	-20.0	Horizontal	30.4
1537.0250	48.1	-49.3	-20.0	Vertical	29.3
1537.0250	49.1	-48.3	-20.0	Horizontal	28.3
1756.6000	50.2	-47.2	-20.0	Vertical	27.2
1756.6000	50.0	-47.4	-20.0	Horizontal	27.4
1976.1750	53.3	-44.1	-20.0	Vertical	24.1
1976.1750	53.2	-44.2	-20.0	Horizontal	24.2
2195.7500	55.1	-42.3	-20.0	Vertical	22.3
2195.7500	54.8	-42.6	-20.0	Horizontal	22.6

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) and of 2.0 watts (33.0 dBm) gives a limit of -20 dBm.

No measurements were made above the 10th harmonic.

Result: Complies.

Measurement Uncertainty: ± 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: 217.575 MHz

Frequency Error (Hz)

Temperature (°C)	Voltage (10.8 Vdc)	Voltage (13.8 Vdc)	Voltage (15.6 Vdc)
+50	+102.0	+102.0	+100.0
+40	+103.0	+102.0	+101.0
+30	+107.0	+106.0	+106.0
+20	+106.0	+106.0	+105.0
+10	+101.0	+101.0	+100.0
0	+97.0	+97.0	+98.0
-10	+80.0	+81.0	+81.0
-20	+72.0	+71.0	+72.0
-30	+68.0	+69.0	+69.0

Limit:

Part 90.213 states that mobile station transmitters operating between 216 – 220 fixed base stations are required to have a frequency tolerance of 1.0 ppm.

The Part 90 frequency stability requirement has been applied to this transmitter.

This transmitter was tested on 217.575 MHz.

1.0 ppm = 1.0 x = 217.5 Hz.

Result: Complies.

Measurement Uncertainty: ± 30 Hz.

Exposure of humans to RF fields

As per Section 1.1310 mobile transmitters are required to be operated in a manner that ensures the public is not exposed to RF energy levels in accordance with OST/OET Bulletin Number 65.

Calculations have been made using the General Public Exposure limits.

Minimum safe distances have been calculated below.

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

- General Public / Uncontrolled exposure limit will be 0.2 mW/cm^2 or 27.5 V/m .

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:

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

In the band the 216 – 217 MHz a transmitter power (P) of 5 watts was measured on 216.575 MHz

In the band 217 – 220 MHz a transmitter power (P) of 2 watts was measured on 217.575 MHz.

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

General Public / Uncontrolled

216 – 217 MHz band (216.575 MHz) at 5 watts

$$d = \sqrt{30 * 5 * 20 * 1} / 27.5$$

$d = 1.99 \text{ metres or } 199 \text{ cm}$

217 – 220 MHz (217.575 MHz) at 2 watts

$$d = \sqrt{30 * 2 * 20 * 1} / 27.5$$

$d = 1.26 \text{ metres or } 126 \text{ cm}$

Result: Complies if the above safe distance is defined in the user manual for this equipment.

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



