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+ SQ896M141 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:

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. COMPLIANCE STATEMENT

The **4RF SR+ SQ896M141 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 15th and 30th of April 2014 are summarised below.

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

3. TEST SAMPLE DESCRIPTION

Brand Name	Aprisa SR+
Model Number	SQ896M141
Product	Point to Multi Point Digital Radio
Manufacturer	4RF Limited
Manufactured in	New Zealand
Designed in	New Zealand
Serial Numbers	-
FCC ID	UIPSQ896M141

The sample tested has the following specifications:

Rated Transmitter Output Power

5.0 Watts (37.0 dBm)

Transmitter FCC frequency range

901-902 MHz

Test frequencies

Channel	Frequency (MHz)	Power (Watts)	Spacing (kHz)
1	901.075	5.0	12.5, 25.0, 50.0
2	901.525	5.0	12.5, 25.0, 50.0
3	901.975	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 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 Ω 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: 901.525 MHz

Frequency (MHz)	Voltage (Vdc)	Rated (dBm)	Measured (dBm)
901.525	10.0	37.0	36.8
901.525	13.8	37.0	36.9
901.525	30.0	37.0	36.9

Limits:

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

Result: Complies.
Measurement Uncertainty: ± 0.5 dB

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: 901.525 MHz

Emission	Channel (kHz)	Measured (kHz)	Authorised Bandwidth (kHz)
QPSK	12.5	9.198	10.0 kHz
16QAM	12.5	8.992	10.0 kHz
64QAM	12.5	8.523	10.0 kHz
QPSK	25.0	19.075	20.0 kHz
16QAM	25.0	18.525	20.0 kHz
64QAM	25.0	18.172	20.0 kHz
QPSK	50.0	39.925	45.0 kHz
16QAM	50.0	38.550	45.0 kHz
64QAM	50.0	36.250	45.0 kHz

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 plus 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×Log_{10} ((f_d+5)/3.05) 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 20 kHz: at least 43+10 Log_{10} (P) decibels or 80 decibels, whichever is the lesser attenuation.

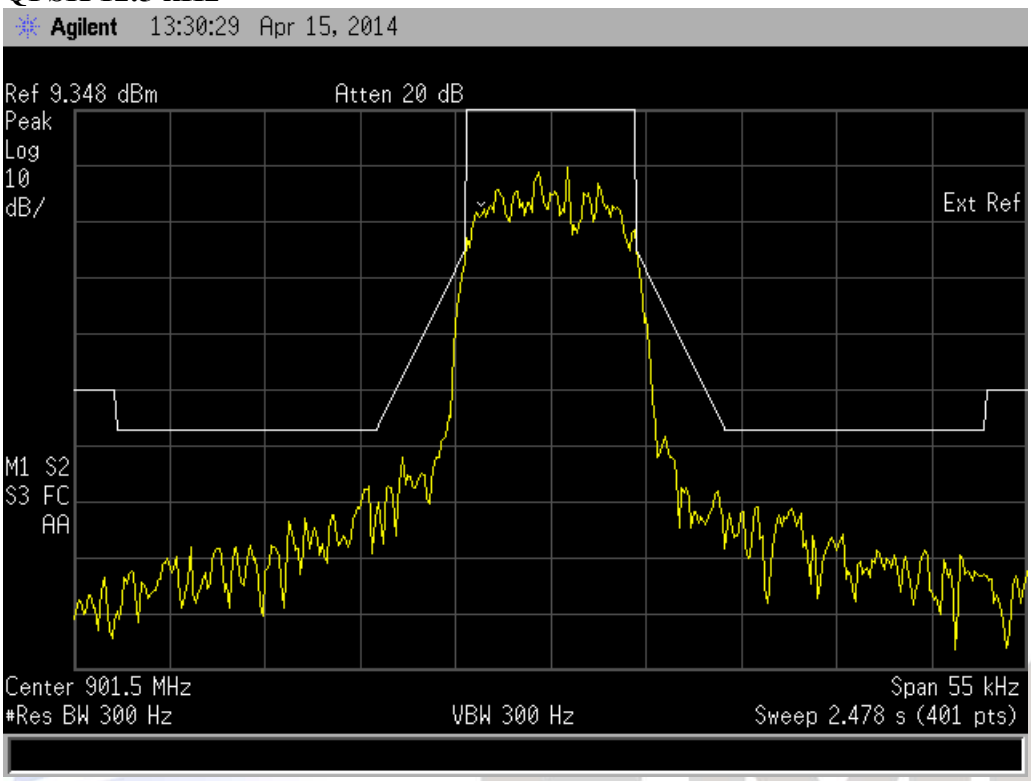
The transmitter can operate in the band 901-902 MHz using an authorised bandwidth of 10 kHz and channel spacing of 12.5 kHz and an authorised bandwidth of 45 kHz and a channel spacing of 50 kHz.

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

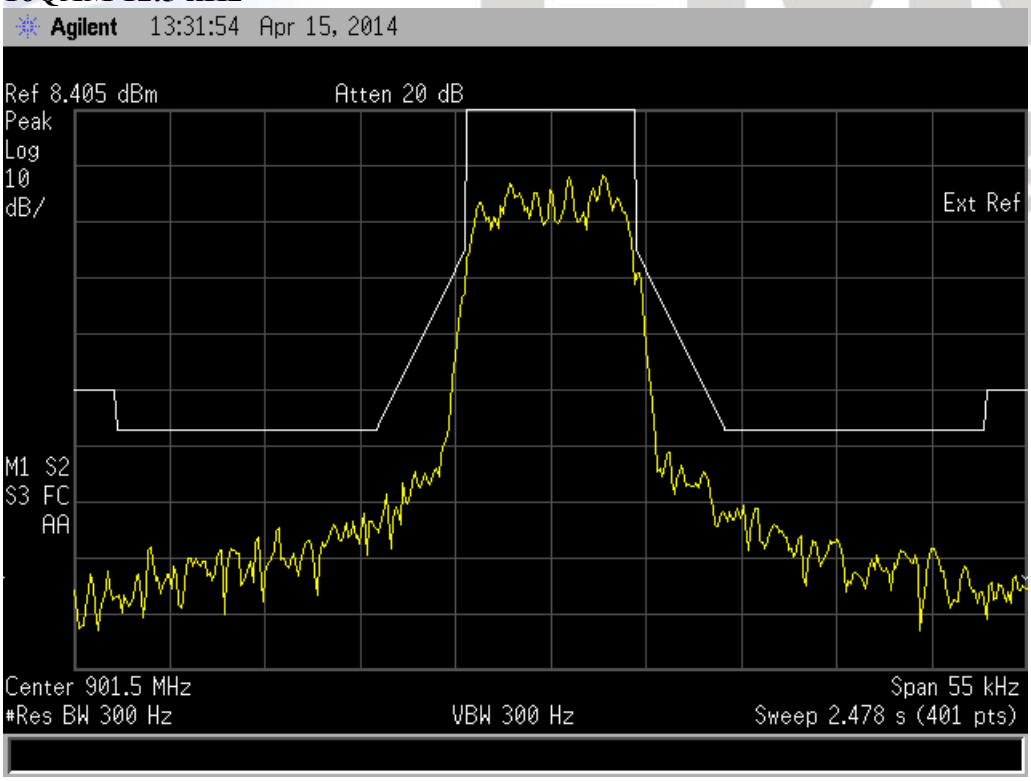
Initially power measurements are made using a resolution bandwidth of 120 kHz.
This level is used as a reference level on the spectrum analyser.

Nominal Frequency: 901.525 MHz

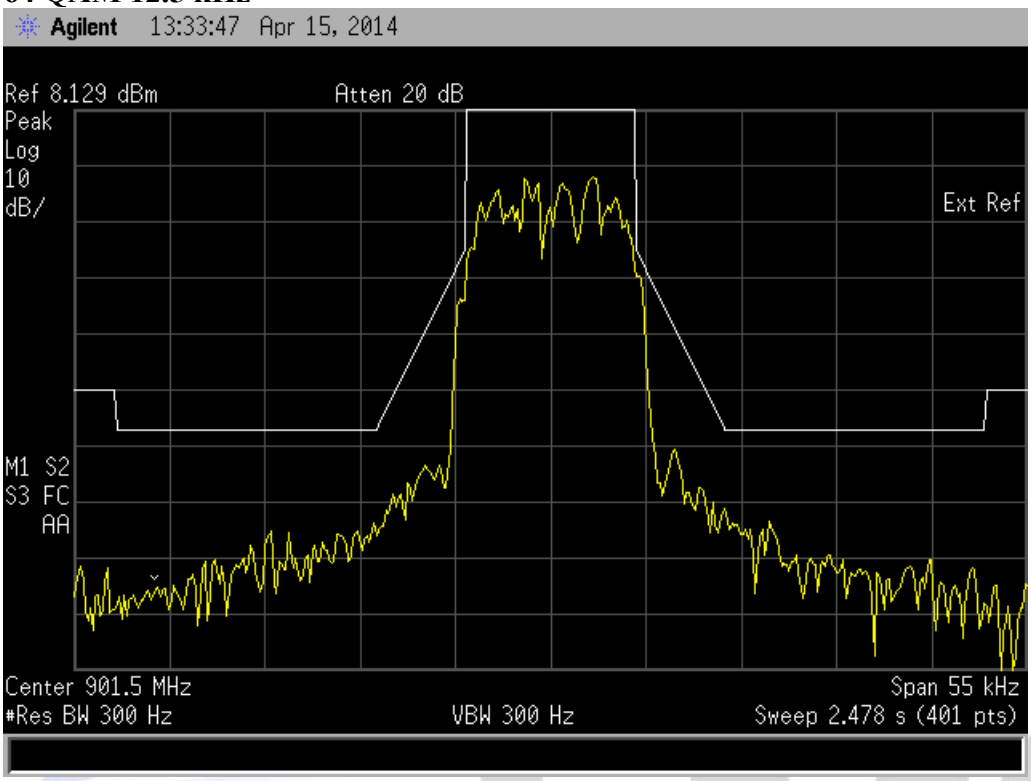
QPSK 12.5 kHz



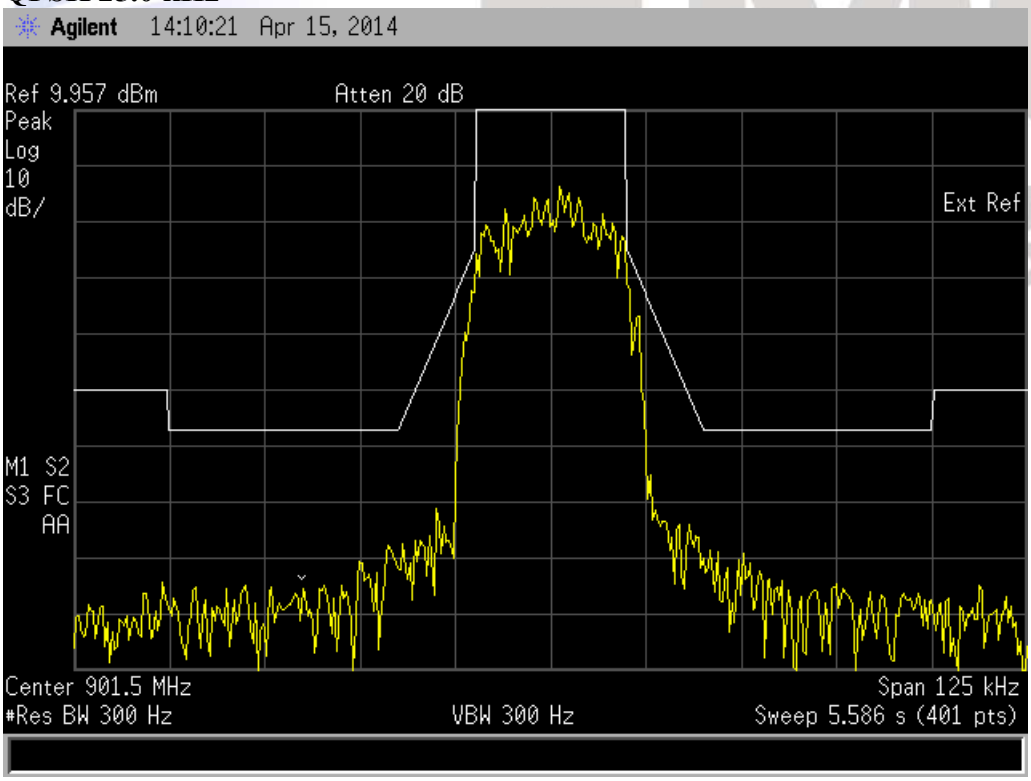
16QAM 12.5 kHz



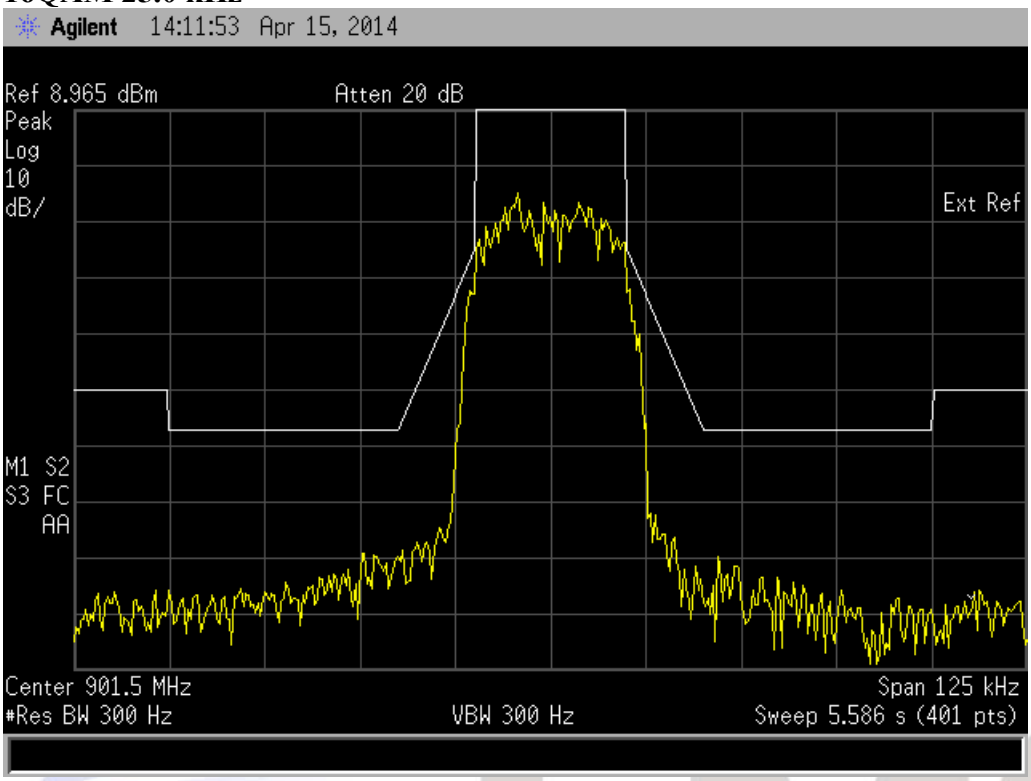
64 QAM 12.5 kHz



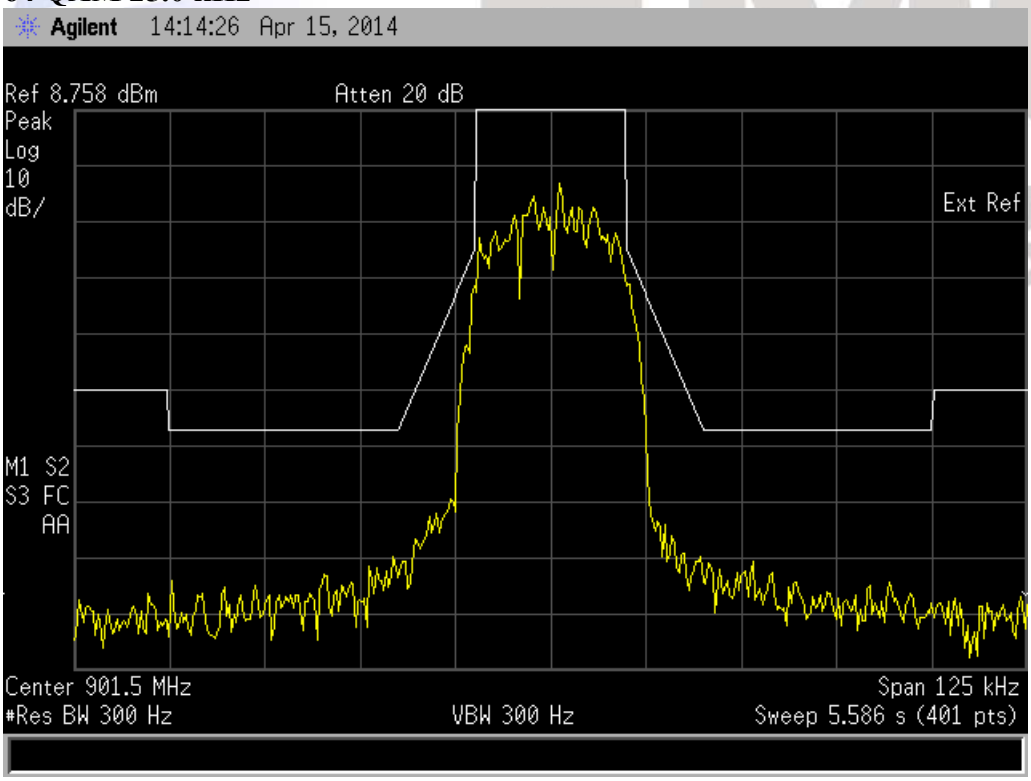
QPSK 25.0 kHz



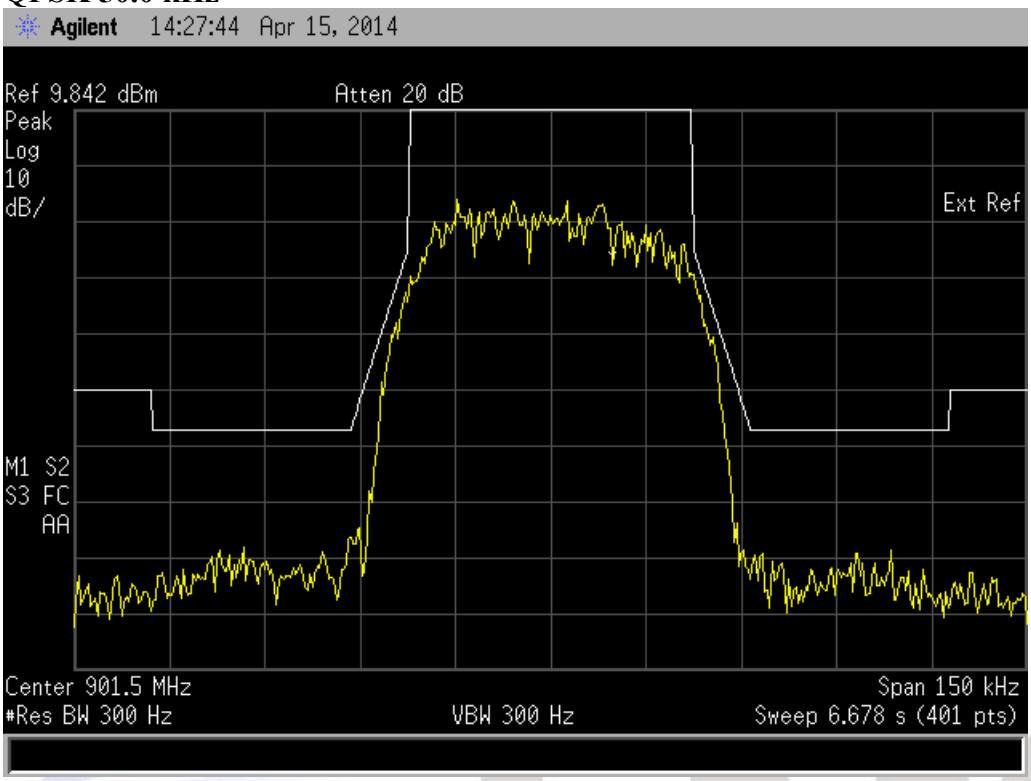
16QAM 25.0 kHz



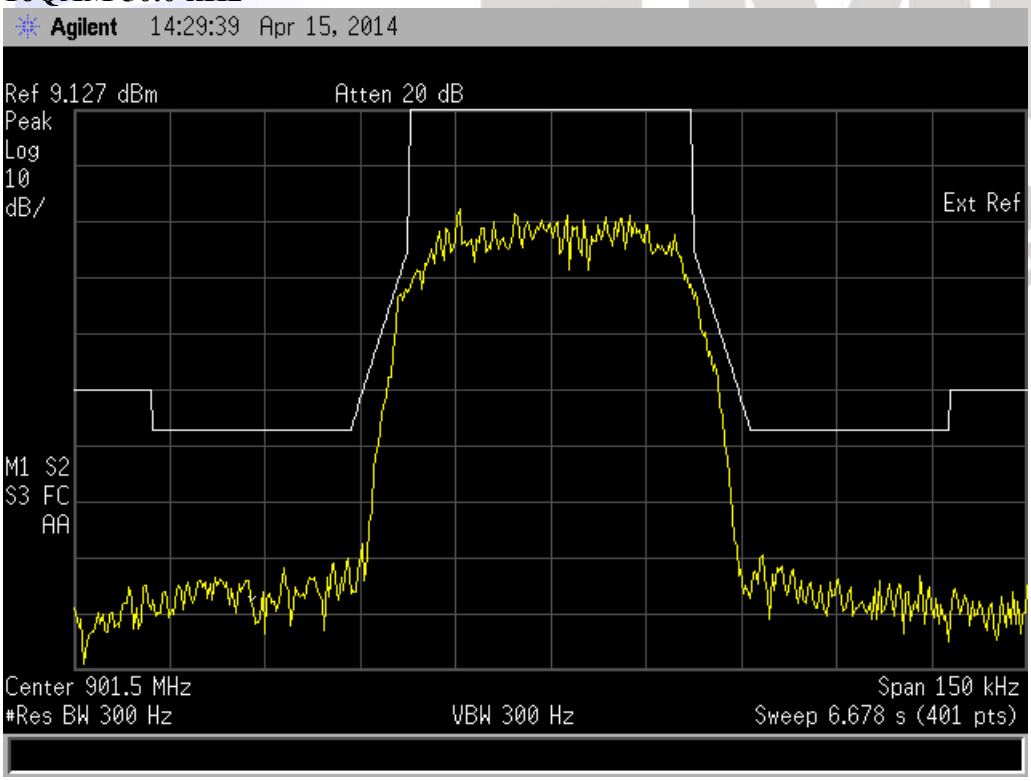
64 QAM 25.0 kHz



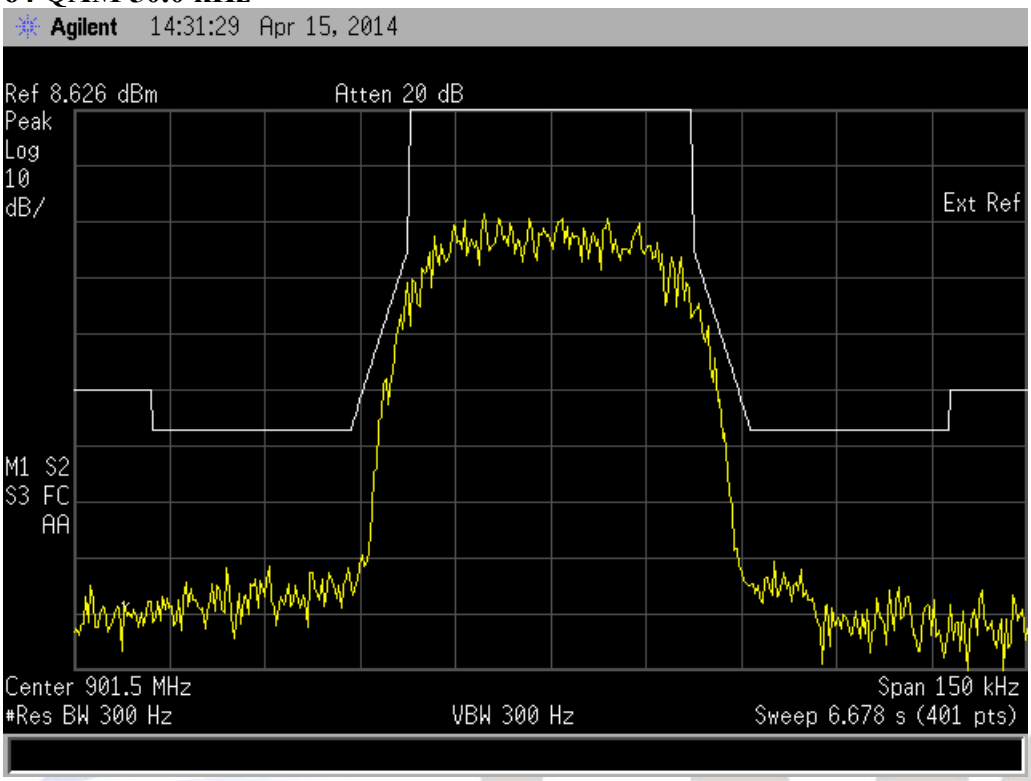
QPSK 50.0 kHz



16QAM 50.0 kHz



64 QAM 50.0 kHz



Result: Complies

Transmitter spurious emissions at the antenna terminals

Nominal Frequency: 901.525 MHz

Spurious emission (MHz)	Emission level (dBm)	Limit (dBm)
1803.050	-60.0	–13 dBm.
2704.575	< -65.0	–13 dBm.
3606.100	< -70.0	–13 dBm.
4507.625	< -70.0	–13 dBm.
5409.150	< -70.0	–13 dBm.
6310.675	< -70.0	–13 dBm.
7212.200	< -70.0	–13 dBm.
8113.725	< -70.0	–13 dBm.
9015.250	< -70.0	–13 dBm.

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^{th} 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^{th} harmonic if the transmitter operates below 10 GHz.

Result: Complies.
Measurement Uncertainty: ± 3.3 dB

Field strength of the transmitter spurious emissions

Nominal Frequency: 901.525 MHz

Frequency (MHz)	Level (dBµV/m)	Level (dBm)	Limit (dBm)	Polarity	Margin (dB)	Result
1803.050	48.1	-49.3	-20.0	Vertical	29.3	Pass
1803.050	47.5	-49.9	-20.0	Horizontal	29.9	Pass
2704.575	41.0	-56.4	-20.0	Vertical	36.4	Pass
2704.575	41.0	-56.4	-20.0	Horizontal	36.4	Pass
3606.100	44.0	-53.4	-20.0	Vertical	33.4	Pass
3606.100	44.0	-53.4	-20.0	Horizontal	33.4	Pass
4507.625	46.0	-51.4	-20.0	Vertical	31.4	Pass
4507.625	46.0	-51.4	-20.0	Horizontal	31.4	Pass
5409.150	48.0	-49.4	-20.0	Vertical	29.4	Pass
5409.150	48.0	-49.4	-20.0	Horizontal	29.4	Pass
6310.675	51.0	-46.4	-20.0	Vertical	26.4	Pass
6310.675	51.0	-46.4	-20.0	Horizontal	26.4	Pass
7212.200	47.0	-50.4	-20.0	Vertical	30.4	Pass
7212.200	47.0	-50.4	-20.0	Horizontal	30.4	Pass
8113.725	48.0	-49.4	-20.0	Vertical	29.4	Pass
8113.725	48.0	-49.4	-20.0	Horizontal	29.4	Pass
9015.250	51.0	-46.4	-20.0	Vertical	26.4	Pass
9015.250	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.

The power level of each emission was determined by replacing the transmitter with a dipole antenna that was connected to a signal generator.

The signal generator output level was increased until the same field strength level was observed at each emission frequency.

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

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

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^{th} 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: 901.525 MHz

Frequency Error (Hz)

Temperature (°C)	Voltage (10.8 Vdc)	Voltage (13.8 Vdc)	Voltage (15.6 Vdc)
+50	+114.0	+115.0	+116.0
+40	+120.0	+120.0	+121.0
+30	+118.0	+118.0	+117.0
+20	+123.0	+123.0	+124.0
+10	+98.0	+99.0	+99.0
0	+101.0	+101.0	+104.0
-10	+88.0	+89.0	+93.0
-20	+55.0	+56.0	+59.0
-30	+3.0	+9.0	+11.0

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

This transmitter was tested on 901.525 MHz.

1.0 ppm = 1.0 x = 901.5 Hz.

A worst case frequency error of 124 Hz was observed which equates to 0.138 ppm

Result: Complies.
Measurement Uncertainty: ± 30 Hz.

Exposure of humans to RF fields

Transmit Frequency 901.525 MHz

Minimum safe distances have been calculated below.

Power density, $mW/cm^2 = E^2/3770$

- Occupational / Controlled Exposure limit will be 3.00 mW/cm^2
(f/300 = 901.525 MHz/300)

- General Population / Uncontrolled exposure limit will be 0.60 mW/cm^2
(f/1500 = 901.525 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, V/m = (√ (30 * P * G)) / d

Controlled	**Uncontrolled**
$E = 3.10\ mW/cm^2 = E^2/3770$	$E = 0.62\ mW/cm^2 = E^2/3770$
E= √3.0*3770	E= √0.6*3770
E = 106.3 V/m	E = 47.6 V/m

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

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

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

Controlled	**Uncontrolled**
d = √(30 * P * G*DC) / E	
d = √(30 * 5 * 631 *1) / 106.3	d = √(30 * 5 * 631 *1) / 47.6
d = 2.89 metres or 289 cm	d = 6.46 metres or 646 cm

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

7. TEST EQUIPMENT USED

Instrument	Manufacturer	Model	Serial #	Asset	Cal Due	Int
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	7 Feb 2015	1 year
Biconical Antenna	Schwarzbeck	BBA 9106	-	3612	7 Feb 2015	1 year
Log Periodic	Schwarzbeck	VUSLP 91111	9111-228	3785	7 Feb 2015	1 year
Horn Antenna	Electrometrics	RGA-60	6234	E1494	04 July 2014	1 year
Receiver	R & S	ESIB-40	100171	EMC4003	21 April 2015	1 year
Mod Analyzer	R & S	FMA	837807/020	E1552	15 Jan 2015	1 year
Power Supply	Hewlett Packard	6032A	2743A-02859	E1069	N/a	N/a
Signal Generator	R & S	SMHU	838923/028	E1493	22 Jan 2015	1 year
Spectrum Analyzer	Hewlett Packard	E7405A	US39150142	RFS 3776	26 May 2014	1 year
Thermal chamber	Contherm	M180F	86025	E1129	01 June 2014	1 year
Thermometer	DSIR	RT200	035	E1049	01 June 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