



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+ 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 that reads "Andrew Cutler".

Andrew Cutler - General Manager



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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 31st March and 10th 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.

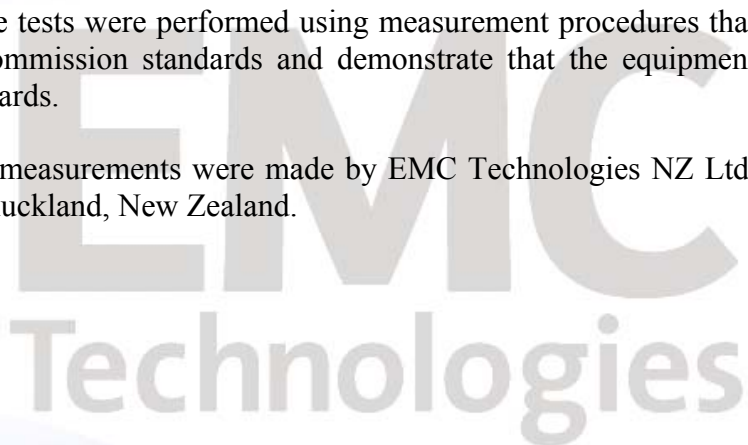
In addition this equipment has been tested in accordance with the requirements contained in the appropriate Commission regulations.

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

EMC
Technologies

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 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: 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: ± 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.

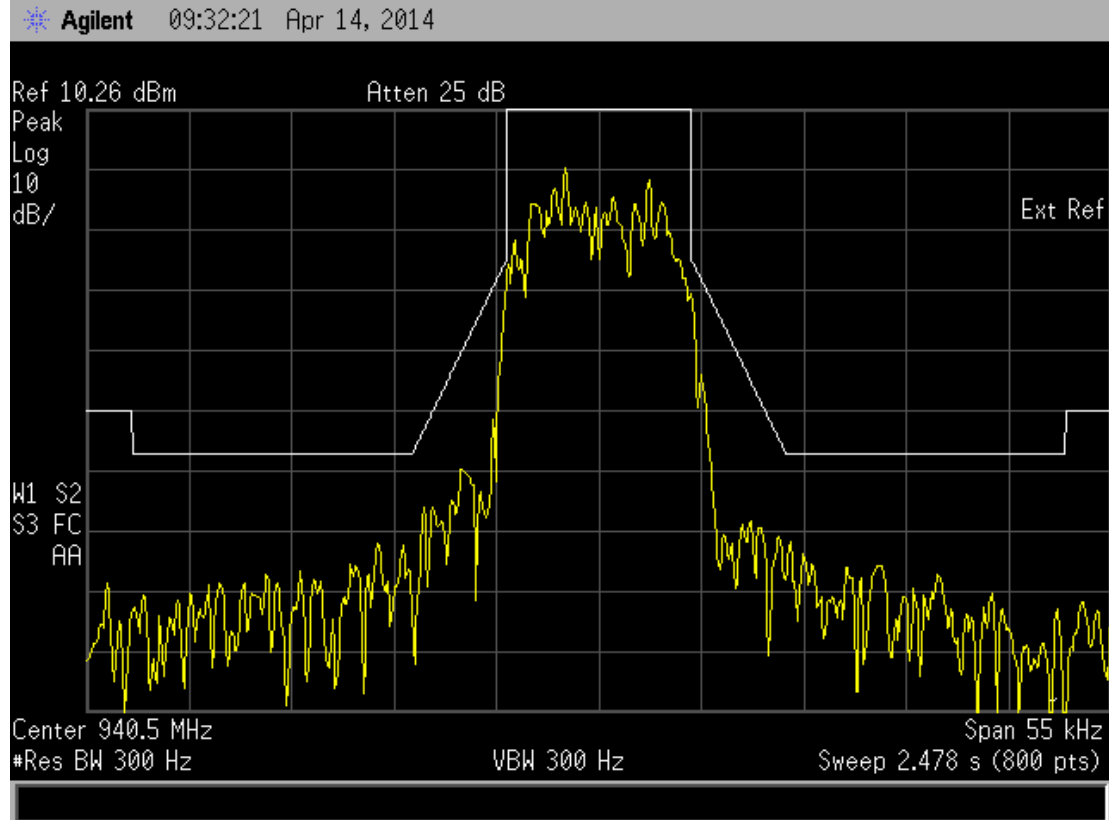
Measurements have been made of each modulation type using a spectrum analyser operating in peak hold mode and a 30 dB attenuator.

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

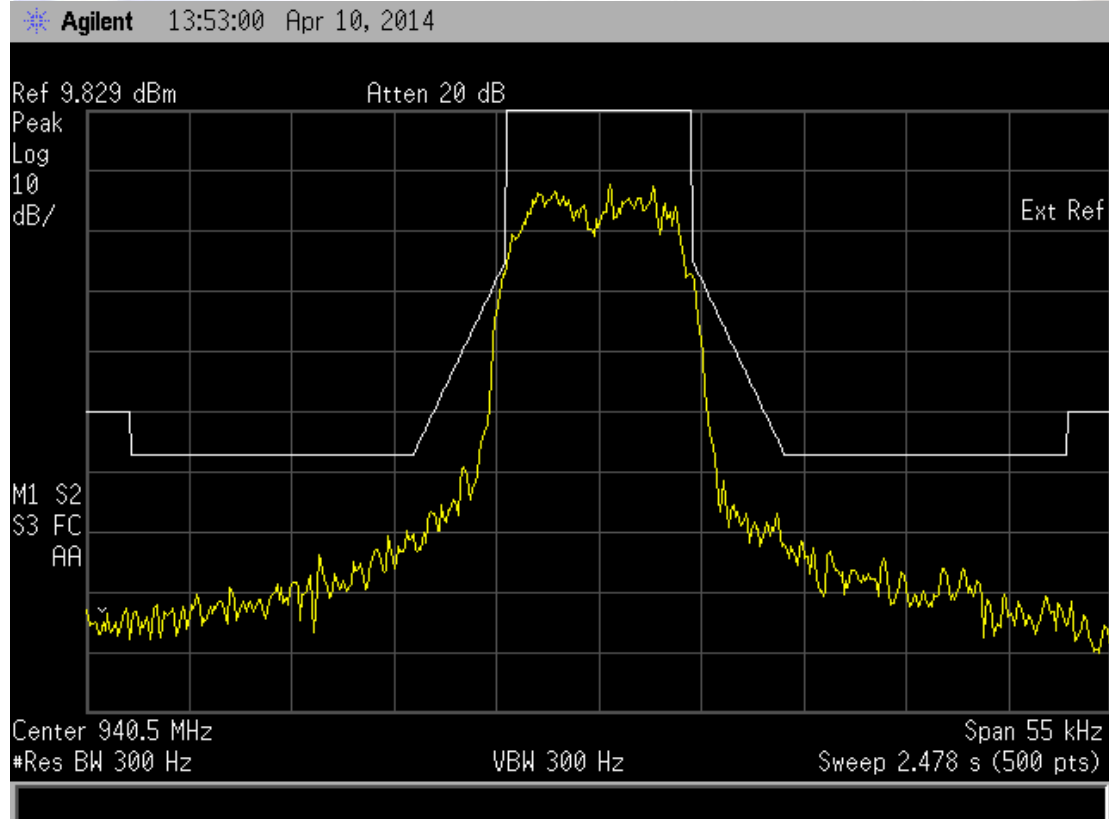
This level is used as a reference level on the spectrum analyser.

Nominal Frequency: 940.525 MHz

QPSK 12.5 kHz

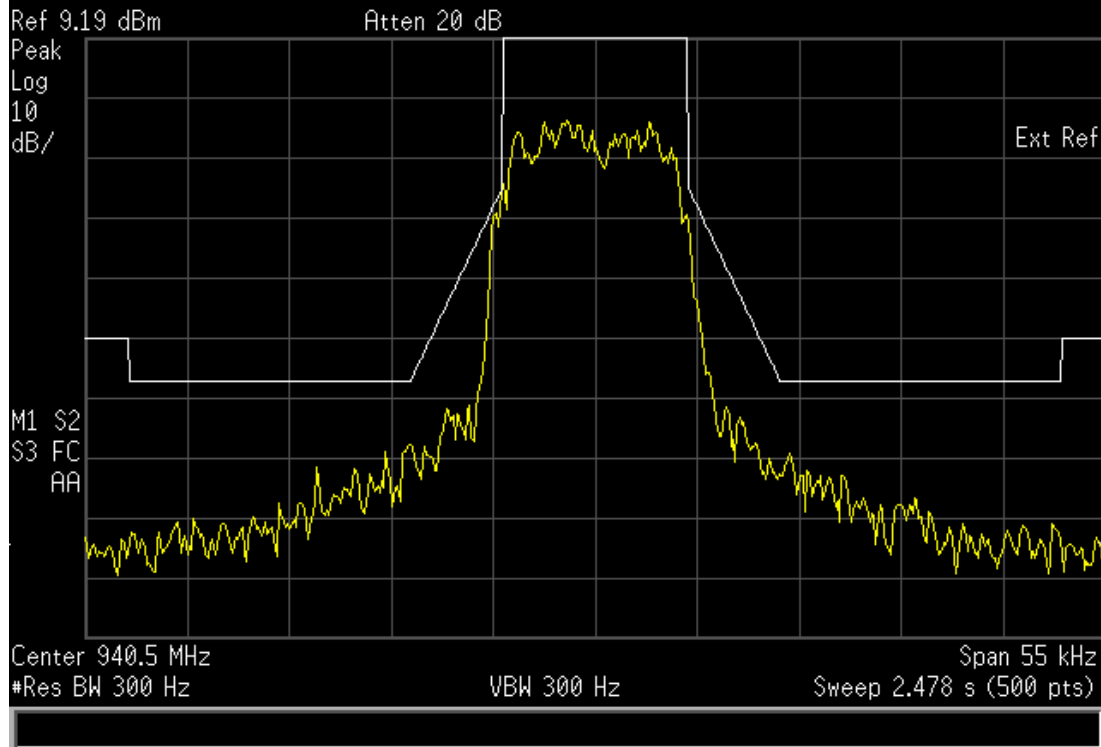


16QAM 12.5 kHz



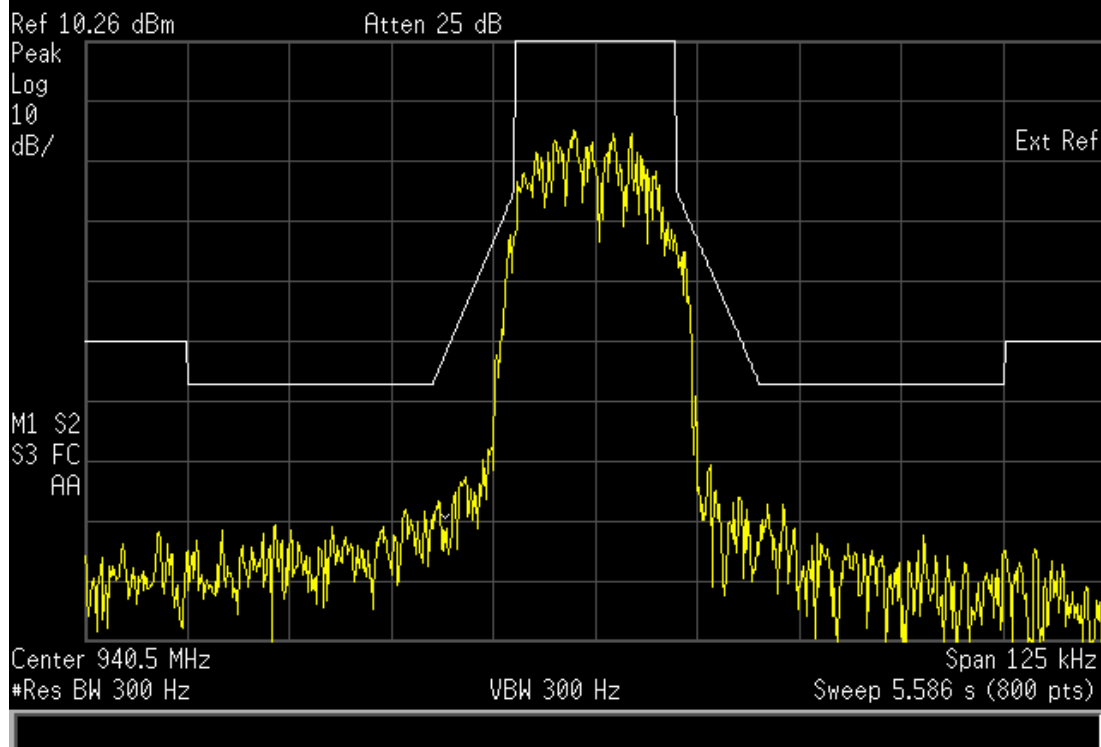
64 QAM 12.5 kHz

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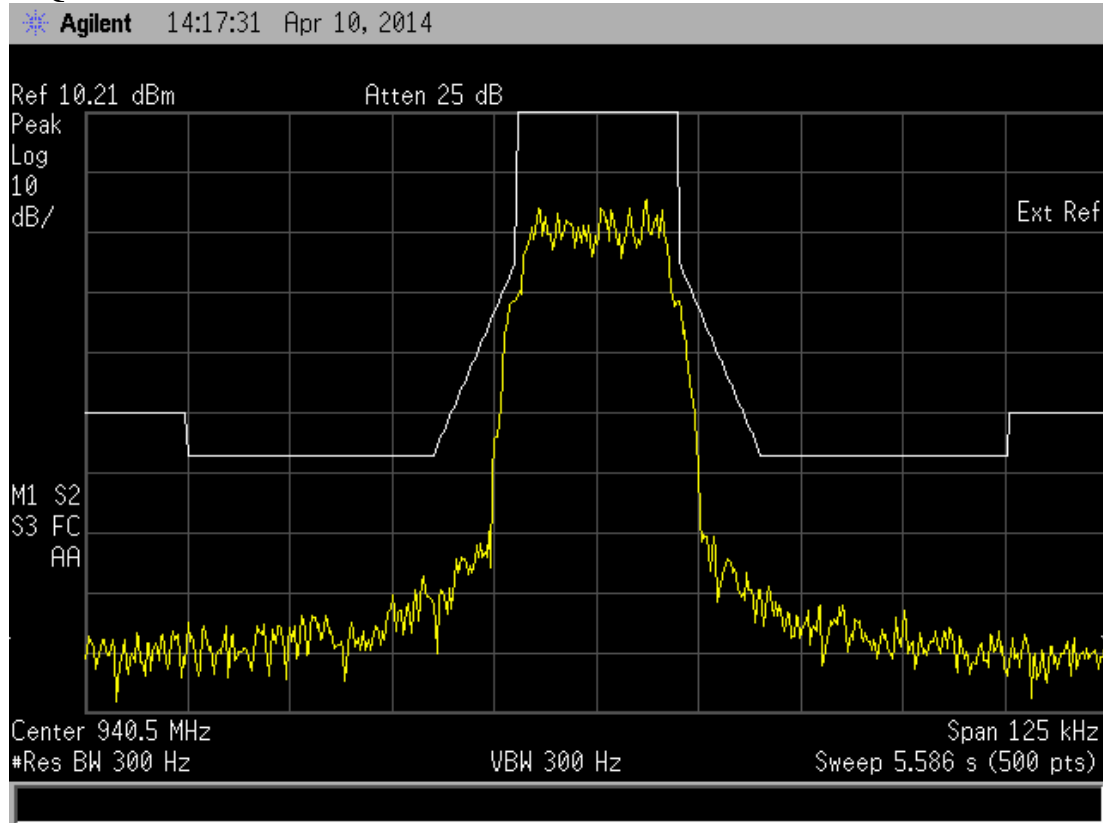


QPSK 25.0 kHz

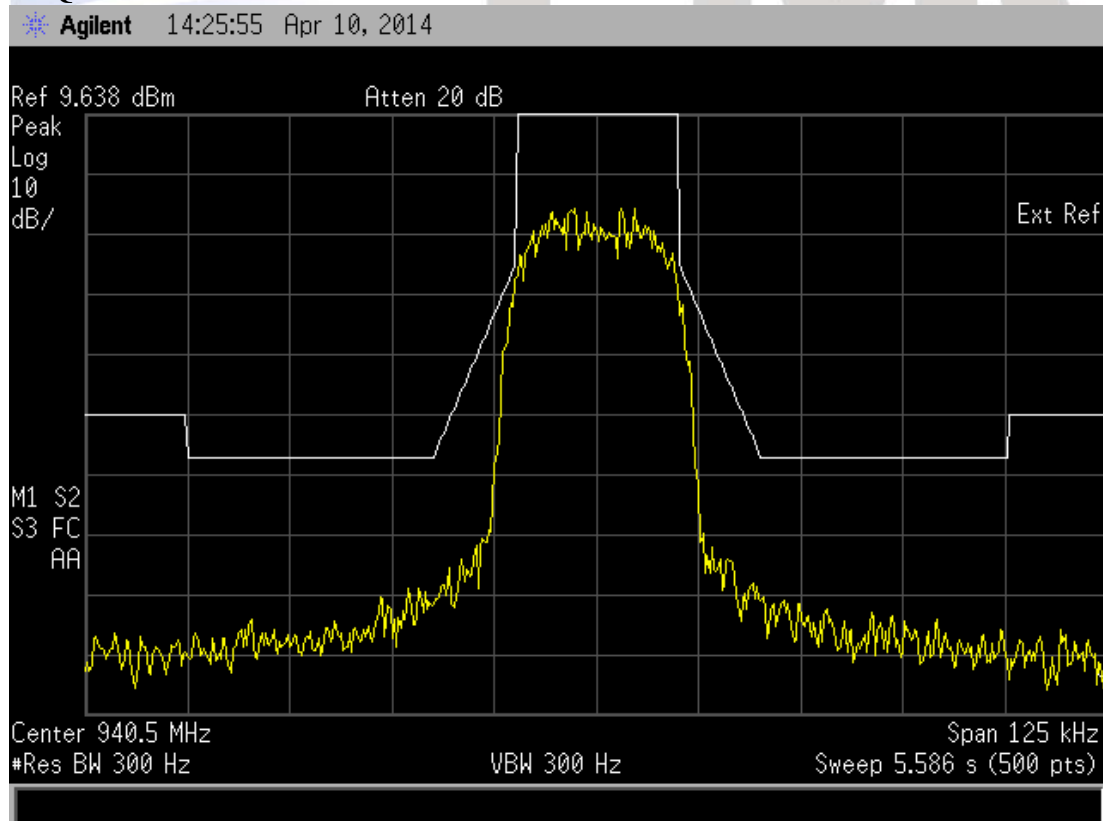
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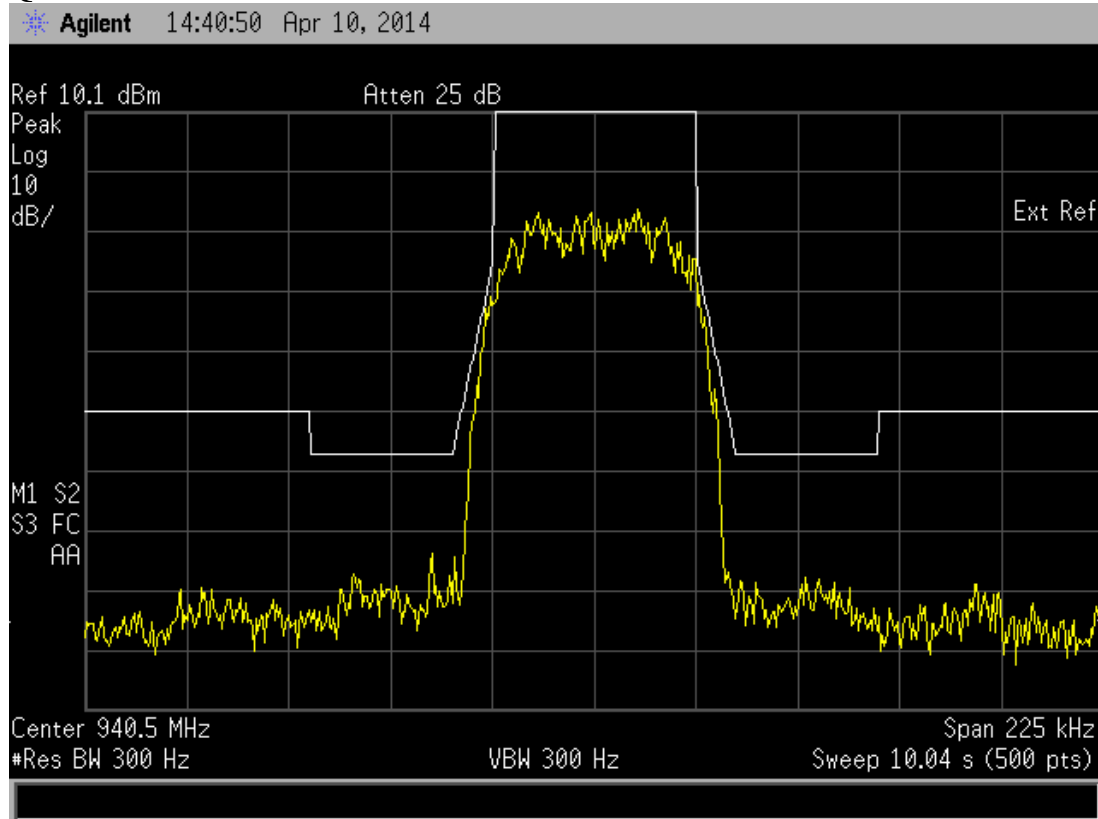
16QAM 25.0 kHz



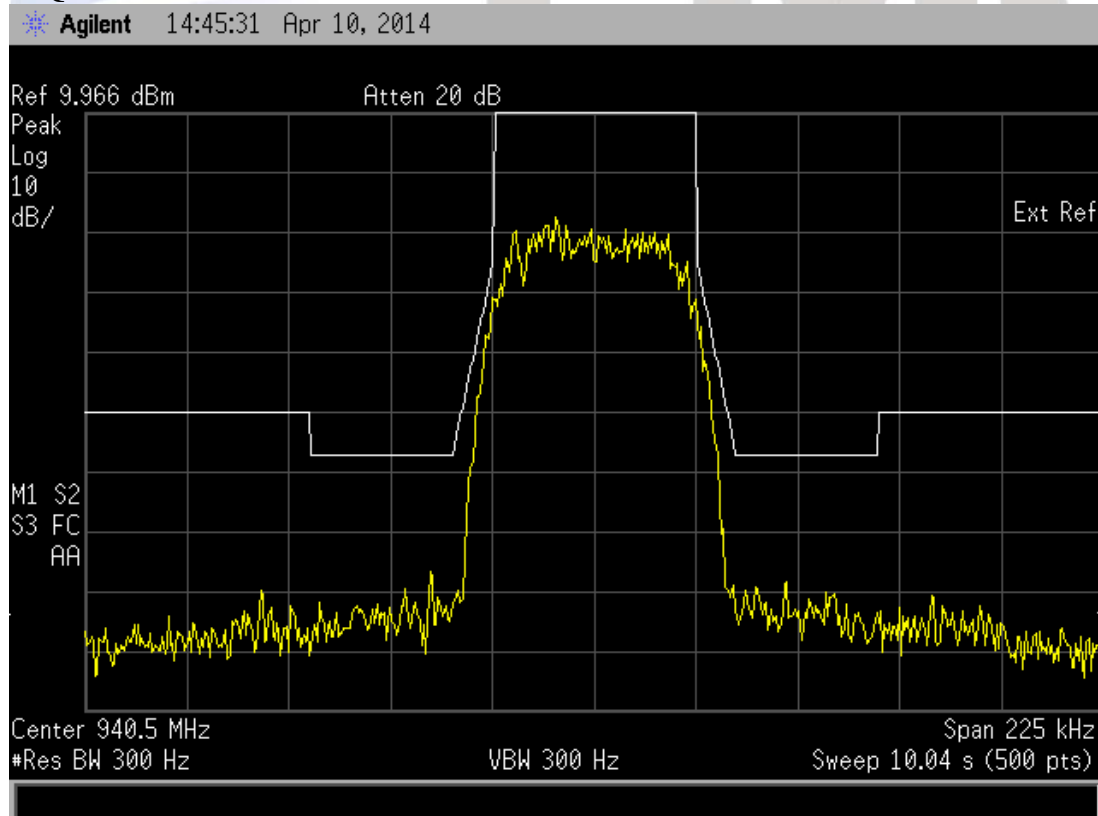
64 QAM 25.0 kHz



QPSK 50.0 kHz

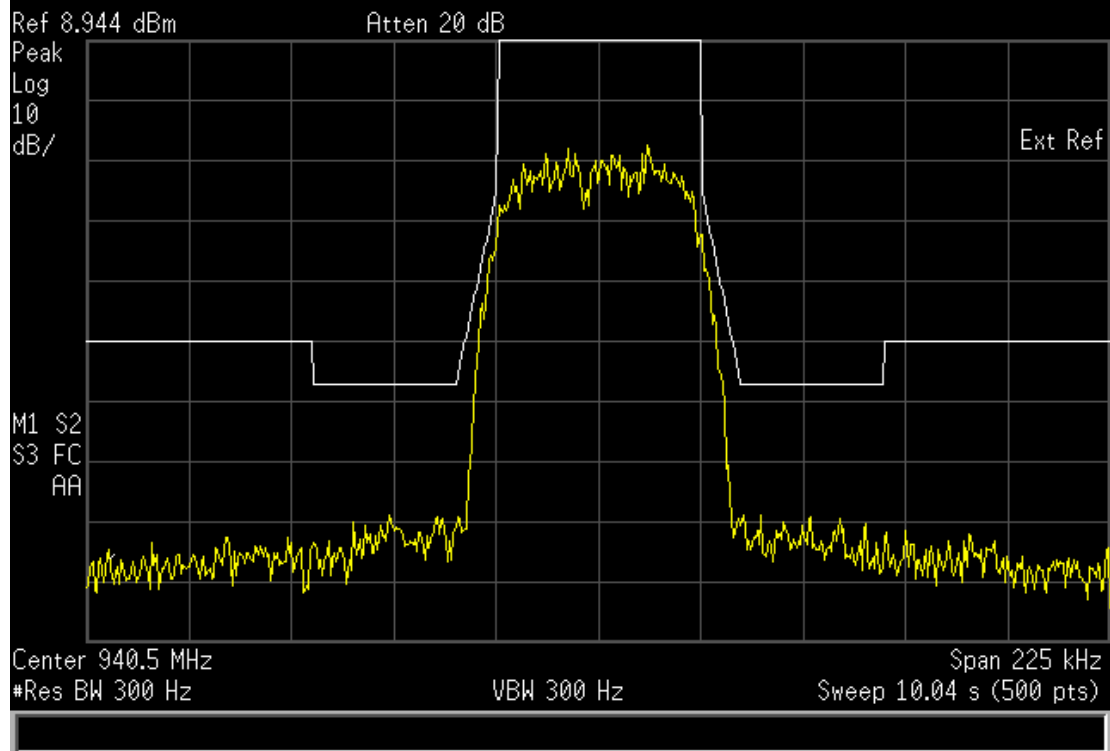


16QAM 50.0 kHz



64 QAM 50.0 kHz

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Result: Complies

Transmitter spurious emissions at the antenna terminals

Nominal Frequency: 930.525 MHz

Spurious emission (MHz)	Emission level (dBm)	Limit (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 (MHz)	Emission level (dBm)	Limit (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 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: 930.525 MHz

Frequency (MHz)	Level (dB μ V/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 (dB μ V/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 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: 940.525 MHz

Temperature (°C)	Voltage (10.8 Vdc)	Voltage (13.8 Vdc)	Voltage (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, $\text{mW/cm}^2 = E^2/3770$

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

- General Population / Uncontrolled exposure limit will be 0.62 mW/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

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

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

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

Uncontrolled

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

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

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

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.

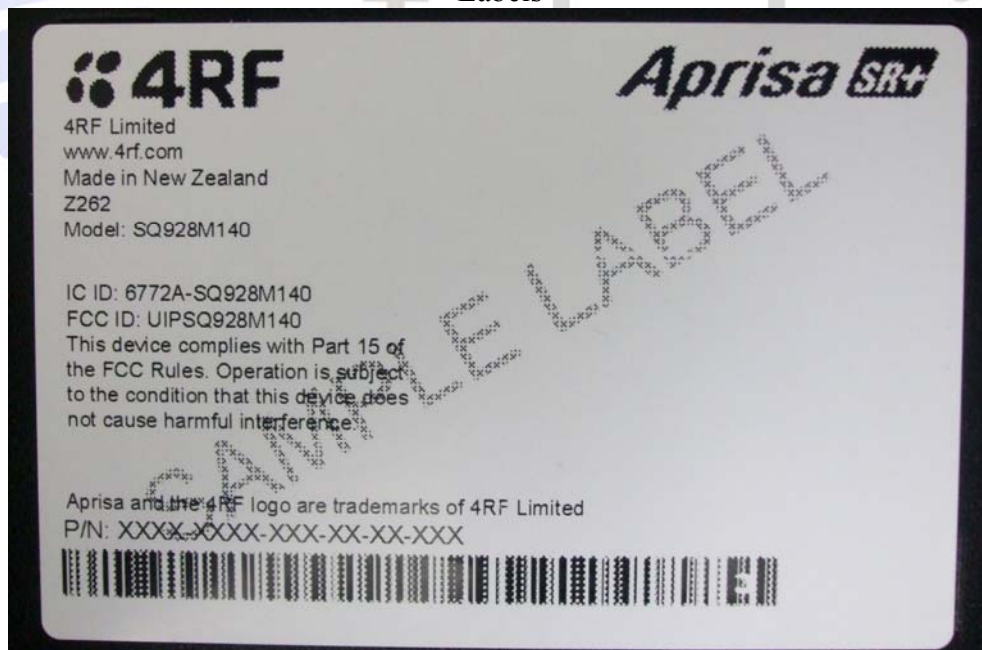
International Accreditation New Zealand has Mutual Recognition Arrangements for testing and calibration with various accreditation bodies in a number of economies. This includes NATA (Australia), UKAS (UK), SANAS (South Africa), NVLAP (USA), A2LA (USA), SWEDAC (Sweden). Further details can be supplied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

9. PHOTOGRAPHS

External photos of the device tested



Labels



Radiated emissions test set up photos



