EMC Technologies (NZ) Ltd

Test Report No **40616.1**
Report date: 29 July 2004

TEST REPORT

RFI-9256 OEM
900 MHz Spread Spectrum Radio Modem Module

tested for compliance with the

Code of Federal Regulations (CFR) 47

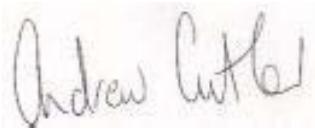
Part 15 – Radio Frequency Devices,
Subpart C – Intentional Radiators

Section 15.247 – Operation in the band
902 – 928 MHz

for

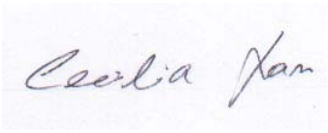
RF Innovations Pty Ltd

This Test Report is issued with the authority of:



Andrew Cutler - General Manager

Report prepared by:



Cecilia Lam – Office Administrator

All tests reported herein have been performed in accordance with the laboratory's scope of accreditation

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1. CLIENT INFORMATION

Company Name	RF Innovations Pty Ltd
Address	22 Boulder Road, Malaga
State	Western Australia 6090
Country	Australia
Contact	Mr Carlos M Tomaz

2. DESCRIPTION OF TEST SAMPLE

Brand Name	RFI
Model Number	RFI 9256 OEM
Product	900 MHz Spread Spectrum Radio Modem Module
Manufacturer	RF Innovations Pty Ltd
Country of Origin	Australia
Serial Number	407221CB3825
FCC ID	P5M9256OEM

3. SUMMARY OF TEST RESULTS AND COMPLIANCE STATEMENT

The RFI 9256 OEM 900 MHz Spread Spectrum Radio Module **complies with** 47 CFR Part 15.

Testing was carried out in accordance with the test methods defined in 47 CFR Part 15 and in particular Sections, 15.111, 15.205, 15.207, 15.209 and 15.247.

CLAUSE	TEST PERFORMED	RESULT
15.111	Antenna power conduction for receivers	Complies
15.203	Antenna requirement	Complies
15.205	Operation in restricted bands	Complies
15.207	Conducted emissions	Complies
15.209	Radiated emissions	Complies
15.247:		
(a)(1)(i)	Channel occupancy / bandwidth	Complies
(b)(2)	Peak output power	Complies
(b)(4)	Radio frequency hazard	Complies
(c)	Out of band emissions	Complies

4. ARTICLES SUBMITTED

The following items were submitted:

- 902 – 928 MHz frequency hopping spread spectrum transceiver
- Whip antenna
- Length of coax cable

The transmitter has no external user controls.

All changes to the device were carried out using password protected software that was supplied by the client

This software allowed the following changes:

- Frequency hopping in two bands: 902 – 915 MHz and 915 – 928 MHz for Australian approval.
- Frequency hopping over the whole band 902 – 928 MHz
- Operation on 902 and 927 MHz only
- Single frequency operation.
- Variation of the output power

5. TEST SAMPLE DESCRIPTION

The sample tested is a frequency hopping spread spectrum transceiver with the following specifications:

Rated Transmitter Output Power

1 watt (30 dBm)

FCC frequency allocation

902 – 928 MHz

Test frequencies

902.5000 MHz – 927.7500 MHz

102 frequencies in a pseudo random sequence with a frequency spacing of 250 kHz

Hopping configuration no 2 was utilised.

For operations in Australia between 915 – 928 MHz hopping configuration no 34 was utilised.

Power Supply

This system is sold without an AC power supply with only a DC supply input provided.

Provision of a power supply will be the responsibility of the purchaser.

Conducted measurements have been carried out using a laboratory supplied representative
110 Vac / 12 Vdc power supply.

External Ports

The Radio Telemetry Module has the following ports:
- antenna port (unique connector)
- RS 232 port

6. ATTESTATION

This report describes the tests and measurements performed for the purpose of determining compliance with the specification with the following conditions:

The test sample was selected by the client.

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. RESULTS

Section 15.111(a) – Antenna power conduction limits for receivers

In accordance with Section 15.109 (f) receiver power conduction measurements have been made at the antenna terminals.

Device operated in receive only mode. This was achieved by operating the device as a Slave.

Receive Frequency: 902.500 MHz (Channel 0)

Measured Spurious Emission		
Emission (MHz)	**Emission level (dBm)**	**Limit (dBm)**
677.800	-83.0	-57.0
1355.600	-96.0	-57.0
2033.400	-69.8	-57.0
2711.200	-92.1	-57.0
4744.588	-82.3	-57.0
Others		
214.001	-77.1	-57.0
1070.100	-74.1	-57.0

First IF = 224.700 MHz.
Second IF = 10.7 MHz

In accordance with Section 15.31(o) only levels within 20 dB of the limit have been reported.

In the range 30 – 5000 MHz the power at the antenna terminal shall not exceed 2 nW (-57 dBm).

Testing was carried out on one channel only.

Result: Complies.

Section 15.203 – Antenna requirement

The antenna to be used with this system is a RF Industries Pty Ltd CD1625 Series GSM antenna.

This antenna is attached to the system using a unique connector.

The connector looks like a standard BNC connector however it is not and needs to be milled to the appropriate standard.

A photograph of this unique connector is contained within this report.

Section 15.205 – Restricted bands of operation

Refer to measurements made with reference to Section 15.247 (c)

Section 15.207 – Conducted emissions

This system is sold without an AC power supply. Provision of a power supply will be the responsibility of the purchaser.

Conducted emission measurements have been carried out using a representative 110 Vac / 12 Vdc power supply over the frequency range of 150 kHz to 30 MHz.

Testing was carried out in the laboratory's MacKelvie Street screened room.

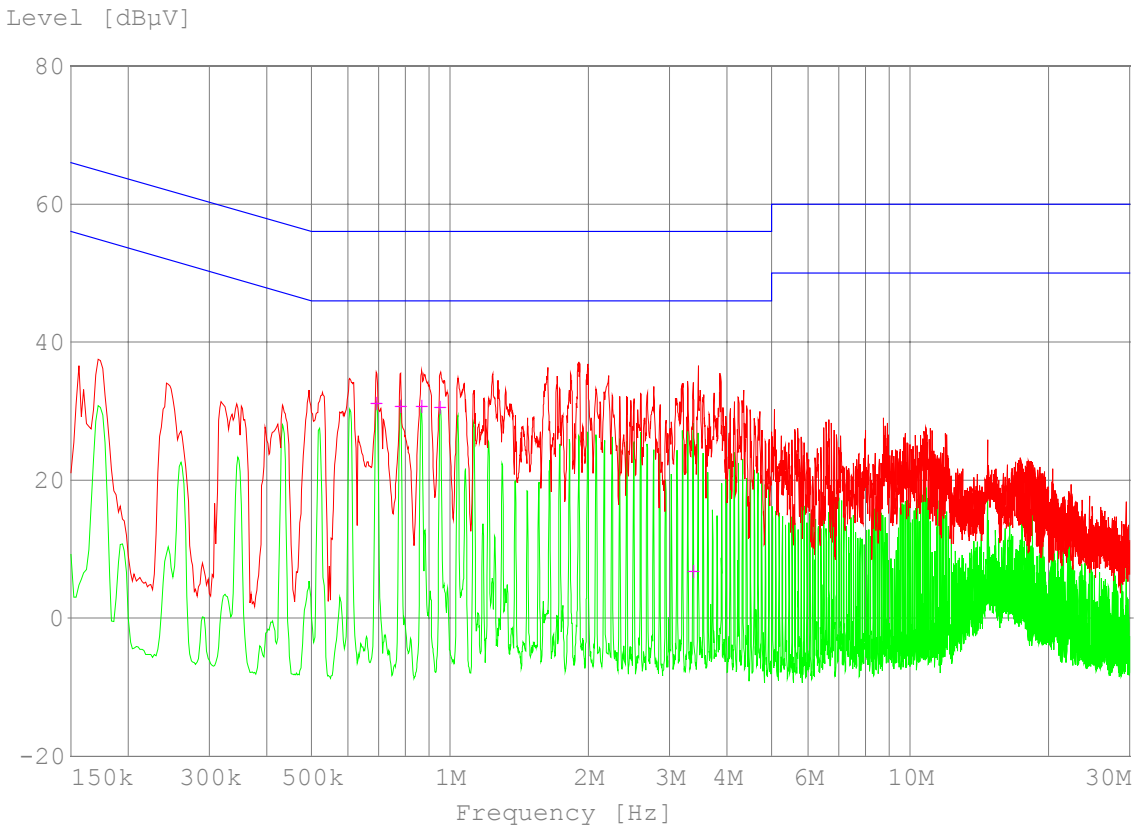
The device was placed on top of the test table, which is 1m x 1.5m, 80cm above the screened room floor which acts as the horizontal ground plane. In addition the device was positioned 40cm away from the screened room wall which acts as the vertical ground plane. The artificial mains network was bonded to the screened room floor. At all times the device was kept more than 80cm from the artificial mains network.

Quasi peak measurements were made with a receiver bandwidth of 9 kHz.

Measurement uncertainty with a confidence interval of 95% is:
- Mains terminal tests (0.15 - 30 MHz) ± 2.2 dB

Conducted Emissions Test

Comments:	Device tested when transmitting continuously at +30 dBm in hop mode when powered at 110 Vac using a representative AC adapator.



Quasi-Peak Measurements

Frequency MHz	Level dBµV	Limit dBµV	Margin dB	Exceed	Phase	Rechecks dBµV
No emissions recorded						

Average Measurements

Frequency MHz	Level dBµV	Limit dBµV	Margin dB	Exceed	Phase	Rechecks dBµV
0.692000	31.20	46.00	14.80		L1	30.5
0.780000	30.71	46.00	15.29		L1	
0.866000	30.76	46.00	15.24		L1	
0.952000	30.58	46.00	15.42		N	
3.445560	27.89	46.00	39.11		L1	

Section 15.209 – Radiated emissions

In accordance with section 15.247(c) attenuation below the general limits specified in Section 15.209(a) except those emissions that fall within the restricted bands defined in Section 15.205(a).

Section 15.247 (a) (1) (i) - Channel occupancy / bandwidth

Device observed operating between 902 – 928 MHz when using hopping sequence no 2.

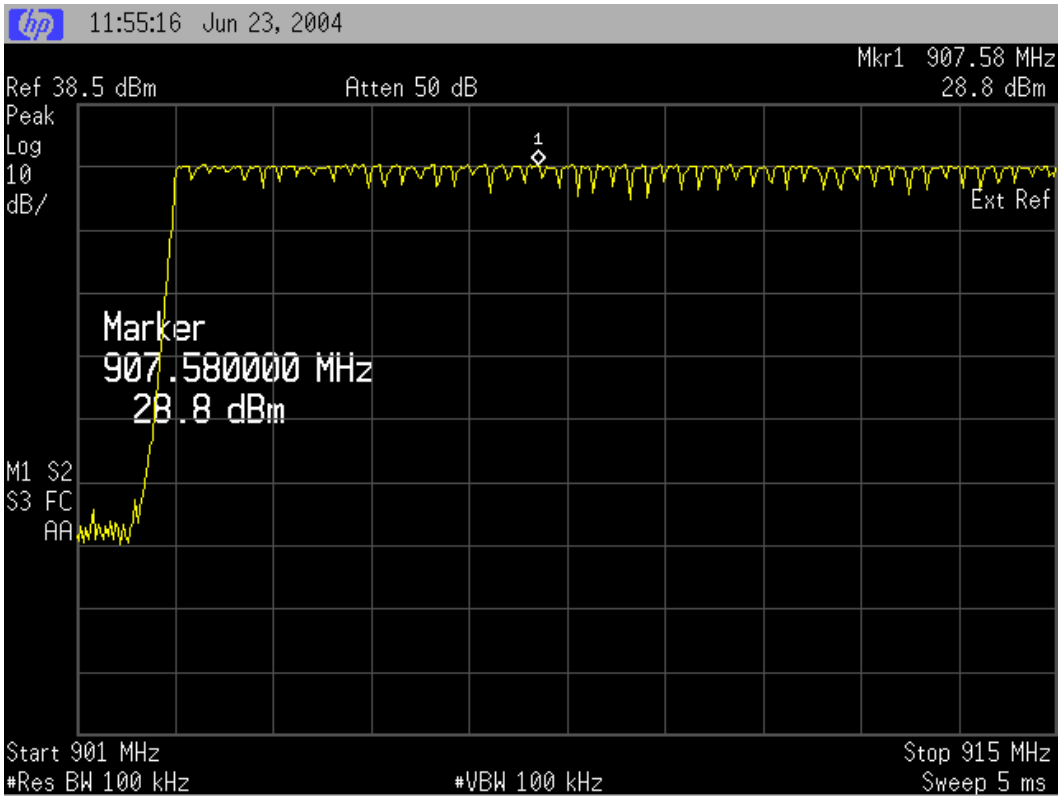
The hop frequency is given by the following formula:

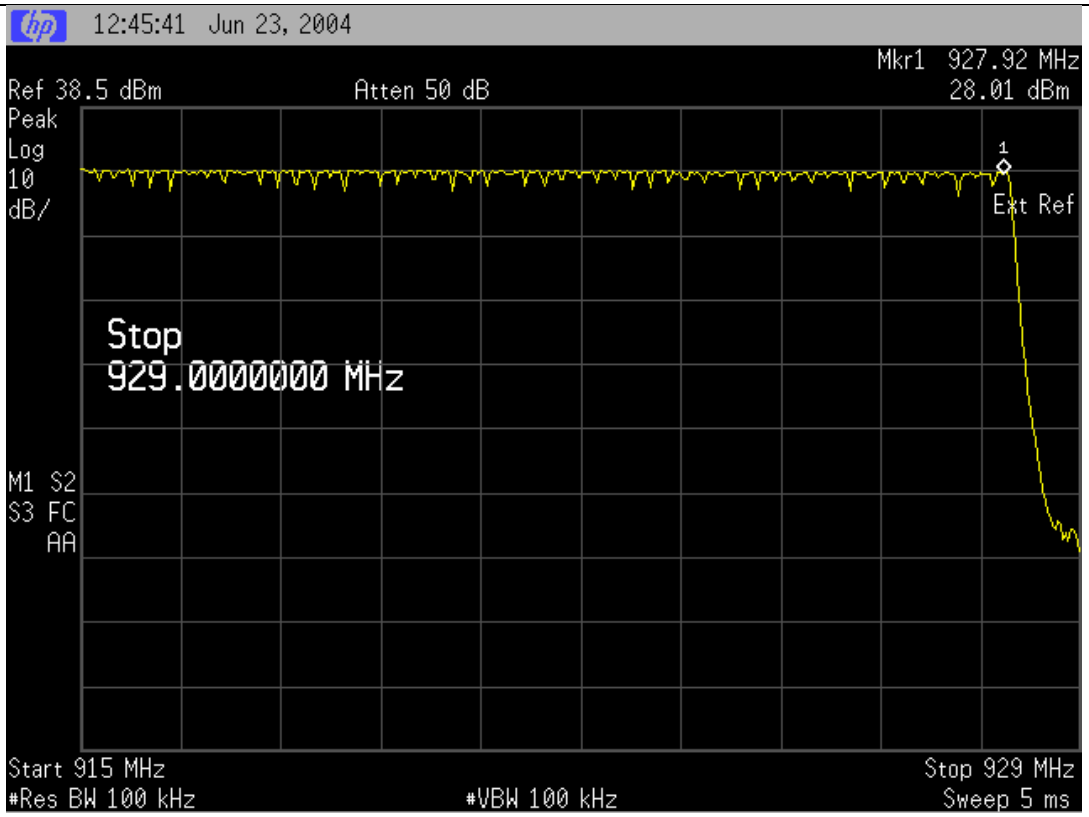
F(MHz) = 902.500 + N*0.25

Where N = 0 to 101

102 channels can be observed in operation.

In order to count the number of channels the band was split in half.





50 channels can be counted between 902 – 915 MHz and 52 channels can be counted between 915 – 928 MHz which makes a total of 102 channels.

Band edge measurements have been made using a resolution bandwidth of 100 kHz.

The maximum emission level detected between 902 – 928 MHz was 29.69 dBm at approximately 915 MHz.

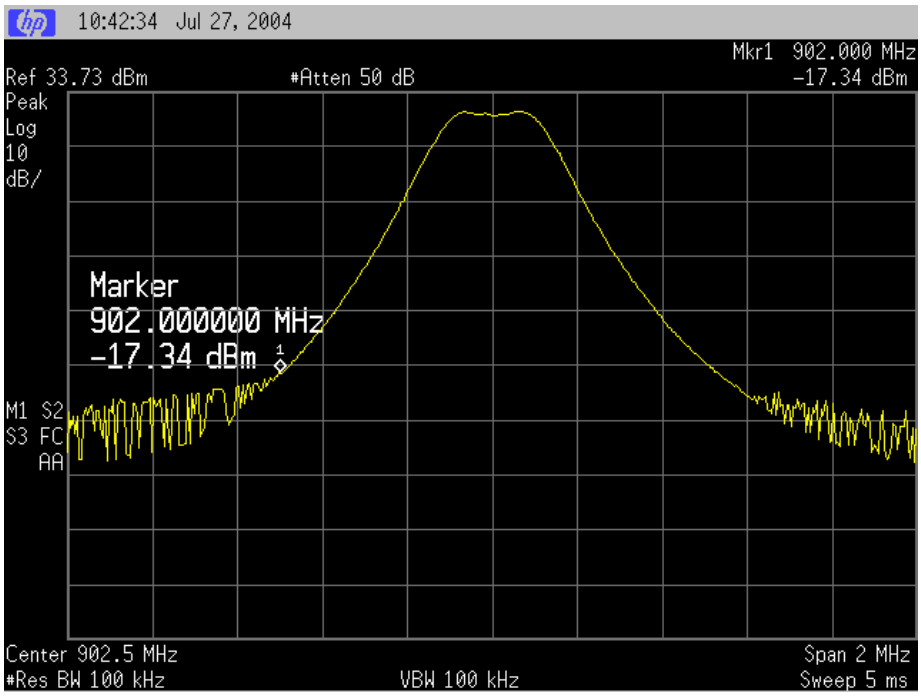
The plots show that at the band edges the emission levels are:

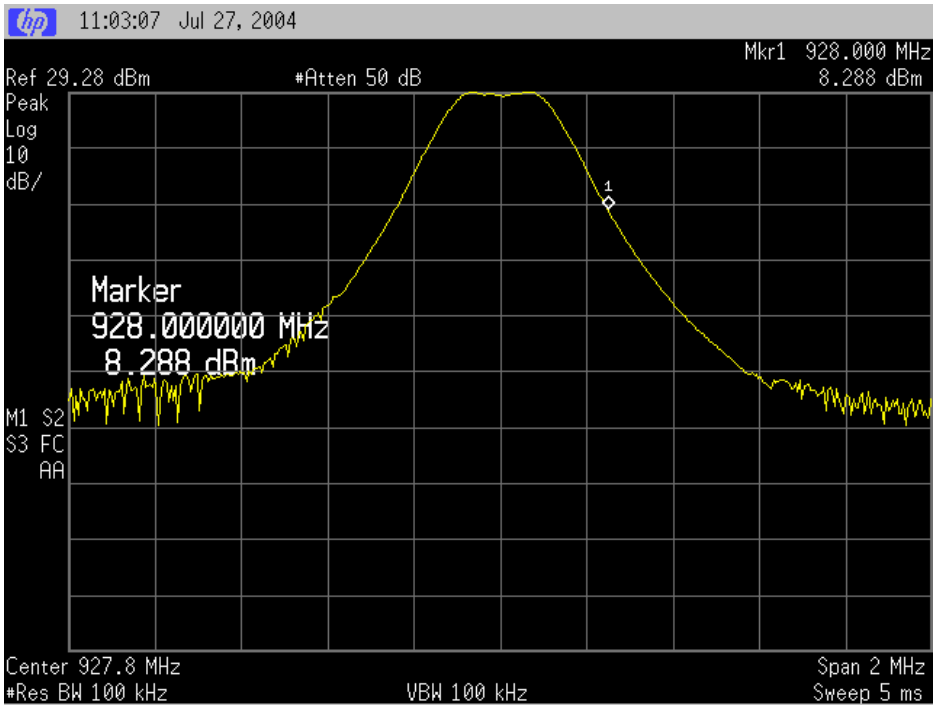
- at 902.000 MHz the emission level is – 46.9 dB down on the emission peak

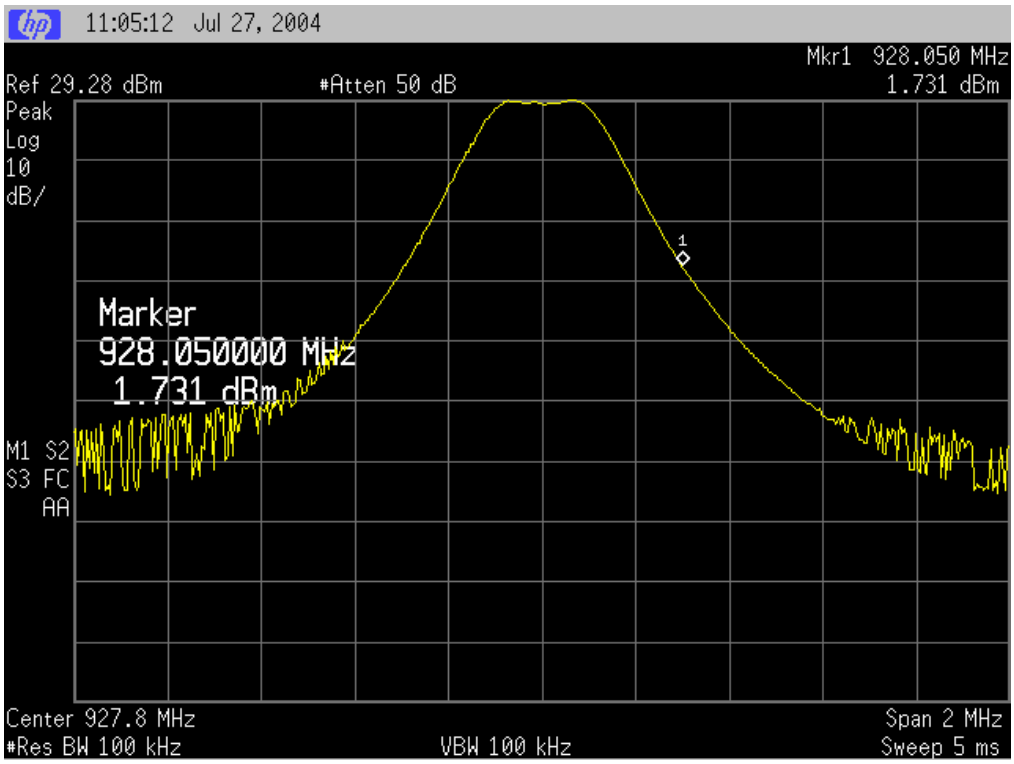
- at 928.000 MHz the emission level is –21.3 dB down on the emission peak

An additional measurement was made at 928.050 MHz that is the centre of the first 100 kHz bandwidth.

- at 928.050 MHz the emission level is –27.9 dB down on the emission peak


10:42:34 Jul 27, 2004
Mkr1 902.000 MHz
-17.34 dBm
Ref 33.73 dBm
#Atten 50 dB
Peak
Log
10
dB/
Marker
902.000000 MHz
-17.34 dBm
M1 S2
S3 FC
AA
Center 902.5 MHz
#Res BW 100 kHz
VBW 100 kHz
Span 2 MHz
Sweep 5 ms


11:03:07 Jul 27, 2004
Mkr1 928.000 MHz
8.288 dBm
Ref 29.28 dBm
#Atten 50 dB
Peak
Log
10
dB/
Marker
928.000000 MHz
8.288 dBm
M1 S2
S3 FC
AA
Center 927.8 MHz
#Res BW 100 kHz
VBW 100 kHz
Span 2 MHz
Sweep 5 ms



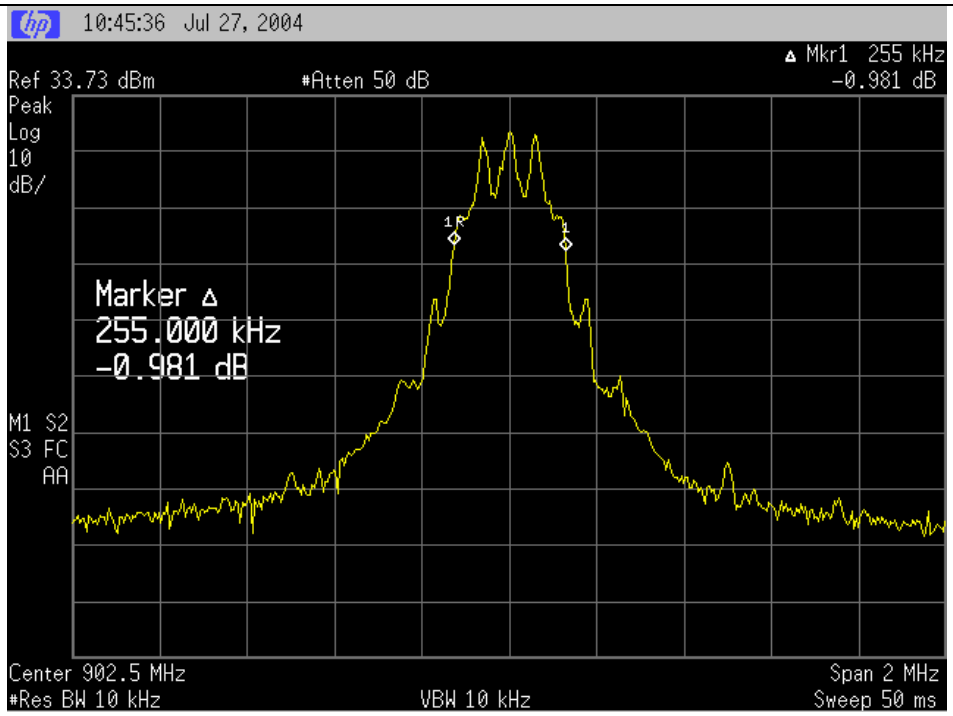
This device operates using 102 channels based upon hopping channels with a separation of 250 kHz.

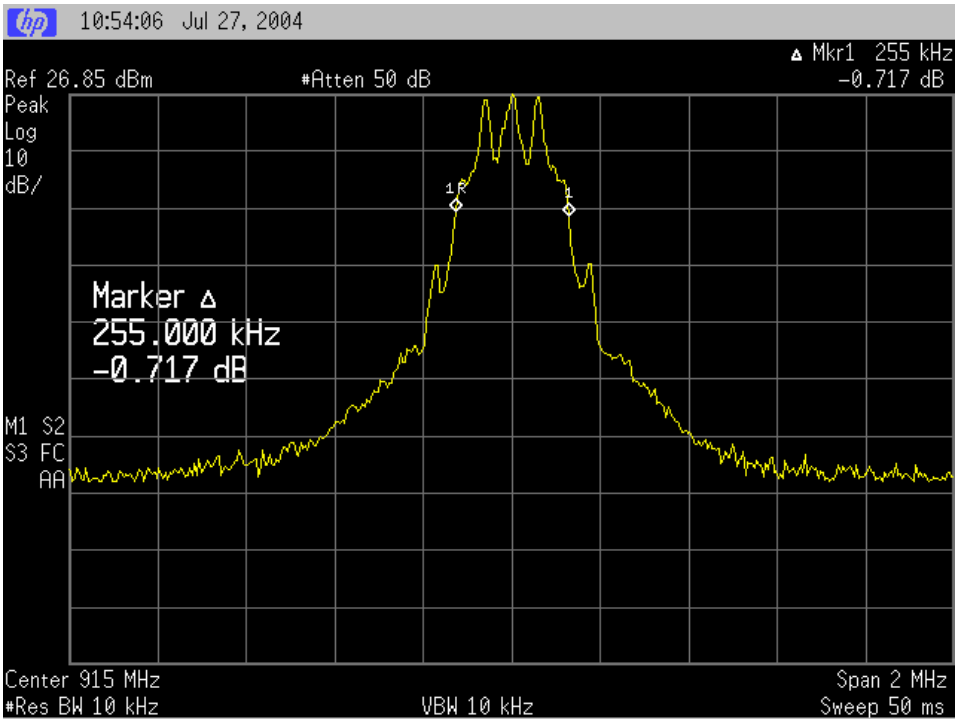
Measurements of the 20 dB bandwidth have been carried out on hopping channel 0 (902.500 MHz), channel 51 (915.250 MHz) and channel 101 (927.750 MHz) using a resolution bandwidth of 10 kHz which shows the individual modulation peaks.

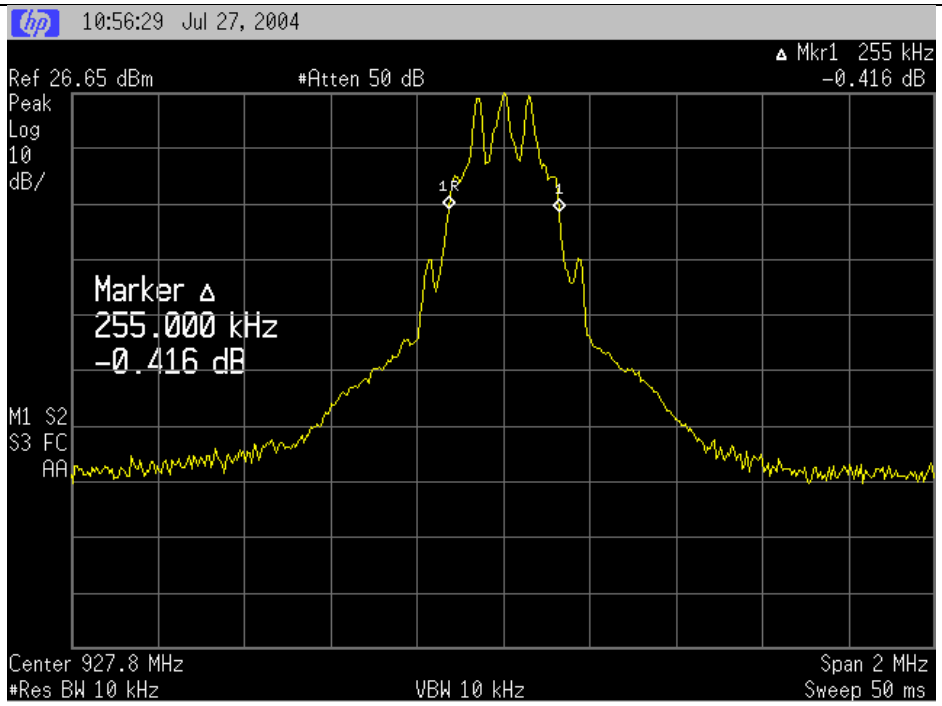
The results are as follows:

Channel	Frequency	20 dB Bandwidth
0	902.500 MHz	255 kHz
51	915.250 MHz	255 kHz
101	927.750 MHz	255 kHz

The measurement plots are attached







The 20 dB bandwidth measurement for each channel is 255 kHz.

The maximum 20 dB bandwidth allowed is 500 kHz.

As the 20 dB bandwidth of the hopping channel is greater than 250 kHz a minimum of 25 hopping frequencies must be utilised.

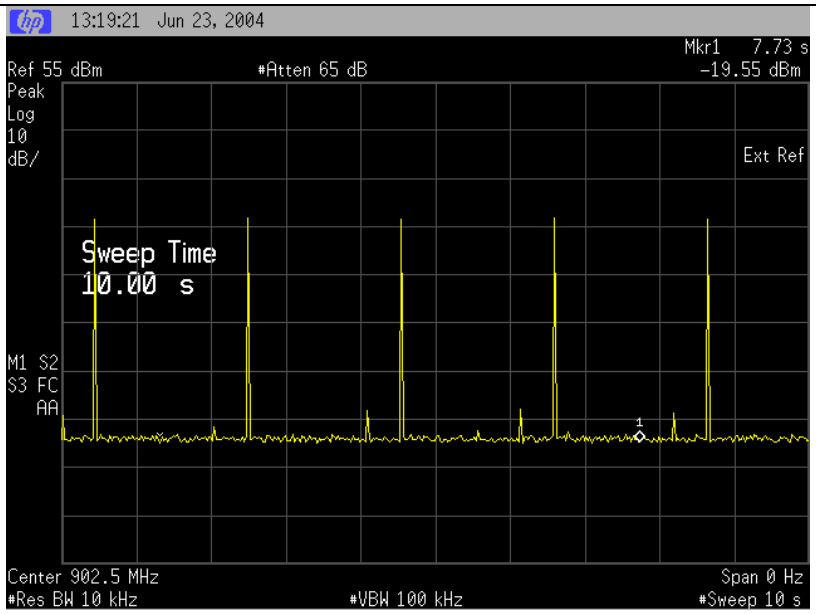
This device utilises 102 hopping frequencies.

Result: Complies

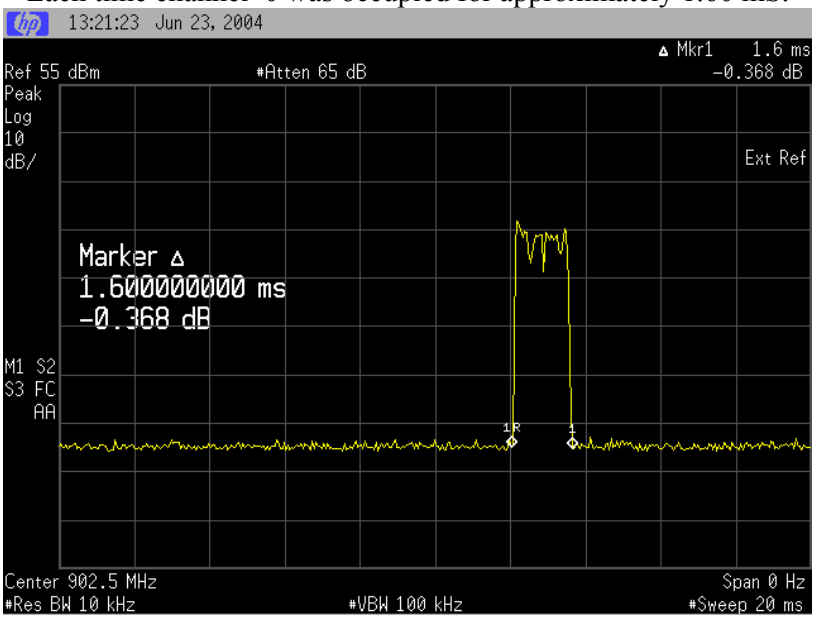
As the hopping channel bandwidth is greater than 250 kHz the average time of occupancy on each channel shall not be greater than 0.4 seconds (400 ms) within a 10 second period.

Observations were made on channel 0 with the spectrum analyser having a span of 0 Hz.

In any 10 second period the channel was observed to be occupied at least 5 times



Each time channel 0 was occupied for approximately 1.60 mS.



Therefore in any 10 second period the channel was occupied for 5 x 1.60 ms = 8.0 mS = 0.008 seconds.

The average time of occupancy shall not be greater than 0.4 seconds in any 10 second period.

Result: Complies

Section 15.247 (b) (2) & (3) – Peak output power

Measurements were carried out at the RF output terminals of the transmitter using a spectrum analyser.

Measurements were carried out on channel 0, 51 and 100 using a span of 5 MHz and a resolution bandwidth of 1 MHz.

Measurements were made using a representative 110 Vac to 12 Vdc AC adaptor.

	RF power output (dBm)		
Channel	**-15%**	**Nominal**	**+15%**
0	29.67	29.67	29.67
51	29.69	29.69	29.69
101	29.61	29.61	29.61

The nominal power of this device is +30 dBm.

The antenna to be used with this system is a RF Industries Pty Ltd CD1625 Series GSM antenna.

This antenna has a gain of 3 dB over a dipole.

Converting the antenna dB gain to dBi gives 3 + 2.15 = 5.15 dBi.

As the antenna gain is less than 6 dBi the transmitter power need not be reduced.

A copy of the antenna specifications is contained in Appendix A.

Limits:
The maximum peak output power for frequency hopping systems operating in the 902 – 928 MHz shall not exceed 1 watts (+30 dBm) for systems employing at least 50 channels.

The peak output power of an intentional radiator shall be reduced below +30 dBm by the amount in dB that the antenna exceeds 6 dBi.

Result: Complies

Measurement Uncertainty: *±0.5 dB*

Section 15.247 (b) (5) – Radio Frequency Hazard Information

As per Section 15.247 (b) (4) spread spectrum transmitters operating in the 902 – 928 MHz band are required to be operated in a manner that ensures that the public is not exposed to rf energy levels in accordance with CFR 47, Section 1.1307(b)(1).

In accordance with this section, and also Section 2.1091, this device has been defined as a mobile device whereby a distance of 20 cm can normally be maintained between the user and the device.

In accordance with Section 1.1310 the Maximum Permissible Exposure (MPE) limits for the General Population / Uncontrolled Exposure of f/1500 have been applied.

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

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

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

$$\text{E for MPE: } (902/1500) = E^2/3770$$
$$E = \sqrt{(902/1500)*3770}$$
$$E = \underline{47.6 \text{ V/m}}$$

The antenna used with this system has a gain of 5.15 dBi (gain = 3.27).

The transmitter power was measured at 29.69 dBm or 0.912 watts.

Therefore:

$$d = \sqrt{(30 * P * G)} / E$$
$$= \sqrt{(30 * 0.912 * 3.27)} / 47.6$$
$$= \underline{0.198 \text{ metres or } 19.8 \text{ cm which is approximately } 20.0}$$

Calculations show that this device with the described antenna meets the MPE requirement for mobile devices falling below the 20 cm clearance required.

Result: Complies

Section 15.247 (c) – Out of band emissions

Measurements were made at the antenna port with a resolution bandwidth of 100 kHz on channels 0, 51 and 101.

Frequency: 902.500 MHz (Channel 0)

Measured Spurious Emission		
Emission (MHz)	**Emission level (dBm)**	**Limit (dBm)**
Harmonics		
1804.4875	> -41.0	+9.69
2707.7130	-43.0	+9.69
3610.2750	-56.5	+9.69
4512.8380	-63.5	+9.69
5415.4000	-61.0	+9.69
6317.9000	-73.0	+9.69
7220.0000	-	+9.69
8122.5000	-	+9.69
9025.0000	-	+9.69
Other emissions		
93.53000	> -66.0	+9.69
295.6000	> -66.0	+9.69
747.0000	> -67.0	+9.69

Frequency: 915.2500 MHz (Channel 51)

Measured Spurious Emission		
Emission (MHz)	**Emission level (dBm)**	**Limit (dBm)**
1830.4000	> -41.0	+9.69
2745.9650	-47.5	+9.69
3660.8100	-54.7	+9.69
4576.2600	-54.0	+9.69
5491.2150	-60.8	+9.69
6406.7500	-	+9.69
7322.0000	-	+9.69
8237.2500	-	+9.69
9152.5000	-61.0	+9.69
Other emissions		
131.5000	> -66.0	+9.69
327.5000	> -66.0	+9.69
785.0000	> -67.0	+9.69

Frequency: 927.7500 MHz (Channel 101)

Measured Spurious Emission		
Emission (MHz)	**Emission level (dBm)**	**Limit (dBm)**
Harmonics		
1855.6730	> 41.0	+9.69
2783.5200	-47.1	+9.69
3711.3280	-56.1	+9.69
4639.1650	-69.5	+9.69
5566.9850	-61.0	+9.69
6494.2600	-	+9.69
7422.0100	-	+9.69
8349.7600	-	+9.69
9277.5100	-	+9.69
Other emissions		
169.3000	> -66.0	+9.69
359.4000	> -66.0	+9.69
822.8000	> -67.0	+9.69

Result: Complies

Limit:
In any 100 kHz bandwidth outside the frequency band of operation, the RF power produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power.

A limit of +9.69 dBm has been applied as the highest level of desired power observed was +29.69 dBm.

Measurement Uncertainty: *±3.3 dB*

A number of out of band emissions have been shown to fall within the restricted bands of operation as defined in section 15.205(a).

Radiated emission measurements were carried out with the limits as per section 15.209 applied.

Testing was carried out at EMC Technologies NZ Ltd Open Area Test Site, which is located at Orere Point, Auckland. Details of this site have been filed with the Commission, Registration Number: 90838, that was last updated on February 17, 2004.

The device was placed on the test table top which was a total of 0.8 m above the test site ground plane.

Measurements of the radiated field were made with the antenna located at a 3 m horizontal distance from the boundary of the device under test.

Measurements were made when the device was made to continuously transmit on a channels 0, 51 and 101.

Measurements below 1000 MHz were made using an Quasi Peak Detector with a bandwidth of 120 kHz.

Measurements above 1000 MHz were made using an average detector with a bandwidth of 1.0 MHz.

Attached to the device was a laptop computer which was used to control the device and a whip antenna.

When an emission is located, it is positively identified and its maximum level is found by rotating the automated turntable, and by varying the antenna height with an automated antenna tower. The emission is measured in both vertical and horizontal antenna polarisations.

The emission level is determined in field strength by taking the following into consideration:

Level (dBµV/m) = Receiver Reading (dBµV) + Antenna Factor (dB) + Coax Loss (dB)

Result: Complies.

Measurement uncertainty (30 – 10,000 MHz) ± 4.1 dB

Results:

Transmitting on 902.500 MHz

Frequency	Level		Limit	Margin	Result	Antenna
MHz	Vert dBuV/m	Hort dBuV/m	dBuV/m	dBuV		
1805.000	-	-	-	-	Pass	Vert/Hort
2707.500	-	-	54.0	-	Pass	Vert/Hort
3610.000	-	-	54.0	-	Pass	Vert/Hort
4512.500	-	-	54.0	-	Pass	Vert/Hort
5415.000	-	-	54.0	-	Pass	Vert/Hort
6317.500	-	-	-	-	Pass	Vert/Hort
7220.000	-	-	-	-	Pass	Vert/Hort
8122.500	-	-	54.0	-	Pass	Vert/Hort
9025.000	-	-	54.0	-	Pass	Vert/Hort

Transmitting on 915.250 MHz

Frequency	Level		Limit	Margin	Antenna	Result
MHz	Vert dBuV/m	Hort dBuV/m	dBuV/m	dBuV		
1830.500	-	-	-	-	Vert/Hort	Pass
2745.750	-	-	54.0	-	Vert/Hort	Pass
3661.000	-	-	54.0	-	Vert/Hort	Pass
4576.250	-	-	54.0	-	Vert/Hort	Pass
5491.500	-	-	-	-	Vert/Hort	Pass
6406.750	-	-	-	-	Vert/Hort	Pass
7322.000	-	-	54.0	-	Vert/Hort	Pass
8237.250	-	-	54.0	-	Vert/Hort	Pass
9152.500	-	-	54.0	-	Vert/Hort	Pass

NB: Where an emission falls outside of the restricted bands no limit has been recorded.

Transmitting on 927.750 MHz

Frequency	Level		Limit	Margin	Antenna
MHz	Vert dBuV/m	Hort dBuV/m	dBuV/m		
1855.500	-	-	-	Pass	Vert/Hort
2783.250	-	-	54.0	Pass	Vert/Hort
3711.000	-	-	54.0	Pass	Vert/Hort
4638.750	-	-	54.0	Pass	Vert/Hort
5566.500	-	-	-	Pass	Vert/Hort
6494.250	-	-	54.0	Pass	Vert/Hort
7422.000	-	-	54.0	Pass	Vert/Hort
8349.750	-	-	54.0	Pass	Vert/Hort
9277.500	-	-	-	Pass	Vert/Hort

Other emissions observed

Frequency	Level		Limit	Margin	Result	Antenna
MHz	Vert dBuV/m	Hort dBuV/m	dBuV/m	dBuV		
46.000	21.0		-	-	Pass	Vertical
59.000	21.0		-	-	Pass	Vertical
66.375	24.1		-	-	Pass	Vertical
73.750	23.5		40.0	16.5	Pass	Vertical
81.125	25.3		-	14.7	Pass	Vertical
95.875	30.7		-	12.8	Pass	Vertical
103.250	24.4		-	19.1	Pass	Vertical
110.625	34.5		43.5	9.0	Pass	Vertical
118.000	32.4		43.5	11.1	Pass	Vertical
125.375	26.3		43.5	17.2	Pass	Vertical
132.750	26.2		43.5	17.3	Pass	Vertical
147.500	36.9	37.6	-	-	Pass	Horizontal
140.125	26.6		-	-	Pass	Vertical
154.875	24.6		-	-	Pass	Vertical
199.125	28.6		43.5	14.9	Pass	Vertical

NB: Where an emission falls outside of the restricted bands no limit has been recorded.

8. TEST EQUIPMENT USED

Instrument	Manufacturer	Model	Serial #	Asset
Attenuator 20 dB	Hewlett Packard	8491B	22146	E1041
RF Power Meter	Hewlett Packard	HP 436A	2512A22439	E1198
Spectrum Analyser	Hewlett Packard	E 7405A	US 39150142	3776
Measurement Receiver	Rohde & Schwarz	ESCS 30	847124/020	E1595
Aerial Controller	EMCO	1090	9112-1062	3710
Aerial Mast	EMCO	1070-1	9203-1661	3708
Turntable	EMCO	1080-1-2.1	9109-1578	RFS 3709
Biconical Antenna	Schwarzbeck	BBA 9106	-	3612
Log Periodic Antenna	Schwarzbeck	VUSLP 9111	9111-228	3785
Horn Antenna	EMCO	3115	9511-4629	E1526

9. 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 updated on February 17th, 2004.

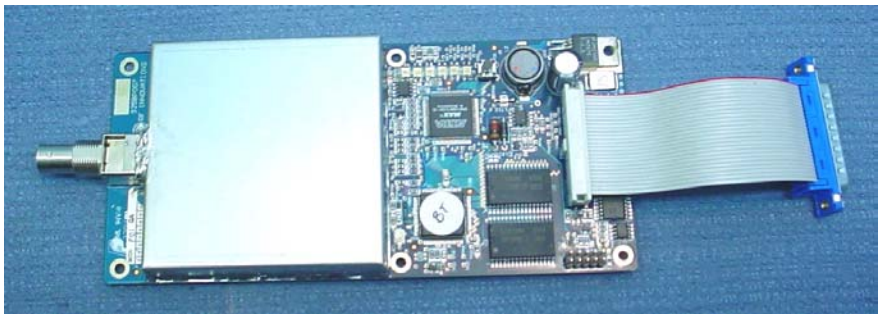
In addition testing was carried out in accordance with the terms of EMC Technologies (NZ) Ltd's International Accreditation New Zealand (IANZ) Accreditation to IEC/ISO 17025: 1999.

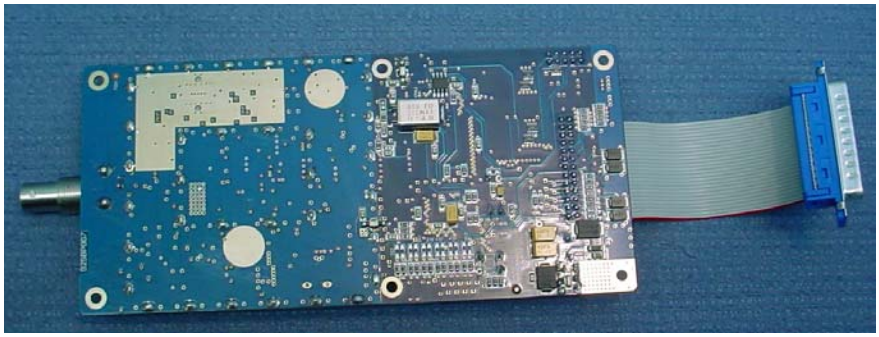
All measurement equipment has been calibrated in accordance with the terms of EMC Technologies (NZ) Ltd's International Accreditation New Zealand (IANZ) Accreditation to IEC/ISO 17025: 1999.

International Accreditation New Zealand has Mutual Recognition Arrangements for testing and calibration with 46 accreditation bodies in 34 economies. This includes NATA (Australia), UKAS (UK), SANAS (South Africa), NVLAP (USA), A2LA (USA), SWEDAC (Sweden). Further details can be supplied on request.

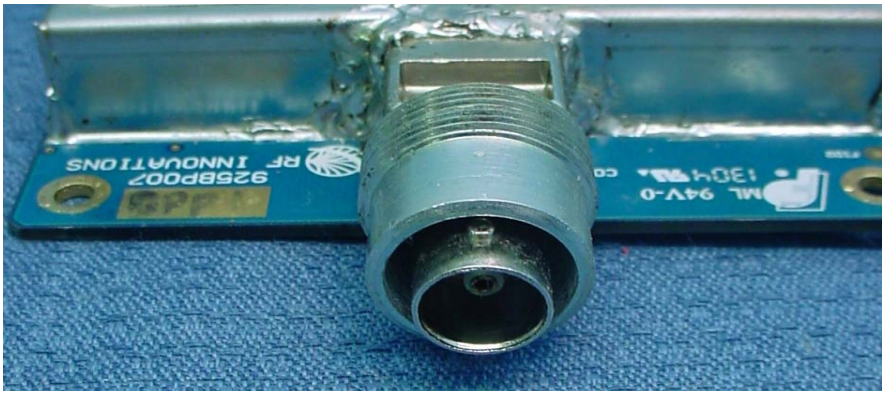
10. PHOTOGRAPH (S)

Device tested

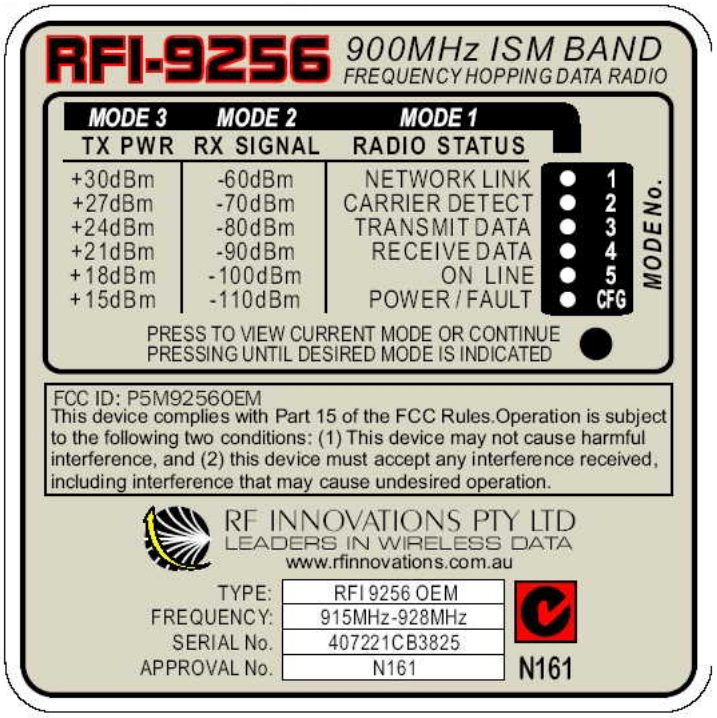




Antenna connector

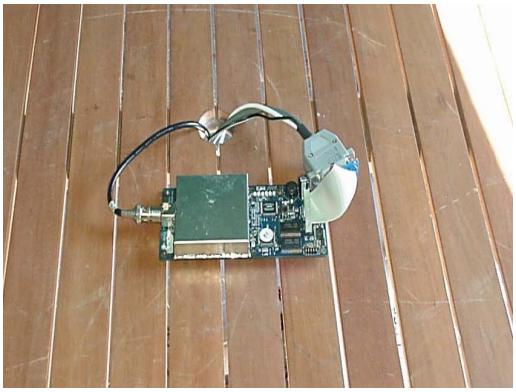


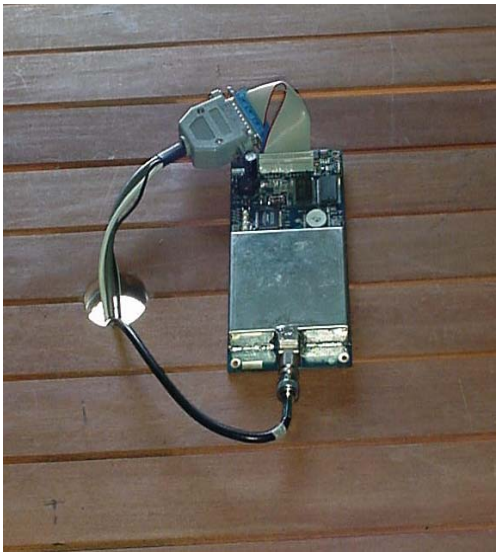
Label details

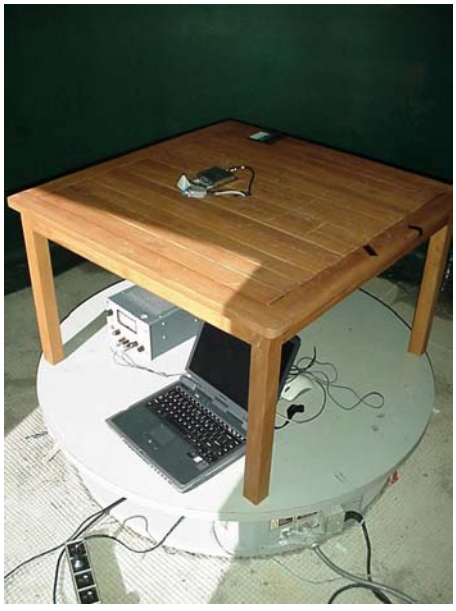


Conducted emissions test set up

Radiated emissions test set up







Antenna