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ELPRO S2900 900 MHz Module Transceiver

tested to the

47 Code of Federal Regulations

Part 15 - Radio Frequency Devices

Subpart C – Intentional Radiators

Section 15.247 - Operation in the band 902 – 928 MHz

for

ELPRO Technologies Pty Ltd

This Test Report is issued with the authority of:

A handwritten signature in black ink, appearing to read "Andrew Cutler", is written over a light blue rectangular background.

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 **ELPRO S2900 900 MHz Module Transceiver** complies with FCC Part 15 Subpart C Section 15.247 as an Intentional Radiator when the methods as described in ANSI C63.4 - 2003 are applied along with the requirements contained in FCC Public Notice DA 00-705.

2. RESULT SUMMARY

The results of testing carried out in May 2015 are summarised below.

Clause	Parameter	Result
15.201	Equipment authorisation requirement	Certification required as limited modular approval is being sought.
15.203	Antenna requirement	Not applicable. Unique antenna connector not required as equipment is installed by professional installers.
15.204	External PA and antenna modifications	Noted.
15.205	Restricted bands of operation	Complies.
15.207	Conducted limits	Complies.
15.209	Radiated emission limits	Complies.
15.247		
(a)(1)	Hopping channel separation	Complies
(a)(1)(i)(iii)	Channel occupancy / Bandwidth	Complies
(b)(1)(2)	Peak output power	Complies
(b)(4)	Antenna gain less than 6 dBi	Complies
(d)	Out of band emissions	Complies
(g)	Use of all channels	Not applicable
(h)	Intelligent frequency hopping	Not applicable
(i)	Radio frequency hazards	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.

All compliance statements have been made with respect of the specification limit with no reference to the measurement uncertainty.

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 ELPRO Technologies Pty Ltd
Address 9/12 Billabong Street
City Stafford
State Queensland 4053
Country Australia
Contact Mr Robert Tsien

5. TEST SAMPLE DESCRIPTION

Brand Name ELPRO
Model Number S2900
Product 900 MHz Module Transceiver
Manufacturer ELPRO Technologies Pty Ltd
Manufactured in Australia
Serial Number Module not serialised
FCC ID 09P-S2900

The device tested is a 900 MHz Transceiver Module that operates in the 902 - 928 MHz band using frequency hopping spread spectrum modulation techniques.

Testing was carried out in order to gain Limited Modular Certification.

The device tested had the following specifications:

Rated Transmitter Conducted Output Power

1.0 Watts (30.0 dBm)

Transmitter Frequency Operating Range

902 - 928 MHz

FCC Band:

902 - 928 MHz

Channel Spacing:

250 kHz

Modes of operation:

2FSK modulation with a data rate of up to 115200 bps

Test frequencies / No of channels etc

Device operates using:

50 channels between 902.625 - 914.875 MHz

50 channels between 915.125 - 927.375 MHz

Testing was therefore carried out on various channels but specific tests were carried out on:

902.625 MHz, 915.125 MHz, 927.375 MHz

Power Supply

DC voltage supply from 9 - 30 Vdc.

Typically the device would be powered at 12 Vdc using a lead acid battery.

Testing was carried out using a representative 120 Vac / 60 Hz to 12 Vdc external power supply.

Host Transceiver

Testing was carried out when the module was installed in an ELPRO 905U-D Serial Modem Transmitter which has serial number Sn# 04151900001.

Antennas

Testing was carried out using the following antennas which have the highest gain of the antennas that would typically be supplied with this device

- YU16-900 15 dBi Yagi antenna using a 20 metre length of CC20-SMA coax
- SG900-6 8 dBi Colinear antenna using 10 metre length of CC10-SMA coax

Intended Use

The client has declared that this device will typically be used in Class A Commercial, Industrial or Business environments.

6. TEST RESULTS

Standard

The sample was tested in accordance with 47 CFR Part 15 Subpart C and in particular section 15.247

Methods and Procedures

The following measurement methods and procedures have been applied:

- ANSI C63.4 – 2003
- FCC Public Notice DA 00-0705

Section 15.201: Equipment authorisation requirement

Certification as detailed in Subpart J of Part 2 is required for this device.

Section 15.203: Antenna requirement

This device uses a standard SMA connector, which is not unique, as this equipment will be installed by professional installers..

Result: Complies

Section 15.204: External radio frequency power amplifiers and antenna modifications

The device is not supplied with an external power amplifier and the user manual defines that antennas that can be used with this device.

Result: Complies.

Section 15.205: Restricted bands of operation

The device tested can operate between 902 - 928 MHz

Specifically it transmits on 50 channels between 902.625 - 914.875 MHz and 50 channels between 915.625 - 927.625 MHz using frequency hopping spread spectrum techniques.

Section 15.247 allows this between 902.0 – 928.0 MHz

The requirements of the restricted bands have been noted

Result: Complies.

Section 15.207: Conducted emissions testing

Conducted emissions testing was carried out over the frequency range of 150 kHz to 30 MHz which was carried out at the laboratory's MacKelvie Street premises in a 2.4 m x 2.4 m x 2.4 m screened room

Testing was carried out when device was powered at 120 Vac 60 Hz using at representative AC power supply that supplied 12 Vdc to the device.

Testing was carried out in standby / receiver mode and when it was transmitting continuously.

The device was placed on top of the emissions table, which is 1 m x 1.5 m, 80 cm above the screened room floor which acts as the horizontal ground plane.

In addition the device was positioned 40 cm 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 80 cm from the artificial mains network.

The Class B limits have been applied.

The supplied plot is combined plot showing the worst case quasi peak and average results of both the phase and neutral lines.

Quasi peak and average detectors have been used with resolution bandwidths of 9 kHz.

Measurement uncertainty with a confidence interval of 95% is:

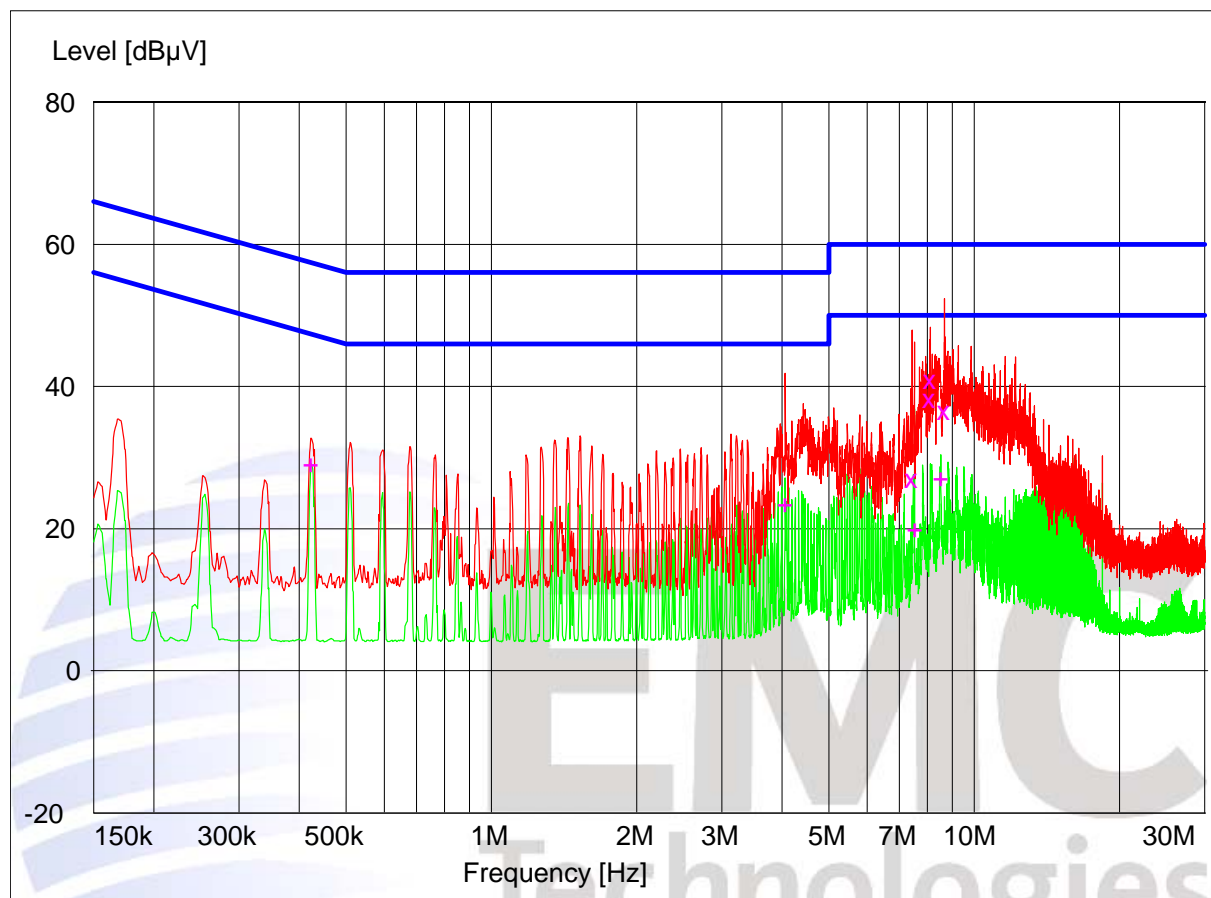
- AC Mains port (0.15 - 30 MHz) \pm 2.8 dB

Result: Complies.

Conducted Emissions – AC Input Power Port

Setup: Device tested in standby / receive mode when powered using a representative AC power supply that was powered at 120 Vac 60 Hz.

Peak --- Average -- Quasi Peak X Average +



Final Quasi-Peak Measurements

Frequency (MHz)	Level (dBµV)	Limit (dBµV)	Margin (dB)	Phase	Rechecks (dBµV)
7.440500	27.00	60.0	33.0	L1	
8.097500	38.30	60.0	21.7	L1	
8.106500	41.00	60.0	19.0	L1	
8.669000	36.60	60.0	23.4	N	

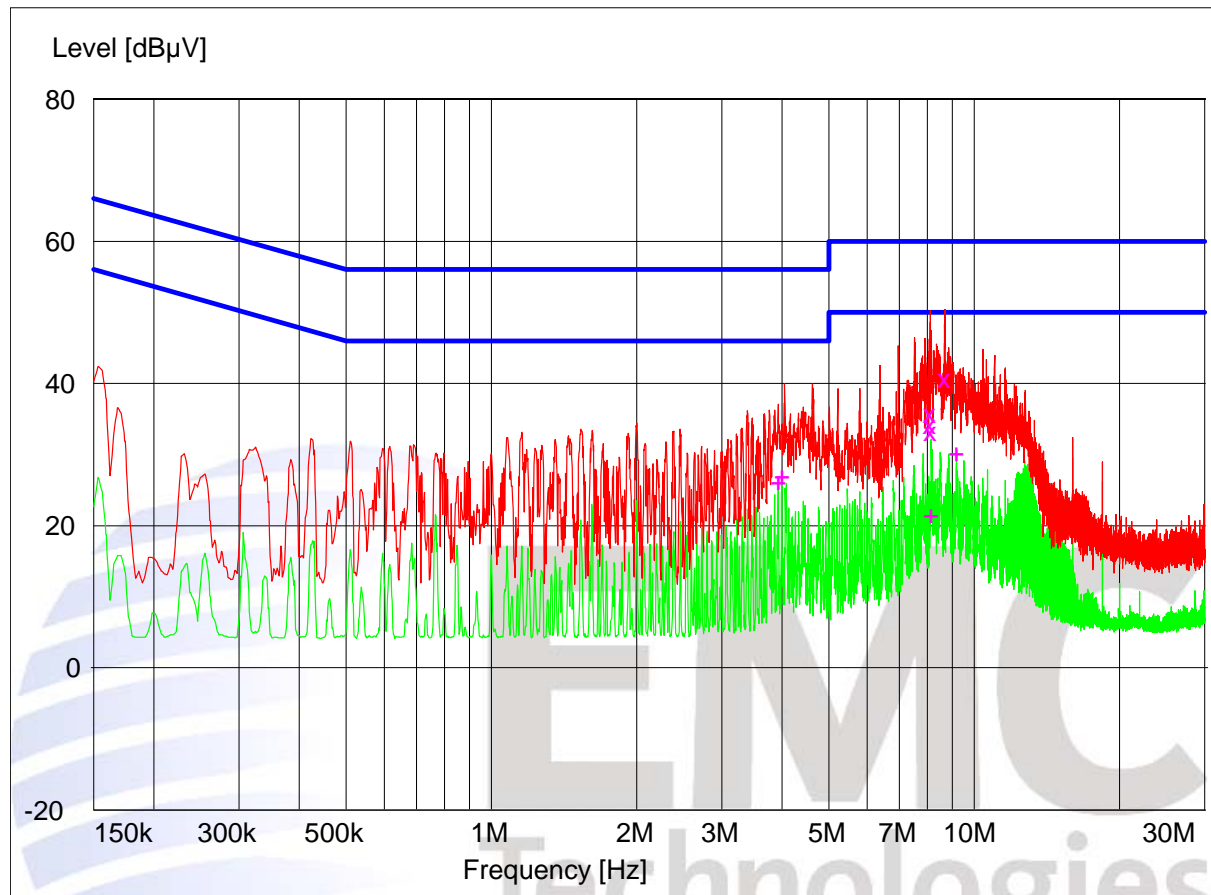
Final Average Measurements

Frequency (MHz)	Level (dBµV)	Limit (dBµV)	Margin (dB)	Phase	Rechecks (dBµV)
0.423000	29.20	47.4	18.2	N	
4.056500	23.60	46.0	22.4	N	
7.517000	20.00	50.0	30.0	N	
8.516000	27.20	50.0	22.8	N	

Conducted Emissions – AC Input Power Port

Setup: Device tested transmitting continuously in frequency hopping mode when powered using a representative AC power supply that was powered at 120 Vac 60 Hz.

Peak --- Average -- Quasi Peak X Average +



Final Quasi-Peak Measurements

Frequency (MHz)	Level (dBµV)	Limit (dBµV)	Margin (dB)	Phase	Rechecks (dBµV)
8.102000	34.20	60.0	25.8	L1	
8.115500	35.80	60.0	24.2	L1	
8.129000	33.20	60.0	26.8	L1	
8.691500	40.70	60.0	19.3	L1	

Final Average Measurements

Frequency (MHz)	Level (dBµV)	Limit (dBµV)	Margin (dB)	Phase	Rechecks (dBµV)
3.926000	26.20	46.0	19.8	L1	
3.993500	27.00	46.0	19.0	N	
8.142500	21.60	50.0	28.4	L1	
9.182000	30.30	50.0	19.7	L1	

Section 15.209: Radiated emission limits, general requirements below 30 MHz

As this device contains digital devices that are likely to operate using frequencies below 30 MHz (8 MHz), low frequency radiated emission measurements were attempted between 10 kHz – 30 MHz at the open area test site over a distance of 10 metres using a loop antenna the centre of which was 1 metre above the ground.

Details of the general test set up are provided in the photograph section of this report.

The device was powered using representative AC power supply that was powered at 120 Vac 60 Hz.

Attached to the device was a ANTYU16-900 15 dBi Yagi antenna and a laptop computer that was attached to the serial port using a 1 metre length of data cable.

The device tested while it was frequency hopping continuously between 902 - 915 MHz.

The general limits described in 15.209 have been applied with the 300 metre and 30 metre limits being extrapolated by a factor of 40 dB per decade as allowed for in section 15.31(d)(2).

Between 100 – 490 kHz an Average detector and a Peak detector were used.

Where a peak detector was used the limit was increased by +20 dB.

Between 490 kHz and 30 MHz a Quasi Peak detector was used.

No emissions were detected from this device over the range of 10 kHz – 30 MHz.

Result: Complies.

Measurement uncertainty with a confidence interval of 95% is:

- Free radiation tests (9 kHz – 30 MHz) ± 4.8 dB

Section 15.209: Radiated emission limits, general requirements above 30 MHz

Testing for general emissions was carried out at EMC Technologies NZ Ltd Open Area Test Site, which is located at Driving Creek, Orere Point, Auckland.

The limits as per section 15.209 have been applied to emissions coming from the device that were not directly associated with the transmitter.

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

All emissions were measured in both vertical and horizontal antenna polarisations.

As the device has a highest operating frequency of 927.625 MHz measurements were attempted between 30 MHz - 10 GHz.

Measurements below 1000 MHz were made using a 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 and also a peak detector with a bandwidth of 1.0 MHz.

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

Level (dB μ V/m) = Receiver Reading (dB μ V) + Antenna Factor (dB/m) + Coax Loss (dB) – Amplifier Gain (dB)

Result: Complies.

Measurement uncertainty: ± 4.1 dB.

Radiated emissions 30 MHz – 10 GHz

The device was placed in the centre of the test table, standing upright, at a height of 80 cm

The device was powered using representative AC power supply that was powered at 120 Vac 60 Hz.

Attached to the device was a ANTYU16-900 15 dBi Yagi antenna and a laptop computer that was attached to the serial port using a 1 metre length of data cable.

The device tested while it was frequency hopping continuously between 902 - 915 MHz.

Frequency (MHz)	Vertical (dB μ V/m)	Horizontal (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Antenna	Detector
63.226	25.2		40.0	14.8	Vertical	QP
126.473	33.5		43.5	10.0	Vertical	QP
184.535		26.9	46.0	19.1	Horizontal	QP
366.472	31.1		46.0	14.9	Vertical	QP
384.000	31.5		46.0	14.5	Vertical	QP
432.000	29.5		46.0	16.5	Vertical	QP
498.713	32.8		46.0	13.2	Vertical	QP
499.725		27.8	40.0	12.2	Horizontal	QP
564.132	33.1		40.0	6.9	Vertical	QP

All further general emissions observed from the system tested had a margin to the limit that exceeded 15 dB when measurements were attempted up to 10 GHz using either horizontal or vertical polarisations.

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

The results are summarised as follows:

Parameter	Limit	Observation	Result
Number of channels	Minimum of 50 channels	50 channels observed in each band of operation.	Pass
20 dB bandwidth	Less than the channel spacing	A worst case bandwidth of 232.5 kHz was measured	Pass
Hop interval	Greater than 20 dB bandwidth	250 kHz was measured.	Pass
Dwell time	Not to exceed 400 ms in any 20 second period	234.5 ms was measured	Pass

Result: Complies.

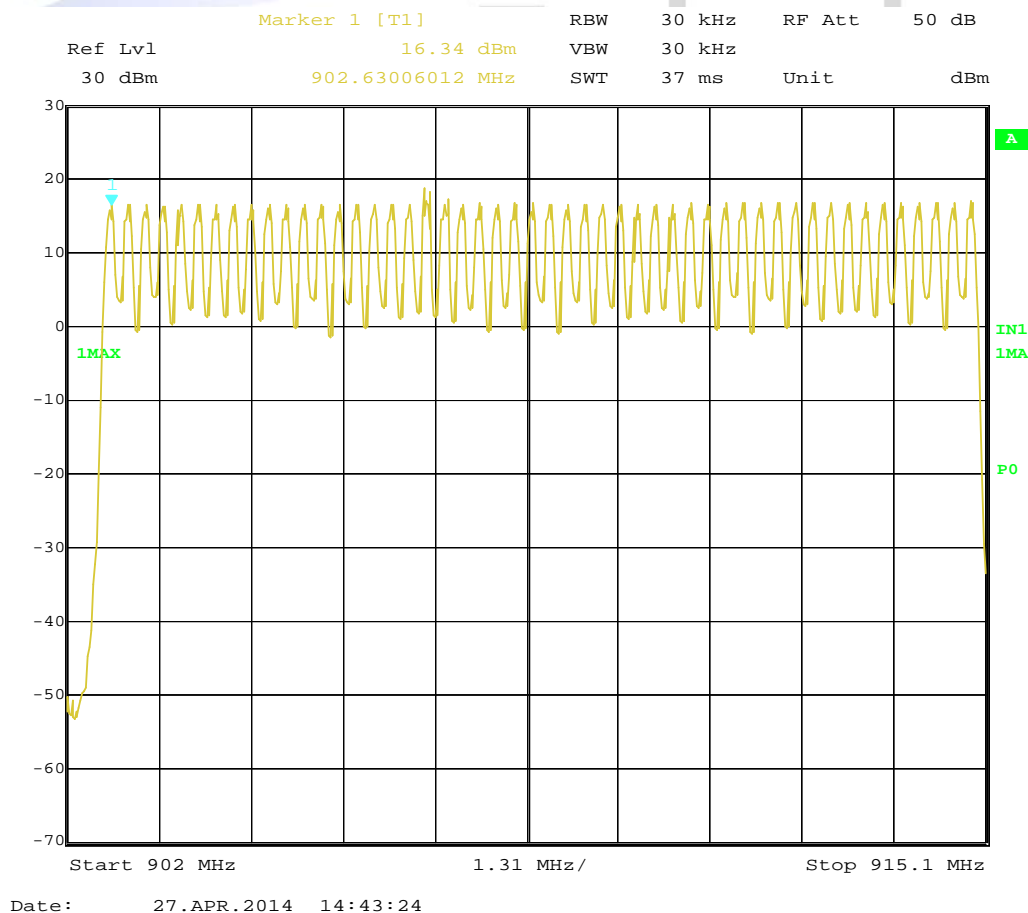
This device operates using Frequency Hopping Spread Spectrum techniques in the 902 - 928 MHz band with two bands of operation between 902 - 915 MHz and 915 MHz to 928 MHz.

50 channels were observed in operation in each band as can be seen below.

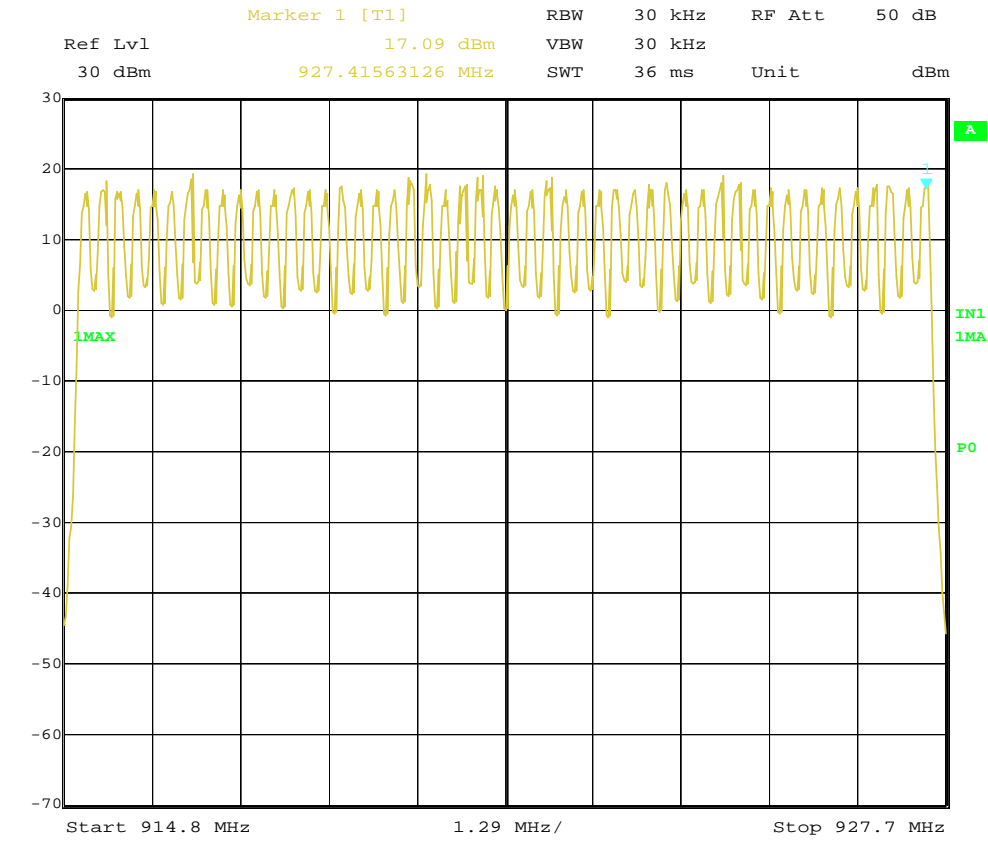
$$914.875 - 902.625 \text{ MHz} / 250 \text{ kHz} = 49 + 1 = 50$$

$$927.375 - 915.125 \text{ MHz} / 250 \text{ kHz} = 49 + 1 = 50$$

50 channels can be seen to be in operation between 902 - 915 MHz

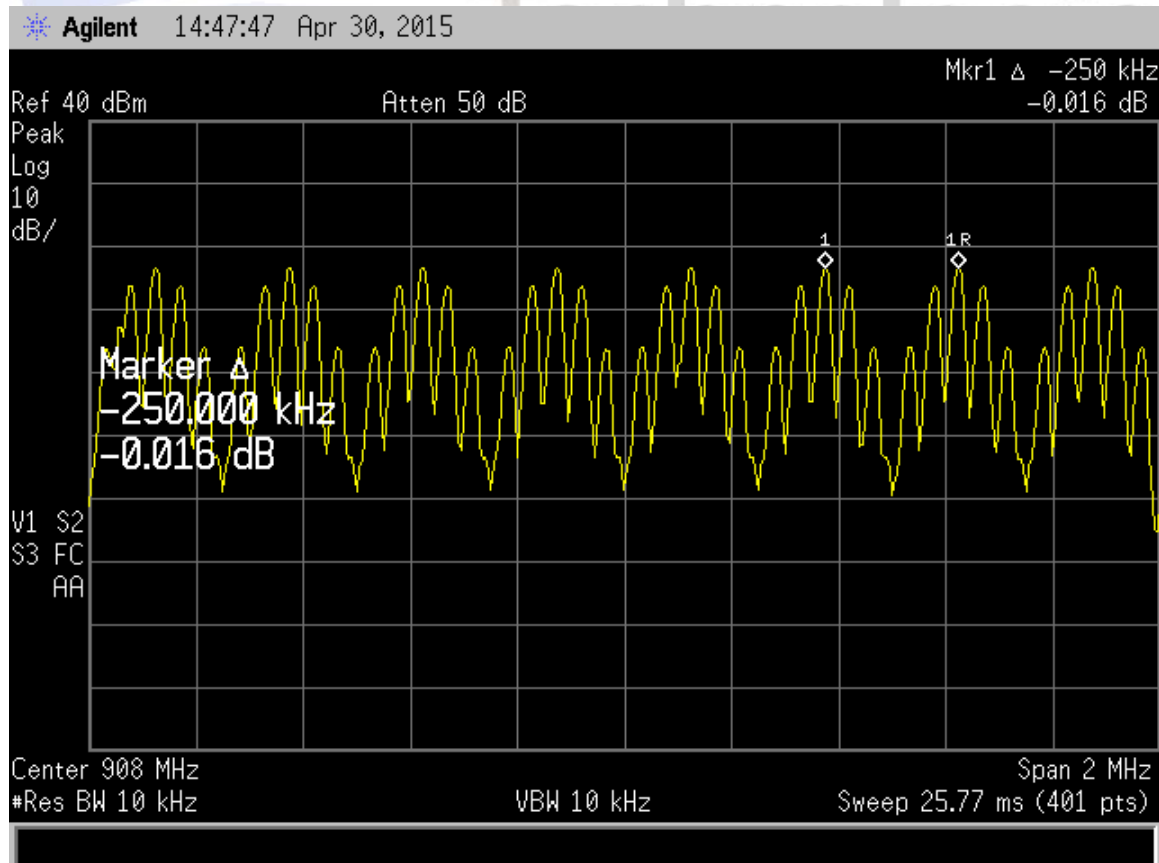


50 channels can be seen to be in operation between 915 - 928 MHz

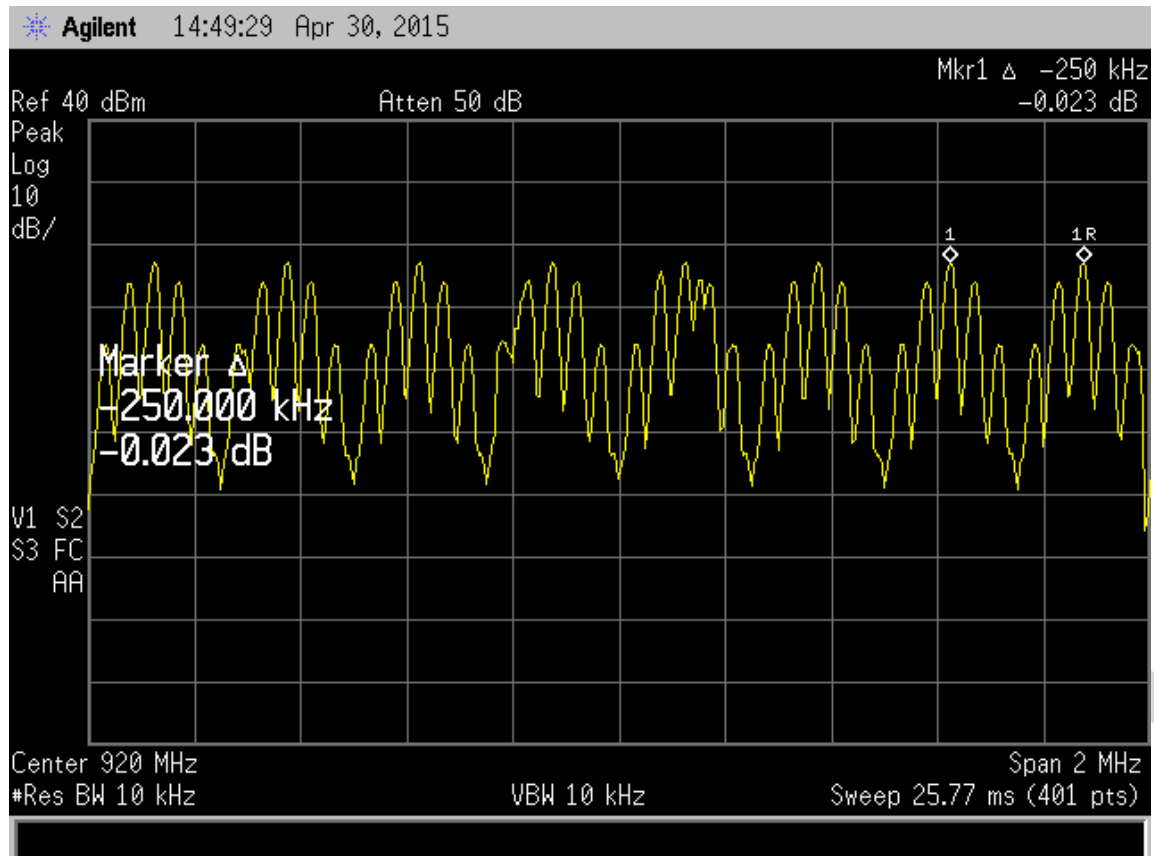


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A channel spacing of 250 kHz was observed to be in operation in the 902 - 915 MHz band

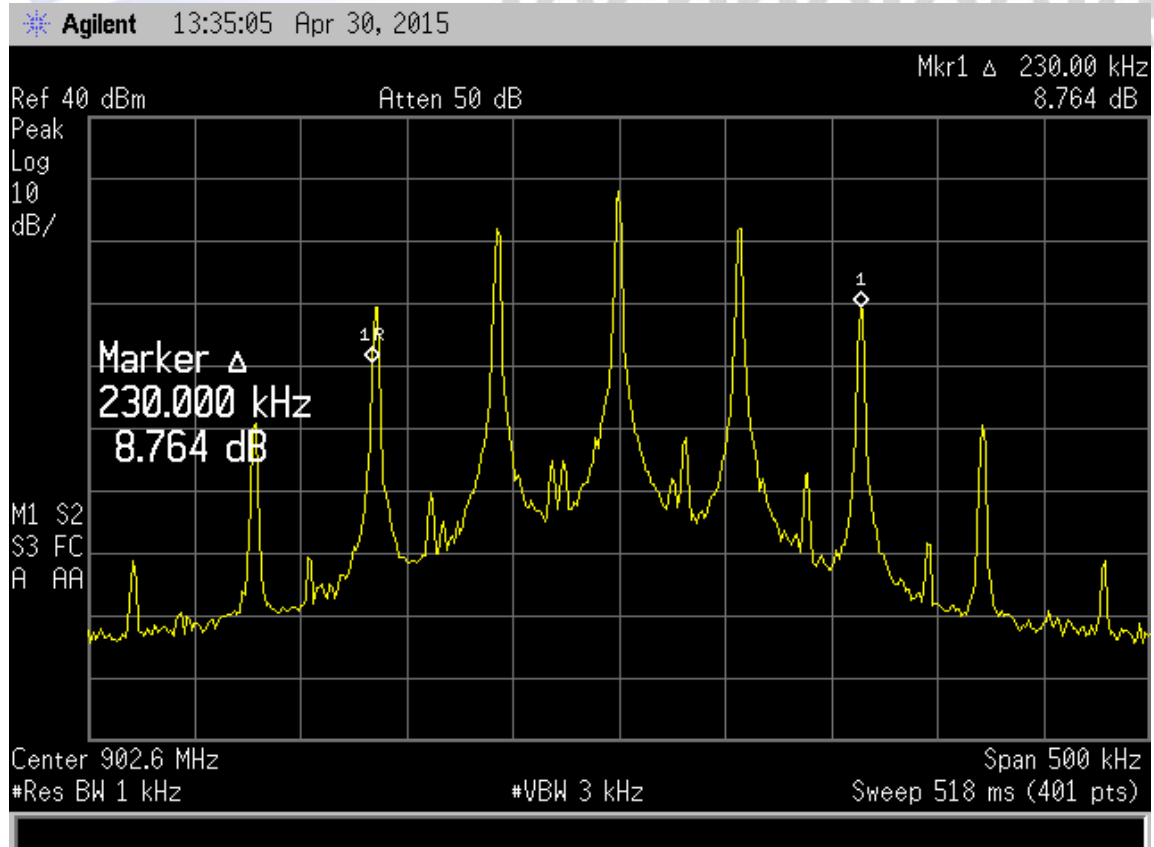


A channel spacing of 250 kHz was observed to be in operation in the 915 - 928 MHz band

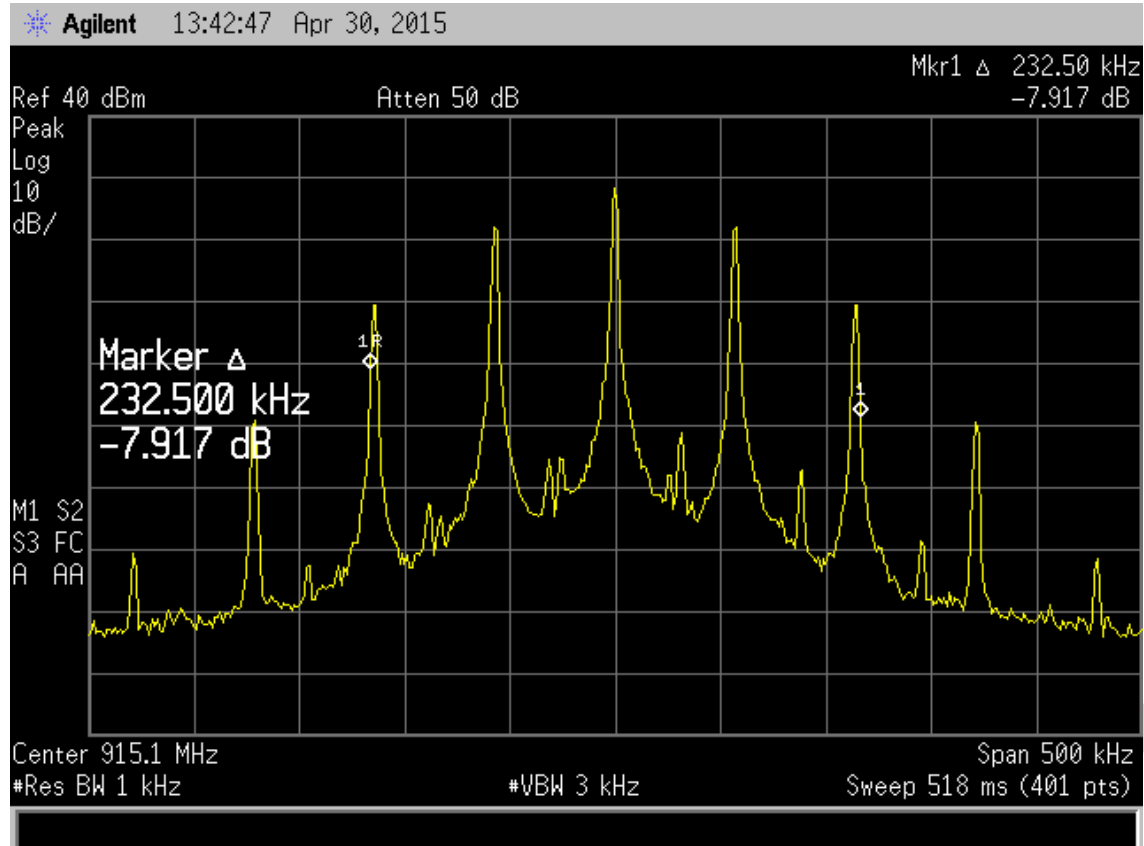


The -20 dB bandwidth has been determined below.

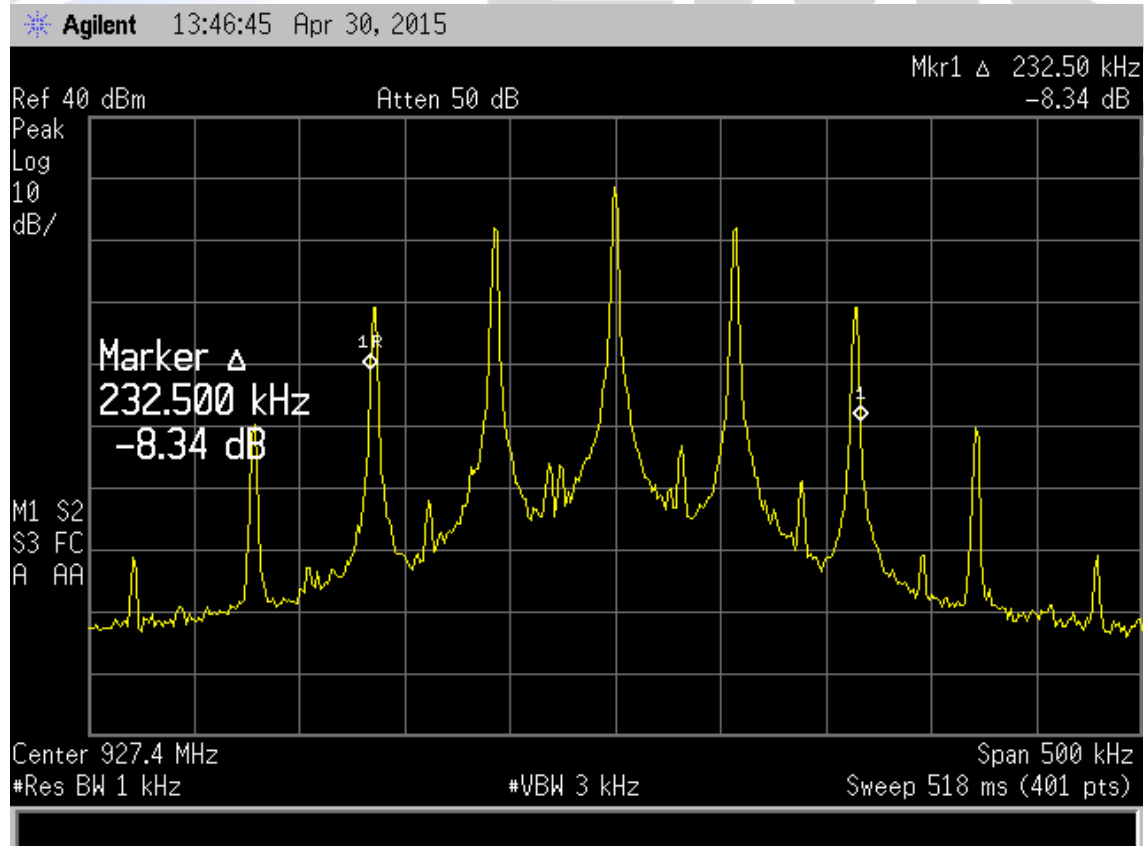
902.626 MHz



915.125 MHz

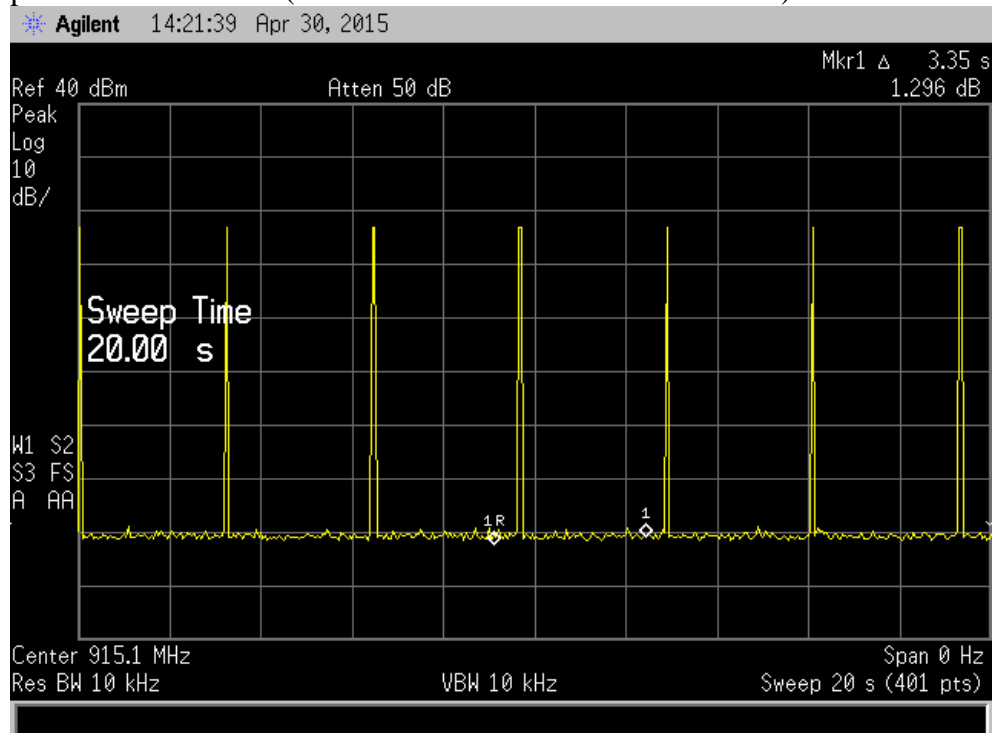


927.375 MHz

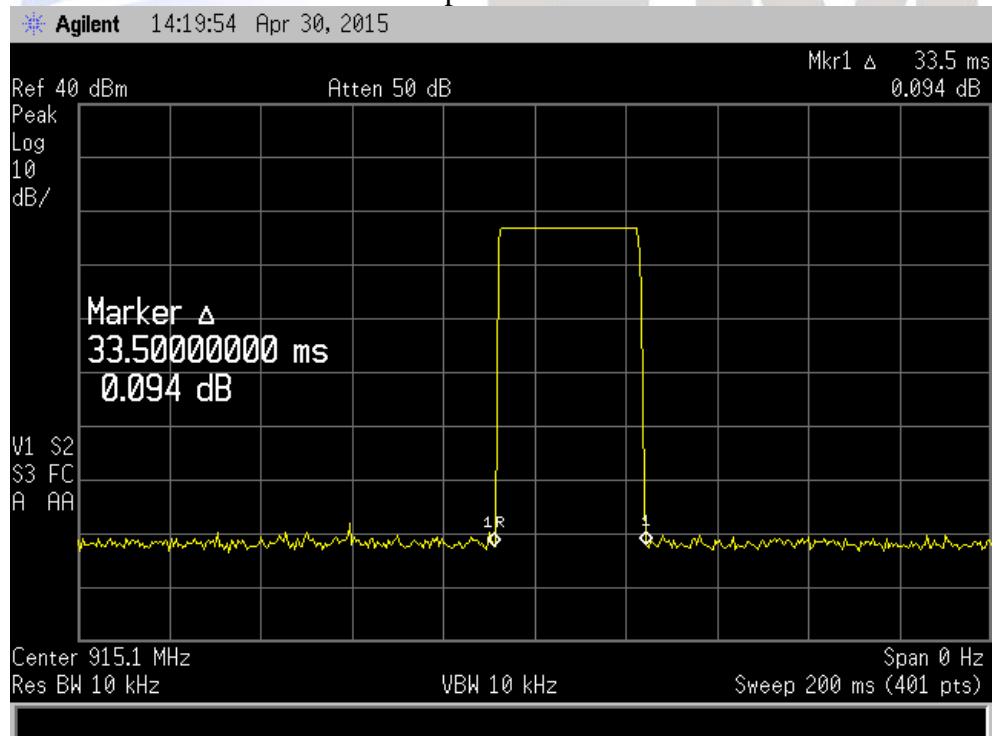


A worst case 20 dB bandwidth of 232.5 kHz was measured which is less than the step size of 250 kHz.

When operating continuously the device was observed to operate on average 7 times in a period of 20 seconds (20 dB bandwidth is less than 250 kHz)



The transmitter was observed to operate for 33.5 ms each time it transmitted



Therefore the dwell time will be $7 \times 33.5 \text{ ms} = 234.5 \text{ ms}$

In any 20 second period the transmitter dwell time cannot exceed 400 ms

Result: Complies.

Section 15.247(b) (1) + (2) – Peak output power

Conducted Power

Conducted power measurements were made on the low, mid and high frequency using a spectrum analyser with a 1 MHz resolution bandwidth that was connected to the antenna port

The following levels were recorded.

Frequency (MHz)	Level (dBm)	Limit (dBm)
902.625	29.7	30.0
915.125	29.8	30.0
927.375	30.0	30.0

A conducted power limit of 1 watt (+30 dBm) is specified for this device

Radiated Power

Radiated power measurements were made at the test site

The Yagi antenna has a gain of 15 dBi and the 20 metre length of coax has an attenuation factor of 6.6 dB which gives a total gain of approximately 8.4 dBi

The Collinear antenna has a gain of 8 dBi and the 10 metre length of coax has an attenuation factor of 3.2 dB which gives a total gain of approximately 4.8 dBi

Testing was carried out when the collinear antenna placed vertically upright and when the yagi antenna was vertically polarised at a height of approximately 50 cm above the test table which is 80 cm above the test site ground plane.

Measurements were made in both vertical and horizontal polarisations with the worst field strength level being recorded at each frequency.

The radiated power level in dBm was determined by formula from the field strength using the formula $\text{Field strength (V/m)} = (\text{square root of } (30 \times \text{transmitter power (watts)})) / \text{distance (metres)}$.

Measurements have been shown for vertical polarisation as this is the polarisation that gave the highest level for both antenna types

The antenna gain is the difference between the measured output power and the calculated radiated power.

Collinear antenna

Frequency (MHz)	Field Strength (dB μ V/m)	Calculated Radiated Power (dBm)	Measured Conducted Power (dBm)	Measured Antenna Gain (dBi)	Calculated Antenna Gain (dBi)	Antenna Polarisation
902.625	126.8	31.6	29.7	1.9	4.8	Vertical
915.125	127.7	32.5	29.8	2.7	4.8	Vertical
927.375	125.5	30.3	30.0	0.3	4.8	Vertical

There is a 2.1 dB difference between the measured antenna gain and the theoretical antenna gain.

A conducted limit of 1.0 watt (+30 dBm) has been applied.

The measured gain approximates the calculated gain and both the measured and calculated gains are less than 6 dBi when the Collinear antenna is used.

Yagi antenna

Frequency (MHz)	Field Strength (dB μ V/m)	Calculated Radiated Power (dBm)	Measured Conducted Power (dBm)	Measured Antenna Gain (dBi)	Calculated Antenna Gain (dBi)	Antenna Polarisation
902.625	130.5	35.3	29.7	5.6	8.4	Vertical
915.125	131.2	36.0	29.8	6.2	8.4	Vertical
927.375	128.7	33.5	30.0	3.5	8.4	Vertical

There is a 2.2 dB difference between the measured antenna gain and the theoretical antenna gain.

A conducted limit of 1.0 watt (+30 dBm) has been applied.

The measured gain approximates the calculated gain with both gains being greater than 6 dBi.

The calculated gain is greater than 6 dBi

The highest measured antenna gain is greater 6 dBi however at this frequency the measured power is less than 30 dBm so the total radiated power does not exceed +36 dBm.

Result: Complies.

Measurement Uncertainty: ± 4.1 dB

Section 15.247 (d) – Out of band emissions

Band edge measurements:

At the band edges of 902 and 928 MHz all emissions are required to be attenuated by more than 20 dB relative to the highest 100 kHz resolution bandwidth emission level observed in the band of operation.

Measurements were at the antenna port showing that the -20 dBc points remain within the 902 to 928 MHz band.

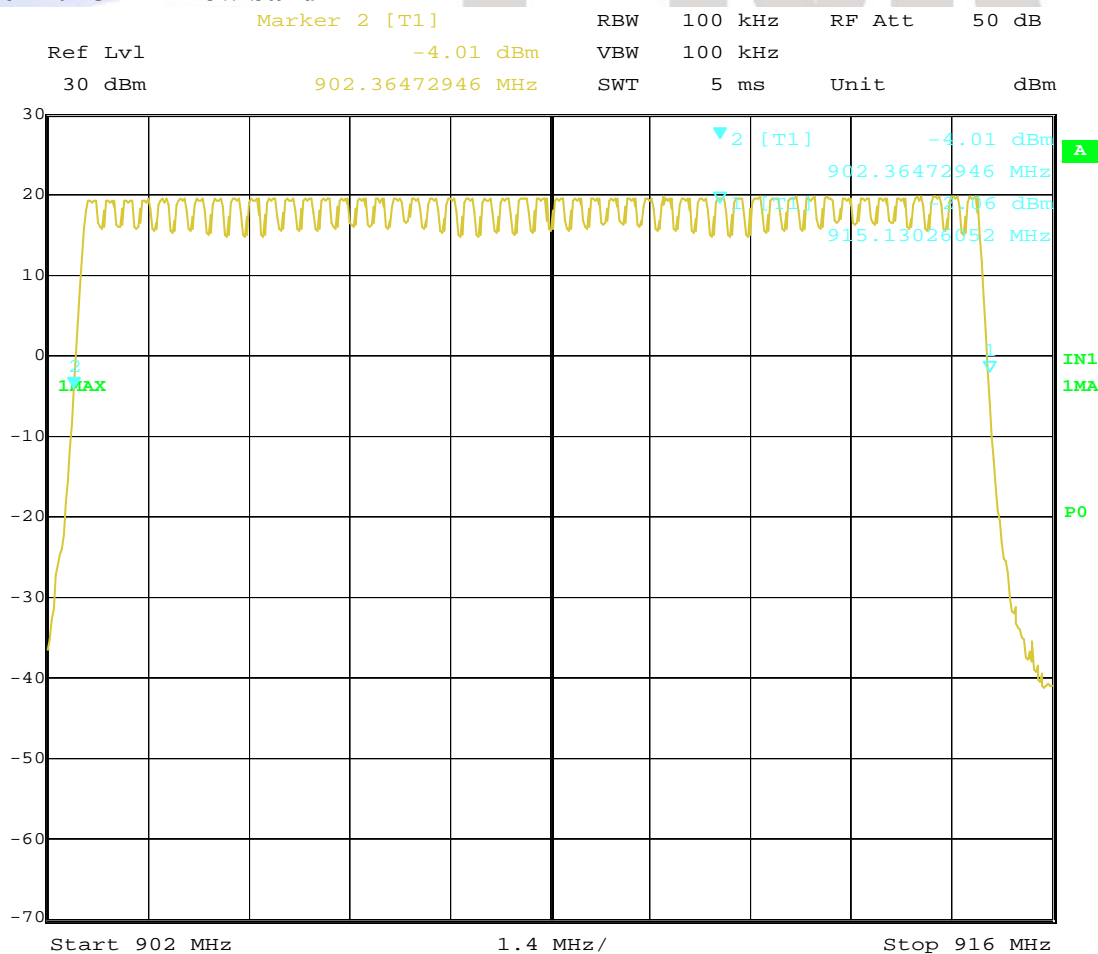
Measurements were made when the device was operating in hopping and not hopping modes.

Investigations were made using the various data rates that the device can operate with, with final measurements being made when operating at 115200 bps which gave the worst case.

Hopping mode:

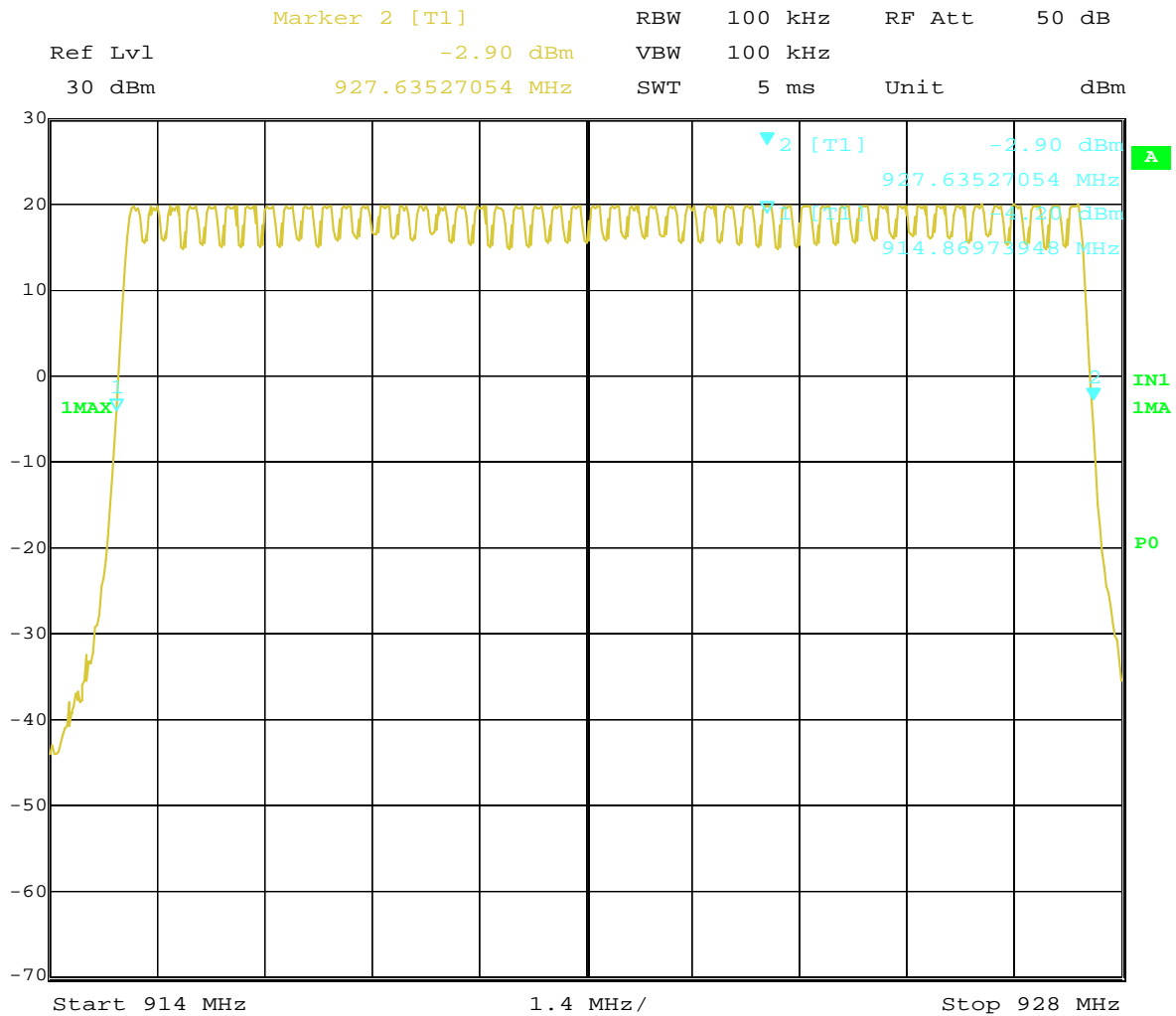
Band (MHz)	-20 dBc (MHz)	Limit (MHz)
902 - 915	902.3647	> 902.000
915 - 928	927.6353	< 928.000

902 - 915 MHz low band



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915 - 928 MHz high band



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Measurements were also made when the device was made to transmit continuously on 902.625 MHz and 927.375 MHz.

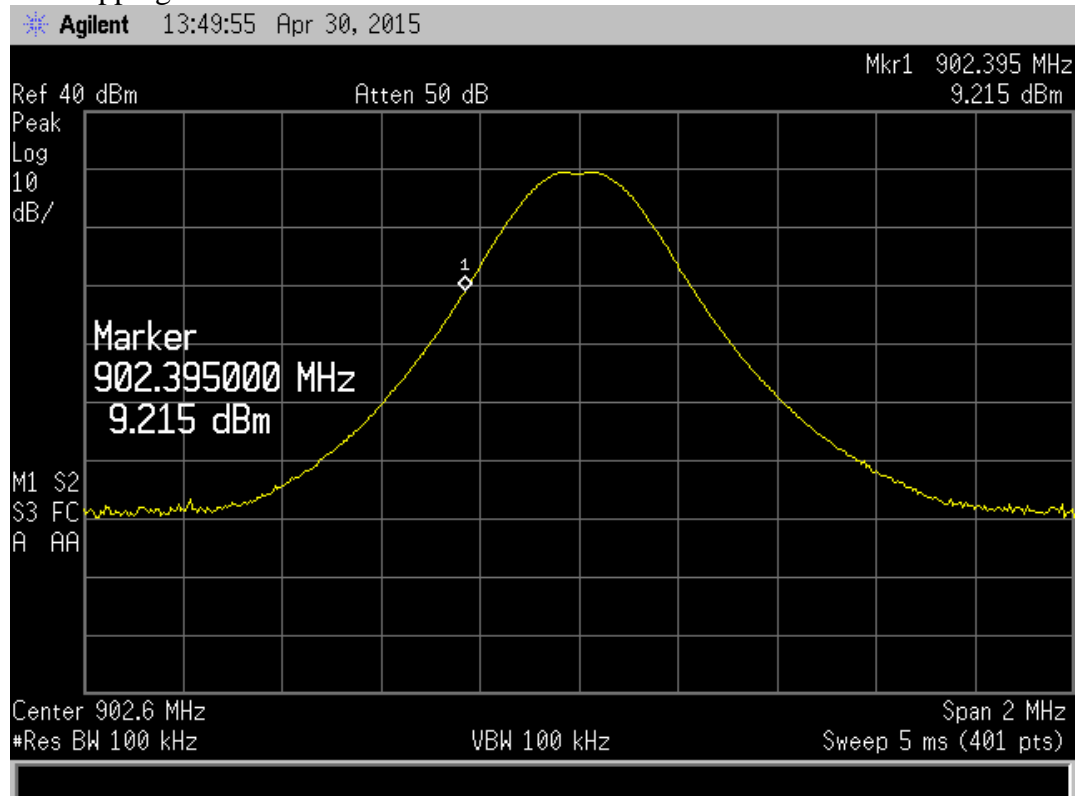
Measurements were made using a resolution bandwidth of 100 kHz with the -20 dB point being located 20 dB down on the emission peak when operating at 115,200 bps.

The rated output power of the transmitter is +30 dBm

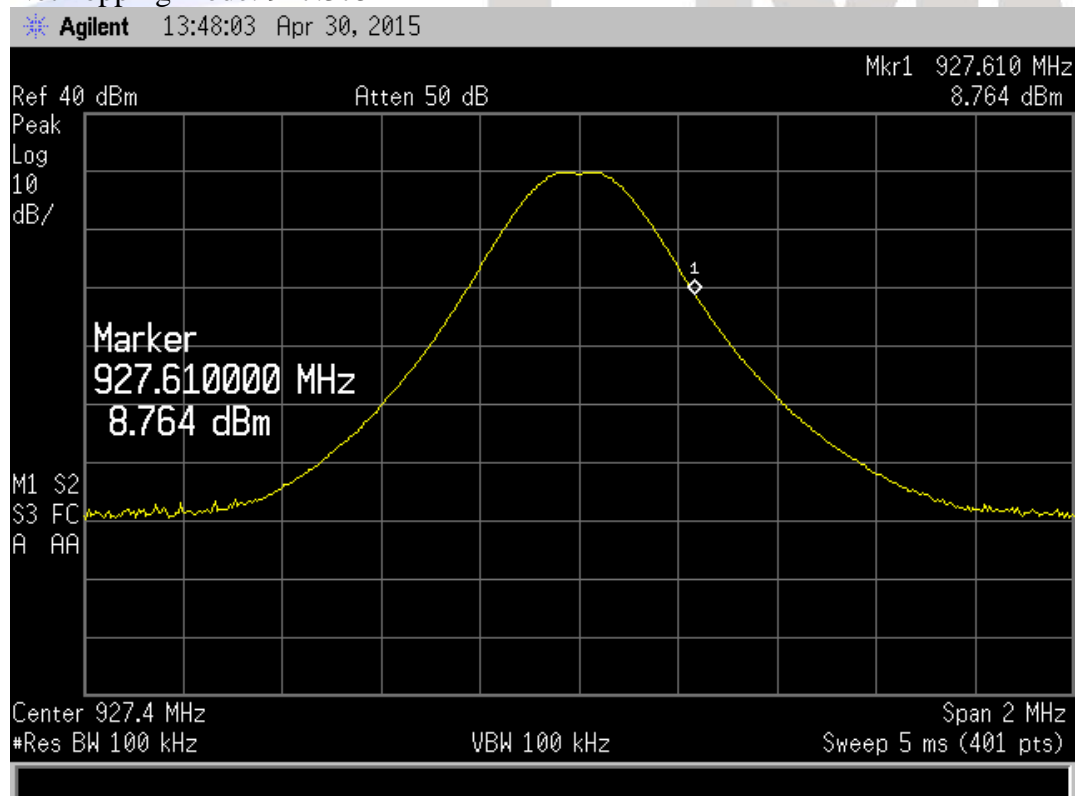
Not hopping mode:

Band Edge (MHz)	-20 dBc (MHz)	Limit (MHz)
902.000	902.3950	> 902.000
928.000	927.6100	< 928.000

Not hopping mode: 902.625 MHz



Not hopping mode: 927.375 MHz



Result: Complies.

Conducted Spurious emissions at the antenna terminal

Testing for conducted spurious emissions was carried out at the antenna port of the transmitter.

The transmitter was made to transmit continuously on a low, middle and high frequency over the operating band of 902 - 928 MHz with modulation applied.

As the device operates in the 900 MHz band measurements were attempted between 1 MHz and up to 10Fc on each transmit frequency.

Measurements were made using a spectrum analyser with a resolution bandwidth of 100 kHz.

A limit of -20 dBc with reference to the highest emission observed in the operating band when measured using a bandwidth of 100 kHz has been applied.

The highest emission level observed in the 902 - 928 MHz band was +30.0 dBm

A limit of +10 dBm has therefore been applied

Frequency (MHz)	Level (dBm)	Frequency (MHz)	Level (dBm)	Frequency (MHz)	Level (dBm)	Limit (dBm)
902.6250	+29.7	915.1250	+29.8	927.3750	+30.0	+30.0
1805.2500	< -40.0	1830.2500	< -40.0	1854.7500	< -40.0	+10.0
2707.8750	< -45.0	2745.3750	< -45.0	2782.1250	< -45.0	+10.0
3610.5000	< -70.0	3660.5000	< -70.0	3709.5000	< -70.0	+10.0
4513.1250	< -70.0	4575.6250	< -70.0	4636.8750	< -70.0	+10.0
5415.7500	-60.0	5490.7500	-57.1	5564.2500	-54.9	+10.0
6318.3750	-50.6	6405.8750	-44.0	6491.6250	-43.5	+10.0
7221.0000	-58.9	7321.0000	-59.9	7419.0000	-55.6	+10.0
8123.6250	< -70.0	8236.1250	< -70.0	8346.3750	< -70.0	+10.0
9026.2500	< -70.0	9151.2500	< -70.0	9273.7500	< -70.0	+10.0

No other spurious emissions were detected at the antenna terminal except for the harmonic emissions recorded above.

Result: Complies.

Measurement uncertainty: ± 2.1 dB.

Spurious emissions and restricted band radiated emission measurements

Testing was carried out at EMC Technologies NZ Ltd Open Area Test Site, which is located at Driving Creek, Orere Point, Auckland.

Radiated emission measurements were carried out with the limits as per section 15.209 applied to all emissions observed and not just the emissions that fell within the restricted bands except for 2Fc where a limit of -20 dBc was applied.

Testing was carried out on a low, middle and high frequency in the 902 - 928 MHz range up to 10 Fc on each transmit frequency.

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

Attached to the transmitter was a Collinear antenna and also a Yagi antenna.

Test was carried out in transmit and also receive modes of operation.

All emissions were measured in both vertical and horizontal antenna polarisations.

Measurements below 1000 MHz were made using a 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 and also a peak detector with a bandwidth of 1.0 MHz.

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

Level (dB μ V/m) = Receiver Reading (dB μ V) + Antenna Factor (dB/m) + Coax Loss (dB) – Amplifier Gain (dB)

Result: Complies.

Measurement uncertainty: ± 4.1 dB.

Collinear antenna. Transmitting on 902.625 MHz

Frequency (MHz)	Vertical (dBuV/m)	Horizontal (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna	Detector
1805.2500	48.4		107.7	62.8	Vertical	Peak
1805.2500		45.4	92.5	50.1	Horizontal	Peak
2707.8750	< 51.4	< 51.4	74.0	> 22.6	Vert/Hort	Peak
2707.8750	< 39.3	< 39.3	54.0	> 14.7	Vert/Hort	Average
3610.5000	< 44.0	< 44.0	74.0	> 30.0	Vert/Hort	Peak
3610.5000	< 31.0	< 31.0	54.0	> 23.0	Vert/Hort	Average
4513.1250	< 48.0	< 48.0	74.0	> 26.0	Vert/Hort	Peak
4513.1250	< 35.0	< 35.0	54.0	> 19.0	Vert/Hort	Average
5415.7500	< 51.0	< 51.0	74.0	> 23.0	Vert/Hort	Peak
5415.7500	< 38.0	< 38.0	54.0	> 16.0	Vert/Hort	Average
6318.3750	< 56.0	< 56.0	74.0	> 18.0	Vert/Hort	Peak
6318.3750	< 42.0	< 42.0	54.0	> 12.0	Vert/Hort	Average
7221.0000	< 49.0	< 49.0	74.0	> 25.0	Vert/Hort	Peak
7221.0000	< 36.0	< 36.0	54.0	> 18.0	Vert/Hort	Average
8123.6250	< 51.0	< 51.0	74.0	> 23.0	Vert/Hort	Peak
8123.6250	< 39.0	< 39.0	54.0	> 15.0	Vert/Hort	Average
9026.2500	< 52.0	< 52.0	74.0	> 22.0	Vert/Hort	Peak
9026.2500	< 39.0	< 39.0	54.0	> 15.0	Vert/Hort	Average

The general emission limit has been applied to all frequencies except at 2Fc.

Collinear antenna. Transmitting continuously on 915.125 MHz

Frequency (MHz)	Vertical (dBuV/m)	Horizontal (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna	Detector
1830.2500	48.4		107.7	59.3	Vertical	Peak
1830.2500		45.4	92.5	47.1	Horizontal	Peak
2745.3750	< 51.4	< 51.4	74.0	> 22.6	Vert/Hort	Peak
2745.3750	< 39.3	< 39.3	54.0	> 14.7	Vert/Hort	Average
3660.5000	< 44.0	< 44.0	74.0	> 30.0	Vert/Hort	Peak
3660.5000	< 31.0	< 31.0	54.0	> 23.0	Vert/Hort	Average
4575.6250	< 48.0	< 48.0	74.0	> 26.0	Vert/Hort	Peak
4575.6250	< 35.0	< 35.0	54.0	> 19.0	Vert/Hort	Average
5490.7500	< 51.0	< 51.0	74.0	> 23.0	Vert/Hort	Peak
5490.7500	< 38.0	< 38.0	54.0	> 16.0	Vert/Hort	Average
6405.8750	< 56.0	< 56.0	74.0	> 18.0	Vert/Hort	Peak
6405.8750	< 42.0	< 42.0	54.0	> 12.0	Vert/Hort	Average
7321.0000	< 49.0	< 49.0	74.0	> 25.0	Vert/Hort	Peak
7321.0000	< 36.0	< 36.0	54.0	> 18.0	Vert/Hort	Average
8236.1250	< 51.0	< 51.0	74.0	> 23.0	Vert/Hort	Peak
8236.1250	< 39.0	< 39.0	54.0	> 15.0	Vert/Hort	Average
9151.2500	< 52.0	< 52.0	74.0	> 22.0	Vert/Hort	Peak
9151.2500	< 39.0	< 39.0	54.0	> 15.0	Vert/Hort	Average

The general emission limit has been applied to all frequencies except at 2F_c.

Collinear antenna. Transmitting continuously on 927.375 MHz

Frequency (MHz)	Vertical (dBuV/m)	Horizontal (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna	Detector
1854.7500	48.4		107.7	62.8	Vertical	Peak
1854.7500		45.4	92.5	50.1	Horizontal	Peak
2782.1250	< 51.4	< 51.4	74.0	> 22.6	Vert/Hort	Peak
2782.1250	< 39.3	< 39.3	54.0	> 14.7	Vert/Hort	Average
3709.5000	< 44.0	< 44.0	74.0	> 30.0	Vert/Hort	Peak
3709.5000	< 31.0	< 31.0	54.0	> 23.0	Vert/Hort	Average
4636.8750	< 48.0	< 48.0	74.0	> 26.0	Vert/Hort	Peak
4636.8750	< 35.0	< 35.0	54.0	> 19.0	Vert/Hort	Average
5564.2500	< 51.0	< 51.0	74.0	> 23.0	Vert/Hort	Peak
5564.2500	< 38.0	< 38.0	54.0	> 16.0	Vert/Hort	Average
6491.6250	< 56.0	< 56.0	74.0	> 18.0	Vert/Hort	Peak
6491.6250	< 42.0	< 42.0	54.0	> 12.0	Vert/Hort	Average
7419.0000	< 49.0	< 49.0	74.0	> 25.0	Vert/Hort	Peak
7419.0000	< 36.0	< 36.0	54.0	> 18.0	Vert/Hort	Average
8346.3750	< 51.0	< 51.0	74.0	> 23.0	Vert/Hort	Peak
8346.3750	< 39.0	< 39.0	54.0	> 15.0	Vert/Hort	Average
9273.7500	< 52.0	< 52.0	74.0	> 22.0	Vert/Hort	Peak
9273.7500	< 39.0	< 39.0	54.0	> 15.0	Vert/Hort	Average

The general emission limit has been applied to all frequencies except at 2Fc.

Yagi antenna. Transmitting on 902.625 MHz

Frequency (MHz)	Vertical (dBuV/m)	Horizontal (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna	Detector
1805.2500	47.9		111.2	63.3	Vertical	Peak
1805.2500		48.5	95.5	47.0	Horizontal	Peak
2707.8750	54.1	51.8	74.0	19.9	Vertical	Peak
2707.8750	45.3	41.5	54.0	8.7	Vertical	Average
3610.5000	< 44.0	< 44.0	74.0	> 30.0	Vert/Hort	Peak
3610.5000	< 31.0	< 31.0	54.0	> 23.0	Vert/Hort	Average
4513.1250	< 48.0	< 48.0	74.0	> 26.0	Vert/Hort	Peak
4513.1250	< 35.0	< 35.0	54.0	> 19.0	Vert/Hort	Average
5415.7500	< 51.0	< 51.0	74.0	> 23.0	Vert/Hort	Peak
5415.7500	< 38.0	< 38.0	54.0	> 16.0	Vert/Hort	Average
6318.3750	< 56.0	< 56.0	74.0	> 18.0	Vert/Hort	Peak
6318.3750	< 42.0	< 42.0	54.0	> 12.0	Vert/Hort	Average
7221.0000	< 49.0	< 49.0	74.0	> 25.0	Vert/Hort	Peak
7221.0000	< 36.0	< 36.0	54.0	> 18.0	Vert/Hort	Average
8123.6250	< 51.0	< 51.0	74.0	> 23.0	Vert/Hort	Peak
8123.6250	< 39.0	< 39.0	54.0	> 15.0	Vert/Hort	Average
9026.2500	< 52.0	< 52.0	74.0	> 22.0	Vert/Hort	Peak
9026.2500	< 39.0	< 39.0	54.0	> 15.0	Vert/Hort	Average

The general emission limit has been applied to all frequencies except at 2Fc.

Yagi antenna. Transmitting continuously on 915.125 MHz

Frequency (MHz)	Vertical (dBuV/m)	Horizontal (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna	Detector
1830.2500	46.4		111.2	64.8	Vertical	Peak
1830.2500		46.1	95.5	49.4	Horizontal	Peak
2745.3750	51.5	51.4	74.0	23.1	Vertical	Peak
2745.3750	40.9	39.3	54.0	13.1	Vertical	Average
3660.5000	< 44.0	< 44.0	74.0	> 30.0	Vert/Hort	Peak
3660.5000	< 31.0	< 31.0	54.0	> 23.0	Vert/Hort	Average
4575.6250	< 48.0	< 48.0	74.0	> 26.0	Vert/Hort	Peak
4575.6250	< 35.0	< 35.0	54.0	> 19.0	Vert/Hort	Average
5490.7500	< 51.0	< 51.0	74.0	> 23.0	Vert/Hort	Peak
5490.7500	< 38.0	< 38.0	54.0	> 16.0	Vert/Hort	Average
6405.8750	< 56.0	< 56.0	74.0	> 18.0	Vert/Hort	Peak
6405.8750	< 42.0	< 42.0	54.0	> 12.0	Vert/Hort	Average
7321.0000	< 49.0	< 49.0	74.0	> 25.0	Vert/Hort	Peak
7321.0000	< 36.0	< 36.0	54.0	> 18.0	Vert/Hort	Average
8236.1250	< 51.0	< 51.0	74.0	> 23.0	Vert/Hort	Peak
8236.1250	< 39.0	< 39.0	54.0	> 15.0	Vert/Hort	Average
9151.2500	< 52.0	< 52.0	74.0	> 22.0	Vert/Hort	Peak
9151.2500	< 39.0	< 39.0	54.0	> 15.0	Vert/Hort	Average

The general emission limit has been applied to all frequencies except at 2Fc.

Yagi antenna. Transmitting continuously on 927.375 MHz

Frequency (MHz)	Vertical (dBuV/m)	Horizontal (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna	Detector
1854.7500	46.5		111.2	64.7	Vertical	Peak
1854.7500		45.4	95.5	50.1	Horizontal	Peak
2782.1250	< 51.4	< 51.4	74.0	> 22.6	Vert/Hort	Peak
2782.1250	< 39.3	< 39.3	54.0	> 14.7	Vert/Hort	Average
3709.5000	< 44.0	< 44.0	74.0	> 30.0	Vert/Hort	Peak
3709.5000	< 31.0	< 31.0	54.0	> 23.0	Vert/Hort	Average
4636.8750	< 48.0	< 48.0	74.0	> 26.0	Vert/Hort	Peak
4636.8750	< 35.0	< 35.0	54.0	> 19.0	Vert/Hort	Average
5564.2500	< 51.0	< 51.0	74.0	> 23.0	Vert/Hort	Peak
5564.2500	< 38.0	< 38.0	54.0	> 16.0	Vert/Hort	Average
6491.6250	< 56.0	< 56.0	74.0	> 18.0	Vert/Hort	Peak
6491.6250	< 42.0	< 42.0	54.0	> 12.0	Vert/Hort	Average
7419.0000	< 49.0	< 49.0	74.0	> 25.0	Vert/Hort	Peak
7419.0000	< 36.0	< 36.0	54.0	> 18.0	Vert/Hort	Average
8346.3750	< 51.0	< 51.0	74.0	> 23.0	Vert/Hort	Peak
8346.3750	< 39.0	< 39.0	54.0	> 15.0	Vert/Hort	Average
9273.7500	< 52.0	< 52.0	74.0	> 22.0	Vert/Hort	Peak
9273.7500	< 39.0	< 39.0	54.0	> 15.0	Vert/Hort	Average

The general emission limit has been applied to all frequencies except at 2Fc.

Section 15.247(i) – Radio Frequency Hazard Information

As per Section 15.247 (i) 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 or greater can normally be maintained between the user and the device antenna.

In accordance with Section 1.1310 a Maximum Permissible Exposure (MPE) limit of 0.601 mW/cm² (902 MHz / 1500) or the General Population / Uncontrolled Exposure has 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:

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

$$\text{Power density, mW/cm}^2 = E^2/3770 = 0.601$$

$$E \text{ for MPE:} = \sqrt{0.601 * 3770}$$

$$E = \underline{47.6 \text{ V/m}}$$

The maximum radiated power measured was +36.0 dBm or 4 Watts

Therefore:

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

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

$$d = \sqrt{30 * 4} / 47.6$$

$$d = \underline{0.23 \text{ m or } 23 \text{ cm}}$$

In order to meet the MPE requirement for mobile devices a minimum safe distance of at least 23 cm will be required when the highest gain antenna is applied to the output of this transmitter.

Result: Complies

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
Loop Antenna	EMCO	6502	9003-2485	3798	4 July 2017	3 years
VHF Balun	Schwarzbeck	VHA9103	-	3603	03/02/2018	3 years
Biconical Antenna	Schwarzbeck	BBA 9106	-	3612	03/02/2018	3 years
Log Periodic Ant	Schwarzbeck	VUSLP 9111	9111-228	3785	17/12/2017	3 years
Horn Antenna	EMCO	3115	9511-4629	E1526	04/06/2017	3 years
SG Horn Antenna	EMCO	3160-04	00224819	-	11/9/2018	3 years
SG Horn Antenna	EMCO	3160-05	00114635	-	11/9/2018	3 years
SG Horn Antenna	EMCO	3160-06	00114821	-	11/9/2018	3 years
SG Horn Antenna	EMCO	3160-07	00144919	-	11/9/2018	3 years
SG Horn Antenna	EMCO	3160-08	00114637	-	11/9/2018	3 years
Receiver	Rohde & Schwarz	ESIB-40	100171	EMC4003	16/04/2016	1 year
Spectrum Analyzer	Hewlett Packard	E7405A	US39150142	RFS 3776	26/06/2015	1 year
Thermal chamber	Contherm	M180F	86025	E1129	01/06/2015	N/a
Thermometer	DSIR	RT200	035	E1049	01/06/2015	N/a
Power Supply	Hewlett Packard	6032A	2743A-02859	E1069	N/a	N/a

At the time of testing all test equipment was within calibration.

8. ACCREDITATIONS

Testing was carried out in accordance with EMC Technologies Ltd registration with the Federal Communications Commission as a listed facility, registration number: 90838, which was updated in June 2014.

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

All measurement equipment has been calibrated in accordance with the terms of the EMC Technologies (NZ) Ltd International Accreditation New Zealand (IANZ) Accreditation to NZS/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 Host Photos







Radiated emissions test set up photos - Collinear Antenna

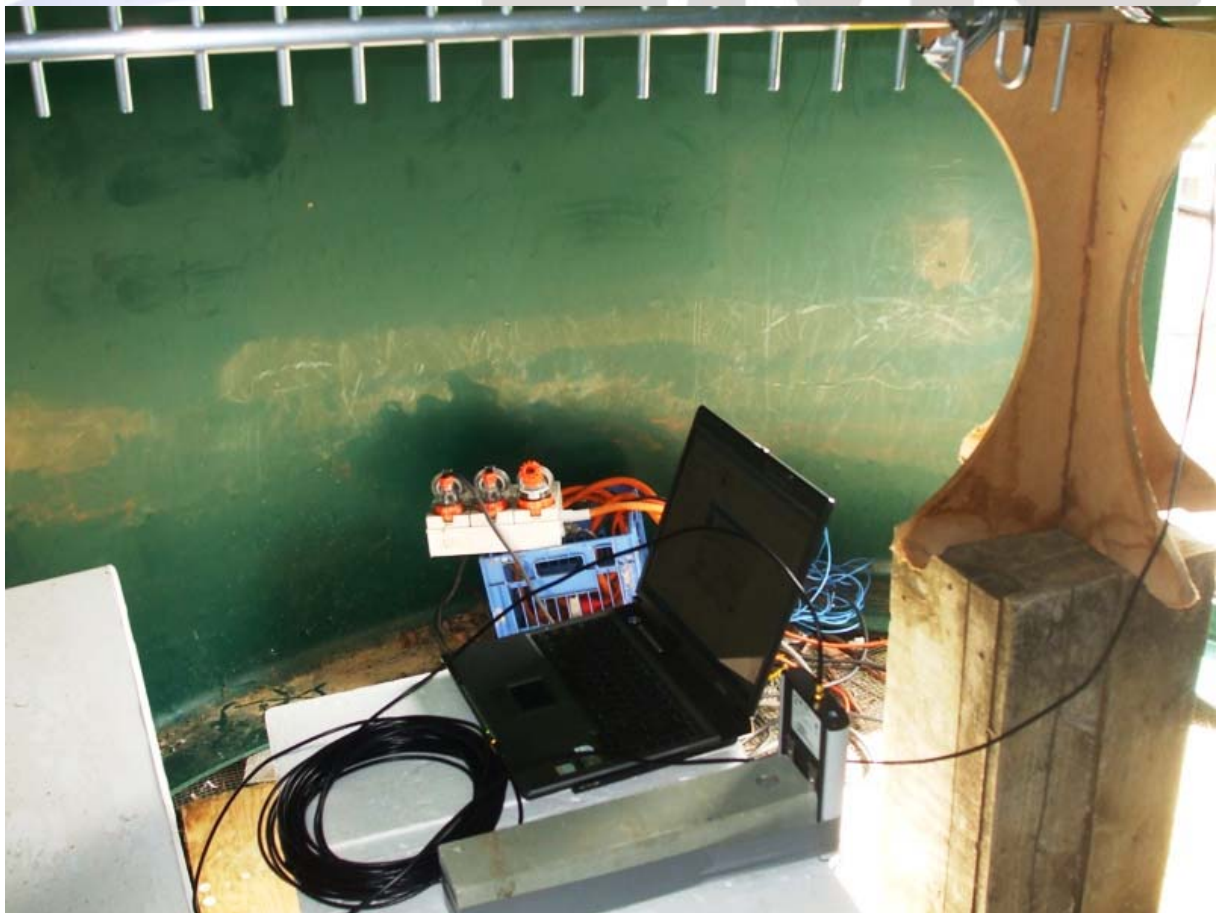
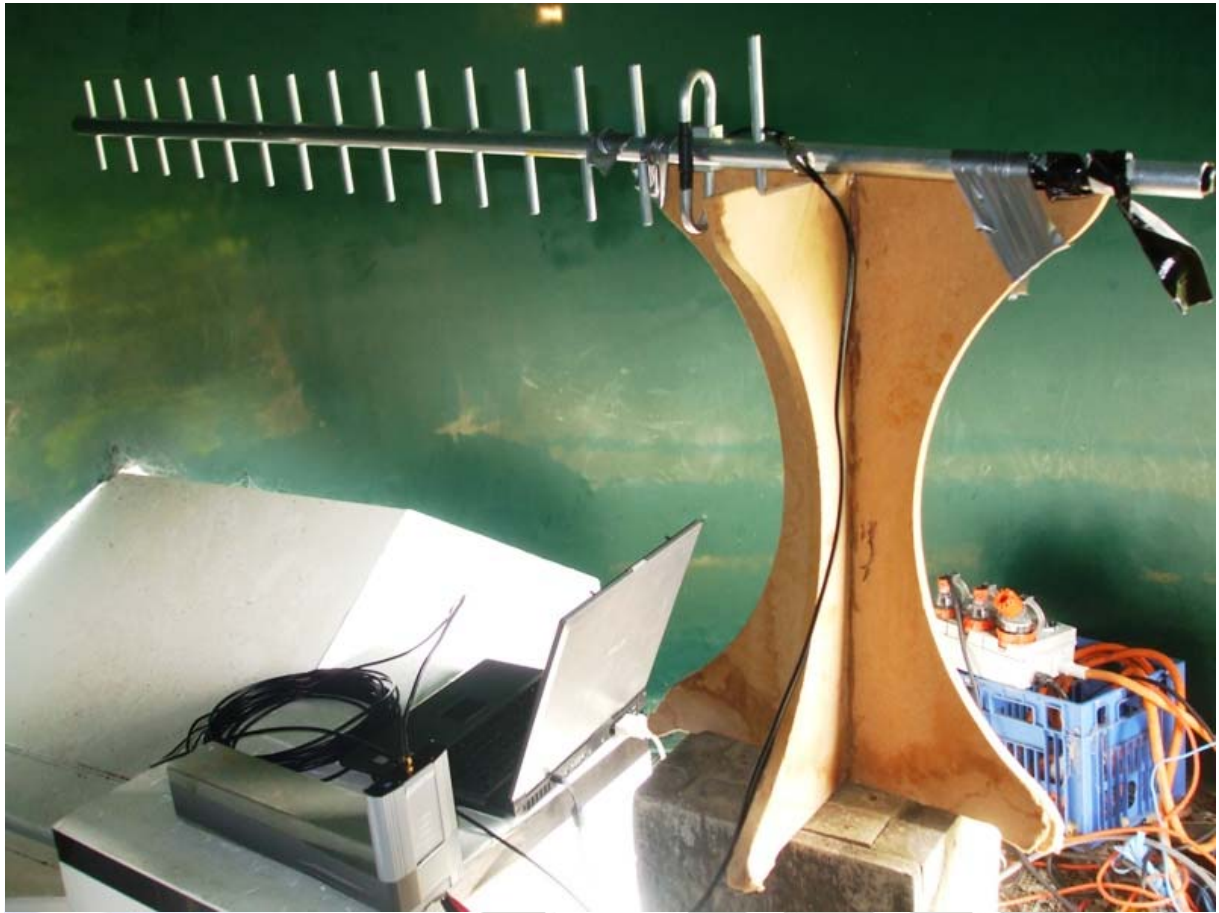


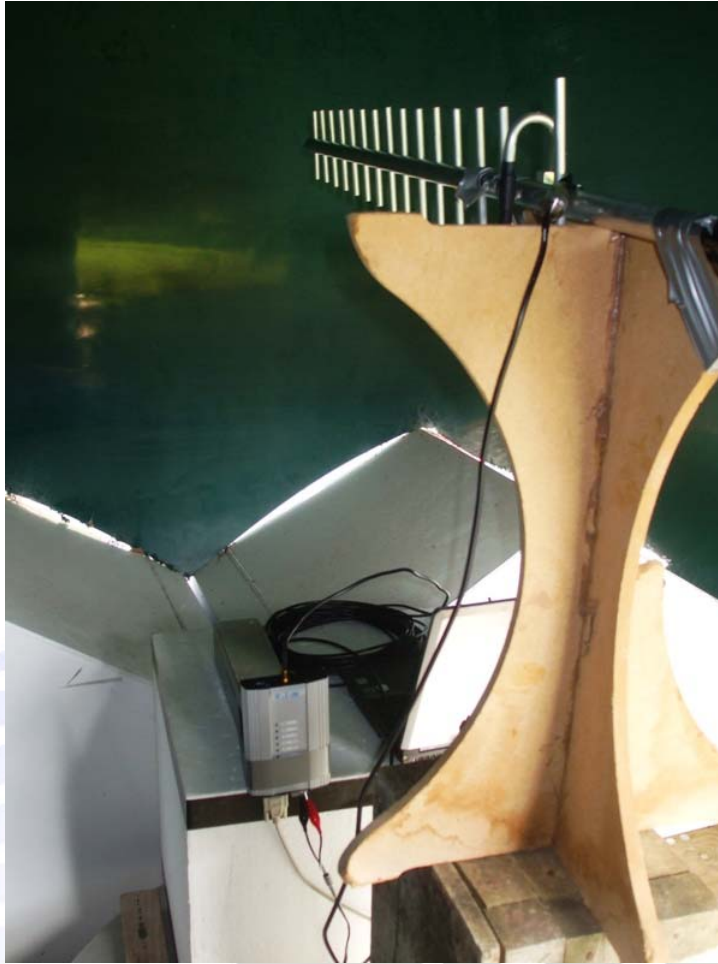




Radiated emissions test set up photos - Yagi Antenna







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Conducted emissions test set up photos



