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TEST REPORT

Windcave BRF210F RelC
Secure Card Reader (NFC Only)

tested to the specification

47 Code of Federal Regulations

Part 15 - Radio Frequency Devices

Subpart C – Intentional Radiators

Section 15.225
Operation within the band 13.110 -14.010 MHz

for

Windcave Ltd

This test report is issued with the authority of:

Andrew Cutler - General Manager

ACCREDITED
IANZ
TESTING LABORATORY

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

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1. STATEMENT OF COMPLIANCE

The **Windcave BRF210F ReIC Secure Card Reader (NFC only)** complies with FCC Part 15 Subpart C Section 15.225 as an Intentional Radiator when the methods as described in ANSI C63.10 - 2013 are applied.

2. RESULTS SUMMARY

The results from testing carried out between November and December 2021 are detailed in the following table:

Clause	Parameter	Result
15.201	Equipment authorisation requirement	Certification maybe required
15.203	Antenna requirement	Complies. Antenna internal to the device
15.204	External PA and antenna modifications	Not applicable. No external devices
15.205	Restricted bands of operation	Complies. Device transmits on a nominal frequency of 13.560 MHz
15.207	Conducted limits	Complies
15.209	Radiated emission limits - Emissions < 30 MHz	Complies
15.209	Radiated emission limits – Emissions > 30 MHz	Complies
15.225	Radiated emission limits - Fundamental	Complies
15.225	Frequency stability	Complies

3. INTRODUCTION

This report describes the tests and measurements performed for the purpose of determining compliance with the specification.

The client selected the test sample.

This report relates only to the sample tested.

This report contains no 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.

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

All testing was carried out as per the standard in the worst-case configuration with no deviations being applied.

4. CLIENT INFORMATION

Company Name	Windcave Ltd
Address	33 Wilkinson Rd, Ellerslie
State	Auckland 1060
Country	New Zealand
Contact	Cameron Collard

5. DESCRIPTION OF TEST SAMPLE

Brand Name	Windcave	
Model Number	BRF210F ReIC	
Product	Secure Card Reader (NFC only)	
Manufacturer	Windcave Limited	
Country of Origin	New Zealand	
Serial Number(s)	NFC sample:	2821390130
	NFC dummy load sample:	2822410080
Release Version	C	
FCC ID	2AC2O-BRF210F	

The device tested is a Near Field Contactless Secure Card Reader (NFC Card Reader) that operates on 13.560 MHz.

The device contains no FCC certified modules.

Testing was carried out when the device under test was attached to a laptop computer using a USB to UART converter that was attached to the USB port on the laptop computer.

The UART convertor was attached to the device using a 1 metre length of Ethernet cable with the UART converter powering the device under test.

The client has declared the highest frequency in use in the device is 108 MHz.

Testing was carried out using a laptop computer that used Windcave test software to exercise the test sample where the NFC transmitter was operating with the signal being modulated.

Testing was carried out to determine the effects of a change to the NFC contacless standard (EMV Contactless v3) which has required an update to the NFC front end integrated circuit.

No other changes have been made to the device that was originally certified.

6. SETUPS AND PROCEDURES

Standard

The sample was tested in accordance with 47 CFR Part 15 Subpart C.

Methods and Procedures

The measurement methods and procedures as described in ANSI C63.10 - 2013 were used.

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

The device has a permanently attached internal 13.560 MHz antenna.

Result: Complies.

Section 15.204: External radio frequency power amplifiers and antenna modifications

It is NOT possible to attach an external power amplifier to this transmitter.

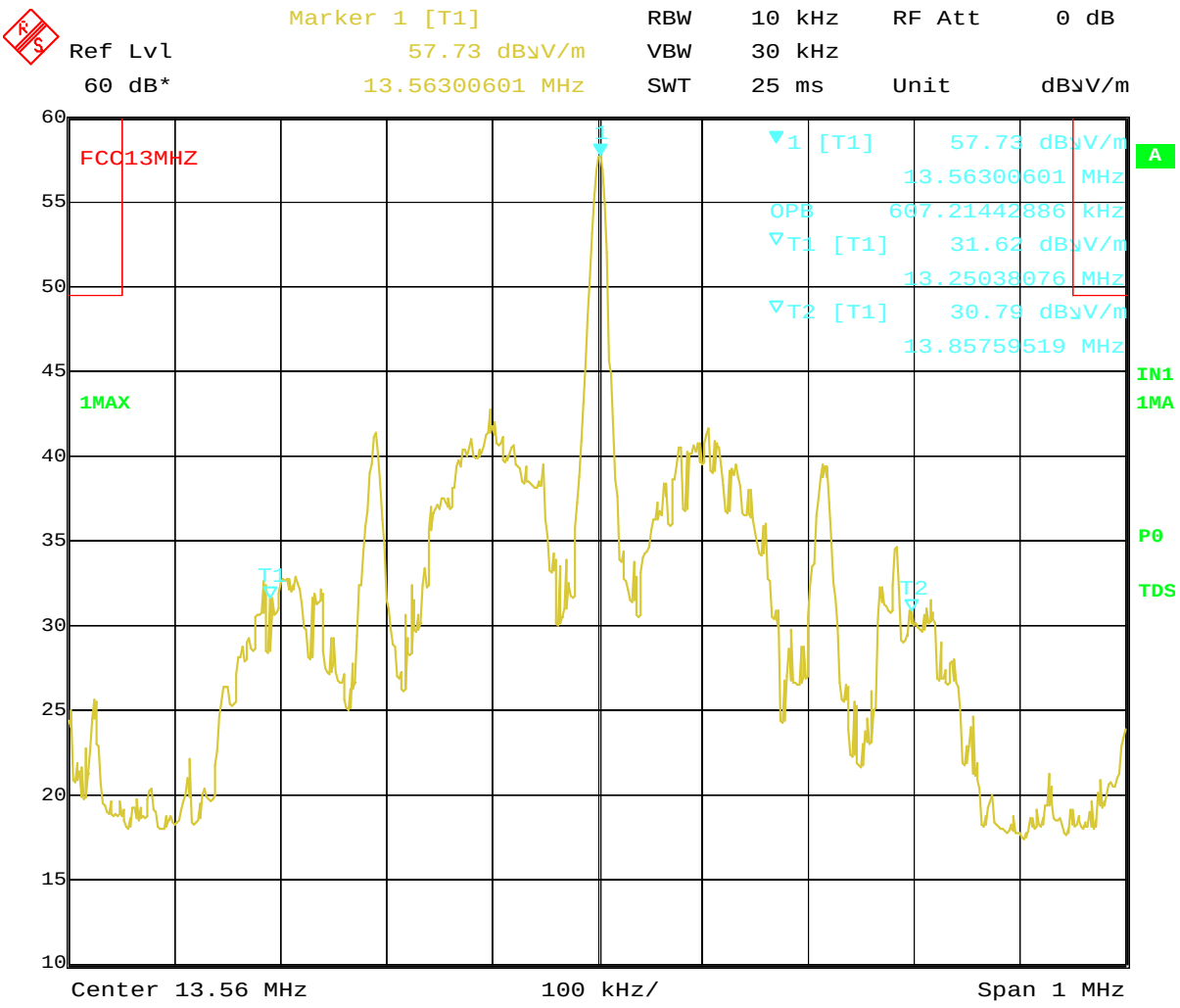
Result: Complies.

Section 15.205: Restricted bands of operation

The device transmits on a nominal frequency of 13.560 MHz.

13.560 MHz transmissions would fall into the 13.110 – 14.010 MHz band that is covered by Section 15.225.

The 99% occupied bandwidth of the device was measured to be 607.214 kHz



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.

The NFC Card Reader operates at 13.560 MHz.

Testing was carried out when the NFC Card Reader was operating normally with the internal antenna connected while continuously reading a card was that placed close to the reader.

Testing was then carried out with NFC Card Reader antenna replaced with a resistive dummy load attached with the results compared.

The device was placed on top of the emissions table, which is 0.8 m x 0.8 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 supplied plot is combined plot showing the worst case quasi peak and average results of both the phase and neutral lines to the representative AC power supply.

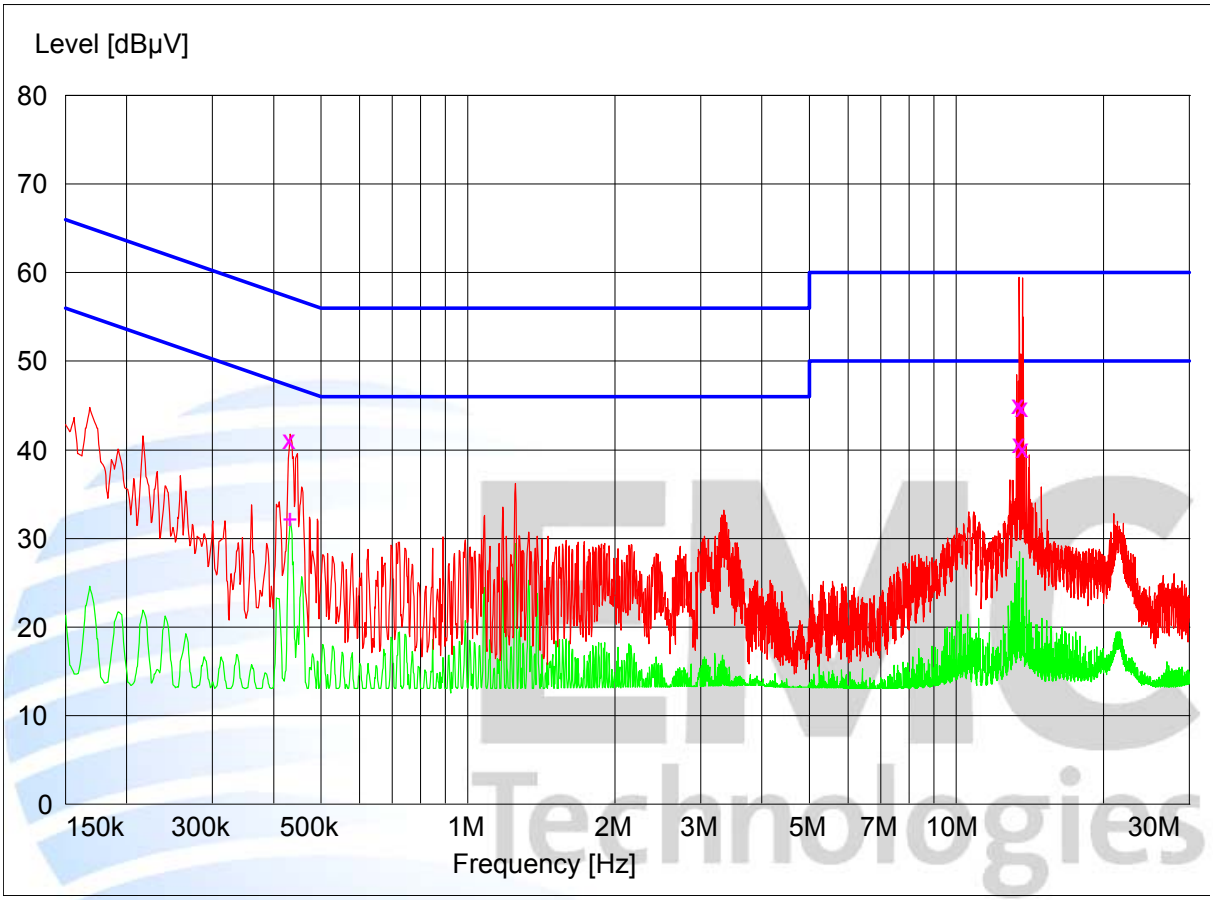
Quasi peak and average detectors have been used with resolution bandwidths of 9 kHz.

Measurement uncertainty with a confidence interval of 95% is:
- AC Mains port (0.15-30 MHz) ± 2.8 dB

Conducted Emissions – AC Input Power Port

Setup:	BRF210F ReIC. Powered by 120 VAC. Connected to auxiliary equipment. Connected to software on laptop. Software running. NFC on 13.560 MHz.

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



Final Quasi-Peak Measurements

Frequency (MHz)	Level (dBµV)	Limit (dBµV)	Margin (dB)	Phase	Rechecks (dBµV)
0.432000	41.10	57.2	16.1	L1	
13.443500	45.10	60.0	14.9	N	
13.493000	40.80	60.0	19.2	L1	
13.560000	77.00	60.0	-17.0	L1	*Manual*
13.655000	44.80	60.0	15.2	N	
13.700000	40.20	60.0	19.8	L1	

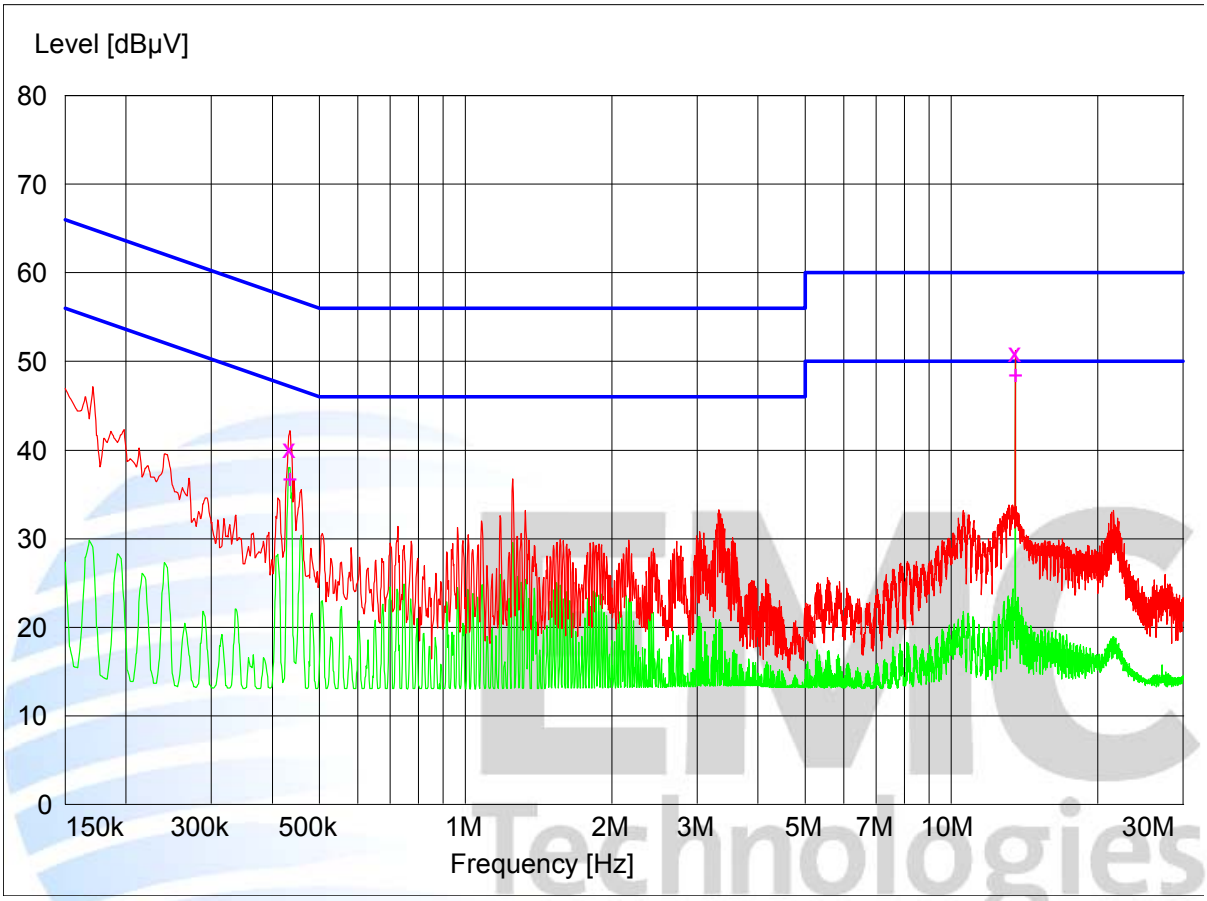
Final Average Measurements

Frequency (MHz)	Level (dBµV)	Limit (dBµV)	Margin (dB)	Phase	Rechecks (dBµV)
0.432000	32.10	47.2	15.1	L1	

Conducted Emissions – AC Input Power Port - Dummy Load

Setup:	BRF210F ReIC. Powered by 120VAC. Dummy Load Device. Connected to auxiliary equipment. Connected to software on laptop. Software running. NFC on 13.560 MHz.

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



Final Quasi-Peak Measurements

Frequency (MHz)	Level (dBµV)	Limit (dBµV)	Margin (dB)	Phase	Rechecks (dBµV)
0.435000	40.20	57.2	17.0	N	
13.560500	51.00	60.0	9.0	L1	*49.5*

Final Average Measurements

Frequency (MHz)	Level (dBµV)	Limit (dBµV)	Margin (dB)	Phase	Rechecks (dBµV)
0.435000	36.70	47.1	10.4	L1	
13.560500	48.40	50.0	1.6	L1	*48.8*

Section 15.209: Radiated emission limits, general requirements

Measurements between 30 – 2000 MHz have been made at a distance of 3 metres.

Testing was carried out at the laboratory's open area test site - located at Driving Creek, Orere Point, Auckland, New Zealand.

Testing was carried out when the device under test was attached to a laptop computer using a USB to UART converter that was attached to the USB port on the laptop computer.

The UART convertor was attached to the device using a 1.2 metre length of Ethernet cable with the UART converter powering the device under test.

The UART convertor was powered using a representative AC power supply that was powered at 120 Vac 60 Hz.

All interconnecting cables were bundled in 40 cm long bundles.

A custom programme was run on the computer which exercised all operational aspects of the device.

The device was transmitting continuously on 13.560 MHz with a NFC card being placed close to the card reader which was periodically read by the card reader.

Correct operations were indicated by an indication on the computer screen.

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, where appropriate, with an automated antenna tower.

Below 30 MHz a magnetic loop is used with the centre of the loop being 1 metre above the ground with measurements being made using a quasi peak detector at a distance of 10 metres.

Above 30 MHz the emission is measured in both vertical and horizontal antenna polarisations.

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

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

For example, if an emission of 30 dBµV was observed at 30 MHz.

45.5 dBµV/m = 30.0 dBµV + 14 dB/m + 1.5 dB

Section 15.209: 13.560 MHz transmitter below 30 MHz spurious emission measurements

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
27.120	10.5	48.6	38.1	Pass

The device was transmitting continuously on 13.560 MHz with a NFC card being placed close to the card reader which was periodically read by the card reader.

Magnetic loop measurements were made at a distance of 10 metres.

A measurement receiver with a quasi peak detector with a 9 kHz bandwidth was used.

The 30 metre limit has been scaled by a factor of 40 dB per decade, as per section 15.31 (f) (2).

The limit at 27.120 MHz when measured at 30 metres is 30 uV/m or 29.54 dBuV/m.

Therefore the scaled limit at 10 metres will be 48.6 dBuV/m.

The spurious emission observed does not exceed the level of the fundamental emission.

No other low frequency spurious emissions were detected from the device when measurements were attempted from 10 kHz - 30.0 MHz

Result: Complies.
Measurement uncertainty with a confidence interval of 95% is:
- Free radiation tests (10 kHz – 30 MHz) ± 4.8 dB

Section 15.209: Spurious Emissions (above 30 MHz)

Measurements were made between 30 – 2000 MHz at a distance of 3 metres.

A receiver with a quasi peak detector with a 120 kHz bandwidth was used between 30 – 1000 MHz.

Between 1000 – 2000 MHz a measuring receiver with using a peak detector and an average detector with a 1 MHz bandwidth was used.

The limits as described in Section 15.209 have been applied.

Testing was carried out with NFC operating continuously.

Emissions observed

Frequency (MHz)	Vertical (dBµV/m)	Horizontal (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result	Antenna Polarisation
40.680	-	27.6	40.0	12.4	Pass	Horizontal
176.240	-	25.0	43.5	18.5	Pass	Horizontal

All other emissions observed had a margin to the limit that exceed at least 15 dB when measurements were made between 30 – 2000 MHz using both vertical and horizontal polarisations.

Result: Complies

Measurement uncertainty with a confidence interval of 95% is:
- Free radiation tests (30 – 2000 MHz) ± 4.1 dB

Section 15.225: Fundamental emission:

Measurements were made using a magnetic loop antenna and a receiver with a quasi peak detector using a 9 kHz bandwidth.

Measurements were made at a distance of 10 metres with the limit being determined by using the extrapolation factor of 40 dB per decade limit, as detailed in section 15.31 f (2).

The limit at 30 m at 13.560 MHz is 15,848 uV/m or 84.0 dBuV/m.

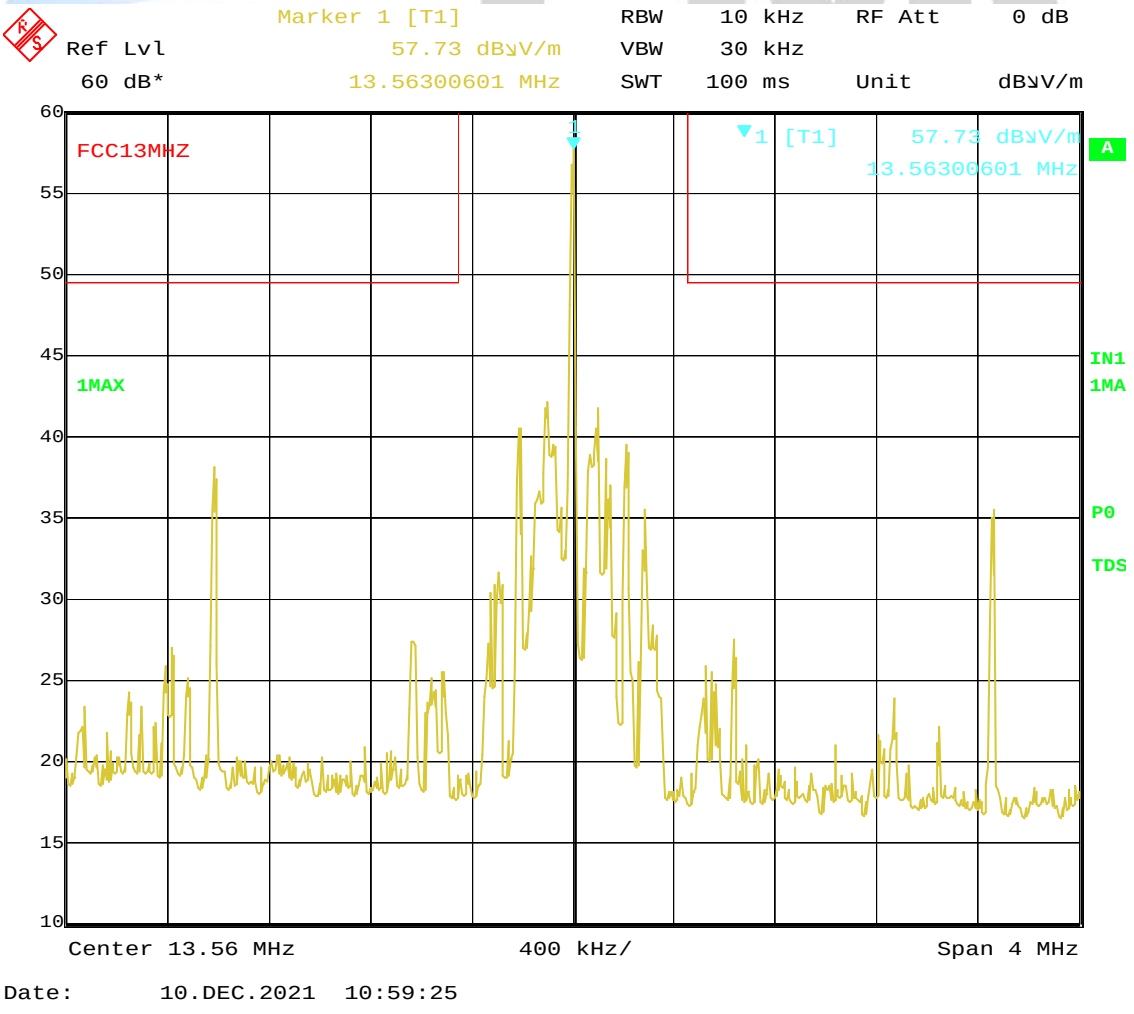
Applying the extrapolation factor of 40 dB/ per decade, the limit at 10 m is 103.1 dBuV/m.

Testing was also carried out to determine whether a variation in the DC supply voltage to the UART convertor would cause a significant change in field strength.

The 13.6 Vdc supply to the device was varied by +/- 15% between 11.6 Vdc and 15.6 Vdc.

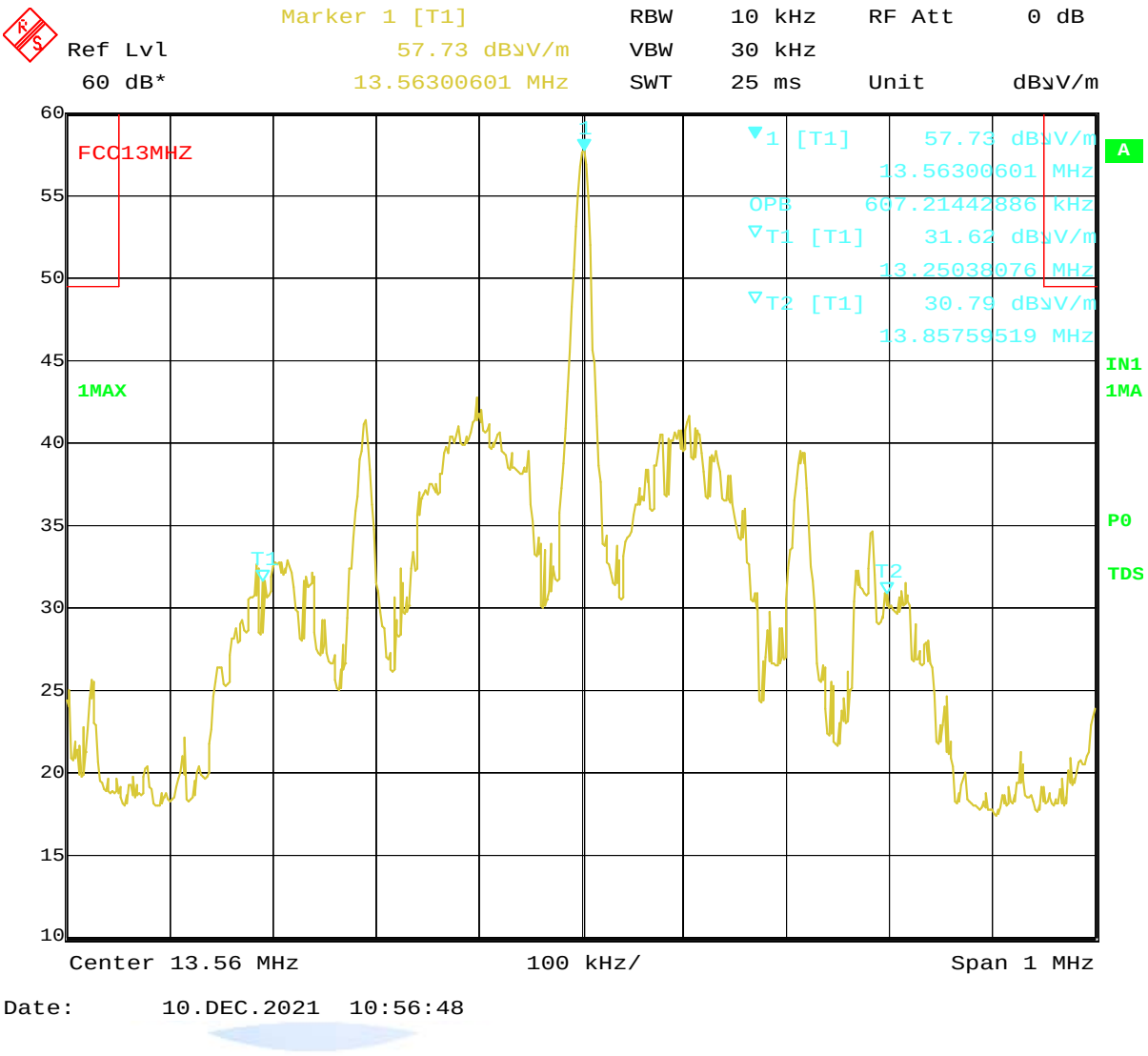
Voltage (Vdc)	Frequency (MHz)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)
11.6	13.560	51.0	103.1	52.1
13.6	13.560	51.0	103.1	52.1
15.6	13.560	51.0	103.1	52.1

Spectrum analyser plot show the carrier and modulation peaks within +/- 2 MHz.



Section 15.225: Fundamental emission: cont.

Spectrum analyser plots show the carrier and modulation peaks within +/- 500 kHz.



Result: Complies.

Measurement uncertainty with a confidence interval of 95% is:
- Free radiation tests (100 kHz – 30 MHz) ± 4.8 dB

Section 15.225: Frequency tolerance:

The frequency tolerance of the carrier is required to be +/- 0.01% of operating frequency when the temperature is varied between -20 degrees C and +50 degrees C.

The device operates nominally on 13.560 MHz which gives a frequency tolerance of +/- 1,356.0 Hz.

Temperature (°C)	Frequency (MHz)	Difference (Hz)
50.0	13.560 030	+30
40.0	13.560 050	+50
30.0	13.560 075	+75
20.0	13.560 070	+70
10.0	13.560 100	+100
0.0	13.560 015	+15
-10.0	13.560 135	+135
-20.0	13.560 140	+140

The 13.6 Vdc supply voltage was varied by +/- 15% at 20 degrees C (ambient).

Voltage (Vdc)	Frequency (MHz)	Difference (Hz)
11.6	13.560 080	+80
13.6	13.560 070	+70
15.6	13.560 080	+80

Result: Complies.

Measurement uncertainty with a confidence interval of 95% is:
Frequency tolerance ± 50 Hz

7. TEST EQUIPMENT USED

Instrument	Manufacturer	Model	Serial No	Asset Ref	Cal Due	Period
Aerial Controller	EMCO	1090	9112-1062	RFS 3710	Not applic	N/a
Aerial Mast	EMCO	1070-1	9203-1661	RFS 3708	Not applic	N/a
Biconical Antenna	Schwarzbeck	BBA 9106	-	3680	29 Mar 2022	3 years
Horn Antenna	EMCO	3115	9511-4629	E1526	1 Jan 2022	3 years
Log Periodic	Schwarzbeck	VUSLP 9111	9111-112	EMC4025	25 Mar 2022	3 years
Loop Antenna	EMCO	6502	9003-2485	3798	12 Feb 2022	3 years
Mains Network	R & S	ESH2-Z5	881362/032	3628	17 May 2022	2 years
Receiver	R & S	ESHS 10	828404/005	3728	27 Sept 2022	2 year
Receiver	R & S	ESIB 40	100295	INV0818	03 Jun 2023	2 year
Turntable	EMCO	1080-1-2.1	9109-1578	RFS 3709	Not applic	N/a
VHF Balun	Schwarzbeck	VHA 9103	9594	3696	29 Mar 2022	3 years
Heliax cable	Andrews	L6PNM-RPD	22869	Oats Cable	30 Dec 2022	1 year
Succoflex cable	Huber and Suhner	104 3m n-n	339901/4	13938	10 Nov 2022	1 year
Succoflex cable	Huber and Suhner	104 1m n-n	340521/4	13937	10 Nov 2022	1 year
Power Supply	APT	7008	4170003	-	Not applic	N/a
Thermal chamber	Contherm	M180F	86025	N/a	N/a	N/a
Thermometer	DSIR	RT200	35	EMC4029	9 April 2023	5 years
Voltage Variac	Powerteck	SRV-5	RFS3800	-	-	N/a

8. ACCREDITATIONS

Testing was carried out in accordance with EMC Technologies NZ Ltd designation as a FCC Accredited Laboratory by International Accreditation New Zealand, designation number: NZ0002 under the APEC TEL MRA.

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 International Laboratory Accreditation Council (ILAC) Mutual Recognition Arrangements for testing and calibration with various accreditation bodies in a number of economies.

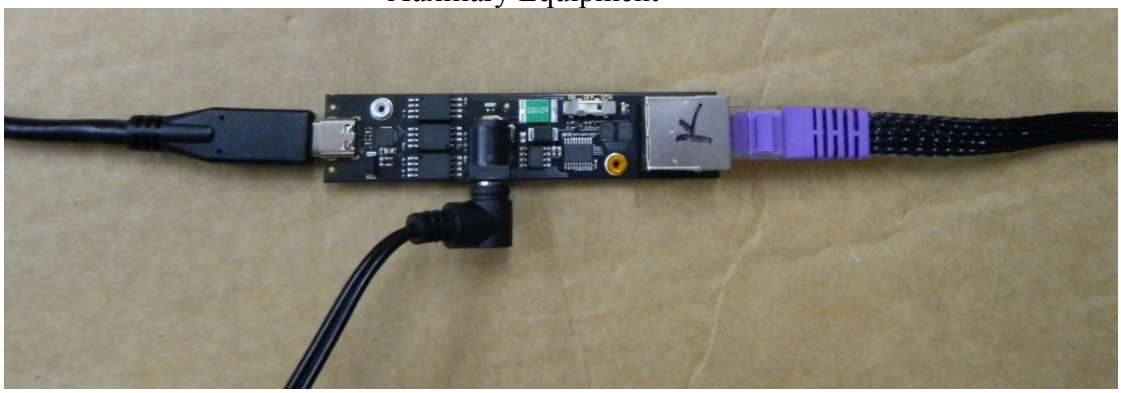
This includes NATA (Australia), UKAS (UK), SANAS (South Africa), NVLAP (USA), A2LA (USA), SWEDAC (Sweden).

Further details can be supplied on request.

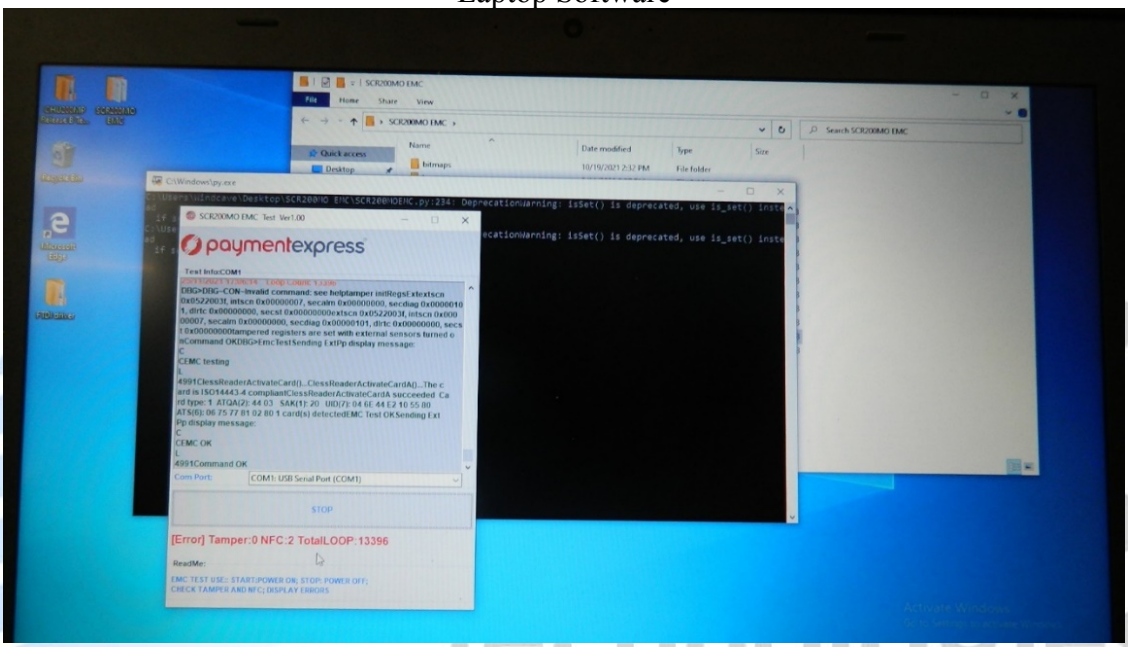
9. PHOTOGRAPHS

External Views

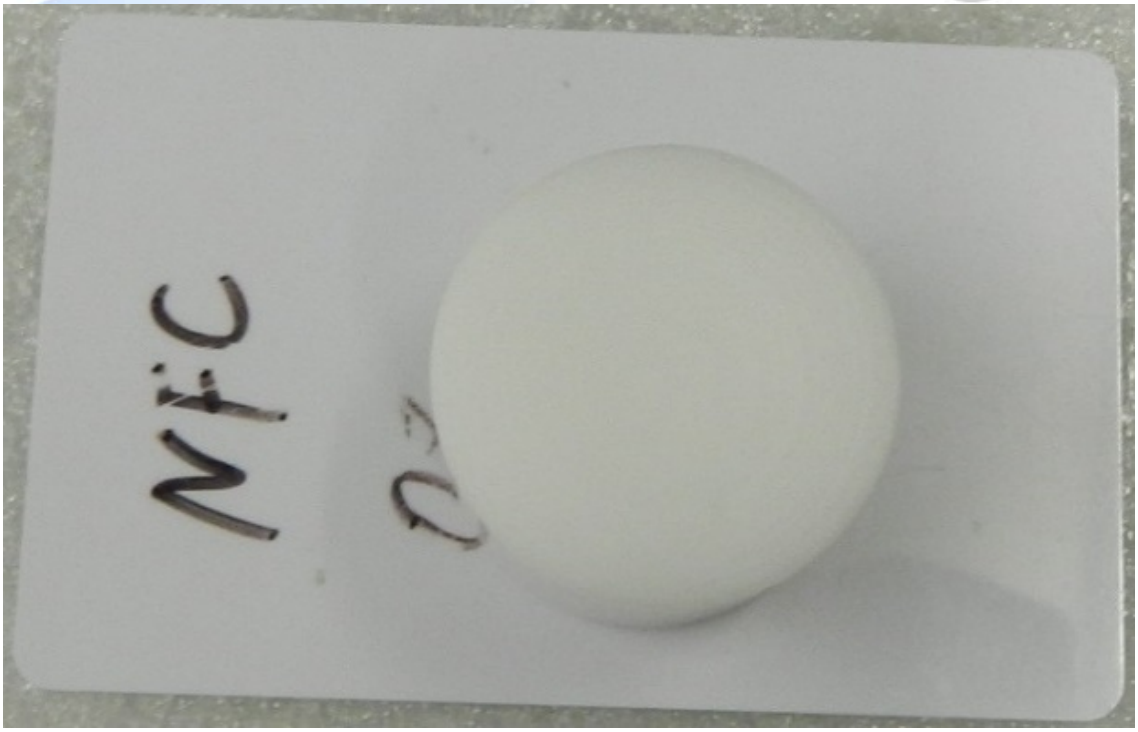
Auxiliary Equipment



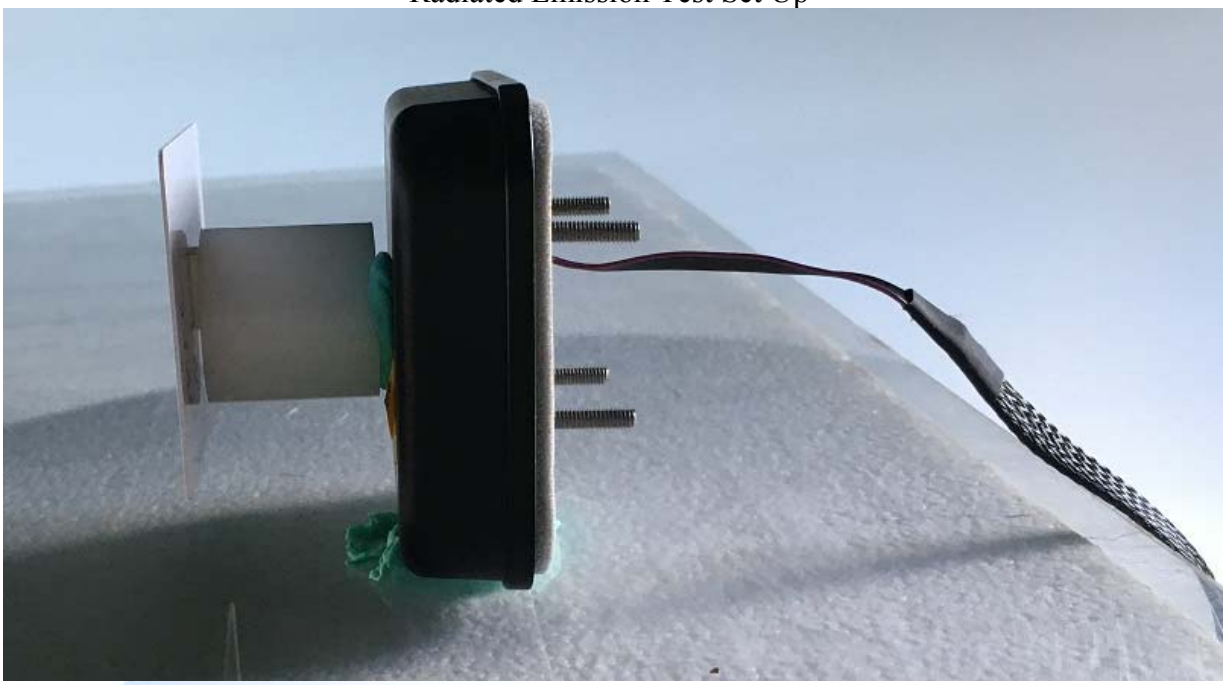
Laptop Software



NFC Card



Radiated Emission Test Set Up



Radiated Emissions Test Set Up

Conducted emissions test set up