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TEST REPORT

TSL Standard Proximity Card Reader with Bluetooth

tested to

47 Code of Federal Regulations

Part 15 - Radio Frequency Devices
Subpart C – Intentional Radiators

Section 15.209

Section 15.225
Operation within the band 13.110 -14.010 MHz

Section 15.249
Operation in the band 2400 – 2483.5 MHz

for

Integrated Control Technologies

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 **TSL Standard Proximity Card Reader with Bluetooth** complies with FCC Part 15 Subpart C Section 15.209, 15.225 and 15.249 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 in July and August 2022 are summarised in the following table:

Clause	Parameter	Result
15.201	Equipment authorisation requirement	Certification required.
15.203	Antenna requirement	Complies. Antennas internal to the device.
15.204	External PA and antenna modifications	Not applicable. No external devices.
15.205	Restricted bands of operation	Complies.
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
15.249 (a)	Field strength of fundamental	Complies
15.249 (a)	Field strength of harmonics	Complies
15.249 (b)	Fixed, point to point operations	Not applicable
15.249 (c)	3 metre measurement distance	Noted
15.249 (d)	Spurious emission levels except harmonics	Complies
15.249 (e)	Detectors above 1000 MHz	Noted
15.249 (f)	Reference to section 15.37(d)	Noted

3. INTRODUCTION

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.

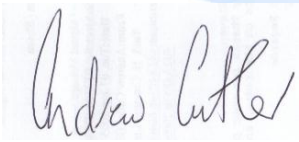
All compliance statements have been made with respect of the specification limit with no reference to the measurement uncertainty.

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

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	Integrated Control Technologies
Address	4 John Glenn Avenue Albany
City	Auckland 0632
Country	New Zealand
Contact	Hayden Burr

5. DESCRIPTION OF TEST SAMPLE

Brand Name	TSL
Model Number Tested	Standard (TSL-STD-RK-HL)
Product	Proximity Card Reader with Bluetooth
Manufacturer	Integrated Control Technology Ltd. (ICT)
Country of Origin	New Zealand
Serial Number	E5B50FA6
FCC ID	UAUSLS

Product Description:

The TSL Reader comes in three main editions (Standard, Extra, and Mini) and with a range of optional features.

Each edition is available with support for either 125 kHz or Mifare/DESFire cards and comes with Bluetooth wireless technology.

The Standard and Extra are also available in a combo model combining support for Mifare, DESFire, and 125 kHz cards from a single reader, and with an optional keypad.

All models are available in either black or white.

The model tested is a dual mode transmitter operating on 125 kHz and 13.560 MHz and was also transmitting in the 2.4 GHz band.

Testing was carried out when all three transmitters were transmitting continuously.

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

This device has internal antennas for the 125 kHz and 13.560 MHz transmitters.

This device has internal antennas for the 2.4 GHz Bluetooth transmitter.

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

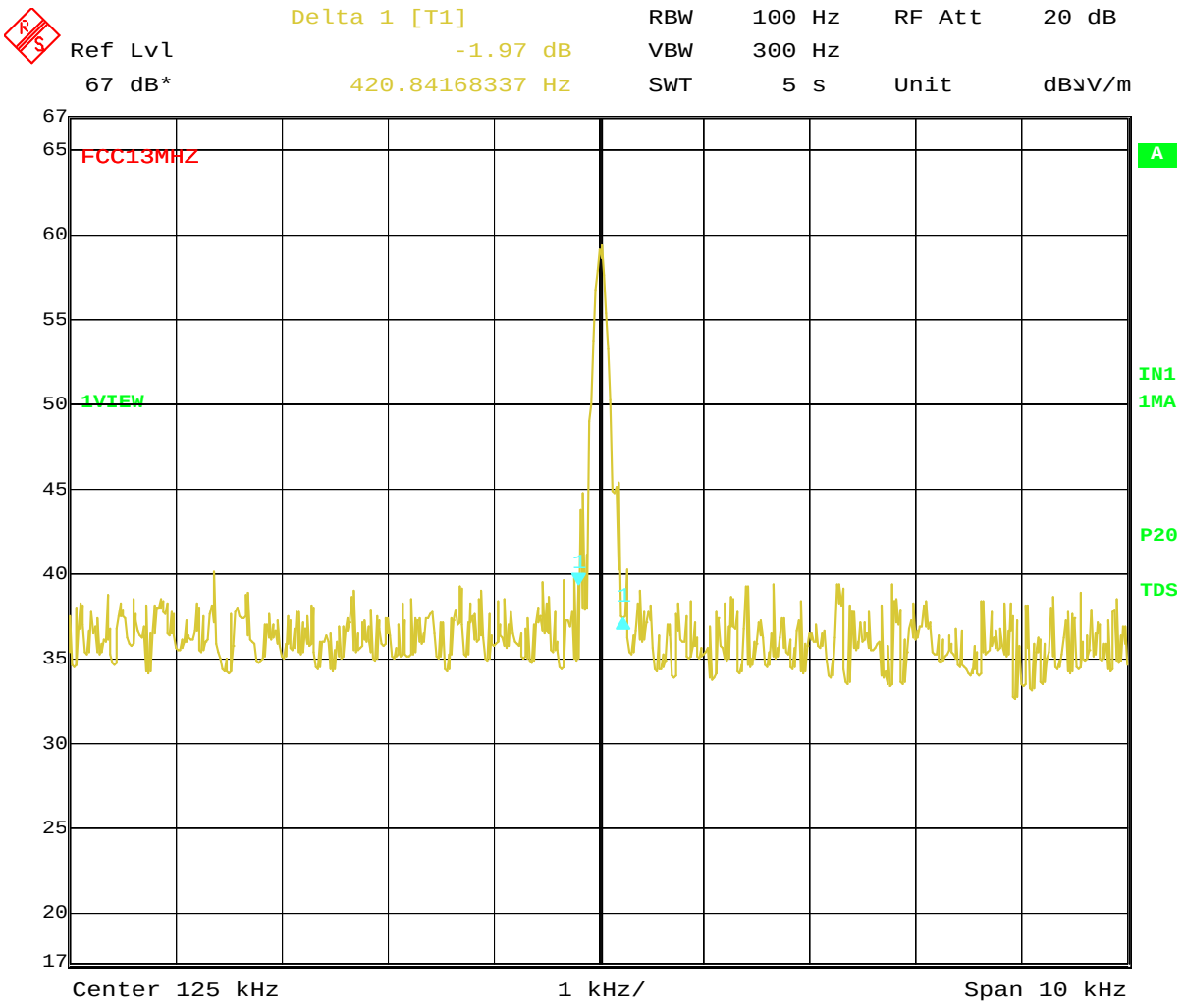
The transmitter transmits on 125.000 kHz.

This device would therefore fall between the restricted bands of 90 – 110 kHz and 495 – 505 kHz.

Measurements were made using a span of 10 kHz with a resolution bandwidth of 100 Hz and a video bandwidth of 300 Hz.

The -20 dB bandwidth has been measured using a spectrum analyser.

At 125 kHz the 20 dB bandwidth was measured to be 420.8 Hz.



The transmitter also transmits on 13.560 MHz.

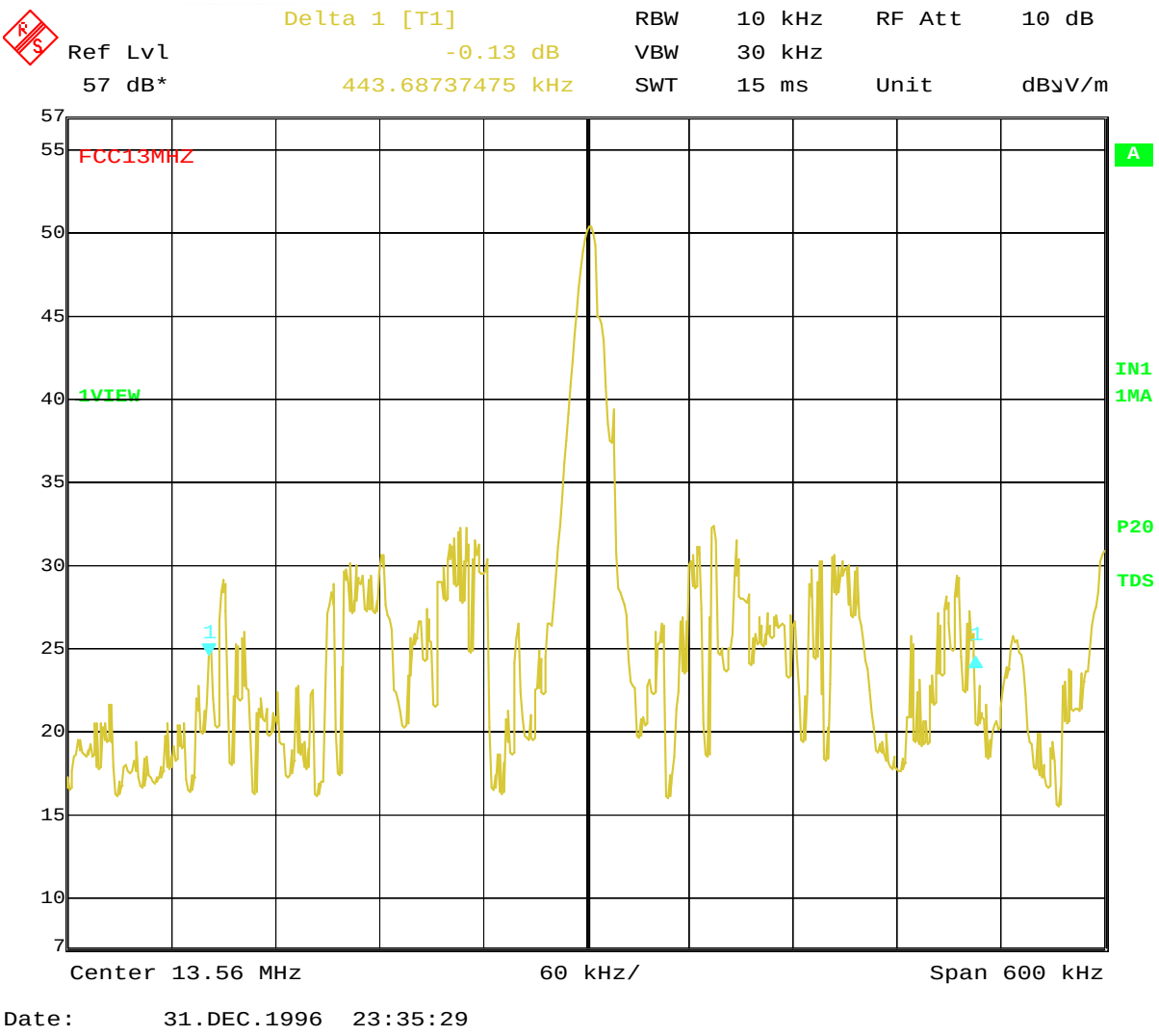
This device would therefore fall into the band of 13.110 – 14.010 MHz that is covered by Section 15.225.

Representative measurements were made based upon the field strength measured at the test site.

Measurements of the 26 dB bandwidth were made using a spectrum analyser.

Measurements were made using a span of 1.0 MHz with a resolution bandwidth of 10 kHz and a video bandwidth of 30 kHz.

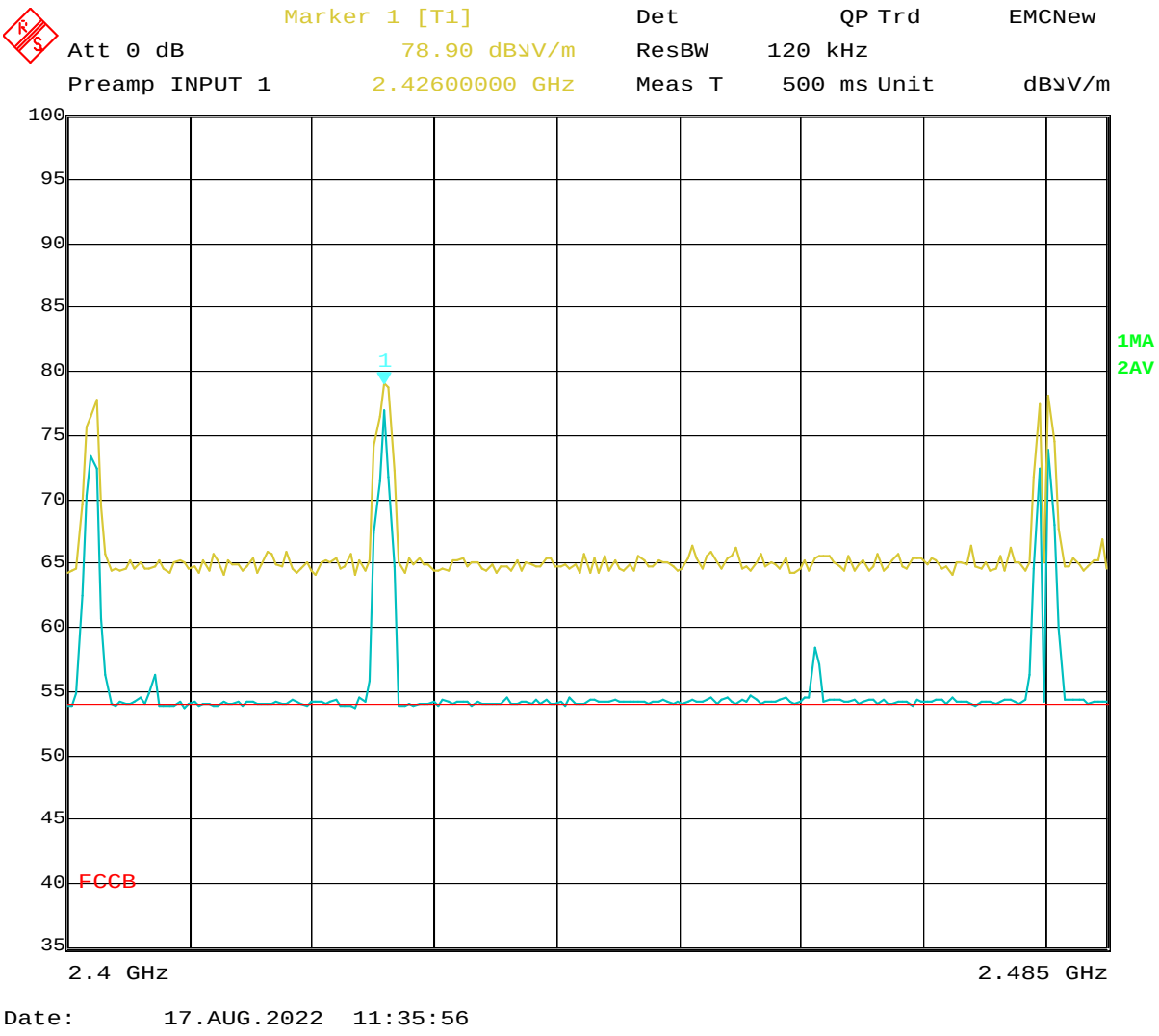
A worst case 26 dB bandwidth of 443.68 kHz was measured



The Bluetooth transmitter was observed transmitting on 2402, 2426 and 2480 MHz.

This device would therefore fall into the band of 2400.0 – 2483.5 MHz band that is covered by Section 15.249.

This is shown below



Result: Complies

Section 15.207: Conducted emissions testing (125 kHz, 13.560 MHz, 2.4 GHz Bluetooth)

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

Device was tested when powered at 12 Vdc using a representative 120 Vac 60 Hz AC mains supply when operating continuously.

The card reader was attached to a USB serial interface which displayed data on the laptop screen.

When a card was placed near the reader it beeped which indicated that the card reader was active.

Testing was carried out when transmitting continuously on 125 kHz, 13.560 MHz and in the 2.4 GHz band.

Testing was carried out with the transmitters operating with their standard antennas attached.

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 to the representative AC power supply.

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

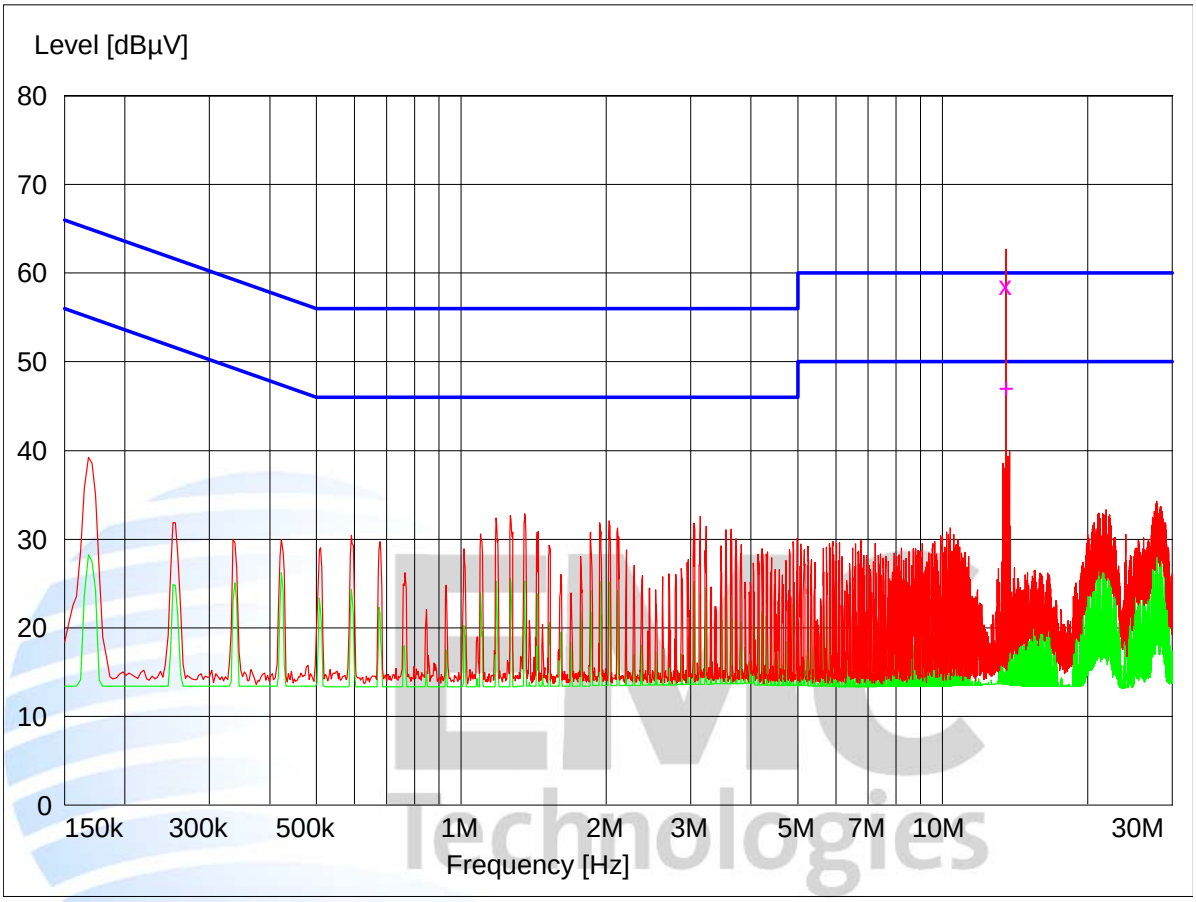
Measurement uncertainty with a confidence interval of 95% is:
- AC Mains port (0.15-30 MHz) ± 2.8 dB

Result: Complies

Conducted Emissions – AC Input Power Port

Setup:	Device tested when powered at 12 Vdc using a representative 120 Vac 60 Hz AC mains supply when operating continuously. Standard card reader with USB serial interface showing some data on the laptop screen. Card beeps when swiped. Reader active.

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



Final Quasi-Peak Measurements

Frequency (MHz)	Level (dBµV)	Limit (dBµV)	Margin (dB)	Phase	Rechecks (dBµV)
13.560500	58.60	60.0	1.4	N	*Fundamental*

Final Average Measurements

Frequency (MHz)	Level (dBµV)	Limit (dBµV)	Margin (dB)	Phase	Rechecks (dBµV)
13.560500	47.00	50.0	3.0	N	*Fundamental*

Section 15.209: Radiated emission limits, general requirements (125 kHz, 13.560 MHz and 2.4 GHz Bluetooth)

Radiated emissions testing was carried out over the frequency range of 100 kHz to 25,000 MHz as the device contains a Bluetooth Transmitter.

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

An enclosure containing absorber material, Panashield HYB-NF-12, has been placed between the turntable and the measurement antenna for when measurements are made above 1 GHz.

This material has no absorbing affect below 1 GHz with site verification measurements confirming this.

Testing carried out when the device was placed in the centre of the table standing upright.

Below 1000 MHz the top of the test table was 80 cm above the test site ground plane.

Above 1000 MHz the top of the test table was 150 cm above the test site ground plane

Device tested has 125 kHz and 13.560 MHz security card readers that were operating continuously.

The device also supports Bluetooth functionality in the 2.4 GHz band which was active during the test.

Device was tested when powered at 12 Vdc using a lead acid battery.

Device was attached to a RS-485 to USB to Serial convertor board which was attached to a laptop computer running Terminal which displayed random data on the screen.

The laptop and convertor board were located in the test house and was attached to the device using a 40 metre long unshielded cable.

Device was periodically activated using a supplied swipe card which caused the device to beep which confirmed continuing correct operations.

Power and data cables were placed vertically downwards

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 a test distance of 10 metres being used.

Between 100 – 490 kHz a Peak and Average detector with a bandwidth of 9 kHz was used

Between 490 kHz – 30 MHz a Quasi Peak detector with a bandwidth of 9 kHz was used.

Section 15.209: Radiated emission limits, general requirements (125 kHz, 13.560 MHz and 2.4 GHz Bluetooth) cont.

Above 30 MHz the emission is measured in both vertical and horizontal antenna polarisations, where appropriate at a test distance of 3 metres.

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

Above 1000 MHz an Average and a Peak detector were used which used a bandwidth of 1 MHz

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

Result: Complies

Measurement uncertainty with a confidence interval of 95% is:

- Free radiation tests (30 – 25000 MHz) ± 4.1 dB
- Free radiation tests (100 kHz – 30 MHz) ± 4.8 dB

Section 15.209: 125 kHz Fundamental emission:

Measurements were made using a magnetic loop antenna and a receiver with an average detector and a peak detector both using a 9 kHz bandwidth

Frequency (kHz)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Distance (metres)
125.000	61.0	84.7	23.7	Average	10
125.000	70.5	104.7	34.2	Peak	10

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 300 metre limit between 125 – 490 kHz has been scaled by a factor of 40 dB per decade, as per section 15.31 (f) (2).

The average limit at 300 m at 125.0 kHz is 19.2 uV/m or 25.7 dBuV/m and 45 dBuV/m in peak.

= 25.7 dBuV/m + -40 dB/decade * (log (10) - log (300))
= 25.7 dBuV/m + -40 dB/decade * (1.000 - 2.477)
= 25.7 dBuV/m + -40 dB/decade * - 1.477
= 25.7 dBuV/m + 59.08
= 84.7 dBuV/m

This gives a limit at 10 m at 125 kHz of 84.7 dBuV/m and 104.7 dBuV/m in peak

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

As a worst case indication the 12 Vdc supply to the card reader was varied by +/- 15% between 10.2 Vdc and 13.8 Vdc.

Voltage (Vdc)	Field Strength (dBuV/m)
10.2	70.5
12.0	70.5
13.8	70.5

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

Section 15.209: 125 kHz Spurious Emissions (below 30 MHz)

A receiver with an average detector and a peak detector using a 9 kHz bandwidth was used between 110 – 490 kHz and a Quasi Peak detector with a 9 kHz bandwidth was used between 490 kHz – 30.0 MHz.

Frequency (kHz)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Comment
250.000	43.0	78.7	-	Average	Noise Floor
250.000	55.0	98.7	-	Peak	Noise Floor
375.000	39.0	75.2	-	Average	Noise Floor
375.000	50.0	95.2	-	Peak	Noise Floor
500.000	<48.0	52.7	-	Quasi Peak	Noise Floor
625.000	<44.0	50.8	-	Quasi Peak	Ambient
750.000	<44.0	49.2	-	Quasi Peak	Noise Floor
875.000	<44.0	47.8	-	Quasi Peak	Ambient
1000.000	<40.0	46.7	-	Quasi Peak	Noise Floor
1125.000	<40.0	45.7	-	Quasi Peak	Noise Floor
1250.000	<40.0	44.7	-	Quasi Peak	Ambient
1375.000	<40.0	43.9	-	Quasi Peak	Noise Floor
1500.000	<40.0	43.2	-	Quasi Peak	Noise Floor
1625.000	<40.0	42.5	-	Quasi Peak	Noise Floor

Magnetic loop measurements were made a distance of 10 metres with the measurement antenna being further adjusted to give the highest field strength.

The 300 metre limit between 125 – 490 kHz has been scaled by a factor of 40 dB per decade, as per section 15.31 (f) (2).

= Limit (dBuV/m) + -40 dB/decade * (log (10) - log (300))
= Limit (dBuV/m) + -40 dB/decade * (1.000 - 2.477)
= Limit (dBuV/m) + -40 dB/decade * - 1.477
= Limit (dBuV/m) + 59.08

The limit between 110 – 490 kHz was increased by 20 dB when the peak detector was used.

The 30 metre limit between 490 – 1705 kHz has been scaled by a factor of 40 dB per decade, as per section 15.31 (f) (2).

= Limit (dBuV/m) + -40 dB/decade * (log (10) - log (30))
= Limit (dBuV/m) + -40 dB/decade * (1.000 - 1.477)
= Limit (dBuV/m) + -40 dB/decade * - 0.477
= Limit (dBuV/m) + 19.08

The spurious emissions observed do not exceed the level of the fundament emission.

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

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

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)
27.120	10.0	48.6	38.6

Testing was carried out when the device was transmitting continuously.

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

A receiver with a Quasi Peak detector with a 9 kHz bandwidth was used between 490 kHz – 30.0 MHz.

The 30 metre limit between 1.705 MHz – 30 MHz 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 when scaled the limit at 10 metres will be 48.6 dBuV/m as detailed below.

= 29.54 dBuV/m + -40 dB/decade * (log (10) - log (30))
= 29.54 dBuV/m + -40 dB/decade * (1.000 - 1.477)
= 29.54 dBuV/m + -40 dB/decade * - 0.477
= 29.54 dBuV/m + 19.08
= 48.6 dBuV/m

The spurious emission observed does not exceed the level of the fundament emission

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

Section 15.209: Spurious Emissions (above 30 MHz) - (125 kHz, 13.560 MHz and 2.4 GHz Bluetooth)

Measurements between 30 – 25000 MHz have been made at a distance of 3 metres.

Device tested has 125 kHz and 13.560 MHz security card readers that were operating continuously.

The device also supports Bluetooth functionality in the 2.4 GHz band which was active during the test.

A receiver using a Quasi Peak detector with a 120 kHz bandwidth was used between 30 – 1000 MHz

Above 1000 MHz 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.

Frequency (MHz)	Vertical (dBµV/m)	Horizontal (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Antenna Pol.	Detector	BW (kHz)
58.880	25.2	-	40.0	14.8	Vertical	QP	120
61.120	22.7	-	40.0	17.3	Vertical	QP	120

Above 1000 MHz the only emissions observed were from the Bluetooth transmitter that was observed advertising on 2402, 2426 and 2480 MHz.

All other emissions observed had a margin to the limit that exceeded 15 dB when measurements were made between 30 – 25000 MHz using both vertical and horizontal polarisations.

Result: Complies.

Measurement uncertainty with a confidence interval of 95% is:

- Free radiation tests (30 MHz – 25000 MHz) ± 4.1 dB

Section 15.225: Fundamental emission (13.560 MHz):

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.

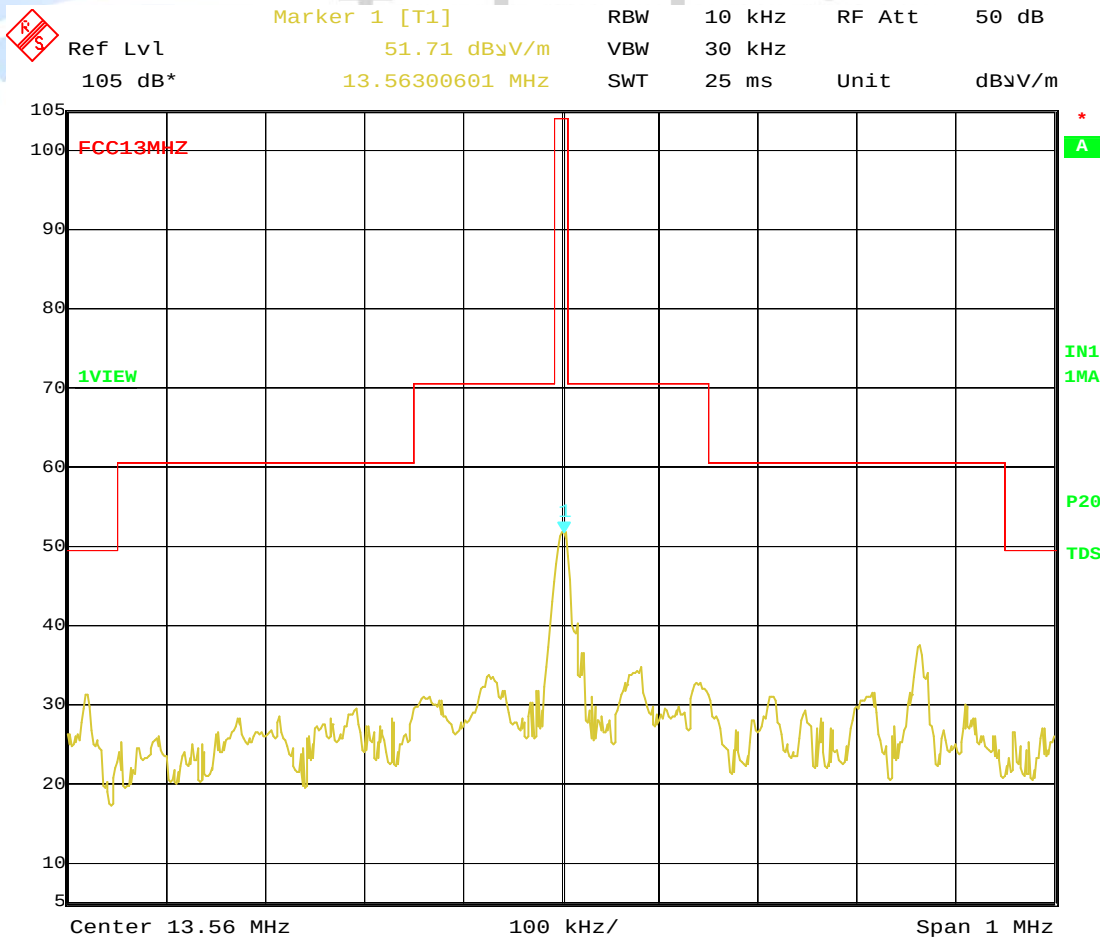
Applying the extrapolation factor of 40 dB/ per decade, the limit is 103.1 dBuV/m.

= 84.0 dBuV/m + -40 dB/decade * (log (10) - log (30))
= 84.0 dBuV/m + 19.08
= 103.1 dBuV/m

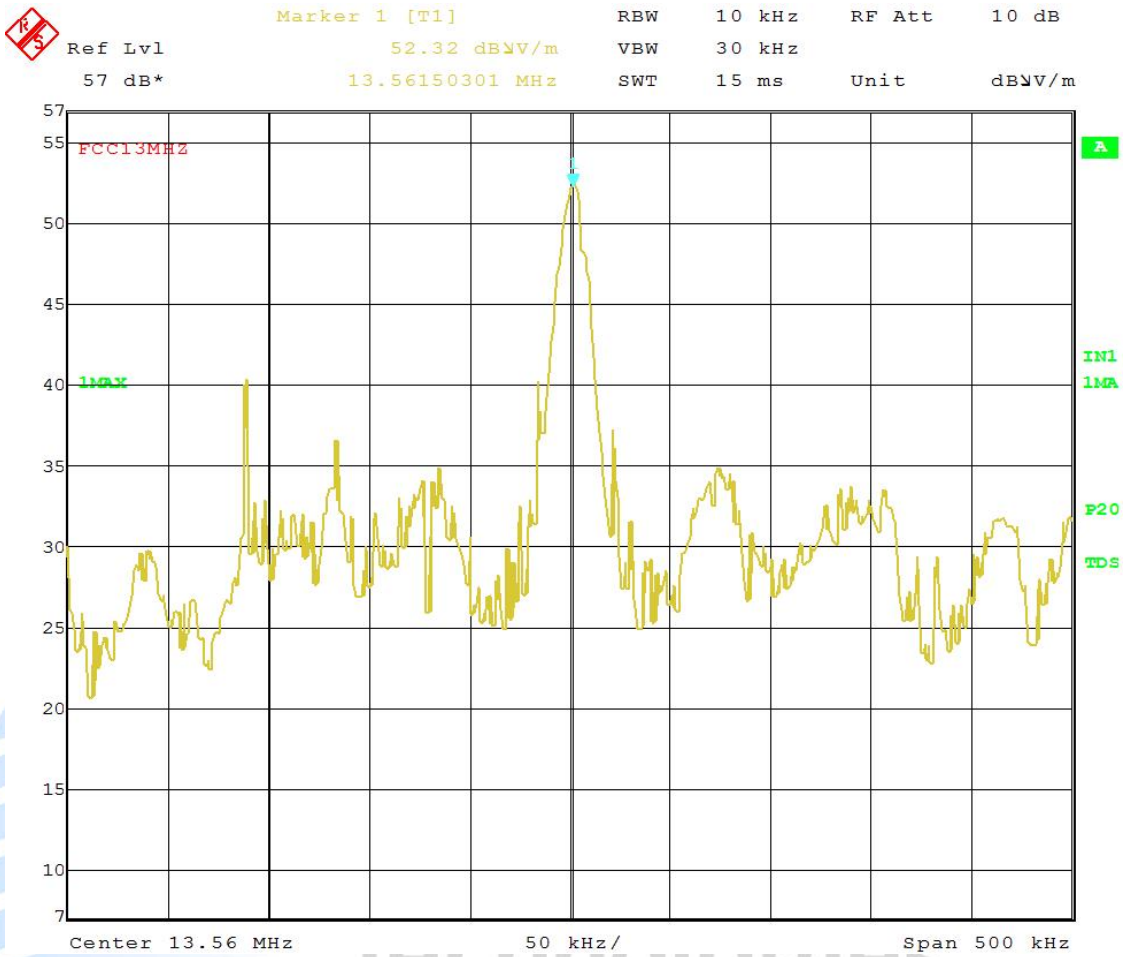
As a worst case testing was also carried out when the device was transmitting continuously when the 12.0 Vdc supply to the device was varied by +/- 15%.

Frequency (MHz)	Level (dBuV/m)	Distance (metres)	Limit (dBuV/m)	Voltage (Vdc)	Margin (dB)
13.560	46.5	10.0	103.1	10.2	56.6
13.560	46.5	10.0	103.1	12.0	56.6
13.560	46.5	10.0	103.1	13.8	56.6

A spectrum analyser plot showing the carrier and modulation peaks within, +/- 500 kHz.



A spectrum analyser plot showing the carrier and modulation peaks within, +/- 250 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 (13.560 MHz):

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	13.559 785	-215
40.0	13.559 788	-212
30.0	13.559 772	-228
20.0	13.559 723	-277
10.0	13.559 721	-279
0.0	13.559 695	-305
-10.0	13.559 681	-319
-20.0	13.559 678	-322

The 12 Vdc supply voltage was varied by +/- 15% at 20 degrees C (ambient).

Voltage (Vdc)	Frequency (MHz)	Difference (Hz)
10.2	13.559 721	-279
12.0	13.559 721	-279
13.8	13.559 722	-278

Result: Complies.

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

Section 15.249 (a) – Field strength of the Fundamental and Harmonics (2.4 GHz Bluetooth)

Radiated emission measurements were carried out with the limits as per section 15.249 (a) being applied to the Fundamental and Harmonics of each transmitter.

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

An enclosure containing absorber material, Panashield HYB-NF-12, has been placed between the turntable and the measurement antenna for when measurements are made above 1 GHz.

This material has no absorbing affect below 1 GHz with site verification measurements.

Below 1000 MHz the transmitter was placed on the test table top which was a total of 0.8 m above the test site ground plane.

Above 1000 MHz the transmitter was placed on the test table top which was a total of 1.5 m above the test site ground plane.

Measurements of the radiated field were made 3 metres from the transmitting antenna.

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.

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

The emission is measured in both vertical and horizontal antenna polarisations with no measurements were made above the 10^{th} harmonic.

Testing was carried out when the device was powered using a 12 Vdc battery.

Testing was carried out with the device being placed in the centre of the test table standing vertically upright.

The Bluetooth frequency hopping device was tested when transmitting continuously on 2402, 2426 and 2480 MHz only.

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

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

Fundamental emission

Testing was carried out as detailed below

Frequency (MHz)	Vertical (dBµV/m)	Horizontal (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Antenna Pol.	Detector	BW
2402.000	83.8	80.1	114.0	30.2	Vertical	Peak	1 MHz
2402.000	53.9	53.4	94.0	40.1	Vertical	Average	1 MHz
-	-	-	-	-	-	-	-
2426.000	85.2	80.7	114.0	28.8	Vertical	Peak	1 MHz
2426.000	54.3	53.6	94.0	39.7	Vertical	Average	1 MHz
-	-	-	-	-	-	-	-
2480.000	86.6	83.4	114.0	27.4	Vertical	Peak	1 MHz
2480.000	54.7	54.2	94.0	39.3	Vertical	Average	1 MHz

Section 15.249 specifies a limit of 50 mV/m (94 dBuV/m) when an average detector is used for devices operating in the band of 2400 – 2483.5 MHz.

A peak limit of 114 dBuV/m has also been applied.

This limit has been converted to dBuV/m using the formula 20 * (log 0.050 / 0.000001)

Result: Complies.

Measurement uncertainty with a confidence interval of 95% is:

- Free radiation tests (30 – 25,000 MHz) ± 4.1 dB

Spurious emissions

Transmitting on 2402 MHz

Frequency (MHz)	Vertical (dBuV/m)	Horizontal (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Antenna	BW
4804.000	< 59	< 59	74.0	> 15	Peak	Vert/Horiz	1 MHz
4804.000	< 46	< 46	54.0	> 8	Average	Vert/Horiz	1 MHz
-	-	-	-	-	-	-	-
7206.000	< 59	< 59	74.0	> 15	Peak	Vert/Horiz	1 MHz
7206.000	< 46	< 46	54.0	> 8	Average	Vert/Horiz	1 MHz
-	-	-	-	-	-	-	-
9608.000	< 59	< 59	74.0	> 15	Peak	Vert/Horiz	1 MHz
9608.000	< 46	< 46	54.0	> 8	Average	Vert/Horiz	1 MHz
-	-	-	-	-	-	-	-
12010.000	< 59	< 59	74.0	> 15	Peak	Vert/Horiz	1 MHz
12010.000	< 46	< 46	54.0	> 8	Average	Vert/Horiz	1 MHz
-	-	-	-	-	-	-	-
14413.000	< 59	< 59	74.0	> 15	Peak	Vert/Horiz	1 MHz
14413.000	< 46	< 46	54.0	> 8	Average	Vert/Horiz	1 MHz
-	-	-	-	-	-	-	-
16814.000	< 59	< 59	74.0	> 15	Peak	Vert/Horiz	1 MHz
16814.000	< 46	< 46	54.0	> 8	Average	Vert/Horiz	1 MHz
-	-	-	-	-	-	-	-
19216.000	< 59	< 59	74.0	> 15	Peak	Vert/Horiz	1 MHz
19216.000	< 46	< 46	54.0	> 8	Average	Vert/Horiz	1 MHz
-	-	-	-	-	-	-	-
21618.000	< 59	< 59	74.0	> 15	Peak	Vert/Horiz	1 MHz
21618.000	< 46	< 46	54.0	> 8	Average	Vert/Horiz	1 MHz
-	-	-	-	-	-	-	-
24020.000	< 59	< 59	74.0	> 15	Peak	Vert/Horiz	1 MHz
24020.000	< 46	< 46	54.0	> 8	Average	Vert/Horiz	1 MHz

Spurious emissions

Transmitting on 2426 MHz

Frequency (MHz)	Vertical (dBuV/m)	Horizontal (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Antenna	BW
4852.000	< 59	< 59	74.0	> 15	Peak	Vert/Horiz	1 MHz
4852.000	< 46	< 46	54.0	> 8	Average	Vert/Horiz	1 MHz
-	-	-	-	-	-	-	-
7278.000	< 59	< 59	74.0	> 15	Peak	Vert/Horiz	1 MHz
7278.000	< 46	< 46	54.0	> 8	Average	Vert/Horiz	1 MHz
-	-	-	-	-	-	-	-
9704.000	< 59	< 59	74.0	> 15	Peak	Vert/Horiz	1 MHz
9704.000	< 46	< 46	54.0	> 8	Average	Vert/Horiz	1 MHz
-	-	-	-	-	-	-	-
12130.000	< 59	< 59	74.0	> 15	Peak	Vert/Horiz	1 MHz
12130.000	< 46	< 46	54.0	> 8	Average	Vert/Horiz	1 MHz
-	-	-	-	-	-	-	-
14556.000	< 59	< 59	74.0	> 15	Peak	Vert/Horiz	1 MHz
14556.000	< 46	< 46	54.0	> 8	Average	Vert/Horiz	1 MHz
-	-	-	-	-	-	-	-
16982.000	< 59	< 59	74.0	> 15	Peak	Vert/Horiz	1 MHz
16982.000	< 46	< 46	54.0	> 8	Average	Vert/Horiz	1 MHz
-	-	-	-	-	-	-	-
19408.000	< 59	< 59	74.0	> 15	Peak	Vert/Horiz	1 MHz
19408.000	< 46	< 46	54.0	> 8	Average	Vert/Horiz	1 MHz
-	-	-	-	-	-	-	-
21834.000	< 59	< 59	74.0	> 15	Peak	Vert/Horiz	1 MHz
21834.000	< 46	< 46	54.0	> 8	Average	Vert/Horiz	1 MHz
-	-	-	-	-	-	-	-
24260.000	< 59	< 59	74.0	> 15	Peak	Vert/Horiz	1 MHz
24260.000	< 46	< 46	54.0	> 8	Average	Vert/Horiz	1 MHz

Spurious emissions

Transmitting on 2480 MHz

Frequency (MHz)	Vertical (dBuV/m)	Horizontal (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Antenna	BW
4960.000	< 59	< 59	74.0	> 15	Peak	Vert/Horiz	1 MHz
4960.000	< 46	< 46	54.0	> 8	Average	Vert/Horiz	1 MHz
-	-	-	-	-	-	-	-
7440.000	< 59	< 59	74.0	> 15	Peak	Vert/Horiz	1 MHz
7440.000	< 46	< 46	54.0	> 8	Average	Vert/Horiz	1 MHz
-	-	-	-	-	-	-	-
9920.000	< 59	< 59	74.0	> 15	Peak	Vert/Horiz	1 MHz
9920.000	< 46	< 46	54.0	> 8	Average	Vert/Horiz	1 MHz
-	-	-	-	-	-	-	-
12400.000	< 59	< 59	74.0	> 15	Peak	Vert/Horiz	1 MHz
12400.000	< 46	< 46	54.0	> 8	Average	Vert/Horiz	1 MHz
-	-	-	-	-	-	-	-
14880.000	< 59	< 59	74.0	> 15	Peak	Vert/Horiz	1 MHz
14880.000	< 46	< 46	54.0	> 8	Average	Vert/Horiz	1 MHz
-	-	-	-	-	-	-	-
17360.000	< 59	< 59	74.0	> 15	Peak	Vert/Horiz	1 MHz
17360.000	< 46	< 46	54.0	> 8	Average	Vert/Horiz	1 MHz
-	-	-	-	-	-	-	-
19840.000	< 59	< 59	74.0	> 15	Peak	Vert/Horiz	1 MHz
19840.000	< 46	< 46	54.0	> 8	Average	Vert/Horiz	1 MHz
-	-	-	-	-	-	-	-
22320.000	< 59	< 59	74.0	> 15	Peak	Vert/Horiz	1 MHz
22320.000	< 46	< 46	54.0	> 8	Average	Vert/Horiz	1 MHz
-	-	-	-	-	-	-	-
24800.000	< 59	< 59	74.0	> 15	Peak	Vert/Horiz	1 MHz
24800.000	< 46	< 46	54.0	> 8	Average	Vert/Horiz	1 MHz

Measurements were performed at a distance of 3 metres using vertical and horizontal polarisations with a peak and an average detector with a 1 MHz bandwidth being used.

As per section 15.249 a limit of 500 uV/m applies to the harmonic emissions when an average detector is used.

This limit has been converted to dBuV/m using the formula 20 * (log 500) with a factor of + 20 dB being added to determine the peak limit.

Result: Complies.

Measurement uncertainty with a confidence interval of 95% is:
- Free radiation tests (30 – 25,000 MHz) ± 4.1 dB

Section 15.215 (c) – Additional provisions to the general radiated emission limitations (2.4 GHz Bluetooth)

The device operates in the 2400 – 2483.5 MHz band.

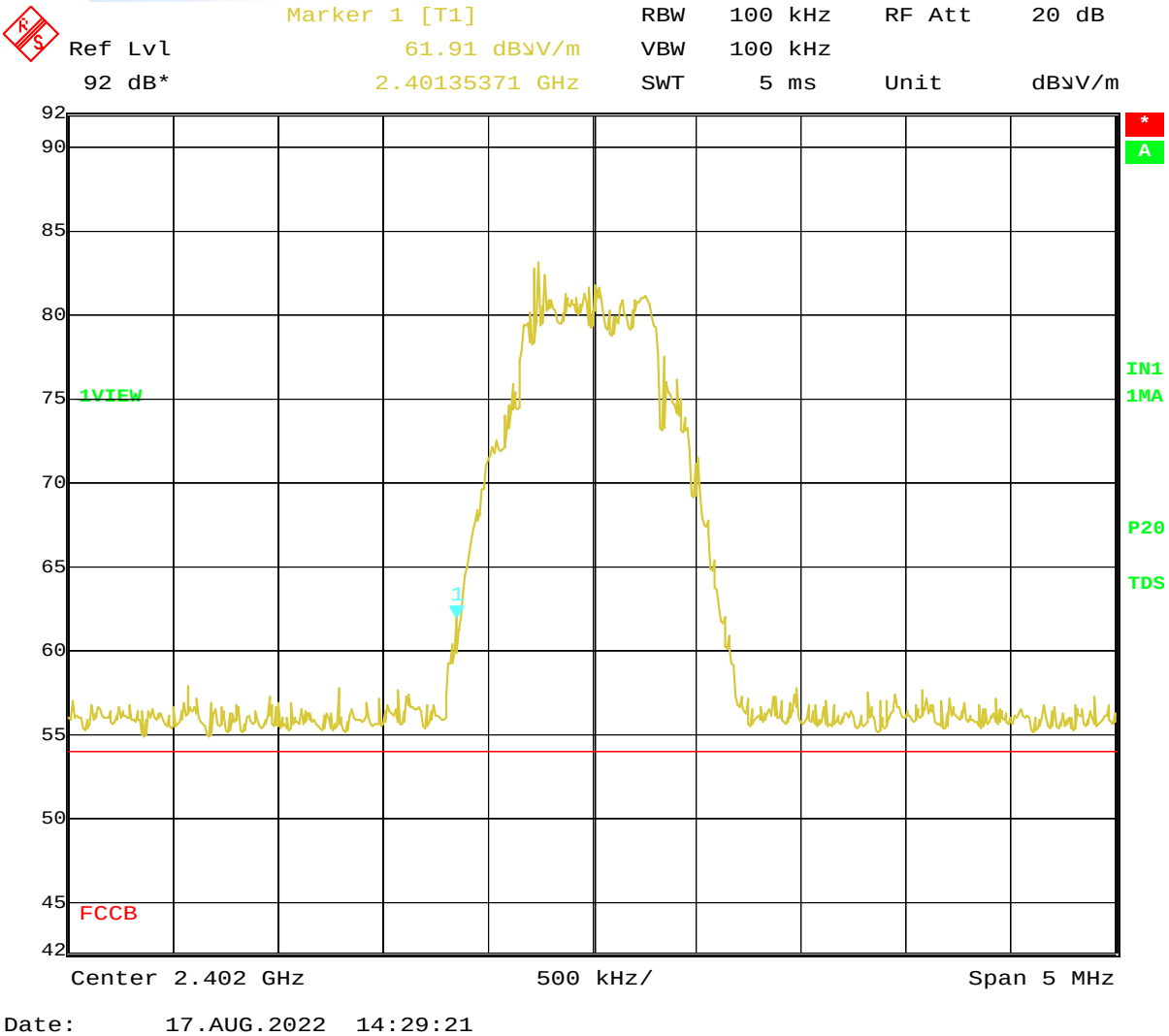
Relative spectrum mask measurements have been made when the device was operating on 2402 MHz, 2426 MHz and 2480 MHz

Measurements made at the -20 dB points.

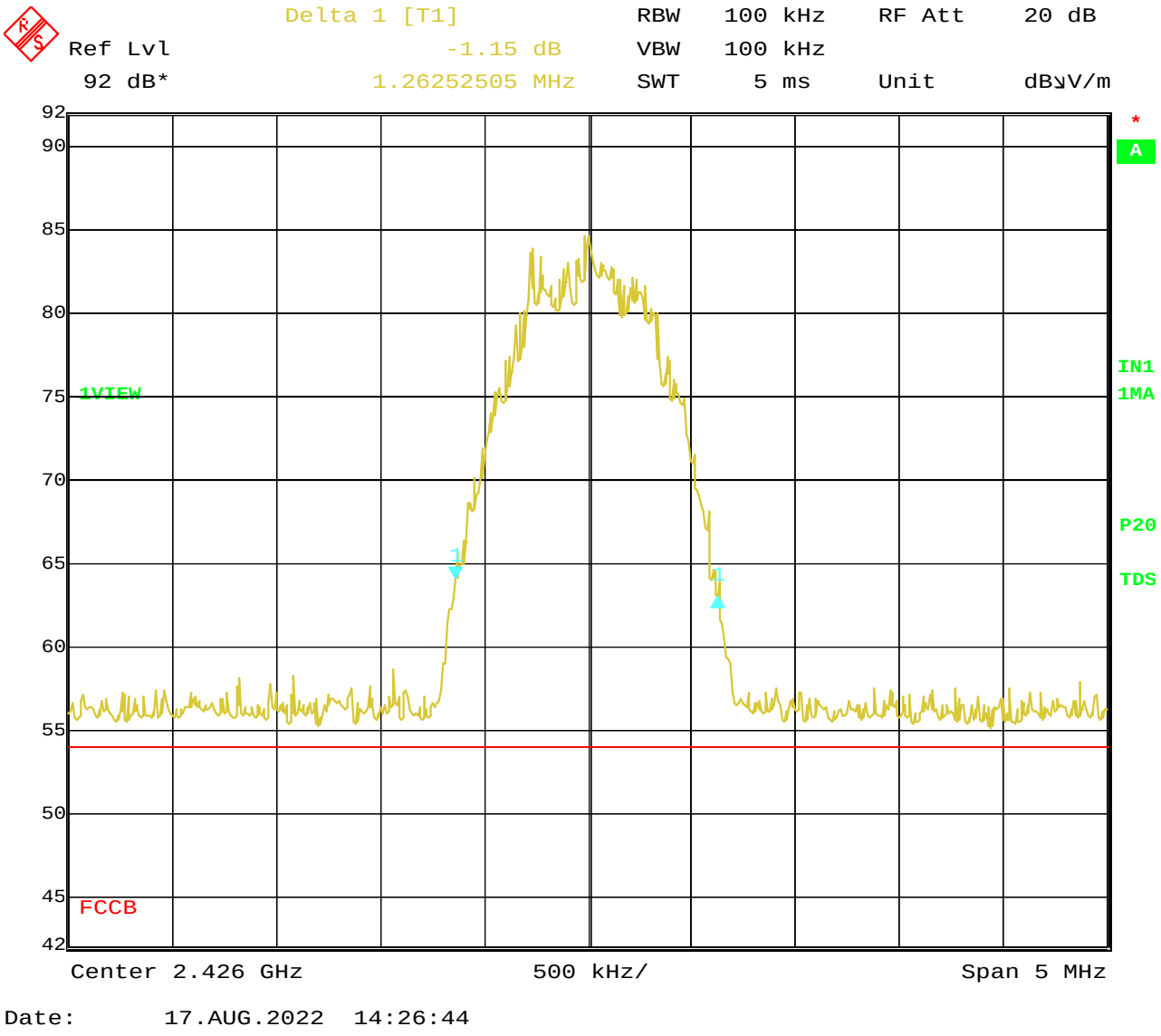
Frequency (MHz)	F low (MHz)	F high (MHz)
2402.000	2401.3537	-
2480.000	-	2480.6162

The device can be seen to stay within the band of 2400 – 2483.5 MHz at the -20 dB points

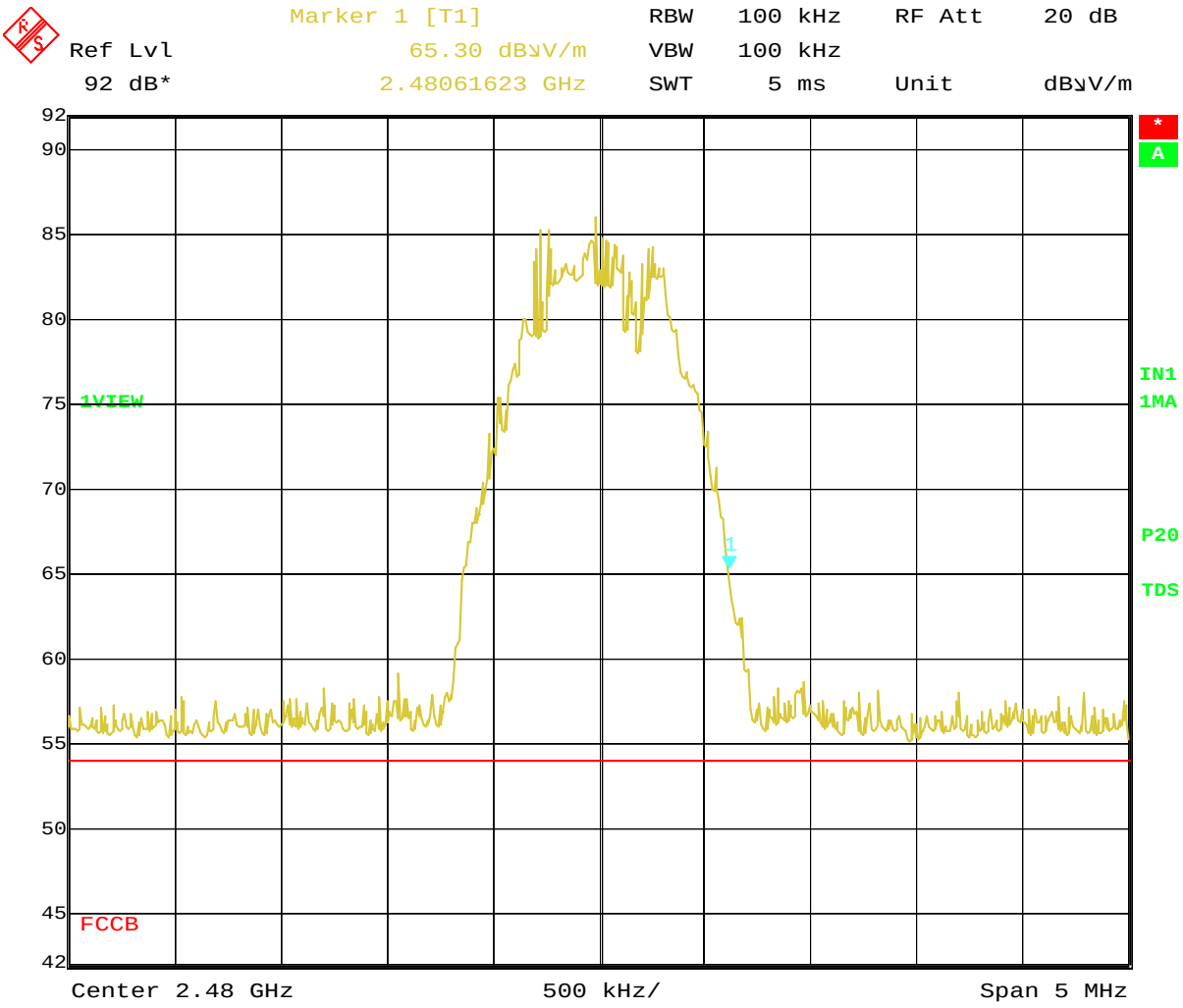
Transmitting on 2402 MHz



Transmitting on 2426 MHz. 20 dB bandwidth = 1.26 MHz.



Transmitting on 2480 MHz



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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 2023	3 years
Horn Antenna	EMCO	3115	9511-4629	E1526	1 Jan 2023	3 years
Horn Antenna	EMCO	3116	92035	E1527	1 Jan 2023	3 years
Log Periodic	Schwarzbeck	VUSLP 9111	9111-112	EMC4025	25 Mar 2023	3 years
Loop Antenna	EMCO	6502	9003-2485	3798	12 Feb 2023	3 years
Mains Network	R & S	ESH2-Z5	881362/032	3628	17 May 2023	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 2023	3 years
Heliax cable	Andrews	L6PNM-RPD	22869	Oats Cable	30 Dec 2023	1 year
Succoflex cable	Huber and Suhner	104 3m n-n	339901/4	13938	10 Nov 2023	1 year
Succoflex cable	Huber and Suhner	104 1m n-n	340521/4	13937	10 Nov 2023	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

At the time of testing all equipment was within calibration.

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.

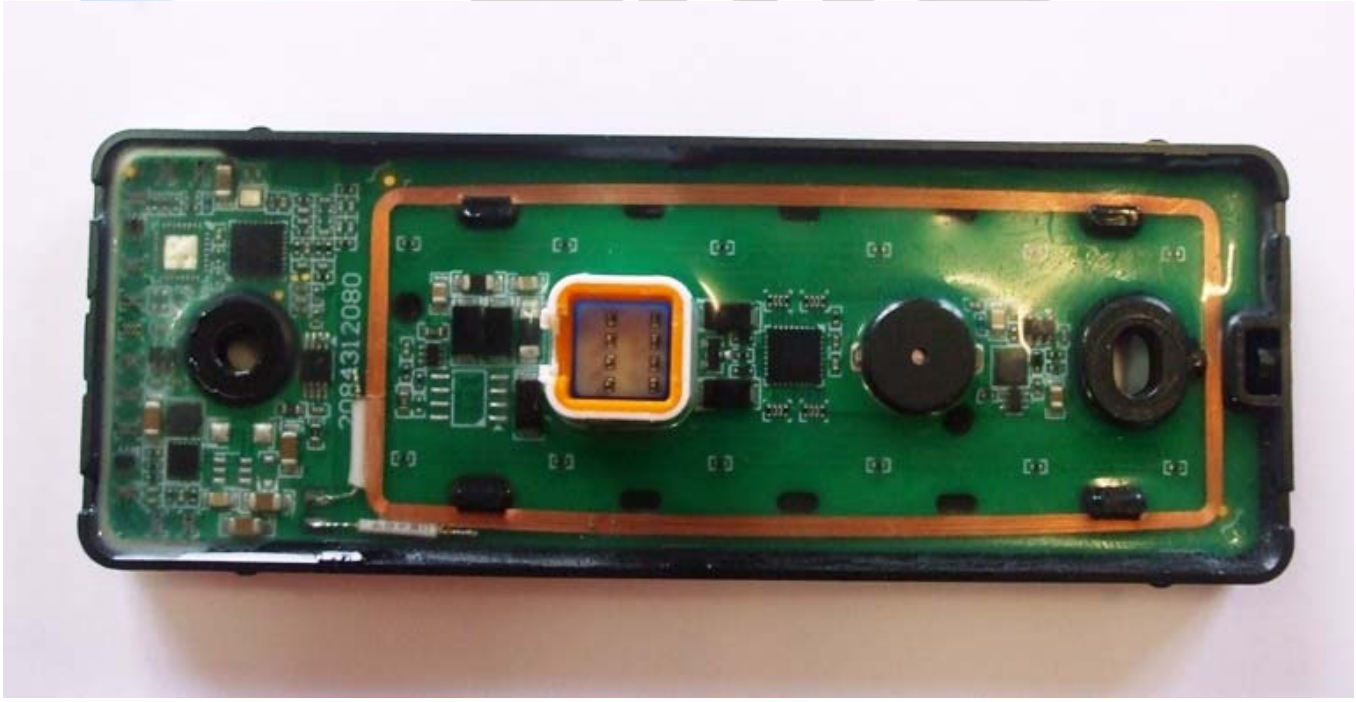
This includes NATA (Australia), UKAS (UK), SANAS (South Africa), NVLAP (USA), A2LA (USA), SWEDAC (Sweden).

Further details can be supplied on request.

9. PHOTOGRAPHS

Front View

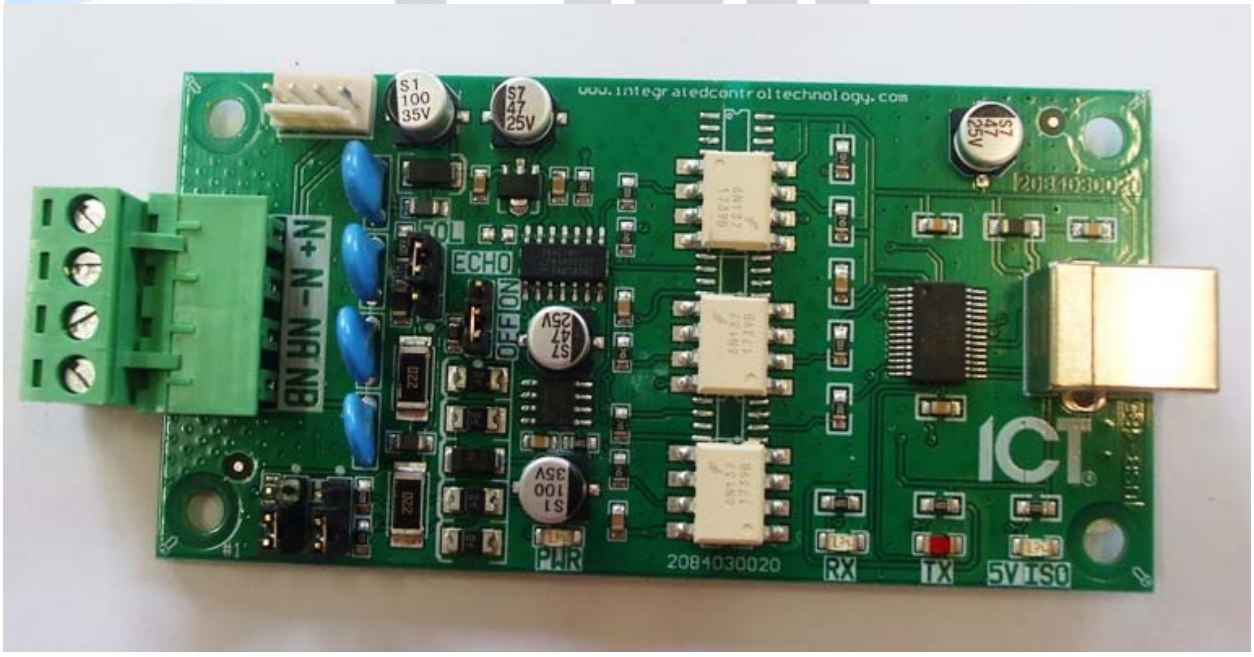
Back View



Side View

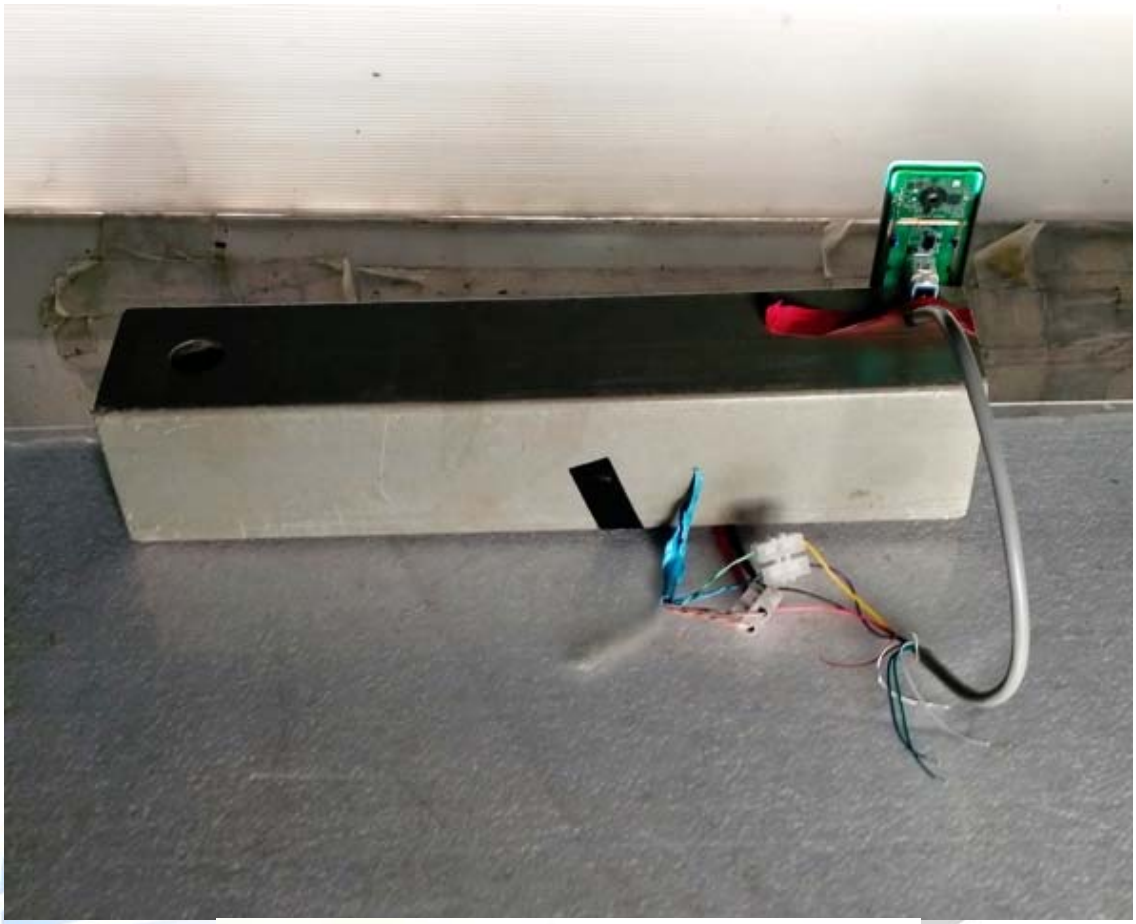
Ancillary: RS-485 to USB to Serial convertor board

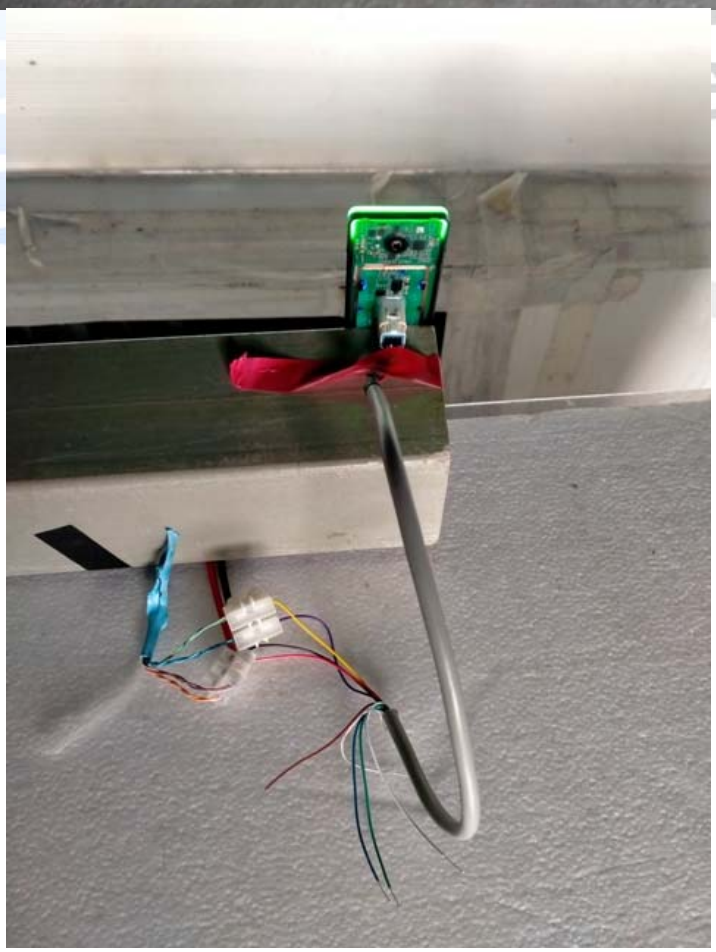
Ancillary: RS-485 to USB to Serial convertor board

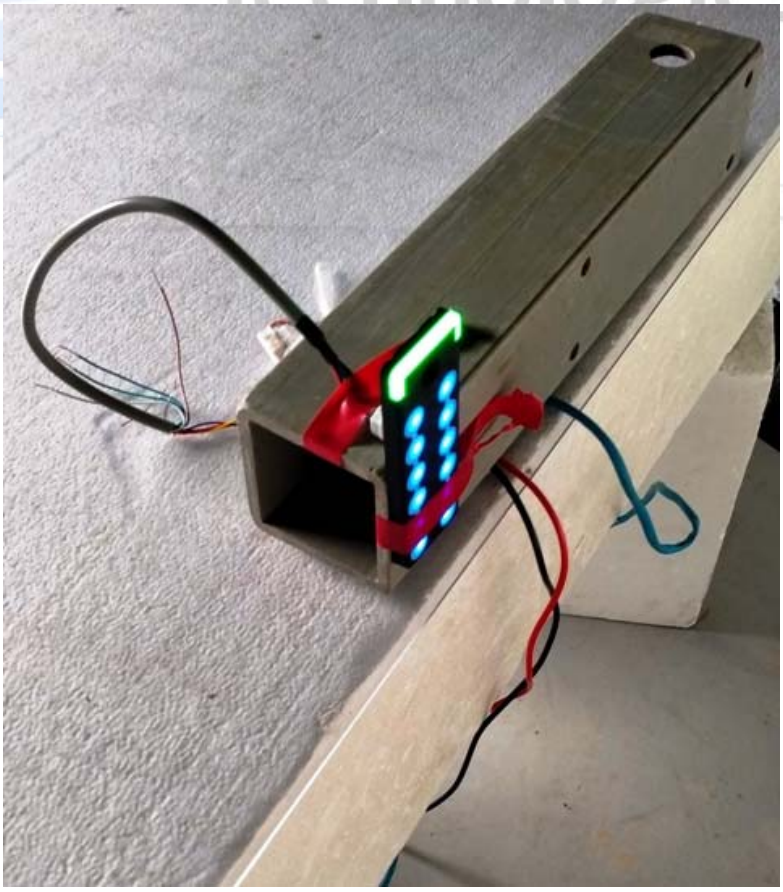


Conducted emissions test setup

Radiated emissions test setup







Radiated emissions ancillary equipment