Radio Test Report

Bare Conductive Ltd

Severn Board

BLD5

47 CFR Part 15.247 Effective Date 1st October 2020
DSS: Part 15 Spread Spectrum Transmitter
Test Date: 17th June 2022 to 28th June 2022
Report Number: 06-13539-5-22 Issue 02
Supersedes report: 06-13539-5-22 Issue 01

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This laboratory is accredited in accordance with the recognised International Standard ISO/IEC 17025. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer joint ISO-ILAC-IAF communiqué dated April 2017).

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Certificate of Test 13539-5

The equipment noted below has been fully tested by R.N. Electronics Limited and, where appropriate, conforms to the relevant subpart of 47 CFR Part 15C. This is a certificate of test only and should not be confused with an equipment authorisation. Other standards may also apply.

Equipment:	Severn Board
Model Number:	BLD5
Unique Serial Number:	2213010300000002 (Radiated unit) 2213010300000003 (Conducted unit)
Applicant:	Bare Conductive Ltd 98 Commercial Street London E1 6LZ
Proposed FCC ID	2A6TX-LRSB001
Full measurement results are detailed in Report Number:	06-13539-5-22 Issue 02
Test Standards:	47 CFR Part 15.247 Effective Date 1st October 2020 DSS: Part 15 Spread Spectrum Transmitter

NOTE:
Certain tests were not performed based upon applicant's declarations. Certain other requirements are subject to applicant's declaration only and have not been tested/verified. For details refer to section 3 of this report.

DEVIATIONS:
No deviations have been applied.

This certificate relates only to the unit tested as identified by a unique serial number and in the condition at the time it was tested. It does not relate to any other similar equipment and performance of the product before or after the test cannot be guaranteed. Whilst every effort is made to assure quality of testing, type tests are not exhaustive and although no non-conformances may be found, this doesn't exclude the possibility of unit not meeting the intentions of the standard or the requirements of the Federal Regulations, particularly under different conditions to those during testing. Any compliance statements are made reliant on (a) the application of the product and use of the assigned band being acceptable to the FCC and (b) the modes of operation as instructed to us by the Customer based on their specific knowledge of the application and functionality of the EUT. Statements of compliance, where measurements were made, do not include the measurement uncertainty. The measurement uncertainty, where stated, is the expanded uncertainty based on a standard uncertainty multiplied by a coverage factor of k=2, providing a level of confidence of approximately 95%.

Date Of Test: 17th June 2022 to 28th June 2022

Test Engineer: Digitally signed by: Daniel Sims
DN: CN = Daniel Sims C = GB O = RN Electronics Ltd
Date: 2022.12.05 14:12:24 Z

Approved By:
Test Development Engineer: Ian Rose
Digitally signed by: Ian Rose
DN: CN = Ian Rose email = Ian@RNElectronics.com C = GB O = Rn Electronics
Date: 2022.12.05 14:31:50 Z

Customer Representative:

2360

0 Revision History

Issue Number	Revision History	Page Reference(s)
01	First Issue	-
02	Updated report issue no. and filename issue number Updated date of issue Firmware/FVIN updated to WL001.000.000 Declared Antenna Gain updated to 2.4dBi for SMD915	1,2 5 7 7

1 Contents

2 Equipment under test (EUT)

2.1 Equipment specification

Applicant	Bare Conductive Ltd 98 Commercial Street London E1 6LZ	
Manufacturer of EUT	Bare Conductive Ltd	
Full Name of EUT	Severn Board	
Model Number of EUT	BLD5	
Serial Number of EUT	2213010300000002 (Radiated unit) 2213010300000003 (Conducted unit)	
Date Received	30th May 2022	
Date of Test:	17th June 2022 to 28th June 2022	
Purpose of Test	To demonstrate design compliance to the relevant rules of Chapter 47 of the Code of Federal Regulations.	
Date Report Issued	16th November 2022	
Main Function	Battery powered LoRaWAN connected water leak detector	
Information Specification	Height	23 mm
	Width	62 mm
	Depth	95 mm
	Weight	0.15 kg
	Voltage	3.6 V dc Lithium AA Battery
	Current	Not specified

2.2 Configurations for testing

General Parameters	
EUT Normal use position	Various
Choice of model(s) for type tests	Pre-production
Antenna details	Integral antenna: Proant PRO-OB-471, 2.4dBi (SMD915)
Antenna port	No
Baseband Data port (yes/no)?	No
Highest Signal generated in EUT	914.9 MHz (High TX Channel)
Lowest Signal generated in EUT	32.768 kHz
Hardware Version (HVIN)	BLD5
Software Version	N/A
Firmware Version (FVIN)	WL001.000.000
Type of Equipment	Portable
Technology Type	LoRa (FHSS)
Geo-location (yes/no)	No
TX Parameters	
Alignment range – transmitter	902.3-914.9 MHz
EUT Declared Modulation Parameters	FHSS with CSS
EUT Declared Power level	+22dBm Conducted
EUT Declared Signal Bandwidths	125 kHz set
EUT Declared Channel Spacing's	200 kHz
EUT Declared Duty Cycle	<0.1%
Unmodulated carrier available?	Yes
Declared frequency stability	Not specified
RX Parameters	
Alignment range – receiver	902.3-914.9 MHz
EUT Declared RX Signal Bandwidth	125 kHz
Receiver Signal Level (RSL)	Approx. -120 dBm
Method of Monitoring Receiver BER	Not required
FCC Parameters	
FCC Transmitter Class	DSS: Part 15 Spread Spectrum Transmitter
FHSS Parameters	
No. Of hop channels	64
Dwell time per hop channel	<400 ms

2.3 Functional description

Unit comprises a main PCB housed within an enclosure. A Lithium Thionyl Chloride AA cell is fitted to the PCB to power the system and a printed sensor attaches to a zero-insertion force flat-flex connector on the PCB. The sensor comprises carbon-based conductive ink printed on a PET substrate. Once the battery is inserted and the enclosure is shut, the unit is controlled using a magnet that triggers a magnet sensor on the PCB and the unit status is indicated using an onboard RGB LED.

At power-on, the device connects to a LoRaWAN network via OTAA authentication and then is stepped through signal strength indication and self-test using a magnet swipe gesture to advance each stage. Status at each stage is indicated by flashing the RGB LED specific colours and in specific patterns. Once self-test is passed the unit enters a low-power state, waking once every minute to measure a number of resistances on the printed sensor. LoRaWAN messages are sent to determine signal strength and to communicate the self-test result to the gateway.

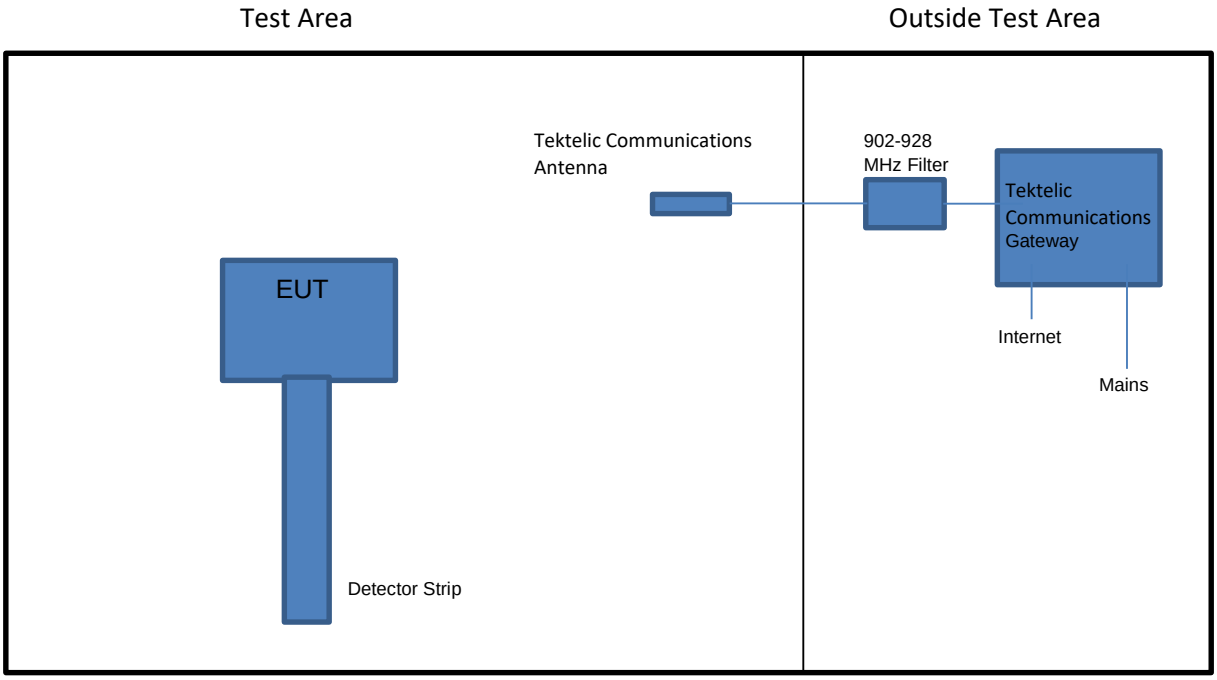
If the resistances on the printed sensor breach particular thresholds, a LoRaWAN message is sent. If a given period has elapsed with no LoRaWAN messages having been sent, a "heartbeat" message is sent to indicate that the unit is still operating.

Swiping the magnet across the unit when it is running puts it back into self-test mode, sending another LoRaWAN message after self-test runs - this allows the end user to check that the unit is operating correctly if required.

2.4 Modes of operation

Mode Reference	Description	Used for testing
Mode 1	Continuous Transmit with Modulation, Low Channel (902.3MHz) SF7	Yes
Mode 2	Continuous Transmit with Modulation, Low Channel (902.3MHz) SF10	Yes
Mode 3	Continuous Transmit with Modulation, Mid Channel (908.6MHz) SF7	Yes
Mode 4	Continuous Transmit with Modulation, Mid Channel (908.6MHz) SF10	Yes
Mode 5	Continuous Transmit with Modulation, High Channel (914.9MHz) SF7	Yes
Mode 6	Continuous Transmit with Modulation, High Channel (914.9MHz) SF10	Yes
Mode 7	Hopping All channels SF10	Yes

2.5 Emissions configuration



The equipment under test was supplied by a new 3.6V Lithium Thionyl Chloride AA battery, normally supplied with the EUT. The detector strip supplied was considered part of the EUT and was fitted for all tests.
There were no other ports on the EUT.
For radiated emissions tests the standard integral antenna unit was situated in the test chamber and support equipment was situated outside the chamber and was used to verify operation of the equipment, where required.

For conducted tests a UFL to SMA lead was connected directly to the RAK3172. The units software/firmware was updated to include engineering test modes to allow permanent transmit and hopping/ non-hopping modes of the device on the top, middle and bottom channels as stated within section 2.4 of this report. The power settings for each channel were as provided, and at the default settings with no power control provided or available during testing.-

Low Channel 902.3 MHz
Mid Channel 908.6 MHz
High Channel 914.9 MHz

2.5.1 Signal leads

Port Name	Cable Type	Connected
Detector strip	Specialised Detector strip	Yes

3 Summary of test results

The Severn Board, BLD5 was tested for compliance to the following standard(s):

47 CFR Part 15.247 Effective Date 1st October 2020
DSS: Part 15 Spread Spectrum Transmitter

Any compliance statements are made reliant on (a) the application of the product and use of the assigned band being acceptable to the FCC and (b) the modes of operation as instructed to us by the Customer based on their specific knowledge of the application and functionality of the EUT. Whilst every effort is made to assure quality of testing, type tests are not exhaustive and although no non-conformances may be found, this doesn't exclude the possibility of equipment not meeting the intentions of the standard or the essential requirements of the directive, particularly under different conditions to those during testing. Statements of compliance, where measurements were made, do not include the measurement uncertainty. The measurement uncertainty, where stated, is the expanded uncertainty based on a standard uncertainty multiplied by a coverage factor of k=2, providing a level of confidence of approximately 95%.

Title	References	Results
Transmitter Tests		
1. AC power line conducted emissions	47 CFR Part 15C Part 15.207	NOT APPLICABLE[1]
2. Radiated emissions 9 - 150 kHz	47 CFR Part 15C Part 15.209	PASSED
3. Radiated emissions 150 kHz - 30 MHz	47 CFR Part 15C Part 15.209	PASSED
4. Radiated emissions 30 MHz -1 GHz	47 CFR Part 15C Part 15.247(d) & 15.209	PASSED
5. Radiated emissions above 1 GHz	47 CFR Part 15C Part 15.247(d) & 15.209	PASSED[2]
6. Effective radiated power field strength	47 CFR Part 15C Part 15.247(d)	PASSED
7. Band Edge Compliance	47 CFR Part 15C Part 15.215 & 15.247(d)	PASSED
8. Occupied bandwidth	47 CFR Part 15C Part 15.247(a)(1)(i)	PASSED
9. Maximum Average conducted output power	47 CFR Part 15C Part 15.247(b)(3)	NOT APPLICABLE[3]
10. Maximum Peak conducted output power	47 CFR Part 15C Part 15.247(b)(3)	PASSED
11. Maximum Power Spectral Density	47 CFR Part 15C Part 15.247(e)	NOT APPLICABLE[4]
12. Antenna power conducted emissions	47 CFR Part 15C Part 15.247(d)	NOT APPLICABLE[5]
13. Duty cycle	47 CFR Part 15C Part 15.35(c)	NOT APPLICABLE[6]
14. FHSS carrier frequency separation	47 CFR Part 15C Part 15.247(a1)	PASSED
15. Average time of occupancy	47 CFR Part 15C Part 15.247(a)(1)(i)	PASSED
16. Number of Hop Channels	47 CFR Part 15C Part 15.247(a)(1)(i)	PASSED

[1] EUT does not operate from the AC power lines nor contain provisions for operation while connected to AC power lines.
[2] Spectrum investigated up to a frequency of 9.2GHz based on 10 times the highest Transmit channel generated in equipment of 914.9MHz.
[3] Peak conducted power tested instead.
[4] EUT uses FHSS technology and is therefore not applicable to this test.
[5] Applies to EUT's with an antenna port. The EUT has an integral antenna only & the EUT was tested for radiated emissions with its dedicated antenna in position.
[6] EUT does not employ DTS technology, FHSS timings are covered under average time of occupancy test.

4 Specifications

The tests were performed and operated in accordance with R.N. Electronics Ltd procedures and the relevant standards listed below.

4.1 Relevant standards

Ref.	Standard Number	Version	Description
4.1.1	47 CFR Part 15C	2020	Federal Communications Commission PART 15 – RADIO FREQUENCY DEVICES
4.1.2	ANSI C63.10	2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
4.1.3	ANSI C63.4	2014	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
4.1.4	KDB 558074 D01 v05r02	2019	Federal Communications Commission Office of Engineering and Technology Laboratory Division; GUIDANCE FOR COMPLIANCE MEASUREMENTS ON DIGITAL TRANSMISSION SYSTEM, FREQUENCY HOPPING SPREAD SPECTRUM SYSTEM, AND HYBRID SYSTEM DEVICES OPERATING UNDER SECTION 15.247 OF THE FCC RULES

4.2 Deviations

No deviations were applied.

5 Tests, methods and results

5.1 AC power line conducted emissions

NOT APPLICABLE: EUT does not operate from the AC power lines nor contain provisions for operation while connected to AC power lines.

5.2 Radiated emissions 9 - 150 kHz

5.2.1 Test methods

Test Requirements:	47 CFR Part 15C Part 15.209 [Reference 4.1.1 of this report]
Test Method:	ANSI C63.10 Clause 6.4 [Reference 4.1.2 of this report]
Limits:	47 CFR Part 15C Part 15.209/15.247(d) [Reference 4.1.1 of this report]

5.2.2 Configuration of EUT

The EUT was placed on a 0.8 metres high turntable. The front edge of the EUT was initially positioned facing the antenna. The EUT was measured at a distance of 3 metres. The EUT was rotated in all three orthogonal planes. Radiated Emissions testing was performed with a new battery.
No discernible difference was noted between channels/modes so mode 4 was used for full tests.

5.2.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment noted below.
Measurements were made in a semi-anechoic chamber (pre-scan) with any final measurements required performed on an OATS without a ground plane. The antenna was placed 1m above the ground. The equipment was rotated 360 degrees to record the worst case emissions.
At least 6 signals within 20dB and all signals within 10dB of the limit were investigated.
Tests were performed using Test Site M.

5.2.4 Test equipment

TMS81, ZSW1, E624, E411

See Section 9 for more details

5.2.5 Test results

Temperature of test environment	18°C
Humidity of test environment	59%
Pressure of test environment	101kPa

Band	902-928 MHz
Power Level	22 dBm
Channel Spacing	200 kHz
Mod Scheme	LoRa SF10
Mid channel	908.6 MHz

Plot refs
13539-5 Rad 2 9k-150kHz Para
13539-5 Rad 2 9k-150kHz Perp

Peak detector “Max held” Analyser plots against the Quasi-Peak / Average limit line(s) can be found in Section 6 of this report.

LIMITS:
15.209 limits are applicable in the restricted bands of 15.205 with the relevant detector.
15.247(d) other emissions, outside the intentional band, must be attenuated by at least 20/30dB from the level of the fundamental / meet the general limits of 15.209.
The general limits of 15.209 are as drawn on the respective plots.

These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows:

9kHz - 30MHz ±3.9dB

5.3 Radiated emissions 150 kHz - 30 MHz

5.3.1 Test methods

Test Requirements:	47 CFR Part 15C Part 15.209 [Reference 4.1.1 of this report]
Test Method:	ANSI C63.10 Clause 6.4 [Reference 4.1.2 of this report]
Limits:	47 CFR Part 15C Part 15.209/15.247(d) [Reference 4.1.1 of this report]

5.3.2 Configuration of EUT

The EUT was placed on a 0.8 metres high turntable. The front edge of the EUT was initially positioned facing the antenna. The EUT was measured at a distance of 3 metres. The EUT was rotated in all three orthogonal planes. Radiated Emissions testing was performed with a new battery.
No discernible difference was noted between channels/modes so mode 4 was used for full tests.

5.3.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment noted below.
Measurements were made in a semi-anechoic chamber (pre-scan) with any final measurements required performed on an OATS without a ground plane. The antenna was placed 1m above the ground. The equipment was rotated 360 degrees to record the worst case emissions.
At least 6 signals within 20dB and all signals within 10dB of the limit were investigated.

Tests were performed using Test Site M.

5.3.4 Test equipment

TMS81, ZSW1, E624, E411

See Section 9 for more details

5.3.5 Test results

Temperature of test environment	18°C
Humidity of test environment	59%
Pressure of test environment	101kPa

Band	902-928 MHz
Power Level	22 dBm
Channel Spacing	200 kHz
Mod Scheme	LoRa SF10
Mid channel	902.3 MHz

Plot refs
13539-5 Rad 2 150k-30MHz Para
13539-5 Rad 2 150k-30MHz Perp

Peak detector “Max held” Analyser plots against the Quasi-Peak / Average limit line(s) can be found in Section 6 of this report.

LIMITS:
15.209 limits are applicable in the restricted bands of 15.205 with the relevant detector.
15.247(d) other emissions, outside the intentional band, must be attenuated by at least 20/30dB from the level of the fundamental / meet the general limits of 15.209.
The general limits of 15.209 are as drawn on the respective plots.

These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows:
9kHz - 30MHz ±3.9dB

5.4 Radiated emissions 30 MHz -1 GHz

5.4.1 Test methods

Test Requirements:	47 CFR Part 15C Part 15.247(d) & 15.209 [Reference 4.1.1 of this report]
Test Method:	ANSI C63.10 Clause 6.5 [Reference 4.1.2 of this report]
Limits:	47 CFR Part 15C Part 15.209/15.247(d) [Reference 4.1.1 of this report]

5.4.2 Configuration of EUT

The EUT was placed on a 0.8 metres high turntable. The front edge of the EUT was initially positioned facing the antenna. The EUT was measured at a distance of 3 metres. The EUT was rotated in all three orthogonal planes. Radiated Emissions testing was performed with a new battery. No discernible difference was noted between Spreading Factor 7 and 10 modes, therefore for full tests the EUT was operated in Mode 2, Mode 4 and Mode 6.

5.4.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment noted below.
The equipment was rotated 360 degrees and the antenna scanned 1 – 4 metres in both horizontal and vertical polarisations to record the worst case emissions.
At least 6 signals within 20dB and all signals within 10dB of the limit were investigated.

Tests were performed using Test Site M.

5.4.4 Test equipment

LPE364, E743, NSA-M, ZSW1, E624, E411

See Section 9 for more details

5.4.5 Test results

Temperature of test environment	17 - 18°C
Humidity of test environment	59 - 61%
Pressure of test environment	101kPa

Band	902-928 MHz
Power Level	22 dBm
Channel Spacing	200 kHz
Mod Scheme	LoRa SF10
Low channel	902.3 MHz

Plot refs
13539-5 Rad 1 VHF Horiz
13539-5 Rad 1 VHF Vert
13539-5 Rad 1 UHF Horiz
13539-5 Rad 1 UHF Vert

Band	902-928 MHz
Power Level	22 dBm
Channel Spacing	200 kHz
Mod Scheme	LoRa SF10
Mid channel	908.6 MHz

Plot refs
13539-5 Rad 2 VHF Horiz
13539-5 Rad 2 VHF Vert
13539-5 Rad 2 UHF Horiz
13539-5 Rad 2 UHF Vert

Band	902-928 MHz
Power Level	22 dBm
Channel Spacing	200 kHz
Mod Scheme	LoRa SF10
High channel	914.9 MHz

Plot refs
13539-5 Rad 3 VHF Horiz
13539-5 Rad 3 VHF Vert
13539-5 Rad 3 UHF Horiz
13539-5 Rad 3 UHF Vert

Table of signals measured for Rad 1 Horizontal Sig List

Signal No.	Freq (MHz)	Peak Amp (dBuV/m)	QP Amp (dBuV/m)	QP -Lim (dB)
1	46.700	23.6	17.8	-22.2
2	870.241	39.3	35.9	-10.1
3	885.771	35.4	29.1	-16.9
4	907.490	39.2	32.9	-13.1
5	934.240	36.9	32.7	-13.3

Table of signals measured for Rad 1 Vertical Sig List

Signal No.	Freq (MHz)	Peak Amp (dBuV/m)	QP Amp (dBuV/m)	QP -Lim (dB)
1	870.240	38.5	34.1	-11.9
2	934.298	38.6	34.0	-12.0

Table of signals measured for Rad 2 Horizontal Sig List

Signal No.	Freq (MHz)	Peak Amp (dBuV/m)	QP Amp (dBuV/m)	QP -Lim (dB)
1	876.636	39.1	35.1	-10.9
2	940.607	34.5	34.9	-11.1

Table of signals measured for Rad 2 Vertical Sig List

Signal No.	Freq (MHz)	Peak Amp (dBuV/m)	QP Amp (dBuV/m)	QP -Lim (dB)
1	876.576	36.6	31.1	-14.9
2	940.608	37.7	33.2	-12.8

Table of signals measured for Rad 3 Horizontal Sig List

Signal No.	Freq (MHz)	Peak Amp (dBuV/m)	QP Amp (dBuV/m)	QP -Lim (dB)
1	882.900	38.2	34.1	-11.9
2	946.869	38.2	31.2	-14.8

Table of signals measured for Rad 3 Vertical Sig List

Signal No.	Freq (MHz)	Peak Amp (dBuV/m)	QP Amp (dBuV/m)	QP -Lim (dB)
1	882.880	35.0	31.6	-14.4
2	946.962	36.2	31.8	-14.2

Peak detector “Max held” Analyser plots against the Quasi-Peak / Average limit line(s) can be found in Section 6 of this report.

No discernible difference was noted in emissions between Spreading factor settings (exploratory measurements), therefore final measurements are presented for SF10 Low, Mid and High channel modes. For band edge requirements please refer to section 5.7 within this report.

LIMITS:
15.209 limits are applicable in the restricted bands of 15.205 with the relevant detector.
15.247(d) other emissions, outside the intentional band, must be attenuated by at least 20/30dB from the level of the fundamental / meet the general limits of 15.209.
The general limits of 15.209 are as drawn on the respective plots.

These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows:
30MHz - 1000MHz ±6.1dB

5.5 Radiated emissions above 1 GHz

5.5.1 Test methods

Test Requirements:	47 CFR Part 15C Part 15.247(d) & 15.209 [Reference 4.1.1 of this report]
Test Method:	ANSI C63.10 Clause 6.6 [Reference 4.1.2 of this report]
Limits:	47 CFR Part 15C Part 15.247(d) & 15.209 [Reference 4.1.1 of this report]

5.5.2 Configuration of EUT

The EUT was placed on a 1.5 metres high turntable. The front edge of the EUT was initially positioned facing the antenna. The EUT was measured at a distance of 3 metres. The EUT was rotated in all three orthogonal planes. Radiated Emissions testing was performed with a new battery. No discernible difference was noted between Spreading Factor 7 and 10 modes, therefore for full tests the EUT was operated in Mode 2, Mode 4 and Mode 6.

5.5.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment noted below. Measurements were made in a semi-anechoic chamber with appropriate absorbing material for use in this range. Horn antennas were used at heights where the whole of the EUT was contained within the main beam and emissions maximised. The EUT was rotated through 360 degrees to record the worst case emissions. A measurement distance of 3m was used between the test range 1 - 6GHz, and 1.2m was used in the test range 6 – 9.2GHz.
At least 6 signals within 20dB and all signals within 10dB of the limit were investigated.
Tests were performed using Test Site M.

5.5.4 Test equipment

E136, E411, E624, F269, F270, TMS82.

See Section 9 for more details

5.5.5 Test results

Temperature of test environment	16°C
Humidity of test environment	65%
Pressure of test environment	101.5kPa

Setup Table

Band	902-928 MHz
Power Level	22 dBm
Channel Spacing	200 kHz
Mod Scheme	LoRa SF10
Low channel	902.3 MHz

Spurious Frequency (MHz)	Measured Peak Level (dBµV/m)	Difference to Peak Limit (dB)	Measured Average Level (dBµV/m)	Difference to Average Limit (dB)	EUT Polarisation	Antenna Polarisation
1804.6	46.39	-27.61	43.59	-10.41	Upright	Vertical
1804.6	46.39	-27.61	42.19	-11.81	Flat	Horizontal
6316.1	44.39	-29.61	40.29	-13.71	Flat	Vertical
6316.1	43.69	-30.31	39.19	-14.81	Flat	Horizontal
8120.7	50.51	-23.49	48.51	-5.49	Flat	Vertical
8120.7	47.31	-26.69	44.01	-9.99	Upright	Horizontal
9023	42.96	-31.04	35.36	-18.64	Flat	Vertical

Plots
13539-5 1-3 GHz Horizontal Low Channel Flat Position
13539-5 1-3 GHz Vertical Low Channel Flat Position
13539-5 3-6 GHz Horizontal Low Channel Flat Position

13539-5 3-6 GHz Vertical Low Channel Flat Position
13539-5 6-9.2GHz Horizontal Low Channel Flat Position
13539-5 6-9.2GHz Vertical Low Channel Flat Position

Setup Table

Band	902-928 MHz
Power Level	22 dBm
Channel Spacing	200 kHz
Mod Scheme	LoRa SF10
Mid channel	908.6 MHz

Spurious Frequency (MHz)	Measured Peak Level (dBµV/m)	Difference to Peak Limit (dB)	Measured Average Level (dBµV/m)	Difference to Average Limit (dB)	EUT Polarisation	Antenna Polarisation
1817.2	49.99	-24.01	45.79	-8.21	Upright	Vertical
1817.2	45.29	-28.71	40.69	-13.31	Side	Horizontal
6360.2	42.59	-31.41	38.29	-15.71	Flat	Vertical
6360.2	40.69	-33.31	34.89	-19.11	Flat	Horizontal
8177.4	48.81	-25.19	45.91	-8.09	Flat	Vertical
8177.4	44.31	-29.69	38.01	-15.99	Flat	Horizontal

Plots
13539-5 1-3 GHz Horizontal Mid Channel Flat Position
13539-5 1-3 GHz Vertical Mid Channel Flat Position
13539-5 3-6 GHz Horizontal Mid Channel Flat Position
13539-5 3-6 GHz Vertical Mid Channel Flat Position
13539-5 6-9.2GHz Horizontal Mid Channel Flat Position
13539-5 6-9.2GHz Vertical Mid Channel Flat Position

Setup Table

Band	902-928 MHz
Power Level	22 dBm
Channel Spacing	200 kHz
Mod Scheme	LoRa SF10
High channel	914.9 MHz

Spurious Frequency (MHz)	Measured Peak Level (dBµV/m)	Difference to Peak Limit (dB)	Measured Average Level (dBµV/m)	Difference to Average Limit (dB)	EUT Polarisation	Antenna Polarisation
1829.8	47.69	-26.31	44.99	-9.01	Flat	Horizontal
6404.3	44.49	-29.51	41.39	-12.61	Flat	Vertical
6404.3	45.49	-28.51	42.79	-11.21	Side	Horizontal
8234.1	49.31	-24.69	46.71	-7.29	Flat	Vertical
8234.1	53.01	-20.99	51.41	-2.59	Side	Horizontal
9149	44.56	-29.44	36.76	-17.24	Flat	Vertical
9149	44.56	-29.44	38.26	-15.74	Side	Horizontal

Plots
13539-5 1-3 GHz Horizontal High Channel Flat Position
13539-5 1-3 GHz Vertical High Channel Flat Position
13539-5 3-6 GHz Horizontal High Channel Flat Position
13539-5 3-6 GHz Vertical High Channel Flat Position
13539-5 6-9.2GHz Horizontal High Channel Flat Position
13539-5 6-9.2GHz Vertical High Channel Flat Position

Peak detector “Max held” Analyser plots against the Average limit line can be found in Section 6 of this report.

Note: Whilst Low, Mid and High channels were tested with the EUT in 3 orthogonal positions, plots are for illustrative purposes only, and only Mid channel plots in flat EUT position are shown in this report. No discernible difference between Spreading Factor settings was observed for emission amplitudes, therefore SF10 has been used for final measurements.

LIMITS:
15.209 limits are applicable in the restricted bands of 15.205 with the relevant detector.
15.247(d) other emissions, outside the intentional band, must be attenuated by at least 20/30dB from the level of the fundamental / meet the general limits of 15.209.
The general limits of 15.209 are as drawn on the respective plots.

These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows:
1 – 18 GHz ±3.5dB

5.6 Effective radiated power field strength

5.6.1 Test methods

Test Requirements: 47 CFR Part 15C Part 15.247(d) [Reference 4.1.1 of this report]
Test Method: ANSI C63.10 Clause 6.5 [Reference 4.1.2 of this report]
Limits: 47 CFR Part 15C Part 15.247(d) & 15.209(a) [Reference 4.1.1 of this report]

5.6.2 Configuration of EUT

The EUT was placed on a 0.8 metres high turntable. The front edge of the EUT was initially positioned facing the antenna. The EUT was rotated in all three orthogonal planes to maximise emissions. Final measurements were taken at 3m. Testing was performed with a new battery. The EUT was operated in Mode 2, Mode 4 and Mode 6.

5.6.3 Test procedure

Tests were made in accordance with the Test Method noted above using the measuring equipment listed in the 'Test Equipment used' section. The equipment was rotated 360 degrees in each of 3 orthogonal EUT positions and the antenna scanned 1 – 4 metres in both horizontal and vertical polarisations to record the highest fundamental field strength. The power stated is Peak field strength.
Tests were performed in test site M.

5.6.4 Test equipment

E411, E624, LPE364, E743

See Section 9 for more details

5.6.5 Test results

Temperature of test environment 16°C
Humidity of test environment 65%
Pressure of test environment 101.5kPa

Band	902-928 MHz
Power Level	22 dBm
Channel Spacing	200 kHz
Mod Scheme	LoRa SF10
Low channel	902.3 MHz
Mid channel	908.6 MHz
High channel	914.9 MHz

	Low channel	Mid channel	High channel
Duty Cycle (%)	100.00	100.00	100.00
Duty Cycle correction	0.00	0.00	0.00

	Low channel	Mid channel	High channel
Peak Level (dBµV/m @3m)	112.05	112.09	111.01
Plot reference	J13539-5 Low channel ERP flat EUT horiz meas Ant.	J13539-5 Mid channel ERP flat EUT horiz meas Ant.	J13539-5 High channel ERP flat EUT horiz meas Ant.
Antenna Polarisation	Horizontal	Horizontal	Horizontal
EUT Polarisation	Flat	Flat	Flat

Analyser plots can be found in Section 6 of this report.

LIMITS:
The maximum output power in all cases is 30dBm/ 1watt. (125.23 dBuV/m @3m)

These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows:
<± 3.9 dB

5.7 Band Edge Compliance

5.7.1 Test methods

Test Requirements: 47 CFR Part 15C Part 15.215 & 15.247(d) [Reference 4.1.1 of this report]
Test Method: ANSI C63.10 Clause 6.10 [Reference 4.1.2 of this report]
Limits: 47 CFR Part 15C Part 15.209(a) & 15.247(d) [Reference 4.1.1 of this report]

5.7.2 Configuration of EUT

The EUT was placed on a 0.8 metres high turntable and set-up as for the fundamental field strength test in section 5.6 above. The front edge of the EUT was initially positioned facing the antenna. The EUT was measured at a distance of 3 metres and emissions were maximised to obtain worst case band edge results.

The EUT was operated in Modes 1 to mode 7.

5.7.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment noted below. The emission from the EUT were maximised before taking any plots. Band edge tests were performed in both hopping and Non-hopping modes, whilst restricted band edge tests were performed in non-hopping mode only. The restricted band edges closest to the EUT Band of 902-928 MHz are 614 MHz and 960 MHz, further wider span plots showing this requirement is met are shown under section 5.4 and in plots section 6.

Tests were performed using Test Site M.

5.7.4 Test equipment

E136, E411, E624, F269, F270, TMS82.

See Section 9 for more details

5.7.5 Test results

Temperature of test environment	16°C
Humidity of test environment	65%
Pressure of test environment	101.5kPa

Band	902-928 MHz
Power Level	22 dBm
Channel Spacing	200 kHz
Mod Scheme	LoRa SF7
Low channel	902.3 MHz
High channel	914.9 MHz

Restricted Band Edges	Low channel	High channel
Restricted Peak Level measured (dBuV/m @3m)	30	35
Restricted band edge Peak Plot	see further wide span radiated emissions plots	see further wide span radiated emissions plots
Restricted Average Level measured (dBuV/m @3m)	30	35
Restricted band edge Average Plot	N/A, Peak value less than average limit	N/A, Peak value less than average limit

Authorised Band Edges	Low channel	High channel
Authorised Band Edge (dBc) value measured	-48.7	-59.6
Authorised Band Edge Plot	J13539-5 Authorised band edge Low channel SF7	J13539-5 Authorised band edge High channel SF7
Authorised Band Edge (dBc)	-50.49	-58.5

Hopping value measured		
Authorised Band Edge Hopping Plot	13539-5 Authorised band edge channel Hopping Mode	13539-5 Authorised band edge channel Hopping Mode

Band	902-928 MHz
Power Level	22 dBm
Channel Spacing	200 kHz
Mod Scheme	LoRa SF10
Low channel	902.3 MHz
High channel	914.9 MHz

Restricted Band Edges	Low channel	High channel
Restricted Peak Level measured (dBuV/m@3m)	30	35
Restricted band edge Peak Plot	see further wide span radiated emissions plots	see further wide span radiated emissions plots
Restricted Average Level measured (dBuV/m@3m)	30	35
Restricted band edge Average Plot	N/A, Peak value less than average limit	N/A, Peak value less than average limit

Authorised Band Edges	Low channel	High channel
Authorised Band Edge (dBc) value measured	-48.49	-55.5
Authorised Band Edge Plot	J13539-5 Authorised band edge Low channel SF10	J13539-5 Authorised band edge High channel SF10
Authorised Band Edge (dBc) Hopping value measured	-50.49	-58.5
Authorised Band Edge Hopping Plot	13539-5 Authorised band edge channel Hopping Mode	13539-5 Authorised band edge channel Hopping Mode

Analyser plots for the Band Edge Compliance can be found in Section 6 of this report. These show the 20/30dBc requirement of 15.247(d) are met at the band edges of 902 and 928 MHz. Restricted band edge plots are also shown in section 6.
The tables list the field strengths observed in the adjacent restricted bands, which are required to meet the tighter 15.209 limits. No difference was observed between SF7 and SF10 in hopping mode.

LIMITS:
Authorised band edges are 20/30dBc requirement of 15.247(d)
Restricted band edges are 614 MHz QP = 46dBuV/m @3m, and 960 MHz AV = 54 dBuV/m @3m.
The restricted band edges closest to the EUT frequency of 902-928MHz are 614 & 960MHz.

Further wider span plots have been taken to show the fact that there are no spurious emissions above the restricted limits of 15.209.

These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows:
<± 3.9 dB

5.8 Occupied bandwidth

5.8.1 Test methods

Test Requirements:	47 CFR Part 15C Part 15.247(a)(1)(i) [Reference 4.1.1 of this report]
Test Method:	ANSI C63.10 Clause 6.9 [Reference 4.1.2 of this report]
Limits:	47 CFR Part 15C Part 15.215(c)/ 15.247(a)(1)(i) [Reference 4.1.1 of this report]

5.8.2 Configuration of EUT

The EUT was measured radiated in a chamber in maximised field strength position using a spectrum analyser. The EUT was operated in Modes 1 to 6.

5.8.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment noted below. A 4.7kHz RBW, 3x VBW, auto sweep time and max hold settings were used for the 20dB bandwidth. The 99% Bandwidth was also shown on the plots taken using Bandwidth measuring mode of the analyser.

Tests were performed using Test Site B.

5.8.4 Test equipment

E327, E642, E856

See Section 9 for more details

5.8.5 Test results

Temperature of test environment	20°C
Humidity of test environment	70%
Pressure of test environment	101kPa

Band	902-928 MHz
Power Level	22 dBm
Channel Spacing	200 kHz
Mod Scheme	LoRa SF7
Low channel	902.3 MHz
Mid channel	908.7 MHz
High channel	914.9 MHz

	Low channel	Mid channel	High channel
20 dB Bandwidth Result (MHz)	0.143	0.145	0.144
Plot for 20 dB Bandwidth Result (MHz)	13539-5 OBW Low Ch SF7	13539-5 OBW Mid Ch SF7	13539-5 OBW High Ch SF7
99 % Bandwidth Result (MHz)	0.128	0.127	0.128
Frequency Error (kHz)	4.702	4.631	4.48
Operating frequency (MHz)	902.3	908.6	914.9
20 dB FLOW Worst case (MHz)	902.233202	908.532131	914.83248
20 dB FHIGH Worst case (MHz)	902.376202	908.677131	914.97648

Band	902-928 MHz
Power Level	22 dBm
Channel Spacing	200 kHz
Mod Scheme	LoRa SF10
Low channel	902.3 MHz
Mid channel	908.6 MHz
High channel	914.9 MHz

	Low channel	Mid channel	High channel
20 dB Bandwidth Result (MHz)	0.144	0.144	0.144
Plot for 20 dB Bandwidth Result (MHz)	13539-5 OBW Low Ch SF10	13539-5 OBW Mid Ch SF10	13539-5 OBW High Ch SF10
99 % Bandwidth Result (MHz)	0.130	0.130	0.130
Frequency Error (kHz)	2.915	3.096	2.862
Operating frequency (MHz)	902.3	908.6	914.9
20 dB FLOW Worst case (MHz)	902.230915	908.531096	914.830862
20 dB FHIGH Worst case (MHz)	902.374915	908.675096	914.974862

Analyser plots for the 20dB bandwidth can be found in Section 6 of this report.

LIMITS:
15.215(c) The 20dB bandwidth of the emission must be contained within the designated frequency band.
15.247(a)(1)(i) The maximum allowed 20dB bandwidth of the hopping channel is 500kHz.

These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows:
<± 1.9 %

5.9 Maximum Average conducted output power

NOT APPLICABLE: EUT uses FHSS technology and is therefore not applicable to this test.

5.10 Maximum Peak conducted output power

5.10.1 Test methods

Test Requirements: 47 CFR Part 15C Part 15.247(b)(2) [Reference 4.1.1 of this report]
Test Method: ANSI C63.10 Clause [Reference 4.1.2 of this report]
Limits: 47 CFR Part 15C Part 15.247(b)(2) [Reference 4.1.1 of this report]

5.10.2 Configuration of EUT

The EUT was measured on a bench using a spectrum analyser connected to the temporary internal RF port.
The EUT was operated in Modes 1 to 6 for this test.

5.10.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment noted below.
Peak stated reading is maximum power observed using a spectrum analyser RBW > 20dB BW of the EUT, per ANSI C63.10. Measurements were made on a test bench in site A.

5.10.4 Test equipment

E602, F128, H072, LPE315

See Section 9 for more details

5.10.5 Test results

Temperature of test environment 21°C
Humidity of test environment 55%
Pressure of test environment 101kPa

Band	902-928 MHz
Power Level	22 dBm
Channel Spacing	200 kHz
Mod Scheme	LoRa SF7
Low channel	902.3 MHz
Mid channel	908.6 MHz
High channel	914.9 MHz

Nominal voltage result (dBm)	18.79	18.77	18.84
Plot reference	J13539-5 PK cond Power Low channel SF7	J13539-5 PK cond Power Mid channel SF7	J13539-5 PK cond Power High channel SF7
85% of voltage result (dBm)	18.78	18.77	18.84
115% voltage result (dBm)	18.79	18.77	18.84
Limit in dBm	30.00	30.00	30.00
Maximum result (dBm)	18.79	18.77	18.84
Margin to Limit (dB)	-11.21	-11.23	-11.16
Result in (W)	0.076	0.075	0.077

Band	902-928 MHz
Power Level	22 dBm
Channel Spacing	200 kHz
Mod Scheme	LoRa SF10
Low channel	902.3 MHz
Mid channel	908.6 MHz
High channel	914.9 MHz

Nominal voltage result (dBm)	18.80	18.80	18.84
Plot reference	J13539-5 PK cond Power Low channel SF10	J13539-5 PK cond Power Mid channel SF10	J13539-5 PK cond Power High channel SF10
85% of voltage result (dBm)	18.80	18.80	18.84
115% voltage result (dBm)	18.79	18.80	18.83
Limit in dBm	30.00	30.00	30.00
Maximum result (dBm)	18.80	18.80	18.84
Margin to Limit (dB)	-11.20	-11.20	-11.16
Result in (W)	0.076	0.076	0.077

LIMITS:
15.247(b)(2) For FHSS operating 902-928 MHz employing at least 50 channels 1 Watt.
These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows:
<± 1.0 dB

5.11 Maximum Power Spectral Density

NOT APPLICABLE: EUT does not employ DTS technology.

5.12 Antenna power conducted emissions

NOT APPLICABLE: Applies to EUT's with an antenna port. The EUT has an integral antenna only & the EUT was tested for radiated emissions with its dedicated antenna in position.

5.13 Duty cycle

NOT APPLICABLE: EUT uses FHSS technology and is therefore not applicable to this test.

5.14 FHSS carrier frequency separation

5.14.1 Test methods

Test Requirements: 47 CFR Part 15C Part 15.247(a)(1) [Reference 4.1.1 of this report]
Test Method: ANSI C63.10 Clause 7.8 [Reference 4.1.2 of this report]
Limits: 47 CFR Part 15C Part 15.247(a)(1) [Reference 4.1.1 of this report]

5.14.2 Configuration of EUT

The EUT was tested on the bench and ambient conditions were monitored. The EUT was operated in Mode 7.

5.14.3 Test procedure

Tests were made using the measuring equipment listed in the 'Test Equipment' Section. With the EUT hopping, a span was set on the spectrum analyser to show two adjacent channel peaks. The analyser was set to Peak detector and a max held trace captured, the trace was allowed enough sweeps to stabilise.

Tests were performed in test site A.

5.14.4 Test equipment

E602, F128, H072

See Section 9 for more details

5.14.5 Test results

Temperature of test environment	21°C
Humidity of test environment	52%
Pressure of test environment	101.5kPa

Band	902-928 MHz
Power Level	22 dBm
Channel Spacing	200 kHz
Mod Scheme	LoRa SF10
Single channel	Hopping all channels

	Single channel
Separation (kHz)	199.62
Plot of Separation (kHz)	J13539-5 Carrier Separation

Note: No difference was observed between SF7 and SF10 settings, SF10 setting was used for test.

Analyser plots for the carrier separation can be found in Section 6 of this report.

LIMITS:
FHSS shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the-20 dB bandwidth of the hopping channel, whichever is greater.

These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows:
<± 1.9 %

5.15 Average time of occupancy

5.15.1 Test methods

Test Requirements: 47 CFR Part 15C Part 15.247(a)(1)(i) [Reference 4.1.1 of this report]
Test Method: ANSI C63.10 Clause 7.8 [Reference 4.1.2 of this report]
Limits: 47 CFR Part 15C Part 15.247(a)(1)(i) [Reference 4.1.1 of this report]

5.15.2 Configuration of EUT

The EUT was measured on a bench using a spectrum analyser connected to the temporary internal RF port. Ambient conditions were monitored. The EUT was operated in Mode 7 for this test as the worst case / longest channel occupancy time.

5.15.3 Test procedure

Tests were made using the measuring equipment listed in the 'Test Equipment' Section. The EUT was set into hopping mode using SF10 (maximum on air time). A spectrum analyser was set to zero span and TX bursts were captured using the appropriate sweep times. Accumulated TX time was then calculated from number of transmissions in the observation time multiplied by a single TX On time for the test mode. Tests were performed in test site A.

5.15.4 Test equipment

E602, F128, H072

See Section 9 for more details

5.15.5 Test results

Temperature of test environment	20°C
Humidity of test environment	52%
Pressure of test environment	102kPa

Band	902-928 MHz
Power Level	22 dBm
Channel Spacing	200 kHz
Mod Scheme	LoRa SF10
Single channel	Hopping all channels

Measured Dwell time/pulse width (ms)	370.8
Observation Period time (s)	20
Instances of pulses within period time	1
Average time of occupancy (ms)	370.8
Measured Dwell time/pulse width (ms)	J13539-5 Average time of occupancy single TX on time (low channel)
Period time (s)	J13539-5 Average time of occupancy 20s period (low channel)

Analyser plots showing pulse width and period /repetition can be found in Section 6 of this report.

LIMITS:
For FHSS in the band 902-928 MHz: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 20-second period.

These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows:
2.57 ms

5.16 Number of Hop Channels

5.16.1 Test methods

Test Requirements: 47 CFR Part 15C Part 15.247(a)(1)(i) [Reference 4.1.1 of this report]
Test Method: ANSI C63.10 Clause 7.8 [Reference 4.1.2 of this report]
Limits: 47 CFR Part 15C Part 15.247(a)(1)(i) [Reference 4.1.1 of this report]

5.16.2 Configuration of EUT

The EUT was measured on a bench using a spectrum analyser connected to the internal RF port. Ambient conditions were monitored. The EUT was operated in Mode 7 for this test.

5.16.3 Test procedure

Tests were made using the measuring equipment noted in the 'Test Equipment' Section at Site A. With the EUT hopping, a suitable span and RBW was set on the spectrum analyser to show clearly over a range of plots the number of channels being used by the EUT. The analyser was set to Peak detector and max held and the trace was allowed to stabilise for each plot.

5.16.4 Test equipment

E602, F128, H072

See Section 9 for more details

5.16.5 Test results

Temperature of test environment	21°C
Humidity of test environment	52%
Pressure of test environment	102kPa

Band	902-928 MHz
Power Level	22 dBm
Channel Spacing	200 kHz
Mod Scheme	LoRa SF10
Single channel	Hopping all channels

No of hopping Channels	64
Minimum No. Required number by specification	50
Plot of Hopping Channels 1-64	J13539-5 Number of hopping channels

Analyser plots showing the number of hopping channels can be found in Section 6 of this report.

LIMITS:
For FHSs in the band 902-928 MHz: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping channels.

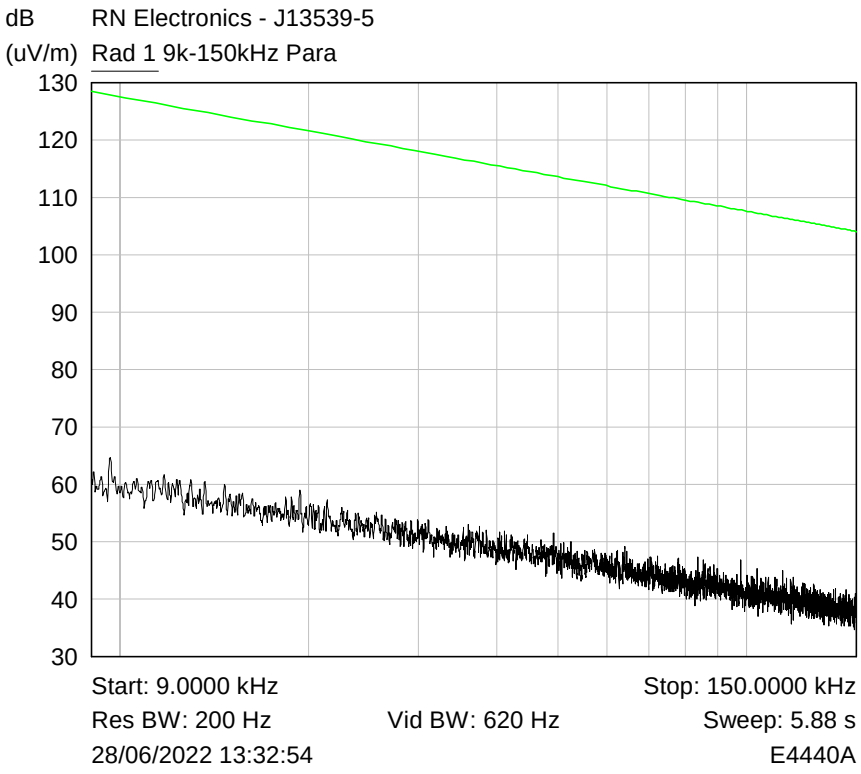
These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows:
<± 1.9 %

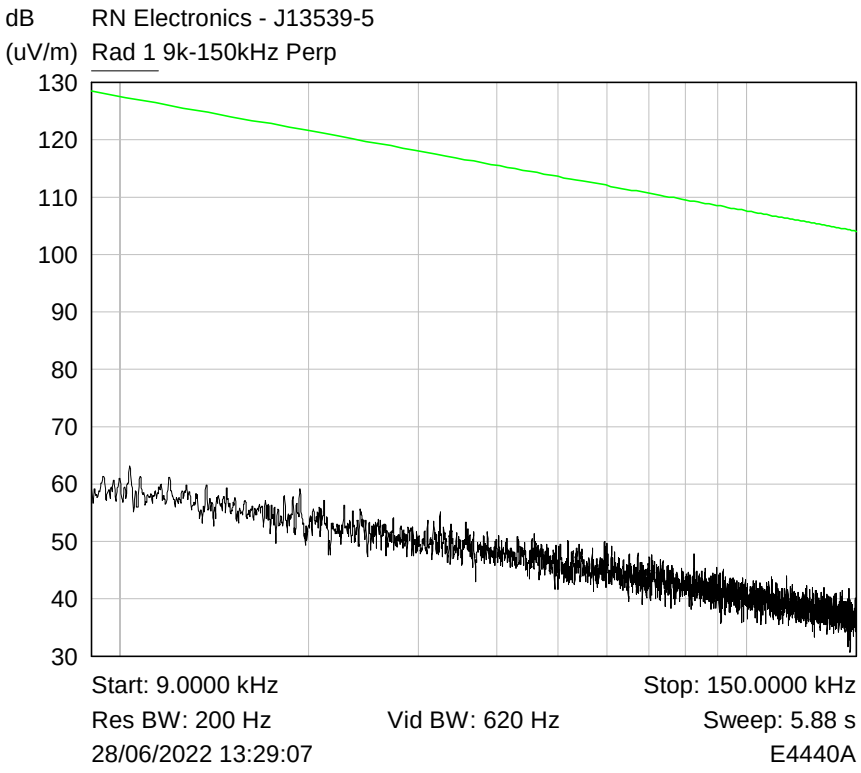
6 Plots/Graphical results

6.1 Radiated emissions 9 - 150 kHz

RF Parameters: Band 902-928 MHz, Power 22 dBm, Channel Spacing 200 kHz, Modulation LoRa SF10, Channel 908.6 MHz



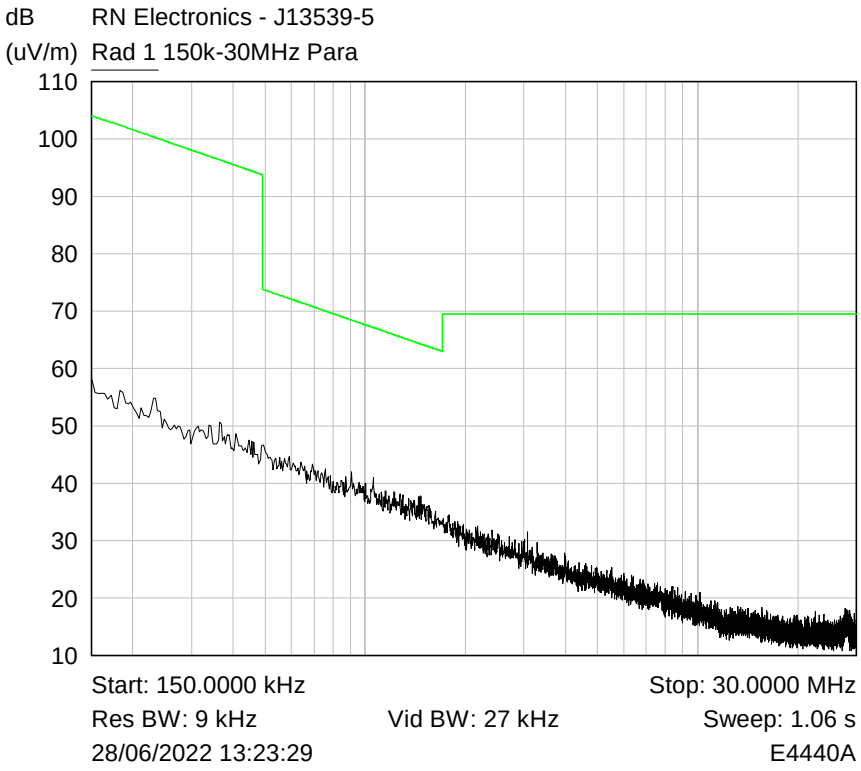
Plot of 9k-150kHz Parallel



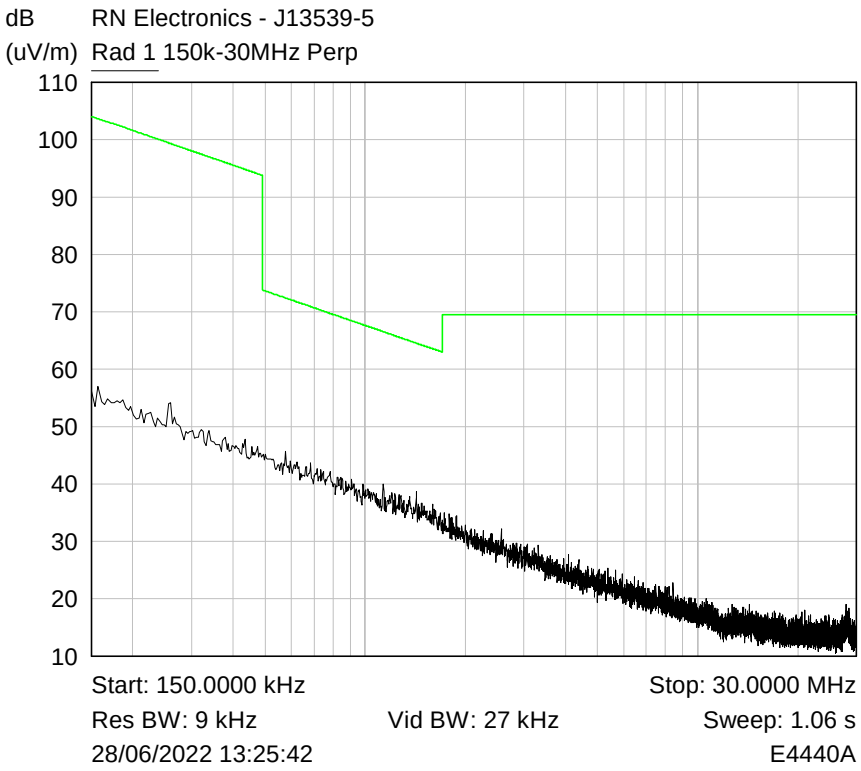
Plot of 9k-150kHz Perpendicular

6.2 Radiated emissions 150 kHz - 30 MHz

RF Parameters: Band 902-928 MHz, Power 22 dBm, Channel Spacing 200 kHz, Modulation LoRa SF10, Channel 908.6 MHz



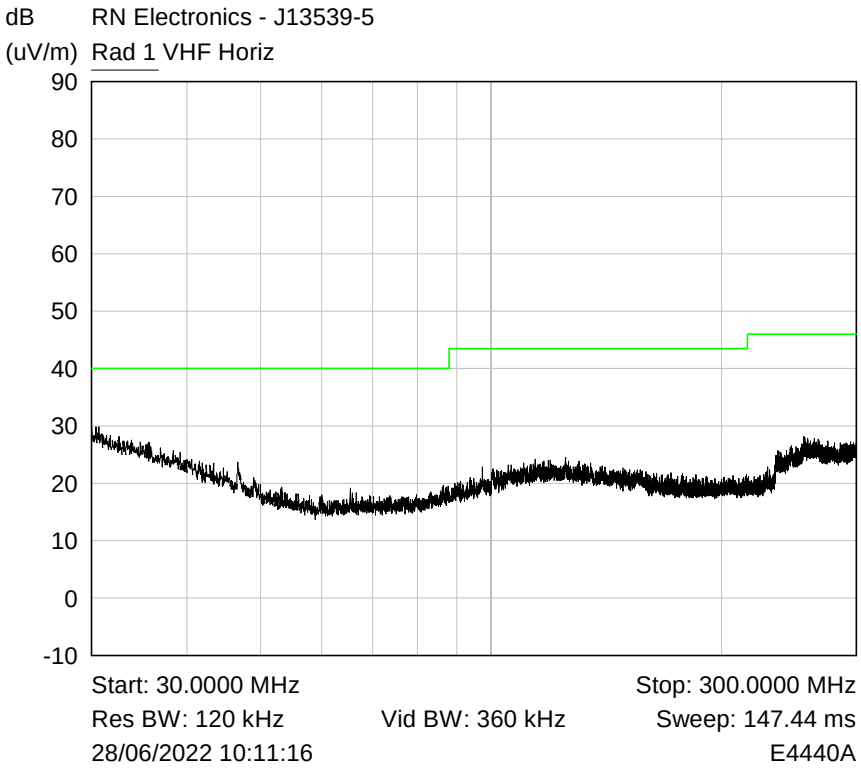
Plot of 150kHz-30MHz Parallel



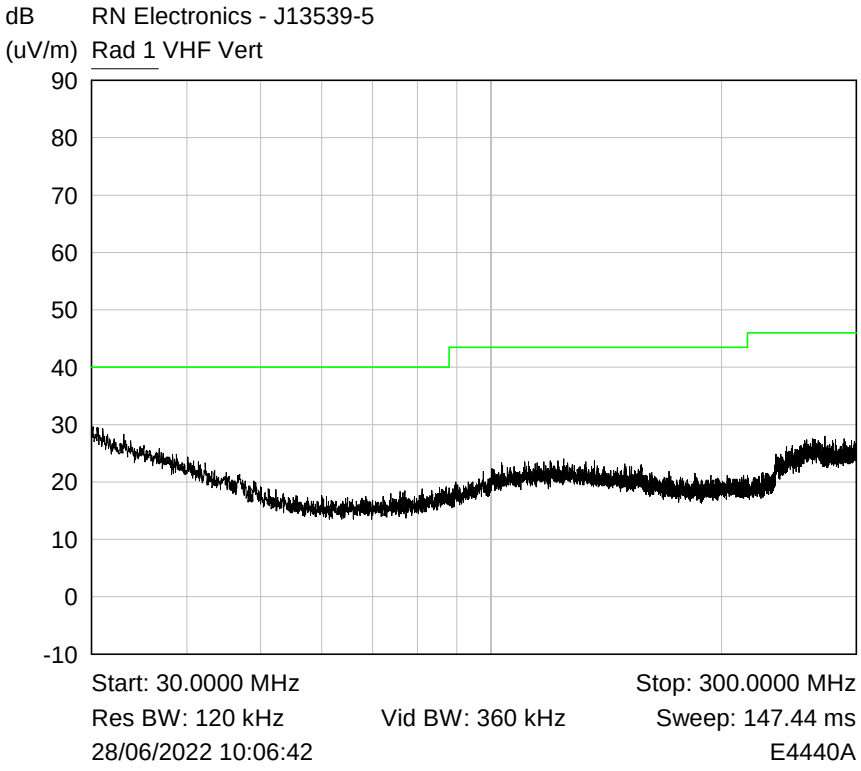
Plot of 150kHz-30MHz Perpendicular

6.3 Radiated emissions 30 MHz -1 GHz

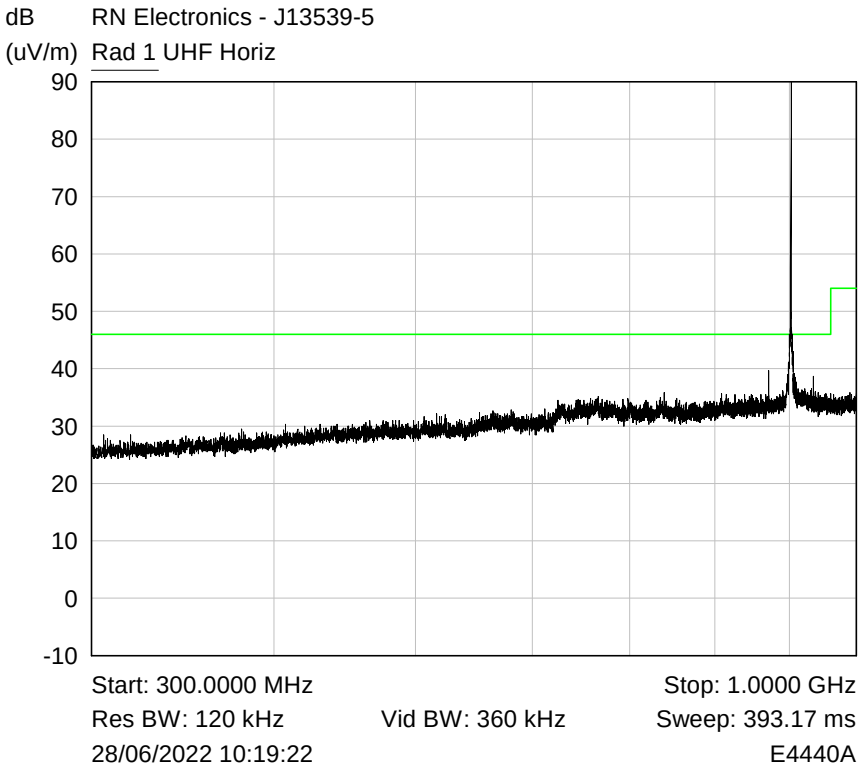
RF Parameters: Band 902-928 MHz, Power 22 dBm, Channel Spacing 200 kHz, Modulation LoRa SF10, Channel 902.3 MHz



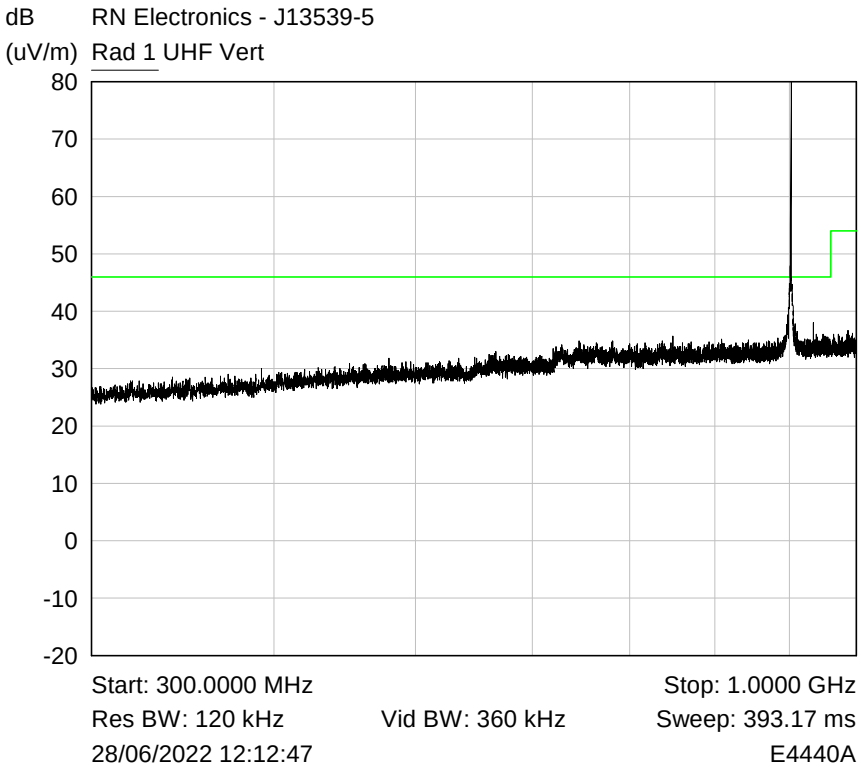
Plot of Peak emissions for VHF Horizontal against the QP limit line.



Plot of Peak emissions for VHF Vertical against the QP limit line.

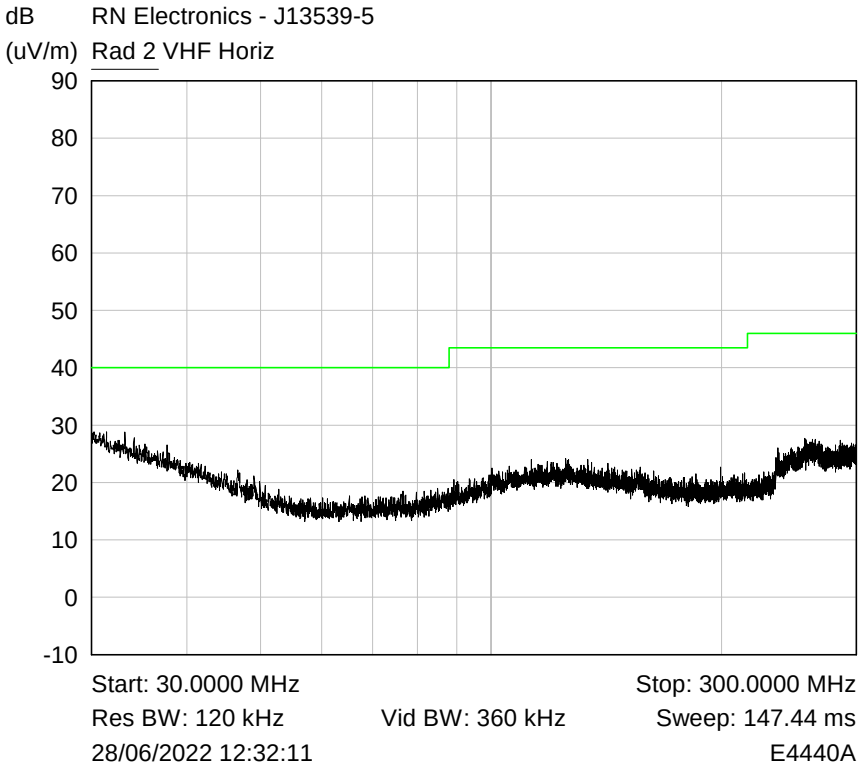


Plot of Peak emissions for UHF Horizontal against the QP limit line.
(Note: fundamental frequency is shown on the plot)

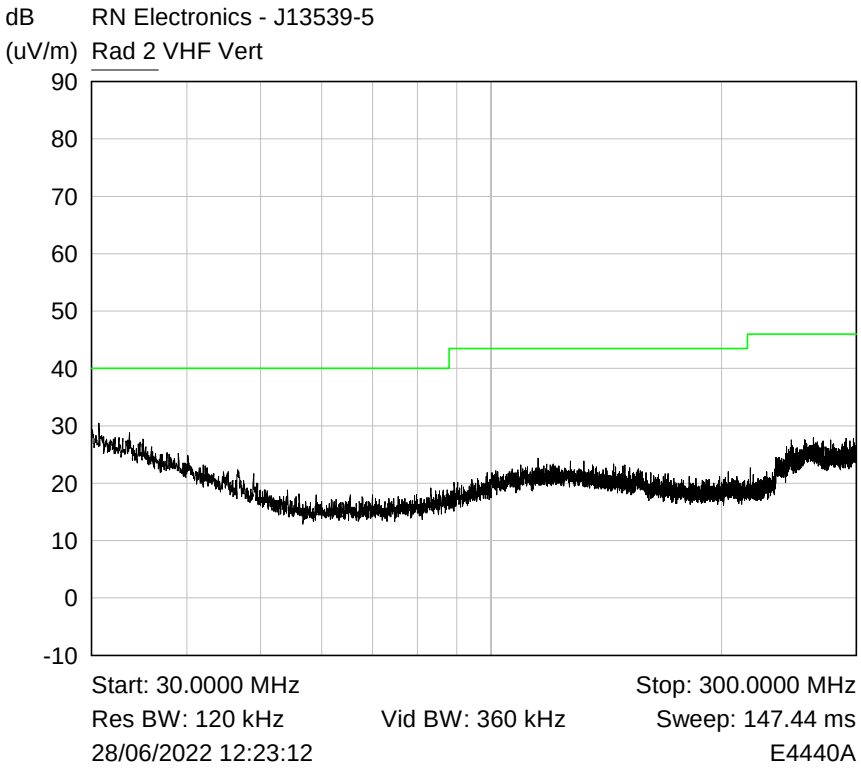


Plot of Peak emissions for UHF Vertical against the QP limit line.
(Note: fundamental frequency is shown on the plot)

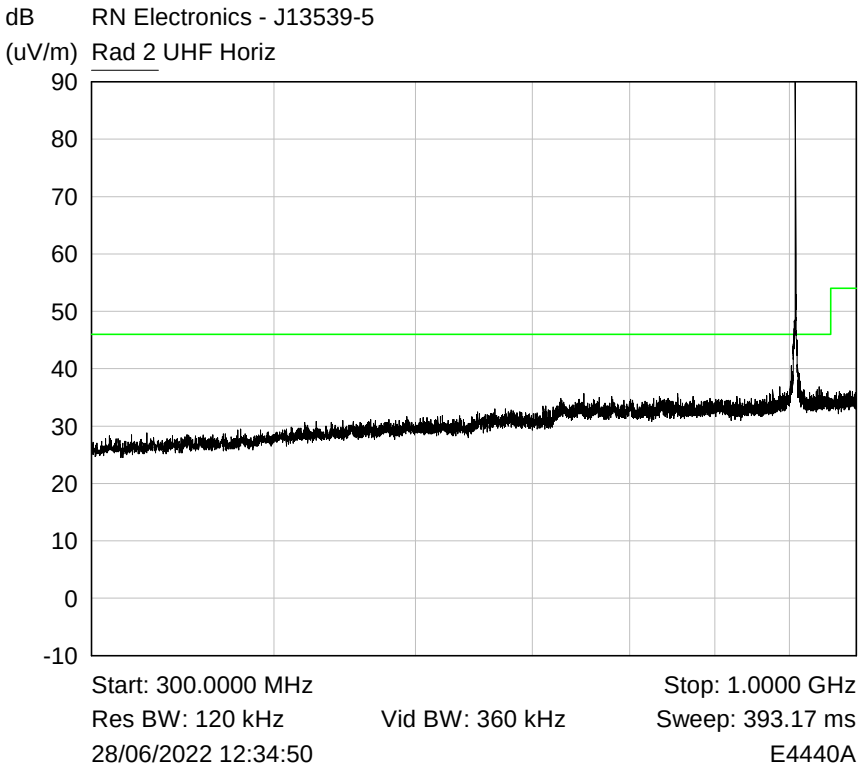
RF Parameters: Band 902-928 MHz, Power 22 dBm, Channel Spacing 200 kHz, Modulation LoRa SF10, Channel 908.6 MHz



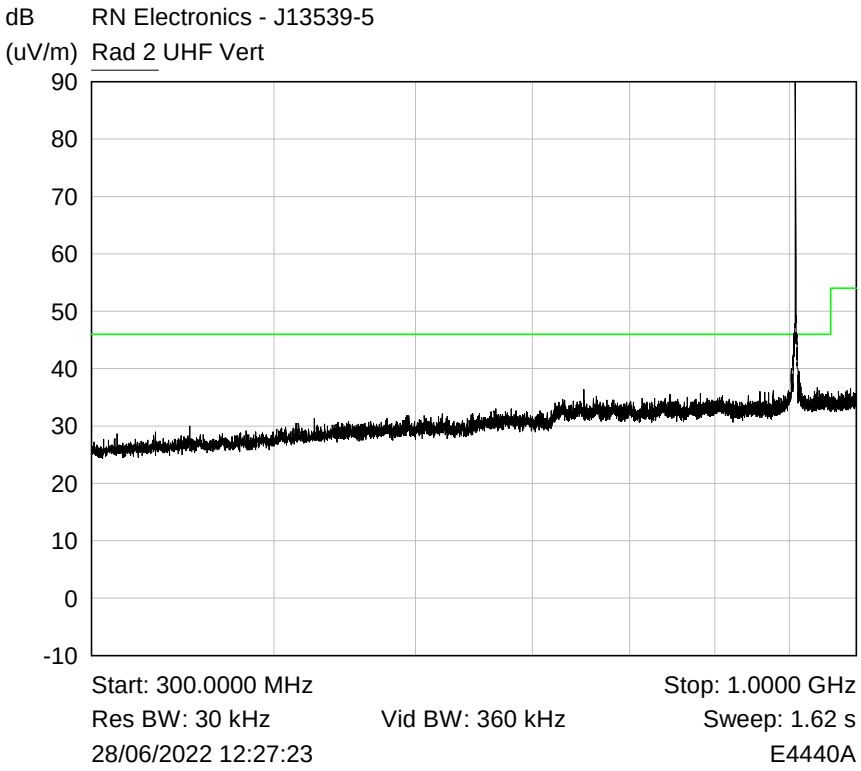
Plot of Peak emissions for VHF Horizontal against the QP limit line.



Plot of Peak emissions for VHF Vertical against the QP limit line.

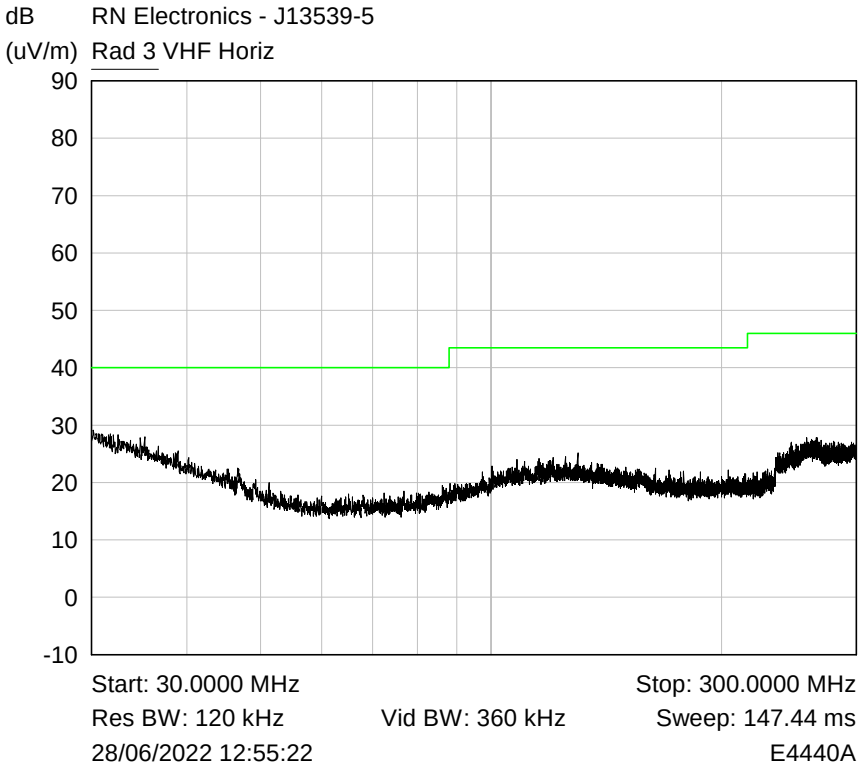


Plot of Peak emissions for UHF Horizontal against the QP limit line.
(Note: fundamental frequency is shown on the plot)

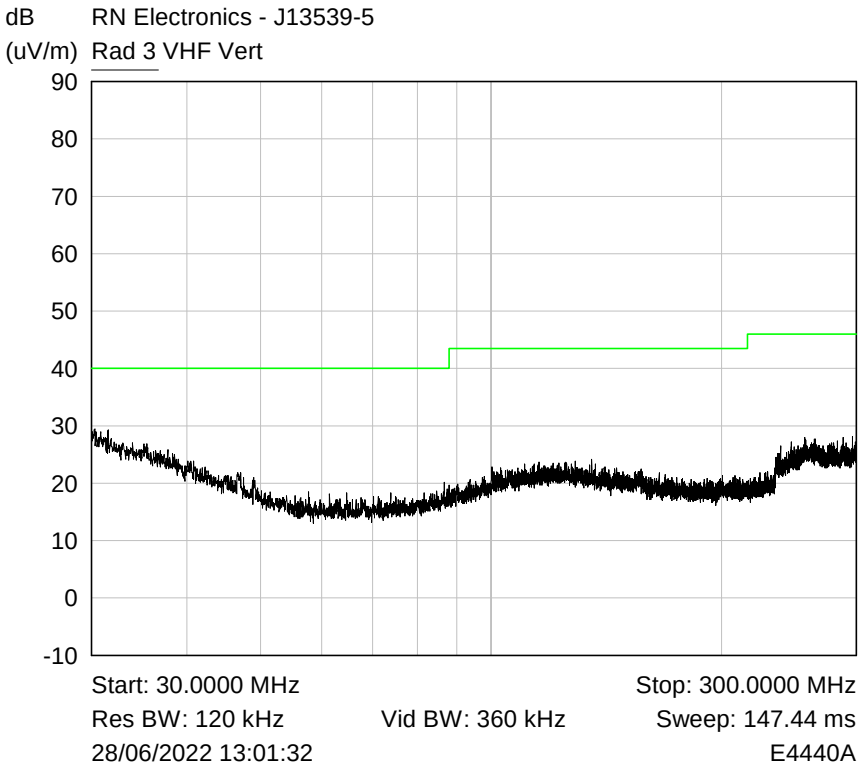


Plot of Peak emissions for UHF Vertical against the QP limit line.
(Note: fundamental frequency is shown on the plot)

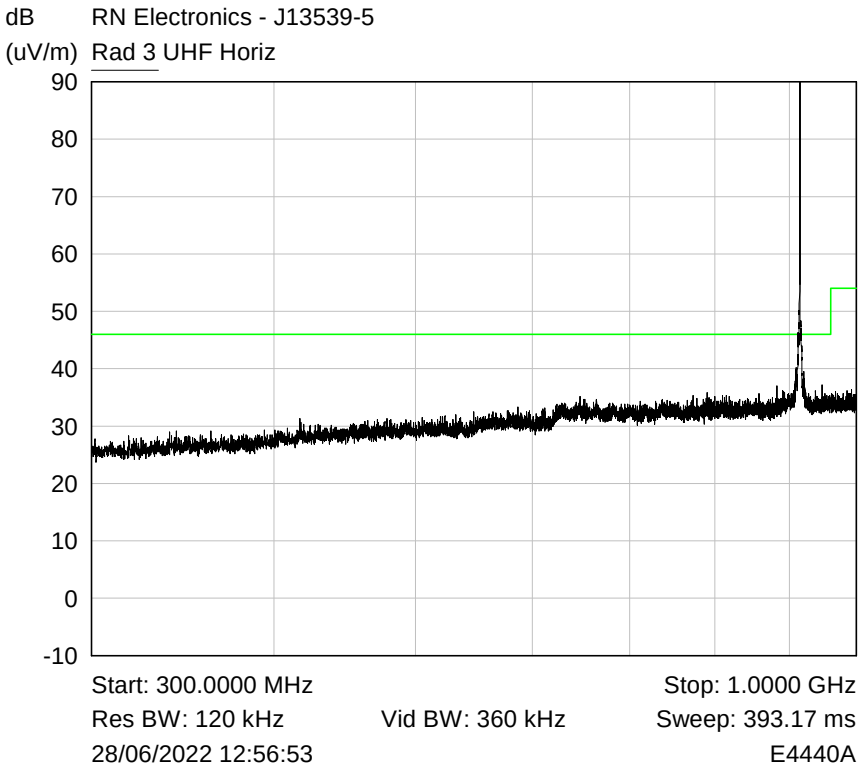
RF Parameters: Band 902-928 MHz, Power 22 dBm, Channel Spacing 200 kHz, Modulation LoRa SF10, Channel 914.9 MHz



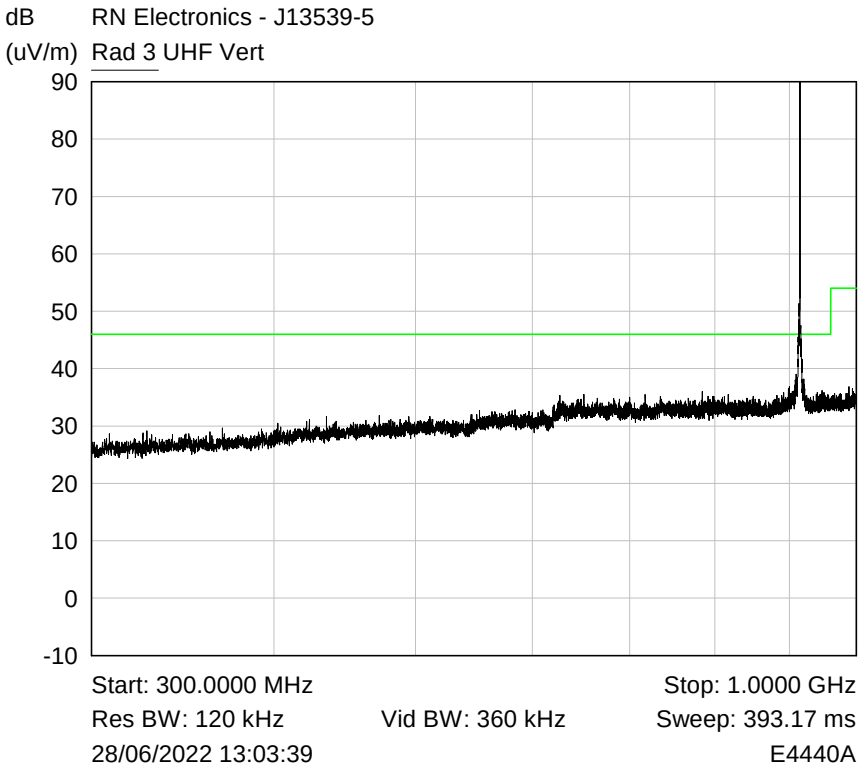
Plot of Peak emissions for VHF Horizontal against the QP limit line.



Plot of Peak emissions for VHF Vertical against the QP limit line.



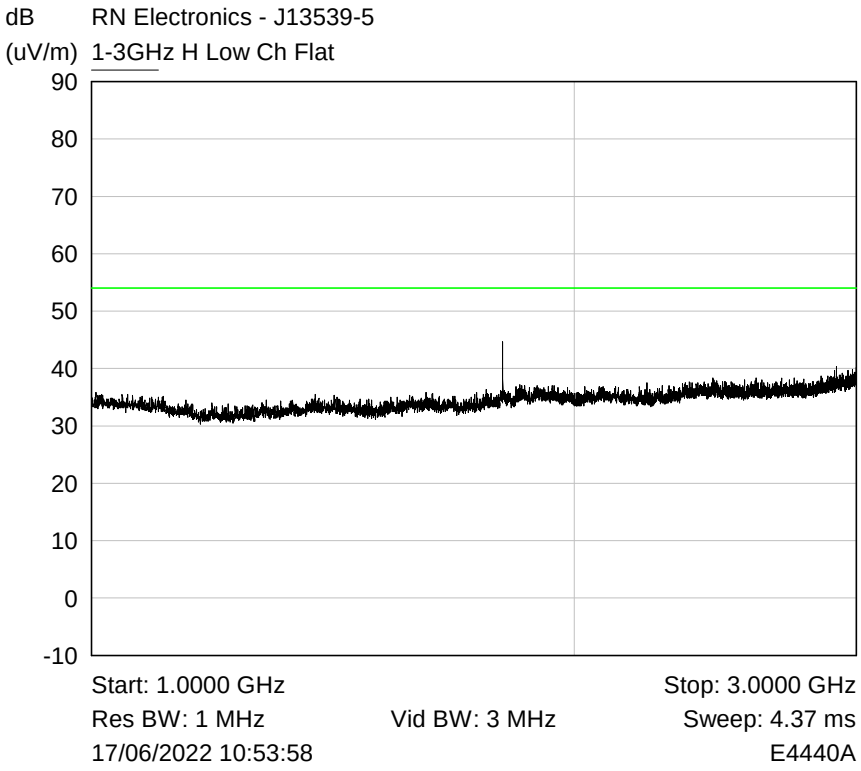
Plot of Peak emissions for UHF Horizontal against the QP limit line.
(Note: fundamental frequency is shown on the plot)

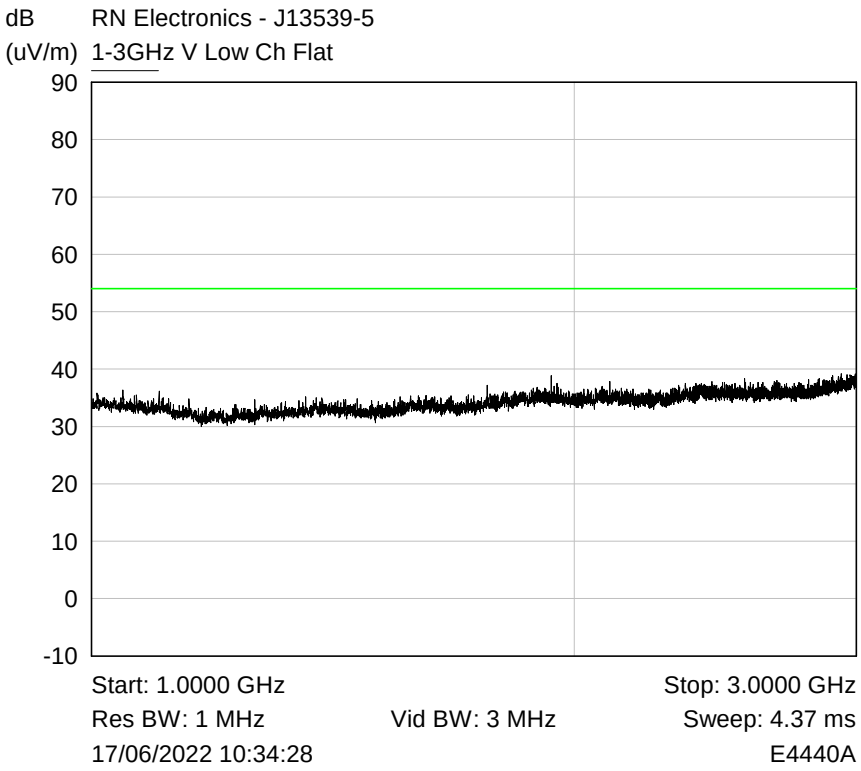


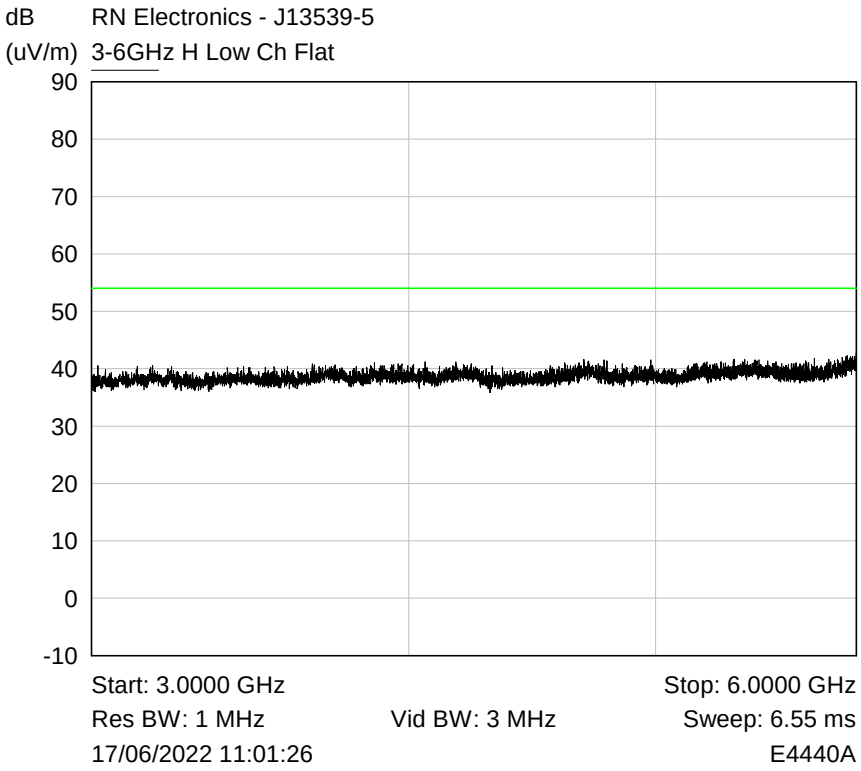
Plot of Peak emissions for UHF Vertical against the QP limit line.
(Note: fundamental frequency is shown on the plot)

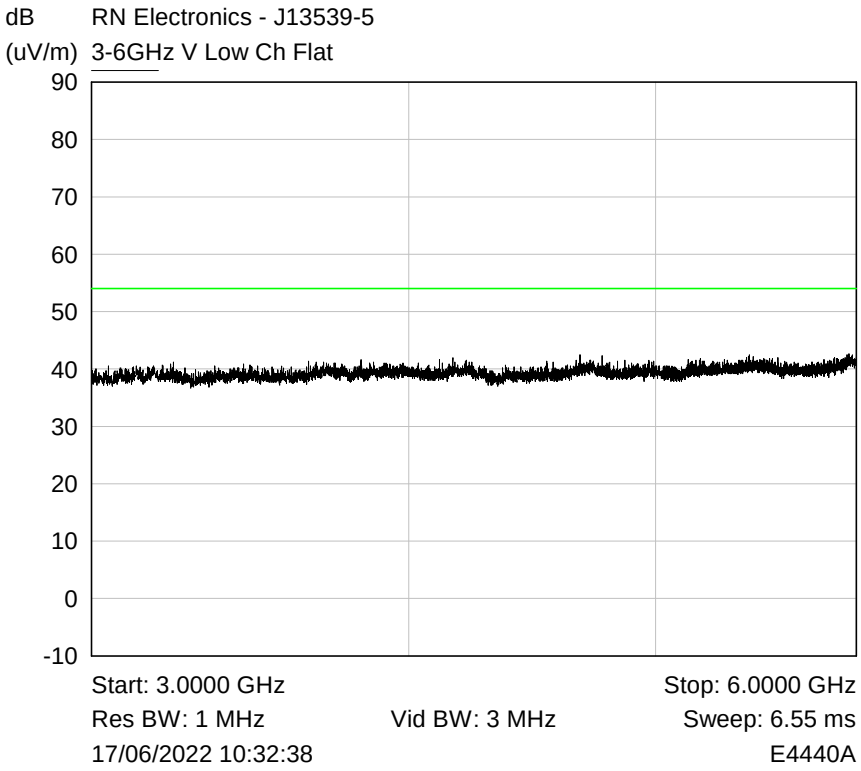
6.4 Radiated emissions above 1 GHz

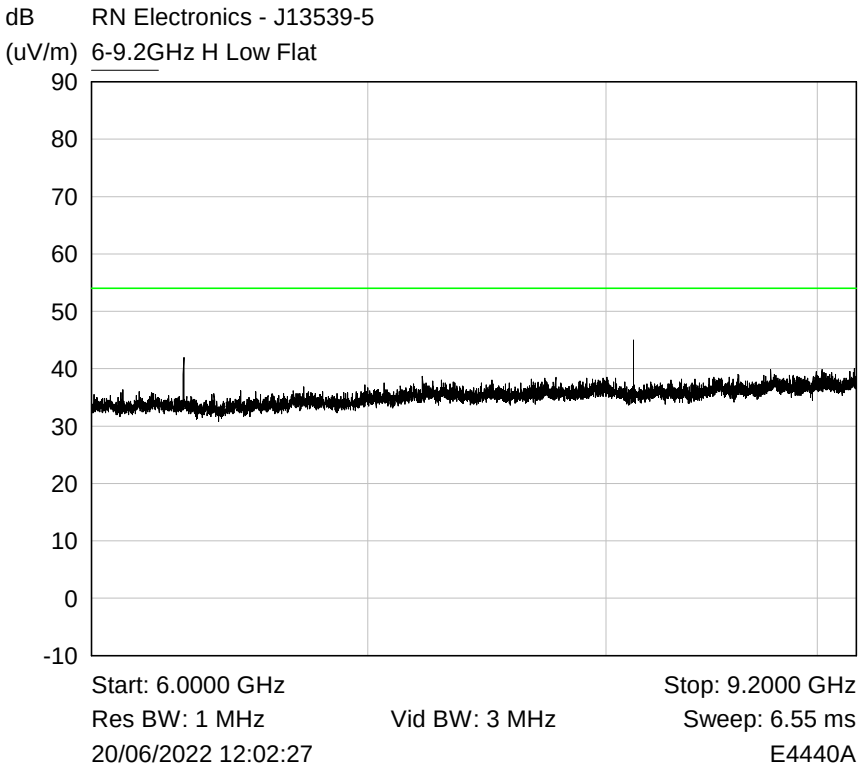
RF Parameters: Band 902-928 MHz, Power 22 dBm, Channel Spacing 200 kHz, Modulation LoRa SF10, Channel 902.3 MHz

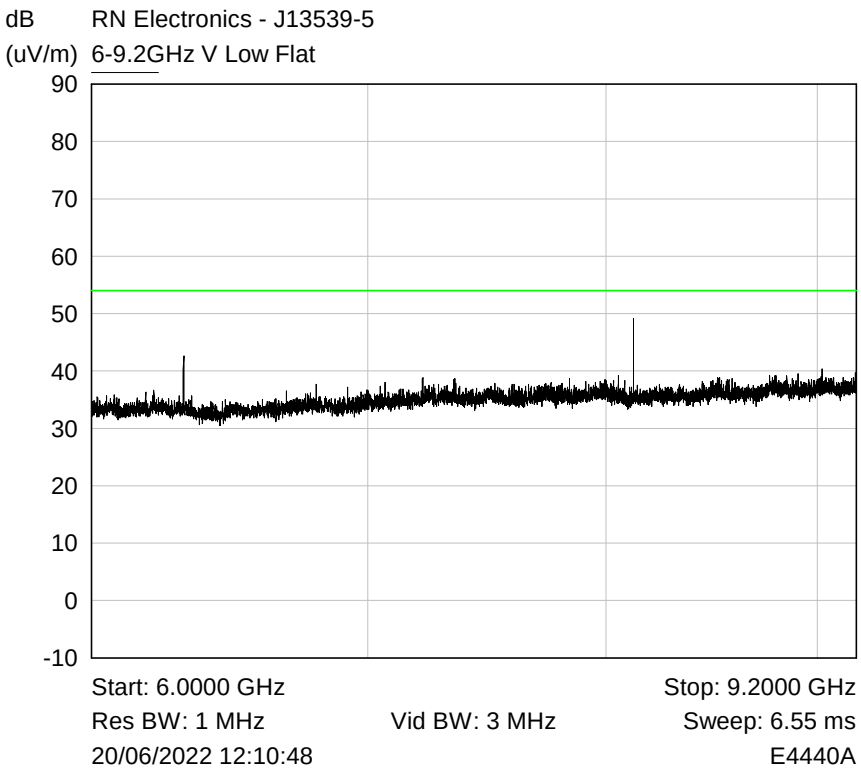




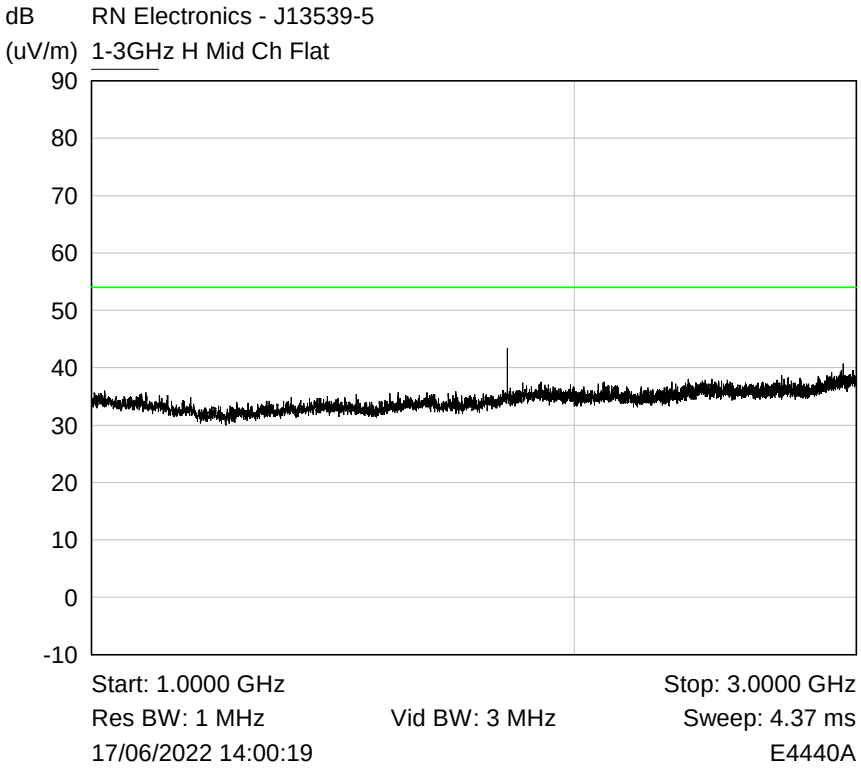


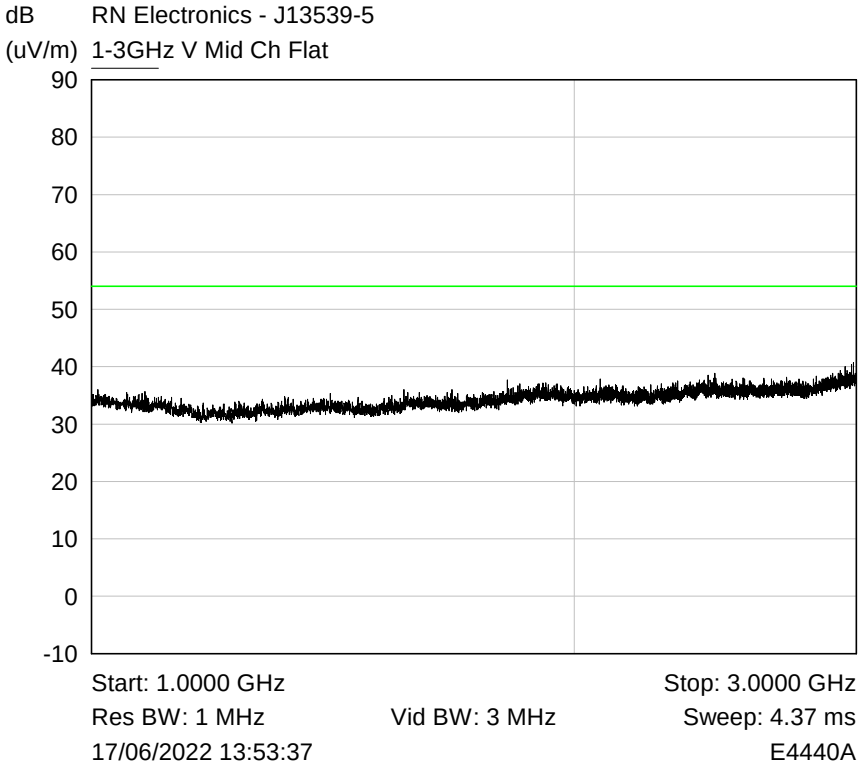


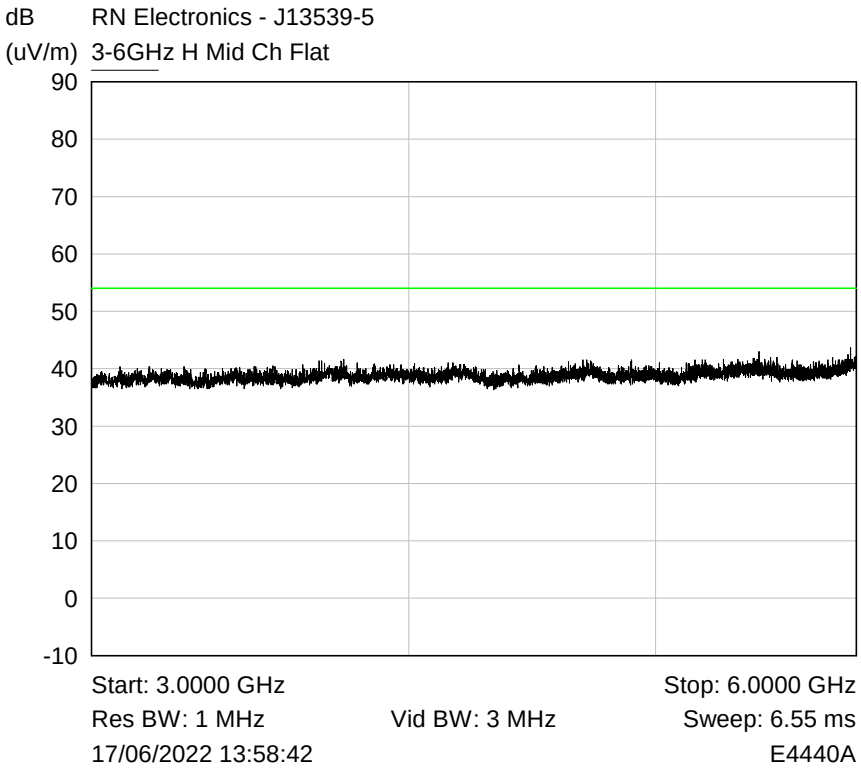


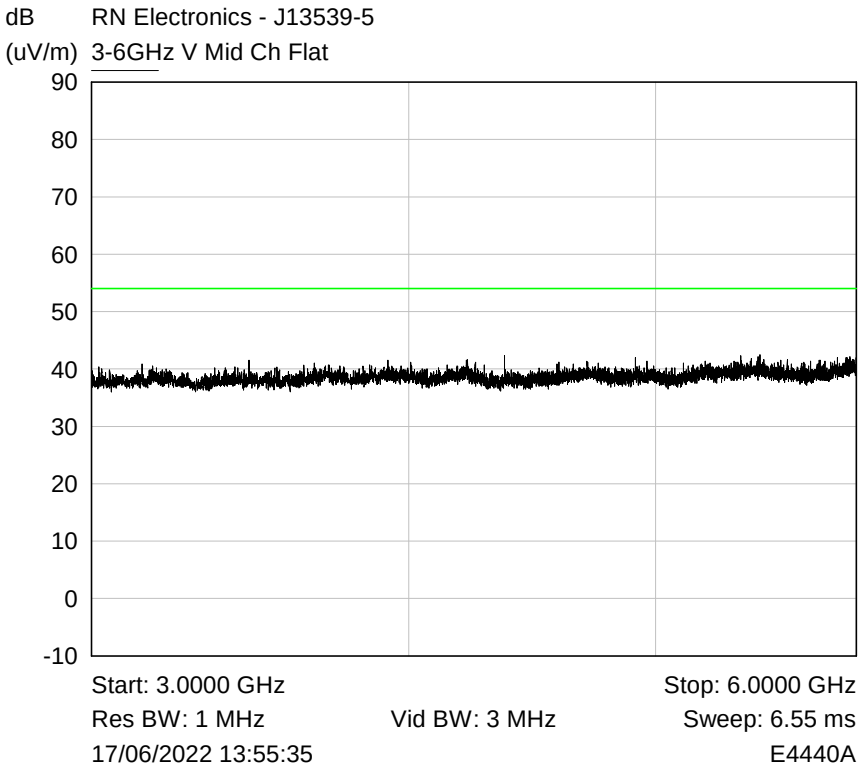


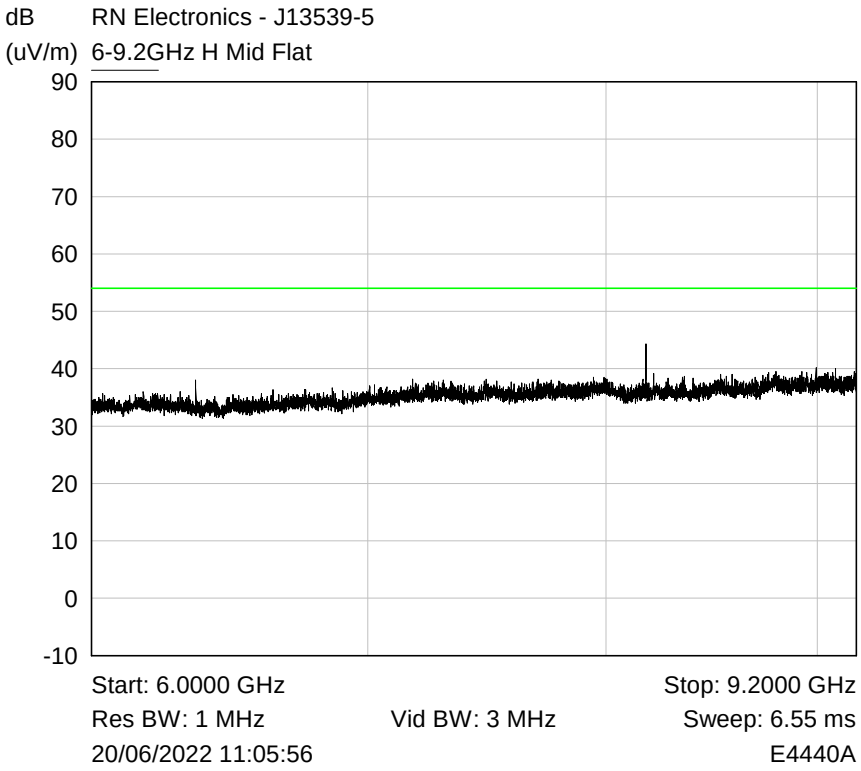
RF Parameters: Band 902-928 MHz, Power 22 dBm, Channel Spacing 200 kHz, Modulation LoRa SF10, Channel 908.6 MHz

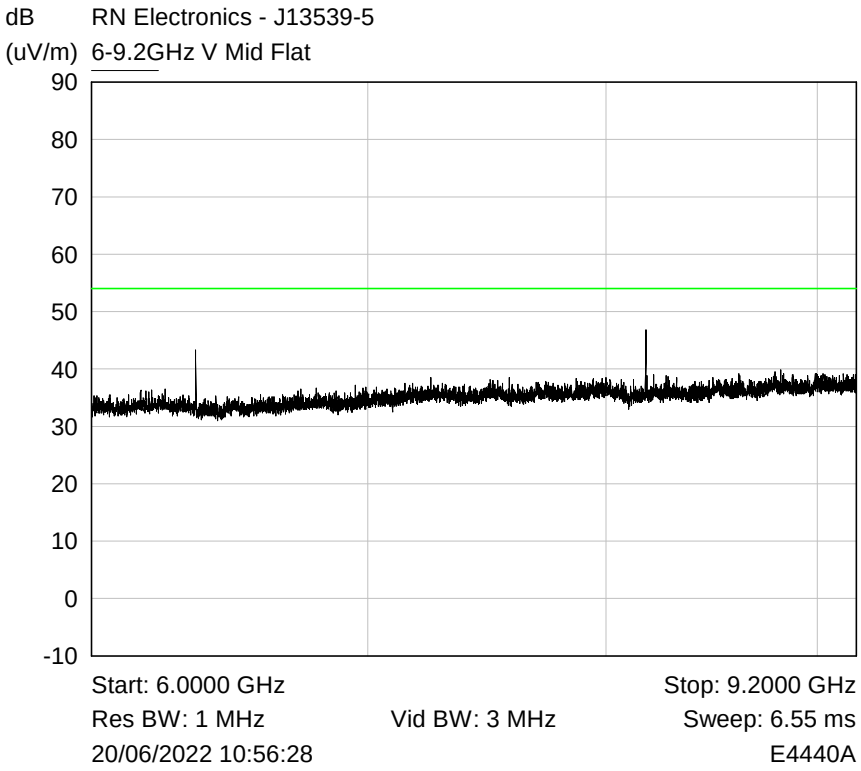




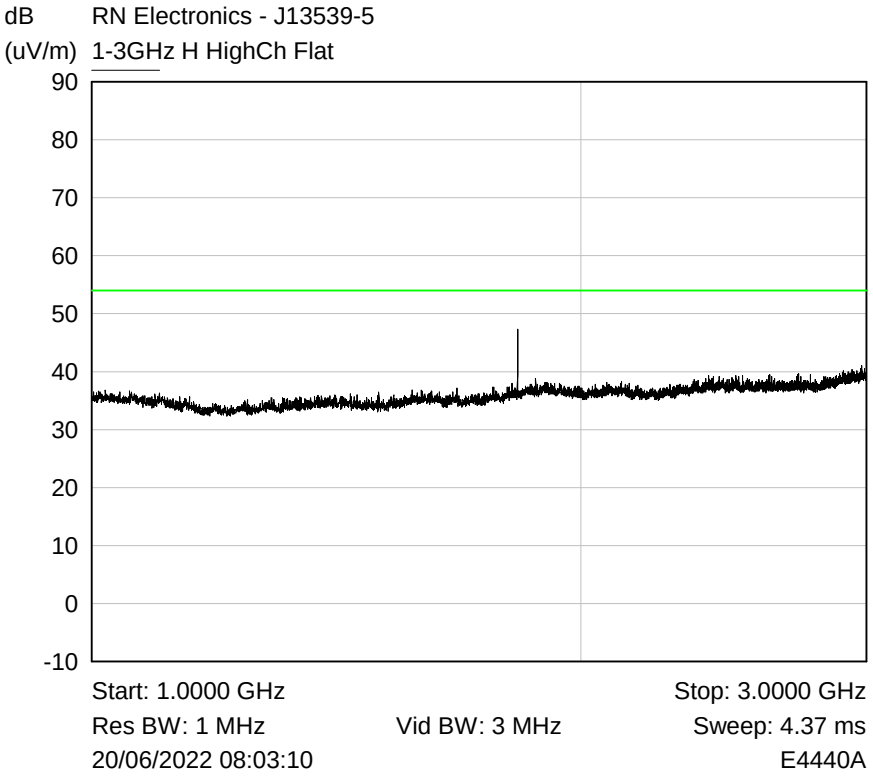


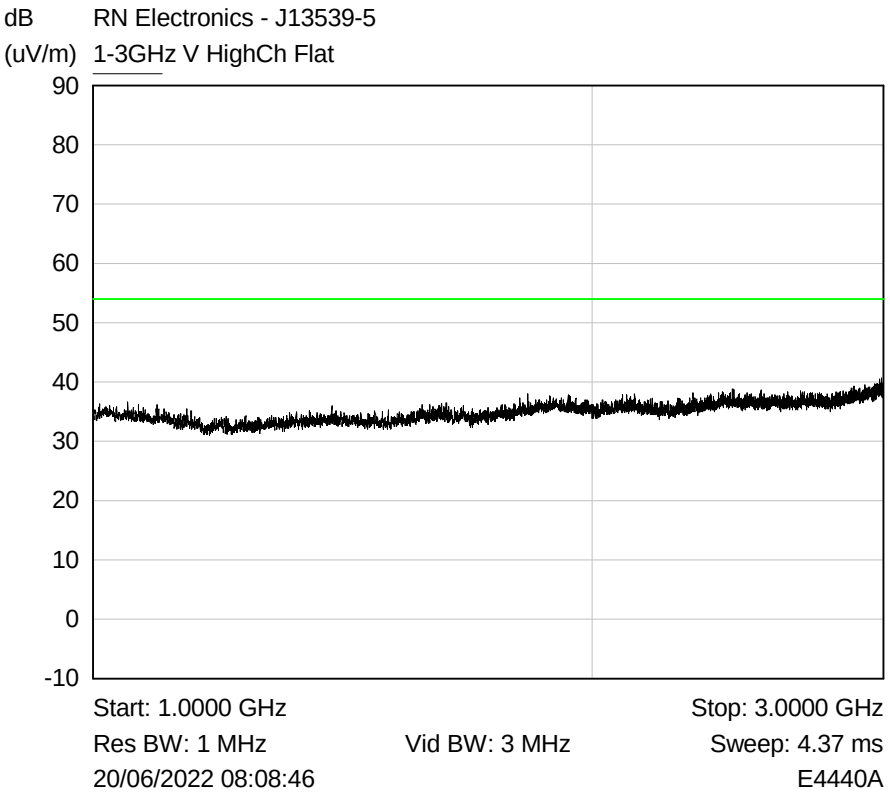


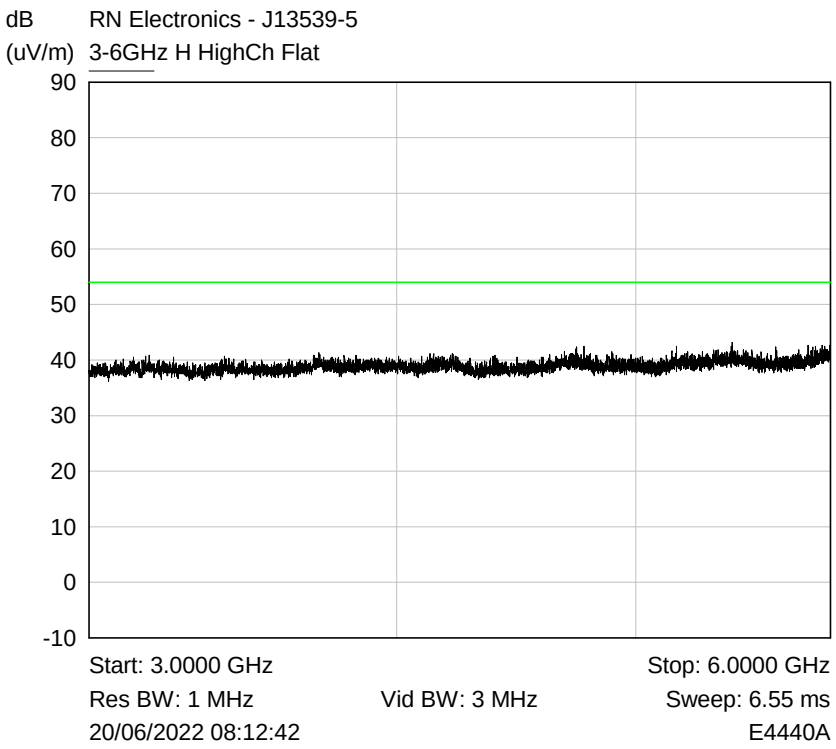


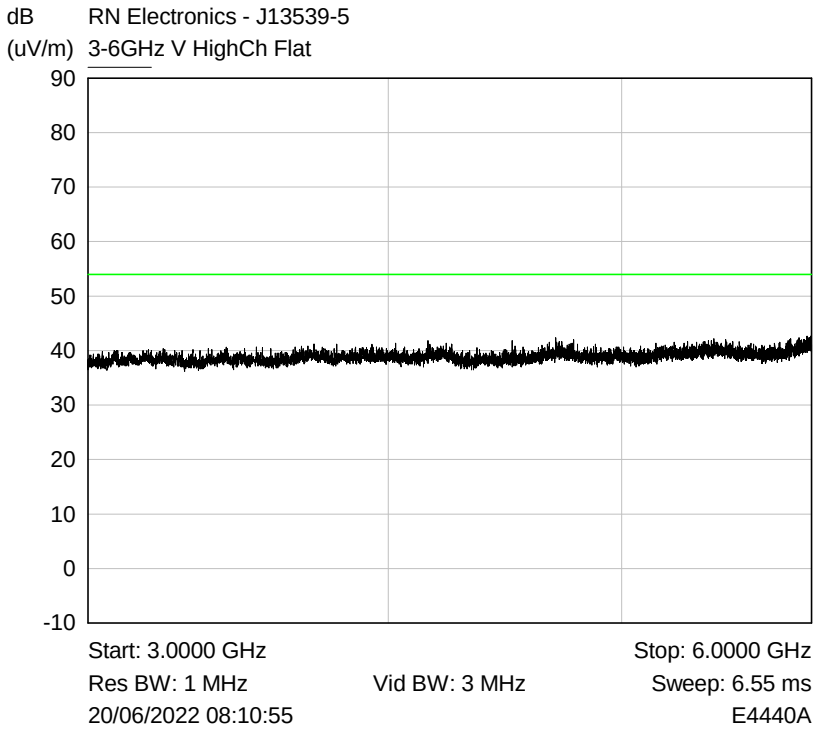


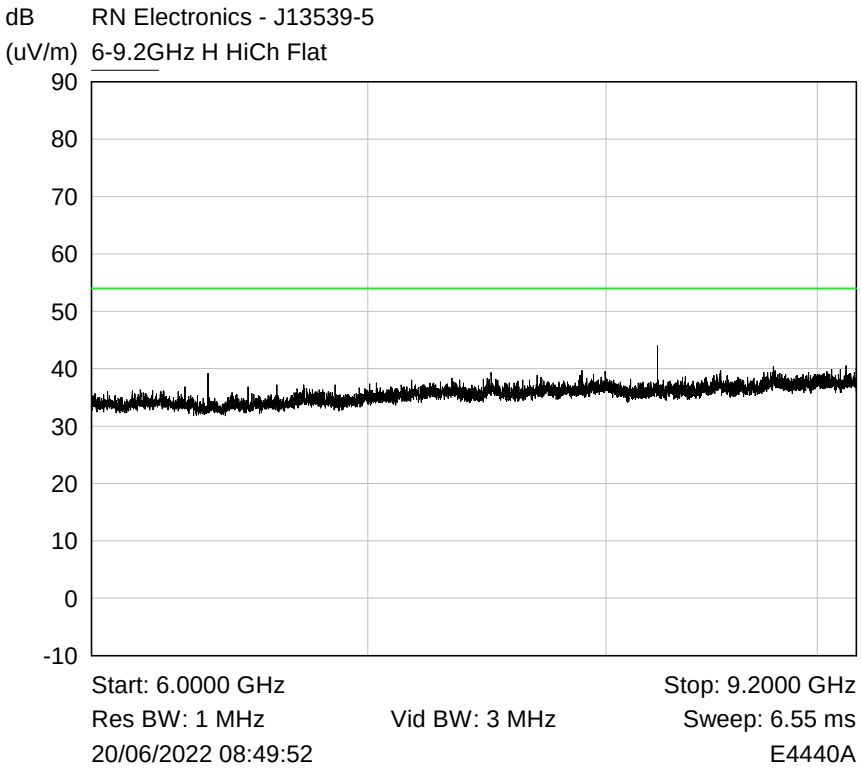
RF Parameters: Band 902-928 MHz, Power 22 dBm, Channel Spacing 200 kHz, Modulation LoRa SF10, Channel 914.9 MHz

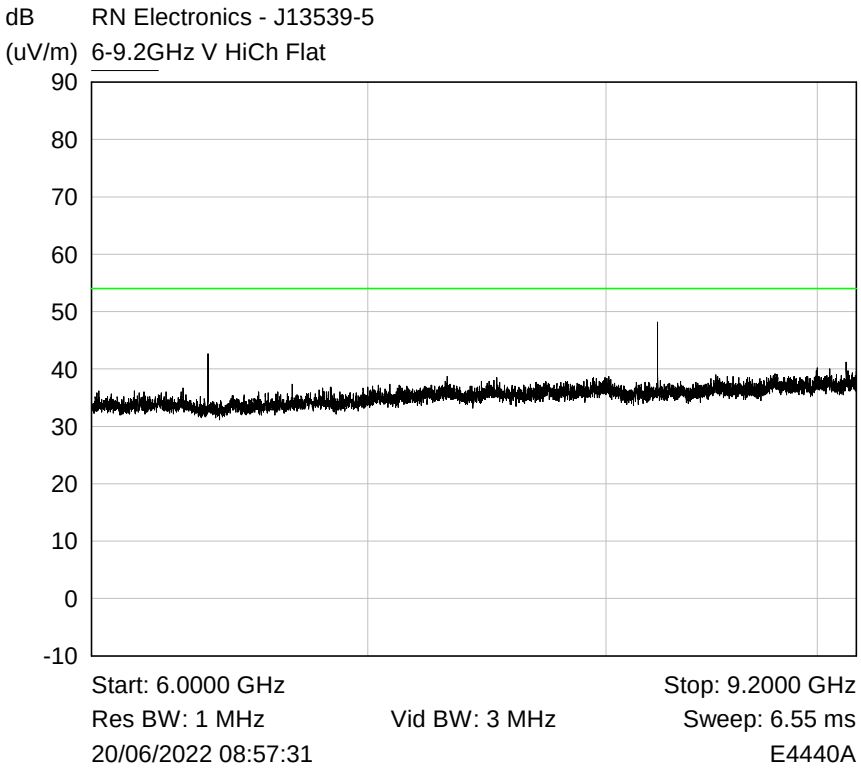






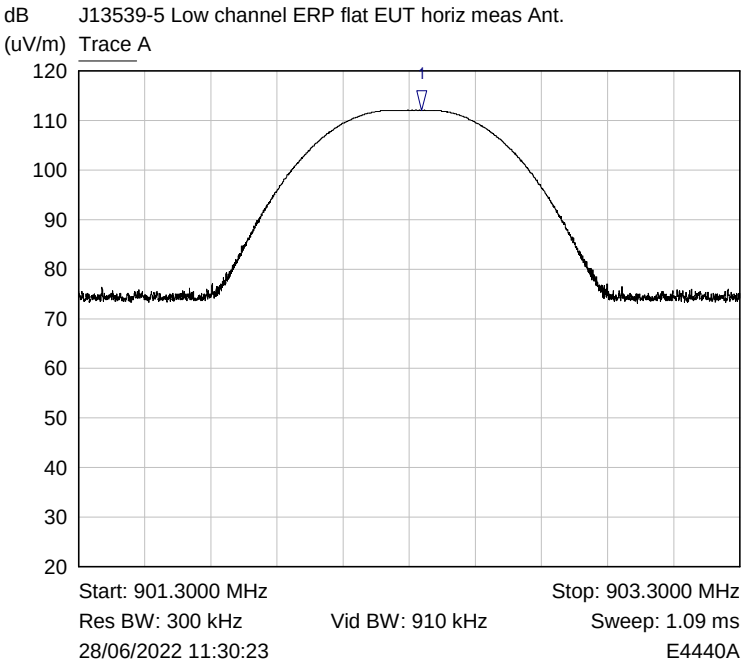






6.5 Effective radiated power field strength

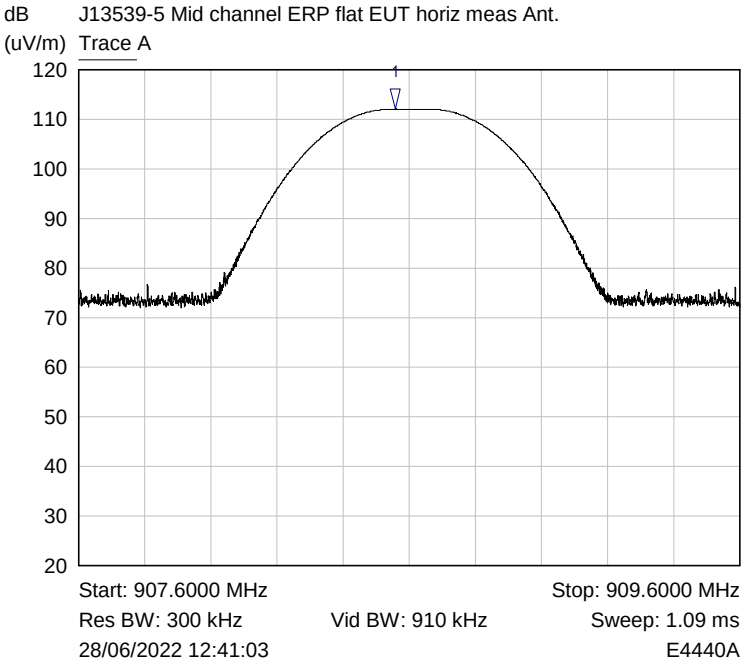
RF Parameters: Band 902-928 MHz, Power 22 dBm, Channel Spacing 200 kHz, Modulation LoRa SF10, Channel 902.3 MHz



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	902.3387 MHz	112.05 dB(uV/m)	

Plot of Horiz polarisation and EUT in Flat position

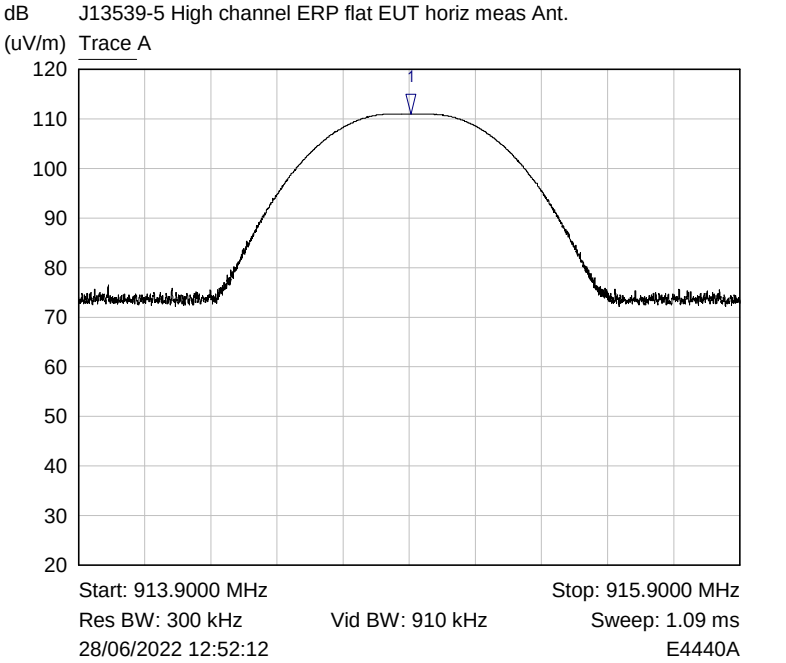
RF Parameters: Band 902-928 MHz, Power 22 dBm, Channel Spacing 200 kHz, Modulation LoRa SF10, Channel 908.6 MHz



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	908.5581 MHz	112.09 dB(uV/m)	

Plot of Horiz polarisation and EUT in Flat position

RF Parameters: Band 902-928 MHz, Power 22 dBm, Channel Spacing 200 kHz, Modulation LoRa SF10, Channel 914.9 MHz

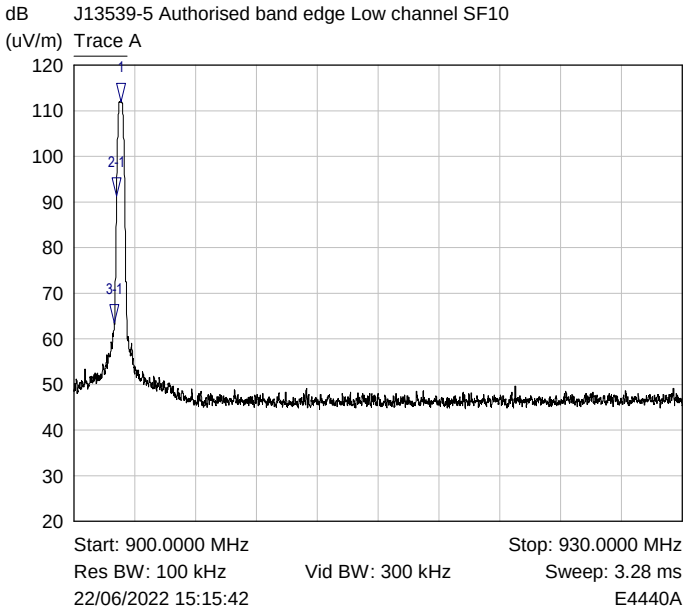


Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	914.9045 MHz	111.01 dB(uV/m)	

Plot of Horiz polarisation and EUT in Flat position

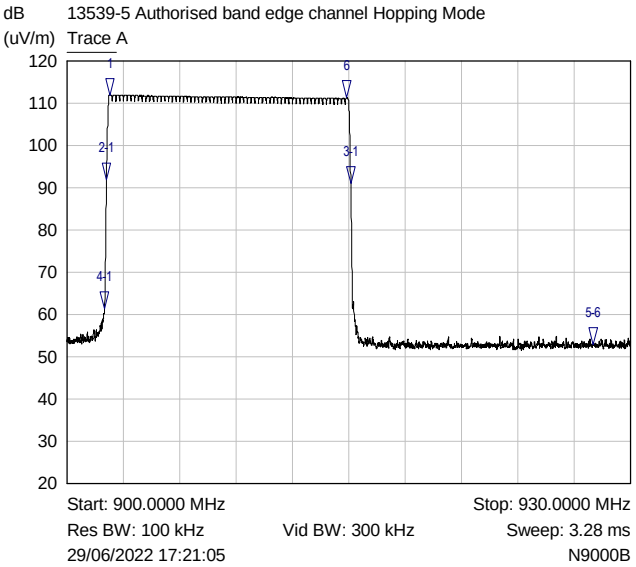
6.6 Band Edge Compliance

RF Parameters: Band 902-928 MHz, Power 22 dBm, Channel Spacing 200 kHz, Modulation LoRa SF10, Channel 902.3 MHz



Mkr	Trace	X-Axis	Value	Notes
1	Trace A	902.3294 MHz	112.02 dB(uV/m)	
2-1	Trace A	902.1023 MHz	-20.62 dB	
3-1	Trace A	901.9998 MHz	-48.49 dB	

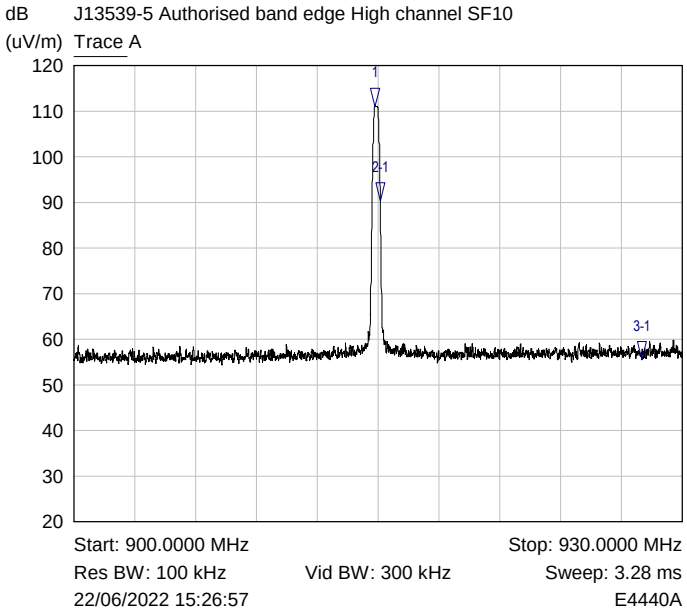
Authorised Band Edge Non-hopping Plot



Mkr	Trace	X-Axis	Value	Notes
1	Trace A	902.3001 MHz	111.89 dB(uV/m)	
2-1	Trace A	902.1023 MHz	-20.10 dB	
3-1	Trace A	915.1044 MHz	-20.84 dB	
4-1	Trace A	901.9998 MHz	-50.49 dB	
5-6	Trace A	928.0002 MHz	-58.56 dB	
6	Trace A	914.8993 MHz	111.32 dB(uV/m)	

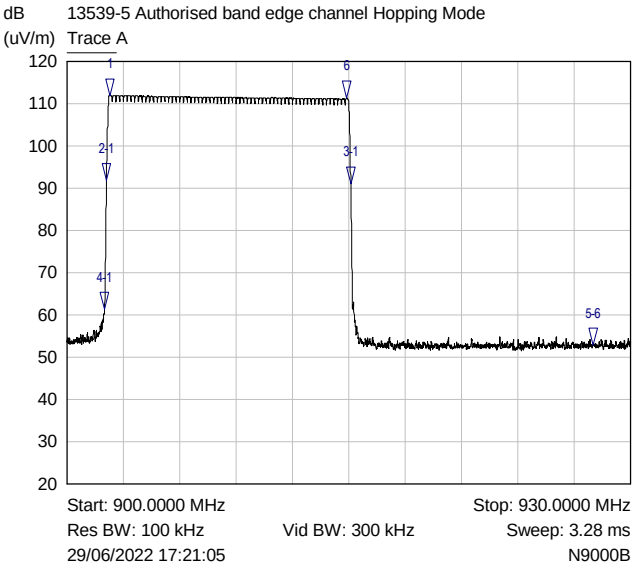
Auth Band Edge hop Plot

RF Parameters: Band 902-928 MHz, Power 22 dBm, Channel Spacing 200 kHz, Modulation LoRa SF10, Channel 914.9 MHz



Mkr	Trace	X-Axis	Value	Notes
1	Trace A	914.8480 MHz	111.03 dB(uV/m)	
2-1	Trace A	915.1080 MHz	-20.73 dB	
3-1	Trace A	928.0002 MHz	-55.47 dB	

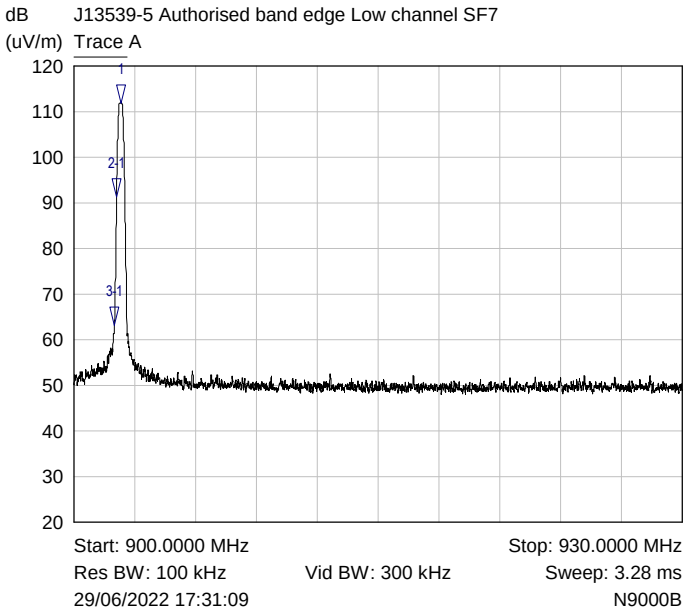
Authorised Band Edge Non-hopping Plot



Mkr	Trace	X-Axis	Value	Notes
1	Trace A	902.3001 MHz	111.89 dB(uV/m)	
2-1	Trace A	902.1023 MHz	-20.10 dB	
3-1	Trace A	915.1044 MHz	-20.84 dB	
4-1	Trace A	901.9998 MHz	-50.49 dB	
5-6	Trace A	928.0002 MHz	-58.56 dB	
6	Trace A	914.8993 MHz	111.32 dB(uV/m)	

Auth Band Edge hop Plot

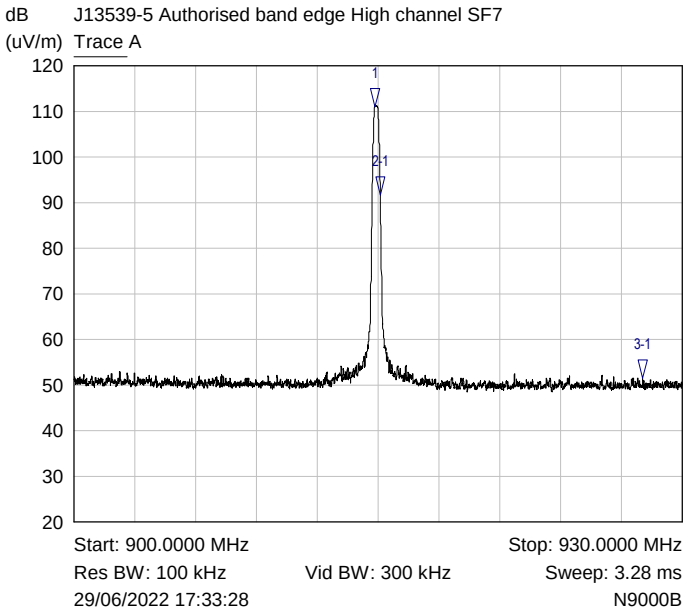
RF Parameters: Band 902-928 MHz, Power 22 dBm, Channel Spacing 200 kHz, Modulation LoRa SF7, Channel 902.3 MHz



Mkr	Trace	X-Axis	Value	Notes
1	Trace A	902.3294 MHz	111.90 dB(uV/m)	
2-1	Trace A	902.1023 MHz	-20.49 dB	
3-1	Trace A	901.9998 MHz	-48.71 dB	

Authorised Band Edge Non-hopping Plot

RF Parameters: Band 902-928 MHz, Power 22 dBm, Channel Spacing 200 kHz, Modulation LoRa SF7, Channel 914.9 MHz

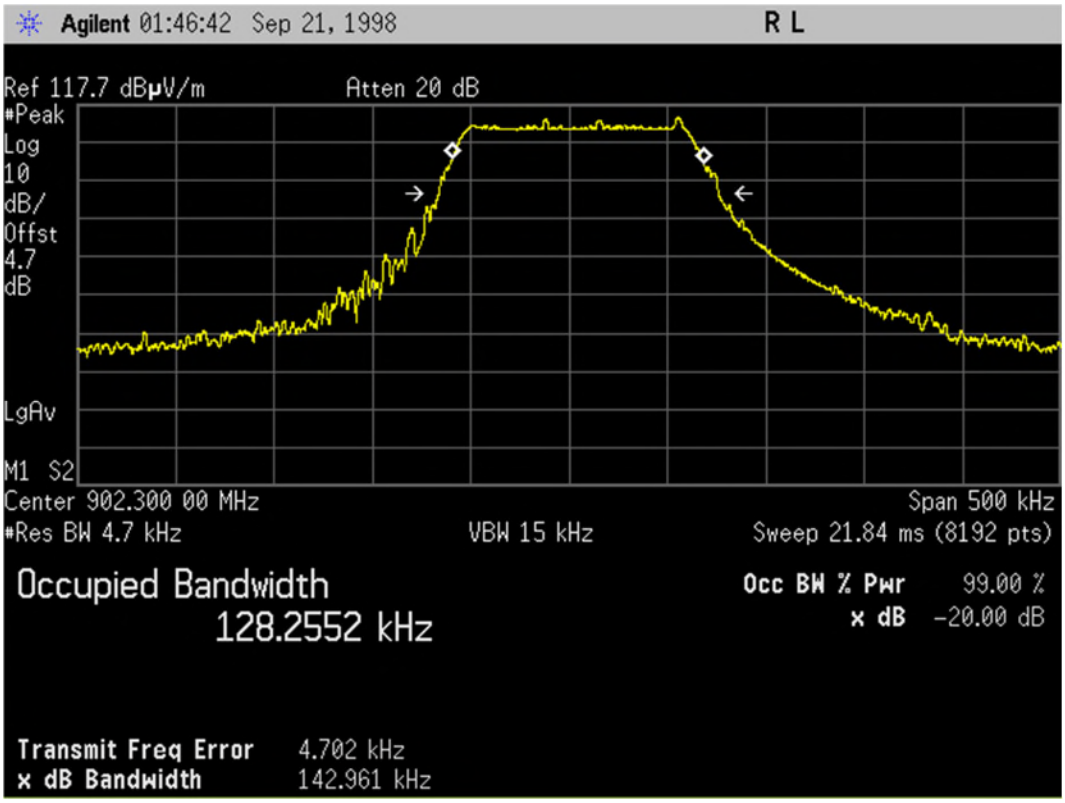


Mkr	Trace	X-Axis	Value	Notes
1	Trace A	914.8480 MHz	111.07 dB(uV/m)	
2-1	Trace A	915.1080 MHz	-19.45 dB	
3-1	Trace A	928.0588 MHz	-59.65 dB	

Authorised Band Edge Non-hopping Plot

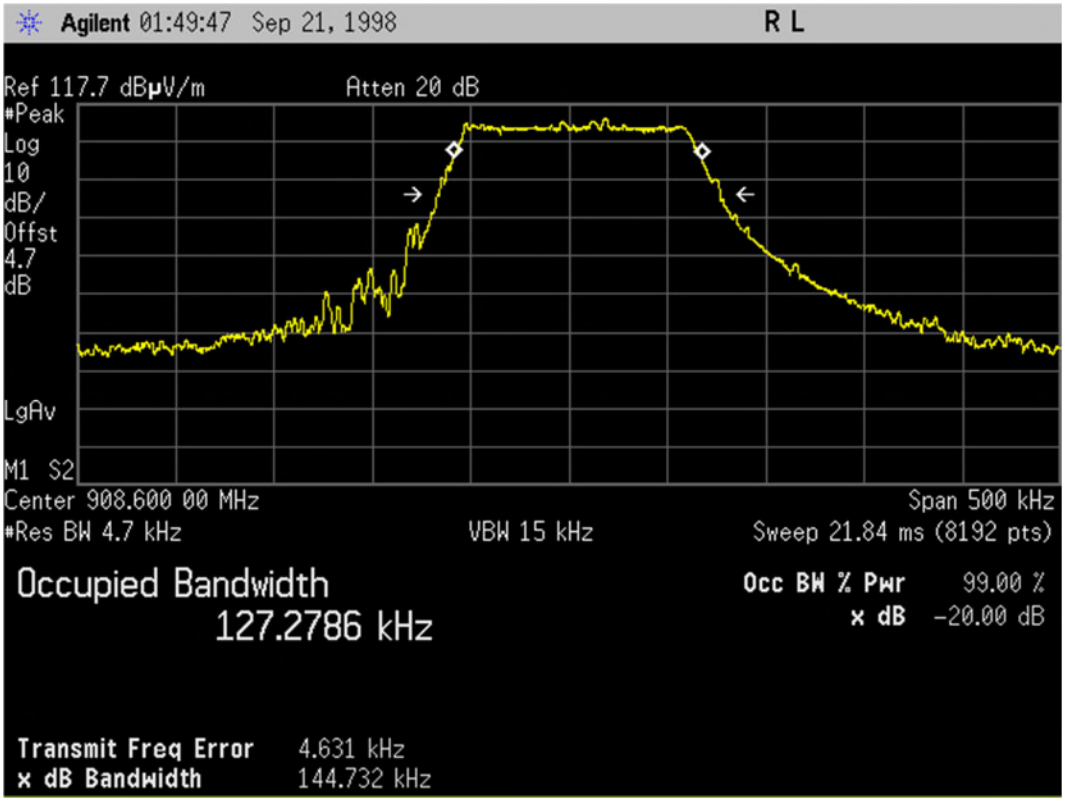
6.7 Occupied bandwidth

RF Parameters: Band 902-928 MHz, Power 22 dBm, Channel Spacing 200 kHz, Modulation LoRa SF7, Channel 902.3 MHz



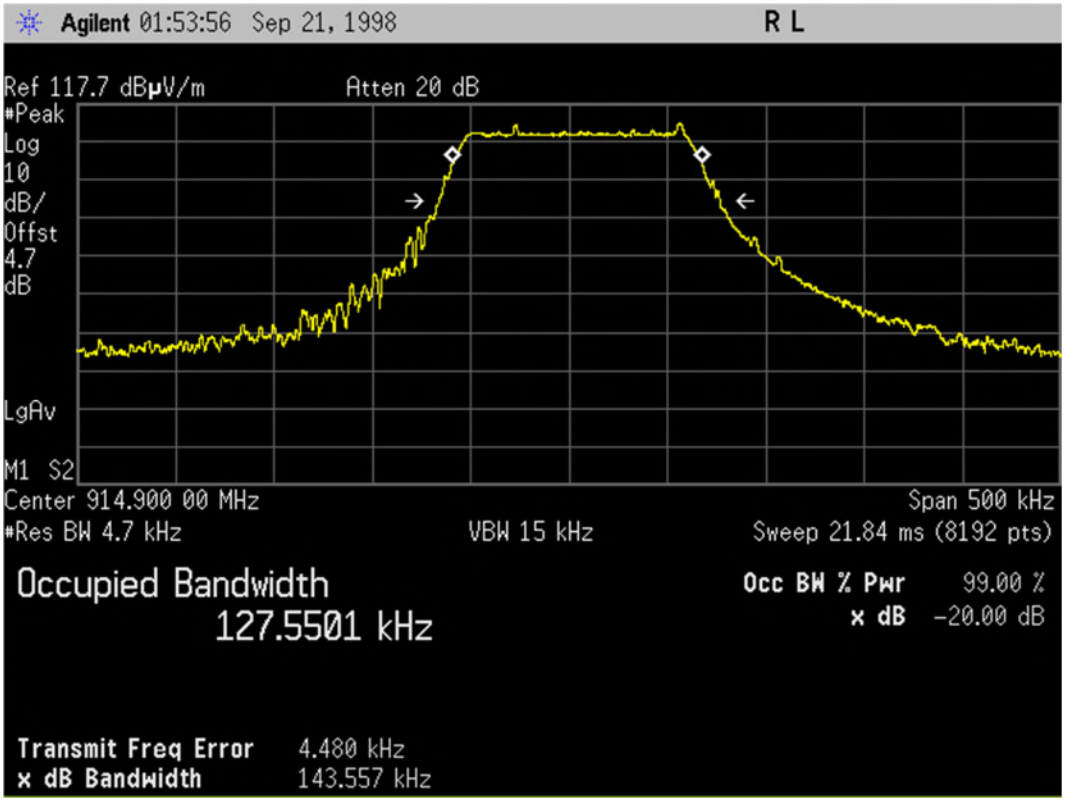
Plot for 20 dB Bandwidth Result (kHz)

RF Parameters: Band 902-928 MHz, Power 22 dBm, Channel Spacing 200 kHz, Modulation LoRa SF7, Channel 908.6 MHz



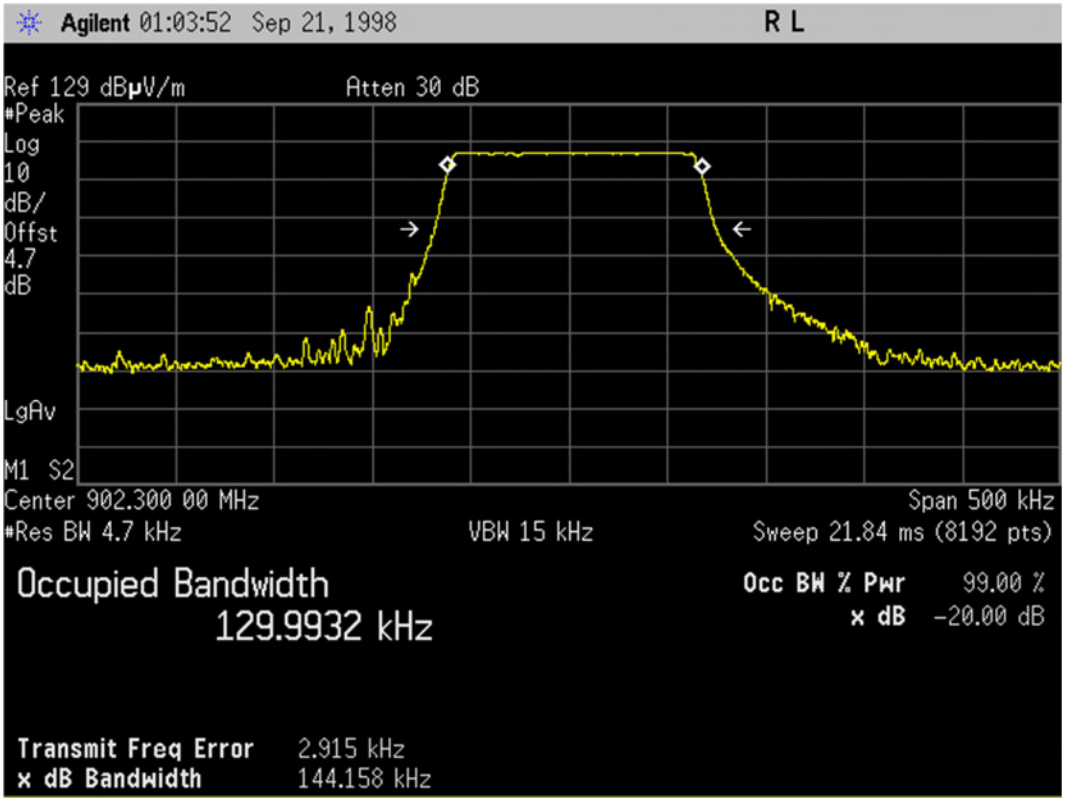
Plot for 20 dB Bandwidth Result (kHz)

RF Parameters: Band 902-928 MHz, Power 22 dBm, Channel Spacing 200 kHz, Modulation LoRa SF7, Channel 914.9 MHz



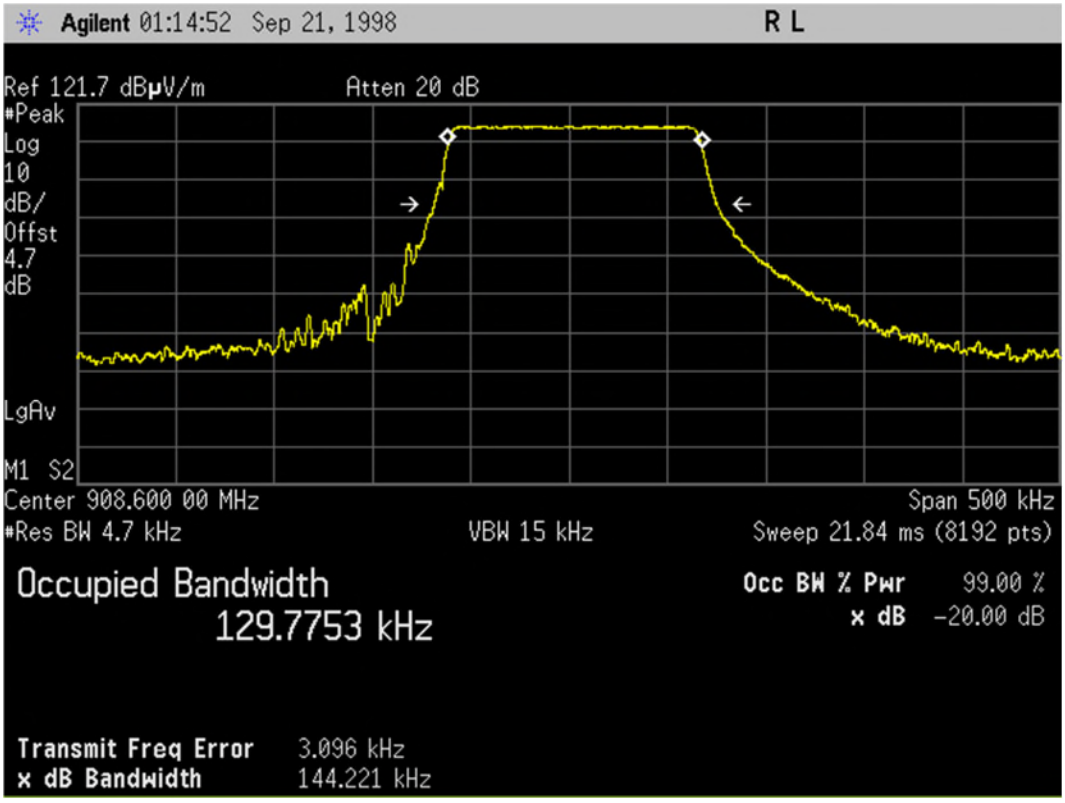
Plot for 20 dB Bandwidth Result (kHz)

RF Parameters: Band 902-928 MHz, Power 22 dBm, Channel Spacing 200 kHz, Modulation LoRa SF10, Channel 902.3 MHz



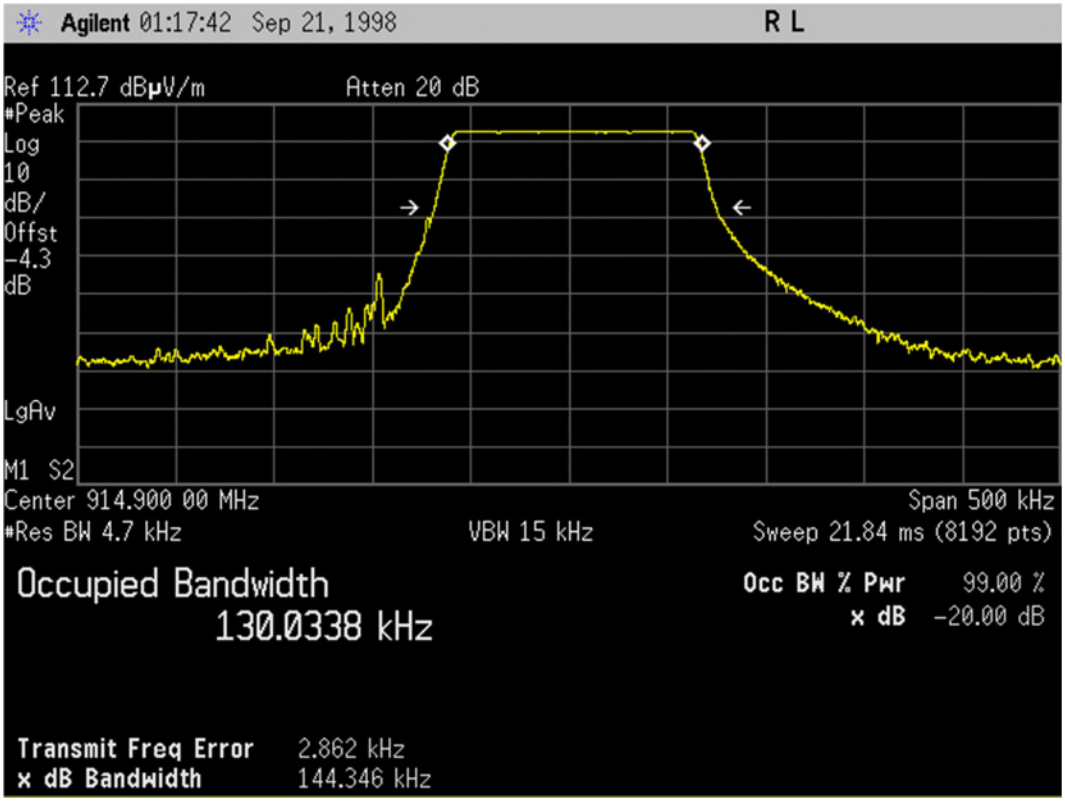
Plot for 20 dB Bandwidth Result (kHz)

RF Parameters: Band 902-928 MHz, Power 22 dBm, Channel Spacing 200 kHz, Modulation LoRa SF10, Channel 908.7 MHz



Plot for 20 dB Bandwidth Result (kHz)

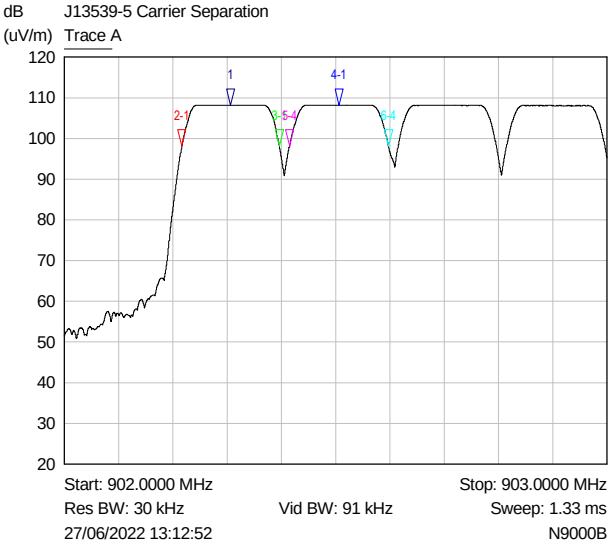
RF Parameters: Band 902-928 MHz, Power 22 dBm, Channel Spacing 200 kHz, Modulation LoRa SF10, Channel 914.9 MHz



Plot for 20 dB Bandwidth Result (kHz)

6.8 FHSS carrier frequency separation

RF Parameters: Band 902-928 MHz, Power 22 dBm, Channel Spacing 200 kHz, Modulation LoRa SF10

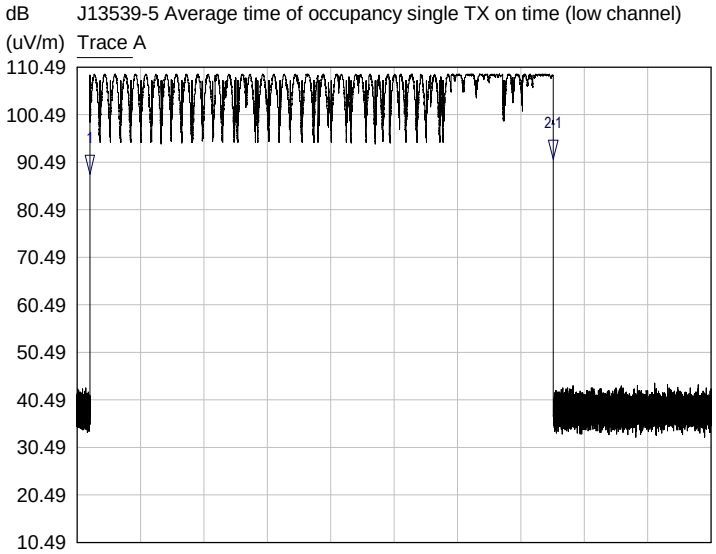


Mkr	Trace	X-Axis	Value	Notes
1	Trace A	902.3063 MHz	108.16 dB(uV/m)	
2-1	Trace A	902.2167 MHz	-9.96 dB	
3-1	Trace A	902.3959 MHz	-9.99 dB	(mk3+mk2)/2 = 902.306331 = CF1
4-1	Trace A	199.6200 kHz	-0.02 dB	Carrier Separation
5-4	Trace A	902.4147 MHz	-10.02 dB	
6-4	Trace A	902.5972 MHz	-10.01 dB	(mk6+mk5)/2 = 902.5059505 = CF2

Plot of Separation (kHz)

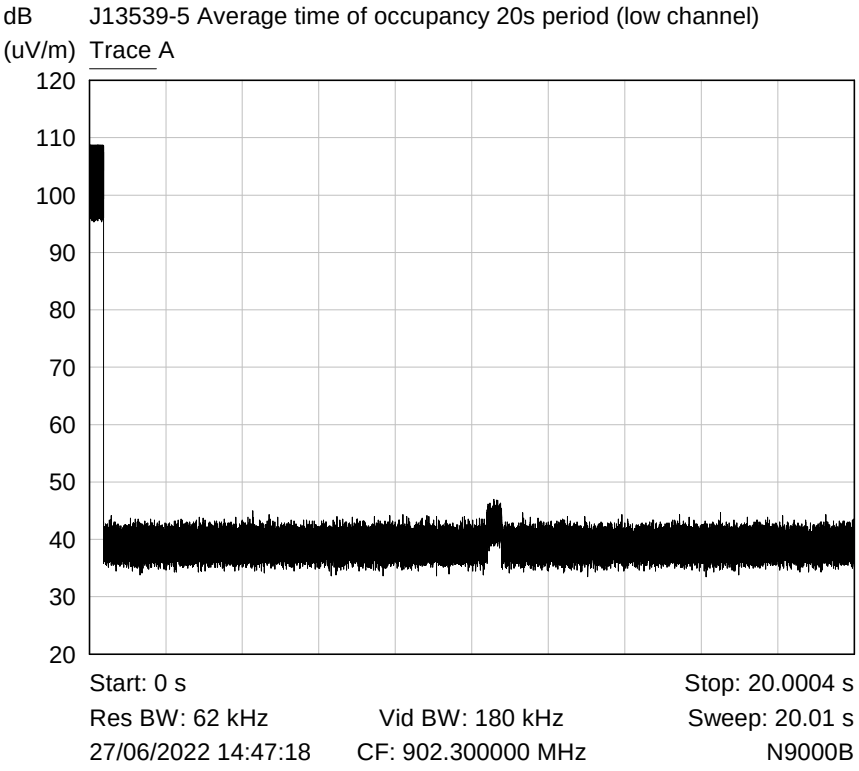
6.9 Average time of occupancy

RF Parameters: Band 902-928 MHz, Power 22 dBm, Channel Spacing 200 kHz, Modulation LoRa SF10, Channel Hopping all channels



Mkr	Trace	X-Axis	Value	Notes
1	Trace A	10.0371 ms	87.93 dB(uV/m)	
2-1	Trace A	370.8445 ms	3.30 dB	

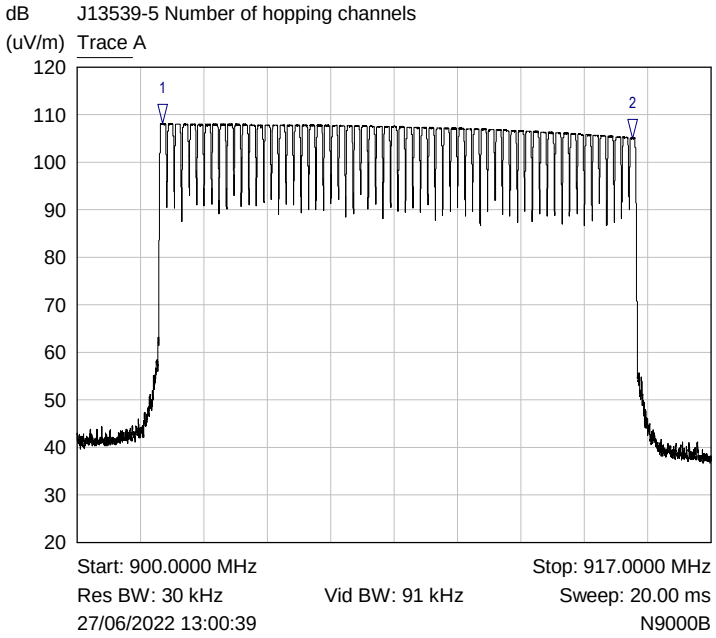
Measured Dwell time/pulse width (ms)



Observation Period time (s)

6.10 Number of Hop Channels

RF Parameters: Band 902-928 MHz, Power 22 dBm, Channel Spacing 200 kHz, Modulation LoRa SF10, Channel Hopping all channels



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	902.3000 MHz	108.10 dB(uV/m)	Channel 1
2 ▽	Trace A	914.9000 MHz	105.08 dB(uV/m)	Channel 64

Plot of Hopping Channels 1-64

7 Explanatory Notes

7.1 Explanation of Table of Signals Measured

Measurements are made as required by the standard. These measurements are made and recorded using detectors, either peak, quasi peak or average dependant on the test. A table of results has been given following the relevant plots. This table looks similar to the one illustrated below dependant on the measurements required by the test: -

Signal No.	Freq (MHz)	Peak Amp (dBuV)	Pk – Lim 1 (dB)	QP Amp (dBuV)	QP - Lim1 (dB)	Av Amp (dBuV)	Av - Lim1 (dB)
1	12345	54.9	-10.5	48	-12.6	37.6	-14.4

Column One - Labelled Signal No. is an incremental number that the receiver has given to each signal that has been measured.

Column Two - Labelled Freq (MHz) is the approximate frequency of the signal received.

Column Three - Labelled Peak Amp (dBμV) is the level of received signal that was measured in dB above 1μV using the peak detector.

Column Four - Labelled Pk - Lim1 (dB) is the difference in level from the peak signal given to the active limit line. If this column appears in the table the peak detector measurement is required by the standard for this test. The results entered in this column indicate the signal level relative to the compliance limit required. Negative numbers indicate that the product is compliant.

Column Five - Labelled QP Amp (dBμV) is the level of received signal that was measured in dB above 1μV using the quasi-peak detector.

Column Six - Labelled QP - Lim1 (dB) is the difference in level from the quasi-peak signal given to the active limit line. If this column appears in the table the quasi-peak detector measurement is required by the standard for this test. The results entered in this column indicate the signal level relative to the compliance limit required. Negative numbers indicate that the product is compliant.

Column Seven - Labelled Av Amp (dBμV) is the level of received signal that was measured in dB above 1μV using the average detector.

Column Eight - Labelled Av - Lim1 (dB) is the difference in level from the average signal given to the active limit line. If this column appears in the table the average detector measurement is required by the standard for this test. The results entered in this column indicate the signal level relative to the compliance limit required. Negative numbers indicate that the product is compliant.

Only signals highlighted in red are deemed to exceed the limit of the detector required.

7.2 Explanation of limit line calculations for radiated measurements

The limits given in the test standard are normally expressed as absolute values (e.g. in μV/m at a specified distance), whereas the measured values are expressed as peak, quasi peak or average values in dBμV/m referenced to the measuring instrument inputs. RN Electronics calibrate the test set-up to account for any path losses, antenna gains, etc. so that the value read at the receiver relates directly to the absolute value required, except that it is expressed in dB relative to one microVolt and may need to take account of any alternative measuring distance used. Examples:

(a) limit of 500 μV/m equates to 20.log (500) = 54 dB μV/m.

(b) limit of 300 μV/m at 10m equates to 20.log (300 . 10/3) = 60 dB μV/m at 3m

(c) limit of 30 μV/m at 30m, but below 30MHz, equates to 20.log(30) + 40.log(30/3) = 69.5 dBμV/m at 3m, as

extrapolation factor below 30MHz is 40dB/decade per 15.31(f)(2).

The measurement receiver used for emissions testing, performs the field strength (FS) calculations automatically. The receiver combines the signal amplitude (RA), Antenna Factor (AF) and Cable Loss (CL) factors for the frequency to be measured.

Example calculation: - FS = RA + AF + CL.

Receiver amplitude (RA)	Antenna factor (3m) (AF)	Cable loss (CL)	Field strength result (3m) (FS)
20dBuV	25 dB	3 dB	48dBuV/m

Additional calculation examples per ANSI C63.10 clause 9.4 – 9.6 equations 21, 22, 25 & 26:

Equation 21: $E_{Linear} = 10^{((E_{log}-120)/20)}$
And therefore equation 21 transposed is: $E_{Log} = 20xLog(E_{Linear}) +120$
Where:
E_{Linear} is the field strength of the emission in V/m
E_{Log} is the field strength of the emissions in dBµV/m

Equation 22: $EIRP = E_{Meas} + 20log(d_{Meas}) -104.7$
Where:
EIRP is equivalent isotropically radiated power in dBm
E_{Meas} is the field strength of the emission at the measurement distance in dBµV/m
d_{Meas} is the measurement distance in metres

Equation 25: $PD = EIRP_{Linear} / 4\pi d^2$
And therefore equation 25 transposed is: $EIRP_{Linear} = PD \times 4\pi d^2$
Where:
PD is the power density at distance specified by the limit, in W/m^2
$EIRP_{Linear}$ is the equivalent isotropically radiated power in Watts
d is the distance at which the power density limit is specified in metres

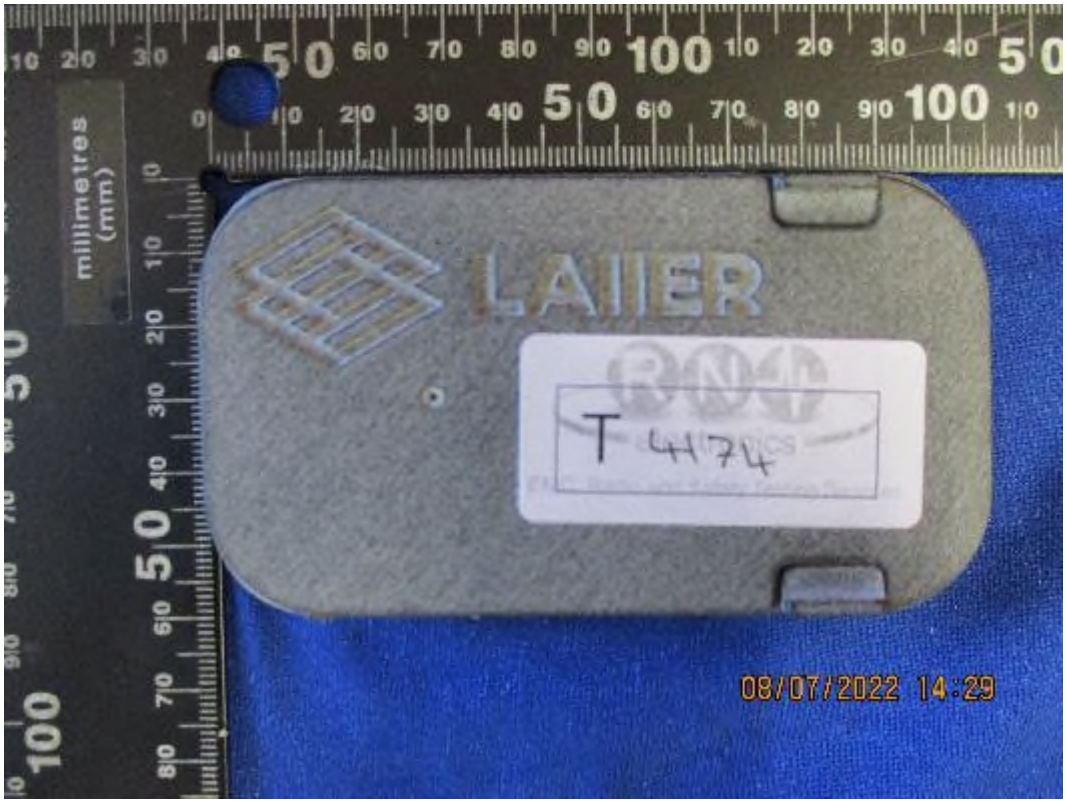
Equation 26: $PD = E^2_{Speclimit} / 377$
And therefore equation 26 transposed is: $E_{Spec\ limit} = \sqrt{(PD \times 377)}$
Where:
PD is the power density at distance specified by the limit, in W/m^2
$E_{spec\ limit}$ is the field strength at the distance specified by the limit in V/m

Example:
Radiated spurious emissions limit at 3metres of $90pW/cm^2$.
$90pW/cm^2 \times 100^2 = 0.9\ \mu W/m^2$ = (EIRP Linear)

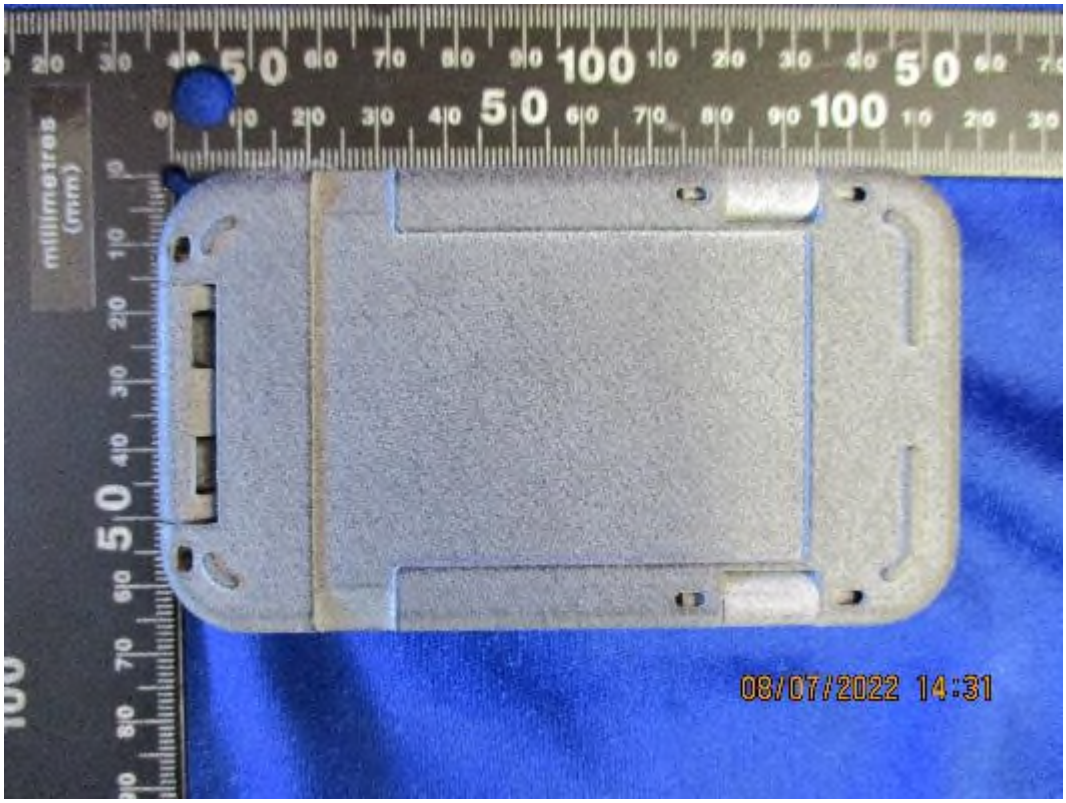
Equation 25 transposed: $0.9 \times 10^{-6} \times 4 \times \pi \times 3^2 = 0.0001017876$ W
And
Equation 26 transposed: $E_{Spec\ limit} = \sqrt{(0.9x10^{-6} \times 377)} = 0.01842$ V/m.
And
Equation 21 transposed: $E_{Log} = 20Log(0.01842) +120 = 85.3dB\mu V/m$ @ 3m.

8 Photographs

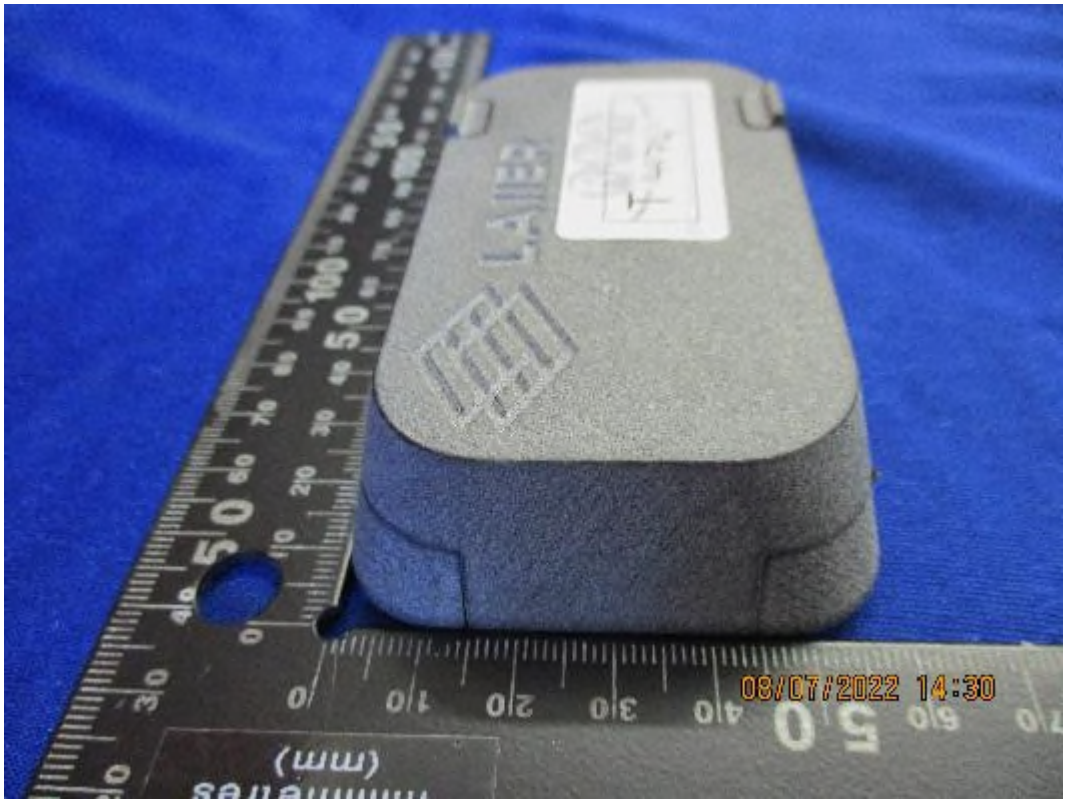
8.1 EUT Front View



8.2 EUT Reverse Angle

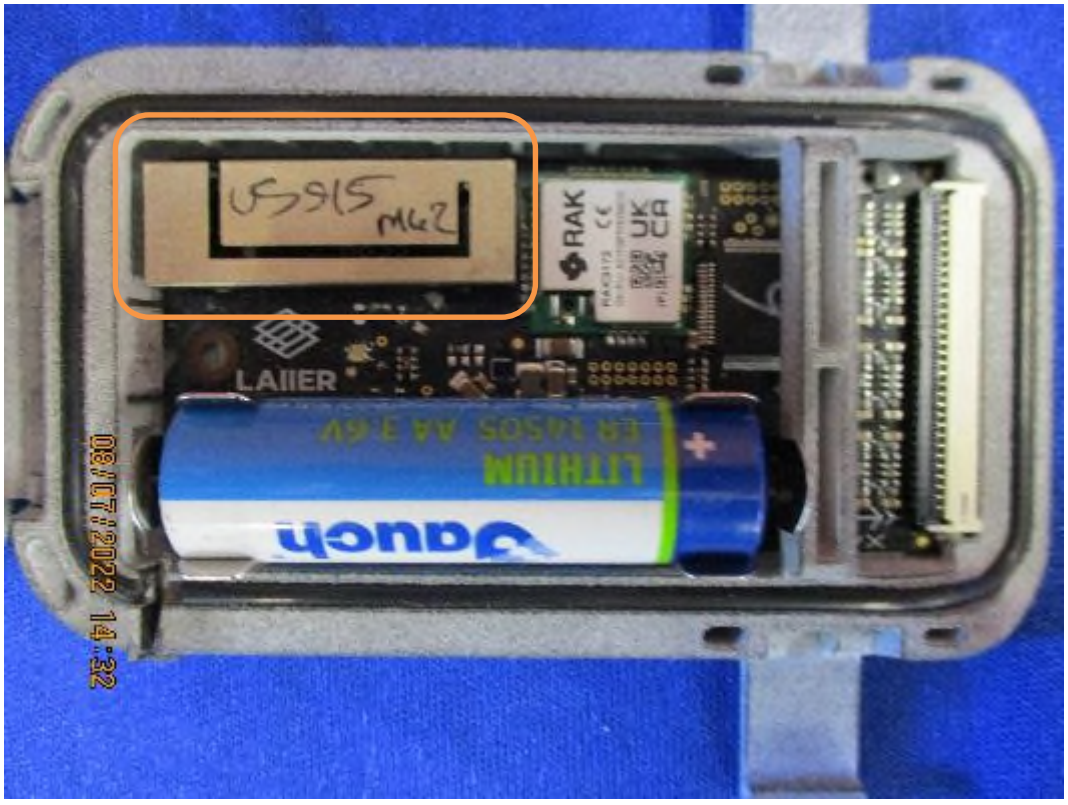


8.3 EUT Left side View



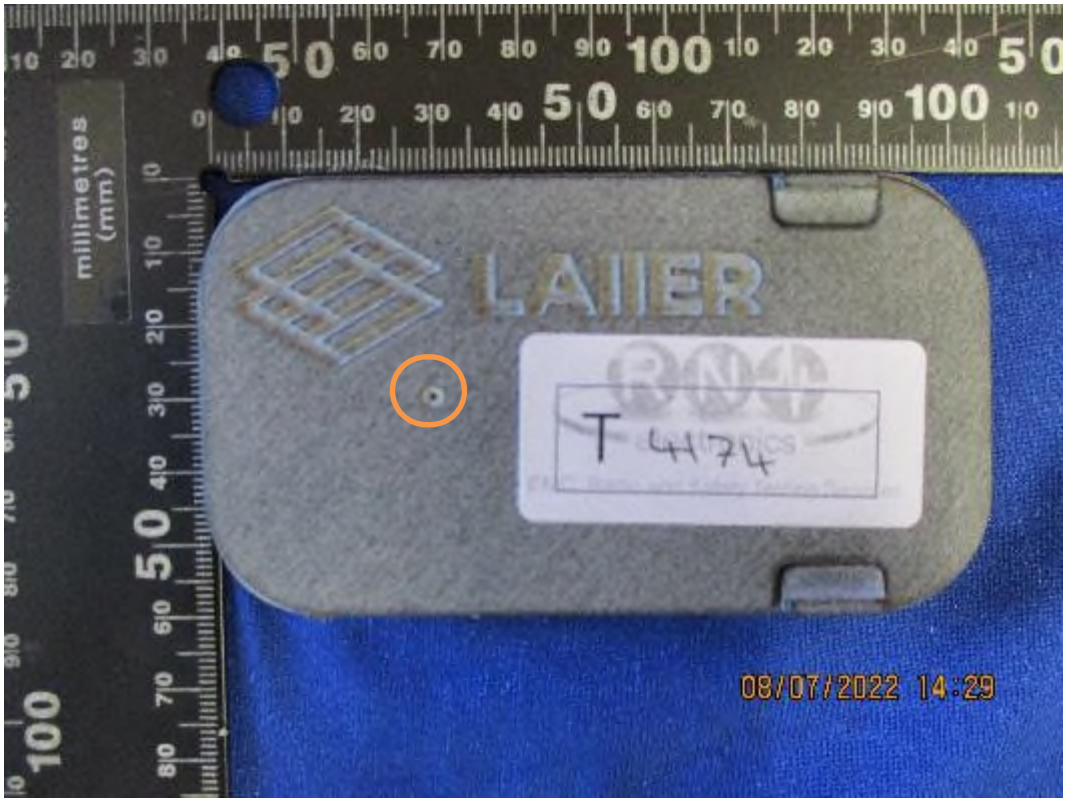
8.4 EUT Right side View

8.5 EUT Antenna Port



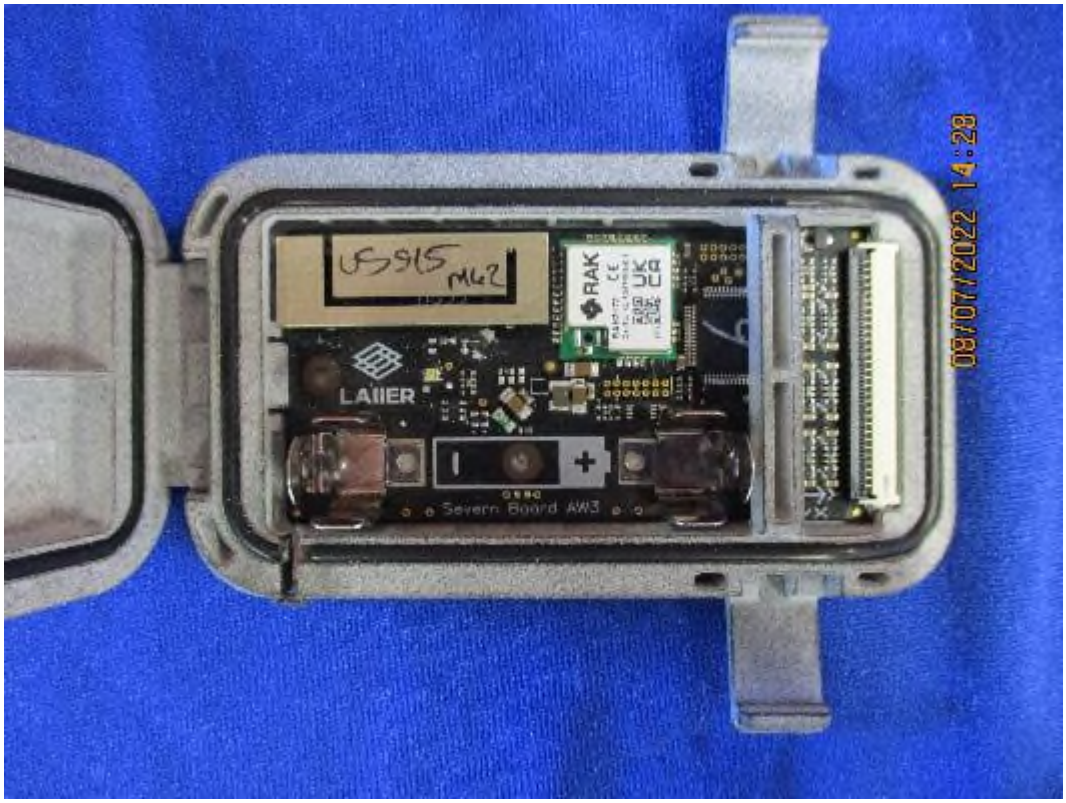
Antenna marked in orange rectangle

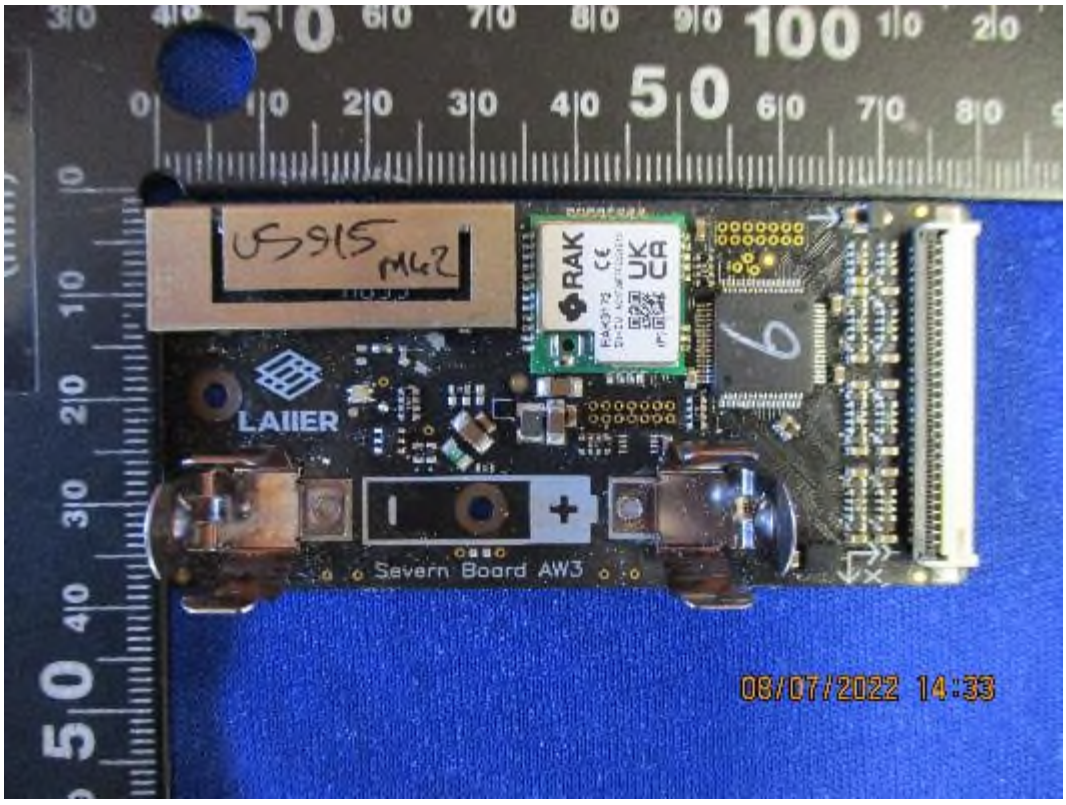
8.6 EUT Display & Controls

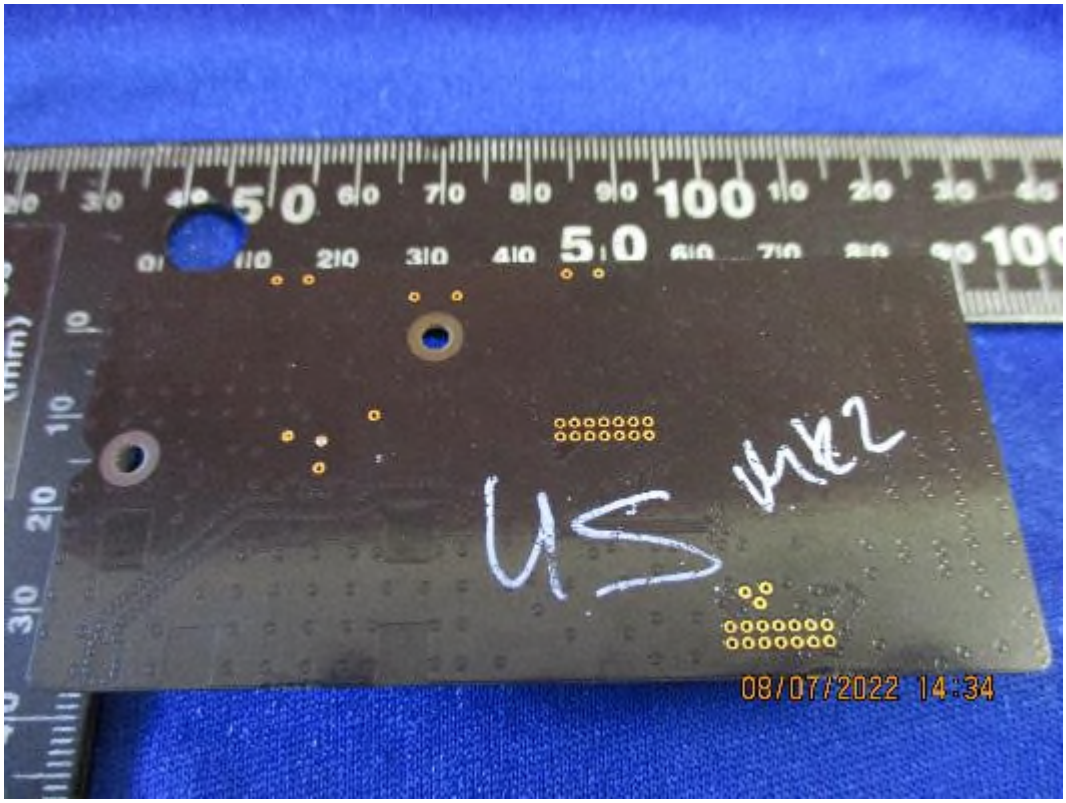


LED marked in orange circle

8.7 EUT Internal photos





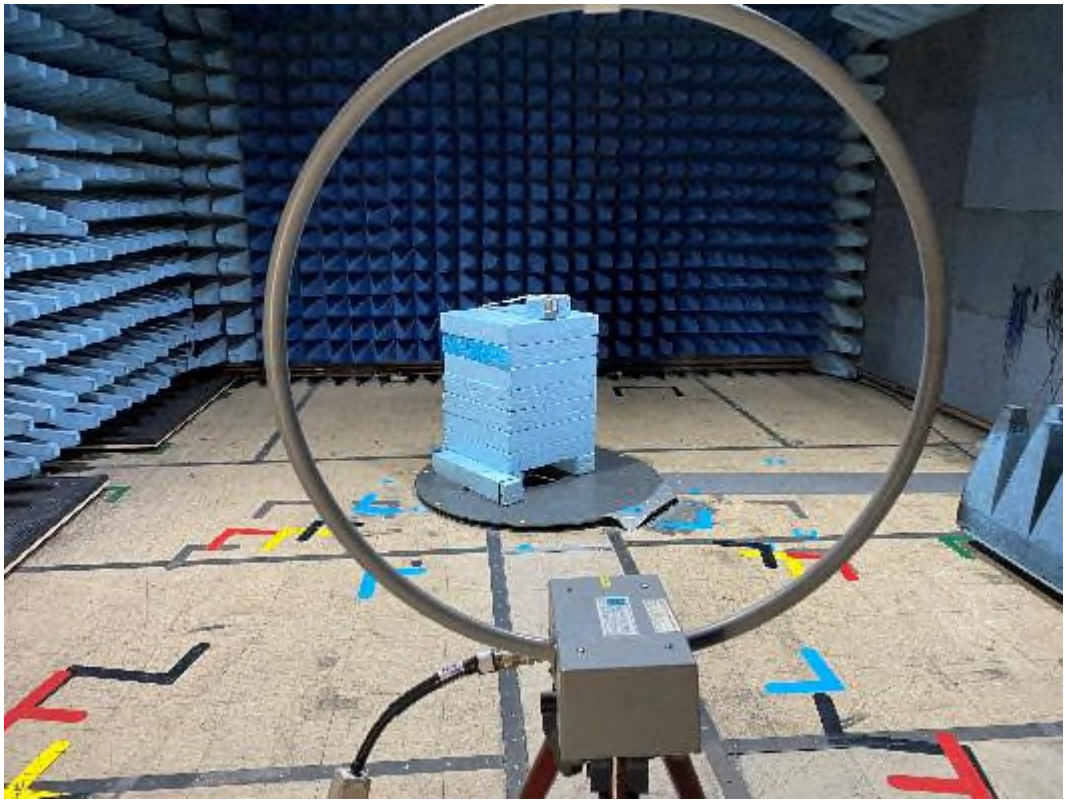


8.8 EUT ID Label

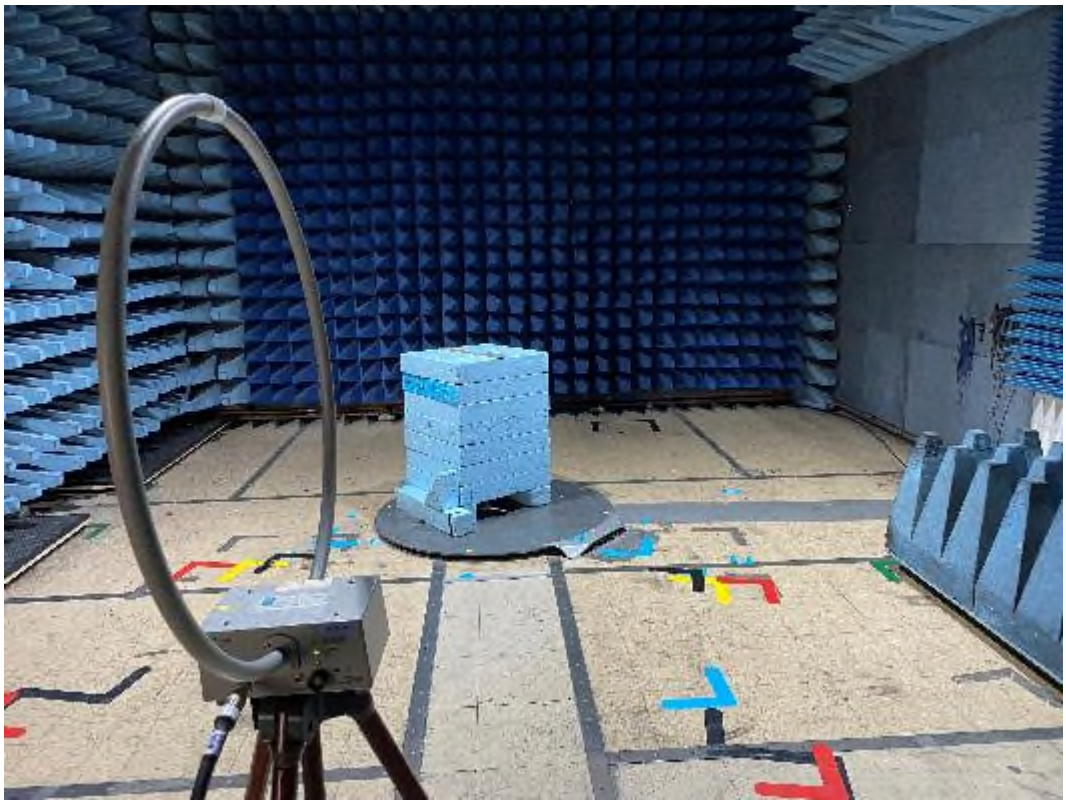
No label supplied at time of test.

8.9 EUT Chassis

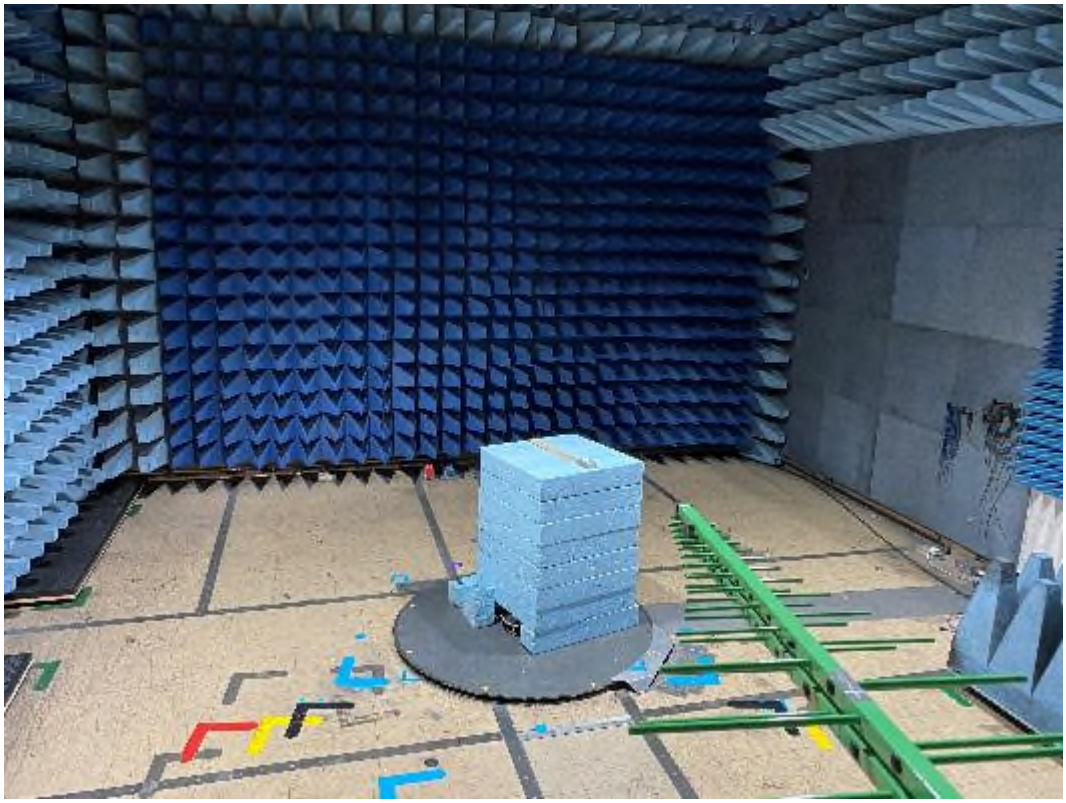
8.10 Radiated emissions 9 - 150 kHz

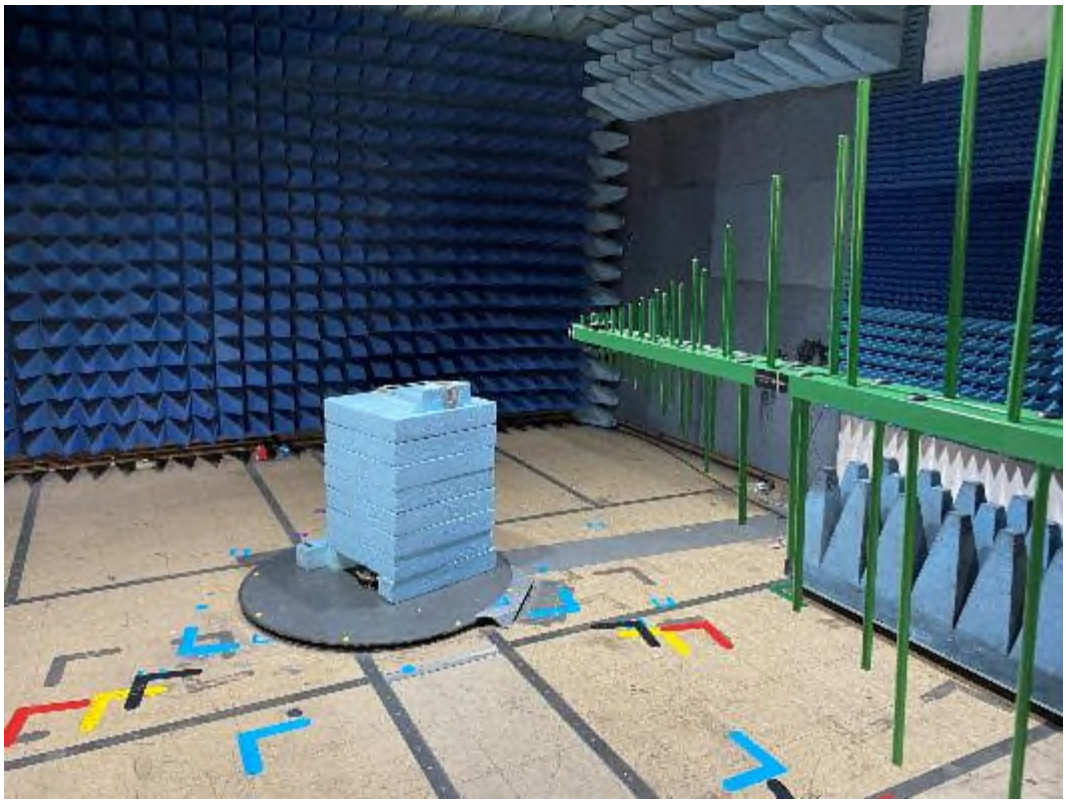


8.11 Radiated emissions 150 kHz - 30 MHz



8.12 Radiated emissions 30 MHz -1 GHz



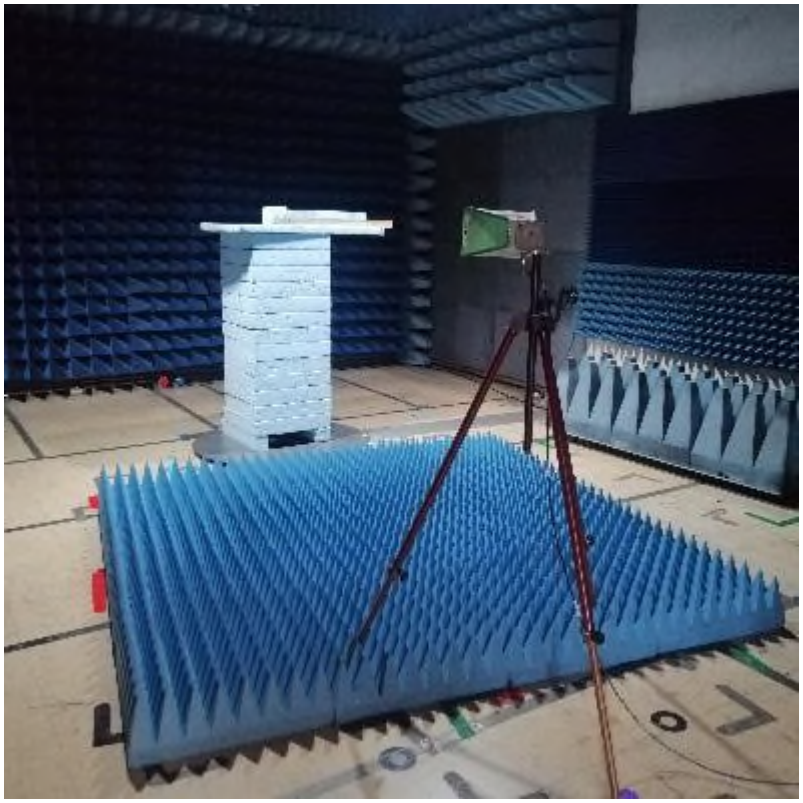


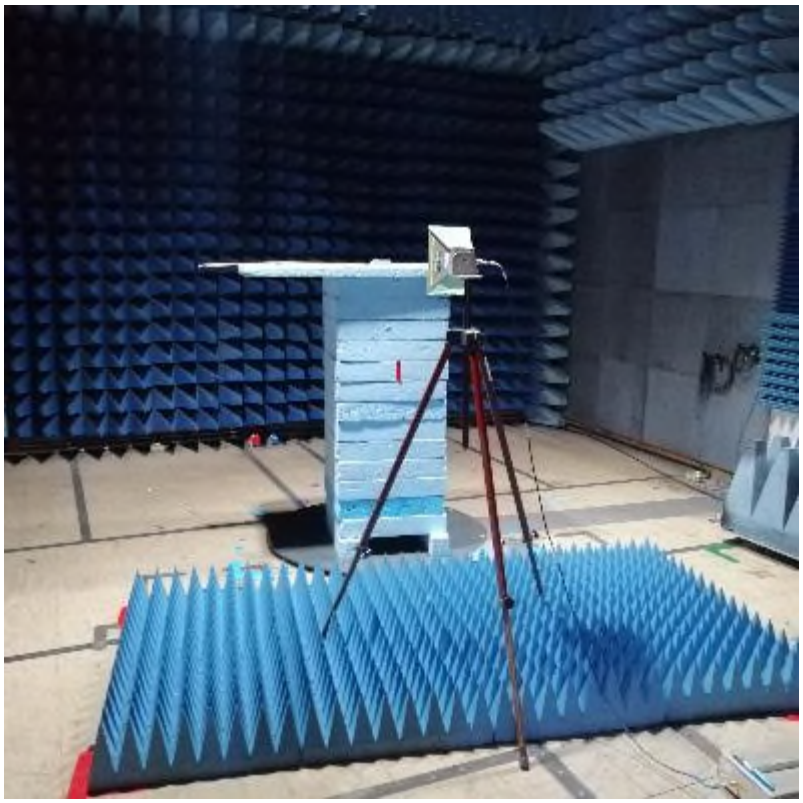
EUT on side

EUT upright

EUT Flat

8.13 Radiated emissions above 1 GHz





8.14 Radiated emission diagrams

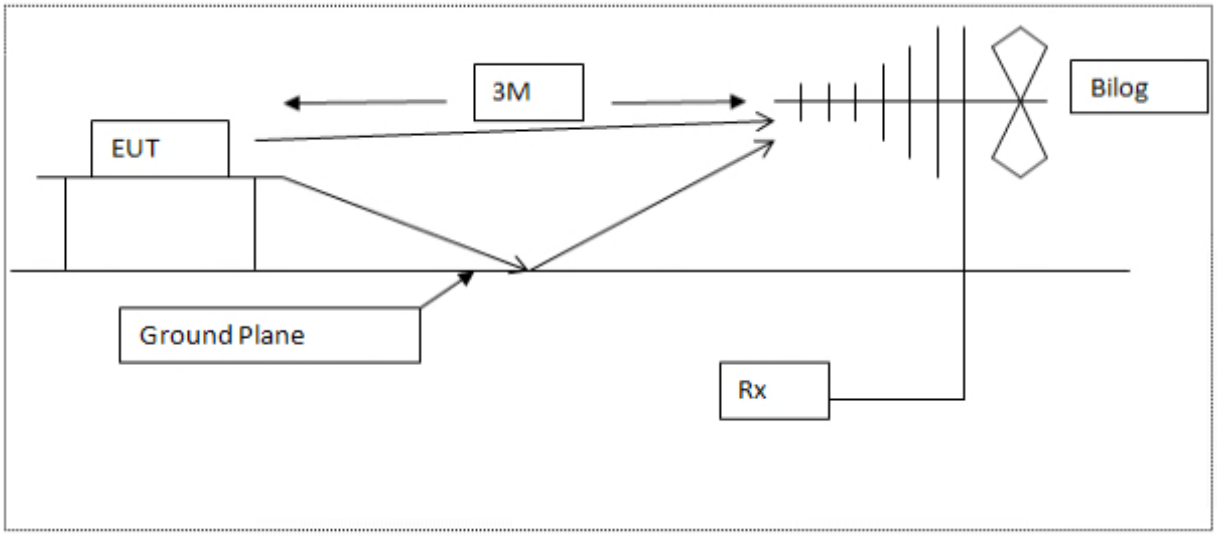


Diagram of the radiated emissions test setup 30 - 1000 MHz

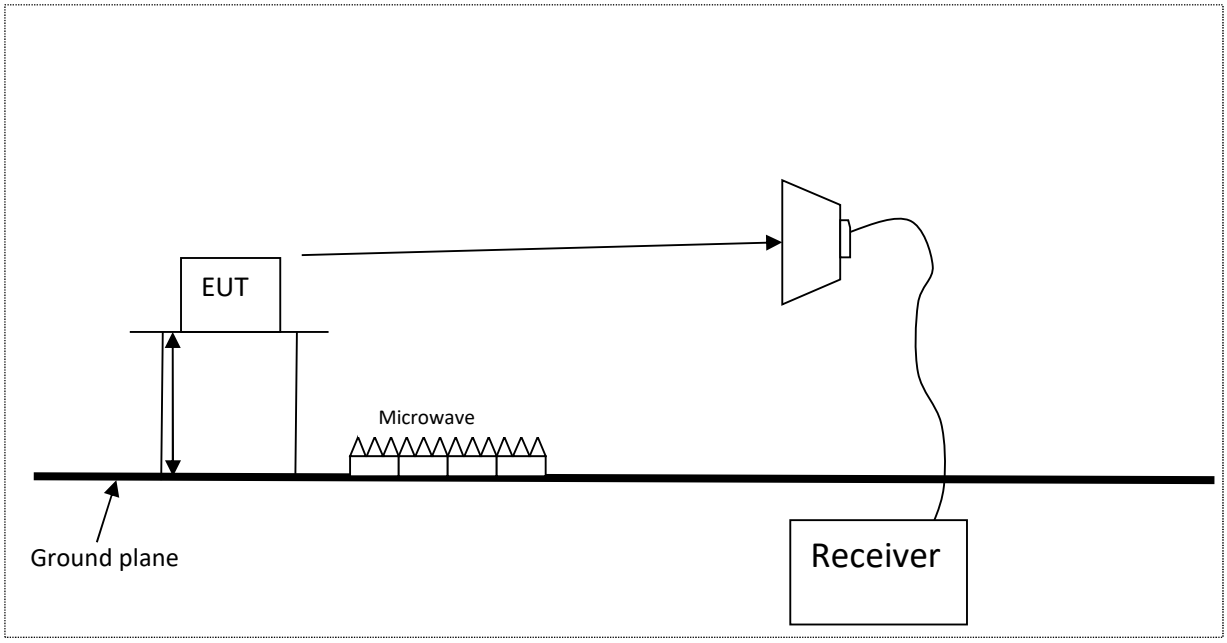


Diagram of the radiated emissions test setup above 1GHz

9 Test equipment calibration list

The following is a list of the test equipment used by R.N. Electronics Ltd to test the unit detailed within this report. In line with our procedures, the equipment was within calibration for the period during which testing was carried out.

RN No.	Model No.	Description	Manufacturer	Calibration date	Cal period
E136	3105	Horn Antenna 1 - 12.5 GHz	EMCO	02-Apr-2022	12 months
E327	CBL6141A	Antenna BiLog 30MHz to 2GHz	Schaffner	03-Oct-2020	24 months
E411	N9039A	9 kHz - 1 GHz RF Filter Section	Agilent Technologies	08-Jul-2021	12 months
E602	MG3692A	Signal Generator 10 MHz - 20 GHz	Anritsu	21-Feb-2022	12 months
E624	E4440A	PSA 3 Hz - 26.5 GHz	Agilent Technologies	08-Jul-2021	24 months
E642	E4440A	PSA 3 Hz - 26.5 GHz	Agilent Technologies	14-Dec-2021	24 months
E743	2017 4/2dB	Attenuator 4/2dB 30-1000MHz	RN Electronics	10-Mar-2022	12 months
E856	N9039A	9 kHz - 1 GHz RF Filter Section	Agilent Technologies	14-Dec-2021	12 months
F128	AA18-10H	Attenuator SMA 10dB 18GHz	AtlanTecRF	27-Aug-2021	12 months
F269	VHF-1080+	Filter High Pass 1150 - 5000 MHz	Mini-Circuits	N/A	N/A
F270	VHF-2700A+	Filter High Pass 3070 - 8500 MHz	Mini-Circuits	N/A	N/A
H072	N9000B	CXA Signal Analyser 9 kHz to 26.5 GHz	Keysight Technologies	09-Feb-2021	24 months
LPE315	34401A	Digital Multimeter 6.5 digit	Agilent Technologies	01-Nov-2021	12 months
LPE364	CBL6112A	Antenna BiLog 30MHz - 2GHz	Chase Electronics Ltd	28-Mar-2022	24 months
NSA-M	NSA - M	NSA - Site M	RN Electronics	29-Nov-2021	36 months
TMS81	6502	Antenna Active Loop	EMCO	22-Jul-2021	24 months
TMS82	8449B	Pre-Amplifier 1GHz - 26.5GHz	Agilent Technologies	16-Dec-2021	12 months
ZSW1	V2.5.2	Measurement Software Suite	RN Electronics	N/A	N/A

10 Auxiliary and peripheral equipment

10.1 Customer supplied equipment

Item No.	Model No.	Description	Manufacturer	Serial No.
1	T0004855 Rev F	Kona Micro Gateway	Tektelic communications	1948A0069

10.2 RN Electronics supplied equipment

No RN Electronics Ltd supplied equipment was used.

11 Condition of the equipment tested

In order for the EUT to produce the results shown within this report the following modifications, if any, were implemented.

11.1 Modifications before test

No modifications were made before test by RN Electronics Ltd.

11.2 Modifications during test

No modifications were made during test by RN Electronics Ltd.

12 Description of test sites

Site A Radio Laboratory and Anechoic Chamber

Site B Semi-Anechoic Chamber and Control Room
FCC Registration No. 293246, ISED Registration No. 5612A-4

Site C Transient Laboratory

Site D Screened Room (Conducted Immunity)

Site E Screened Room (Control Room for Site D)

Site F Screened Room (Conducted Emissions)

Site G Screened Room (Control Room for Site H)

Site H 3m Semi-Anechoic Chamber (indoor OATS)
FCC Registration No. 293246, ISED Registration No. 5612A-2, VCCI Registration No. 4065

Site J Transient Laboratory

Site K Screened Room (Control Room for Site M)

Site M 3m Semi-Anechoic Chamber (indoor OATS)
FCC Registration No. 293246, ISED Registration No. 5612A-3

Site N Radio Laboratory

Site Q Fully-Anechoic Chamber

Site OATS 3m and 10m Open Area Test Site
FCC Registration No. 293246, ISED Registration No. 5612A-1

Site R Screened Room (Conducted Immunity)

Site S Safety Laboratory

Site T Transient Laboratory

RN Electronics CAB identifier as issued by Innovation, Science and Economic Development Canada is UK0002
RN Electronics CAB identifier as issued by FCC is UK0015

13 Abbreviations and units

%	Percent
λ	Wavelength
µA/m	microAmps per metre
µV	microVolts
µW	microWatts
AC	Alternating Current
ACK	ACKnowledgement
ACP	Adjacent Channel Power
AFA	Adaptive Frequency Agility
ALSE	Absorber Lined Screened Enclosure
AM	Amplitude Modulation
Amb	Ambient
ANSI	American National Standards Institute
ATPC	Automatic Transmit Power Control
AVG	Average
AWGN	Additive White Gaussian Noise
BER	Bit Error Rate
BPSK	Binary Phase Shift Keying
BT	BlueTooth
BLE	BlueTooth Low Energy
BW	Bandwidth
ºC	Degrees Celsius
C/I	Carrier / Interferer
CAC	Channel Availability Check
CCA	Clear Channel Assessment
CEPT	European Conference of Postal and Telecommunications Administrations
CFR	Code of Federal Regulations
CISPR	Comité International Spécial des Perturbations Radioélectriques
cm	centimetre
COFDM	Coherent OFDM
COT	Channel Occupancy Time
CS	Channel Spacing
CW	Continuous Wave
DAA	Detect And Avoid
dB	deciBels
dBµA/m	deciBels relative to 1µA/m
dBµV	deciBels relative to 1µV
dBµV/m	deciBels relative to 1µV/m
dBc	deciBels relative to Carrier
dBd	deciBels relative to dipole gain
dBi	deciBels relative to isotropic gain
dBm	deciBels relative to 1mW
dBr	deciBels relative to a maximum value
dBW	deciBels relative to 1W
DC	Direct Current
DFS	Dynamic Frequency Selection
DMO	Dynamic Modulation Order
DSSS	Direct Sequence Spread Spectrum
DTA	Digital Transmission Analyser
EIRP	Equivalent Isotropic Radiated Power
emf	electromotive force
ERC	European Radiocommunications Committee
ERP	Effective Radiated Power
ETSI	European Telecommunications Standards Institute
EU	European Union
EUT	Equipment Under Test
FCC	Federal Communications Commission
FER	Frame Error Rate
FHSS	Frequency Hopping Spread Spectrum
FM	Frequency Modulation
FSK	Frequency Shift Keying
FSS	Fixed Satellite Service
g	Grams
GHz	GigaHertz
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
Hz	Hertz
IEEE	Institute of Electrical and Electronics Engineers
IF	Intermediate Frequency
ISED	Innovation Science and Economic Development
ITU	International Telecommunications Union
KDB	Knowledge DataBase

kg	kilogram
kHz	kiloHertz
kPa	Kilopascal
LBT	Listen Before Talk
LISN	Line Impedance Stabilisation Network
LNA	Low Noise Amplifier
LNB	Low Noise Block
LO	Local Oscillator
m	metre
mA	milliAmps
max	maximum
Mbit/s	MegaBits per second
MCS	Modulation and Coding Scheme
MHz	MegaHertz
mic	Microphone
MIMO	Multiple Input, Multiple Output
min	minimum
mm	millimetres
ms	milliseconds
mW	milliWatts
NA	Not Applicable
NFC	Near Field Communications
nom	Nominal
nW	nanoWatt
OATS	Open Area Test Site
OBW	Occupied Band Width
OCW	Occupied Channel Width
OFDM	Orthogonal Frequency Division Multiplexing
OOB	Out Of Band
ppm	Parts per million
PER	Packet Error Rate
PK	Peak
PMR	Private Mobile Radio
PRBS	Pseudo Random Bit Sequence
PRF	Pulse Repitition Frequency
PSD	Power Spectral Density
PSU	Power Supply Unit
pW	picoWatts
QAM	Quadrature Amplitude Modulation
QP	Quasi Peak
QPSK	Quadrature Phase Shift Keying
RBW	Resoution Band Width
RED	Radio Equipment Directive
R&TTE	Radio and Telecommunication Terminal Equipment
Ref	Reference
RF	Radio Frequency
RFC	Remote Frequency Control
RFID	Radio Frequency IDentification
RLAN	Radio Local Area Network
RMS	Root Mean Square
RNSS	Radio Navigation Satellite Service
RSL	Received Signal Level
RSSI	Received Signal Strength Indicator
RTP	Room Temperature and Pressure
RTPC	Remote Transmit Power Control
Rx	Receiver
s	Seconds
SINAD	Signal to Noise And Distortion
SRD	Short Range Device
Tx	Transmitter
UKAS	United Kingdom Accreditation Service
UKCA	United Kingdom Conformity Assessed
UKRER	United Kingdom Radio Equipment Regulations
UHF	Ultra High Frequency
U-NII	Unlicensed National Information Infrastructure
USB	Universal Serial Bus
UWB	Ultra Wide Band
V	Volts
V/m	Volts per metre
VBW	Video Band Width
VHF	Very High Frequency
VSAT	Very Small Aperture Terminal
W	Watts

====== END OF TEST REPORT ======