Radio Test Report

Salunda Ltd

Latch Hawk Wireless 1701 E 1.6

47 CFR Part 15.247 Effective Date 1st October 2021
DTS: Digital Transmission System
Test Date: 4th October 2022 to 10th October 2022
Report Number: 10-13658-4-22 Issue 01

The testing was carried out by RN Electronics Ltd, an independent test house, at their test facility located at:

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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).

Arnolds Court, Arnolds Farm Lane, Mountnessing, Brentwood Essex, CM13 1UT

Certificate of Test 13658-4

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:	Latch Hawk Wireless 1701 E
Model Number:	1.6
Unique Serial Number:	50000040(All other tests) 50000038 (Conducted power and Power Spectral Density tests)
Applicant:	Salunda Ltd Unit 6 Avonbury Business Park Howes Lane Bicester Oxfordshire OX26 2UA
Proposed FCC ID	2ALTW170116
Full measurement results are detailed in Report Number:	10-13658-4-22 Issue 01
Test Standards:	47 CFR Part 15.247 Effective Date 1st October 2021 DTS: Digital Transmission System

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:	4th October 2022 to 10th October 2022
Test Engineer:	Jack Chilvers Digitally signed by: Jack Chilvers DN: CN = Jack Chilvers email = Jack.Chilvers@kiwa.com C = GB O = RN Electronics OU = RN Electronics Date: 2022.12.08 08:17:23 Z
Approved By: Radio Manager	Digitally signed by: Daniel Sims DN: CN = Daniel Sims C = GB O = RN Electronics Ltd Date: 2022.12.07 15:41:19 Z
Customer Representative:	

1 Contents

2 Equipment under test (EUT)

2.1 Equipment specification

Applicant	Salunda Ltd Unit 6 Avonbury Business Park Howes Lane Bicester Oxfordshire OX26 2UA	
Manufacturer of EUT	Salunda Ltd	
Full Name of EUT	Latch Hawk Wireless 1701 E	
Model Number of EUT	1.6	
Serial Number of EUT	50000040(All other tests) 50000038 (Conducted power and Power Spectral Density tests)	
Date Received	20th September 2022	
Date of Test:	4th October 2022 to 10th October 2022	
Purpose of Test	To demonstrate design compliance to the relevant rules of Chapter 47 of the Code of Federal Regulations.	
Date Report Issued	25th November 2022	
Main Function	To measure latch angles on drilling rigs	
Information Specification	Height	27 mm
	Width	90 mm
	Depth	35 mm
	Weight	250 g
	Voltage	3.6 V Max
	Current	Not declared

2.2 Configurations for testing

General Parameters	
EUT Normal use position	Tabletop
Choice of model(s) for type tests	Production samples
Antenna details	Integral. Johanson Technology 2450AT42E010B. -1 dB PK gain, -3.5dB AV gain.
Antenna port	None. Integral antenna.
Baseband Data port (yes/no)?	No
Highest Signal generated in EUT	2480 MHz
Lowest Signal generated in EUT	32.768 kHz
Hardware Version (HVIN)	1.6
Software Version	5
Firmware Version (FVIN)	5
Type of Equipment	ZigBee
Technology Type	802.15.4
Geo-location (yes/no)	No
TX Parameters	
Alignment range – transmitter	2400-2483.5 MHz
EUT Declared Modulation Parameters	DSSS
EUT Declared Power level	6.5 dBm (Conducted)
EUT Declared Signal Bandwidths	2 MHz
EUT Declared Channel Spacing's	5 MHz
EUT Declared Duty Cycle	Not stated
Unmodulated carrier available?	Yes
Declared frequency stability	20 ppm
RX Parameters	
Alignment range – receiver	2400-2483.5 MHz
EUT Declared RX Signal Bandwidth	2 MHz
Receiver Signal Level (RSL)	-75 dBm
Method of Monitoring Receiver BER	80 % successful message ratio
FCC Parameters	
FCC Transmitter Class	DTS: Digital Transmission System

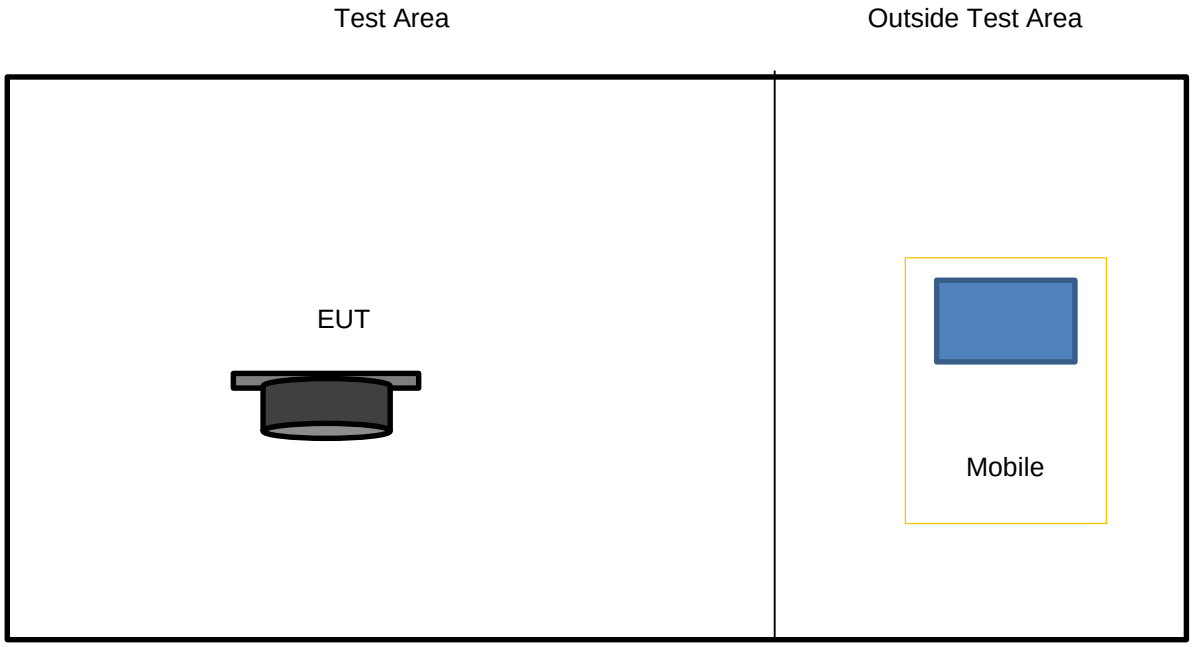
2.3 Functional description

Angle sensed then transmitted over 2.4GHz 802.15.4. The equipment also includes NFC Tag operating at 13.56 MHz. The equipment is battery powered and has no external wired connections.

2.4 Modes of operation

Mode Reference	Description	Used for testing
Low Chan TX	2405 MHz Burst Mod Max Power	Yes
Low Chan RX	2405 MHz receive	No
Mid Chan TX	2440 MHz Burst Mod Max Power	Yes
Mid Chan RX	2440 MHz receive	No
High Chan TX	2480 MHz Burst Mod Max Power	Yes
High Chan RX	2480 MHz receive	No
Mid Chan Link	Receiving transmissions from ancillary EUT on 2440 MHz	No
High Chan Link	Receiving transmissions from ancillary EUT on 2480 MHz	No
Low Chan Link	Receiving transmissions from ancillary EUT on 2405 MHz	No
Low Chan continuous TX	2405 MHz Continuous Max Power	No
Mid Chan continuous TX	2440 MHz Continuous Max Power	No
High Chan continuous TX	2480 MHz Continuous Max Power	No

2.5 Emissions configuration



For radiated emissions and ERP tests, the EUT unit was powered from its internal battery. Prior to test the EUT was configured using an ancillary mobile phone via NFC. This allowed the EUT to be set into the relevant test modes as stated in section 2.4. The support equipment was removed from the test area prior to test.

Note: Although the NFC tag in the EUT is connected to the internal electronics of the EUT, it is a passive tag and does not generate its own electromagnetic field.

For conducted tests, a second test unit was provided where the integral antenna was disconnected, and a coax cable was connected directly to the EUT transmit / receive port. The battery was disconnected by cutting a track on the PCB and wires were soldered directly to the power connections. The power cables were connected to an adjustable bench power supply.

2.5.1 Signal leads

The EUT has no cables or ports

3 Summary of test results

The Latch Hawk Wireless 1701 E 1.6 was tested for compliance to the following standard(s):

47 CFR Part 15.247 Effective Date 1st October 2021
DTS: Digital Transmission System

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
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(2)/15.215	PASSED
9. Maximum Average conducted output power	47 CFR Part 15C Part 15.247	NOT APPLICABLE[2]
10. Maximum Peak conducted output power	47 CFR Part 15C Part 15.247(2)/(b)(3)	PASSED
11. Maximum Power Spectral Density	47 CFR Part 15C Part 15.247(e)	PASSED
12. Antenna power conducted emissions	47 CFR Part 15C Part 15.247	NOT APPLICABLE[2]
13. Duty cycle	47 CFR Part 15C Part 15.35	NOT APPLICABLE[4]
14. FHSS carrier frequency separation	47 CFR Part 15C Part 15.247	NOT APPLICABLE[3]
15. Average time of occupancy	47 CFR Part 15C Part 15.247	NOT APPLICABLE[3]
16. Number of Hop Channels	47 CFR Part 15C Part 15.247	NOT APPLICABLE[3]

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

2 The EUT was tested for radiated emissions with its dedicated antenna in position.

3 EUT does not employ FHSS technology

4 No limits apply, however duty cycle measurement performed to verify any possible correction factors for average emissions.

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	2021	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	DA 00-705	2000	PUBLIC NOTICE Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems
4.1.5	KDB 558074 D01 v03r03	2013	Federal Communications Commission Office of Engineering and Technology Laboratory Division; Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247

4.2 Deviations

No deviations were applied

4.3 Test fixtures

In order to measure conducted peak power a modified unit was provided by the applicant where the integral chip-antenna was removed, and a coax cable was soldered directly to the EUT RF output to create a temporary RF port. This test unit was also used for Power Spectral Density tests.

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.

The EUT was operated in Low Chan TX, Mid Chan TX and High Chan TX modes. There was no discernible difference in emissions observed between modes, therefore for full test Mid Chan TX mode was used.

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 H.

5.2.4 Test equipment

TMS81, ZSW1, E534, E535

See Section 9 for more details

5.2.5 Test results

Temperature of test environment	20°C
Humidity of test environment	50%
Pressure of test environment	102kPa

Band	2400-2483.5 MHz
Power Level	6.5 dBm (Conducted)
Channel Spacing	5 MHz
Mod Scheme	OQPSK
Mid channel	2440 MHz

Plot refs
13658-4 Rad 2 9k-150kHz Para
13658-4 Rad 2 9k-150kHz Perp

No signals observed on any channel during pre-scans in the chamber, therefore final measurements on an OATS were not required, and only Mid channel plots are shown in this report.

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.

The EUT was operated in Low Chan TX, Mid Chan TX and High Chan TX modes. There was no discernible difference in emissions observed between modes, therefore for full test Mid Chan TX mode was used.

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 final measurements (if required) on an OATS without a ground plane. The antenna was placed 1m above the ground. The equipment and the antenna were 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 H.

5.3.4 Test equipment

TMS81, ZSW1, E534, E535

See Section 9 for more details

5.3.5 Test results

Temperature of test environment	20°C
Humidity of test environment	50%
Pressure of test environment	102kPa

Band	2400-2483.5 MHz
Power Level	6.5 dBm (Conducted)
Channel Spacing	5 MHz
Mod Scheme	OQPSK
Mid channel	2440 MHz

Plot refs
13658-4 Rad 2 150k-30MHz Para
13658-4 Rad 2 150k-30MHz Perp

No spurious emissions were observed on any channel within 20 dB of the limit during pre-scans in the chamber, therefore final measurements on an OATS were not required, and only Mid channel plots are shown in this report.

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.

The EUT was operated in Low Chan TX, Mid Chan TX and High Chan TX modes. There was no discernible difference in emissions observed between modes, therefore for full test Mid Chan TX mode was used.

5.4.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment noted below.
Measurements were made on a site listed with the FCC. 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 H.

5.4.4 Test equipment

E914, E745, NSA-H, ZSW1, E534, E535

See Section 9 for more details

5.4.5 Test results

Temperature of test environment	20°C
Humidity of test environment	50%
Pressure of test environment	102kPa

Band	2400-2483.5 MHz
Power Level	6.5 dBm (Conducted)
Channel Spacing	5 MHz
Mod Scheme	OQPSK
MId channel	2440 MHz

Plot refs
13658-4 Rad 2 VHF Horiz
13658-4 Rad 2 VHF Vert
13658-4 Rad 2 UHF Horiz
13658-4 Rad 2 UHF Vert

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 channel settings (exploratory measurements), therefore final measurements are presented for TX mid channel mode only for these test ranges.

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.

The EUT was operated in Low Chan TX, Mid Chan TX and High Chan TX modes.

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. 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, 1.2m was used in the test range 6 - 18GHz and 0.3m was used in the test range 18 - 25GHz.

At least 6 signals within 20dB and all signals within 10dB of the limit were investigated.

Tests were performed using Test Sites H & B.

5.5.4 Test equipment

E428, E289, VSWR-B, ZSW1, E642, E856, TMS78, TMS79, E429, LPE261, LPE333, VSWR-H, ZSW1, E535, E972

See Section 9 for more details

5.5.5 Test results

Temperature of test environment	20°C
Humidity of test environment	50%
Pressure of test environment	102kPa

Setup Table

Band	2400-2483.5 MHz
Power Level	6.5 dBm (Conducted)
Channel Spacing	5 MHz
Mod Scheme	OQPSK
Low channel	2405 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
7215	56.2	-17.8	47.2	-6.8	side	Vertical
7215	56.8	-17.2	48.6	-5.4	Upright	Horizontal

Setup Table

Band	2400-2483.5 MHz
Power Level	6.5 dBm (Conducted)
Channel Spacing	5 MHz
Mod Scheme	OQPSK
Mid channel	2440 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
7320	56	-18	47.6	-6.4	side	Vertical
7320	56.2	-17.8	48.1	-5.9	Upright	Horizontal

Plots
13658-4 Rad 2 1-2GHz Horiz
13658-4 Rad 2 1-2GHz Vert
13658-4 Rad 2 2-5GHz Horiz
13658-4 Rad 2 2-5GHz Vert
13658-4 Rad 2 2-5GHz Horiz Showing intentional transmission
13658-4 Rad 2 2-5GHz Vert Showing intentional transmission
13658-4 Rad 2 5-6GHz Horiz
13658-4 Rad 2 5-6GHz Vert
13658-4 Rad 2 6upto10GHz Horiz
13658-4 Rad 2 6upto10GHz Vert
13658-4 Rad 2 10upto12_5GHz Horiz
13658-4 Rad 2 10upto12_5GHz Vert
13658-4 Rad 2 12-15GHz Horiz
13658-4 Rad 2 12-15GHz Vert
13658-4 Rad 2 15-18GHz Horiz
13658-4 Rad 2 15-18GHz Vert
13658-4 Rad 2 18-22GHz Horiz
13658-4 Rad 2 18-22GHz Vert
13658-4 Rad 2 22-25GHz Horiz
13658-4 Rad 2 22-25GHz Vert

Setup Table

Band	2400-2483.5 MHz
Power Level	6.5 dBm (Conducted)
Channel Spacing	5 MHz
Mod Scheme	OQPSK
High channel	2480 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
7440	57.59	-16.41	49.44	-4.56	side	Vertical
7440	58.1	-15.9	50.4	-3.6	Upright	Horizontal

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, plots are for illustrative purposes only and only Mid channel plots are shown in 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:
1 – 18 GHz ±3.5dB
18 – 25 GHz ±3.9dB

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 6.5/6.6 [Reference 4.1.2 of this report]
Limits: See section 5.6.5 of this report

5.6.2 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 rotated in all three orthogonal planes to maximise emissions. Final measurements were taken at 3m. The EUT was operated in Low Chan TX, Mid Chan TX and High Chan TX.

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 power stated is Peak field strength. The EUT was rotated through 360° to capture maximum field strength. Tests were performed in test site B.

5.6.4 Test equipment

E289, E428, E642, E856

See Section 9 for more details

5.6.5 Test results

Temperature of test environment 20°C
Humidity of test environment 40%
Pressure of test environment 102kPa

Band	2400-2483.5 MHz
Power Level	6.5 dBm (Conducted)
Channel Spacing	5 MHz
Mod Scheme	OQPSK
Low channel	2405 MHz
Mid channel	2440 MHz
High channel	2480 MHz

	Low channel	Mid channel	High channel
Peak Level (dBµV/m)	95.74	94.70	92.93
Plot reference	13658-4 Low Chan ERP Horiz side	13658-4 Mid Chan ERP Vert Upright	13658-4 High Chan ERP Horiz side
Antenna Polarisation	Horiz	Vert	Horiz
EUT Polarisation	Side	Upright	Side

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

LIMITS:
Test performed to determine the maximum in band field strength in 100kHz RBW for calculating the 20dBc limit for use on non- restricted band emissions where required.
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 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 operated in Low Chan TX and High Chan TX modes.

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 was maximised before taking the plots that showed authorised and restricted band edges.

Tests were performed using Test Site B.

5.7.4 Test equipment

E289, E428, E642, E856

See Section 9 for more details

5.7.5 Test results

Temperature of test environment	20°C
Humidity of test environment	48%
Pressure of test environment	102kPa

Band	2400-2483.5 MHz
Power Level	6.5 dBm (Conducted)
Channel Spacing	5 MHz
Mod Scheme	OQPSK
Low channel	2405 MHz
High channel	2480 MHz

Restricted Band Edges	Low channel	High channel
Restricted Peak Level measured (dBuV/m)	40.81	51.31
Restricted band edge Peak Plot	13658-4 Low Chan restricted Pk band edge Horiz side	13658-4 High Chan restricted Pk band edge Horiz side
Restricted Average Level measured (dBuV/m)	PK complied to AVG limit	PK complied to AVG limit
Restricted band edge Average Plot	N/A PK complied to AVG limit	N/A PK complied to AVG limit

Authorised Band Edges	Low channel	High channel
Authorised Band Edge (dBc) value measured	-57.74	-51.29
Authorised Band Edge Plot	13658-4 Low Chan Authorised band edge Horiz side	13658-4 High Chan Authorised band edge Horiz side

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 2400 and 2483.5 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.

LIMITS:
AV = 54dBuV/m at band edges
PK = 74dBuV/m at band edges

The restricted band edges closest to the EUT frequency of 2400-2483.5MHz are 2390 & 2483.5MHz.

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)(2) / 15.215 [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 15.247(a)(2) [Reference 4.1.1 of this report]

5.8.2 Configuration of EUT

The EUT was configured as for the conducted power test. The EUT was operated in Low Chan TX, Mid Chan TX and High Chan TX modes.

5.8.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment noted below. A 100kHz RBW, 3x VBW, auto sweep time and max hold settings were used for the 6dB bandwidth.

Tests were performed using Test Site A.

5.8.4 Test equipment

E412, E640

See Section 9 for more details

5.8.5 Test results

Temperature of test environment	18°C
Humidity of test environment	50%
Pressure of test environment	102kPa

Band	2400-2483.5 MHz
Power Level	6.5 dBm (Conducted)
Channel Spacing	5 MHz
Mod Scheme	OQPSK
Low channel	2405 MHz
Mid channel	2440 MHz
High channel	2480 MHz

	Low channel	Mid channel	High channel
6 dB Bandwidth Result (MHz)	1.551	1.539	1.254
Plot for 6 dB Bandwidth Result (MHz)	13658-4 Low Chan 6dB BW	13658-4 Mid Chan 6dB BW	13658-4 High Chan 6dB BW
99 % Bandwidth Result (MHz)	2.252	2.262	2.256
Frequency Error (kHz) (include sign)	-36.136	-36.863	-36.964
Operating frequency (MHz)	2405	2440	2480
6 dB FLOW Worst case (MHz)	2404.188364	2439.193637	2479.336036
6 dB FHIGH Worst case (MHz)	2405.739364	2440.732637	2480.590036

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

LIMITS:
15.247(a) (2) The minimum 6dB bandwidth shall be at least 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: The EUT was tested for radiated emissions with its dedicated antenna in position.

5.10 Maximum Peak conducted output power

5.10.1 Test methods

Test Requirements: 47 CFR Part 15C Part 15.247(a)(3) [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(a)(3) [Reference 4.1.1 of this report]

5.10.2 Configuration of EUT

The EUT was powered by its internal battery. Measurements were made at the temporary RF port.

The EUT was operated in Low Chan TX and Mid Chan TX and High Chan TX modes 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 > 6dB BW of the EUT.
Measurements were made on a test bench in site A.

5.10.4 Test equipment

E412, E640

See Section 9 for more details

5.10.5 Test results

Temperature of test environment	18°C
Humidity of test environment	50%
Pressure of test environment	102kPa

Band	2400-2483.5 MHz
Power Level	6.5 dBm (Conducted)
Channel Spacing	5 MHz
Mod Scheme	OQPSK
Low channel	2405 MHz
Mid channel	2440 MHz
High channel	2480 MHz

Nominal voltage result (dBm)	5.92	6.58	6.21
Plot reference	13658-4 Low Chan Pk Cond PWR	13658-4 Mid Chan Pk Cond PWR	13658-4 High Chan Pk Cond PWR
Limit in dBm	30.00	30.00	30.00
Maximum result (dBm)	5.92	6.58	6.21
Margin to Limit (dB)	-24.08	-23.42	-23.79
Result in (W)	0.004	0.005	0.004

LIMITS:
15.247(a) (2)
For systems using digital modulation in the 902-928, 2400-2483.5 or 5725-5850 MHz bands 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

5.11.1 Test methods

Test Requirements: 47 CFR Part 15C Part 15.247(e) [Reference 4.1.1 of this report]
Test Method: ANSI C63.10 Clause 10.10 [Reference 4.1.2 of this report]
Limits: 47 CFR Part 15C Part 15.247(e) [Reference4.1.1 of this report]

5.11.2 Configuration of EUT

The EUT was configured as for the conducted power test. The EUT was operated in Low Chan TX, Mid Chan TX and High Chan TX modes for this test.

5.11.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment noted below. PEP was recorded in the required span and bandwidth. Measurements & plots were taken with the span set to 1.5 times the measured DTS bandwidth. Tests were performed using Test Site A.

5.11.4 Test equipment

E412, E640

See Section 9 for more details

5.11.5 Test results

Temperature of test environment	18°C
Humidity of test environment	50%
Pressure of test environment	102kPa

Band	2400-2483.5 MHz
Power Level	6.5 dBm (Conducted)
Channel Spacing	5 MHz
Mod Scheme	OQPSK
Low channel	2405 MHz
Mid channel	2440 MHz
High channel	2480 MHz

	Low channel	Mid channel	High channel
dBm per 3 kHz	-4.13	-3.51	-3.96
Plot reference	13658-4 Low Chan PSD	13658-4 Mid Chan PSD	13658-4 High Chan PSD

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

LIMITS:
15.247(e) +8dBm/3kHz.

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 dB

5.12 Antenna power conducted emissions

NOT APPLICABLE: The EUT was tested for radiated emissions with its dedicated antenna in position.

5.13 Duty cycle

NOT APPLICABLE: No limits apply, however duty cycle measurement performed to verify any possible correction factors for average emissions.

5.14 FHSS carrier frequency separation

NOT APPLICABLE: EUT does not employ FHSS technology

5.15 Average time of occupancy

NOT APPLICABLE: EUT does not employ FHSS technology

5.16 Number of Hop Channels

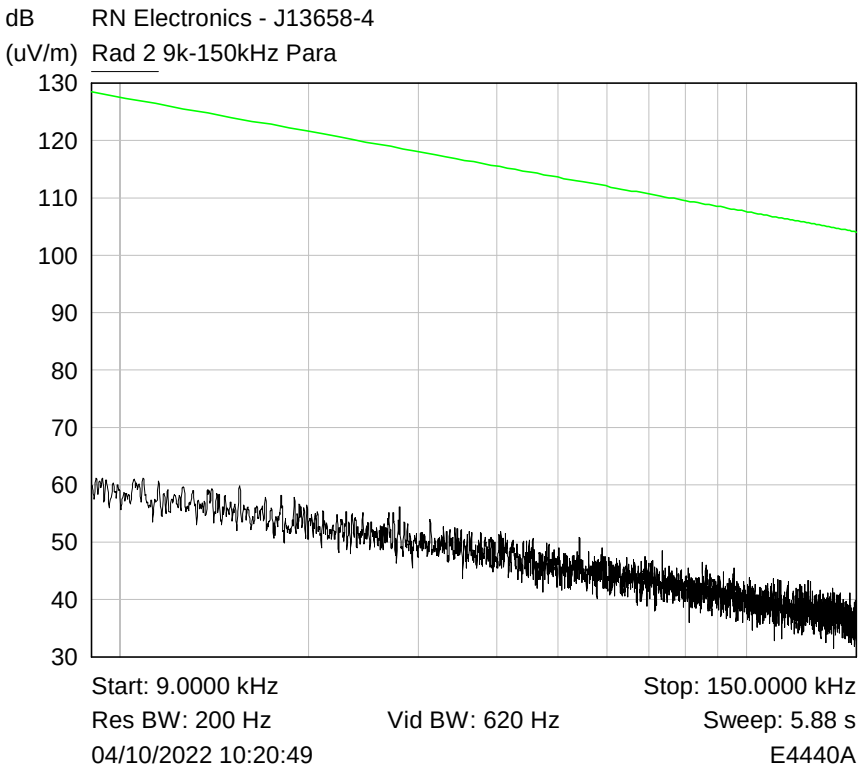
NOT APPLICABLE: EUT does not employ FHSS technology

6 Plots/Graphical results

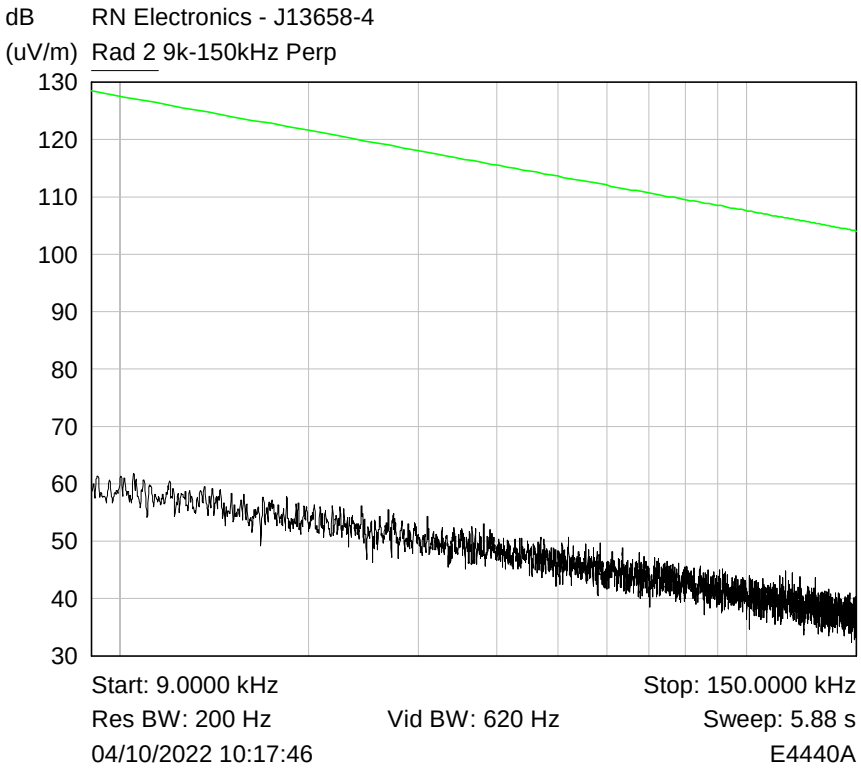
6.1 Radiated emissions 9 - 150 kHz

Note: Whilst Low, Middle and High channels have been tested, to minimise report size, only middle channel plots are shown. Plots are PK detector max held against Quasi-Peak / Average limit line.

RF Parameters: Band 2400-2483.5 MHz, Power 6.5 dBm (Conducted), Channel Spacing 5 MHz, Modulation OQPSK, Channel 2440 MHz



Plot of 9 k-150 kHz Parallel

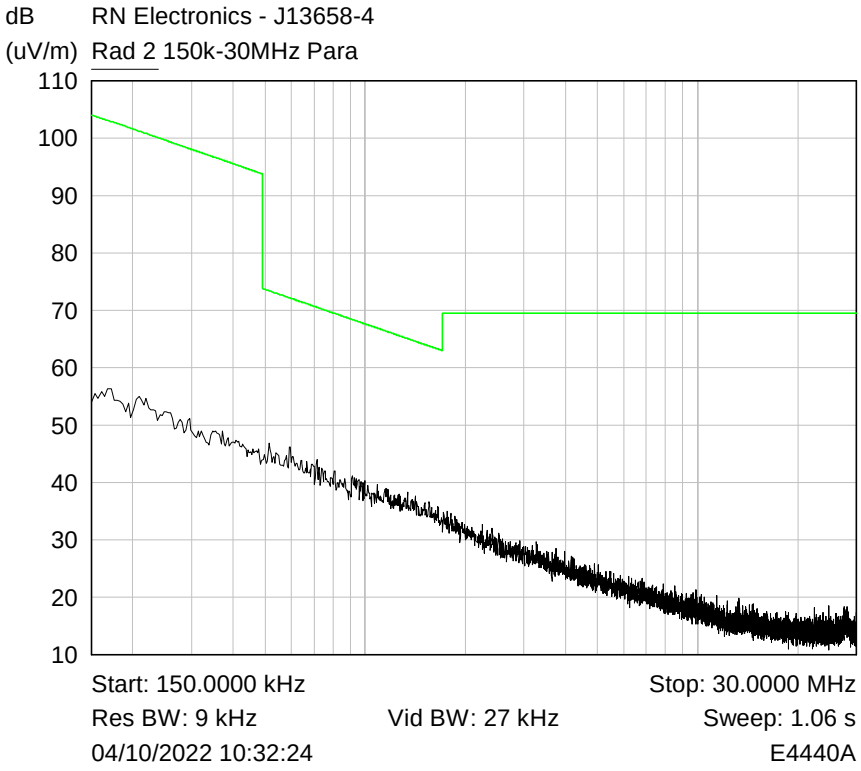


Plot of 9 k-150 kHz Perpendicular

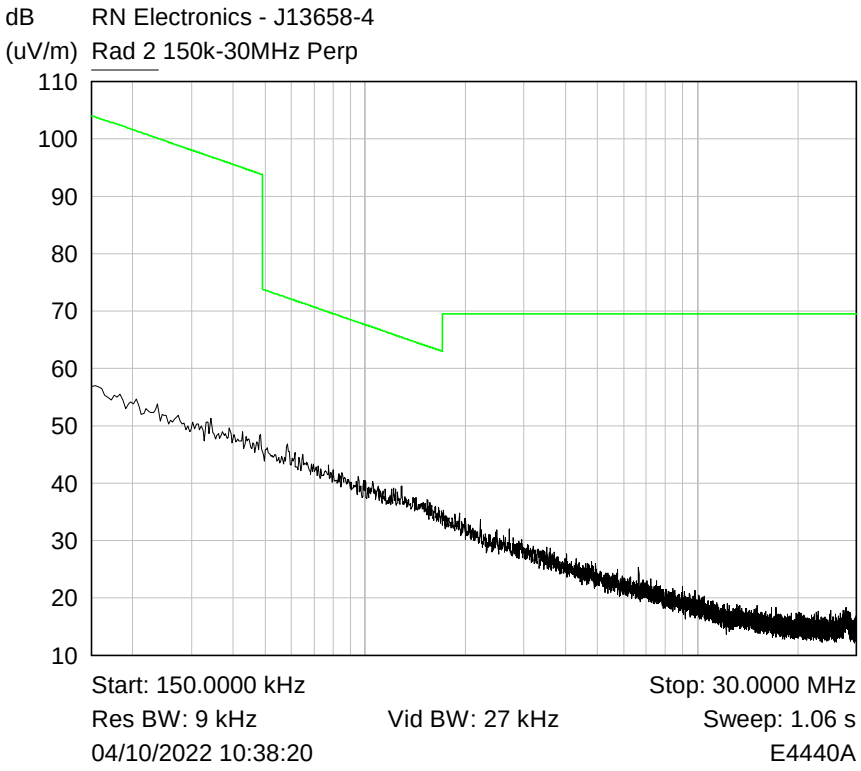
6.2 Radiated emissions 150 kHz - 30 MHz

Note: Whilst Low, Middle and High channels have been tested, to minimise report size, only middle channel plots are shown. Plots are PK detector max held against Quasi-Peak / Average limit line.

RF Parameters: Band 2400-2483.5 MHz, Power 6.5 dBm (Conducted), Channel Spacing 5 MHz, Modulation OQPSK, Channel 2440 MHz



Plot of 150kHz-30MHz Parallel

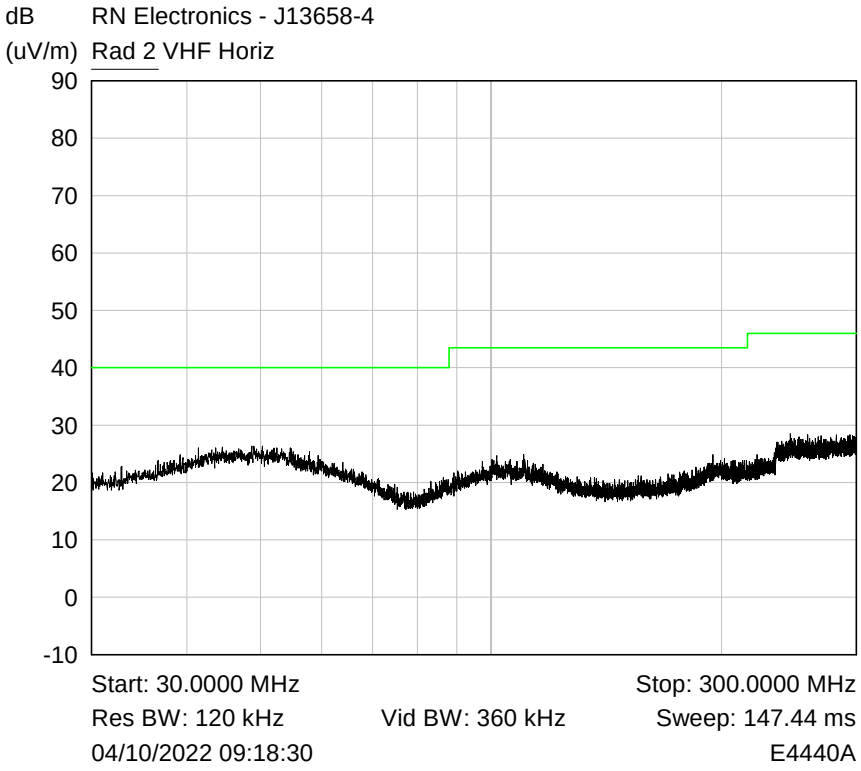


Plot of 150kHz-30MHz Perpendicular

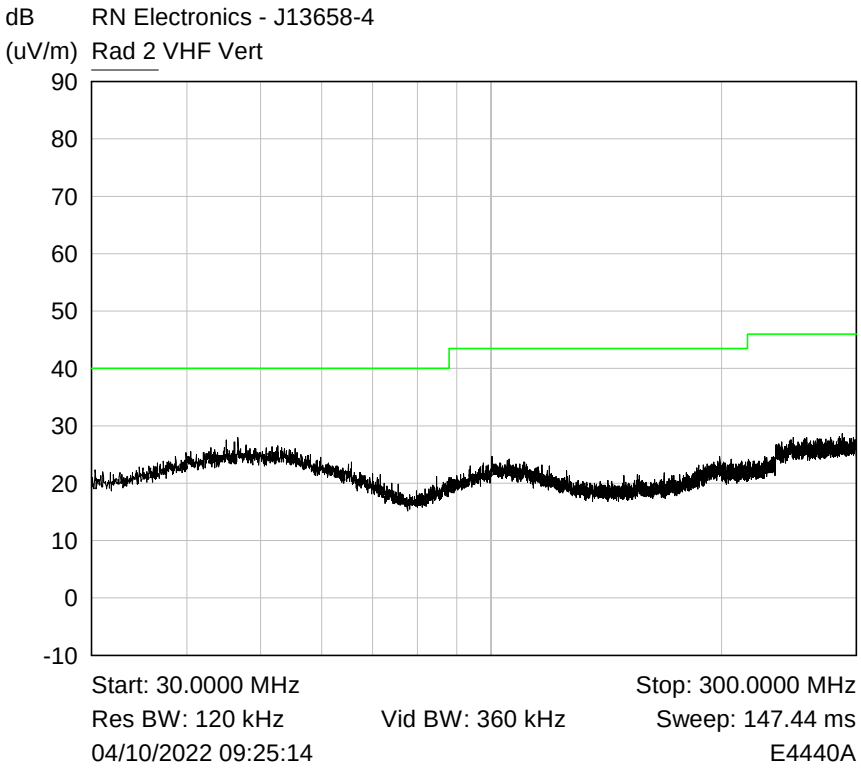
6.3 Radiated emissions 30 MHz -1 GHz

Note: Whilst Low, Middle and High channels have been tested, to minimise report size, only middle channel plots are shown. Plots are PK detector max held against Quasi-Peak / Average limit line.

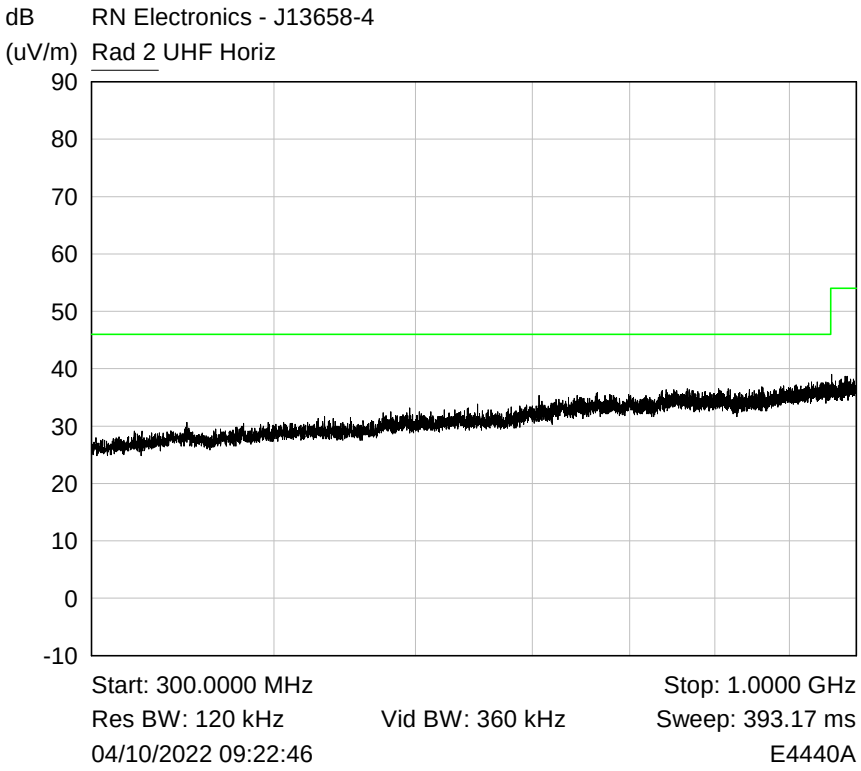
RF Parameters: Band 2400-2483.5 MHz, Power 6.5 dBm (Conducted), Channel Spacing 5 MHz, Modulation OQPSK, Channel 2440 MHz



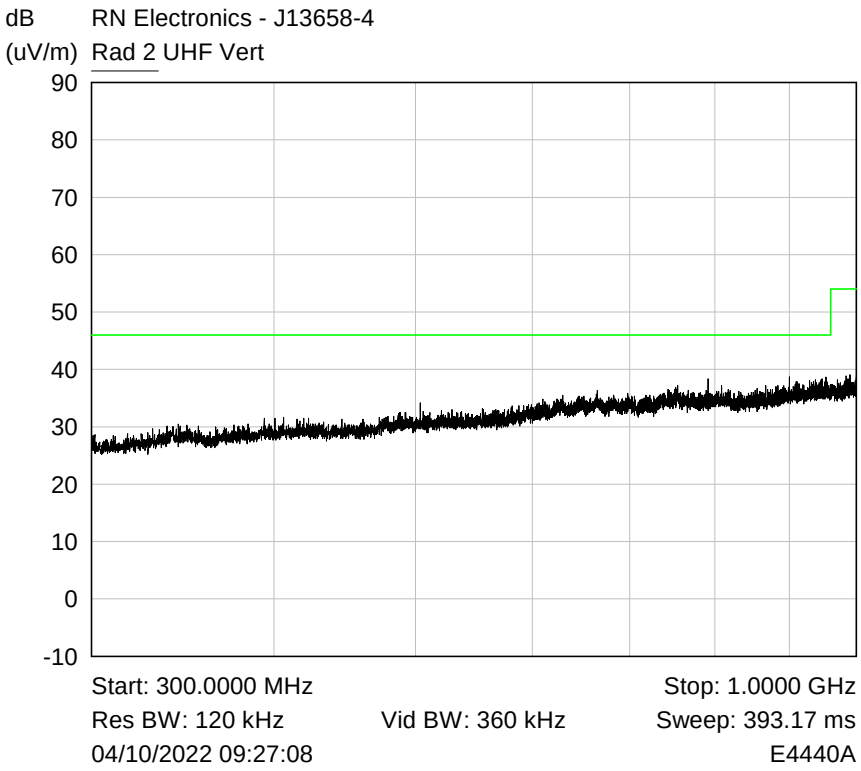
Plot of Peak emissions for VHF Horizontal against the QP limit line.



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



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

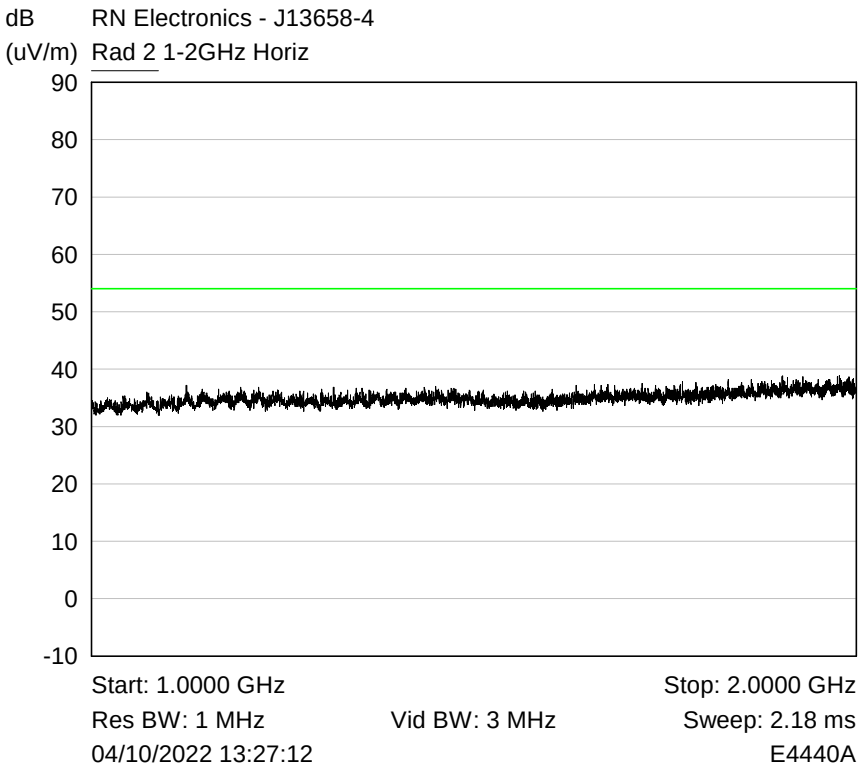


Plot of Peak emissions for UHF Vertical against the QP limit line.

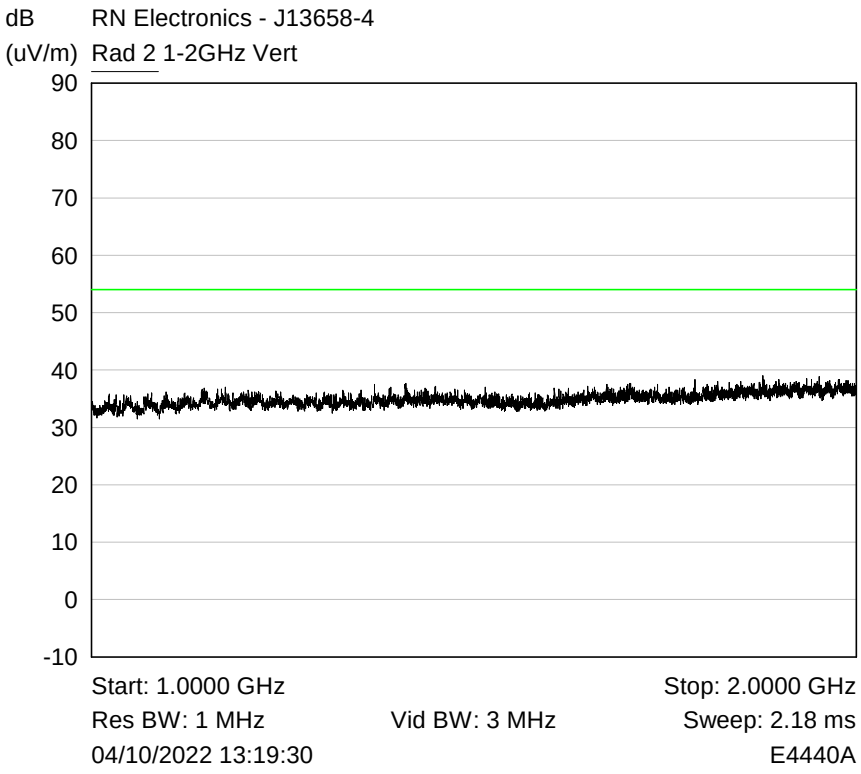
6.4 Radiated emissions above 1 GHz

Note: Whilst Low, Middle and High channels have been tested, to minimise report size, only middle channel plots are shown. Plots are PK detector max held against Average limit line.

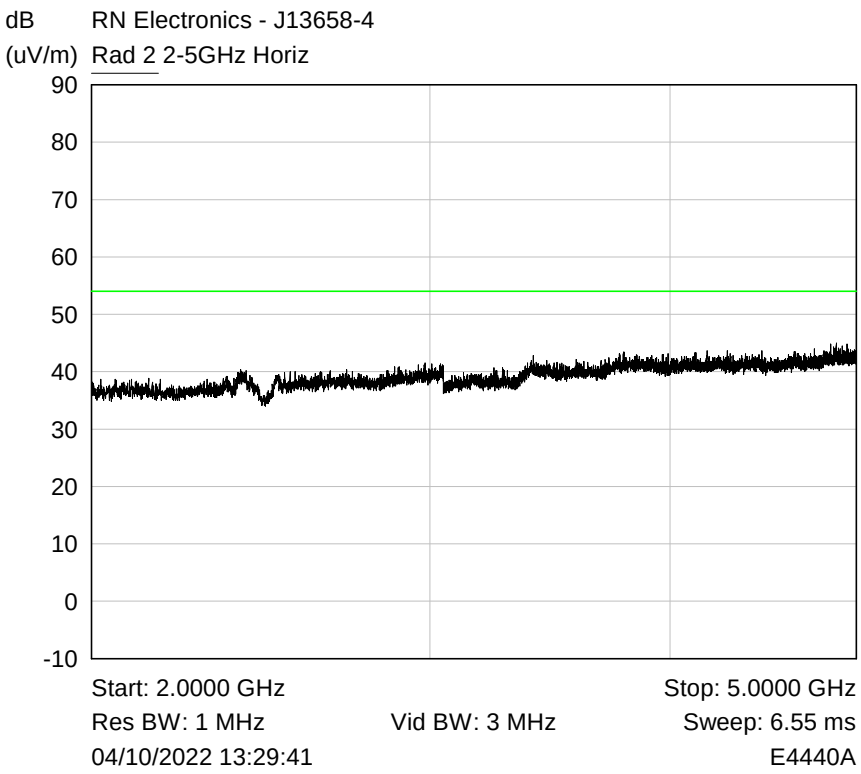
RF Parameters: Band 2400-2483.5 MHz, Power 6.5 dBm (Conducted), Channel Spacing 5 MHz, Modulation OQPSK, Channel 2440 MHz



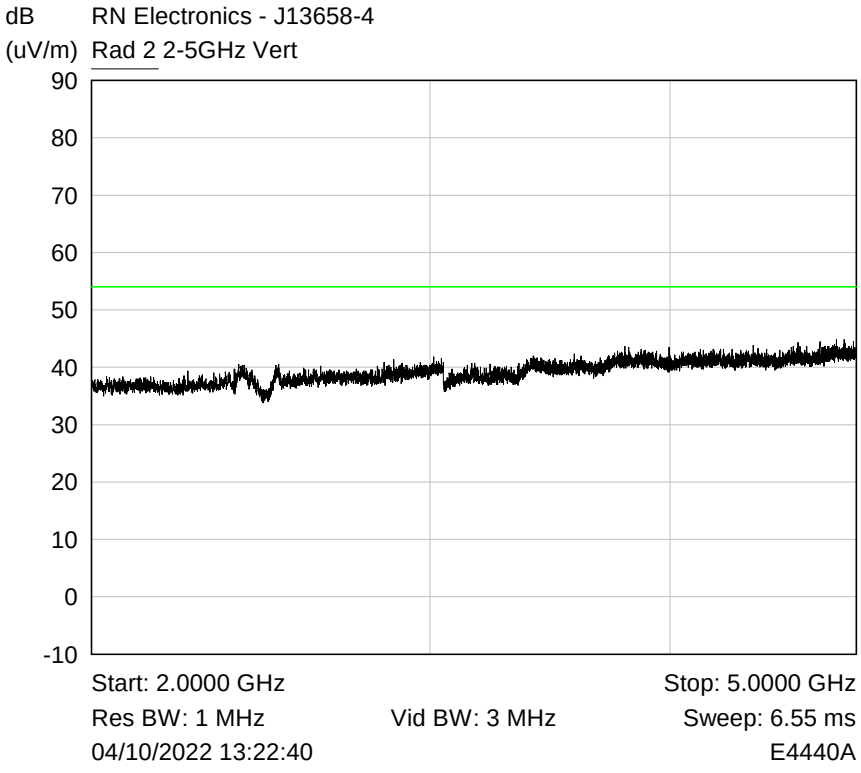
Plot Showing 1-2GHz Horiz



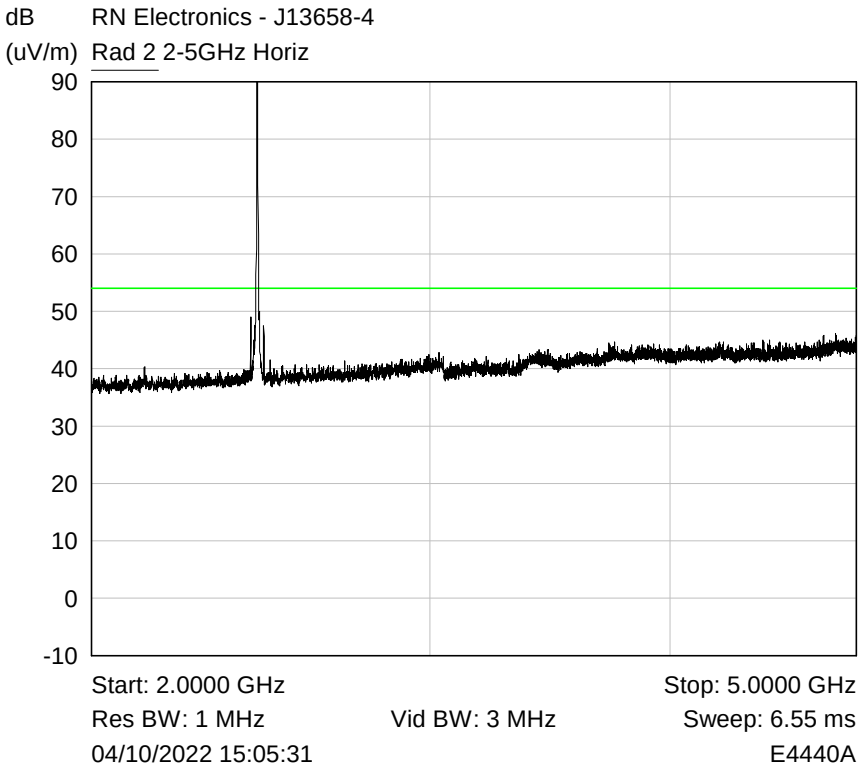
Plot Showing 1-2GHz Vert



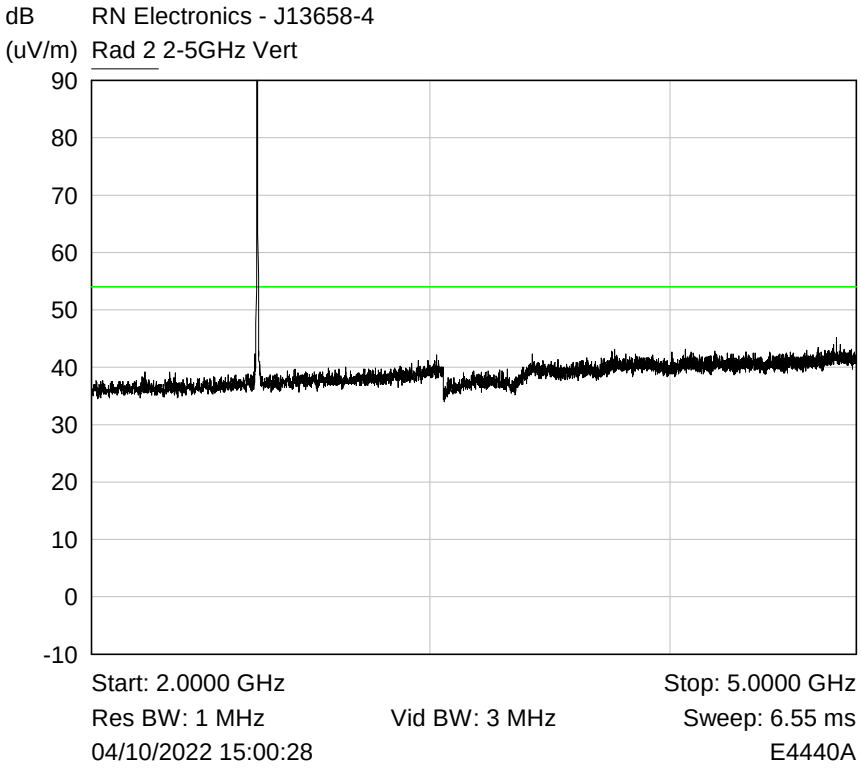
Plot Showing 2-5GHz Horiz



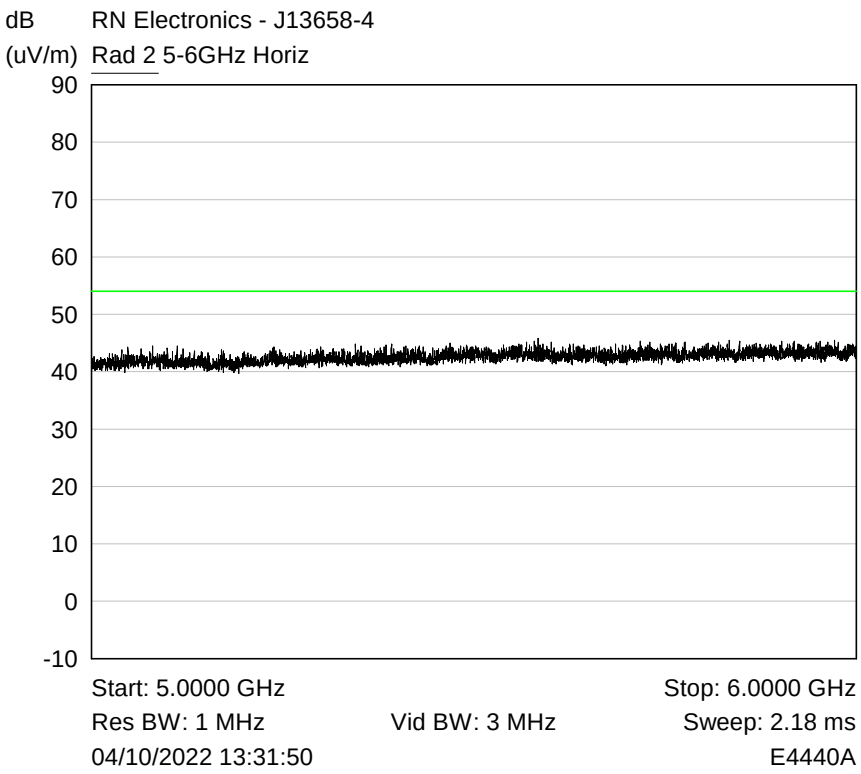
Plot Showing 2-5GHz Vert



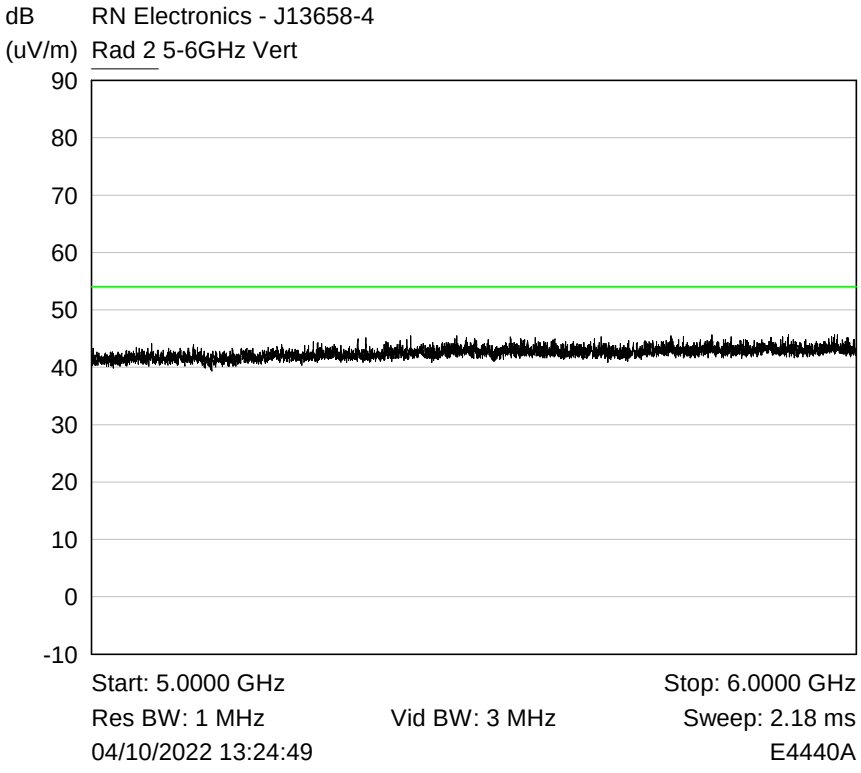
Plot showing 2-5GHz Horiz Showing intentional transmission



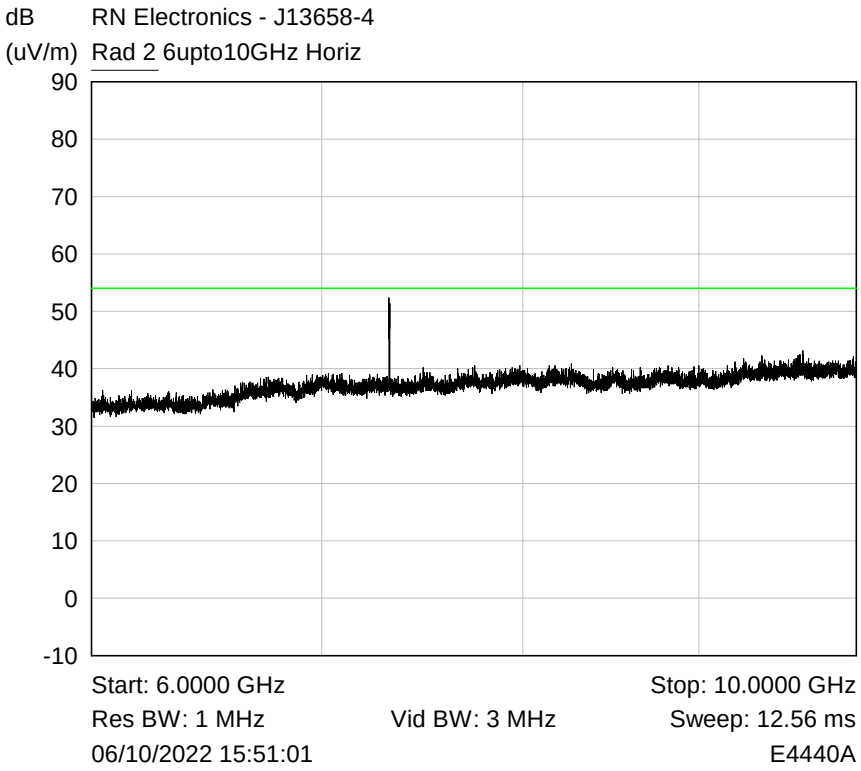
Plot showing 2-5GHz Vert Showing intentional transmission



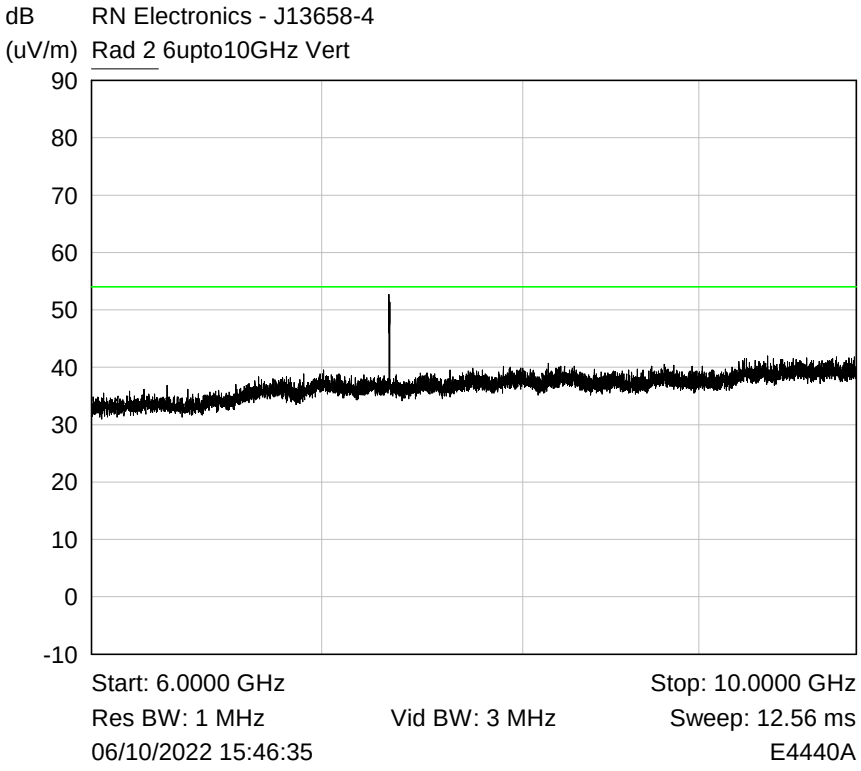
Plot Showing 5-6GHz Horiz



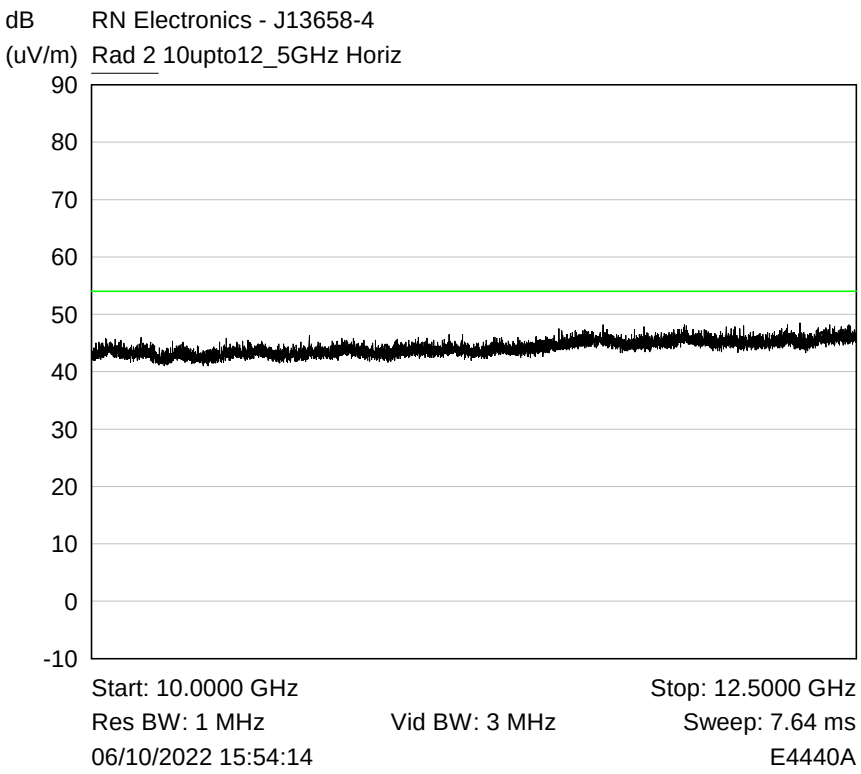
Plot Showing 5-6GHz Vert



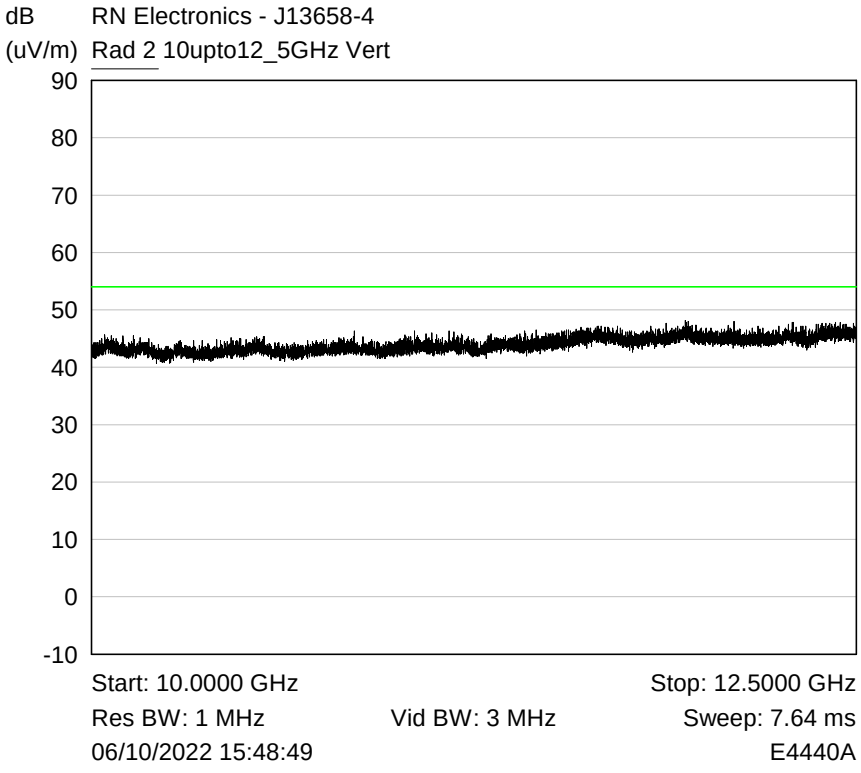
Plot Showing 6 to 10GHz Horiz



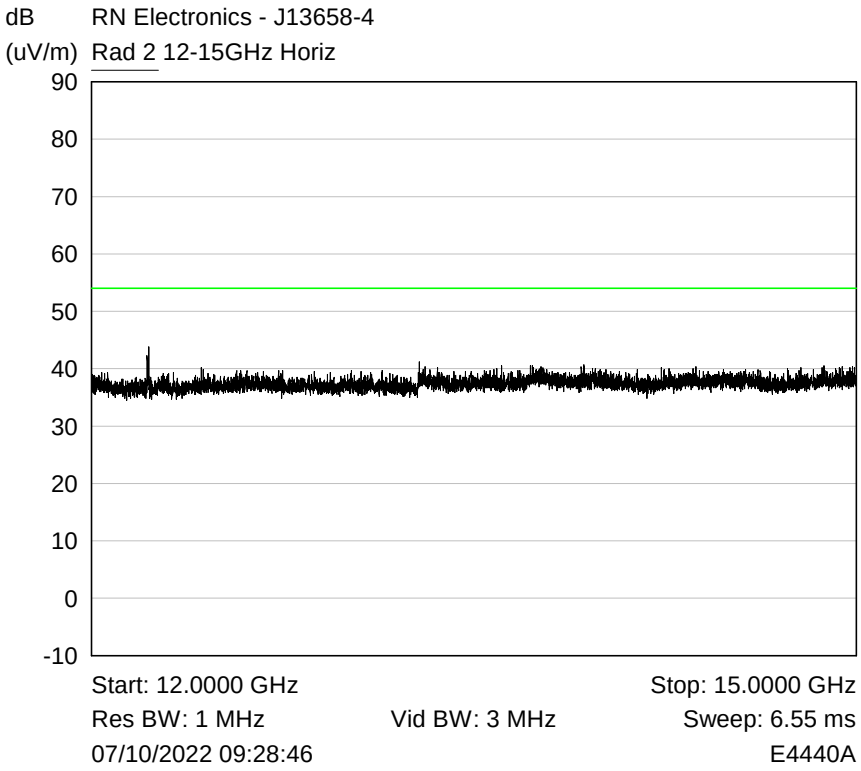
Plot Showing 6 to 10GHz Vert



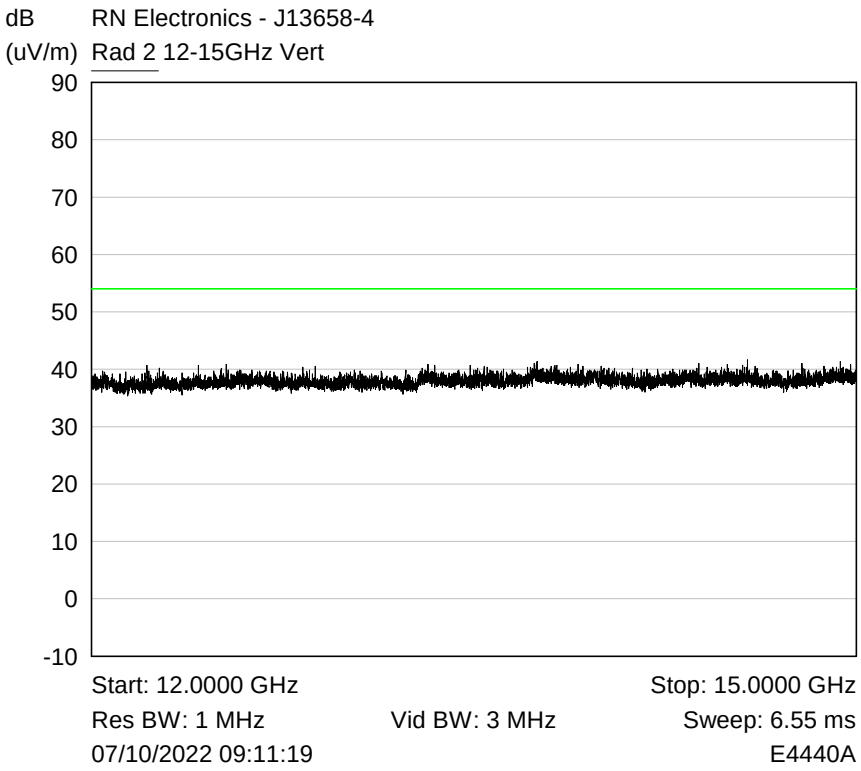
Plot Showing 10 to 12.5GHz Horiz



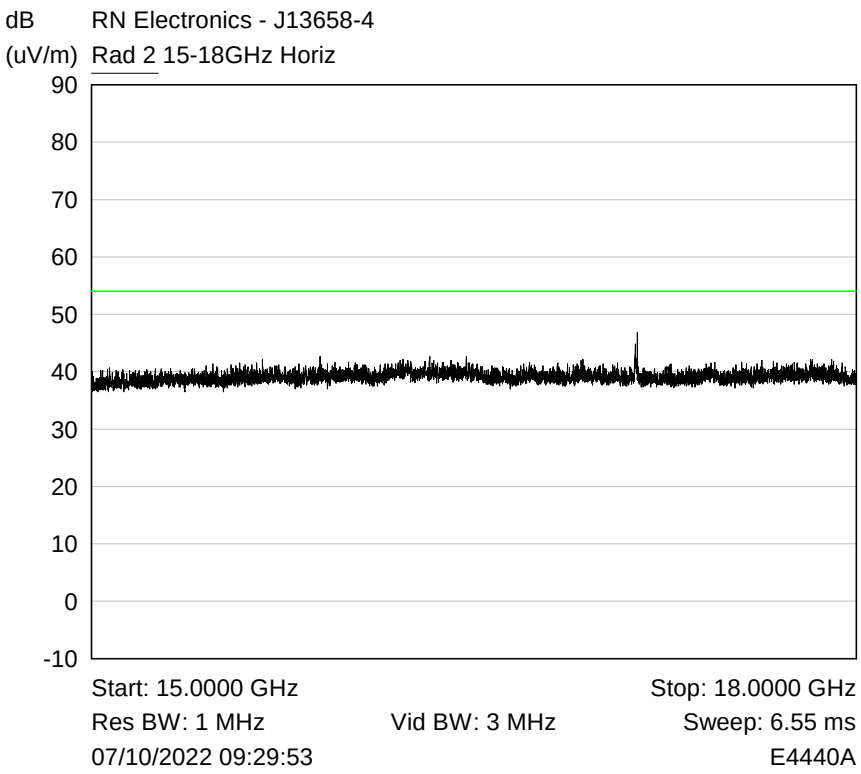
Plot Showing 10 to 12.5GHz Vert



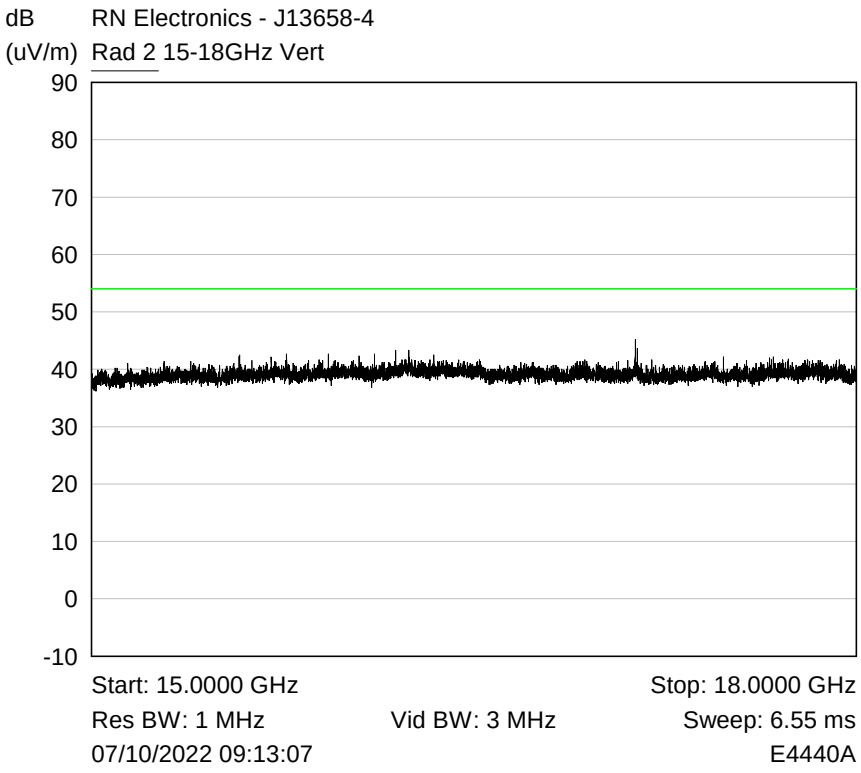
Plot Showing 12-15GHz Horiz



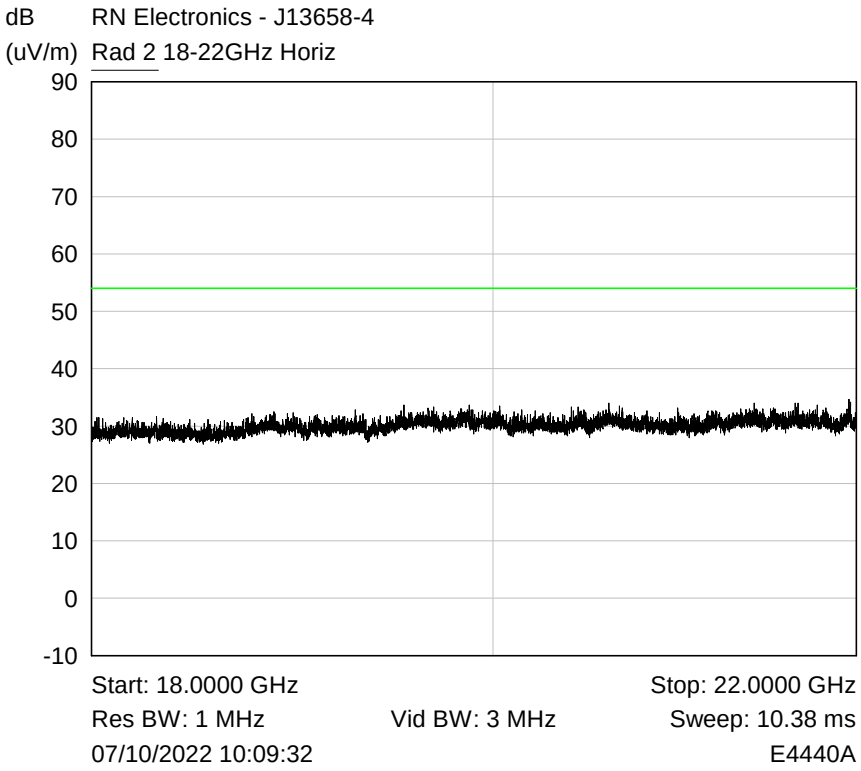
Plot Showing 12-15GHz Vert



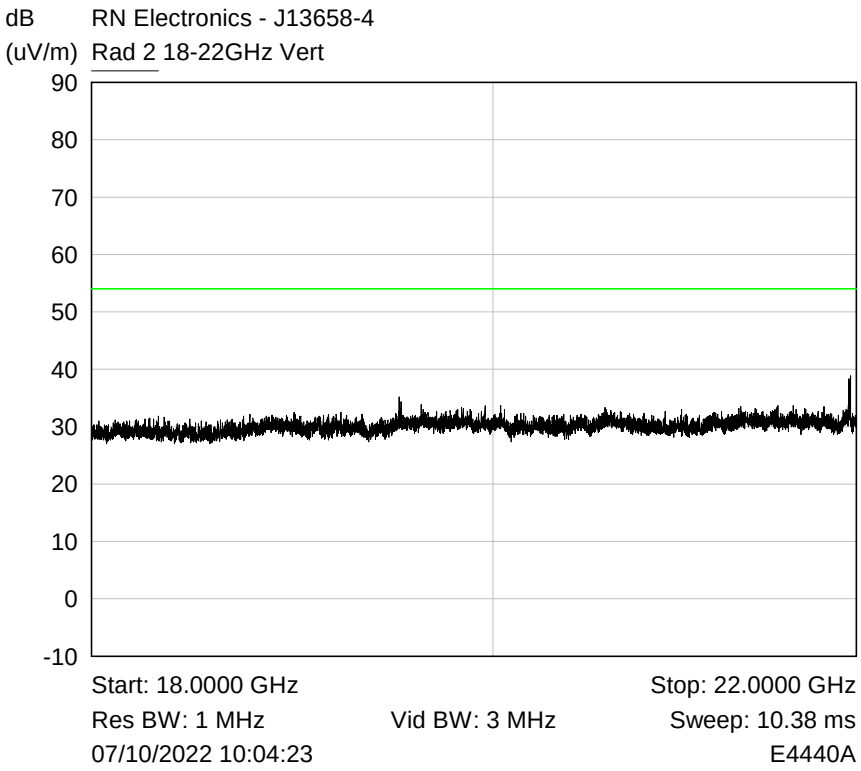
Plot Showing 15-18GHz Horiz



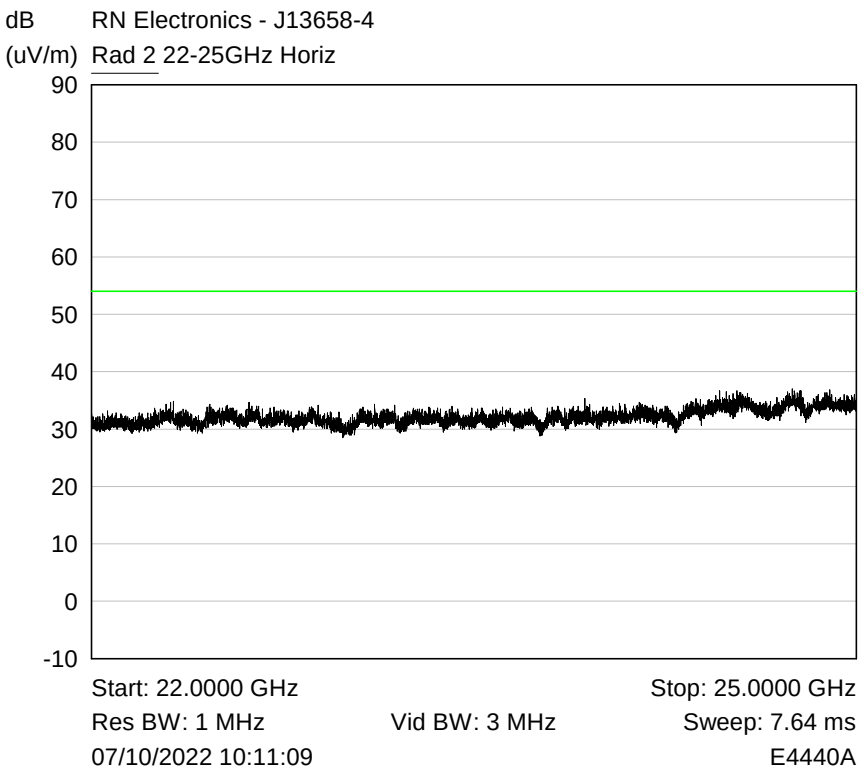
Plot Showing 15-18GHz Vert



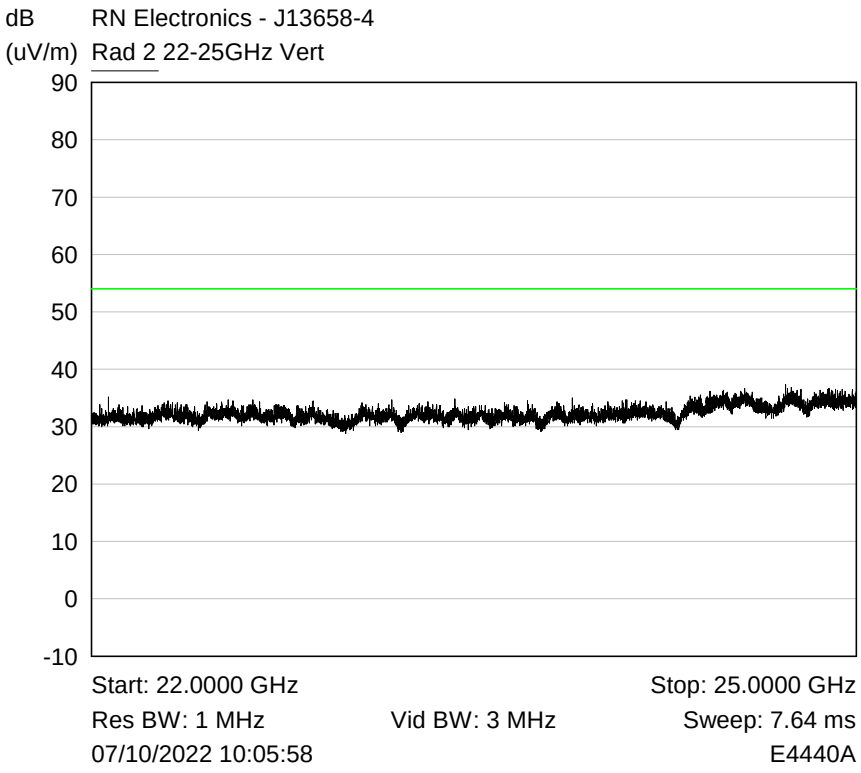
Plot Showing 18-22GHz Horiz



Plot Showing 18-22GHz Vert



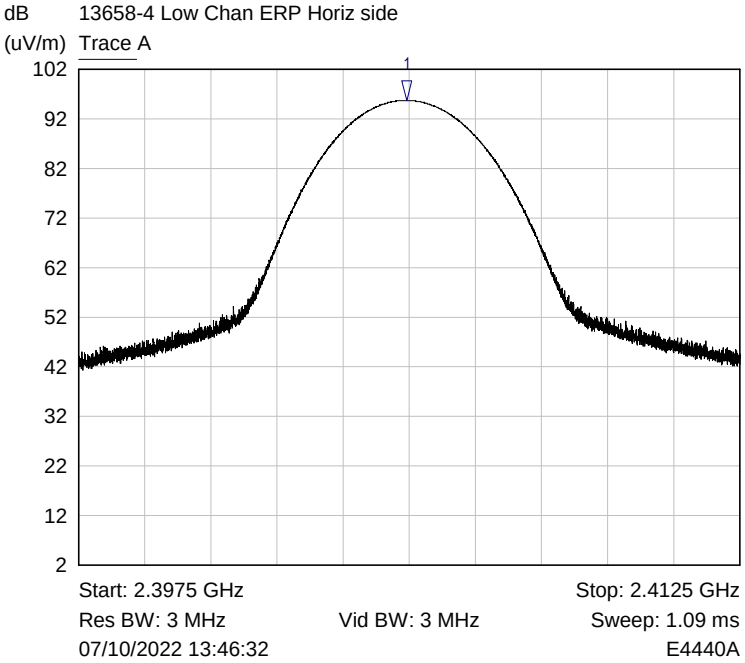
Plot Showing 22-25GHz Horiz



Plot Showing 22-25GHz Vert

6.5 Effective radiated power field strength

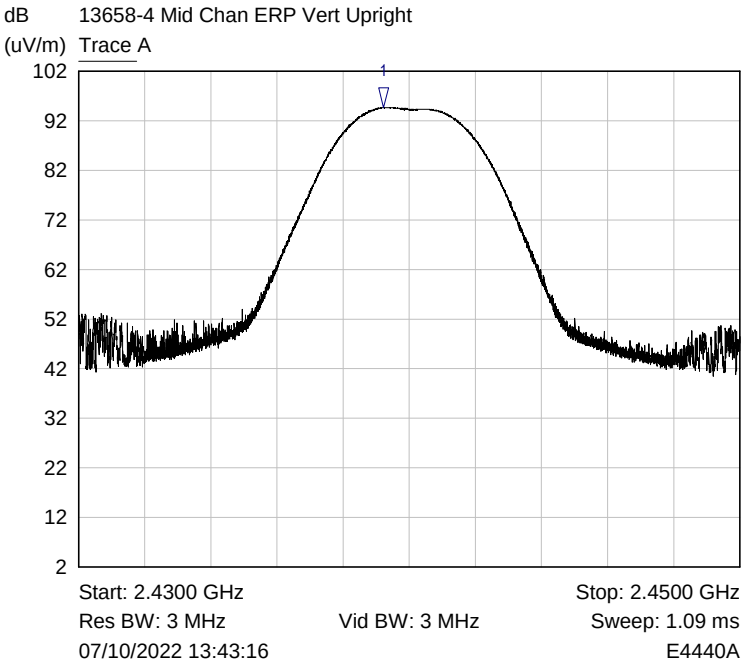
RF Parameters: Band 2400-2483.5 MHz, Power 6.5 dBm (Conducted), Channel Spacing 5 MHz, Modulation OQPSK, Channel 2405 MHz



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4049 GHz	95.74 dB(uV/m)	

Plot of Horizontal polarisation and EUT in the Side position

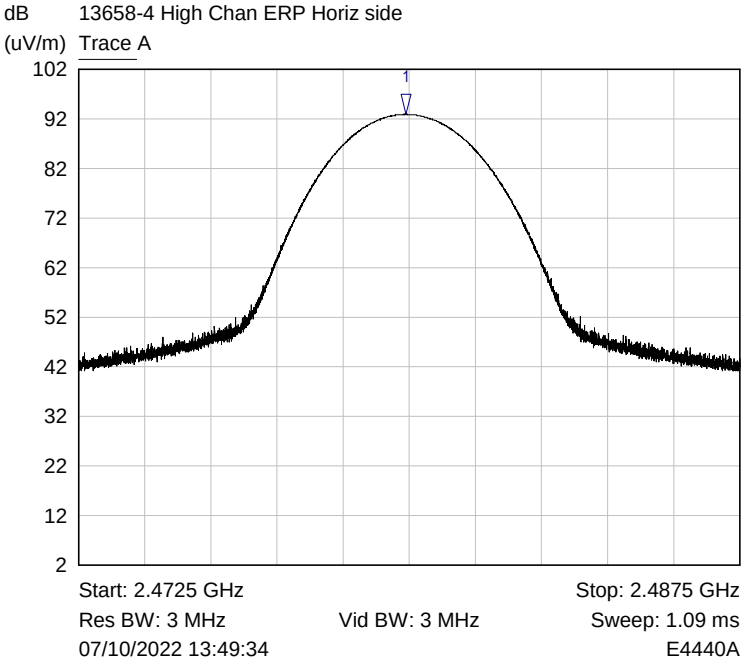
RF Parameters: Band 2400-2483.5 MHz, Power 6.5 dBm (Conducted), Channel Spacing 5 MHz, Modulation OQPSK, Channel 2440 MHz



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4392 GHz	94.73 dB(uV/m)	

Plot of Vertical polarisation and EUT in the upright position

RF Parameters: Band 2400-2483.5 MHz, Power 6.5 dBm (Conducted), Channel Spacing 5 MHz, Modulation OQPSK, Channel 2480 MHz

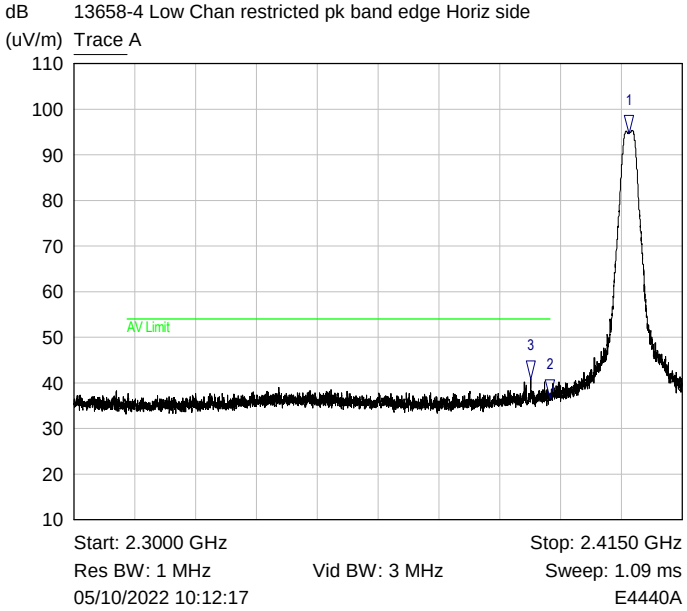


Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4799 GHz	92.93 dB(uV/m)	

Plot of Horizontal polarisation and EUT in the Side position

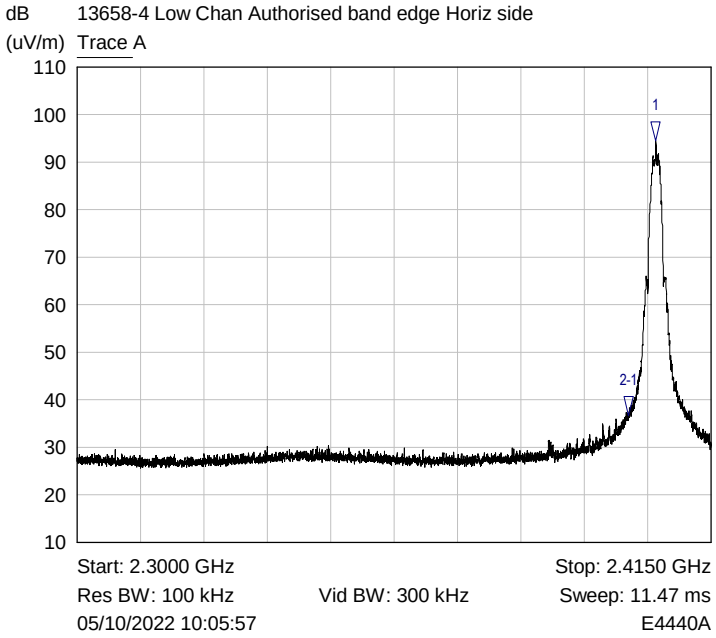
6.6 Band Edge Compliance

RF Parameters: Band 2400-2483.5 MHz, Power 8.2 dBm, Channel Spacing 5 MHz, Modulation OQPSK, Channel 2405 MHz



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4050 GHz	94.73 dB(uV/m)	
2 ▽	Trace A	2.3900 GHz	36.72 dB(uV/m)	
3 ▽	Trace A	2.3864 GHz	40.81 dB(uV/m)	

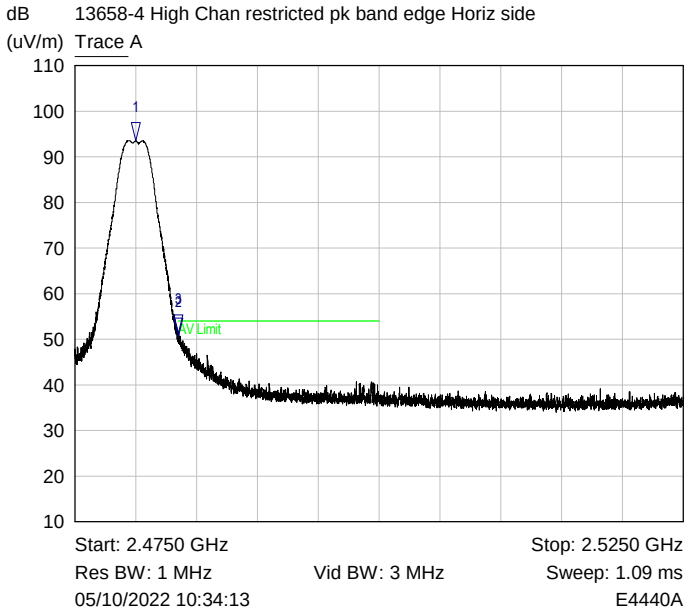
Restricted band edge Peak Plot



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4050 GHz	94.48 dB(uV/m)	
2-1 ▽	Trace A	2.4000 GHz	-57.74 dB	

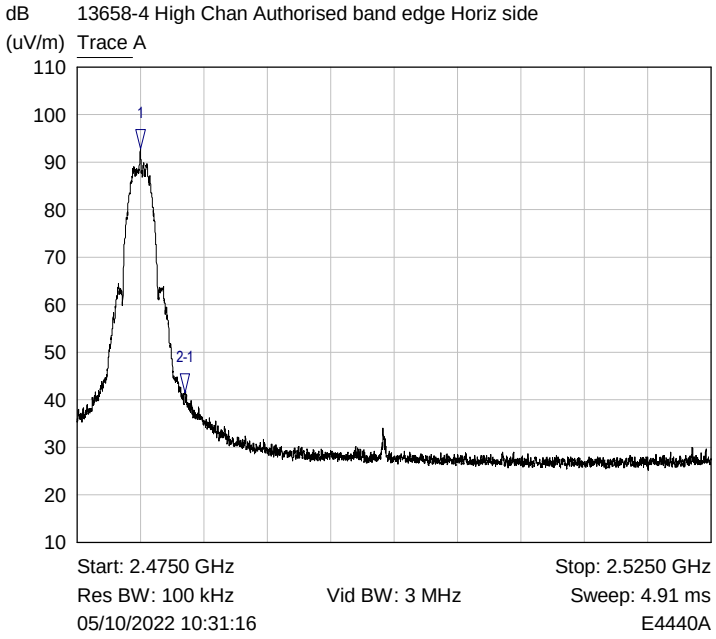
Authorised Band Edge Plot

RF Parameters: Band 2400-2483.5 MHz, Power 8.2 dBm, Channel Spacing 5 MHz, Modulation OQPSK, Channel 2480 MHz



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4800 GHz	93.52 dB(uV/m)	
2 ▽	Trace A	2.4835 GHz	50.71 dB(uV/m)	
3 ▽	Trace A	2.4835 GHz	51.31 dB(uV/m)	

Restricted band edge Peak Plot

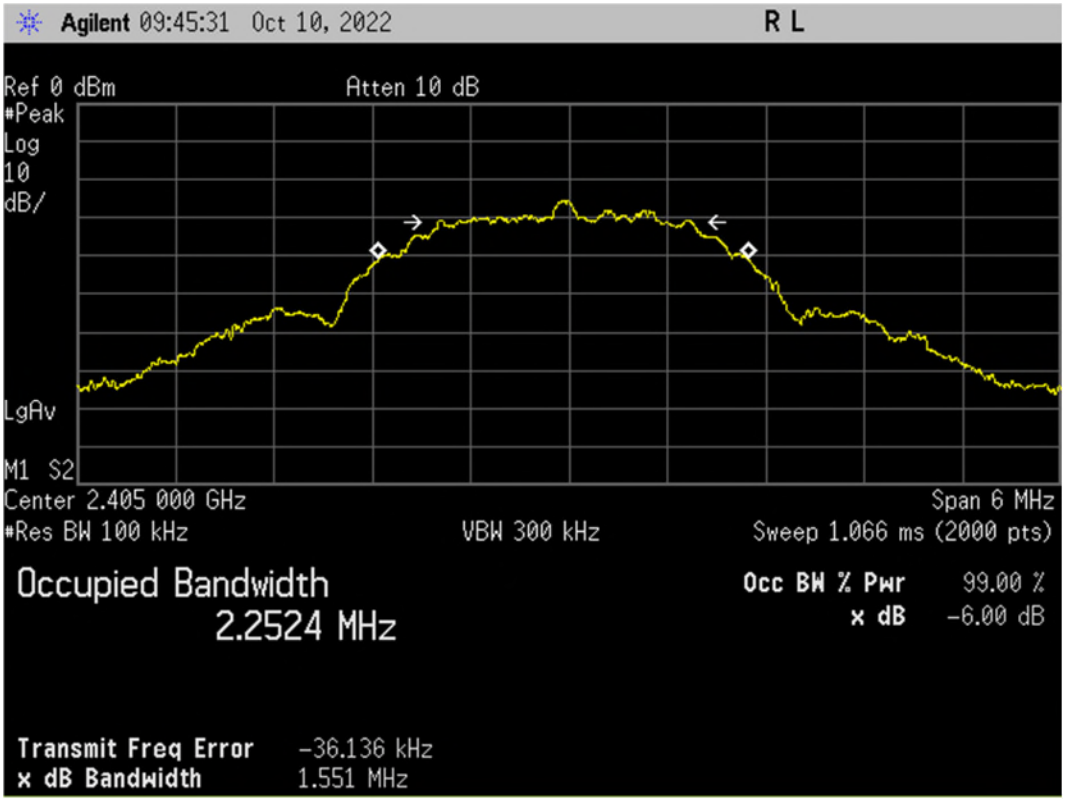


Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4800 GHz	92.86 dB(uV/m)	
2-1 ▽	Trace A	2.4835 GHz	-51.29 dB	

Authorised Band Edge Plot

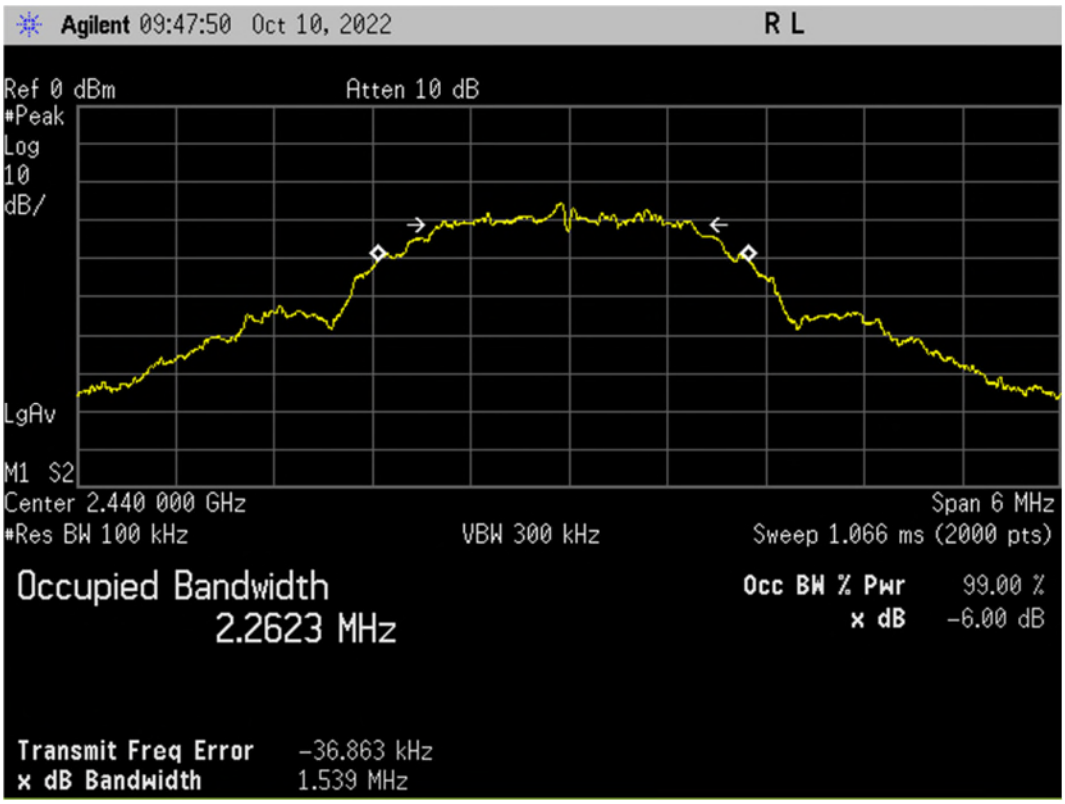
6.7 Occupied bandwidth

RF Parameters: Band 2400-2483.5 MHz, Power 6.5 dBm (Conducted), Channel Spacing 5 MHz, Modulation OQPSK, Channel 2405 MHz



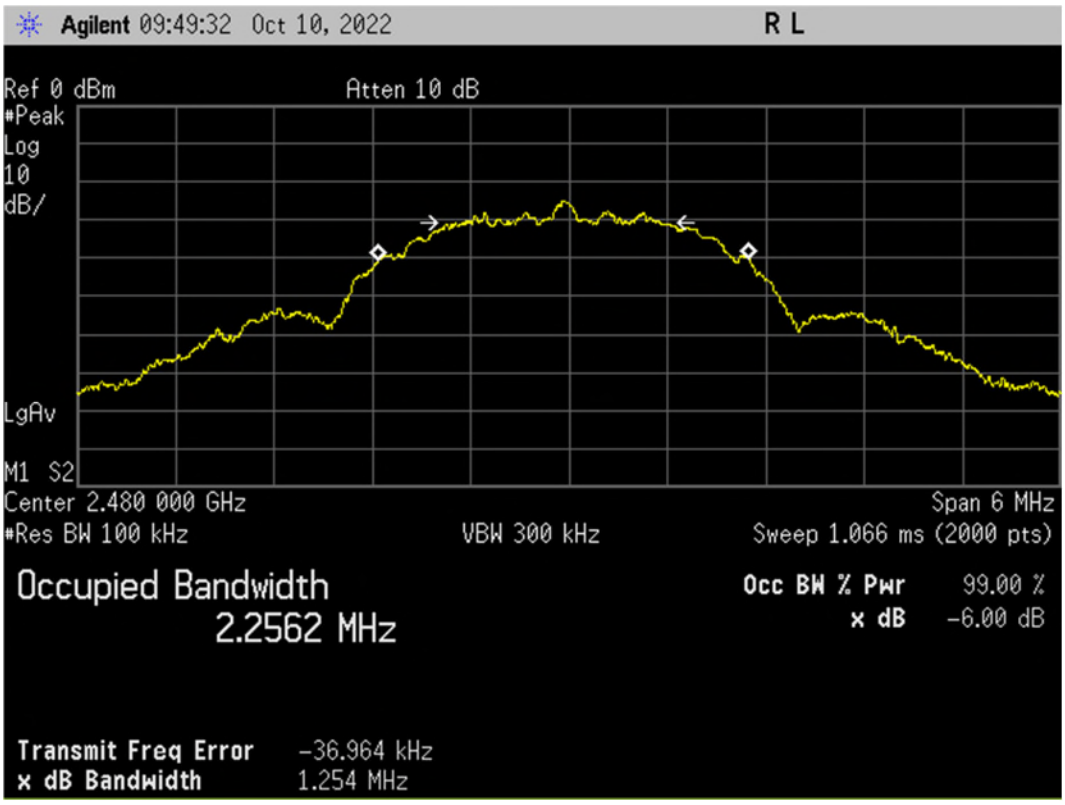
Plot for 6 dBBandwidth Result (MHz)

RF Parameters: Band 2400-2483.5 MHz, Power 6.5 dBm (Conducted), Channel Spacing 5 MHz, Modulation OQPSK, Channel 2440 MHz



Plot for 6 dBBandwidth Result (MHz)

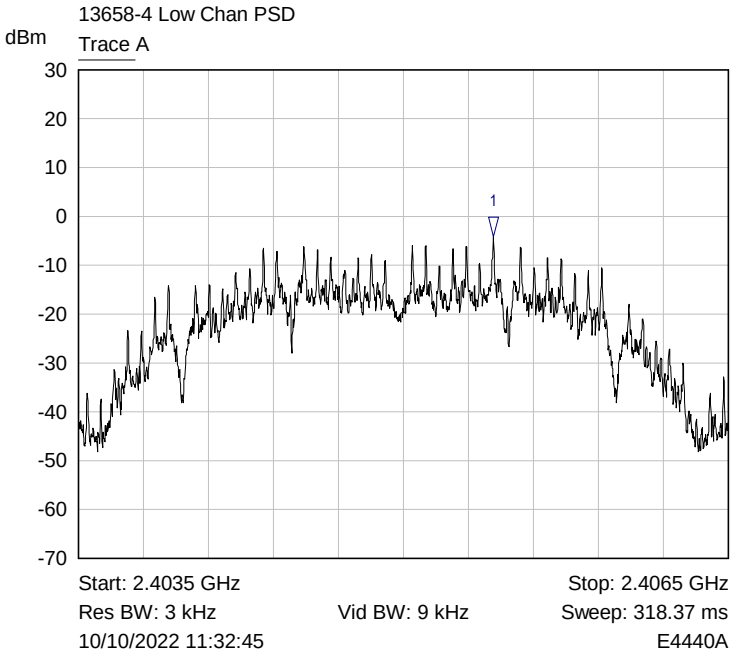
RF Parameters: Band 2400-2483.5 MHz, Power 6.5 dBm (Conducted), Channel Spacing 5 MHz, Modulation OQPSK, Channel 2480 MHz



Plot for 6 dBBandwidth Result (MHz)

6.8 Maximum Power Spectral Density

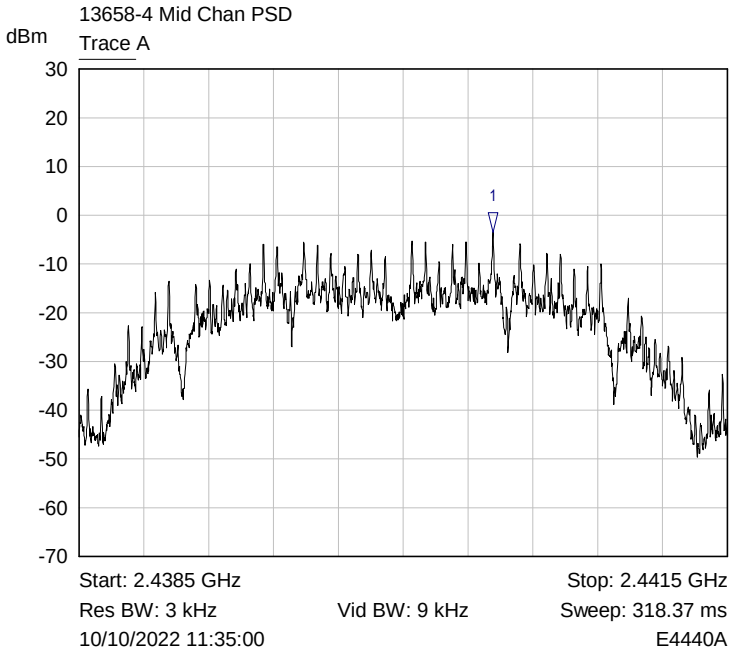
RF Parameters: Band 2400-2483.5 MHz, Power 6.5 dBm (Conducted), Channel Spacing 5 MHz, Modulation OQPSK, Channel 2405 MHz



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4054 GHz	-4.13 dBm	

Power Spectral Density (Low channel)

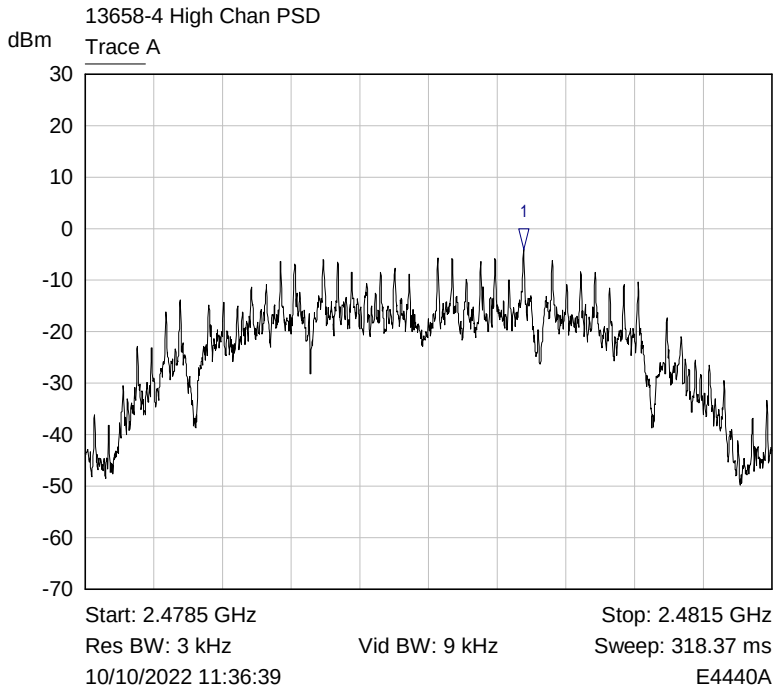
RF Parameters: Band 2400-2483.5 MHz, Power 6.5 dBm (Conducted), Channel Spacing 5 MHz, Modulation OQPSK, Channel 2440 MHz



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4404 GHz	-3.51 dBm	

Power Spectral Density (Mid channel)

RF Parameters: Band 2400-2483.5 MHz, Power 6.5 dBm (Conducted), Channel Spacing 5 MHz, Modulation OQPSK, Channel 2480 MHz



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4804 GHz	-3.96 dBm	

Power Spectral Density (High channel)

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: $E_{Spec\ limit} = \sqrt{(0.9 \times 10^{-6} \times 377)} = 0.01842$ 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

Internal pictures not included due to confidentiality purposes.

8.6 EUT Display & Controls

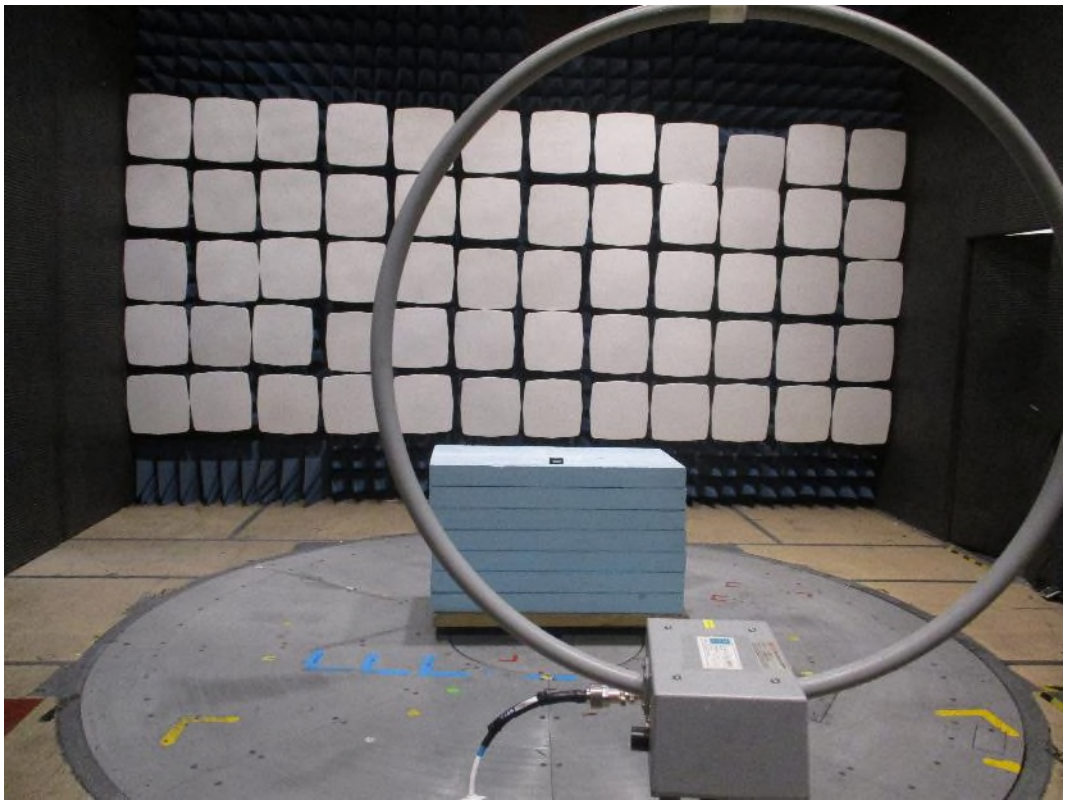
The EUT has no Display or Controls.

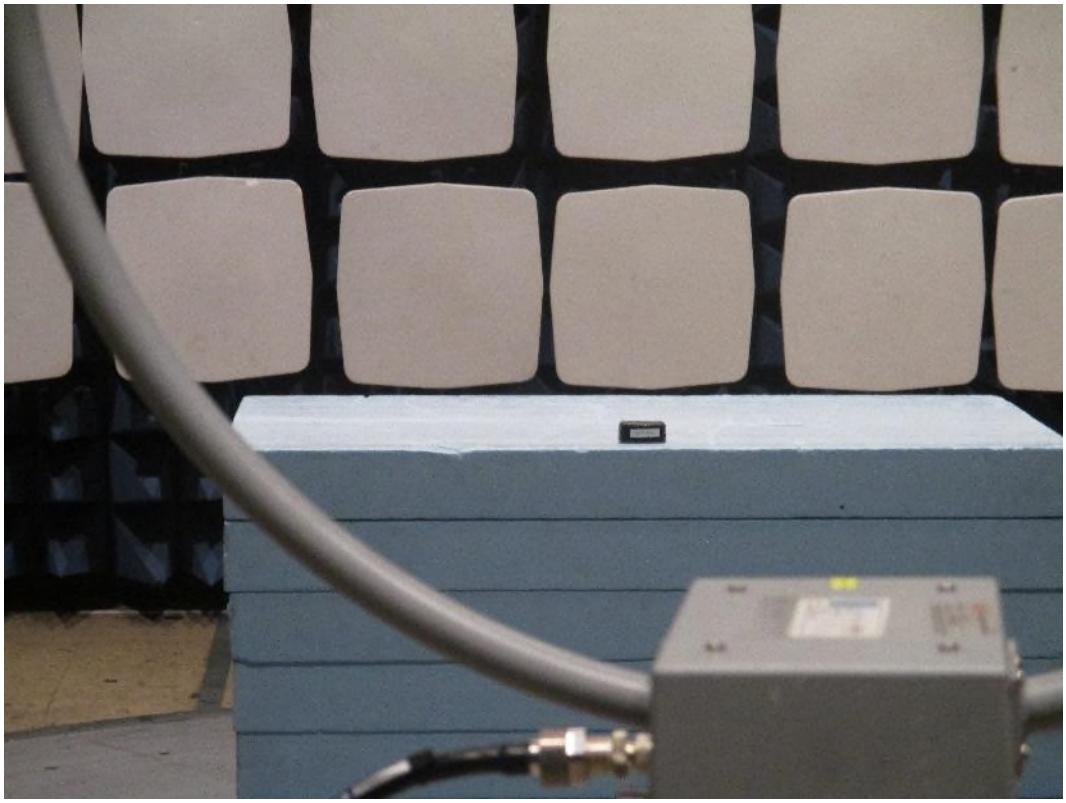
8.7 EUT Internal photos

Internal pictures not included due to confidentiality purposes.

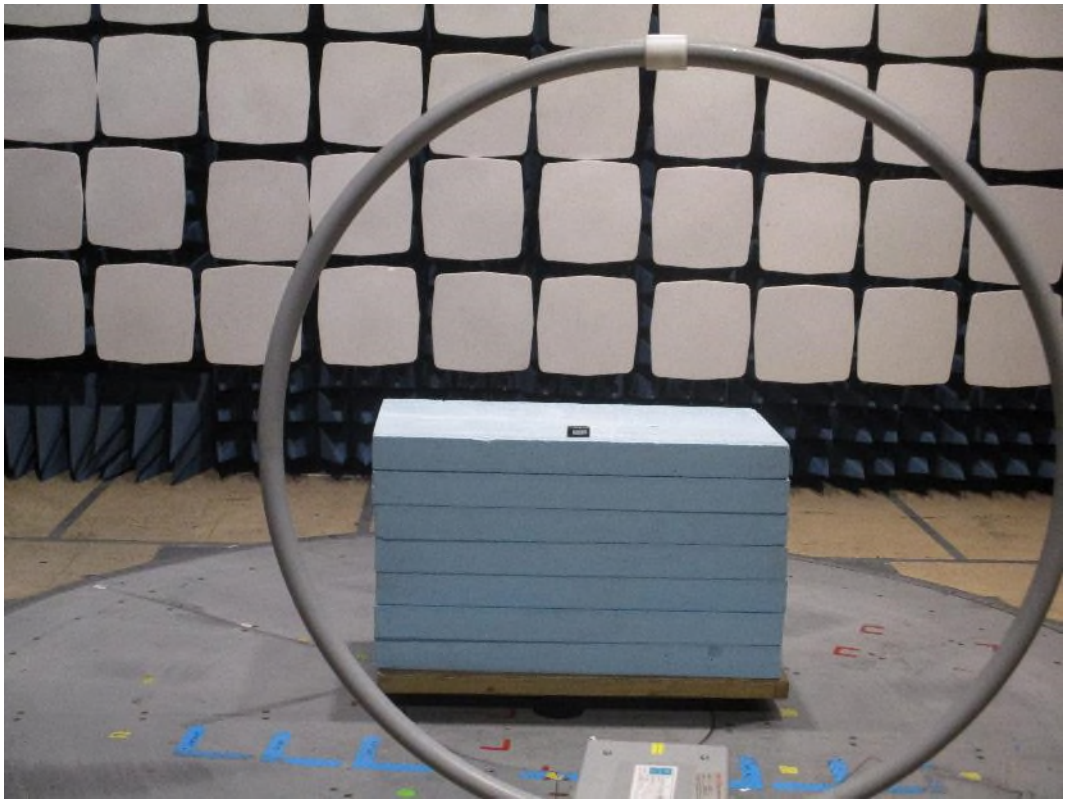
8.8 EUT ID Label

8.9 Radiated emissions 9 - 150 kHz

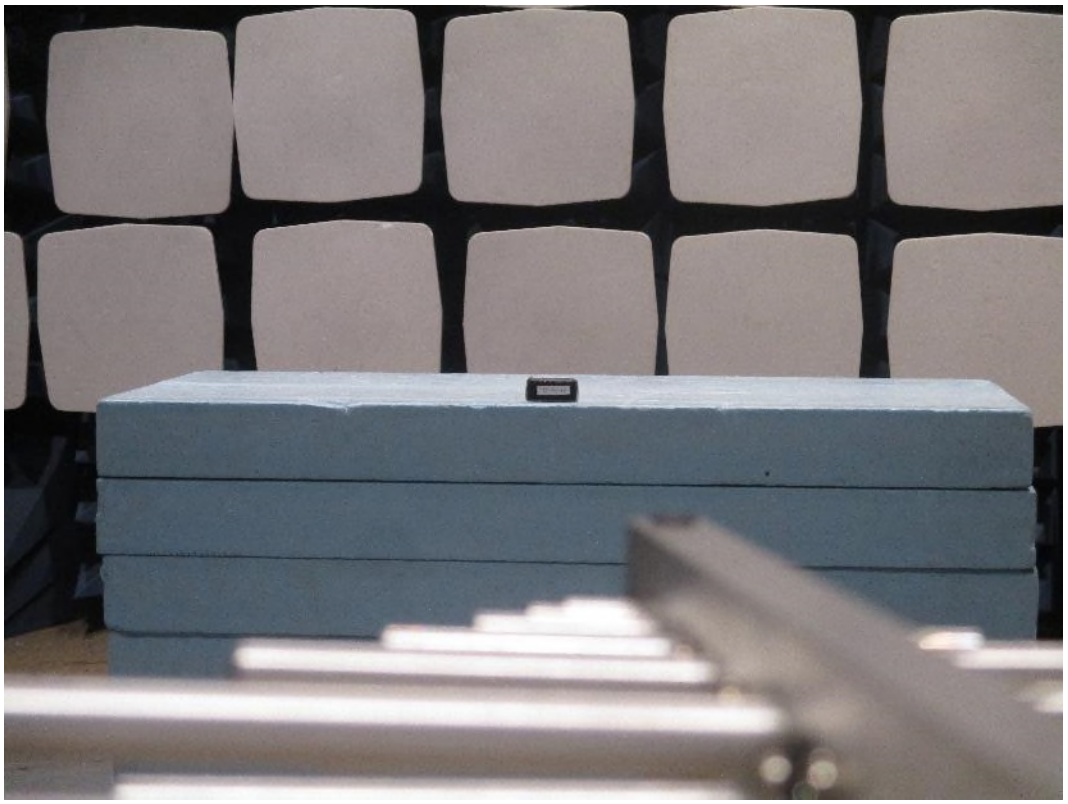


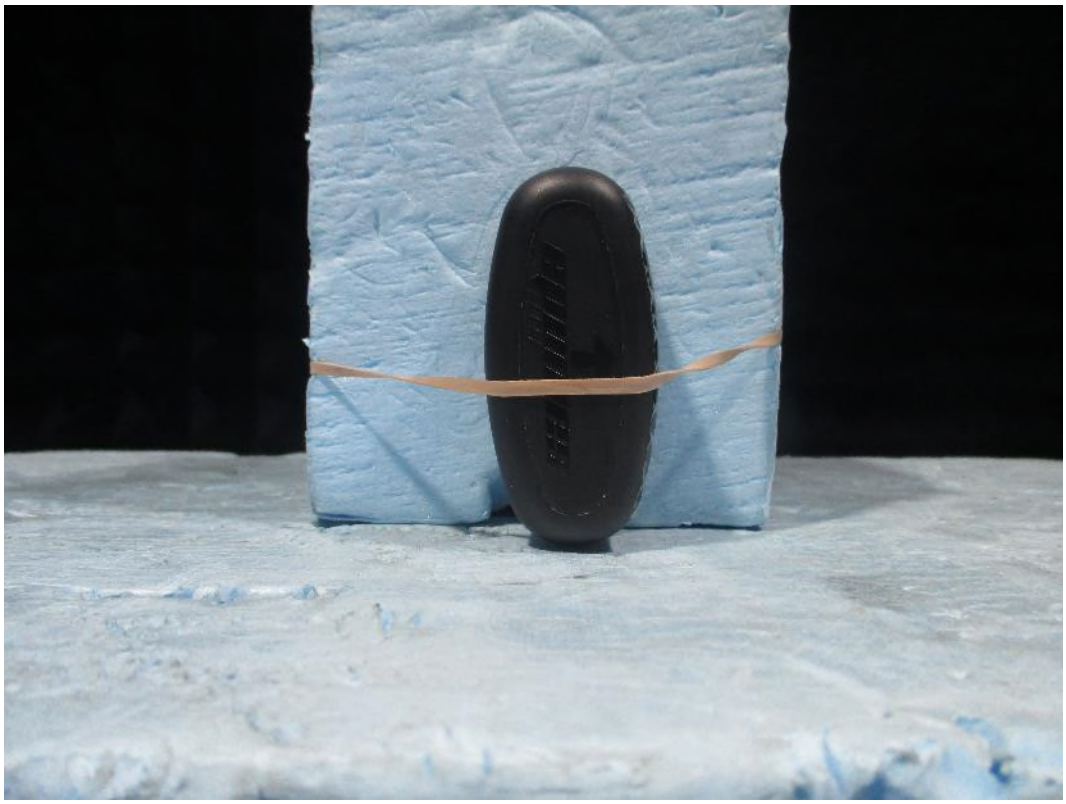


8.10 Radiated emissions 150 kHz - 30 MHz

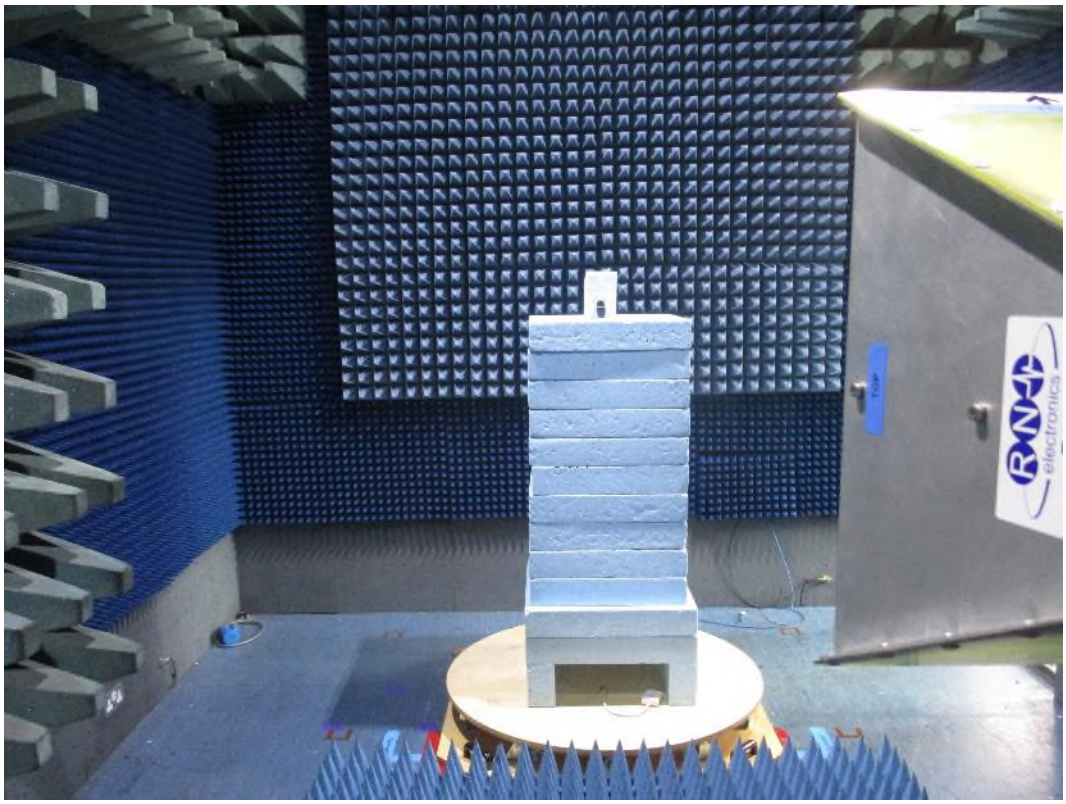


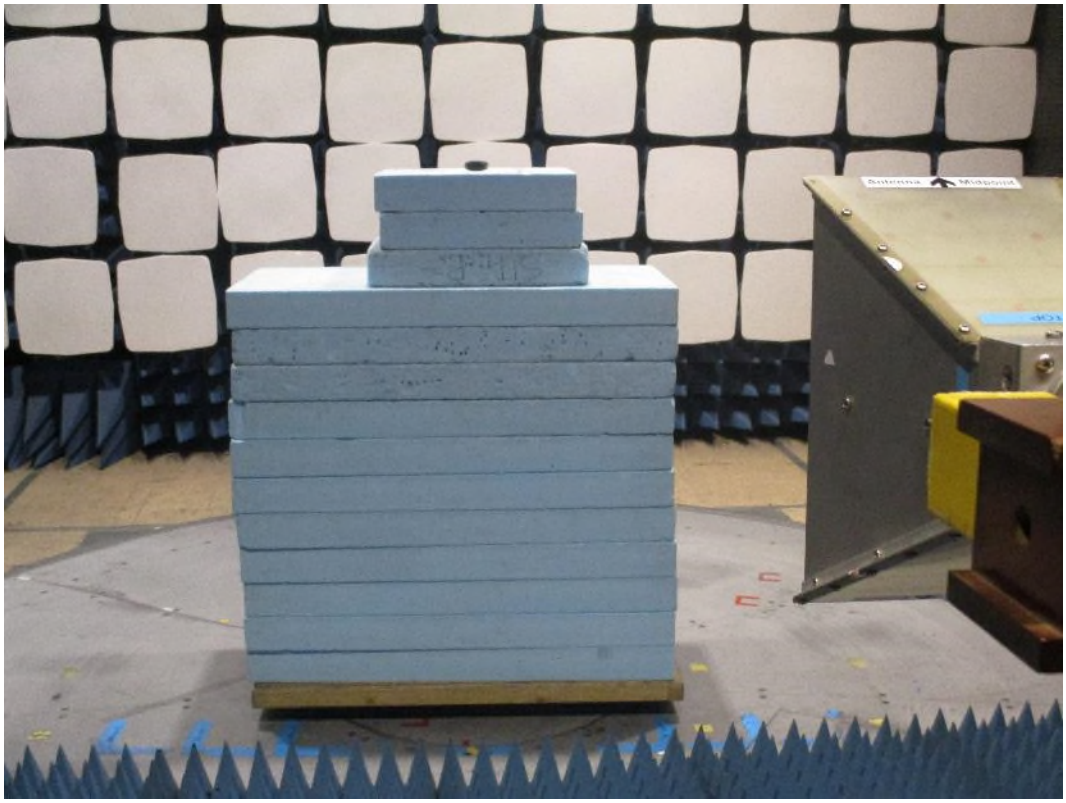
8.11 Radiated emissions 30 MHz -1 GHz

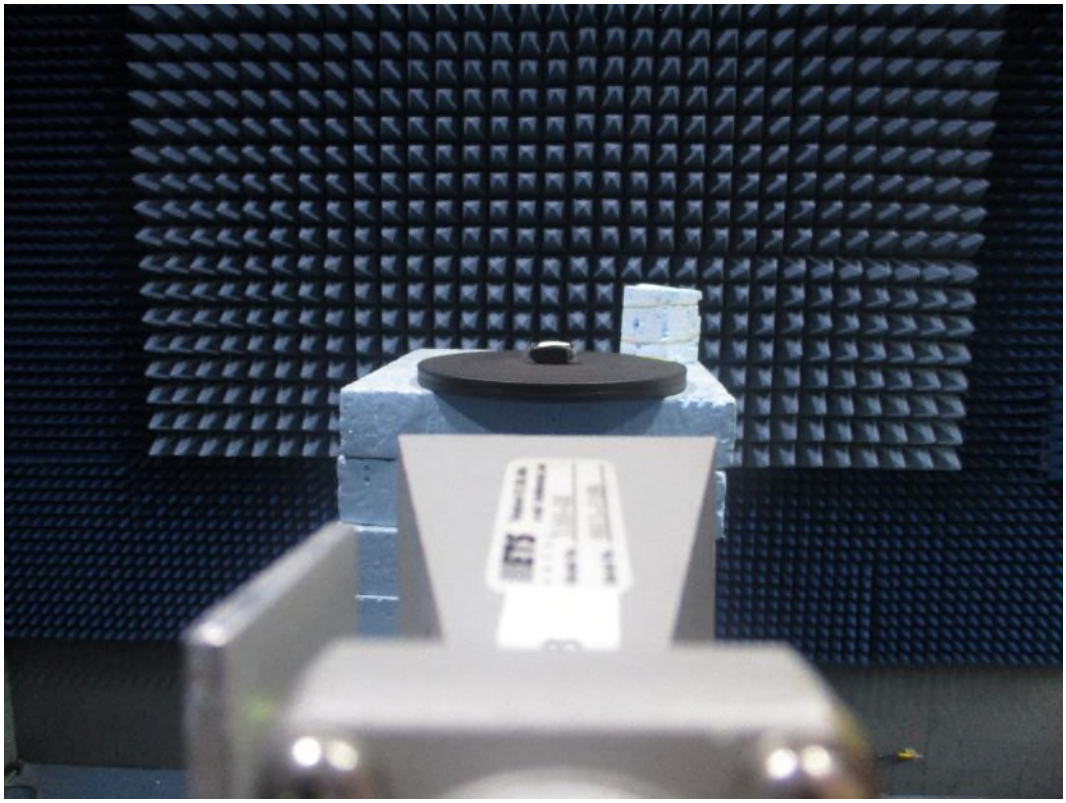


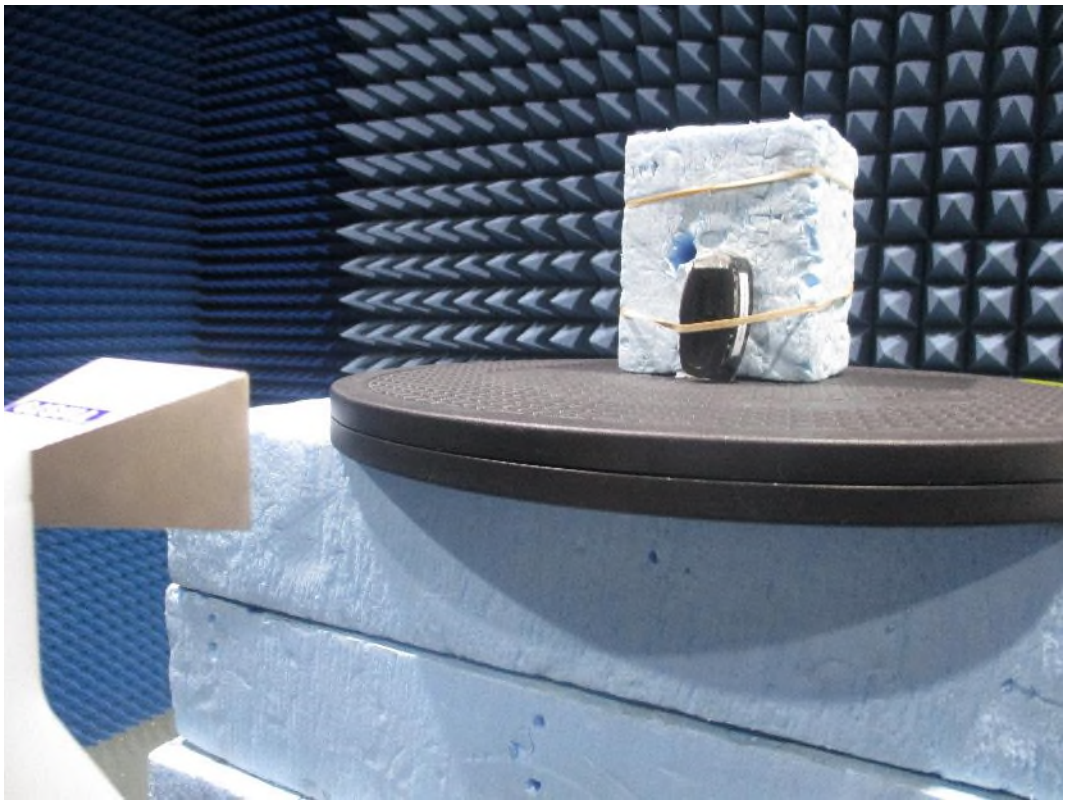


8.12 Radiated emissions above 1 GHz









8.13 Radiated emission diagrams

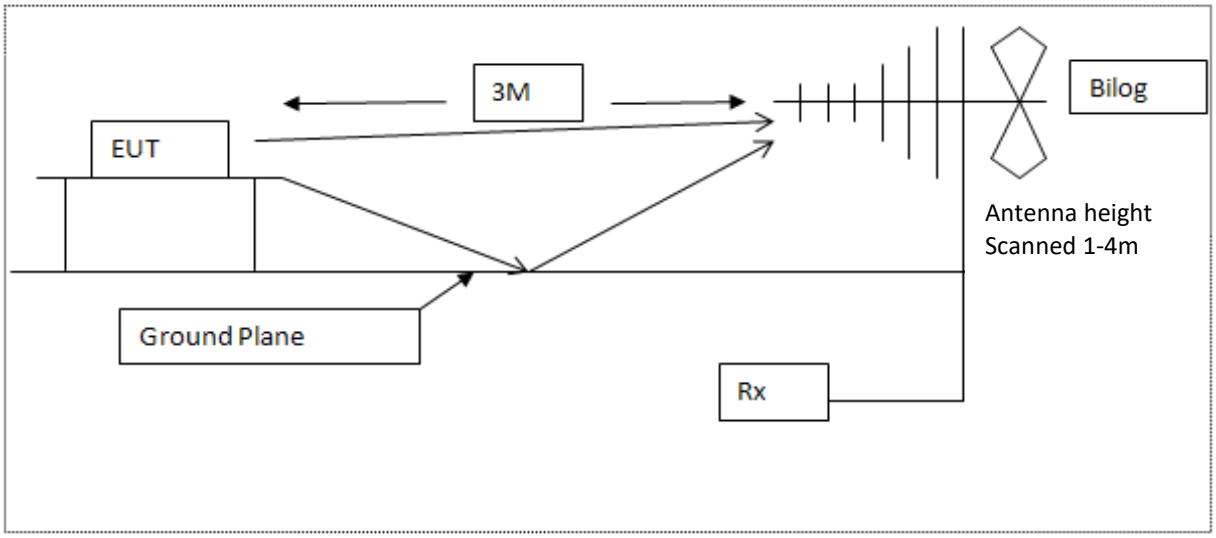


Diagram of the radiated emissions test setup 30 - 1000 MHz

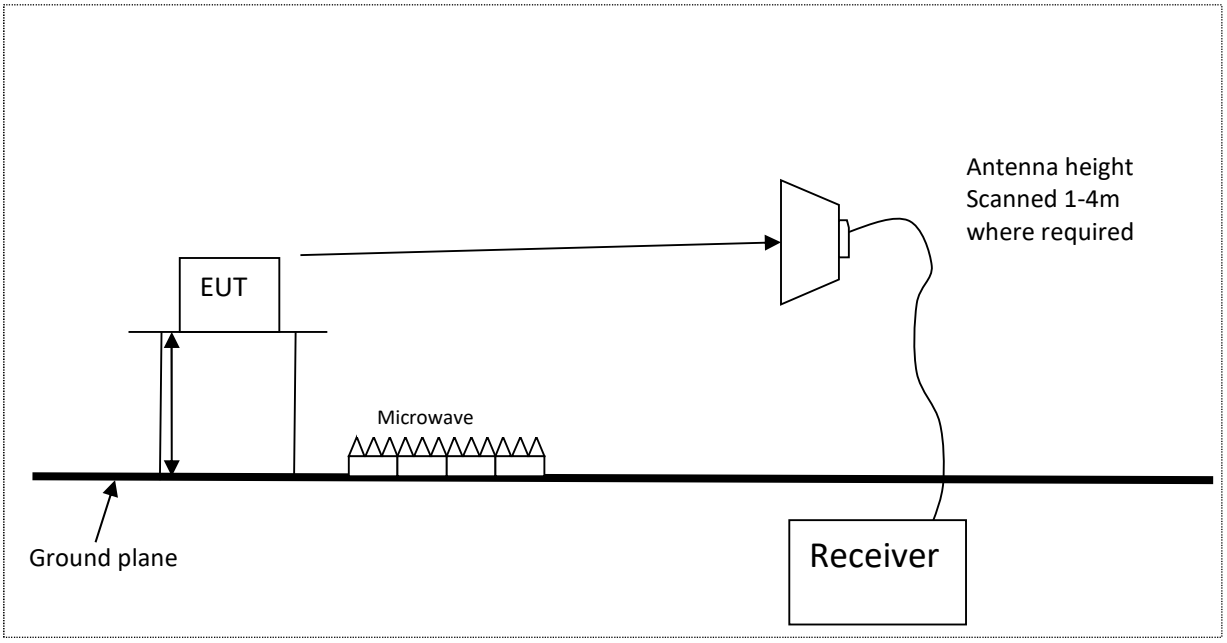


Diagram of the radiated emissions test setup above 1GHz

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
E289	8449B	Pre-Amplifier 1GHz - 26.5GHz	Hewlett Packard	24-Jun-2022	12 months
E412	E4440A	PSA 3 Hz - 26.5 GHz	Agilent Technologies	21-Jun-2022	24 months
E428	HF906	Horn Antenna 1 - 18 GHz	Rohde & Schwarz	02-Apr-2022	12 months
E429	-	Filter Box 5 Switch Filters 0.91 GHz - 16.3 GHz	RN Electronics	23-Aug-2022	12 months
E534	E4440A	PSA 3 Hz - 26.5 GHz	Agilent Technologies	24-Jan-2022	24 months
E535	N9039A	9 kHz - 1 GHz RF Filter Section	Agilent Technologies	25-Jan-2022	12 months
E640	6630.19.AA	Attenuator 30dB 18GHz	Suhner	15-Feb-2022	12 months
E642	E4440A	PSA 3 Hz - 26.5 GHz	Agilent Technologies	14-Dec-2021	24 months
E745	2017 4/2dB	Attenuator 4/2dB 30-1000MHz	RN Electronics	04-Feb-2022	12 months
E856	N9039A	9 kHz - 1 GHz RF Filter Section	Agilent Technologies	14-Dec-2021	12 months
E914	VULB 9163	Antenna BiLog 30MHz to 3GHz	Schwarzbeck	23-Apr-2022	12 months
E972	WRCGV10-2363.5-2400-2483.5-2520-60SS	Filter Band Reject 2400 to 2483.5 MHz	Wainwright Instruments	08-Apr-2022	12 months
LPE261	3115	Horn Antenna 1 - 18 GHz	EMCO	02-Apr-2022	12 months
LPE333	8449B	Pre-Amplifier 1GHz - 26.5GHz	Hewlett Packard	27-May-2022	12 months
NSA-H	NSA - H	NSA - Site H	RN Electronics	11-Dec-2019	36 months
TMS78	3160-08	Horn Std Gain 12.4 - 18 GHz	ETS Systems	22-Sep-2021	12 months
TMS79	3160-09	Horn Std Gain 18 - 26.5 GHz	ETS Systems	25-May-2022	12 months
TMS81	6502	Antenna Active Loop	EMCO	22-Jul-2021	24 months
VSWR-B	VSWR	VSWR 1-18GHz	RN Electronics	09-Feb-2022	36 months
VSWR-H	VSWR	VSWR 1-18GHz	RN Electronics	21-Jan-2020	36 months
ZSW1	V2.5.2	Measurement Software Suite	RN Electronics	Not Applicable	

10 Auxiliary and peripheral equipment

10.1 Customer supplied equipment

Item No.	Model No.	Description	Manufacturer	Serial No.
1	SM-A202F/DS	Mobile phone	Samsung	RF8N92XY0CJ

10.2 RN Electronics supplied equipment

RN No.	Model No.	Description	Manufacturer	Serial No
P281	L30-2	PSU 30V 2A	Farnell	3888

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

Test	Modification	Time of modification	Photo Reference
TX Rad Em FCC15_247	Power was reduced by 2dB in order for the 3rd harmonic to comply with the limits.	Before testing	Not applicable performed in software.

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