Radio Test Report

Sound Devices LLC

Multi-Channel Wireless Microphone Receiver

A20-NEXUS

47 CFR Part 15.247 Effective Date 1st October 2021
DSS: Part 15 Spread Spectrum Transmitter
Test Date: 20th October 2022 to 24th January 2023
Report Number: 01-13348-11-23 Issue 01

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

R.N. Electronics Ltd.
Arnolds Court
Arnolds Farm Lane
Mountnessing
Essex
CM13 1UT
U.K.

www.RNelectronics.com

Telephone: +44 (0) 1277 352219
Email: sales@RNelectronics.com

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 13348-11

The equipment noted below has been partially 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:	Multi-Channel Wireless Microphone Receiver
Model Number:	A20-NEXUS
Unique Serial Number:	JY0022171001
Applicant:	Sound Devices LLC E7556 State Road 23 and 33 Reedsburg, Wisconsin 53959 USA
Proposed FCC ID	2AKLX-10873
Full measurement results are detailed in Report Number:	01-13348-11-23 Issue 01
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. This report pertains to the proprietary FHSS 2.4G Proprietary technology operation only.

DEVIATIONS:
No deviations 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: 20th October 2022 to 24th January 2023

Test Engineer:
Jack Chilvers

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: 2023.03.16 13:44:44 Z

Approved By:
Radio Approvals Manager

Digitally signed by: Daniel Sims
DN: CN = Daniel Sims C = GB O = RN Electronics Ltd
Date: 2023.03.16 13:15:54 Z

Customer Representative:

UKAS TESTING 2360

1 Contents

2 Equipment under test (EUT)

2.1 Equipment specification

Applicant	Sound Devices LLC E7556 State Road 23 and 33 Reedsburg Wisconsin 53959 USA	
Manufacturer of EUT	Sound Devices LLC	
Full Name of EUT	Multi-Channel Wireless Microphone Receiver	
Model Number of EUT	A20-NEXUS	
Serial Number of EUT	JY0022171001	
Date Received	22nd September 2022	
Date of Test:	20th October 2022 to 24th January 2023	
Purpose of Test	To demonstrate design compliance to the relevant rules of Chapter 47 of the Code of Federal Regulations.	
Date Report Issued	30th January 2023	
Main Function	Multi-channel wireless microphone receiver	
Information Specification	Height	40 mm
	Width	205 mm
	Depth	155 mm
	Weight	1.2 kg
	Voltage	10 - 18 VDC
	Current	12 VDC 5 Amp

2.2 Configurations for testing

General Parameters	
EUT Normal use position	Portable
Choice of model(s) for type tests	A20-NEXUS
Antenna details	Pulse Electronics W1010 2.4GHz External Antenna
Antenna port	2 SMA ports (A & B)
Baseband Data port (yes/no)?	No
Highest Signal generated in EUT	2481.6 MHz (Proprietary FHSS FHSS 2.4G Proprietary)
Lowest Signal generated in EUT	Not Specified
Hardware Version (HVIN)	Rev01
Software Version	Not Specified
Firmware Version (FVIN)	0.01.6149
Type of Equipment	Multi-Radio
Technology Type	Proprietary FHSS 2.4G Proprietary
Geo-location (yes/no)	No
TX Parameters	
Alignment range – transmitter	2400.8 – 2481.6 MHz
EUT Declared Modulation Parameters	FHSS 2.4G Proprietary Chirp
EUT Declared Power level	<10mW EIRP
EUT Declared Signal Bandwidths	203 kHz
EUT Declared Channel Spacing's	400 kHz
EUT Declared Duty Cycle	<400ms max dwell time
Unmodulated carrier available?	Yes, via engineering menu in GUI
Declared frequency stability	1 ppm
RX Parameters	
Alignment range – receiver	2400.8 – 2481.6
EUT Declared RX Signal Bandwidth	203 kHz
Method of Monitoring Receiver BER	Engineering test mode via GUI
FCC Parameters	
FCC Transmitter Class	DSS: Part 15 Spread Spectrum Transmitter

2.3 Functional description

The A20-NEXUS is a portable 8-channel digital wireless receiver intended for professional programme making and special events (PMSE) applications. It is compatible with the A10-TX and A20-MINI wireless microphone transmitters from Sound Devices. It has a very wide tuning range 169-1525 MHz for accessing new wireless microphone spectrum allocations in Europe, Asia, Japan, United States and Canada.

The receiver can be mounted in a rack (rack shelf included) or mounted remotely; a planned future upgrade will allow it to be directly mounted to an 8-series Sound Devices recorder via an expansion port. It includes a Dante and Ethernet interface; USB-C; 16 analogue/AES outputs; front & rear diversity antenna inputs with antenna powering and support for Smart Active antennas; a long-range proprietary 2.4 GHz wireless backlink ("SynqLink") for remote control of transmitters; Bluetooth LE for remote operation via an iOS/Android App; 3.5 mm headphone jack; OLED touchscreens and/or a Web App for setup, control, and monitoring.

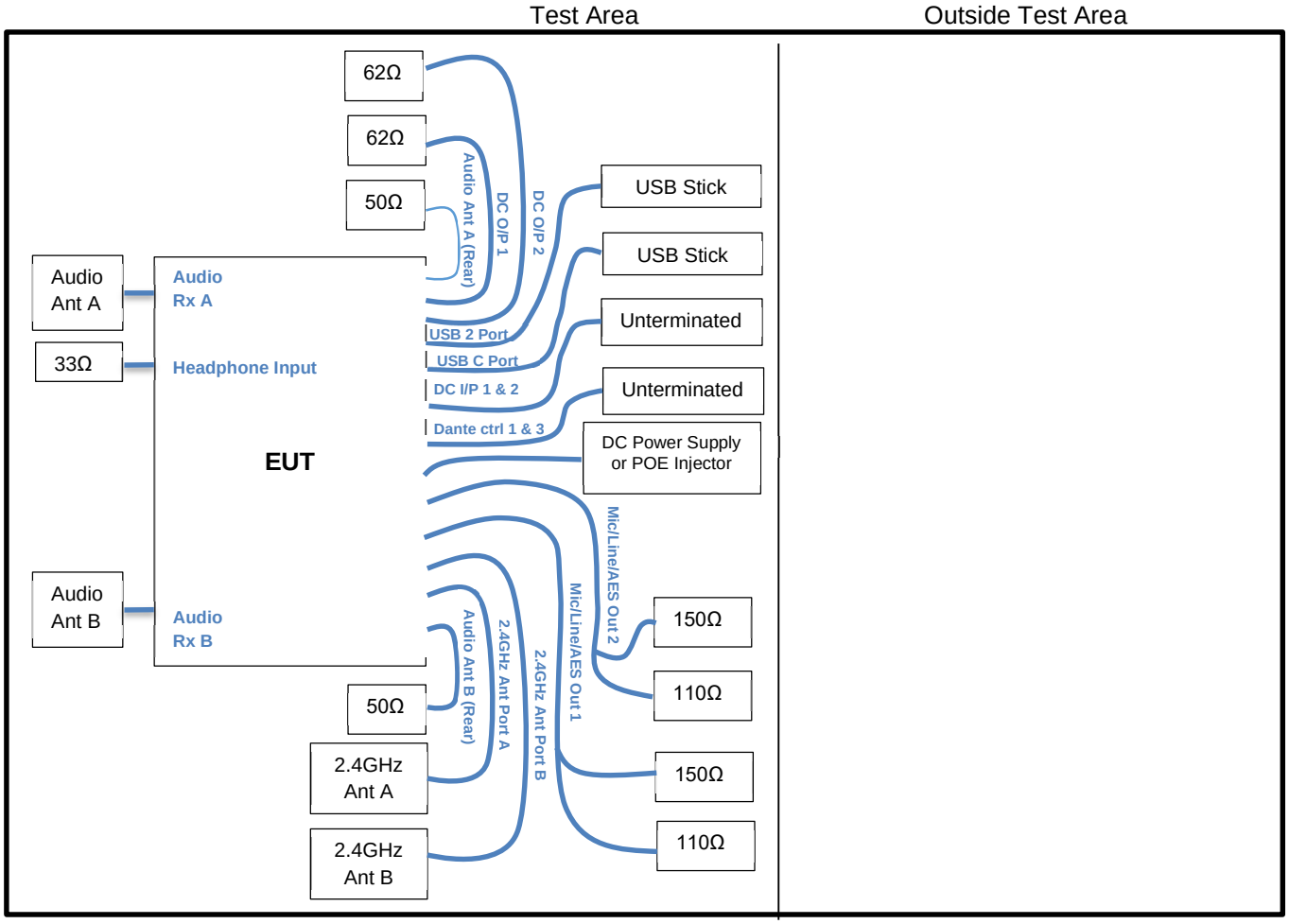
There are two options for powering: POE+ (48 V) and 10-18 V DC via 2x TA4 connectors.

2.4 Modes of operation

Mode Reference	Description	Used for testing
TX LOW	Transmitting continuously at 2400.8 MHz with modulation.	Yes
TX MID	Transmitting continuously at 2440.8 MHz with modulation.	Yes
TX HIGH	Transmitting continuously at 2481.6 MHz with modulation.	Yes
Hopping	The EUT is hopping in normal mode and transmitting on random channels across the band	Yes

Note: Test modes cover Proprietary FHSS 2.4G Proprietary operation of the device only

2.5 Emissions configuration



The unit was powered from either 12 Vdc via a 'DC input' port (the other DC input would normally be connected to a backup battery) or by PoE via 'Dante ctrl 2 PoE' port. The customer provided a companion 'HYN@NET Industrial Gigabit PoE Injector' to power the EUT via Ethernet and an RN DC Power supply was used to power the EUT via 'DC Input' port. The manufacturer specified that the EUT can only be power by either 12 Vdc or PoE, not both at the same time. When powering using 12 Vdc only 1 'DC Input' should be powered. The 2 'Mic/Line/AES' ports each had 4 inputs and 4 outputs, the inputs were each terminated with a 110Ω load and each of the outputs a 150Ω. The EUT had identical Audio ports A and B at the front and the rear of the unit, the front ports were active during testing and the rear ports were terminated with 50Ω loads.

For AC conducted emissions the EUT was tested powered from an AC/DC adaptor supplied by the customer. The DC power lead to the EUT is supplied with the EUT but the AC/DC adaptor is not.

For conducted tests the external antenna SMA ports were used. The unit was configured with engineering menus in software to allow permanent transmit modes of device on the top, middle and bottom channels as stated within section 2.4 of this report. The Transmit modes were set using the engineering mode provided within the unit. The power settings for each channel were as stated below:-
Low Channel (2402 MHz) = Power Setting:8 (Declared Maximum)
Mid Channel (2440 MHz) only = Power Setting:8 (Declared Maximum)
High Channel (2480 MHz) only = Power Setting:8 (Declared Maximum)

2.5.1 Signal leads

Port Name	Cable Type	Connected
Ant A (Rear)	BNC	Yes
Ant B (Rear)	BNC	Yes
x2 Mic/Line/AES	25-pin D-Type	Yes
Ant 2.4G(A)	SMA	Yes
Ant 2.4G(B)	SMA	Yes
x2 10-18V DC Inputs	2-core	Yes
x2 DC Outputs	2-core	Yes
USB A	1 metre cable	Yes
USB C	1 metre cable	Yes
Mini Display Port	1 metre cable	Yes
Dante/Ctrl 2/POE+	1 metre cable	Yes
Dante/Ctrl 1	1 metre cable	Yes
Dante/Ctrl 3 (Optical)	1 metre cable	Yes

3 Summary of test results

The Multi-Channel Wireless Microphone Receiver, A20-NEXUS was tested for compliance to the following standard:

47 CFR Part 15.247 Effective Date 1st October 2021
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	PASSED
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(a)(1) & 15.215	PASSED
9. Maximum Average conducted output power	47 CFR Part 15C Part 15.247(b3)	NOT APPLICABLE[1]
10. Maximum Peak conducted output power	47 CFR Part 15C Part 15.247(b)(1)	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[2]
13. Duty cycle	47 CFR Part 15C Part 15.35(c)	NOT APPLICABLE[3]
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)(iii)	PASSED
16. Number of Hop Channels	47 CFR Part 15C Part 15.247(a)(1)(iii)	PASSED

[1] Peak power measurement performed instead.

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

[3] No limits apply assessed for reference only.

[4] EUT uses FHSS technology and is therefore not applicable to this 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	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	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 applied

4.3 Tests at extremes of temperature & voltage

The following EUT nominal and extreme conditions were declared by the manufacturer.

Temperature Test Conditions		Voltage Test Conditions	
T nominal	20 °C	V nominal	12V DC
T minimum	-10 °C	V minimum	10V DC
T maximum	55 °C	V maximum	18V DC

The ambient test conditions of humidity and pressure in the laboratory were as specified in each specific test section within this report.

4.4 Test fixtures

No Ancillary test fixtures used for testing.

5 Tests, methods and results

5.1 AC power line conducted emissions

5.1.1 Test methods

Test Requirements:	47 CFR Part 15C Part 15.207 [Reference 4.1.1 of this report]
Test Method:	ANSI C63.10 Clause 6.2 [Reference 4.1.2 of this report]
Limits:	47 CFR Part 15C Part 15.207 [Reference 4.1.1 of this report]

5.1.2 Configuration of EUT

The EUT was placed on a wooden table 0.8m above the ground plane and connected to a LISN via a 1m mains cable.

Details of the Peripheral and Ancillary Equipment connected for this test are listed in section 10.

During the initial scan, the emissions profile was identical in all modes on both ports therefore TX MID mode was used for final measurements.

5.1.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment listed in the 'Test Equipment' Section. Measurements were made on the live and neutral conductors using both average and quasi-peak detection.

All signals within 20dB of the limit were investigated.

Tests were performed in Test Site F.

5.1.4 Test equipment

E150, E035, ZSW1, E624, E411

See Section 9 for more details

5.1.5 Test results

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

Band	2400-2483.5 MHz
Power Level	10 dBm (Ant A and Ant B)
Channel Spacing	400 kHz
Mod Scheme	FHSS 2.4G Proprietary
Single channel	2440.8 MHz (Middle channel)

Plot refs
13348-11 Cond 1 AC Live 150k-30M Average
13348-11 Cond 1 AC Live 150k-30M Quasi-Peak
13348-11 Cond 1 AC Neutral 150k-30M Average
13348-11 Cond 1 AC Neutral 150k-30M Quasi-Peak

Table of signals measured for Cond 1 AC Live 150k-30M

Signal No.	Freq (MHz)	Peak Amp (dBuV)	QP Amp (dBuV)	QP -Lim (dB)	AV Amp (dBuV)	AV -Lim (dB)
1	0.158	58.7	52.3	-13.3	31.9	-23.7
2	0.182	56.2	50.2	-14.2	37.1	-17.3
3	0.239	49.9	42.9	-19.2	17.2	-34.9
4	0.271	47.5	40.6	-20.5	16.0	-35.1
5	0.288	45.9	39.8	-20.8	21.4	-29.2
6	0.647	40.2	35.5	-20.5	25.6	-20.4
7	0.652	39.5	35.1	-20.9	26.7	-19.3

Table of signals measured for Cond 1 AC Neutral 150k-30M

Signal No.	Freq (MHz)	Peak Amp (dBuV)	QP Amp (dBuV)	QP -Lim (dB)	AV Amp (dBuV)	AV -Lim (dB)
1	0.150	60.0	54.9	-11.1	44.0	-12.0
2	0.184	55.5	49.6	-14.7	36.5	-17.8
3	0.204	52.6	46.3	-17.1	18.2	-35.2
4	0.215	52.5	45.8	-17.2	26.7	-26.3
5	0.231	50.4	44.1	-18.3	19.7	-32.7
6	0.256	47.7	42.1	-19.5	23.6	-28.0
7	0.647	41.0	36.0	-20.0	26.8	-19.2

No discernible difference was noted in emissions between channels (exploratory measurements); therefore the final measurements are presented for TX mid channel mode only.

Peak detector “Max held” Analyser plots against the Quasi-Peak / Average limit line can be found in Section 6 of this report./ Only results within 20dB of limits have been reported.

LIMITS:
15.207: as given in the above tables / 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: 150kHz to 30MHz ±3.4dB (UE71)

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 whilst powered by 12 Vdc using an RN power supply and by PoE using the manufacturers provided 'Industrial Gigabit PoE Injector'.

The EUT was operated in TX LOW and TX MID and TX HIGH modes.

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.

All signals within 20dB 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	20°C
Humidity of test environment	50%
Pressure of test environment	102kPa

Note:
No noticeable differences between Low, Mid and High channels or antenna ports A and B were observed, therefore Middle channel plots for antenna A are reported only.

Band	2400-2483.5 MHz (Port A)
Power Level	10 dBm (Ant A and Ant B)
Channel Spacing	400 kHz
Mod Scheme	FHSS 2.4G Proprietary
Single channel	2440.8 MHz

No signals were observed within 20dB of their respective limit line.

Plot refs
13348-11 Rad 1 9k-150kHz Para
13348-11 Rad 1 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 whilst powered by 12 Vdc using an RN power supply and by PoE using the manufacturers provided 'Industrial Gigabit PoE Injector'.

The EUT was operated in TX LOW and TX MID and TX HIGH modes.

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.

All signals within 20dB 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	20°C
Humidity of test environment	50%
Pressure of test environment	102kPa

Note:
No noticeable differences between Low, Mid and High channels or antenna ports A and B were observed, therefore Middle channel plots for antenna A are reported only.

Band	2400-2483.5 MHz
Power Level	10 dBm (Ant A and Ant B)
Channel Spacing	400 kHz
Mod Scheme	FHSS 2.4G Proprietary
Low channel	2400.8 MHz

Table of signals measured for Parallel 150kHz-30MHz:

Signal No.	Freq (MHz)	Peak Amp (dBuV/m)	QP Amp (dBuV/m)	QP -Lim (dB)
1	1.195	50.3	49.3	-16.8
2	1.593	47.7	46.9	-16.7

Table of signals measured for Perpendicular 150kHz-30MHz:

No signals were observed within 20dB of their respective limit line.

Plot refs
13348-11 Rad 1 150k-30MHz Para
13348-11 Rad 1 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 whilst powered by 12 Vdc using an RN power supply and by PoE using the manufacturers provided 'Industrial Gigabit PoE Injector'.

The EUT was operated in TX LOW and TX MID and TX HIGH modes.

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.

All signals within 20dB 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	20°C
Humidity of test environment	50%
Pressure of test environment	102kPa

DC Supply Radiated measurements:

Band	2400-2483.5 MHz
Power Level	10 dBm
Channel Spacing	400 kHz
Mod Scheme	FHSS 2.4G Proprietary
Mid channel	2440.8 MHz

Plot refs
13348-11 Rad 1 VHF Horiz
13348-11 Rad 1 VHF Vert
13348-11 Rad 1 UHF Horiz
13348-11 Rad 1 UHF Vert

Table of signals measured for 2440 MHz (Mid) Horizontal Sig List

Signal No.	Freq (MHz)	Peak Amp (dBuV/m)	QP Amp (dBuV/m)	QP -Lim (dB)
1	33.727	27.1	21.6	-18.4
2	100.882	25.9	19.1	-24.4
3	103.529	26.2	18.9	-24.6
4	124.566	26.0	20.1	-23.4
5	154.787	26.0	19.1	-24.4
6	263.450	27.6	20.9	-25.1
7	375.002	38.6	37.0	-9.0
8	500.002	34.2	28.4	-17.6
9	500.002	35.7	31.0	-15.0
10	625.003	42.1	40.1	-5.9
11	681.667	35.0	28.3	-17.7
12	701.087	34.6	27.9	-18.1
13	789.427	35.1	28.4	-17.6
14	884.739	40.2	37.3	-8.7
15	963.493	35.5	29.1	-24.9

Table of signals measured for 2440 MHz (Mid) Vertical Sig List

Signal No.	Freq (MHz)	Peak Amp (dBuV/m)	QP Amp (dBuV/m)	QP -Lim (dB)
1	31.317	30.0	23.0	-17.0
2	31.331	29.2	22.9	-17.1
3	46.485	25.0	18.4	-21.6
4	55.980	23.3	17.4	-22.6
5	73.729	24.5	21.7	-18.3
6	101.833	25.8	19.1	-24.4
7	115.223	26.0	20.3	-23.2
8	375.005	35.9	33.4	-12.6
9	446.250	31.0	23.9	-22.1
10	449.306	31.3	24.2	-21.8
11	450.241	30.9	24.3	-21.7
12	450.241	31.2	24.2	-21.8
13	500.019	36.0	33.3	-12.7
14	523.785	31.8	24.8	-21.2
15	525.765	31.9	24.7	-21.3
16	528.454	31.4	24.6	-21.4
17	624.955	38.7	36.2	-9.8
18	884.740	38.3	33.9	-12.1

Note: Results for DC bench powering method were generic and not related to channel setting and thus shown for missile channel only.

POE Supply Radiated measurements:

Note: All 3 channels were measured and plotted due to differences observed in settings.

Band	2400-2483.5 MHz
Power Level	10 dBm
Channel Spacing	400 kHz
Mod Scheme	FHSS 2.4G Proprietary
Low channel	2402 MHz (Low)

Plot refs
13348-11Rad 1 VHF Horiz
13348-11Rad 1 VHF Vert
13348-11Rad 1 UHF Horiz
13348-11Rad 1 UHF Vert

Band	2400-2483.5 MHz
Power Level	10 dBm
Channel Spacing	400 kHz
Mod Scheme	FHSS 2.4G Proprietary
Mid channel	2440 MHz (Mid)

Plot refs
13348-11Rad 2 VHF Horiz
13348-11Rad 2 VHF Vert
13348-11Rad 2 UHF Horiz
13348-11Rad 2 UHF Vert

Band	2400-2483.5 MHz
Power Level	10 dBm
Channel Spacing	400 kHz
Mod Scheme	FHSS 2.4G Proprietary
High channel	2480 MHz (High)

Plot refs
13348-11Rad 3 VHF Horiz
13348-11Rad 3 VHF Vert
13348-11Rad 3 UHF Horiz
13348-11Rad 3 UHF Vert

Table of signals measured for 2402 MHz (Low) Horizontal Signal List

Signal No.	Freq (MHz)	Peak Amp (dBuV/m)	QP Amp (dBuV/m)	QP -Lim (dB)
1	366.656	36.9	31.8	-14.2
2	375.004	41.2	39.1	-6.9
3	390.450	38.3	32.3	-13.7
4	393.204	40.2	35.3	-10.7
5	417.808	35.1	29.7	-16.3
6	460.057	36.5	30.4	-15.6
7	491.522	41.4	36.8	-9.2
8	495.649	41.5	36.0	-10.0
9	500.004	41.1	36.7	-9.3
10	548.959	43.7	38.1	-7.9
11	651.511	38.0	31.6	-14.4
12	786.416	41.0	36.3	-9.7

13	884.739	44.4	40.8	-5.2

Table of signals measured for 2402 MHz (Low) Vertical Signal List

Signal No.	Freq (MHz)	Peak Amp (dBuV/m)	QP Amp (dBuV/m)	QP -Lim (dB)
1	98.304	26.0	22.7	-20.8
2	125.001	35.0	32.4	-11.1
3	196.608	29.1	26.7	-16.8
4	262.234	29.0	22.8	-23.2
5	365.134	33.1	27.7	-18.3
6	392.734	29.6	23.3	-22.7
7	457.533	29.9	24.2	-21.8
8	491.520	36.4	32.1	-13.9
9	518.452	32.4	26.5	-19.5
10	550.504	37.8	32.6	-13.4
11	572.027	35.3	29.3	-16.7
12	786.417	39.7	34.6	-11.4
13	852.427	33.9	28.1	-17.9
14	885.927	33.9	28.2	-17.8

Table of signals measured for 2440 MHz (Mid) Horizontal Signal List

Signal No.	Freq (MHz)	Peak Amp (dBuV/m)	QP Amp (dBuV/m)	QP -Lim (dB)
1	124.991	28.3	22.8	-20.7
2	259.994	34.9	31.0	-15.0
3	260.169	32.8	26.4	-19.6
4	375.003	35.9	33.1	-12.9
5	393.219	35.5	30.7	-15.3
6	448.093	33.0	27.5	-18.5
7	483.092	37.7	32.1	-13.9
8	493.331	41.3	36.4	-9.6
9	509.913	38.1	32.1	-13.9
10	553.412	40.4	35.2	-10.8
11	565.706	36.3	31.1	-14.9
12	668.413	35.9	30.1	-15.9

Table of signals measured for 2440 MHz (Mid) Vertical Signal List

Signal No.	Freq (MHz)	Peak Amp (dBuV/m)	QP Amp (dBuV/m)	QP -Lim (dB)
1	62.844	18.6	11.7	-28.3
2	73.725	21.1	16.3	-23.7
3	98.304	30.3	27.5	-16.0
4	115.260	26.4	20.4	-23.1
5	124.992	30.1	25.2	-18.3
6	550.152	37.4	31.9	-14.1

Table of signals measured for 2480 MHz (High) Horizontal Signal List

Signal No.	Freq (MHz)	Peak Amp (dBuV/m)	QP Amp (dBuV/m)	QP -Lim (dB)
1	105.561	26.7	19.8	-23.7
2	270.336	32.3	28.6	-17.4
3	495.389	43.1	38.2	-7.8
4	569.575	35.6	30.8	-15.2
5	599.039	31.8	26.0	-20.0
6	651.519	37.0	31.8	-14.2
7	884.736	40.9	36.5	-9.5

Table of signals measured for 2480 MHz (High) Vertical Signal List

Signal No.	Freq (MHz)	Peak Amp (dBuV/m)	QP Amp (dBuV/m)	QP -Lim (dB)
1	35.366	38.2	36.7	-3.3
2	48.991	28.3	24.8	-15.2
3	98.304	31.3	29.3	-14.2
4	125.002	30.4	26.4	-17.1
5	153.770	24.8	18.8	-24.7
6	197.641	30.3	22.7	-20.8
7	257.731	26.9	21.2	-24.8
8	493.599	40.4	35.6	-10.4
9	567.178	36.0	29.7	-16.3
10	699.995	37.7	34.4	-11.6
11	884.739	39.5	35.3	-10.7

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:
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 whilst powered by 12 Vdc using an RN power supply and by PoE using the manufacturers provided 'Industrial Gigabit PoE Injector'.

The EUT was operated in TX LOW and TX MID and TX HIGH 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.

All signals within 10dB of the limit were investigated.

Tests were performed using Test Site B.

5.5.4 Test equipment

E289, E428, E429, E642, E654, E856, E856, E904, TMS78, TMS79, VSWR-B, ZSW1

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

No signals were observed within 20dB of their respective limit line for Low, Mid or High channels on antenna A or B.

Setup Table

Band	2400-2483.5 MHz
Power Level	10 dBm
Channel Spacing	400 kHz
Mod Scheme	FHSS 2.4G Proprietary
Mid channel	2440.8 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
No emissions observed						

Plots
13348-11 Horiz 1-2GHz mid flat
13348-11 Horiz 2-2.7G mid flat
13348-11 Horiz 2.7-3.9G mid flat
13348-11 Horiz 3.9-6 mid flat
13348-11 Horiz 6-7.7 mid flat
13348-11 Horiz 7.7-10 mid flat
13348-11 Horiz 10-12.5 mid flat
13348-11 Rad 1 12-15GHz Horiz
13348-11 Rad 1 15-18GHz Horiz
13348-11 Rad 1 18-22GHz Horiz
13348-11 Rad 1 22-25GHz Horiz
13348-11 Vert 1-2GHz mid flat
13348-11 Vert 2-2.7G mid flat
13348-11 Vert 2.7-3.9G mid flat
13348-11 Vert 3.9-6 mid flat
13348-11 Vert 6-7.7 mid flat
13348-11 Vert 7.7-10 mid flat
13348-11 Vert 10-12.5 mid flat
13348-11 Rad 1 12-15GHz Vert
13348-11 Rad 1 15-18GHz Vert
13348-11 Rad 1 18-22GHz Vert
13348-11 Rad 1 22-25GHz Vert

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, both antenna ports (A & B) and powered via POE & DC, plots are for illustrative purposes only and only Middle channel, Antenna port A, DC Powered 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 6.6 [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 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 TX LOW and TX MID and TX HIGH modes on port A & B.

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.
Tests were performed in test site B.

5.6.4 Test equipment

E904, E428, E642, E856, F307

See Section 9 for more details

5.6.5 Test results

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

Note: no difference was observed in power between PoE or DC bench powering method, therefore DC bench PSU was used.

Band	2400-2483.5 MHz (Port A)
Power Level	10 mW
Channel Spacing	400 kHz
Mod Scheme	FHSS 2.4G Proprietary
Low channel	2400.8 MHz
Mid channel	2440.8 MHz
High channel	2481.6 MHz

	Low channel	Mid channel	High channel
Peak Level (dBµV/m)	**105.90**	**105.70**	**106.70**
Plot reference	13348-11 ERP Port A FHSS 2.4G Proprietary Low Channel	13348-11 ERP Port A FHSS 2.4G Proprietary Mid Channel	13348-11 ERP Port a FHSS 2.4G Proprietary High Channel
Antenna Polarisation	Horiz	Horiz	Horiz
EUT Polarisation	Side	Side	Side

Band	2400-2483.5 MHz (Port B)
Power Level	10 mW
Channel Spacing	400 kHz
Mod Scheme	FHSS 2.4G Proprietary
Low channel	2400.8 MHz
Mid channel	2440.8 MHz
High channel	2481.6 MHz

	Low channel	Mid channel	High channel
Peak Level (dBµV/m)	**105.60**	**105.30**	**106.20**
Plot reference	13348-11 ERP Port B FHSS 2.4G Proprietary Low Channel	13348-11 ERP Port B FHSS 2.4G Proprietary Mid Channel	13348-11 ERP Port B FHSS 2.4G Proprietary High Channel
Antenna Polarisation	Horiz	Horiz	Horiz
EUT Polarisation	Side	Side	Side

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

LIMITS:
The maximum output power in all cases is 30dBm/ 1watt.

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 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 TX LOW and TX HIGH modes on port A & B.

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. 1MHz RBW setting was employed for the restricted band edge tests. 100kHz RBW was employed for the Authorised band edge tests. Due to the influence of high in-band signals when using the specified resolution bandwidth the Marker Delta method was employed for the restricted band edge tests.

Tests were performed using Test Site B.

5.7.4 Test equipment

E307, E412, E428, E904

See Section 9 for more details

5.7.5 Test results

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

Note: no difference was observed in power between PoE or DC bench powering method, therefore DC bench PSU was used.

Band	2400-2483.5 MHz (Port A)
Power Level	10 dBm
Channel Spacing	400 kHz
Mod Scheme	FHSS 2.4G Proprietary Port A
Low channel	2400.8 MHz
High channel	2481.6 MHz

Restricted Band Edges	Low channel	High channel
Restricted Peak Level measured (dBuV/m)	48.2	65.8
Restricted band edge Peak Plot	13348-11 Rest Band Edge - Port A - Low chan - Peak	13348-11 Rest Band Edge - Port A - High chan - Peak
Restricted Average Level measured (dBuV/m)	37.1	50.53
Restricted band edge Average Plot	13348-11 Rest Band Edge - Port A - Low chan - Video averaging	13348-11 Rest Band Edge - Port A - High chan - Delta Marker

Authorised Band Edges	Low channel	High channel
Authorised Band Edge (dBc) value measured	43.2	57.6
Authorised Band Edge Plot	13348-11 Auth Band Edge Low chan Port A - Peak	13348-11 Auth Band Edge High chan Port A - Peak
Authorised Band Edge (dBc) Hopping value measured	47.6	66.8
Authorised Band Edge Hopping Plot	13348-11 Auth Band Edge Low chan Port A - Peak - Hopping	13348-11 Auth Band Edge High chan Port A - Peak - Hopping

Band	2400-2483.5 MHz (Port B)
Power Level	10 dBm
Channel Spacing	400 kHz
Mod Scheme	FHSS 2.4G Proprietary Port B
Low channel	2400.8 MHz
High channel	2481.6 MHz

Restricted Band Edges	Low channel	High channel
Restricted Peak Level measured (dBuV/m)	48.3	65.2
Restricted band edge Peak Plot	13348-11 Rest Band Edge - Port B - Low chan - Peak	13348-11 Rest Band Edge - Port B - High chan - Peak
Restricted Average Level measured (dBuV/m)	39	48
Restricted band edge Average Plot	13348-11 Rest Band Edge - Port B - Low chan - Video averaging	13348-11 Rest Band Edge - Port B - High chan - Delta Marker

Authorised Band Edges	Low channel	High channel
Authorised Band Edge (dBc) value measured	43.6	55.8
Authorised Band Edge Plot	13348-11 Auth Band Edge Low chan Port B - Peak	13348-11 Auth Band Edge High chan Port B - Peak
Authorised Band Edge (dBc) Hopping value measured	57.1	65.4
Authorised Band Edge Hopping Plot	13348-11 Auth Band Edge Low chan Port B - Peak - Hopping	13348-11 Auth Band Edge High chan Port B - Peak - Hopping

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.

∆ Delta Marker method used due to the influence of high in band signal at band edge.

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)(1), 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 15.215(c)/ 15.247(a)(1) [Reference 4.1.1 of this report]

5.8.2 Configuration of EUT

The EUT was measured on a bench using a spectrum analyser connected to the external RF port. The EUT was operated in TX LOW and TX MID and TX HIGH 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 20dB bandwidth.

Tests were performed using Test Site A.

5.8.4 Test equipment

E412, E420

See Section 9 for more details

5.8.5 Test results

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

Note:
No noticeable differences between antenna ports A and B were observed, therefore port A plots are reported only.

Band	2400-2483.5 MHz
Power Level	10 dBm
Channel Spacing	400 kHz
Mod Scheme	FHSS 2.4G Proprietary (port A)
Low channel	2400.8 MHz
Mid channel	2440.8 MHz
High channel	2481.6 MHz

	Low channel	Mid channel	High channel
20 dB Bandwidth Result (kHz)	235.261	232.075	232.405
Plot for 20 dB Bandwidth Result	13348-11 OBW low chan port A	13348-11 OBW mid chan port A	13348-11 OBW high chan port A
99 % Bandwidth Result (kHz)	209.8179	209.3179	209.5854
Frequency Error (kHz) (include sign)	-0.464	-0.402	-0.532
Operating frequency (MHz)	2400.8	2440.8	2481.6
20 dB FLOW Worst case (MHz)	2400.6904	2440.683561	2481.483266
20 dB FHIGH Worst case (MHz)	2400.908673	2440.915636	2481.715671

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) Frequency hopping systems 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. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

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 TESTED: Peak power measurement performed instead.

5.10 Maximum Peak conducted output power

5.10.1 Test methods

Test Requirements: 47 CFR Part 15C Part 15.247(b)(1) [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)(1) [Reference 4.1.1 of this report]

5.10.2 Configuration of EUT

The EUT was measured on a spectrum analyser connected to the external RF port.

The EUT was set to each mode and test signal in turn (see section 2.4) and highest power levels recorded.

The EUT was operated in TX LOW and TX MID and TX HIGH mode 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 with RBW greater than 6dB bandwidth. Measurements were made on a test bench in site A.

5.10.4 Test equipment

E412, E420

See Section 9 for more details

5.10.5 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	10 dBm
Channel Spacing	400 kHz
Mod Scheme	FHSS 2.4G Proprietary
Low channel	2400.8 MHz
Mid channel	2440.8 MHz
High channel	2481.6 MHz

Nominal voltage result (dBm)	7.04	6.67	7.29
Plot reference	13348-11 PK cond PWR port A low chan	13348-11 PK cond PWR port A mid chan	13348-11 PK cond PWR port A High chan
Limit in dBm	30.00	30.00	30.00
Maximum result (dBm)	7.04	6.67	7.29
Margin to Limit (dB)	-22.96	-23.33	-22.71
Result in (W)	0.005	0.005	0.005

LIMITS:
15.247(b)(1)
For FHSS operating 2400-2483.5 MHz employing at least 75 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 uses FHSS technology and is therefore not applicable to this test.

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 assessed for reference only.

5.14 FHSS carrier frequency separation

5.14.1 Test methods

Test Requirements: 47 CFR Part 15C Part 15.247(a1) [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(a1) [Reference 4.1.1 of this report]

5.14.2 Configuration of EUT

The EUT was tested on the bench with the door open and ambient conditions were monitored. The EUT was operated in Hopping mode.

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, the trace was allowed enough sweeps to stabilise.

Tests were performed in test site A.

5.14.4 Test equipment

E307, E412, E777

See Section 9 for more details

5.14.5 Test results

Temperature of test environment	20°C
Humidity of test environment	50%
Pressure of test environment	101kPa

Band	2400-2483.5 MHz
Power Level	10 dBm
Channel Spacing	400 kHz
Mod Scheme	Port A FHSS 2.4G Proprietary
Single channel	2444.4 and 2444.8 MHz

	Single channel
Separation (kHz)	400
Plot of Separation (kHz)	13348-11 Channel separation

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. Alternatively, FHSs operating in the band 2400-2483.5 MHz may have hopping channel carrier frequencies that are separated by 25 kHz or two thirds of the -20 dB bandwidth of the hopping channel, whichever is greater, provided that the systems operate with an output power no greater than 0.125 W.

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) iii) [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)(iii) [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 external RF port. Ambient conditions were monitored. The EUT was operated in Hopping mode for this test. No difference was observed between ports A and B, therefore port A was used for tests.

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. A spectrum analyser was set to zero span and its Y amplitude/Video output connected to a high resolution oscilloscope input. 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 desired scheme.

Tests were performed in test site A.

5.15.4 Test equipment

E640, H071

See Section 9 for more details

5.15.5 Test results

Temperature of test environment	24°C
Humidity of test environment	22%
Pressure of test environment	104kPa

Band	2400-2483.5 MHz
Power Level	10 dBm
Channel Spacing	400 kHz
Mod Scheme	Port A FHSS 2.4G Proprietary
Single channel	2400.8 GHz

Measured Dwell time/pulse width (ms)	362.48
Period time (s)	78.8
Instances of pulse within period time	1
Average time of occupancy (ms)	362.48
Measured Dwell time/pulse width (ms)	J13348-11 TX on time low channel
Period time (s)	J13348-11 Average time of Occupancy Low channel

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

LIMITS:

FHSS operating in the band 2400-2483.5 MHz shall use at least 15 hopping channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds, multiplied by the number of hopping channels employed. Transmissions on particular hopping frequencies may be avoided or suppressed provided that at least 15 hopping channels are used.

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)(iii) [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)(iii) [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 external RF port. Ambient conditions were monitored. The EUT was operated in Hopping mode 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 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

E558, H072

See Section 9 for more details

5.16.5 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	10 dBm
Channel Spacing	400 kHz
Mod Scheme	Port A FHSS 2.4G Proprietary
Low channel	2400.8 MHz

No of hopping Channels	197
Minimum No. Required by specification	15
Plot of Hopping Channels -plot 1	13348-11 Number of hopping channels - Plot 1
Plot of Hopping Channels -plot 2	13348-11 Number of hopping channels - Plot 2
Plot of Hopping Channels -plot 3	13348-11 Number of hopping channels - Plot 3
Plot of Hopping Channels -plot 4	13348-11 Number of hopping channels - Plot 4

Note: Manufacturer declares that 6 channels over the range are not used in the hopping sequence.

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

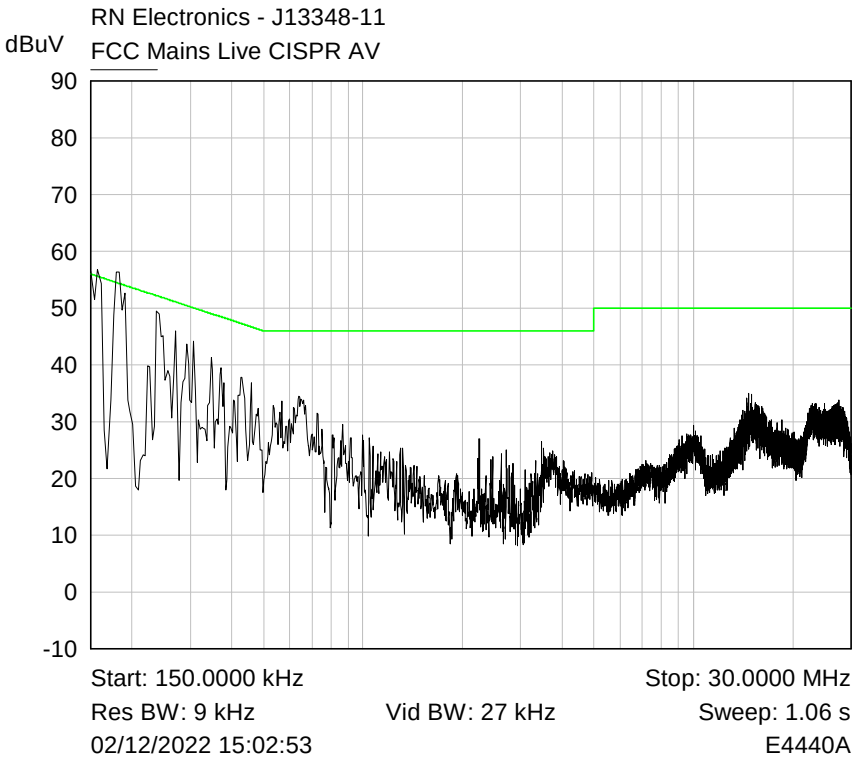
LIMITS:
FHSS operating in the band 2400-2483.5 MHz shall use at least 15 hopping channels. Transmissions on particular hopping frequencies may be avoided or suppressed provided that at least 15 hopping channels are used.
These results show that the EUT has PASSED this test.

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

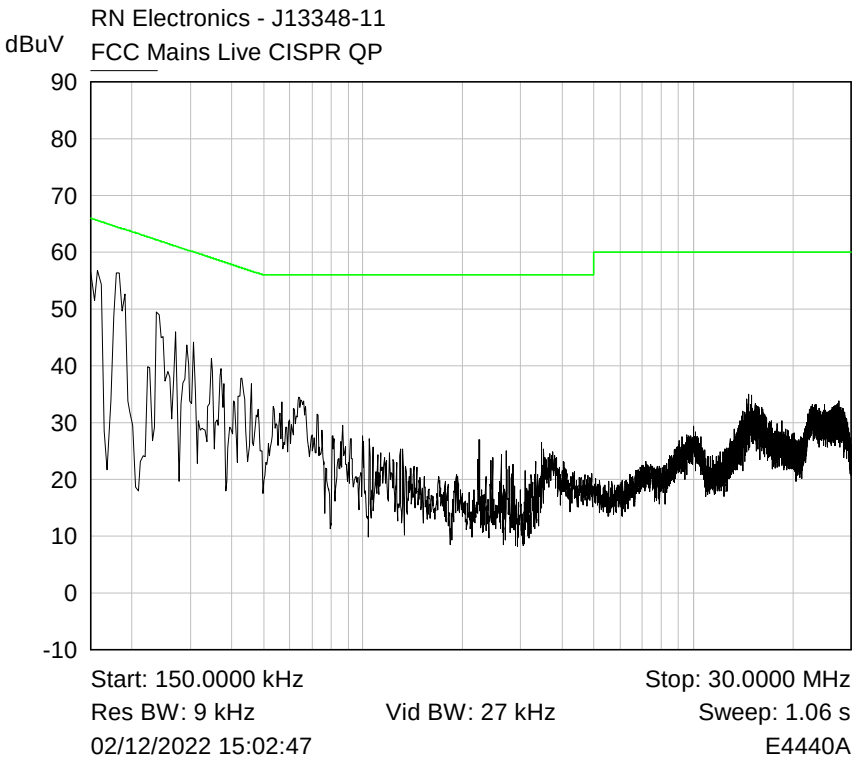
6 Plots/Graphical results

6.1 AC power line conducted emissions

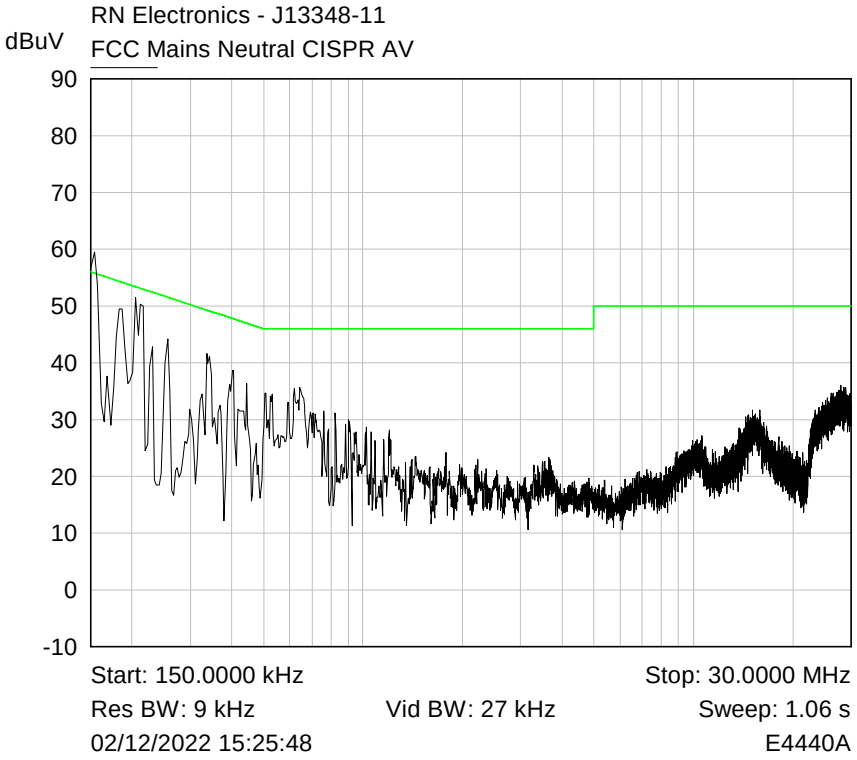
RF Parameters: Band 2400-2483.5 MHz (Port A), Power 10 MHz, Channel Spacing 400 MHz, Modulation FHSS 2.4G Proprietary, and Channel 2440.8 MHz



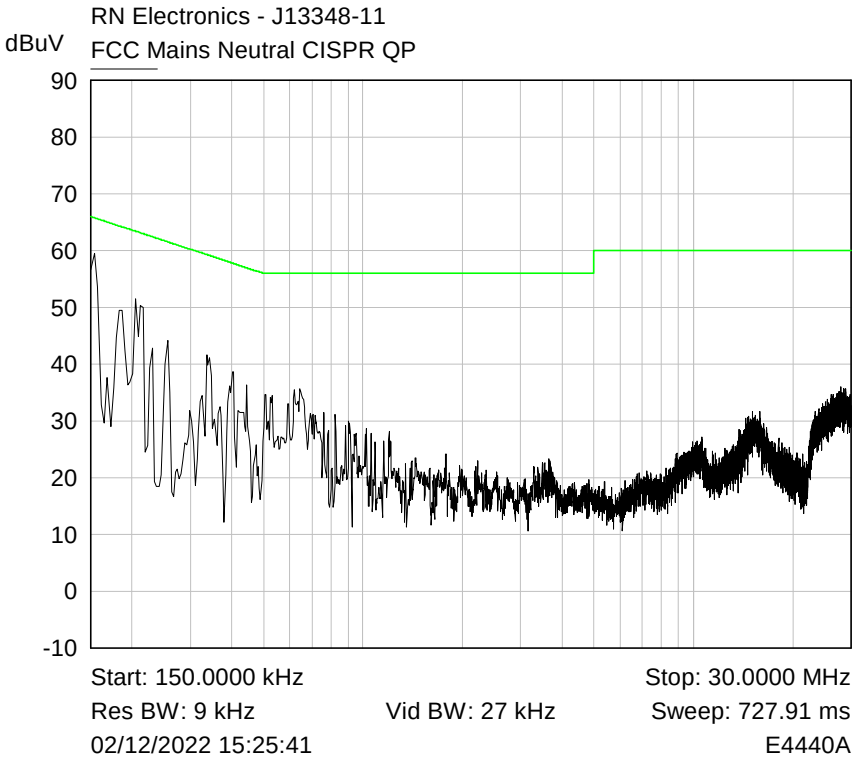
Plot of Live150k-30M Average



Plot of Live150k-30M Quasi-Peak



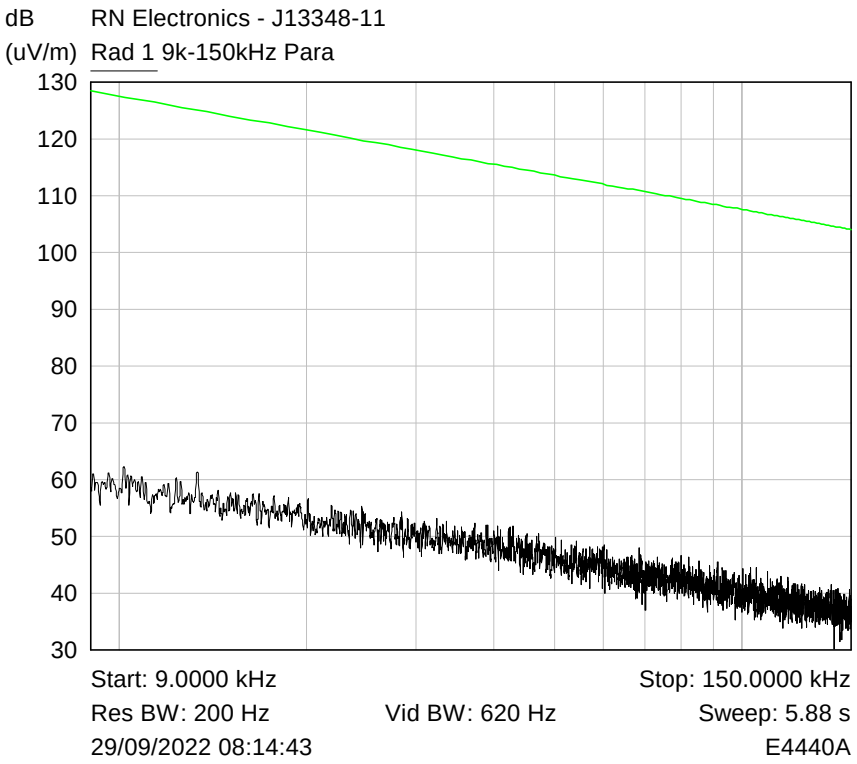
Plot of Neutral150k-30M Average



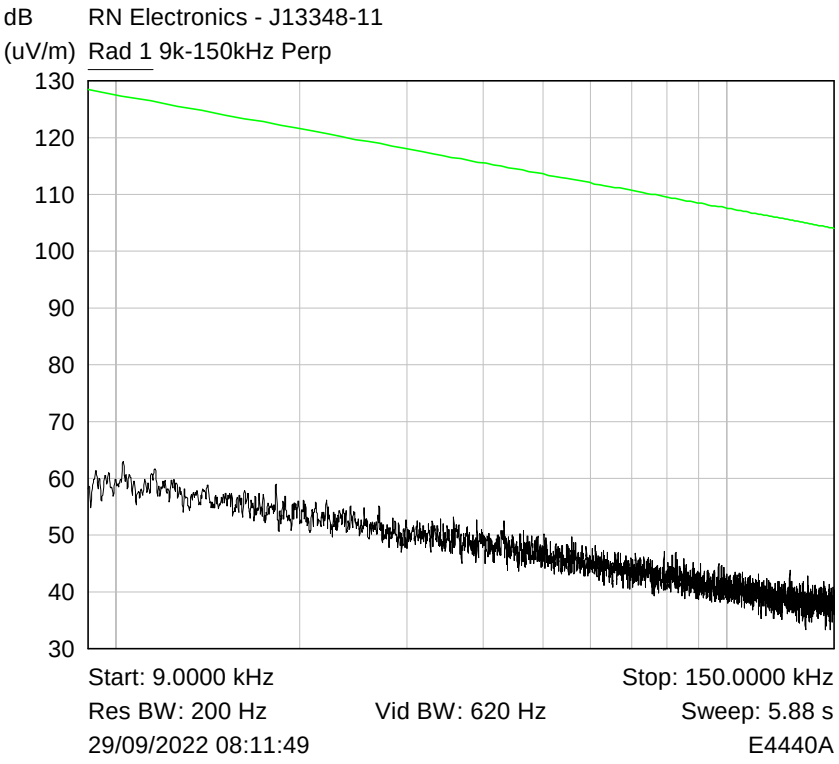
Plot of Neutral150k-30M Quasi-Peak

6.2 Radiated emissions 9 - 150 kHz

RF Parameters: Band 2400-2483.5 MHz (Port A), Power 10 MHz, Channel Spacing 400 MHz, Modulation FHSS 2.4G Proprietary, and Channel 2440.8 MHz



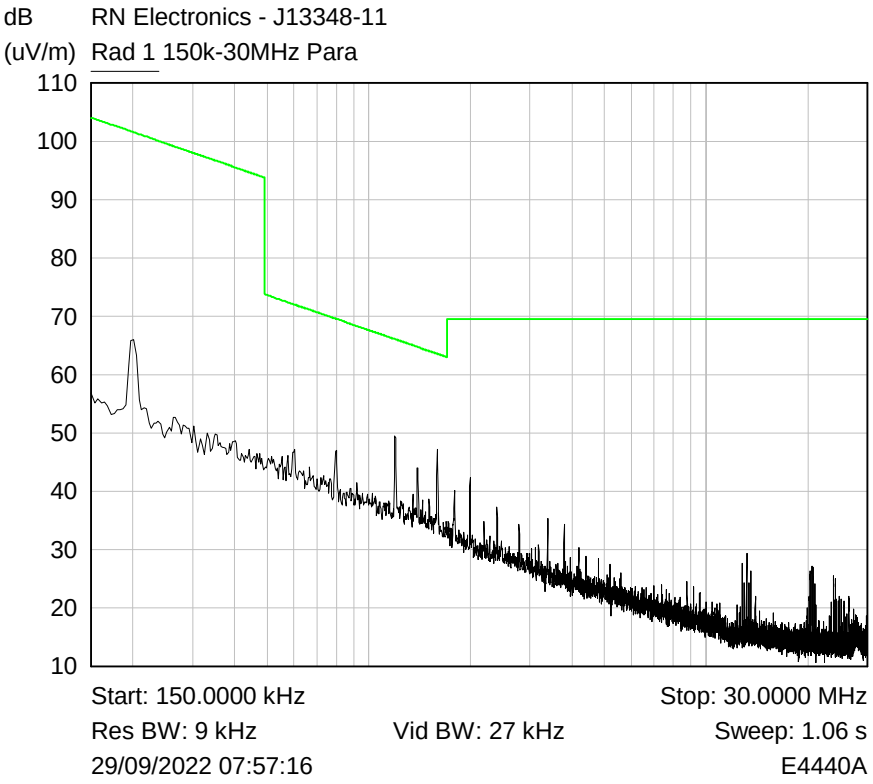
Plot of 9k-150kHz Parallel



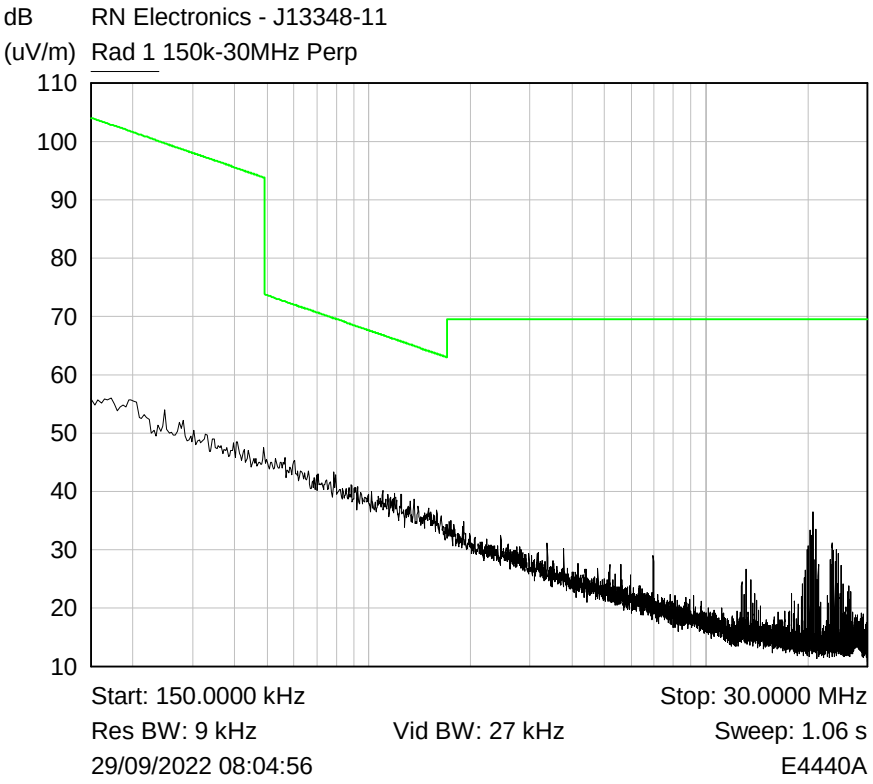
Plot of 9k-150kHz Perpendicular

6.3 Radiated emissions 150 kHz - 30 MHz

RF Parameters: Band 2400-2483.5 MHz (Port A), Power 10 mW, Channel Spacing 400 kHz, Modulation FHSS 2.4G Proprietary, and Channel 2400.8 MHz



Plot of 150kHz-30MHz Parallel

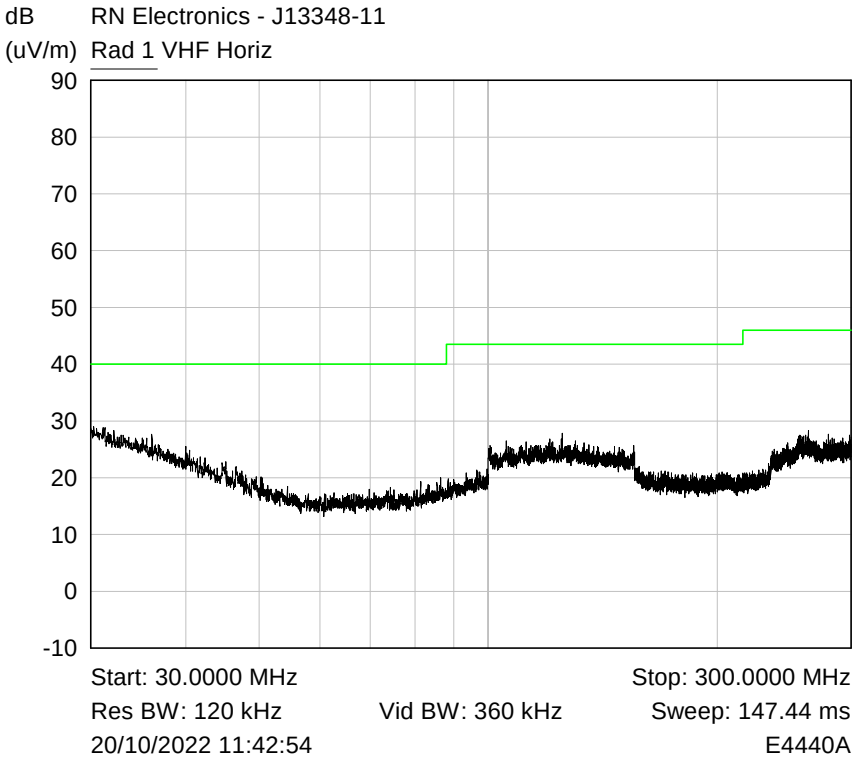


Plot of 150kHz-30MHz Perpendicular

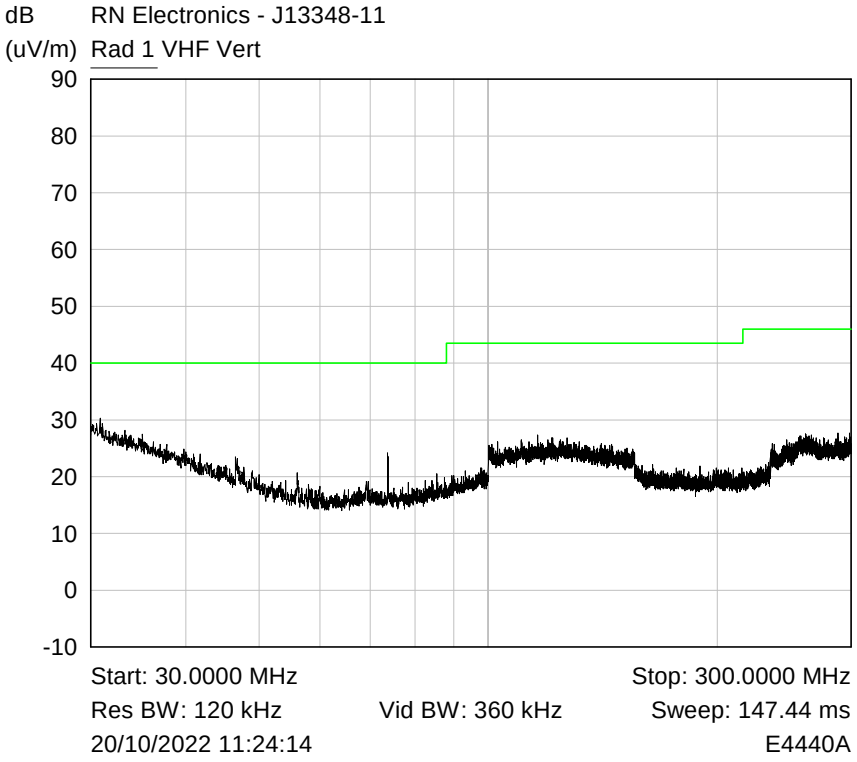
6.4 Radiated emissions 30 MHz -1 GHz

DC Supply:

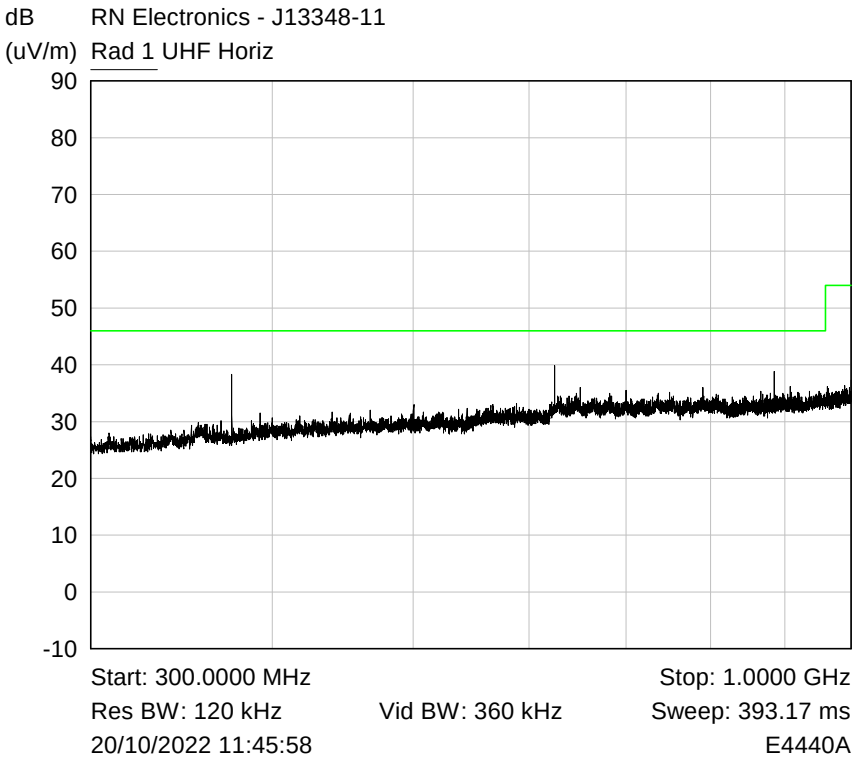
RF Parameters: Band 2400-2483.5 MHz, Power 10 dBm, Channel Spacing 400 kHz, Modulation FHSS 2.4G Proprietary, Channel 2400.8 MHz



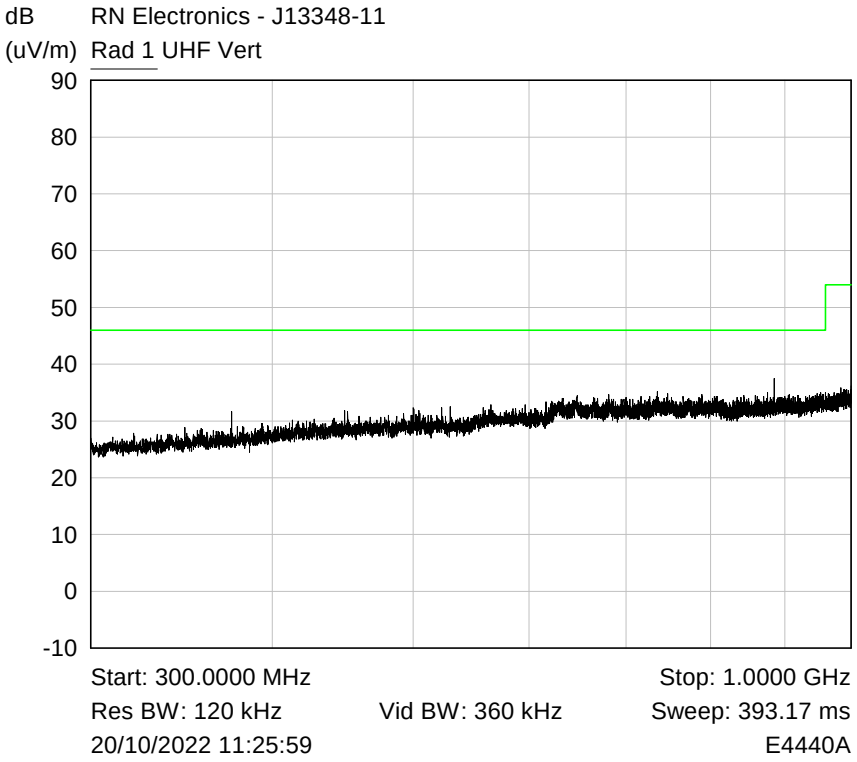
Plot of Peak emissions for VHF Horizontal against the QP limit line.



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



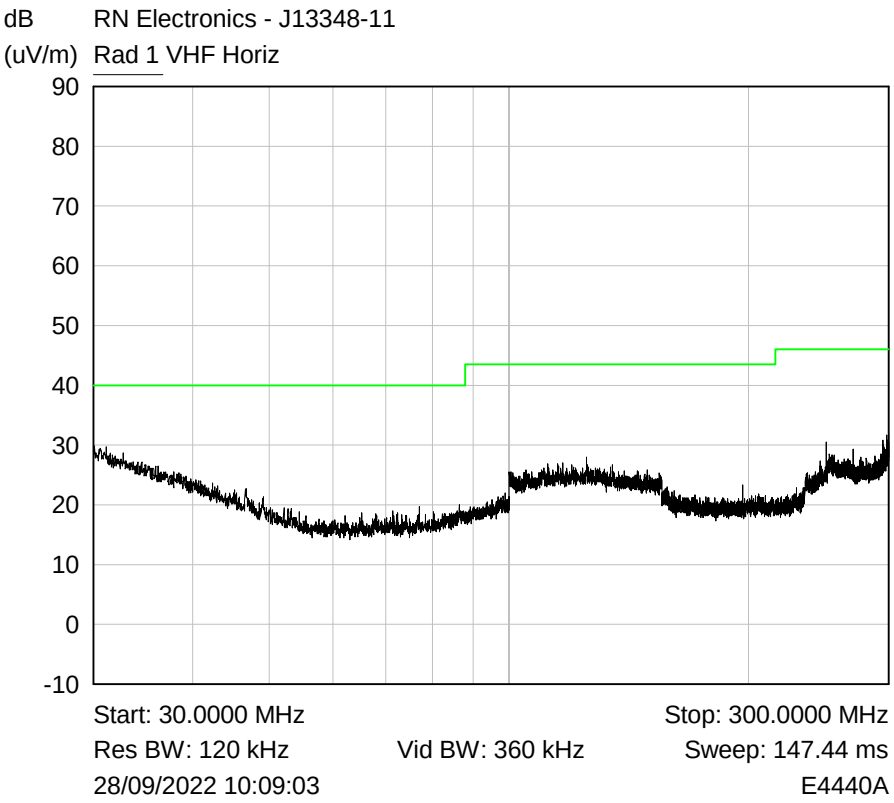
Plot of Peak emissions for UHF Horizontal against the QP limit line.



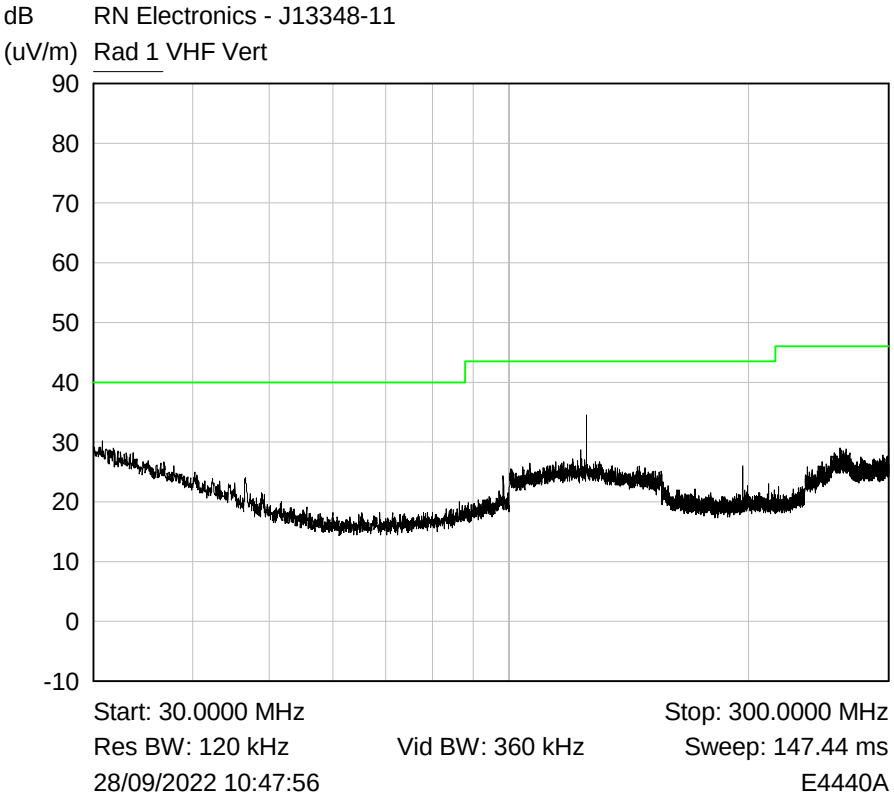
Plot of Peak emissions for UHF Vertical against the QP limit line.

POE Supply:

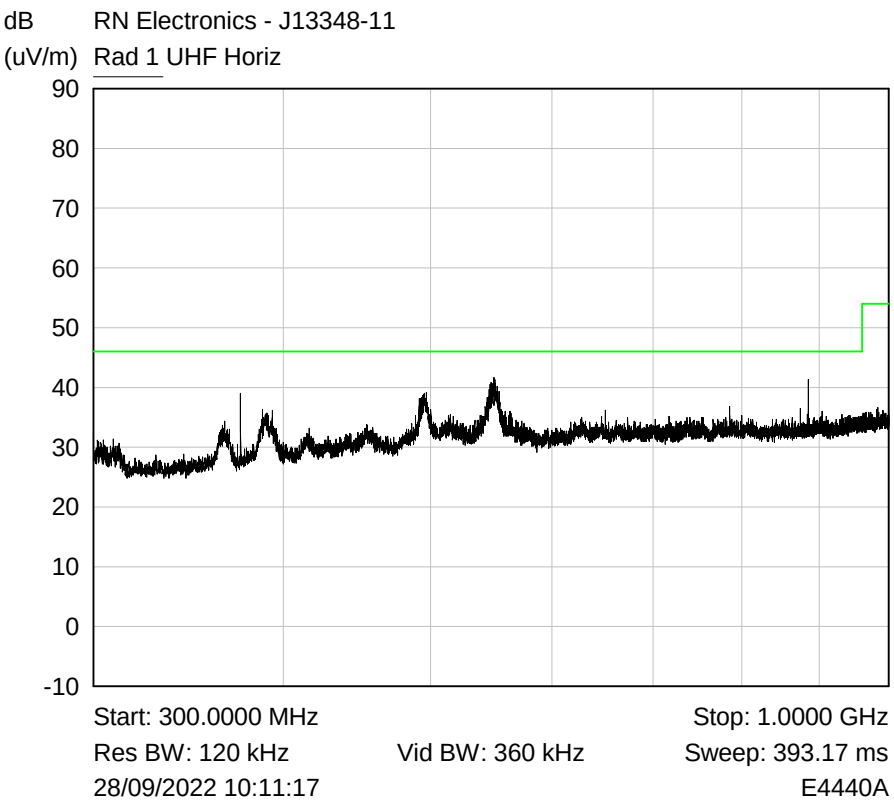
RF Parameters: Band 2400-2483.5 MHz, Power 10 dBm, Channel Spacing 400 kHz, Modulation FHSS 2.4G Proprietary, Channel 2402 MHz (Low)



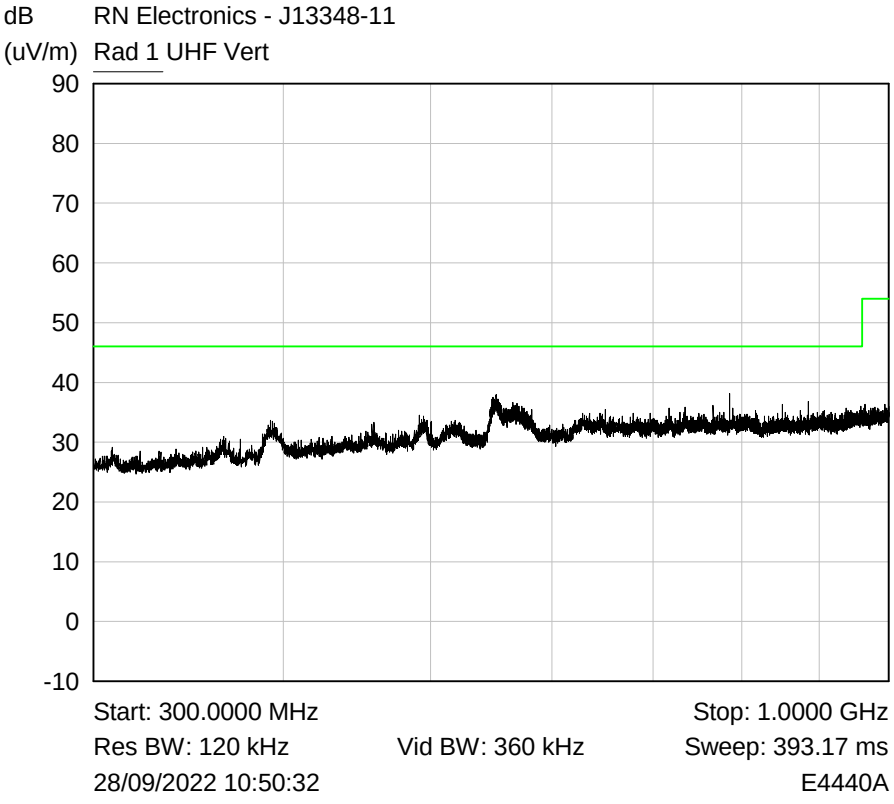
Plot of Peak emissions for VHF Horizontal against the QP limit line.



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

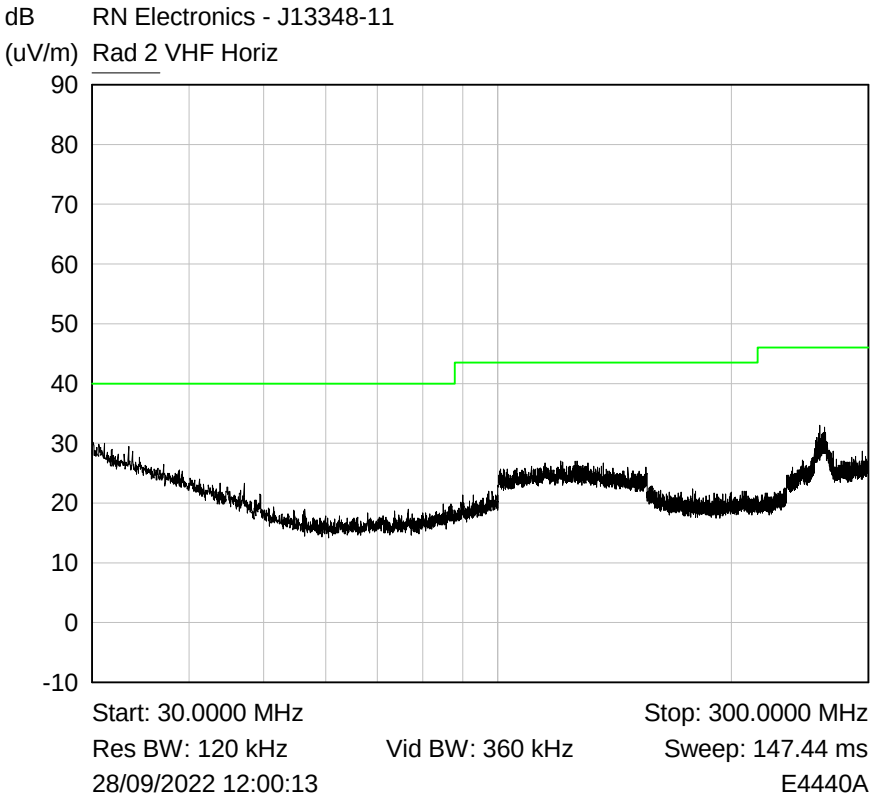


Plot of Peak emissions for UHF Horizontal against the QP limit line.

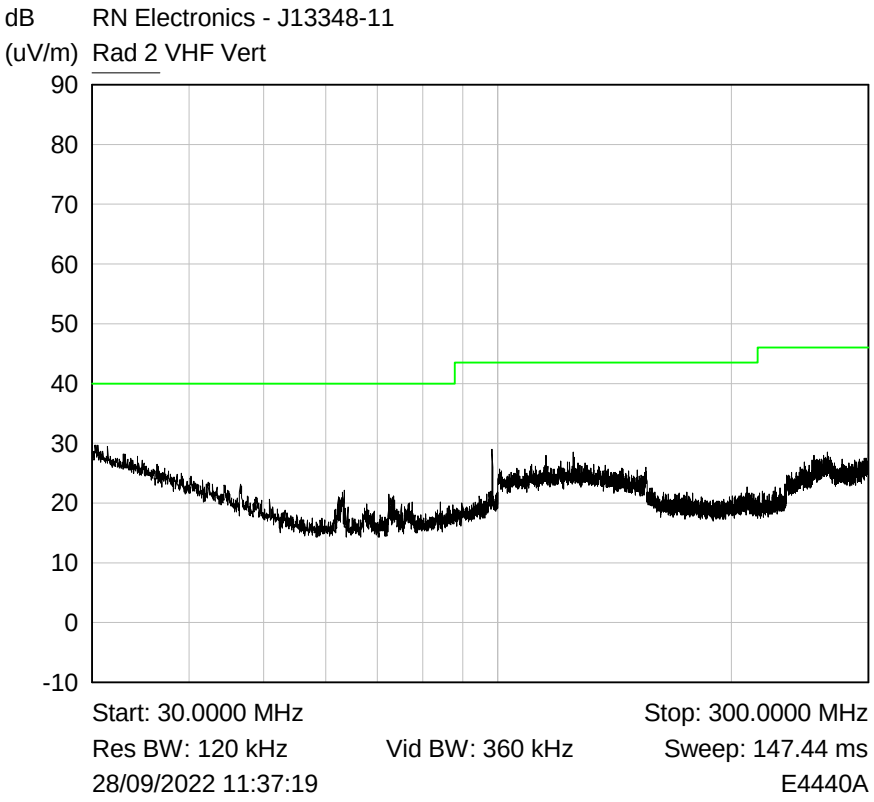


Plot of Peak emissions for UHF Vertical against the QP limit line.

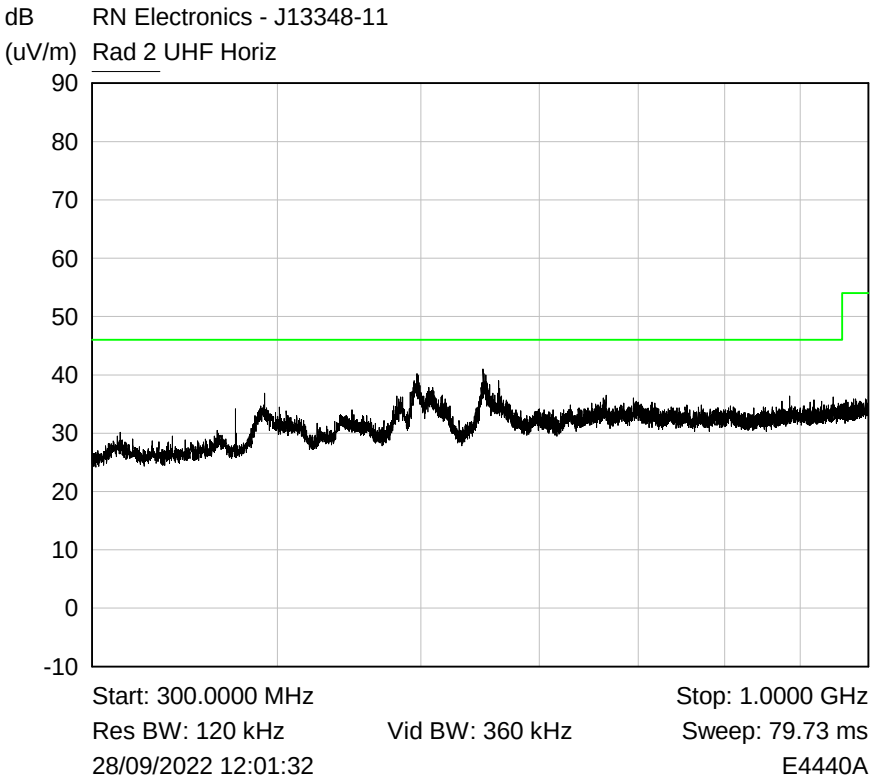
RF Parameters: Band 2400-2483.5 MHz, Power 10 dBm, Channel Spacing 400 kHz, Modulation FHSS 2.4G Proprietary, Channel 2440 MHz (Mid)



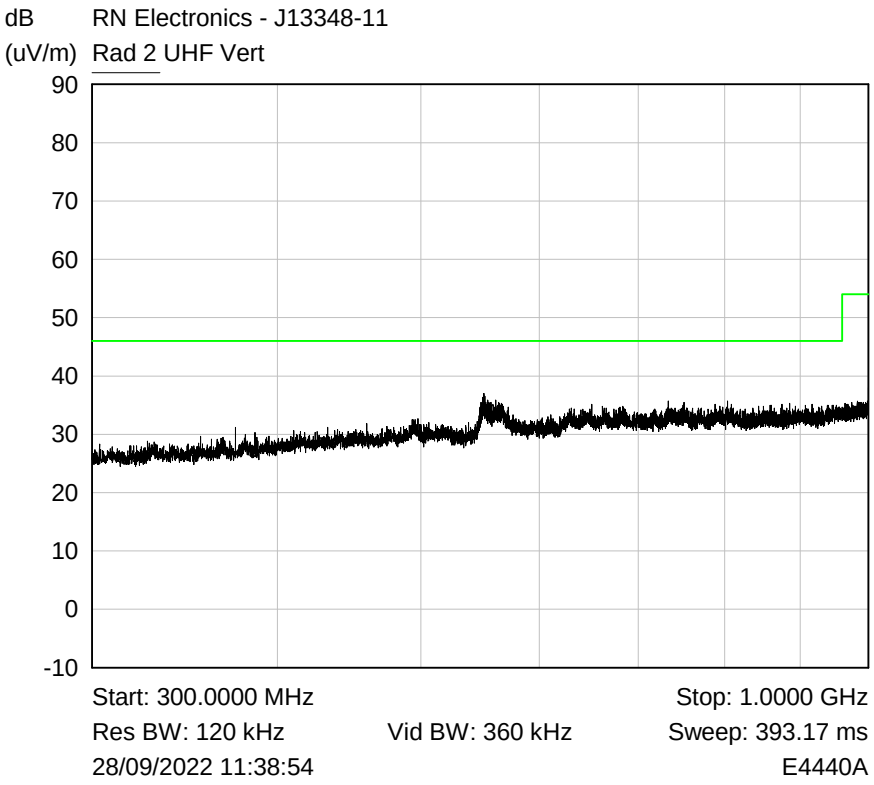
Plot of Peak emissions for VHF Horizontal against the QP limit line.



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

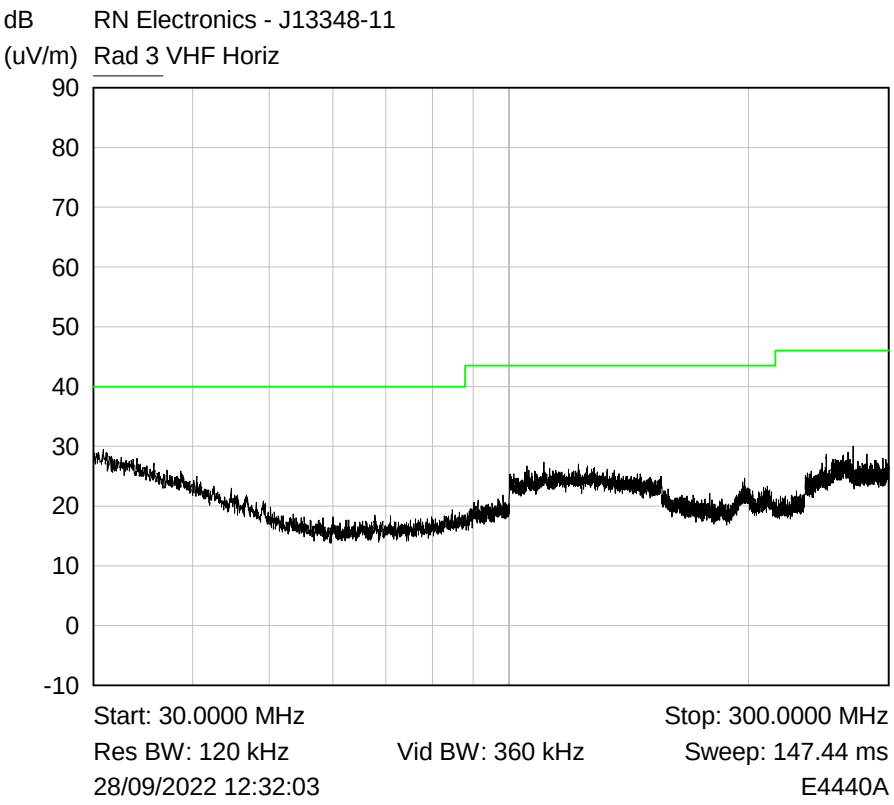


Plot of Peak emissions for UHF Horizontal against the QP limit line.

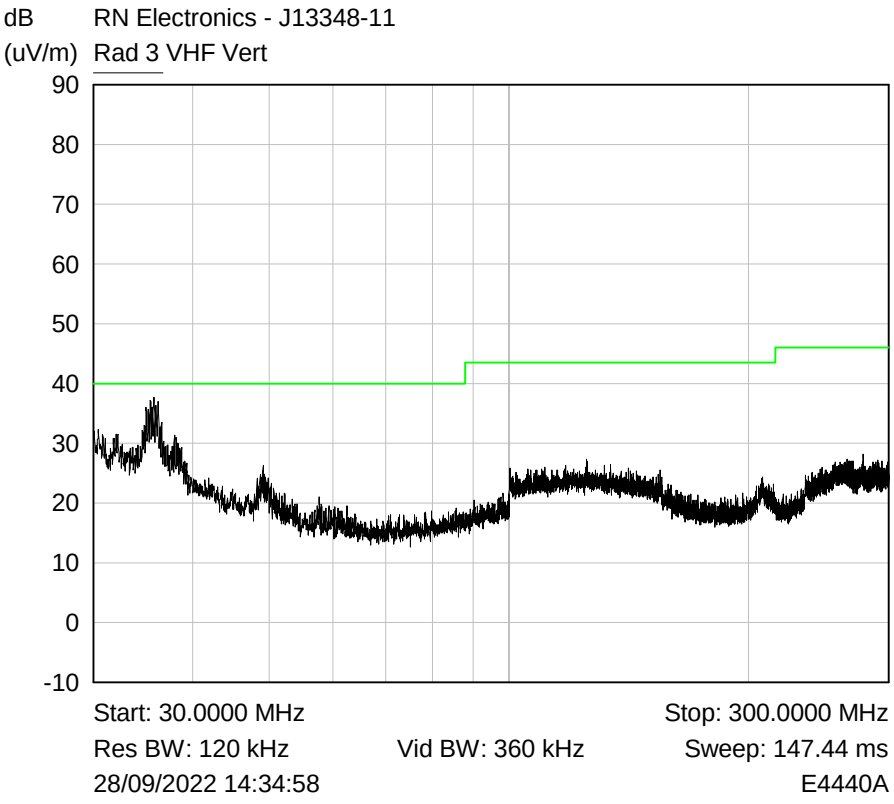


Plot of Peak emissions for UHF Vertical against the QP limit line.

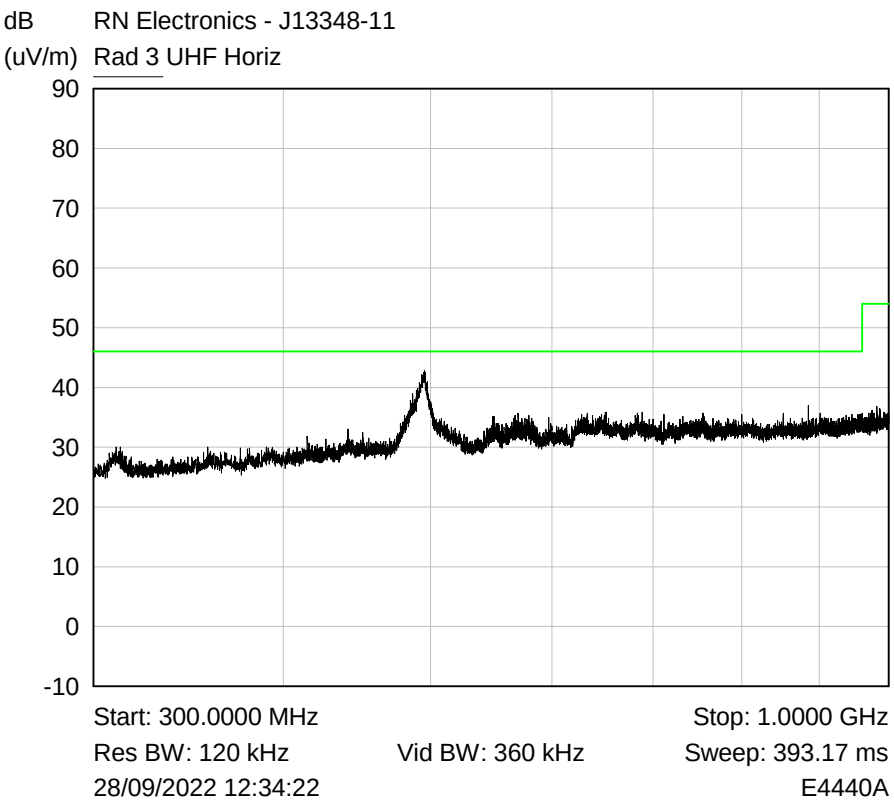
RF Parameters: Band 2400-2483.5 MHz, Power 10 dBm, Channel Spacing 400 kHz, Modulation FHSS 2.4G Proprietary, Channel 2480 MHz (High)



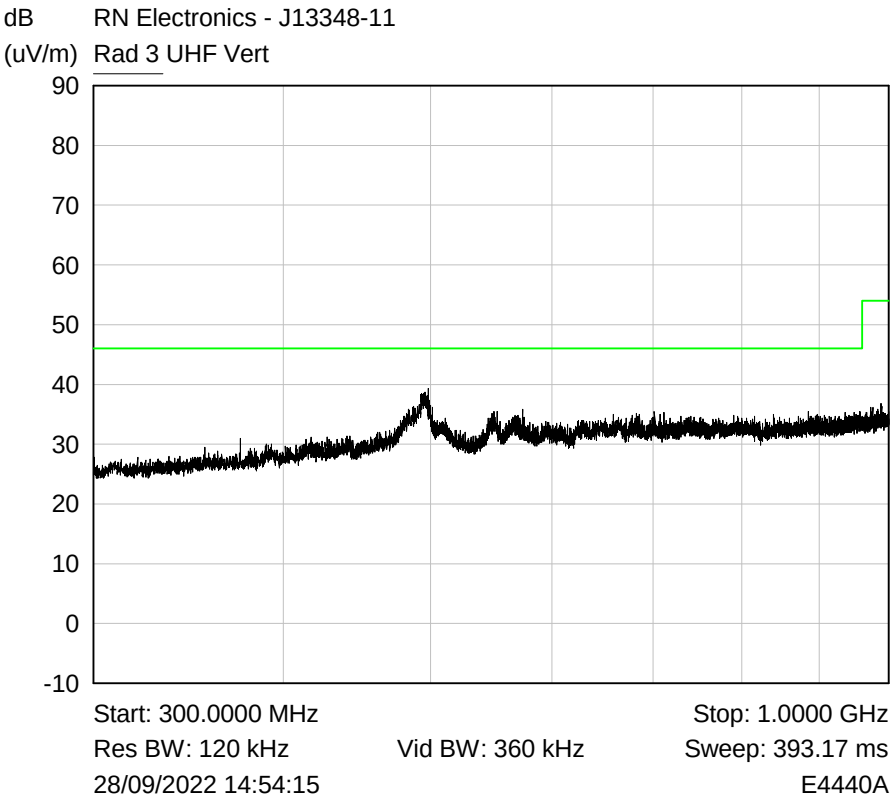
Plot of Peak emissions for VHF Horizontal against the QP limit line.



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



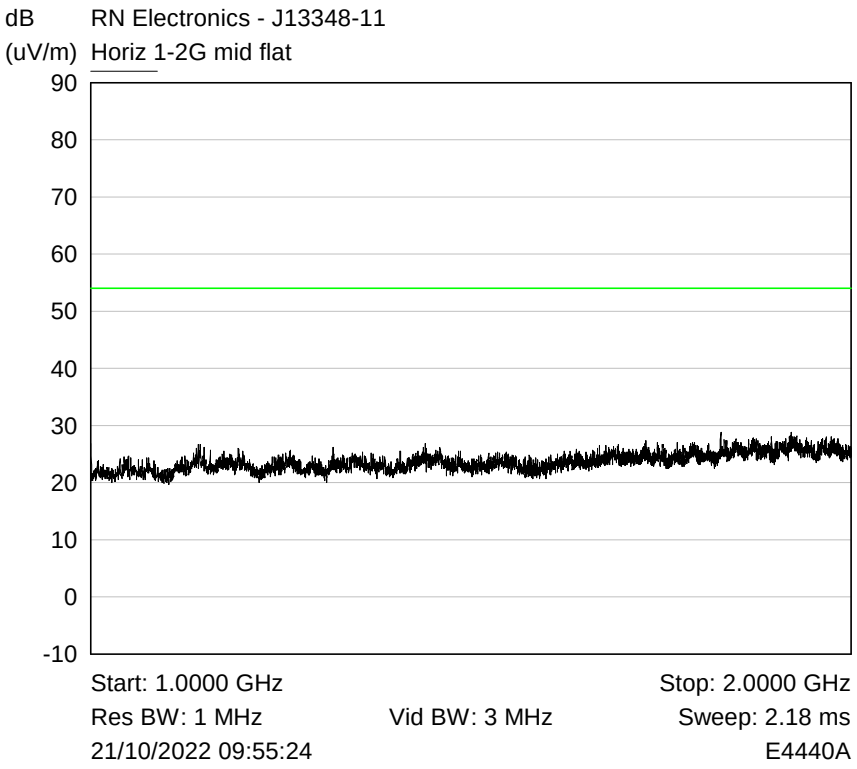
Plot of Peak emissions for UHF Horizontal against the QP limit line.

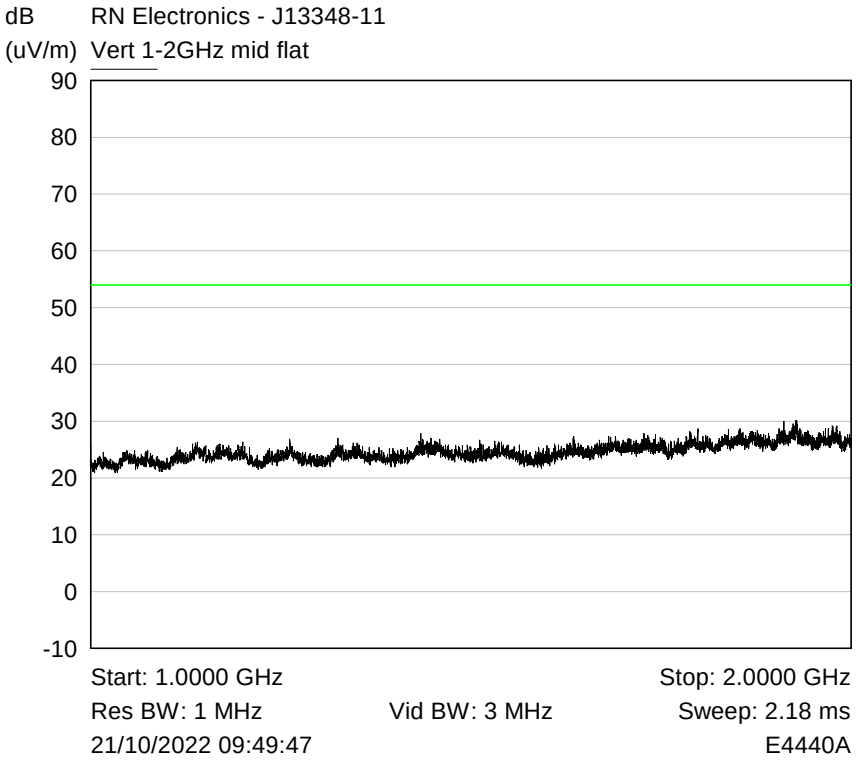


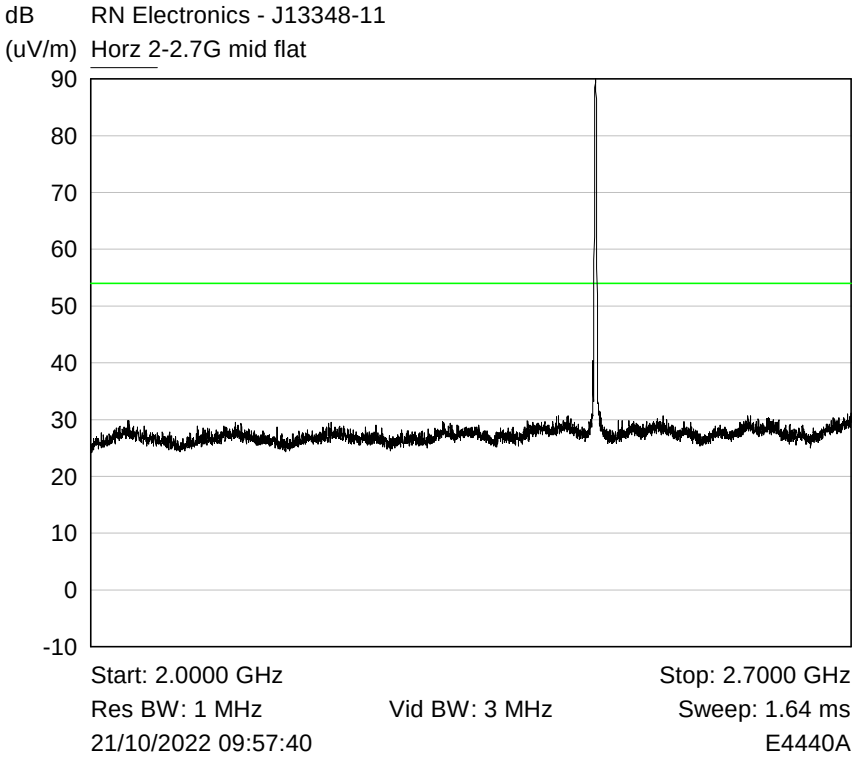
Plot of Peak emissions for UHF Vertical against the QP limit line.

6.5 Radiated emissions above 1 GHz

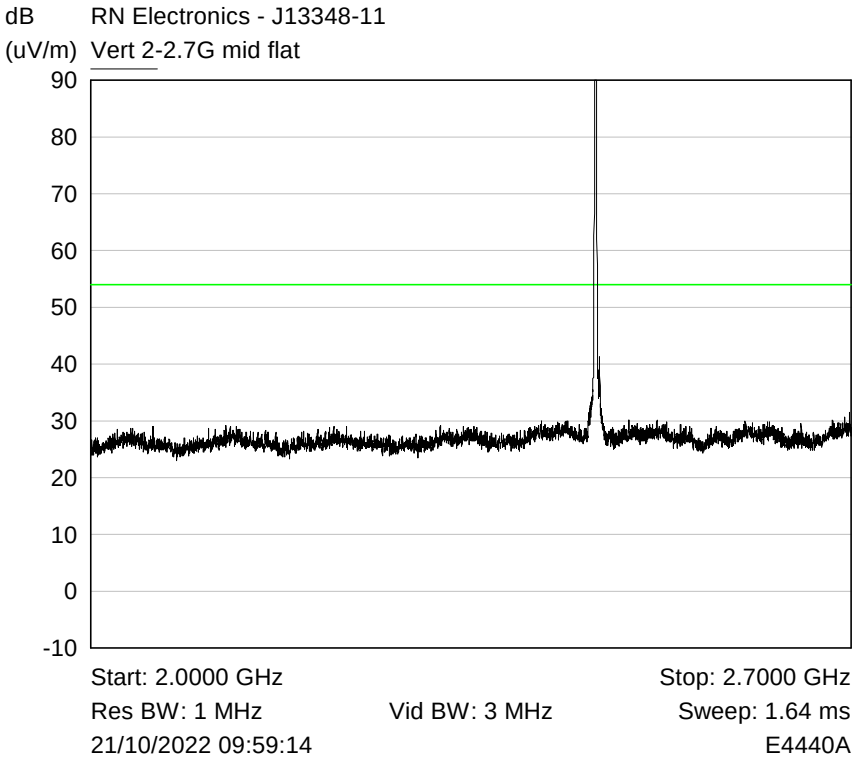
RF Parameters: Band 2400-2483.5 MHz, Power 10 dBm, Channel Spacing 400 kHz, Modulation FHSS 2.4G Proprietary, Channel 2440.8 MHz



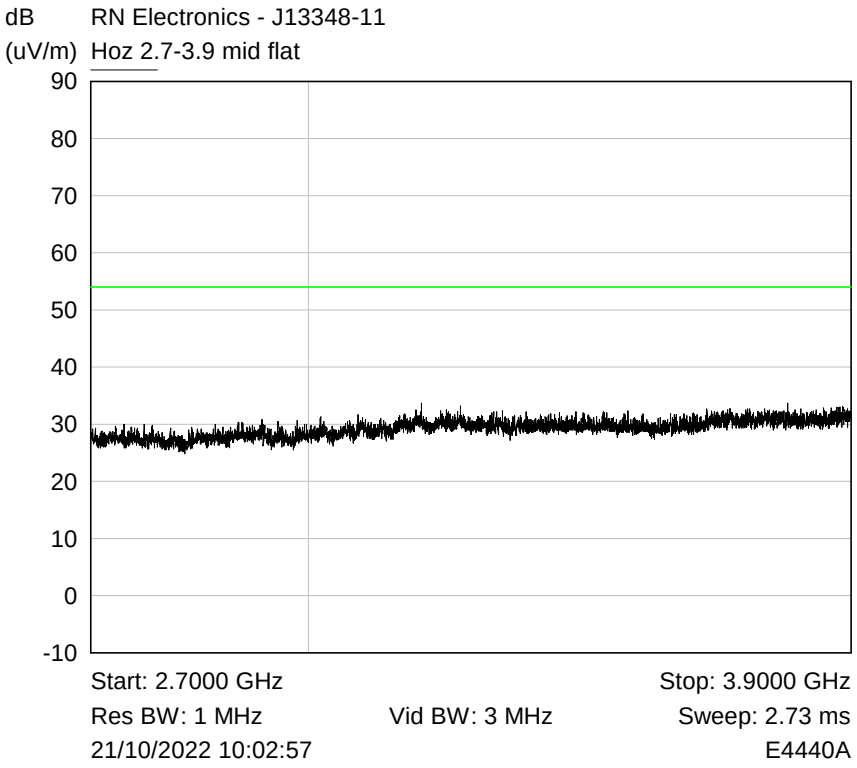


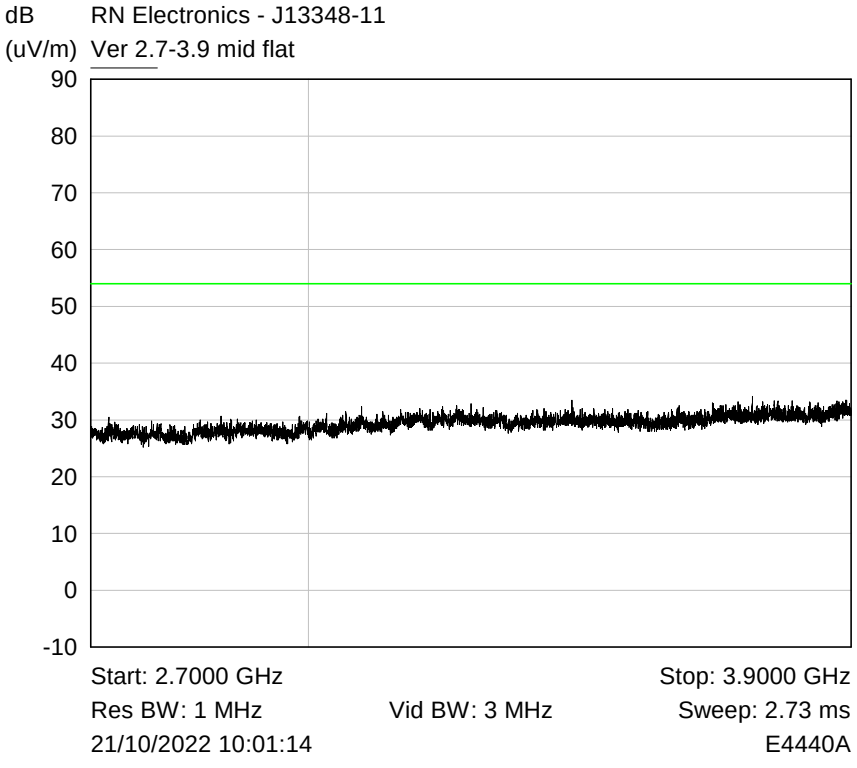


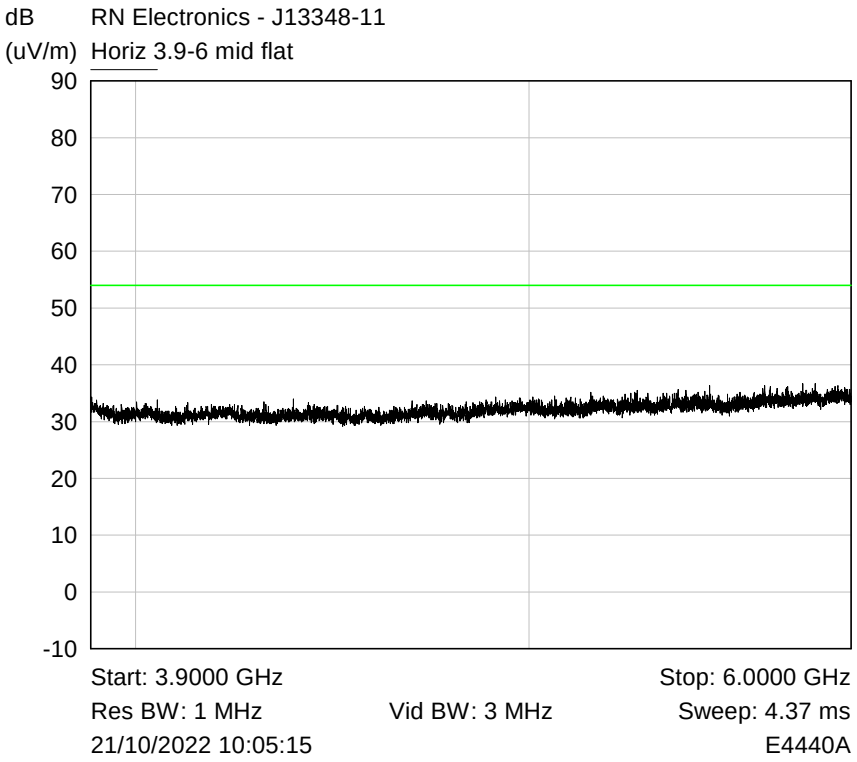
Note: The emission seen on the plot above is an intentional transmission from the 2.4 GHz FHSS 2.4G Proprietary Radio.

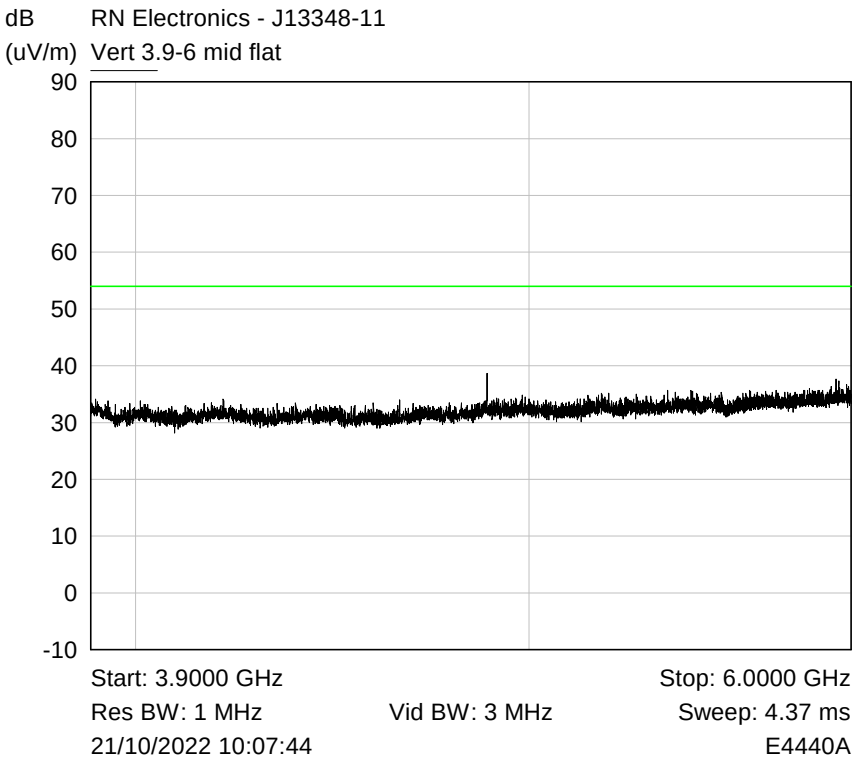


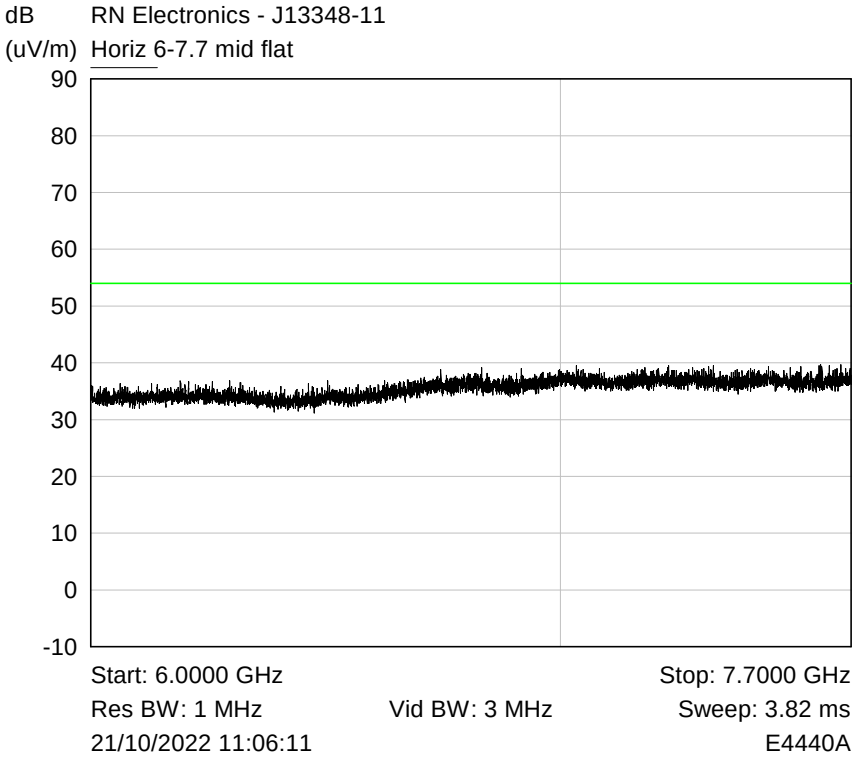
Note: The emission seen on the plot above is an intentional transmission from the 2.4 GHz FHSS 2.4G Proprietary Radio.

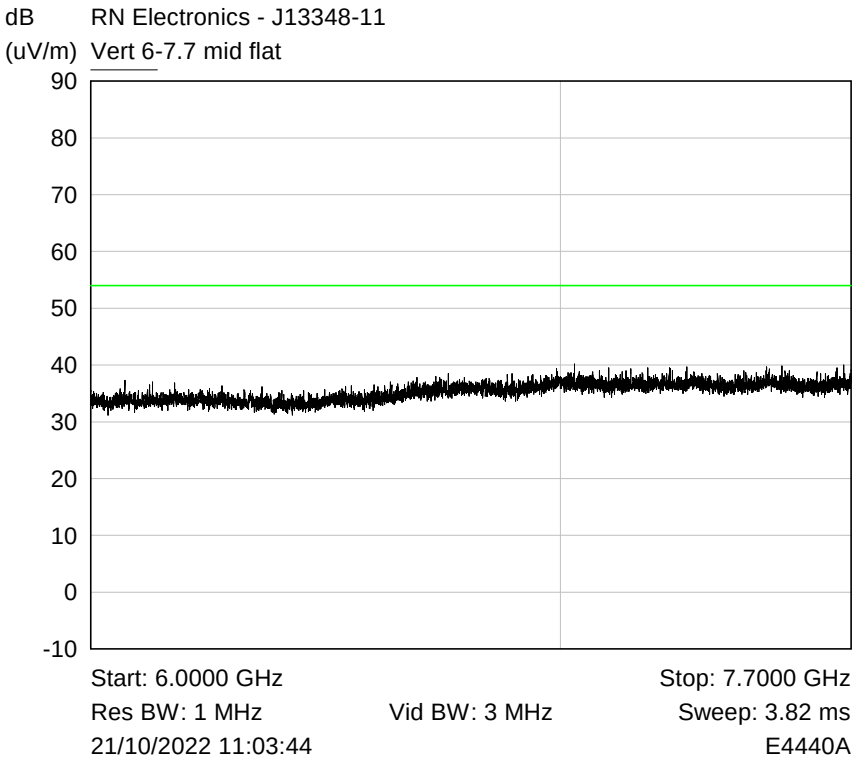

dB
(uV/m)
RN Electronics - J13348-11
Hoz 2.7-3.9 mid flat
90
80
70
60
50
40
30
20
10
0
-10
Start: 2.7000 GHz
Stop: 3.9000 GHz
Res BW: 1 MHz
Vid BW: 3 MHz
Sweep: 2.73 ms
21/10/2022 10:02:57
E4440A

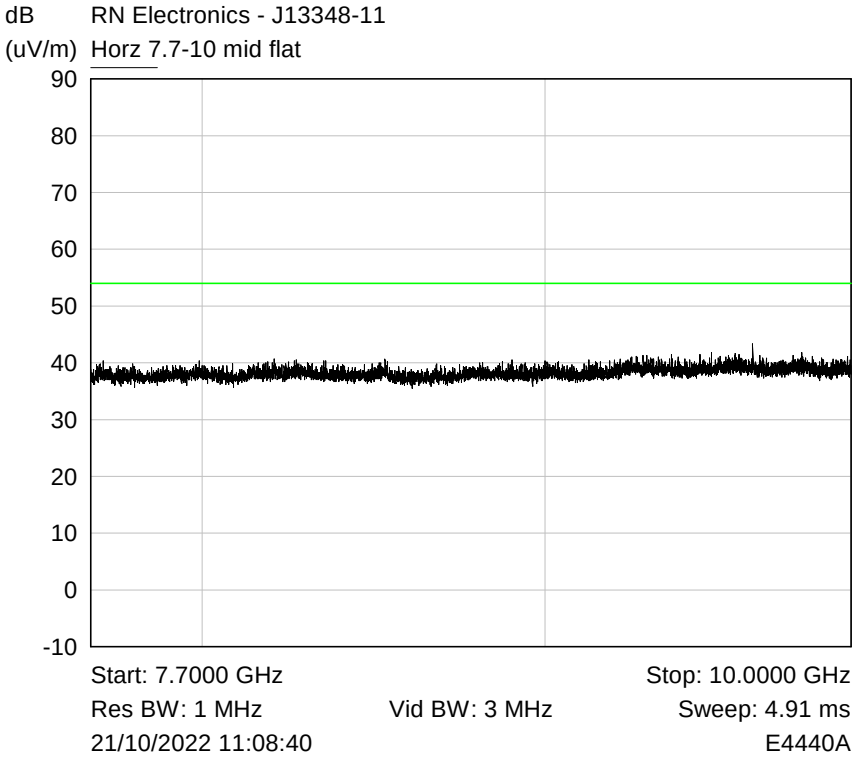

dB
(uV/m)
RN Electronics - J13348-11
Ver 2.7-3.9 mid flat
90
80
70
60
50
40
30
20
10
0
-10
Start: 2.7000 GHz
Stop: 3.9000 GHz
Res BW: 1 MHz
Vid BW: 3 MHz
Sweep: 2.73 ms
21/10/2022 10:01:14
E4440A

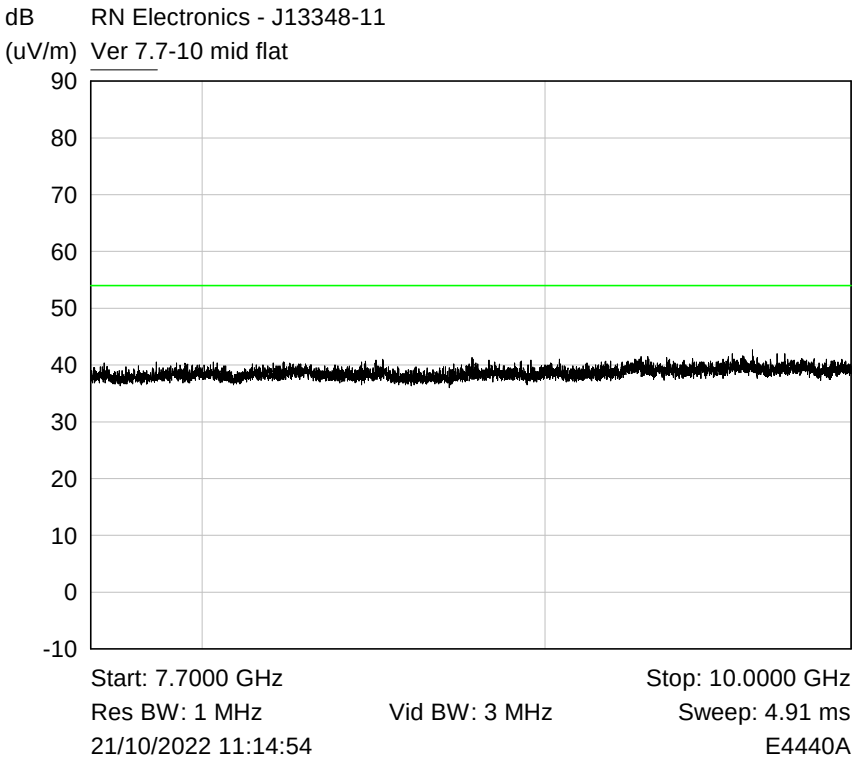


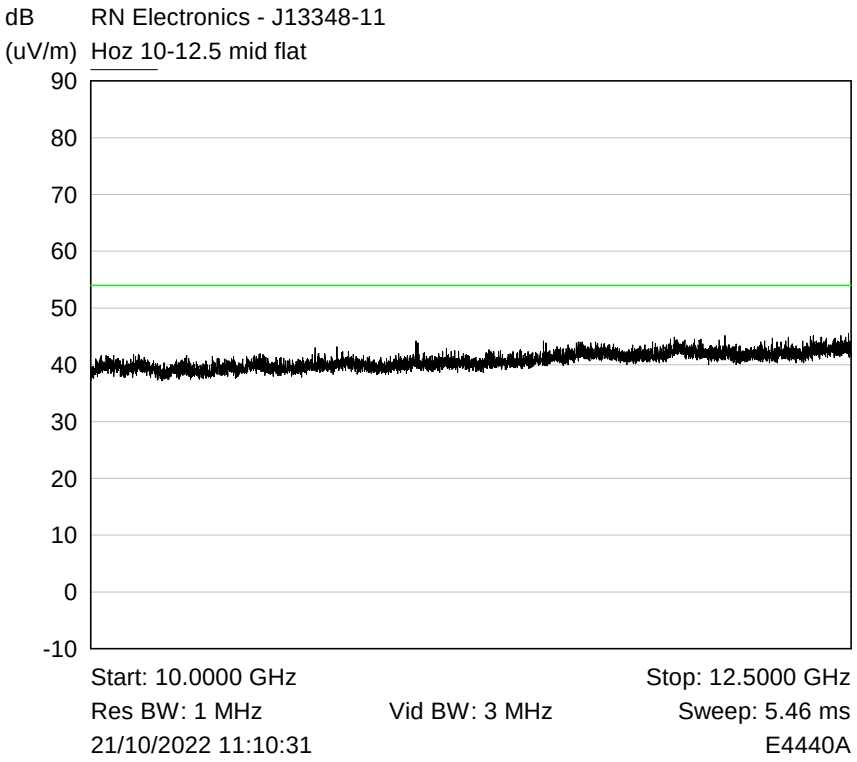


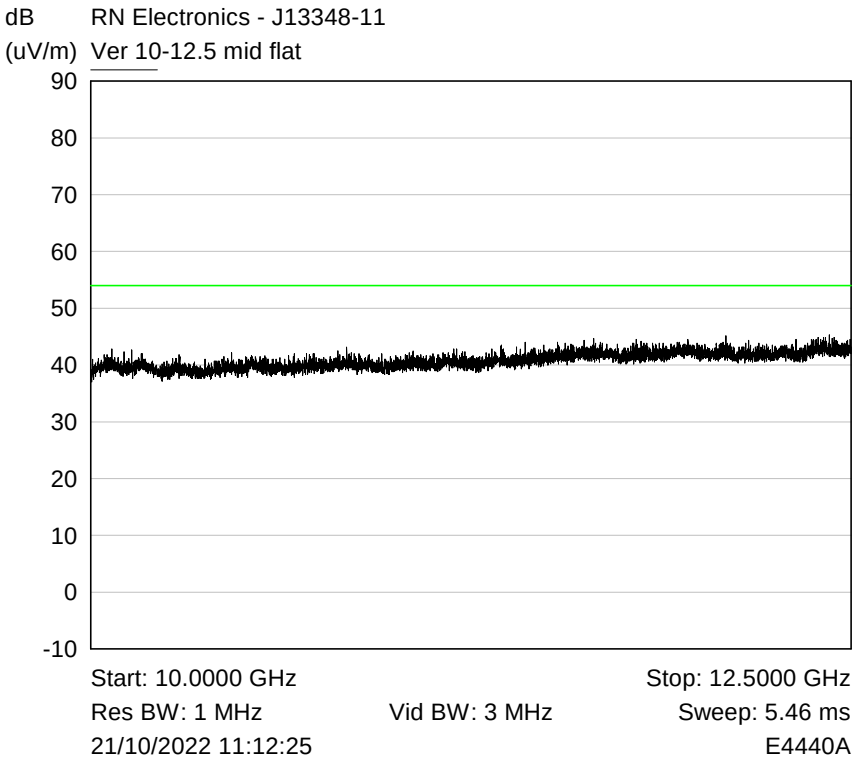

dB
(uV/m)
RN Electronics - J13348-11
Horiz 6-7.7 mid flat
90
80
70
60
50
40
30
20
10
0
-10
Start: 6.0000 GHz
Stop: 7.7000 GHz
Res BW: 1 MHz
Vid BW: 3 MHz
Sweep: 3.82 ms
21/10/2022 11:06:11
E4440A

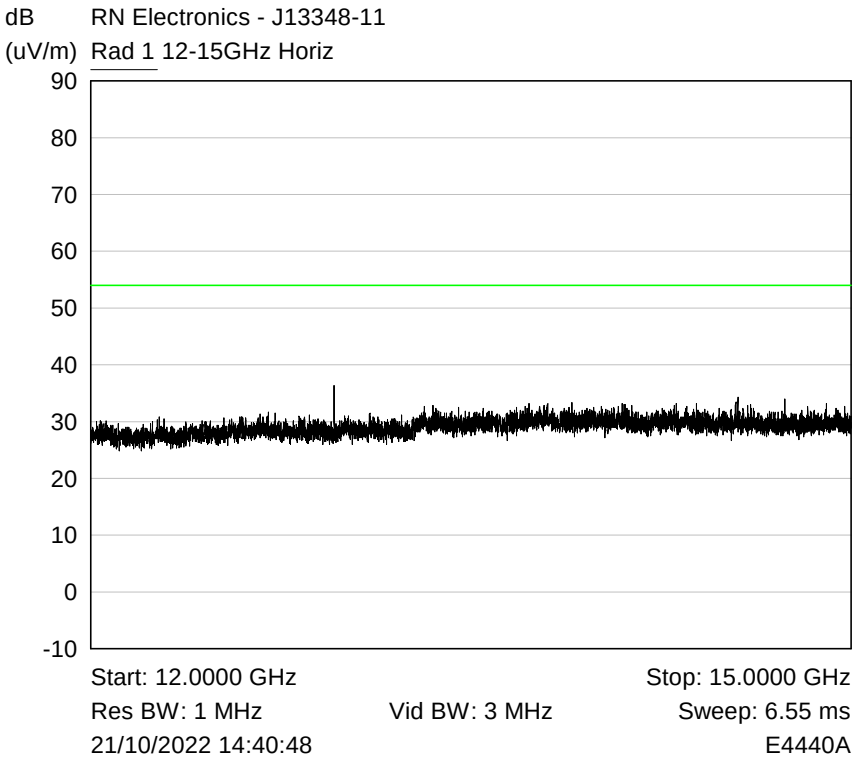

dB
(uV/m)
RN Electronics - J13348-11
Vert 6-7.7 mid flat
90
80
70
60
50
40
30
20
10
0
-10
Start: 6.0000 GHz
Stop: 7.7000 GHz
Res BW: 1 MHz
Vid BW: 3 MHz
Sweep: 3.82 ms
21/10/2022 11:03:44
E4440A

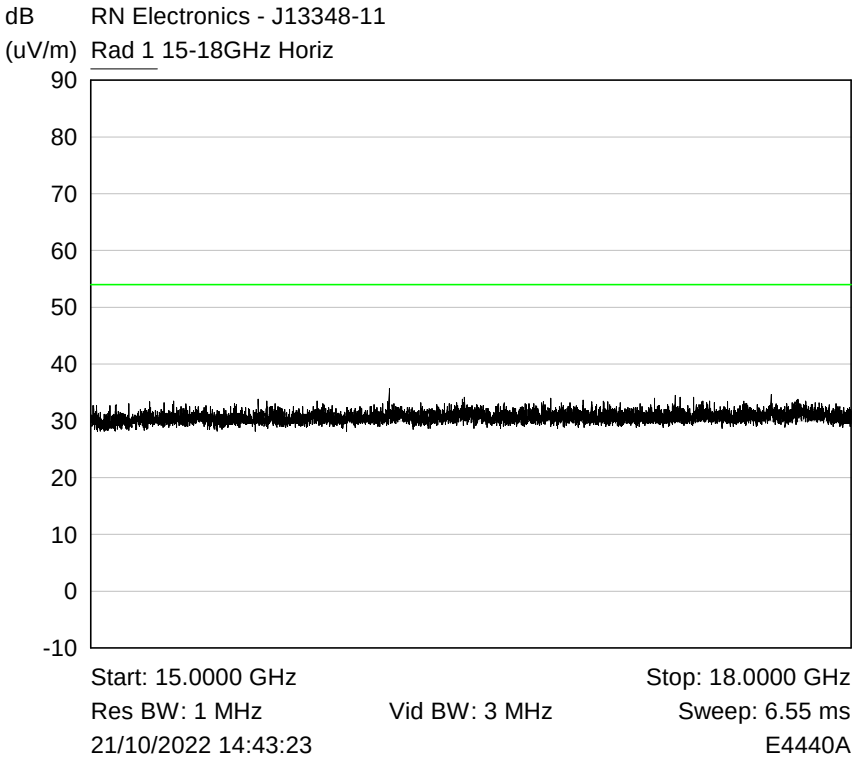

dB
(uV/m)
RN Electronics - J13348-11
Horz 7.7-10 mid flat
90
80
70
60
50
40
30
20
10
0
-10
Start: 7.7000 GHz
Stop: 10.0000 GHz
Res BW: 1 MHz
Vid BW: 3 MHz
Sweep: 4.91 ms
21/10/2022 11:08:40
E4440A

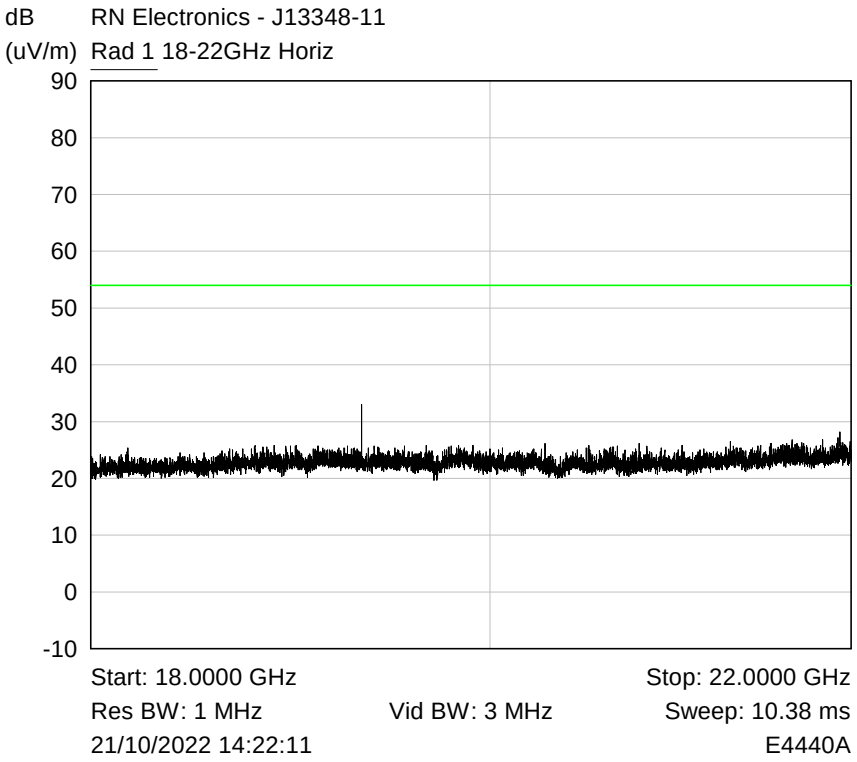

dB
(uV/m)
RN Electronics - J13348-11
Ver 7.7-10 mid flat
90
80
70
60
50
40
30
20
10
0
-10
Start: 7.7000 GHz
Stop: 10.0000 GHz
Res BW: 1 MHz
Vid BW: 3 MHz
Sweep: 4.91 ms
21/10/2022 11:14:54
E4440A

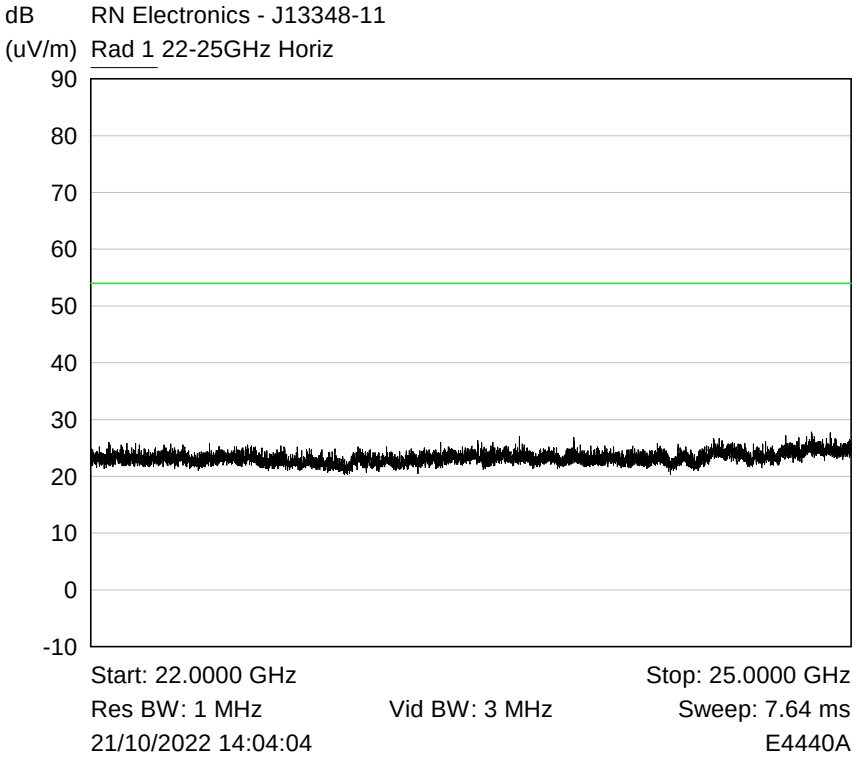

dB
(uV/m)
RN Electronics - J13348-11
Hoz 10-12.5 mid flat
90
80
70
60
50
40
30
20
10
0
-10
Start: 10.0000 GHz
Stop: 12.5000 GHz
Res BW: 1 MHz
Vid BW: 3 MHz
Sweep: 5.46 ms
21/10/2022 11:10:31
E4440A

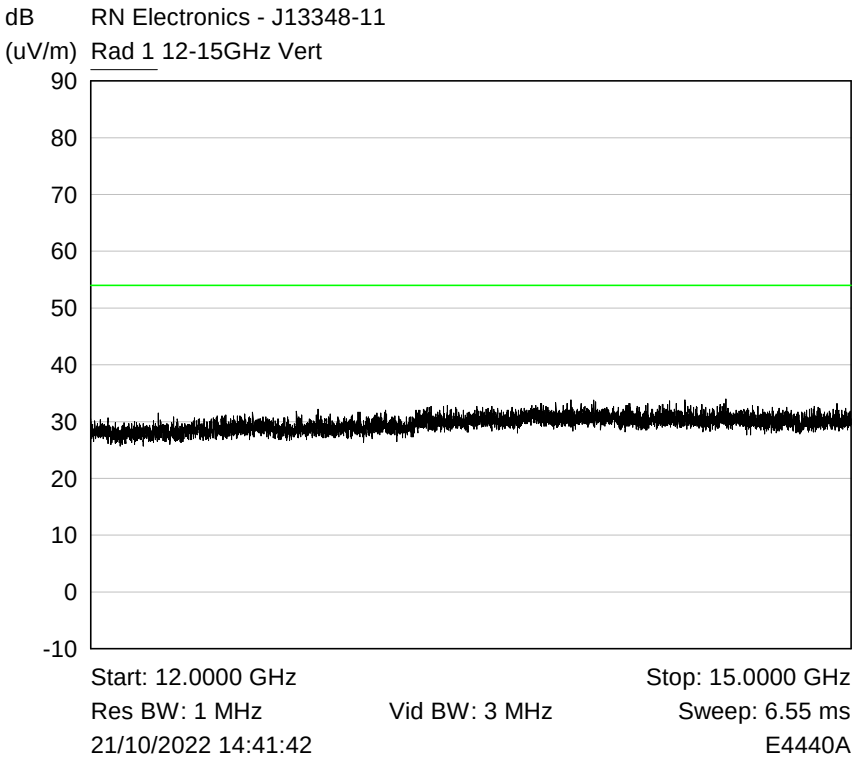

dB
(uV/m)
RN Electronics - J13348-11
Ver 10-12.5 mid flat
90
80
70
60
50
40
30
20
10
0
-10
Start: 10.0000 GHz
Stop: 12.5000 GHz
Res BW: 1 MHz
Vid BW: 3 MHz
Sweep: 5.46 ms
21/10/2022 11:12:25
E4440A

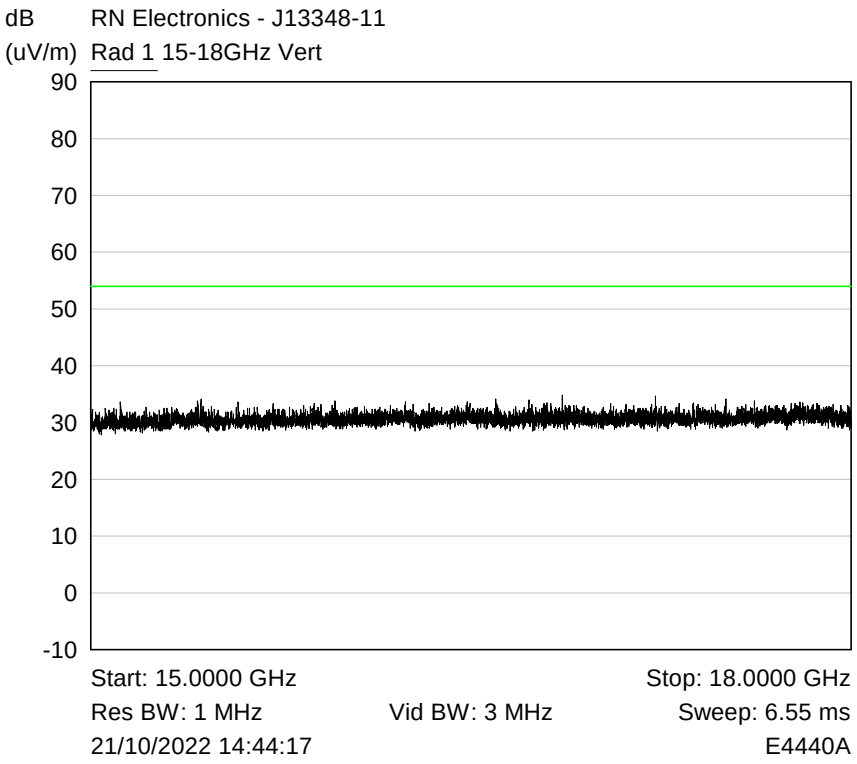


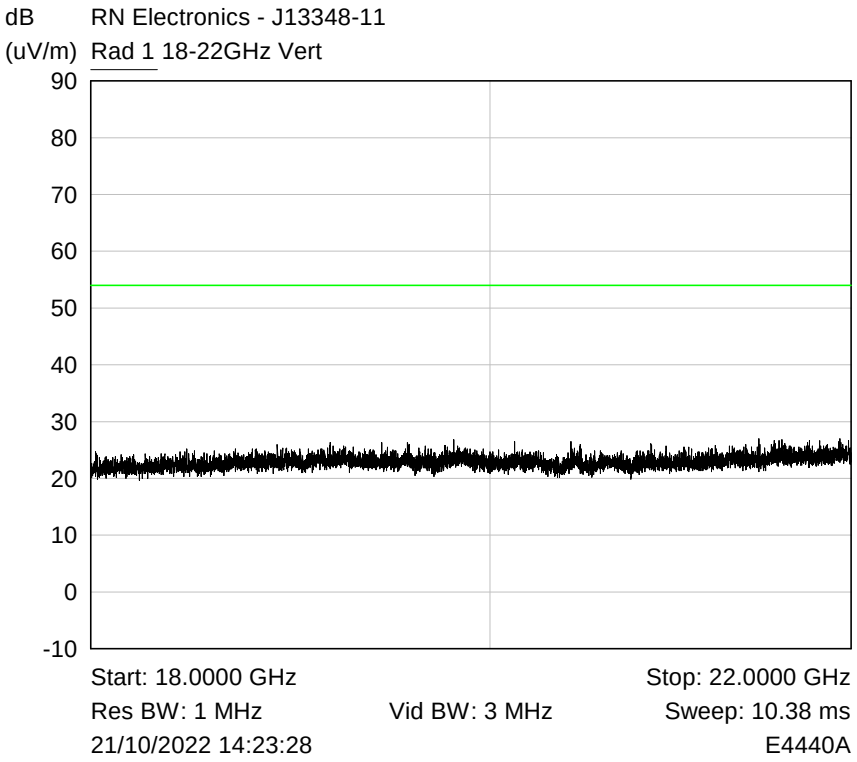


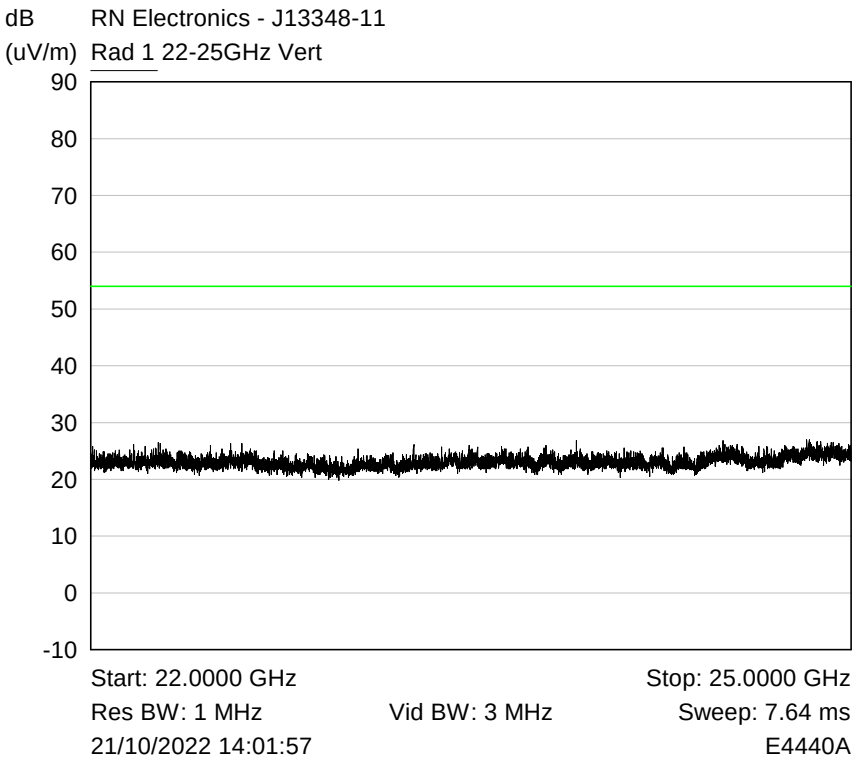






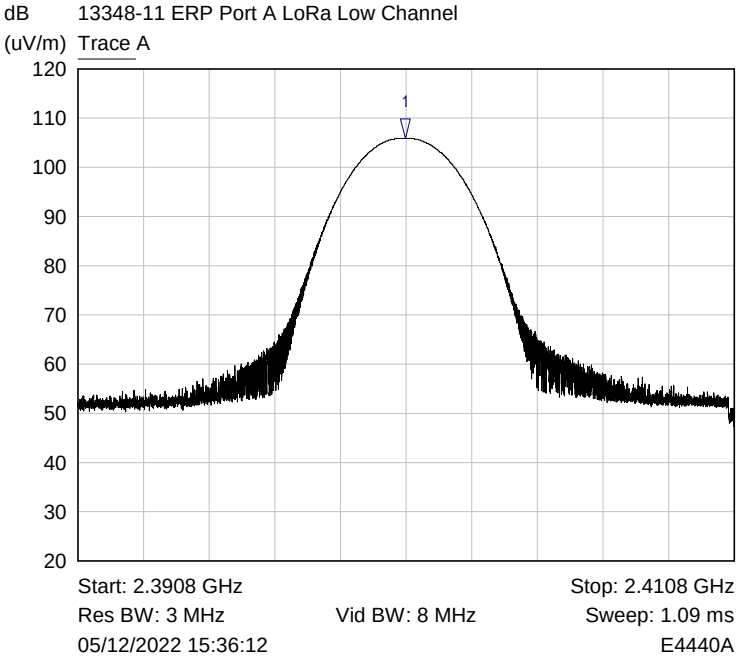






6.6 Effective radiated power field strength

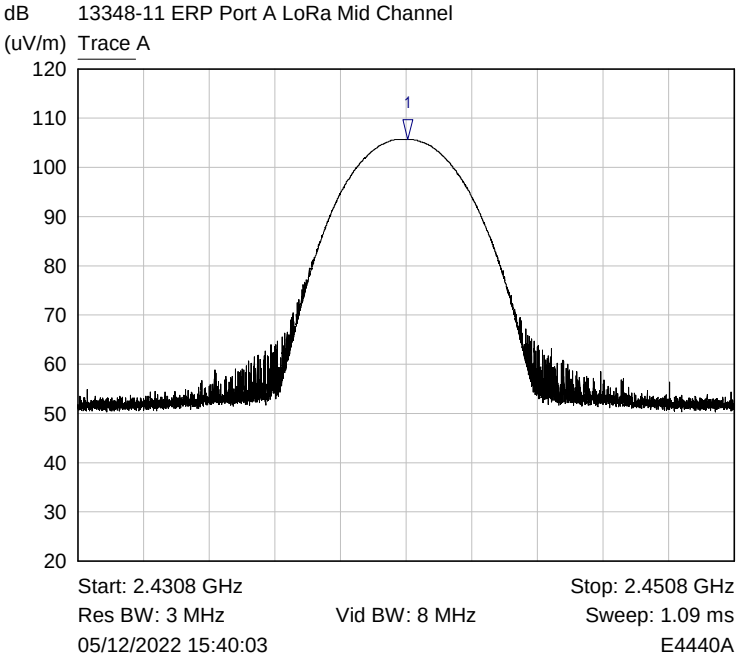
RF Parameters: Band 2400-2483.5 MHz (Port A), Power 10 mW, Channel Spacing 400 kHz, Modulation FHSS 2.4G Proprietary, and Channel 2400.8 MHz



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4008 GHz	105.89 dB(uV/m)	

Plot of Horiz polarisation and EUT in the Side position

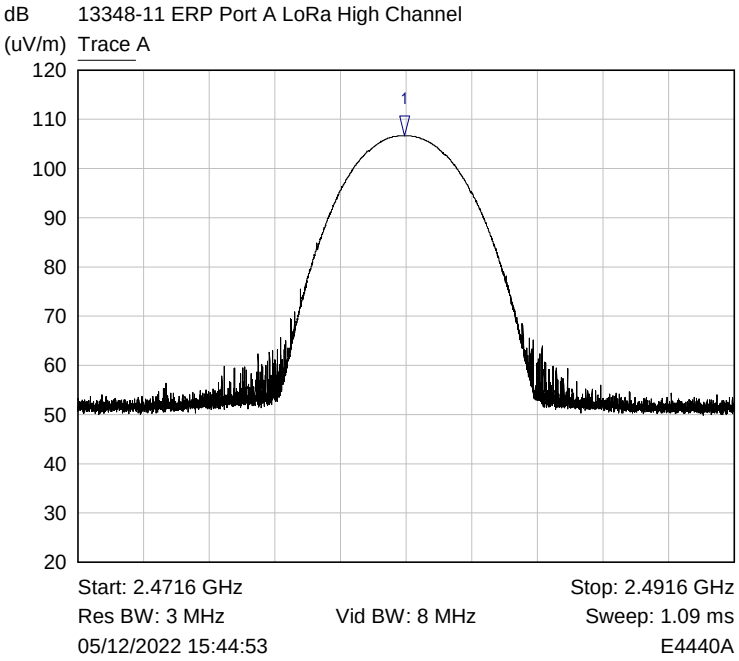
RF Parameters: Band 2400-2483.5 MHz (Port A), Power 10 mW, Channel Spacing 400 kHz, Modulation FHSS 2.4G Proprietary, and Channel 2440.8 MHz



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4408 GHz	105.74 dB(uV/m)	

Plot of Horiz polarisation and EUT in the Side position

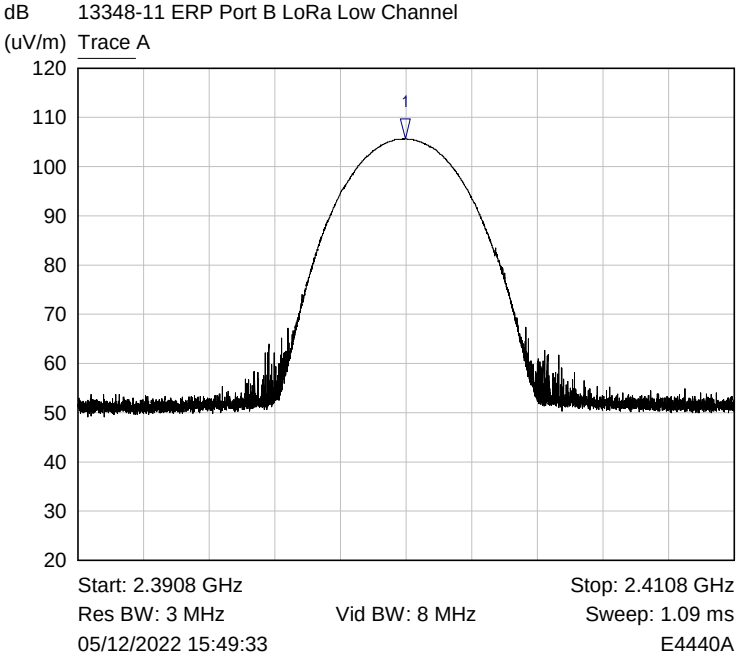
RF Parameters: Band 2400-2483.5 MHz (Port A), Power 10 mW, Channel Spacing 400 kHz, Modulation FHSS 2.4G Proprietary, and Channel 2481.6 MHz



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4816 GHz	106.68 dB(uV/m)	

Plot of Horiz polarisation and EUT in the Side position

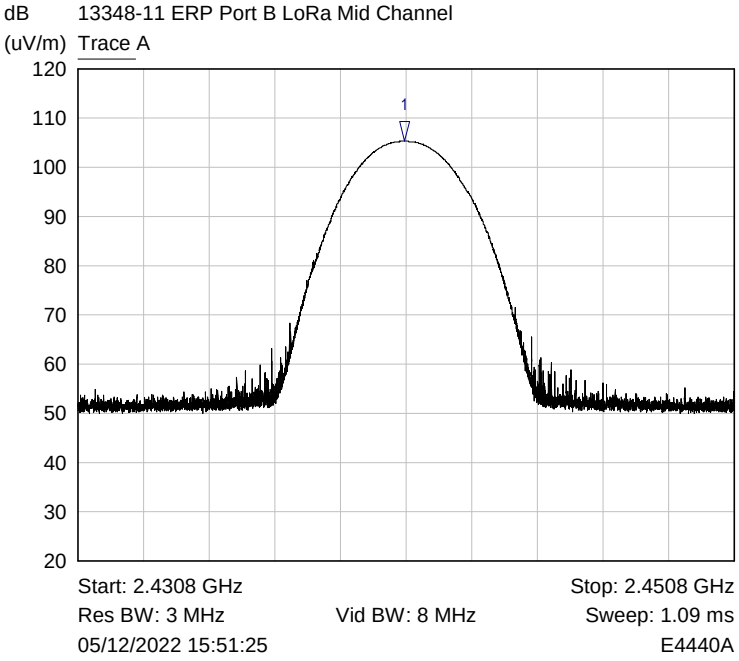
RF Parameters: Band 2400-2483.5 MHz (Port B), Power 10 mW, Channel Spacing 400 kHz, Modulation FHSS 2.4G Proprietary, and Channel 2400.8 MHz



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4008 GHz	105.60 dB(uV/m)	

Plot of Horiz polarisation and EUT in the Side position

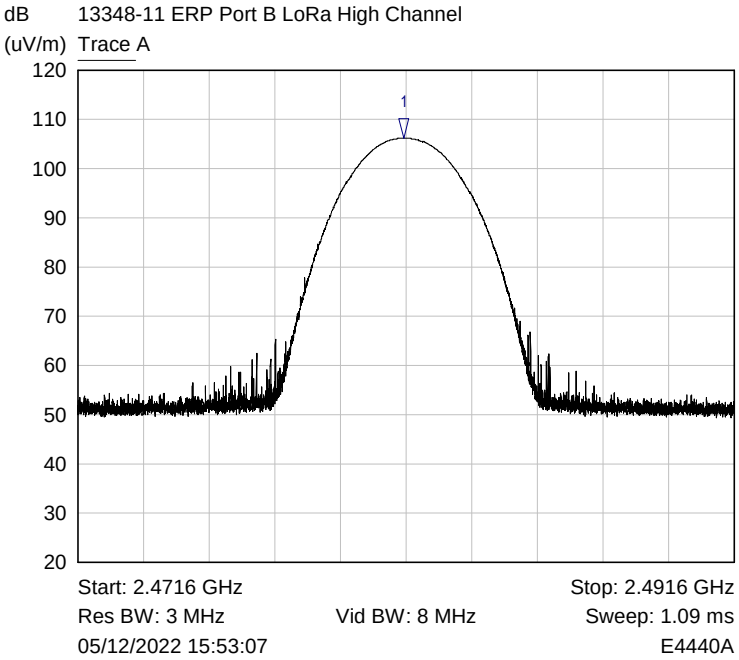
RF Parameters: Band 2400-2483.5 MHz (Port B), Power 10 mW, Channel Spacing 400 kHz, Modulation FHSS 2.4G Proprietary, and Channel 2440.8 MHz



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4407 GHz	105.31 dB(uV/m)	

Plot of Horiz polarisation and EUT in the Side position

RF Parameters: Band 2400-2483.5 MHz (Port B), Power 10 mW, Channel Spacing 400 kHz, Modulation FHSS 2.4G Proprietary, and Channel 2481.6 MHz

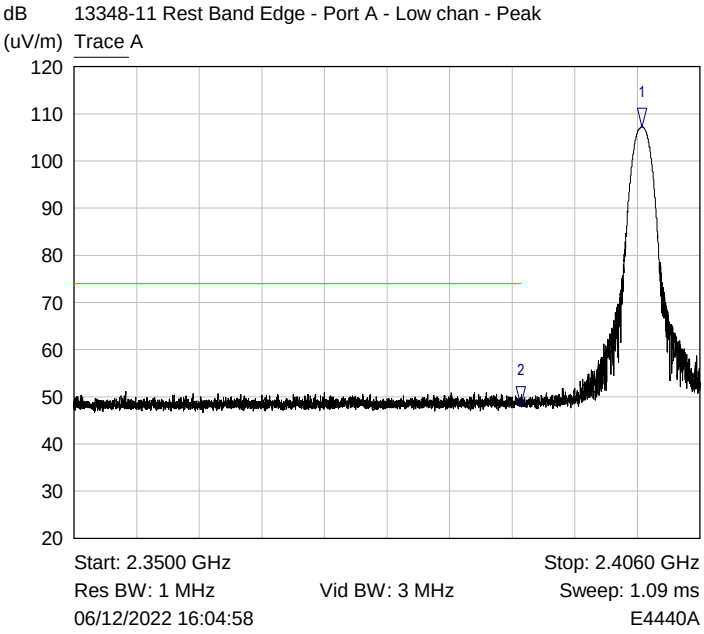


Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4815 GHz	106.21 dB(uV/m)	

Plot of Horiz polarisation and EUT in the Side position

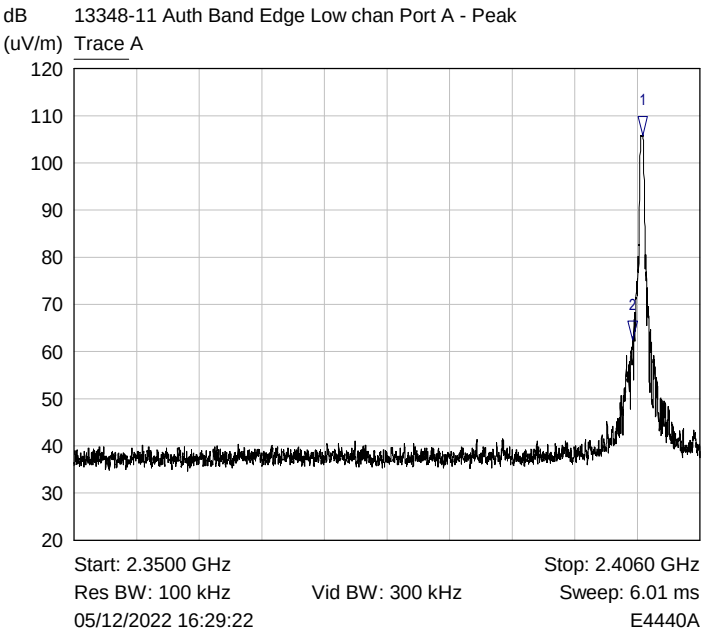
6.7 Band Edge Compliance

RF Parameters: Band 2400-2483.5 MHz (Port A), Power 10 dBm, Channel Spacing 400 kHz, Modulation FHSS 2.4G Proprietary Port A, Channel 2400.8 MHz



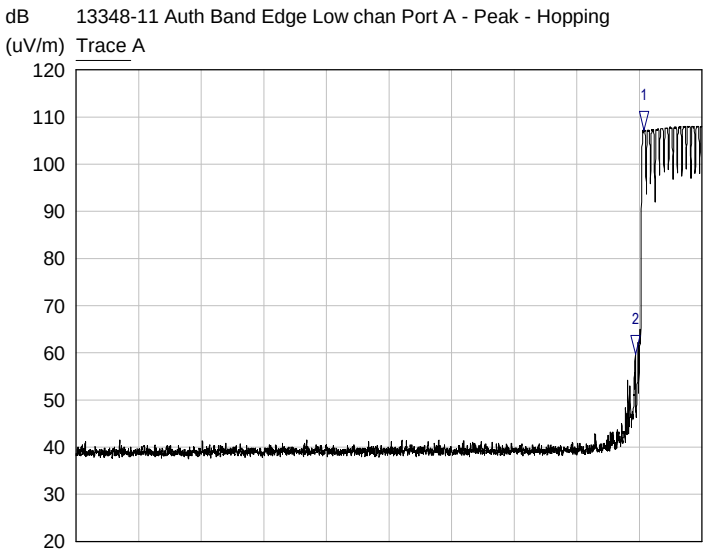
Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4008 GHz	107.15 dB(uV/m)	
2 ▽	Trace A	2.3900 GHz	48.15 dB(uV/m)	

Restricted band edge Peak Plot



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4009 GHz	105.77 dB(uV/m)	
2 ▽	Trace A	2.4000 GHz	62.58 dB(uV/m)	43.2 dBc

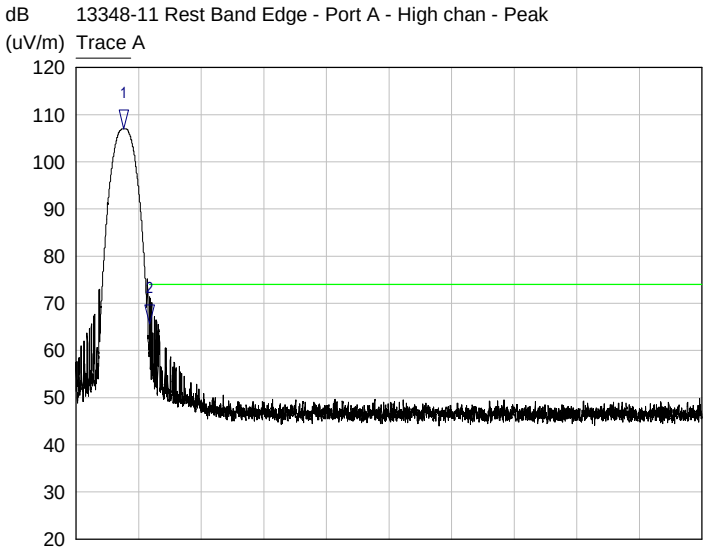
Authorised Band Edge Plot



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4008 GHz	107.20 dB(uV/m)	
2 ▽	Trace A	2.4000 GHz	59.61 dB(uV/m)	47.6 dBc

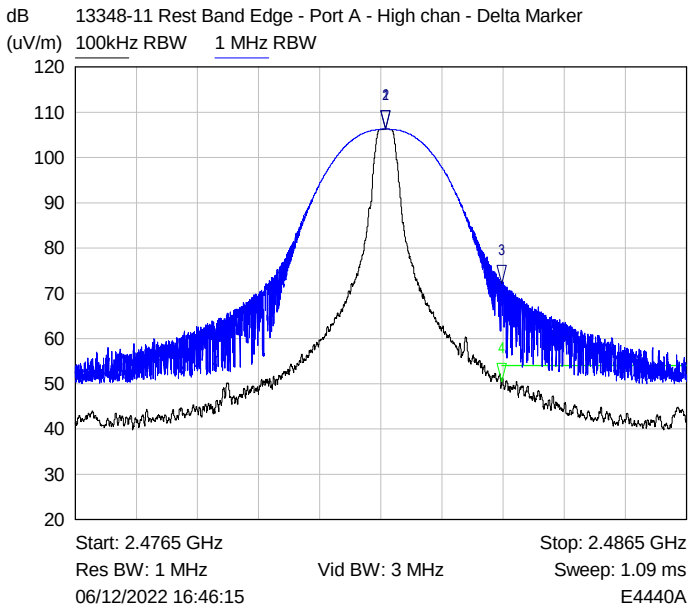
Authorised Band Edge hopping Plot

RF Parameters: Band 2400-2483.5 MHz (Port A), Power 10 dBm, Channel Spacing 400 kHz, Modulation FHSS 2.4G Proprietary Port A, Channel 2481.6 MHz



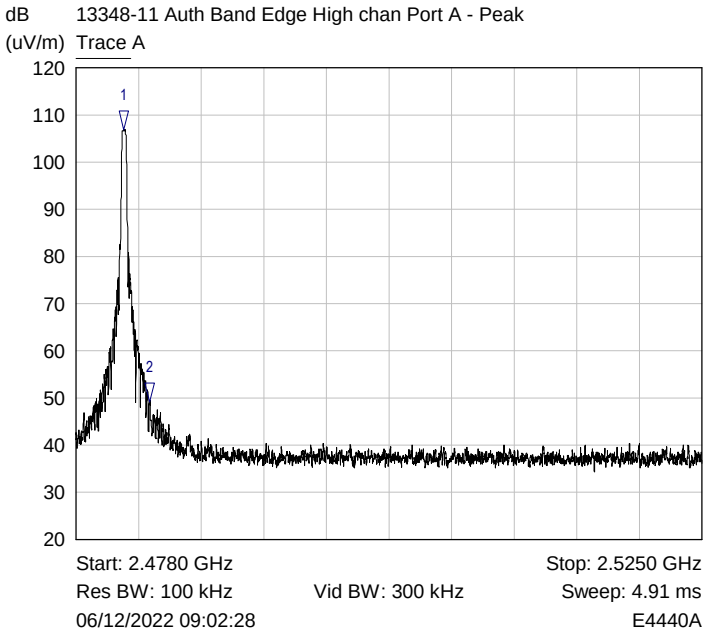
Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4816 GHz	107.05 dB(uV/m)	
2 ▽	Trace A	2.4835 GHz	65.75 dB(uV/m)	

Restricted band edge Peak Plot



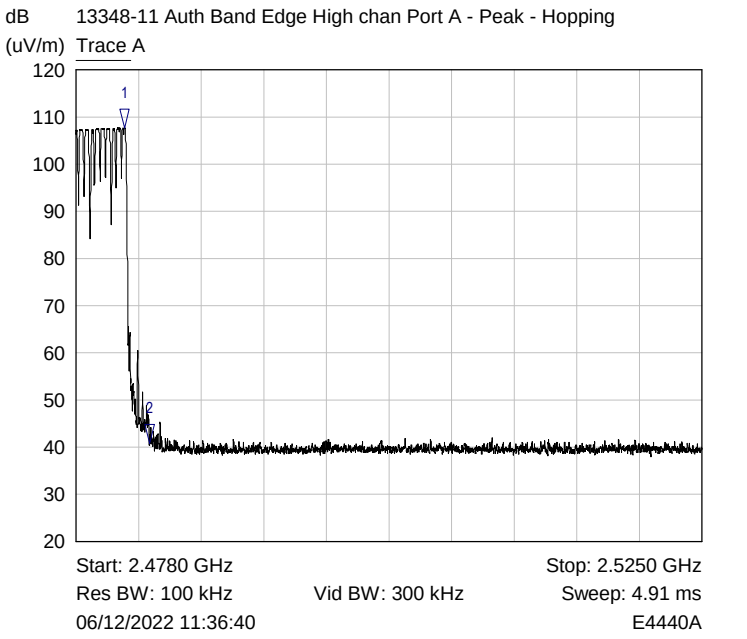
Mkr	Trace	X-Axis	Value	Notes
1	1 MHz RBW	2.4816 GHz	106.42 dB(uV/m)	
2	100kHz RBW	2.4816 GHz	106.42 dB(uV/m)	
3	1 MHz RBW	2.4835 GHz	72.20 dB(uV/m)	50.53dBuV/m @3m Res BE
4	100kHz RBW	2.4835 GHz	50.53 dB(uV/m)	55.89 dBc mkr 2to4

Restricted band edge Average Plot



Mkr	Trace	X-Axis	Value	Notes
1	Trace A	2.4816 GHz	106.79 dB(uV/m)	
2	Trace A	2.4835 GHz	49.18 dB(uV/m)	57.6 dBc

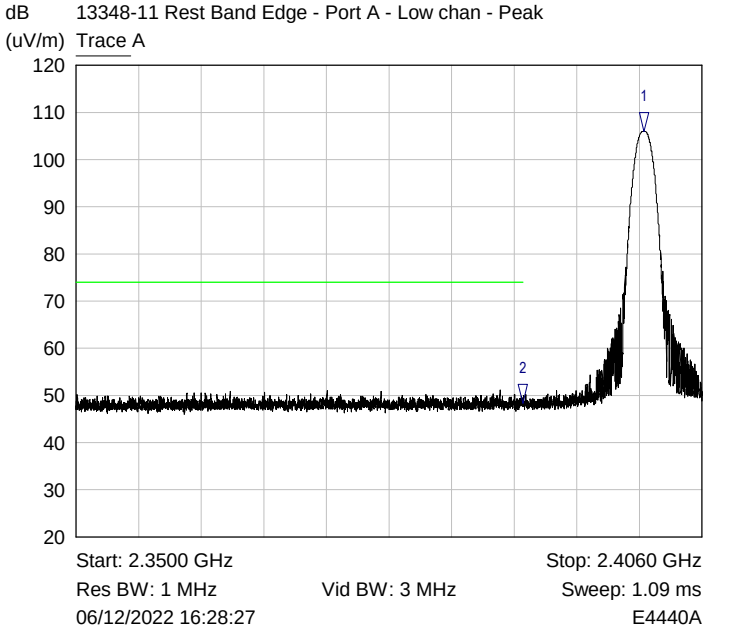
Authorised Band Edge Plot



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4816 GHz	107.64 dB(uV/m)	
2 ▽	Trace A	2.4835 GHz	40.87 dB(uV/m)	66.8 dBc

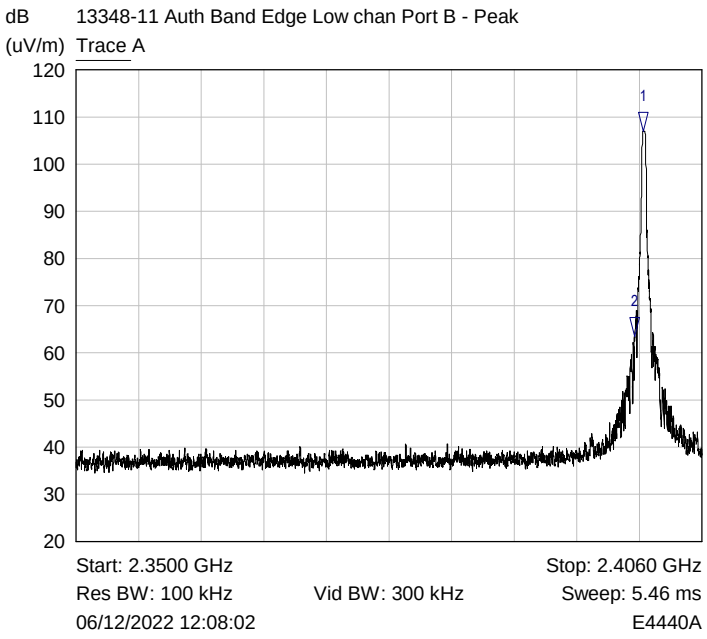
Authorised Band Edge hop Plot

RF Parameters: Band 2400-2483.5 MHz (Port A), Power 10 dBm, Channel Spacing 400 kHz, Modulation FHSS 2.4G Proprietary Port B, Channel 2440.8 MHz



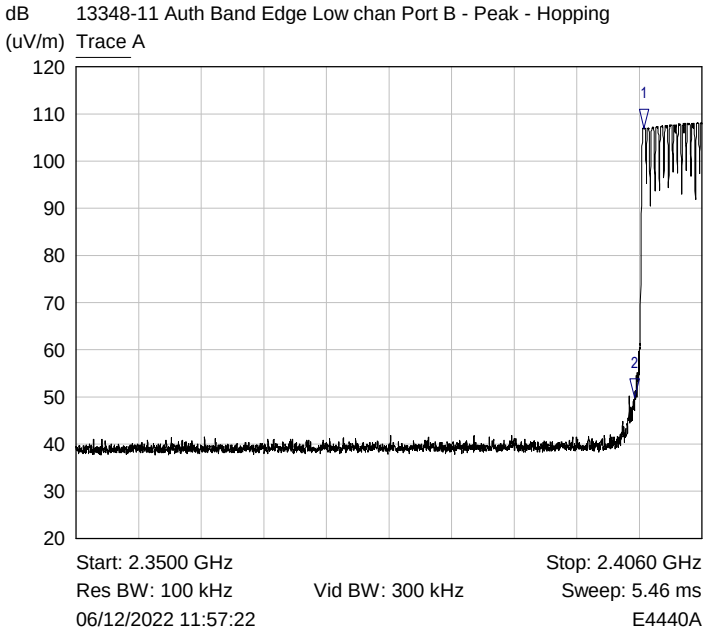
Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4008 GHz	106.01 dB(uV/m)	
2 ▽	Trace A	2.3900 GHz	48.33 dB(uV/m)	

Restricted band edge Peak Plot



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4007 GHz	107.07 dB(uV/m)	
2 ▽	Trace A	2.4000 GHz	63.49 dB(uV/m)	43.6 dBc

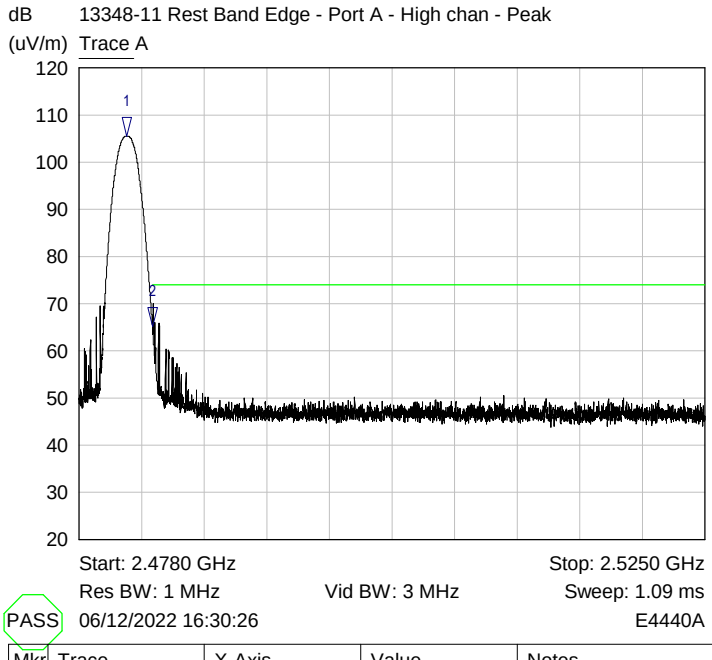
Authorised Band Edge Plot



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4008 GHz	107.01 dB(uV/m)	
2 ▽	Trace A	2.4000 GHz	49.87 dB(uV/m)	57.1 dBc

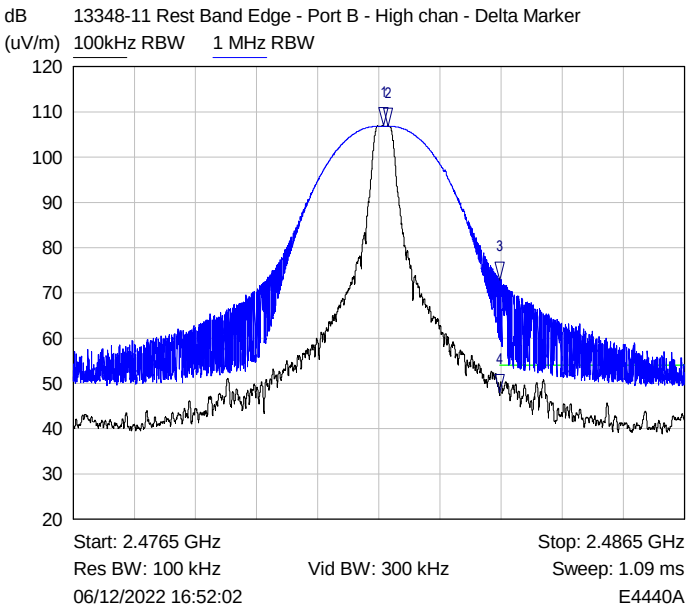
Authorised Band Edge hop Plot

RF Parameters: Band 2400-2483.5 MHz (Port A), Power 10 dBm, Channel Spacing 400 kHz, Modulation FHSS 2.4G Proprietary Port B, Channel 2481.6 MHz



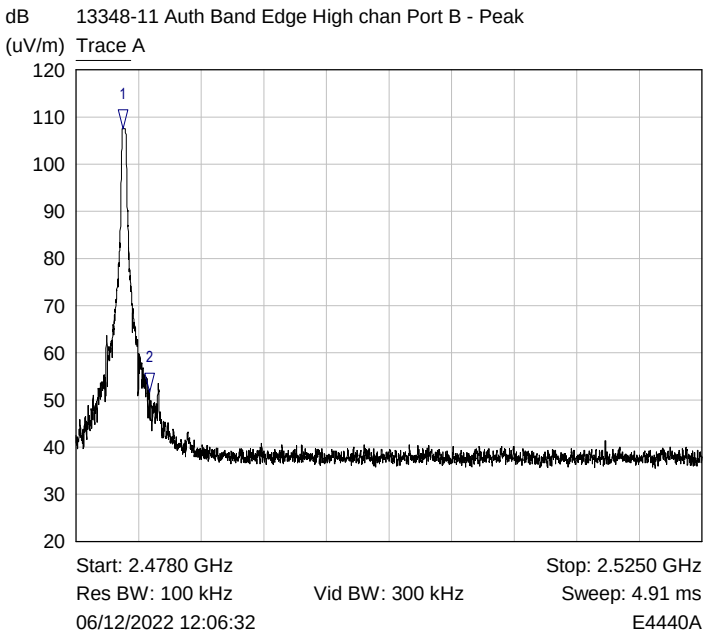
Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4816 GHz	105.54 dB(uV/m)	
2 ▽	Trace A	2.4835 GHz	65.20 dB(uV/m)	

Restricted band edge Peak Plot



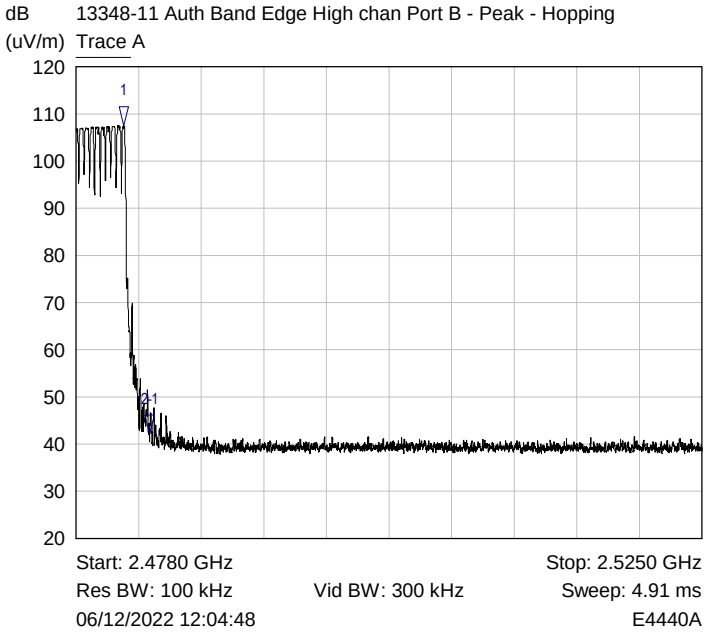
Mkr	Trace	X-Axis	Value	Notes
1 ▽	100kHz RBW	2.4816 GHz	106.92 dB(uV/m)	
2 ▽	1 MHz RBW	2.4817 GHz	106.84 dB(uV/m)	
3 ▽	1 MHz RBW	2.4835 GHz	72.84 dB(uV/m)	47.87 dBuV/m @3m Res BE
4 ▽	100kHz RBW	2.4835 GHz	47.95 dB(uV/m)	58.97 dBc Mkr 4to2

Restricted band edge Average Plot



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4815 GHz	107.53 dB(uV/m)	
2 ▽	Trace A	2.4835 GHz	51.74 dB(uV/m)	55.8 dBc

Authorised Band Edge Plot

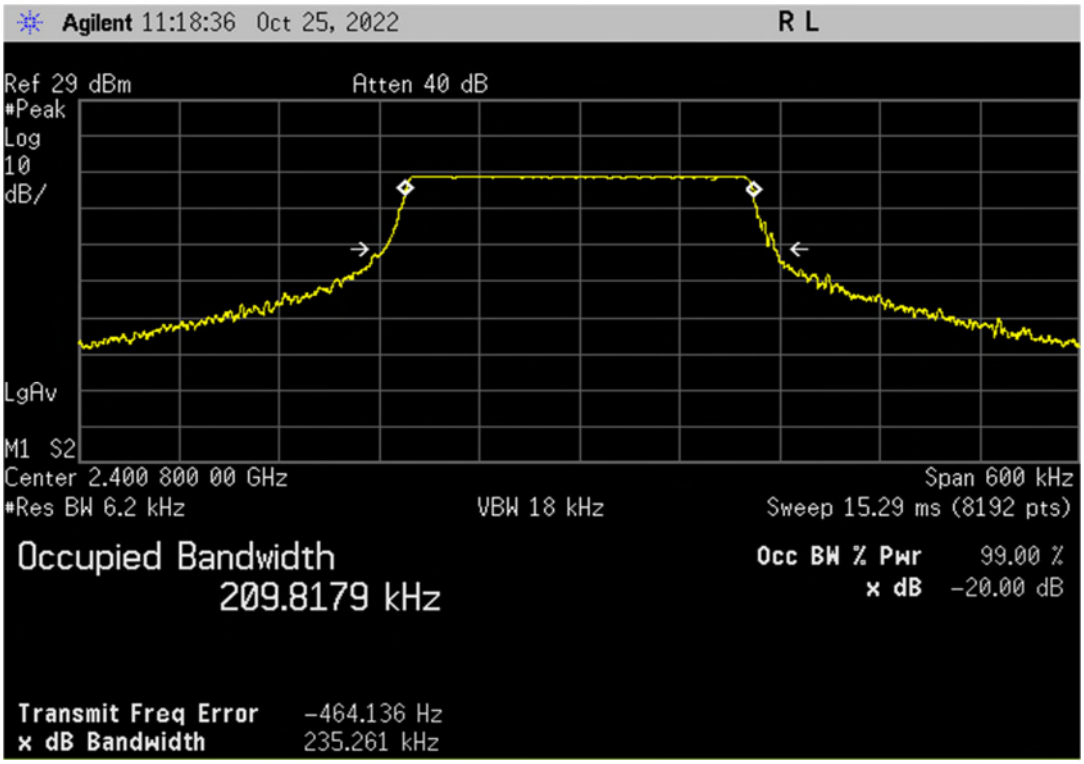


Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4816 GHz	107.48 dB(uV/m)	
2-1 ▽	Trace A	1.9108 MHz	-65.37 dB	65.4 dBc

Authorised Band Edge hop Plot

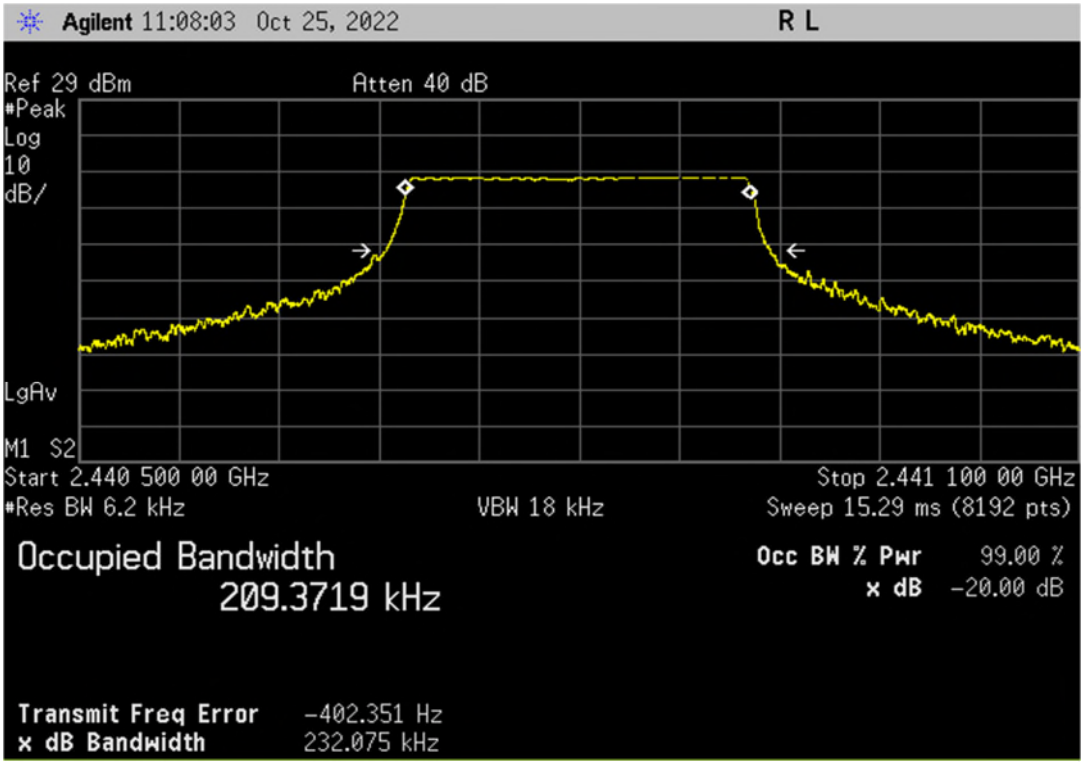
6.8 Occupied bandwidth

RF Parameters: Band 2400-2483.5 MHz, Power 10 dBm, Channel Spacing 400 kHz, Modulation FHSS 2.4G Proprietary, Channel 2400.8 MHz



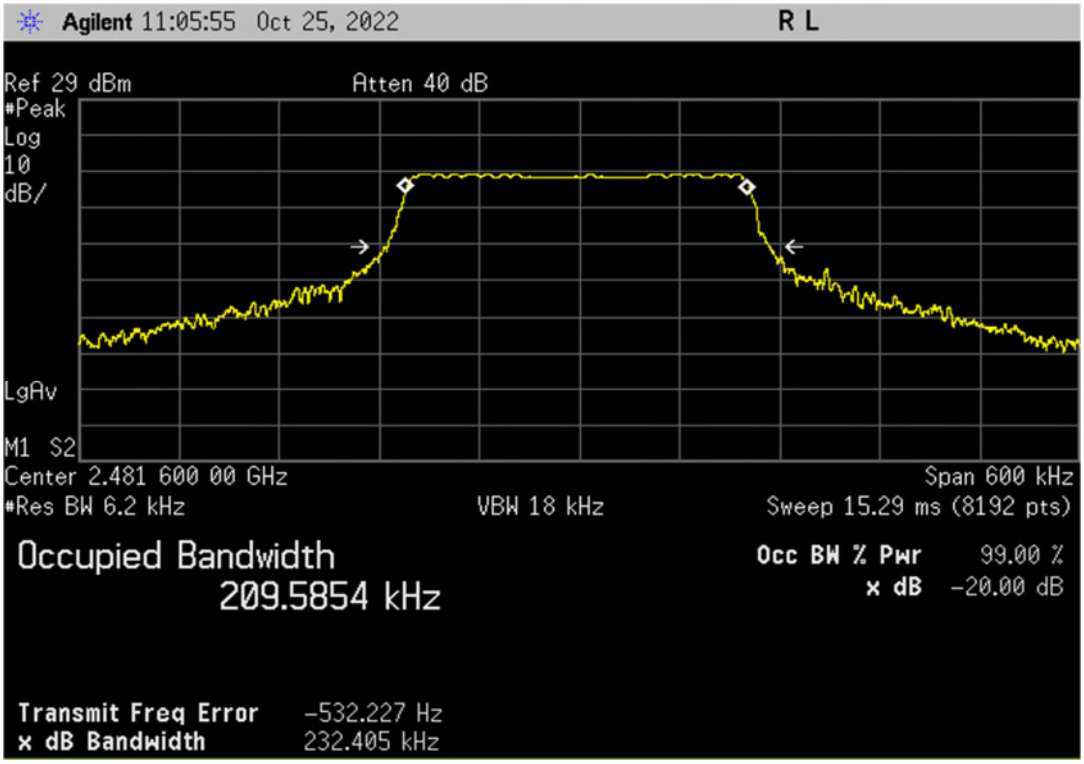
Plot for 20 dB Bandwidth Result (kHz)

RF Parameters: Band 2400-2483.5 MHz, Power 10 dBm, Channel Spacing 400 kHz, Modulation FHSS 2.4G Proprietary, Channel 2440.8 MHz



Plot for 20 dB Bandwidth Result (kHz)

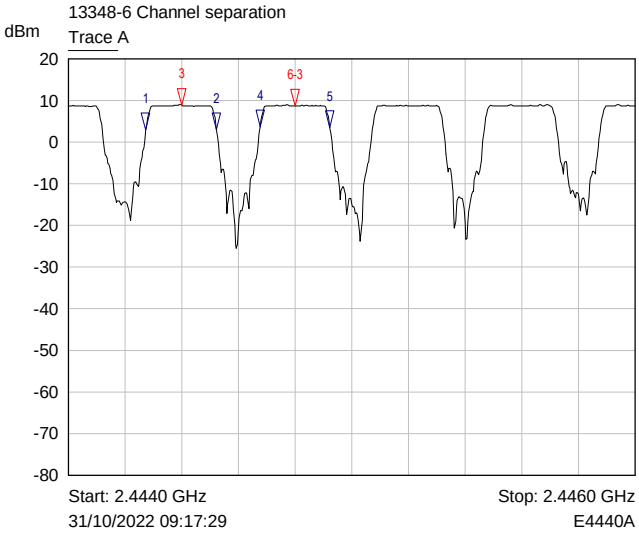
RF Parameters: Band 2400-2483.5 MHz, Power 10 dBm, Channel Spacing 400 kHz, Modulation FHSS 2.4G Proprietary, Channel 2481.6 MHz



Plot for 20 dB Bandwidth Result (kHz)

6.9 FHSS carrier frequency separation

RF Parameters: Band 2400-2483.5 MHz, Power 10 dBm, Channel Spacing 400 kHz, Modulation Port A FHSS 2.4G Proprietary

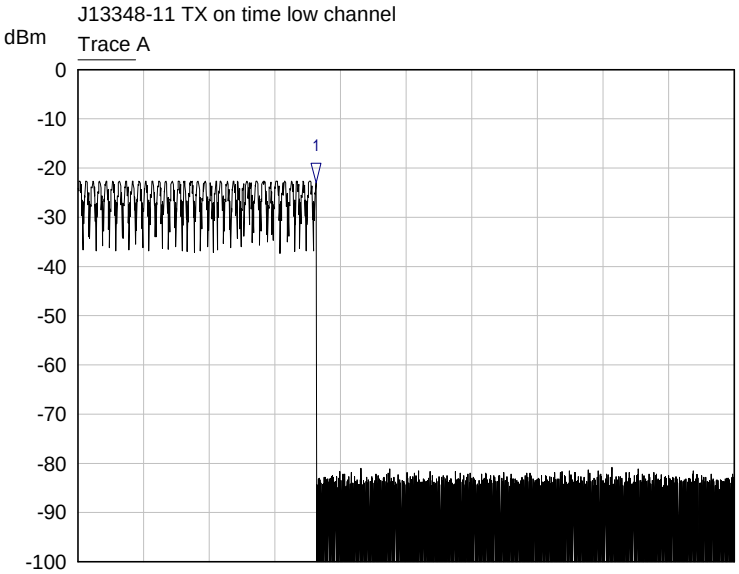


Mkr	Trace	X-Axis	Value	Notes
1	Trace A	2.4443 GHz	3.00 dBm	
2	Trace A	2.4445 GHz	3.03 dBm	
3	Trace A	2.4444 GHz	8.85 dBm	
4	Trace A	2.4447 GHz	3.68 dBm	
5	Trace A	2.4449 GHz	3.58 dBm	
6-3	Trace A	400.0000 kHz	-0.10 dB	Channel spacing

Plot of Separation (kHz)

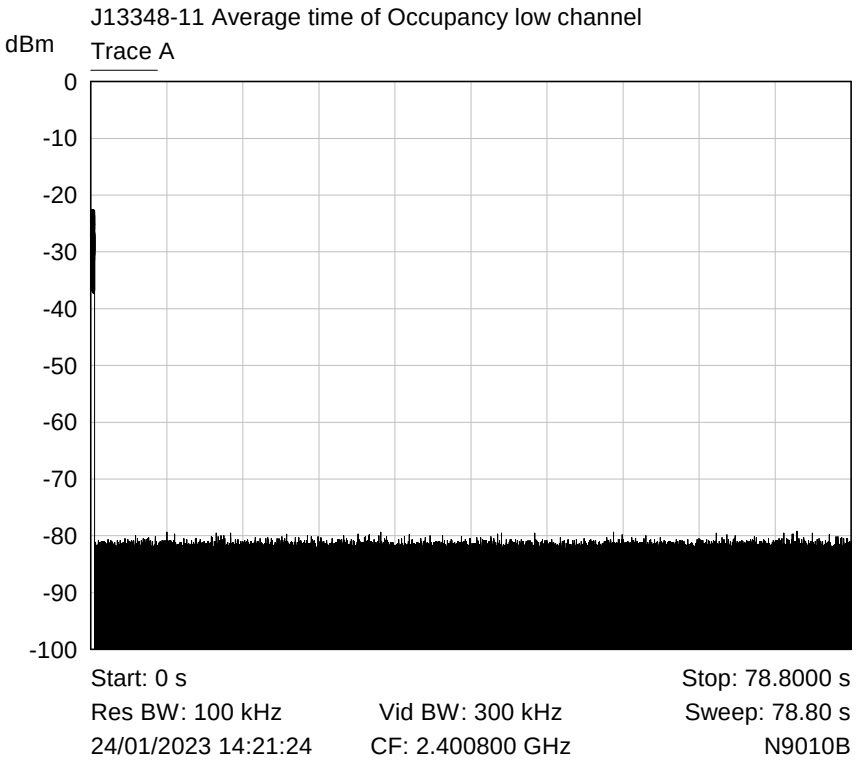
6.10 Average time of occupancy

RF Parameters: Band 2400-2483.5 MHz, Power 10 dBm, Channel Spacing 400 kHz, Modulation Port A FHSS 2.4G Proprietary, Channel 2440.8 MHz



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	362.4800 ms	-23.02 dBm	

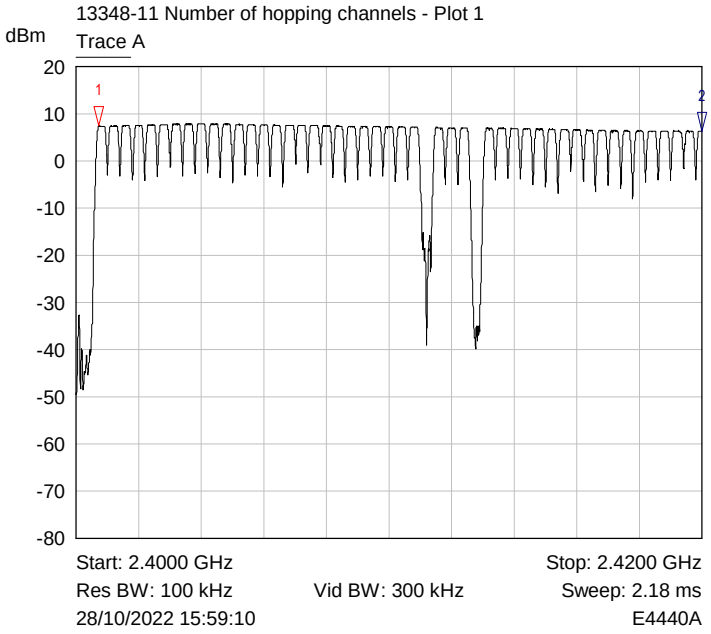
Measured Dwell time/pulse width (ms)



Period time (s)

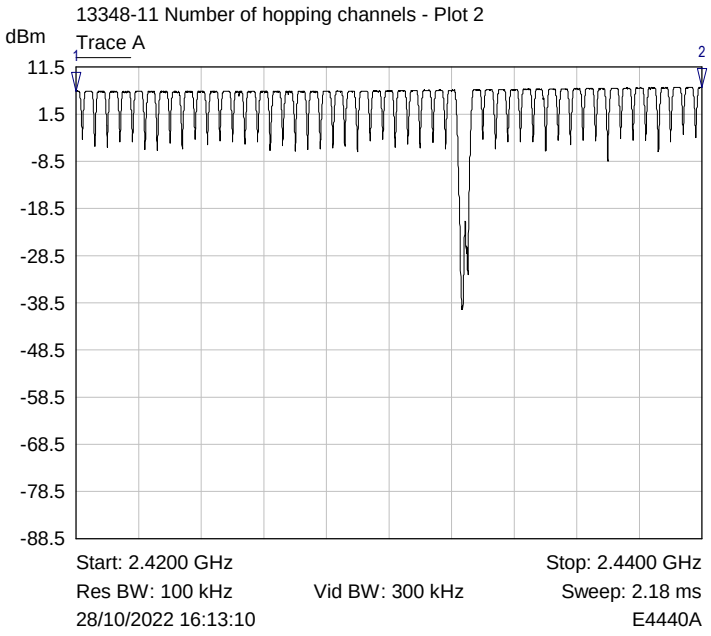
6.11 Number of Hop Channels

RF Parameters: Band 2400-2483.5 MHz, Power 10 dBm, Channel Spacing 400 kHz, Modulation Port A FHSS 2.4G Proprietary, Channel 2400.8 MHz



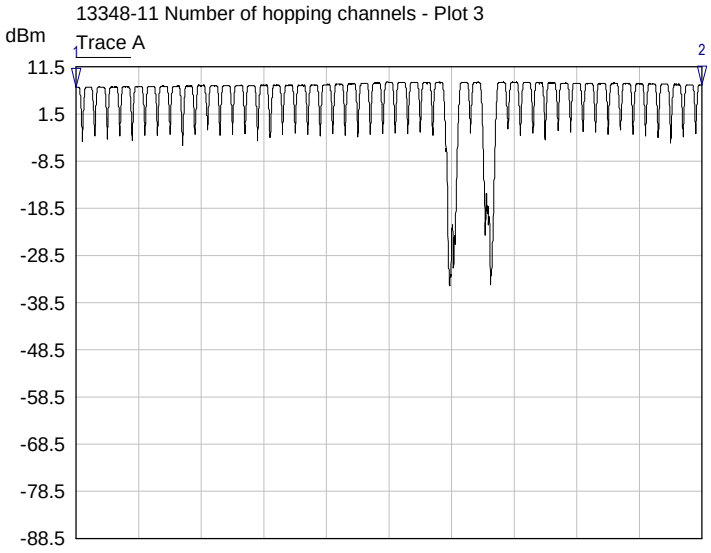
Mkr	Trace	X-Axis	Value	Notes
1	Trace A	2.4007 GHz	7.44 dBm	Channel 1
2	Trace A	2.4200 GHz	6.35 dBm	

Plot 1 of Hopping Channels 2.4-2.42 GHz



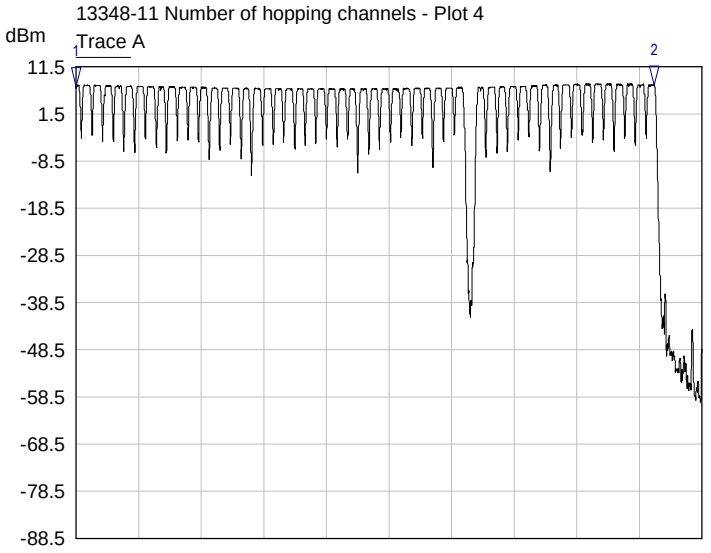
Mkr	Trace	X-Axis	Value	Notes
1	Trace A	2.4200 GHz	6.39 dBm	
2	Trace A	2.4400 GHz	7.15 dBm	

Plot 2 of Hopping Channels 2.42-2.44 GHz



Mkr	Trace	X-Axis	Value	Notes
1	Trace A	2.4400 GHz	7.14 dBm	
2	Trace A	2.4600 GHz	7.63 dBm	

Plot 3 of Hopping Channels 2.44-2.46 GHz



Mkr	Trace	X-Axis	Value	Notes
1	Trace A	2.4600 GHz	7.35 dBm	
2	Trace A	2.4817 GHz	7.65 dBm	

Plot 1 of Hopping Channels 2.46-2.4835 GHz

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 x 100^2 = 0.9 µW/m^2 = (EIRP Linear)

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

8 Photographs

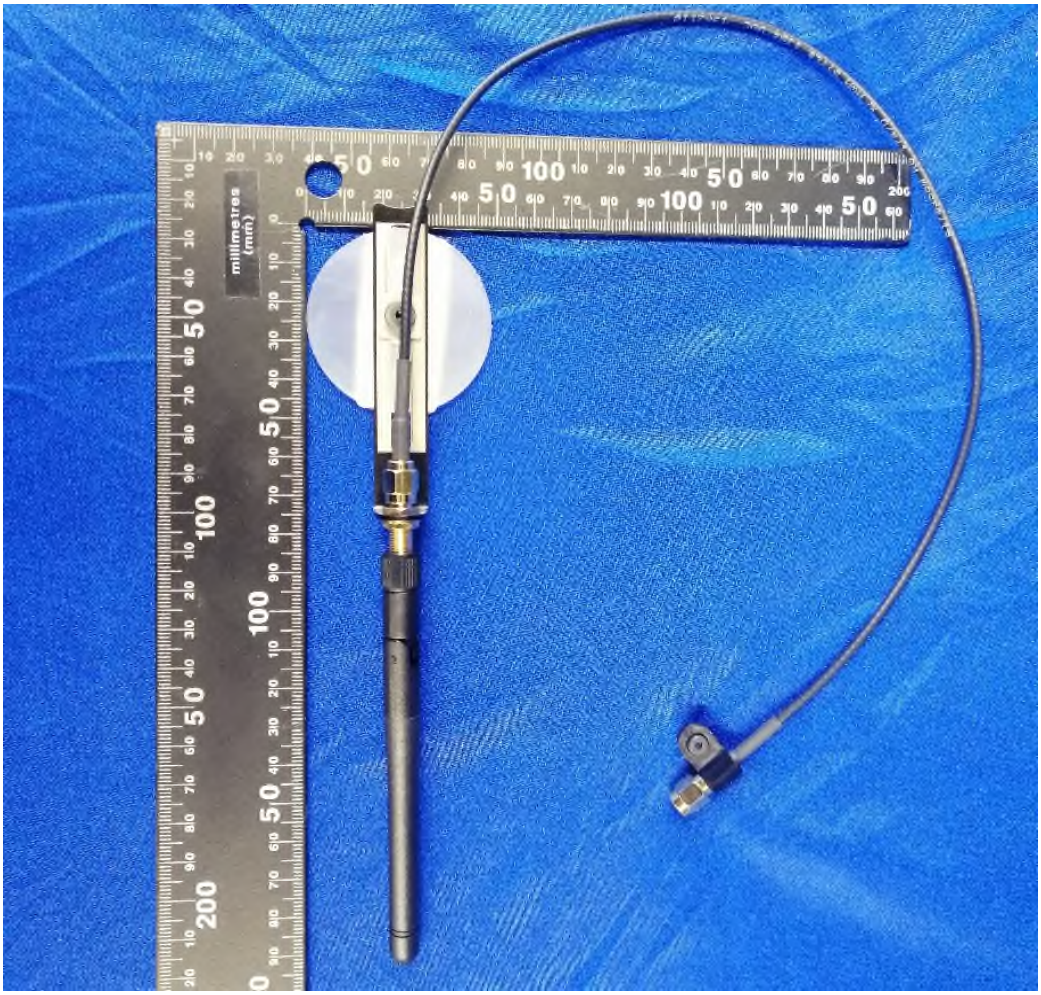
8.1 EUT Front View

8.2 EUT Reverse Angle

8.3 EUT Left side View

8.4 EUT Right side View

8.5 EUT Antenna Port



8.6 EUT Display & Controls

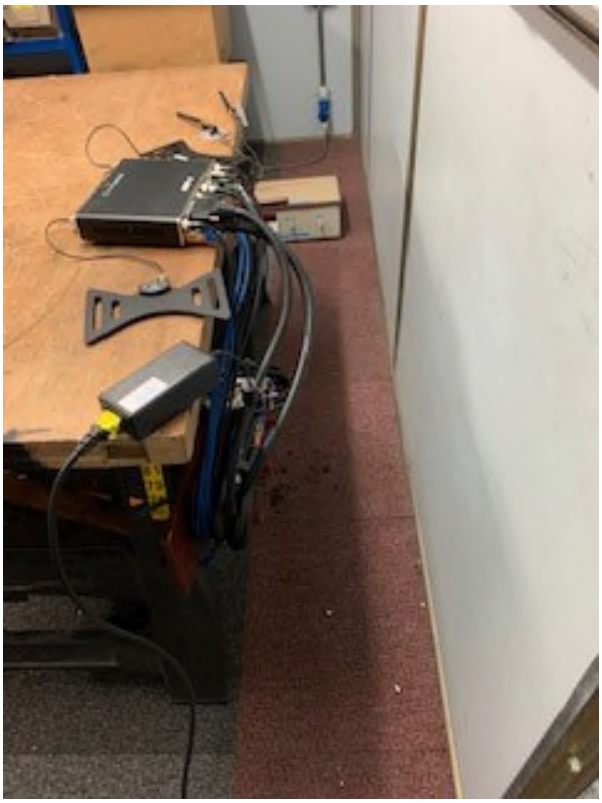
8.7 EUT Internal photos

Due to the complexity of the EUT, no internal photographs were taken

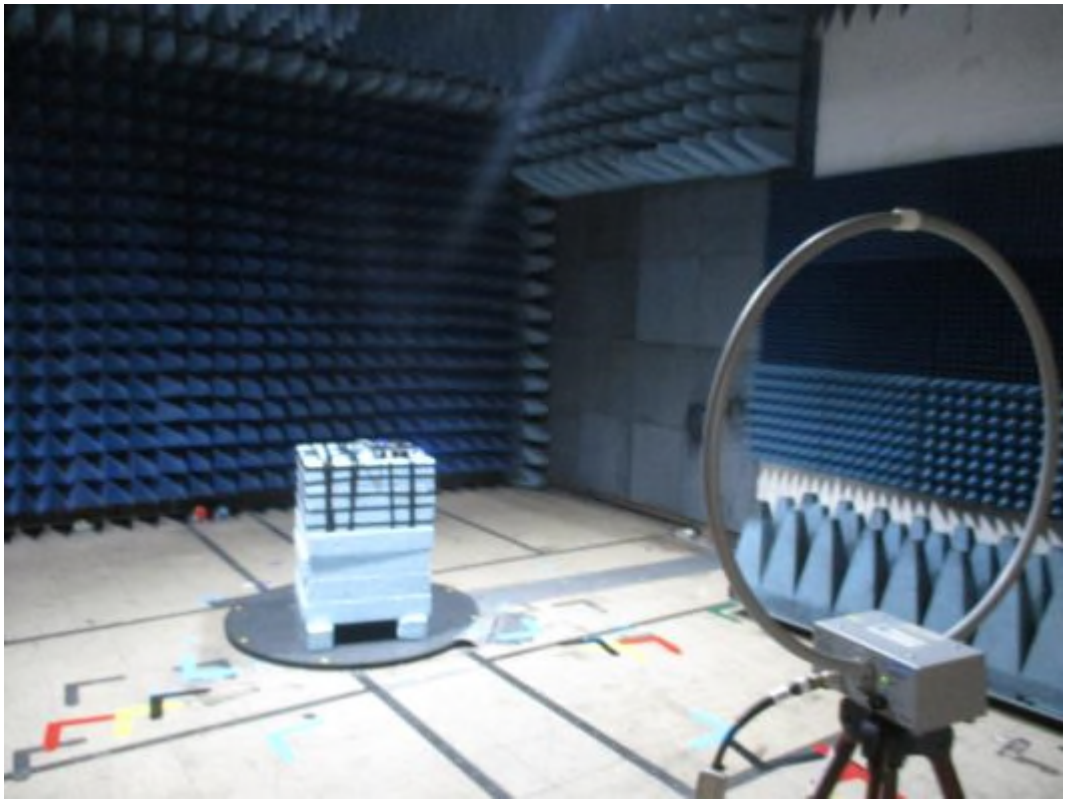
8.8 EUT ID Label

8.9 EUT Chassis

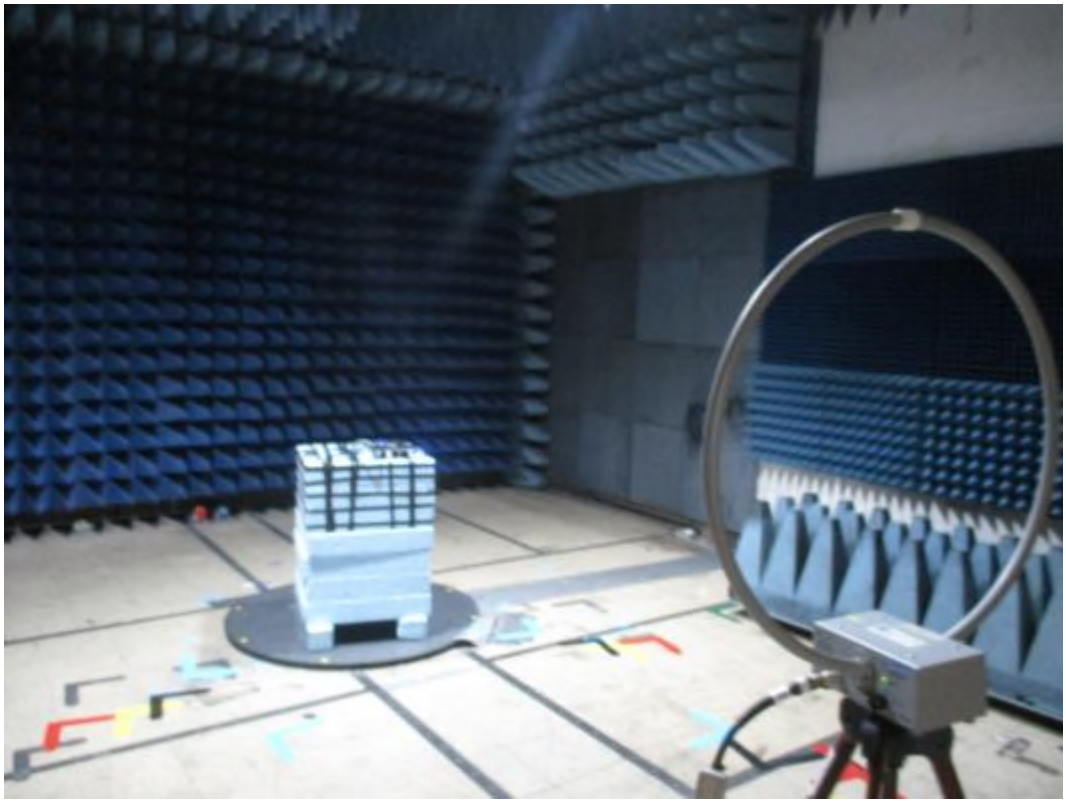
8.10 AC power line conducted emissions



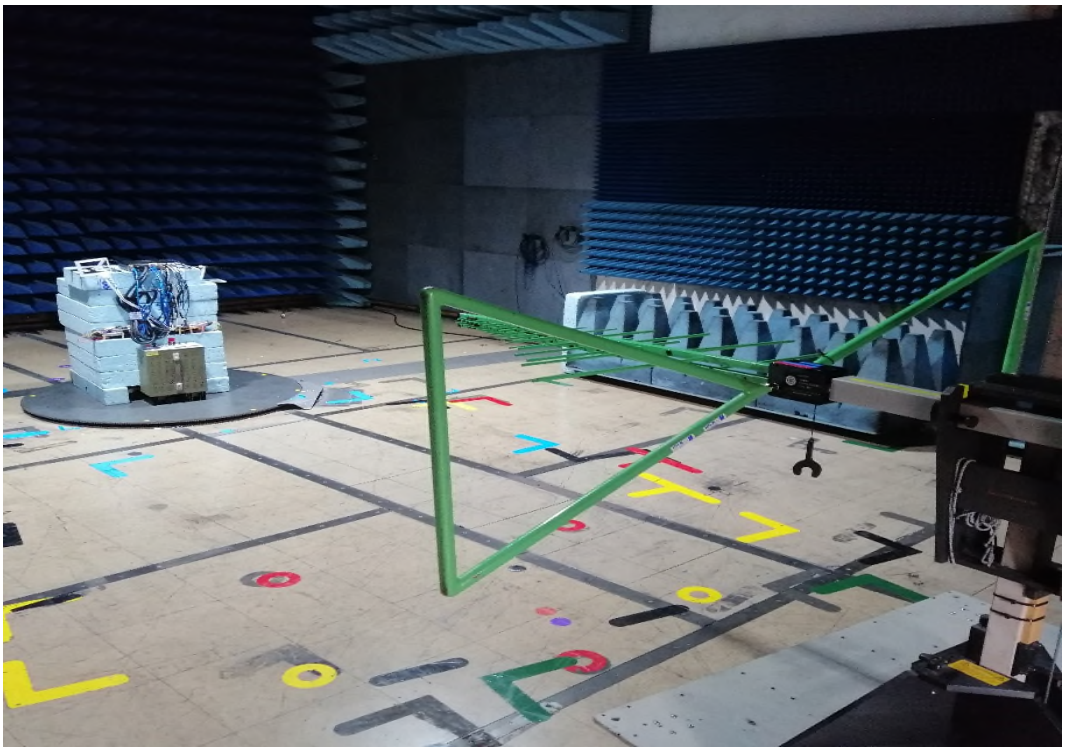
8.11 Radiated emissions 9 - 150 kHz

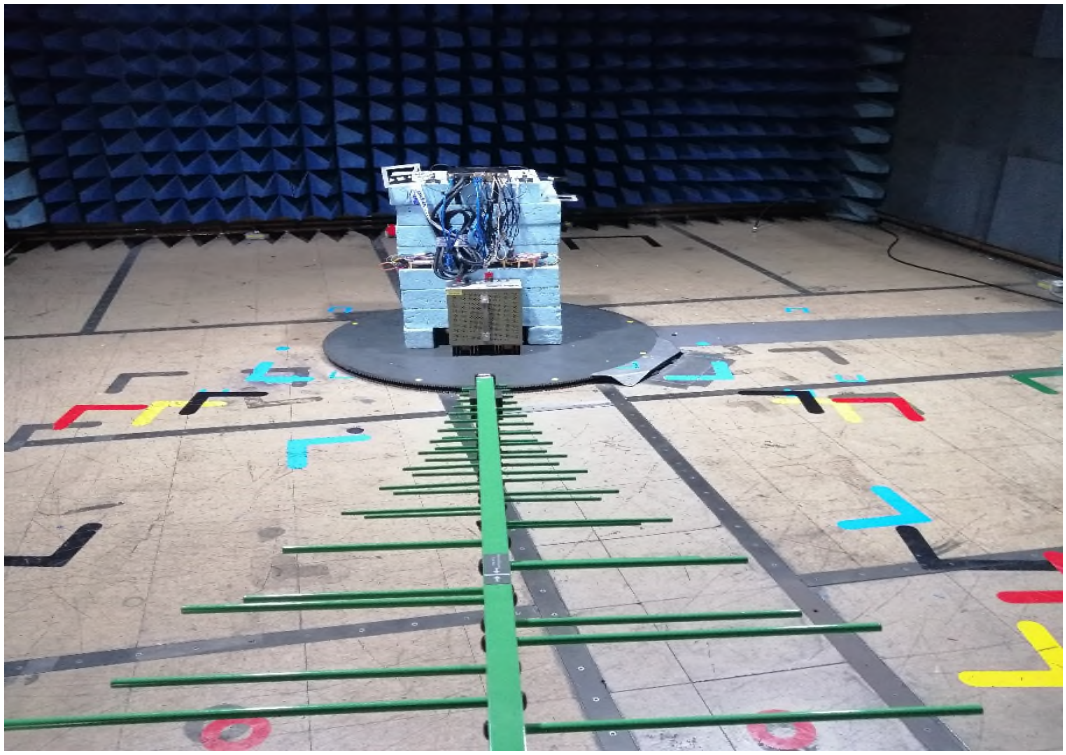


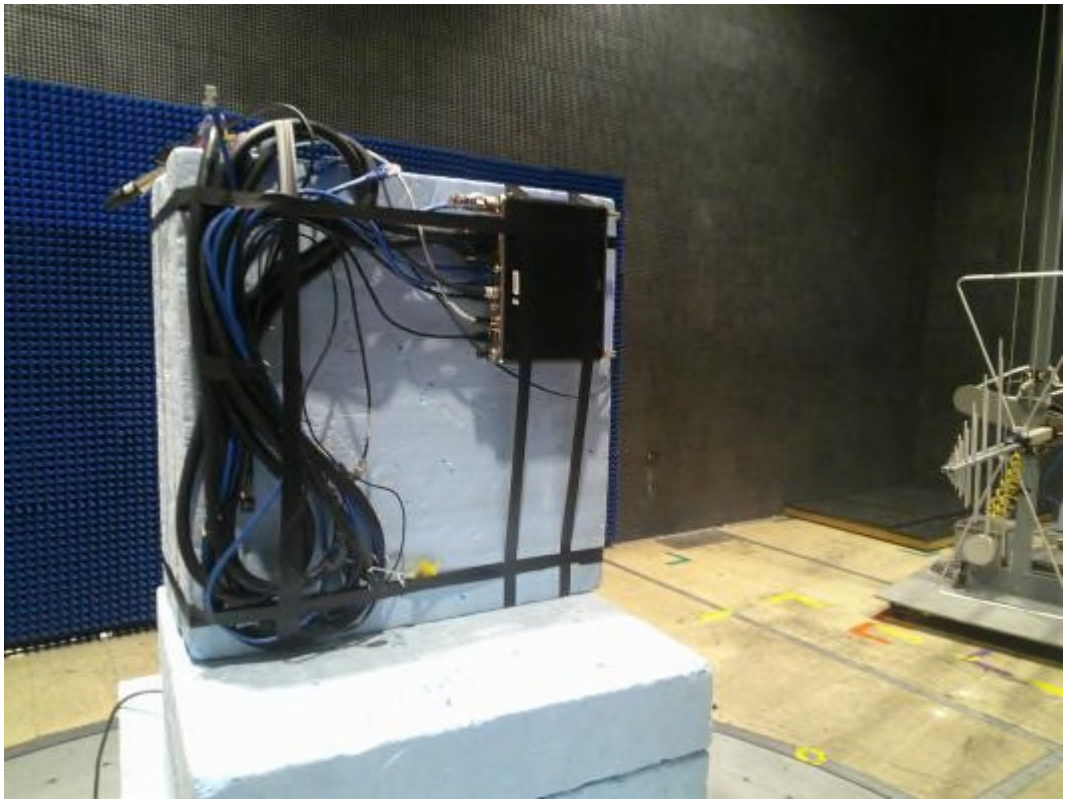
8.12 Radiated emissions 150 kHz - 30 MHz



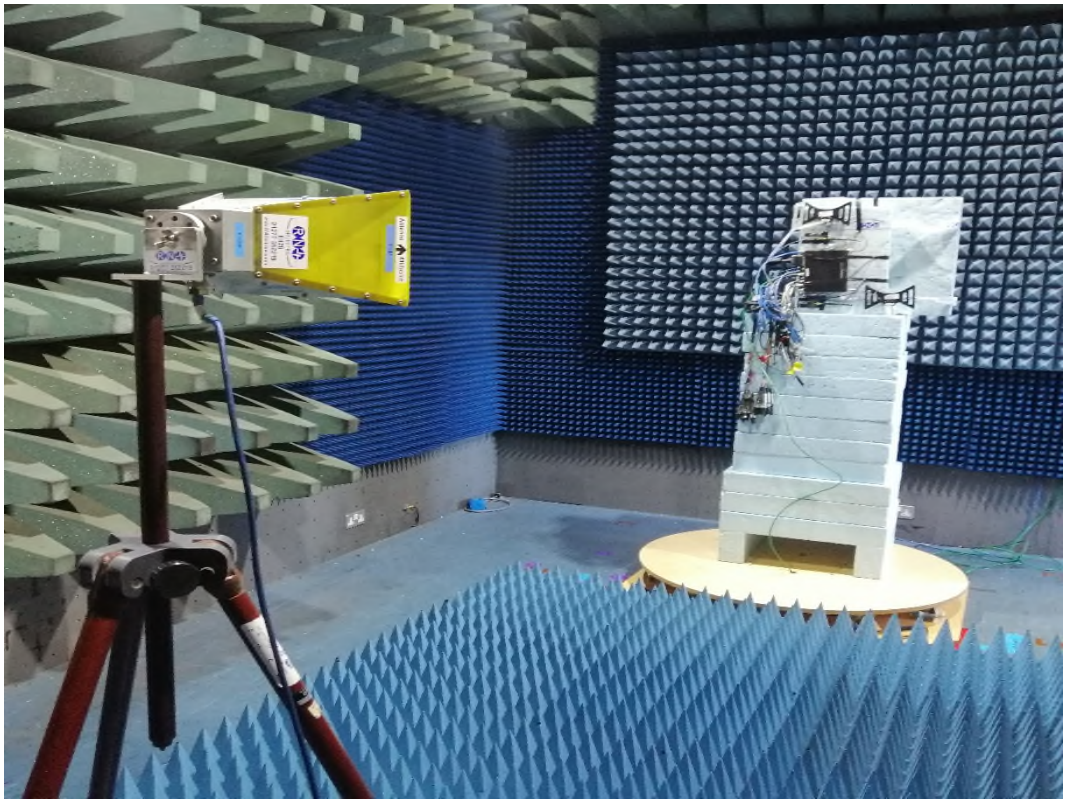
8.13 Radiated emissions 30 MHz -1 GHz

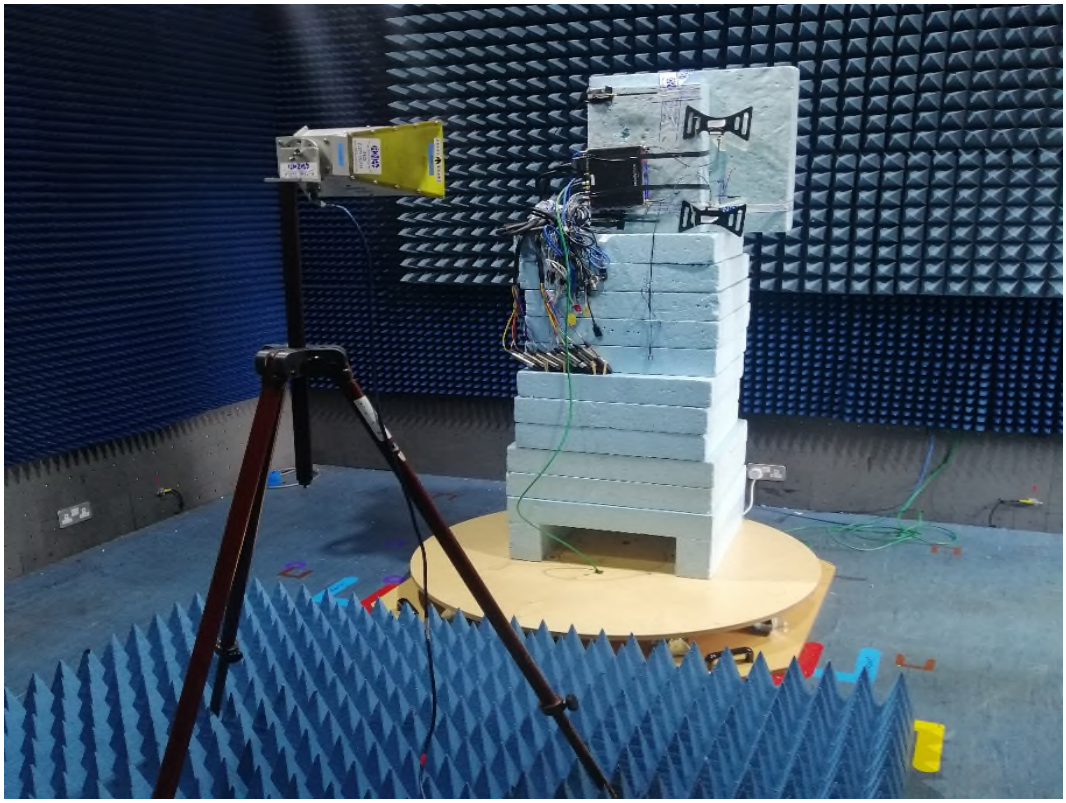


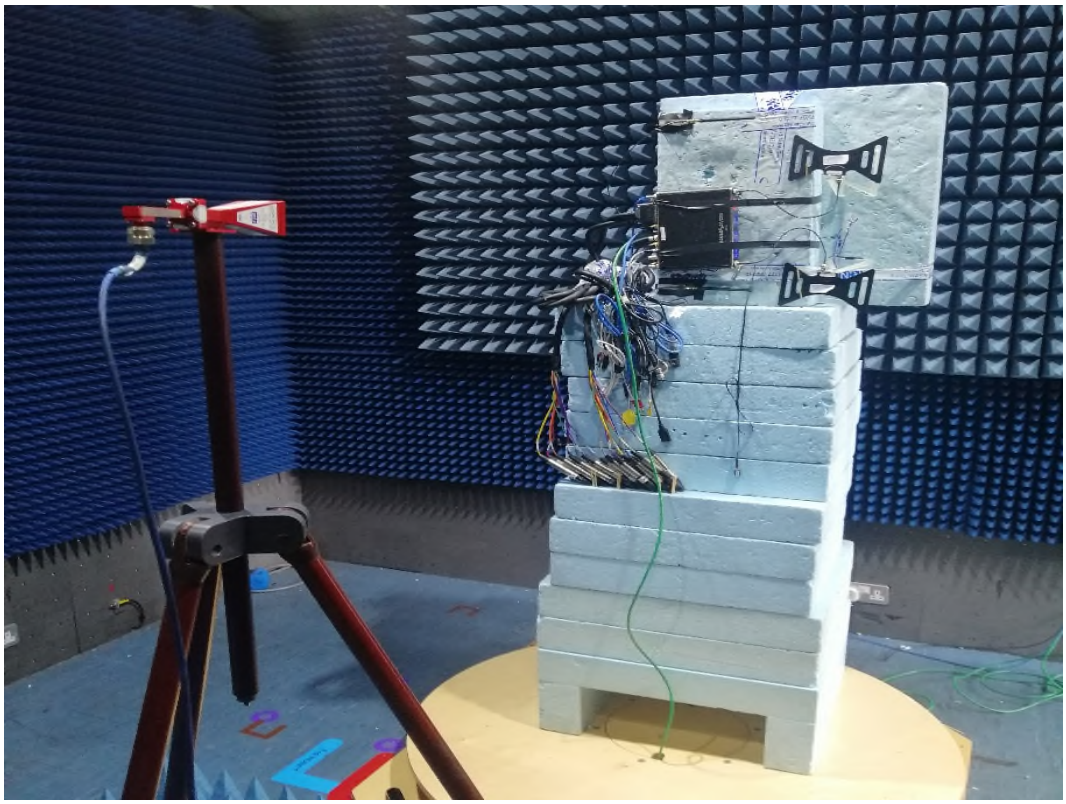


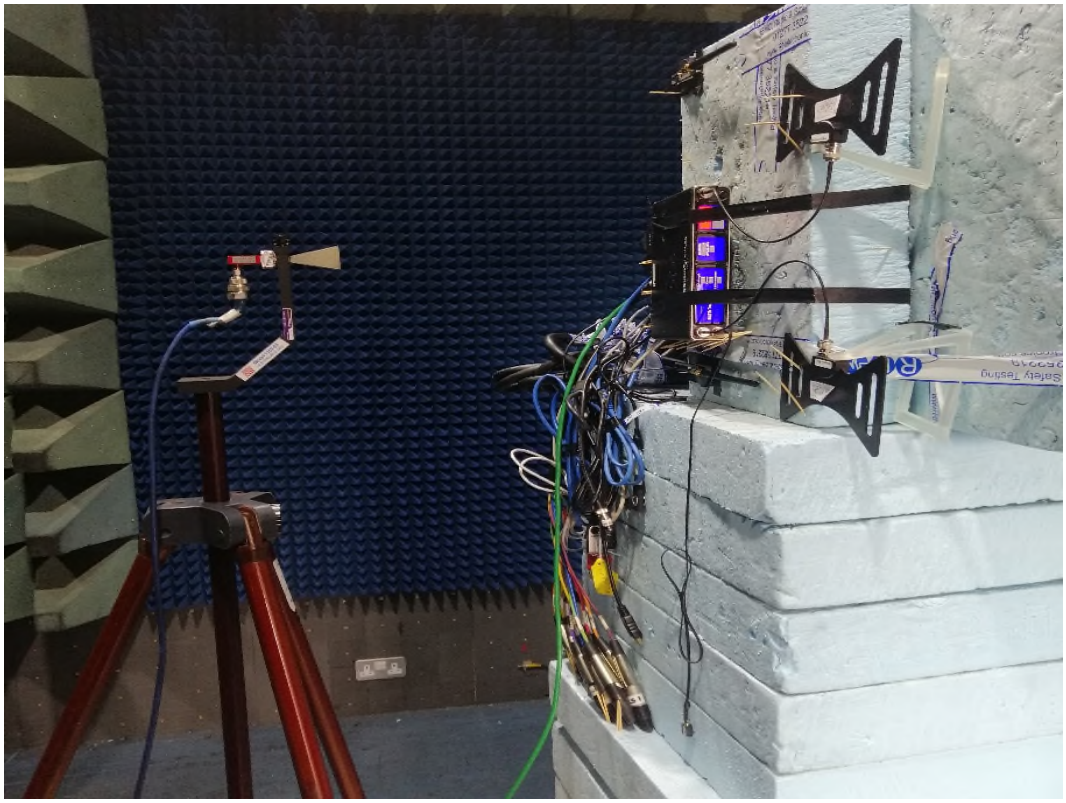


8.14 Radiated emissions above 1 GHz

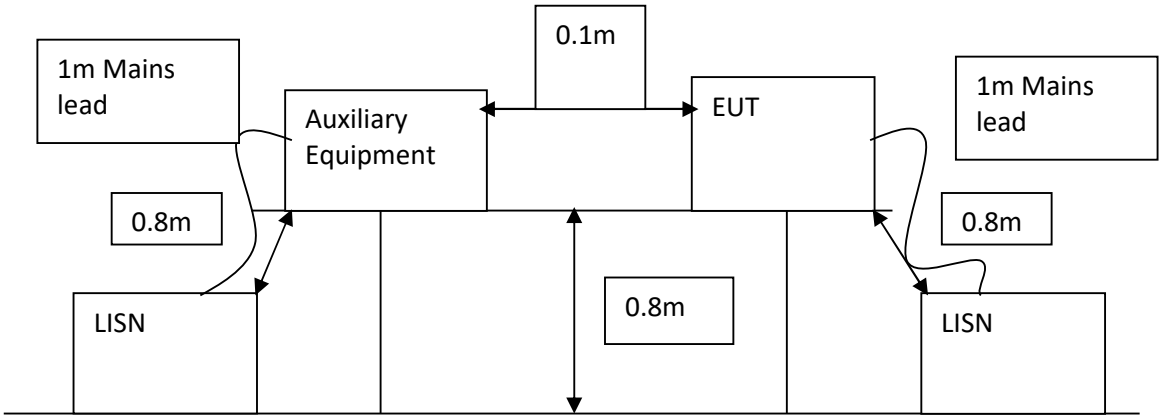




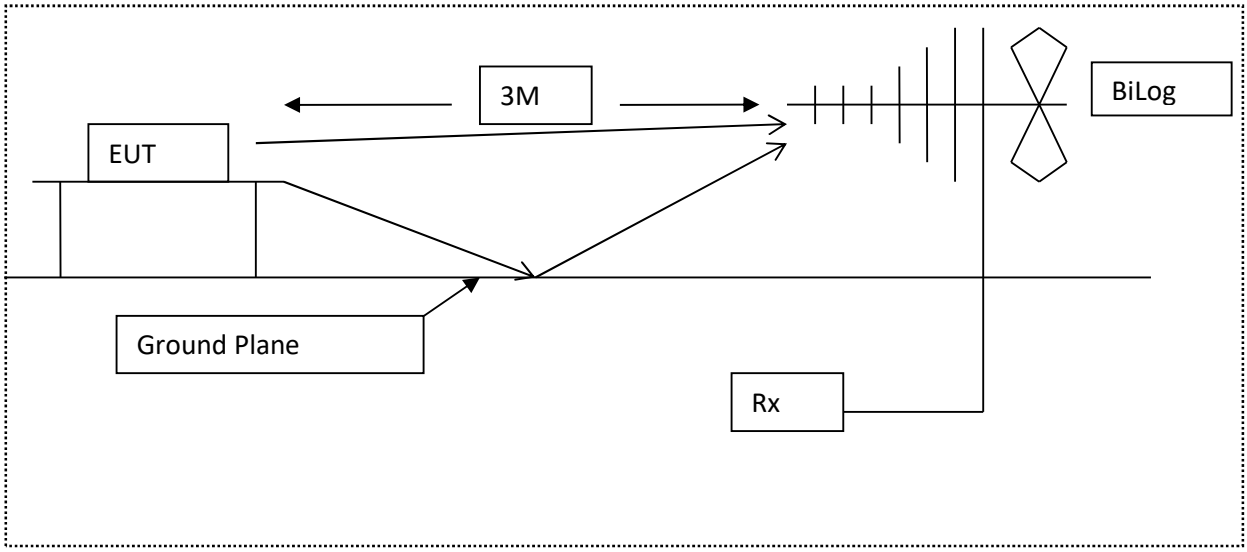




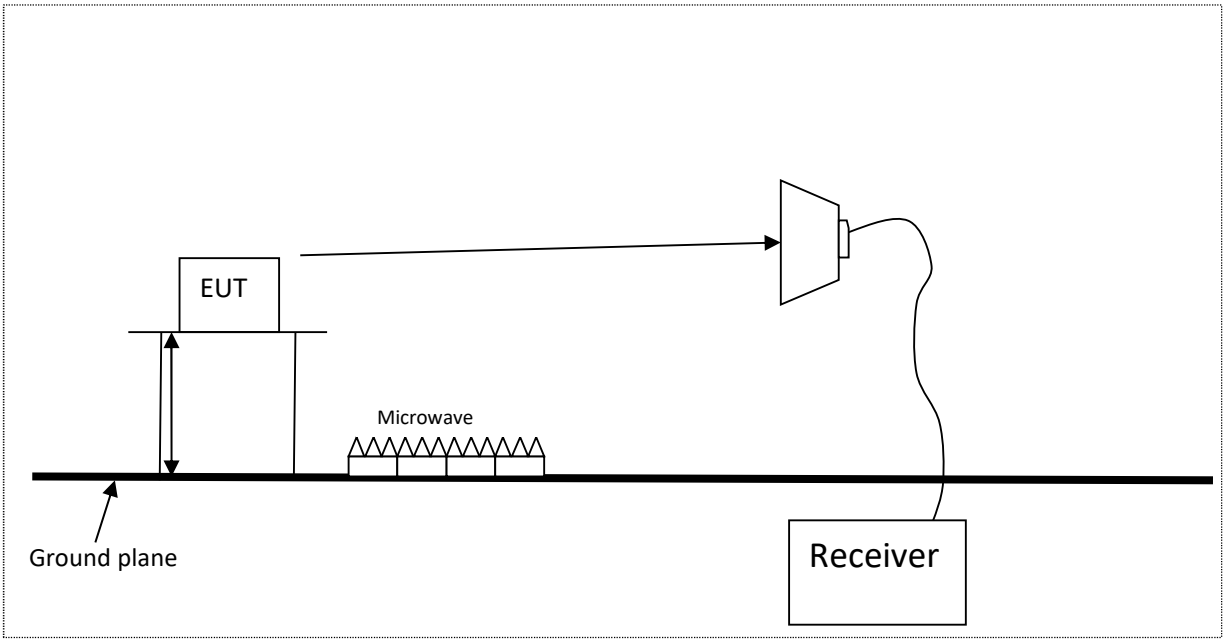
8.15 Emission diagrams



AC conducted emissions test setup for bench top equipment



Radiated Emissions test setup below 1GHz for bench top equipment



Radiated Emissions test setup above 1GHz for bench top equipment

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
E035	11947A	Transient Limiter 9kHz - 200MHz	Hewlett Packard	#16-Dec-2022	12 months
E150	MN2050	LISN 13A	Chase	25-Apr-2022	12 months
E289	8449B	Pre-Amplifier 1GHz - 26.5GHz	Hewlett Packard	24-Jun-2022	12 months
E307	769-10	Attenuator 10dB 6GHz 150W	Narda	#28-Nov-2022	12 months
E411	N9039A	9 kHz - 1 GHz RF Filter Section	Agilent Technologies	07-Jul-2022	12 months
E412	E4440A	PSA 3 Hz - 26.5 GHz	Agilent Technologies	21-Jun-2022	24 months
E420	E4438C	Signal Generator 250 kHz - 3 GHz	Agilent Technologies	24-Aug-2022	12 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
E558	18N20W-30dB	Attenuator 30dB 20W	Inmet	17-Mar-2022	12 months
E624	E4440A	PSA 3 Hz - 26.5 GHz	Agilent Technologies	06-Jul-2022	24 months
E640	6630.19.AA	Attenuator 30dB 18GHz	Suhner	15-Feb-2022	12 months
E642	E4440A	PSA 3 Hz - 26.5 GHz	Agilent Technologies	#06-Dec-2022	24 months
E654	MWX221	Cable N Type to SMA Blue 2m (B)	Junflon	11-Oct-2022	12 months
E743	2017 4/2dB	Attenuator 4/2dB 30-1000MHz	RN Electronics	10-Mar-2022	12 months
E777	MG3695B	Signal Generator 8 MHz - 50 GHz	Anritsu	21-Jun-2022	12 months
E856	N9039A	9 kHz - 1 GHz RF Filter Section	Agilent Technologies	#06-Dec-2022	12 months
E904	5086-7805	Pre-Amplifier 1GHz - 26.5GHz	Hewlett Packard	04-Mar-2022	12 months
F307	AA18-10H	SMA Attenuator 10dB 18GHz	Atlantic Microwave	15-Feb-2022	12 months
H071	N9010B	EXA Signal Analyser 10 Hz to 44 GHz	Keysight Technologies	#12-Dec-2022	24 months
H072	N9000B	CXA Signal Analyser 9 kHz to 26.5 GHz	Keysight Technologies	09-Feb-2021	24 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
TMS78	3160-08	Horn Std Gain 12.4 - 18 GHz	ETS Systems	30-Sep-2022	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
ZSW1	V2.5.2	Measurement Software Suite	RN Electronics	N/A	N/A

Equipment was within calibration dates for tests and has been re-calibrated since/during date of tests.

10 Auxiliary and peripheral equipment

10.1 Customer supplied equipment

Item No.	Model No.	Description	Manufacturer	Serial No.
1	Galaxy Tab S5e	Tablet	Samsung	Not stated
2	A20-MINI	Wireless Microphone Transmitter	Sound Devices LLC	GE0321181000
3	Not stated	50 Ohm load (Audio RX A port)	Not stated	Not stated
4	Not stated	33 Ohm load (Headphone Input)	Not stated	Not stated
5	Not stated	50 Ohm load (Audio Rx B port)	Not stated	Not stated
6	Not stated	62 Ohm load (DC O/P 2)	Not stated	Not stated
7	Not stated	62 Ohm load (DC O/P 1)	Not stated	Not stated
8	Not stated	50 Ohm load (Audio RX B port)	Not stated	Not stated
9	Not stated	50 Ohm load (Audio RX A port)	Not stated	Not stated
10	Not stated	50 Ohm load (2.4 GHz A port)	Not stated	Not stated
11	Not stated	50 Ohm load (2.4 GHz B port)	Not stated	Not stated
12	Not stated	USB Stick (USB 2 port)	Not stated	Not stated
13	Not stated	USB Stick (USB-C port)	Not stated	Not stated
14	Not stated	150 Ohm load (MIC / LINE / AES O/P 2)	Not stated	Not stated
15	Not stated	110 Ohm load (MIC / LINE / AES O/P 2)	Not stated	Not stated
16	Not stated	150 Ohm load (MIC / LINE / AES O/P 1)	Not stated	Not stated
17	Not stated	110 Ohm load (MIC / LINE / AES O/P 1)	Not stated	Not stated

10.2 RN Electronics supplied equipment

RN No.	Model No.	Description	Manufacturer	Serial No
P274	TPS2000	PSU 15V 10A	TOPWARD ELECTRIC INSTRUMENTS	920243
N/A	None	USB Memory Stick	Not Specified	N/A

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

Test	Modification	Time of modification
Average time of occupancy	Client updated EUT firmware so AVG occupancy time is below 400ms. Firmware file supplied: A20- ini_7.20.7090_23010902.prg	During Test

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

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