Radio Test Report

Dynamic Metrics Ltd

GaitSmart

GS2

47 CFR Part 15.247 Effective Date 1st October 2021
DSS: Part 15 Spread Spectrum Transmitter
Test Date: 6th December 2022 to 2nd February 2023
Report Number: 02-13840-1-23 Issue 01

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

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

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

Certificate of Test 13840-1

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

Equipment:	GaitSmart
Model Number:	GS2
Unique Serial Number:	78:DB:2F:2B:D4:E2 (Radiated unit) 7C:01:0A:2F:58:46 (Conducted unit)
Applicant:	Dynamic Metrics Ltd Codicote Innovation Centre, St Albans Road Codicote, Hertfordshire SG4 8WH
Proposed FCC ID	2A9NE-GS2
Full measurement results are detailed in Report Number:	02-13840-1-23 Issue 01
Test Standards:	47 CFR Part 15.247 Effective Date 1st October 2021 DSS: Part 15 Spread Spectrum Transmitter

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

DEVIATIONS:
No deviations have been applied.

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

Date of Test:	6th December 2022 to 2nd February 2023
Test Engineer: Chee-Wah Yeung	Chee-Wah Yeung Digitally signed by: Chee-Wah Yeung DN: CN = Chee-Wah Yeung email = chee-wah.yeung@rnelectronics.com C = GB O = RN Electronics Ltd Date: 2023.11.13 14:00:41 Z
Approved By: Radio Manager	Digitally signed by: Daniel Sims DN: CN = Daniel Sims email = Daniel.Sims@kiwa.com C = GB O = Kiwa Electrical Compliance - Brentwood Date: 2023.11.13 13:52:14 Z
Customer Representative:	

2360

1 Contents

2 Equipment under test (EUT)

2.1 Equipment specification

Applicant	Dynamic Metrics Ltd Codicote Innovation Centre St Albans Road Codicote Hertfordshire SG4 8WH	
Manufacturer of EUT	Dynamic Metrics Ltd	
Full Name of EUT	GaitSmart	
Model Number of EUT	GS2	
Serial Number of EUT	78:DB:2F:2B:D4:E2 (Radiated) 7C:01:0A:2F:58:46 (Conducted)	
Date Received	6th December 2022	
Date of Test:	6th December 2022 to 2nd February 2023	
Purpose of Test	To demonstrate design compliance to the relevant rules of Chapter 47 of the Code of Federal Regulations.	
Date Report Issued	14th September 2023	
Main Function	Sensor is an IMU and is controlled by a Smart App on a tablet.	
Information Specification	Height	22 mm
	Width	160 mm
	Depth	130 mm
	Weight	0.5 kg
	Voltage	3.7 Vdc
	Current	13 mA

2.2 Configurations for testing

General Parameters	
EUT Normal use position	Portable - Fixed to lower half of human or animal body
Choice of model(s) for type tests	GS2
Antenna details	Integral antenna: 2.45GHz single ceramic chip antenna. Linx Technology 712-ANT-2.45-CHP-T. Bandwidth 180MHz.
Antenna port	No
Baseband Data port (yes/no)?	No
Highest Signal generated in EUT	2480 MHz
Lowest Signal generated in EUT	32.768 kHz
Hardware Version (HVIN)	MU0057 V1.0
Software Version	N/A
Firmware Version (FVIN)	1.2.0
Type of Equipment	portable
Technology Type	Bluetooth 4.0+ Classic
Geo-location (yes/no)	No
TX Parameters	
Alignment range – transmitter	2.4 - 2.4835 GHz
EUT Declared Modulation Parameters	GFSK, DQPSK, 8DPSK
EUT Declared Power level	< -15dBm
EUT Declared Signal Bandwidths	1MHz
EUT Declared Channel Spacing's	1MHz
EUT Declared Duty Cycle	Up to 100%
Unmodulated carrier available?	Yes
Declared frequency stability	ppm
RX Parameters	
Alignment range – receiver	2.4 - 2.4835 GHz
EUT Declared RX Signal Bandwidth	1MHz
Receiver Signal Level (RSL)	Not specified
Method of Monitoring Receiver BER	Successful message ratio
FCC Parameters	
FCC Transmitter Class	DSS: Part 15 Spread Spectrum Transmitter
FHSS Parameters	
Maximum No. Of hop channels	79
Minimum No. Of hop channels	Not specified
Dwell time per hop channel	Bluetooth classic 4.0
Return time to same channel	Not specified
Frequency Occupation (statistical)	N/A

2.3 Functional description

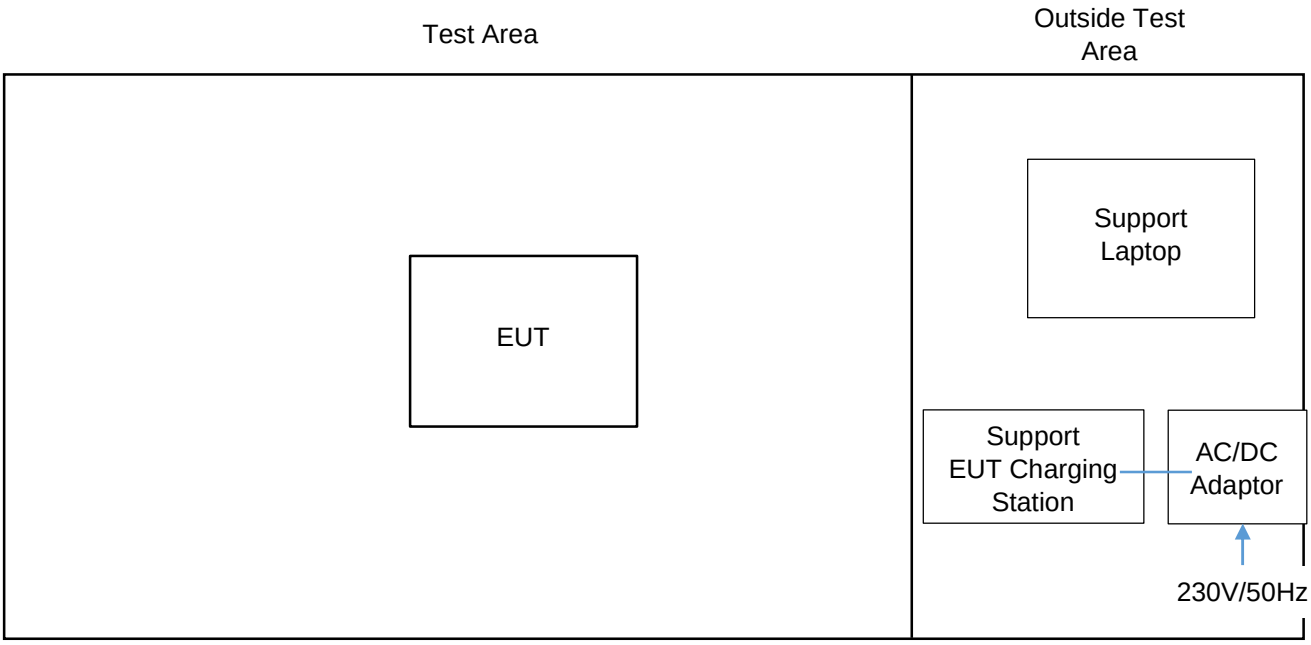
The product is to measure the motion of humans or animals in a clinical, home or outside setting. The motion is measured using a IMU sensor attached to the subject using sensor holder straps.
The GS2 GaitSmart system comprises of the following elements.
1. Charger. This item can charge up to 8 GS2 sensors. The power supply to the charger is a commercial off the shelf item supplying 5Vdc and up to 5 amps. The charger has indicator lights to notify the user the following actions: 1) Power is supplied to the charger unit. 2) A sensor is attached to the charger unit, and 3) a sensor is being charged.
2. Sensor. This item is an IMU and is powered by a lithium-ion battery. Communication to the sensor is by Bluetooth 4.0 Classic using a bespoke GS application which is installed on a user's own device (tablet or laptop). Once the application on the user's device has linked to the sensors the application communicates to the sensor to enable and carry out a set off procedures. These being battery status, time stamp, turn on/off logging motion. Transfer of logged motion data to the smart app device.
3. Application Software. This is installed on a user's own device or laptop. The function of this software to communicate to a cloud-based service. The logged data of the sensors is transferred to the cloud and calculations are carried out. The results are transferred back to the device application and displayed in a table. Depending on the results a number of exercises are suggested.

2.4 Modes of operation

Mode Reference	Description	Used for testing
Mode 1	Constant Tx, DH1, Power Setting: 10, Low Channel (2402MHz)	Yes
Mode 2	Constant Tx, DH3, Power Setting: 10, Low Channel (2402MHz)	Yes
Mode 3	Constant Tx, DH5, Power Setting: 10, Low Channel (2402MHz)	Yes
Mode 4	Constant Tx, 2-DH1, Power Setting: 10, Low Channel (2402MHz)	Yes
Mode 5	Constant Tx, 2-DH3, Power Setting: 10, Low Channel (2402MHz)	Yes
Mode 6	Constant Tx, 2-DH5, Power Setting: 10, Low Channel (2402MHz)	Yes
Mode 7	Constant Tx, 3-DH1, Power Setting: 10, Low Channel (2402MHz)	Yes
Mode 8	Constant Tx, 3-DH3, Power Setting: 10, Low Channel (2402MHz)	Yes
Mode 9	Constant Tx, 3-DH5, Power Setting: 10, Low Channel (2402MHz)	Yes
Mode 10	Constant Tx, DH1, Power Setting: 10, Mid Channel (2441MHz)	Yes
Mode 11	Constant Tx, DH3, Power Setting: 10, Mid Channel (2441MHz)	Yes
Mode 12	Constant Tx, DH5, Power Setting: 10, Mid Channel (2441MHz)	Yes
Mode 13	Constant Tx, 2-DH1, Power Setting: 10, Mid Channel (2441MHz)	Yes
Mode 14	Constant Tx, 2-DH3, Power Setting: 10, Mid Channel (2441MHz)	Yes
Mode 15	Constant Tx, 2-DH5, Power Setting: 10, Mid Channel (2441MHz)	Yes
Mode 16	Constant Tx, 3-DH1, Power Setting: 10, Mid Channel (2441MHz)	Yes
Mode 17	Constant Tx, 3-DH3, Power Setting: 10, Mid Channel (2441MHz)	Yes
Mode 18	Constant Tx, 3-DH5, Power Setting: 10, Mid Channel (2441MHz)	Yes
Mode 19	Constant Tx, DH1, Power Setting: 10, High Channel (2480MHz)	Yes
Mode 20	Constant Tx, DH3, Power Setting: 10, High Channel (2480MHz)	Yes
Mode 21	Constant Tx, DH5, Power Setting: 10, High Channel (2480MHz)	Yes
Mode 22	Constant Tx, 2-DH1, Power Setting: 10, High Channel (2480MHz)	Yes
Mode 23	Constant Tx, 2-DH3, Power Setting: 10, High Channel (2480MHz)	Yes
Mode 24	Constant Tx, 2-DH5, Power Setting: 10, High Channel (2480MHz)	Yes
Mode 25	Constant Tx, 3-DH1, Power Setting: 10, High Channel (2480MHz)	Yes
Mode 26	Constant Tx, 3-DH3, Power Setting: 10, High Channel (2480MHz)	Yes
Mode 27	Constant Tx, 3-DH5, Power Setting: 10, High Channel (2480MHz)	Yes
Mode 28	Hopping on all channels, DH5, Power Setting: 10	Yes
Mode 29	Hopping on Channel 1 (2403MHz), DH5, Power Setting: 10	Yes
Mode 30	Hopping on Channel 1 (2403MHz), 2-DH5, Power Setting: 10	Yes
Mode 31	Hopping on Channel 1 (2403MHz), 3-DH5, Power Setting: 10	Yes

Mode 32	Hopping on all channels, DH1, Power setting 10	Yes
Mode 33	Hopping on all channels, DH3, Power setting 10	Yes
Mode 34	Hopping on all channels, 2DH1, Power setting 10	Yes
Mode 35	Hopping on all channels, 2DH3, Power setting 10	Yes
Mode 36	Hopping on all channels, 2DH5, Power setting 10	Yes
Mode 37	Hopping on all channels, 3DH1, Power setting 10	Yes
Mode 38	Hopping on all channels, 3DH3, Power setting 10	Yes
Mode 39	Hopping on all channels, 3DH5, Power setting 10	Yes
Mode 40	Constant Tx, GFSK, Power Setting: 10, Low Channel (2402MHz)	Yes
Mode 41	Constant Tx, GFSK, Power Setting: 10, High Channel (2480MHz)	Yes
Mode 42	Constant Tx, DQPSK, Power Setting: 10, Low Channel (2402MHz)	Yes
Mode 43	Constant Tx, DQPSK, Power Setting: 10, High Channel (2480MHz)	Yes
Mode 44	Constant Tx, 8DPSK, Power Setting: 10, Low Channel (2402MHz)	Yes
Mode 45	Constant Tx, 8DPSK, Power Setting: 10, High Channel (2480MHz)	Yes
Mode 46	Hopping on all channels, GFSK, Power Setting: 10	Yes
Mode 47	Hopping on all channels, DQPSK, Power Setting: 10	Yes
Mode 48	Hopping on all channels, 8DPSK, Power Setting: 10	Yes
Mode 49	Hopping on Channel 0 (2402MHz), DH5, Power Setting: 10	Yes
Mode 50	Hopping on Channel 0 (2402MHz), 2-DH5, Power Setting: 10	Yes
Mode 51	Hopping on Channel 0 (2402MHz), 3-DH5, Power Setting: 10	Yes
Mode 52	Hopping on Channel 79 (2480MHz), DH5, Power Setting: 10	Yes
Mode 53	Hopping on Channel 79 (2480MHz), 2-DH5, Power Setting: 10	Yes
Mode 54	Hopping on Channel 79 (2480MHz), 3-DH5, Power Setting: 10	Yes

2.5 Emissions configuration



The EUT was powered from its internal battery which was charged using the Charging station provided by the client. The Charging station had been modified for testing to allow the EUT mode of operation to be reset to a standby state. For conducted tests the client provided a separate sample with a temporary soldered SMA connector. The unit was configured via Bluetooth 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. A support laptop was supplied by the client with their custom application 'LoGS' which allowed the EUT test mode to be configured (channel, power, data rate etc.) and sent to the EUT via Bluetooth. To change test modes the EUT had to be reset and re-configured using the software each time.

The power settings for each channel were as stated below:-
Low Channel (2402 MHz) = level setting 10
Mid Channel (2441 MHz) = level setting 10
High Channel (2480 MHz) = level setting 10

Note: Power setting using decimal figure 10 is not related to a final output power unit such as dBm or mW.

2.5.1 Signal leads

The EUT had no signal leads, just a set of charging pins.

3 Summary of test results

The GaitSmart, GS2 was tested for compliance to the following standard(s):

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	NOT APPLICABLE[6]
2. Radiated emissions 9 - 150 kHz	47 CFR Part 15C Part 15.209	PASSED[4]
3. Radiated emissions 150 kHz - 30 MHz	47 CFR Part 15C Part 15.209	PASSED[4]
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[5]
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)(iii)/ 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[3]
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 test carried out, therefore this test is not applicable.

[2] Applies to EUT's with an antenna port. The EUT has an integral antenna only.

[3] EUT uses FHSS technology and is therefore not applicable to this test.

[4] Spectrum below 30MHz started at a frequency of 9 kHz up to a frequency of 30MHz based on the lowest signal generated/used within the equipment as declared by the applicant.

[5] Spectrum investigated up to a frequency of 25GHz based on 10 times the highest channel/ signal generated in equipment of 2480MHz.

[6] EUT is battery powered and does not operate in a transmit state whilst connected to a charger.

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 were applied.

4.3 EUT extremes of temperature & voltage

The following extreme EUT conditions were declared by the client.

Declared Temperature Conditions		Declared Voltage	
T nominal	20 °C	V nominal	5V DC
T minimum	-20 °C	V minimum	Not Specified
T maximum	50 °C	V maximum	Not Specified

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

In order to measure RF parameters at temperature extremes, the EUT was tested in a temperature controlled chamber as follows:

A temporary RF port was created for testing.

5 Tests, methods and results

5.1 AC Power line conducted emissions

NOT APPLICABLE: EUT is battery powered and does not operate in a transmit state whilst connected to a charger.

5.2 Radiated emissions 9 - 150 kHz

5.2.1 Test methods

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

5.2.2 Configuration of EUT

The EUT was placed on a 0.8 metres high turntable. The front edge of the EUT was initially positioned facing the antenna. The EUT was measured at a distance of 3 metres. The EUT was rotated in all three orthogonal planes. Radiated Emissions testing was performed with a fully charged battery.

The EUT was operated in Modes 1, 10 and 19.

5.2.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment noted below.

Measurements were made in a semi-anechoic chamber (pre-scan) with any final measurements required performed on an OATS without a ground plane. The antenna was placed 1m above the ground. The equipment was rotated 360 degrees to record the worst case emissions.

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

Tests were performed using Test Site H.

5.2.4 Test equipment

E534, E535, TMS81, ZSW1

See Section 9 for more details

5.2.5 Test results

Temperature of test environment	20°C
Humidity of test environment	44%
Pressure of test environment	101kPa

Band	2400-2483.5 MHz
Power setting	10
Channel Spacing	1 MHz
Mod Scheme	DH1, DH3 & DH5
Low channel	2402 MHz

Plot refs
13840-1 Rad 1 9k-150kHz Para
13840-1 Rad 1 9k-150kHz Perp

Band	2400-2483.5 MHz
Power Level	10 set in GUI
Channel Spacing	1 MHz
Mod Scheme	DH1, DH3 & DH5
Mid channel	2441 MHz

Plot refs
13840-1 Rad 2 9k-150kHz Para
13840-1 Rad 2 9k-150kHz Perp

Band	2400-2483.5 MHz
Power setting	10 set in GUI
Channel Spacing	1 MHz
Mod Scheme	DH1, DH3 & DH5
High channel	2480 MHz

Plot refs
13840-1 Rad 3 9k-150kHz Para
13840-1 Rad 3 9k-150kHz Perp

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

LIMITS:

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

These results show that the EUT has PASSED this test.

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

5.3 Radiated emissions 150 kHz - 30 MHz

5.3.1 Test methods

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

5.3.2 Configuration of EUT

The EUT was placed on a 0.8 metres high turntable. The front edge of the EUT was initially positioned facing the antenna. The EUT was measured at a distance of 3 metres. The EUT was rotated in all three orthogonal planes. Radiated Emissions testing was performed with a fully charged battery.

The EUT was operated in Modes 1, 10 and 19.

5.3.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment noted below.

Measurements were made in a semi-anechoic chamber (pre-scan) with any final measurements required performed on an OATS without a ground plane. The antenna was placed 1m above the ground. The equipment was rotated 360 degrees to record the worst case emissions.

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

Tests were performed using Test Site H.

5.3.4 Test equipment

E534, E535, TMS81, ZSW1

See Section 9 for more details

5.3.5 Test results

Temperature of test environment 20°C
Humidity of test environment 44%
Pressure of test environment 101kPa

Band	2400-2483.5 MHz
Power setting	10 set in GUI
Channel Spacing	1 MHz
Mod Scheme	DH1, DH3 & DH5
Low channel	2402 MHz

Plot refs
13840-1 Rad 1 150k-30MHz Para
13840-1 Rad 1 150k-30MHz Perp

Band	2400-2483.5 MHz
Power setting	10 set in GUI
Channel Spacing	1 MHz
Mod Scheme	DH1, DH3 & DH5
Mid channel	2441 MHz

Plot refs
13840-1 Rad 2 150k-30MHz Para
13840-1 Rad 2 150k-30MHz Perp

Band	2400-2483.5 MHz
Power setting	10 set in GUI
Channel Spacing	1 MHz
Mod Scheme	DH1, DH3 & DH5
High channel	2480 MHz

Plot refs
13840-1 Rad 3 150k-30MHz Para
13840-1 Rad 3 150k-30MHz Perp

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

LIMITS:

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

These results show that the EUT has PASSED this test.

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

5.4 Radiated emissions 30 MHz -1 GHz

5.4.1 Test methods

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

5.4.2 Configuration of EUT

The EUT was placed on a 0.8 metres high turntable. The front edge of the EUT was initially positioned facing the antenna. The EUT was measured at a distance of 3 metres. The EUT was rotated in all three orthogonal planes. Radiated Emissions testing was performed with a fully charged battery.

The EUT was operated in Modes 1, 10 and 19.

5.4.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment noted below.

Measurements were made on a site listed with the FCC. The equipment was rotated 360 degrees and the antenna scanned 1 – 4 metres in both horizontal and vertical polarisations to record the worst case emissions.

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

Tests were performed using Test Site H.

5.4.4 Test equipment

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

See Section 9 for more details

5.4.5 Test results

Temperature of test environment	16°C
Humidity of test environment	44%
Pressure of test environment	101kPa

Band	2400-2483.5 MHz
Power setting	10 set in GUI
Channel Spacing	1 MHz
Mod Scheme	DH1, DH3 & DH5
Low channel	2402 MHz

Plot refs
13840-1 Rad 1 VHF Horiz
13840-1 Rad 1 VHF Vert
13840-1 Rad 1 UHF Horiz
13840-1 Rad 1 UHF Vert

Band	2400-2483.5 MHz
Power setting	10 set in GUI
Channel Spacing	1 MHz
Mod Scheme	DH1, DH3 & DH5
Mid channel	2441 MHz

Plot refs
13840-1 Rad 2 VHF Horiz

13840-1 Rad 2 VHF Vert
13840-1 Rad 2 UHF Horiz
13840-1 Rad 2 UHF Vert

Band	2400-2483.5 MHz
Power setting	10 set in GUI
Channel Spacing	1 MHz
Mod Scheme	DH1, DH3 & DH5
High channel	2480 MHz

Plot refs
13840-1 Rad 3 VHF Horiz
13840-1 Rad 3 VHF Vert
13840-1 Rad 3 UHF Horiz
13840-1 Rad 3 UHF Vert

Table of signals measured for Rad 1 Horizontal Sig List

Signal No.	Freq (MHz)	Peak Amp (dBuV/m)	QP Amp (dBuV/m)	QP -Lim (dB)
1	52.712	26.0	19.9	-20.1
2	100.346	24.4	18.0	-25.5
3	485.290	32.1	25.7	-20.3

Table of signals measured for Rad 1 Vertical Sig List

Signal No.	Freq (MHz)	Peak Amp (dBuV/m)	QP Amp (dBuV/m)	QP -Lim (dB)
1	46.719	27.4	20.7	-19.3
2	106.712	23.5	17.0	-26.5
3	496.303	31.8	25.8	-20.2

Table of signals measured for Rad 2 Horizontal Sig List

Signal No.	Freq (MHz)	Peak Amp (dBuV/m)	QP Amp (dBuV/m)	QP -Lim (dB)
1	48.844	27.3	21.2	-18.8
2	48.844	27.0	21.1	-18.9
3	100.617	24.4	17.7	-25.8

Table of signals measured for Rad 2 Vertical Sig List

Signal No.	Freq (MHz)	Peak Amp (dBuV/m)	QP Amp (dBuV/m)	QP -Lim (dB)
1	44.681	26.0	20.2	-19.8
2	100.712	24.2	17.7	-25.8
3	484.158	31.4	25.7	-20.3

Table of signals measured for Rad 3 Horizontal Sig List

Signal No.	Freq (MHz)	Peak Amp (dBuV/m)	QP Amp (dBuV/m)	QP -Lim (dB)
1	52.869	25.6	20.0	-20.0
2	100.529	24.0	17.9	-25.6
3	483.387	31.8	25.6	-20.4

Table of signals measured for Rad 3 Vertical Sig List

Signal No.	Freq (MHz)	Peak Amp (dBuV/m)	QP Amp (dBuV/m)	QP -Lim (dB)
1	51.011	26.7	20.6	-19.4
2	105.569	23.5	17.2	-26.3
3	497.793	31.3	25.8	-20.2

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

Note: The worst case modulation was found to be GFSK with no discernible difference between data rates using this modulation of DH1, DH3 and DH5, therefore DH1 was used for final tests.
Whilst Low, Mid and High channels were tested, plots are for illustrative purposes only and only Mid channel plots are shown in this report.

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

These results show that the EUT has PASSED this test.

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

5.5 Radiated emissions above 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 6.6 [Reference 4.1.2 of this report]
Limits: 47 CFR Part 15C Part 15.247(d) & 15.209 [Reference 4.1.1 of this report]

5.5.2 Configuration of EUT

The EUT was placed on a 1.5 metres high turntable. The front edge of the EUT was initially positioned facing the antenna. The EUT was measured at a distance of 3 metres. The EUT was rotated in all three orthogonal planes. Radiated Emissions testing was performed with a fully charged battery.

The EUT was operated in Modes 1, 10 and 19.

5.5.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment noted below.

Measurements were made in a semi-anechoic chamber with appropriate absorbing material for use in this range. Horn antennas were used at heights where the whole of the EUT was contained within the main beam. The EUT was rotated through 360 degrees to record the worst case emissions. A measurement distance of 3m was used between the test range 1 - 6GHz, 1.2m was used in the test range 6 - 18GHz and 0.3m was used in the test range 18 - 25GHz.

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

Tests were performed using Test Site H.

5.5.4 Test equipment

E429, E534, E535, LPE261, LPE333, TMS78, TMS79

See Section 9 for more details

5.5.5 Test results

Temperature of test environment 16°C
Humidity of test environment 50%
Pressure of test environment 103kPa

Note only emissions measured within 20dB of limits have been reported/listed below.
Setup Table

Band	2400-2483.5 MHz
Power setting	10 set in GUI
Channel Spacing	1 MHz
Mod Scheme	GFSK
Low channel	2402 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
7206	59	-15	52	-2	Upright	Vertical
7206	61	-13	53.38	-0.62	Upright	Horizontal
9608	50.4	-23.6	40.3	-13.7	Upright	Vertical
9608	48.1	-25.9	36.3	-17.7	Upright	Horizontal

Setup Table

Band	2400-2483.5 MHz
Power setting	10 set in GUI
Channel Spacing	1 MHz
Mod Scheme	GFSK
Mid channel	2441 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
7323	58.3	-15.7	51.2	-2.8	Upright	Vertical
7323	58.5	-15.5	51.5	-2.5	Upright	Horizontal
9764	50.7	-23.3	41.3	-12.7	Upright	Vertical
9764	45.9	-28.1	34.1	-19.9	Upright	Horizontal

Plots
13840-1 Rad 1 1-2GHz Vert
13840-1 Rad 1 1-2GHz Horiz
13840-1 Rad 1 2-2.7GHz Vert
13840-1 Rad 1 2-2.7GHz Horiz
13840-1 Rad 1 2.7-5GHz Vert
13840-1 Rad 1 2.7-5GHz Horiz
13840-1 Rad 1 5-6GHz Horiz
13840-1 Rad 1 5-6GHz Vert
13840-1 Rad 1 6upto7.77GHz Vert
13840-1 Rad 1 6upto7.77GHz Horiz
13840-1 Rad 1 7.77upto10GHz Vert
13840-1 Rad 1 7.77upto10GHz Horiz
13840-1 Rad 1 10upto12_5GHz Vert
13840-1 Rad 1 10upto12_5GHz Horiz
13840-1 Rad 1 12-15GHz Vert
13840-1 Rad 1 12-15GHz Horiz
13840-1 Rad 1 15-18GHz Vert
13840-1 Rad 1 15-18GHz Horiz
13840-1 Rad 1 18-22GHz Vert
13840-1 Rad 1 18-22GHz Horiz
13840-1 Rad 1 22-25GHz Vert
13840-1 Rad 1 22-25GHz Horiz

Setup Table

Band	2400-2483.5 MHz
Power setting	10 set in GUI
Channel Spacing	1 MHz
Mod Scheme	GFSK
High channel	2480 MHz

Spurious Frequency (MHz)	Measured Peak Level (dBµV/m)	Difference to Peak Limit (dB)	Measured Average Level (dBµV/m)	Difference to Average Limit (dB)	EUT Polarisation	Antenna Polarisation
7440	58.3	-15.7	51.3	-2.7	upright	Vertical
7440	57.6	-16.4	50.2	-3.8	upright	Horizontal
9920	47.1	-26.9	34.8	-19.2	upright	Vertical

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

Note: The worst-case modulation was found to be GFSK with no discernible difference between data rates using this modulation of DH1, DH3 and DH5, therefore DH1 was used for final tests.
Whilst Low, Mid and High channels were tested, plots are for illustrative purposes only and only Mid channel plots are shown in this report.

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

These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows:
1 – 18 GHz ±3.5dB, 18 – 26.5 GHz ±3.9dB

5.6 Effective radiated power field strength

5.6.1 Test methods

Test Requirements: 47 CFR Part 15C Part 15.247(d) [Reference 4.1.1 of this report]
Test Method: ANSI C63.10 Clause 6.5/6.6 [Reference 4.1.2 of this report]
Limits: 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 Modes 1 to 27.

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 H.

5.6.4 Test equipment

E534, E535, LPE261, LPE333

See Section 9 for more details

5.6.5 Test results

Temperature of test environment 19°C
Humidity of test environment 48%
Pressure of test environment 101kPa

Band	2400-2483.5 MHz
Power setting	10 set in GUI
Channel Spacing	1 MHz
Mod Scheme	DH1, DH3, DH5, 2-DH1, 2-DH3, 2-DH5, 3-DH1, 3-DH3 & 3-DH5
Low channel	2402 MHz
Mid channel	2441 MHz
High channel	2480 MHz

	Low channel	Mid channel	High channel
Peak Level (dBµV/m)	77.98	76.05	77.14
Plot reference	13840-1 Radiated Power Low Channel (2402MHz) Flat Horizontal DH5- power 10	13840-1 Radiated Power Mid Channel (2441MHz) Flat Horizontal 3-DH1- power 10	13840-1 Radiated Power High Channel (2480MHz) Flat Horizontal DH1- power 10
Antenna Polarisation	Horiz	Horiz	Horiz
EUT Polarisation	Flat	Flat	Flat

Note: table shows worst-case/highest field strength out of all the modulation schemes and rates.

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

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

These results show that the EUT has PASSED this test.

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

5.7 Band Edge Compliance

5.6.1 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 Modes 40 to 54.

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 Band edge tests were performed in both hopping and Non-hopping modes, whilst restricted band edge tests were performed in non-hopping mode only. The restricted band edges closest to the EUT Band of 2400-2483.5 MHz are 2390 MHz and 2483.5 MHz, further wider span plots showing this requirement is met are shown under section 5.4 and in plots section 6.

Tests were performed using Test Site H.

5.7.4 Test equipment

E534, E535, LPE261, LPE333

See Section 9 for more details

5.7.5 Test results

Temperature of test environment	21°C
Humidity of test environment	48%
Pressure of test environment	101kPa

Note: No difference was observed in band edge emissions when changing rates/packet lengths in the 3 modulation schemes, Therefore DH5, 2DH5 and 3DH5 were used for the hopping authorised band edge test.

Band	2400-2483.5 MHz
Power setting	10 set in GUI
Channel Spacing	1 MHz
Mod Scheme	GFSK / DH5
Low channel	2402 MHz (Low)
High channel	2480 MHz (High)

Restricted Band Edges	Low channel	High channel
Restricted Peak Level measured (dBuV/m)	38	36.5
Restricted band edge Peak Plot	13840-1 Restricted Band Edge Low Channel (2402 MHz) GFSK Flat Position Horizontal	13840-1 Restricted Band Edge High Channel (2480 MHz) GFSK Flat Position Horizontal
Restricted Average Level measured (dBuV/m)	Not measured, Peak measured lower than AV limit	Not measured, Peak measured lower than AV limit
Restricted band edge Average Plot	N/A	N/A

Authorised Band Edges	Low channel	High channel
Authorised Band Edge (dBc) value measured	46.3	53.4
Authorised Band Edge Plot	13840-1 Authorised band edge Low Channel (2402MHz) GFSK Flat Position Horizontal Non-Hopping	13840-1 Authorised band edge High Channel (2480MHz) GFSK Flat Position Horizontal Non-Hopping
Authorised Band Edge (dBc) Hopping value measured	44.6	53.3
Authorised Band Edge Hopping Plot	13840-1 Authorised band edge Low Channel (2402MHz) GFSK Flat Position Horizontal Hopping	13840-1 Authorised band edge High Channel (2480MHz) GFSK Flat Position Horizontal Hopping

Band	2400-2483.5 MHz
Power setting	10 set in GUI
Channel Spacing	1 MHz
Mod Scheme	DQPSK / 2DH5
Low channel	2402 MHz (Low)
High channel	2480 MHz (High)

Restricted Band Edges	Low channel	High channel
Restricted Peak Level measured (dBuV/m)	38.4	39.4
Restricted band edge Peak Plot	13840-1 Restricted Band Edge Low Channel (2402 MHz) DQPSK Flat Position Horizontal	13840-1 Restricted Band Edge High Channel (2480 MHz) DQPSK Flat Position Horizontal
Restricted Average Level measured (dBuV/m)	Not measured, Peak measured lower than AV limit	Not measured, Peak measured lower than AV limit
Restricted band edge Average Plot	N/A	N/A

Authorised Band Edges	Low channel	High channel
Authorised Band Edge (dBc) value measured	42.6	44.5
Authorised Band Edge Plot	13840-1 Authorised band edge Low Channel (2402MHz) DQPSK Flat Position Horizontal Non-Hopping	13840-1 Authorised band edge High Channel (2480MHz) DQPSK Flat Position Horizontal Non-Hopping
Authorised Band Edge (dBc) Hopping value measured	46.4	46.9
Authorised Band Edge Hopping Plot	13840-1 Authorised band edge Low Channel (2402MHz) DQPSK Flat Position Horizontal Hopping	13840-1 Authorised band edge High Channel (2480MHz) DQPSK Flat Position Horizontal Hopping

Band	2400-2483.5 MHz
Power setting	10 set in GUI
Channel Spacing	1 MHz
Mod Scheme	8DPSK / 3DH5
Low channel	2402 MHz (Low)
High channel	2480 MHz (High)

Restricted Band Edges	Low channel	High channel
Restricted Peak Level measured (dBuV/m)	39.3	39.2
Restricted band edge Peak Plot	13840-1 Restricted Band Edge Low Channel (2402 MHz) 8DPSK Flat Position Horizontal	13840-1 Restricted Band Edge High Channel (2480 MHz) 8DPSK Flat Position Horizontal
Restricted Average Level measured (dBuV/m)	Not measured, Peak measured lower than AV limit	Not measured, Peak measured lower than AV limit
Restricted band edge Average Plot	N/A	N/A

Authorised Band Edges	Low channel	High channel
Authorised Band Edge (dBc) value measured	42.1	43.8
Authorised Band Edge Plot	13840-1 Authorised band edge Low Channel (2402MHz) 8DPSK Flat Position Horizontal Non-Hopping	13840-1 Authorised band edge High Channel (2480MHz) 8DPSK Flat Position Horizontal Non-Hopping
Authorised Band Edge (dBc) Hopping value measured	42.2	50.2
Authorised Band Edge Hopping Plot	13840-1 Authorised band edge Low Channel (2402MHz) 8DPSK Flat Position Horizontal Hopping	13840-1 Authorised band edge High Channel (2480MHz) 8DPSK Flat Position Horizontal 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.

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

5.7.1 Test methods

Test Requirements: 47 CFR Part 15C Part 15.247(a)(1)(iii)/ 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)(ii) [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 temporary RF port. The EUT was operated in Modes 1 to 27.

5.8.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment noted below. A 30kHz RBW, 3x VBW, auto sweep time and max hold settings were used for the 20dB bandwidth.

Tests were performed using Test Site N.

5.8.4 Test equipment

F079, H071

See Section 9 for more details

5.7.5 Test results

Temperature of test environment 26°C
Humidity of test environment 48%
Pressure of test environment 102kPa

Band	2400-2483.5 MHz
Power setting	10 set in GUI
Channel Spacing	1 MHz
Mod Scheme	DH1
Low channel	2402 MHz (Low)
Mid channel	2441 MHz (Mid)
High channel	2480 MHz (High)

	Low channel	Mid channel	High channel
20 dB Bandwidth Result (MHz)	0.8753	0.8846	0.8436
Plot for 20 dB Bandwidth Result (MHz)	13840-1 OBW BTC Low Ch (2402MHz) DH1	13840-1 OBW BTC Mid Ch (2441MHz) DH1	13840-1 OBW BTC High Ch (2480MHz) DH1
99 % Bandwidth Result (MHz)	0.84986	0.84496	0.8448
Frequency Error (kHz) (include sign)	55.19	57.082	58.209
Operating frequency (MHz)	2402	2441	2480
20 dB FLOW Worst case (MHz)	2401.61754	2440.614782	2479.636409
20 dB FHIGH Worst case (MHz)	2402.49284	2441.499382	2480.480009

Band	2400-2483.5 MHz
Power setting	10 set in GUI
Channel Spacing	1 MHz

Mod Scheme	DH3
Low channel	2402 MHz (Low)
Mid channel	2441 MHz (Mid)
High channel	2480 MHz (High)

	Low channel	Mid channel	High channel
20 dB Bandwidth Result (MHz)	0.8449	0.8344	0.8421
Plot for 20 dB Bandwidth Result (MHz)	13840-1 OBW BTC Low Ch (2402MHz) DH3	13840-1 OBW BTC Mid Ch (2441MHz) DH3	13840-1 OBW BTC Mid Ch (2441MHz) 3-DH3
99 % Bandwidth Result (MHz)	0.83245	0.83722	0.84068
Frequency Error (kHz) (include sign)	56.988	57.176	58.796
Operating frequency (MHz)	2402	2441	2480
20 dB FLOW Worst case (MHz)	2401.634538	2440.639976	2479.637746
20 dB FHIGH Worst case (MHz)	2402.479438	2441.474376	2480.479846

Band	2400-2483.5 MHz
Power setting	10 set in GUI
Channel Spacing	1 MHz
Mod Scheme	DH5
Low channel	2402 MHz (Low)
Mid channel	2441 MHz (Mid)
High channel	2480 MHz (High)

	Low channel	Mid channel	High channel
20 dB Bandwidth Result (MHz)	0.7794	0.7748	0.783
Plot for 20 dB Bandwidth Result (MHz)	13840-1 OBW BTC Low Ch (2402MHz) DH5	13840-1 OBW BTC Mid Ch (2441MHz) DH5	13840-1 OBW BTC High Ch (2480MHz) DH5
99 % Bandwidth Result (MHz)	0.80929	0.80741	0.8117
Frequency Error (kHz) (include sign)	59.877	60.254	62.217
Operating frequency (MHz)	2402	2441	2480
20 dB FLOW Worst case (MHz)	2401.670177	2440.672854	2479.670717
20 dB FHIGH Worst case (MHz)	2402.449577	2441.447654	2480.453717

Band	2400-2483.5 MHz
Power setting	10 set in GUI
Channel Spacing	1 MHz
Mod Scheme	2-DH1
Low channel	2402 MHz (Low)
Mid channel	2441 MHz (Mid)
High channel	2480 MHz (High)

	Low channel	Mid channel	High channel
20 dB Bandwidth Result (MHz)	1.158	1.158	1.154
Plot for 20 dB Bandwidth Result (MHz)	13840-1 OBW BTC Low Ch (2402MHz) 2-DH1	13840-1 OBW BTC Mid Ch (2441MHz) 2-DH1	13840-1 OBW BTC High Ch (2480MHz) 2-DH1
99 % Bandwidth Result (MHz)	1.0996	1.0964	1.0984
Frequency Error (kHz) (include sign)	57.794	58.933	60.242
Operating frequency (MHz)	2402	2441	2480
20 dB FLOW Worst case (MHz)	2401.478794	2440.479933	2479.483242
20 dB FHIGH Worst case (MHz)	2402.636794	2441.637933	2480.637242

Band	2400-2483.5 MHz
Power setting	10 set in GUI
Channel Spacing	1 MHz
Mod Scheme	2-DH3
Low channel	2402 MHz (Low)
Mid channel	2441 MHz (Mid)
High channel	2480 MHz (High)

	Low channel	Mid channel	High channel
20 dB Bandwidth Result (MHz)	1.143	1.14	1.142
Plot for 20 dB Bandwidth Result (MHz)	13840-1 OBW BTC Low Ch (2402MHz) 2-DH3	13840-1 OBW BTC Mid Ch (2441MHz) 2-DH3	13840-1 OBW BTC High Ch (2480MHz) 2-DH3
99 % Bandwidth Result (MHz)	1.0816	1.0823	1.0829
Frequency Error (kHz) (include sign)	53.217	55.023	56.23
Operating frequency (MHz)	2402	2441	2480
20 dB FLOW Worst case (MHz)	2401.481717	2440.485023	2479.48523
20 dB FHIGH Worst case (MHz)	2402.624717	2441.625023	2480.62723

Band	2400-2483.5 MHz
Power setting	10 set in GUI
Channel Spacing	1 MHz
Mod Scheme	2-DH5
Low channel	2402 MHz (Low)
Mid channel	2441 MHz (Mid)
High channel	2480 MHz (High)

	Low channel	Mid channel	High channel
20 dB Bandwidth Result (MHz)	1.149	1.15	1.144
Plot for 20 dB Bandwidth Result (MHz)	13840-1 OBW BTC Low Ch (2402MHz) 2-DH5	13840-1 OBW BTC Mid Ch (2441MHz) 2-DH5	13840-1 OBW BTC High Ch (2480MHz) 2-DH5
99 % Bandwidth Result (MHz)	1.0891	1.0894	1.0879
Frequency Error (kHz) (include sign)	50.753	51.045	52.647
Operating frequency (MHz)	2402	2441	2480
20 dB FLOW Worst case (MHz)	2401.476253	2440.476045	2479.480647
20 dB FHIGH Worst case (MHz)	2402.625253	2441.626045	2480.624647

Band	2400-2483.5 MHz
Power setting	10 set in GUI
Channel Spacing	1 MHz
Mod Scheme	3-DH1
Low channel	2402 MHz (Low)
Mid channel	2441 MHz (Mid)
High channel	2480 MHz (High)

	Low channel	Mid channel	High channel
20 dB Bandwidth Result (MHz)	1.156	1.158	1.151
Plot for 20 dB Bandwidth Result (MHz)	13840-1 OBW BTC Low Ch (2402MHz) 3-DH1	13840-1 OBW BTC Mid Ch (2441MHz) 3-DH1	13840-1 OBW BTC High Ch (2480MHz) 3-DH1
99 % Bandwidth Result (MHz)	1.0848	1.0837	1.084
Frequency Error (kHz) (include sign)	50.264	51.135	52.698
Operating frequency (MHz)	2402	2441	2480
20 dB FLOW Worst case (MHz)	2401.472264	2440.472135	2479.477198
20 dB FHIGH Worst case (MHz)	2402.628264	2441.630135	2480.628198

Band	2400-2483.5 MHz
Power setting	10 set in GUI
Channel Spacing	1 MHz
Mod Scheme	3-DH3
Low channel	2402 MHz (Low)
Mid channel	2441 MHz (Mid)

High channel	2480 MHz (High)

	Low channel	Mid channel	High channel
20 dB Bandwidth Result (MHz)	1.124	1.124	1.126
Plot for 20 dB Bandwidth Result (MHz)	13840-1 OBW BTC Low Ch (2402MHz) 3-DH3	13840-1 OBW BTC Mid Ch (2441MHz) 3-DH3	13840-1 OBW BTC High Ch (2480MHz) 3-DH3
99 % Bandwidth Result (MHz)	1.0831	1.0817	1.0825
Frequency Error (kHz) (include sign)	48.162	49.629	50.703
Operating frequency (MHz)	2402	2441	2480
20 dB FLOW Worst case (MHz)	2401.486162	2440.487629	2479.487703
20 dB FHIGH Worst case (MHz)	2402.610162	2441.611629	2480.613703

Band	2400-2483.5 MHz
Power setting	10 set in GUI
Channel Spacing	1 MHz
Mod Scheme	3-DH5
Low channel	2402 MHz (Low)
Mid channel	2441 MHz (Mid)
High channel	2480 MHz (High)

	Low channel	Mid channel	High channel
20 dB Bandwidth Result (MHz)	1.128	1.128	1.127
Plot for 20 dB Bandwidth Result (MHz)	13840-1 OBW BTC Low Ch (2402MHz) 3-DH5	13840-1 OBW BTC Mid Ch (2441MHz) 3-DH5	13840-1 OBW BTC High Ch (2480MHz) 3-DH5
99 % Bandwidth Result (MHz)	1.0802	1.0787	1.0788
Frequency Error (kHz) (include sign)	51.433	52.987	53.289
Operating frequency (MHz)	2402	2441	2480
20 dB FLOW Worst case (MHz)	2401.487433	2440.488987	2479.489789
20 dB FHIGH Worst case (MHz)	2402.615433	2441.616987	2480.616789

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)(ii) The maximum allowed 20dB bandwidth of the hopping channel is 1MHz.
These results show that the EUT has PASSED this test.

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

5.9 Maximum Average conducted output power

NOT APPLICABLE: Peak Power test carried out, therefore this test is not applicable.

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 7.8.5 [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 bench using a spectrum analyser connected to the temporary 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 Modes 1 to 27 for this test.

5.10.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment noted below.

Peak stated reading is maximum power observed using a spectrum analyser RBW > 20dB BW of the EUT.

Measurements were made on a test bench in site N.

5.10.4 Test equipment

E227, F079, H071

See Section 9 for more details

5.10.5 Test results

Temperature of test environment 26°C
Humidity of test environment 48%
Pressure of test environment 102kPa

Band	2400-2483.5 MHz
Power setting	10 set in GUI
Channel Spacing	1 MHz
Mod Scheme	DH1
Low channel	2402 MHz (Low)
Mid channel	2441 MHz (Mid)
High channel	2480 MHz (High)

Nominal voltage result (dBm)	-22.10	-20.15	-19.97
Plot reference	13840-1 Peak Conducted RF Power BTC Low Channel (2402MHz) DH1 Power Setting_10	13840-1 Peak Conducted RF Power BTC Mid Channel (2441MHz) DH1 Power Setting_10	13840-1 Peak Conducted RF Power BTC High Channel (2480MHz) DH1 Power Setting_10
85% of voltage result (dBm)	-22.10	-20.15	-19.97
115% voltage result (dBm)	-22.10	-20.15	-19.97
Limit in dBm	30.00	30.00	30.00
Maximum result (dBm)	-22.10	-20.15	-19.97
Margin to Limit (dB)	-52.10	-50.15	-49.97
Result in (W)	<0.00001	<0.00001	<0.00001

Band	2400-2483.5 MHz
Power setting	10 set in GUI
Channel Spacing	1 MHz
Mod Scheme	DH3
Low channel	2402 MHz (Low)
Mid channel	2441 MHz (Mid)
High channel	2480 MHz (High)

Nominal voltage result (dBm)	-21.40	-20.23	-20.06
Plot reference	13840-1 Peak Conducted RF Power BTC Low Channel (2402MHz) DH3 Power Setting_10	13840-1 Peak Conducted RF Power BTC Mid Channel (2441MHz) DH3 Power Setting_10	13840-1 Peak Conducted RF Power BTC High Channel (2480MHz) DH3 Power Setting_10
85% of voltage result (dBm)	-21.40	-20.23	-20.06
115% voltage result (dBm)	-21.40	-20.23	-20.06
Limit in dBm	30.00	30.00	30.00
Maximum result (dBm)	-21.40	-20.23	-20.06
Margin to Limit (dB)	-51.40	-50.23	-50.06
Result in (W)	<0.00001	<0.00001	<0.00001

Band	2400-2483.5 MHz
Power setting	10 set in GUI
Channel Spacing	1 MHz
Mod Scheme	DH5
Low channel	2402 MHz (Low)
Mid channel	2441 MHz (Mid)
High channel	2480 MHz (High)

Nominal voltage result (dBm)	-21.52	-20.38	-20.09
Plot reference	13840-1 Peak Conducted RF Power BTC Low Channel (2402MHz) DH5 Power Setting_10	13840-1 Peak Conducted RF Power BTC Mid Channel (2441MHz) DH5 Power Setting_10	13840-1 Peak Conducted RF Power BTC High Channel (2480MHz) DH5 Power Setting_10
85% of voltage result (dBm)	-21.52	-20.38	-20.09
115% voltage result (dBm)	-21.52	-20.38	-20.09
Limit in dBm	30.00	30.00	30.00
Maximum result (dBm)	-21.52	-20.38	-20.09
Margin to Limit (dB)	-51.52	-50.38	-50.09
Result in (W)	<0.00001	<0.00001	<0.00001

Band	2400-2483.5 MHz
Power setting	10 set in GUI
Channel Spacing	1 MHz
Mod Scheme	2-DH1
Low channel	2402 MHz (Low)
Mid channel	2441 MHz (Mid)
High channel	2480 MHz (High)

Nominal voltage result (dBm)	-21.55	-20.50	-20.08
Plot reference	13840-1 Peak Conducted RF Power BTC Low Channel (2402MHz) 2-DH1 Power Setting_10	13840-1 Peak Conducted RF Power BTC Mid Channel (2441MHz) 2-DH1 Power Setting_10	13840-1 Peak Conducted RF Power BTC High Channel (2480MHz) 2-DH1 Power Setting_10
85% of voltage result (dBm)	-21.55	-20.50	-20.08
115% voltage result (dBm)	-21.55	-20.50	-20.08
Limit in dBm	30.00	30.00	30.00

Maximum result (dBm)	-21.55	-20.50	-20.08
Margin to Limit (dB)	-51.55	-50.50	-50.08
Result in (W)	<0.00001	<0.00001	<0.00001

Band	2400-2483.5 MHz
Power setting	10 set in GUI
Channel Spacing	1 MHz
Mod Scheme	2-DH3
Low channel	2402 MHz (Low)
Mid channel	2441 MHz (Mid)
High channel	2480 MHz (High)

Nominal voltage result (dBm)	-21.01	-20.95	-19.86
Plot reference	13840-1 Peak Conducted RF Power BTC Low Channel (2402MHz) 2-DH3 Power Setting_10	13840-1 Peak Conducted RF Power BTC Mid Channel (2441MHz) 2-DH3 Power Setting_10	13840-1 Peak Conducted RF Power BTC High Channel (2480MHz) 2-DH3 Power Setting_10
85% of voltage result (dBm)	-21.01	-20.95	-19.86
115% voltage result (dBm)	-21.01	-20.95	-19.86
Limit in dBm	30.00	30.00	30.00
Maximum result (dBm)	-21.01	-20.95	-19.86
Margin to Limit (dB)	-51.01	-50.95	-49.86
Result in (W)	<0.00001	<0.00001	<0.00001

Band	2400-2483.5 MHz
Power setting	10 set in GUI
Channel Spacing	1 MHz
Mod Scheme	2-DH5
Low channel	2402 MHz (Low)
Mid channel	2441 MHz (Mid)
High channel	2480 MHz (High)

Nominal voltage result (dBm)	-21.40	-21.28	-20.11
Plot reference	13840-1 Peak Conducted RF Power BTC Low Channel (2402MHz) 2-DH5 Power Setting_10	13840-1 Peak Conducted RF Power BTC Mid Channel (2441MHz) 2-DH5 Power Setting_10	13840-1 Peak Conducted RF Power BTC High Channel (2480MHz) 2-DH5 Power Setting_10
85% of voltage result (dBm)	-21.40	-21.28	-20.11
115% voltage result (dBm)	-21.40	-21.28	-20.11
Limit in dBm	30.00	30.00	30.00
Maximum result (dBm)	-21.40	-21.28	-20.11
Margin to Limit (dB)	-51.40	-51.28	-50.11
Result in (W)	<0.00001	<0.00001	<0.00001

Band	2400-2483.5 MHz
Power setting	10 set in GUI
Channel Spacing	1 MHz
Mod Scheme	3-DH1
Low channel	2402 MHz (Low)
Mid channel	2441 MHz (Mid)
High channel	2480 MHz (High)

Nominal voltage result (dBm)	-21.29	-21.23	-20.05
Plot reference	13840-1 Peak Conducted RF Power BTC Low Channel	13840-1 Peak Conducted RF Power BTC Mid Channel	13840-1 Peak Conducted RF Power BTC High Channel

	(2402MHz) 3-DH1 Power Setting_10	(2441MHz) 3-DH1 Power Setting_10	(2480MHz) 3-DH1 Power Setting_10
85% of voltage result (dBm)	-21.29	-21.23	-20.05
115% voltage result (dBm)	-21.29	-21.23	-20.05
Limit in dBm	30.00	30.00	30.00
Maximum result (dBm)	-21.29	-21.23	-20.05
Margin to Limit (dB)	-51.29	-51.23	-50.05
Result in (W)	<0.00001	<0.00001	<0.00001

Band	2400-2483.5 MHz
Power setting	10 set in GUI
Channel Spacing	1 MHz
Mod Scheme	3-DH3
Low channel	2402 MHz (Low)
Mid channel	2441 MHz (Mid)
High channel	2480 MHz (High)

Nominal voltage result (dBm)	-21.26	-21.30	-20.29
Plot reference	13840-1 Peak Conducted RF Power BTC Low Channel (2402MHz) 3-DH3 Power Setting_10	13840-1 Peak Conducted RF Power BTC Mid Channel (2441MHz) 3-DH3 Power Setting_10	13840-1 Peak Conducted RF Power BTC High Channel (2480MHz) 3-DH3 Power Setting_10
85% of voltage result (dBm)	-21.26	-21.30	-20.29
115% voltage result (dBm)	-21.26	-21.30	-20.29
Limit in dBm	30.00	30.00	30.00
Maximum result (dBm)	-21.26	-21.30	-20.29
Margin to Limit (dB)	-51.26	-51.30	-50.29
Result in (W)	<0.00001	<0.00001	<0.00001

Band	2400-2483.5 MHz
Power setting	10 set in GUI
Channel Spacing	1 MHz
Mod Scheme	3-DH5
Low channel	2402 MHz (Low)
Mid channel	2441 MHz (Mid)
High channel	2480 MHz (High)

Nominal voltage result (dBm)	-21.07	-21.14	-19.91
Plot reference	13840-1 Peak Conducted RF Power BTC Low Channel (2402MHz) 3-DH5 Power Setting_10	13840-1 Peak Conducted RF Power BTC Mid Channel (2441MHz) 3-DH5 Power Setting_10	13840-1 Peak Conducted RF Power BTC High Channel (2480MHz) 3-DH5 Power Setting_10
85% of voltage result (dBm)	-21.07	-21.14	-19.91
115% voltage result (dBm)	-21.07	-21.14	-19.91
Limit in dBm	30.00	30.00	30.00
Maximum result (dBm)	-21.07	-21.14	-19.91
Margin to Limit (dB)	-51.07	-51.14	-49.91
Result in (W)	<0.00001	<0.00001	<0.00001

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: Applies to EUT's with an antenna port. The EUT has an integral antenna only

5.13 Duty cycle

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

5.14 FHSS carrier frequency separation

5.13.1 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 and ambient conditions were monitored. The EUT was operated in Modes 29, 30, 31, 49, 50 and 51.

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 N.

5.14.4 Test equipment

F079, H071

See Section 9 for more details

5.14.5 Test results

Temperature of test environment 26°C
Humidity of test environment 48%
Pressure of test environment 102kPa

Band	2400-2483.5 MHz
Power setting	10 set in GUI
Channel Spacing	1 MHz
Mod Scheme	DH5
Channels	2402 & 2403 MHz

	Hopping
Separation (kHz)	999.6
Plot of Separation (kHz)	13840-1 Carrier Frequency Separation BTC DH5

Band	2400-2483.5 MHz
Power setting	10 set in GUI
Channel Spacing	1 MHz
Mod Scheme	2-DH5
Channels	2402 & 2403 MHz

	Hopping
Separation (kHz)	1002.1
Plot of Separation (kHz)	13840-1 Carrier Frequency Separation BTC 2-DH5

Band	2400-2483.5 MHz
Power setting	10 set in GUI
Channel Spacing	1 MHz
Mod Scheme	3-DH5
Channels	2402 & 2403 MHz

	Hopping
Separation (kHz)	1000.1
Plot of Separation (kHz)	13840-1 Carrier Frequency Separation BTC 3-DH5

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 temporary RF port. Ambient conditions were monitored. The EUT was operated in Modes 28, 32 to 39 for this test.

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 for each applicable scheme/rate. 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

E839, E901, F081, H071

See Section 9 for more details

5.15.5 Test results

Temperature of test environment	21°C
Humidity of test environment	48%
Pressure of test environment	101kPa

Band	2400-2483.5 MHz
Power setting	10 set in GUI
Channel Spacing	1 MHz
Mod Scheme	DH1
Low channel	2402 MHz

Measured Dwell time/pulse width (ms)	0.389
Period time (s)	31.6
Instances of pulse within period time	320
Average time of occupancy (ms)	124.48
Measured Dwell time/pulse width (ms)	13840-1 Single dwell DH1 _ 2-DH1 _ 3-DH1
Period time (s)	DH1 acc tx time

Band	2400-2483.5 MHz
Power setting	10 set in GUI
Channel Spacing	1 MHz
Mod Scheme	DH3
Low channel	2402 MHz

Measured Dwell time/pulse width (ms)	1.65
Period time (s)	31.6
Instances of pulse within period time	161
Average time of occupancy (ms)	265.65

Measured Dwell time/pulse width (ms)	13840-1 Single dwell DH3 _ 2-DH3 _ 3-DH3
Period time (s)	DH3 acc tx time

Band	2400-2483.5 MHz
Power setting	10 set in GUI
Channel Spacing	1 MHz
Mod Scheme	DH5
Low channel	2402 MHz

Measured Dwell time/pulse width (ms)	2.89
Period time (s)	31.6
Instances of pulse within period time	117
Average time of occupancy (ms)	338.13
Measured Dwell time/pulse width (ms)	13840-1 Single dwell DH5 _ 2-DH5 _ 3-DH5
Period time (s)	DH5 acc tx time

Band	2400-2483.5 MHz
Power setting	10 set in GUI
Channel Spacing	1 MHz
Mod Scheme	2-DH1
Low channel	2402 MHz

Measured Dwell time/pulse width (ms)	0.389
Period time (s)	31.6
Instances of pulse within period time	289
Average time of occupancy (ms)	112.421
Measured Dwell time/pulse width (ms)	13840-1 Single dwell DH1 _ 2-DH1 _ 3-DH1
Period time (s)	2DH1 acc tx time

Band	2400-2483.5 MHz
Power setting	10 set in GUI
Channel Spacing	1 MHz
Mod Scheme	2-DH3
Low channel	2402 MHz

Measured Dwell time/pulse width (ms)	1.65
Period time (s)	31.6
Instances of pulse within period time	166
Average time of occupancy (ms)	273.9
Measured Dwell time/pulse width (ms)	13840-1 Single dwell DH3 _ 2-DH3 _ 3-DH3
Period time (s)	2DH3 acc tx time

Band	2400-2483.5 MHz
Power setting	10 set in GUI
Channel Spacing	1 MHz
Mod Scheme	2-DH5
Low channel	2402 MHz

Measured Dwell time/pulse width (ms)	2.89
Period time (s)	31.6
Instances of pulse within period time	108
Average time of occupancy (ms)	312.12
Measured Dwell time/pulse width (ms)	13840-1 Single dwell DH5 _ 2-DH5 _ 3-DH5
Period time (s)	2DH5 acc tx time

Band	2400-2483.5 MHz
Power setting	10 set in GUI
Channel Spacing	1 MHz
Mod Scheme	3-DH1
Low channel	2402 MHz

Measured Dwell time/pulse width (ms)	0.389
Period time (s)	31.6
Instances of pulse within period time	288
Average time of occupancy (ms)	112.032
Measured Dwell time/pulse width (ms)	13840-1 Single dwell DH1 _ 2-DH1 _ 3-DH1
Period time (s)	3DH1 acc tx time

Band	2400-2483.5 MHz
Power setting	10 set in GUI
Channel Spacing	1 MHz
Mod Scheme	3-DH3
Low channel	2402 MHz

Measured Dwell time/pulse width (ms)	1.65
Period time (s)	31.6
Instances of pulse within period time	160
Average time of occupancy (ms)	264
Measured Dwell time/pulse width (ms)	13840-1 Single dwell DH3 _ 2-DH3 _ 3-DH3
Period time (s)	3DH3 acc tx time

Band	2400-2483.5 MHz
Power setting	10 set in GUI
Channel Spacing	1 MHz
Mod Scheme	3-DH5
Low channel	2402 MHz

Measured Dwell time/pulse width (ms)	2.89
Period time (s)	31.6
Instances of pulse within period time	113
Average time of occupancy (ms)	326.57
Measured Dwell time/pulse width (ms)	13840-1 Single dwell DH5 _ 2-DH5 _ 3-DH5

Period time (s)	3DH5 acc tx time

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 temporary RF port. Ambient conditions were monitored. The EUT was operated in Mode 28 for this test.

5.16.3 Test procedure

Tests were made using the measuring equipment noted in the 'Test Equipment' Section at Site N. 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

F079, H071

See Section 9 for more details

5.16.5 Test results

Temperature of test environment	26°C
Humidity of test environment	48%
Pressure of test environment	102kPa

Band	2400-2483.5 MHz
Power setting	10 set in GUI
Channel Spacing	1 MHz
Mod Scheme	DH5
Single channel	Hopping (All Channels)

No of hopping Channels	79
Minimum No. Required number by specification	15
Plot of Hopping Channels 0-38	13840-1 Number of Hopping Channels DH5 Plot 1 of 2
Plot of Hopping Channels 38-78	13840-1 Number of Hopping Channels DH5 Plot 2 of 2

Note: Number of hopping channels was confirmed as 79 regardless of the scheme/rate set.

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

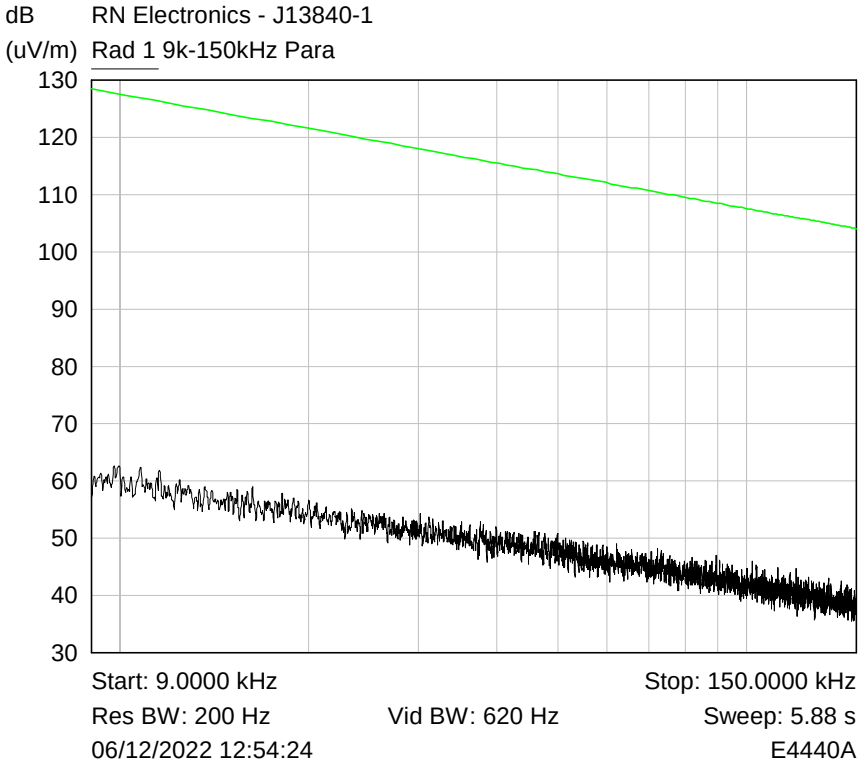
hopping frequencies may be avoided or suppressed provided that at least 15 hopping channels are used. These results show that the EUT has PASSED this test.

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

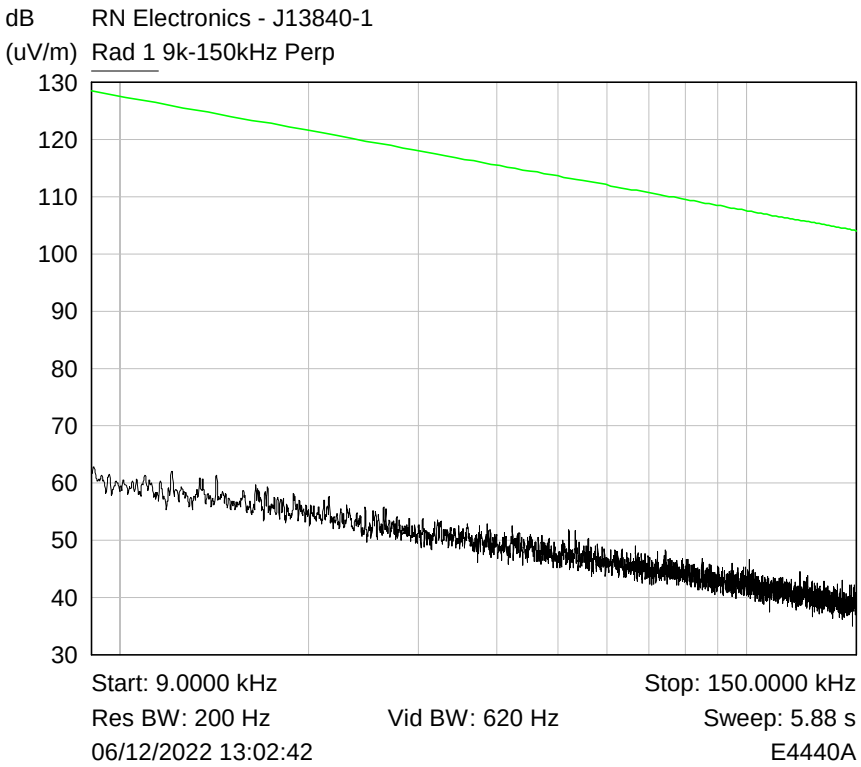
6 Plots/Graphical results

6.1 Radiated emissions 9 - 150 kHz

RF Parameters: Band 2400-2483.5 MHz, Power setting 10 set, Channel Spacing 1 MHz, Modulation DH1, Channel 2441 MHz (MID)



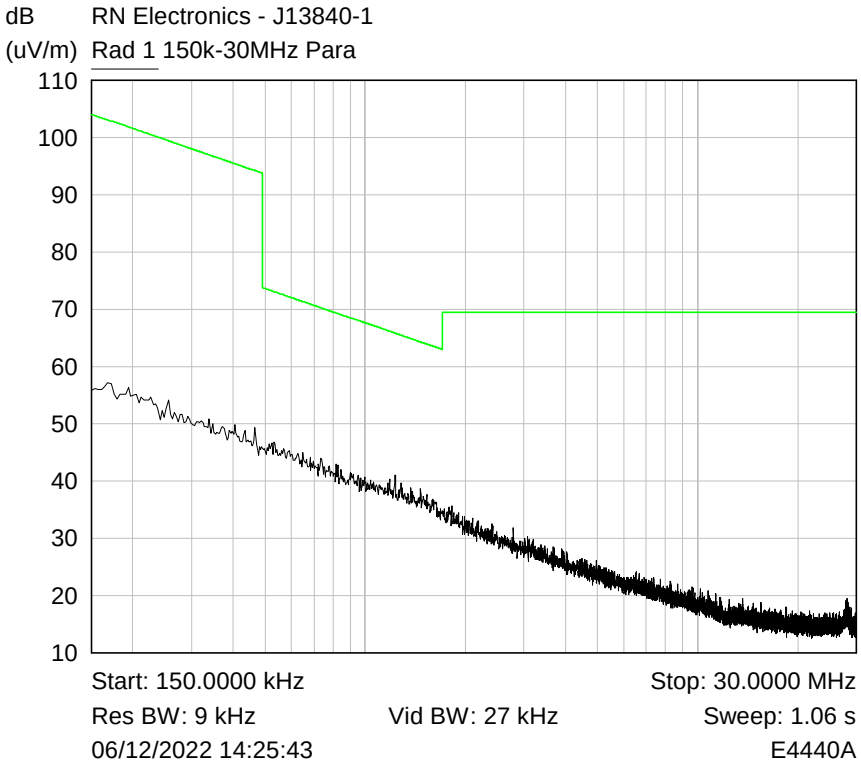
Plot of 9k-150kHz Parallel



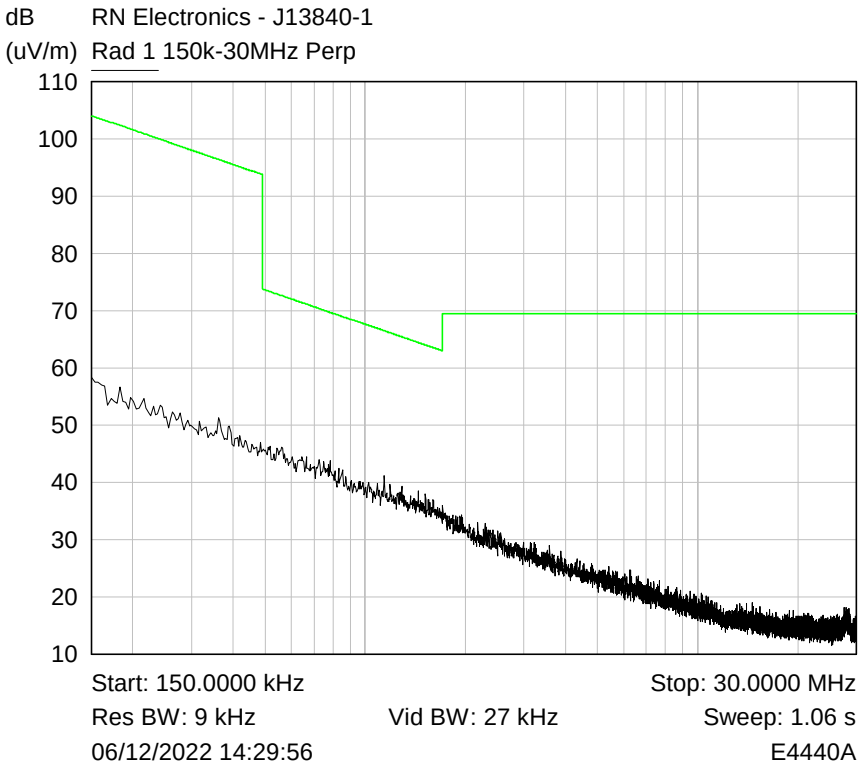
Plot of 9k-150kHz Perpendicular

6.2 Radiated emissions 150 kHz - 30 MHz

RF Parameters: Band 2400-2483.5 MHz, Power level 10 set, Channel Spacing 1 MHz, Modulation DH1, Channel 2441 MHz (MID)



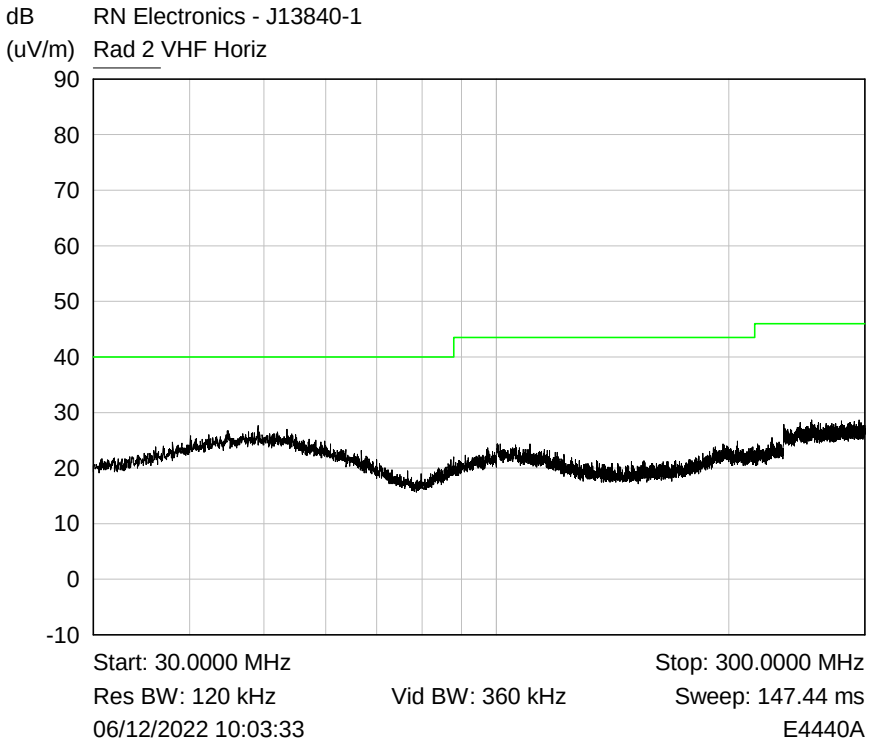
Plot of 150kHz-30MHz Parallel



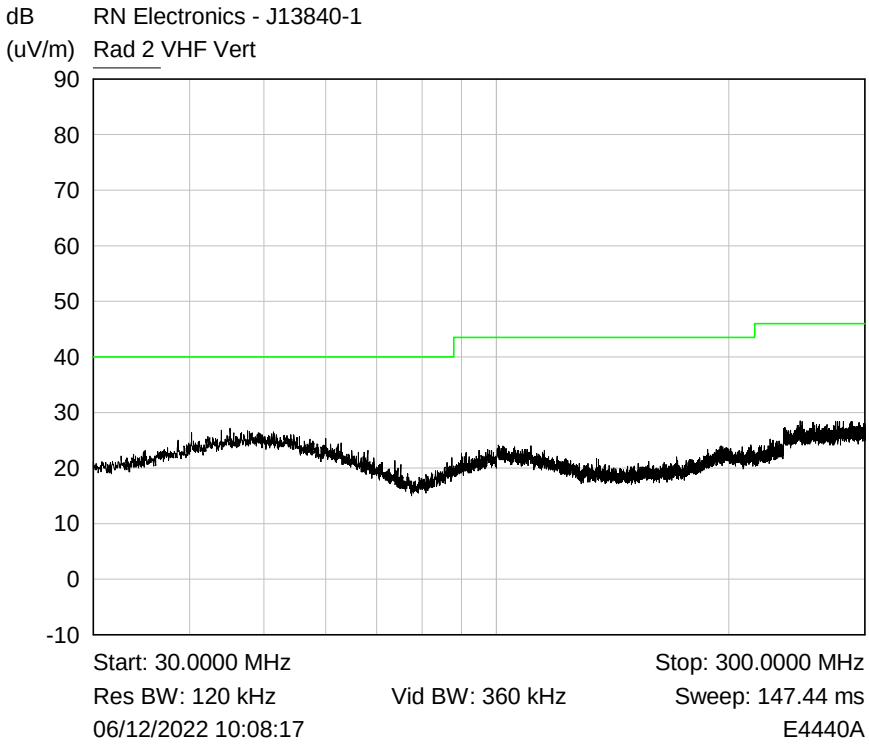
Plot of 150kHz-30MHz Perpendicular

6.3 Radiated emissions 30 MHz -1 GHz

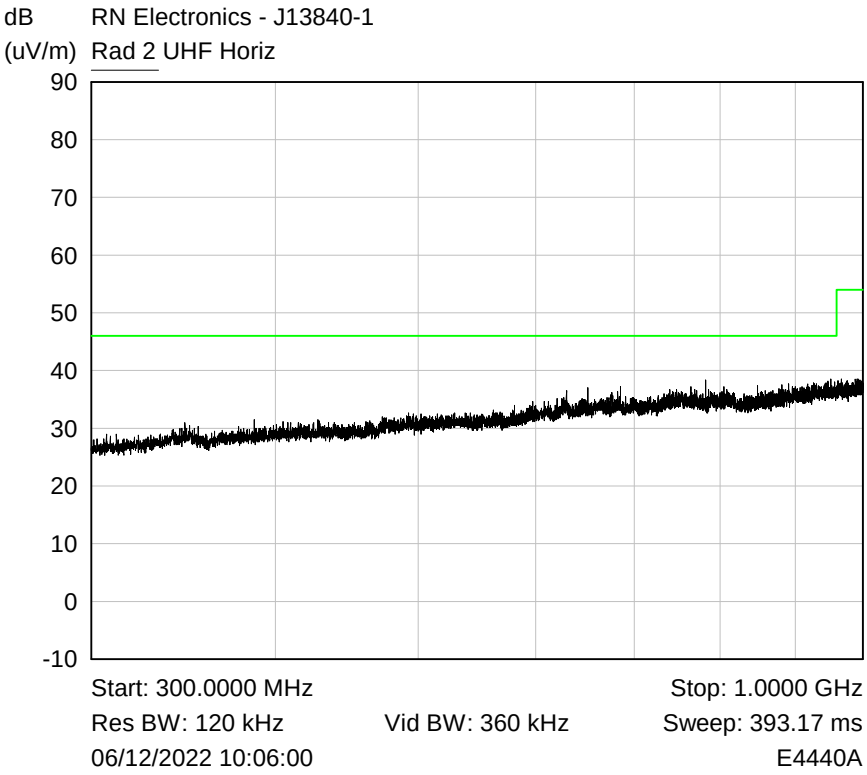
RF Parameters: Band 2400-2483.5 MHz, Power 10 set in GUI, Channel Spacing 1 MHz, Modulation DH1, DH3 & DH5, Channel 2441 MHz (Mid)



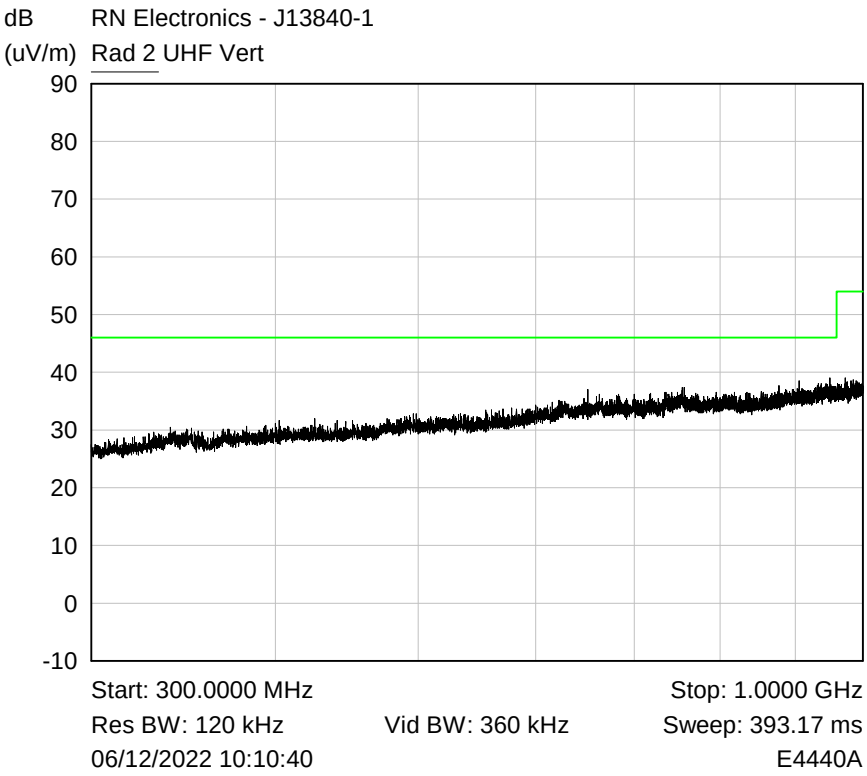
Plot of Peak emissions for VHF Horizontal against the QP limit line.



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



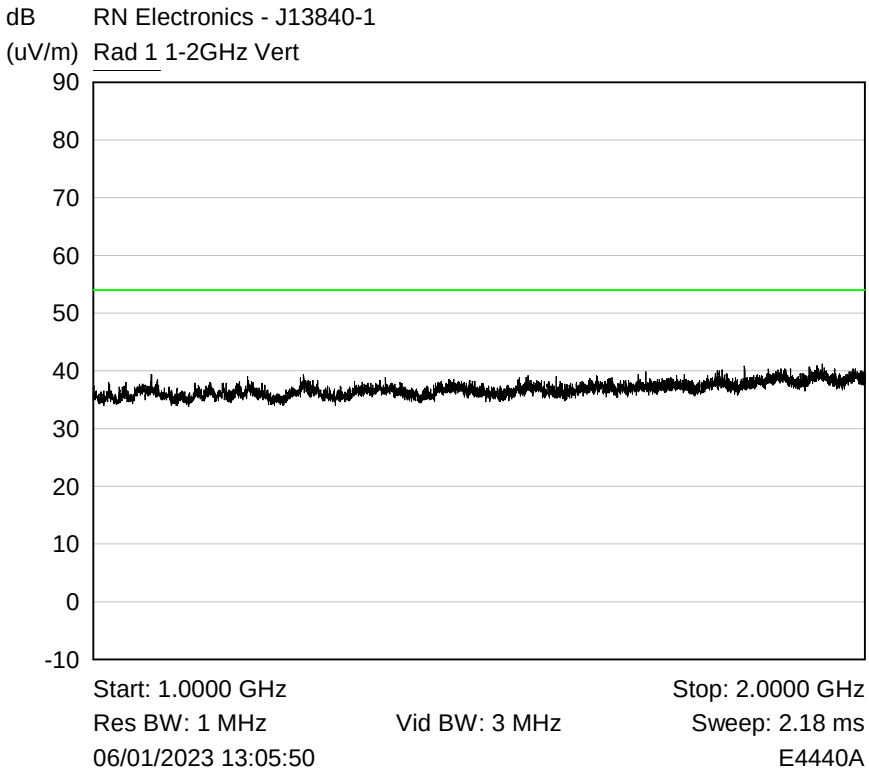
Plot of Peak emissions for UHF Horizontal against the QP limit line.

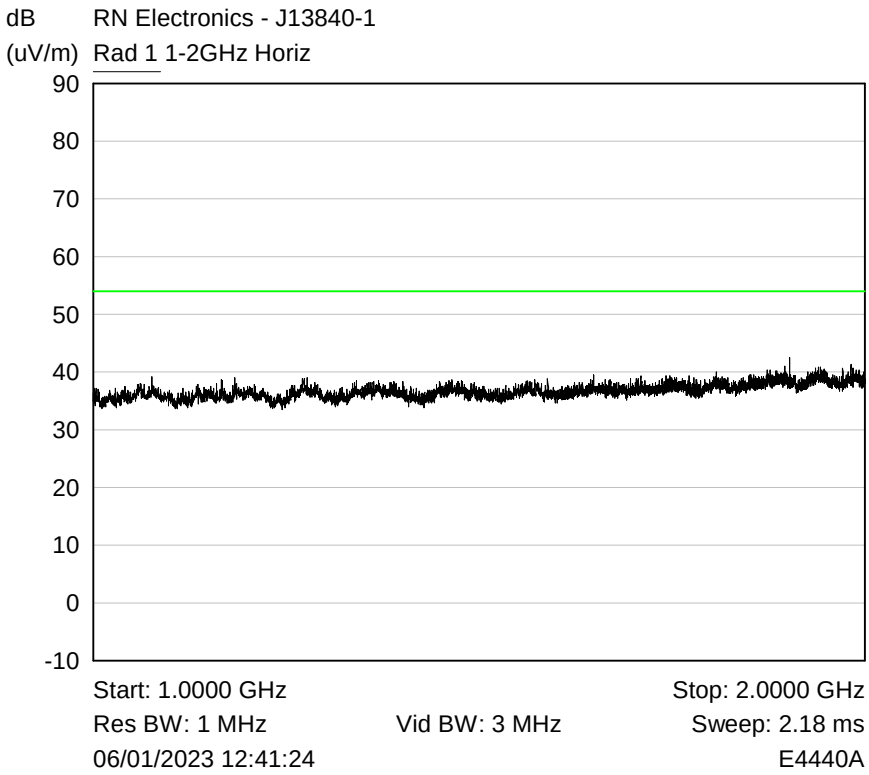


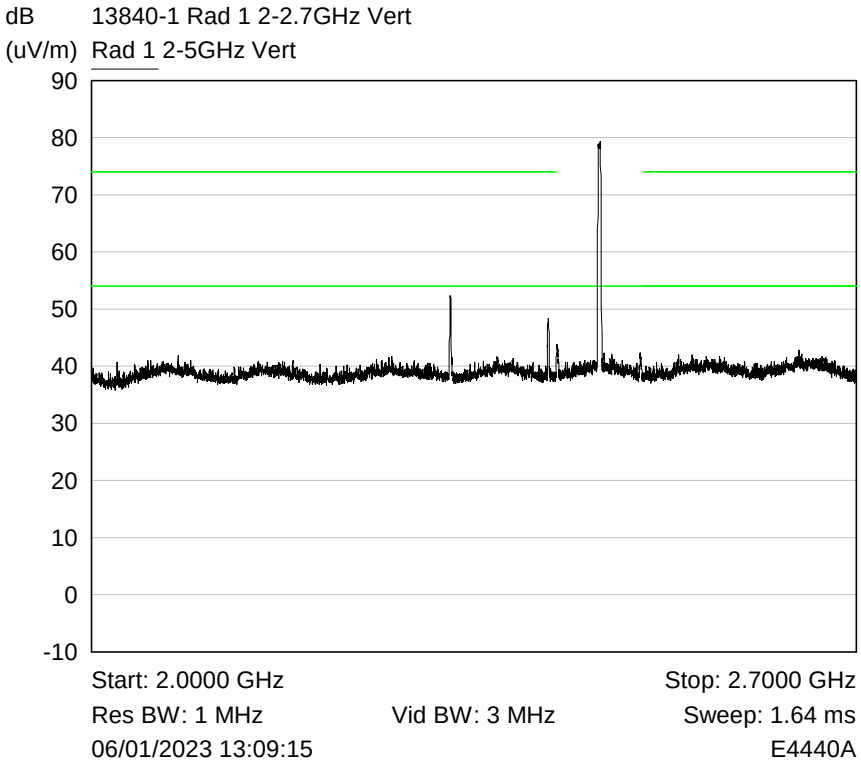
Plot of Peak emissions for UHF Vertical against the QP limit line.

6.4 Radiated emissions above 1 GHz

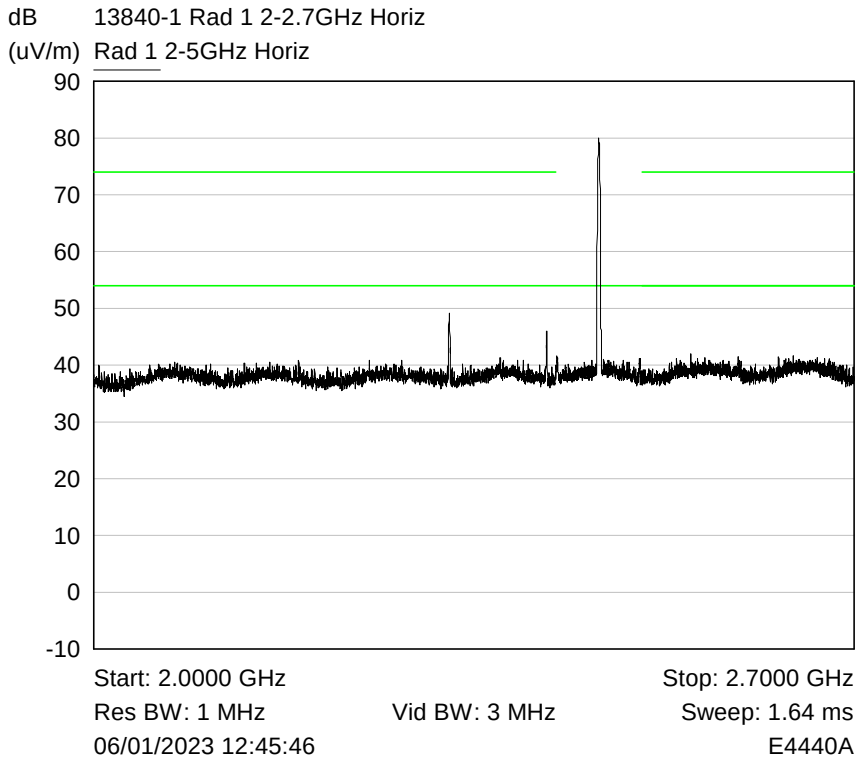
RF Parameters: Band 2400-2483.5 MHz, Power 10 set in GUI, Channel Spacing 1 MHz, Modulation GFSK, Channel 2441 MHz



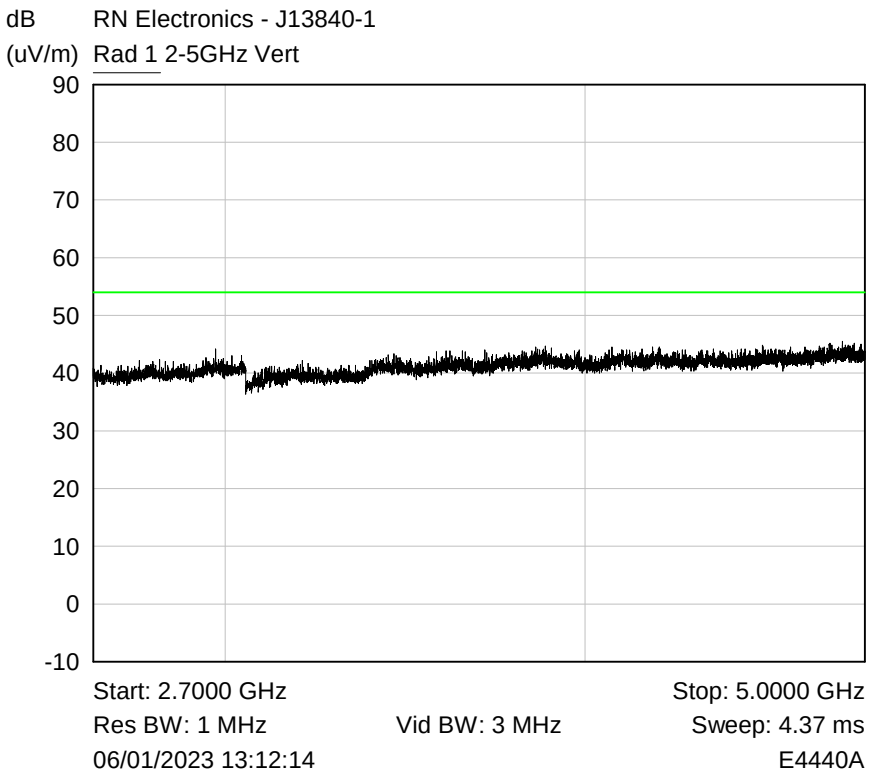


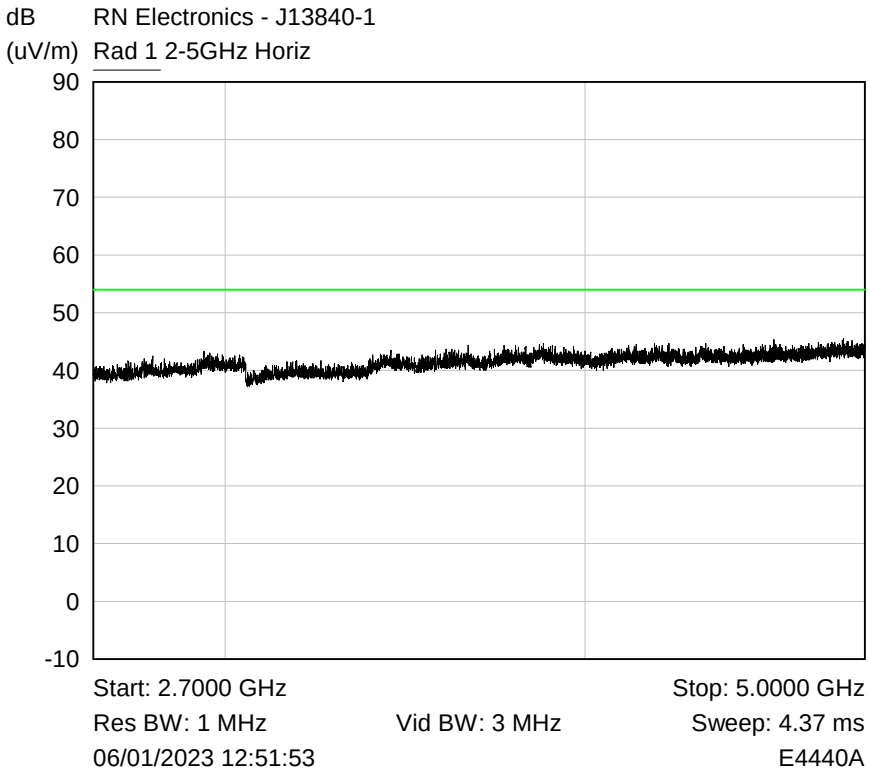


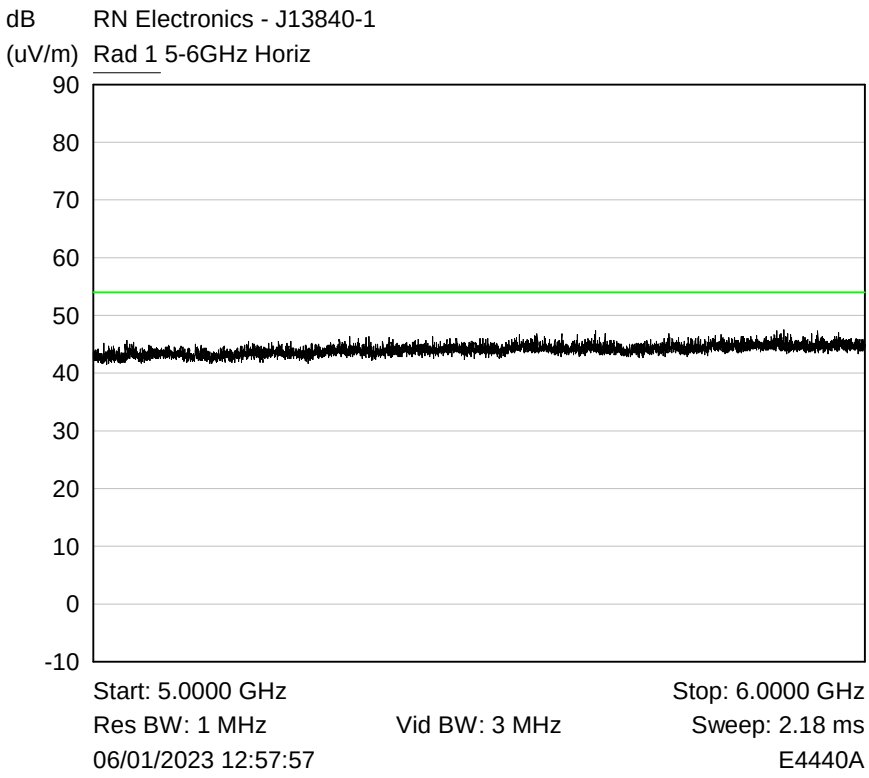
Note: Plot shows fundamental transmit frequency (Mid Channel)

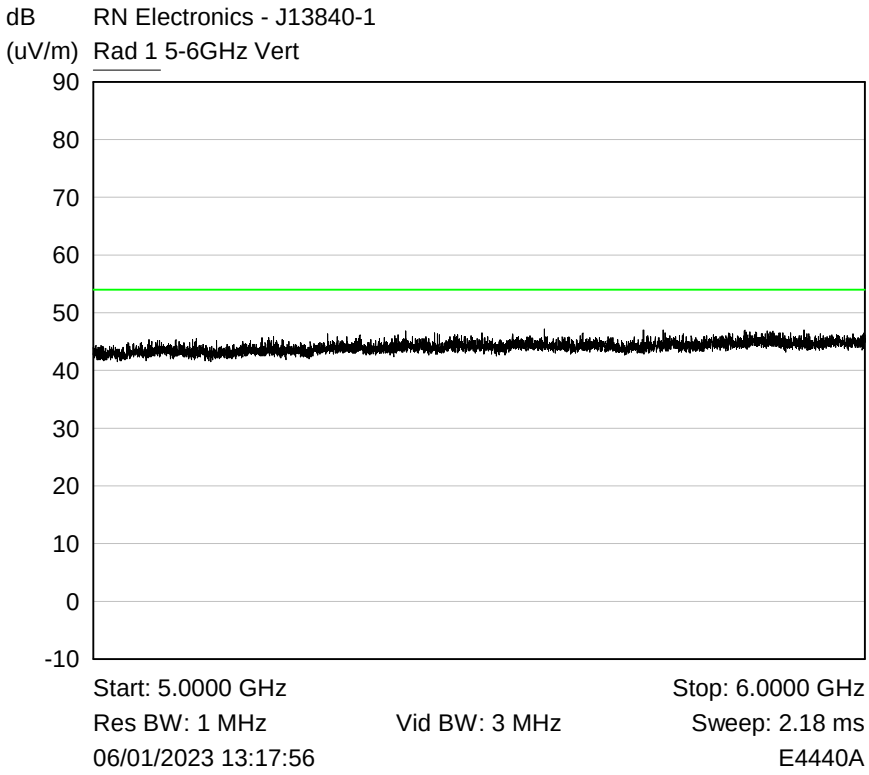


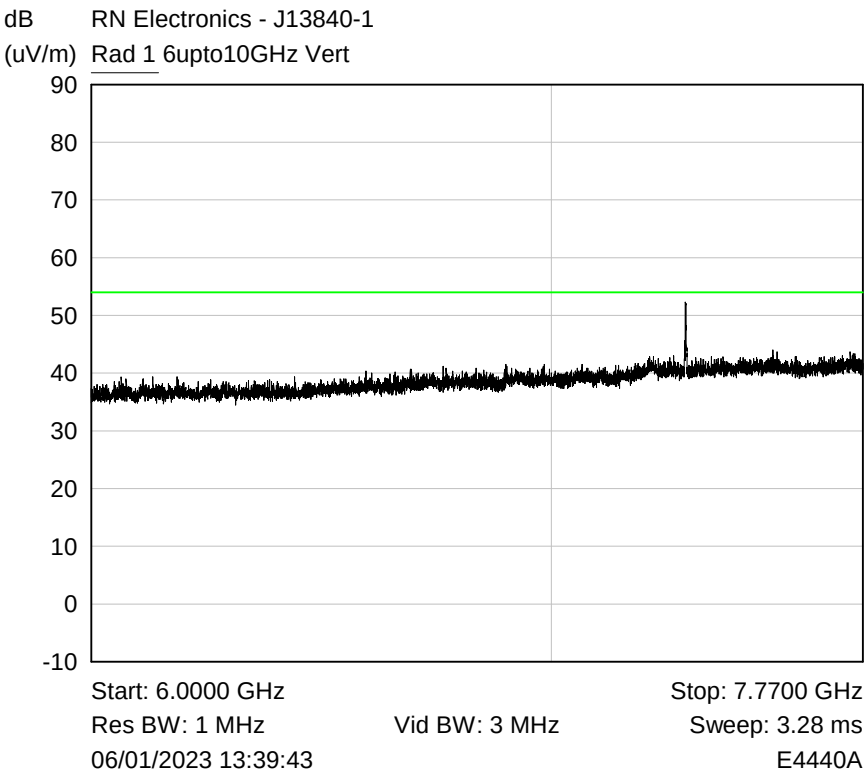
Note: Plot shows fundamental transmit frequency (Mid Channel)

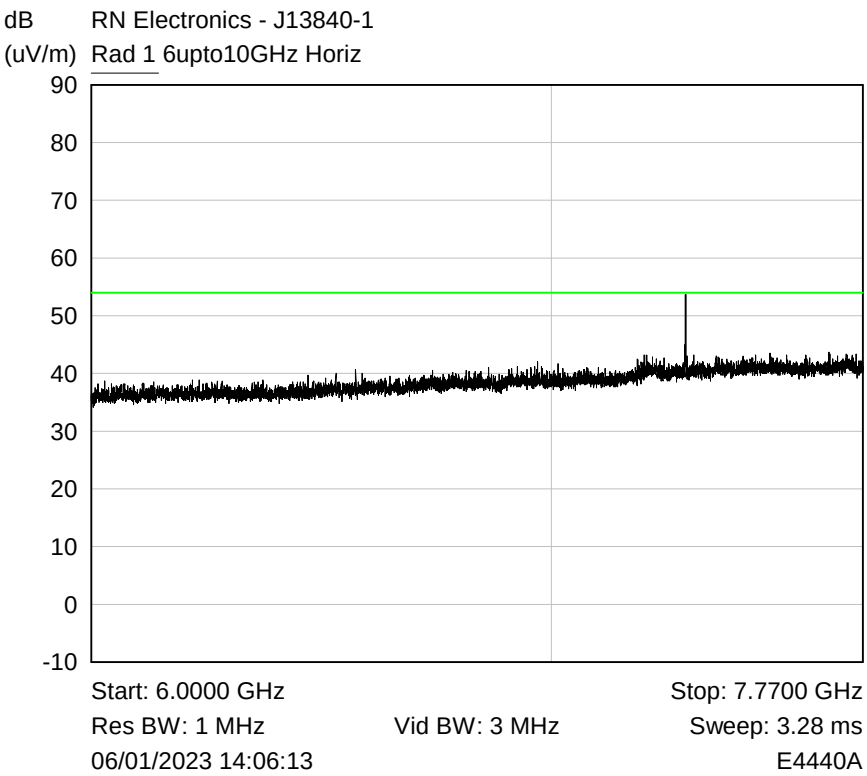


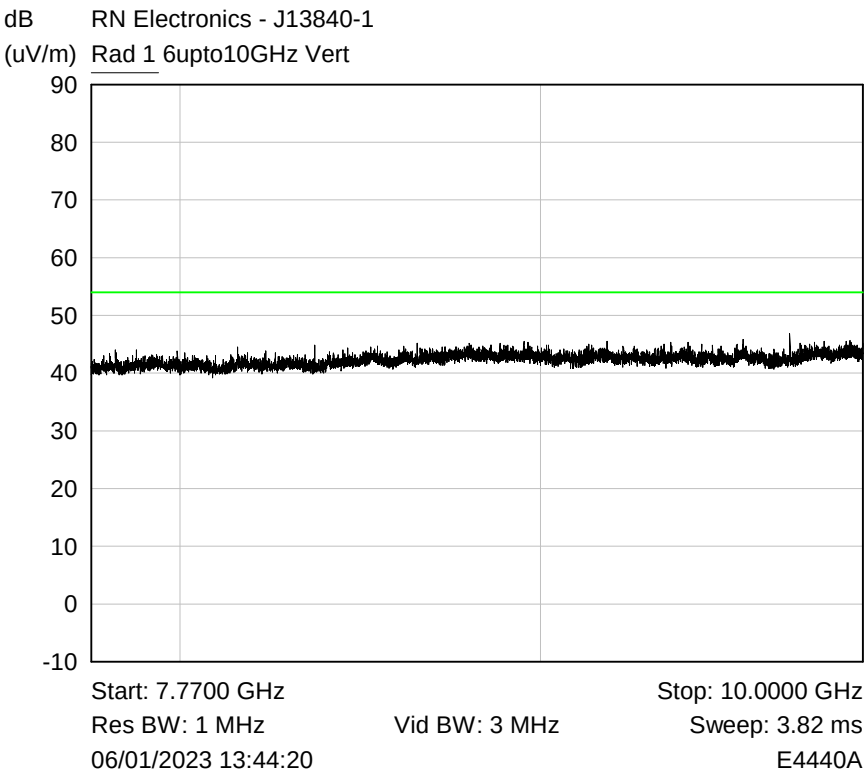


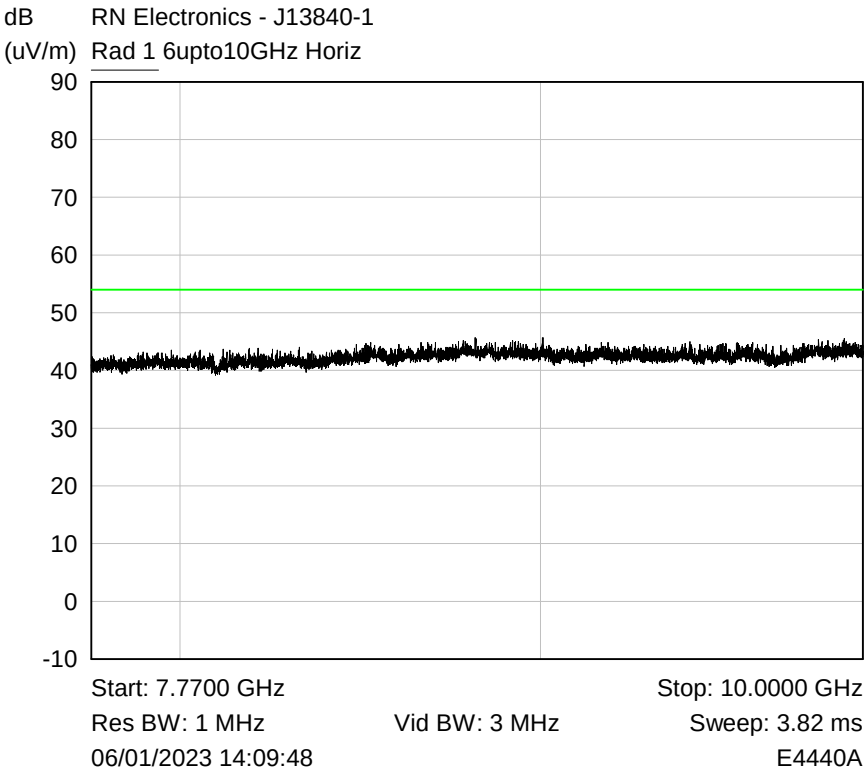


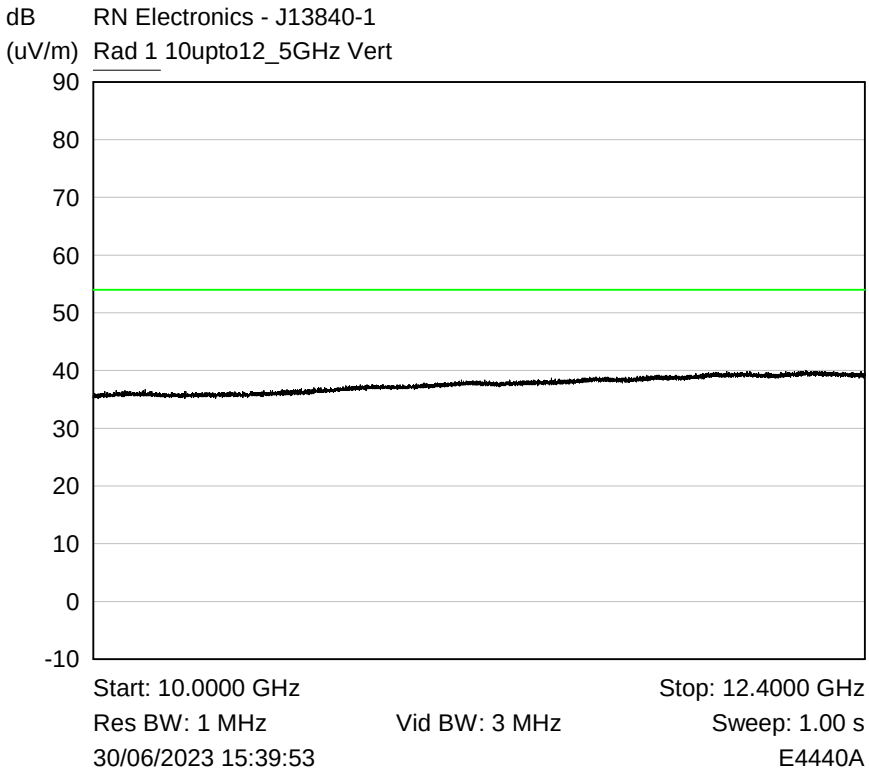


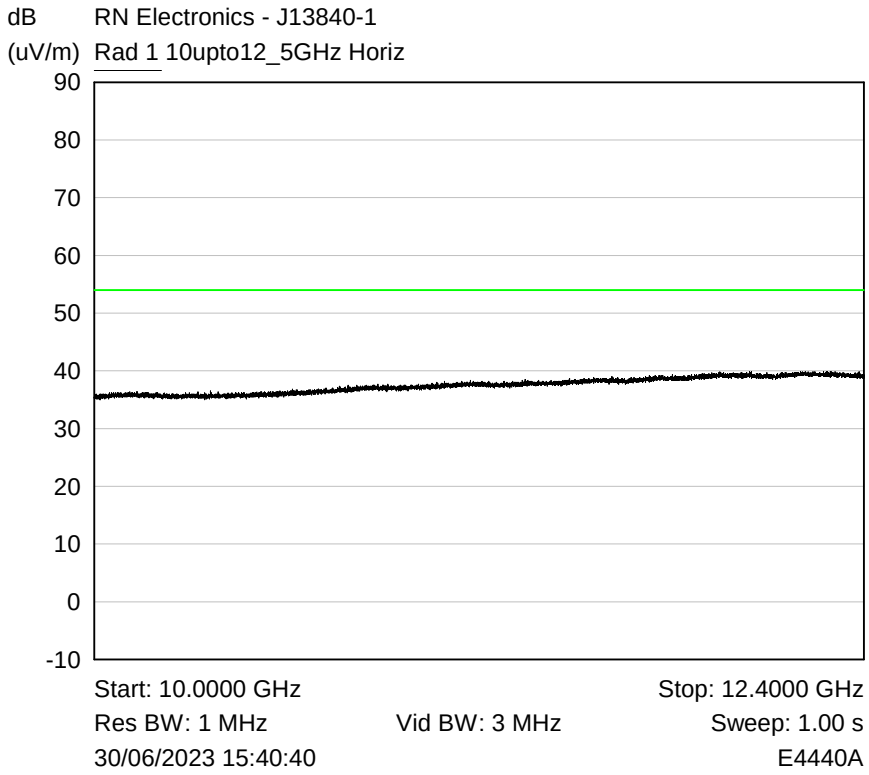


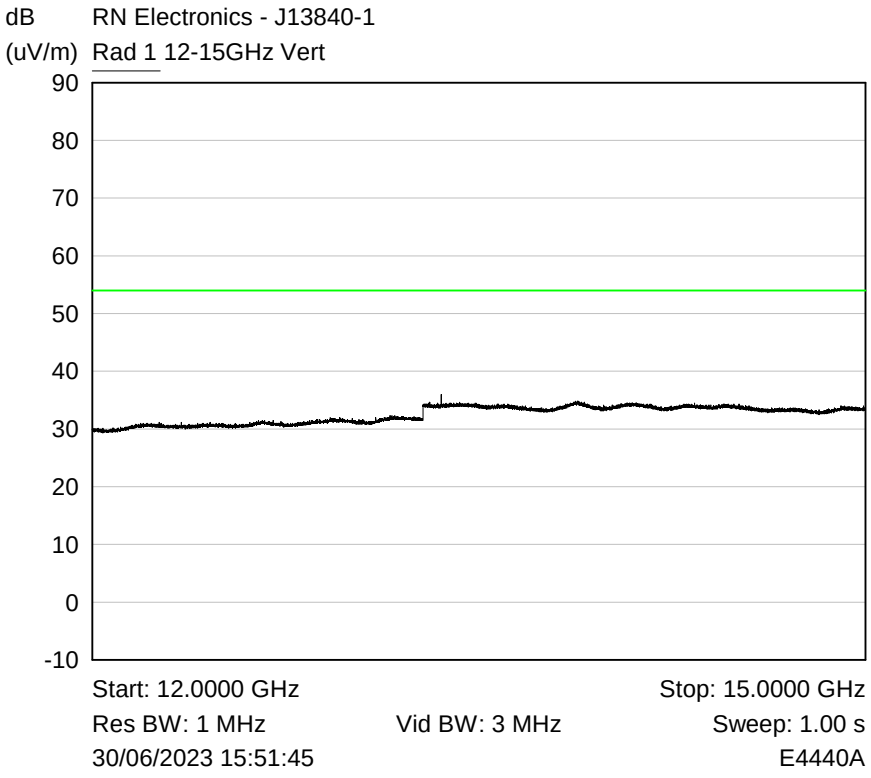


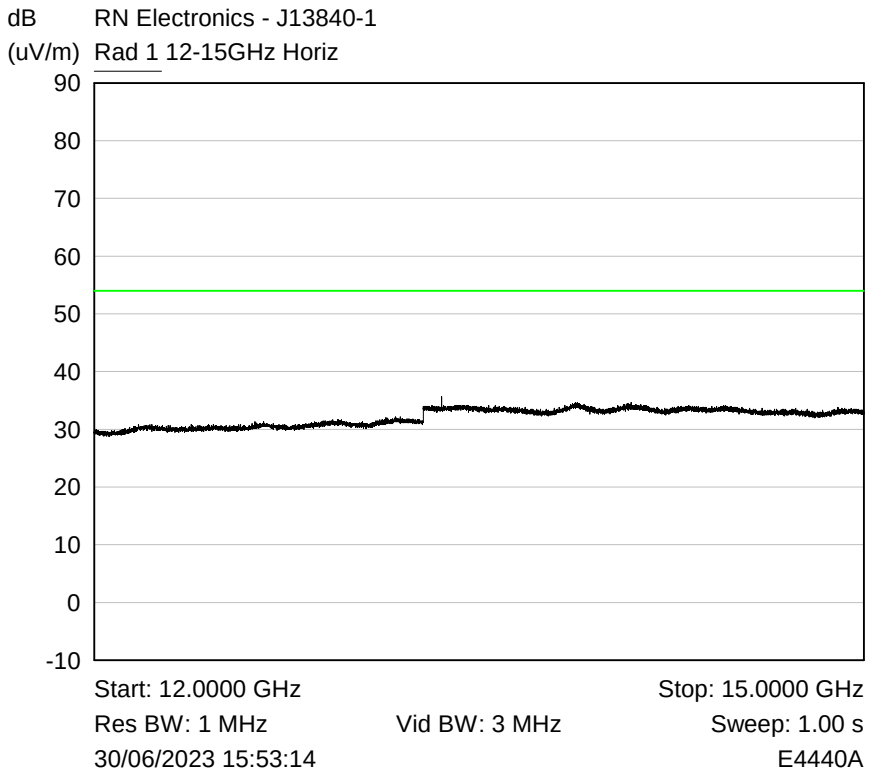


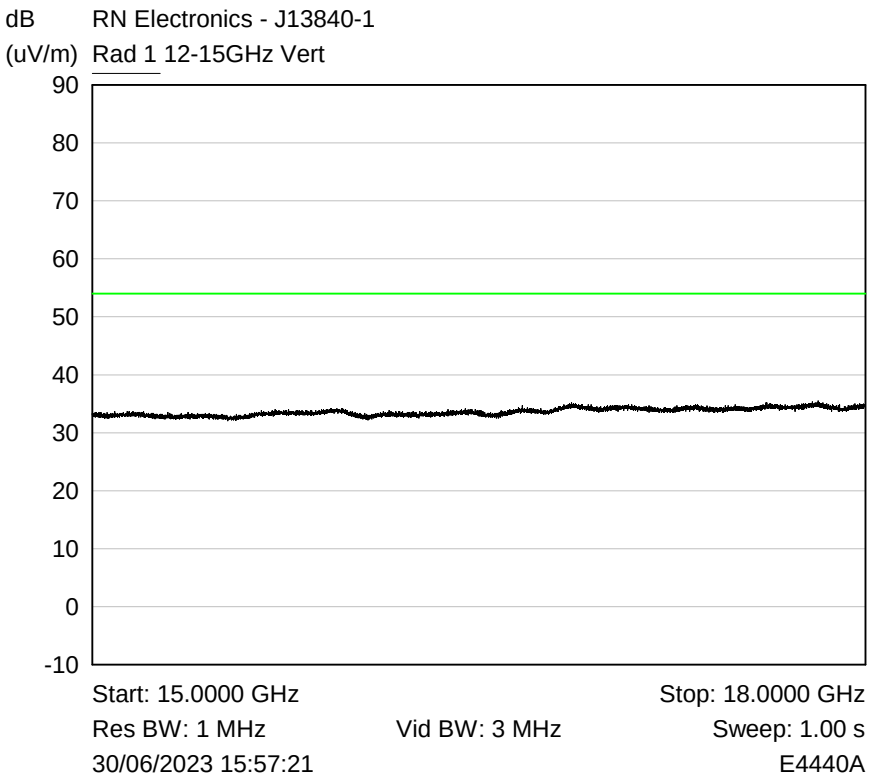


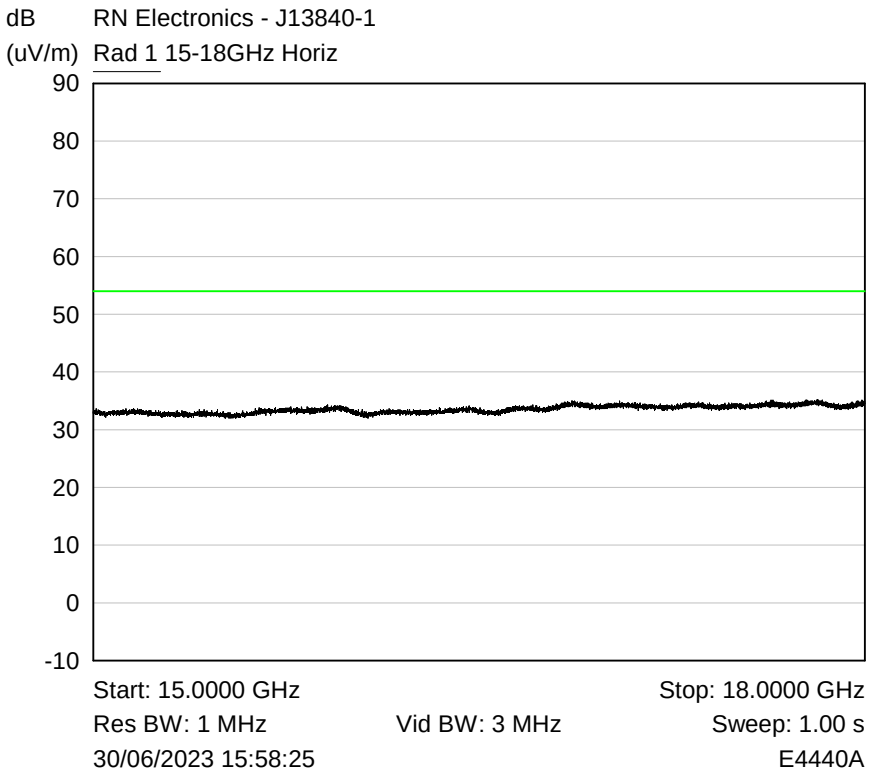


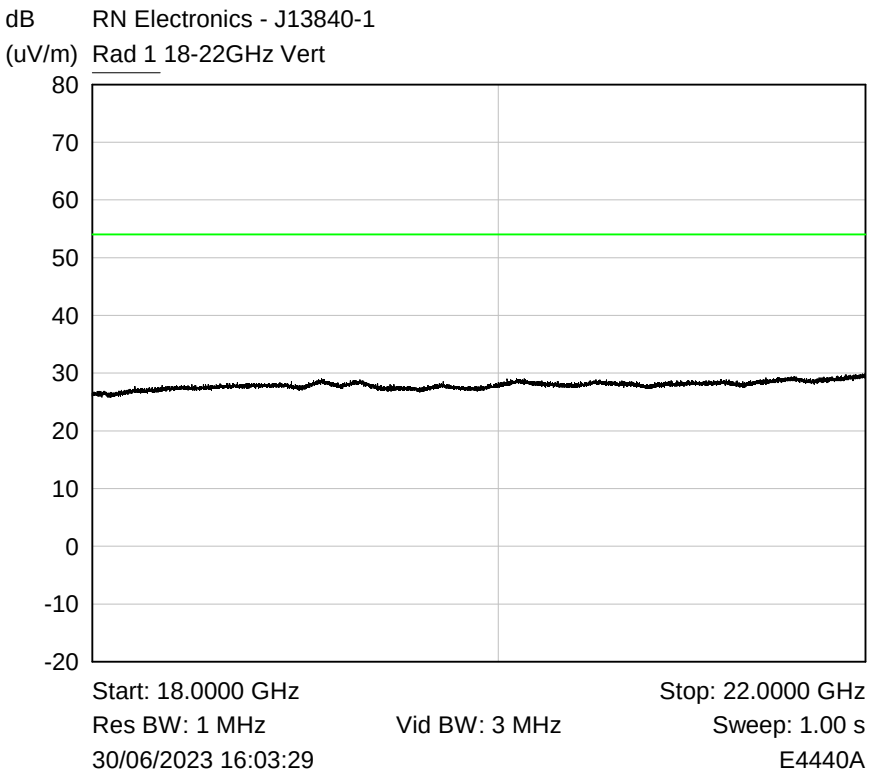


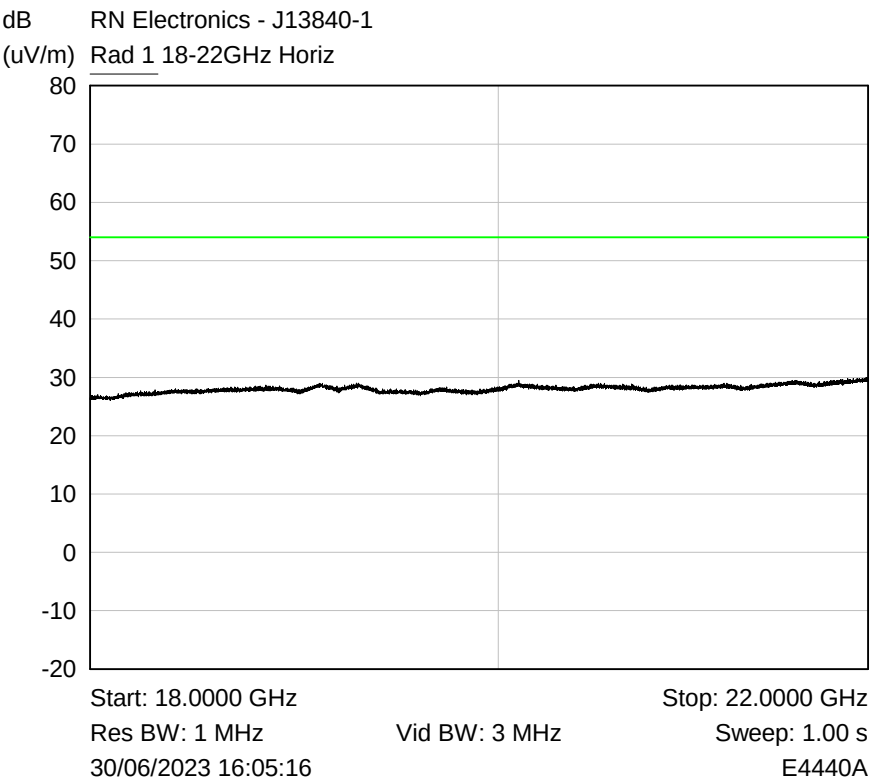


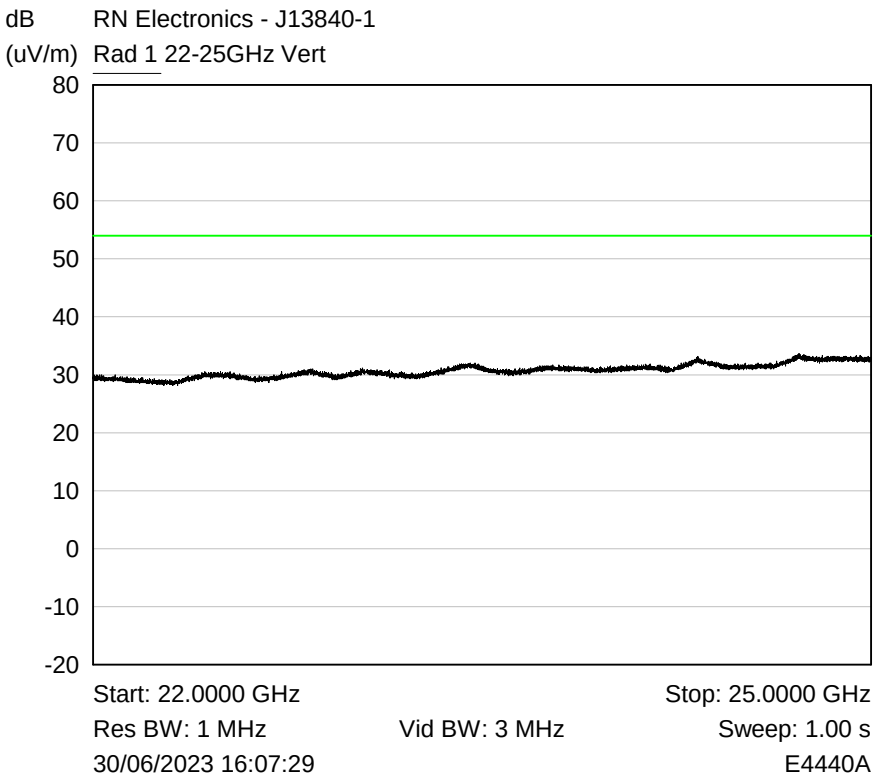


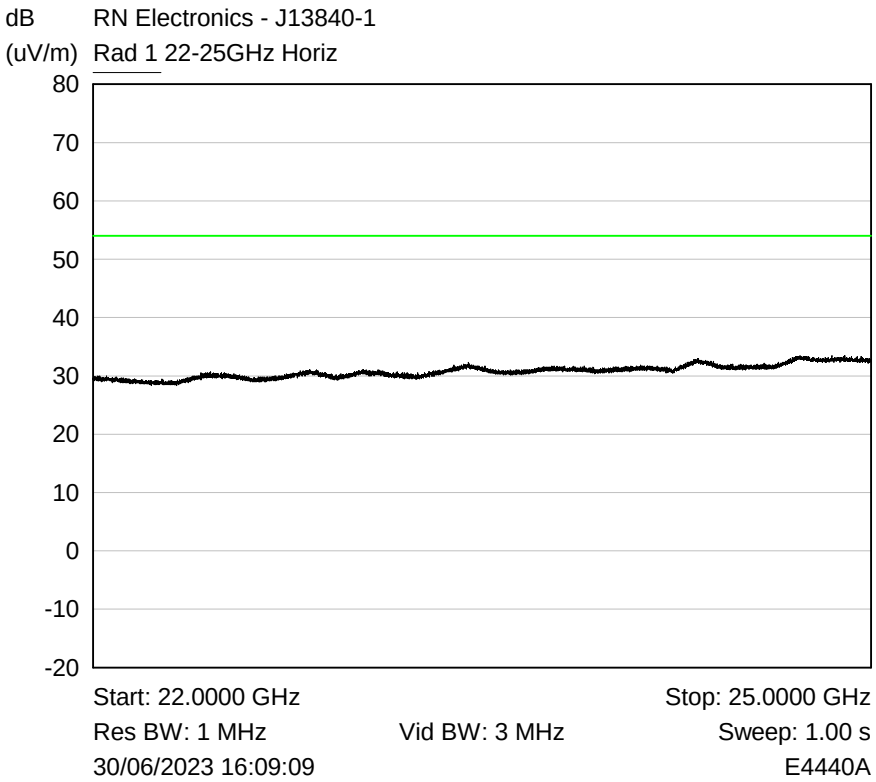






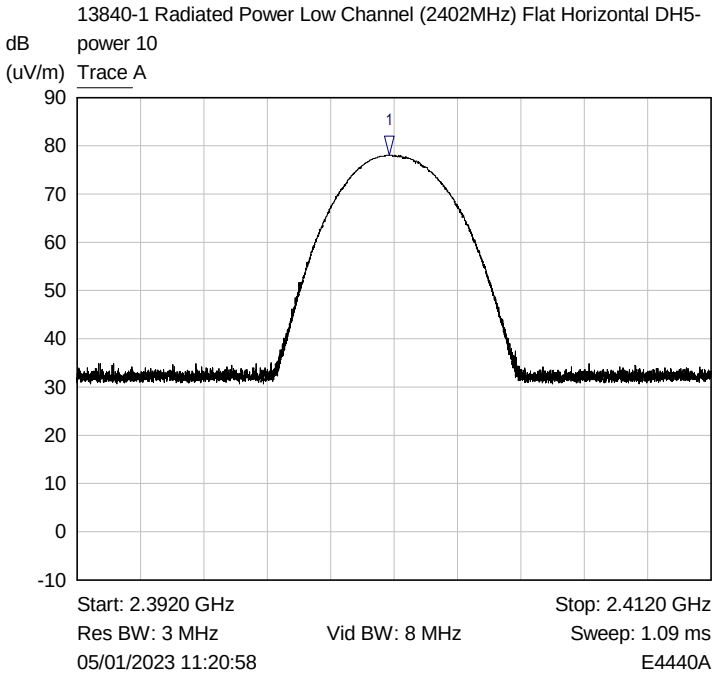






6.5 Effective radiated power field strength

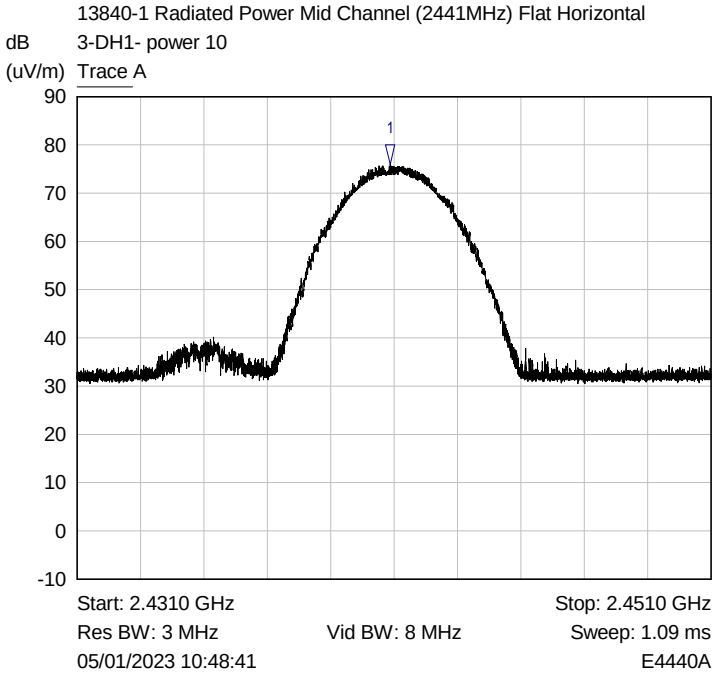
RF Parameters: Band 2400-2483.5 MHz, Power 10 set in GUI, Channel Spacing 1 MHz, Modulation DH5, Channel 2402 MHz (Low)



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4018 GHz	77.98 dB(uV/m)	

Plot of Horiz polarisation and EUT in Flat position

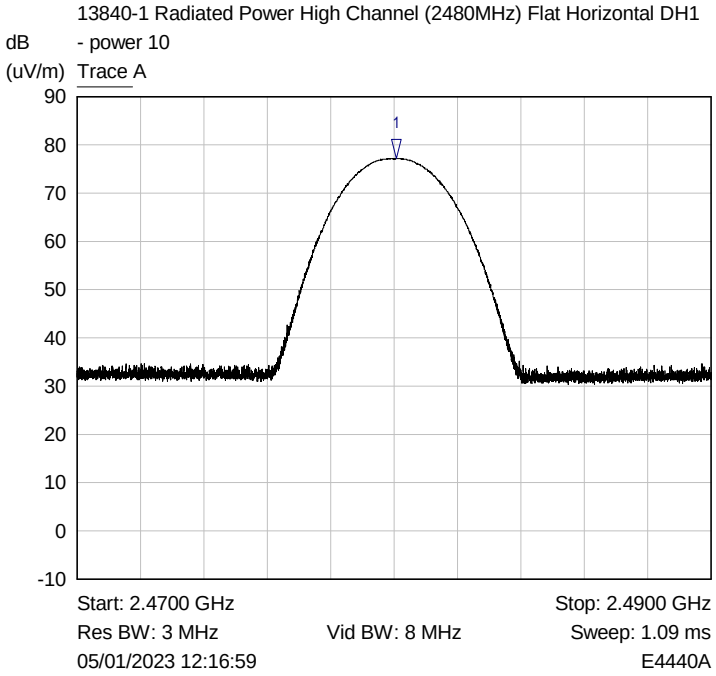
RF Parameters: Band 2400-2483.5 MHz, Power 10 set in GUI, Channel Spacing 1 MHz, Modulation 3-DH1, Channel 2441 MHz (Mid)



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4409 GHz	76.05 dB(uV/m)	

Plot of Horiz polarisation and EUT in Flat position

RF Parameters: Band 2400-2483.5 MHz, Power 10 set in GUI, Channel Spacing 1 MHz, Modulation DH1, Channel 2480 MHz (High)

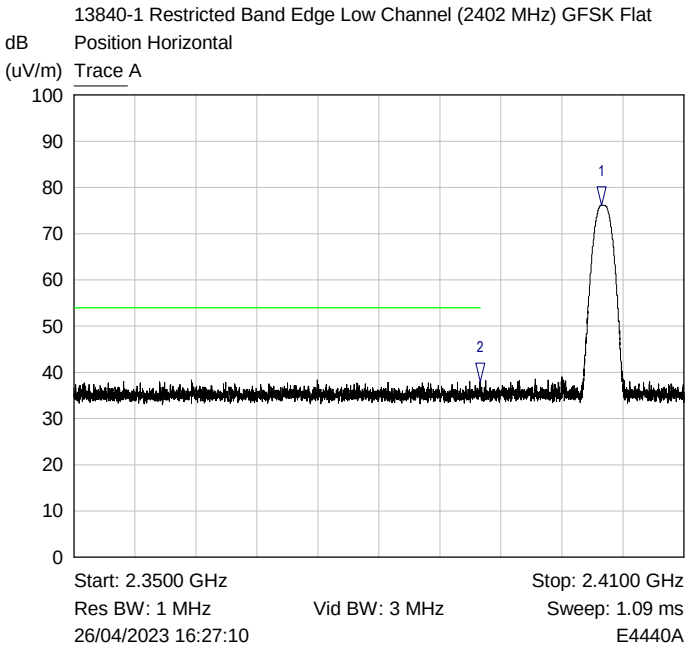


Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4801 GHz	77.14 dB(uV/m)	

Plot of Horiz polarisation and EUT in Flat position

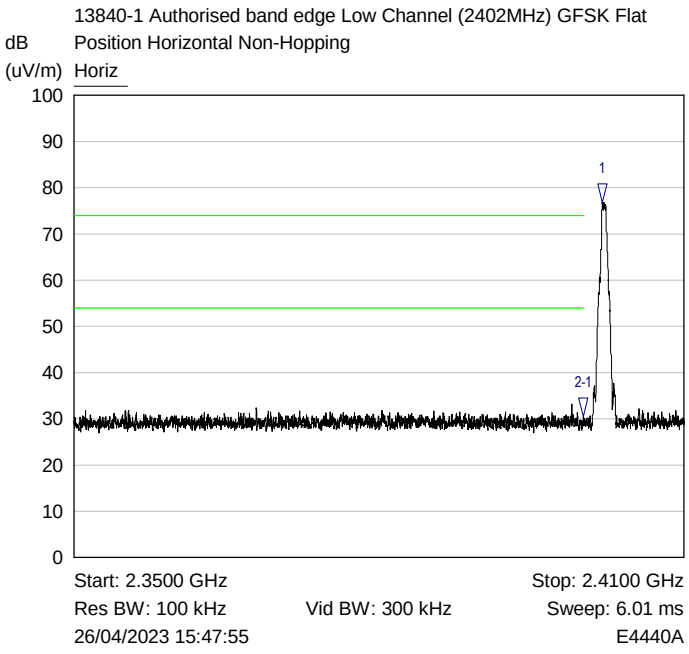
6.6 Band Edge Compliance

RF Parameters: Band 2400-2483.5 MHz, Power 10 set in GUI, Channel Spacing 1 MHz, Modulation GFSK, Channel 2402 MHz (Low)



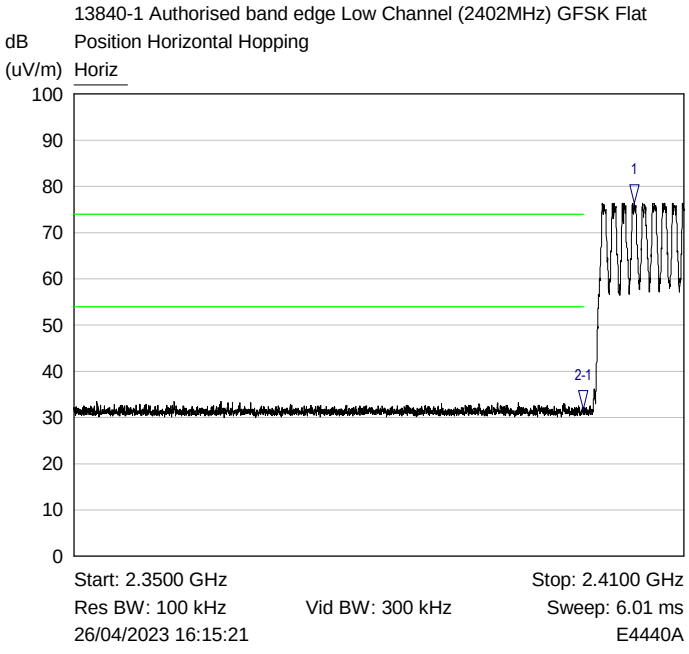
Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4019 GHz	76.18 dB(uV/m)	
2 ▽	Trace A	2.3899 GHz	37.96 dB(uV/m)	

Restricted band edge Peak Plot
(Note: Peak measurement complied with Average limit, so no average plot taken)



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Horiz	2.4019 GHz	76.86 dB(uV/m)	
2-1 ▽	Horiz	2.4000 GHz	-46.32 dB	

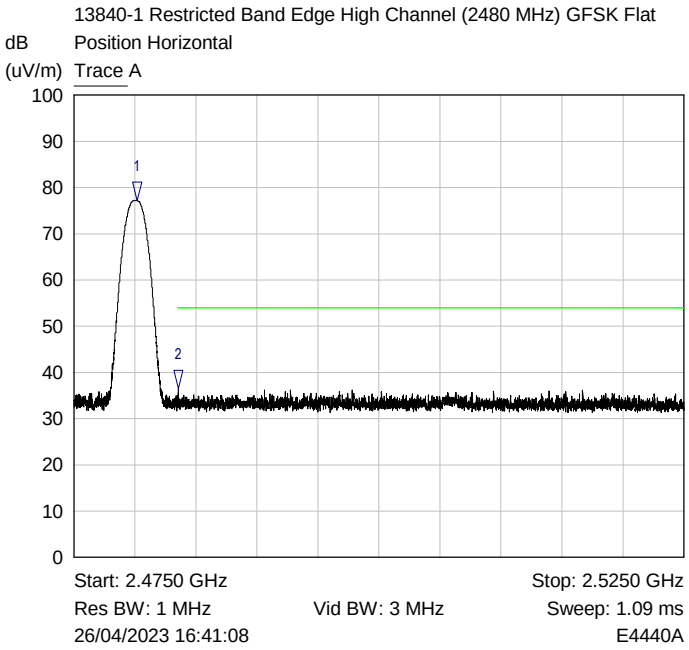
Authorised Band Edge Plot



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Horiz	2.4051 GHz	76.39 dB(uV/m)	
2-1 ▽	Horiz	2.4000 GHz	-44.63 dB	

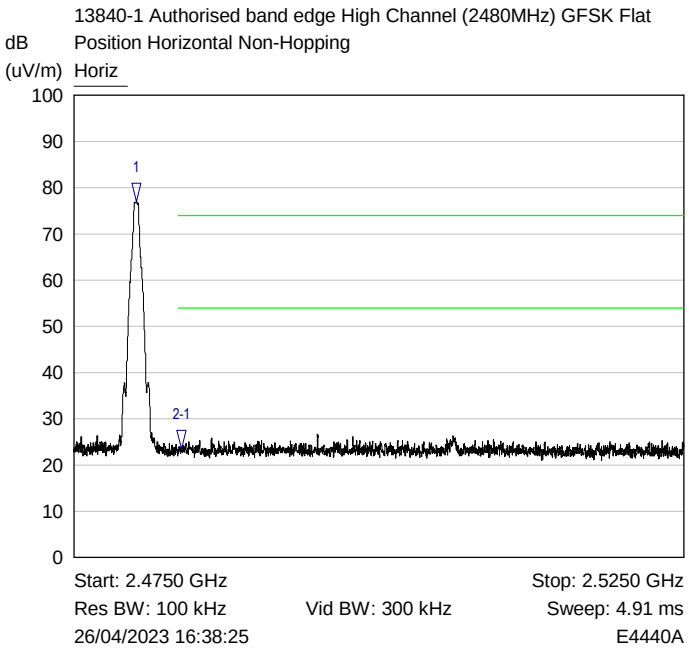
Auth Band Edge hopping Plot

RF Parameters: Band 2400-2483.5 MHz, Power 10 set in GUI, Channel Spacing 1 MHz, Modulation GFSK, Channel 2480 MHz (High)



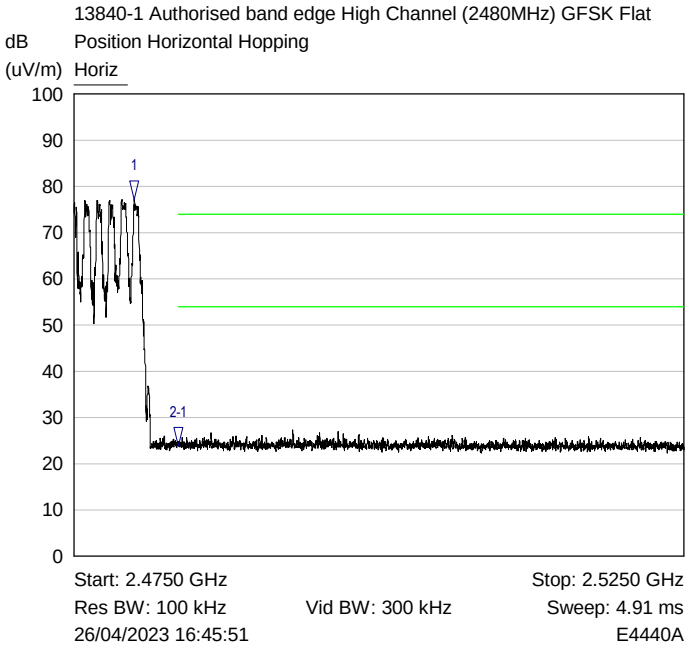
Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4802 GHz	77.17 dB(uV/m)	
2 ▽	Trace A	2.4835 GHz	36.46 dB(uV/m)	

Restricted band edge Peak Plot
(Note: Peak measurement complied with Average limit, so no average plot taken)



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Horiz	2.4801 GHz	76.99 dB(uV/m)	
2-1 ▽	Horiz	2.4837 GHz	-53.42 dB	

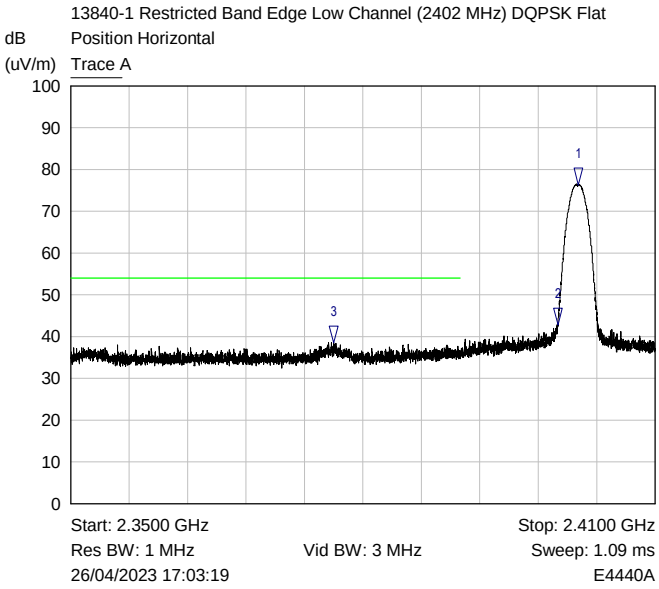
Authorised Band Edge Plot



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Horiz	2.4799 GHz	77.16 dB(uV/m)	
2-1 ▽	Horiz	2.4835 GHz	-53.26 dB	

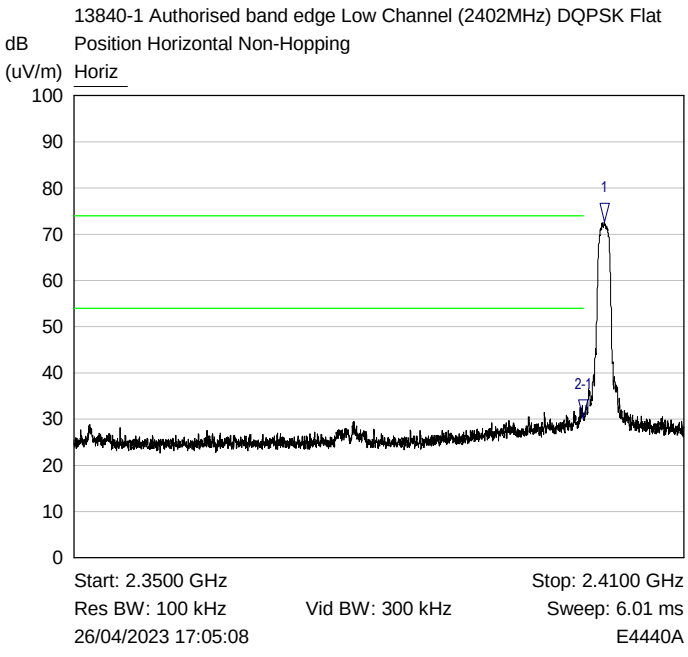
Auth Band Edge hopping Plot

RF Parameters: Band 2400-2483.5 MHz, Power 10 set in GUI, Channel Spacing 1 MHz, Modulation DQPSK, Channel 2402 MHz (Low)



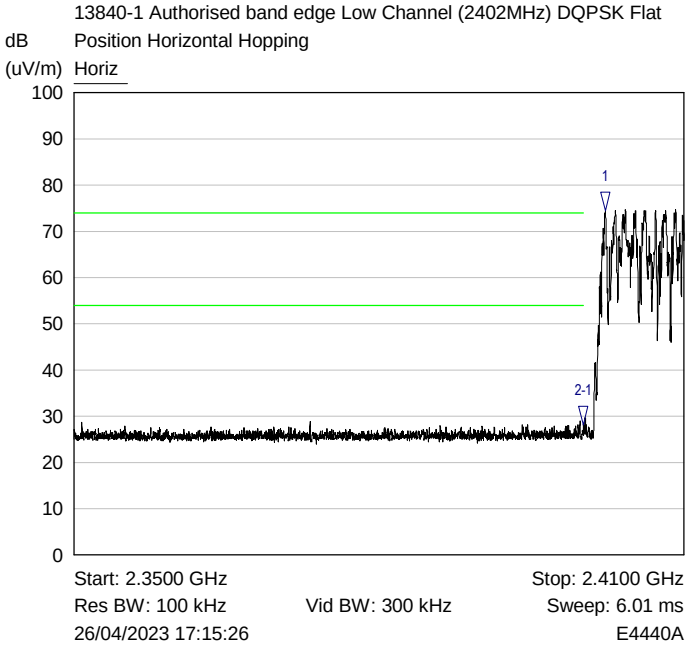
Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4022 GHz	76.30 dB(uV/m)	
2 ▽	Trace A	2.4000 GHz	42.89 dB(uV/m)	
3 ▽	Trace A	2.3770 GHz	38.42 dB(uV/m)	

Restricted band edge Peak Plot
(Note: Peak measurement complied with Average limit, so no average plot taken)



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Horiz	2.4021 GHz	72.72 dB(uV/m)	
2-1 ▽	Horiz	2.4000 GHz	-42.63 dB	

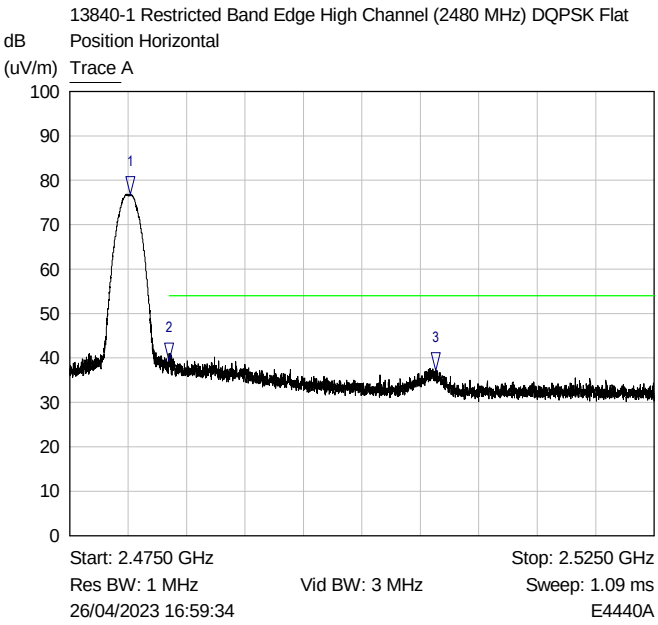
Authorised Band Edge Plot



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Horiz	2.4022 GHz	74.53 dB(uV/m)	
2-1 ▽	Horiz	2.4000 GHz	-46.36 dB	

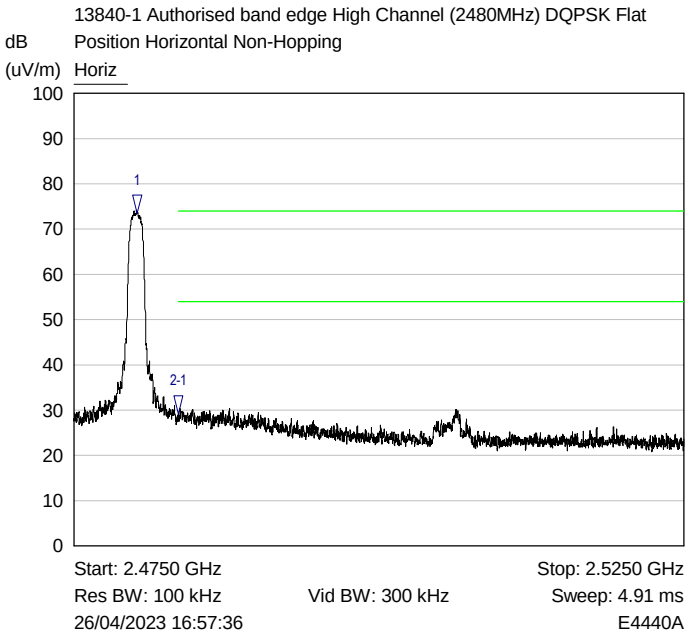
Auth Band Edge hopping Plot

RF Parameters: Band 2400-2483.5 MHz, Power 10 set in GUI, Channel Spacing 1 MHz, Modulation DQPSK, Channel 2480 MHz (High)



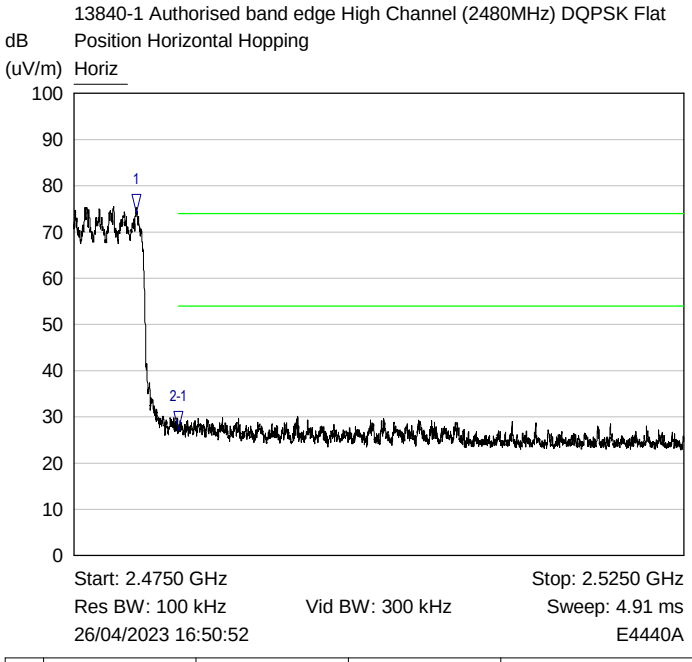
Mkr	Trace	X-Axis	Value	Notes
1	Trace A	2.4802 GHz	76.82 dB(uV/m)	
2	Trace A	2.4835 GHz	39.37 dB(uV/m)	
3	Trace A	2.5063 GHz	37.17 dB(uV/m)	

Restricted band edge Peak Plot
(Note: Peak measurement complied with Average limit, so no average plot taken)



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Horiz	2.4802 GHz	73.57 dB(uV/m)	
2-1 ▽	Horiz	2.4835 GHz	-44.47 dB	

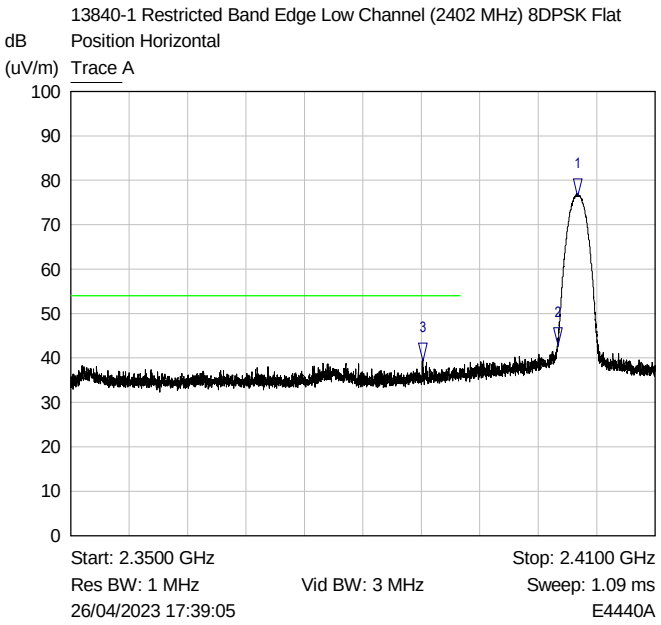
Authorised Band Edge Plot



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Horiz	2.4801 GHz	74.10 dB(uV/m)	
2-1 ▽	Horiz	2.4835 GHz	-46.94 dB	

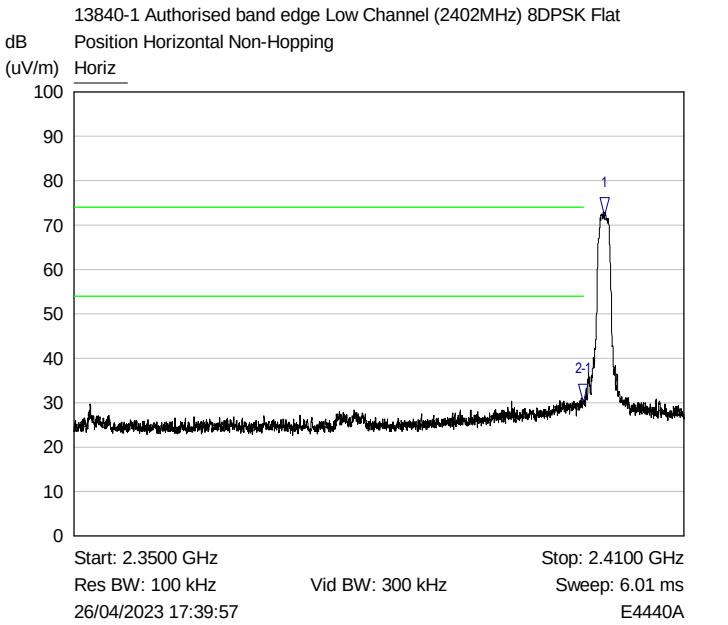
Auth Band Edge hopping Plot

RF Parameters: Band 2400-2483.5 MHz, Power 10 set in GUI, Channel Spacing 1 MHz, Modulation 8DPSK, Channel 2402 MHz (Low)



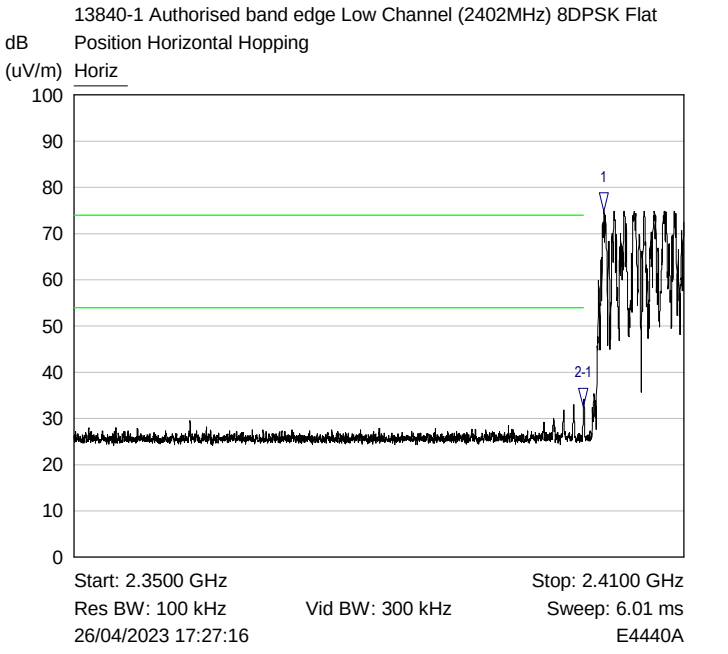
Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4020 GHz	76.40 dB(uV/m)	
2 ▽	Trace A	2.4000 GHz	42.87 dB(uV/m)	
3 ▽	Trace A	2.3861 GHz	39.32 dB(uV/m)	

Restricted band edge Peak Plot
(Note: Peak measurement complied with Average limit, so no average plot taken)



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Horiz	2.4021 GHz	72.22 dB(uV/m)	
2-1 ▽	Horiz	2.4000 GHz	-42.10 dB	

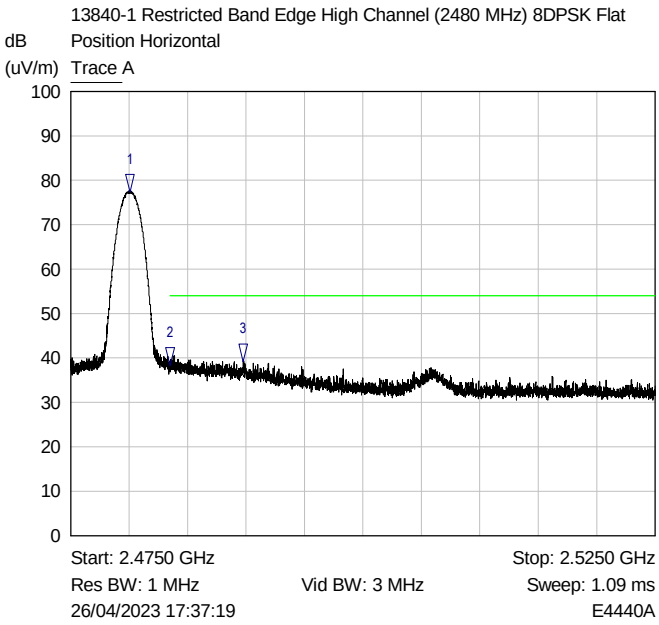
Authorised Band Edge Plot



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Horiz	2.4021 GHz	74.76 dB(uV/m)	
2-1 ▽	Horiz	2.4000 GHz	-42.20 dB	

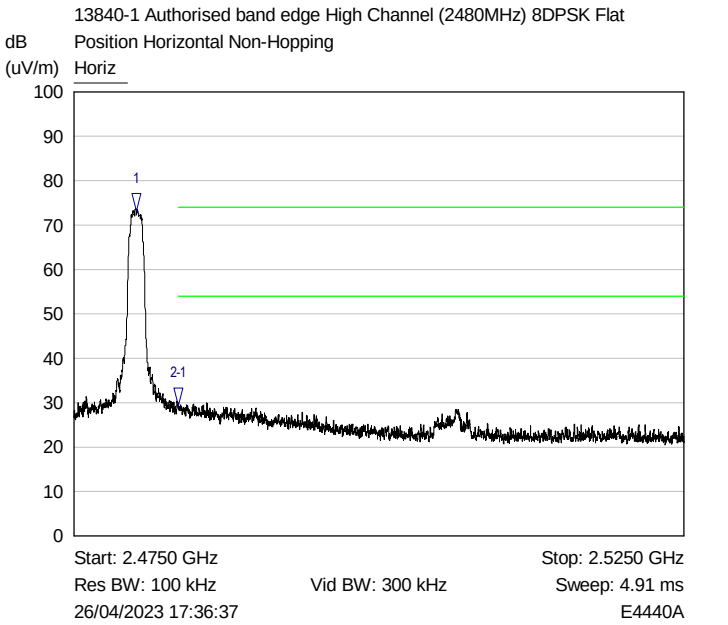
Auth Band Edge hopping Plot

RF Parameters: Band 2400-2483.5 MHz, Power 10 set in GUI, Channel Spacing 1 MHz, Modulation 8DPSK, Channel 2480 MHz (High)



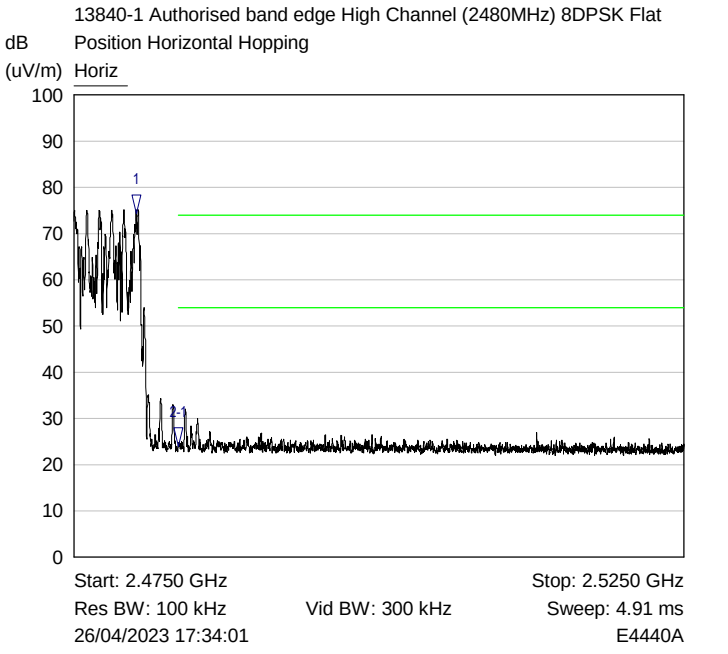
Mkr	Trace	X-Axis	Value	Notes
1	Trace A	2.4800 GHz	77.36 dB(uV/m)	
2	Trace A	2.4835 GHz	38.29 dB(uV/m)	
3	Trace A	2.4898 GHz	39.23 dB(uV/m)	

Restricted band edge Peak Plot
(Note: Peak measurement complied with Average limit, so no average plot taken)



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Horiz	2.4801 GHz	73.21 dB(uV/m)	
2-1 ▽	Horiz	2.4835 GHz	-43.84 dB	

Authorised Band Edge Plot

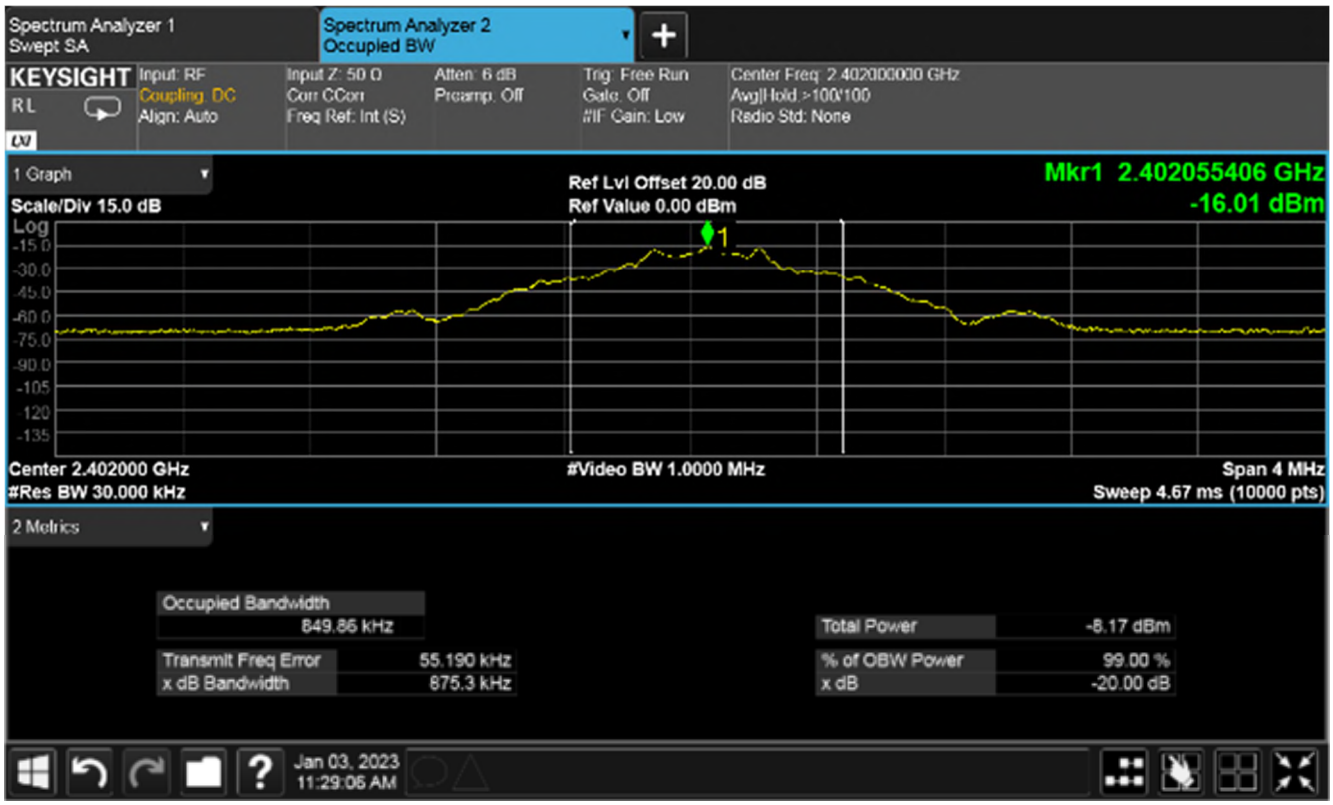


Mkr	Trace	X-Axis	Value	Notes
1 ▽	Horiz	2.4801 GHz	74.26 dB(uV/m)	
2-1 ▽	Horiz	2.4835 GHz	-50.20 dB	

Auth Band Edge hopping Plot

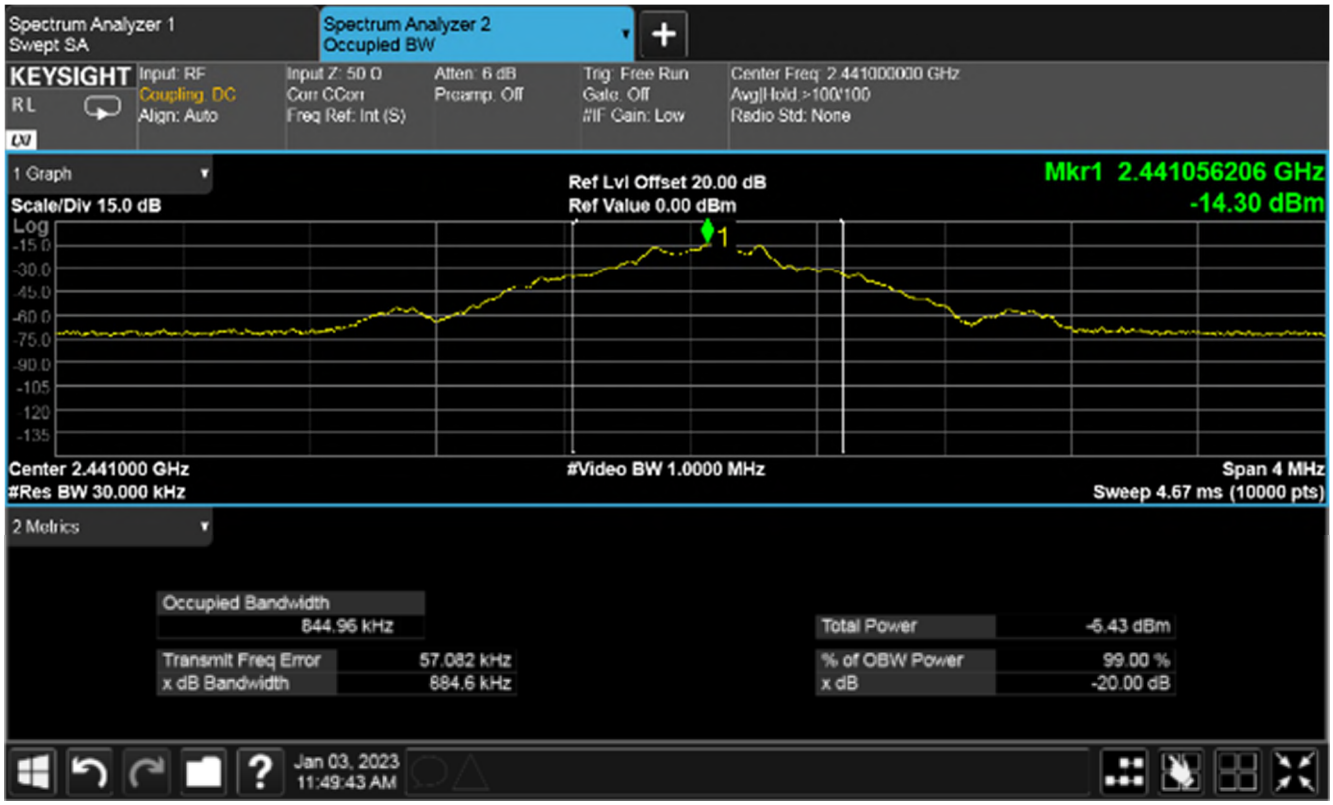
6.7 Occupied bandwidth

RF Parameters: Band 2400-2483.5 MHz, Power 10 set in GUI, Channel Spacing 1 MHz, Modulation DH1, Channel 2402 MHz (Low)



Plot for 20 dB Bandwidth Result (MHz)

RF Parameters: Band 2400-2483.5 MHz, Power 10 set in GUI, Channel Spacing 1 MHz, Modulation DH1, Channel 2441 MHz (Mid)

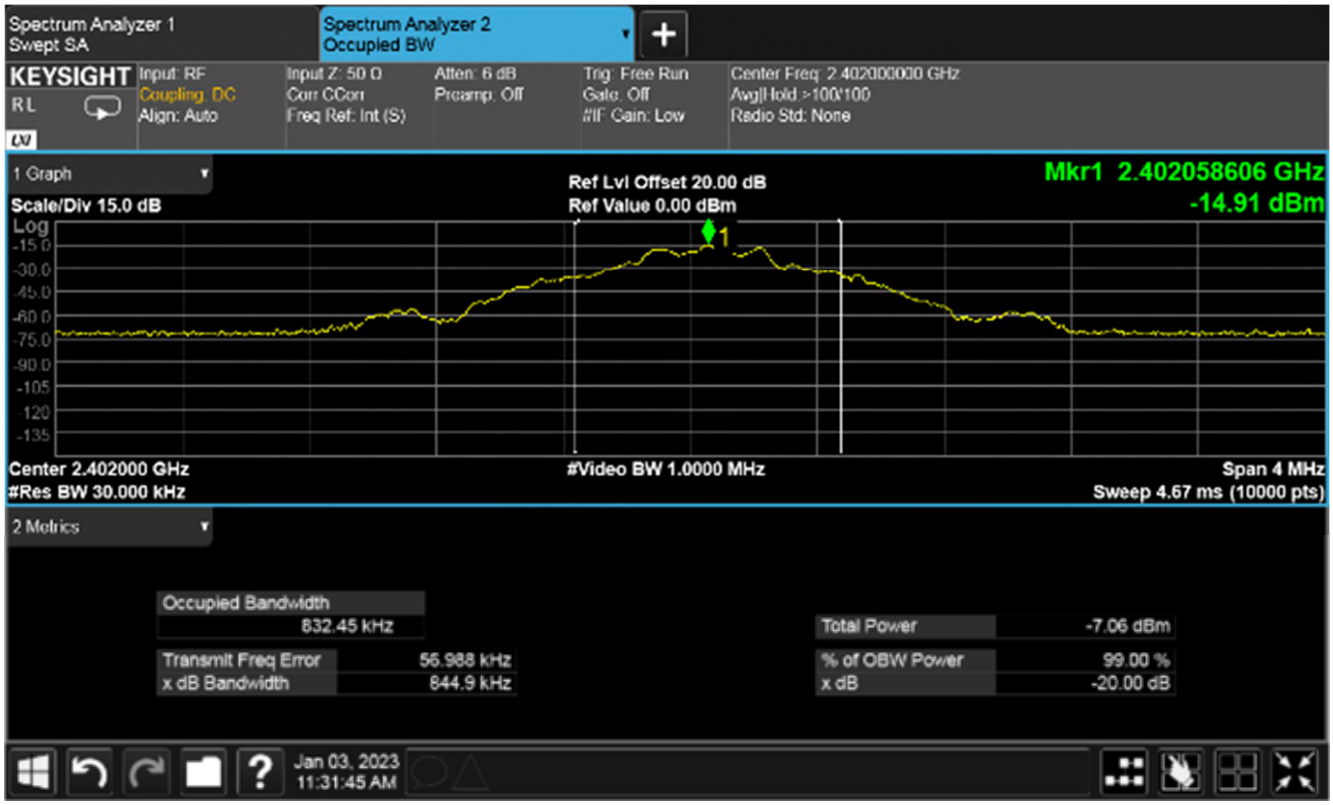


Plot for 20 dB Bandwidth Result (MHz)

RF Parameters: Band 2400-2483.5 MHz, Power 10 set in GUI, Channel Spacing 1 MHz, Modulation DH1, Channel 2480 MHz (High)

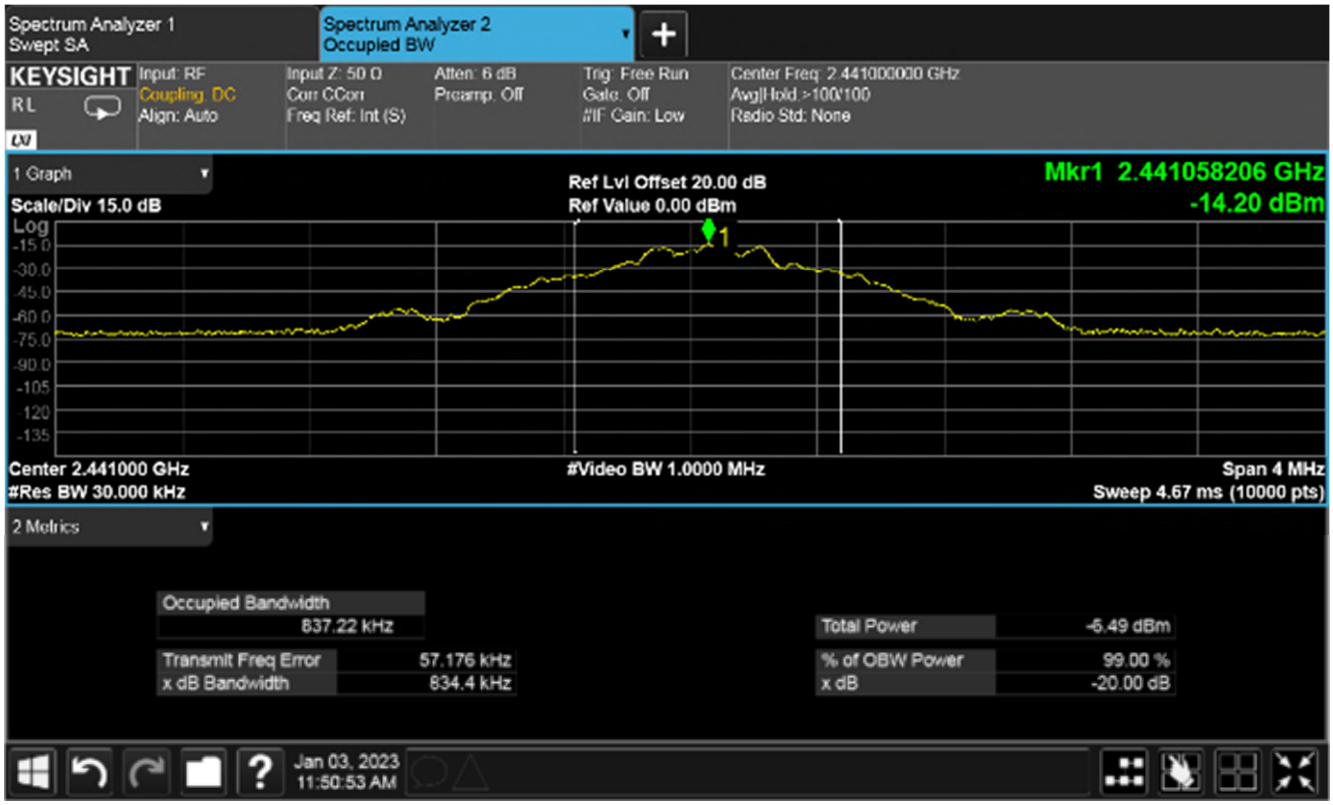
Plot for 20 dB Bandwidth Result (MHz)

RF Parameters: Band 2400-2483.5 MHz, Power 10 set in GUI, Channel Spacing 1 MHz, Modulation DH3, Channel 2402 MHz (Low)



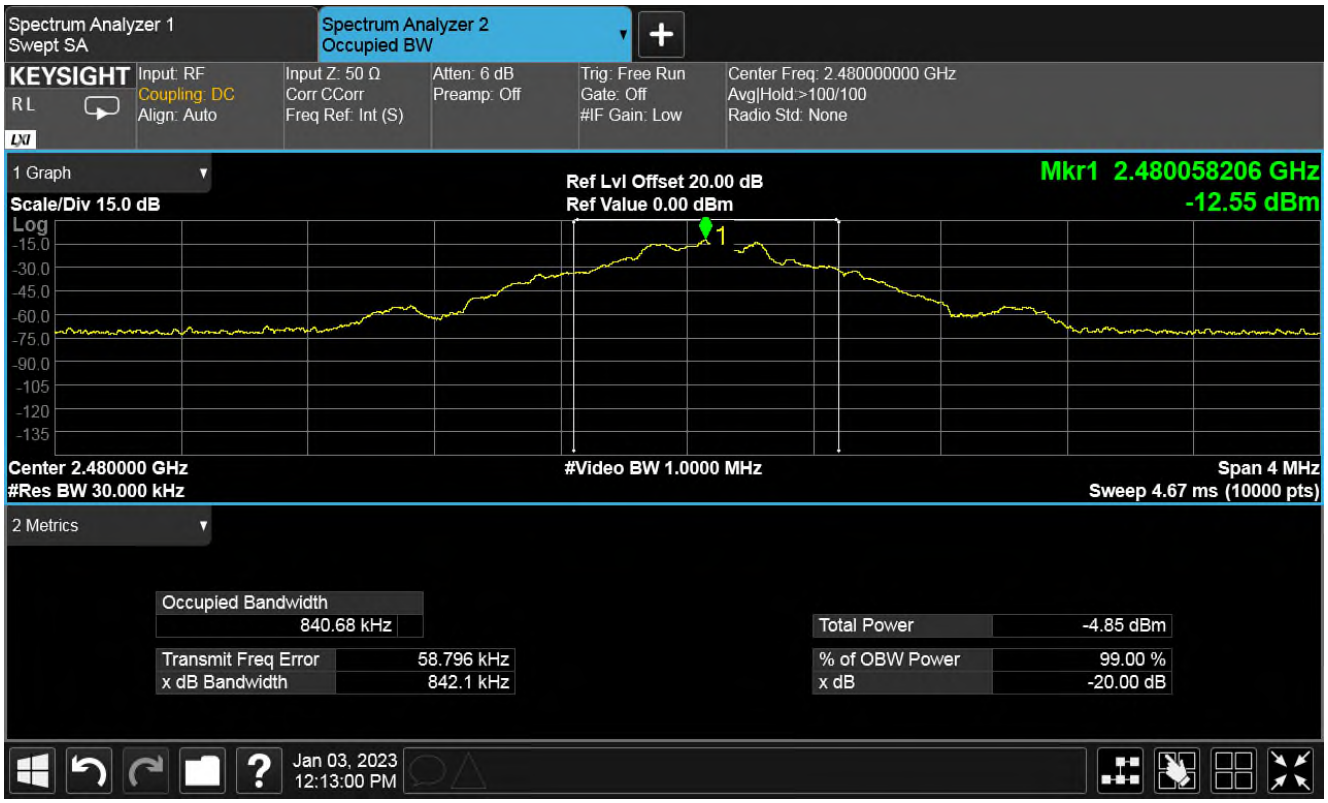
Plot for 20 dB Bandwidth Result (MHz)

RF Parameters: Band 2400-2483.5 MHz, Power 10 set in GUI, Channel Spacing 1 MHz, Modulation DH3, Channel 2441 MHz (Mid)



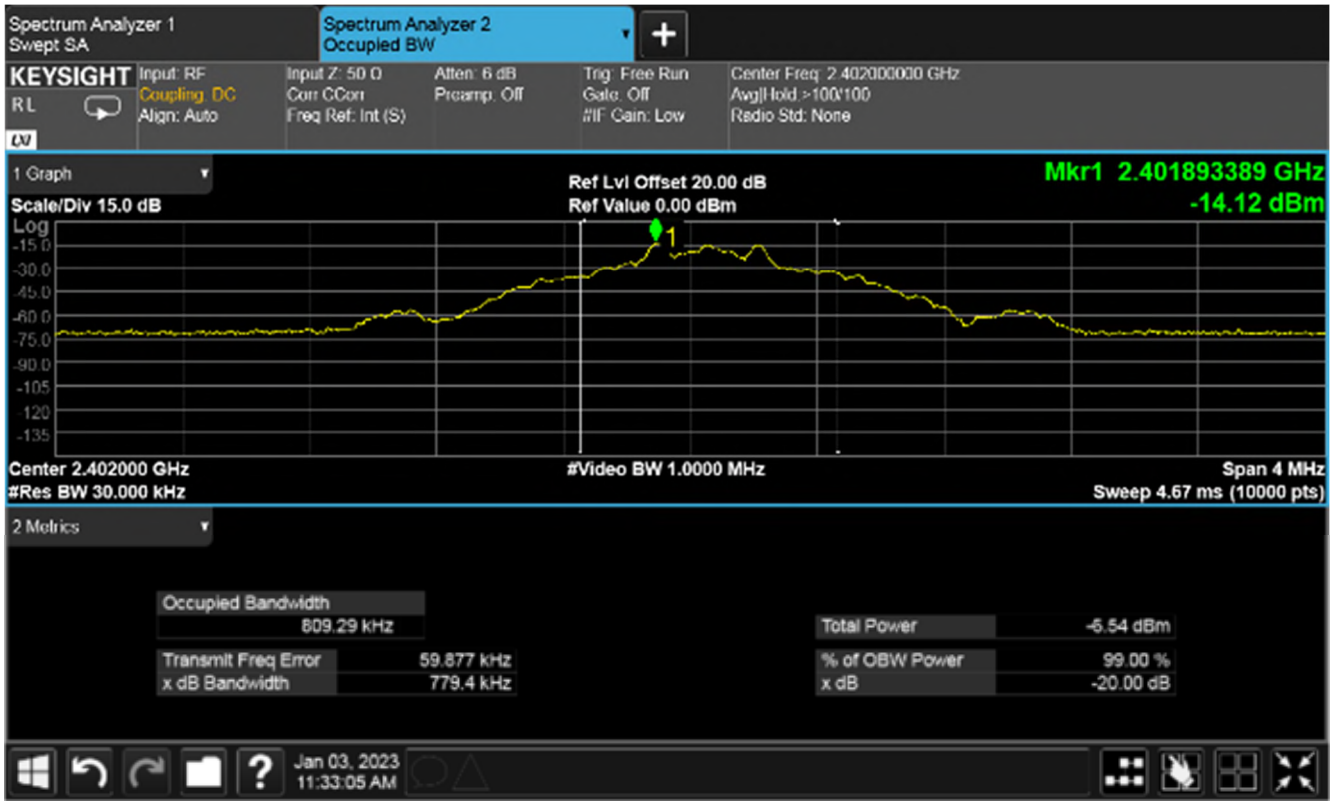
Plot for 20 dB Bandwidth Result (MHz)

RF Parameters: Band 2400-2483.5 MHz, Power 10 set in GUI, Channel Spacing 1 MHz, Modulation DH3, Channel 2480 MHz (High)



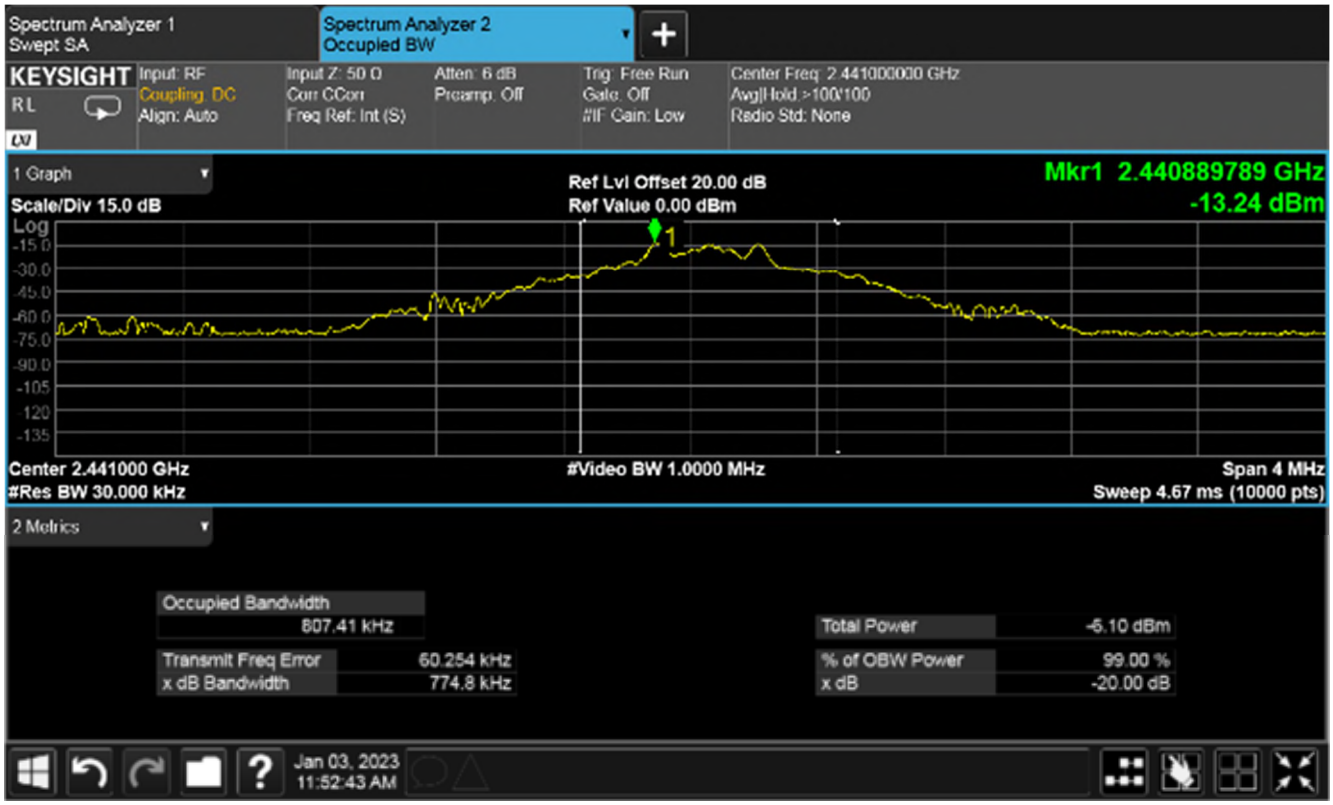
Plot for 20 dB Bandwidth Result (MHz)

RF Parameters: Band 2400-2483.5 MHz, Power 10 set in GUI, Channel Spacing 1 MHz, Modulation DH5, Channel 2402 MHz (Low)



Plot for 20 dB Bandwidth Result (MHz)

RF Parameters: Band 2400-2483.5 MHz, Power 10 set in GUI, Channel Spacing 1 MHz, Modulation DH5, Channel 2441 MHz (Mid)



Plot for 20 dB Bandwidth Result (MHz)

RF Parameters: Band 2400-2483.5 MHz, Power 10 set in GUI, Channel Spacing 1 MHz, Modulation DH5, Channel 2480 MHz (High)

Plot for 20 dB Bandwidth Result (MHz)

RF Parameters: Band 2400-2483.5 MHz, Power 10 set in GUI, Channel Spacing 1 MHz, Modulation 2-DH1, Channel 2402 MHz (Low)

Plot for 20 dB Bandwidth Result (MHz)

RF Parameters: Band 2400-2483.5 MHz, Power 10 set in GUI, Channel Spacing 1 MHz, Modulation 2-DH1, Channel 2441 MHz (Mid)

Plot for 20 dB Bandwidth Result (MHz)

RF Parameters: Band 2400-2483.5 MHz, Power 10 set in GUI, Channel Spacing 1 MHz, Modulation 2-DH1, Channel 2480 MHz (High)

Plot for 20 dB Bandwidth Result (MHz)

RF Parameters: Band 2400-2483.5 MHz, Power 10 set in GUI, Channel Spacing 1 MHz, Modulation 2-DH3, Channel 2402 MHz (Low)

Plot for 20 dB Bandwidth Result (MHz)

RF Parameters: Band 2400-2483.5 MHz, Power 10 set in GUI, Channel Spacing 1 MHz, Modulation 2-DH3, Channel 2441 MHz (Mid)

Plot for 20 dB Bandwidth Result (MHz)

RF Parameters: Band 2400-2483.5 MHz, Power 10 set in GUI, Channel Spacing 1 MHz, Modulation 2-DH3, Channel 2480 MHz (High)

Plot for 20 dB Bandwidth Result (MHz)

RF Parameters: Band 2400-2483.5 MHz, Power 10 set in GUI, Channel Spacing 1 MHz, Modulation 2-DH5, Channel 2402 MHz (Low)

Plot for 20 dB Bandwidth Result (MHz)

RF Parameters: Band 2400-2483.5 MHz, Power 10 set in GUI, Channel Spacing 1 MHz, Modulation 2-DH5, Channel 2441 MHz (Mid)

Plot for 20 dB Bandwidth Result (MHz)

RF Parameters: Band 2400-2483.5 MHz, Power 10 set in GUI, Channel Spacing 1 MHz, Modulation 2-DH5, Channel 2480 MHz (High)

Plot for 20 dB Bandwidth Result (MHz)

RF Parameters: Band 2400-2483.5 MHz, Power 10 set in GUI, Channel Spacing 1 MHz, Modulation 3-DH1, Channel 2402 MHz (Low)

Plot for 20 dB Bandwidth Result (MHz)

RF Parameters: Band 2400-2483.5 MHz, Power 10 set in GUI, Channel Spacing 1 MHz, Modulation 3-DH1, Channel 2441 MHz (Mid)

Plot for 20 dB Bandwidth Result (MHz)

RF Parameters: Band 2400-2483.5 MHz, Power 10 set in GUI, Channel Spacing 1 MHz, Modulation 3-DH1, Channel 2480 MHz (High)

Plot for 20 dB Bandwidth Result (MHz)

RF Parameters: Band 2400-2483.5 MHz, Power 10 set in GUI, Channel Spacing 1 MHz, Modulation 3-DH3, Channel 2402 MHz (Low)

Plot for 20 dB Bandwidth Result (MHz)

RF Parameters: Band 2400-2483.5 MHz, Power 10 set in GUI, Channel Spacing 1 MHz, Modulation 3-DH3, Channel 2441 MHz (Mid)

Plot for 20 dB Bandwidth Result (MHz)

RF Parameters: Band 2400-2483.5 MHz, Power 10 set in GUI, Channel Spacing 1 MHz, Modulation 3-DH3, Channel 2480 MHz (High)

Plot for 20 dB Bandwidth Result (MHz)

RF Parameters: Band 2400-2483.5 MHz, Power 10 set in GUI, Channel Spacing 1 MHz, Modulation 3-DH5, Channel 2402 MHz (Low)

Plot for 20 dB Bandwidth Result (MHz)

RF Parameters: Band 2400-2483.5 MHz, Power 10 set in GUI, Channel Spacing 1 MHz, Modulation 3-DH5, Channel 2441 MHz (Mid)

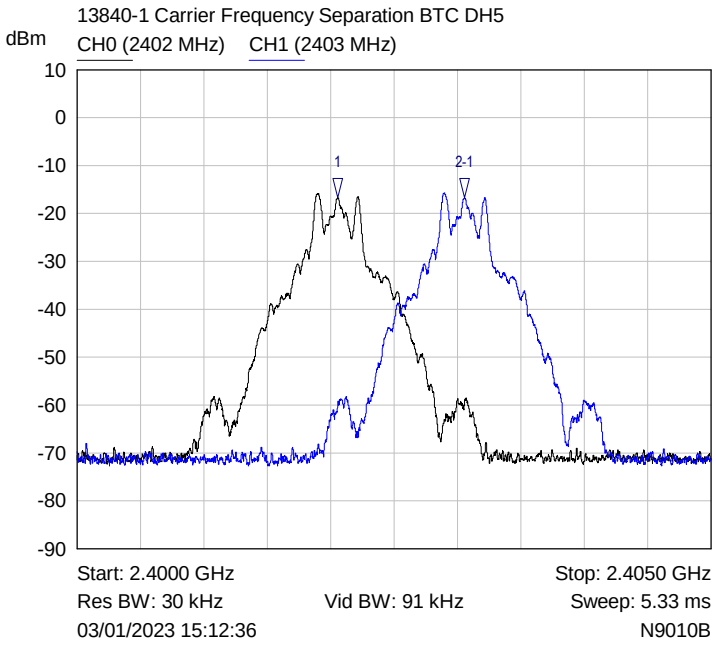
Plot for 20 dB Bandwidth Result (MHz)

RF Parameters: Band 2400-2483.5 MHz, Power 10 set in GUI, Channel Spacing 1 MHz, Modulation 3-DH5, Channel 2480 MHz (High)

Plot for 20 dB Bandwidth Result (MHz)

6.8 FHSS carrier frequency separation

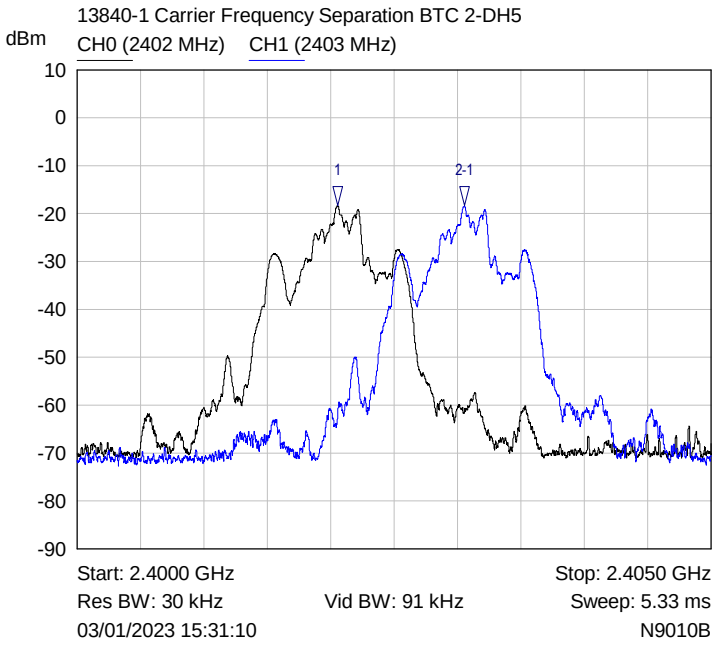
RF Parameters: Band 2400-2483.5 MHz, Power 10 set in GUI, Channel Spacing 1 MHz, Modulation DH5



Mkr	Trace	X-Axis	Value	Notes
1 ▽	CH0 (2402 MHz)	2.4021 GHz	-16.70 dBm	
2-1 ▽	CH1 (2403 MHz)	999.6000 kHz	0.04 dB	

Plot of Separation (kHz)

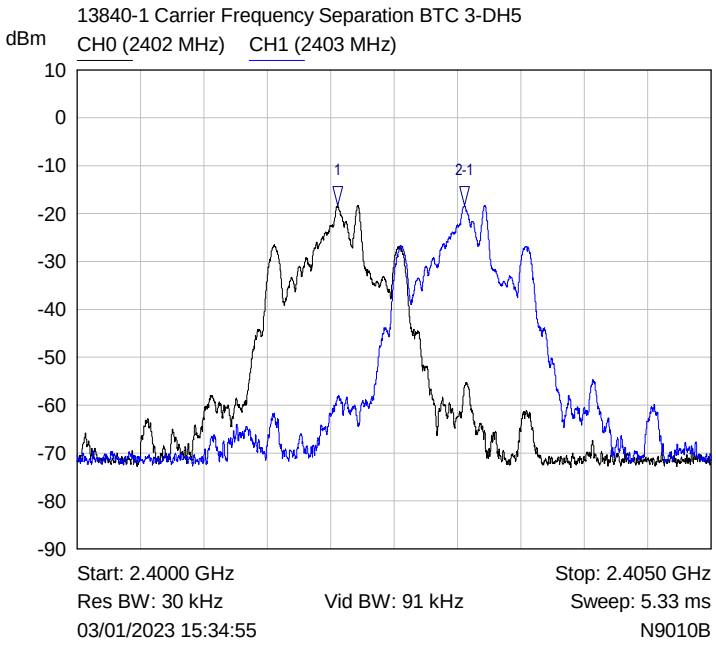
RF Parameters: Band 2400-2483.5 MHz, Power 10 set in GUI, Channel Spacing 1 MHz, Modulation 2-DH5



Mkr	Trace	X-Axis	Value	Notes
1 ▽	CH0 (2402 MHz)	2.4021 GHz	-18.38 dBm	
2-1 ▽	CH1 (2403 MHz)	1.0021 MHz	-0.01 dB	

Plot of Separation (kHz)

RF Parameters: Band 2400-2483.5 MHz, Power 10 set in GUI, Channel Spacing 1 MHz, Modulation 3-DH5

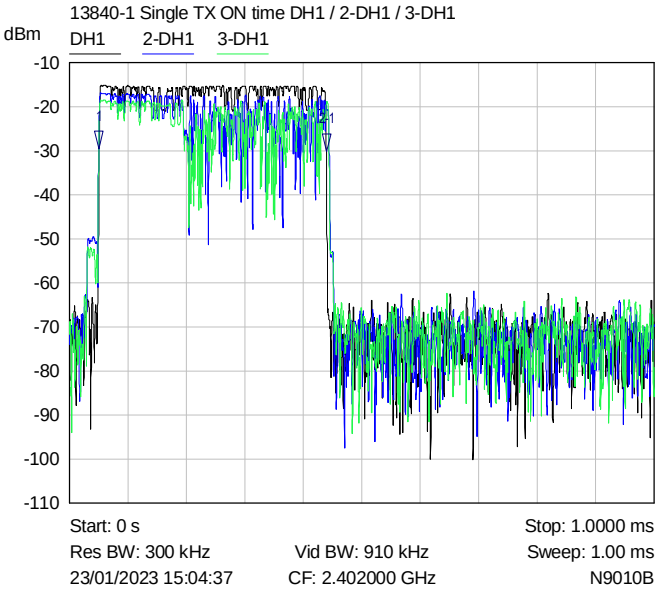


Mkr	Trace	X-Axis	Value	Notes
1 ▽	CH0 (2402 MHz)	2.4021 GHz	-18.38 dBm	
2-1 ▽	CH1 (2403 MHz)	1.0001 MHz	-0.01 dB	

Plot of Separation (kHz)

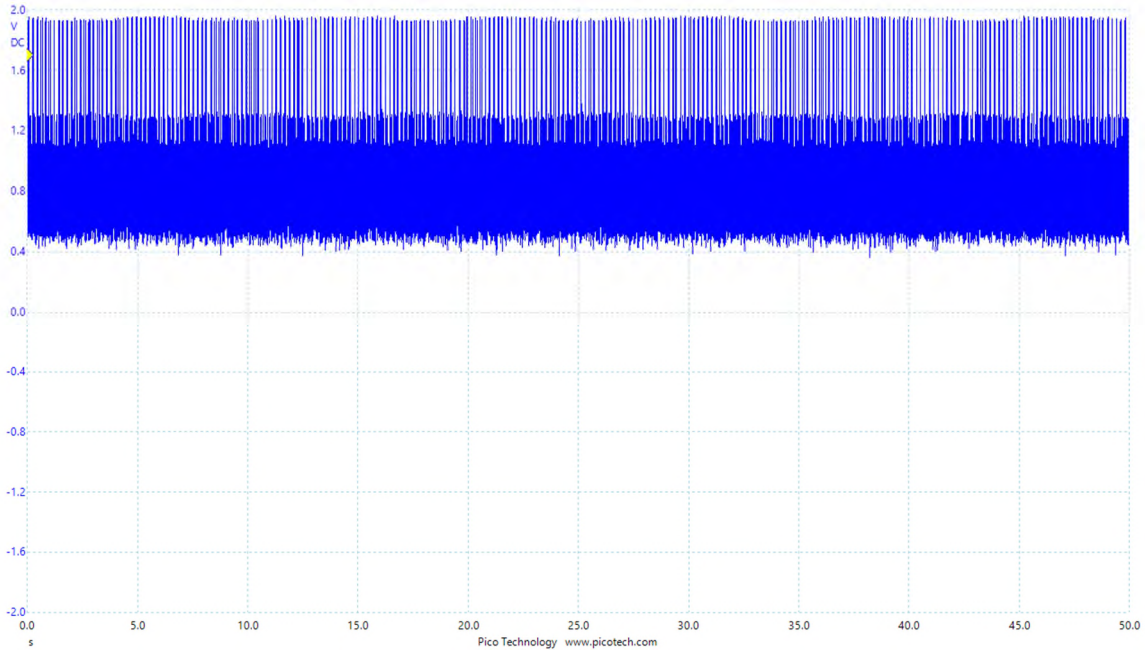
6.9 Average time of occupancy

RF Parameters: Band 2400-2483.5 MHz, Power 10 set in GUI, Channel Spacing 1 MHz, Modulation DH1 Channel 2402 MHz



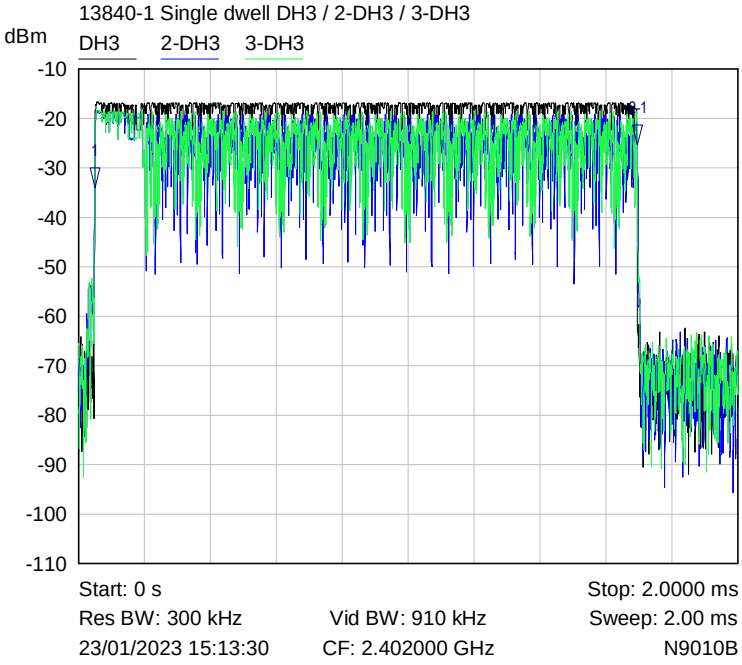
Mkr	Trace	X-Axis	Value	Notes
1 ▽	DH1	50.6051 us	-29.50 dBm	
2-1 ▽	DH1	388.8389 us	-0.61 dB	

Measured Dwell time/pulse width (µs)



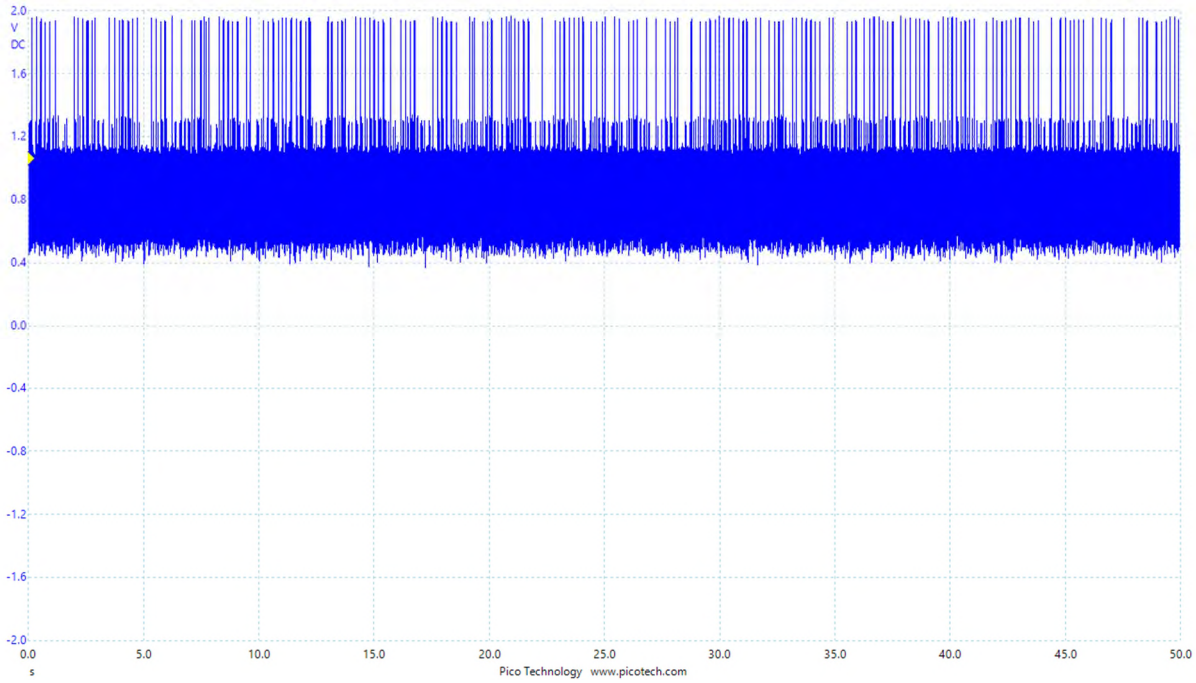
Period time (s)

RF Parameters: Band 2400-2483.5 MHz, Power 10 set in GUI, Channel Spacing 1 MHz, Modulation DH3, Channel 2402 MHz



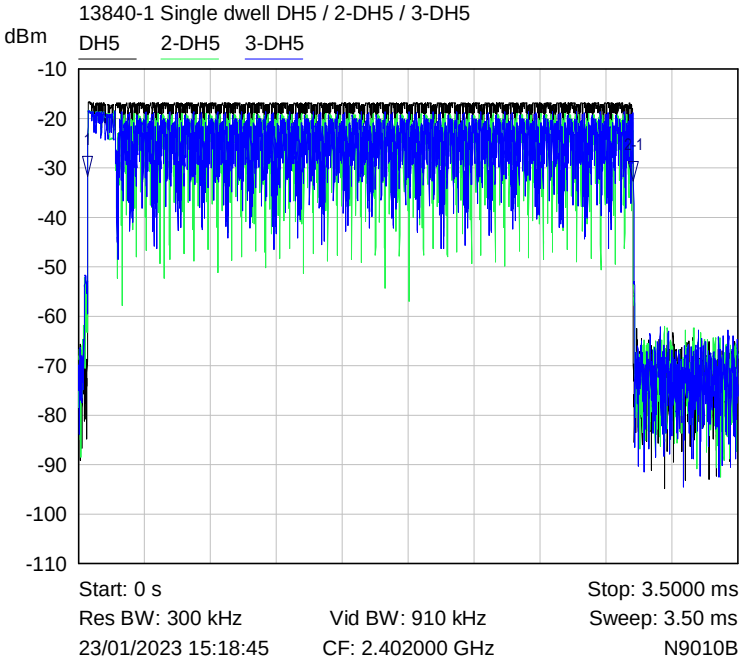
Mkr	Trace	X-Axis	Value	Notes
1 ▽	DH3	49.2049 us	-33.92 dBm	
2-1 ▽	DH3	1.6447 ms	8.63 dB	

Measured Dwell time/pulse width (ms)



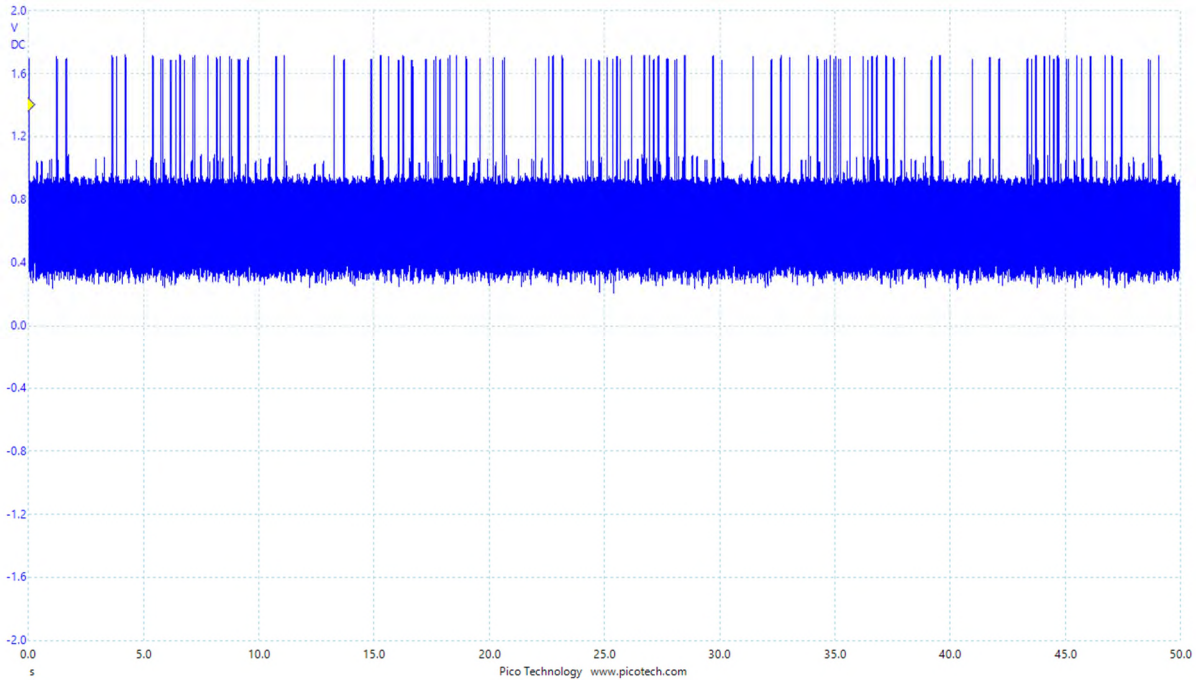
Period time (s)

RF Parameters: Band 2400-2483.5 MHz, Power 10 set in GUI, Channel Spacing 1 MHz, Modulation DH5, Channel 2402 MHz



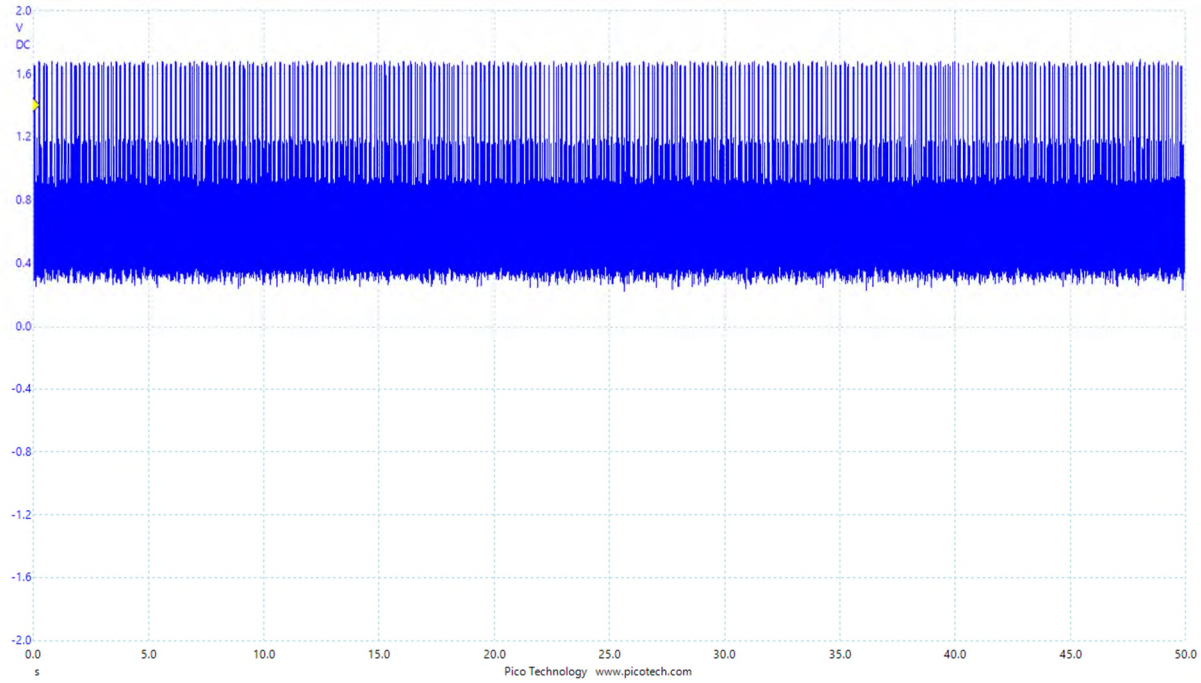
Mkr	Trace	X-Axis	Value	Notes
1 ▽	DH5	49.3549 us	-31.68 dBm	
2-1 ▽	DH5	2.8934 ms	-1.04 dB	

Measured Dwell time/pulse width (ms)



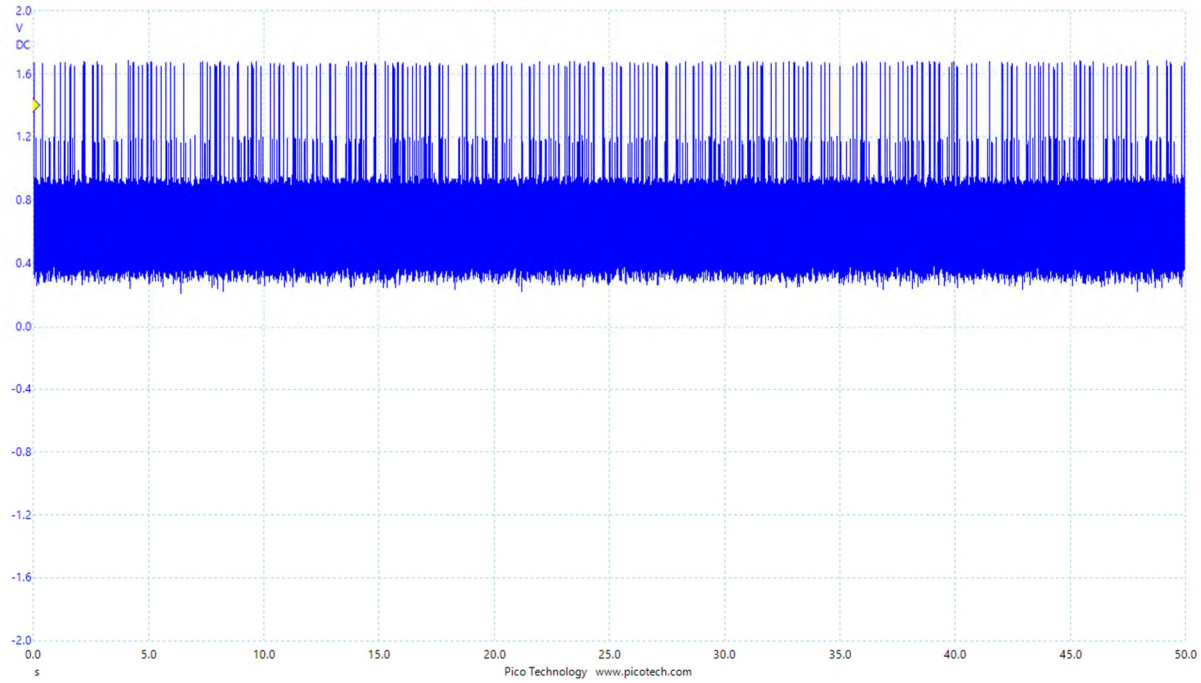
Period time (s)

RF Parameters: Band 2400-2483.5 MHz, Power 10 set in GUI, Channel Spacing 1 MHz, Modulation 2-DH1, Channel 2402 MHz



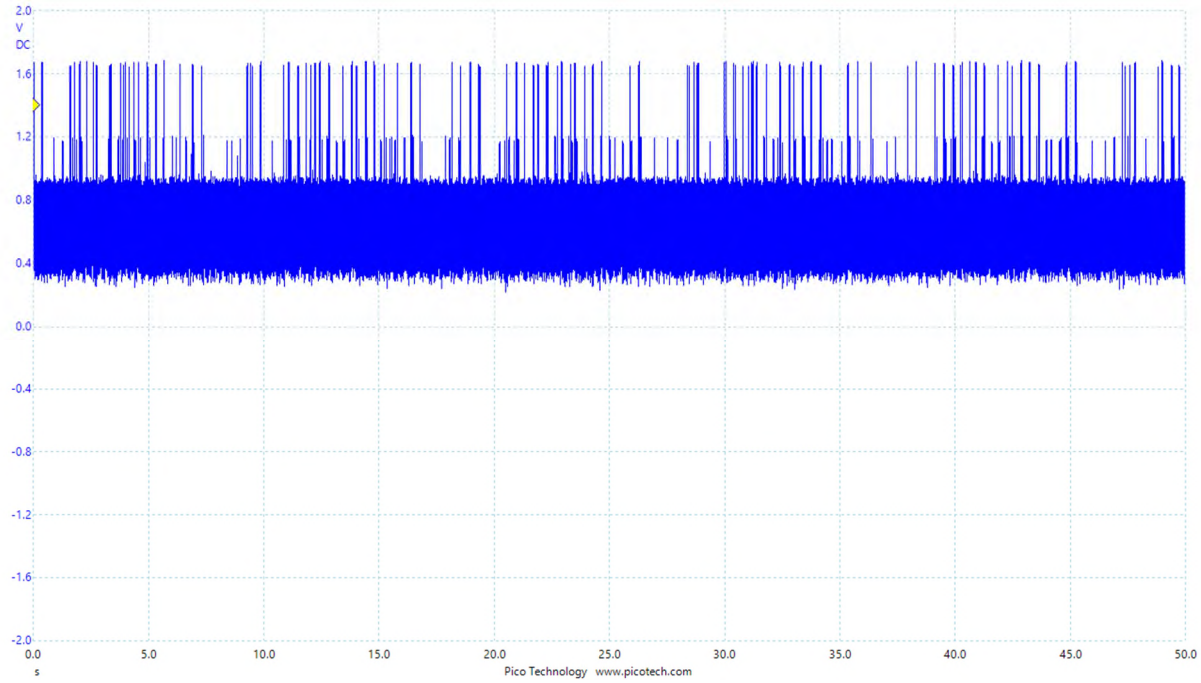
Period time (s)

RF Parameters: Band 2400-2483.5 MHz, Power 10 set in GUI, Channel Spacing 1 MHz, Modulation 2-DH3, Channel 2402 MHz



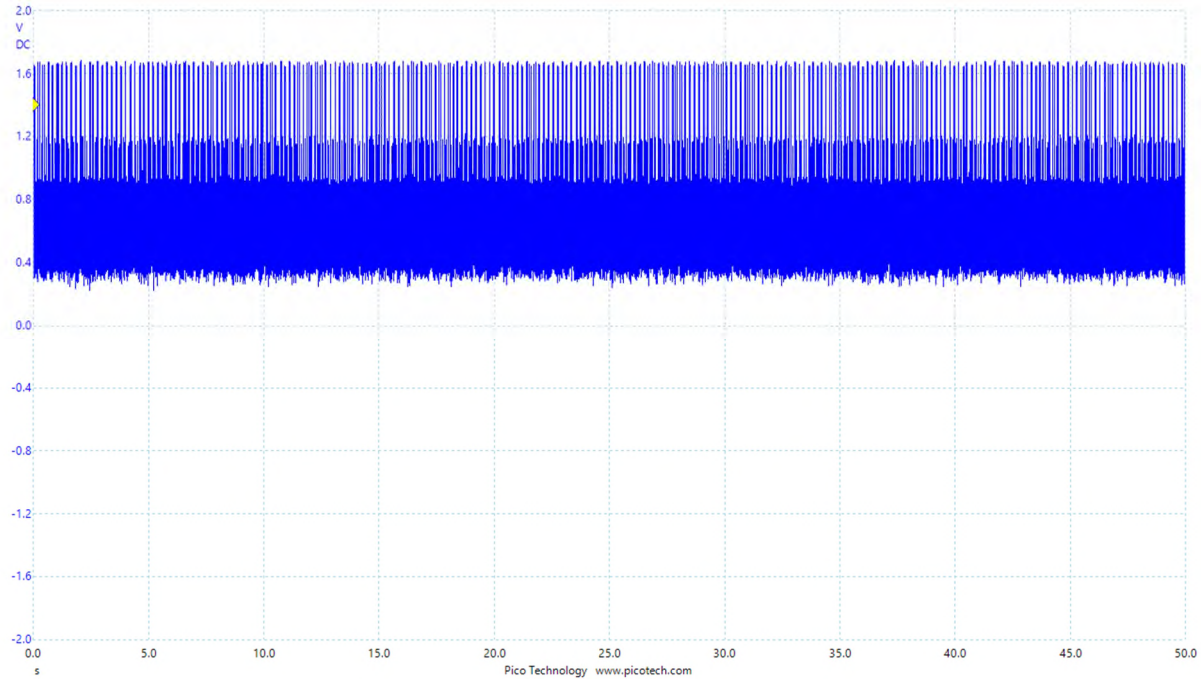
Period time (s)

RF Parameters: Band 2400-2483.5 MHz, Power 10 set in GUI, Channel Spacing 1 MHz, Modulation 2-DH5, Channel 2402 MHz



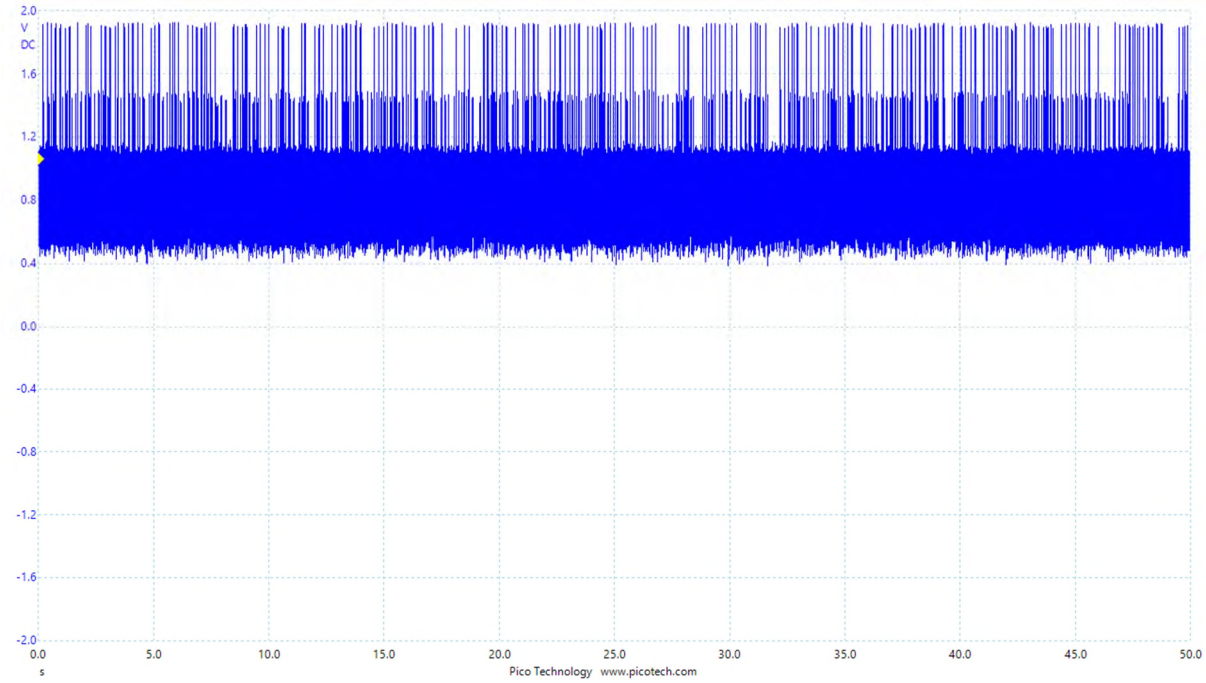
Period time (s)

RF Parameters: Band 2400-2483.5 MHz, Power 10 set in GUI, Channel Spacing 1 MHz, Modulation 3-DH1, Channel 2402 MHz



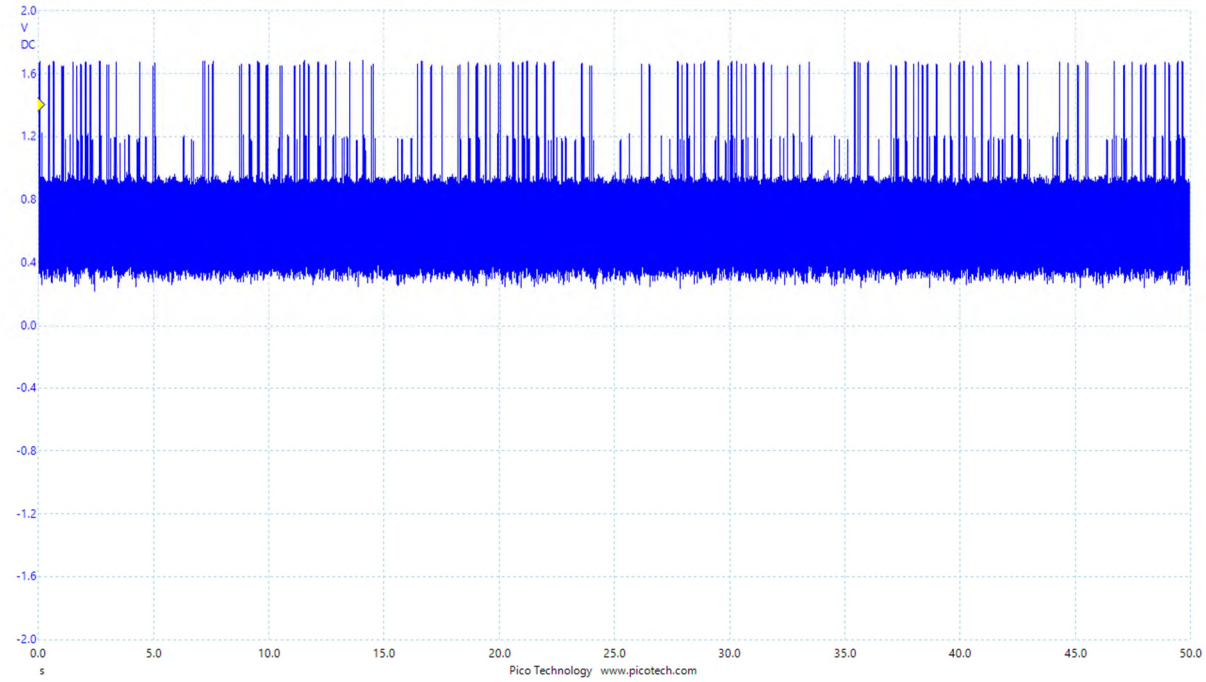
Period time (s)

wRF Parameters: Band 2400-2483.5 MHz, Power 10 set in GUI, Channel Spacing 1 MHz, Modulation 3-DH3, Channel 2402 MHz



Period time (s)

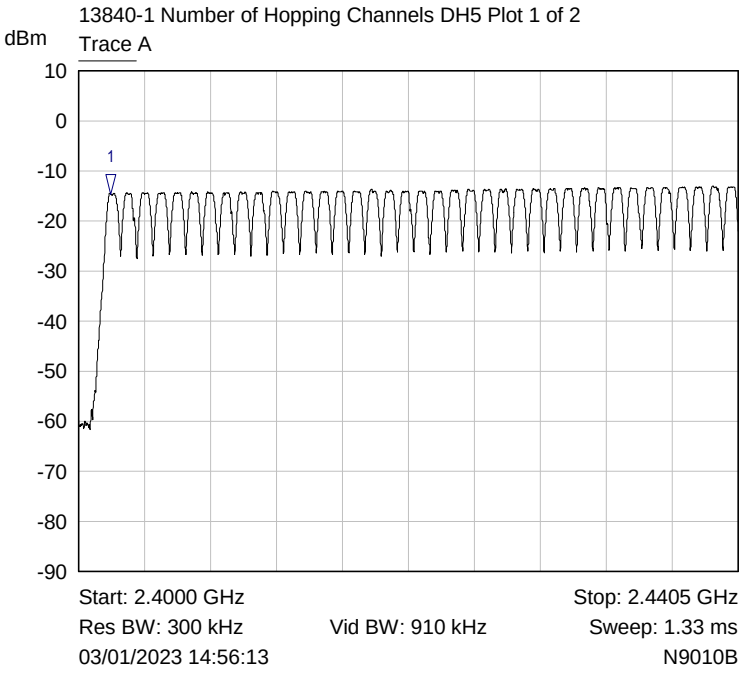
RF Parameters: Band 2400-2483.5 MHz, Power 10 set in GUI, Channel Spacing 1 MHz, Modulation 3-DH5, Channel 2402 MHz



Period time (s)

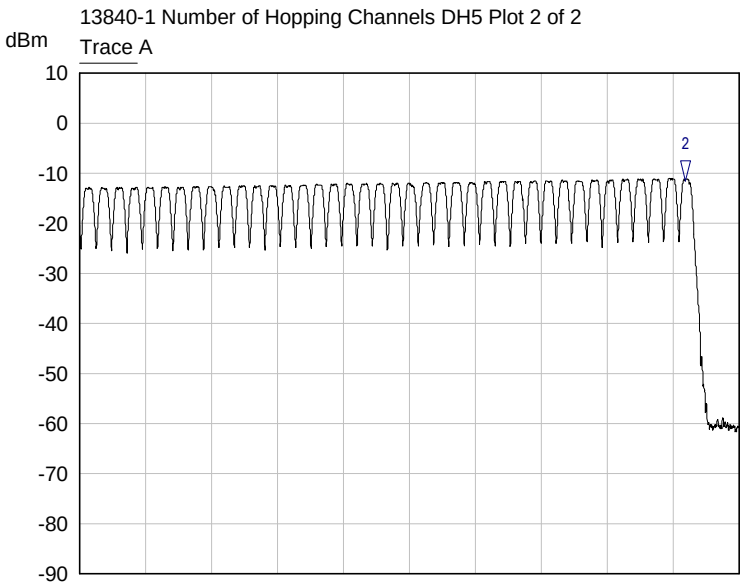
6.10 Number of Hop Channels

RF Parameters: Band 2400-2483.5 MHz, Power 10 set in GUI, Channel Spacing 1 MHz, Modulation DH5, Channel Hopping (All Channels)



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4020 GHz	-14.60 dBm	

Plot of Hopping Channels 1-39



Mkr	Trace	X-Axis	Value	Notes
2 ▽	Trace A	2.4800 GHz	-11.43 dBm	

Plot of Hopping Channels 40-79

7 Explanatory Notes

7.1 Explanation of Table of Signals Measured

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

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

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

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

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

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

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

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

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

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

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

7.2 Explanation of limit line calculations for radiated measurements

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

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

(b) limit of 300 µV/m at 10m equates to 20.log (300 . 10/3) = 60 dB µV/m at 3m
(c) limit of 30 µV/m at 30m, but below 30MHz, equates to 20.log(30) + 40.log(30/3) = 69.5 dBµV/m at 3m, as extrapolation factor below 30MHz is 40dB/decade per 15.31(f)(2).

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

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

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

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

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

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

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

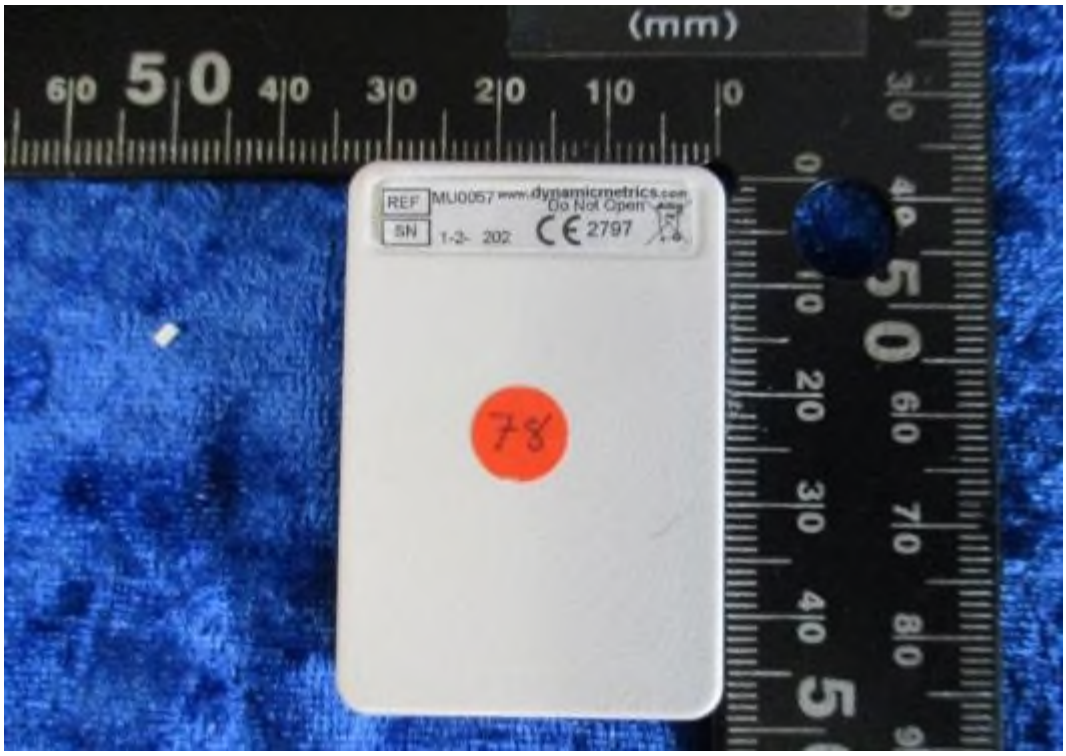
Equation 26: $PD = E^2_{Speclimit} / 377$
And therefore equation 26 transposed is: $E_{Spec\ limit} = \sqrt{(PD \times 377)}$
Where:
PD is the power density at distance specified by the limit, in W/m^2
$E_{spec\ limit}$ is the field strength at the distance specified by the limit in V/m

Example:
Radiated spurious emissions limit at 3metres of $90pW/cm^2$.
$90pW/cm^2 \times 100^2 = 0.9\ \mu W/m^2$ = (EIRP Linear)
Equation 25 transposed: $0.9 \times 10^{-6} \times 4 \times \pi \times 3^2 = 0.0001017876$ W
And
Equation 26 transposed: $E_{Spec\ limit} = \sqrt{(0.9x10^{-6} \times 377)} = 0.01842$ V/m.
And
Equation 21 transposed: $E_{Log} = 20Log(0.01842) +120 = 85.3dB\mu V/m$ @ 3m.

8 Photographs

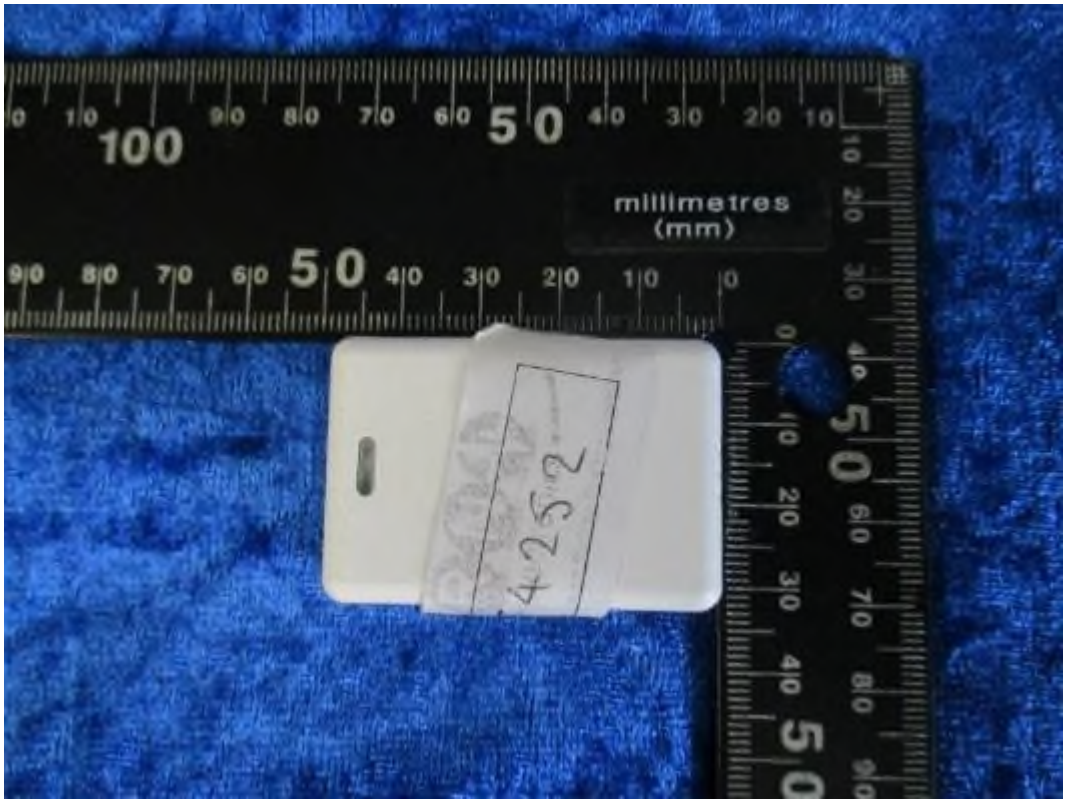
8.1 EUT Front View

8.2 EUT Reverse Angle



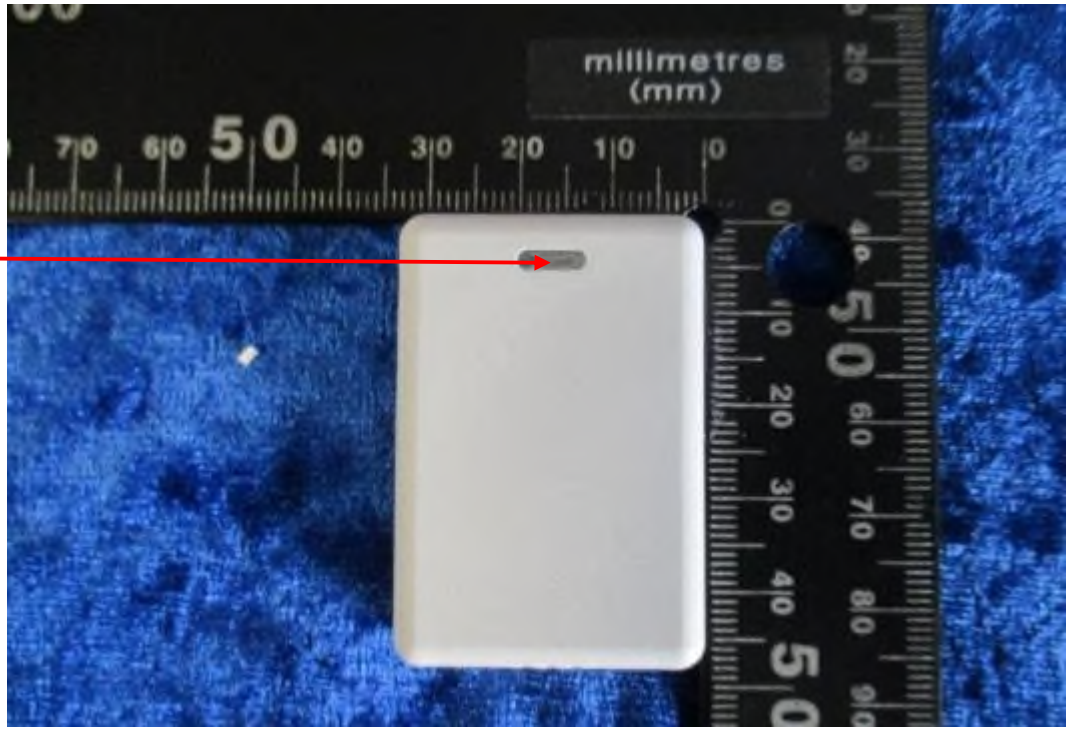
8.3 EUT Left side View

8.4 EUT Right side View

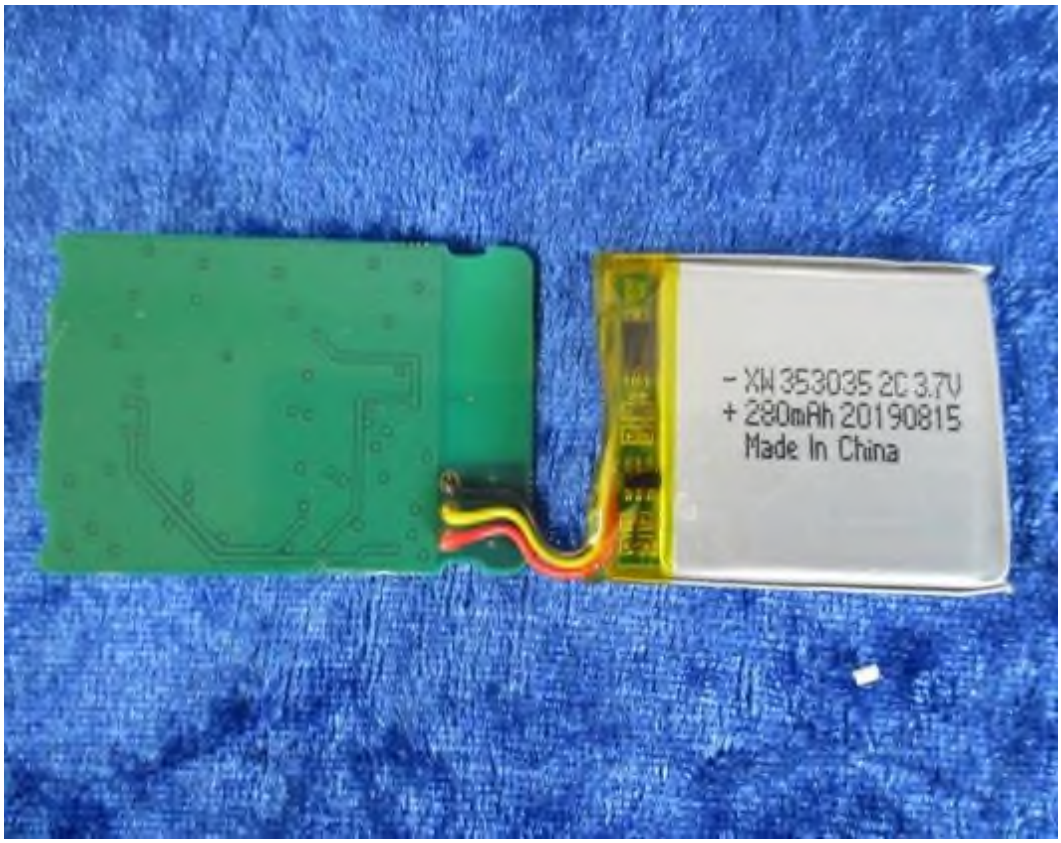


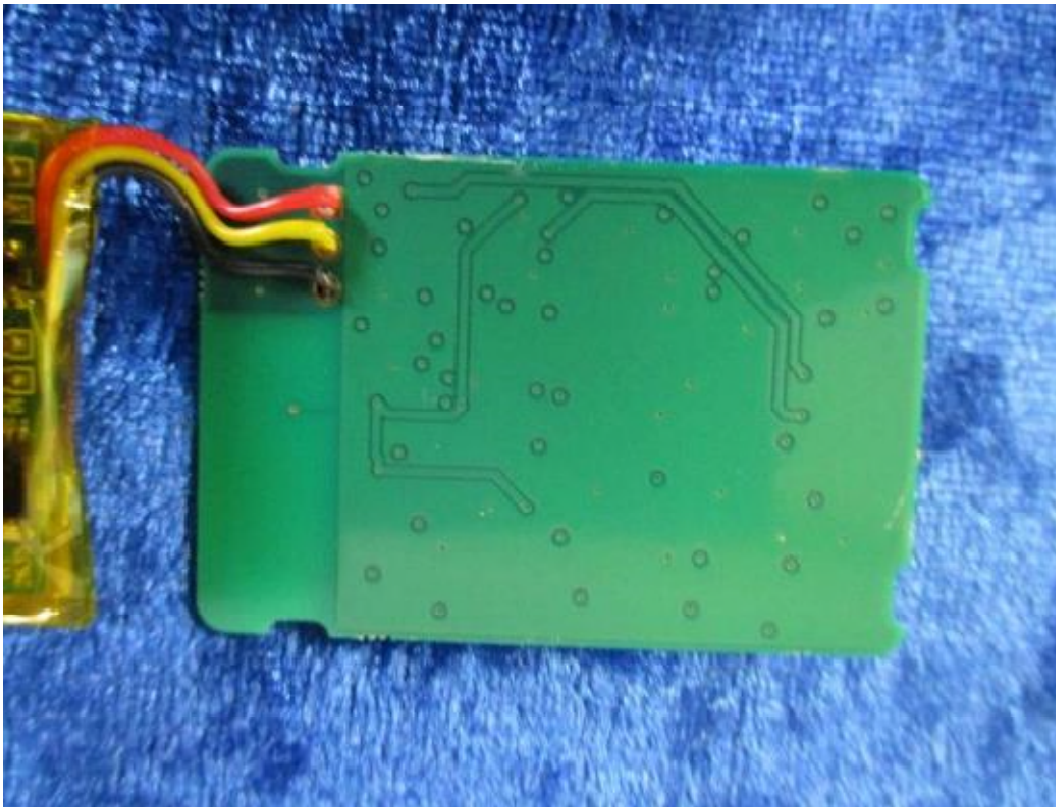
8.5 EUT Antenna Port

8.6 EUT Display & Controls



8.7 EUT Internal photos

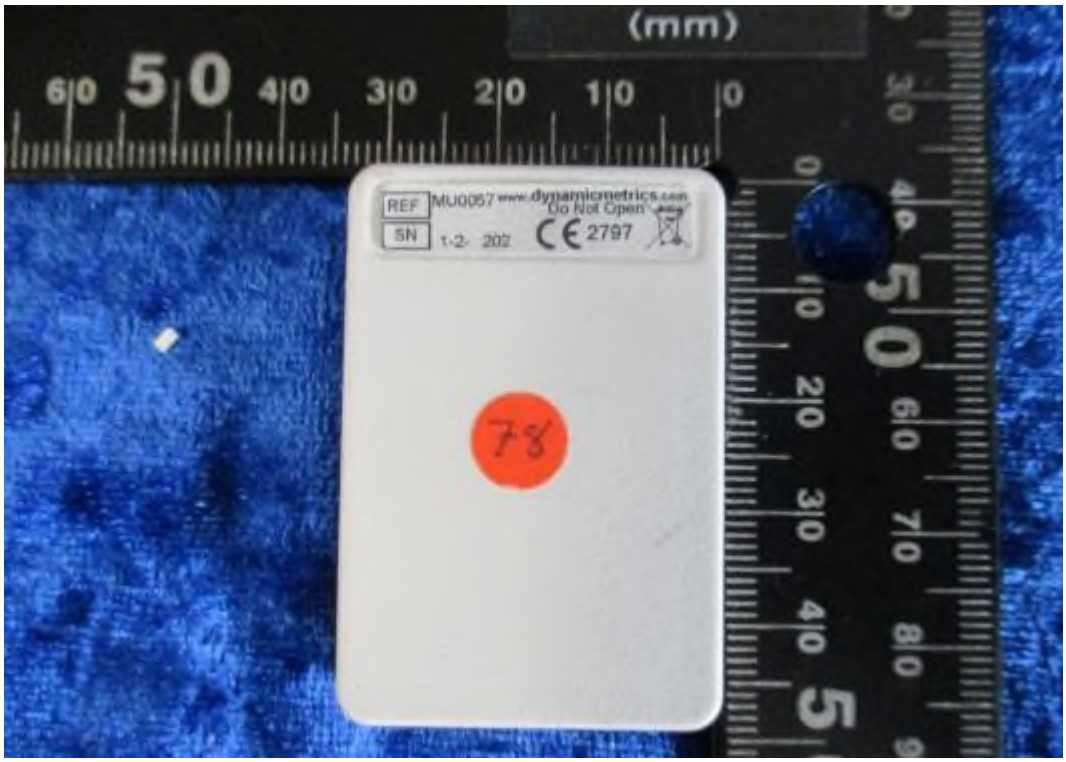




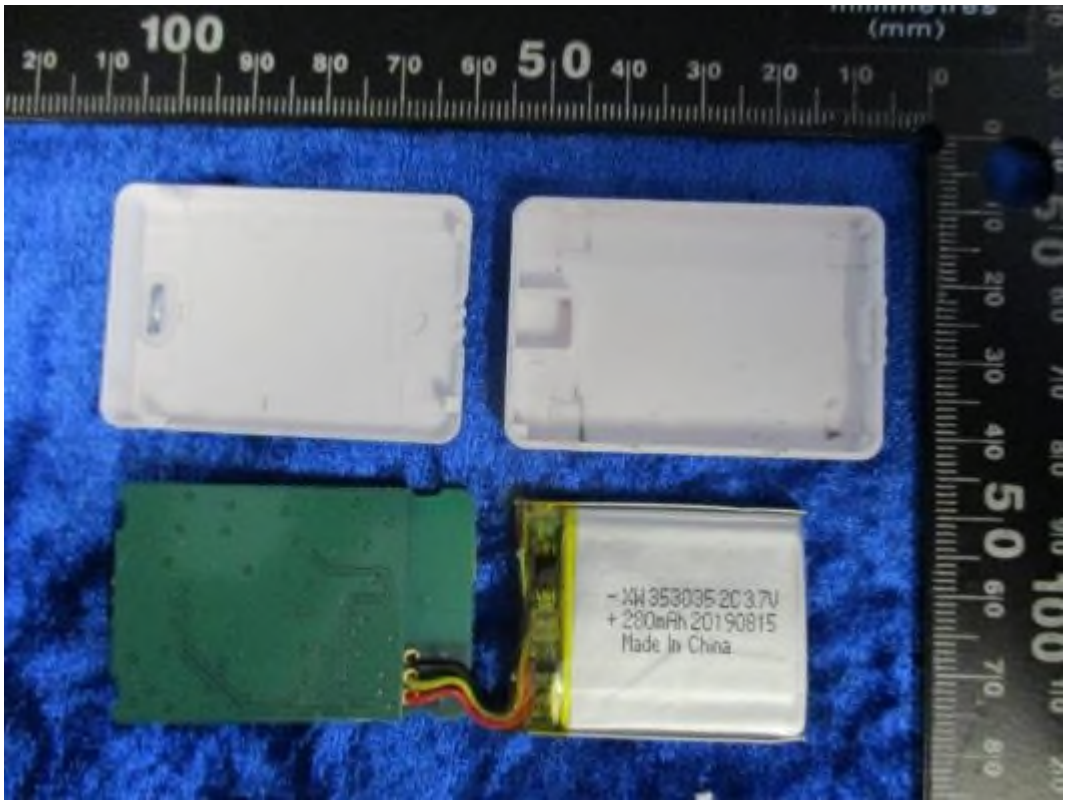

0202
1486-1-2
AF


0202
1486-1-2
AF

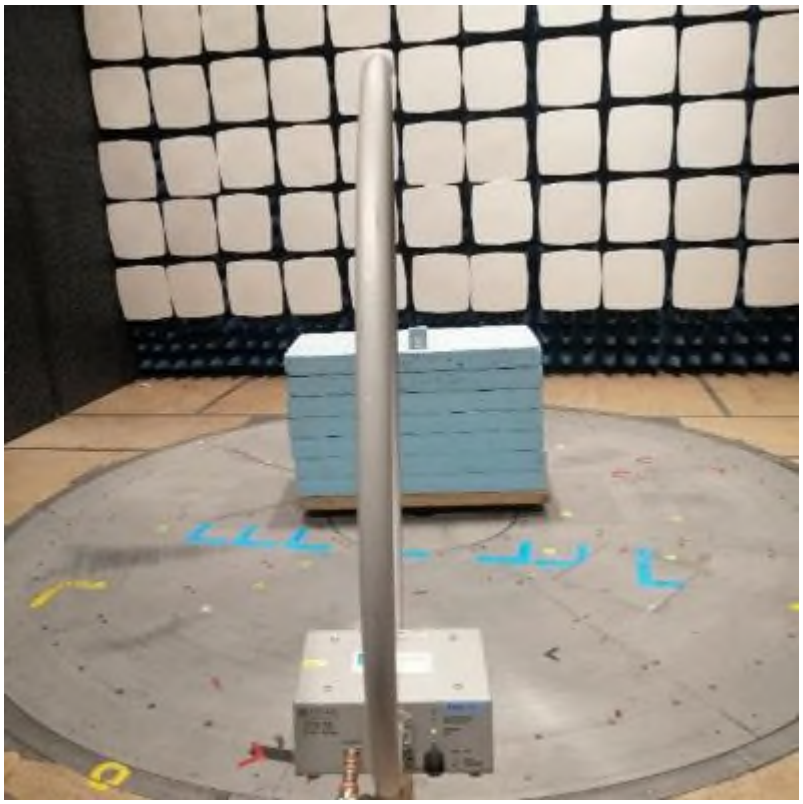
8.8 EUT ID Label



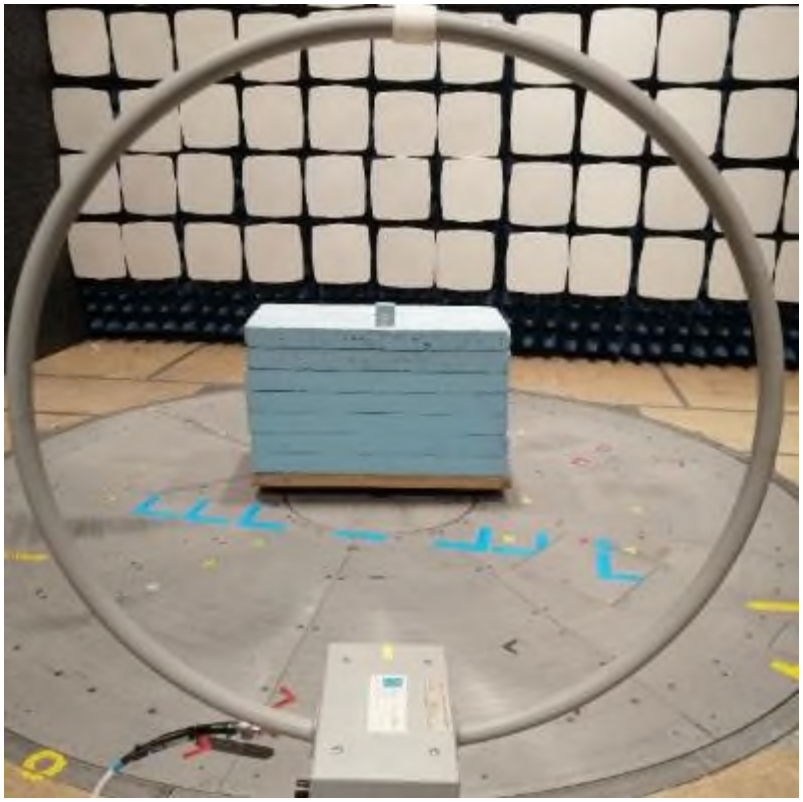
8.9 EUT Chassis



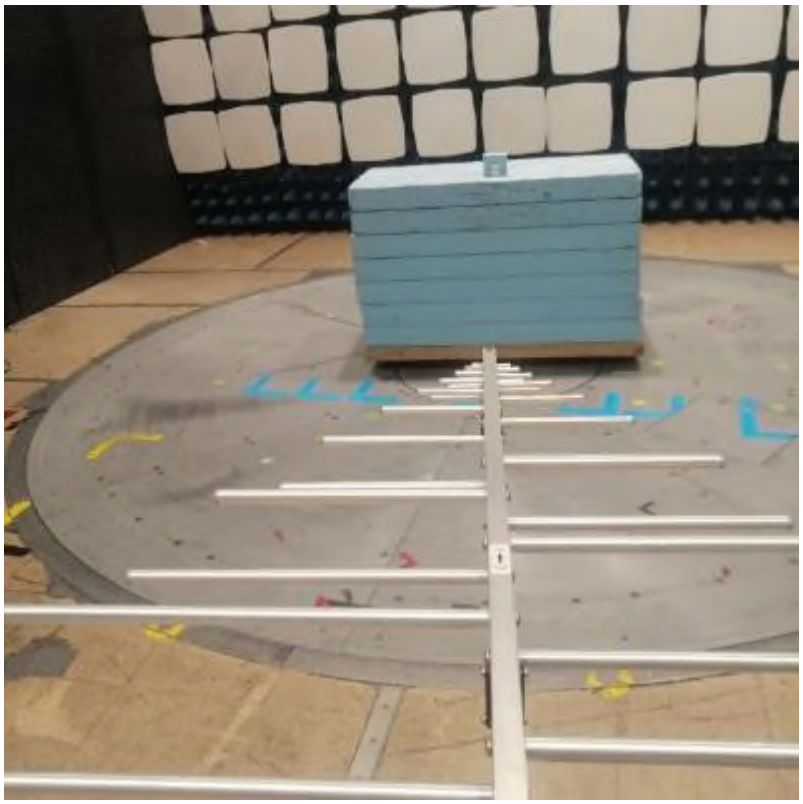
8.10 Radiated emissions 9 - 150 kHz

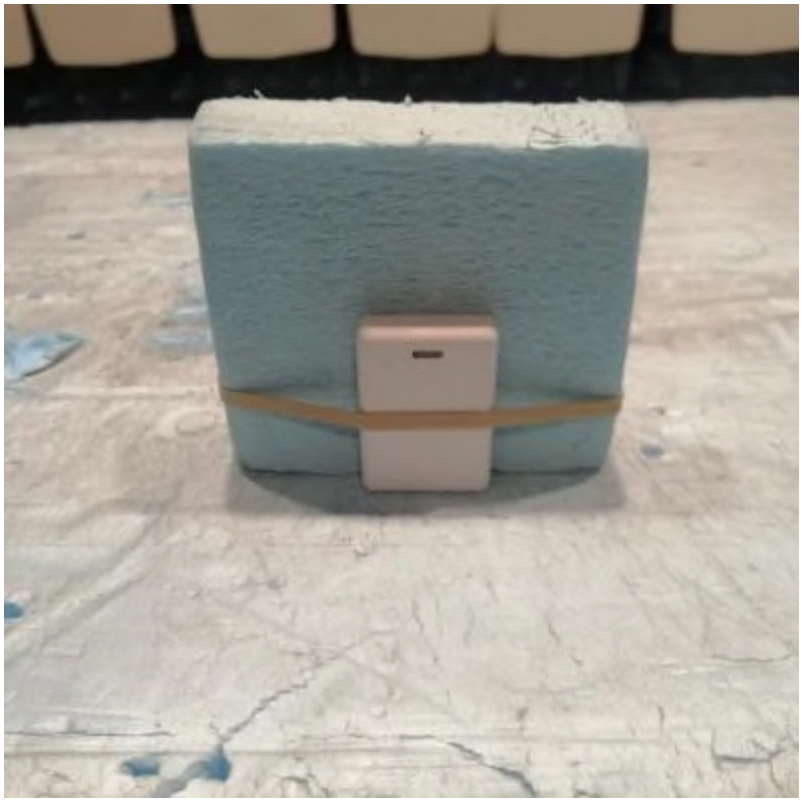


8.11 Radiated emissions 150 kHz - 30 MHz



8.12 Radiated emissions 30 MHz -1 GHz



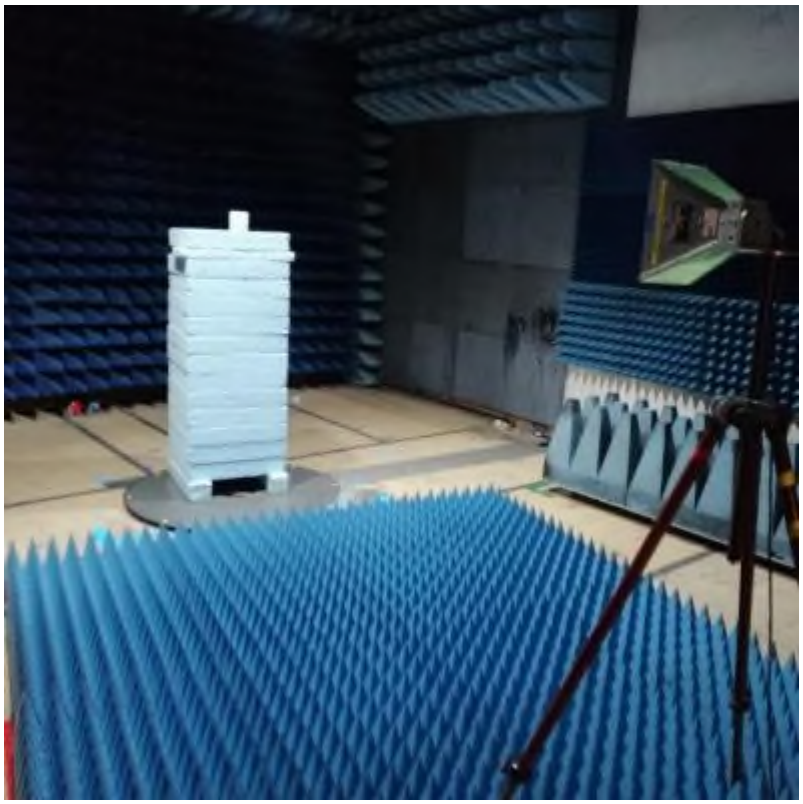


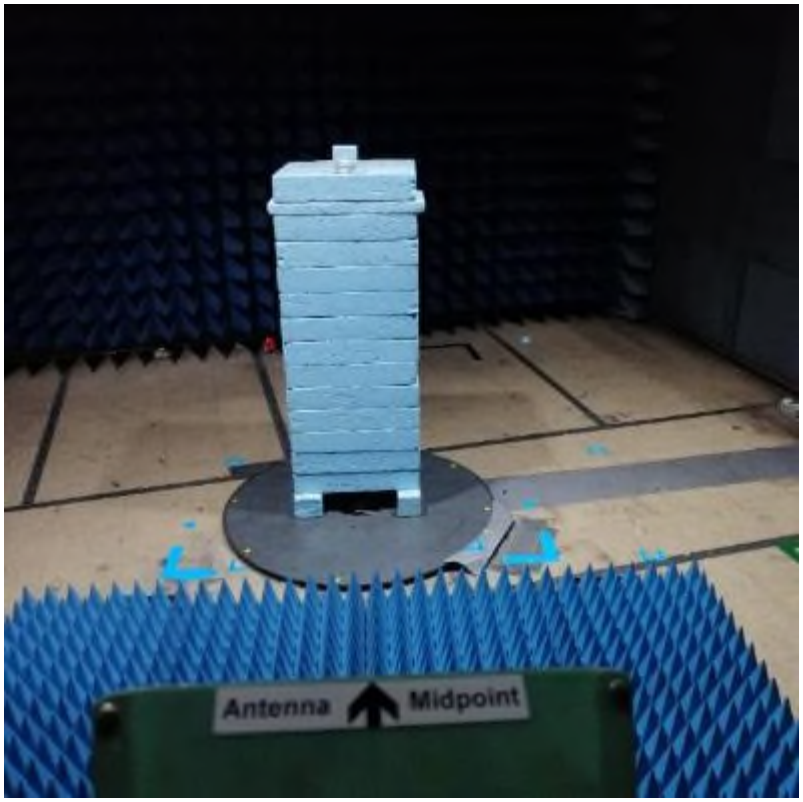
Upright Position

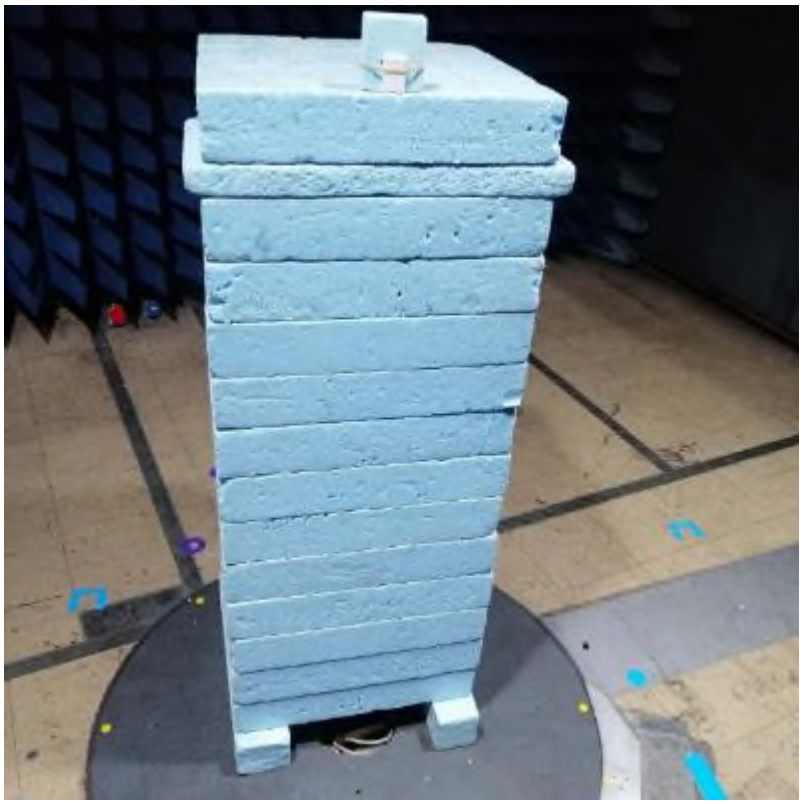
Side Position

Flat Position

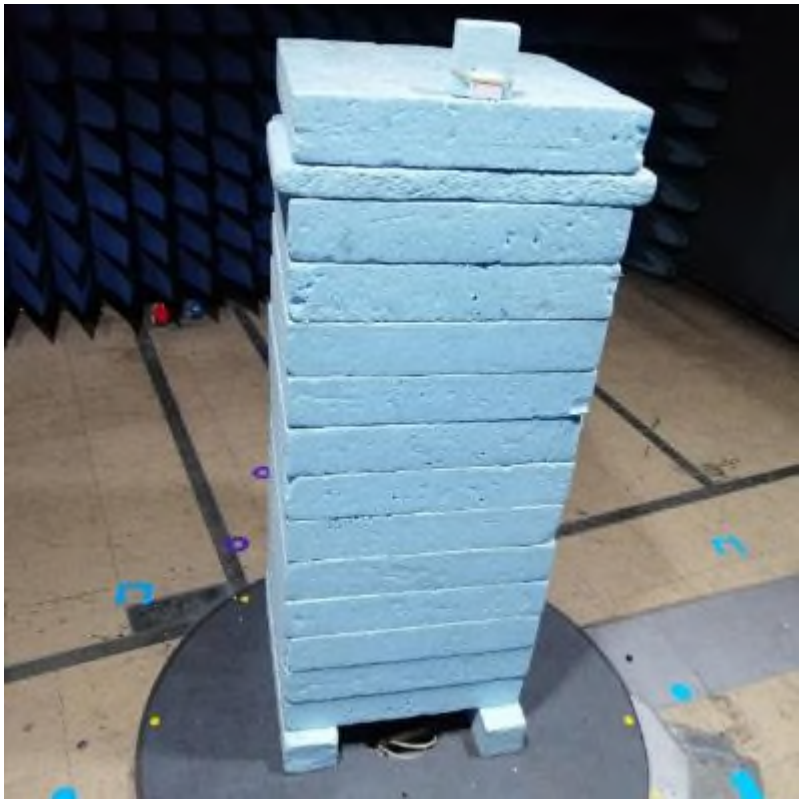
8.13 Radiated emissions above 1 GHz





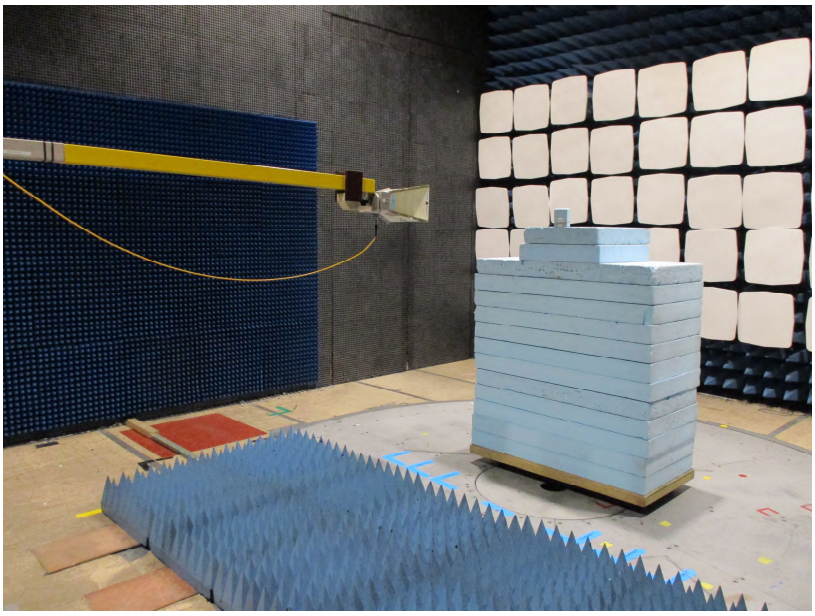


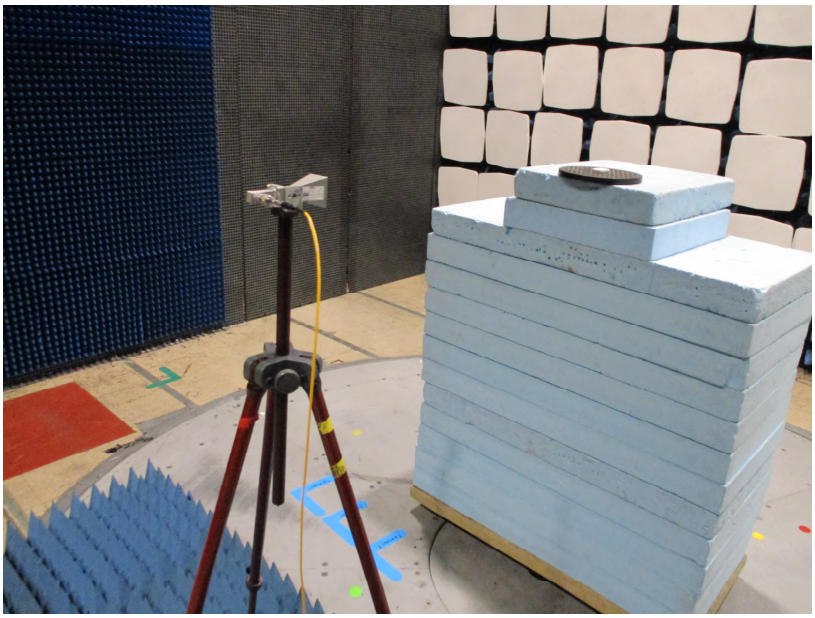
Upright Position

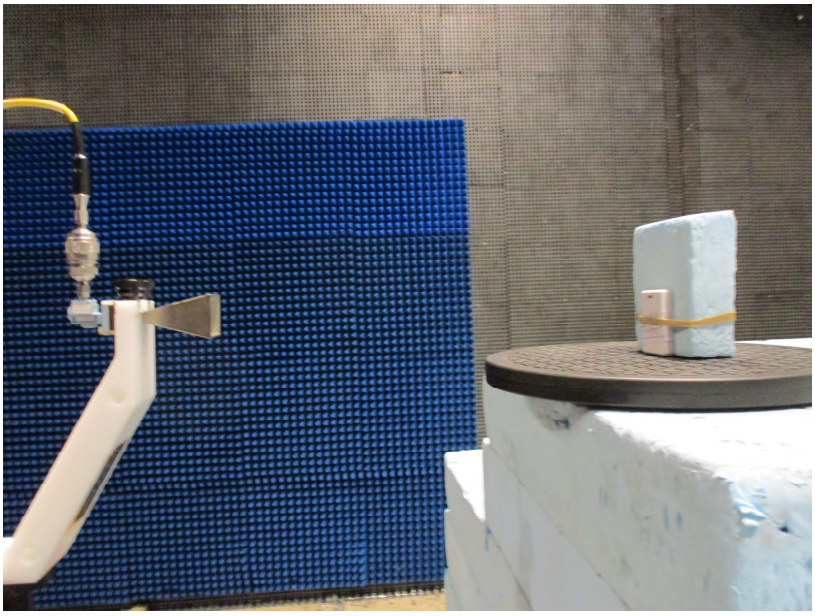


Side Position

Flat Position







8.14 Radiated emission diagrams

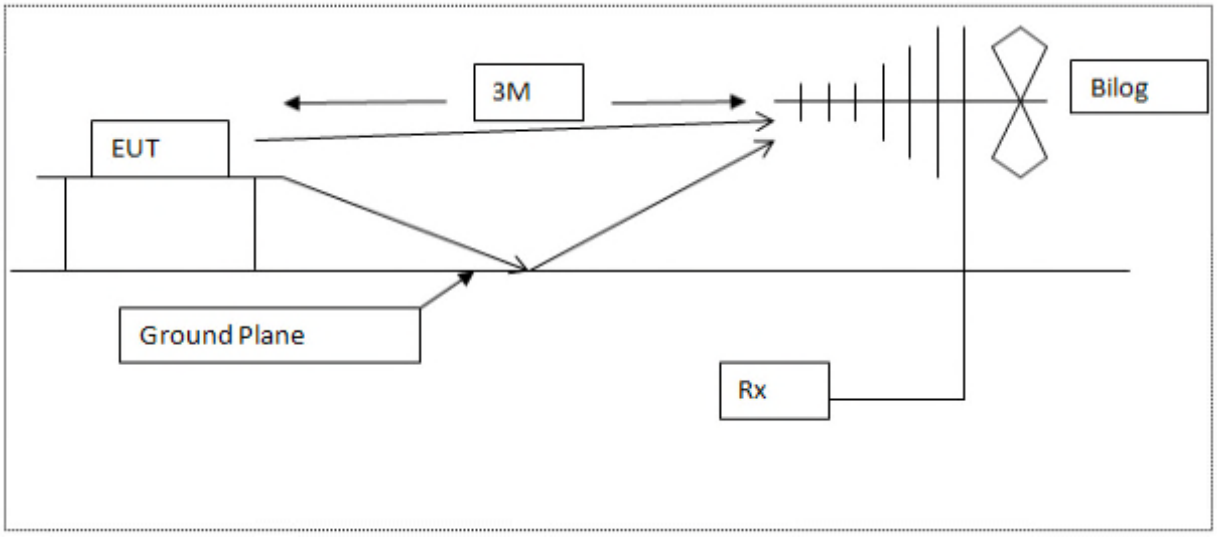


Diagram of the radiated emissions test setup 30 - 1000 MHz

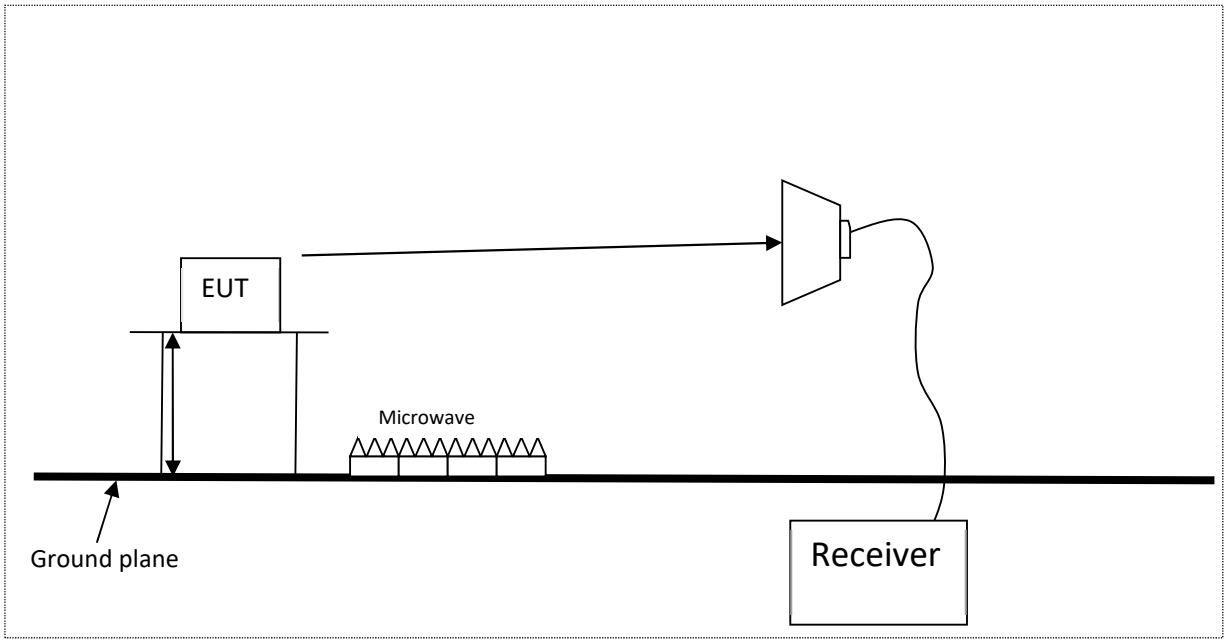


Diagram of the radiated emissions test setup above 1GHz

9 Test equipment calibration list

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

RN No.	Model No.	Description	Manufacturer	Calibration date	Cal period
E227	6632A	PSU System DC Power Supply	Hewlett Packard	20-Mar-2023	12 months
E411	N9039A	9 kHz - 1 GHz RF Filter Section	Agilent Technologies	07-Jul-2022	12 months
E429	-	Filter Box 5 Switch Filters 0.91 GHz - 16.3 GHz	RN Electronics	23-Aug-2022	12 months
E534	E4440A	PSA 3 Hz - 26.5 GHz	Agilent Technologies	#25-Jan-2023	24 months
E535	N9039A	9 kHz - 1 GHz RF Filter Section	Agilent Technologies	#25-Feb-2023	12 months
E624	E4440A	PSA 3 Hz - 26.5 GHz	Agilent Technologies	06-Jul-2022	24 months
E745	2017 4/2dB	Attenuator 4/2dB 30-1000MHz	RN Electronics	#24-Feb-2023	12 months
E839	5244D	Oscilloscope 200MHz 2CH	Pico Technology	#13-Mar-2023	12 months
E901	R3172	Analyser 9kHz - 26.5GHz	Advantest	04-Jul-2022	12 months
E914	VULB 9163	Antenna BiLog 30MHz to 3GHz	Schwarzbeck	23-Apr-2022	24 months
F079	AA18-20H	Attenuator SMA 20dB 18GHz	AtlanTecRF	03-Aug-2022	12 months
F081	AA18-20H	Attenuator SMA 20dB 18GHz	AtlanTecRF	19-Aug-2022	12 months
H071	N9010B	EXA Signal Analyser 10 Hz to 44 GHz	Keysight Technologies	#12-Dec-2022	24 months
LPE261	3115	Horn Antenna 1 - 18 GHz	EMCO	02-Apr-2022	12 months
LPE333	8449B	Pre-Amplifier 1GHz - 26.5GHz	Hewlett Packard	27-May-2022	12 months
NSA-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
ZSW1	V2.5.2	Measurement Software Suite	RN Electronics	Not applicable	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	Probook 450 G5	Laptop	HP	5CD8211PRM
2	MU0056	8 Port Device Charger	Dynamic Metrics	None

10.2 RN Electronics supplied equipment

No RN Electronics Ltd supplied equipment was used.

11 Condition of the equipment tested

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

11.1 Modifications before test

Prior to test:
The Power level setting was decreased from Power Setting 15 to 10 to comply with the spurious emissions harmonic limits.

11.2 Modifications during test

No modifications were made during test by RN Electronics Ltd.

12 Description of test sites

Site A Radio Laboratory and Anechoic Chamber

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

Site C Transient Laboratory

Site D Screened Room (Conducted Immunity)

Site E Screened Room (Control Room for Site D)

Site F Screened Room (Conducted Emissions)

Site G Screened Room (Control Room for Site H)

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

Site J Transient Laboratory

Site K Screened Room (Control Room for Site M)

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

Site N Radio Laboratory

Site Q Fully-Anechoic Chamber

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

Site R Screened Room (Conducted Immunity)

Site S Safety Laboratory

Site T Transient Laboratory

RN Electronics CAB identifier as issued by Innovation, Science and Economic Development Canada is UK0002
RN Electronics CAB identifier as issued by FCC is UK2015

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
°C	Degrees Celsius
C/I	Carrier / Interferer
CAC	Channel Availability Check
CCA	Clear Channel Assessment
CEPT	European Conference of Postal and Telecommunications Administrations
CFR	Code of Federal Regulations
CISPR	Comité International Spécial des Perturbations Radioélectriques
cm	centimetre
COFDM	Coherent OFDM
COT	Channel Occupancy Time
CS	Channel Spacing
CW	Continuous Wave
DAA	Detect And Avoid
dB	deciBels
dBµA/m	deciBels relative to 1µA/m
dBµV	deciBels relative to 1µV
dBµV/m	deciBels relative to 1µV/m
dBc	deciBels relative to Carrier
dBd	deciBels relative to dipole gain
dBi	deciBels relative to isotropic gain
dBm	deciBels relative to 1mW
dBr	deciBels relative to a maximum value
dBW	deciBels relative to 1W
DC	Direct Current
DFS	Dynamic Frequency Selection
DMO	Dynamic Modulation Order
DSSS	Direct Sequence Spread Spectrum
DTA	Digital Transmission Analyser
EIRP	Equivalent Isotropic Radiated Power
emf	electromotive force
ERC	European Radiocommunications Committee
ERP	Effective Radiated Power
ETSI	European Telecommunications Standards Institute
EU	European Union
EUT	Equipment Under Test
FCC	Federal Communications Commission
FER	Frame Error Rate
FHSS	Frequency Hopping Spread Spectrum
FM	Frequency Modulation
FSK	Frequency Shift Keying
FSS	Fixed Satellite Service
g	Grams
GHz	GigaHertz
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
Hz	Hertz
IEEE	Institute of Electrical and Electronics Engineers
IF	Intermediate Frequency
ISED	Innovation Science and Economic Development
ITU	International Telecommunications Union
KDB	Knowledge DataBase

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

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