Radio Test Report

Sound Devices LLC

Multi-Channel Wireless Microphone Receiver

A20-NEXUS

47 CFR Part 15.247 Effective Date 1st October 2021
DTS: Digital Transmission System
Test Date: 28th September 2022 to 7th October 2022
Report Number: 10-13348-13-22 Issue 01

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

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

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Certificate of Test 13348-13

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:	Multi-Channel Wireless Microphone Receiver
Model Number:	A20-NEXUS
Unique Serial Number:	JY0022164000
Applicant:	Sound Devices LLC PO Box 576 E7556 State Road 23-33 Reedsburg WI 53959 USA
Proposed FCC ID	2AKLX-10873
Full measurement results are detailed in Report Number:	10-13348-13-22 Issue 01
Test Standards:	47 CFR Part 15.247 Effective Date 1st October 2021 DTS: Digital Transmission System

DEVIATIONS:
No deviations have been applied.

Note: This report covers Bluetooth operation only.

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: 28th September 2022 to 7th October 2022

Test Engineer:
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Customer Representative:

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2 Equipment under test (EUT)

2.1 Equipment specification

Applicant	Sound Devices LLC PO Box 576 E7556 State Road 23-33 Reedsburg WI 53959 USA	
Manufacturer of EUT	Sound Devices LLC	
Full Name of EUT	Multi-Channel Wireless Microphone Receiver	
Model Number of EUT	A20-NEXUS	
Serial Number of EUT	JY0022164000	
Date Received	21st September 2022	
Date of Test:	28th September 2022 to 7th October 2022	
Purpose of Test	To demonstrate design compliance to the relevant rules of Chapter 47 of the Code of Federal Regulations.	
Date Report Issued	6th January 2023	
Main Function	The A20-NEXUS is a portable 8-channel digital wireless receiver.	
Information Specification	Height	40 mm
	Width	205 mm
	Depth	155 mm
	Weight	<2 kg
	Voltage	10-18V DC
	Current	2A

2.2 Configurations for testing

General Parameters	
EUT Normal use position	Portable
Choice of model(s) for type tests	A20-NEXUS
Antenna details	Pulse Electronics W1010 2.4GHz External Antenna
Antenna port	2 SMA ports (A & B)
Baseband Data port (yes/no)?	No
Highest Signal generated in EUT	2480 MHz (Bluetooth)
Lowest Signal generated in EUT	Not Specified
Hardware Version (HVIN)	Rev01
Software Version	Not Specified
Firmware Version (FVIN)	0.01.6149
Type of Equipment	Multi-Radio
Technology Type	Bluetooth Low Energy
Geo-location (yes/no)	No
TX Parameters	
Alignment range – transmitter	2402-2480 MHz
EUT Declared BLE Type	LE1M
EUT Declared Modulation Scheme	GMSK
EUT Declared Power level	4 dBm (Conducted at SMA connector)
EUT Declared Nominal Channel Bandwidths	2 MHz
EUT Declared Channel Spacing's	2 MHz
EUT Declared Duty Cycle	<10%
Bit Rate	1Mbit/s
Declared frequency stability	Not Specified
RX parameters	
Alignment range – receiver	2402-2480 MHz
EUT Declared RX Signal Bandwidth	2 MHz
Receiver Signal Level (RSL)	Not Specified
General BT Parameters	
Specific Technology Type	Bluetooth Low Energy
Bluetooth Core Version	V5.2
BLE Slave, Master or both	Not Specified
BLE frame based / load based	Load Based
Dynamic frequency selection employed	N/A
TPC	No
Number of channels	40
Number of antennas and type used	2 External SMA (male) connector antennas (A & B)
Antenna Details	Pulse Electronics W1010 2.4GHz External Antenna
Antenna Gain	2.0 dBi
Supported data rates	1Mbit/s
FCC parameters	
FCC Transmitter Class	DTS: Digital Transmission System

2.3 Functional description

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

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

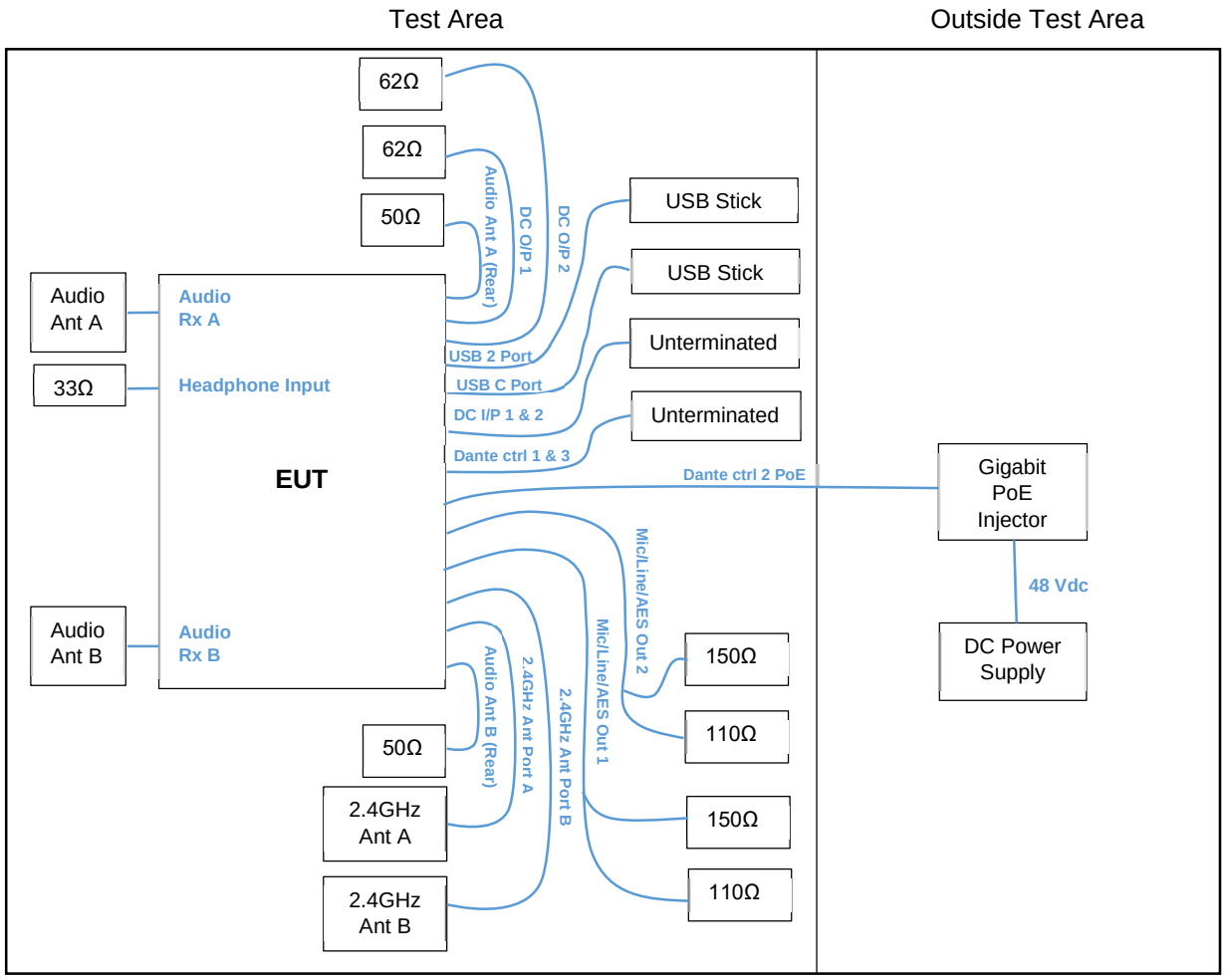
There are two options for powering: POE+ (48 V) and 10-18 V DC via 2x TA4 connectors.

2.4 Modes of operation

Mode Reference	Description	Used for testing
Mode 1	Constant Transmit BLE Channel 0 (2402MHz) BT Antenna Port: B	Yes
Mode 2	Constant Transmit BLE Channel 17 (2440MHz) BT Antenna Port: B	Yes
Mode 3	Constant Transmit BLE Channel 39 (2480MHz) BT Antenna Port: B	Yes
Mode 4	Constant Transmit BLE Channel 0 (2402MHz) BT Antenna Port: A	Yes
Mode 5	Constant Transmit BLE Channel 17 (2440MHz) BT Antenna Port: A	Yes
Mode 6	Constant Transmit BLE Channel 39 (2480MHz) BT Antenna Port: A	Yes

Note: Although EUT uses Bluetooth Low Energy, only LE1M scheme has been declared as being used by the device. Test modes cover Bluetooth operation of the device only.

2.5 Emissions configuration



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

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

The EUT was set to LE1M, 1Mbps data rate during all testing as this was declared by the manufacturer to be the only Bluetooth Low Energy type/ data rate used by the EUT.

For conducted tests the external antenna SMA ports were used. The unit was configured with engineering menus in software to allow permanent transmit modes of device on the top, middle and bottom channels as stated within section 2.4 of this report. The Transmit modes were set using the engineering mode provided within the unit. The transmit mode was repeatedly transmitting with approximately 50% duty cycle. The power settings for each channel were as stated below:-
Low Channel (2402 MHz) = Power Setting:8 (Declared Maximum)
Mid Channel (2440 MHz) only = Power Setting:8 (Declared Maximum)
High Channel (2480 MHz) only = Power Setting:8 (Declared Maximum)

2.5.1 Signal leads

Port Name	Cable Type	Connected
Antenna Input A (Front)	Screened, >3m	BNC female
Antenna Input B (Front)	Screened, >3m	BNC female
Antenna Input A (Rear)	Screened, >3m	BNC female
Antenna Input B (Rear)	Screened, >3m	BNC female
Headphone Input	Screened, <3m	3.5mm socket
2.4GHz Antenna Input A (BLE/FHSS 2.4G Proprietary)	Screened, <3m	SMA Female
2.4GHz Antenna Input B (BLE/FHSS 2.4G Proprietary)	Screened, <3m	SMA Female
Mic/Line/AES Output (Top)	Screened, <3m	25-pin D-Type
Mic/Line/AES Output (Bottom)	Screened, <3m	25-pin D-Type
Dante/Ctrl 1 (1000MBps)	Screened, >3m	RJ45
Dante/Ctrl 2 / POE+ (1000MBps)	Screened, >3m	RJ45
Dante/Ctrl 3 (1000MBps)	Screened, >3m	SFP
LTC/WCK Input	Screened, <3m	BNC female
DC Input 10-18V (Top)	Unscreened, <3m	TA4 male
DC Input 10-18V (Bottom)	Unscreened, <3m	TA4 male
DC Output 1 10-18V (Top)	Unscreened, <3m	Hirose-4, female
DC Output 2 10-18V (Bottom)	Unscreened, <3m	Hirose-4, female
USB-A 2.0	Screened, <3m	USB-A
USB-C 3.2	Screened, <3m	USB-C

3 Summary of test results

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

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

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

Title	References	Results
Transmitter Tests		
1. AC power line conducted emissions	47 CFR Part 15C Part 15.207	PASSED
2. Radiated emissions 9 - 150 kHz	47 CFR Part 15C Part 15.209	PASSED[6]
3. Radiated emissions 150 kHz - 30 MHz	47 CFR Part 15C Part 15.209	PASSED
4. Radiated emissions 30 MHz -1 GHz	47 CFR Part 15C Part 15.247(d) & 15.209	PASSED
5. Radiated emissions above 1 GHz	47 CFR Part 15C Part 15.247(d) & 15.209	PASSED[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)(2)/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)(3)	PASSED
11. Maximum Power Spectral Density	47 CFR Part 15C Part 15.247(e)	PASSED
12. Antenna power conducted emissions	47 CFR Part 15C Part 15.247(d)	NOT APPLICABLE[3]
13. Duty cycle	47 CFR Part 15C Part 15.35(c)	NOT APPLICABLE [4]
14. FHSS carrier frequency separation	47 CFR Part 15C Part 15.247(a1)	NOT APPLICABLE[2]
15. Average time of occupancy	47 CFR Part 15C Part 15.247(a)(1)(i)/(ii)/(iii)	NOT APPLICABLE[2]
16. Number of Hop Channels	47 CFR Part 15C Part 15.247(a)(1)(i)/(ii)/(iii)	NOT APPLICABLE[2]

[1] Peak Conducted RF Power measured therefore this test is not required.

[2] EUT does not employ FHSS technology.

[3] Applies to EUT's with an antenna port. The EUT was tested for radiated emissions with its dedicated antenna in position.

[4] No limits apply included for reference only

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

[6] Spectrum investigated below 30MHz started at a frequency of 9 kHz as no lowest frequency was declared.

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 Tests at extremes of temperature & voltage

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

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

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

5 Tests, methods and results

5.1 AC power line conducted emissions

5.1.1 Test methods

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

5.1.2 Configuration of EUT

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

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

The EUT was operated in Mode 5 (Transmitting on Mid Channel), as the emissions profile was identical to that whilst transmitting on the lowest and highest channels.

5.1.3 Test procedure

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

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

Tests were performed in Test Site F.

5.1.4 Test equipment

E035, E150, E411, E624, ZSW1

See Section 9 for more details

5.1.5 Test results

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

Band	2400-2483.5 MHz
Power Level	10 dBm (Ant: A & B)
Channel Spacing	2 MHz
Mod Scheme	LE1M
Mid channel	2440 MHz (Mid)

Table of signals measured for Live 150kHz-30MHz

Freq (MHz)	Peak Amp (dBuV)	QP Amp (dBuV)	QP -Lim (dB)	AV Amp (dBuV)	AV -Lim (dB)
0.158	58.7	52.3	-13.3	31.9	-23.7
0.182	56.2	50.2	-14.2	37.1	-17.3
0.239	49.9	42.9	-19.2	17.2	-34.9
0.271	47.5	40.6	-20.5	16.0	-35.1
0.288	45.9	39.8	-20.8	21.4	-29.2
0.652	39.5	35.1	-20.9	26.7	-19.3

Table of signals measured for Neutral 150kHz-30MHz

Freq (MHz)	Peak Amp (dBuV)	QP Amp (dBuV)	QP -Lim (dB)	AV Amp (dBuV)	AV -Lim (dB)
0.150	60.0	54.9	-11.1	44.0	-12.0
0.184	55.5	49.6	-14.7	36.5	-17.8
0.204	52.6	46.3	-17.1	18.2	-35.2
0.215	52.5	45.8	-17.2	26.7	-26.3
0.231	50.4	44.1	-18.3	19.7	-32.7
0.256	47.7	42.1	-19.5	23.6	-28.0
0.647	41.0	36.0	-20.0	26.8	-19.2

Plot refs
13348-13 Cond 1 AC Live 150k-30M Average
13348-13 Cond 1 AC Live 150k-30M Quasi-Peak
13348-13 Cond 1 AC Neutral 150k-30M Average
13348-13 Cond 1 AC Neutral 150k-30M Quasi-Peak

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

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

LIMITS:
15.207: as given in the above tables / drawn on the respective plots.

These results show that the EUT has PASSED this test.

The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows: 150kHz to 30MHz ±3.4dB (UE71)

5.2 Radiated emissions 9 - 150 kHz

5.2.1 Test methods

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

5.2.2 Configuration of EUT

The EUT was placed on a 0.8 metres high turntable. The front edge of the EUT was initially positioned facing the antenna. The EUT was measured at a distance of 3 metres. The EUT was rotated in all three orthogonal planes. Radiated Emissions testing was performed whilst powered by 12 Vdc using an RN power supply and by PoE using the manufacturers provided 'Industrial Gigabit PoE Injector'.

The EUT was operated in Modes 1, 2, 3, 4, 5 and 6.

5.2.3 Test procedure

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

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

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

Tests were performed using Test Site M.

5.2.4 Test equipment

E411, E624, TMS81

See Section 9 for more details

5.2.5 Test results

Temperature of test environment	15°C
Humidity of test environment	65%
Pressure of test environment	100kPa

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

Band	2400-2483.5 MHz
Power Level	10 dBm (Ant: B)
Channel Spacing	2 MHz
Mod Scheme	LE1M
Mid channel	2440 MHz (Mid)

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

Plot refs
13348-13 Rad 9k-150kHz Para
13348-13 Rad 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 20dB from the level of the fundamental and meet the general limits of 15.209.
The general limits of 15.209 are as drawn on the respective plots.

These results show that the EUT has PASSED this test.

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

5.3 Radiated emissions 150 kHz - 30 MHz

5.3.1 Test methods

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

5.3.2 Configuration of EUT

The EUT was placed on a 0.8 metres high turntable. The front edge of the EUT was initially positioned facing the antenna. The EUT was measured at a distance of 3 metres. The EUT was rotated in all three orthogonal planes. Radiated Emissions testing was performed whilst powered by 12 Vdc using an RN power supply and by PoE using the manufacturers provided 'Industrial Gigabit PoE Injector'.

The EUT was operated in Modes 1, 2, 3, 4, 5 and 6.

5.3.3 Test procedure

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

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

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

Tests were performed using Test Site M.

5.3.4 Test equipment

E411, E624, TMS81

See Section 9 for more details

5.3.5 Test results

Temperature of test environment	15°C
Humidity of test environment	65%
Pressure of test environment	100kPa

Note: Whilst Low, Mid and High channels were tested and both Bluetooth antenna ports (A & B), plots are for illustrative purposes only and only Middle channel, Bluetooth Antenna B plots are shown in this report.

Band	2400-2483.5 MHz
Power Level	10 dBm (BT Ant: B)
Channel Spacing	2 MHz
Mod Scheme	LE1M
Mid channel	2440 MHz (Mid)

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

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

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

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

Plot refs
13348-13 Rad 150k-30MHz Para
13348-13 Rad 150k-30MHz Perp

There were no noticeable differences between Low, Mid and High channels or antenna ports. Any signals measured are present for all settings.

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 20dB from the level of the fundamental and meet the general limits of 15.209.
The general limits of 15.209 are as drawn on the respective plots.

These results show that the EUT has PASSED this test.

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

5.4 Radiated emissions 30 MHz -1 GHz

5.4.1 Test methods

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

5.4.2 Configuration of EUT

The EUT was placed on a 0.8 metres high turntable. The front edge of the EUT was initially positioned facing the antenna. The EUT was measured at a distance of 3 metres. The EUT was rotated in all three orthogonal planes. Radiated Emissions testing was performed whilst powered by 12 Vdc using an RN power supply and by PoE using the manufacturers provided 'Industrial Gigabit PoE Injector'.

Following investigation Bluetooth antenna B was found to generate higher emissions than antenna A, therefore worst case measurements have been reported. Antennas A & B operate independently.

The EUT was operated in Modes 1, 2, 3, 4, 5 and 6.

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 M.

5.4.4 Test equipment

E411, E624, E743, LPE364

See Section 9 for more details

5.4.5 Test results

Temperature of test environment 15°C
Humidity of test environment 65%
Pressure of test environment 998kPa

Band	2400-2483.5 MHz
Power Level	10 dBm (BT Ant: B)
Channel Spacing	2 MHz
Mod Scheme	LE1M
Low channel	2402 MHz (Low)

Plot refs
13348-13 Rad 1 VHF Horiz
13348-13 Rad 1 VHF Vert
13348-13 Rad 1 UHF Horiz
13348-13 Rad 1 UHF Vert

Band	2400-2483.5 MHz
Power Level	10 dBm (BT Ant: B)
Channel Spacing	2 MHz
Mod Scheme	LE1M
Mid channel	2440 MHz (Mid)

Plot refs
13348-13 Rad 2 VHF Horiz
13348-13 Rad 2 VHF Vert
13348-13 Rad 2 UHF Horiz
13348-13 Rad 2 UHF Vert

Band	2400-2483.5 MHz
Power Level	10 dBm (BT Ant: B)
Channel Spacing	2 MHz
Mod Scheme	LE1M
High channel	2480 MHz (High)

Plot refs
13348-13 Rad 3 VHF Horiz
13348-13 Rad 3 VHF Vert
13348-13 Rad 3 UHF Horiz
13348-13 Rad 3 UHF Vert

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

Signal No.	Freq (MHz)	Peak Amp (dBuV/m)	QP Amp (dBuV/m)	QP -Lim (dB)
1	366.656	36.9	31.8	-14.2
2	375.004	41.2	39.1	-6.9
3	390.450	38.3	32.3	-13.7
4	393.204	40.2	35.3	-10.7
5	417.808	35.1	29.7	-16.3
6	460.057	36.5	30.4	-15.6
7	491.522	41.4	36.8	-9.2
8	495.649	41.5	36.0	-10.0
9	500.004	41.1	36.7	-9.3
10	548.959	43.7	38.1	-7.9
11	651.511	38.0	31.6	-14.4
12	786.416	41.0	36.3	-9.7
13	884.739	44.4	40.8	-5.2

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

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

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

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

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

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

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

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

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

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

Note: Whilst Low, Mid and High channels were tested and both Bluetooth antenna ports (A & B), plots are for illustrative purposes only and only Low, Middle and High channel plots for Bluetooth Antenna B are shown in this report.

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

LIMITS:
15.209 limits are applicable in the restricted bands of 15.205 with the relevant detector.
15.247(d) other emissions, outside the intentional band, must be attenuated by at least 20dB from the level of the fundamental and meet the general limits of 15.209.
The general limits of 15.209 are as drawn on the respective plots.
These results show that the EUT has PASSED this test.

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

5.5 Radiated emissions above 1 GHz

5.5.1 Test methods

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

5.5.2 Configuration of EUT

The EUT was placed on a 1.5 metres high turntable. The front edge of the EUT was initially positioned facing the antenna. The EUT was measured at a distance of 3 metres. The EUT was rotated in all three orthogonal planes. Radiated Emissions testing was performed whilst powered by 12 Vdc using an RN power supply and by PoE using the manufacturers provided 'Industrial Gigabit PoE Injector'.

Following investigation Bluetooth antenna B was found to generate higher emissions than antenna A, therefore worst case measurements have been reported. Antennas A & B operate independently.

The EUT was operated in Modes 1, 2, 3, 4, 5 and 6.

5.5.3 Test procedure

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

Measurements were made in a semi-anechoic chamber with appropriate absorbing material for use in this range. Horn antennas were used at heights where the whole of the EUT was contained within the main beam. 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 B.

5.5.4 Test equipment

E289, E428, E429, E642, E856, E972, F230, F231

See Section 9 for more details

5.5.5 Test results

Temperature of test environment	16°C
Humidity of test environment	56%
Pressure of test environment	100kPa

Setup Table

Band	2400-2483.5 MHz
Power Level	10 dBm (BT Ant: B)
Channel Spacing	2 MHz
Mod Scheme	LE1M
Mid channel	2440 MHz (Mid)

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

Plots
13348-13 A20-DX Tx Radiated Emission 1-4GHz BLE Mid Channel (2440MHz) Ant_ B Side Position Horizontal
13348-13 A20-DX Tx Radiated Emission 1-4GHz BLE Mid Channel (2440MHz) Ant_ B Side Position Vertical
13348-13 A20-DX Tx Radiated Emission 4-6GHz BLE Mid Channel (2440MHz) Ant_ B Side Position Horizontal Peak
13348-13 A20-DX Tx Radiated Emission 4-6GHz BLE Mid Channel (2440MHz) Ant_ B Side Position Horizontal Peak

13348-13 A20-DX Tx Radiated Emission 6-7.77GHz BLE Mid Channel (2440MHz) Ant_ B Side Position Horizontal
13348-13 A20-DX Tx Radiated Emission 6-7.77GHz BLE Mid Channel (2440MHz) Ant_ B Side Position Vertical
13348-13 A20-DX Tx Radiated Emission 7.77-10GHz BLE Mid Channel (2440MHz) Ant_ B Side Position Horizontal
13348-13 A20-DX Tx Radiated Emission 7.77-10GHz BLE Mid Channel (2440MHz) Ant_ B Side Position Vertical
13348-13 A20-DX Tx Radiated Emission 10-12.5GHz BLE Mid Channel (2440MHz) Ant_ B Side Position Horizontal
13348-13 A20-DX Tx Radiated Emission 10-12.5GHz BLE Mid Channel (2440MHz) Ant_ B Side Position Vertical
13348-13 A20-DX Tx Radiated Emission 12.5-15GHz BLE Mid Channel (2440MHz) Ant_ B Side Position Horizontal
13348-13 A20-DX Tx Radiated Emission 12.5-15GHz BLE Mid Channel (2440MHz) Ant_ B Side Position Vertical
13348-13 A20-DX Tx Radiated Emission 15-18GHz BLE Mid Channel (2440MHz) Ant_ B Side Position Horizontal
13348-13 A20-DX Tx Radiated Emission 15-18GHz BLE Mid Channel (2440MHz) Ant_ B Side Position Vertical
13348-13 A20-DX Tx Radiated Emission 18-22GHz BLE Mid Channel (2440MHz) Ant_ B Side Position Horizontal
13348-13 A20-DX Tx Radiated Emission 18-22GHz BLE Mid Channel (2440MHz) Ant_ B Side Position Vertical
13348-13 A20-DX Tx Radiated Emission 22-25GHz BLE Mid Channel (2440MHz) Ant_ B Side Position Horizontal
13348-13 A20-DX Tx Radiated Emission 22-25GHz BLE Mid Channel (2440MHz) Ant_ B Side Position Vertical

Note: Whilst Low, Mid and High channels were tested for both Bluetooth antenna ports (A & B), plots are for illustrative purposes only and only Middle channel, Bluetooth Antenna B plots are shown in this report to minimise report size.

Peak detector “Max held” Analyser plots against the Average limit line 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 20dB from the level of the fundamental and 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 6.6 [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, 2 and 3.

Following investigation Bluetooth antenna B was found to generate higher emissions than antenna A, therefore worst case measurements have been reported. Antennas A & B operate independently.

5.6.3 Test procedure

Tests were made in accordance with the Test Method noted above using the measuring equipment listed in the 'Test Equipment used' section. The power stated is Peak field strength.

Tests were performed in test site B.

5.6.4 Test equipment

E289, E428, E429, E642, E856

See Section 9 for more details

5.6.5 Test results

Temperature of test environment 19°C
Humidity of test environment 58%
Pressure of test environment 100kPa

Band	2400-2483.5 MHz
Power Level	10 dBm (BT Ant: B)
Channel Spacing	2 MHz
Mod Scheme	LE1M
Low channel	2402 MHz (Low)
Mid channel	2440 MHz (Mid)
High channel	2480 MHz (High)

	Low channel	Mid channel	High channel
Peak Level (dBµV/m)	**100.26**	**101.84**	**99.77**
Plot reference	13348-13 Radiated Power BLE Channel 0 (2402 MHz) Upright Position BT Antenna_ B	13348-13 Radiated Power BLE Channel 17 (2440 MHz) Side Position BT Antenna_ B	13348-13 Radiated Power BLE Channel 39 (2480 MHz) Side Position BT Antenna_ B
Antenna Polarisation	Vert	Horiz	Horiz
EUT Polarisation	Upright	Side	Side

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

LIMITS:

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

These results show that the EUT has PASSED this test.

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

5.7 Band Edge Compliance

5.7.1 Test methods

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

5.7.2 Configuration of EUT

The EUT was placed on a 1.5 metres high turntable. The front edge of the EUT was initially positioned facing the antenna. The EUT was measured at a distance of 3 metres.

Following investigation Bluetooth antenna B was found to generate higher emissions than antenna A, therefore worst-case measurements have been reported for Antenna B. The EUT was operated in Modes 1 and 3.

5.7.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment noted below. The emission from the EUT was maximised before taking the plots. 1MHz RBW setting was employed for the restricted band edge tests. 100kHz RBW was employed for the Authorised band edge tests.

Tests were performed using Test Site B.

5.7.4 Test equipment

E289, E428, E429, E642, E856

See Section 9 for more details

5.7.5 Test results

Temperature of test environment 19°C
Humidity of test environment 58%
Pressure of test environment 100kPa

Band	2400-2483.5 MHz
Power Level	10 dBm (Ant B)
Channel Spacing	2 MHz
Mod Scheme	LE1M
Low channel	2402 MHz (CH0)
High channel	2480 MHz (CH39)

Restricted Band Edges	Low channel	High channel
Restricted Peak Level measured (dBuV/m)	39.26	46.6
Restricted band edge Peak Plot	13348-13 Restricted Band Edge BLE Channel 0 (2402 MHz) Upright Position BT Antenna_ B Peak Det	13348-13 Restricted Band Edge BLE Channel 39 (2480 MHz) Upright Position BT Antenna_ B Peak Det

Authorised Band Edges	Low channel	High channel
Authorised Band Edge (dBc) value measured	56.0 dBc	62.66 dBc
Authorised Band Edge Plot	13348-13 Authorised Band Edge BLE Channel 0 (2402 MHz) Upright Position BT Antenna_ B	13348-13 Authorised Band Edge BLE Channel 39 (2480 MHz) Side Position BT Antenna_ B

Analyser plots for the Band Edge Compliance can be found in Section 6 of this report. These show the 20/30dBc requirement of 15.247(d) are met at the band edges of 2400 and 2483.5 MHz. Restricted band edge plots are also shown in section 6.

The tables list the field strengths observed in the adjacent restricted bands, which are required to meet the tighter

15.209 limits.

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

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

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

These results show that the EUT has PASSED this test.

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

5.8 Occupied bandwidth

5.8.1 Test methods

Test Requirements: 47 CFR Part 15C Part 15.247(a)(2) [Reference 4.1.1 of this report]
Test Method: ANSI C63.10 Clause 6.9 [Reference 4.1.2 of this report]
Limits: 47 CFR Part 15C Part 15.247(a)(2) [Reference 4.1.1 of this report]

5.8.2 Configuration of EUT

The EUT was measured on a bench using a spectrum analyser connected to the external RF port. The EUT was operated in Modes 1, 2, 3, 4, 5 and 6.

5.8.3 Test procedure

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

Tests were performed using Test Site A.

5.8.4 Test equipment

E412, E433

See Section 9 for more details

5.8.5 Test results

Temperature of test environment 21°C
Humidity of test environment 46%
Pressure of test environment 103kPa

Band	2400-2483.5 MHz
Power Level	10 dBm (BT Ant: A)
Channel Spacing	2 MHz
Mod Scheme	LE1M
Low channel	2402 MHz (Low)
Mid channel	2440 MHz (Mid)
High channel	2480 MHz (High)

	Low channel	Mid channel	High channel
Operating frequency (MHz)	2402	2440	2480
6 dB Bandwidth Result (MHz)	0.7099255	0.7117568	0.7270175
Frequency Error (kHz)	64.872	65.736	60.988
6 dB FLOW Worst case (MHz)	2401.709909	2439.709858	2479.697479
6 dB FHIGH Worst case (MHz)	2402.419835	2440.421614	2480.424497
Plot for 6 dB Bandwidth Result (MHz)	13348-13 6dBBW BLE Low Channel (2402MHz) Ant_ A	13348-13 6dBBW BLE Mid Channel (2440MHz) Ant_ A	13348-13 6dBBW BLE High Channel (2480MHz) Ant_ A

Band	2400-2483.5 MHz
Power Level	10 dBm (BT Ant: B)
Channel Spacing	2 MHz
Mod Scheme	LE1M
Low channel	2402 MHz (Low)
Mid channel	2440 MHz (Mid)
High channel	2480 MHz (High)

	Low channel	Mid channel	High channel
Operating frequency (MHz)	2402	2440	2480
6 dB Bandwidth Result (MHz)	0.7099255	0.7068734	0.7141985
Frequency Error (kHz) (include sign)	65.088	65.93	61.39
6 dB FLOW Worst case (MHz)	2401.710125	2439.712493	2479.704291
6 dB FHIGH Worst case (MHz)	2402.420051	2440.419367	2480.418489
Plot for 6 dB Bandwidth Result (MHz)	13348-13 6dBBW BLE Low Channel (2402MHz) Ant_ B	13348-13 6dBBW BLE Mid Channel (2440MHz) Ant_ B	13348-13 6dBBW BLE High Channel (2480MHz) Ant_ B

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

LIMITS:
15.247(a)(2) The minimum 6dB bandwidth shall be at least 500kHz.

These results show that the EUT has PASSED this test.

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

5.9 Maximum Average conducted output power

NOT APPLICABLE: Peak Conducted RF Power measured therefore this test is not required.

5.10 Maximum Peak conducted output power

5.10.1 Test methods

Test Requirements: 47 CFR Part 15C Part 15.247(b)(3) [Reference 4.1.1 of this report]
Test Method: ANSI C63.10 Clause [Reference 4.1.2 of this report]
Limits: 47 CFR Part 15C Part 15.247(b)(3) [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 external RF port.

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

The EUT was operated in Modes 1, 2, 3, 4, 5 and 6 for this test.

5.10.3 Test procedure

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

Peak stated reading is maximum power observed using a spectrum analyser RBW > 6dB BW of the EUT.

Measurements were made on a test bench in site A.

5.10.4 Test equipment

E412, E433

See Section 9 for more details

5.10.5 Test results

Temperature of test environment 21°C
Humidity of test environment 46%
Pressure of test environment 103kPa

Band	2400-2483.5 MHz
Power Level	10 dBm (BT Ant: A)
Channel Spacing	2 MHz
Mod Scheme	LE1M
Low channel	2402 MHz (Low)
Mid channel	2440 MHz (Mid)
High channel	2480 MHz (High)

Maximum TX Power observed (dBm)	4.17	4.73	3.70
Limit in dBm	30.00	30.00	30.00
Margin to Limit (dB)	-23.83	-23.27	-24.30
Result in (W)	0.004	0.005	0.004
Plot reference	13348-13 Peak Conducted RF Power BLE Low Channel (2402MHz) Ant_ A	13348-13 Peak Conducted RF Power BLE Mid Channel (2440MHz) Ant_ A	13348-13 Peak Conducted RF Power BLE High Channel (2480MHz) Ant_ A

Band	2400-2483.5 MHz
Power Level	10 dBm (BT Ant: B)
Channel Spacing	2 MHz
Mod Scheme	LE1M
Low channel	2402 MHz (Low)
Mid channel	2440 MHz (Mid)
High channel	2480 MHz (High)

Maximum TX Power observed (dBm)	4.24	4.86	3.70
Limit in dBm	30.00	30.00	30.00
Margin to Limit (dB)	-23.76	-23.14	-24.30
Result in (W)	0.004	0.005	0.004
Plot reference	13348-13 Peak Conducted RF Power BLE Low Channel (2402MHz) Ant_ B	13348-13 Peak Conducted RF Power BLE Mid Channel (2440MHz) Ant_ B	13348-13 Peak Conducted RF Power BLE High Channel (2480MHz) Ant_ B

LIMITS:
15.247(b)(3)
For systems using digital modulation in the 902-928, 2400-2483.5 or 5725-5850 MHz bands 1 Watt.

These results show that the EUT has PASSED this test.

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

5.11 Maximum Power Spectral Density

5.11.1 Test methods

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

5.11.2 Configuration of EUT

The EUT was configured as for the Average conducted power test. The EUT was operated in Modes 1, 2, 3, 4, 5 and 6 for this test.

5.11.3 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 any plots. Measurements & plots were taken with the span set to 1.5 times the measured DTS bandwidth for each modulation scheme setting.

Tests were performed using Test Site A.

5.11.4 Test equipment

E412, E433

See Section 9 for more details

5.11.5 Test results

Temperature of test environment 21°C
Humidity of test environment 47%
Pressure of test environment 103kPa

Band	2400-2483.5 MHz
Power Level	10 dBm (BT Ant: A)
Channel Spacing	2 MHz
Mod Scheme	LE1M
Low channel	2402 MHz (Low)
Mid channel	2440 MHz (Mid)
High channel	2480 MHz (High)

	Low channel	Mid channel	High channel
Duty Cycle (%)	48.18	48.18	48.18
mW per MHz	0.065	0.072	0.053
Plot reference	13348-13 PSD BLE Low Channel (2402MHz) Ant_ A	13348-13 PSD BLE Mid Channel (2440MHz) Ant_ A	13348-13 PSD BLE High Channel (2480MHz) Ant_ A

Band	2400-2483.5 MHz
Power Level	10 dBm (BT Ant: B)
Channel Spacing	2 MHz
Mod Scheme	LE1M
Low channel	2402 MHz (Low)
Mid channel	2440 MHz (Mid)
High channel	2480 MHz (High)

	Low channel	Mid channel	High channel
Duty Cycle (%)	48.18	48.18	48.18
mW per MHz	0.066	0.075	0.054
Plot reference	13348-13 PSD BLE Low Channel (2402MHz) Ant_ B	13348-13 PSD BLE Mid Channel (2440MHz) Ant_ B	13348-13 PSD BLE High Channel (2480MHz) Ant_ B

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

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

These results show that the EUT has PASSED this test.

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

5.12 Antenna power conducted emissions

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

5.13 Duty cycle

5.13.1 Test methods

Test Requirements: 47 CFR Part 15C Part 15.35(c) [Reference 4.1.1 of this report]
Test Method: ANSI C63.10 Clause 7.5 [Reference 4.1.2 of this report]
Limits: 47 CFR Part 15C Part 15.35c [Reference 4.1.1 of this report]

5.13.2 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 Mode 1.

5.13.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment noted below. The centre frequency of the analyser was set to that of the transmitter, and the span set to zero. The sweep time was adjusted so that either the pulse width or the periodic operation could be observed.

Measurements were performed in test site B.

5.13.4 Test equipment

E289, E428, E429, E642, E856

See Section 9 for more details

5.13.5 Test results

Temperature of test environment 19°C
Humidity of test environment 58%
Pressure of test environment 100kPa

Band	2400-2483.5 MHz
Power Level	10 dBm
Channel Spacing	2 MHz
Mod Scheme	LE1M
Single channel	2402 MHz (CH0)

	Single channel
TX on time (mS)	0.6022464
TX on Plot filename	On Time
TX repetition time (S)	0.00125
TX repetition Plot filename	Cycle Time
Calculated TX Duty cycle (%)	48.179712

There is no limit defined in the standard. It was, however, confirmed by observation that the continuous test mode provided was 48.18% duty.

These results show that any duty cycle correction factor for peak to average emissions is therefore 20log (48.18/100) = -6.34 dB

Analyser plots for the dwell time and duty cycle can be found in Section 6 of this report.

LIMITS:

No limits apply. These results have been included for reference only.

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

5.14 FHSS carrier frequency separation

NOT APPLICABLE: EUT does not employ FHSS technology.

5.15 Average time of occupancy

NOT APPLICABLE: EUT does not employ FHSS technology.

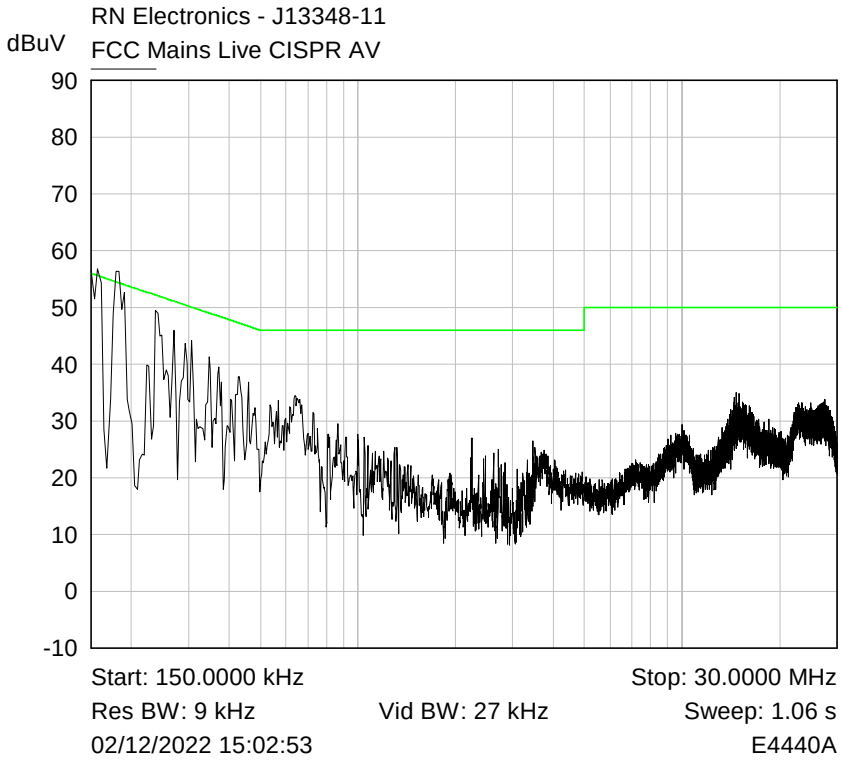
5.16 Number of Hop Channels

NOT APPLICABLE: EUT does not employ FHSS technology.

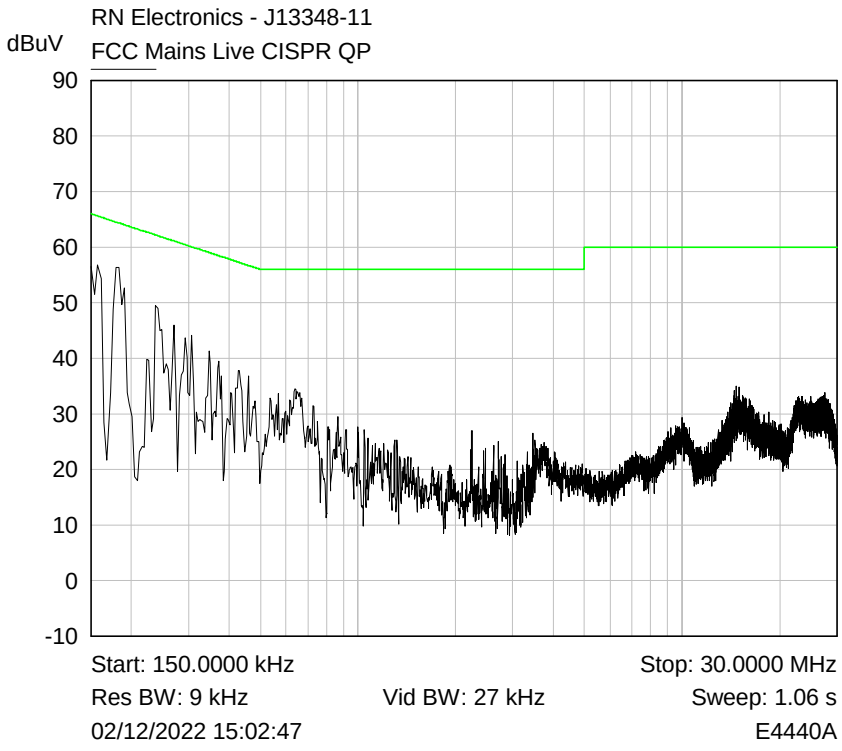
6 Plots/Graphical results

6.1 Conducted emissions 0.15 - 30 MHz

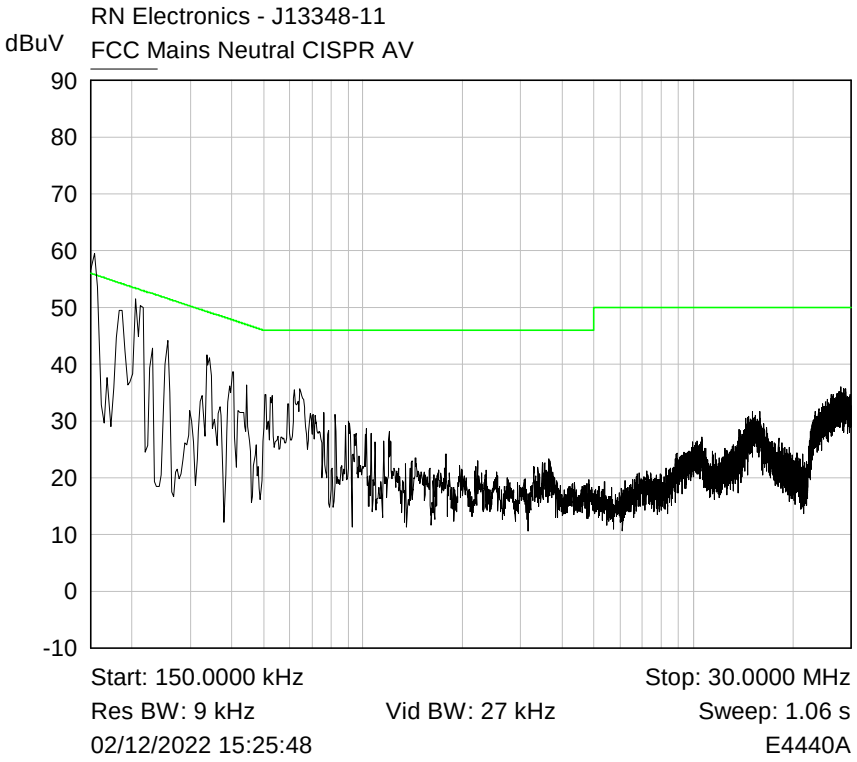
RF Parameters: Band 2400-2483.5 MHz, Power 10 dBm (BT Ant: A), Channel Spacing 2 MHz, Modulation LE1M, Channel 2440 MHz (Mid)



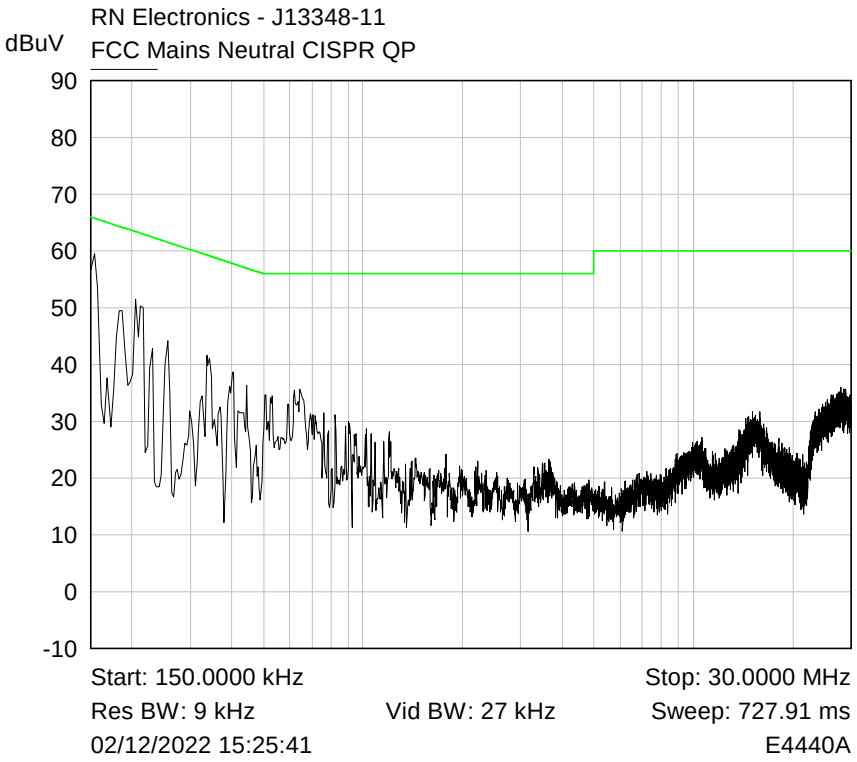
Plot of 0.15-30MHz Live Line AV



Plot of 0.15-30MHz Live Line AV



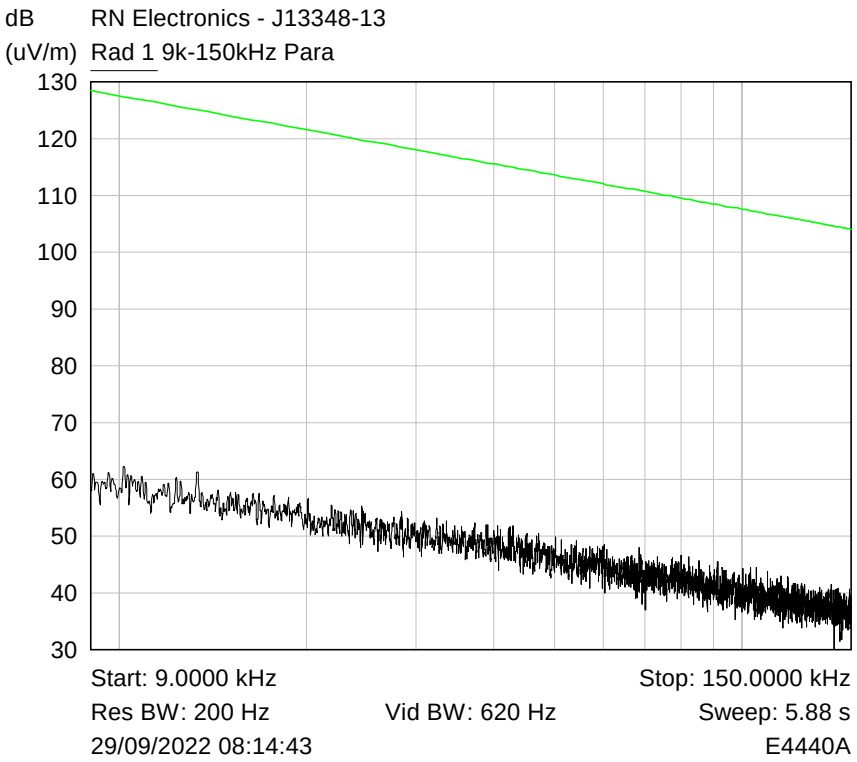
Plot of 0.15-30MHz Neutral Line AV



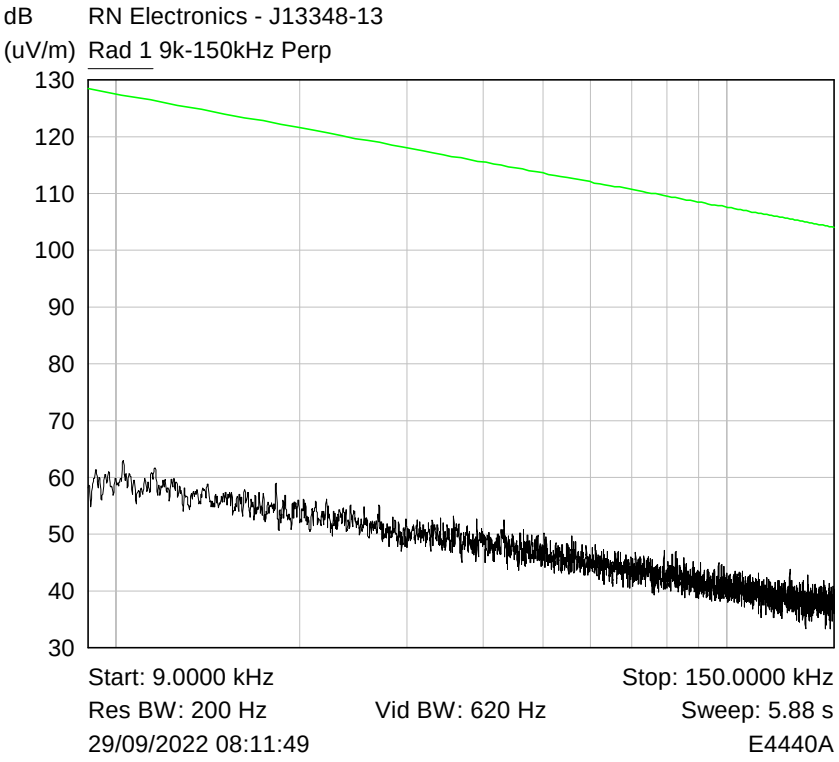
Plot of 0.15-30MHz Neutral Line QP

6.2 Radiated emissions 9 - 150 kHz

RF Parameters: Band 2400-2483.5 MHz, Power 10 dBm (BT Ant: B), Channel Spacing 2 MHz, Modulation LE1M, Channel 2440 MHz (Mid)



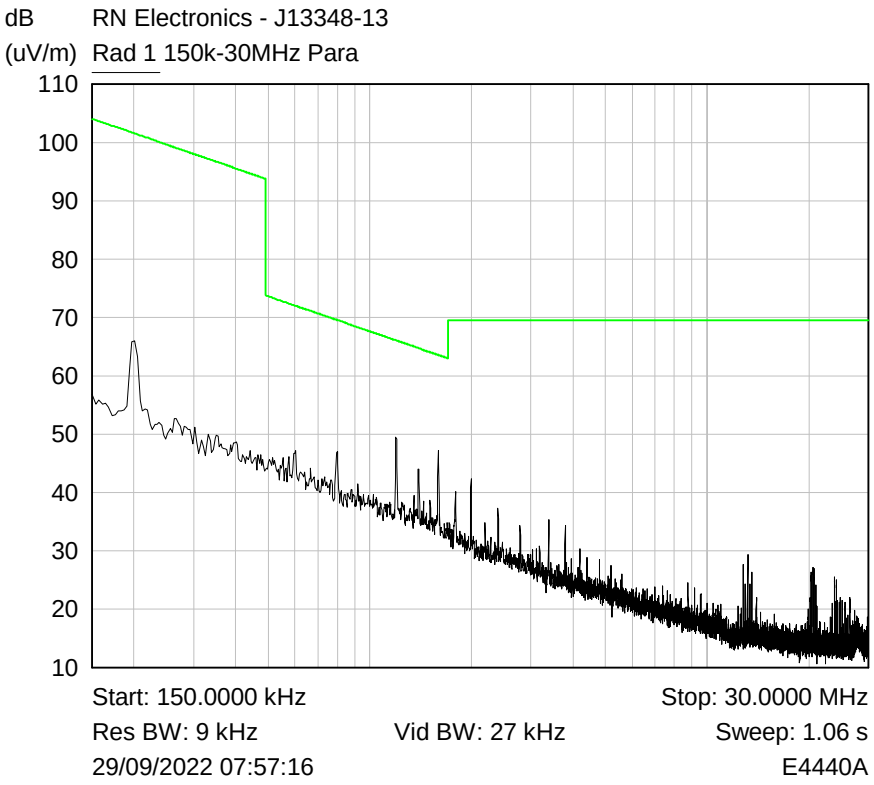
Plot of 9k-150kHz Parallel



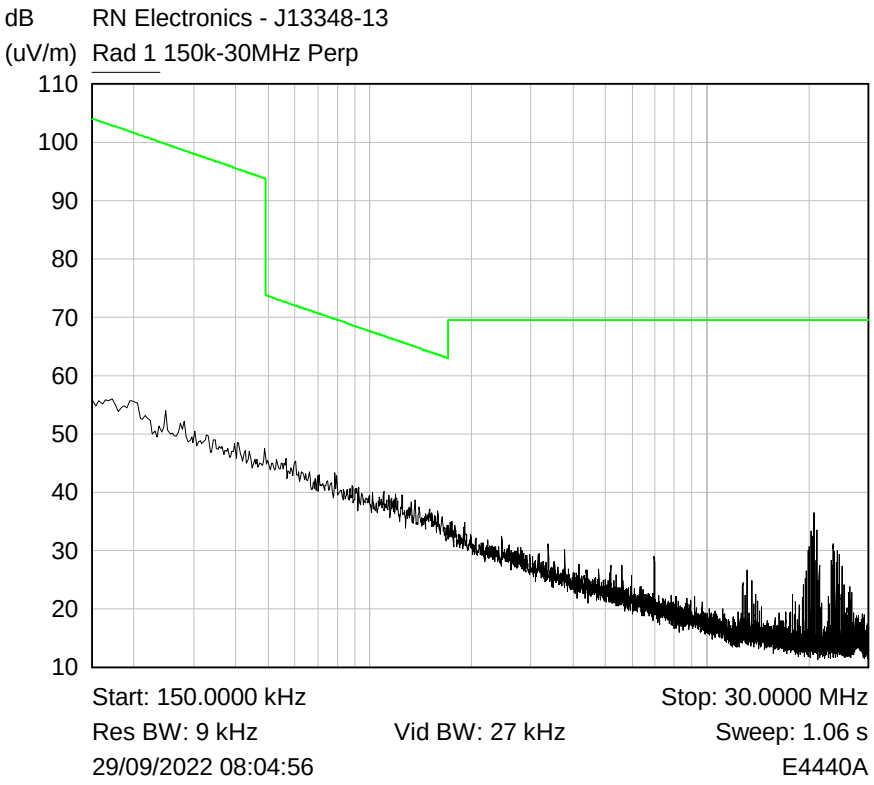
Plot of 9k-150kHz Perpendicular

6.3 Radiated emissions 150 kHz - 30 MHz

RF Parameters: Band 2400-2483.5 MHz, Power 10 dBm (BT Ant: B), Channel Spacing 2 MHz, Modulation LE1M, Channel 2440 MHz (Mid)



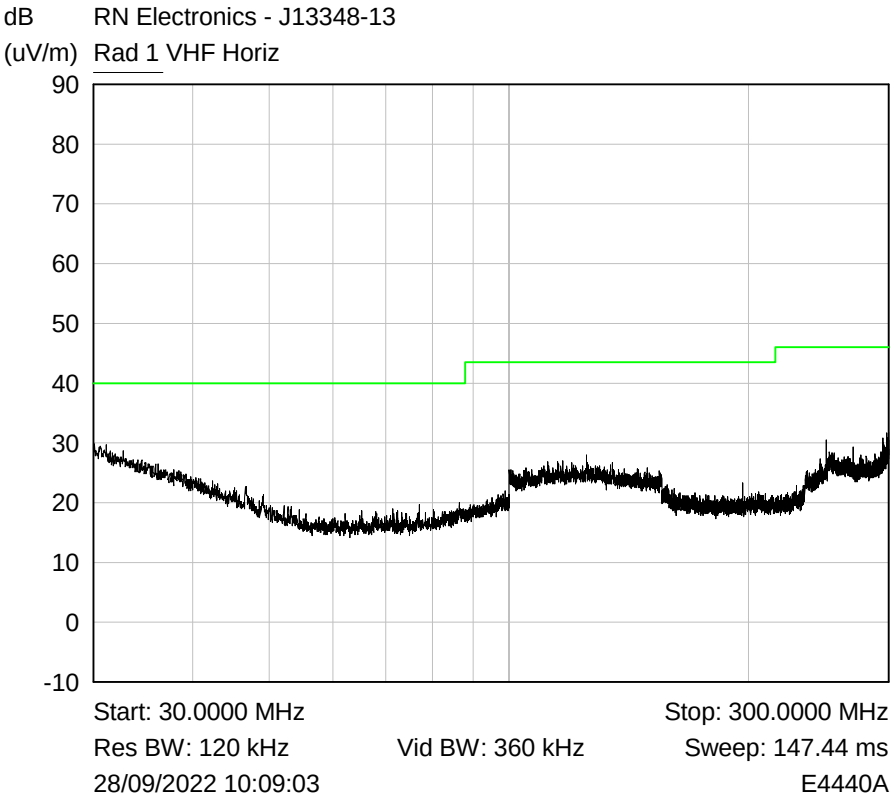
Plot of 150kHz-30MHz Parallel



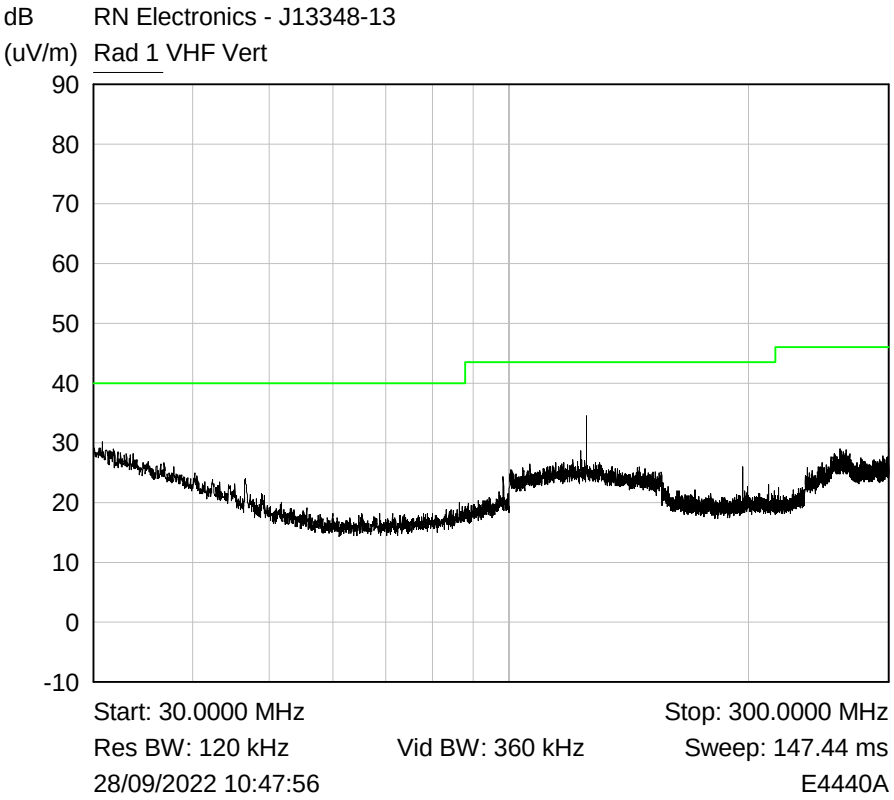
Plot of 150kHz-30MHz Perpendicular

6.4 Radiated emissions 30 MHz -1 GHz

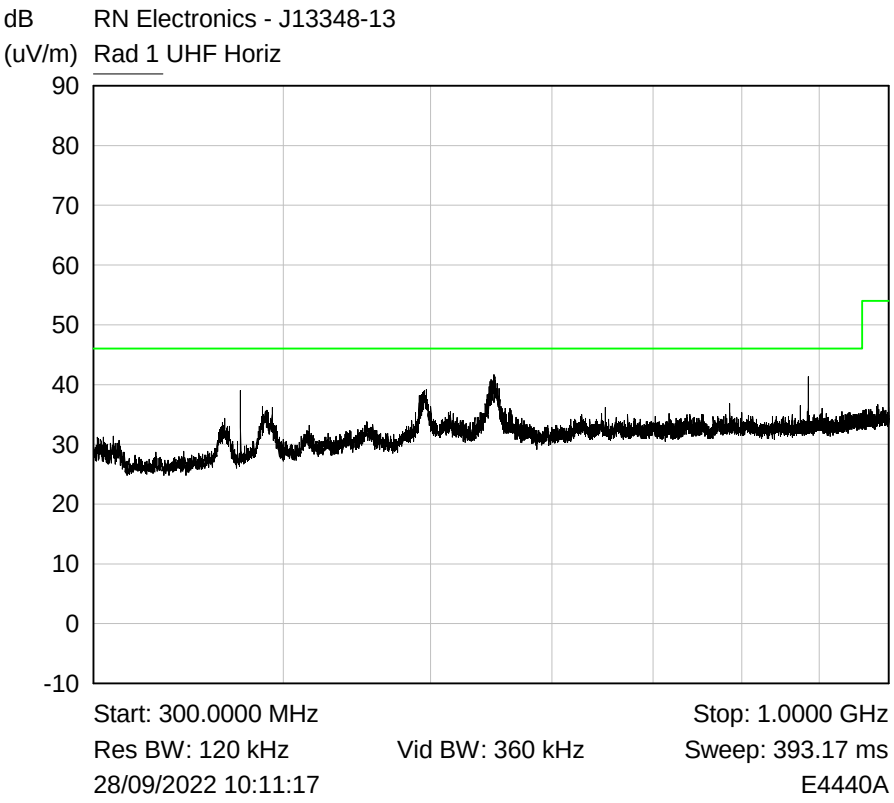
RF Parameters: Band 2400-2483.5 MHz, Power 10 dBm (BT Ant: B), Channel Spacing 2 MHz, Modulation LE1M, Channel 2402 MHz (Low)



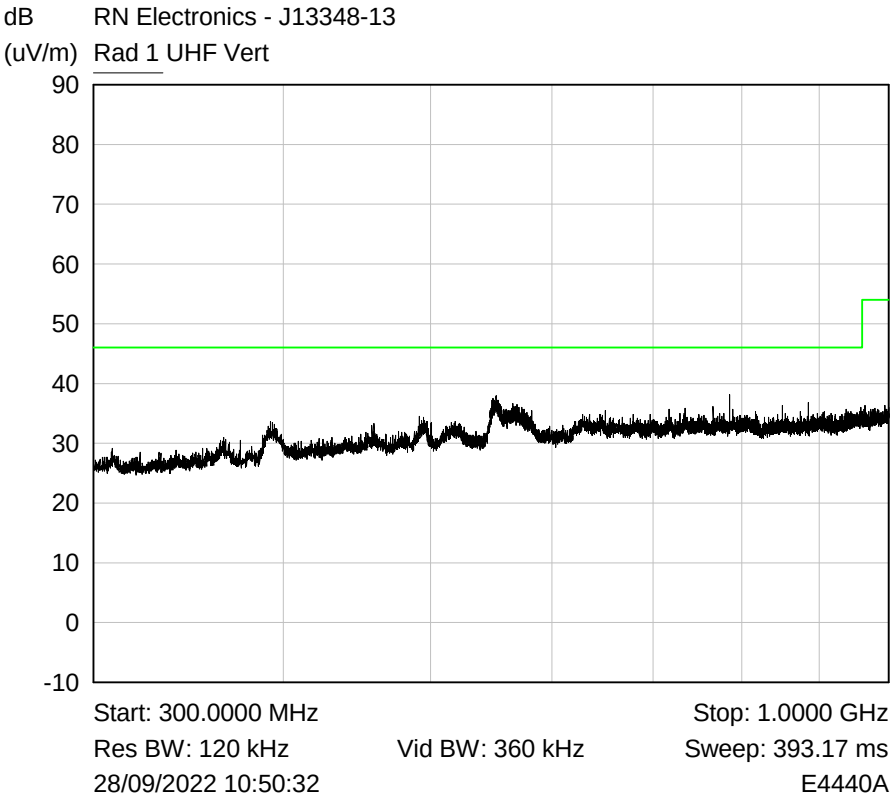
Plot of Peak emissions for VHF Horizontal against the QP limit line.



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

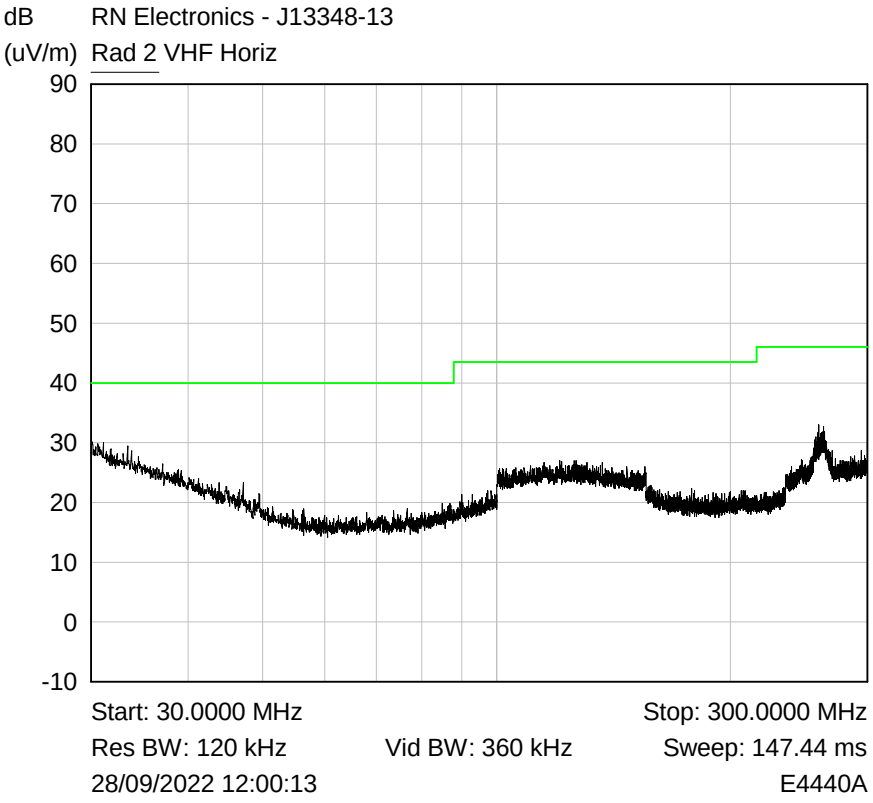


Plot of Peak emissions for UHF Horizontal against the QP limit line.

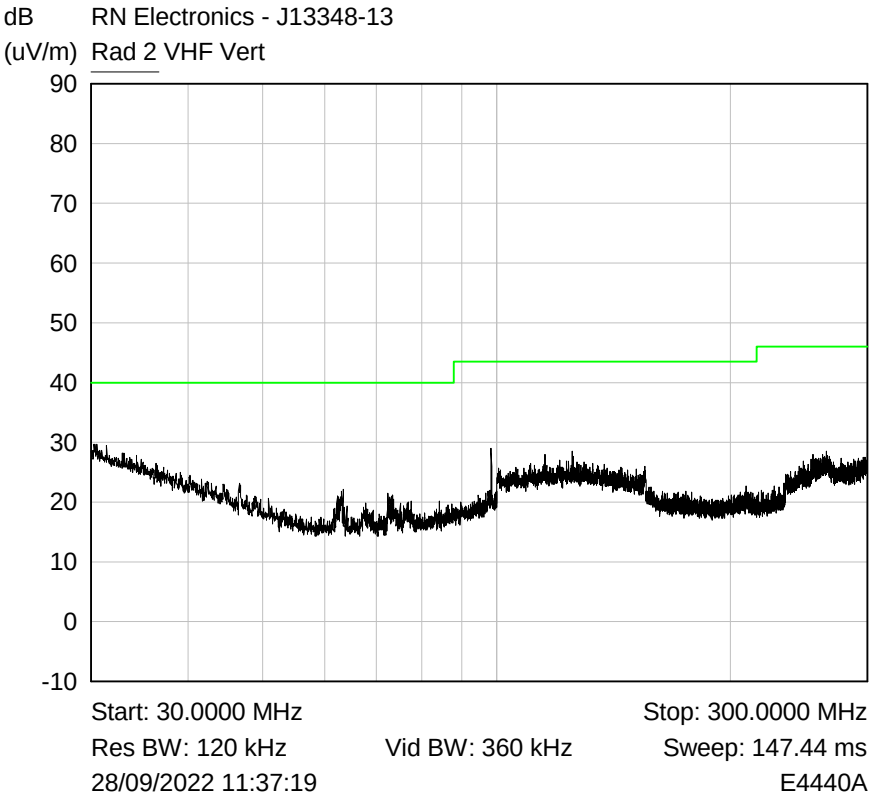


Plot of Peak emissions for UHF Vertical against the QP limit line.

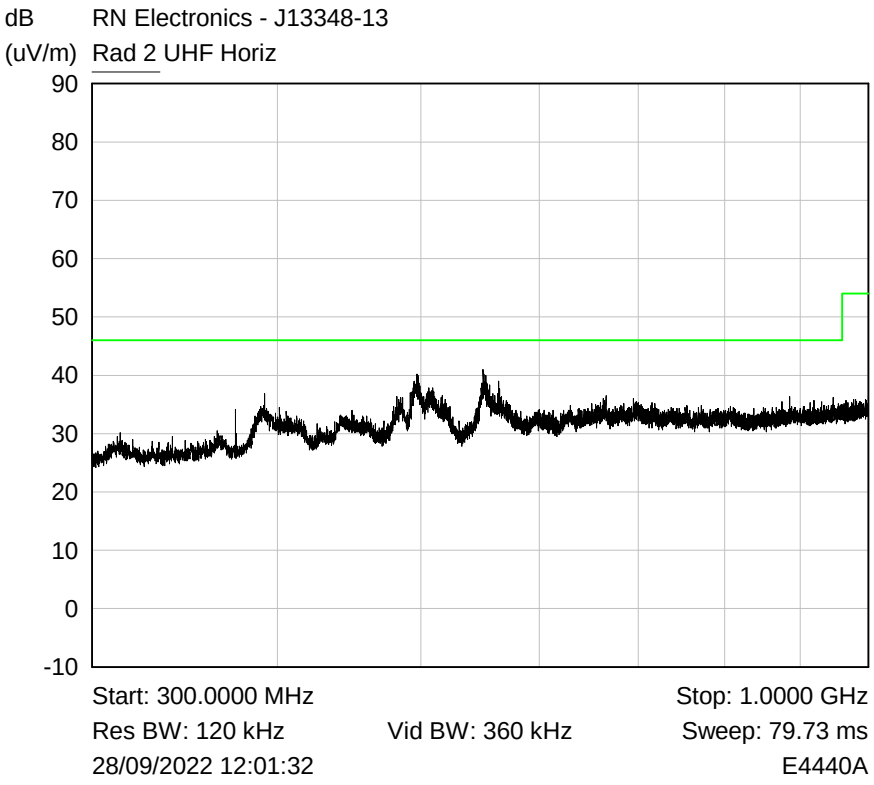
RF Parameters: Band 2400-2483.5 MHz, Power 10 dBm (BT Ant: B), Channel Spacing 2 MHz, Modulation LE1M, Channel 2440 MHz (Mid)



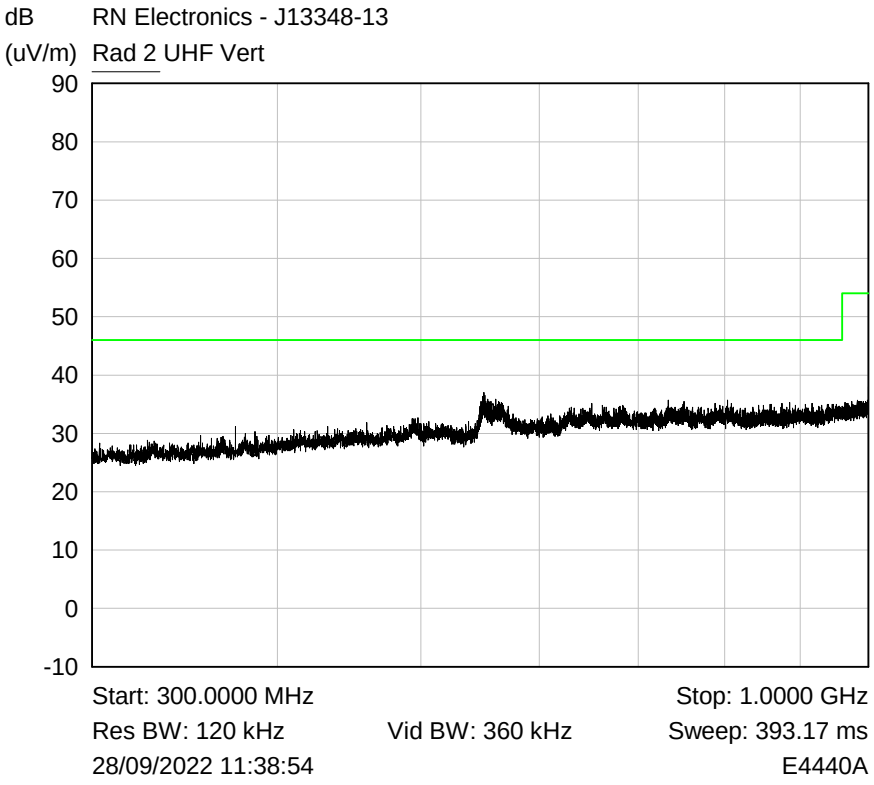
Plot of Peak emissions for VHF Horizontal against the QP limit line.



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

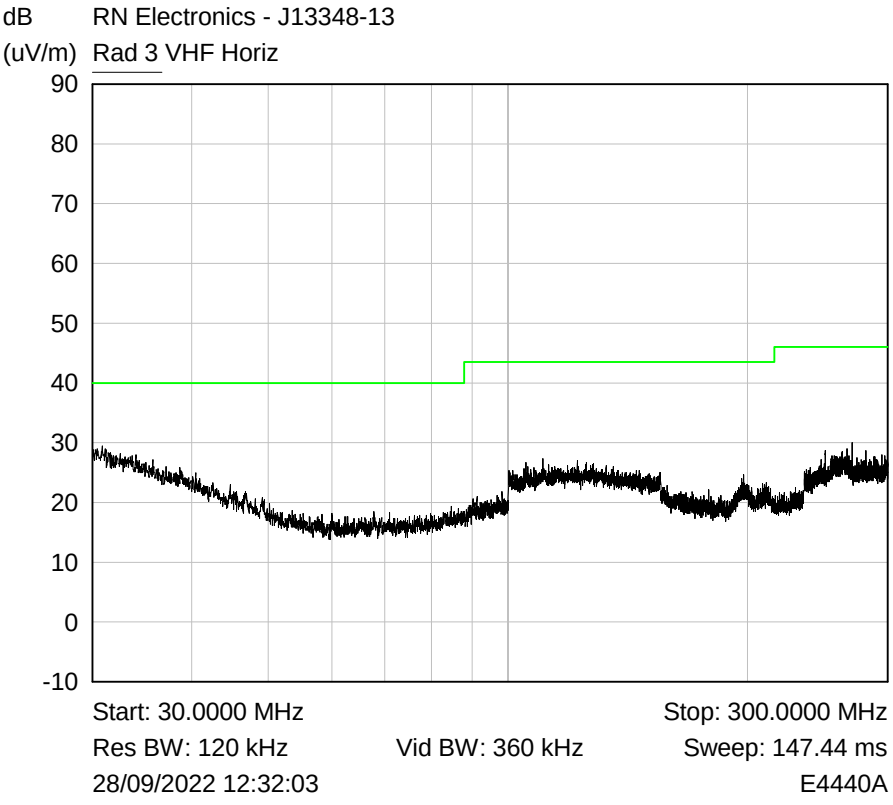


Plot of Peak emissions for UHF Horizontal against the QP limit line.

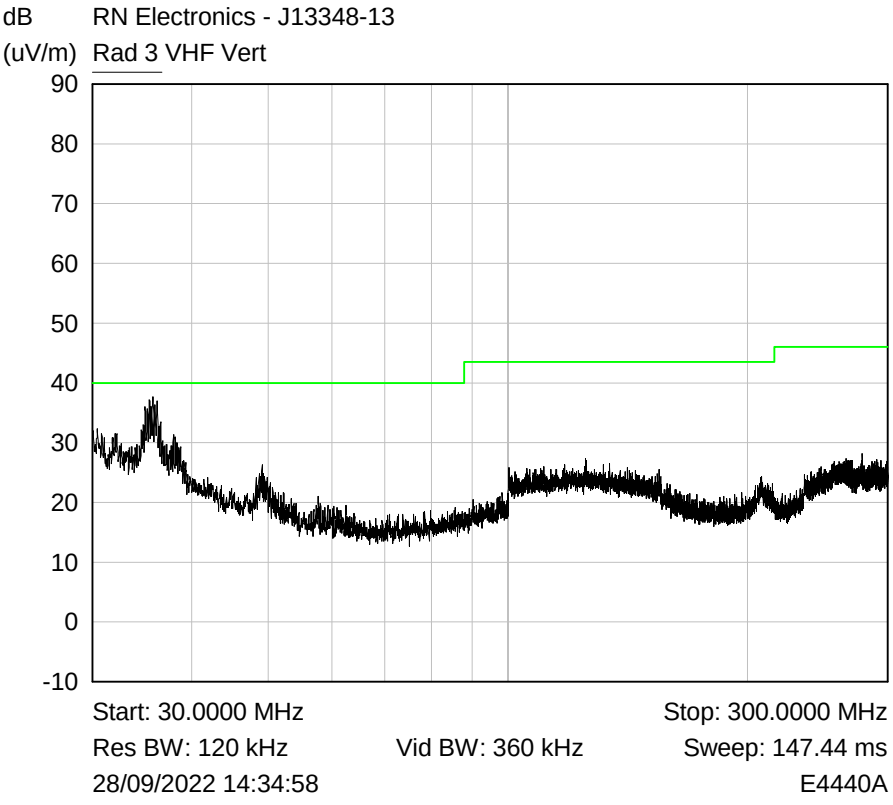


Plot of Peak emissions for UHF Vertical against the QP limit line.

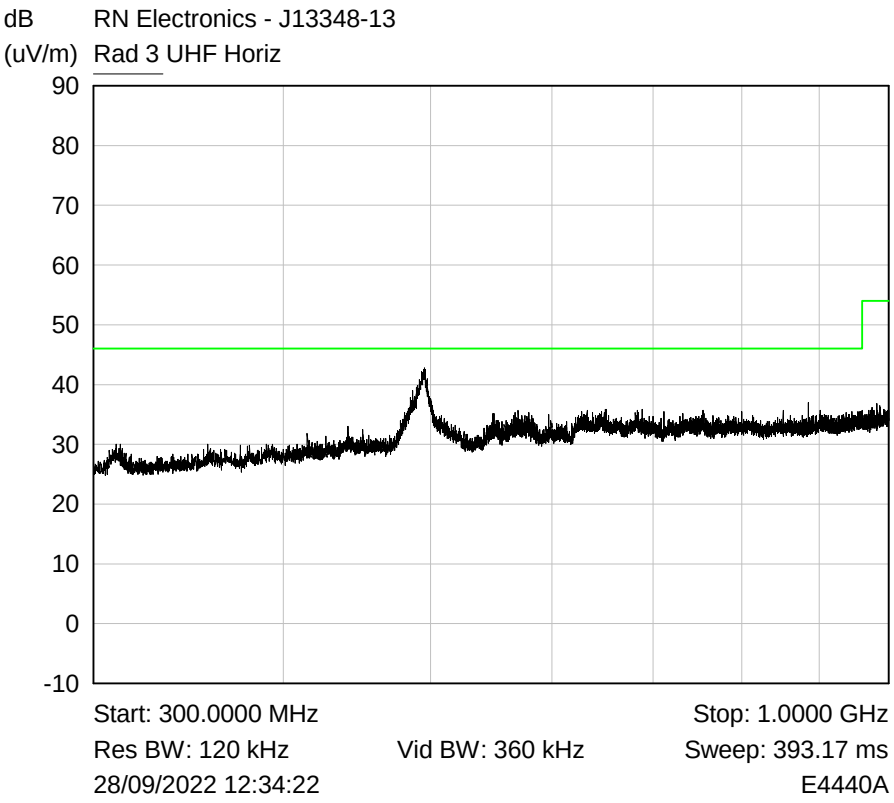
RF Parameters: Band 2400-2483.5 MHz, Power 10 dBm (BT Ant: B), Channel Spacing 2 MHz, Modulation LE1M, Channel 2480 MHz (Mid)



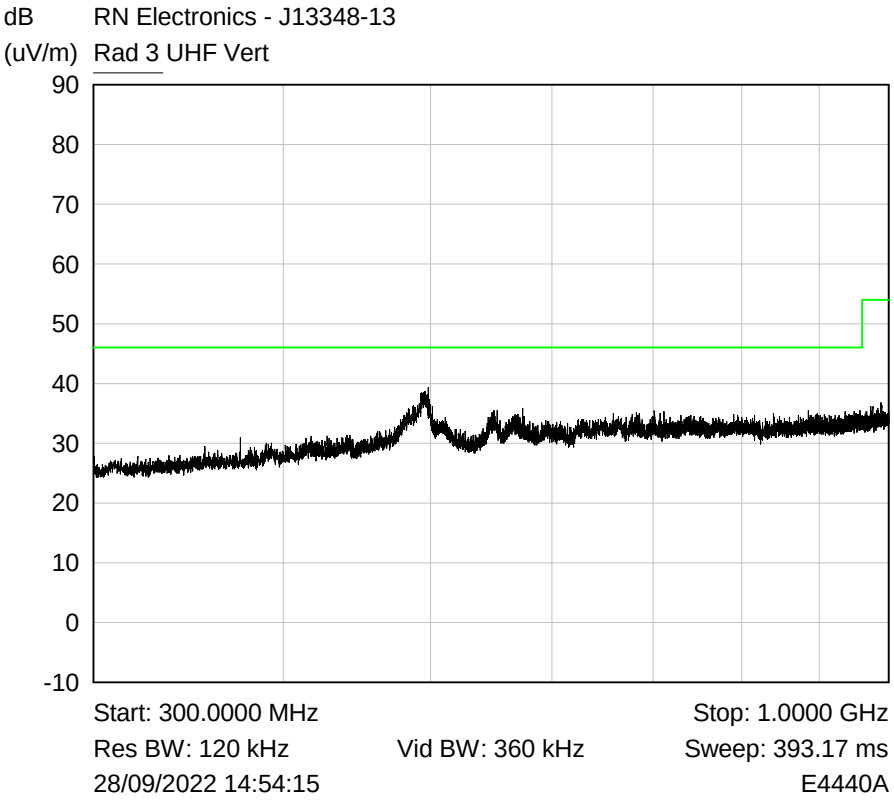
Plot of Peak emissions for VHF Horizontal against the QP limit line.



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



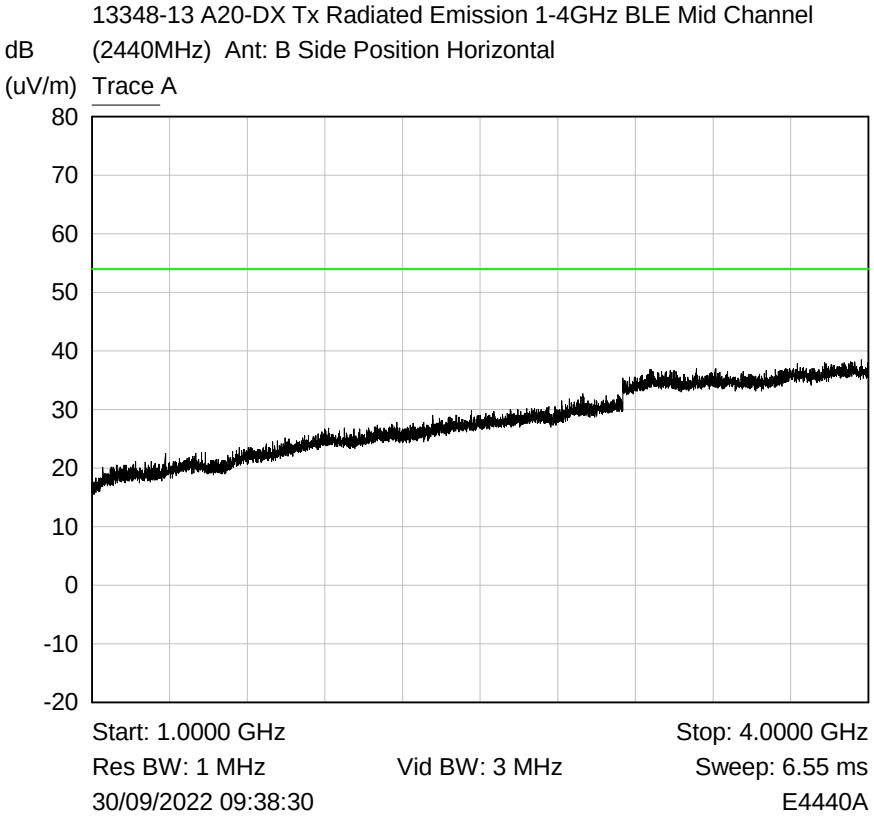
Plot of Peak emissions for UHF Horizontal against the QP limit line.

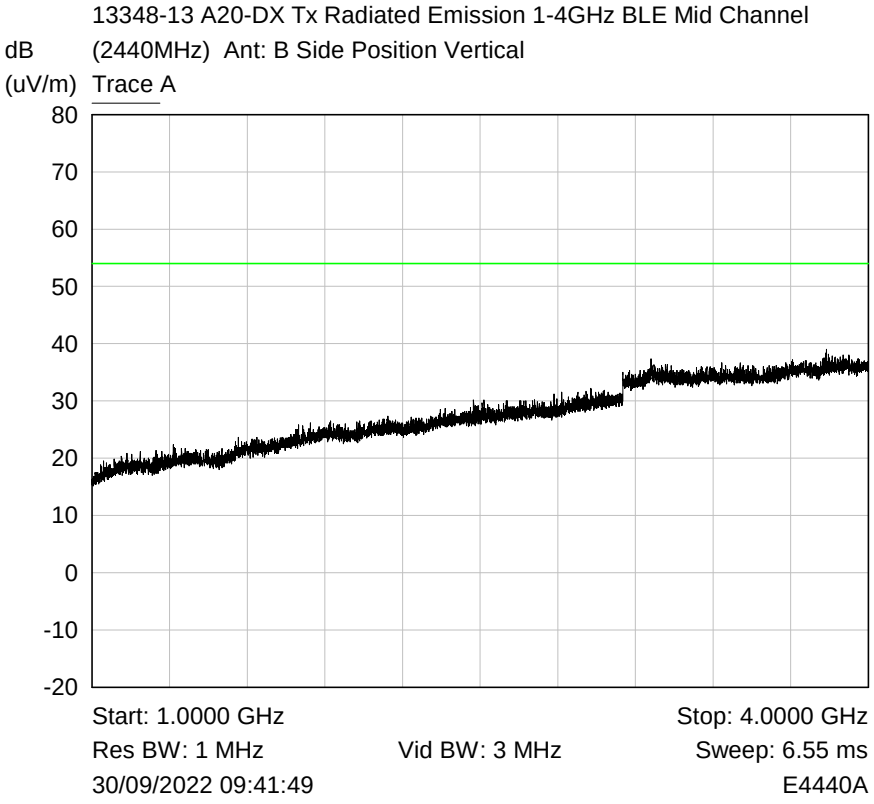


Plot of Peak emissions for UHF Vertical against the QP limit line.

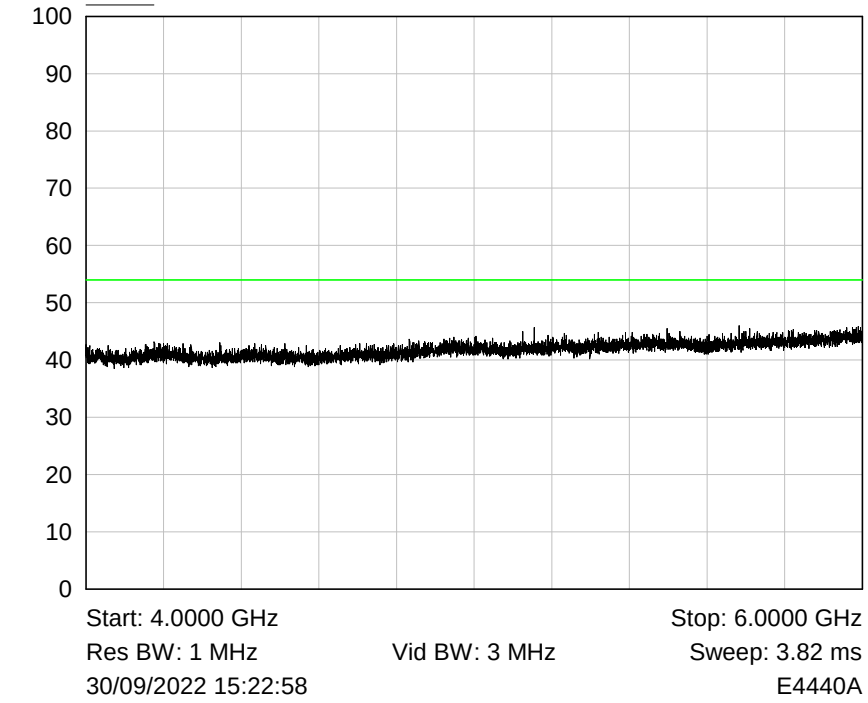
6.5 Radiated emissions above 1 GHz

RF Parameters: Band 2400-2483.5 MHz, Power 10 dBm (BT Ant: B), Channel Spacing 2 MHz, Modulation LE1M, Channel 2440 MHz (Mid)

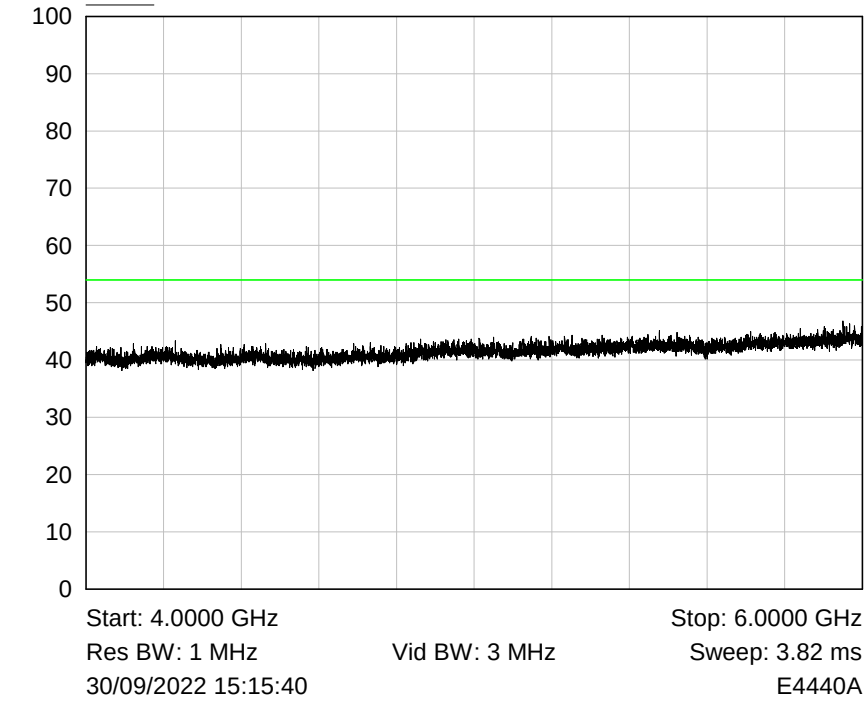




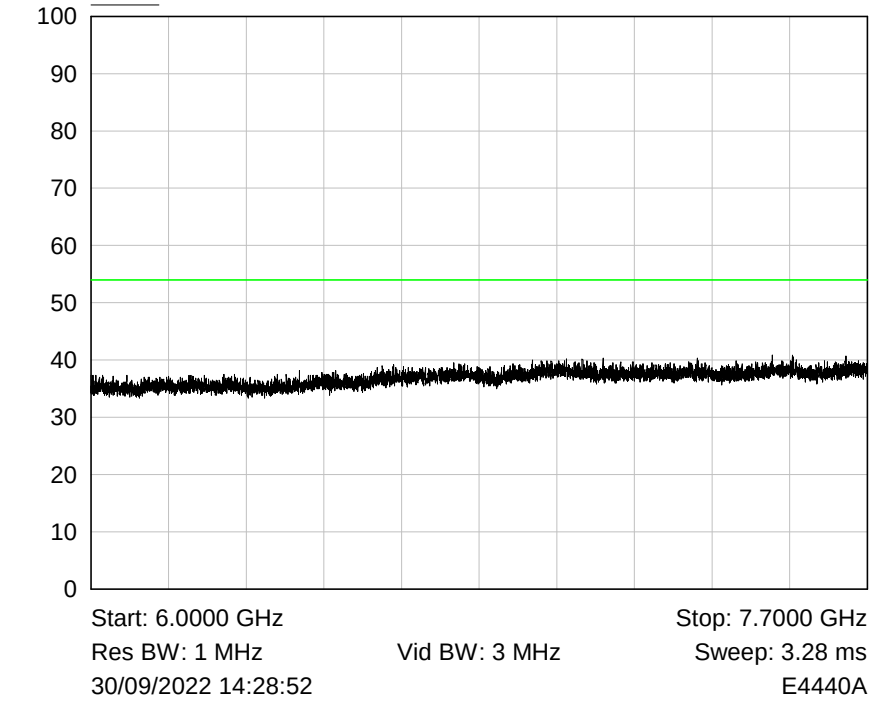
13348-13 A20-DX Tx Radiated Emission 4-6GHz BLE Mid Channel
(2440MHz) Ant: B Side Position Horizontal Peak
Trace A



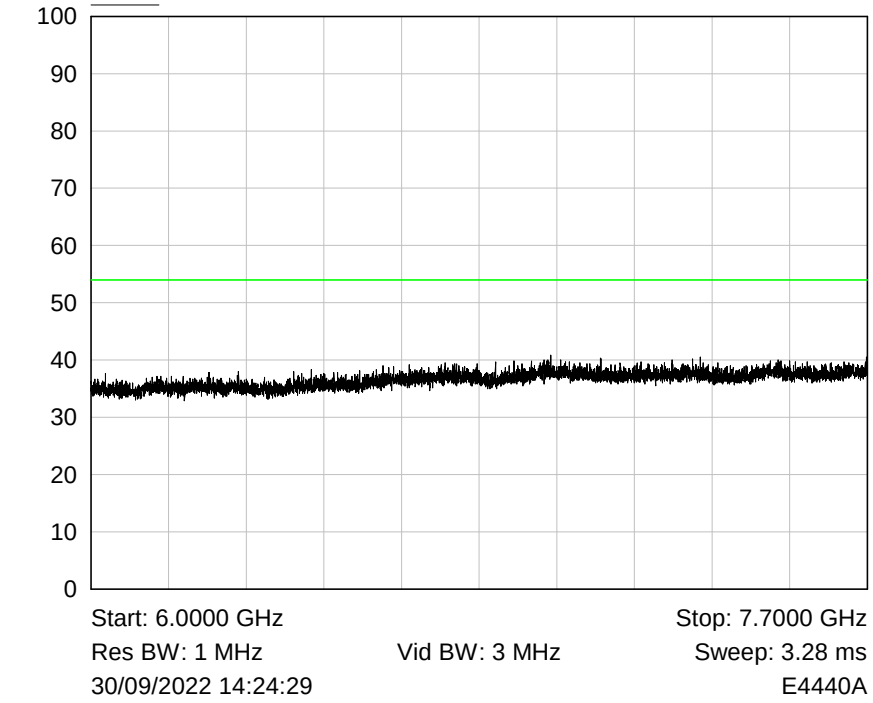
13348-13 A20-DX Tx Radiated Emission 4-6GHz BLE Mid Channel
(2440MHz) Ant: B Side Position Vertical Peak
Trace A



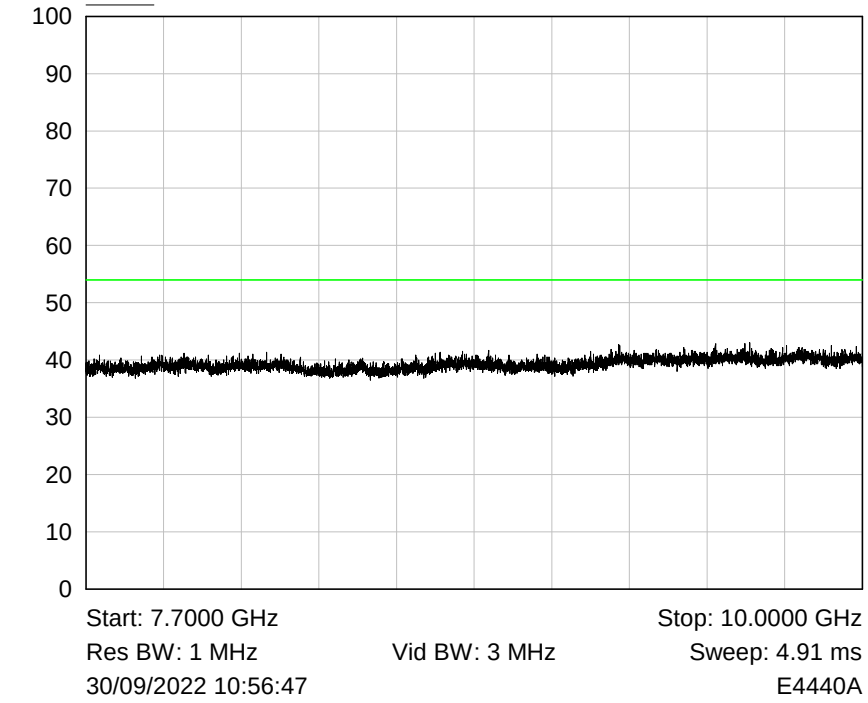
13348-13 A20-DX Tx Radiated Emission 6-7.77GHz BLE Mid Channel
(2440MHz) Ant: B Side Position Horizontal
Trace A



13348-13 A20-DX Tx Radiated Emission 6-7.77GHz BLE Mid Channel
(2440MHz) Ant: B Side Position Vertical
Trace A

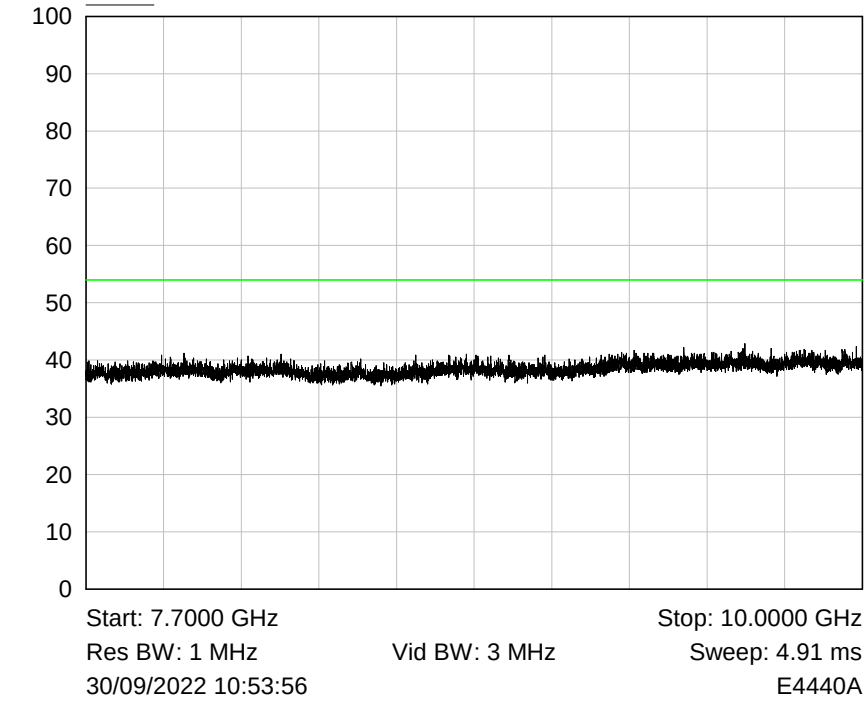


13348-13 A20-DX Tx Radiated Emission 7.77-10GHz BLE Mid Channel
dB (2440MHz) Ant: B Side Position Horizontal
(uV/m) Trace A



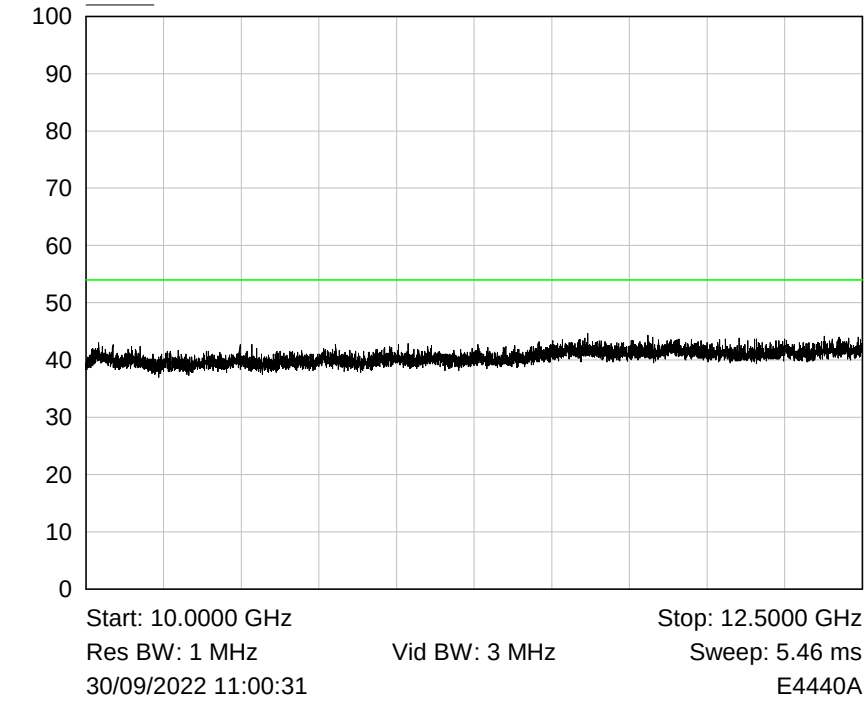
Start: 7.7000 GHz Stop: 10.0000 GHz
Res BW: 1 MHz Vid BW: 3 MHz Sweep: 4.91 ms
30/09/2022 10:56:47 E4440A

13348-13 A20-DX Tx Radiated Emission 7.77-10GHz BLE Mid Channel
dB (2440MHz) Ant: B Side Position Vertical
(uV/m) Trace A



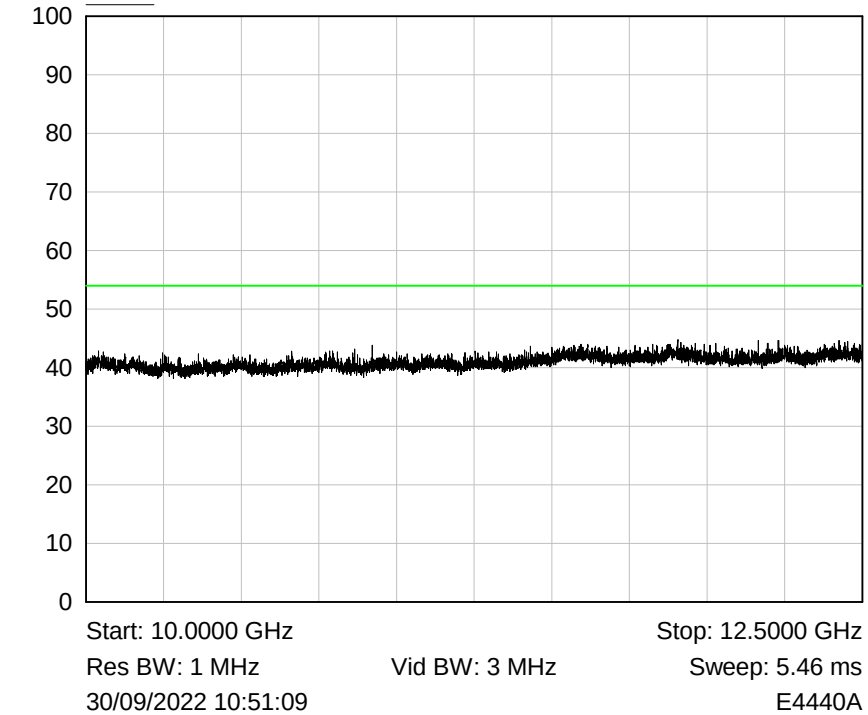
Start: 7.7000 GHz Stop: 10.0000 GHz
Res BW: 1 MHz Vid BW: 3 MHz Sweep: 4.91 ms
30/09/2022 10:53:56 E4440A

13348-13 A20-DX Tx Radiated Emission 10-12.5GHz BLE Mid Channel
dB (2440MHz) Ant: B Side Position Horizontal
(uV/m) Trace A



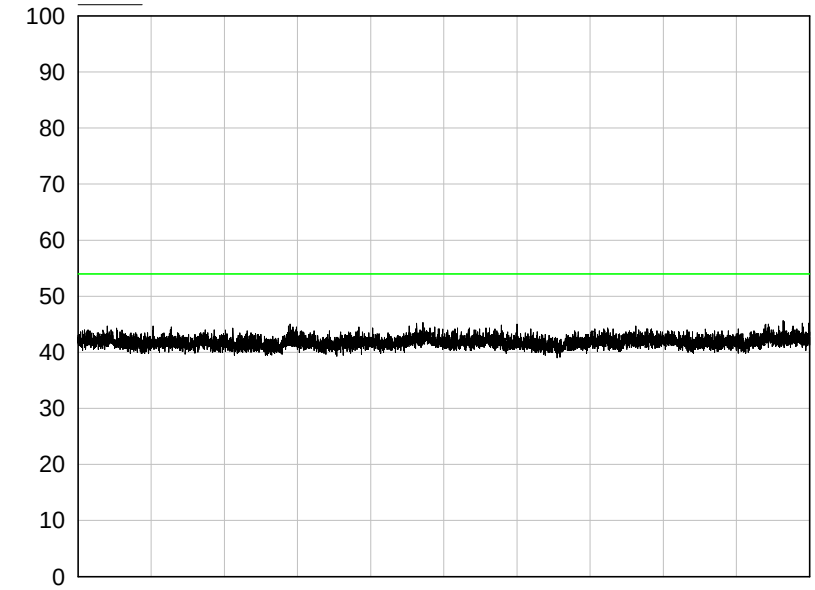
Start: 10.0000 GHz Stop: 12.5000 GHz
Res BW: 1 MHz Vid BW: 3 MHz Sweep: 5.46 ms
30/09/2022 11:00:31 E4440A

13348-13 A20-DX Tx Radiated Emission 10-12.5GHz BLE Mid Channel
dB (2440MHz) Ant: B Side Position Vertical
(uV/m) Trace A



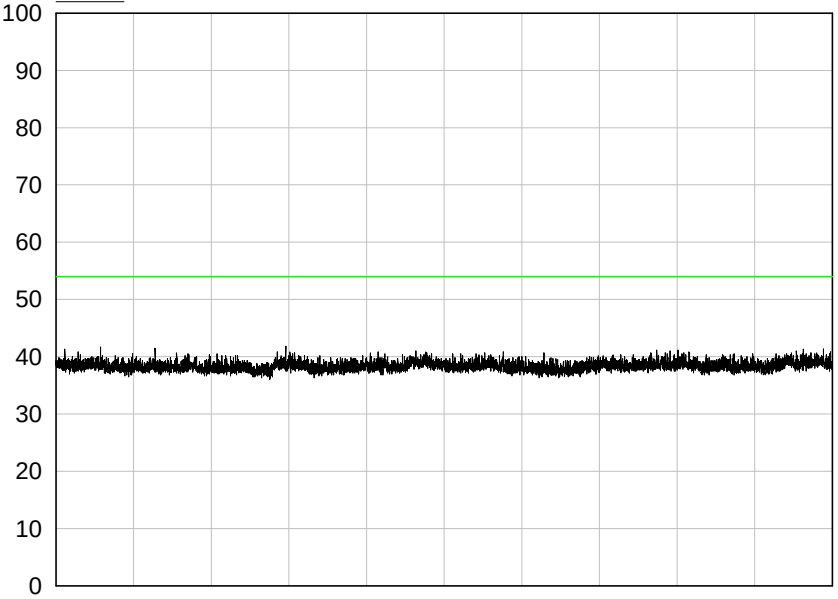
Start: 10.0000 GHz Stop: 12.5000 GHz
Res BW: 1 MHz Vid BW: 3 MHz Sweep: 5.46 ms
30/09/2022 10:51:09 E4440A

13348-13 A20-DX Tx Radiated Emission 12.5-15GHz BLE Mid Channel
dB (2440MHz) Ant: B Side Position Horizontal
(uV/m) Trace A



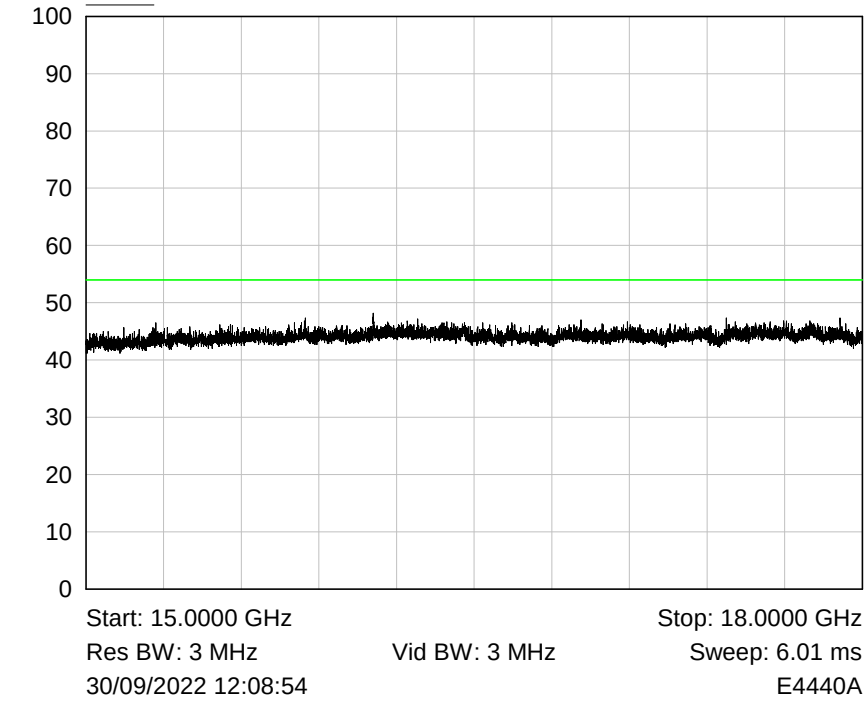
Start: 12.5000 GHz Stop: 15.0000 GHz
Res BW: 3 MHz Vid BW: 3 MHz Sweep: 5.46 ms
30/09/2022 12:11:58 E4440A

13348-13 A20-DX Tx Radiated Emission 12.5-15GHz BLE Mid Channel
dB (2440MHz) Ant: B Side Position Vertical
(uV/m) Trace A

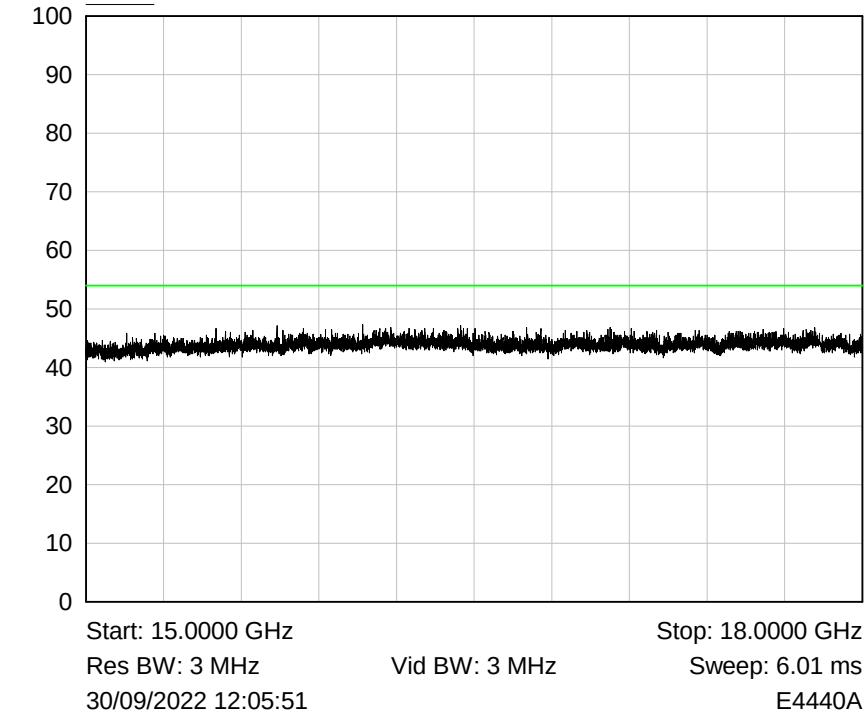


Start: 12.5000 GHz Stop: 15.0000 GHz
Res BW: 1 MHz Vid BW: 3 MHz Sweep: 5.46 ms
30/09/2022 12:02:48 E4440A

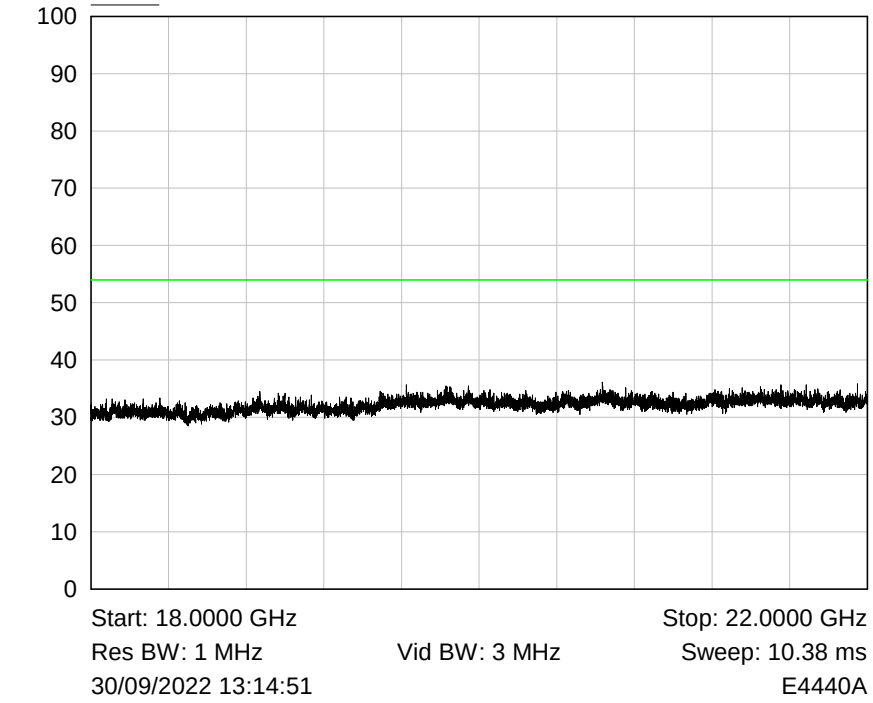
13348-13 A20-DX Tx Radiated Emission 15-18GHz BLE Mid Channel
dB (2440MHz) Ant: B Side Position Horizontal
(uV/m) Trace A



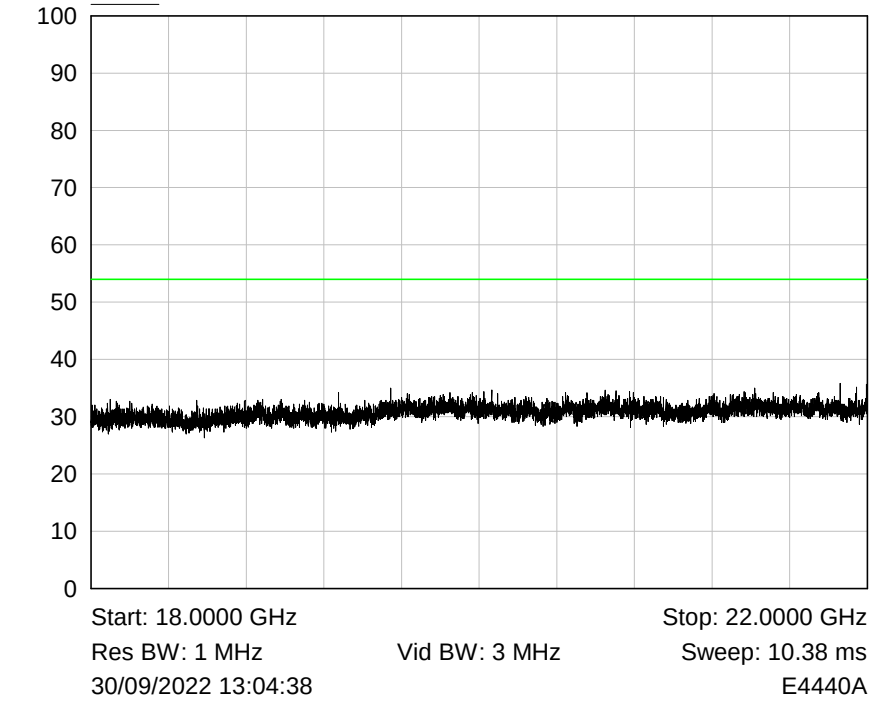
13348-13 A20-DX Tx Radiated Emission 15-18GHz BLE Mid Channel
dB (2440MHz) Ant: B Side Position Vertical
(uV/m) Trace A



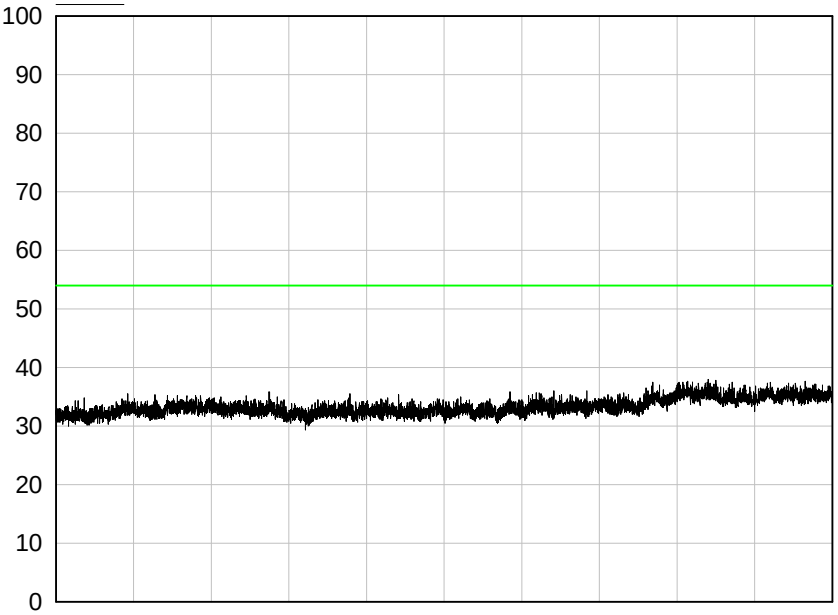
13348-13 A20-DX Tx Radiated Emission 18-22GHz BLE Mid Channel
(2440MHz) Ant: B Side Position Horizontal
Trace A



13348-13 A20-DX Tx Radiated Emission 18-22GHz BLE Mid Channel
(2440MHz) Ant: B Side Position Vertical
Trace A

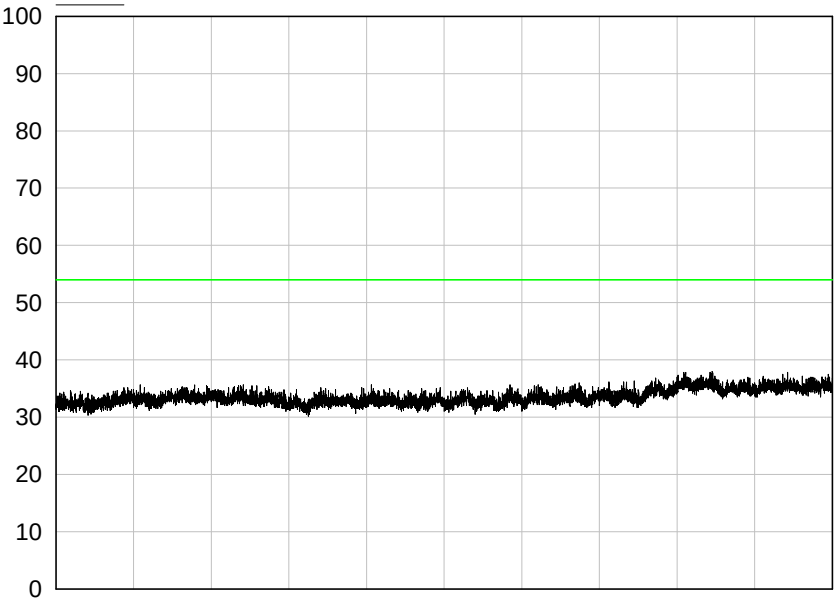


13348-13 A20-DX Tx Radiated Emission 22-25GHz BLE Mid Channel
dB (2440MHz) Ant: B Side Position Horizontal
(uV/m) Trace A



Start: 22.0000 GHz Stop: 25.0000 GHz
Res BW: 1 MHz Vid BW: 3 MHz Sweep: 7.64 ms
30/09/2022 13:10:47 E4440A

13348-13 A20-DX Tx Radiated Emission 22-25GHz BLE Mid Channel
dB (2440MHz) Ant: B Side Position Vertical
(uV/m) Trace A

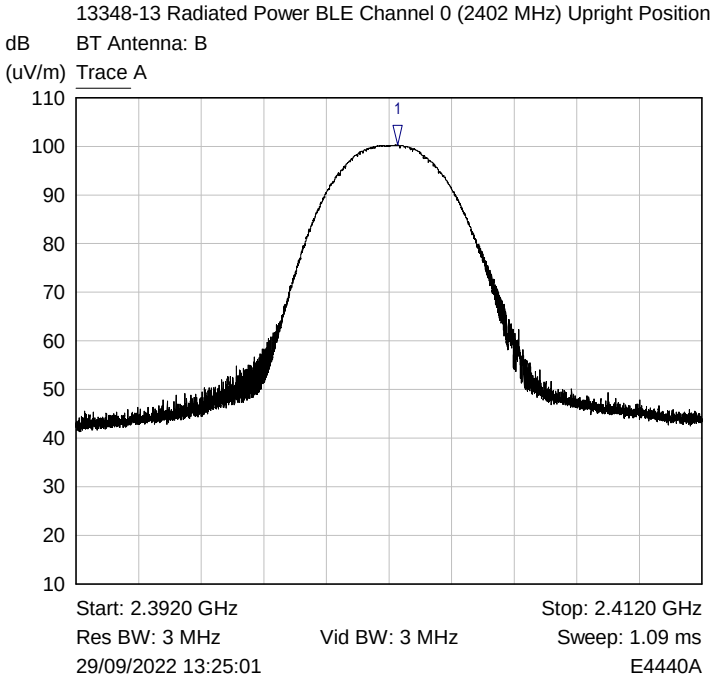


Start: 22.0000 GHz Stop: 25.0000 GHz
Res BW: 1 MHz Vid BW: 3 MHz Sweep: 7.64 ms
30/09/2022 13:07:27 E4440A

6.6 Effective radiated power field strength

Note: Only worst case (highest field strength) Antenna B plots are shown.

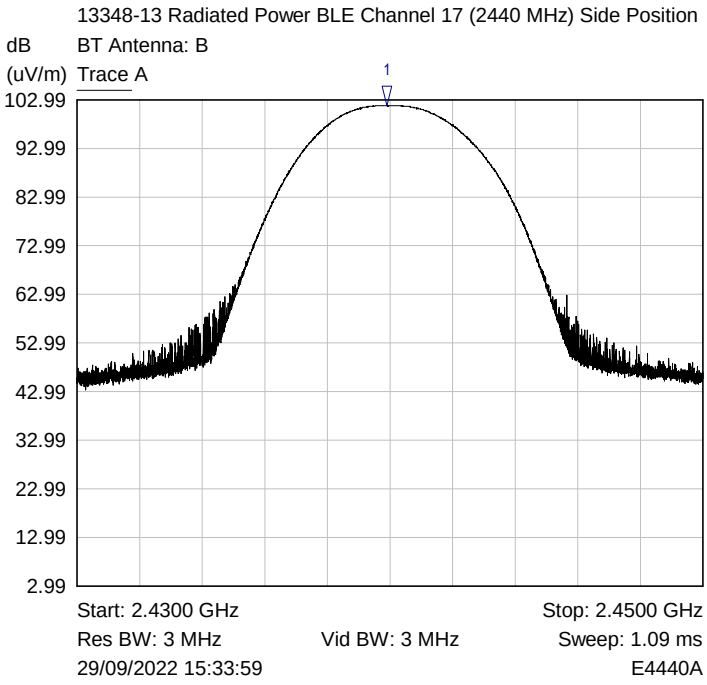
RF Parameters: Band 2400-2483.5 MHz, Power 10 dBm (BT Ant: B), Channel Spacing 2 MHz, Modulation LE1M, Channel 2402 MHz (Low)



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4023 GHz	100.26 dB(uV/m)	

Plot ref of Vert polarisation and EUT in Upright position

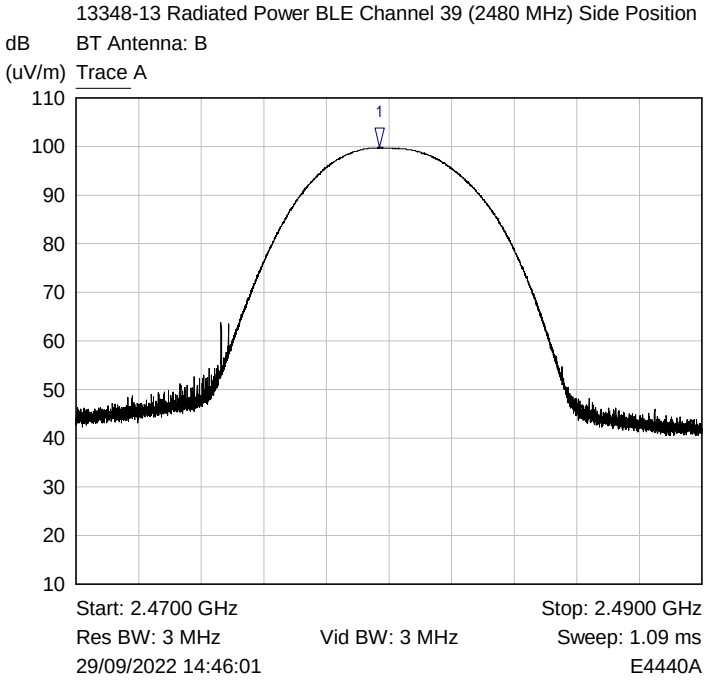
RF Parameters: Band 2400-2483.5 MHz, Power 10 dBm (BT Ant: B), Channel Spacing 2 MHz, Modulation LE1M, Channel 2440 MHz (Mid)



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4399 GHz	101.84 dB(uV/m)	

Plot ref of Vert polarisation and EUT in Upright position

RF Parameters: Band 2400-2483.5 MHz, Power 10 dBm (BT Ant: B), Channel Spacing 2 MHz, Modulation LE1M, Channel 2480 MHz (High)



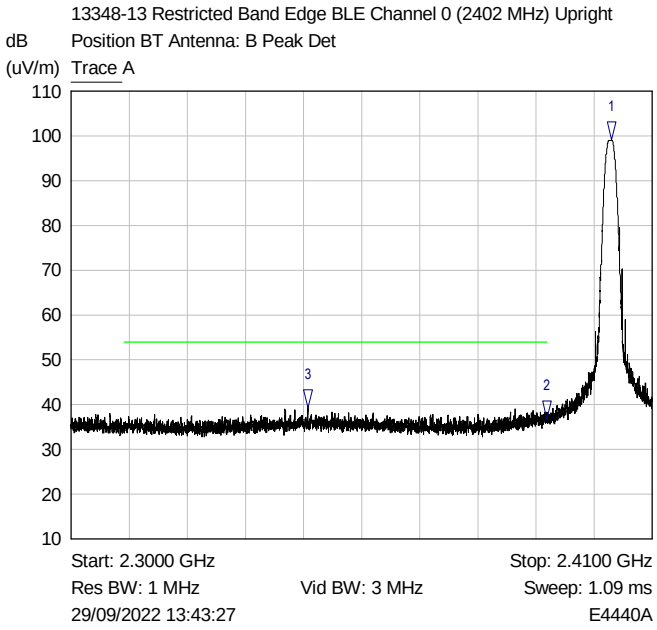
Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4797 GHz	99.77 dB(uV/m)	

Plot ref of Vert polarisation and EUT in Upright position

6.7 Band Edge Compliance

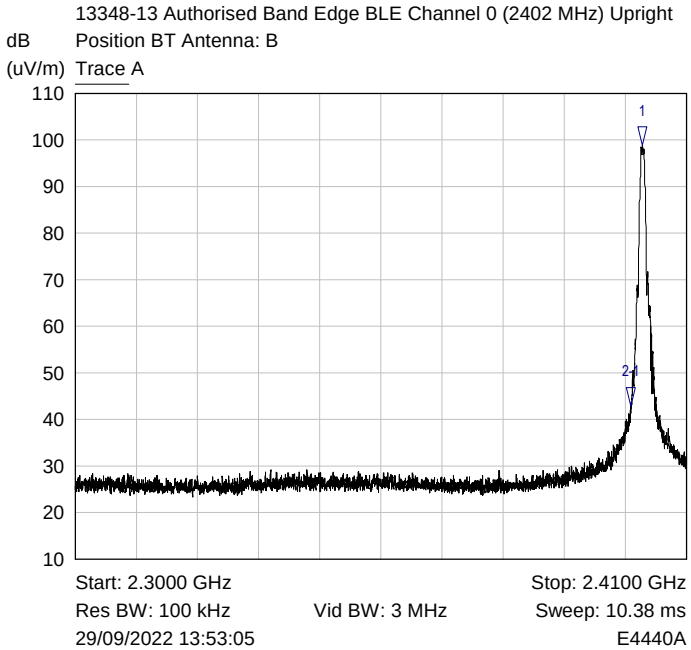
Note: Only worst case (highest field strength) Antenna B plots are shown.

RF Parameters: Band 2400-2483.5 MHz, Power 10 dBm (BT Ant: B), Channel Spacing 2 MHz, Modulation LE1M, Channel 2402 MHz (CH0)



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4023 GHz	99.10 dB(uV/m)	
2 ▽	Trace A	2.3900 GHz	36.77 dB(uV/m)	
3 ▽	Trace A	2.3448 GHz	39.26 dB(uV/m)	

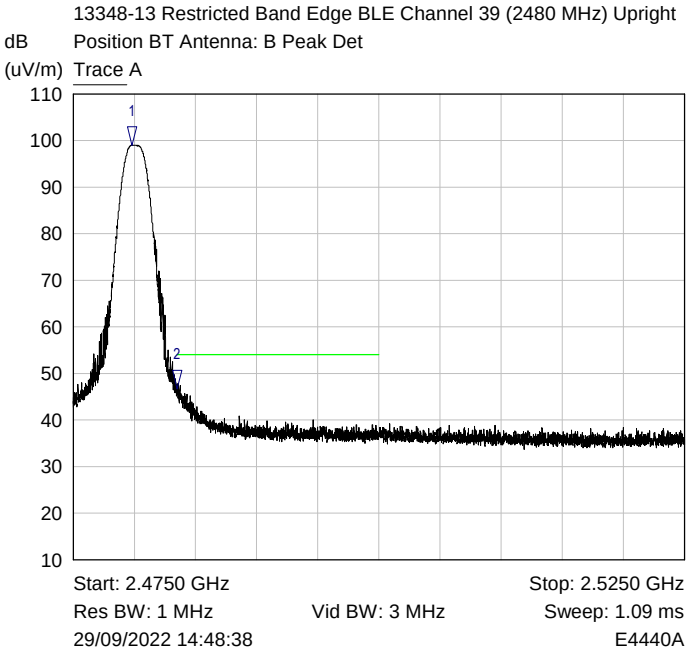
Restricted band edge Peak Plot



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4021 GHz	98.89 dB(uV/m)	
2-1 ▽	Trace A	2.4000 GHz	-56.00 dB	

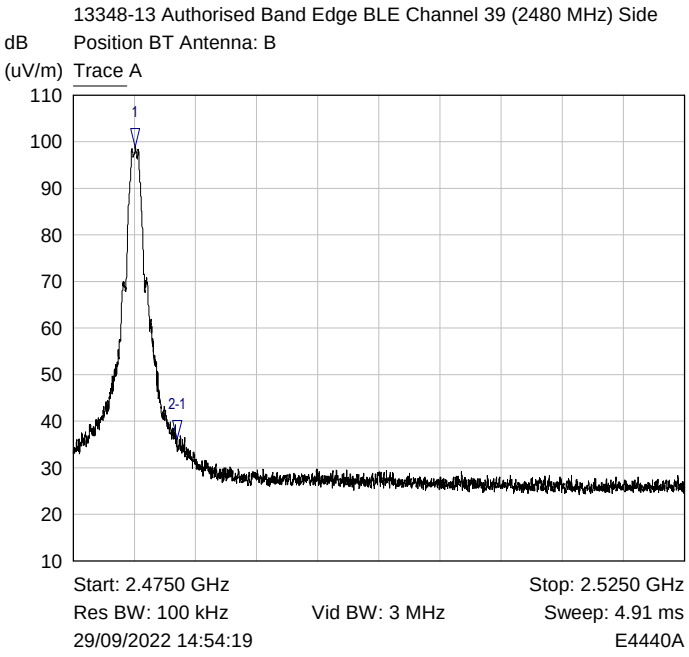
Authorised Band Edge Plot

RF Parameters: Band 2400-2483.5 MHz, Power 10 dBm (BT Ant: B), Channel Spacing 2 MHz, Modulation LE1M, Channel 2480 MHz (CH39)



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4798 GHz	99.06 dB(uV/m)	
2 ▽	Trace A	2.4835 GHz	46.60 dB(uV/m)	

Restricted band edge Peak Plot

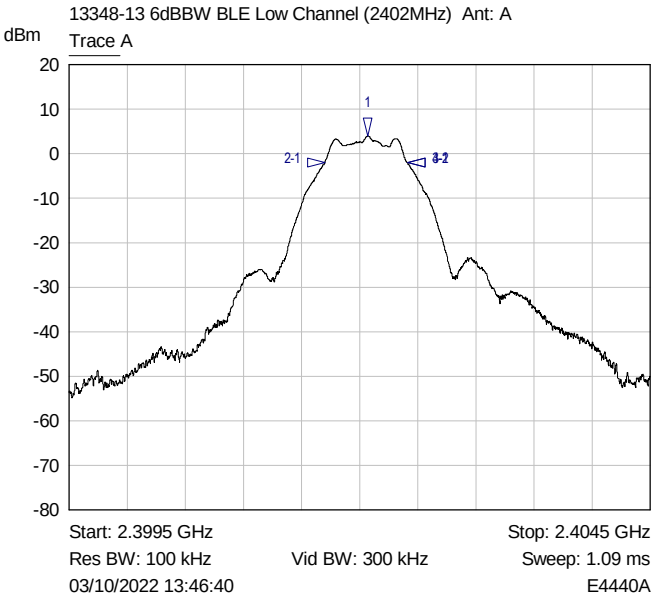


Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4801 GHz	98.88 dB(uV/m)	
2-1 ▽	Trace A	2.4835 GHz	-62.66 dB	

Authorised Band Edge Plot

6.8 Occupied bandwidth

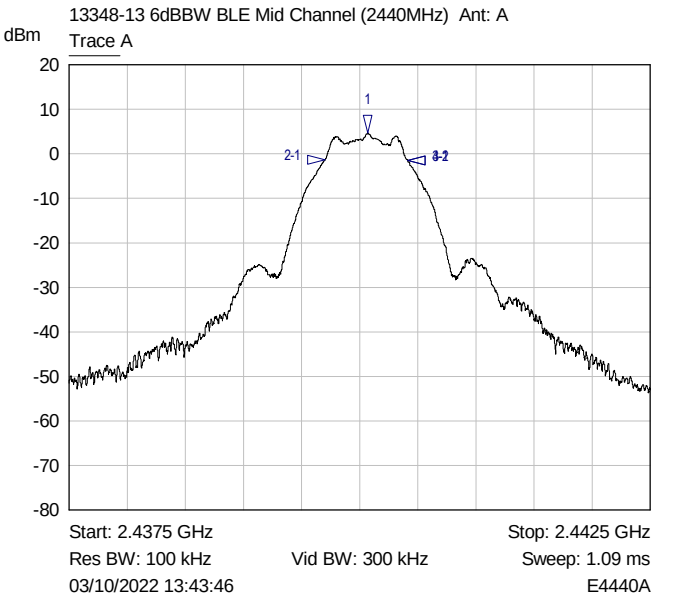
RF Parameters: Band 2400-2483.5 MHz, Power 10 dBm (BT Ant: A), Channel Spacing 2 MHz, Modulation LE1M, Channel 2402 MHz (Low)



Mkr	Trace	X-Axis	Value	Notes
1	Trace A	2.4021 GHz	3.99 dBm	
2-1	Trace A	2.4017 GHz	-5.99 dB	
3-1	Trace A	2.4024 GHz	-6.01 dB	
4-2	Trace A	709.9255 kHz	-2.02 dBm	

Plot for 6 dB Bandwidth Result (MHz)

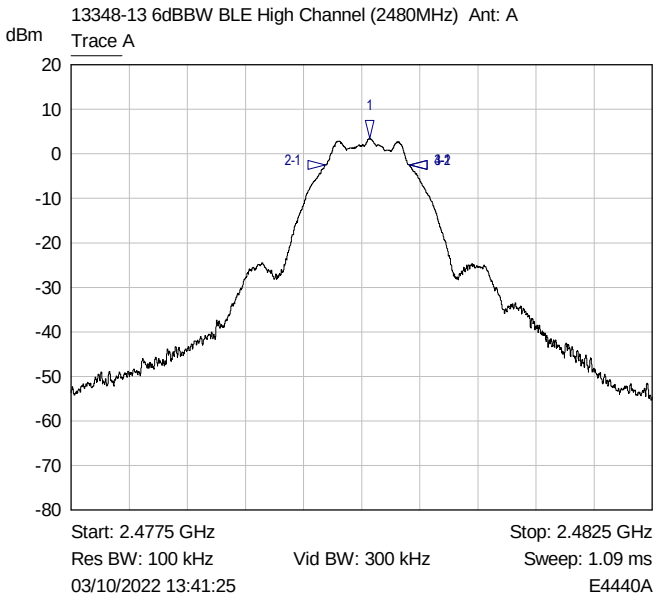
RF Parameters: Band 2400-2483.5 MHz, Power 10 dBm (BT Ant: A), Channel Spacing 2 MHz, Modulation LE1M, Channel 2440 MHz (Mid)



Mkr	Trace	X-Axis	Value	Notes
1	Trace A	2.4401 GHz	4.59 dBm	
2-1	Trace A	2.4397 GHz	-6.00 dB	
3-1	Trace A	2.4404 GHz	-6.01 dB	
4-2	Trace A	711.7568 kHz	-1.42 dBm	

Plot for 6 dB Bandwidth Result (MHz)

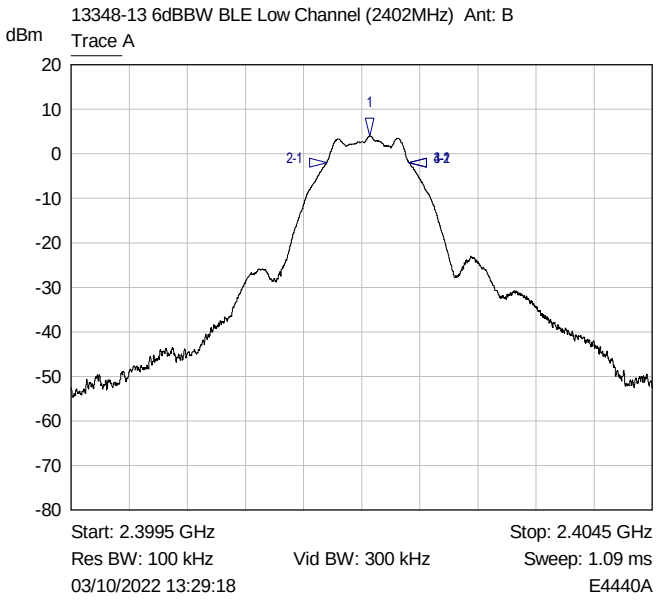
RF Parameters: Band 2400-2483.5 MHz, Power 10 dBm (BT Ant: A), Channel Spacing 2 MHz, Modulation LE1M, Channel 2480 MHz (High)



Mkr	Trace	X-Axis	Value	Notes
1	Trace A	2.4801 GHz	3.44 dBm	
2-1	Trace A	2.4797 GHz	-5.99 dB	
3-1	Trace A	2.4804 GHz	-5.99 dB	
4-2	Trace A	727.0175 kHz	-2.55 dBm	

Plot for 6 dB Bandwidth Result (MHz)

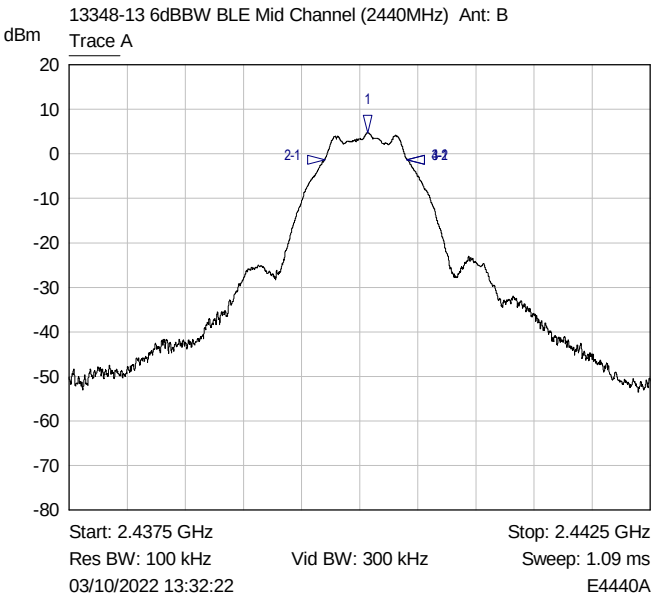
RF Parameters: Band 2400-2483.5 MHz, Power 10 dBm (BT Ant: B), Channel Spacing 2 MHz, Modulation LE1M, Channel 2402 MHz (Low)



Mkr	Trace	X-Axis	Value	Notes
1	Trace A	2.4021 GHz	4.04 dBm	
2-1	Trace A	2.4017 GHz	-6.01 dB	
3-1	Trace A	2.4024 GHz	-5.99 dB	
4-2	Trace A	709.9255 kHz	-1.95 dBm	

Plot for 6 dB Bandwidth Result (MHz)

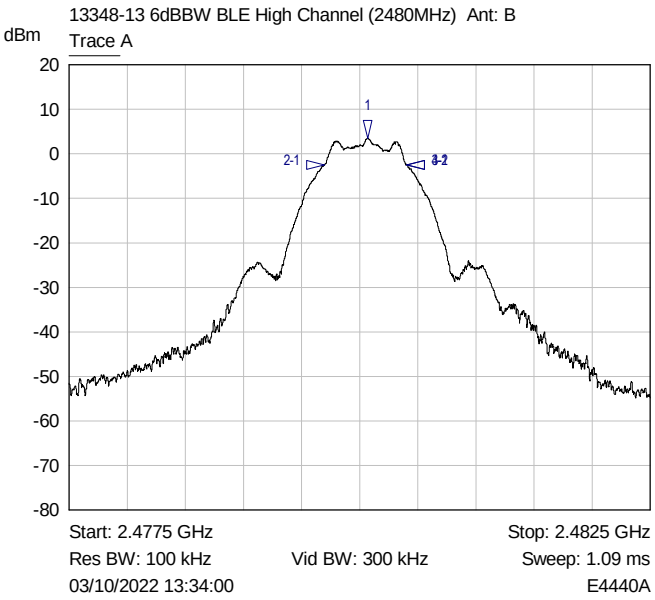
RF Parameters: Band 2400-2483.5 MHz, Power 10 dBm (BT Ant: B), Channel Spacing 2 MHz, Modulation LE1M, Channel 2440 MHz (Mid)



Mkr	Trace	X-Axis	Value	Notes
1	Trace A	2.4401 GHz	4.72 dBm	
2-1	Trace A	2.4397 GHz	-5.98 dB	
3-1	Trace A	2.4404 GHz	-5.99 dB	
4-2	Trace A	706.8734 kHz	-1.27 dBm	

Plot for 6 dB Bandwidth Result (MHz)

RF Parameters: Band 2400-2483.5 MHz, Power 10 dBm (BT Ant: B), Channel Spacing 2 MHz, Modulation LE1M, Channel 2480 MHz (High)

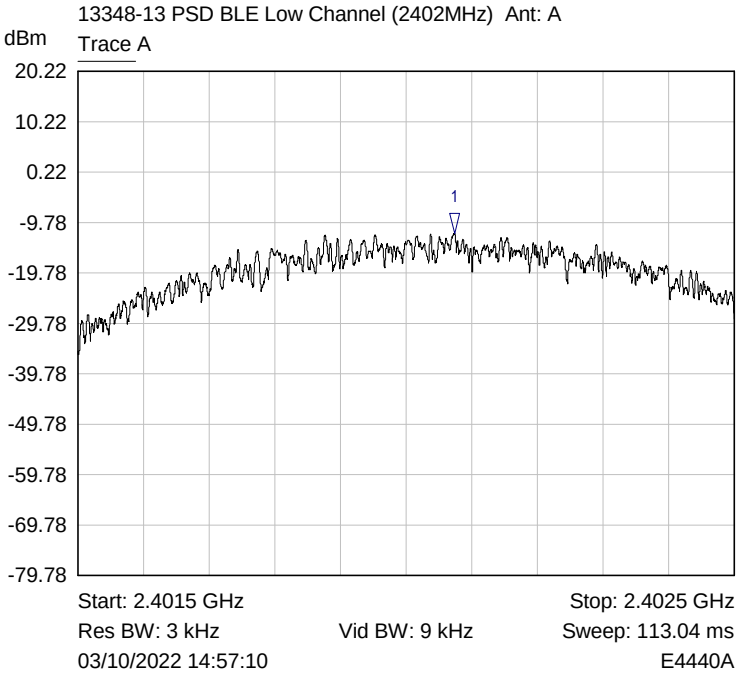


Mkr	Trace	X-Axis	Value	Notes
1	Trace A	2.4801 GHz	3.46 dBm	
2-1	Trace A	2.4797 GHz	-6.00 dB	
3-1	Trace A	2.4804 GHz	-6.02 dB	
4-2	Trace A	714.1985 kHz	-2.57 dBm	

Plot for 6 dB Bandwidth Result (MHz)

6.9 Maximum Power Spectral Density

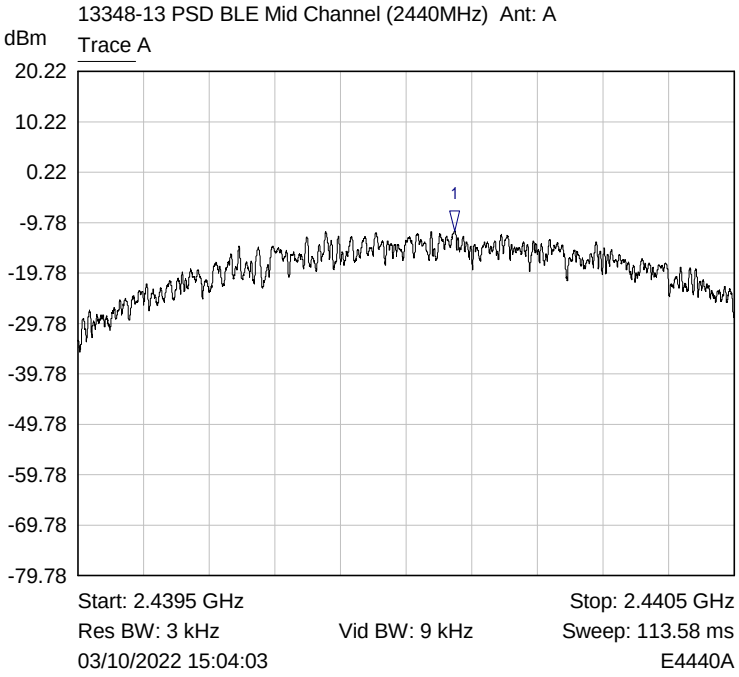
RF Parameters: Band 2400-2483.5 MHz, Power 10 dBm (BT Ant: A), Channel Spacing 2 MHz, Modulation LE1M, Channel 2402 MHz (Low)



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4021 GHz	-11.90 dBm	

Plot for AVGPSD-1 Result

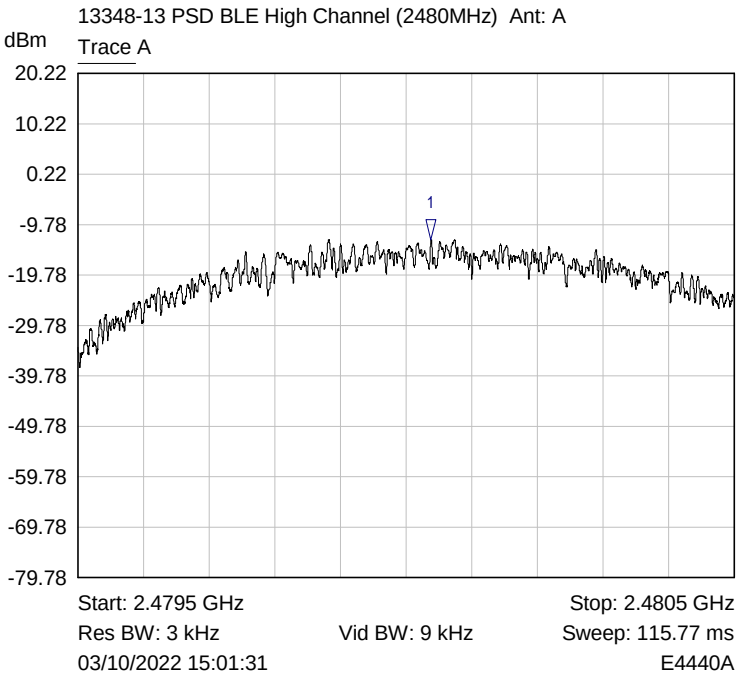
RF Parameters: Band 2400-2483.5 MHz, Power 10 dBm (BT Ant: A), Channel Spacing 2 MHz, Modulation LE1M, Channel 2440 MHz (Mid)



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4401 GHz	-11.40 dBm	

Plot for AVGPSD-1 Result

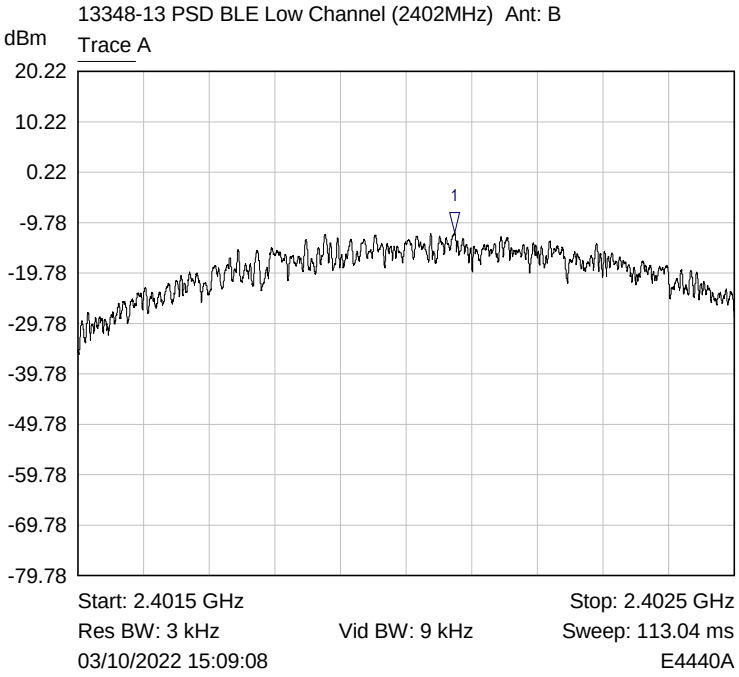
RF Parameters: Band 2400-2483.5 MHz, Power 10 dBm (BT Ant: A), Channel Spacing 2 MHz, Modulation LE1M, Channel 2480 MHz (High)



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4800 GHz	-12.73 dBm	

Plot for AVGPSD-1 Result

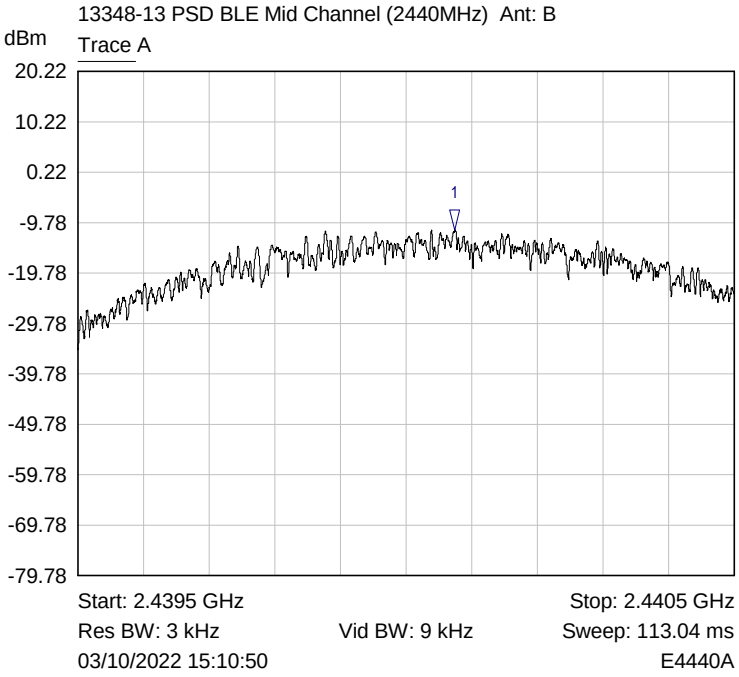
RF Parameters: Band 2400-2483.5 MHz, Power 10 dBm (BT Ant: B), Channel Spacing 2 MHz, Modulation LE1M, Channel 2402 MHz (Low)



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4021 GHz	-11.82 dBm	

Plot for AVGPSD-1 Result

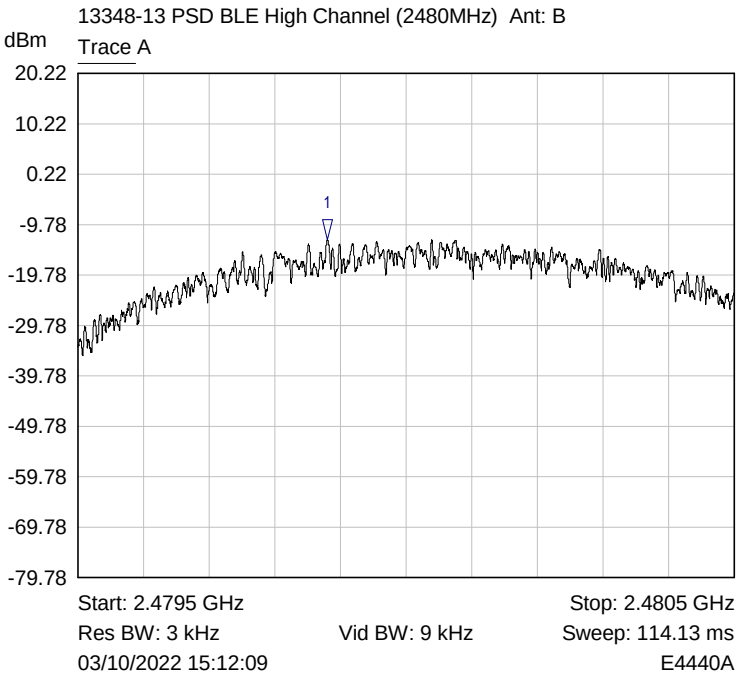
RF Parameters: Band 2400-2483.5 MHz, Power 10 dBm (BT Ant: B), Channel Spacing 2 MHz, Modulation LE1M, Channel 2440 MHz (Mid)



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4401 GHz	-11.24 dBm	

Plot for AVGPSD-1 Result

RF Parameters: Band 2400-2483.5 MHz, Power 10 dBm (BT Ant: B), Channel Spacing 2 MHz, Modulation LE1M, Channel 2480 MHz (High)

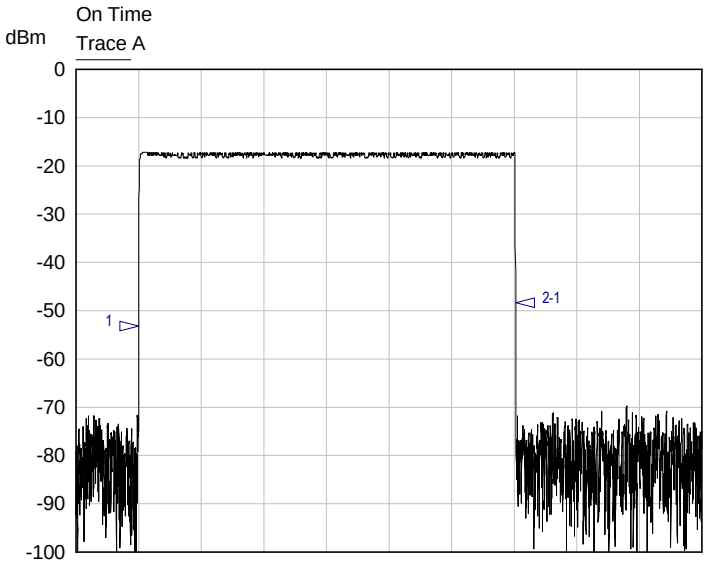


Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4799 GHz	-12.71 dBm	

Plot for AVGPSD-1 Result

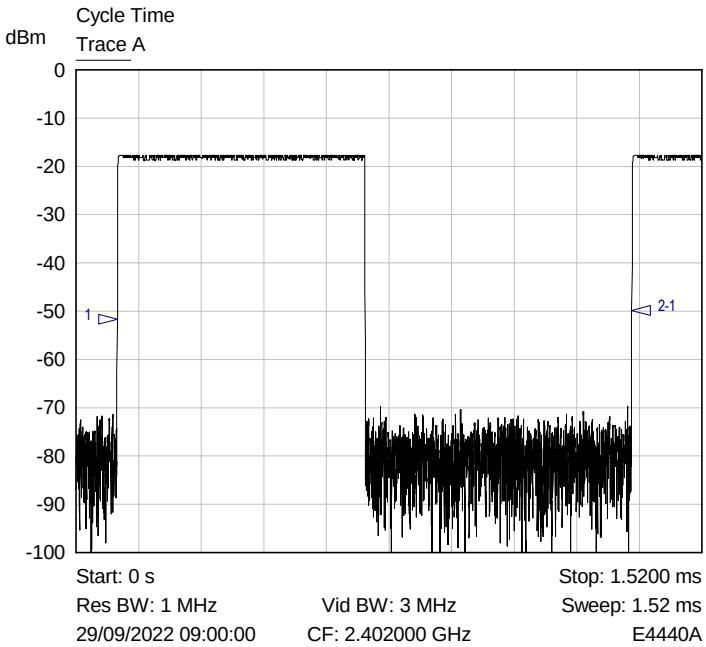
6.10 Duty cycle

RF Parameters: Band 2400-2483.5 MHz, Power 10 dBm, Channel Spacing 2 MHz, Modulation LE1M



Mkr	Trace	X-Axis	Value	Notes
1	Trace A	99.8657 us	-53.17 dBm	
2-1	Trace A	602.2464 us	-48.31 dBm	

TX on time (ms)

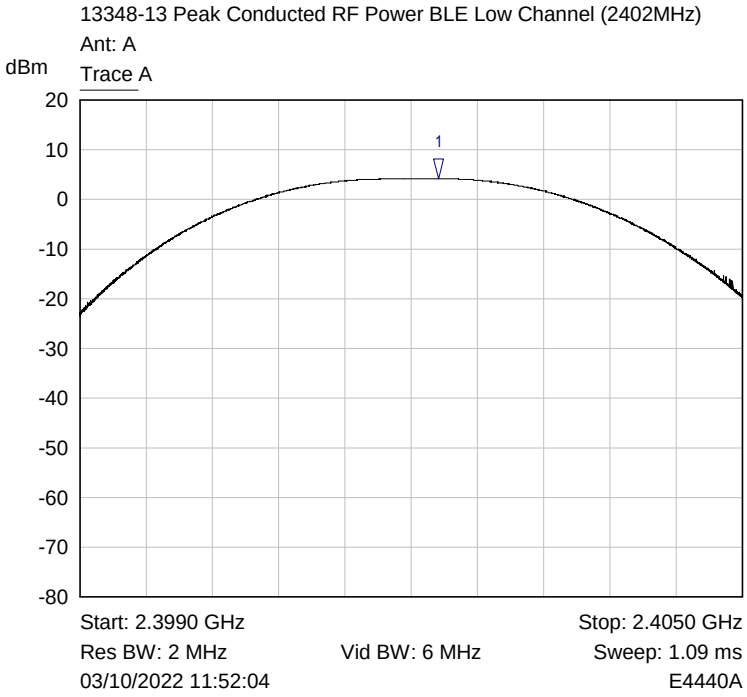


Mkr	Trace	X-Axis	Value	Notes
1	Trace A	99.8364 us	-51.61 dBm	
2-1	Trace A	1.2500 ms	-49.86 dBm	

TX repetition time (S)

6.11 Peak Conducted Power

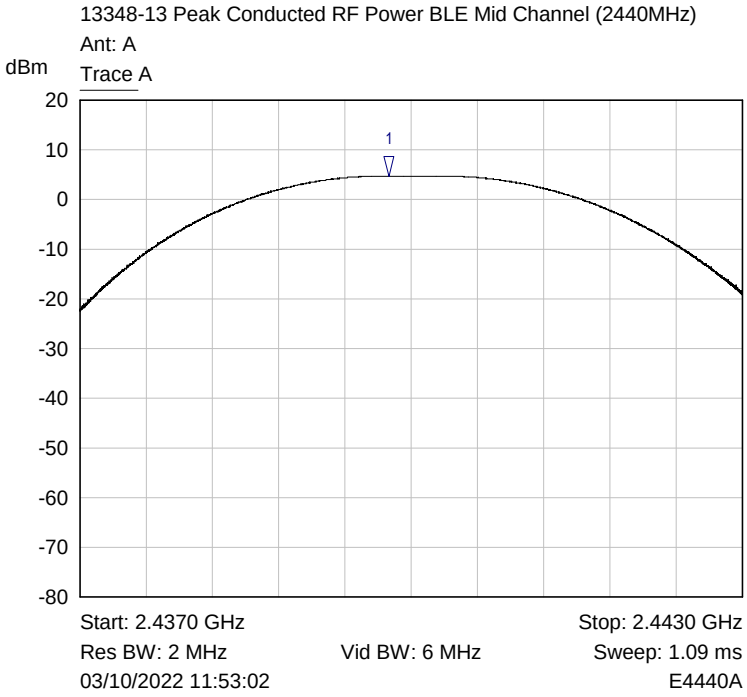
RF Parameters: Band 2400-2483.5 MHz, Power 10 dBm (BT Ant: A), Channel Spacing 2 MHz, Modulation LE1M, Channel 2402 MHz (Low)



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4022 GHz	4.17 dBm	

Plot for Peak conducted power

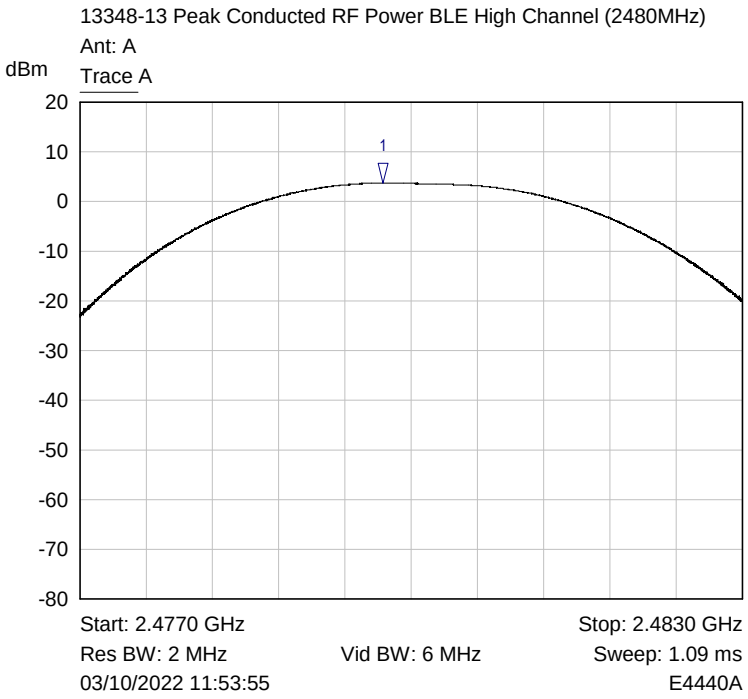
RF Parameters: Band 2400-2483.5 MHz, Power 10 dBm (BT Ant: A), Channel Spacing 2 MHz, Modulation LE1M, Channel 2440 MHz (Mid)



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4398 GHz	4.73 dBm	

Plot for Peak conducted power

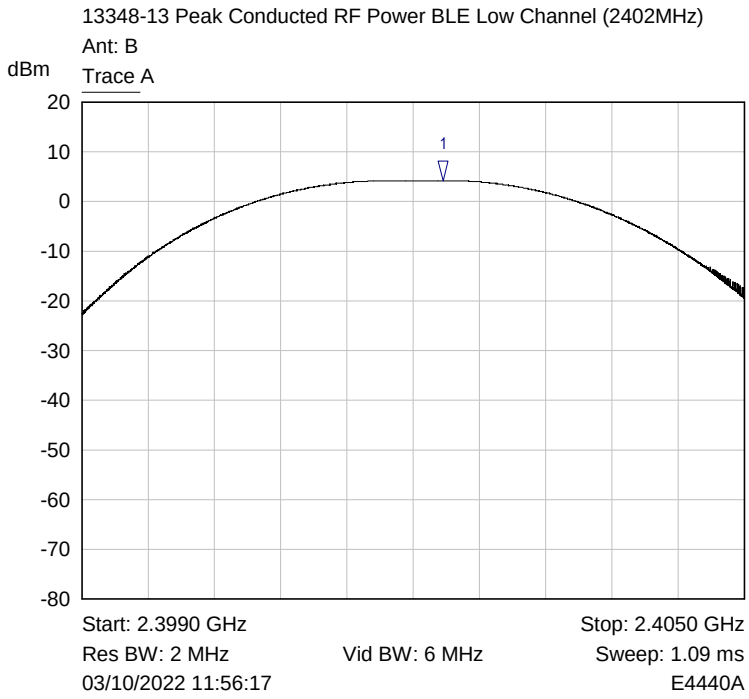
RF Parameters: Band 2400-2483.5 MHz, Power 10 dBm (BT Ant: A), Channel Spacing 2 MHz, Modulation LE1M, Channel 2480 MHz (High)



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4797 GHz	3.70 dBm	

Plot for Peak conducted power

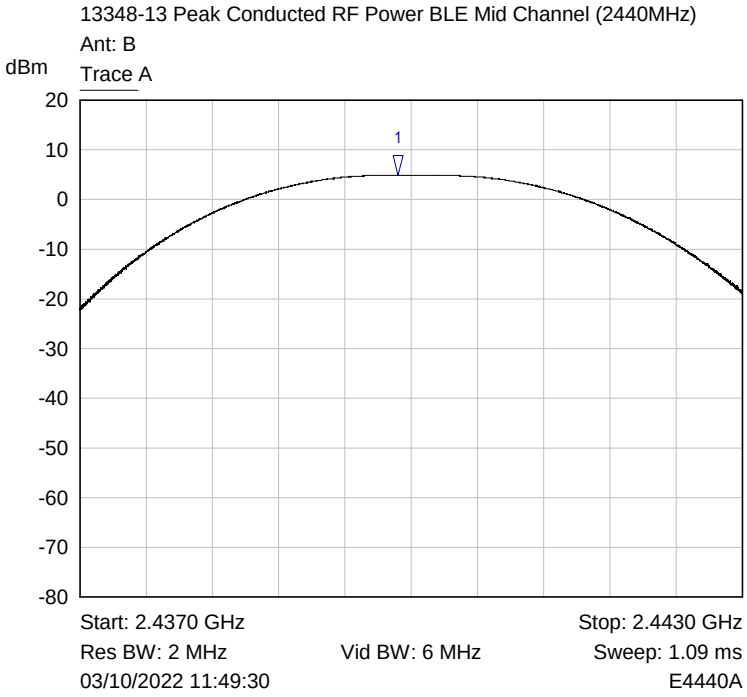
RF Parameters: Band 2400-2483.5 MHz, Power 10 dBm (BT Ant: B), Channel Spacing 2 MHz, Modulation LE1M, Channel 2402 MHz (Low)



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4023 GHz	4.24 dBm	

Plot for Peak conducted power

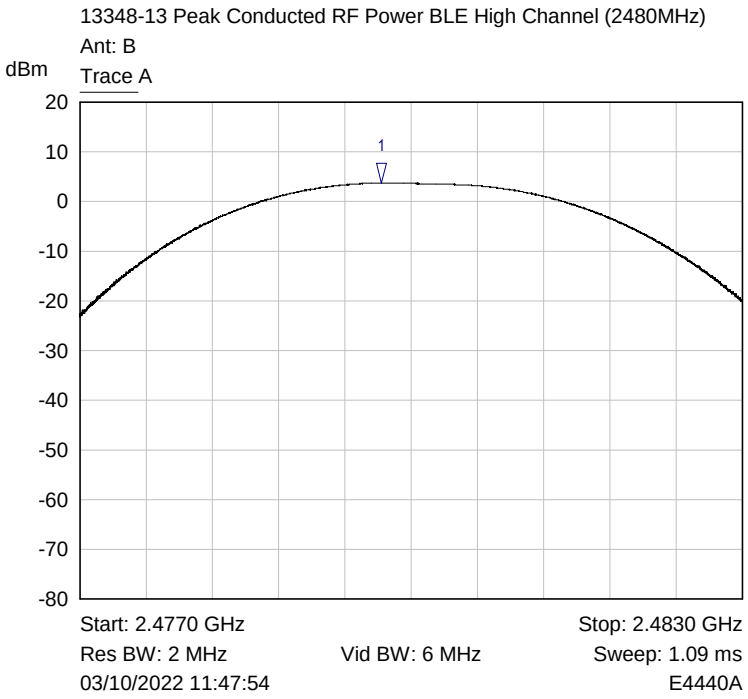
RF Parameters: Band 2400-2483.5 MHz, Power 10 dBm (BT Ant: B), Channel Spacing 2 MHz, Modulation LE1M, Channel 2440 MHz (Mid)



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4399 GHz	4.86 dBm	

Plot for Peak conducted power

RF Parameters: Band 2400-2483.5 MHz, Power 10 dBm (BT Ant: B), Channel Spacing 2 MHz, Modulation LE1M, Channel 2480 MHz (High)



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4797 GHz	3.70 dBm	

Plot for Peak conducted power

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: $E_{Log} = 20Log(0.01842) +120 = 85.3$dBµV/m @ 3m.

8 Photographs

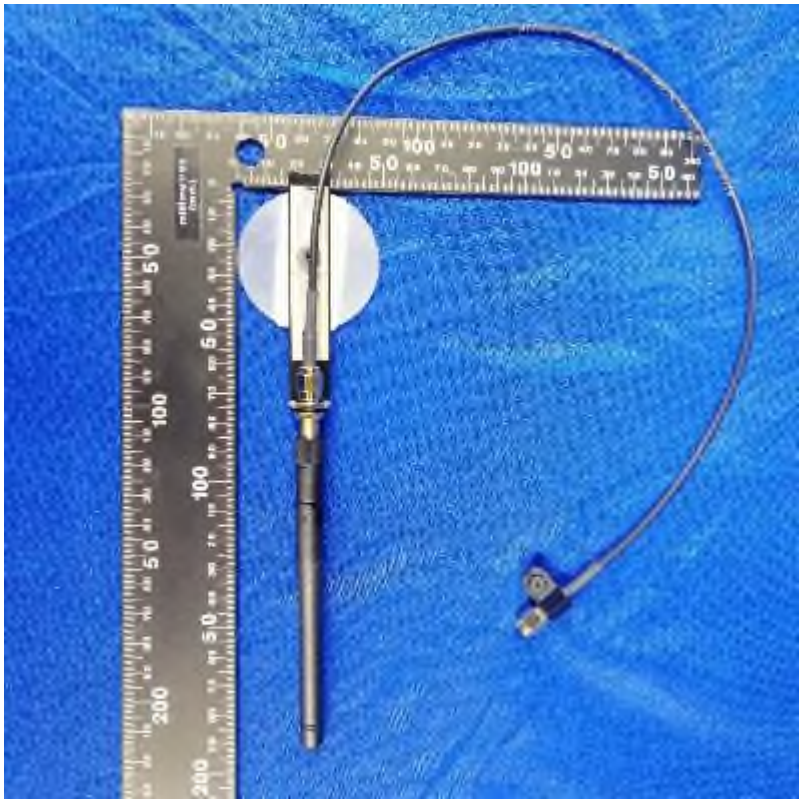
8.1 EUT Front View

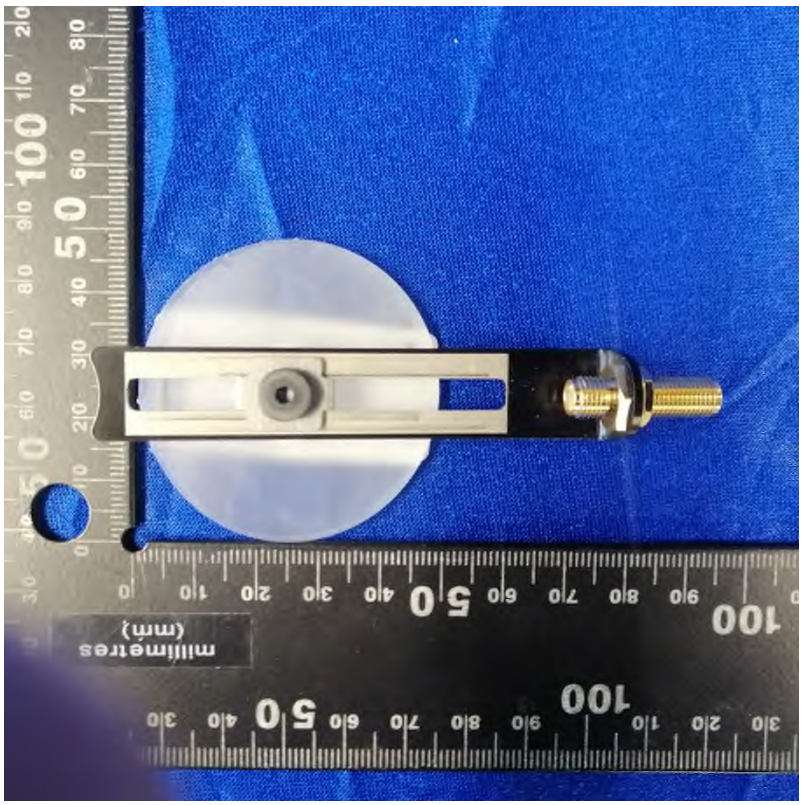
8.2 EUT Reverse Angle

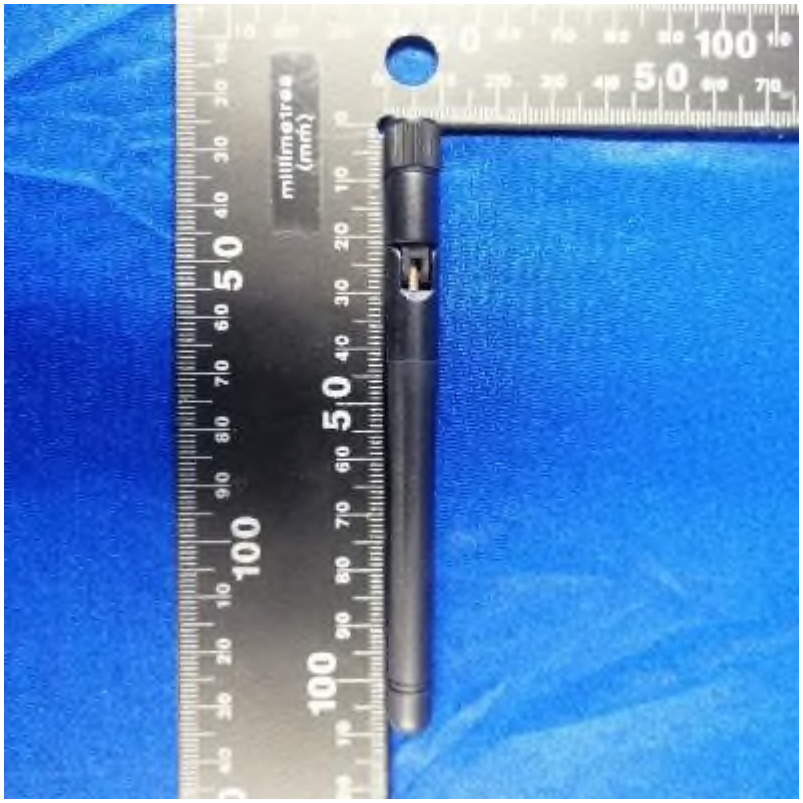
8.3 EUT Left side View

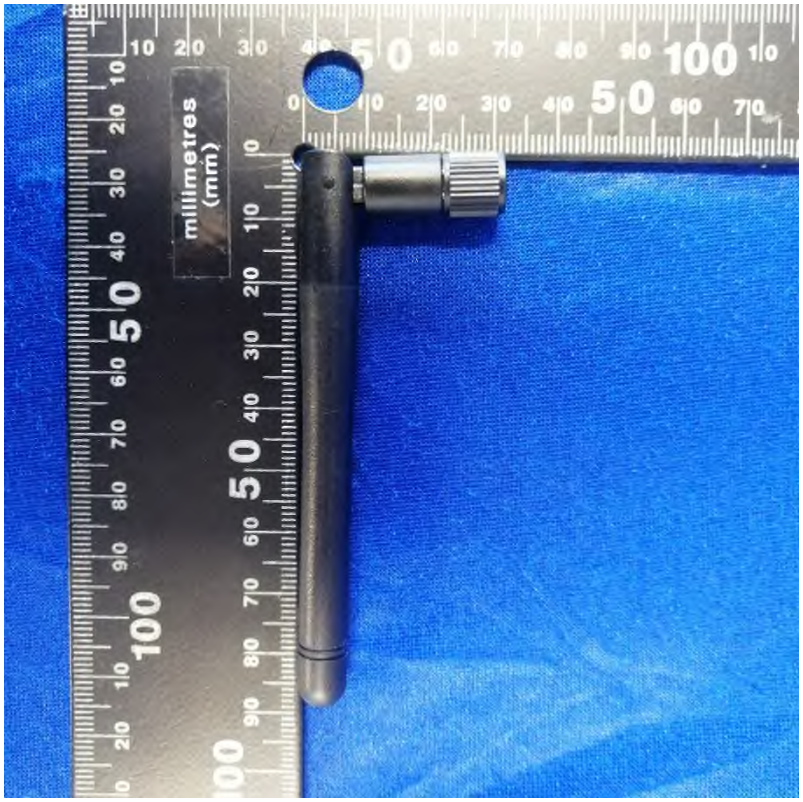
8.4 EUT Right side View

8.5 EUT Antenna Port



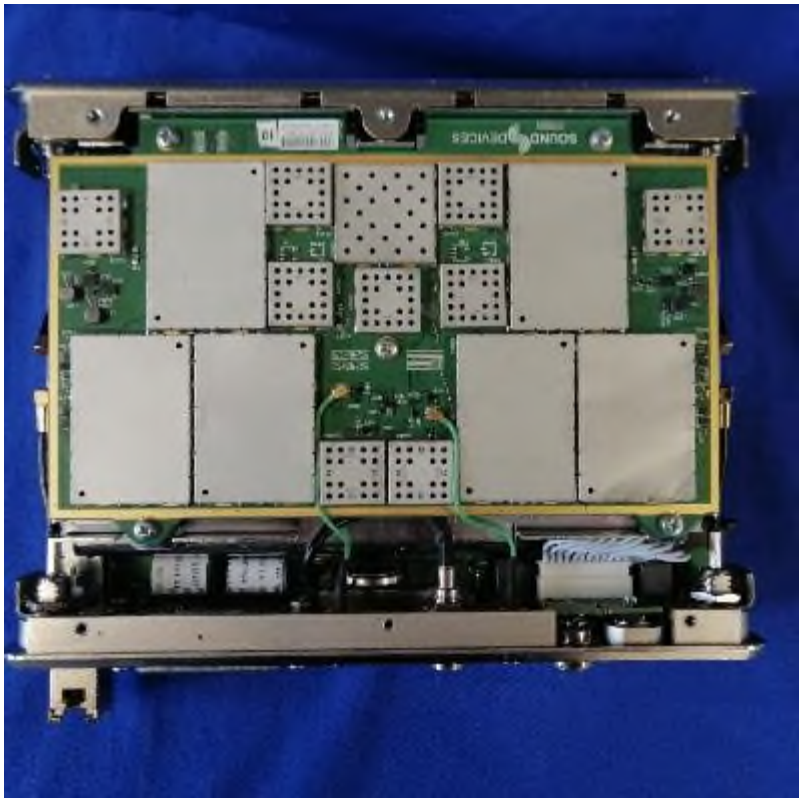

millimetres
(mm)

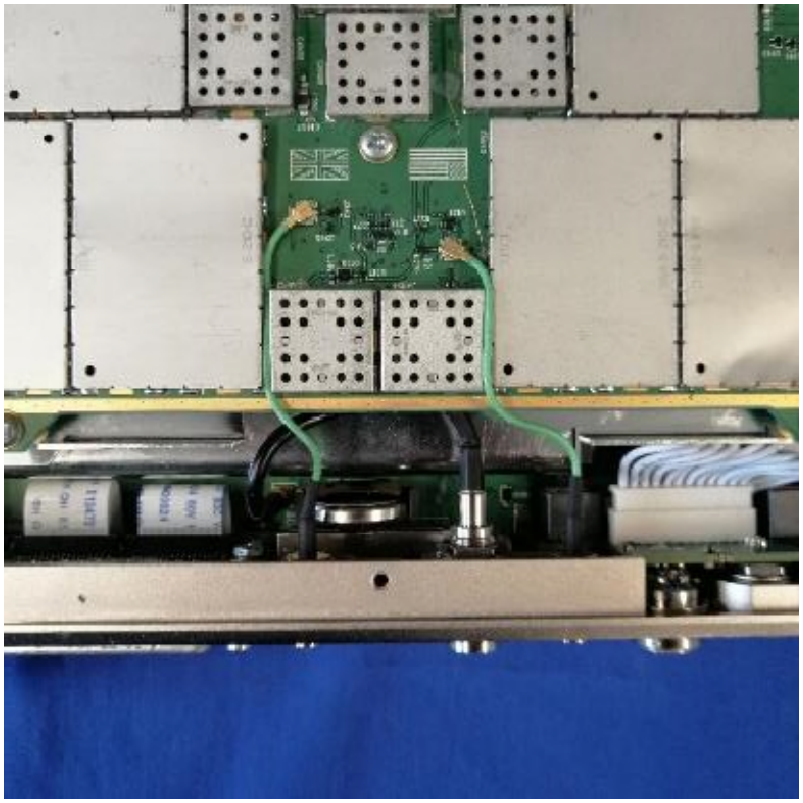

millimetres
(mm)


millimetres
(mm)

8.6 EUT Display & Controls

8.7 EUT Internal photos



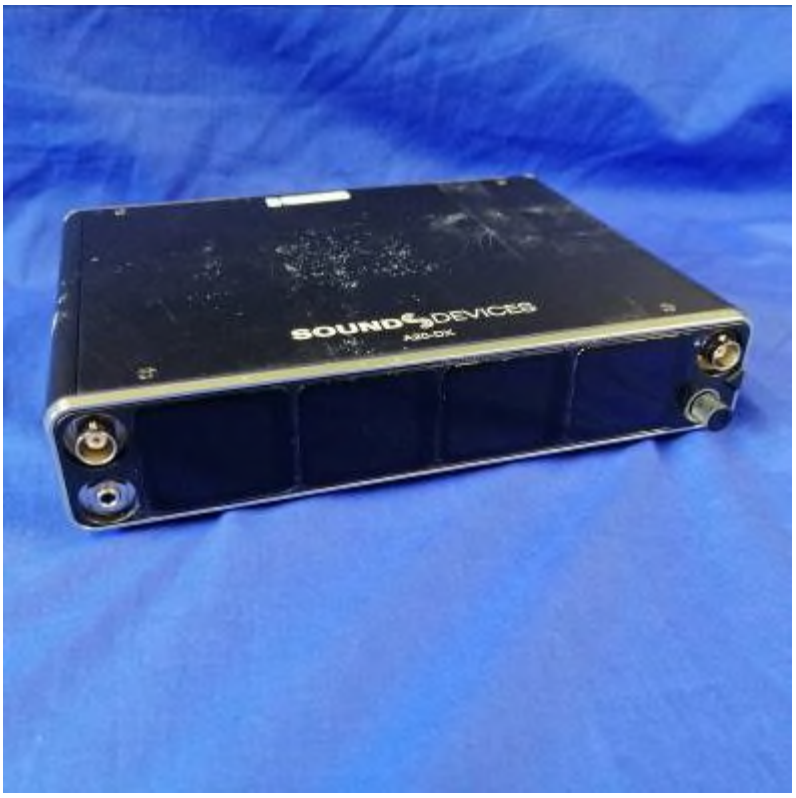


Note: No further disassembly of product was performed due to the complexity of design. RF cans were also not removed for photographic purposes.

8.8 EUT ID Label

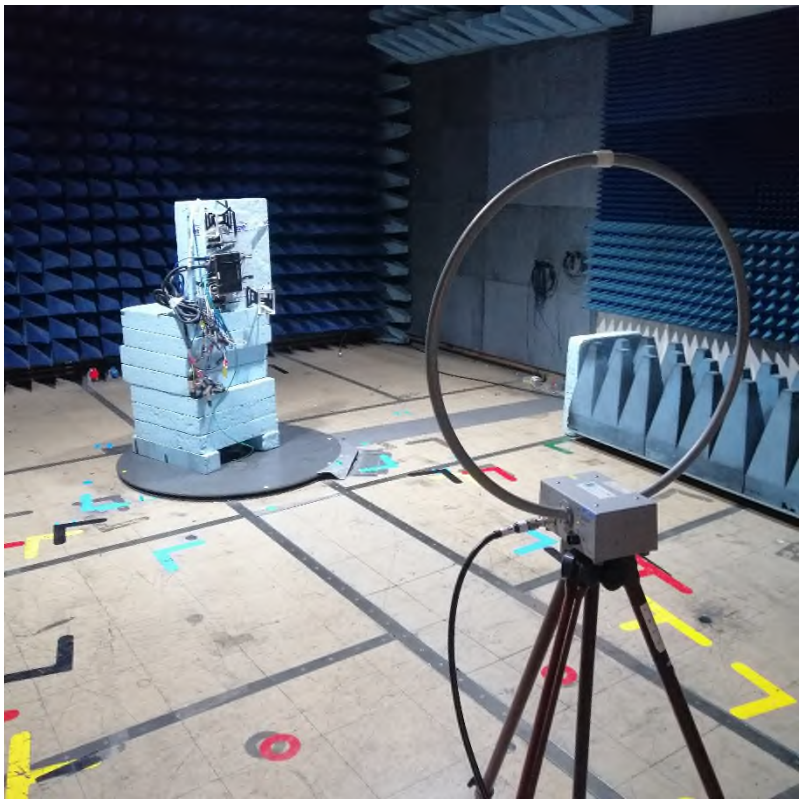

SOUND DEVICES
7

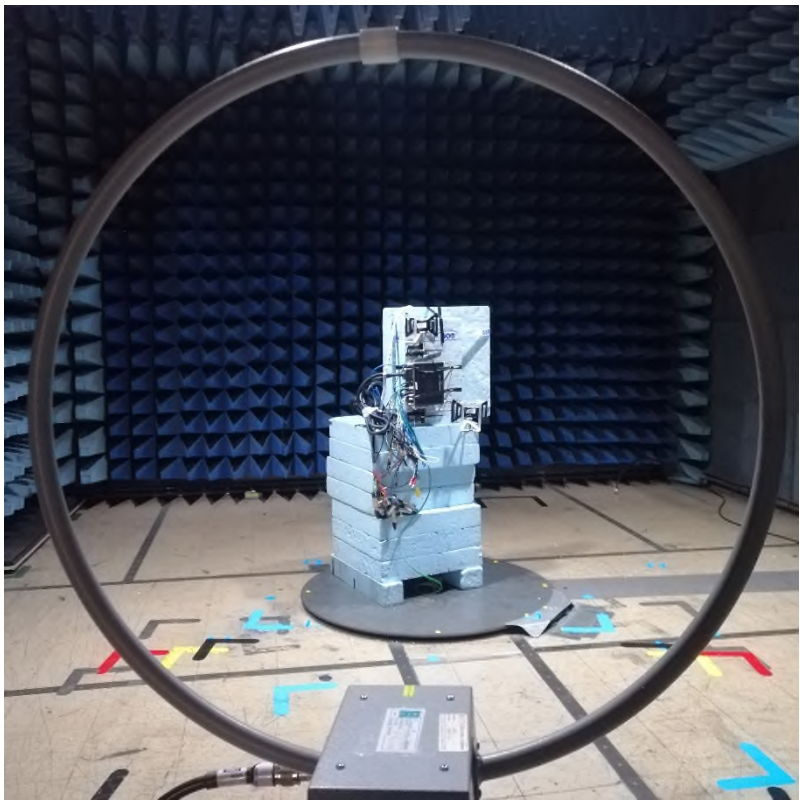
8.9 EUT Chassis



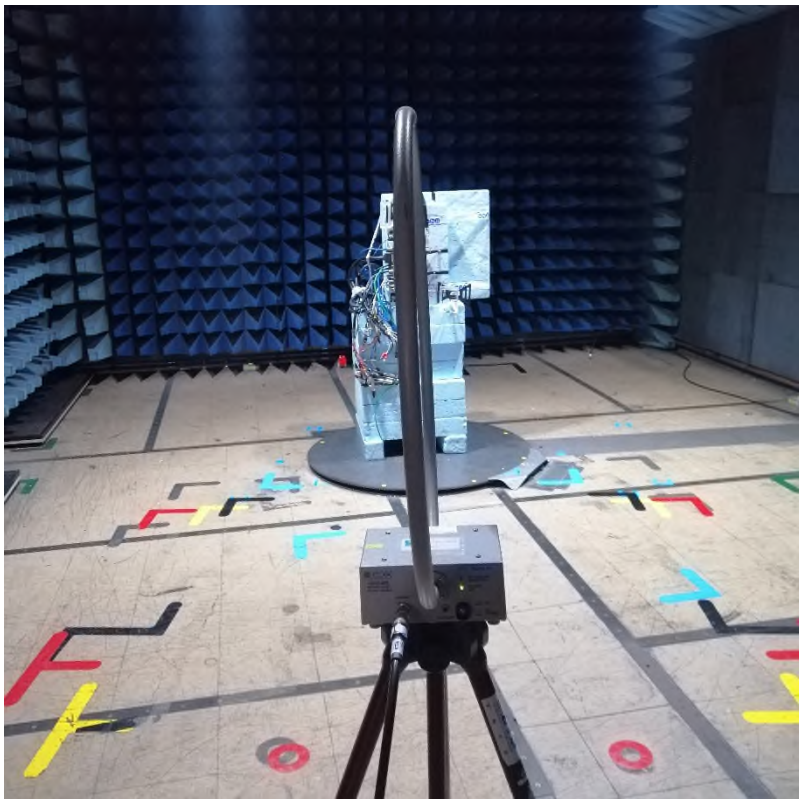
8.10 AC Conducted emissions 0.15 - 30 MHz

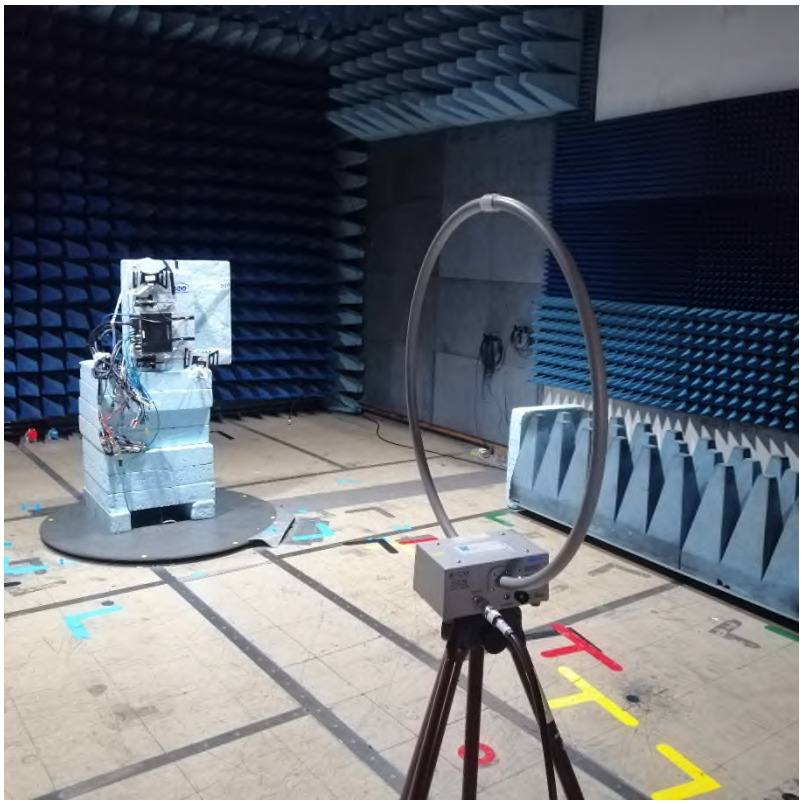
8.11 Radiated emissions 9 - 150 kHz



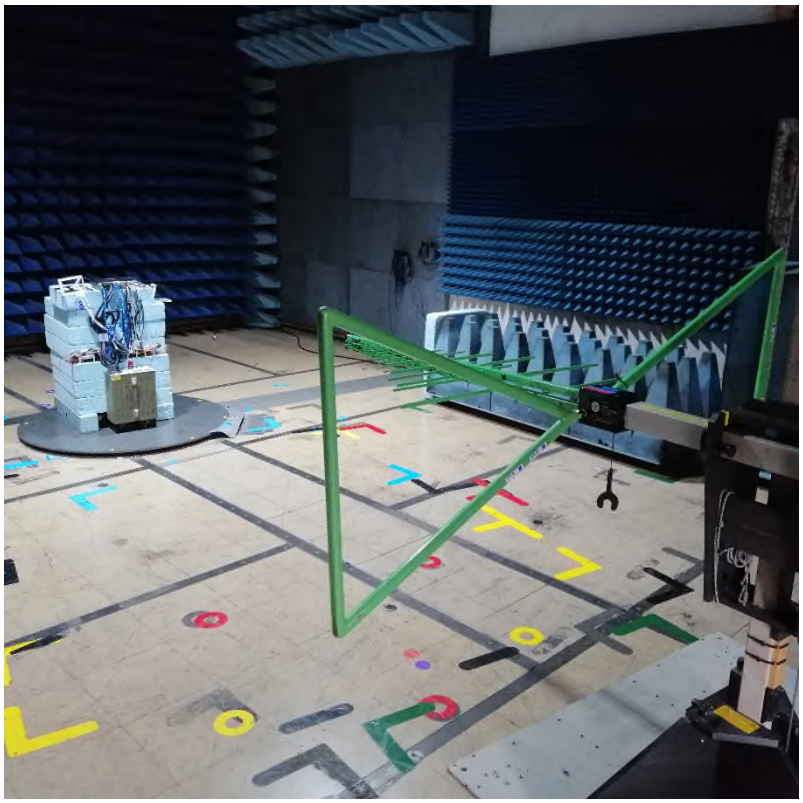


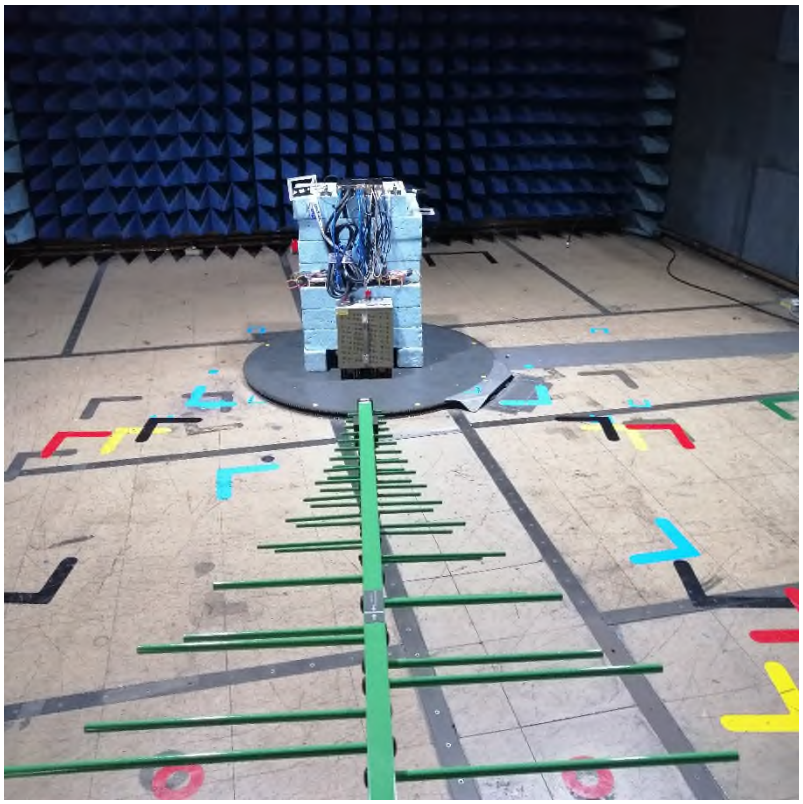
8.12 Radiated emissions 150 kHz - 30 MHz

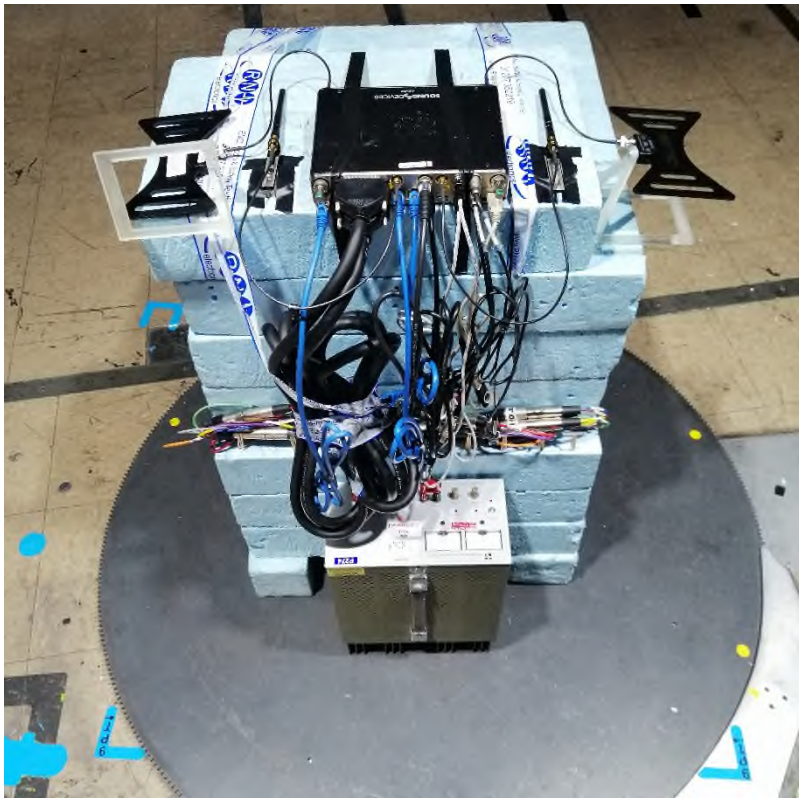




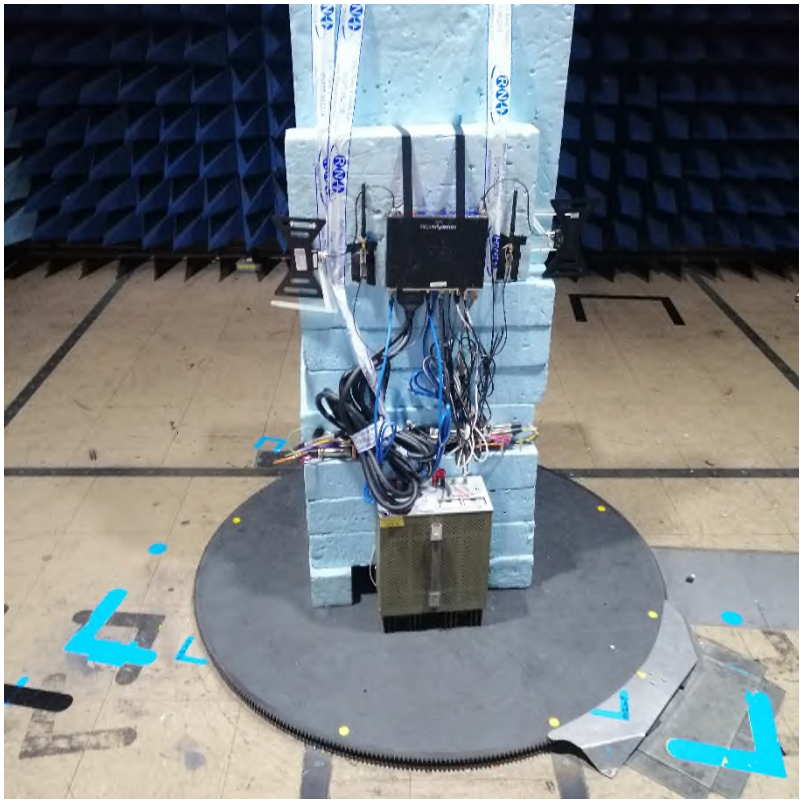
8.13 Radiated emissions 30 MHz -1 GHz



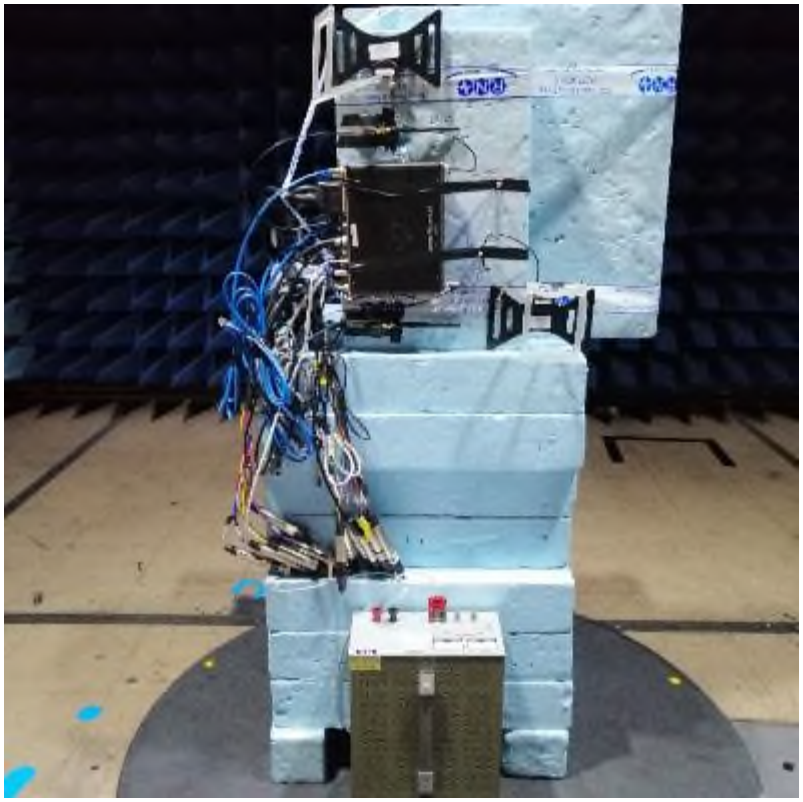




Flat Position

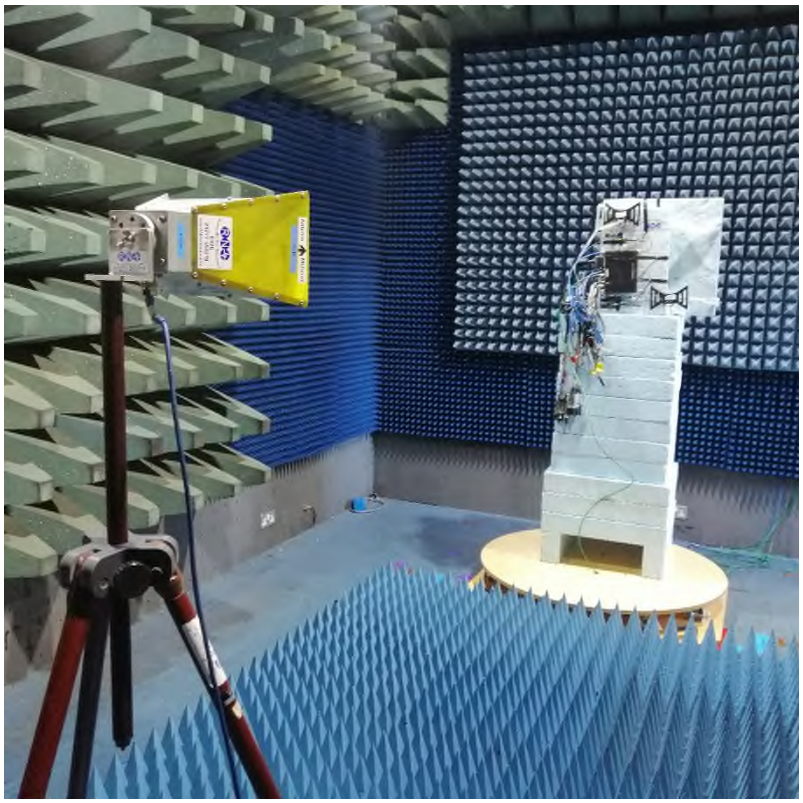


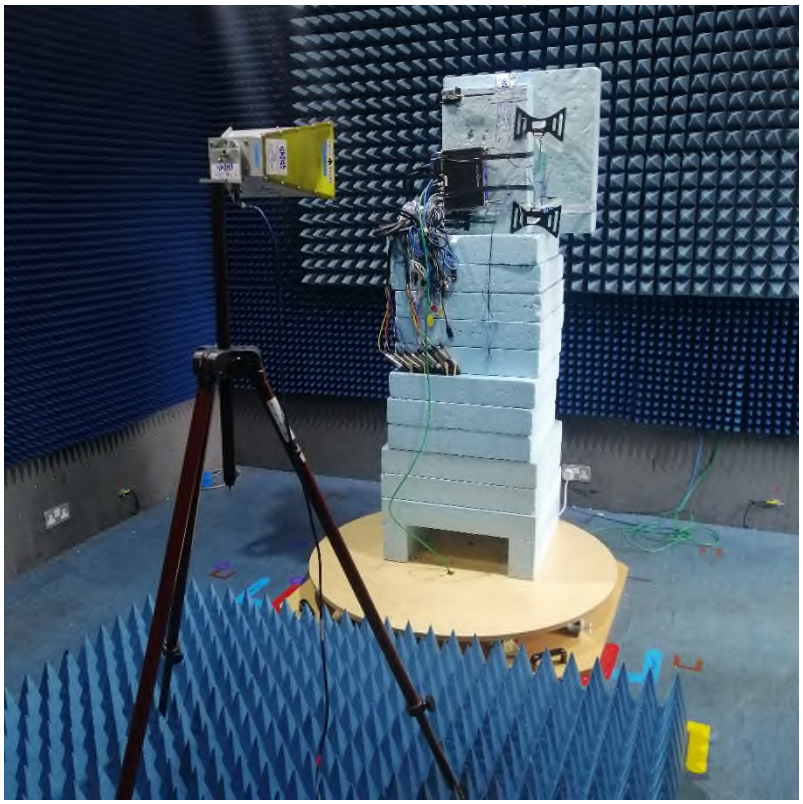
Upright Position

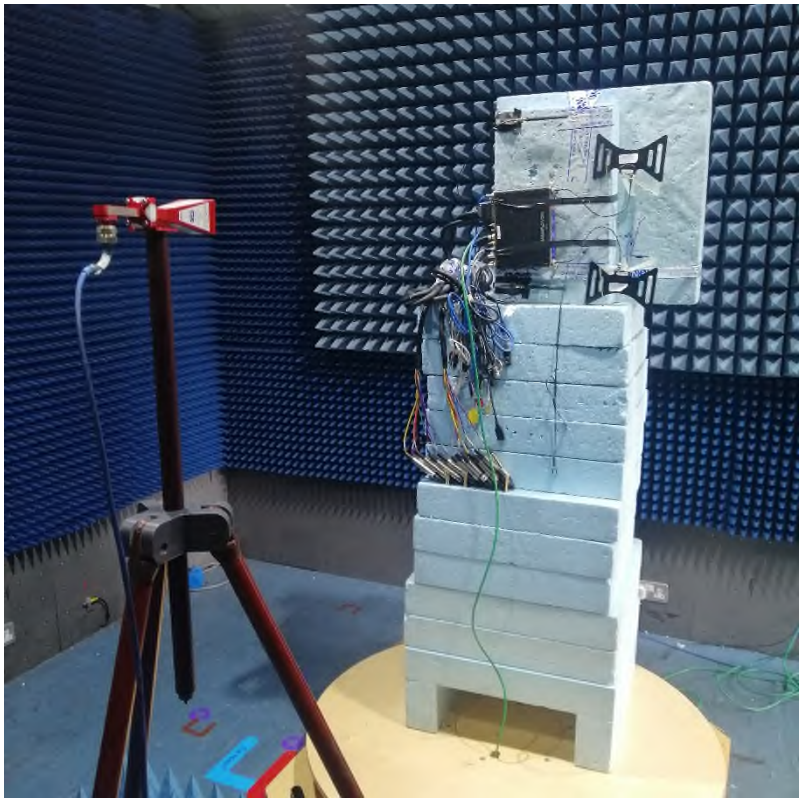


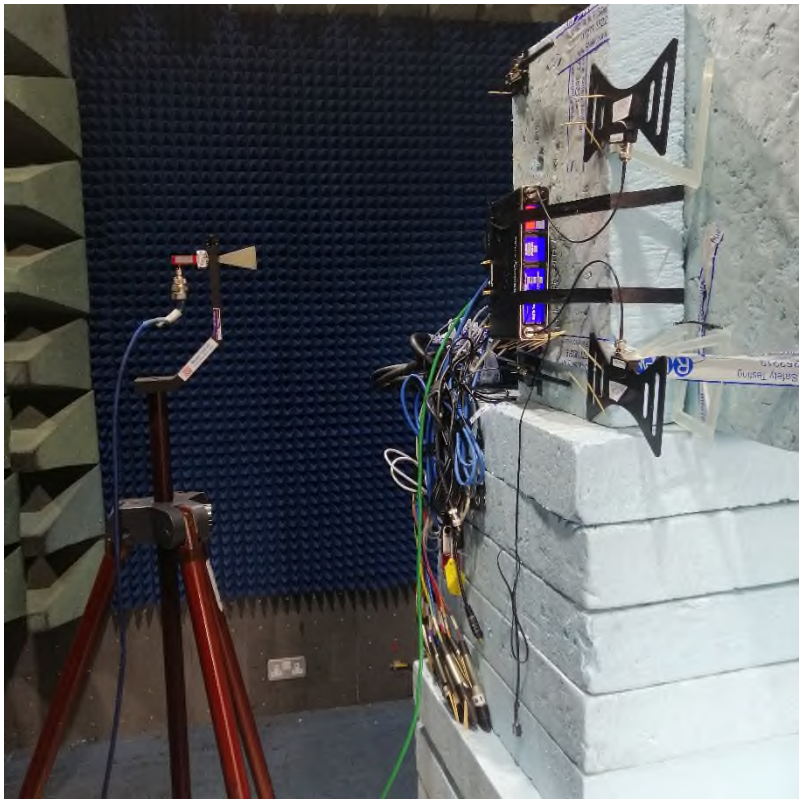
Side Position

8.14 Radiated emissions above 1 GHz









8.15 Radiated emission diagrams

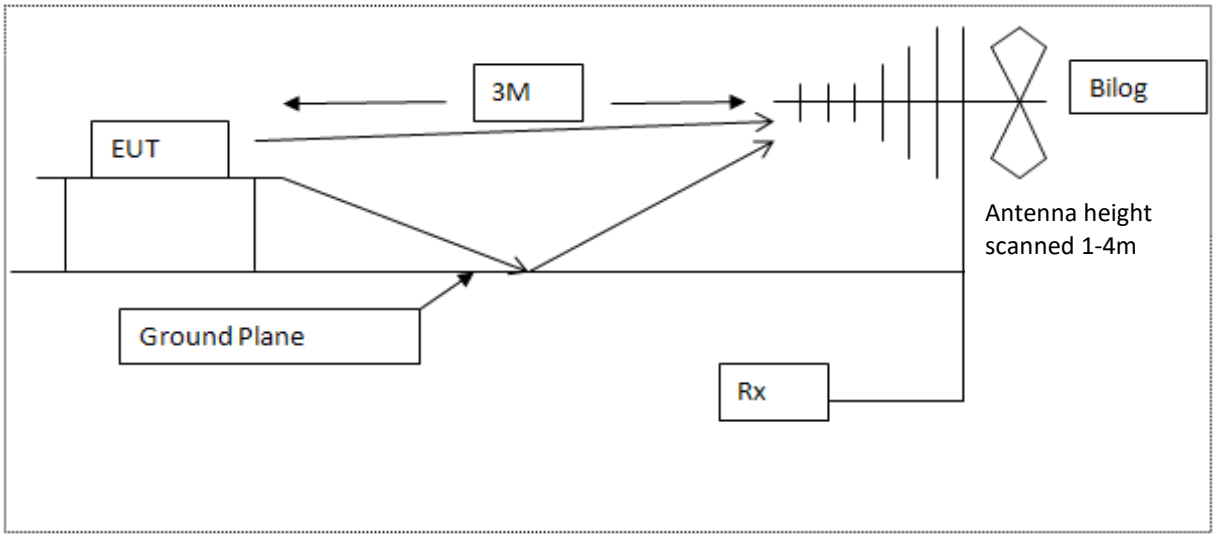


Diagram of the radiated emissions test setup 30 - 1000 MHz

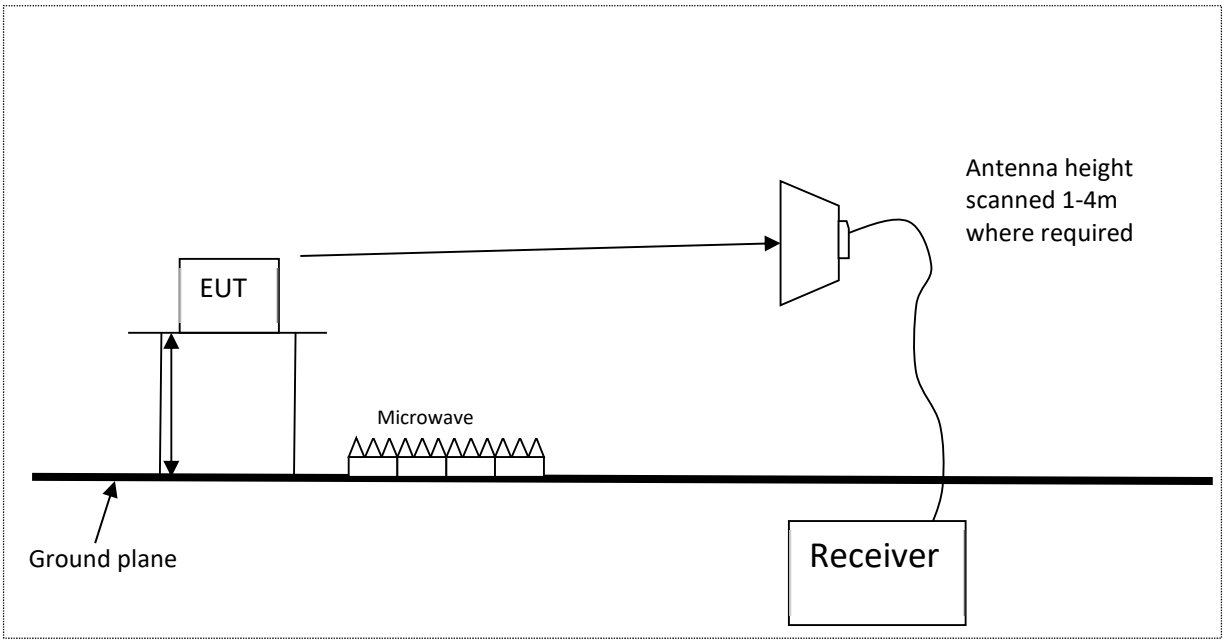


Diagram of the radiated emissions test setup above 1GHz

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
E035	11947A	Transient Limiter 9kHz - 200MHz	Hewlett Packard	#16-Dec-2022	12 months
E150	MN2050	LISN 13A	Chase	25-Apr-2022	12 months
E289	8449B	Pre-Amplifier 1GHz - 26.5GHz	Hewlett Packard	24-Jun-2022	12 months
E411	N9039A	9 kHz - 1 GHz RF Filter Section	Agilent Technologies	07-Jul-2022	12 months
E412	E4440A	PSA 3 Hz - 26.5 GHz	Agilent Technologies	21-Jun-2022	24 months
E428	HF906	Horn Antenna 1 - 18 GHz	Rohde & Schwarz	02-Apr-2022	12 months
E429	-	Filter Box 5 Switch Filters 0.91 GHz - 16.3 GHz	RN Electronics	23-Aug-2022	12 months
E433	MG3693A	Signal Generator 2 GHz - 30 GHz	Anritsu	#03-Oct-2022	12 months
E624	E4440A	PSA 3 Hz - 26.5 GHz	Agilent Technologies	06-Jul-2022	24 months
E642	E4440A	PSA 3 Hz - 26.5 GHz	Agilent Technologies	#06-Dec-2022	24 months
E743	2017 4/2dB	Attenuator 4/2dB 30-1000MHz	RN Electronics	10-Mar-2022	12 months
E856	N9039A	9 kHz - 1 GHz RF Filter Section	Agilent Technologies	#06-Dec-2022	12 months
E972	WRCGV10-2363.5-2400-2483.5-2520-60SS	Filter Band Reject 2400 to 2483.5 MHz	Wainwright Instruments	08-Apr-2022	12 months
F230	3160-08	Horn Std Gain 12.4 - 18 GHz	ETS-Lindgren	25-May-2022	12 months
F231	3160-09	Horn Std Gain 18 - 26.5 GHz	ETS-Lindgren	25-May-2022	12 months
LPE364	CBL6112A	Antenna BiLog 30MHz - 2GHz	Chase Electronics Ltd	28-Mar-2022	24 months
TMS81	6502	Antenna Active Loop	EMCO	22-Jul-2021	24 months

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	IPE30	Industrial Gigabit PoE Injector	Hynanet	IPE3020210900034
2	N/A	33Ω Termination	Not Specified	N/A
3	N/A	62Ω Termination 1	Not Specified	N/A
4	N/A	62Ω Termination 2	Not Specified	N/A
5	N/A	110Ω Termination	Not Specified	N/A
6	N/A	110Ω Termination	Not Specified	N/A
7	N/A	150Ω Termination	Not Specified	N/A
8	N/A	150Ω Termination	Not Specified	N/A

10.2 RN Electronics supplied equipment

RN No.	Model No.	Description	Manufacturer	Serial No
P274	TPS 2000	DC Power Supply	Topward Electric Instruments Co. Ltd.	920243
N/A	None	USB Memory Stick	Not Specified	N/A

11 Condition of the equipment tested

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

11.1 Modifications before test

No modifications were made before test by RN Electronics Ltd.

11.2 Modifications during test

No modifications were made during test by RN Electronics Ltd.

12 Description of test sites

Site A Radio Laboratory and Anechoic Chamber

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

Site C Transient Laboratory

Site D Screened Room (Conducted Immunity)

Site E Screened Room (Control Room for Site D)

Site F Screened Room (Conducted Emissions)

Site G Screened Room (Control Room for Site H)

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

Site J Transient Laboratory

Site K Screened Room (Control Room for Site M)

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

Site N Radio Laboratory

Site Q Fully-Anechoic Chamber

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

Site R Screened Room (Conducted Immunity)

Site S Safety Laboratory

Site T Transient Laboratory

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

13 Abbreviations and units

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

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

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