



A part of



## Radio Test Report

**Salunda Ltd**

**1701E**

**2.0 20**

47 CFR Part 15.247 Effective Date 1st October 2021

DTS: Part 15 Digital Transmission System

Test Date: 7th August 2023 to 4th September 2023

Report Number: 09-13769-1-23 Issue 01

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

***R.N. Electronics Ltd.***

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Arnolds Court, Arnolds Farm Lane, Mountnessing, Brentwood Essex, CM13 1UT  
**Certificate of Test 13769-1**

The equipment noted below has been fully tested by R.N. Electronics Limited and, where appropriate, conforms to the relevant subpart of RSS-139. This is a certificate of test only and should not be confused with an equipment authorisation. Other standards may also apply.

Equipment:	1701E
Model Number:	2.0 20
Unique Serial Number:	60000048 (Radiated) / 69999901 (Conducted)
Applicant:	Salunda Ltd Unit 6 Avonbury Business Park Bicester Oxon OX26 2UA
Proposed FCC ID	2ALTW17012020
Full measurement results are detailed in Report Number:	09-13769-1-23 Issue 01
Test Standards:	47 CFR Part 15.247 Effective Date 1st October 2021 DTS: Part 15 Digital Transmission System

**NOTE:**

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

**DEVIATIONS:**

No deviations have been applied.

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

Date of Test: 7th August 2023 to 4th September 2023

Test Engineer:  
Chee-Wah Yeung

Approved By:  
Radio Approvals  
Manager

Customer  
Representative:



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## 2 Equipment under test (EUT)

### 2.1 Equipment specification

Applicant	Salunda Ltd Unit 6 Avonbury Business Park Bicester Oxon OX26 2UA	
Manufacturer of EUT	Salunda Ltd	
Full Name of EUT	1701E	
Model Number of EUT	2.0 20	
Serial Number of EUT	60000048 (Radiated) / 69999901 (Conducted)	
Date Received	4 <sup>th</sup> August 2023	
Date of Test:	7 <sup>th</sup> August 2023 to 4 <sup>th</sup> September 2023	
Purpose of Test	To demonstrate design compliance to the relevant rules of Chapter 47 of the Code of Federal Regulations.	
Date Report Issued	5 <sup>th</sup> September 2023	
Main Function	To provide latch feedback for a drilling rig over a radio link	
Information Specification	Height	80 mm
	Width	30 mm
	Depth	30 mm
	Weight	0.2 kg
	Voltage	3.6 Vdc
	Current	Not Specified

## 2.2 Configurations for testing

General Parameters	
EUT Normal use position	Mounted on Drilling Rig
Choice of model(s) for type tests	2.0 20 dBm
Antenna details	1 x Integral Johanson P/N: 2450AT42E010B Chip Antenna. Antenna Gain: -1 dBi
Antenna port	No
Baseband Data port (yes/no)?	No
Highest Signal generated in EUT	2480 MHz
Lowest Signal generated in EUT	400 kHz
Hardware Version (HVIN)	7801 C2 20dBm
Software Version	Not Specified
Firmware Version (FVIN)	Not Specified
Type of Equipment	Standalone
Technology Type	Zigbee & NFC
Geo-location (yes/no)	No
TX Parameters	
Alignment range – transmitter	2405-2480 MHz
EUT Declared Modulation Parameters	OQPSK
EUT Declared Power level	10 dBm
EUT Declared Signal Bandwidths	2 MHz
EUT Declared Channel Spacing's	5 MHz
EUT Declared Duty Cycle	Can be up to 80%. Majority of time once per hour for approximately 3ms
Unmodulated carrier available?	Yes
Declared frequency stability	Not Specified
RX Parameters	
Alignment range – receiver	2405-2480 MHz
EUT Declared RX Signal Bandwidth	2 MHz
Receiver Signal Level (RSL)	Not Specified
Method of Monitoring Receiver BER	Not Specified
FCC Parameters	
FCC Transmitter Class	DTS: Part 15 Digital Transmission System
LBT Parameters	
TX off time	2 ms
Minimum listening time	128 $\mu$ s
Dead time	320 $\mu$ s
TX on time	5 ms
Adaptive/Agile Parameters	
No. of agile channels	Not Specified
Is Adaptivity LBT or Non-LBT	LBT
Load based mechanism	No
Frame based mechanism	Yes

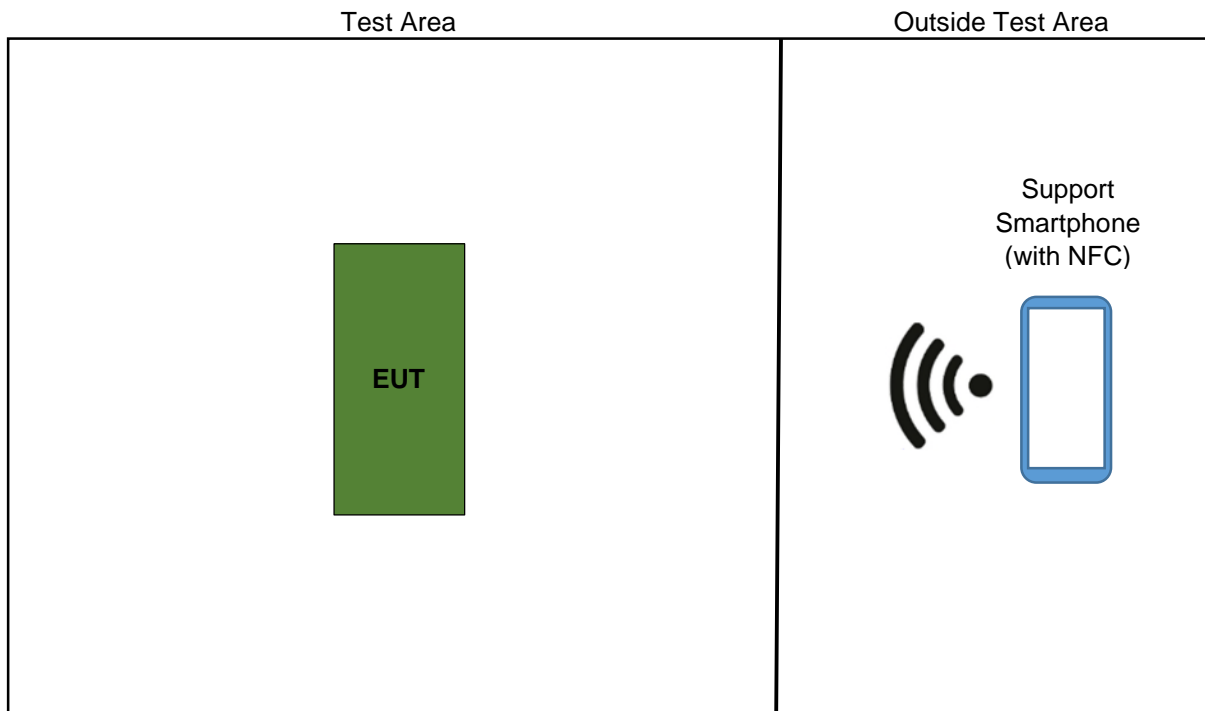
## 2.3 Functional description

Takes a reading of the inclination of the sensor and sends it back over the 2.4GHz radio link.

## 2.4 Modes of operation

Mode Reference	Description	Used for testing
Mode 1	Repeatedly Transmitting, 'Send Message Often' Mode, Channel 11 (2405 MHz)	Yes
Mode 2	Repeatedly Transmitting, 'Send Message Often' Mode, Channel 18 (2440 MHz)	Yes
Mode 3	Repeatedly Transmitting, 'Send Message Often' Mode, Channel 26 (2480 MHz)	Yes

## 2.5 Emissions configuration



The EUT was powered from a single internal, non-rechargeable, 3.6V AA lithium battery (Lithium Thionyl Chloride Li/SOCI<sub>2</sub>). A separate sample was supplied for making conducted measurements which had a temporary SMA connector in place of the internal antenna which allowed external access and measurements to be made. DC power cables were also attached to allow the conducted unit to be powered from a DC power supply. A support smartphone was supplied which was used to configure the EUT in the correct Zigbee mode(s) via NFC. The mode (CW, PRB Sequence etc), Channel and Power Setting were first set on the phone using the 'Salunda NFC Light' application' and the phone NFC antenna was presented to the EUT NFC antenna which configured the EUT into the desired mode. The unit was configured to allow permanent transmit and receive modes of device on the top, middle and bottom channels as stated within section 2.4 of this report.

The declared power settings and Lowest, Middle and Highest channels are stated below:

Low Channel (Channel 11: 2405 MHz): Power setting: 8  
 Mid Channel (Channel 18: 2440 MHz): Power setting: 8  
 High Channel (Channel 26: 2480 MHz): Power setting: 8

### 2.5.1 Signal leads

None.

### 3 Summary of test results

The 1701E, 2.0 20 was tested for compliance to the following standard(s):

47 CFR Part 15.247 Effective Date 1st October 2021  
DTS: Part 15 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
<b>Transmitter Tests</b>		
1. AC power line conducted emissions	47 CFR Part 15C Part 15.207	NOT APPLICABLE <sup>1</sup>
2. Radiated emissions 9 - 150 kHz	47 CFR Part 15C Part 15.209	PASSED
3. Radiated emissions 150 kHz - 30 MHz	47 CFR Part 15C Part 15.209	PASSED
4. Radiated emissions 30 MHz - 1 GHz	47 CFR Part 15C Part 15.247(d) & 15.209	PASSED
5. Radiated emissions above 1 GHz	47 CFR Part 15C Part 15.247(d) & 15.209	PASSED <sup>6</sup>
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 TESTED <sup>2</sup>
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 <sup>4</sup>
13. Duty cycle	47 CFR Part 15C Part 15.35(c)	NOT APPLICABLE <sup>5</sup>
14. FHSS carrier frequency separation	47 CFR Part 15C Part 15.247(a1)	NOT APPLICABLE <sup>3</sup>
15. Average time of occupancy	47 CFR Part 15C Part 15.247(a)(1)(i)/(ii)/(iii)	NOT APPLICABLE <sup>3</sup>
16. Number of Hop Channels	47 CFR Part 15C Part 15.247(a)(1)(i)/(ii)/(iii)	NOT APPLICABLE <sup>3</sup>

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

<sup>2</sup> Peak Conducted Power carried out instead.

<sup>3</sup> EUT does not employ FHSS technology

<sup>4</sup> Applies to EUT's with an antenna port. The EUT has an integral antenna only.

<sup>5</sup> No limits apply, however duty cycle measurements performed to verify any possible correction factors for average results if required.

<sup>6</sup> Spectrum investigated up to a frequency of 25GHz based on 10 times the highest channel/ signal generated in equipment of 2480MHz.

## 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 are declarations of nominal and extremes conditions of the EUT.

Temperature Test Conditions		Voltage Test Conditions	
T nominal	20 °C	V nominal	3.6V DC
T minimum	-25 °C	V minimum	Not Declared
T maximum	70 °C	V maximum	Not Declared

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

### 4.4 Test fixtures

In order to measure conducted RF parameters, the EUT was tested as follows:  
A temporary RF port was created for testing.



## 5 Tests, methods and results

### 5.1 AC power line conducted emissions

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

## 5.2 Radiated emissions 9 - 150 kHz

### 5.2.1 Test methods

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

### 5.2.2 Configuration of EUT

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

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

### 5.2.3 Test procedure

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

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

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

Tests were performed using Test Site H and OATS.

### 5.2.4 Test equipment

E642, E856, TMS81

See Section 9 for more details

### 5.2.5 Test results

Temperature of test environment 21°C  
 Humidity of test environment 57%  
 Pressure of test environment 101kPa

Band	2400-2483.5 MHz
Power Level	8
Channel Spacing	5 MHz
Mod Scheme	OQPSK
Mid channel	2440 MHz (Mid Ch)

Plot refs
13769-1 Rad 1 9k-150kHz Para
13769-1 Rad 1 9k-150kHz Perp

Signal No.	Freq (MHz)	Peak Amp (dBuV/m)	QP Amp (dBuV/m)	QP -Lim (dB)
No spurious emissions within 20 dB of limits				

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

Whilst Low, Mid and High channels were tested, plots are for illustrative purposes only and only Mid channel plots are shown in this report.

**LIMITS:**

15.209 limits are applicable in the restricted bands of 15.205 with the relevant detector.

15.247(d) other emissions, outside the intentional band, must be attenuated by at least 20/30dB from the level of the fundamental / meet the general limits of 15.209.

The general limits of 15.209 are as drawn on the respective plots.

These results show that the EUT has PASSED this test.

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

### 5.3 Radiated emissions 150 kHz - 30 MHz

#### 5.3.1 Test methods

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

#### 5.3.2 Configuration of EUT

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

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

#### 5.3.3 Test procedure

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

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

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

Tests were performed using Test Site H and OATS.

#### 5.3.4 Test equipment

E642, E856, TMS81

See Section 9 for more details

#### 5.3.5 Test results

Temperature of test environment 21°C  
 Humidity of test environment 57%  
 Pressure of test environment 101kPa

Band	2400-2483.5 MHz
Power Level	8
Channel Spacing	5 MHz
Mod Scheme	OQPSK
High channel	2440 MHz (Mid Ch)

Plot refs
13769-1 Rad 1 150k-30MHz Para
13769-1 Rad 1 150k-30MHz Perp

Signal No.	Freq (MHz)	Peak Amp (dBuV/m)	QP Amp (dBuV/m)	QP -Lim (dB)
No spurious emissions within 20 dB of limits				

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

Whilst Low, Mid and High channels were tested, plots are for illustrative purposes only and only Mid channel plots are shown in this report.

**LIMITS:**

15.209 limits are applicable in the restricted bands of 15.205 with the relevant detector.

15.247(d) other emissions, outside the intentional band, must be attenuated by at least 20/30dB from the level of the fundamental / meet the general limits of 15.209.

The general limits of 15.209 are as drawn on the respective plots.

These results show that the EUT has PASSED this test.

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

## 5.4 Radiated emissions 30 MHz -1 GHz

### 5.4.1 Test methods

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

### 5.4.2 Configuration of EUT

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

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

### 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 18°C  
 Humidity of test environment 68%  
 Pressure of test environment 102kPa

Band	2400-2483.5 MHz
Power Level	8
Channel Spacing	5 MHz
Mod Scheme	OQPSK
Mid channel	2440 MHz (Mid Ch)

Plot refs	
13769-1 Rad 1 VHF Horiz	
13769-1 Rad 1 VHF Vert	
13769-1 Rad 1 UHF Horiz	
13769-1 Rad 1 UHF Vert	

**Table of signals measured for Rad 1 Horizontal Signal List**

Signal No.	Freq (MHz)	Peak Amp (dBuV/m)	QP Amp (dBuV/m)	QP -Lim (dB)
1	30.000	17.4	11.7	-28.3
2	119.631	24.1	17.8	-25.7
3	532.361	31.3	24.7	-21.3

### Table of signals measured for Rad 1 Vertical Signal List

Signal No.	Freq (MHz)	Peak Amp (dBuV/m)	QP Amp (dBuV/m)	QP -Lim (dB)
1	30.000	16.9	11.7	-28.3
2	115.840	24.8	17.8	-25.7
3	115.841	24.7	17.7	-25.8
4	522.541	31.7	24.9	-21.1
5	646.197	34.1	27.8	-18.2
6	848.990	33.7	27.7	-18.3

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

No discernible difference was noted in emissions between channel settings (exploratory measurements), therefore final measurements are presented for TX mid channel mode only for these test ranges.

Whilst Low, Mid and High channels were tested, plots are for illustrative purposes only and only Mid channel plots are shown in this report.

**LIMITS:**

15.209 limits are applicable in the restricted bands of 15.205 with the relevant detector.

15.247(d) other emissions, outside the intentional band, must be attenuated by at least 20/30dB from the level of the fundamental / meet the general limits of 15.209.

The general limits of 15.209 are as drawn on the respective plots.

These results show that the EUT has PASSED this test.

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

30MHz - 1000MHz  $\pm 6.1$ dB

## 5.5 Radiated emissions above 1 GHz

### 5.5.1 Test methods

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

### 5.5.2 Configuration of EUT

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

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

### 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 M.

### 5.5.4 Test equipment

E136, E429, E624, TMS78, TMS79, TMS82

See Section 9 for more details

### 5.5.5 Test results

Temperature of test environment 18°C  
 Humidity of test environment 69%  
 Pressure of test environment 100kPa

Band	2400-2483.5 MHz
Power Level	8
Channel Spacing	5 MHz
Mod Scheme	OQPSK
High channel	2402 MHz (Low Ch)

No results measured within 20dB of applicable limits.

#### Setup Table

Band	2400-2483.5 MHz
Power Setting	8
Channel Spacing	5 MHz
Mod Scheme	OQPSK
Mid channel	2440 MHz (Mid Ch)

Spurious Frequency (MHz)	Measured Peak Level (dBµV/m)	Difference to Peak Limit (dB)	Measured Average Level (dBµV/m)	Difference to Average Limit (dB)	EUT Polarisation	Antenna Polarisation
7320	50.87	-23.13	39.04	-14.96	Upright	Vertical
7320	50.07	-23.93	38.78	-15.22	Side	Horizontal



Plots	
13769-1 1701E '2.0 20 dBm' Radiated Emissions 1-2 GHz Channel 18 (2440 MHz) Vertical Power Setting_ 8	
13769-1 1701E '2.0 20 dBm' Radiated Emissions 1-2 GHz Channel 18 (2440 MHz) Horizontal Power Setting_ 8	
13769-1 1701E '2.0 20 dBm' Radiated Emissions 2-2.7 GHz Channel 18 (2440 MHz) Vertical Power Setting_ 8	
13769-1 1701E '2.0 20 dBm' Radiated Emissions 2-2.7 GHz Channel 18 (2440 MHz) Horizontal Power Setting_ 8	
13769-1 1701E '2.0 20 dBm' Radiated Emissions 2.7-5 GHz Channel 18 (2440 MHz) Vertical Power Setting_ 8	
13769-1 1701E '2.0 20 dBm' Radiated Emissions 2.7-5 GHz Channel 18 (2440 MHz) Horizontal Power Setting_ 8	
13769-1 1701E '2.0 20 dBm' Radiated Emissions 5-6 GHz Channel 18 (2440 MHz) Vertical Power Setting_ 8	
13769-1 1701E '2.0 20 dBm' Radiated Emissions 5-6 GHz Channel 18 (2440 MHz) Horizontal Power Setting_ 8	
13769-1 1701E '2.0 20 dBm' Radiated Emissions 6-7.77 GHz Channel 18 (2440 MHz) Vertical Power Setting_ 8	
13769-1 1701E '2.0 20 dBm' Radiated Emissions 6-7.77 GHz Channel 18 (2440 MHz) Horizontal Power Setting_ 8	
13769-1 1701E '2.0 20 dBm' Radiated Emissions 7.77-10 GHz Channel 18 (2440 MHz) Vertical Power Setting_ 8	
13769-1 1701E '2.0 20 dBm' Radiated Emissions 7.77-10 GHz Channel 18 (2440 MHz) Horizontal Power Setting_ 8	
13769-1 1701E '2.0 20 dBm' Radiated Emissions 10-12.5 GHz Channel 18 (2440 MHz) Vertical Power Setting_ 8	
13769-1 1701E '2.0 20 dBm' Radiated Emissions 10-12.5 GHz Channel 18 (2440 MHz) Horizontal Power Setting_ 8	
13769-1 1701E '2.0 20 dBm' Radiated Emissions 12.5-15 GHz Channel 18 (2440 MHz) Vertical Power Setting_ 8	
13769-1 1701E '2.0 20 dBm' Radiated Emissions 12.5-15 GHz Channel 18 (2440 MHz) Horizontal Power Setting_ 8	
13769-1 1701E '2.0 20 dBm' Radiated Emissions 15-18 GHz Channel 18 (2440 MHz) Vertical Power Setting_ 8	
13769-1 1701E '2.0 20 dBm' Radiated Emissions 15-18 GHz Channel 18 (2440 MHz) Horizontal Power Setting_ 8	
13769-1 1701E '2.0 20 dBm' Radiated Emissions 18-22 GHz Channel 18 (2440 MHz) Vertical Power Setting_ 8	
13769-1 1701E '2.0 20 dBm' Radiated Emissions 18-22 GHz Channel 18 (2440 MHz) Horizontal Power Setting_ 8	
13769-1 1701E '2.0 20 dBm' Radiated Emissions 22-25 GHz Channel 18 (2440 MHz) Vertical Power Setting_ 8	
13769-1 1701E '2.0 20 dBm' Radiated Emissions 22-25 GHz Channel 18 (2440 MHz) Horizontal Power Setting_ 8	

Band	2400-2483.5 MHz
Power Level	8
Channel Spacing	5 MHz
Mod Scheme	OQPSK
High channel	2480 MHz (High Ch)

Spurious Frequency (MHz)	Measured Peak Level (dBµV/m)	Difference to Peak Limit (dB)	Measured Average Level (dBµV/m)	Difference to Average Limit (dB)	EUT Polarisation	Antenna Polarisation
7440	50.07	-23.93	37.23	-16.77	Upright	Vertical
7440	49.37	-24.63	36.33	-17.67	Side	Horizontal

Note: Only signals measured within 20dB of 15.209 limits (restricted band limits), or within 20dB of non-restricted band limits are shown in above tables.

Peak detector "Max held" Analyser plots against the Average limit line can be found in Section 6 of this report. Whilst Low, Mid and High channels were tested, plots are for illustrative purposes only and only Mid channel plots are shown in this report.

**LIMITS:**

15.209 limits are applicable in the restricted bands of 15.205 with the relevant detector.

15.247(d) other emissions, outside the intentional band, must be attenuated by at least 20/30dB from the level of the fundamental / meet the general limits of 15.209.

The general limits of 15.209 are as drawn on the respective plots.

These results show that the EUT has PASSED this test.

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

1 – 18 GHz ±3.5dB, 18 – 26.5 GHz ±3.9dB.

## 5.6 Effective radiated power field strength

### 5.6.1 Test methods

Test Requirements: 47 CFR Part 15C Part 15.247(d) [Reference 4.1.1 of this report]  
 Test Method: ANSI C63.10 Clause 6.5/6.6 [Reference 4.1.2 of this report]  
 Limits: 47 CFR Part 15C Part 15.247(d) & 15.209(a) [Reference 4.1.1 of this report]

### 5.6.2 Configuration of EUT

The EUT was placed on a 1.5 metres high turntable. The front edge of the EUT was initially positioned facing the antenna. The EUT was rotated in all three orthogonal planes to maximise emissions. Final measurements were taken at 3m. The EUT was operated in Modes 1, 2 and 3.

### 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 M.

### 5.6.4 Test equipment

E411, E624, E136, TMS82

See Section 9 for more details

### 5.6.5 Test results

Temperature of test environment 18°C  
 Humidity of test environment 68%  
 Pressure of test environment 102kPa

Band	2400-2483.5 MHz
Power Setting	8
Channel Spacing	5 MHz
Mod Scheme	OQPSK
Low channel	2405 MHz (Low)
Mid channel	2440 MHz (Mid)
High channel	2480 MHz (High)

	Low channel	Mid channel	High channel
Peak Level (dBµV/m)	92.24	97.70	97.06
Plot reference	14269-1 Latch Hawk 1701E Radiated Power Channel 11 (2405 MHz) Vertical Power Setting_ 8	14269-1 Latch Hawk 1701E Radiated Power Channel 18 (2440 MHz) Vertical Power Setting_ 8	14269-1 Latch Hawk 1701E Radiated Power Channel 26 (2480 MHz) Vertical Power Setting_ 8
Antenna Polarisation	Vert	Vert	Vert
EUT Polarisation	Upright	Upright	Upright

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

#### LIMITS:

The maximum output power in all cases is 30dBm/ 1Watt, where 30 dBm = 125.2 dBµV/m@3 m

These results show that the EUT has PASSED this test.

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

<± 3.9 dB

## 5.7 Band Edge Compliance

### 5.7.1 Test methods

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

### 5.7.2 Configuration of EUT

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

The EUT was operated in 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 Peak and average plots.

Tests were performed using Test Site M.

### 5.7.4 Test equipment

E411, E624, E136, TMS82

See Section 9 for more details

### 5.7.5 Test results

Temperature of test environment 18°C  
 Humidity of test environment 68%  
 Pressure of test environment 102kPa

Band	2400-2483.5 MHz
Power Setting	8
Channel Spacing	5 MHz
Mod Scheme	OQPSK
Low channel	2405 MHz (Low)
High channel	2480 MHz (High)

Restricted Band Edges	Low channel	High channel
Restricted Peak Level measured (dBuV/m)	36.5	55.1
Restricted band edge Peak Plot	13769-1 Restricted BE Channel 11 (2405 MHz) Power Setting 8 Peak Upright Position Vertical	13769-1 Restricted BE Channel 26 (2480 MHz) Power Setting 8 Peak Upright Position Vertical
Restricted Average Level measured (dBuV/m)	27.0	45.0
Restricted band edge Average Plot	13769-1 Restricted BE Channel 11 (2405 MHz) Power Setting 8 Average Upright Position Vertical	14269-1 Restricted BE Channel 26 (2480 MHz) Power Setting 8 Average Upright Position Vertical

Authorised Band Edges	Low channel	High channel
Authorised Band Edge (dBc) value measured	-58.9	-51.8
Authorised Band Edge Plot	13769-1 Authorised Band Edge Channel 11 (2405 MHz) Power Setting 8 Peak Upright Position Vertical	13769-1 Authorised Band Edge Channel 26 (2480 MHz) Power Setting 8 Peak Upright Position Vertical

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 temporary RF port. The EUT was operated in Modes 1, 2 and 3.

### 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 B.

### 5.8.4 Test equipment

E301, E534, P289

See Section 9 for more details

### 5.8.5 Test results

Temperature of test environment 23°C  
 Humidity of test environment 58%  
 Pressure of test environment 101kPa

Band	2400-2483.5 MHz
Power Setting	8
Channel Spacing	5 MHz
Mod Scheme	OQPSK
Low channel	2405 MHz (Low Ch)
Mid channel	2440 MHz (Mid Ch)
High channel	2480 MHz (High Ch)

	Low channel	Mid channel	High channel
6 dB Bandwidth Result (MHz)	1.277	1.465	1.544
Plot for 6 dB Bandwidth Result (MHz)	13769-1 OBW Low Channel (2405 MHz)	13769-1 OBW Mid Channel (2440 MHz)	13769-1 OBW High Channel (2480 MHz)
99 % Bandwidth Result (MHz)	2.2283	2.2364	2.2478
Frequency Error (kHz) (include sign)	-16.992	-15.168	-18.931
Operating frequency (MHz)	2405	2440	2480
6 dB FLOW Worst case (MHz)	2404.344508	2439.252332	2479.209069
6 dB FHIGH Worst case (MHz)	2405.621508	2440.717332	2480.753069

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:  
 $\leq \pm 1.9 \%$

## 5.9 Maximum Average conducted output power

NOT TESTED: Peak Conducted Power carried out instead.

## 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 11.9 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 temporary RF port.

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

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

### 5.10.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment noted below.  
 Peak stated reading is maximum power observed using a spectrum analyser RBW > 6dB BW of the EUT

Measurements were made on a test bench in site B.

### 5.10.4 Test equipment

E301, E534, P289

See Section 9 for more details

### 5.10.5 Test results

Temperature of test environment 21°C  
 Humidity of test environment 62%  
 Pressure of test environment 102kPa

Band	2400-2483.5 MHz
Power Level	8
Channel Spacing	5 MHz
Mod Scheme	OQPSK
Low channel	2405 MHz (Low Ch)
Mid channel	2440 MHz (Mid Ch)
High channel	2480 MHz (High Ch)

Nominal voltage result (dBm)	5.37	6.72	6.07
Plot reference	13769-1 '2.0 20 dBm' Conducted RF Power Channel 11 (2405 MHz) Power Setting_ 8	13769-1 '2.0 20 dBm' Conducted RF Power Channel 18 (2440 MHz) Power Setting_ 8	13769-1 '2.0 20 dBm' Conducted RF Power Channel 26 (2480 MHz) Power Setting_ 8
Limit in dBm	30.00	30.00	30.00
Maximum result (dBm)	5.37	6.72	6.07
Margin to Limit (dB)	-24.63	-23.28	-23.93
Result in (W)	0.003	0.005	0.004

#### LIMITS:

15.247(b)(3) - For systems using digital modulation in the 902-928, 2400-2483.5 or 5725-5850 MHz bands 1 Watt (+30 dBm).

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 11.10 [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 peak conducted power test. The EUT was operated in Modes 1, 2 and 3 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 B.

### 5.11.4 Test equipment

E301, E534, P289

See Section 9 for more details

### 5.11.5 Test results

Temperature of test environment 21°C  
 Humidity of test environment 62%  
 Pressure of test environment 102kPa

Band	2400-2483.5 MHz
Power Level	8
Channel Spacing	5 MHz
Mod Scheme	OQPSK
Low channel	2405 MHz (Low Ch)
Mid channel	2440 MHz (Mid Ch)
High channel	2480 MHz (High Ch)

	Low channel	Mid channel	High channel
Peak PSD (dBm/3 kHz)	-4.8	-3.35	-4.07
Plot reference	13769-1 '2.0 20 dBm' PSD Channel 11 (2405 MHz) Power Setting_ 8	13769-1 '2.0 20 dBm' PSD Channel 18 (2440 MHz) Power Setting_ 8	13769-1 '2.0 20 dBm' PSD Channel 26 (2480 MHz) Power Setting_ 8

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:  
 $\leq \pm 2$  dB



## 5.12 Antenna power conducted emissions

NOT APPLICABLE: Applies to EUT's with an antenna port. The EUT has an integral antenna only.

## 5.13 Duty cycle

NOT APPLICABLE: No limits apply, however duty cycle measurements performed to verify any possible correction factors for average results (if required). See plots section.

## 5.14 FHSS carrier frequency separation

NOT APPLICABLE: EUT does not employ FHSS technology

## 5.15 Average time of occupancy

NOT APPLICABLE: EUT does not employ FHSS technology

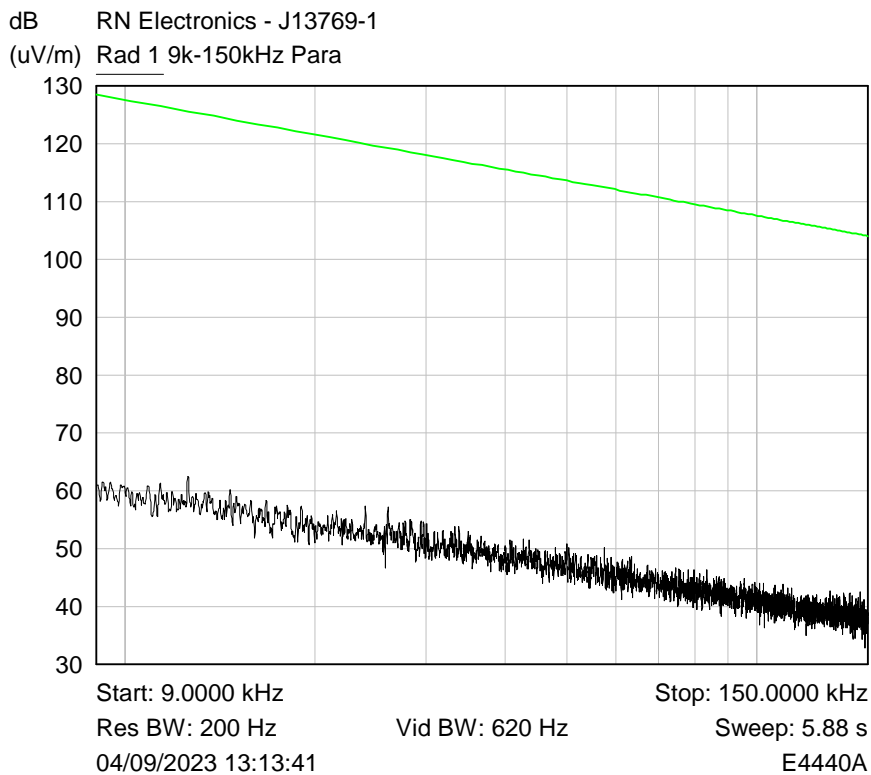
## 5.16 Number of Hop Channels

NOT APPLICABLE: EUT does not employ FHSS technology

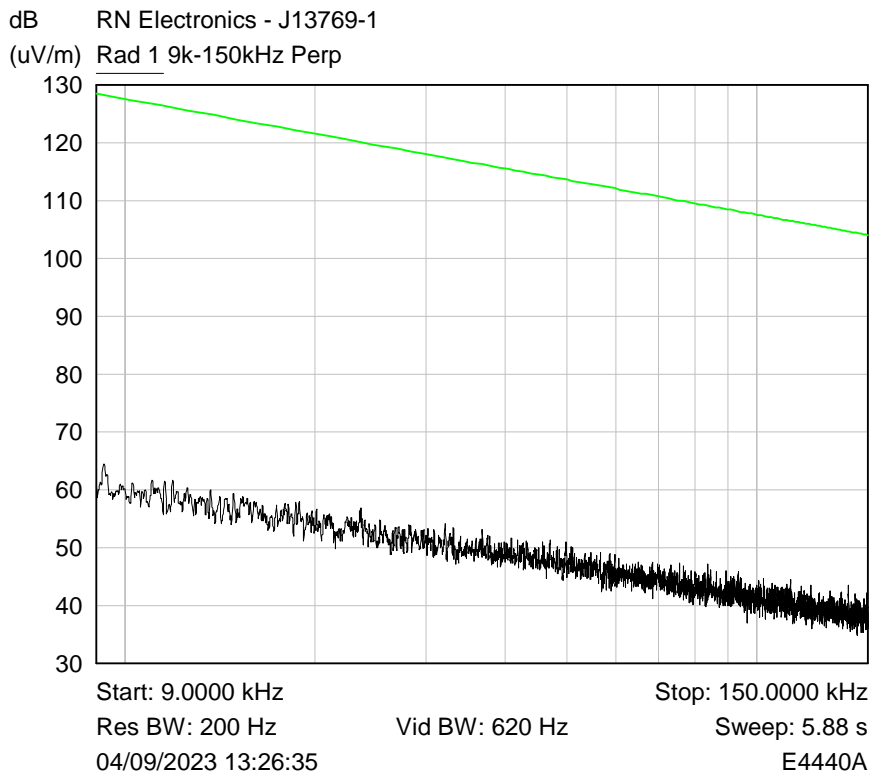
## 6 Plots/Graphical results

### 6.1 Radiated emissions 9 - 150 kHz

RF Parameters: Band 2400-2483.5 MHz, Power 8, Channel Spacing 5 MHz, Modulation OQPSK, Channel 2440 MHz (Mid Ch)



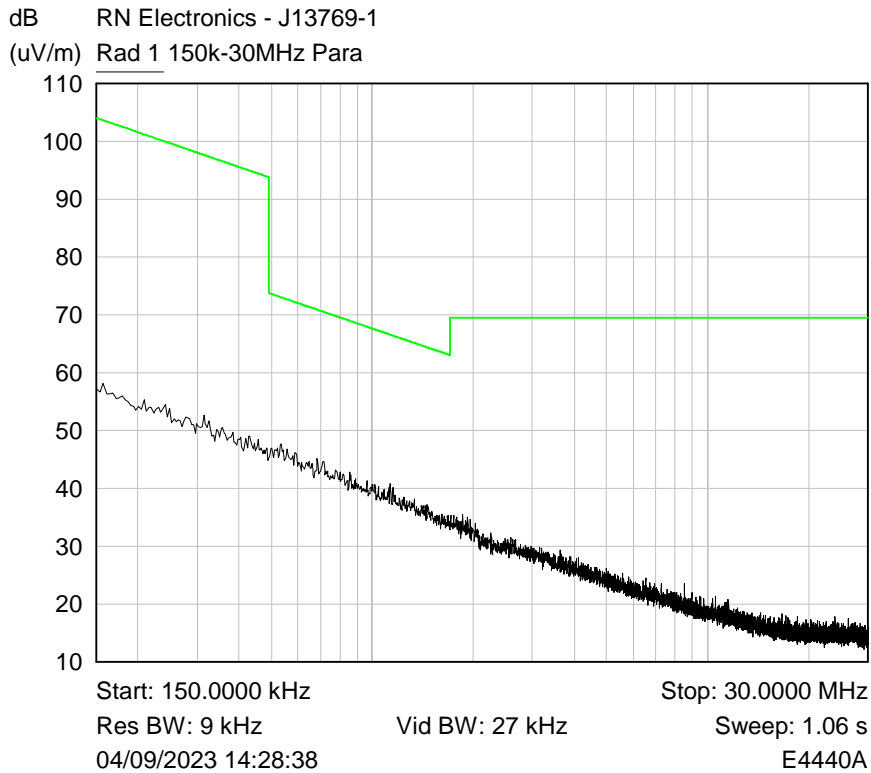
Plot of 9k-150kHz Parallel



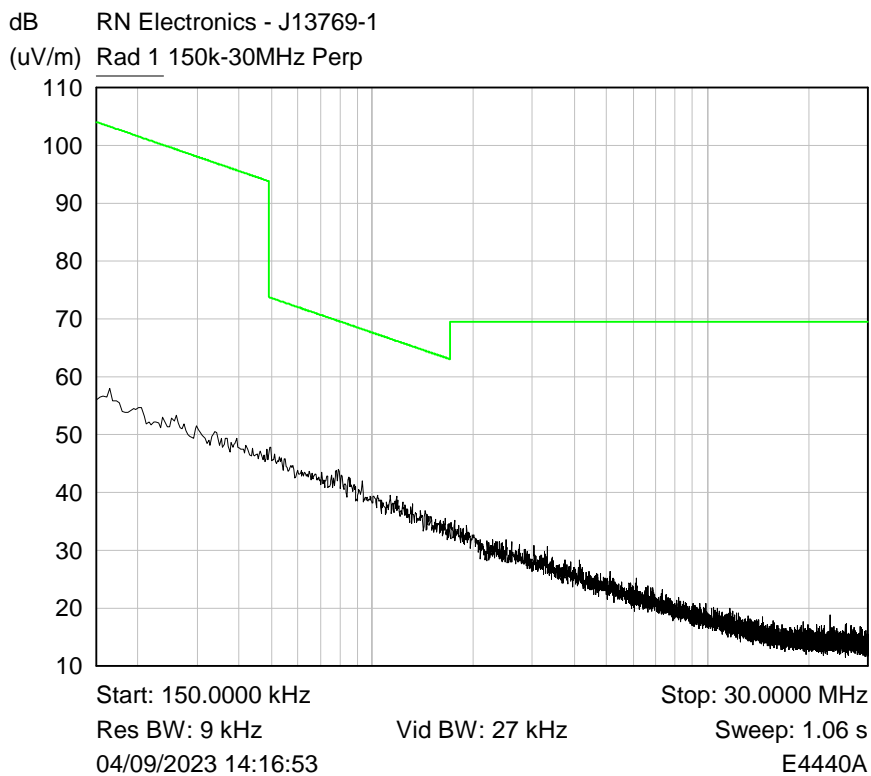
Plot of 9k-150kHz Perpendicular

## 6.2 Radiated emissions 150 kHz - 30 MHz

RF Parameters: Band 2400-2483.5 MHz, Power 8, Channel Spacing 5 MHz, Modulation OQPSK, Channel 2440 MHz (Mid Ch)



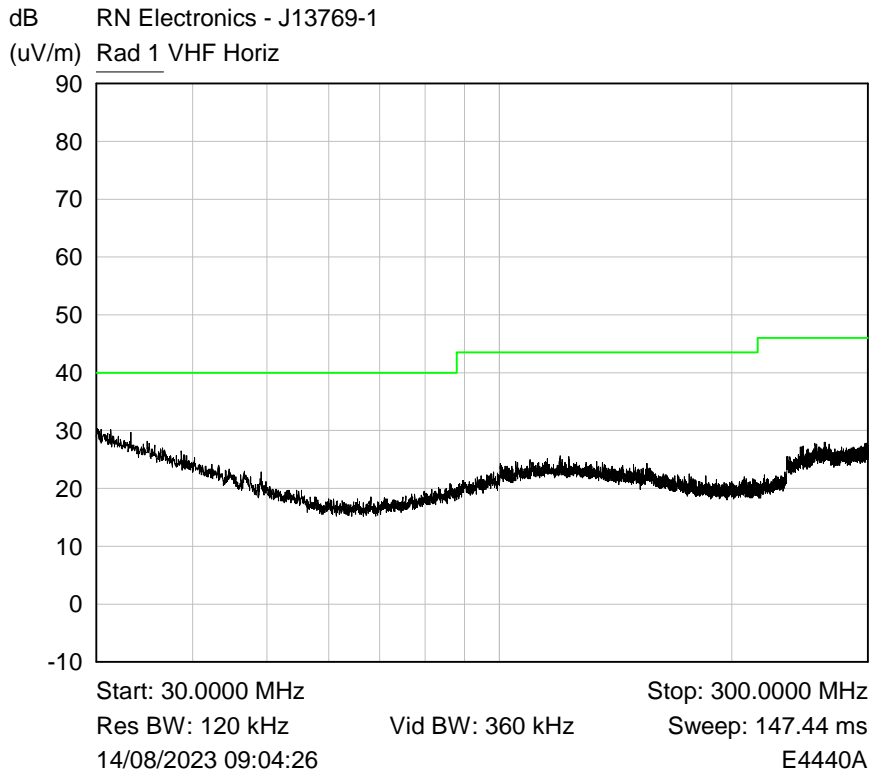
Plot of 150kHz-30MHz Parallel



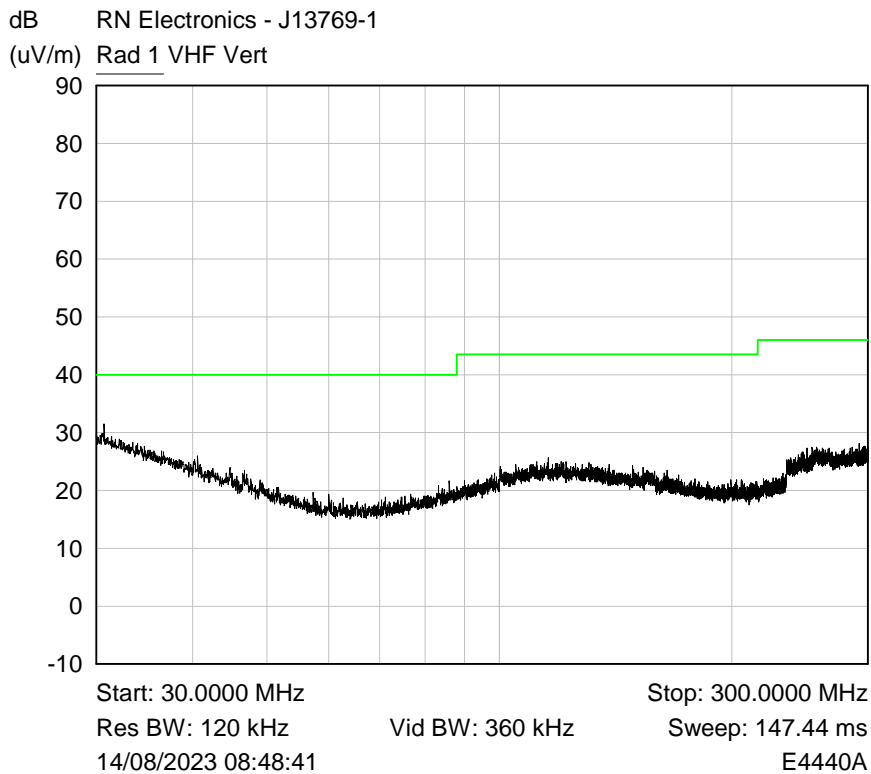
Plot of 150kHz-30MHz Perpendicular

### 6.3 Radiated emissions 30 MHz -1 GHz

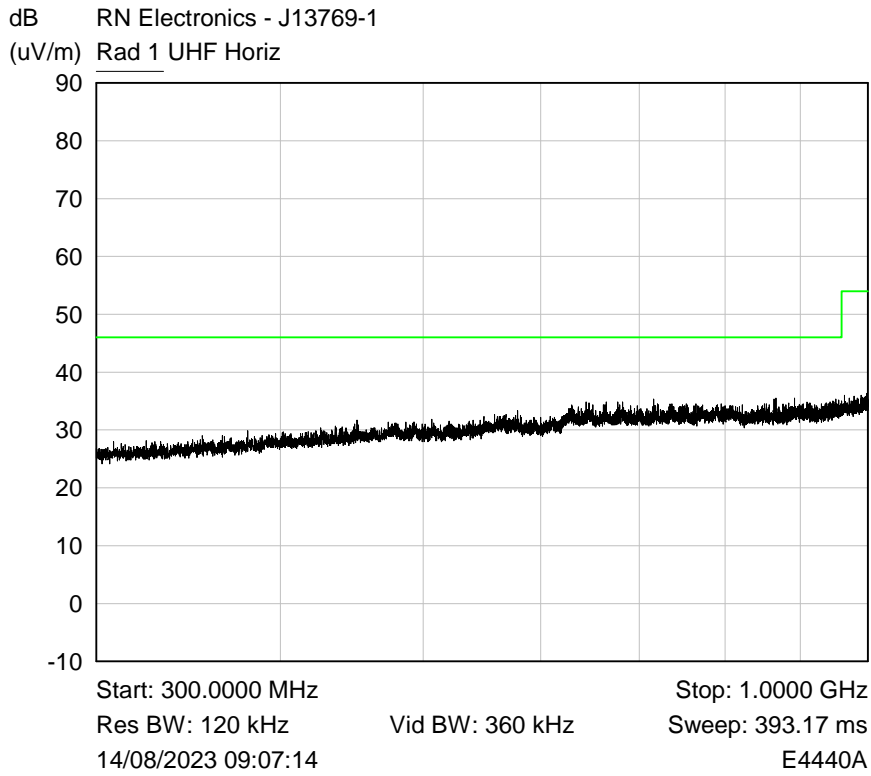
RF Parameters: Band 2400-2483.5 MHz, Power 8, Channel Spacing 5 MHz, Modulation OQPSK, Channel 2440 MHz (Mid Ch)



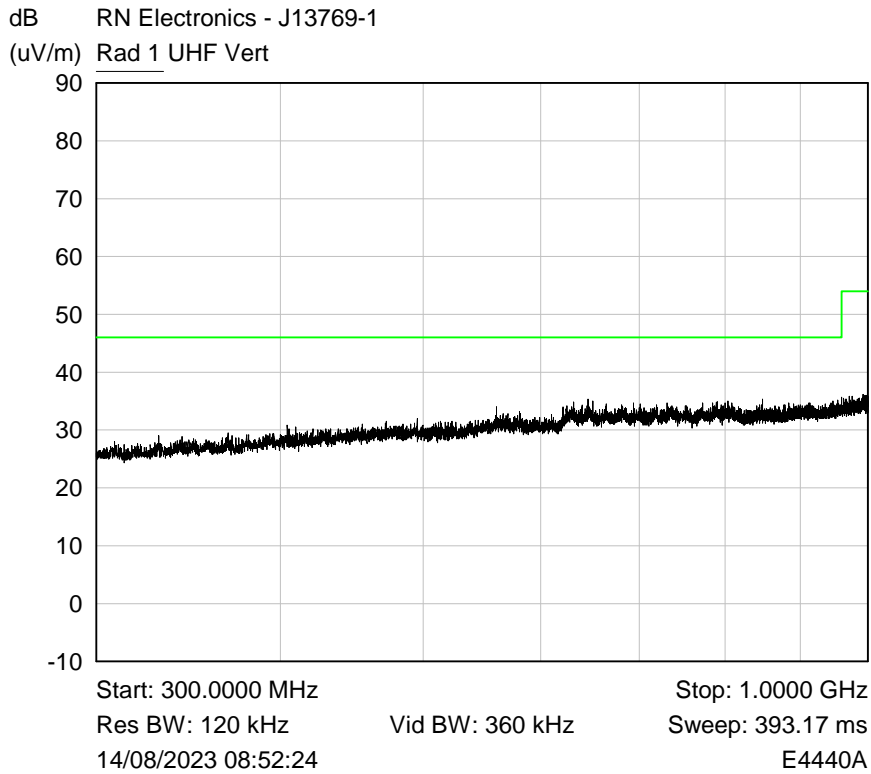
Plot of Peak emissions for VHF Horizontal against the QP limit line.



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



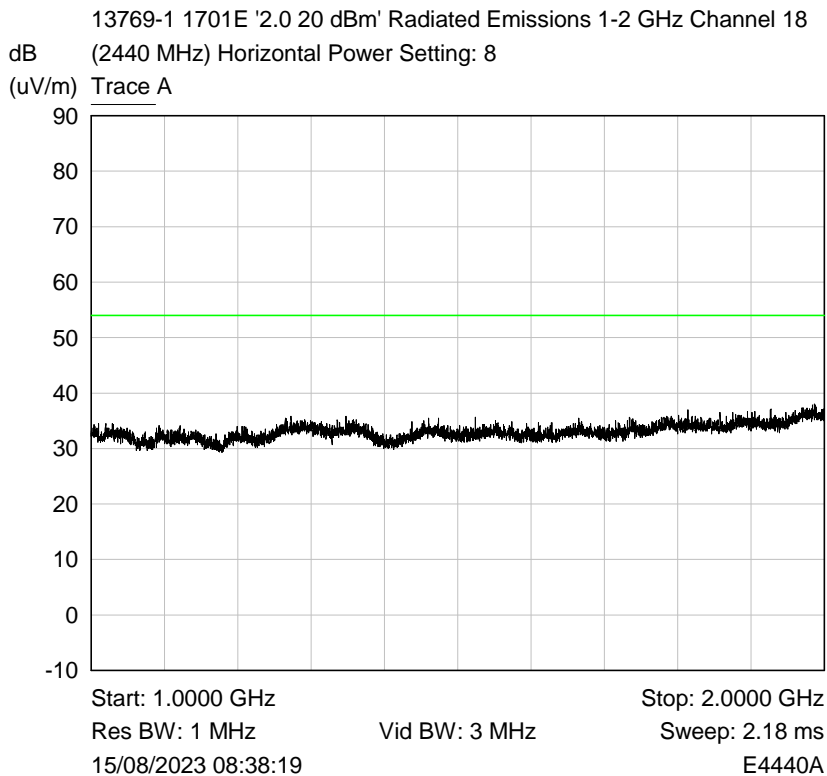
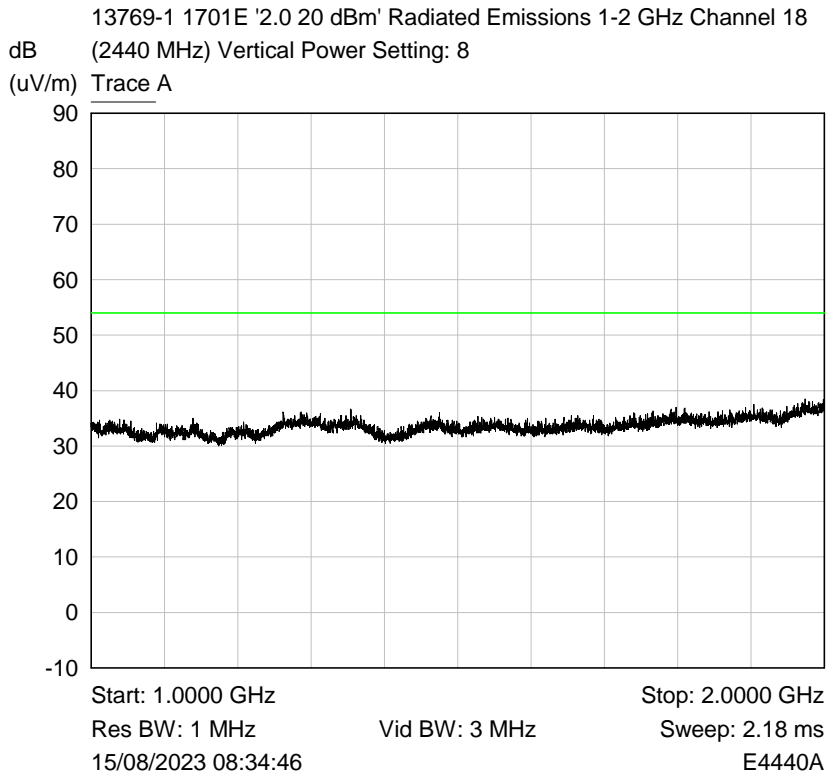
Plot of Peak emissions for UHF Horizontal against the QP limit line.

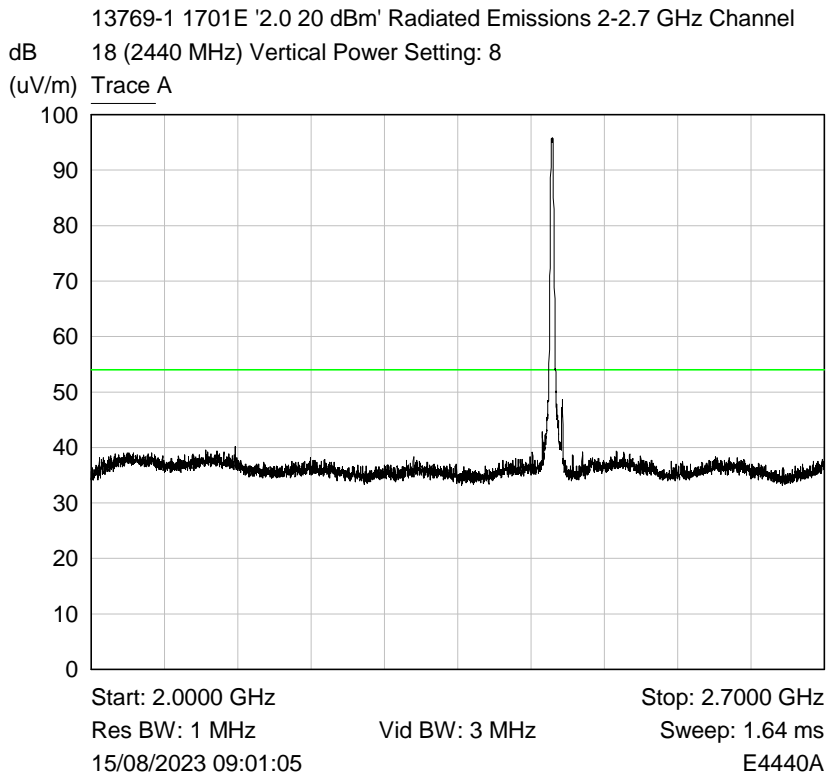


Plot of Peak emissions for UHF Vertical against the QP limit line.

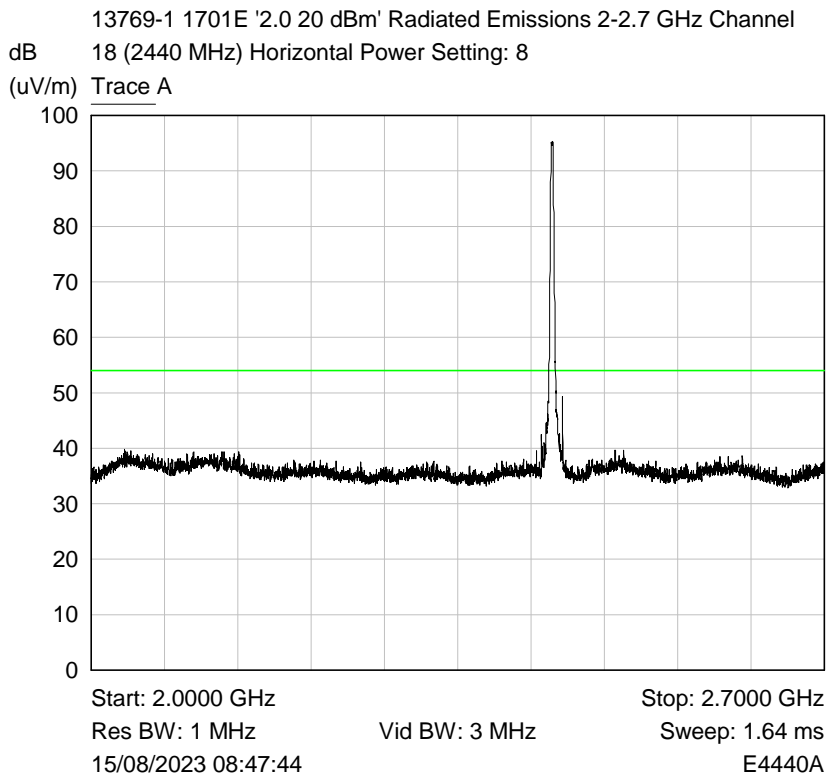
## 6.4 Radiated emissions above 1 GHz

RF Parameters: Band 2400-2483.5 MHz, Power 8, Channel Spacing 5 MHz, Modulation OQPSK, Channel 2440 MHz (Mid Ch)

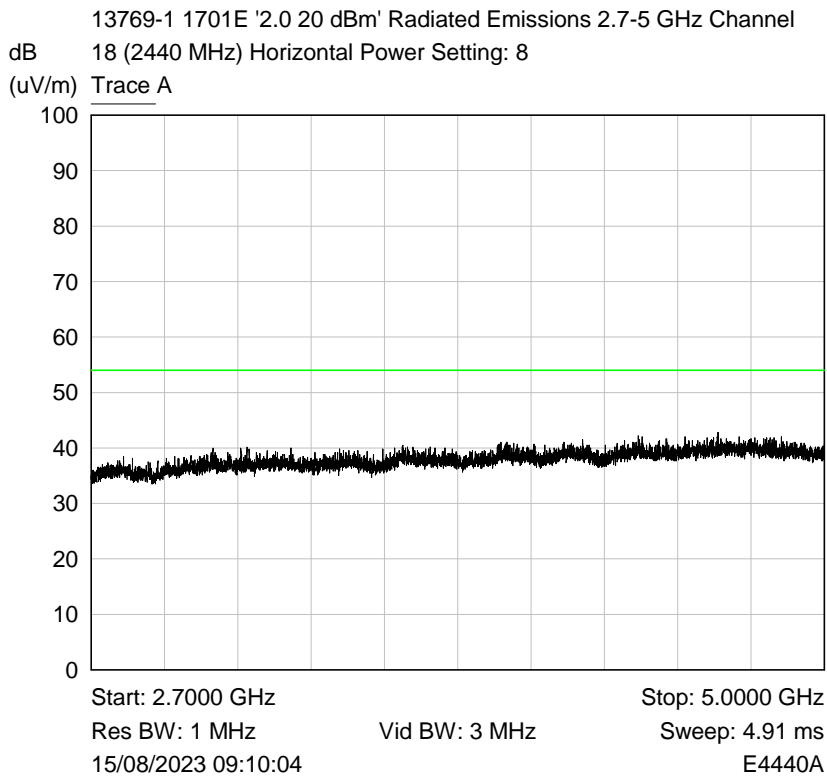
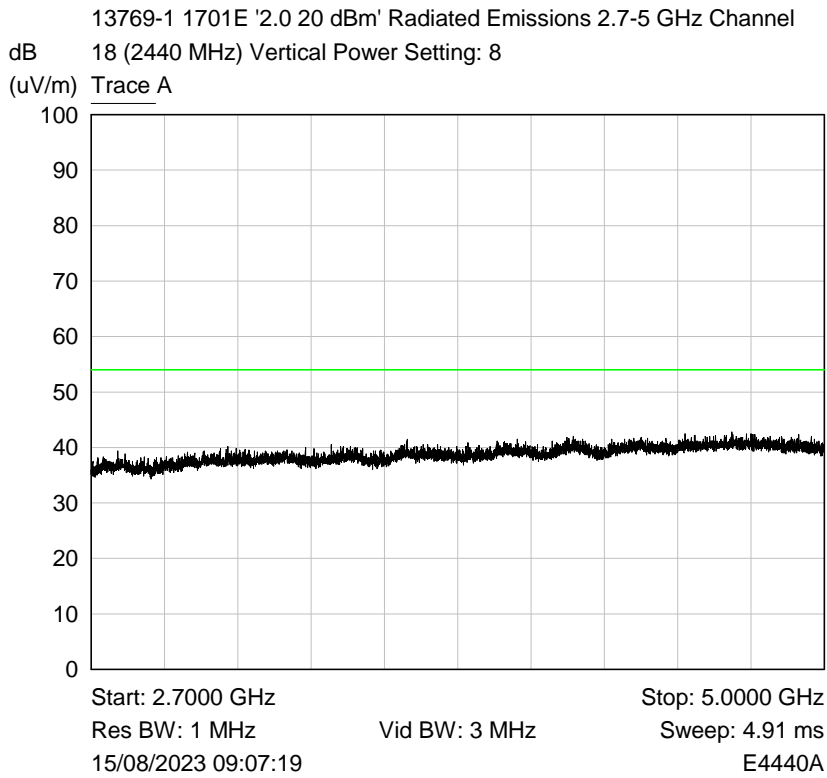




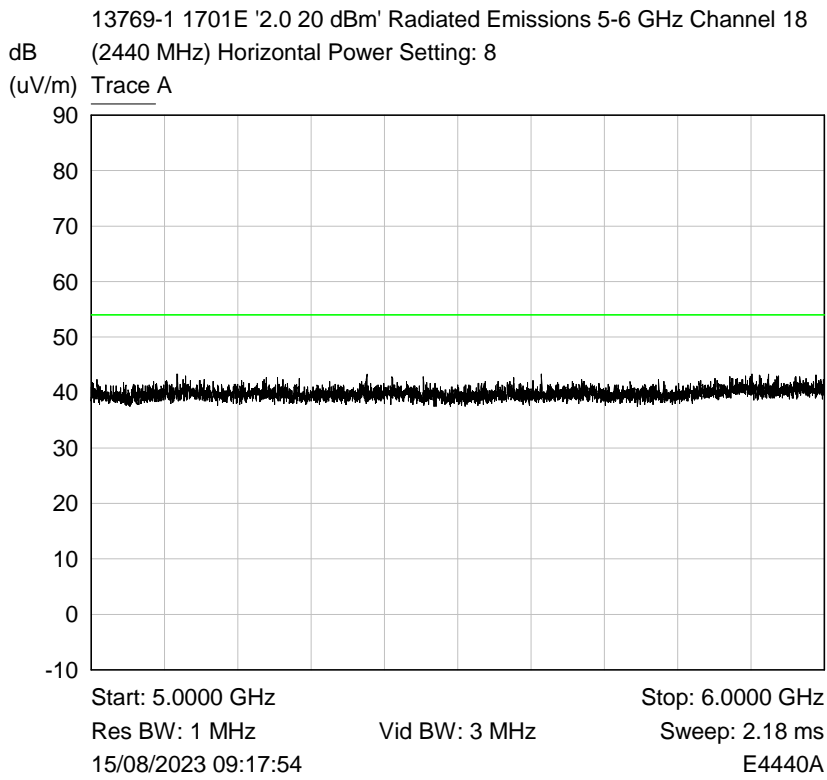
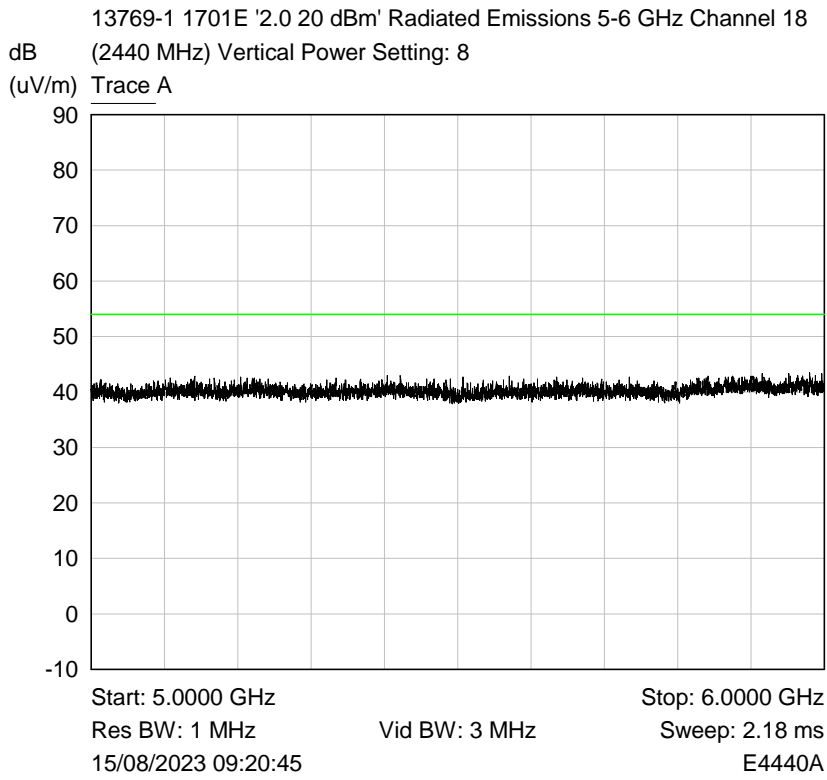
Note: fundamental shown on plot.

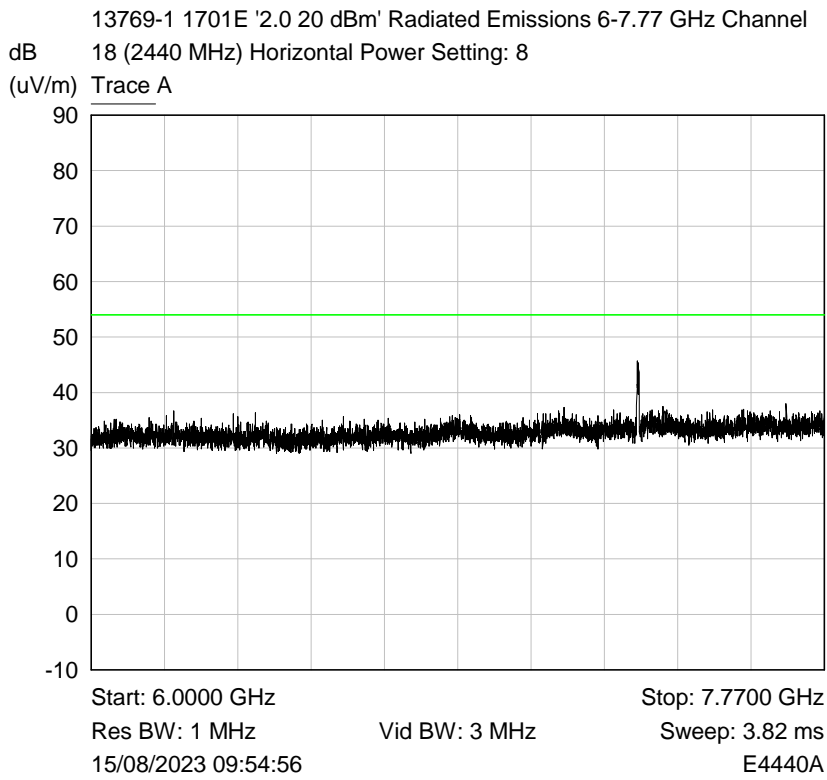
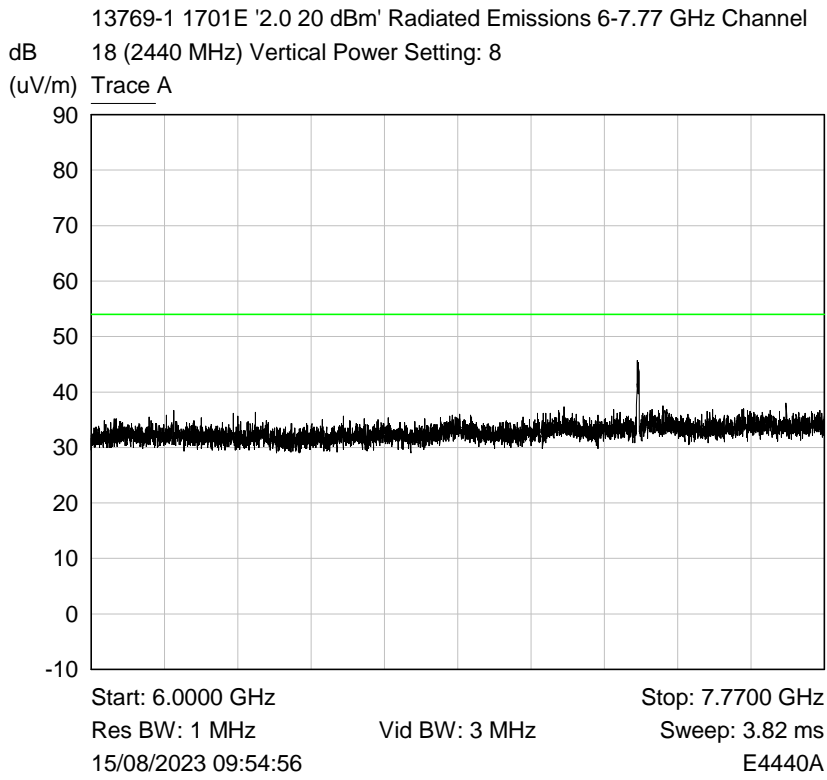


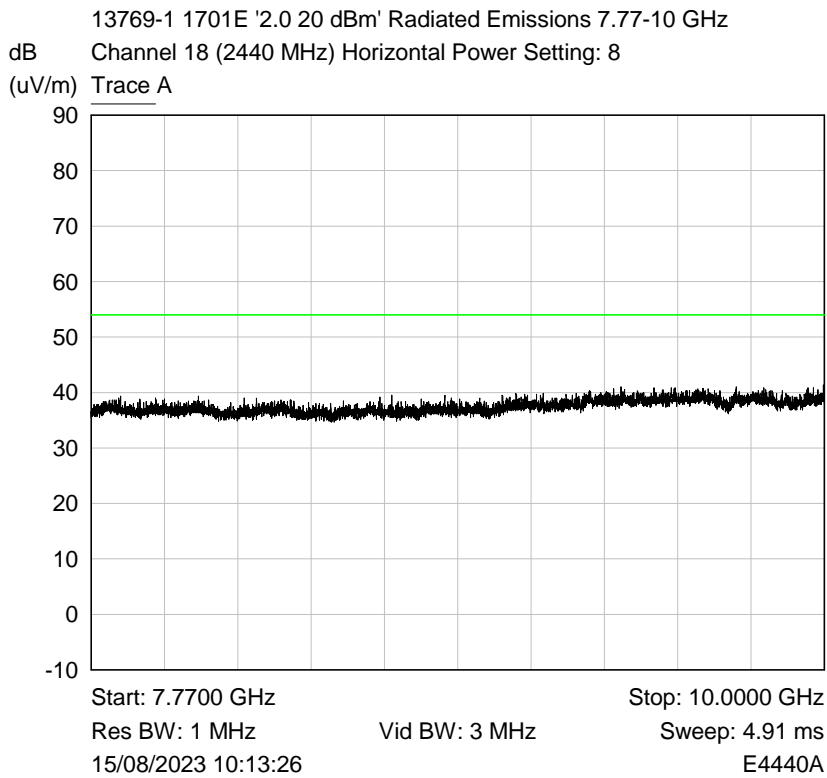
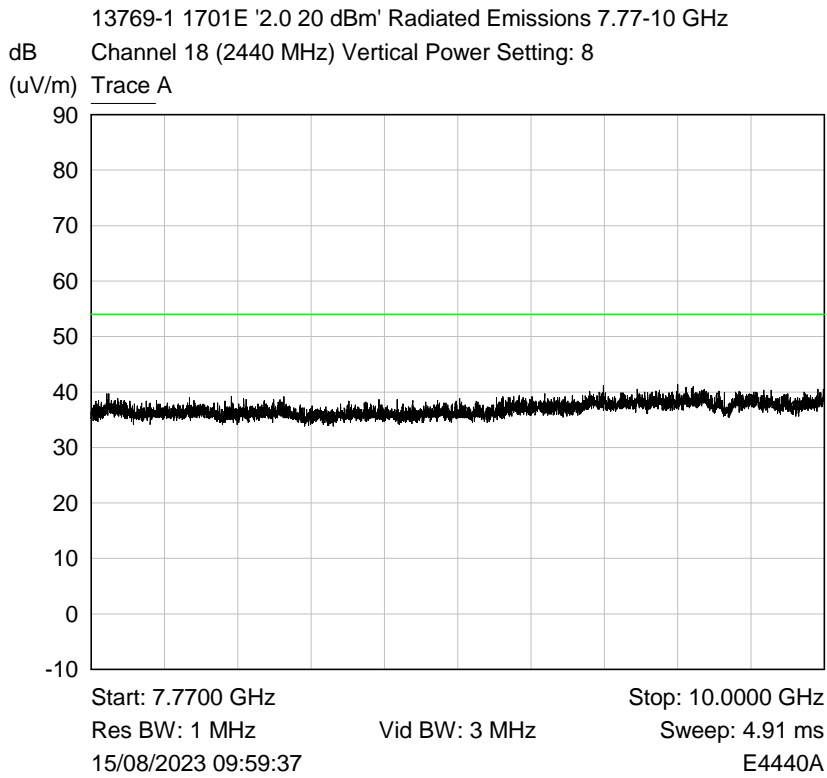
Note: fundamental shown on plot.

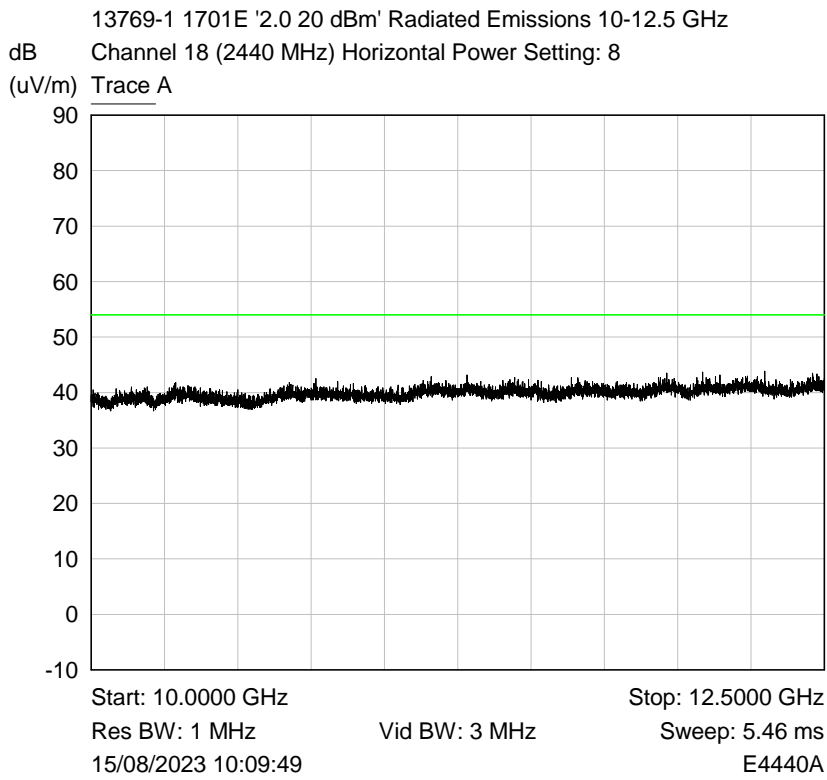
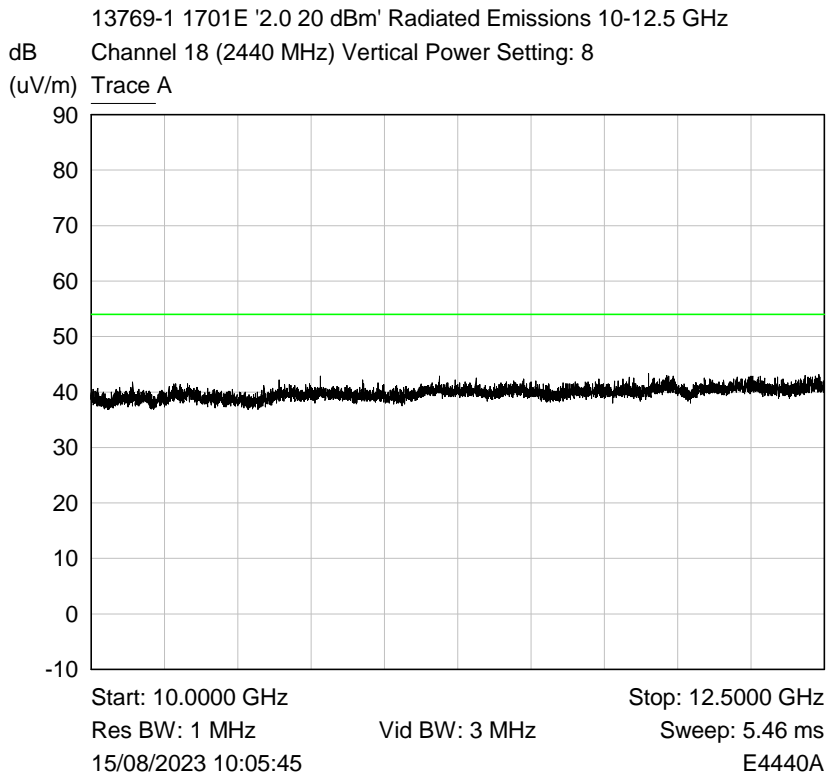


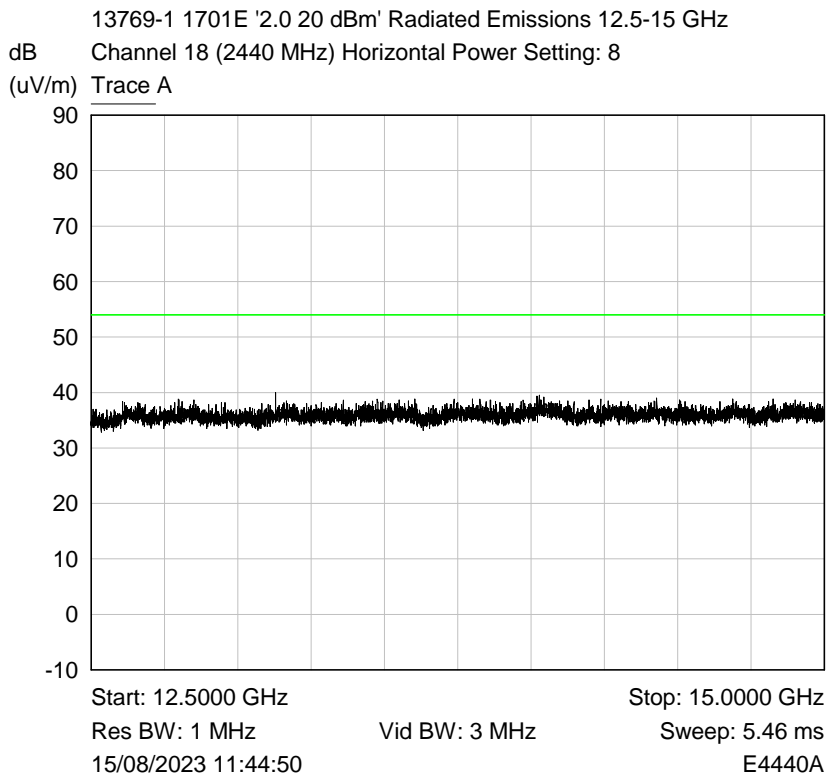
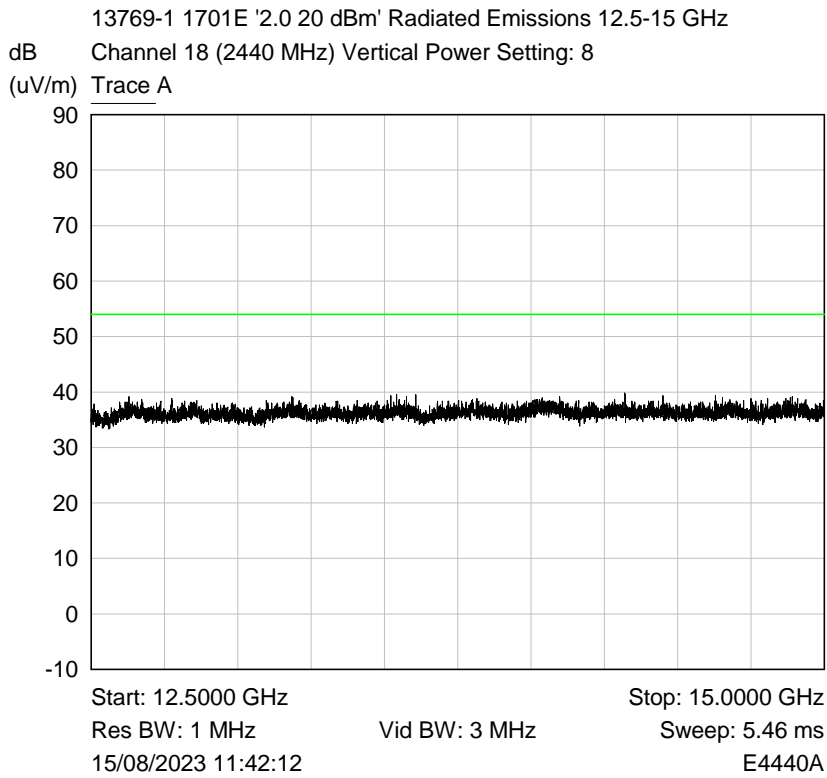


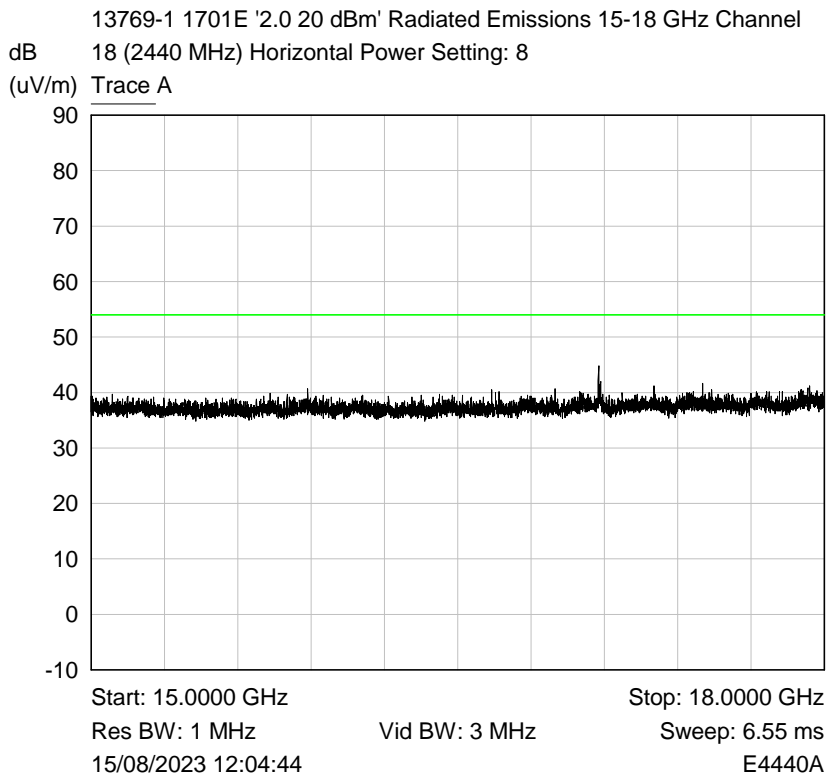
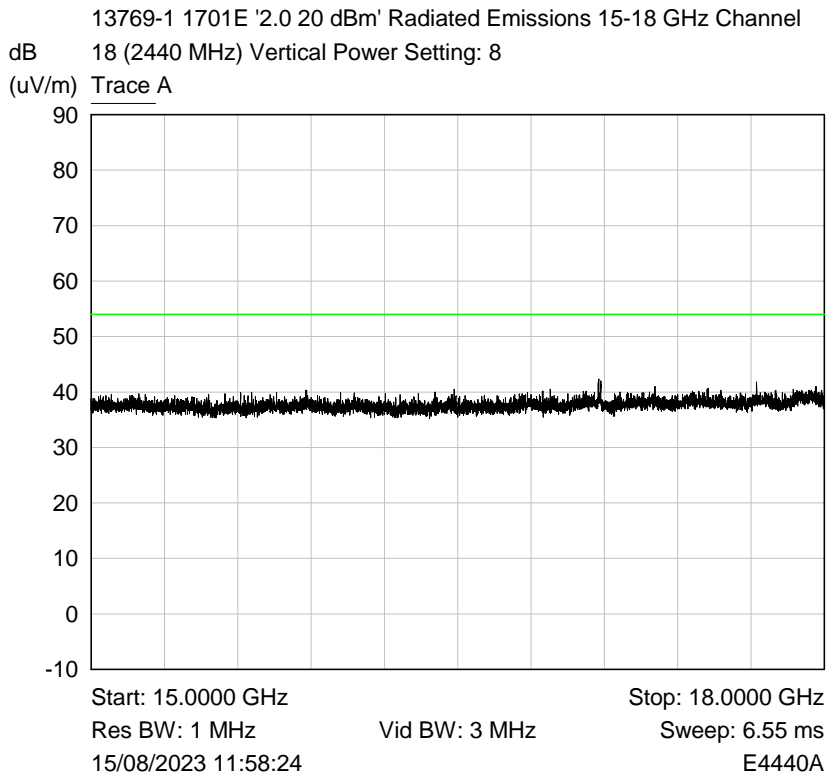


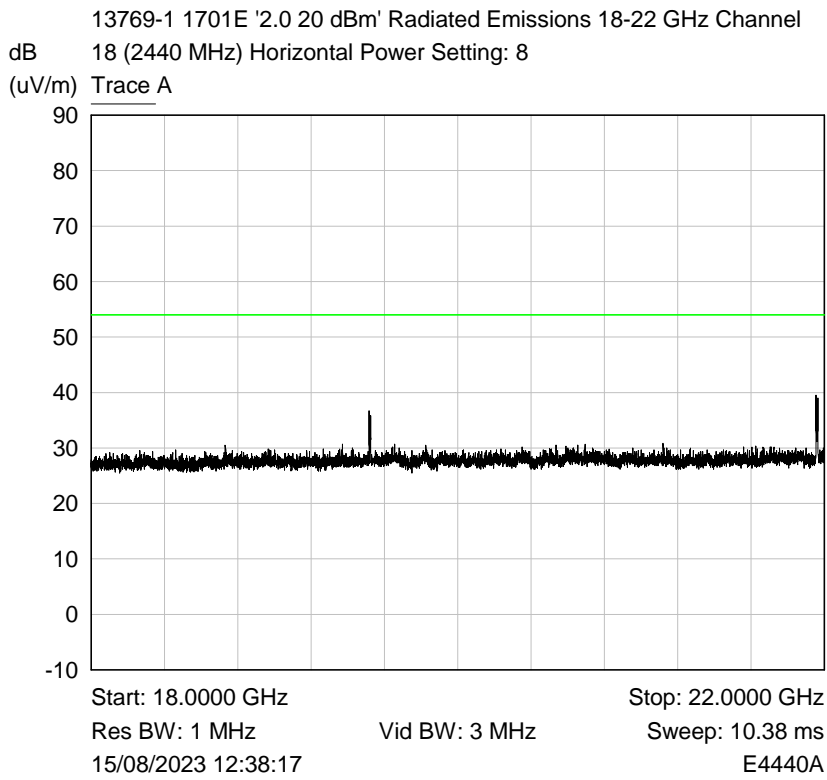
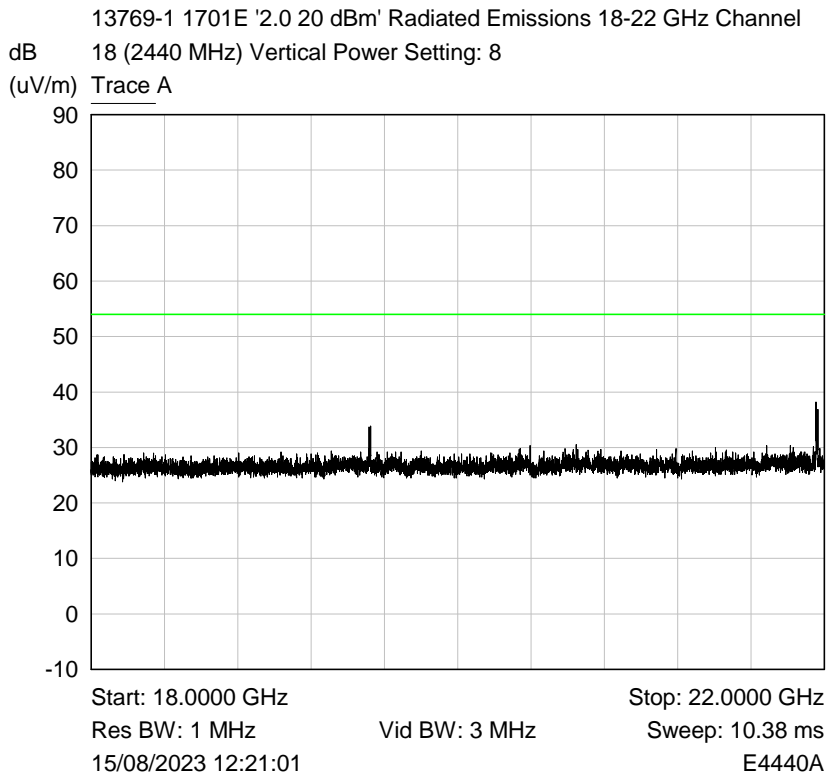


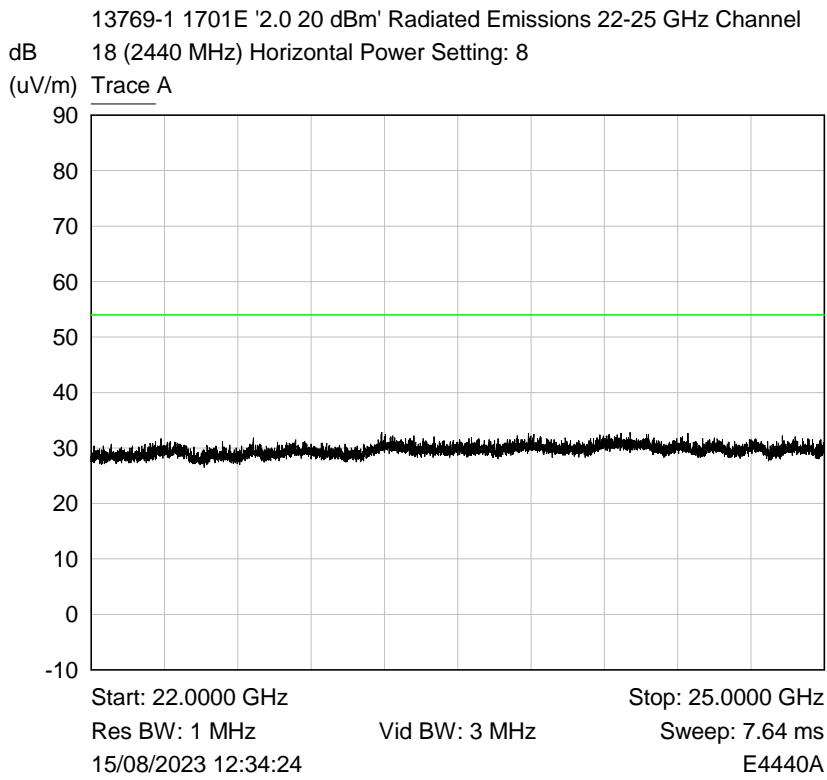
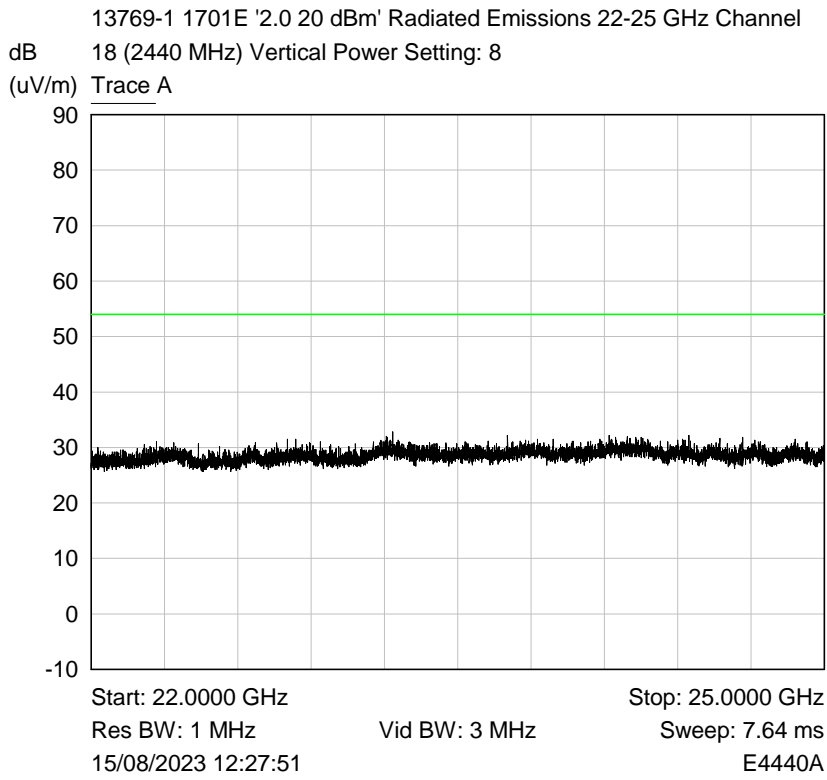








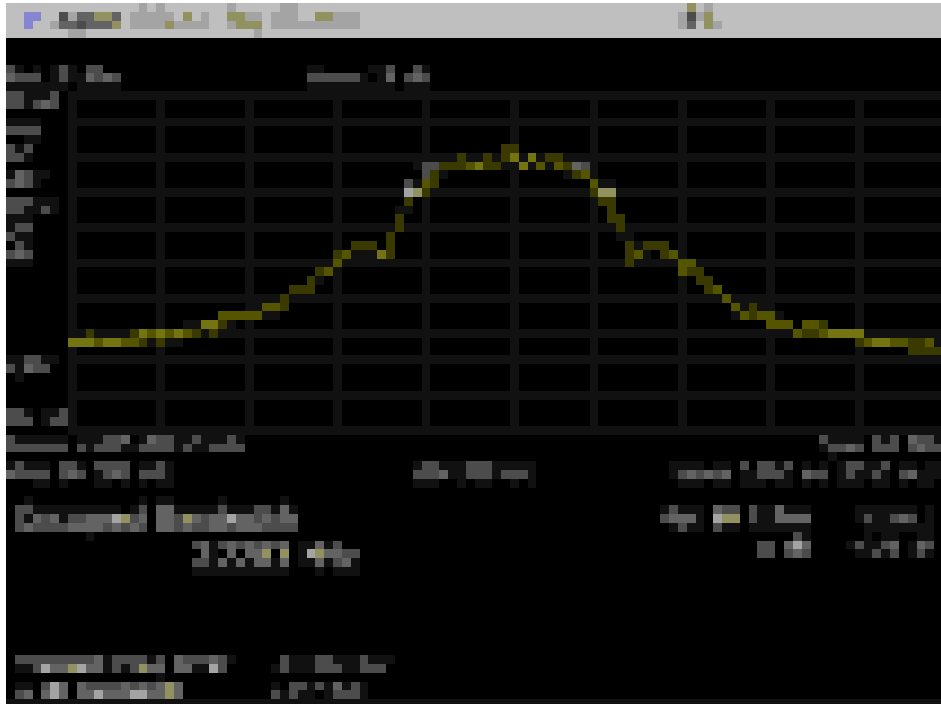






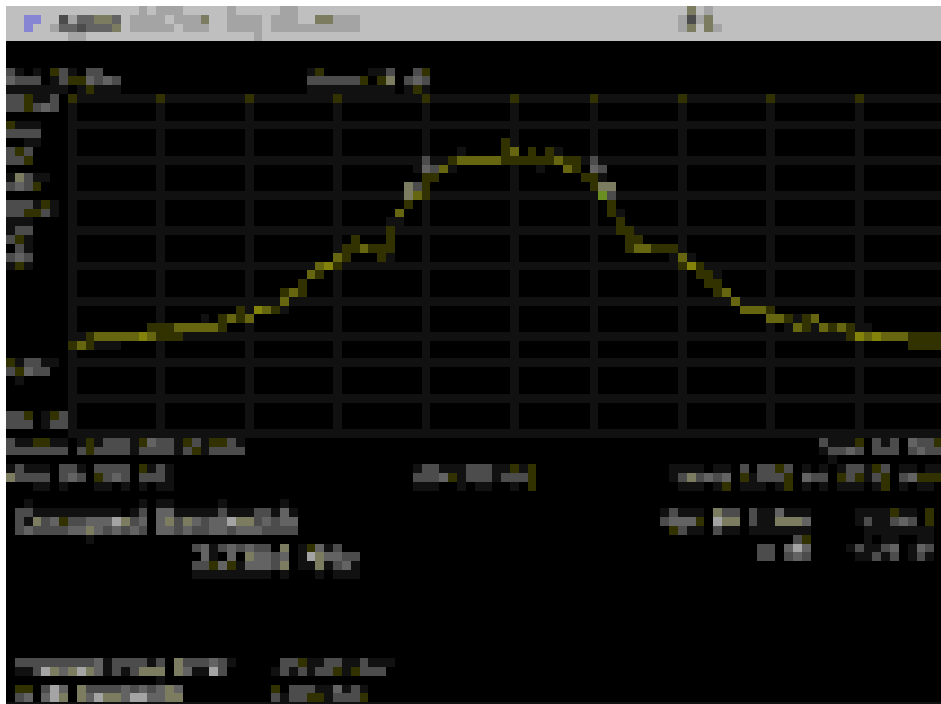
### 6.5 Occupied bandwidth

RF Parameters: Band 2400-2483.5 MHz, Power 8, Channel Spacing 5 MHz, Modulation OQPSK, Channel 2405 MHz (Low Ch)



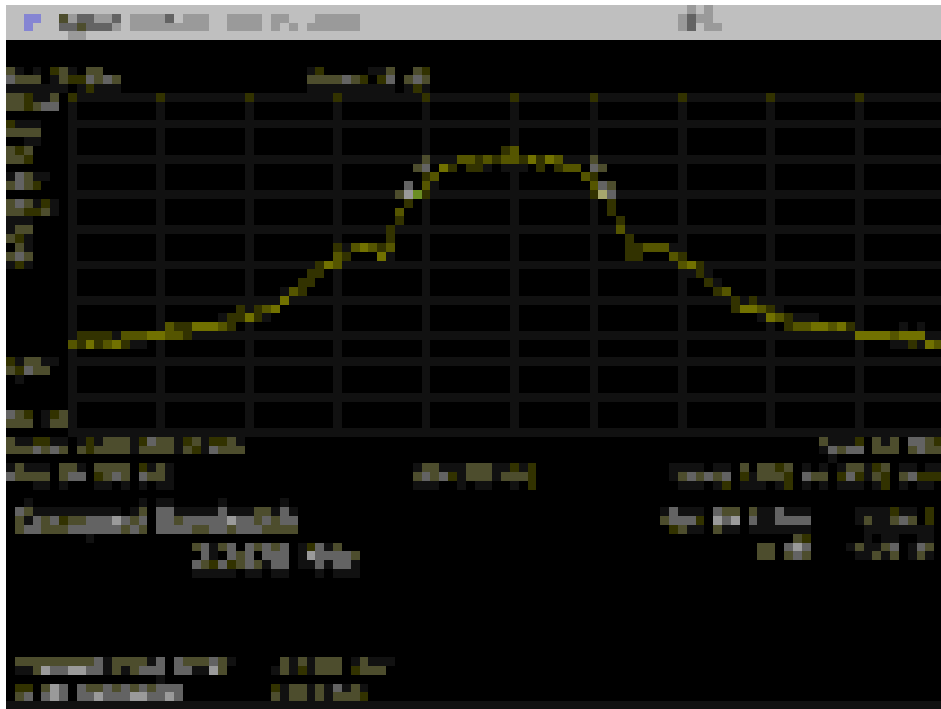
OBW Low Channel (2405 MHz)

RF Parameters: Band 2400-2483.5 MHz, Power 8, Channel Spacing 5 MHz, Modulation OQPSK, Channel 2440 MHz (Mid Ch)



OBW Mid Channel (2440 MHz)

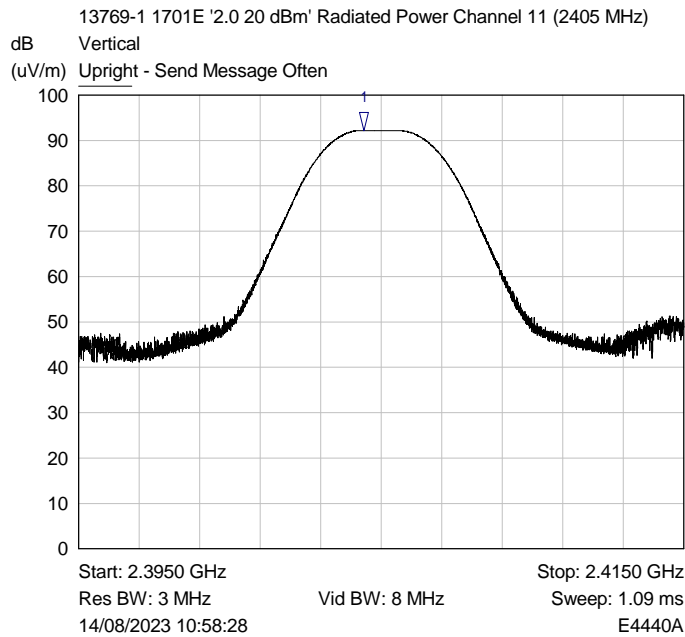
RF Parameters: Band 2400-2483.5 MHz, Power 8, Channel Spacing 5 MHz, Modulation  
OQPSK, Channel 2480 MHz (High Ch)



OBW High Channel (2480 MHz)

### 6.6 Effective radiated power field strength

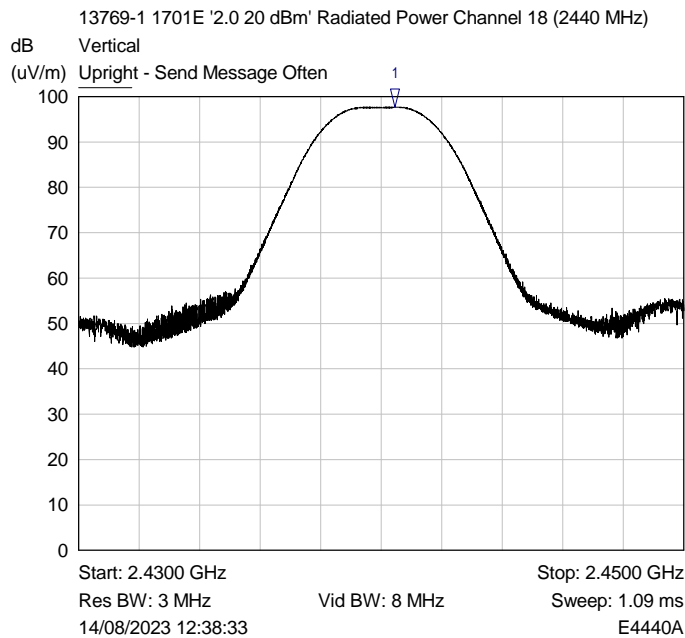
RF Parameters: Band 2400-2483.5 MHz, Power 8, Channel Spacing 5 MHz, Modulation OQPSK, Channel 2405 MHz (Low Ch)



Mkr	Trace	X-Axis	Value	Notes
1 ▾	Upright - Send Message Often	2.4044 GHz	92.24 dB(uV/m)	

Plot of Vert polarisation and EUT in Upright position

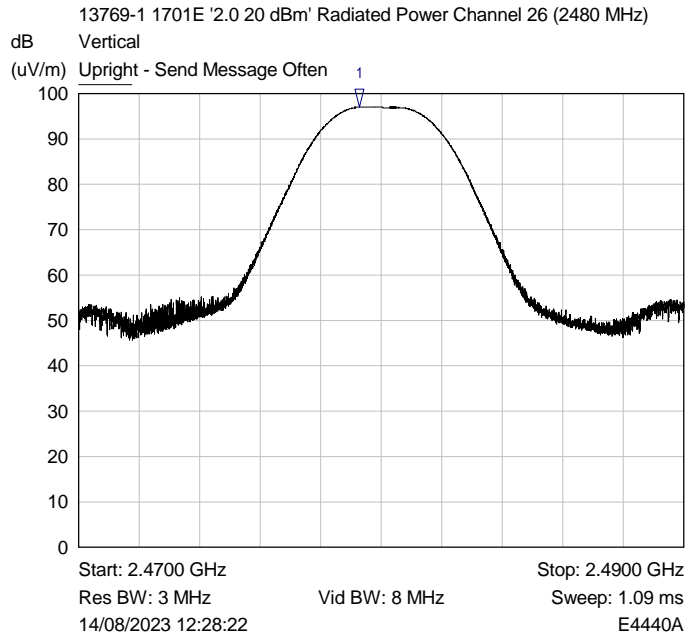
RF Parameters: Band 2400-2483.5 MHz, Power 8, Channel Spacing 5 MHz, Modulation OQPSK, Channel 2440 MHz (Mid Ch)



Mkr	Trace	X-Axis	Value	Notes
1 ▾	Upright - Send Message Often	2.4405 GHz	97.70 dB(uV/m)	

Plot of Vert polarisation and EUT in Upright position

RF Parameters: Band 2400-2483.5 MHz, Power 8, Channel Spacing 5 MHz, Modulation OQPSK, Channel 2480 MHz (High Ch)

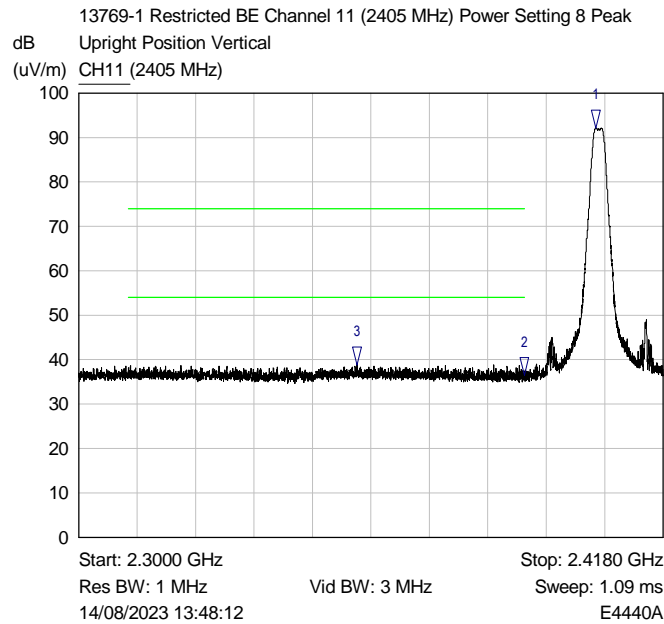


Mkr	Trace	X-Axis	Value	Notes
1 ▾	Upright - Send Message Often	2.4793 GHz	97.06 dB(uV/m)	

Plot of Vert polarisation and EUT in Upright position

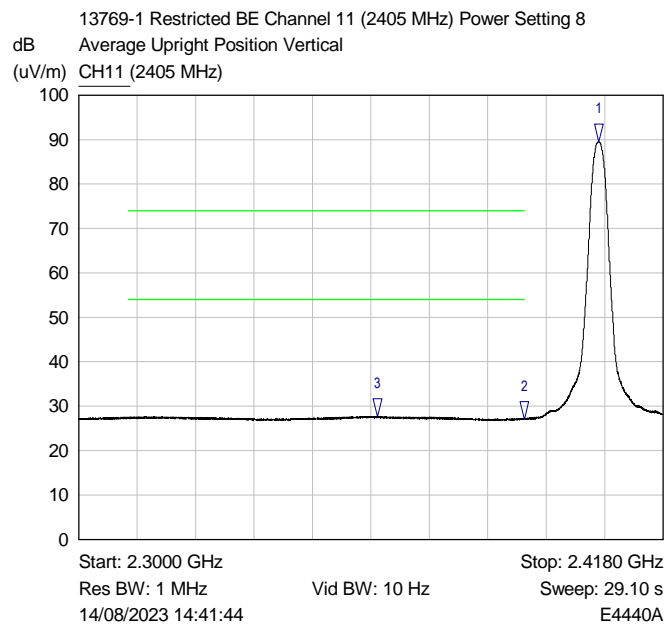
## 6.7 Band Edge Compliance

RF Parameters: Band 2400-2483.5 MHz, Power 8, Channel Spacing 5 MHz, Modulation OQPSK, Channel 2405 MHz (Low Ch)



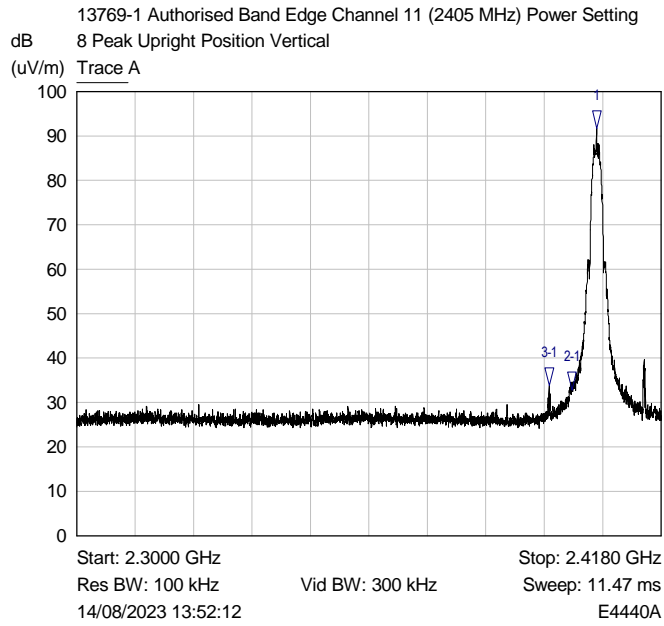
Mkr	Trace	X-Axis	Value	Notes
1 ▽	CH11 (2405 MHz)	2.4044 GHz	92.17 dB(uV/m)	
2 ▽	CH11 (2405 MHz)	2.3900 GHz	36.50 dB(uV/m)	
3 ▽	CH11 (2405 MHz)	2.3562 GHz	38.84 dB(uV/m)	

### Restricted band edge Peak Plot



Mkr	Trace	X-Axis	Value	Notes
1 ▽	CH11 (2405 MHz)	2.4050 GHz	89.53 dB(uV/m)	
2 ▽	CH11 (2405 MHz)	2.3900 GHz	26.96 dB(uV/m)	
3 ▽	CH11 (2405 MHz)	2.3604 GHz	27.68 dB(uV/m)	

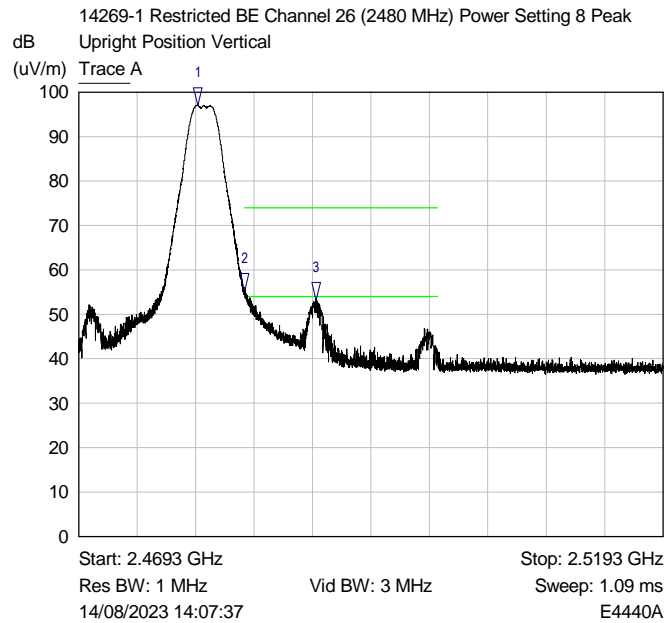
### Restricted band edge Average Plot



Mkr	Trace	X-Axis	Value	Notes
1	Trace A	2.4050 GHz	91.71 dB(uV/m)	
2-1	Trace A	2.4000 GHz	-58.88 dB	
3-1	Trace A	-9.5944 MHz	-57.81 dB	

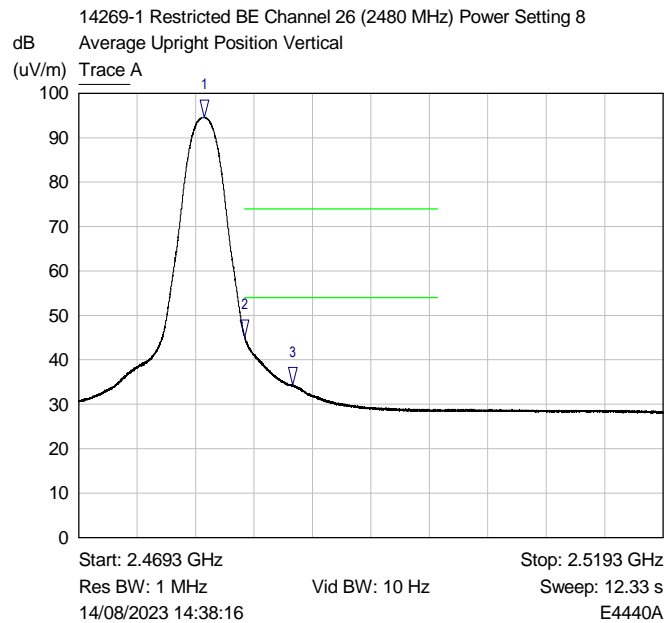
Authorised Band Edge Plot

RF Parameters: Band 2400-2483.5 MHz, Power 8, Channel Spacing 5 MHz, Modulation  
 OQPSK, Channel 2480 MHz (High Ch)



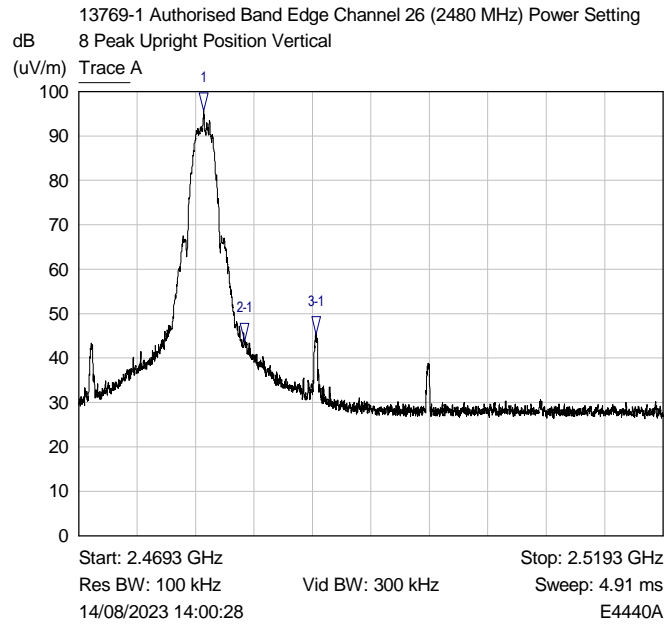
Mkr	Trace	X-Axis	Value	Notes
1 ▾	Trace A	2.4795 GHz	96.98 dB(uV/m)	
2 ▾	Trace A	2.4835 GHz	55.10 dB(uV/m)	
3 ▾	Trace A	2.4896 GHz	53.20 dB(uV/m)	

Restricted band edge Peak Plot



Mkr	Trace	X-Axis	Value	Notes
1 ▾	Trace A	2.4800 GHz	94.54 dB(uV/m)	
2 ▾	Trace A	2.4835 GHz	45.04 dB(uV/m)	
3 ▾	Trace A	2.4876 GHz	34.36 dB(uV/m)	

Restricted band edge Average Plot



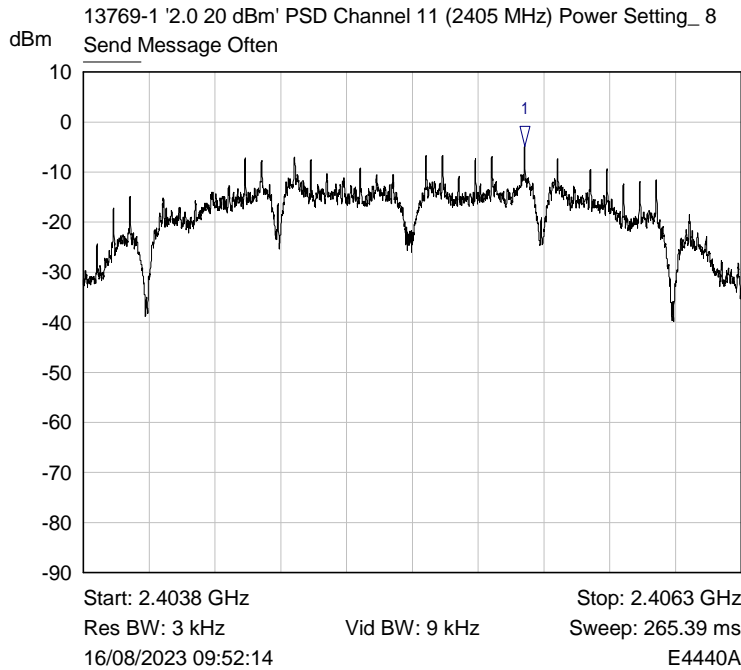
Mkr	Trace	X-Axis	Value	Notes
1 ▾	Trace A	2.4800 GHz	95.71 dB(uV/m)	
2-1 ▾	Trace A	2.4835 GHz	-51.84 dB	
3-1 ▾	Trace A	9.6142 MHz	-50.43 dB	

Authorised Band Edge Plot



## 6.8 Maximum Power Spectral Density

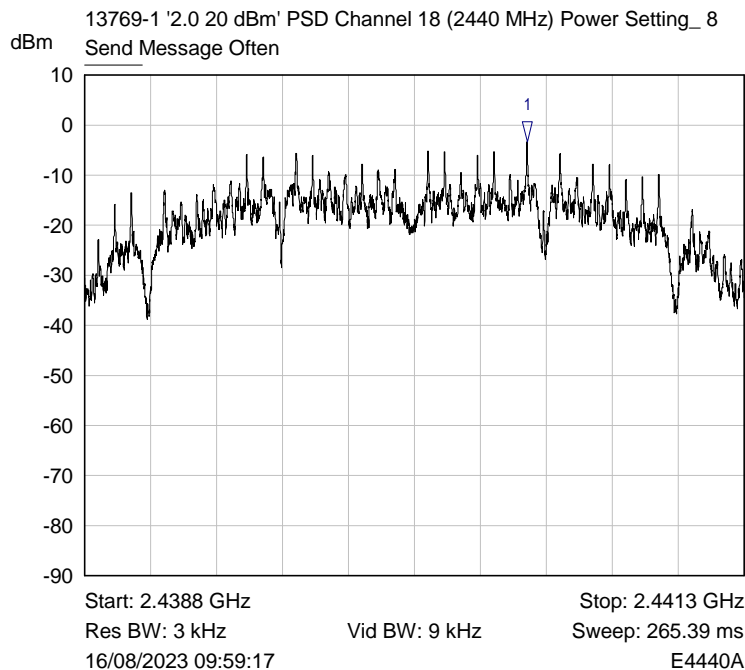
RF Parameters: Band 2400-2483.5 MHz, Power 8, Channel Spacing 5 MHz, Modulation OQPSK, Channel 2402 MHz (Low Ch)



Mkr	Trace	X-Axis	Value	Notes
1 ▾	Send Message Often	2.4054 GHz	-4.80 dBm	

PSD Low Channel (2405 MHz)

RF Parameters: Band 2400-2483.5 MHz, Power 8, Channel Spacing 5 MHz, Modulation OQPSK, Channel 2440 MHz (Mid Ch)



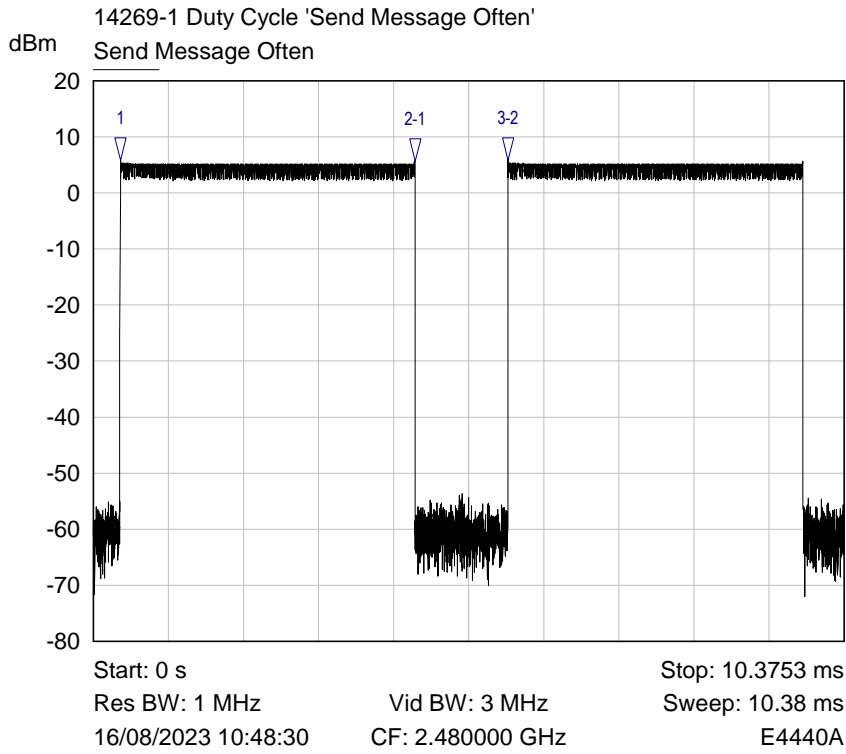
Mkr	Trace	X-Axis	Value	Notes
1 ▾	Send Message Often	2.4404 GHz	-3.35 dBm	

PSD Mid Channel (2440 MHz)



## 6.9 Duty Cycle

RF Parameters: Band 2400-2483.5 MHz, Power 8, Channel Spacing 5 MHz, Modulation OQPSK, Channel 2480 MHz (High Ch)



Mkr	Trace	X-Axis	Value	Notes
1 ▾	Send Message Often	374.9333 us	5.89 dBm	
2-1 ▾	Send Message Often	4.0711 ms	-0.16 dB	DC = 76%
3-2 ▾	Send Message Often	1.2882 ms	0.15 dB	

## 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 (dB $\mu$ V)	Pk – Lim 1 (dB)	QP Amp (dB $\mu$ V)	QP - Lim1 (dB)	Av Amp (dB $\mu$ V)	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 (dB $\mu$ V) is the level of received signal that was measured in dB above 1 $\mu$ V 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 (dB $\mu$ V) is the level of received signal that was measured in dB above 1 $\mu$ V 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 (dB $\mu$ V) is the level of received signal that was measured in dB above 1 $\mu$ V 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  $\mu$ V/m at a specified distance), whereas the measured values are expressed as peak, quasi peak or average values in dB $\mu$ V/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  $\mu$ V/m equates to  $20.\log(500) = 54$  dB  $\mu$ V/m.

(b) limit of 300  $\mu$ V/m at 10m equates to  $20.\log(300 \cdot 10/3) = 60$  dB  $\mu$ V/m at 3m

(c) limit of 30  $\mu$ V/m at 30m, but below 30MHz, equates to  $20.\log(30) + 40.\log(30/3) = 69.5$  dB $\mu$ V/m at 3m, as extrapolation factor below 30MHz is 40dB/decade per 15.31(f)(2).

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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:  $E_{Log} = 20 \times \text{Log}(E_{Linear}) + 120$

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:**  $EIRP = E_{Meas} + 20 \log(d_{Meas}) - 104.7$

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<sup>2</sup>

$EIRP_{Linear}$  is the equivalent isotropically radiated power in Watts

d is the distance at which the power density limit is specified in metres

**Equation 26:**  $PD = E_{Spec\ limit}^2 / 377$

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<sup>2</sup>

$E_{Spec\ limit}$  is the field strength at the distance specified by the limit in V/m

**Example:**

Radiated spurious emissions limit at 3metres of 90pW/cm<sup>2</sup>.

$90\text{pW/cm}^2 \times 100^2 = 0.9 \mu\text{W/m}^2 = (\text{EIRP Linear})$

Equation 25 transposed:  $0.9 \times 10^{-6} \times 4 \times \pi \times 3^2 = 0.0001017876 \text{ W}$

And

Equation 26 transposed:  $E_{Spec\ limit} = \sqrt{(0.9 \times 10^{-6} \times 377)} = 0.01842 \text{ V/m.}$

And

Equation 21 transposed:  $E_{Log} = 20 \text{Log}(0.01842) + 120 = 85.3\text{dB}\mu\text{V/m @ 3m.}$

## 8 Photographs

### 8.1 EUT Front View



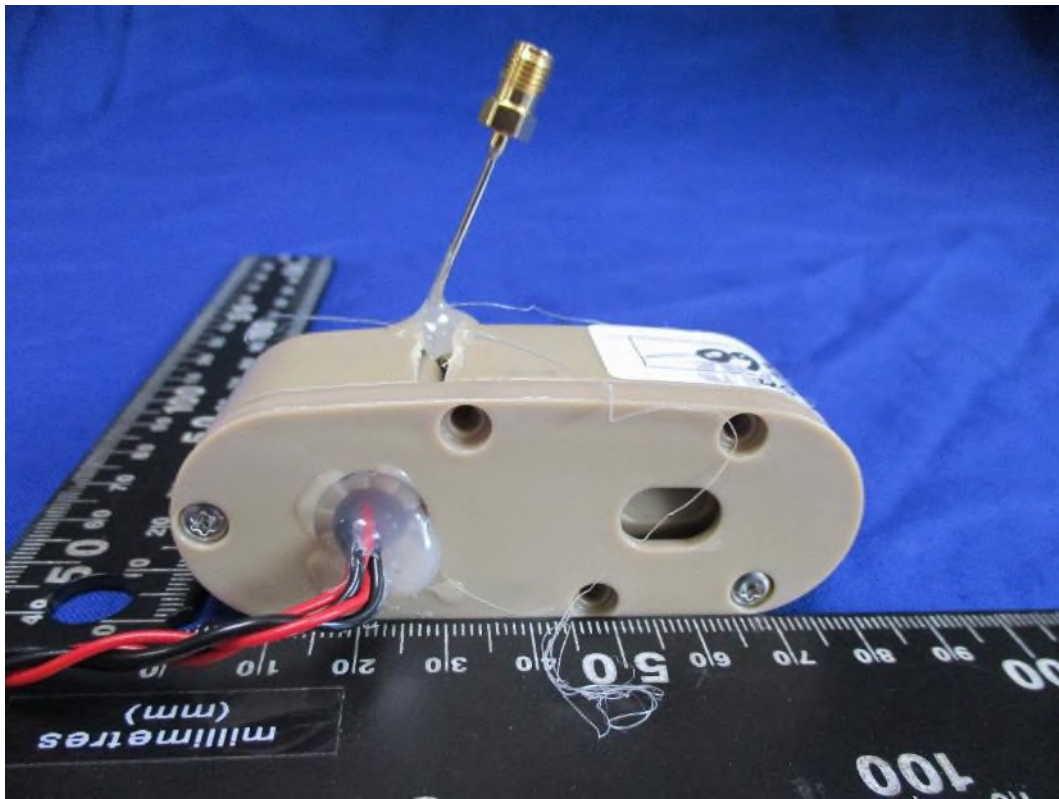


Conducted sample with temporary antenna port

## 8.2 EUT Reverse Angle





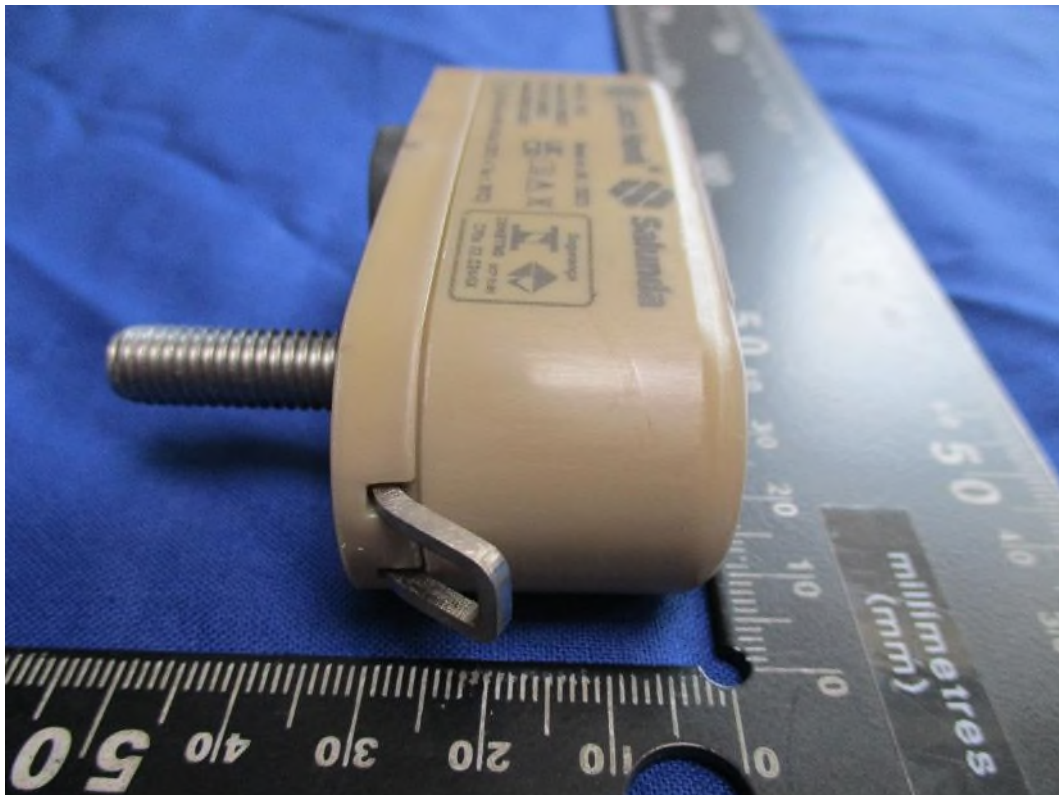


Conducted sample with temporary antenna port

### 8.3 EUT Left side View

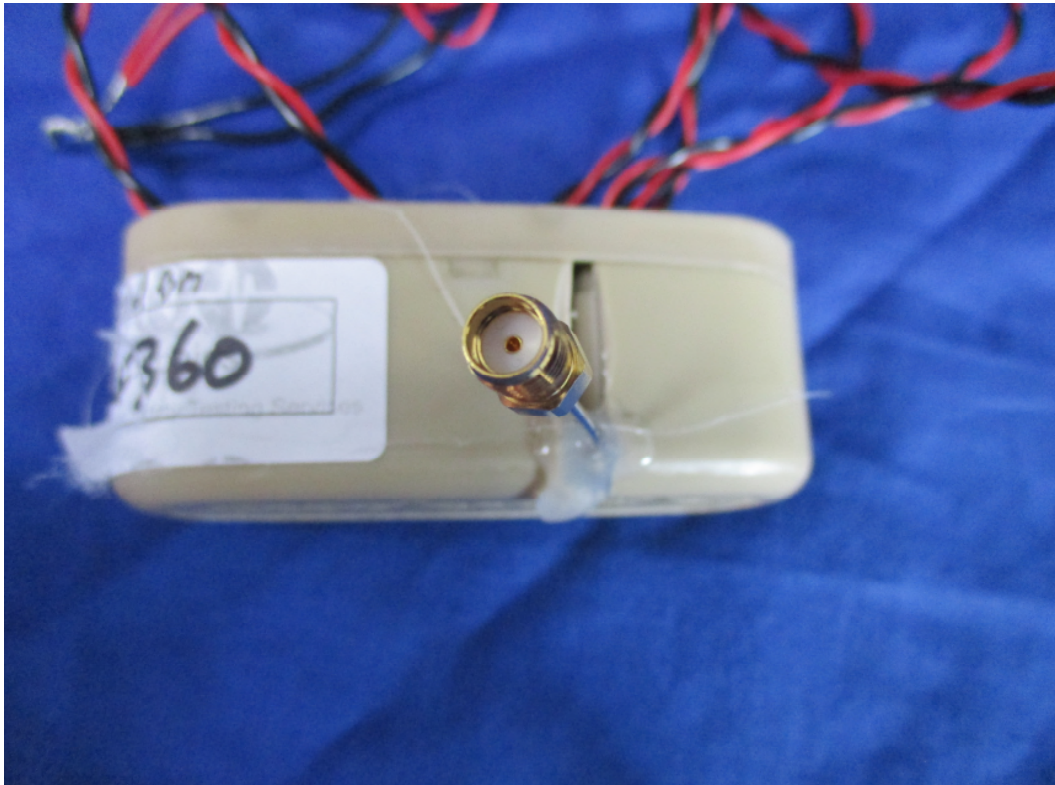


### 8.4 EUT Right side View



## 8.5 EUT Antenna Port

Internal pictures not included due to confidentiality requested for the FCC certification application.



Conducted sample with temporary antenna port

## 8.6 EUT Display & Controls

The EUT did not have any external display or visual controls.

## 8.7 EUT Internal photos

Internal pictures not included due to confidentiality requested for the FCC certification application.

### 8.8 EUT ID Label





## 8.9 EUT Chassis

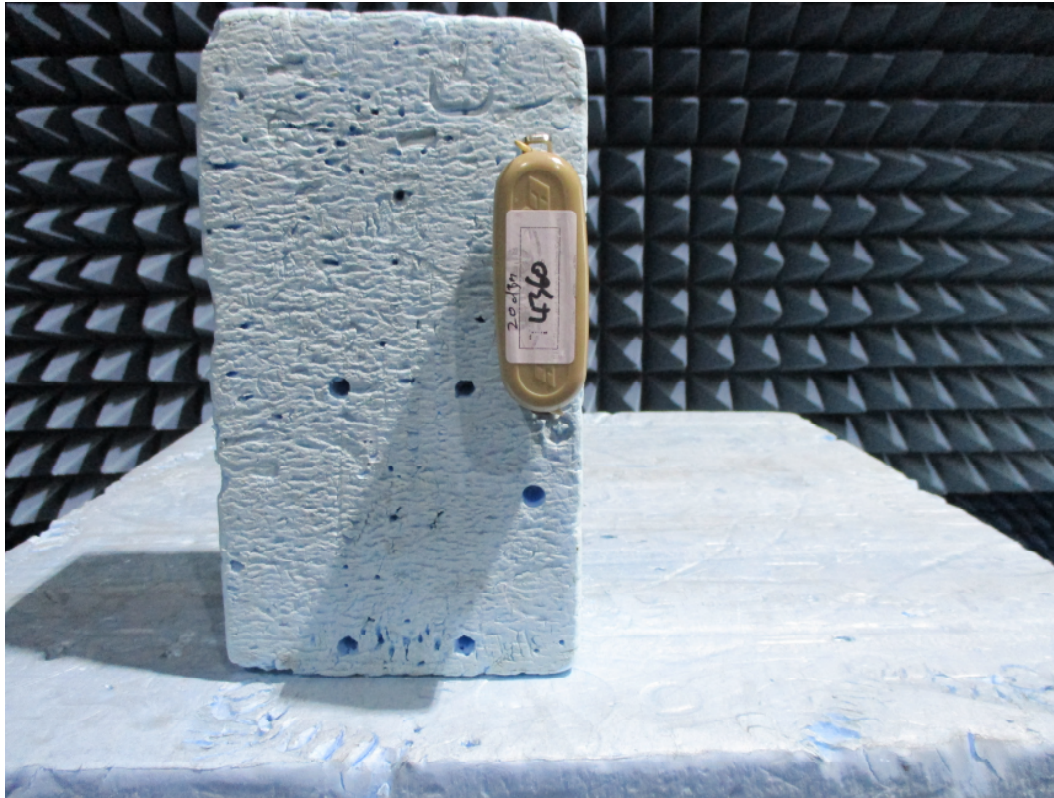
Internal pictures not included due to confidentiality requested for the FCC certification application.

### 8.10 Radiated emissions 9 kHz - 30 MHz





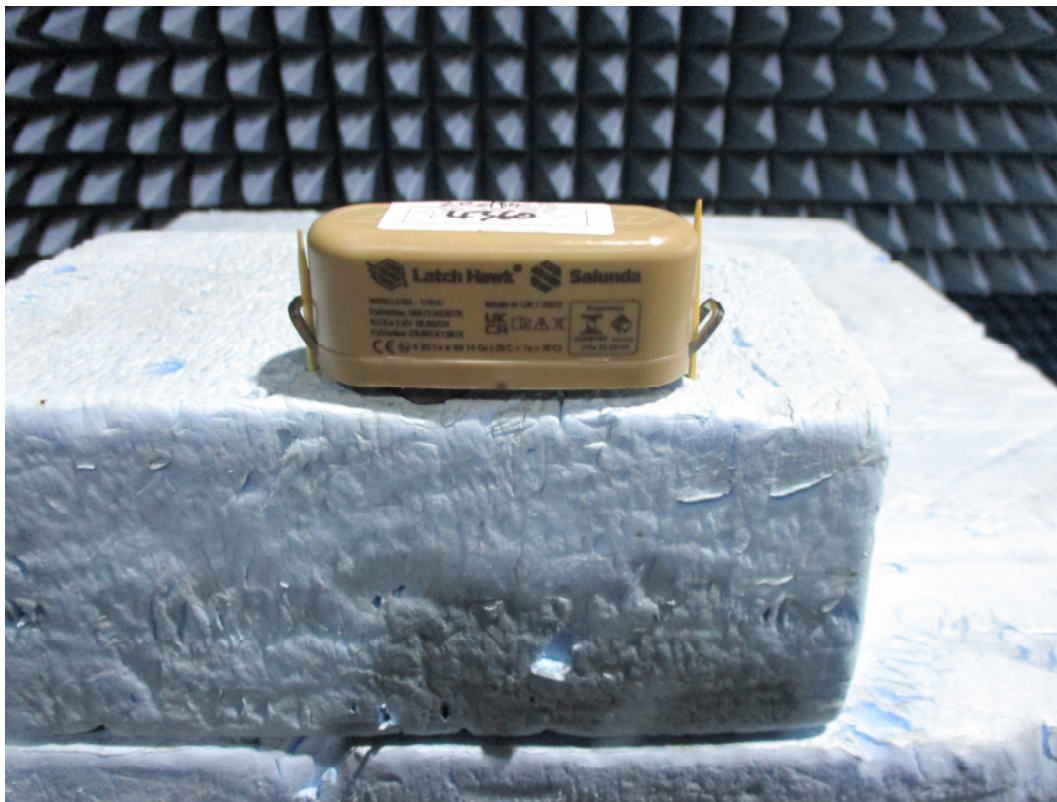
### 8.11 Radiated emissions 30 MHz -1 GHz



**Upright Position**

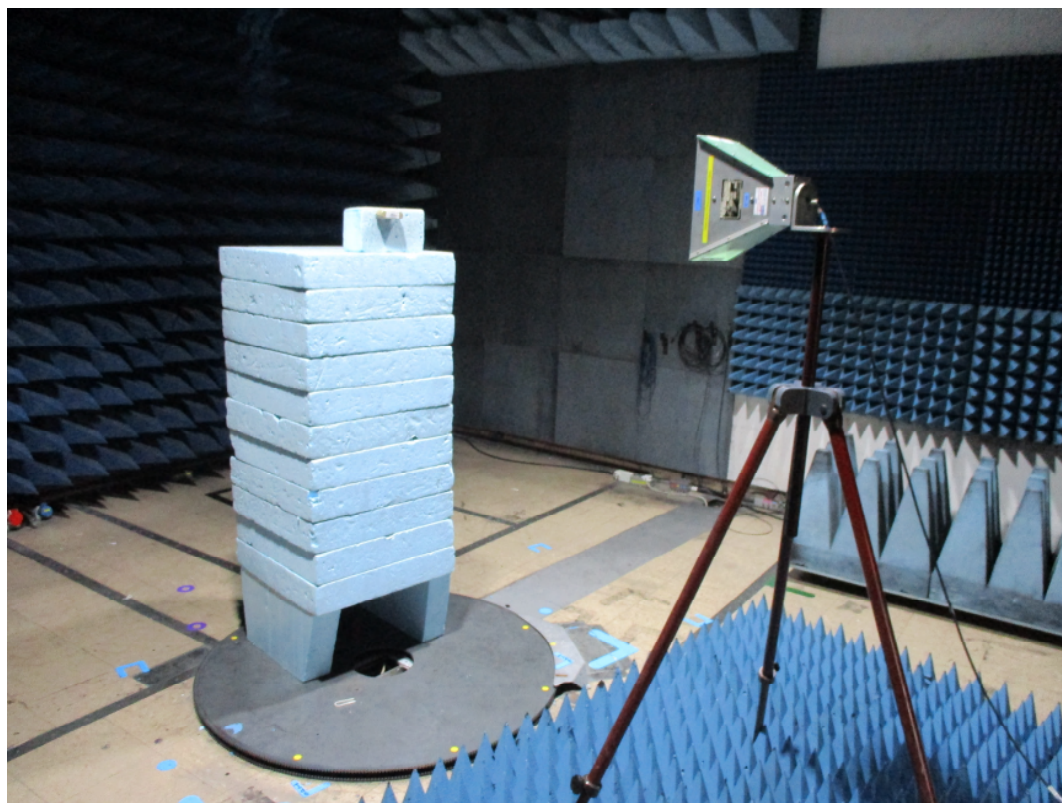
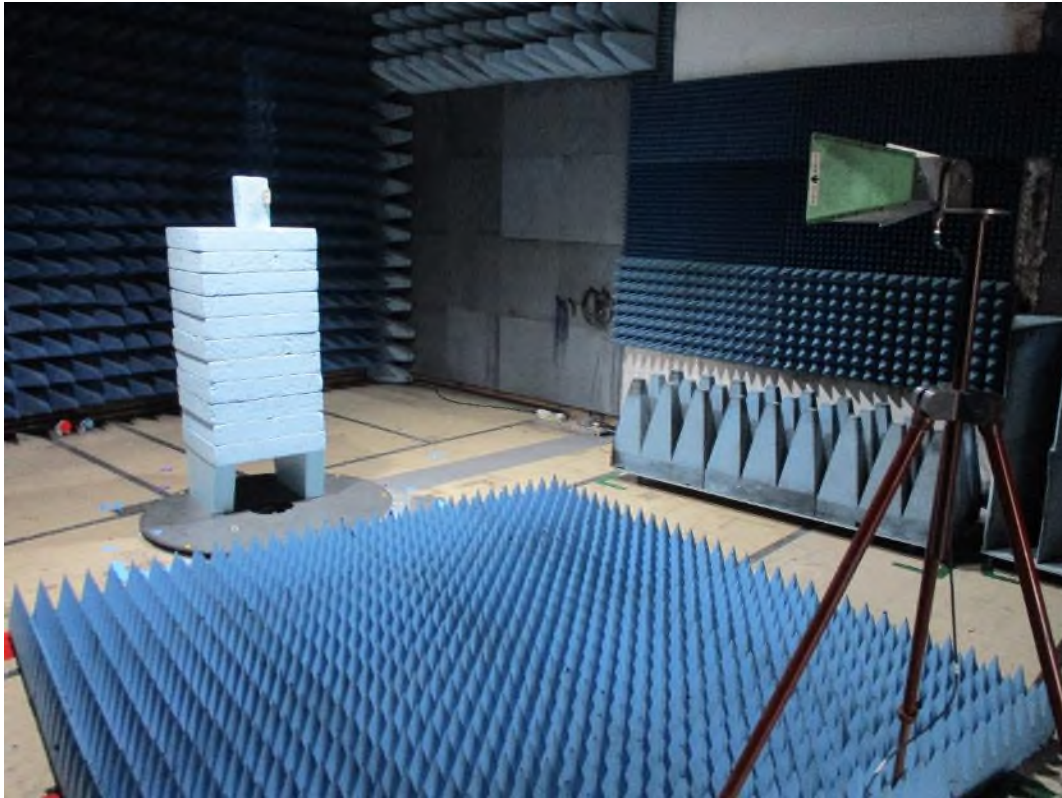


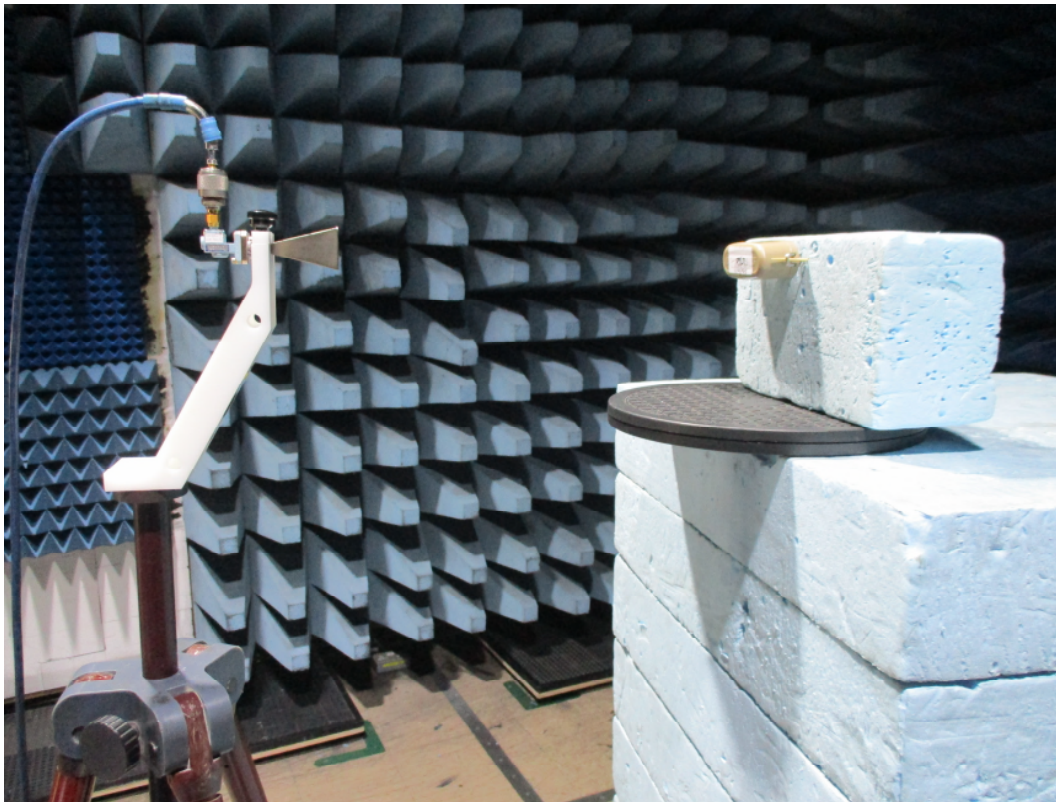
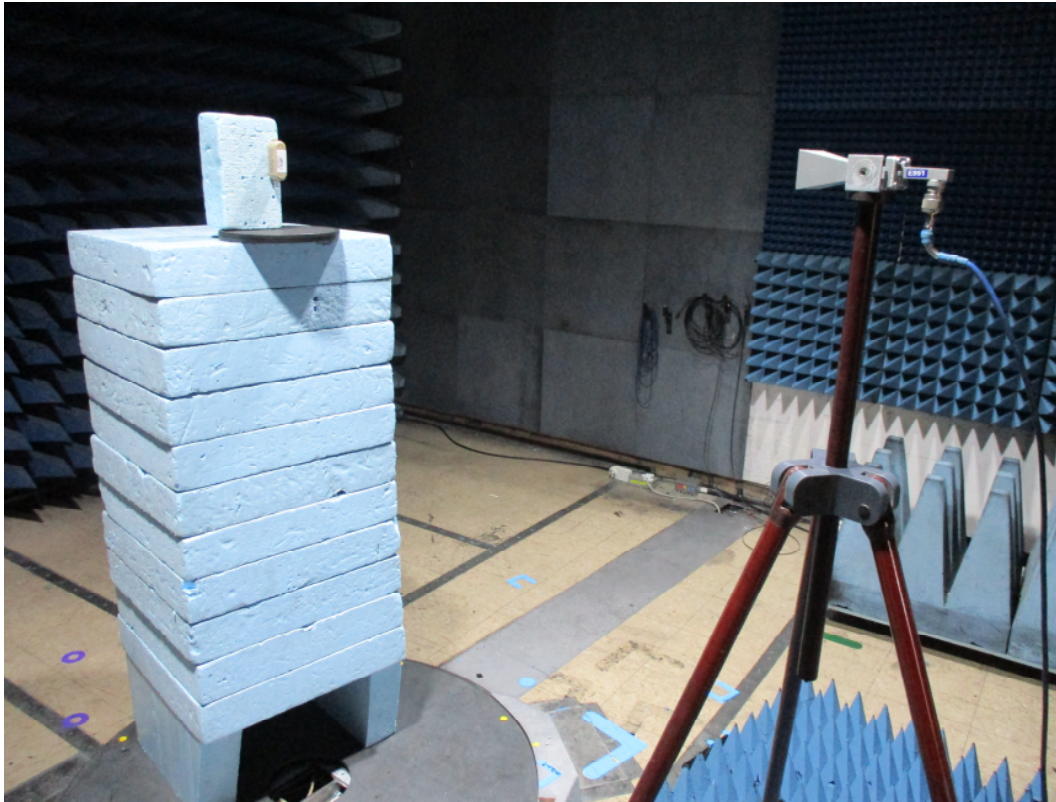
Side Position



Flat Position

## 8.12 Radiated emissions 1-25 GHz





### 8.13 Radiated emission diagrams

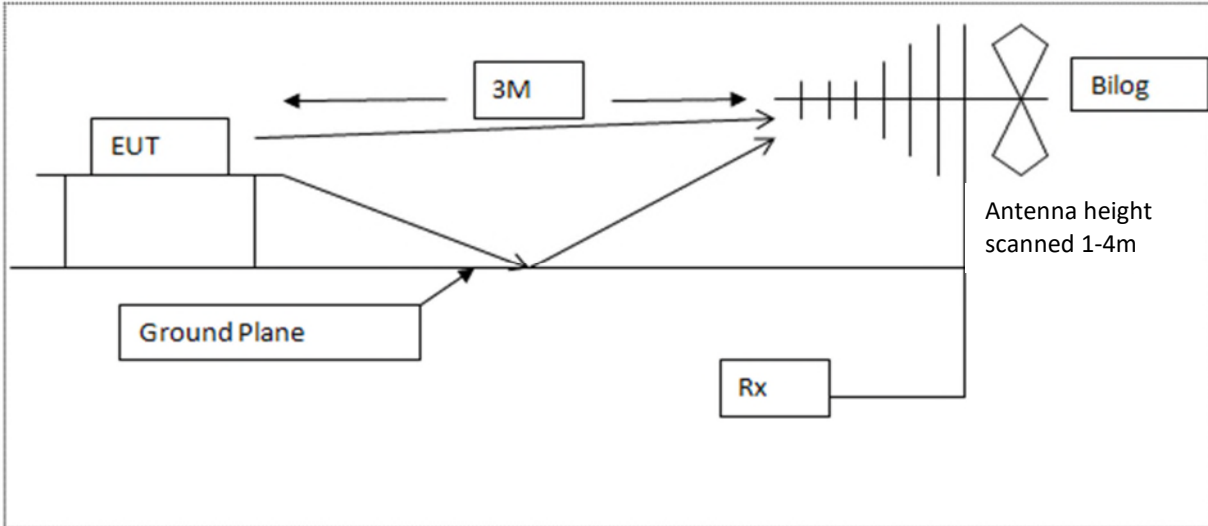


Diagram of the radiated emissions test setup 30 - 1000 MHz

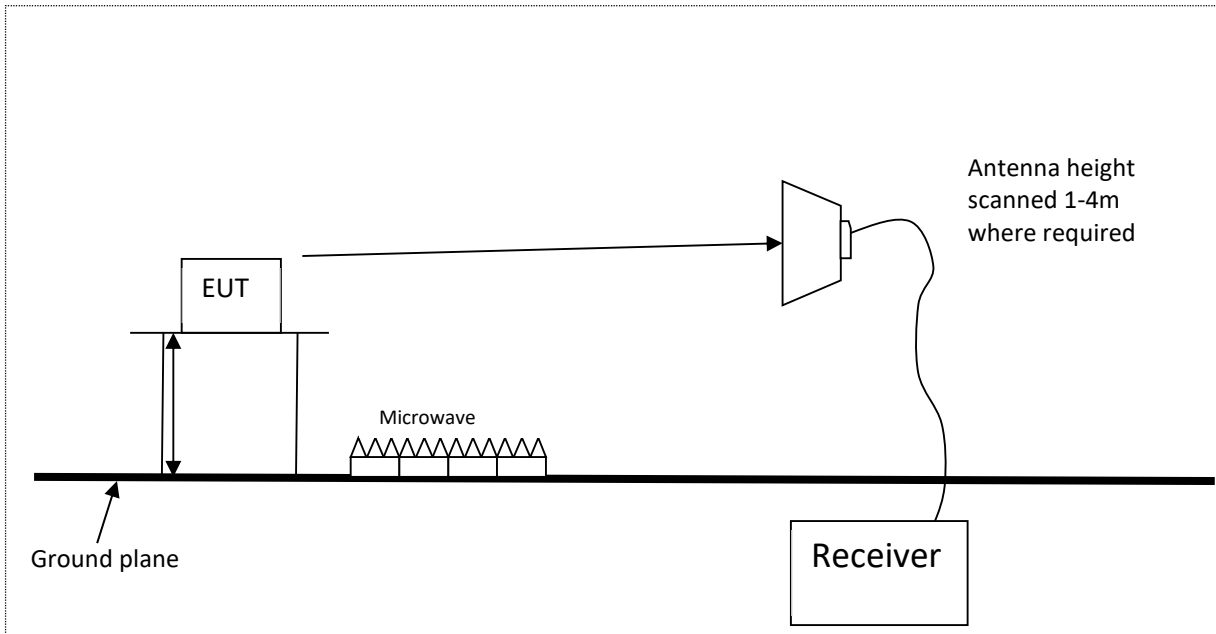


Diagram of the radiated emissions test setup above 1GHz

## 9 Test equipment calibration list

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

RN No.	Model No.	Description	Manufacturer	Calibration date	Cal period
E136	3105	Horn Antenna 1 - 12.5 GHz	EMCO	02-Apr-2023	12 months
E301	8493C	Attenuator 20dB 26.5GHz	Hewlett Packard	28-Feb-2023	12 months
E411	N9039A	9 kHz - 1 GHz RF Filter Section	Agilent Technologies	05-Jul-2023	12 months
E429	-	Filter Box 5 Switch Filters 0.91 GHz - 16.3 GHz	RN Electronics	23-Aug-2022	12 months
E534	E4440A	PSA 3 Hz - 26.5 GHz	Agilent Technologies	25-Jan-2023	24 months
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	15-Mar-2023	12 months
E856	N9039A	9 kHz - 1 GHz RF Filter Section	Agilent Technologies	06-Dec-2022	12 months
LPE364	CBL6112A	Antenna BiLog 30MHz - 2GHz	Chase Electronics Ltd	28-Mar-2022	24 months
P289	D30 4	PSU 30V 4A	Farnell Instruments	28-Sep-2022	12 months
TMS78	3160-08	Horn Std Gain 12.4 - 18 GHz	ETS Systems	30-Sep-2022	12 months
TMS79	3160-09	Horn Std Gain 18 - 26.5 GHz	ETS Systems	23-May-2023	12 months
TMS81	6502	Antenna Active Loop	EMCO	#17-Aug-2023	24 months
TMS82	8449B	Pre-Amplifier 1GHz - 26.5GHz	Agilent Technologies	16-Dec-2022	12 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	SM-A202F/DS	Galaxy A20e Mobile Phone	Samsung	RF8N92XY0CJ

### 10.2 RN Electronics supplied equipment

No RN Electronics Ltd supplied equipment was used.

## 11 Condition of the equipment tested

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

### 11.1 Modifications before test

No modifications were made before test by RN Electronics Ltd.

### 11.2 Modifications during test

No modifications were made during test by RN Electronics Ltd.



## 12 Description of test sites

Site A	Radio Laboratory and Anechoic Chamber
Site B	Semi-Anechoic Chamber and Control Room FCC Registration No. 654321, 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. 654321, 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. 654321, 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. 654321, ISED Registration No. 5612A-1
Site R	Screened Room (Conducted Immunity)
Site S	Safety Laboratory
Site T	Transient Laboratory

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

## 13 Abbreviations and units

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

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

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