Radio Test Report

Salunda Limited

1701E

2.0

47 CFR Part 15.247 Effective Date 1st October 2021
DTS: Digital Transmission System
Test Date: 7th August 2023 to 9th August 2023
Report Number: 08-14269-1-23 Issue 01

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

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

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

Certificate of Test 14269-1

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

Equipment:	1701E
Model Number:	2.0
Unique Serial Number:	60000009 (Radiated) / KEC Sample: #1 (Conducted)
Applicant:	Salunda Ltd Unit 6 Avonbury Business Park Bicester Oxon OX26 2UA
Proposed FCC ID	2ALTW170120
Full measurement results are detailed in Report Number:	08-14269-1-23 Issue 01
Test Standards:	47 CFR Part 15.247 Effective Date 1st October 2021 DTS: Digital Transmission System

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

DEVIATIONS:
None.

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 9th August 2023

Test Engineer:
Chee-Wah Yeung

Chee-Wah Yeung
Digitally signed by: Chee-Wah Yeung
DN: CN = Chee-Wah Yeung email = chee-wah.yeung@rnelectronics.com C = GB O = RN Electronics Ltd
Date: 2023.10.19 14:36:54 Z

Approved By:
Radio Approvals Manager

Digitally signed by: Daniel Sims
DN: CN = Daniel Sims C = GB O = RN Electronics Ltd
Date: 2023.10.19 11:27:36 Z

Customer Representative:

1 Contents

2 Equipment under test (EUT)

2.1 Equipment specification

Applicant	Salunda Limited Unit 6 Avonbury Business Park Bicester Oxon OX26 2UA	
Manufacturer of EUT	Salunda Limited	
Full Name of EUT	1701E	
Model Number of EUT	2.0	
Serial Number of EUT	60000009 (Radiated), KEC Sample #1 (Conducted)	
Date Received	4th August 2023	
Date of Test:	7th August 2023 to 9th August 2023	
Purpose of Test	To demonstrate design compliance to the relevant rules of Chapter 47 of the Code of Federal Regulations.	
Date Report Issued	10th October 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	Production sample
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 10dBm
Software Version	Not Specified
Firmware Version (FVIN)	Not Specified
Type of Equipment	Single Standalone radio equipment
Technology Type	Zigbee & passive 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
FCC Parameters	
FCC Transmitter Class	DTS: Digital Transmission System
LBT Parameters	
TX off time	2 ms
Minimum listening time	128 µs
Dead time	320 µs
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

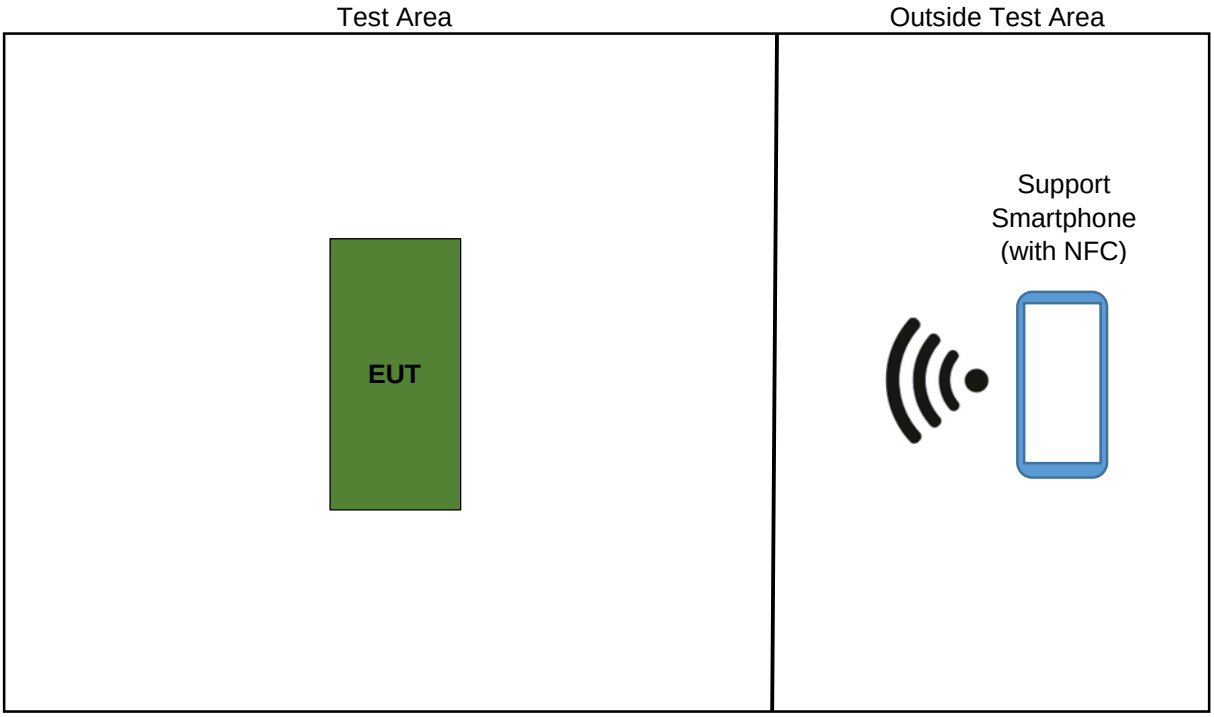
2.3 Functional description

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/SOCI2). 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 the passive 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 repeated transmit 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 used for test 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. Note: A Modified EUT with Temporary DC supply wires provided for test.

3 Summary of test results

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

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

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

Title	References	Results
Transmitter Tests		
1. AC power line conducted emissions	47 CFR Part 15C Part 15.207	NOT APPLICABLE[1]
2. Radiated emissions 9 - 150 kHz	47 CFR Part 15C Part 15.209	PASSED[2]
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[3]
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[4]
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[5]
13. Duty cycle	47 CFR Part 15C Part 15.35(c)	NOT APPLICABLE[6]
14. FHSS carrier frequency separation	47 CFR Part 15C Part 15.247(a1)	NOT APPLICABLE[7]
15. Average time of occupancy	47 CFR Part 15C Part 15.247(a)(1)(i)/(ii)/(iii)	NOT APPLICABLE[7]
16. Number of Hop Channels	47 CFR Part 15C Part 15.247(a)(1)(i)/(ii)/(iii)	NOT APPLICABLE[7]

[1] EUT does not operate from the AC power lines nor contain provisions for operation while connected to AC power lines.
[2]. Spectrum below 30MHz started at a frequency of 9 kHz up to a frequency of 30MHz based on the lowest signal generated/used within the equipment of 400kHz as declared by the applicant
[3] Spectrum investigated up to a frequency of 25GHz based on 10 times the highest channel/ signal generated in equipment of 2480MHz.
[4] Peak Conducted Power carried out instead.
[5] Applies to EUT's with an antenna port. The EUT has an integral antenna only & the EUT was tested for radiated emissions with its dedicated antenna in position.
[6]. No average measurements made requiring corrections.
[7] EUT does not employ FHSS technology

4 Specifications

The tests were performed and operated in accordance with R.N. Electronics Ltd procedures and the relevant standards listed below.

4.1 Relevant standards

Ref.	Standard Number	Version	Description
4.1.1	47 CFR Part 15C	2021	Federal Communications Commission PART 15 – RADIO FREQUENCY DEVICES
4.1.2	ANSI C63.10	2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
4.1.3	ANSI C63.4	2014	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
4.1.4	KDB 558074 D01 v05r02	2019	Federal Communications Commission Office of Engineering and Technology Laboratory Division; Guidance for compliance measurements on digital transmission system, frequency hopping spread spectrum system, and hybrid system devices operating under section 15.247 of the fcc rules

4.2 Deviations

No deviations were applied.

4.3 EUT extremes of temperature & voltage

The following 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	3.6V DC
T maximum	70 °C	V maximum	3.6V DC

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

4.4 Test fixtures

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 M.

5.2.4 Test equipment

E411, E624, TMS81

See Section 9 for more details

5.2.5 Test results

Temperature of test environment	16°C
Humidity of test environment	68%
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
14269-1 Rad 1 9k-150kHz Para
14269-1 Rad 1 9k-150kHz Perp

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

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 ±3.9dB

5.3 Radiated emissions 150 kHz - 30 MHz

5.3.1 Test methods

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

5.3.2 Configuration of EUT

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

The EUT was operated in 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 M.

5.3.4 Test equipment

E411, E624, TMS81

See Section 9 for more details

5.3.5 Test results

Temperature of test environment	16°C
Humidity of test environment	68%
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
14269-1 Rad 3 150k-30MHz Para
14269-1 Rad 3 150k-30MHz Perp

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

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 ±3.9dB

5.4 Radiated emissions 30 MHz -1 GHz

5.4.1 Test methods

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

5.4.2 Configuration of EUT

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

The EUT was operated in 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 16°C
Humidity of test environment 68%
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
14269-1 Rad 2 VHF Horiz
14269-1 Rad 2 VHF Vert
14269-1 Rad 2 UHF Horiz
14269-1 Rad 2 UHF Vert

Table of signals measured for Rad 2 Horizontal Signal List

Signal No.	Freq (MHz)	Peak Amp (dBuV/m)	QP Amp (dBuV/m)	QP -Lim (dB)
1	30.000	16.9	11.8	-28.2
2	116.335	25.5	17.6	-25.9
3	297.230	27.4	20.7	-25.3
4	520.556	31.9	24.5	-21.5
5	651.510	35.9	30.0	-16.0
6	954.180	34.4	28.7	-17.3

Table of signals measured for Rad 2 Vertical Signal List

Signal No.	Freq (MHz)	Peak Amp (dBuV/m)	QP Amp (dBuV/m)	QP -Lim (dB)
1	32.609	28.5	22.2	-17.8
2	125.104	24.9	17.7	-25.8
3	287.397	26.0	20.5	-25.5
4	545.504	31.2	24.9	-21.1
5	681.682	33.5	27.8	-18.2
6	948.752	34.2	28.6	-17.4

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 ±6.1dB

5.5 Radiated emissions above 1 GHz

5.5.1 Test methods

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

5.5.2 Configuration of EUT

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

5.5.4 Test equipment

E428, E429, E642, E904, TMS78, TMS79

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

Setup Table

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

There were no emissions within 20dB of the limit line using Low, Mid and High channel settings.

Plots
14269-1 1701E Radiated Emissions 1-2 GHz Channel 18 (2440 MHz) Vertical Power Setting_ 8
14269-1 1701E Radiated Emissions 1-2 GHz Channel 18 (2440 MHz) Horizontal Power Setting_ 8
14269-1 1701E Radiated Emissions 2-2.7 GHz Channel 18 (2440 MHz) Vertical Power Setting_ 8
14269-1 1701E Radiated Emissions 2-2.7 GHz Channel 18 (2440 MHz) Horizontal Power Setting_ 8
14269-1 1701E Radiated Emissions 2.7-5 GHz Channel 18 (2440 MHz) Vertical Power Setting_ 8
14269-1 1701E Radiated Emissions 2.7-5 GHz Channel 18 (2440 MHz) Horizontal Power Setting_ 8
14269-1 1701E Radiated Emissions 5-6 GHz Channel 18 (2440 MHz) Vertical Power Setting_ 8
14269-1 1701E Radiated Emissions 5-6 GHz Channel 18 (2440 MHz) Horizontal Power Setting_ 8
14269-1 1701E Radiated Emissions 6-7.77 GHz Channel 18 (2440 MHz) Vertical Power Setting_ 8
14269-1 1701E Radiated Emissions 6-7.77 GHz Channel 18 (2440 MHz) Horizontal Power Setting_ 8
14269-1 1701E Radiated Emissions 7.77-10 GHz Channel 18 (2440 MHz) Vertical Power Setting_ 8

14269-1 1701E Radiated Emissions 7.77-10 GHz Channel 18 (2440 MHz) Horizontal Power Setting_ 8
14269-1 1701E Radiated Emissions 10-12.5 GHz Channel 18 (2440 MHz) Vertical Power Setting_ 8
14269-1 1701E Radiated Emissions 10-12.5 GHz Channel 18 (2440 MHz) Horizontal Power Setting_ 8
14269-1 1701E Radiated Emissions 12.5-15 GHz Channel 18 (2440 MHz) Vertical Power Setting_ 8
14269-1 1701E Radiated Emissions 12.5-15 GHz Channel 18 (2440 MHz) Horizontal Power Setting_ 8
14269-1 1701E Radiated Emissions 15-18 GHz Channel 18 (2440 MHz) Vertical Power Setting_ 8
14269-1 1701E Radiated Emissions 15-18 GHz Channel 18 (2440 MHz) Horizontal Power Setting_ 8
14269-1 1701E Radiated Emissions 18-22 GHz Channel 18 (2440 MHz) Vertical Power Setting_ 8
14269-1 1701E Radiated Emissions 18-22 GHz Channel 18 (2440 MHz) Horizontal Power Setting_ 8
14269-1 1701E Radiated Emissions 22-25 GHz Channel 18 (2440 MHz) Vertical Power Setting_ 8
14269-1 1701E Radiated Emissions 22-25 GHz Channel 18 (2440 MHz) Horizontal Power Setting_ 8

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

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

These results show that the EUT has PASSED this test.

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

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

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. 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 in the maximised EUT position and measuring antenna polarisation. Final measurements were taken at 3m.

Tests were performed in test site B.

5.6.4 Test equipment

E428, E642, E904

See Section 9 for more details

5.6.5 Test results

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

Band	2400-2483.5 MHz
Power 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)	92.14	93.47	90.90
Plot reference	14269-1 Latch Hawk 1701E Radiated Power Channel 11 (2405 MHz) Horizontal 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	Horiz	Vert	Vert
EUT Polarisation	Side	Upright	Upright

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

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

These results show that the EUT has PASSED this test.

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

<± 3.9 dB

5.7 Band Edge Compliance

5.7.1 Test methods

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

5.7.2 Configuration of EUT

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

The EUT was operated in 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. Due to the influence of high in-band signals when using the specified resolution bandwidth the Marker Delta method was employed for the restricted band edge tests.

Tests were performed using Test Site B.

5.7.4 Test equipment

E428, E642, E904

See Section 9 for more details

5.7.5 Test results

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

Band	2400-2483.5 MHz
Power 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 @3m)	39.5	47.8
Restricted band edge Peak Plot	14269-1 Restricted BE Channel 11 (2405 MHz) Power Setting 8 Peak Side Position Horizontal	14269-1 Restricted BE Channel 26 (2480 MHz) Power Setting 8 Peak Upright Position Vertical

Note: Average measurements/plots not performed as peak measurements complied with the average limits.

Authorised Band Edges	Low channel	High channel
Authorised Band Edge (dBc) value measured	58.4	52.6
Authorised Band Edge Plot	14269-1 Authorised Band Edge Channel 11 (2405 MHz) Power Setting 8 Peak Side Position Horizontal	14269-1 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)/15.215 [Reference 4.1.1 of this report]
Test Method: ANSI C63.10 Clause 6.9 [Reference 4.1.2 of this report]
Limits: 47 CFR Part 15C Part 15.215(c)/ 15.247(a)(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 A.

5.8.4 Test equipment

E547, E642, P289

See Section 9 for more details

5.8.5 Test results

Temperature of test environment 20°C
Humidity of test environment 60%
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 Ch)
Mid channel	2440 MHz (Mid Ch)
High channel	2480 MHz (High Ch)

	Low channel	Mid channel	High channel
6 dB Bandwidth Result (MHz)	1.527	1.453	1.608
Plot for 6 dB Bandwidth Result (MHz)	14269-1 OBW Low Channel (2405 MHz)	14269-1 OBW Mid Channel (2440 MHz)	14269-1 OBW High Channel (2480 MHz)
99 % Bandwidth Result (MHz)	2.2361	2.2525	2.2649
Frequency Error (kHz)	-13.341	-9.497	-10.577
Operating frequency (MHz)	2405	2440	2480
6 dB FLOW Worst case (MHz)	2404.223159	2439.264003	2479.185423
6 dB FHIGH Worst case (MHz)	2405.750159	2440.717003	2480.793423

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 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 [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 A.

5.10.4 Test equipment

E412, E547, P289

See Section 9 for more details

5.10.5 Test results

Temperature of test environment 21°C
Humidity of test environment 60%
Pressure of test environment 101kPa

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)	5.72	6.49	6.04
Plot reference	14269-1 1701E Conducted RF Power Channel 11 (2405 MHz) Power Setting_ 8	14269-1 1701E Conducted RF Power Channel 18 (2440 MHz) Power Setting_ 8	14269-1 1701E Conducted RF Power Channel 26 (2480 MHz) Power Setting_ 8
Limit in dBm	30.00	30.00	30.00
Maximum result (dBm)	5.72	6.49	6.04
Margin to Limit (dB)	-24.28	-23.51	-23.96
Result in (W)	0.004	0.004	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.

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 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. 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, E547, P289

See Section 9 for more details

5.11.5 Test results

Temperature of test environment 21°C
Humidity of test environment 60%
Pressure of test environment 101kPa

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
Antenna Gain (dBi)	-1	-1	-1
Duty Cycle (%)	76.63	76.63	76.63
PSD (dBm/3 kHz)	-3.76	-3.13	-3.52
Plot reference	14269-1 1701E PSD Channel 11 (2405 MHz) Power Setting_8	14269-1 1701E PSD Channel 18 (2440 MHz) Power Setting_8	14269-1 1701E 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:
<± 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

NOT APPLICABLE: No average measurements made requiring corrections.

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

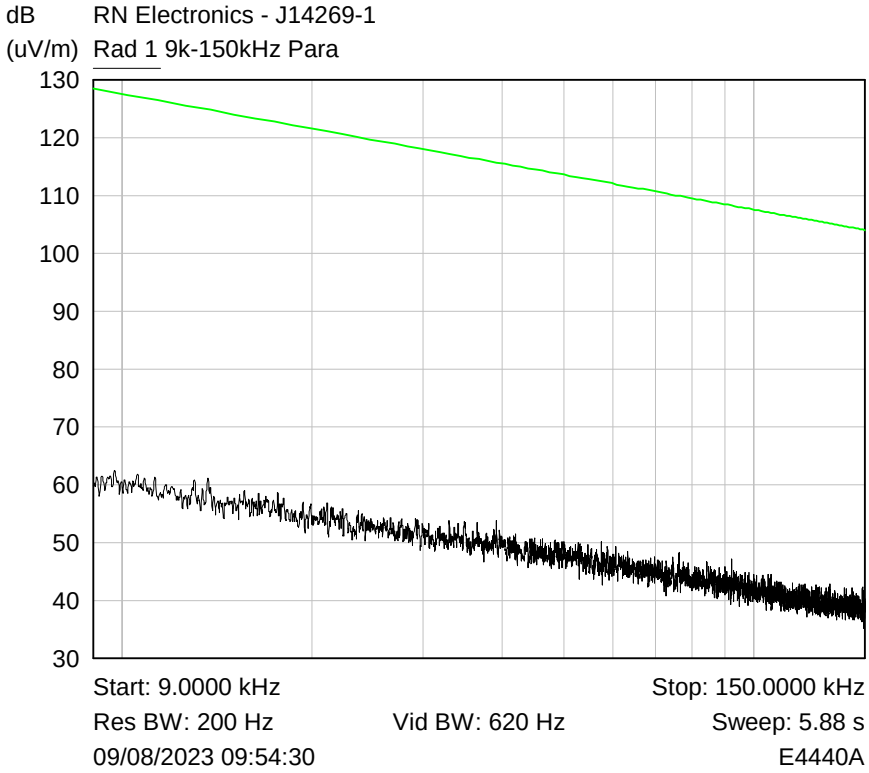
5.16 Number of Hop Channels

NOT APPLICABLE: EUT does not employ FHSS technology

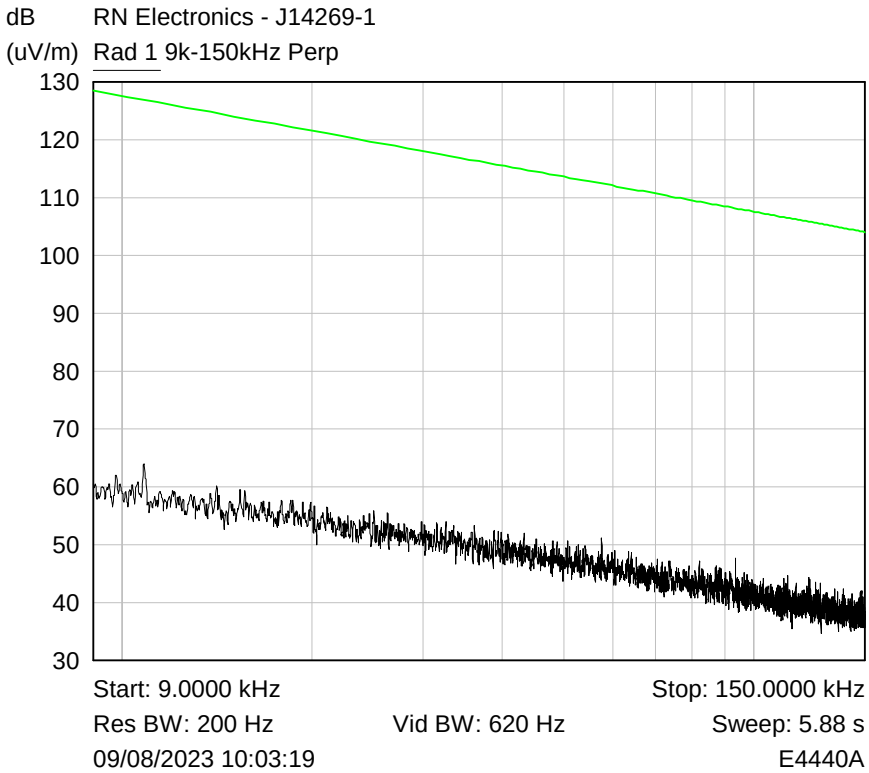
6 Plots/Graphical results

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)



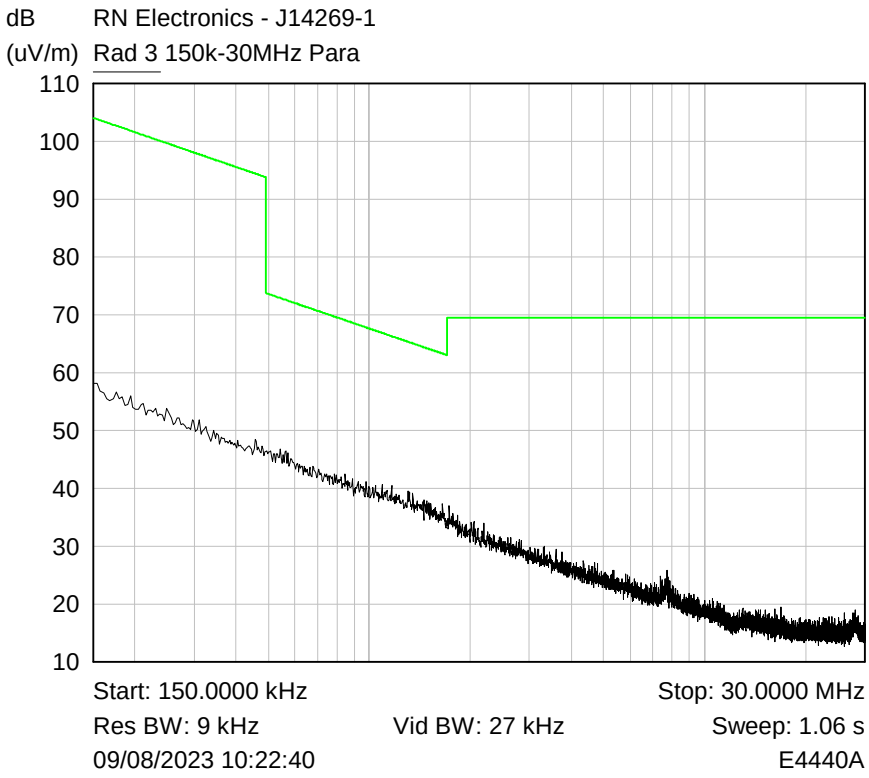
Plot of 9k-150kHz Parallel



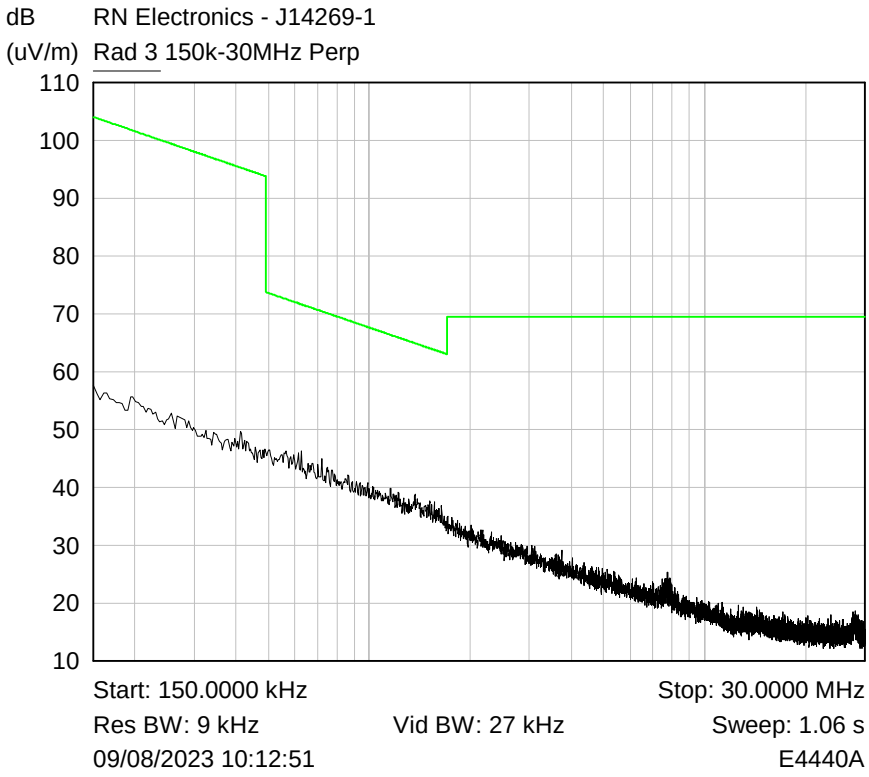
Plot of 9k-150kHz Perpendicular

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)



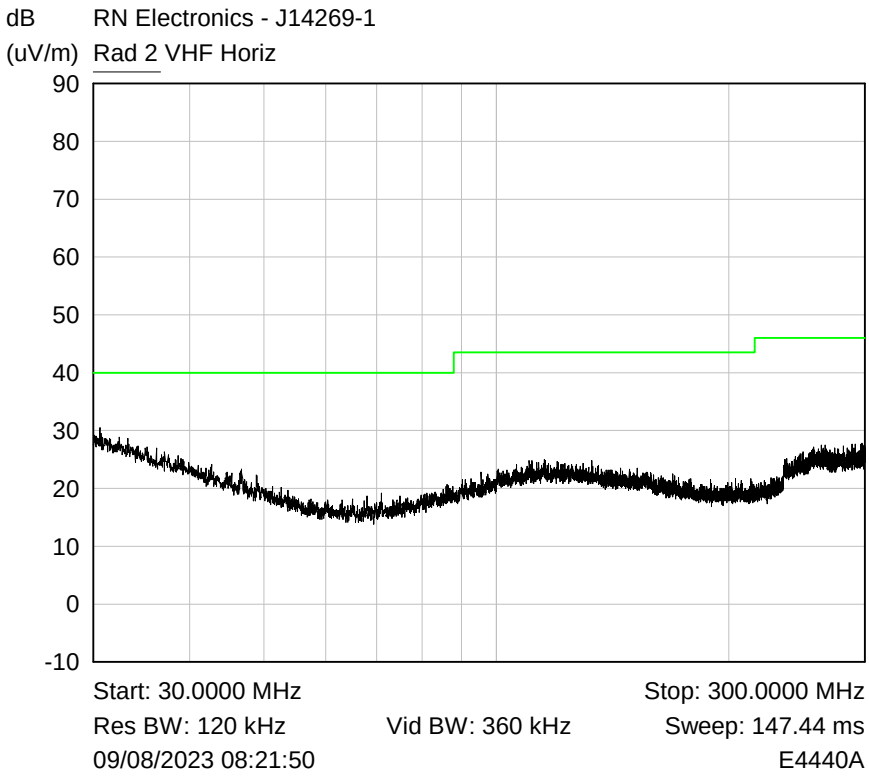
Plot of 150kHz-30MHz Parallel



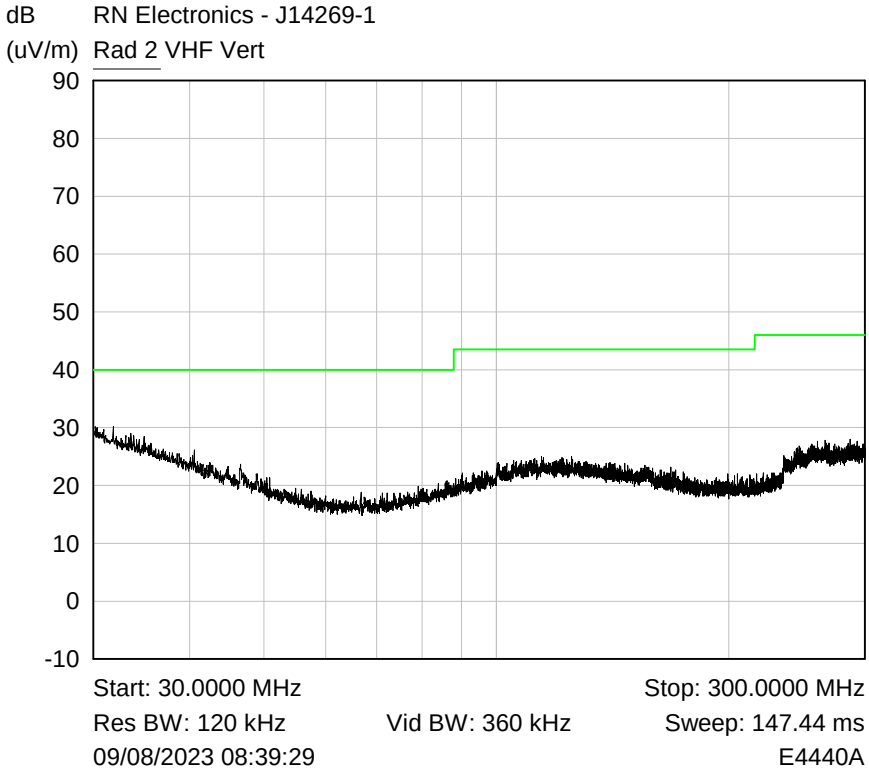
Plot of 150kHz-30MHz Perpendicular

6.3 Radiated emissions 30 MHz -1 GHz

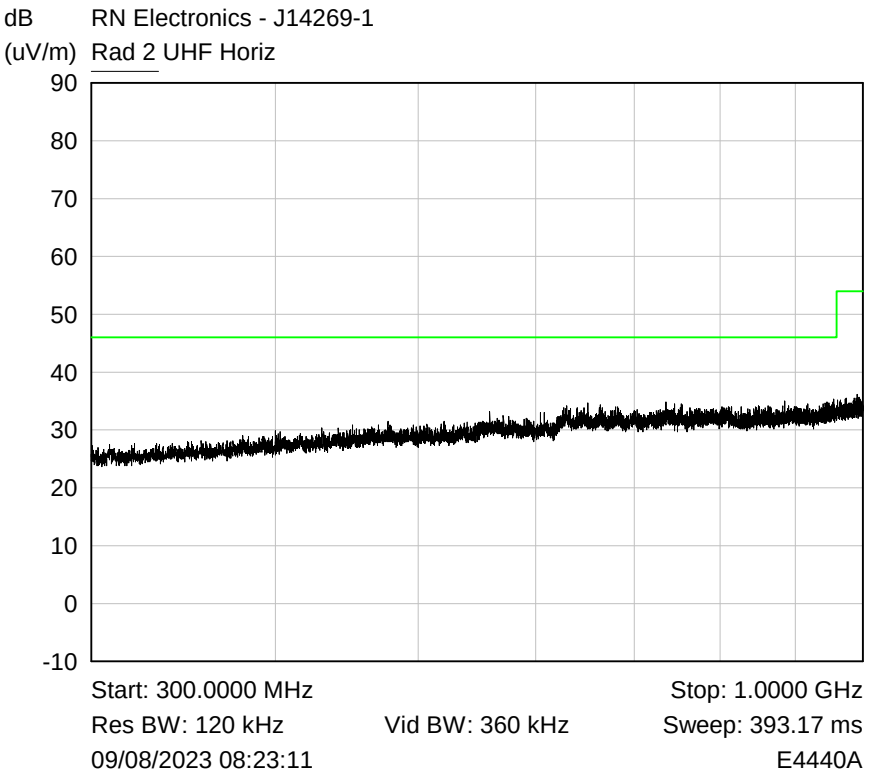
RF Parameters: Band 2400-2483.5 MHz, Power 8, Channel Spacing 5 MHz, Modulation OQPSK, Channel 2440 MHz (Mid Ch)



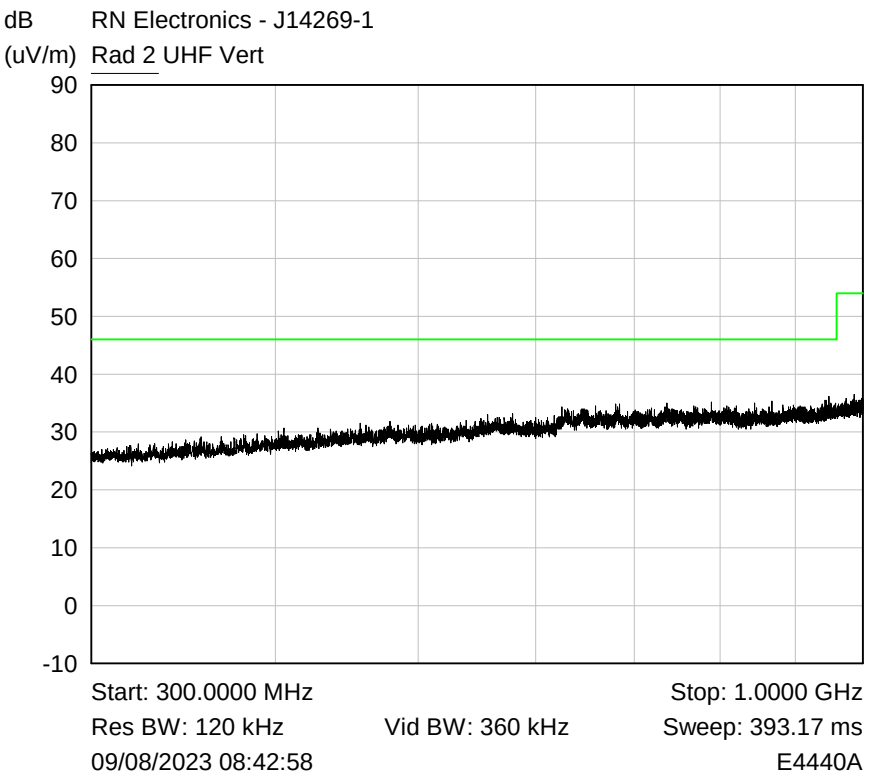
Plot of Peak emissions for VHF Horizontal against the QP limit line.



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



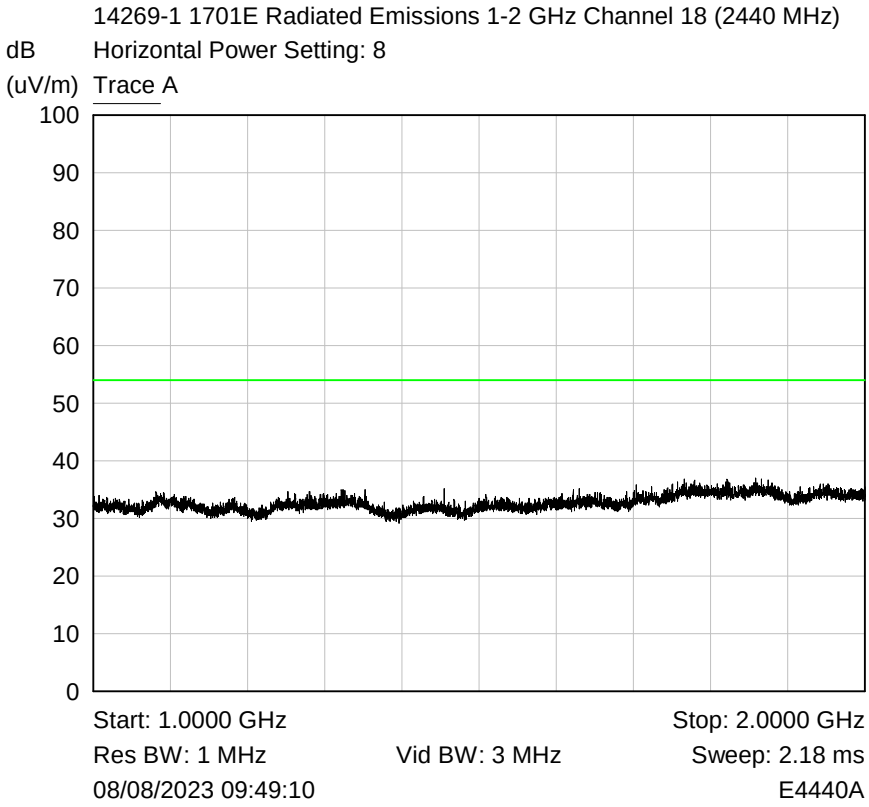
Plot of Peak emissions for UHF Horizontal against the QP limit line.



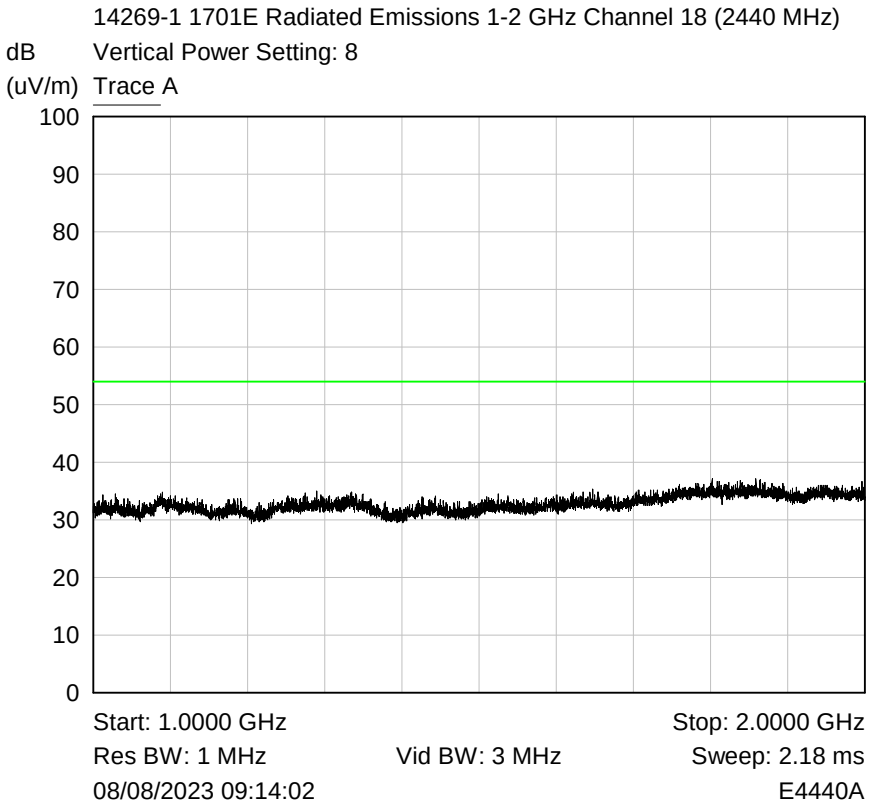
Plot of Peak emissions for UHF Vertical against the QP limit line.

6.3 Radiated emissions 1-25 GHz

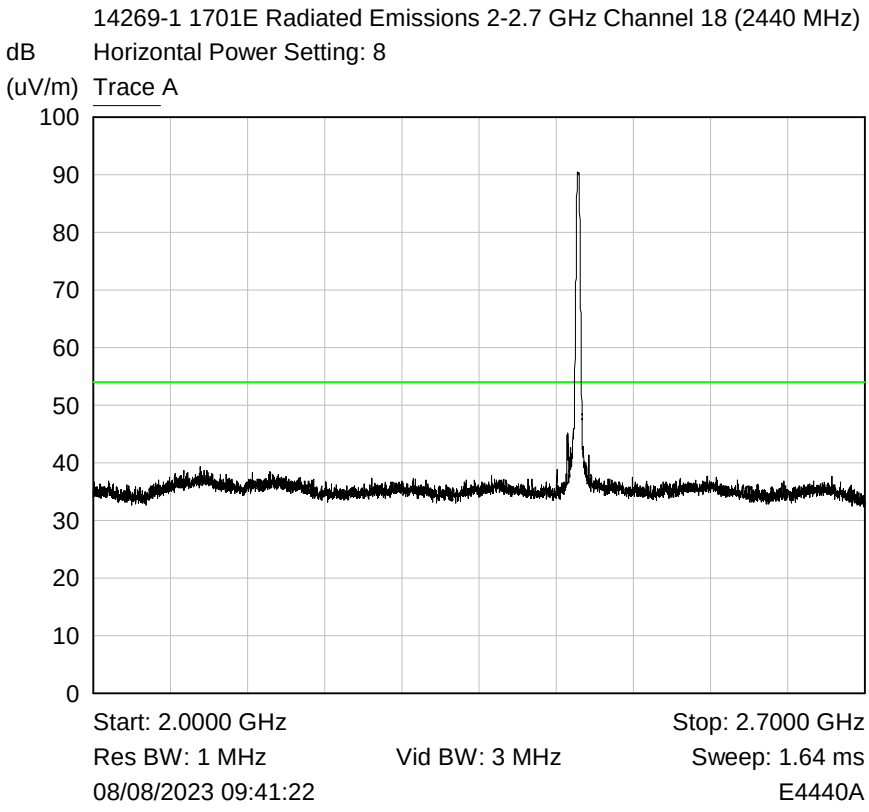
RF Parameters: Band 2400-2483.5 MHz, Power 8, Channel Spacing 5 MHz, Modulation OQPSK, Channel 2440 MHz (Mid Ch)



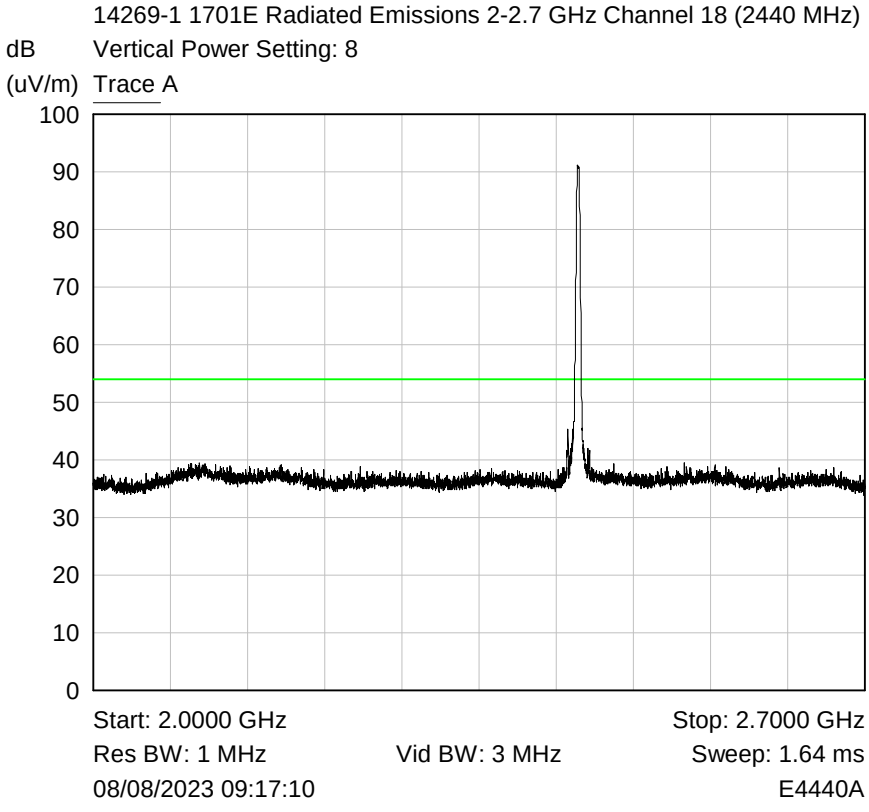
Plot of emissions 1-2 GHz Horizontal



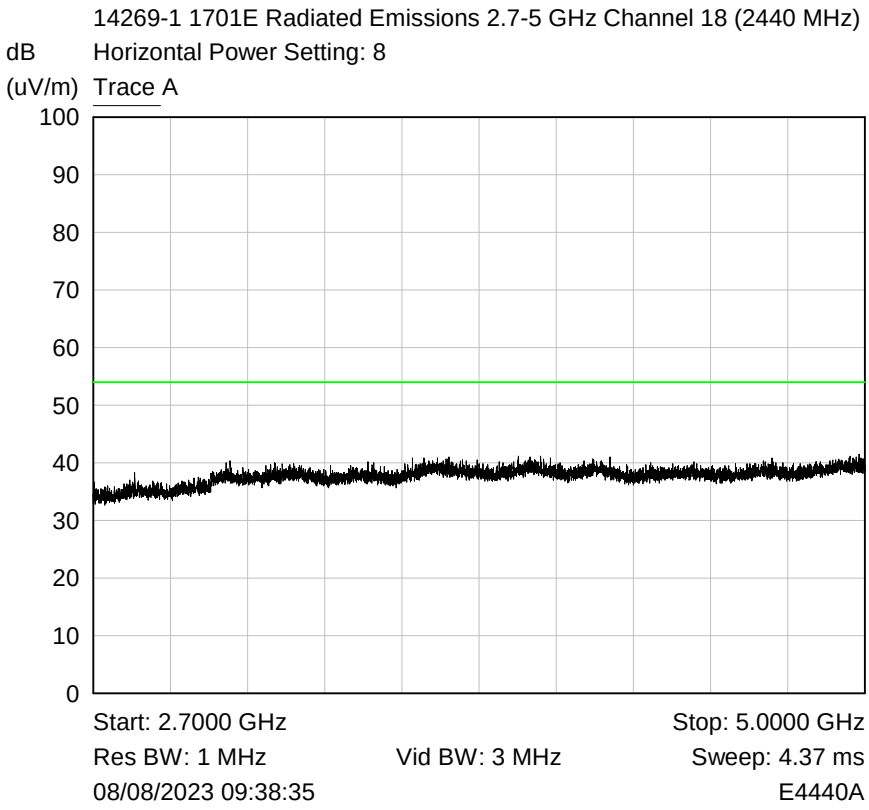
Plot of emissions 1-2 GHz Vertical



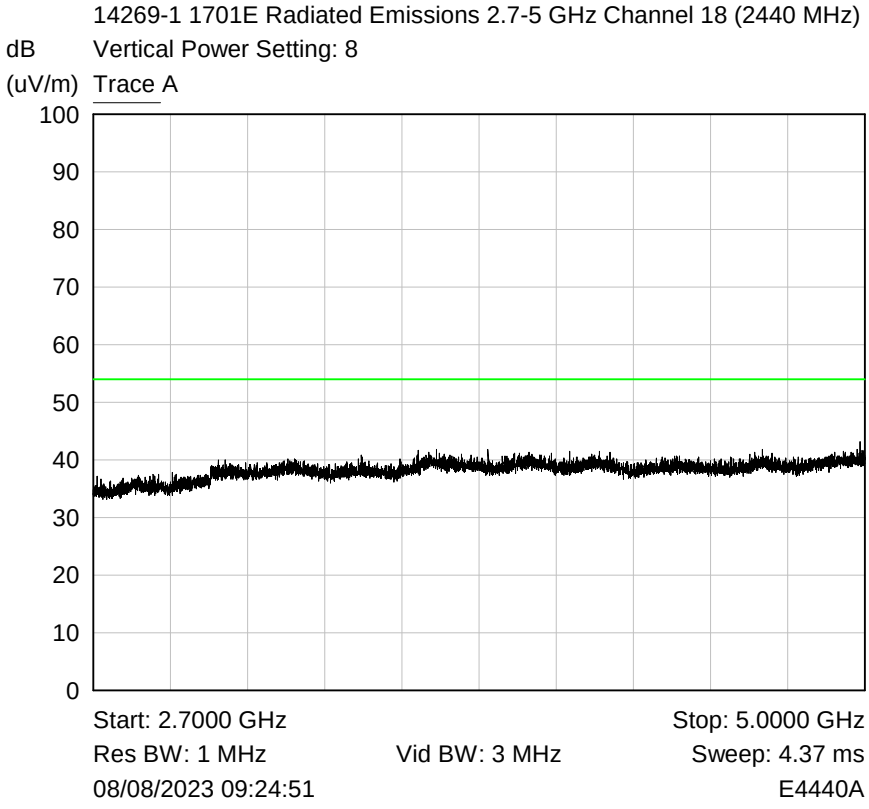
Plot of emissions 2-2.7 GHz Horizontal



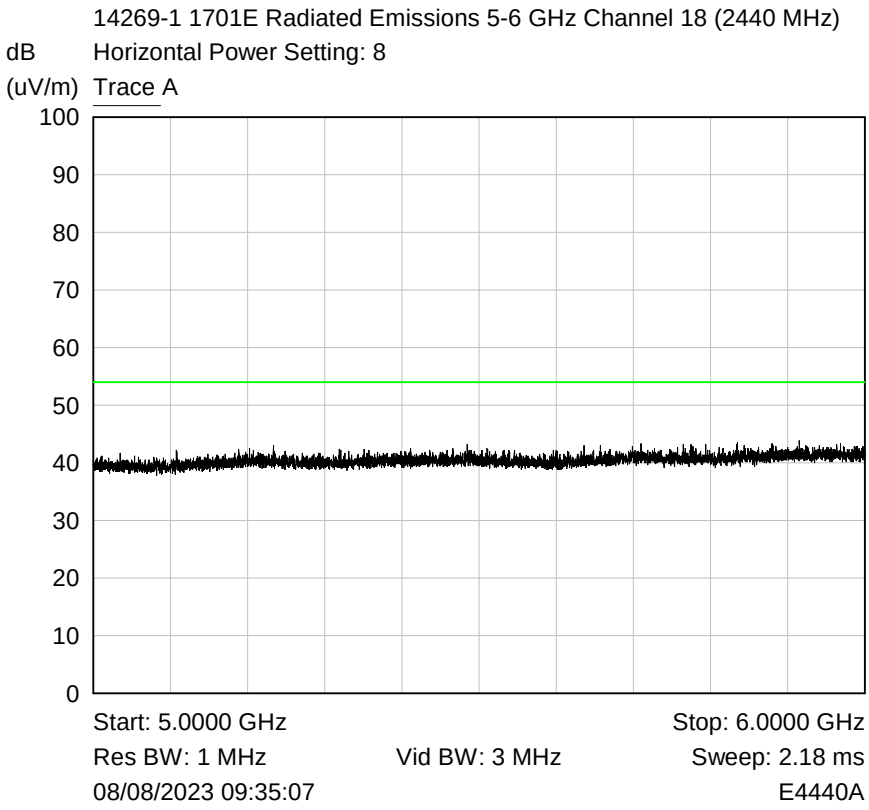
Plot of emissions 2-2.7 GHz Vertical



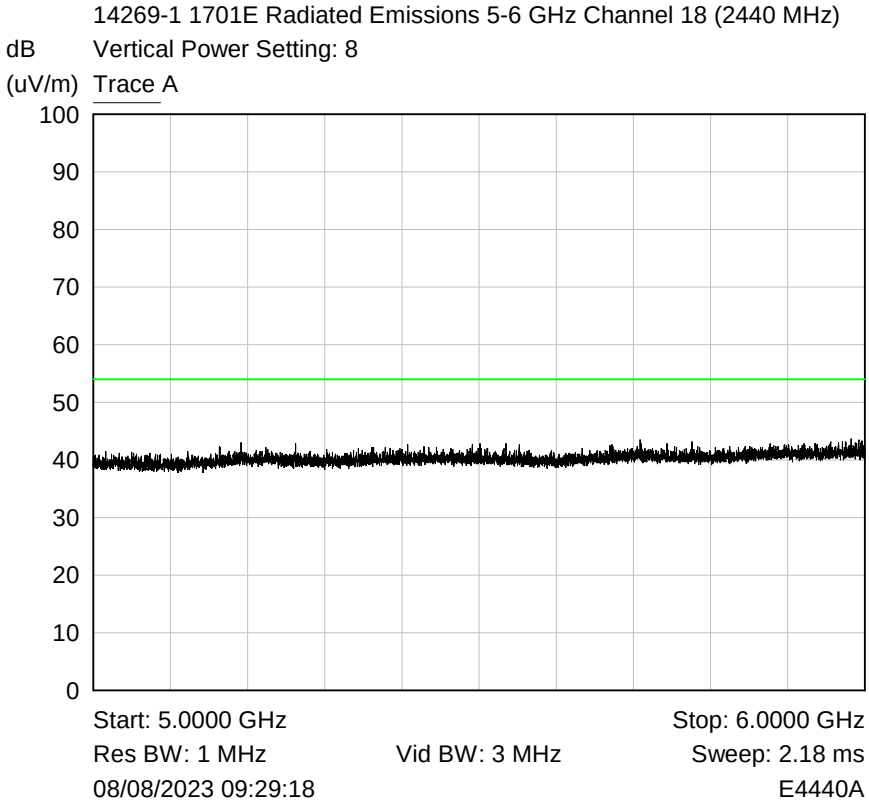
Plot of emissions 2.7-5 GHz Horizontal



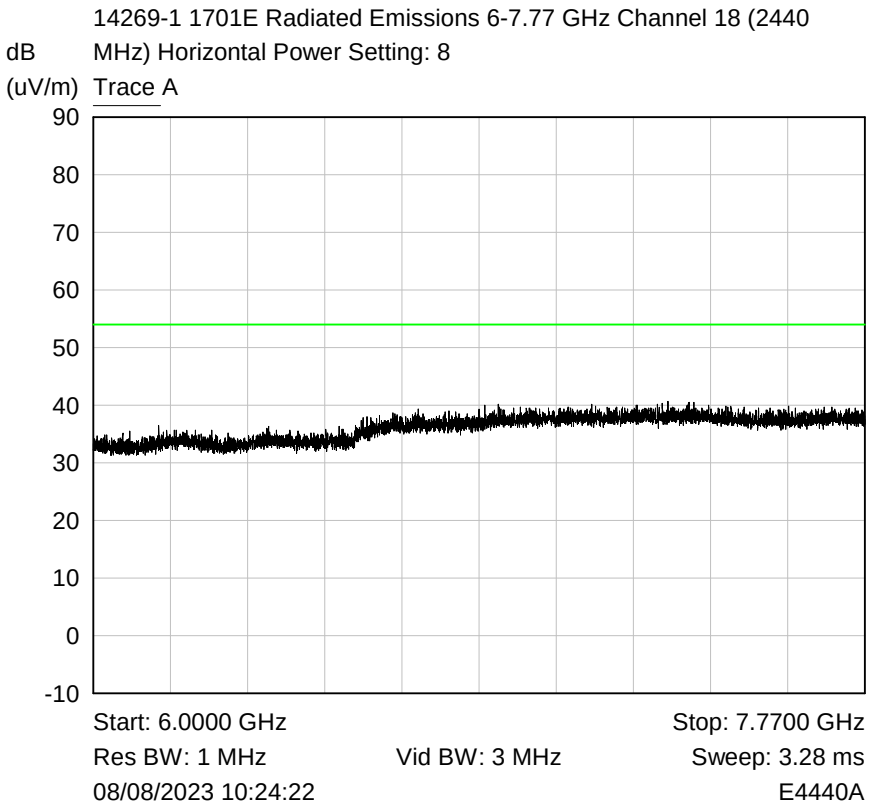
Plot of emissions 2.7-5 GHz Vertical



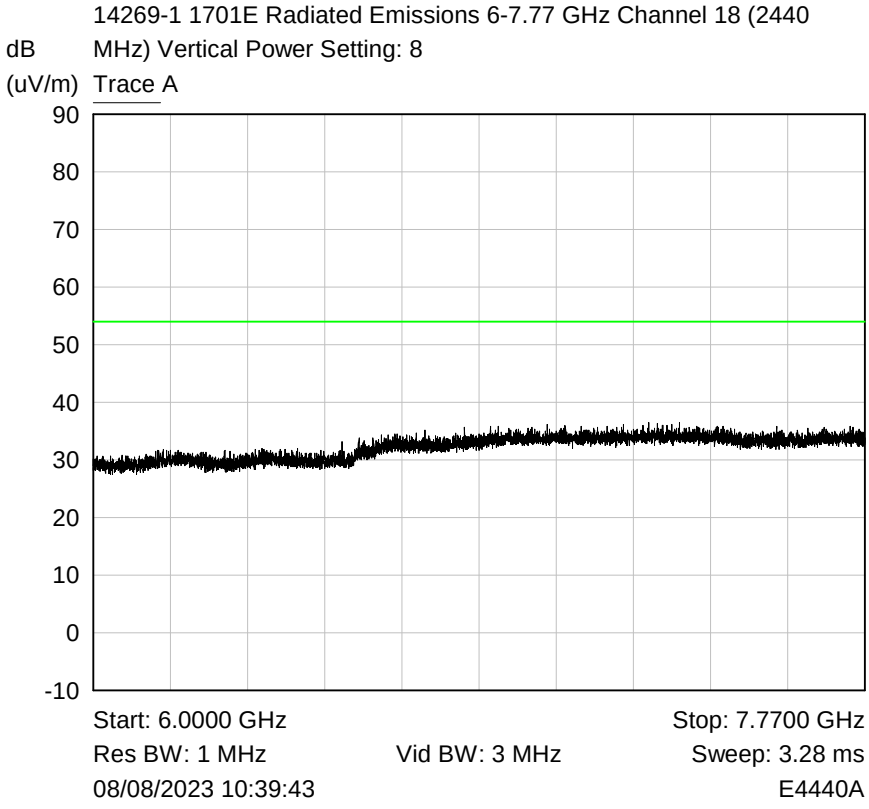
Plot of emissions 5-6 GHz Horizontal



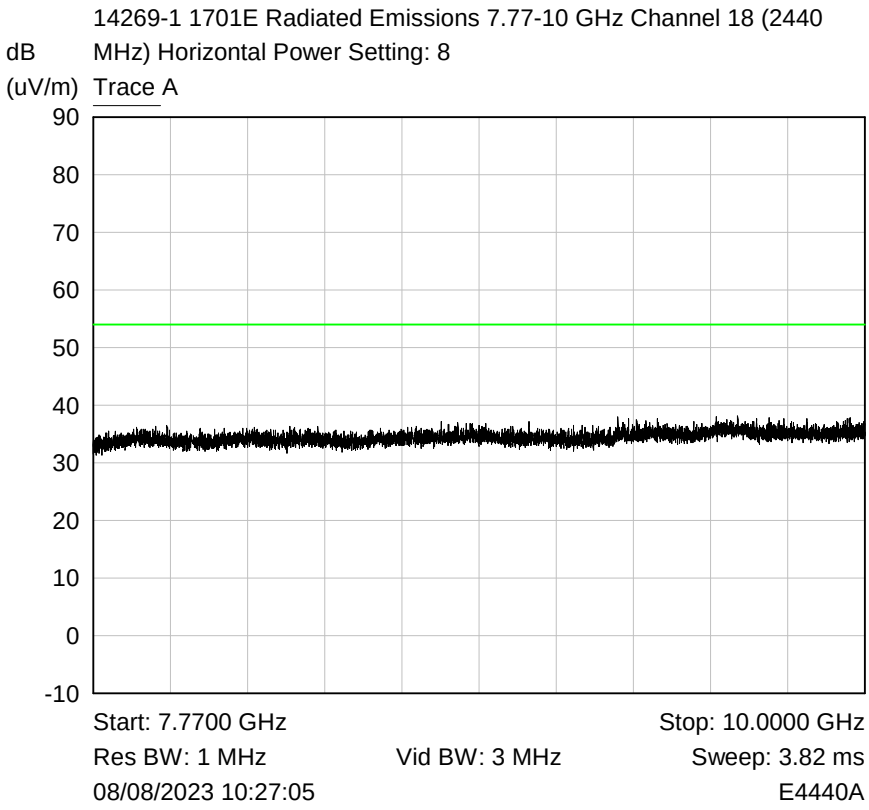
Plot of emissions 5-6 GHz Vertical



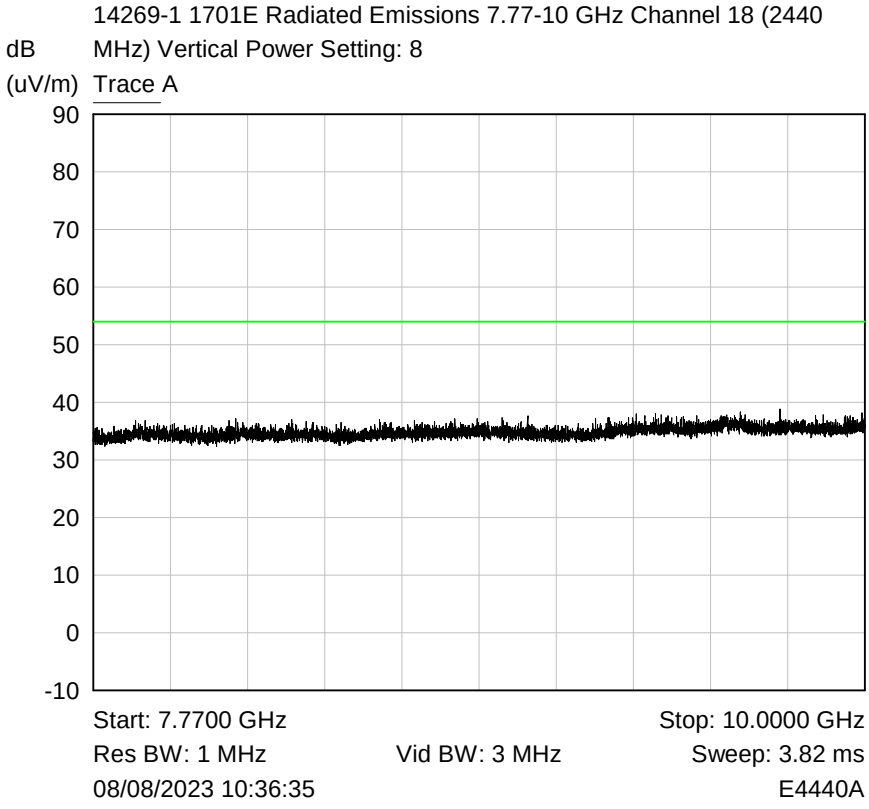
Plot of emissions 6-7.77 GHz Horizontal



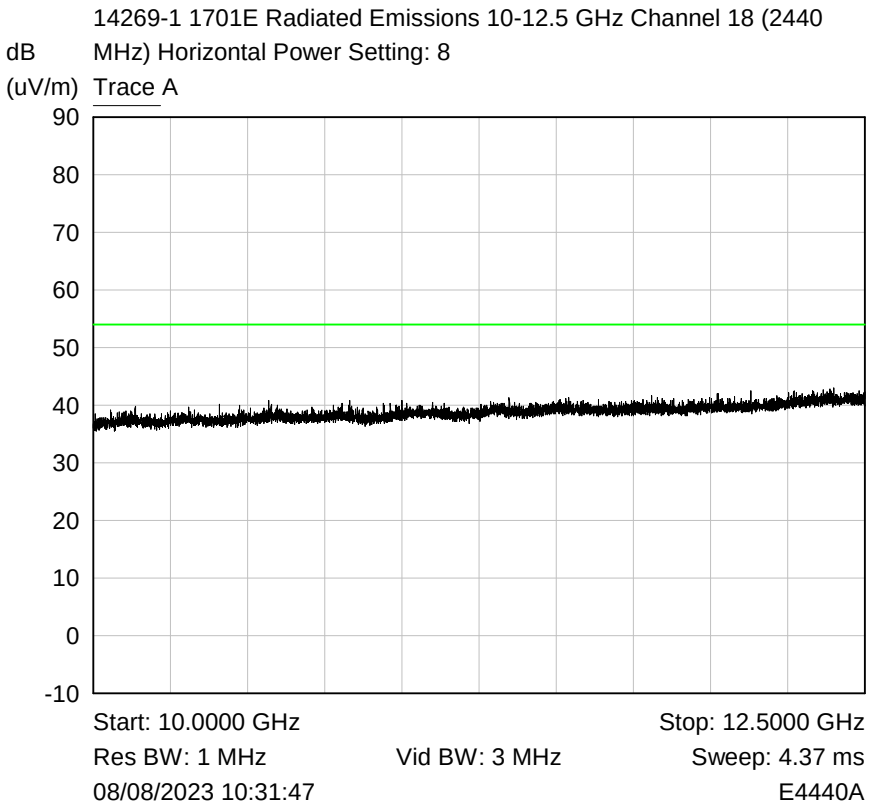
Plot of emissions 6-7.77 GHz Vertical



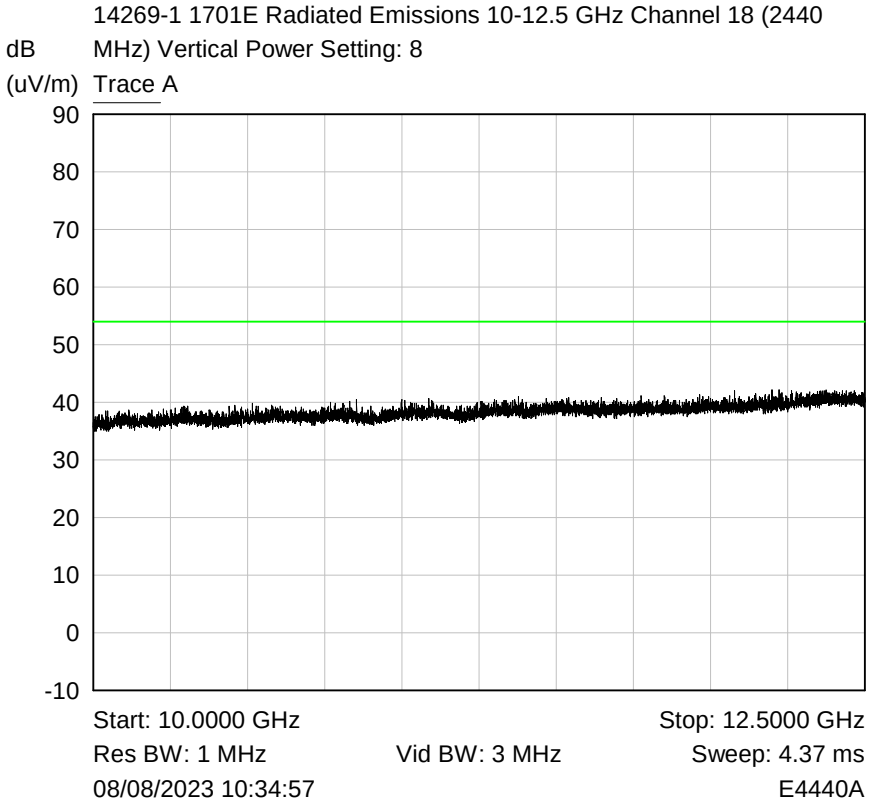
Plot of emissions 7.77-10 GHz Horizontal



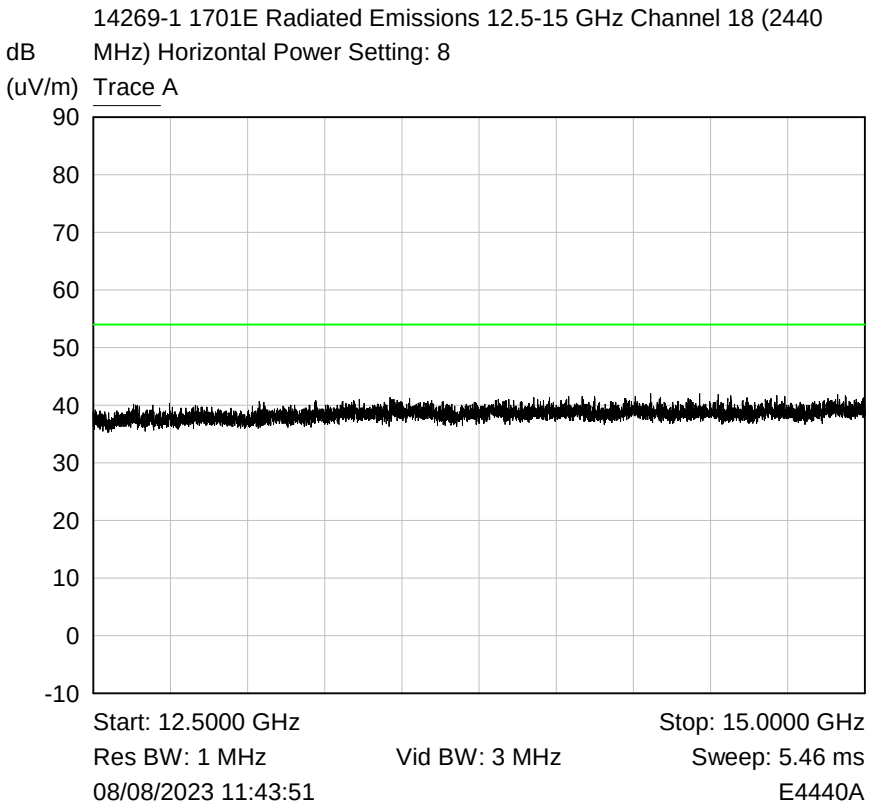
Plot of emissions 7.77-10 GHz Vertical



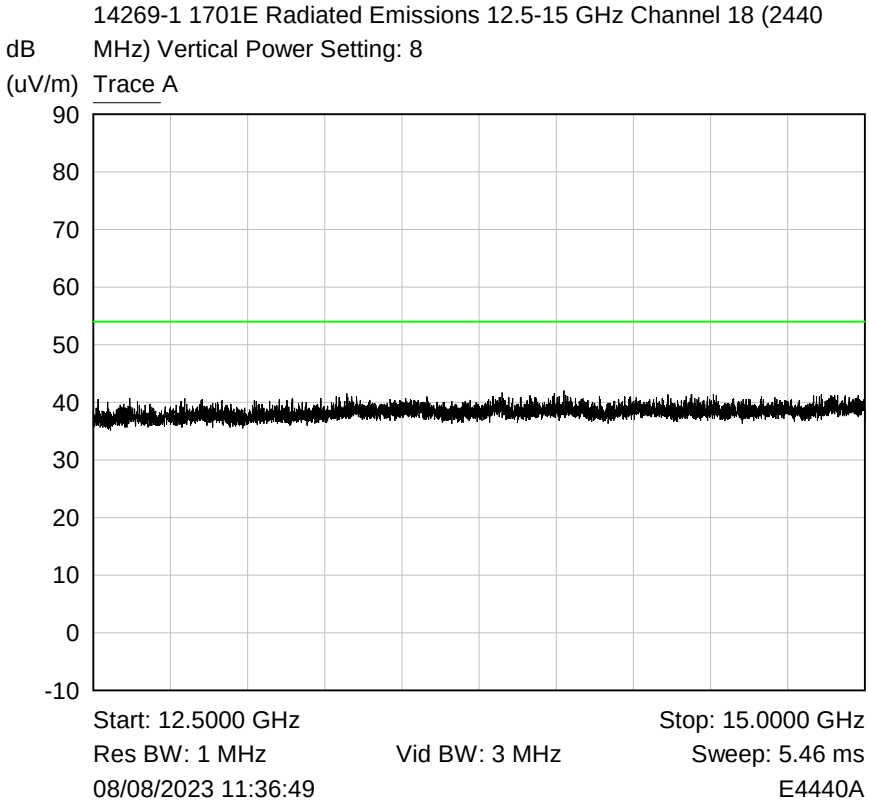
Plot of emissions 10-12.5 GHz Horizontal



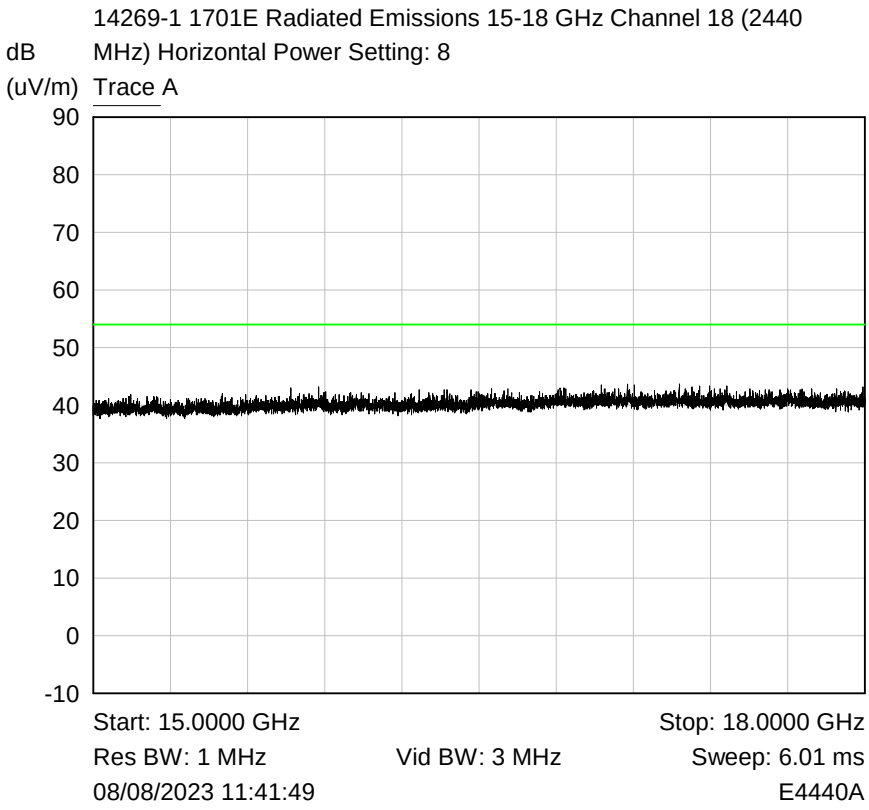
Plot of emissions 10-12.5 GHz Vertical



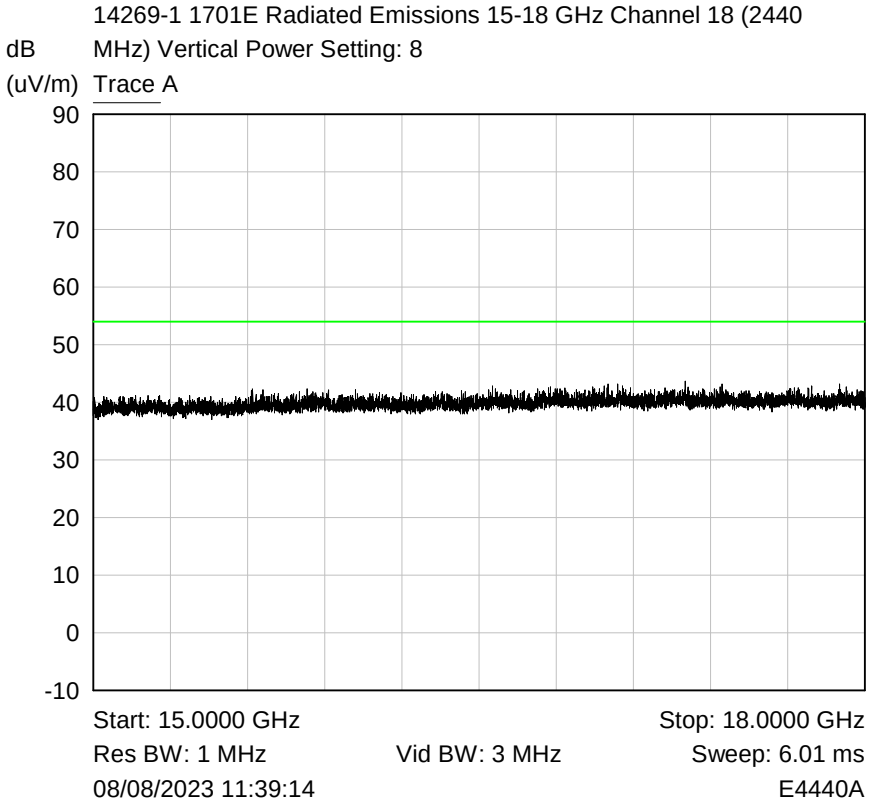
Plot of emissions 12.5-15 GHz Horizontal



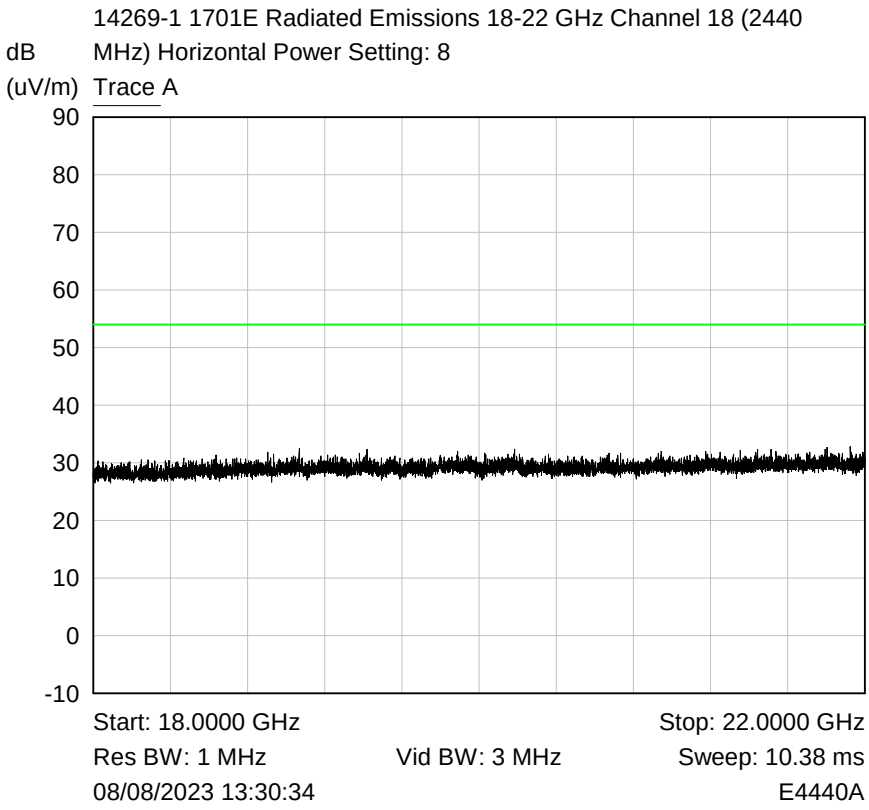
Plot of emissions 12.5-15 GHz Vertical



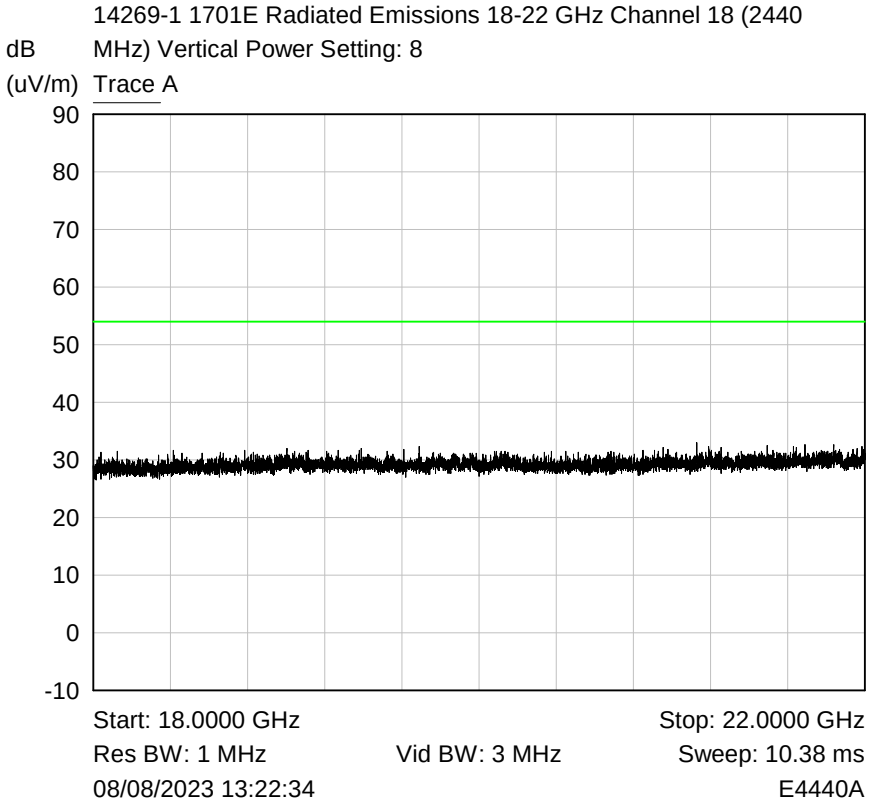
Plot of emissions 15-18 GHz Horizontal



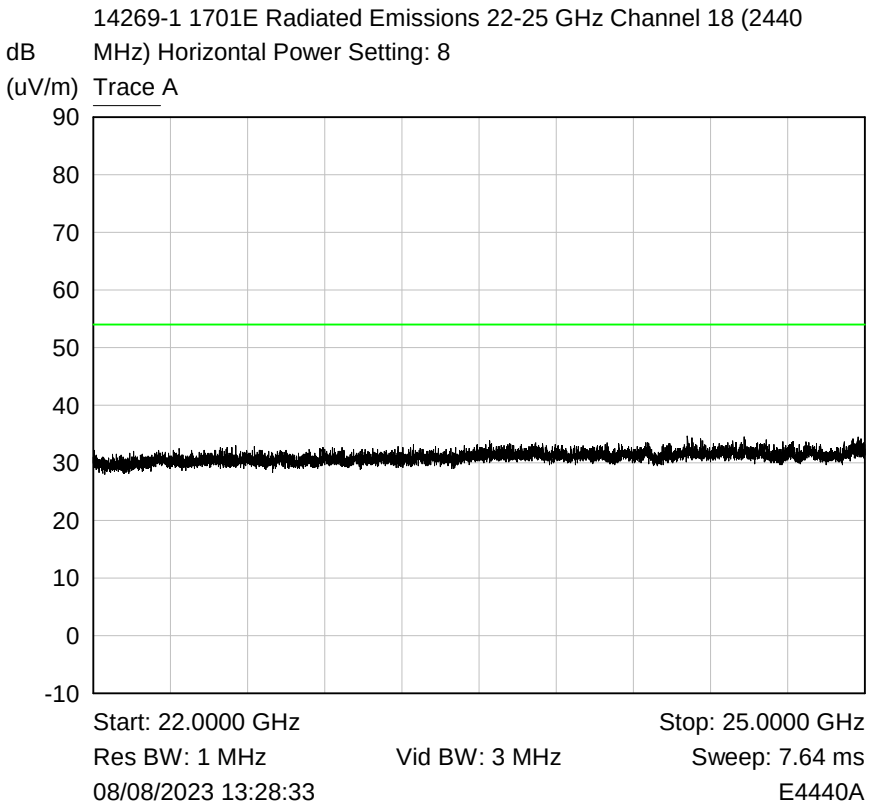
Plot of emissions 15-18 GHz Vertical



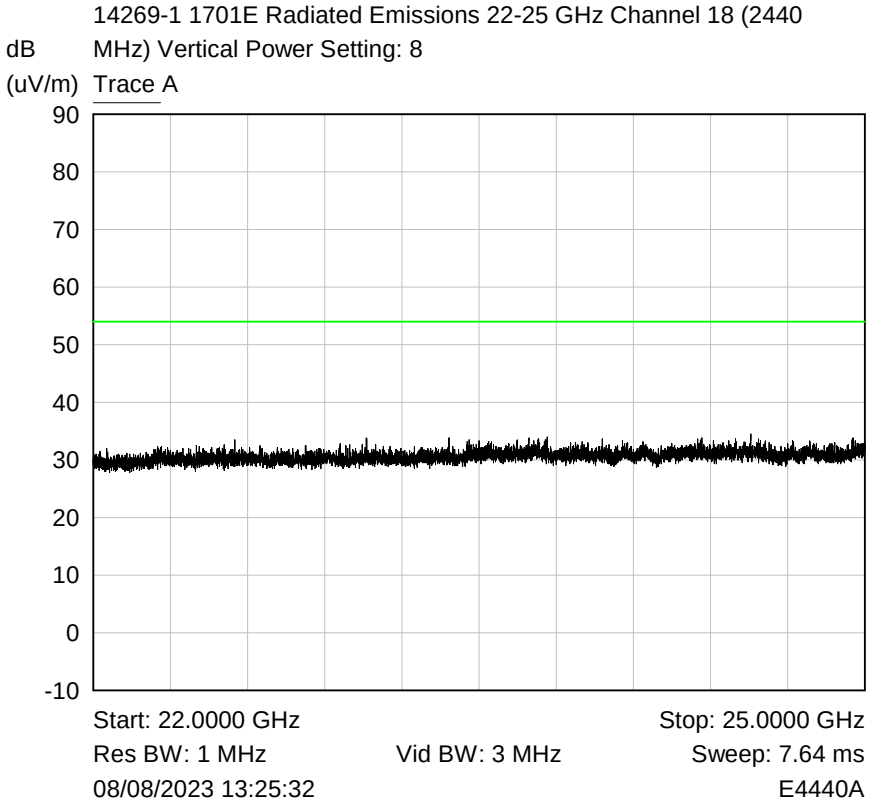
Plot of emissions 18-22 GHz Horizontal



Plot of emissions 18-22 GHz Vertical



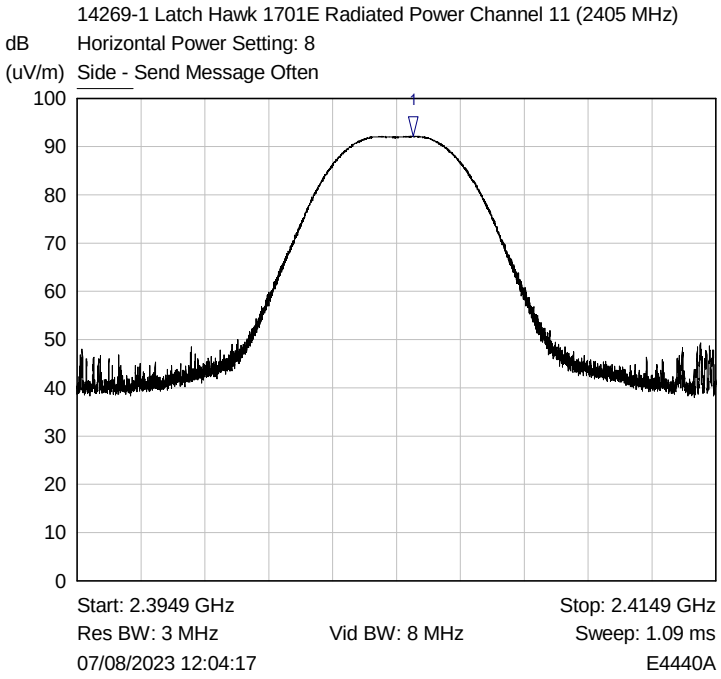
Plot of emissions 22-25 GHz Horizontal



Plot of emissions 22-25 GHz Vertical

6.4 Effective radiated power field strength

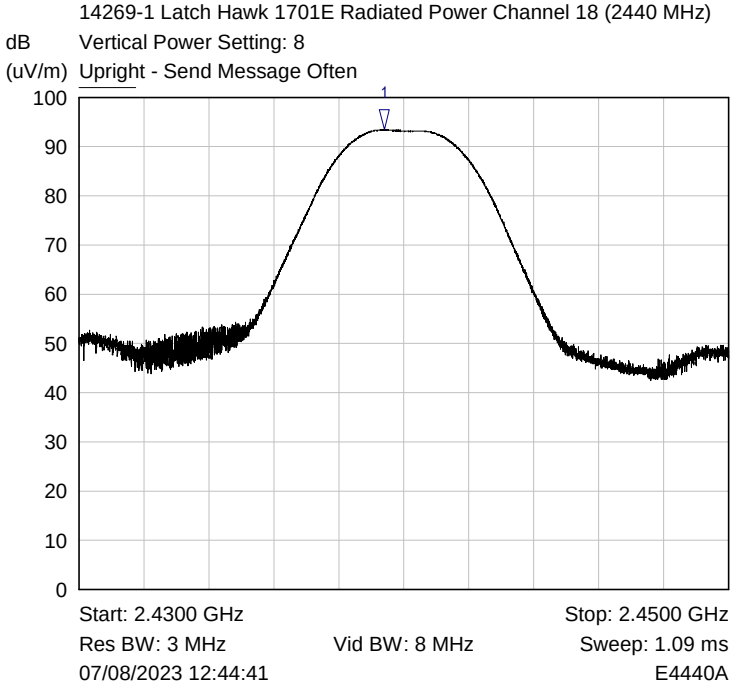
RF Parameters: Band 2400-2483.5 MHz, Power 8, Channel Spacing 5 MHz, Modulation OQPSK, Channel 2405 MHz (Low)



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Side - Send Message Often	2.4055 GHz	92.14 dB(uV/m)	

Plot of Horiz polarisation and EUT in Side position

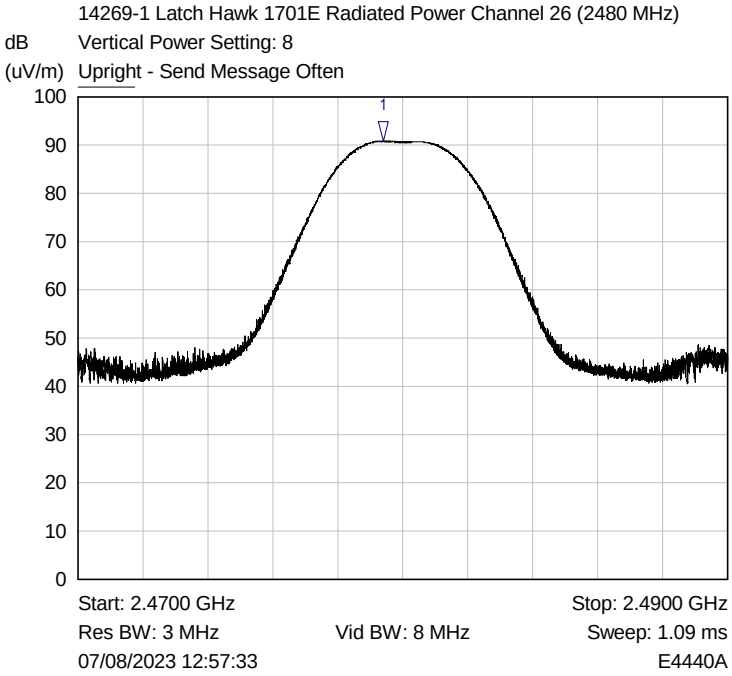
RF Parameters: Band 2400-2483.5 MHz, Power 8, Channel Spacing 5 MHz, Modulation OQPSK, Channel 2440 MHz (Mid)



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Upright - Send Message Often	2.4394 GHz	93.47 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)

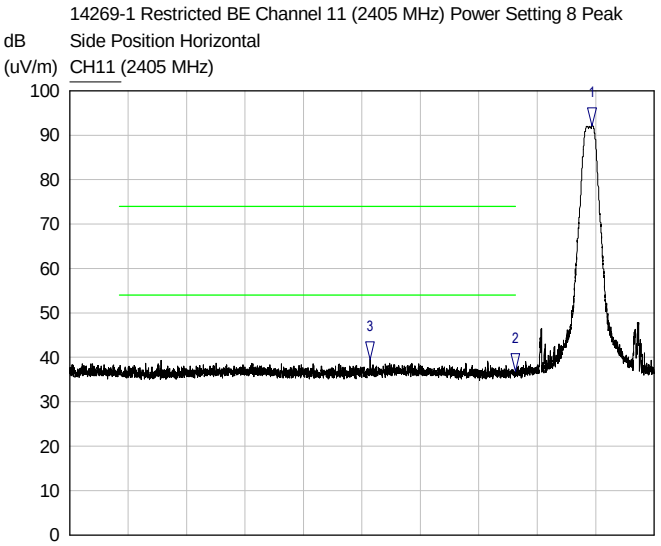


Mkr	Trace	X-Axis	Value	Notes
1 ▽	Upright - Send Message Often	2.4794 GHz	90.90 dB(uV/m)	

Plot of Vert polarisation and EUT in Upright position

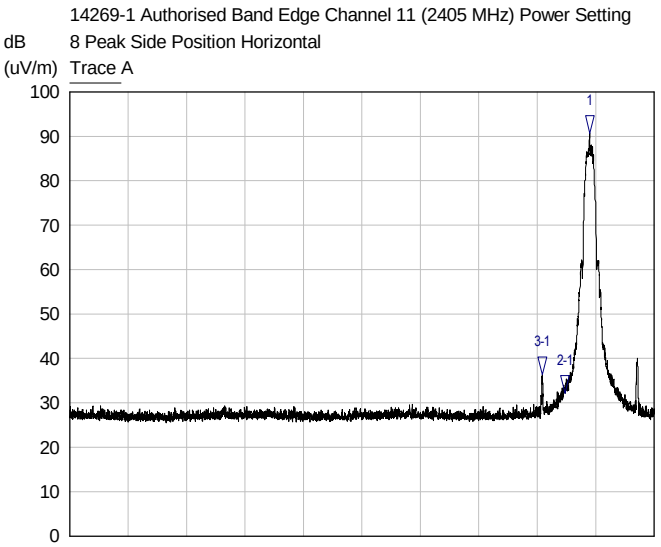
6.5 Band Edge Compliance

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



Mkr	Trace	X-Axis	Value	Notes
1 ▽	CH11 (2405 MHz)	2.4055 GHz	92.17 dB(uV/m)	
2 ▽	CH11 (2405 MHz)	2.3900 GHz	36.82 dB(uV/m)	
3 ▽	CH11 (2405 MHz)	2.3606 GHz	39.50 dB(uV/m)	

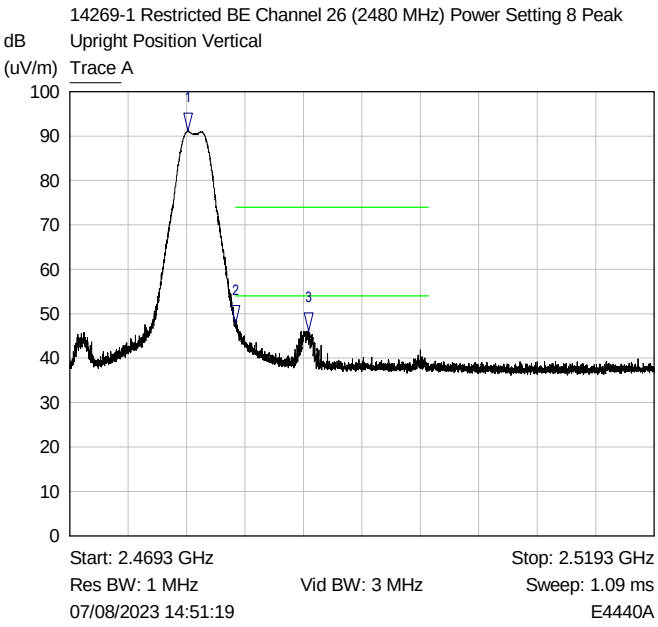
Restricted band edge Peak Plot



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	2.4050 GHz	90.65 dB(uV/m)	
2-1 ▽	Trace A	2.4000 GHz	-58.42 dB	
3-1 ▽	Trace A	-9.5368 MHz	-54.29 dB	

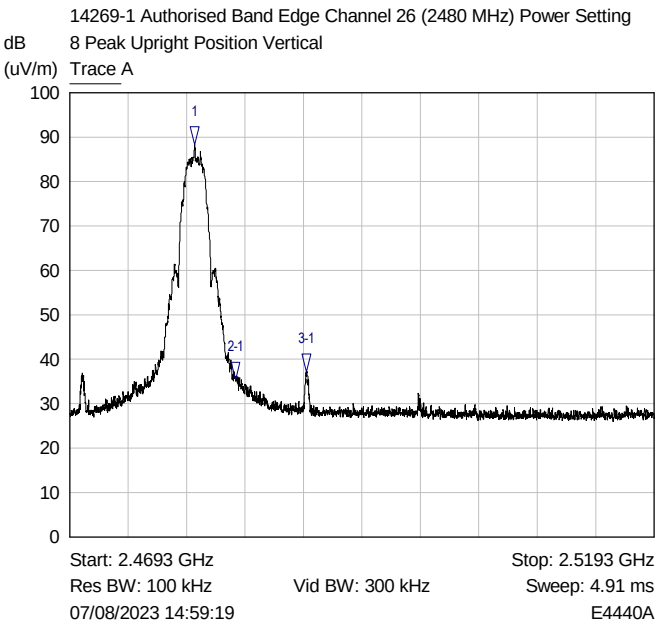
Authorised Band Edge peak Plot

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



Mkr	Trace	X-Axis	Value	Notes
1	Trace A	2.4794 GHz	91.10 dB(uV/m)	
2	Trace A	2.4835 GHz	47.82 dB(uV/m)	
3	Trace A	2.4897 GHz	46.13 dB(uV/m)	

Restricted band edge Peak Plot

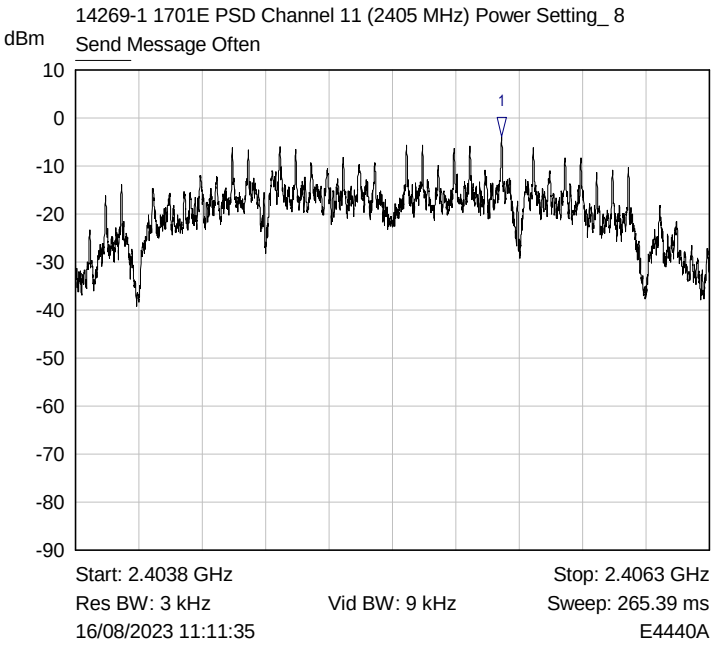


Mkr	Trace	X-Axis	Value	Notes
1	Trace A	2.4800 GHz	88.30 dB(uV/m)	
2-1	Trace A	2.4835 GHz	-52.89 dB	
3-1	Trace A	9.5288 MHz	-51.18 dB	

Authorised Band Edge peak Plot

6.6 Maximum Power Spectral Density

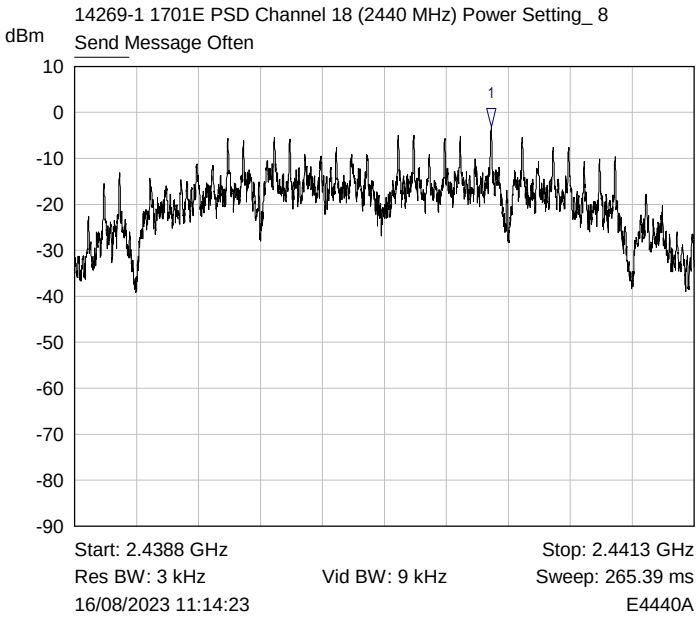
RF Parameters: Band 2400-2483.5 MHz, Power 8, Channel Spacing 5 MHz, Modulation OQPSK, Channel 2405 MHz (Low Ch)



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Send Message Often	2.4054 GHz	-3.76 dBm	

PSD Low Channel (2405 MHz)

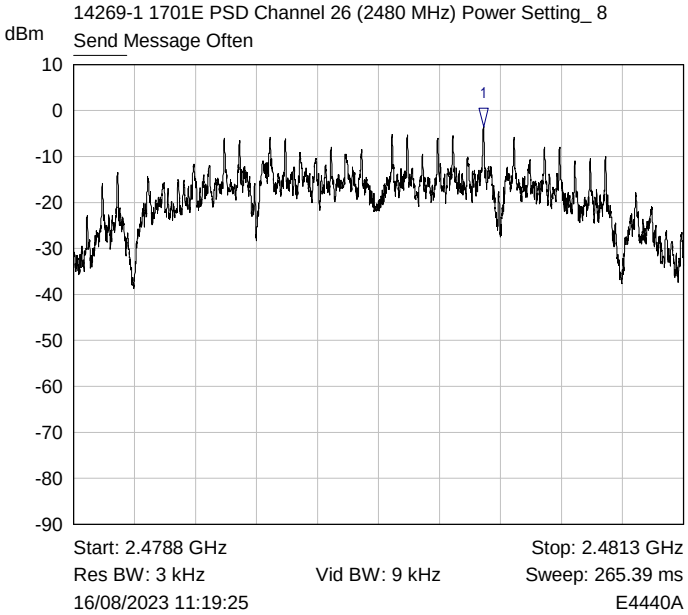
RF Parameters: Band 2400-2483.5 MHz, Power 8, Channel Spacing 5 MHz, Modulation OQPSK, Channel 2440 MHz (Mid Ch)



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Send Message Often	2.4404 GHz	-3.13 dBm	

PSD Mid Channel (2440 MHz)

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	2.4804 GHz	-3.52 dBm	

PSD High Channel (2480 MHz)

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

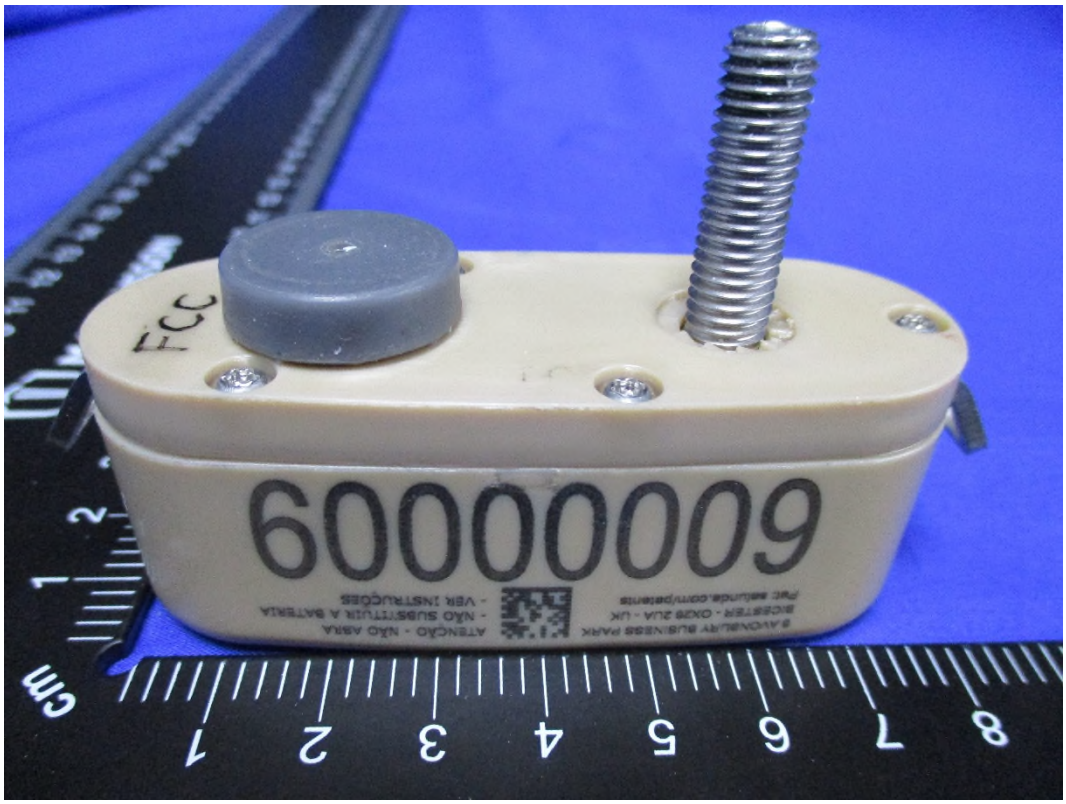
Equation 26 transposed: $E_{Spec\ limit} = \sqrt{(0.9x10^{-6} \times 377)} = 0.01842$ V/m.

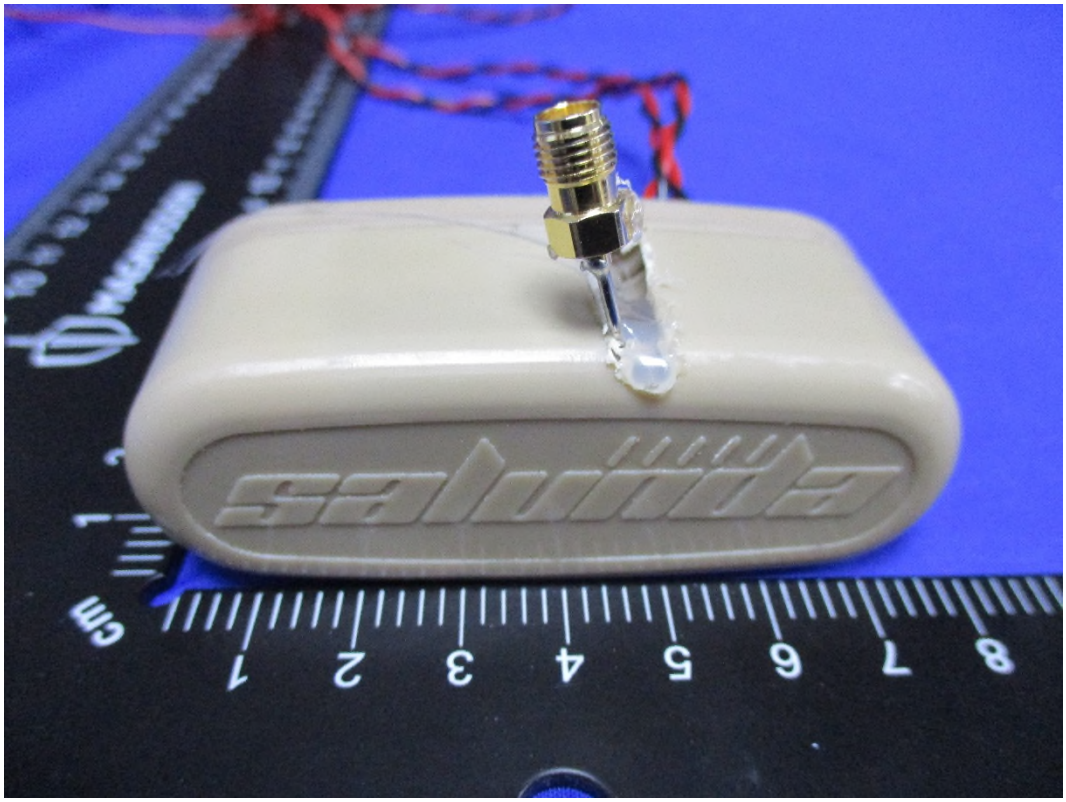
And

Equation 21 transposed: $E_{Log} = 20Log(0.01842) +120 = 85.3$dBµV/m @ 3m.

8 Photographs

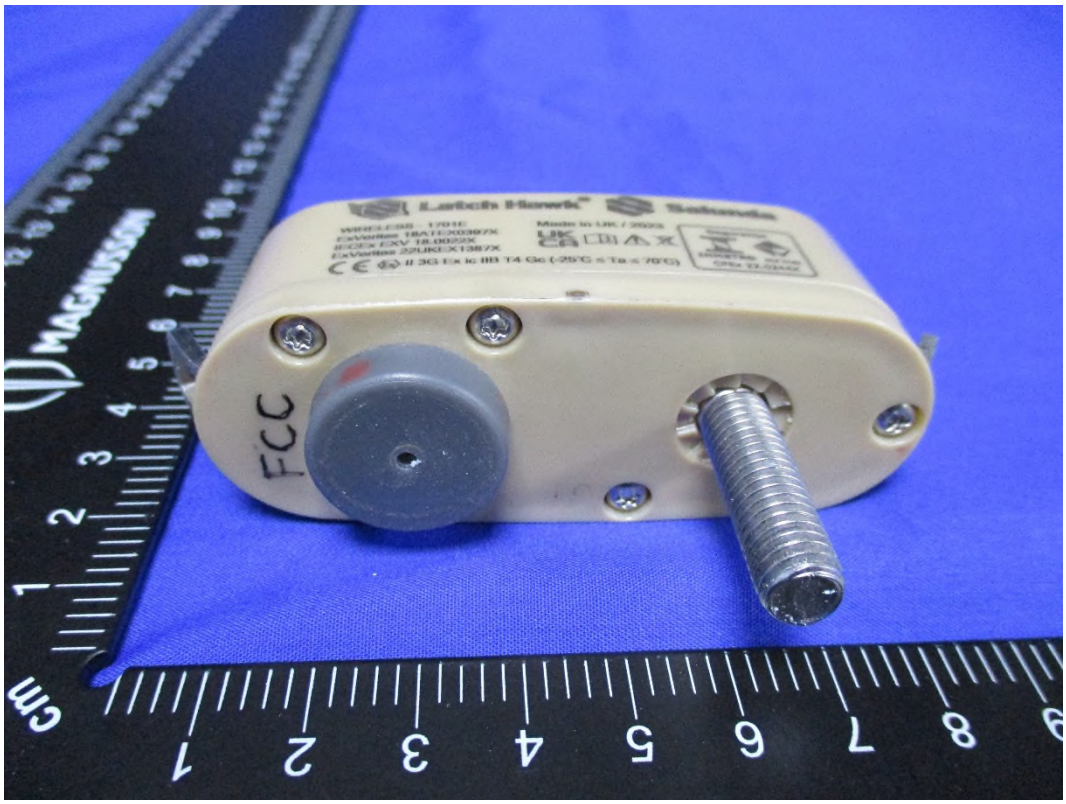
8.1 EUT Front View

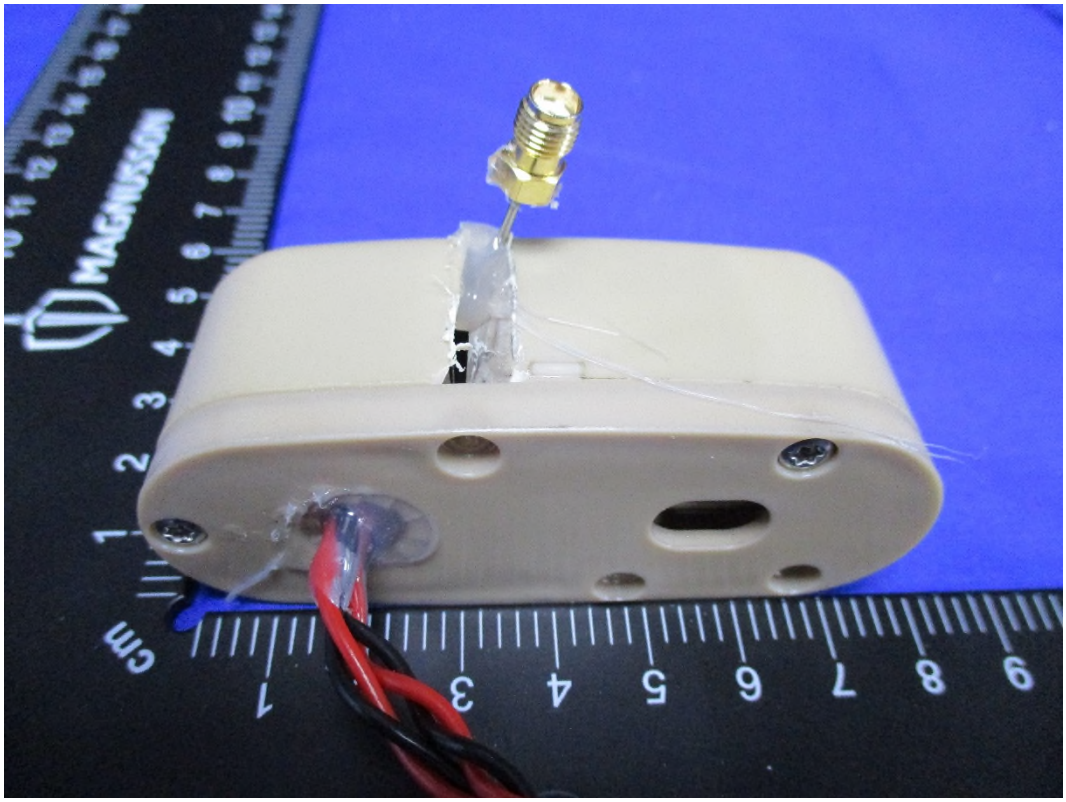




Conducted sample with temporary antenna port

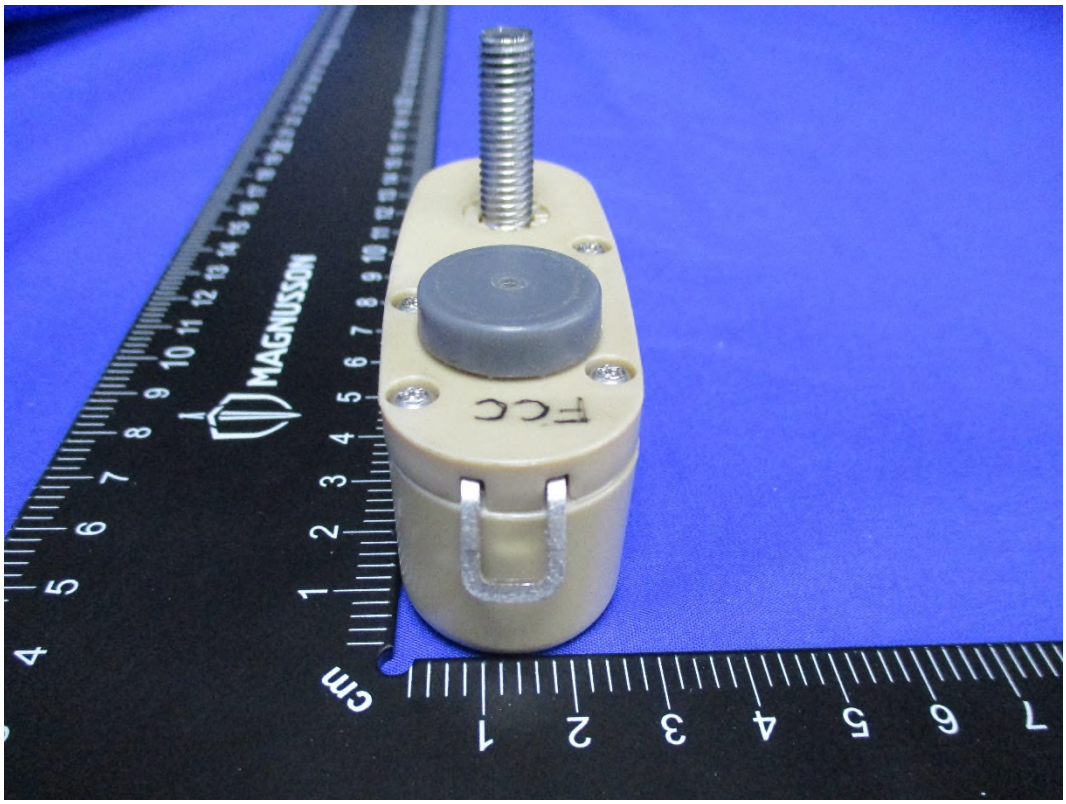
8.2 EUT Reverse Angle



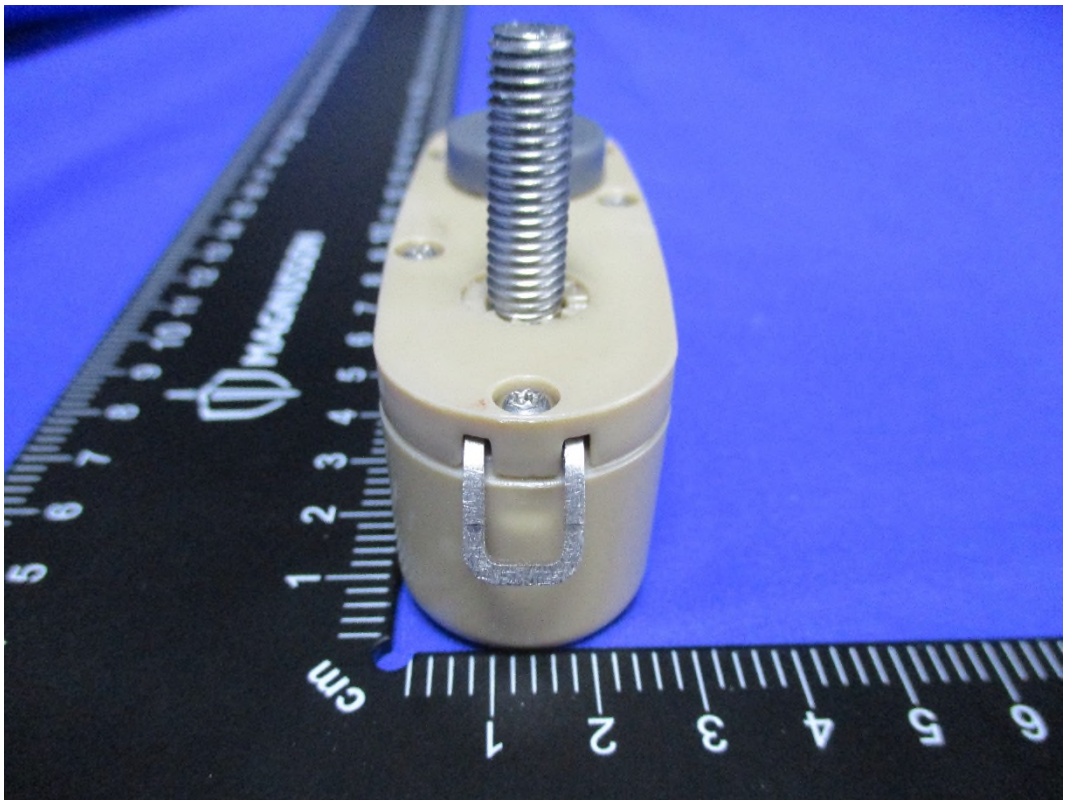


Conducted sample with temporary antenna port and DC cables fitted

8.3 EUT Left side View

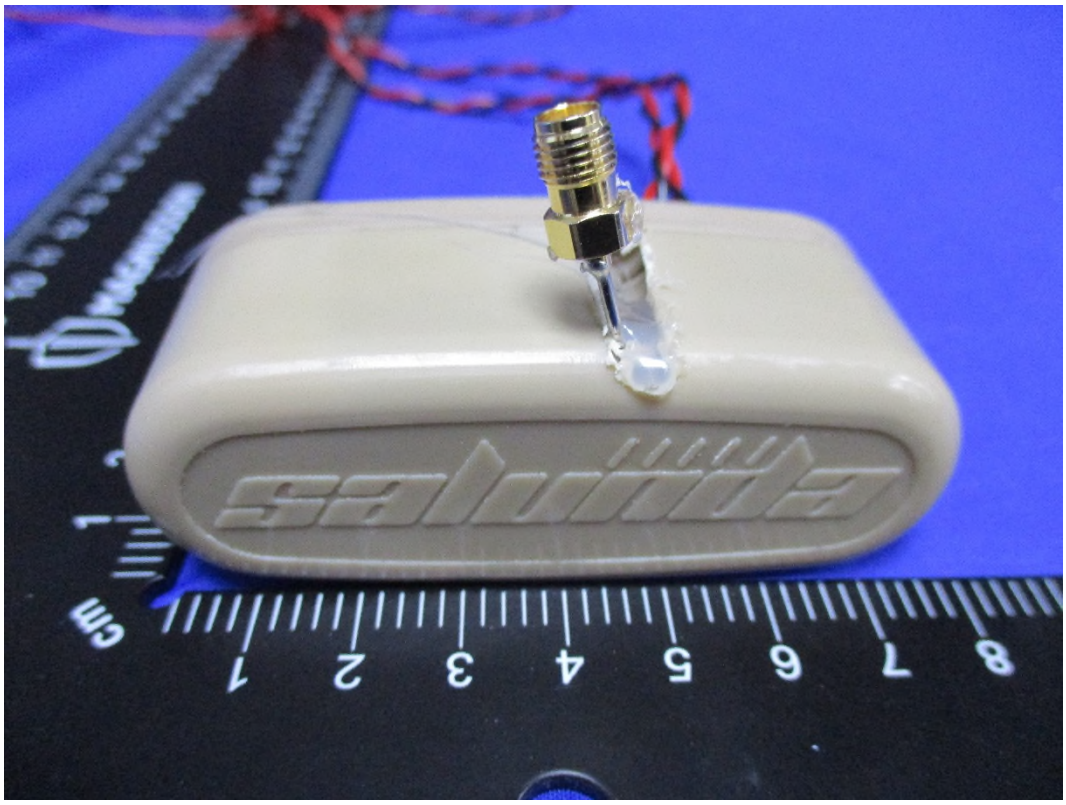


8.4 EUT Right side View



8.5 EUT Antenna Port

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



Conducted sample with temporary ZigBee 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.

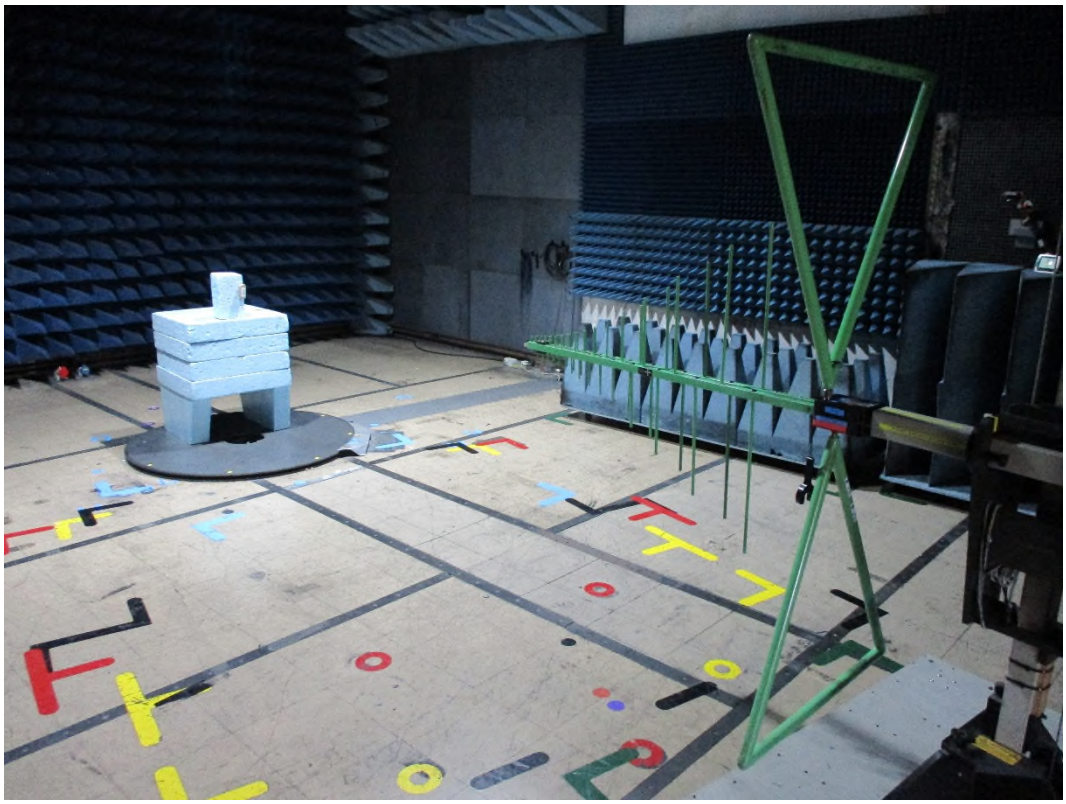
8.8 EUT ID Label

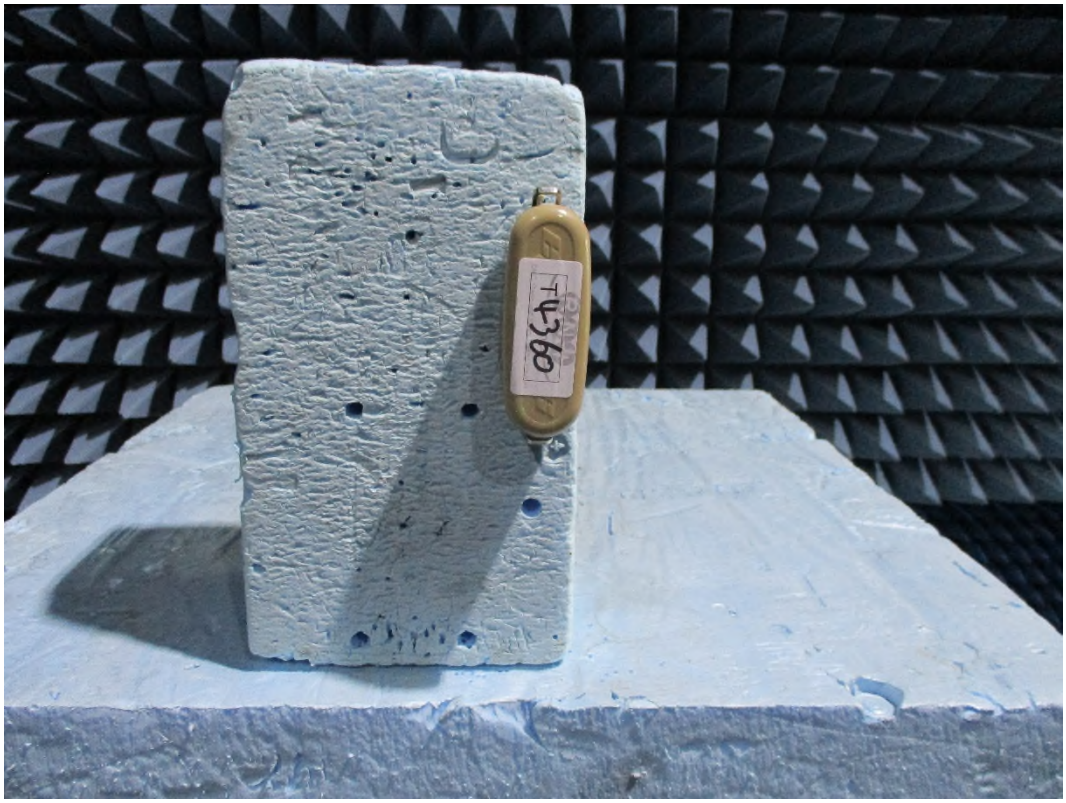
8.9 EUT Chassis

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

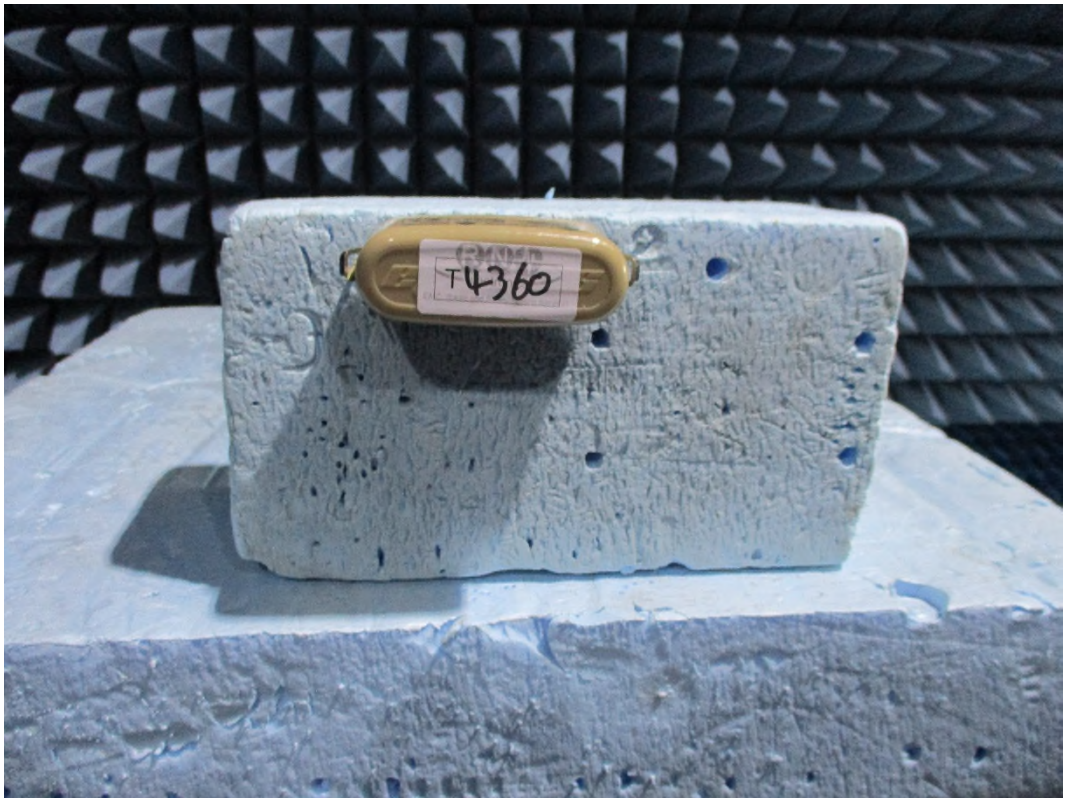
8.10 Radiated emissions 9 kHz - 30 MHz

8.11 Radiated emissions 30 MHz -1 GHz





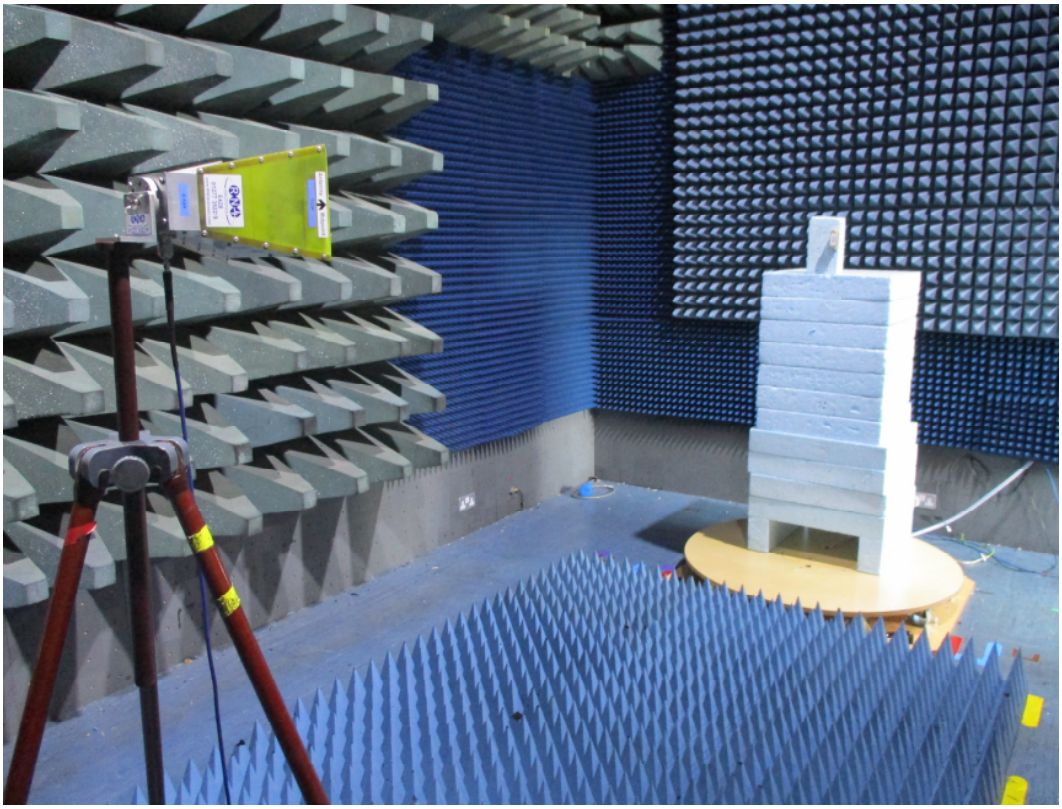
Upright Position

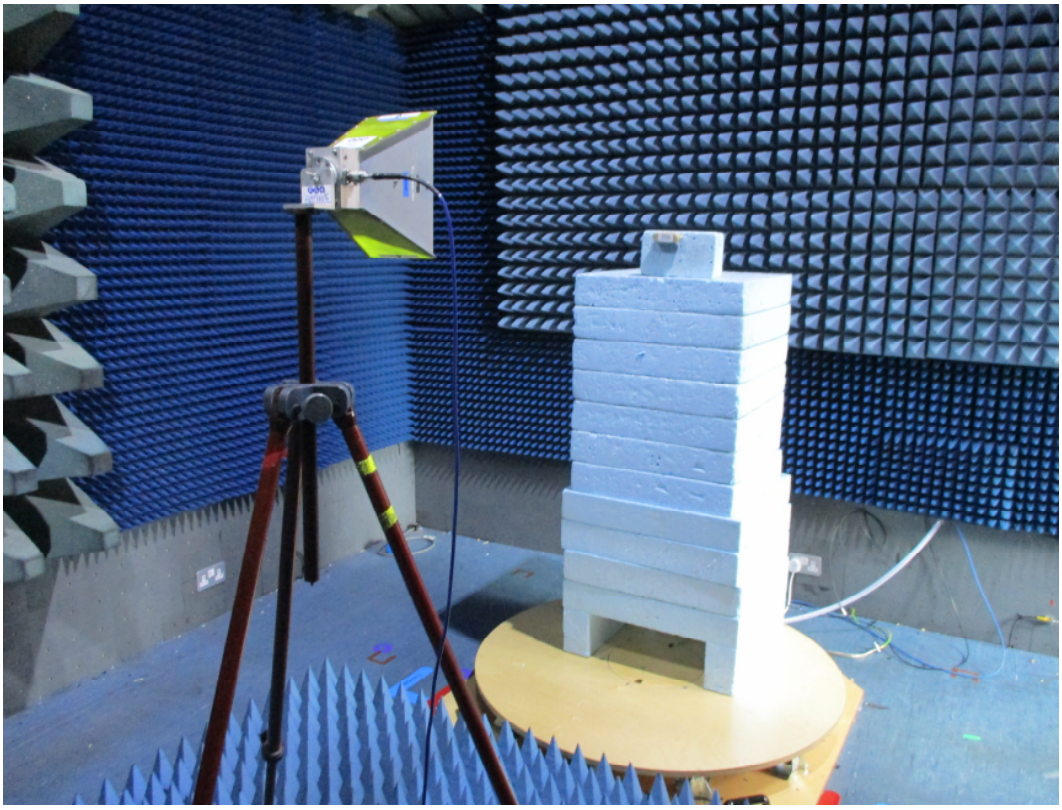


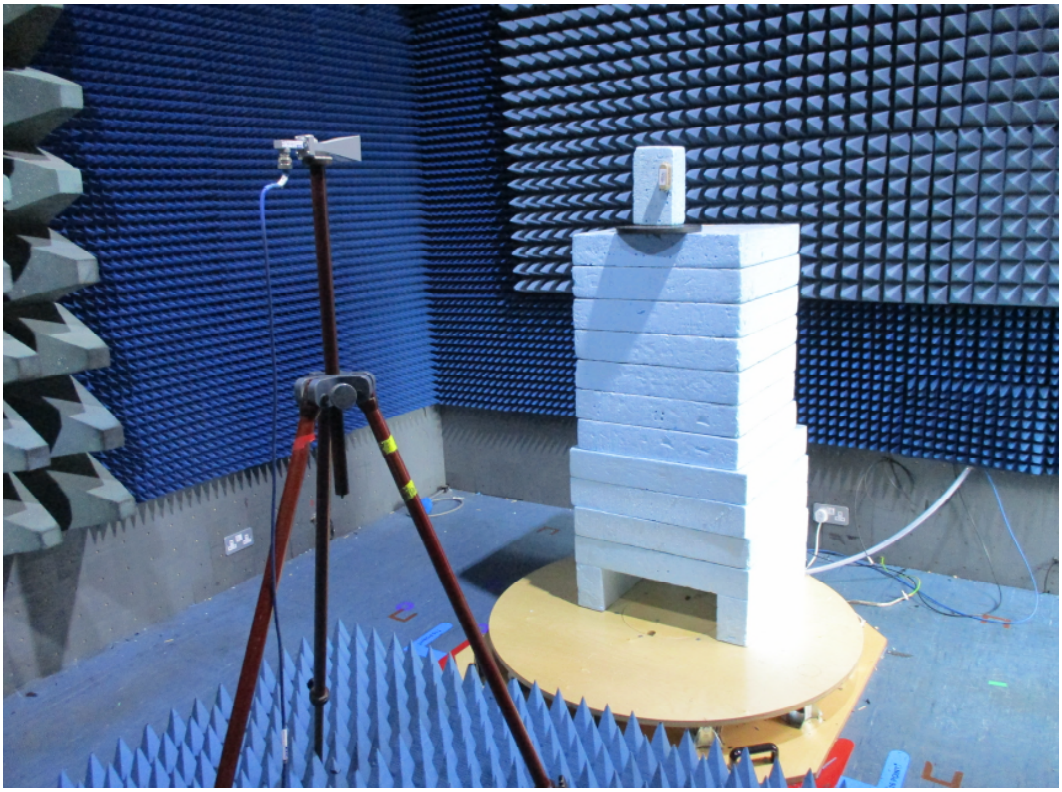
Side Position

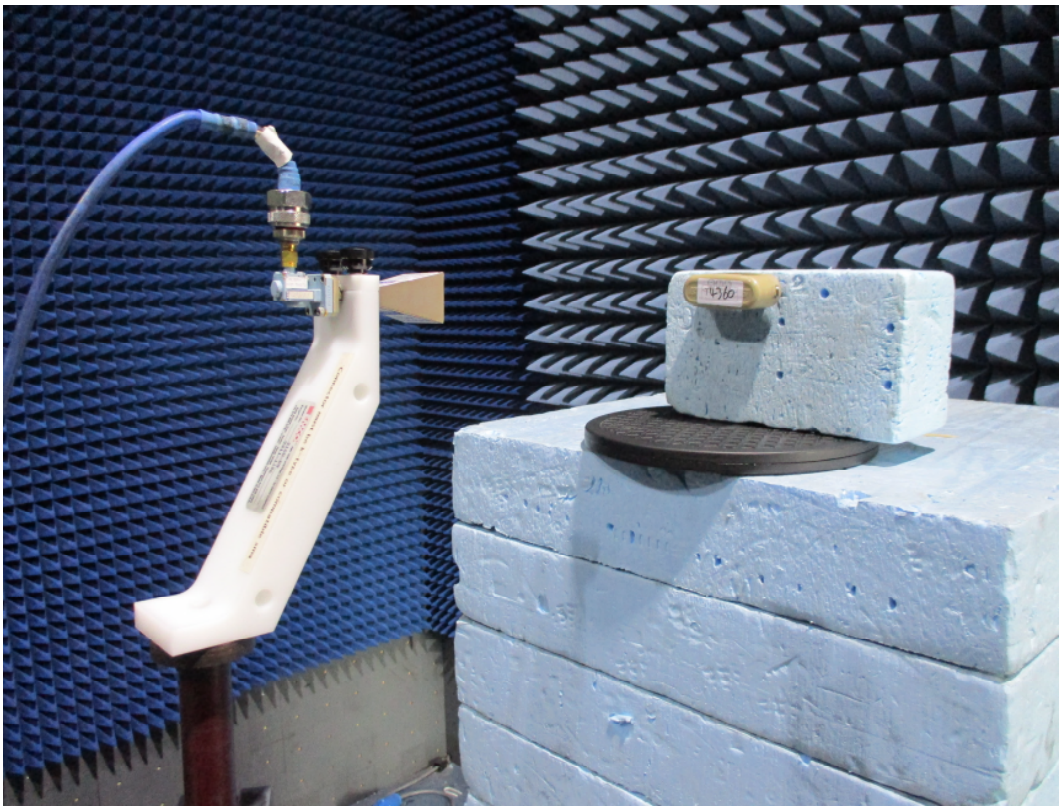
Flat Position

8.12 Radiated emissions 1-25 GHz









8.13 Radiated emission diagrams

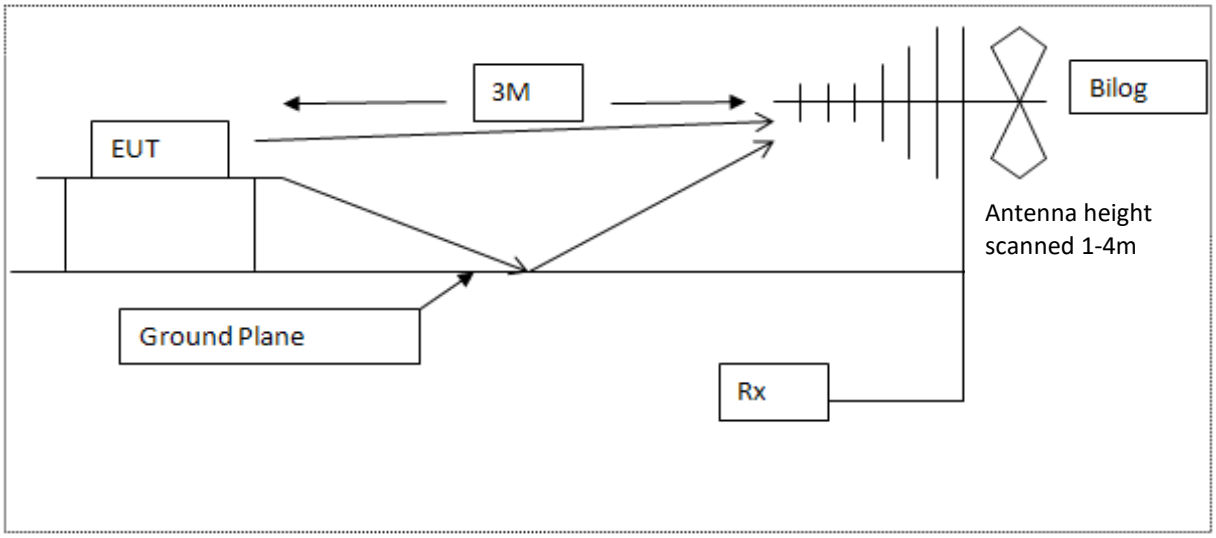


Diagram of the radiated emissions test setup 30 - 1000 MHz

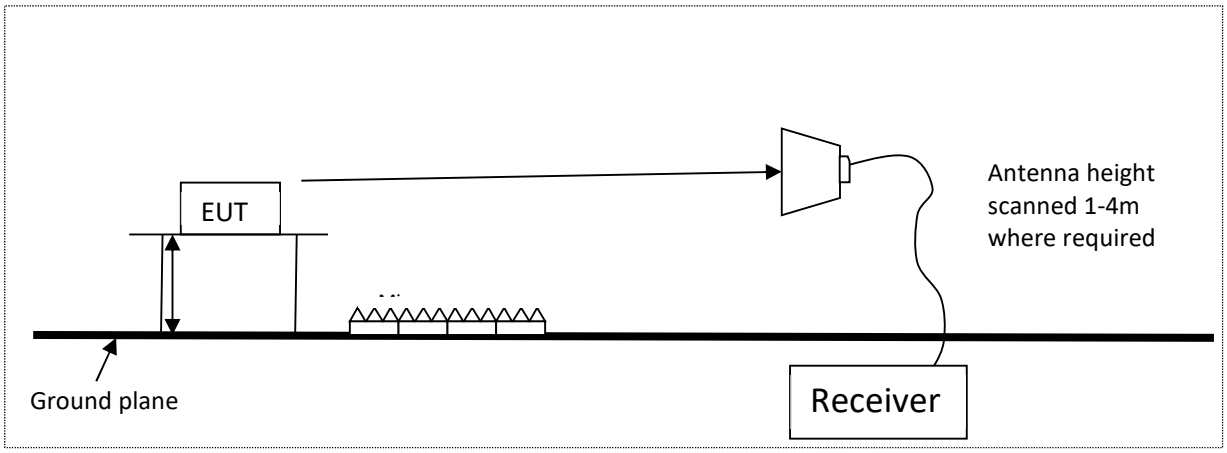


Diagram of the radiated emissions test setup above 1GHz

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
E411	N9039A	9 kHz - 1 GHz RF Filter Section	Agilent Technologies	05-Jul-2023	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-2023	12 months
E429	-	Filter Box 5 Switch Filters 0.91 GHz - 16.3 GHz	RN Electronics	21-Aug-2023	12 months
E547	8493A	Attenuator 20dB 12.4GHz	Hewlett Packard	27-Jul-2023	12 months
E624	E4440A	PSA 3 Hz - 26.5 GHz	Agilent Technologies	06-Jul-2023	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
E904	5086-7805	Pre-Amplifier 1GHz - 26.5GHz	Hewlett Packard	03-May-2023	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

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. 293246, ISED Registration No. 5612A-4

Site C Transient Laboratory

Site D Screened Room (Conducted Immunity)

Site E Screened Room (Control Room for Site D)

Site F Screened Room (Conducted Emissions)

Site G Screened Room (Control Room for Site H)

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

Site J Transient Laboratory

Site K Screened Room (Control Room for Site M)

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

Site N Radio Laboratory

Site Q Fully-Anechoic Chamber

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

Site R Screened Room (Conducted Immunity)

Site S Safety Laboratory

Site T Transient Laboratory

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

13 Abbreviations and units

%	Percent
λ	Wavelength
µA/m	microAmps per metre
µV	microVolts
µW	microWatts
AC	Alternating Current
ACK	ACKnowledgement
ACP	Adjacent Channel Power
AFA	Adaptive Frequency Agility
ALSE	Absorber Lined Screened Enclosure
AM	Amplitude Modulation
Amb	Ambient
ANSI	American National Standards Institute
ATPC	Automatic Transmit Power Control
AVG	Average
AWGN	Additive White Gaussian Noise
BER	Bit Error Rate
BPSK	Binary Phase Shift Keying
BT	BlueTooth
BLE	BlueTooth Low Energy
BW	Bandwidth
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 ======