



A part of



## Radio Test Report

**Salunda Ltd**

**6891**

**D10**

47 CFR Part 15.250 Effective Date 1st October 2021

WBT: Wideband Transmitter

Test Date: 28th November 2022 to 14th February 2023

Report Number: 02-13917-5-23 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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### Certificate of Test 13917-5

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

Equipment:	6891
Model Number:	D10
Unique Serial Number:	0044 (Radiated) 0055 (Conducted)
Applicant:	Salunda Ltd Unit 6 Avonbury Business Park Howes Lane Bicester Oxfordshire OX26 2UA
Proposed FCC ID	2ALTW18016891
Full measurement results are detailed in Report Number:	02-13917-5-23 Issue 01
Test Standards:	47 CFR Part 15.250 Effective Date 1st October 2021 WBT: Wideband Transmitter

NOTE: This report pertains to UWB operation, for 2.4GHz ZigBee operation please refer to RN report 01-13917-2-23.

#### 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: 28th November 2022 to 14th February 2023

Test Engineer:

Approved By:  
Radio Manager

Customer  
Representative:



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## 2 Equipment under test (EUT)

### 2.1 Equipment specification

Applicant	Salunda Ltd Unit 6 Avonbury Business Park Howes Lane Bicester Oxfordshire OX26 2UA	
Manufacturer of EUT	Salunda Ltd	
Full Name of EUT	6891	
Model Number of EUT	D10	
Serial Number of EUT	0044 (Radiated) 0055 (Conducted)	
Date Received	12th December 2022	
Date of Test:	28th November 2022 to 14th February 2023	
Purpose of Test	To demonstrate design compliance to the relevant rules of Chapter 47 of the Code of Federal Regulations.	
Date Report Issued	26th July 2023	
Main Function	Personal / Equipment Locating	
Information Specification	Height	71.5 mm
	Width	41.5 mm
	Depth	5 mm
	Weight	0.02 kg
	Voltage	3 - 4.2 VDC
	Current	Not declared

## 2.2 Configurations for testing

General Parameters	
EUT Normal use position	Body worn
Choice of model(s) for type tests	Sample
Antenna details	Integral. Taoglas UWCCP.01
Antenna port	No
Baseband Data port (yes/no)?	No
Highest Signal generated in EUT	6.5 GHz
Lowest Signal generated in EUT	12 MHz
Hardware Version (HVIN)	Version 1
Software Version	'Salunda NFC Lite' Phone App: 1.7
Firmware Version (FVIN)	2.4GHz RF Processor: 4.251 – GIT Hash: 6b72d63 UWB Main processor: 5.251 – GIT Hash: 67e984d IMU: 1.14
Type of Equipment	Personal/Equipment Locating
Technology Type	UWB IEEE 802.15.4
Geo-location (yes/no)	Location by radio determination
TX Parameters	
Alignment range – transmitter	6.5GHz
EUT Declared Modulation Parameters	802.15.4
EUT Declared Power level	-41.3 dBm/MHz
EUT Declared Signal Bandwidths	500 MHz
EUT Declared Channel Spacing's	Single channel
EUT Declared Duty Cycle	max 10% in operation
Unmodulated carrier available?	Yes
Declared frequency stability	0.5ppm
RX Parameters	
Alignment range – receiver	6.5GHz
EUT Declared RX Signal Bandwidth	500 MHz
FCC Parameters	
FCC Transmitter Class	WBT: Wideband Transmitter

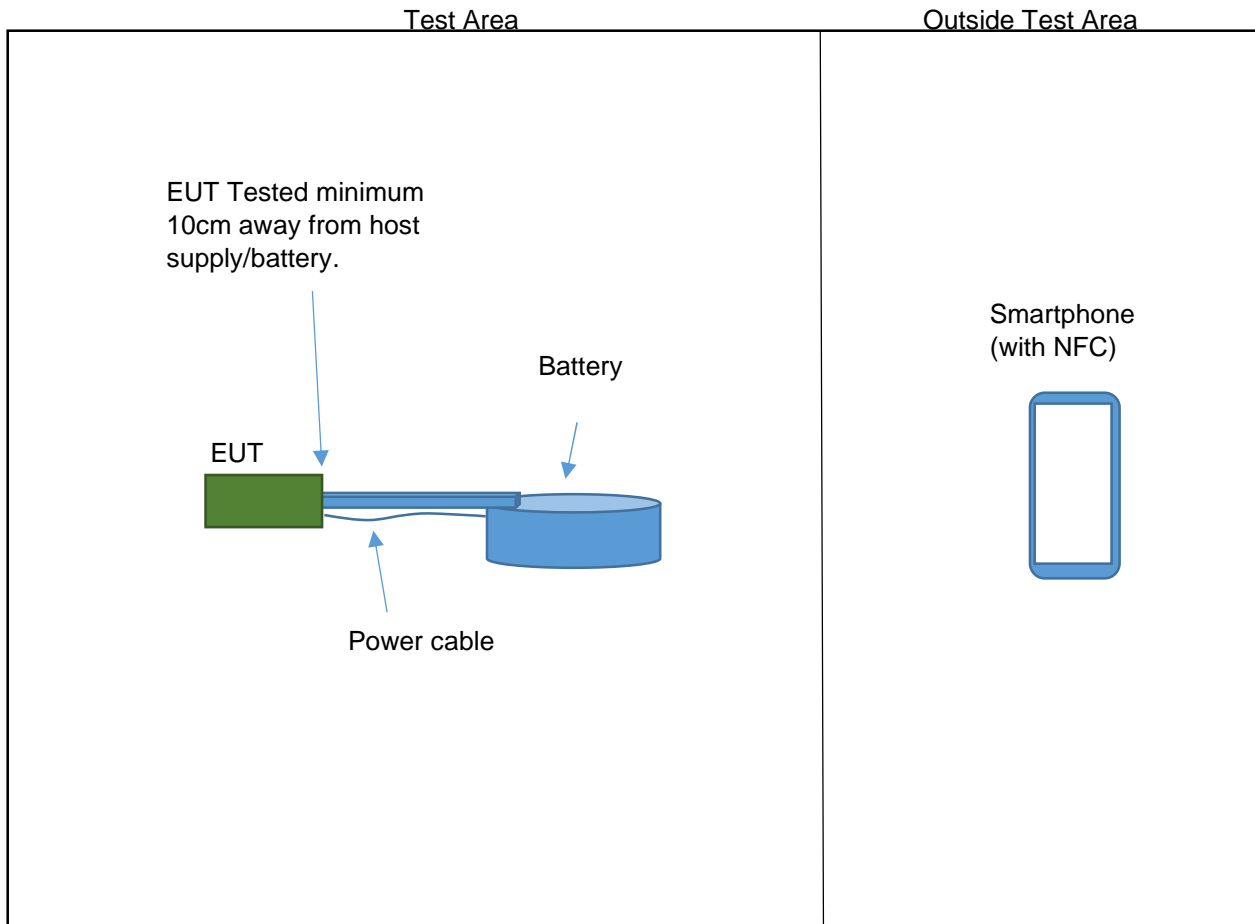
## 2.3 Functional description

Locates via UWB and sends location back to server, configuration over the 2.4GHz network, can also operate as gateway which responds to request to range.

## 2.4 Modes of operation

Mode Reference	Description	Used for testing
TX1	Transmitting continuously at 6500 MHz with system modulation. ZigBee transmitting @ 2440 MHz simultaneously.	Yes
TX2	Transmitting at 10% test mode duty cycle at 6500 MHz with system modulation. ZigBee transmitting @ 2440 MHz simultaneously.	Yes

## 2.5 Emissions configuration



The unit was powered from a fully charged battery and was positioned on a bracket 10 centimetres away from the battery. For conducted tests a separate test unit was provided where the internal antenna had been removed and an SMA semi-rigid cable assembly was fitted in its place. For AC conducted emissions the EUT and battery were connected to an AC mains powered charger at 120V AC 60Hz. The unit was configured using a Smartphone running Salunda NFC Lite engineering software. The relevant radio settings were configured in the app and then the settings were transmitted to the EUT using NFC (13.56MHz) via the smart phone. Refer to section 2.4 for the modes used during testing. The transmit mode used for Peak power tests was 100% duty cycle. For Average power measurements the transmit mode was 10% duty cycle which was the maximum declared duty cycle. The power setting provided by the applicant and used during test to give maximum output power was: -

Single Channel (6500 MHz centre frequency) = Power setting UWB Power Coarse 12.5, UWB Power Fine 3.

Note: Intermodulation emissions checks were performed with the UWB transmitting simultaneously with the ZigBee transmitter.

### 2.5.1 Signal leads

Port Name	Cable Type	Connected
DC Power	2 x single core	Yes

### 3 Summary of test results

The 6891, D10 was tested for compliance to the following standard:

47 CFR Part 15.250 Effective Date 1st October 2021  
WBT: Wideband Transmitter

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

Title	References	Results
<b>Transmitter Tests</b>		
1. 10dB Bandwidth	47 CFR Part 15C Clause 15.250(a) / (b)	PASSED
2. Peak & Average EIRP	47 CFR Part 15C Clause 15.250(d)(1) / (d)(3)	PASSED
3. Radiated emissions 30 MHz -960 MHz	47 CFR Part 15C Clause 15.250 (d)(1) / 15.209	PASSED
4. Radiated emissions above 960 MHz	47 CFR Part 15C Clause 15.250 (d)(1) / 15.209	PASSED <sup>1</sup>
5. Radiated emissions 150 kHz - 30 MHz	47 CFR Part 15C Clause 15.209	PASSED
6. Radiated emissions 9 - 150 kHz	47 CFR Part 15C Clause 15.209	PASSED
7. AC power line conducted emissions	47 CFR Part 15C Part 15.207	PASSED

<sup>1</sup> Spectrum investigated up to a frequency of 40GHz based on the highest channel/ signal generated in equipment of 6500 MHz.

## 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

### 4.2 Deviations

No deviations were applied.

### 4.3 Tests at extremes of temperature & voltage

The following test conditions were used to simulate testing at nominal or extremes.

Temperature Test Conditions		Voltage Test Conditions	
T nominal	20 °C	V nominal	3.6V DC
T minimum	-30 °C	V minimum	3.0V DC
T maximum	50 °C	V maximum	4.2V DC

Extremes of voltage are based on nominal manufacturer's declaration.

Extremes of temperature are based upon 47 CFR Clause 2.1055.

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

### 4.4 Test fixtures

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

A temporary RF port was created for testing.



## 5 Tests, methods and results

### 5.1 10dB Bandwidth

#### 5.1.1 Test methods

Test Requirements:	47 CFR Part 15C Clause 15.250(a) / (b) [Reference 4.1.1 of this report]
Test Method:	ANSI C63.10 Clause 10.1 [Reference 4.1.3 of this report]
Limits:	47 CFR Part 15C Clause 15.250(a) / (b) [Reference 4.1.1 of this report]

#### 5.1.2 Configuration of EUT

The EUT was placed in an environmental chamber and was connected to a spectrum analyser using suitable attenuation. Measurements were made at the temporary RF port. The EUT was powered using a bench power supply. This allowed the supply voltage to be varied during tests to the manufactures declared end-points as stated in section 4.3. The EUT was operated in TX1 mode.

#### 5.1.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment listed below. A 1MHz RBW, 3x VBW, auto sweep time and max hold settings were used for the 10 dB bandwidth. The peak of the signal was found and markers referenced to it were used to determine -10dB Bandwidth. Measurements were performed in an environmental oven at the specified temperature.

Tests were performed using test Site A.

#### 5.1.4 Test equipment

E227, E412, E434, N579, TMS38, TMS80

See Section 9 for more details

### 5.1.5 Test results

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

Band	5925-7250 MHz
Power Level	15.5 dBm
Channel Spacing	Single Channel
Mod Scheme	UWB
Single channel	6489 MHz

EUT supply voltage	FL (MHz)	FH (MHz)	OCC BW (MHz)	Calculated centre frequency FC (MHz)	Highest frequency FM (MHz)	Fractional bandwidth. 2(FH-FL)/(FH+FL)
Nom Voltage	6142.7330	6837.0340	694.0000	6489.7330	6644.5670	0.106982
Plot ref	13917-5 Occupied Bandwidth T 20deg Vnom					
Min Voltage	6144.5530	6832.2730	687.7200	6488.4130	6645.6660	0.105992
Plot ref	13917-5 Occupied Bandwidth T 20deg Vmin					
Max Voltage	6143.1380	6836.7380	693.6000	6489.9380	6645.1160	0.106873
Plot ref	13917-5 Occupied Bandwidth T 20deg Vmax					
Nom Voltage	6074.3510	6942.3330	867.9820	6508.3420	6646.5810	0.133365
Plot ref	13917-5 Occupied Bandwidth T-30deg Vnom					
Nom Voltage	6103.1720	6913.1220	809.9500	6508.1470	6644.9330	0.124452
Plot ref	13917-5 Occupied Bandwidth T-20deg Vnom					
Nom Voltage	6109.4680	6874.2090	764.7410	6491.8385	6645.4830	0.117800
Plot ref	13917-5 Occupied Bandwidth T-10deg Vnom					
Nom Voltage	6109.0640	6875.2080	766.1440	6492.1360	6645.1160	0.118011
Plot ref	13917-5 Occupied Bandwidth T 0deg Vnom					
Nom Voltage	6142.8320	6846.0210	703.1890	6494.4265	6645.3000	0.108276
Plot ref	13917-5 Occupied Bandwidth T 10deg Vnom					
Nom Voltage	6143.1530	6834.9730	691.8200	6489.0630	6644.9330	0.106613
Plot ref	13917-5 Occupied Bandwidth T 30deg Vnom					
Nom Voltage	6143.1370	6836.0650	692.9280	6489.6010	6644.7500	0.106775
Plot ref	13917-5 Occupied Bandwidth T 40deg Vnom					
Nom Voltage	6143.7730	6835.6760	691.9030	6489.7245	6644.2010	0.106615
Plot ref	13917-5 Occupied Bandwidth T 50deg Vnom					

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

#### LIMITS:

47 CFR Part 15C Clause 15.250(a): The -10 dB bandwidth of the fundamental emission must be contained within the 5925-7250 MHz band under all conditions of operation.

47 CFR Part 15C Clause 15.250(b): The -10 dB bandwidth of the fundamental emission shall be at least 50 MHz.

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 %

## 5.2 Peak & Average EIRP

### 5.2.1 Test methods

Test Requirements: 47 CFR Part 15C Clause 15.250(d)(1) / (d)(3) [Reference 4.1.1 of this report]  
 Test Method: ANSI C63.10 Clause 10.3 [Reference 4.1.3 of this report]  
 Limits: 47 CFR Part 15C Clause 15.250(d)(1) / (d)(3) [Reference 4.1.1 of this report]

### 5.2.2 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 1 metre. The EUT was tested using a fully charged battery. The transmit mode used for Peak power tests was 100% duty cycle. For Average power measurements the transmit mode was 10% duty cycle. The EUT was operated in TX1 mode for Peak measurements and TX2 mode for Average measurements.

### 5.2.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment listed below. For peak power measurements a 50MHz RBW, 80MHz VBW, Peak detector and max hold settings were used. The analyser was then switched to an RMS average sweep using a sweep time of 1ms per analyser point at the same frequency to determine Average EIRP.

Tests were performed using test Site M.

### 5.2.4 Test equipment

E602, E268, E595, H079

See Section 9 for more details

### 5.2.5 Test results

Temperature of test environment 12°C  
 Humidity of test environment 50%  
 Pressure of test environment 102kPa

Band	5925-7250 MHz
Power Level	15.5 dBm
Channel Spacing	Single Channel
Mod Scheme	UWB
Single channel	6500 MHz

Highest detected frequency FM (from Bw Test) (MHz)	RBW used (MHz)	Results dBm
6753.120000	50	
Peak result 50MHz RBW (dBm)		-1.60
Peak Plot Max held Filename ref	13917-5 Peak power - Power setting 15.5 dBm	

AV PSD result 1MHz (dBm)	-41.37
AV PSD result filename ref	13917-5 Average power - Power setting 15.5 dBm

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

**LIMITS:**

47 CFR Part 15C Clause 15.250(d)(1): The limit for operation in the 5925 to 7250 MHz band is -41.3 dBm EIRP

47 CFR Part 15C Clause 15.250(d)(3): Peak level of the emissions contained within a 50 MHz bandwidth:  
0dBm EIRP

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

## 5.3 Radiated emissions 30 MHz - 960 MHz

### 5.3.1 Test methods

Test Requirements: 47 CFR Part 15C Clause 15.250 (d)(4) / 15.209 [Reference 4.1.1 of this report]  
Test Method: ANSI C63.10 Clause 10.2 [Reference 4.1.2 of this report]  
Limits: 47 CFR Part 15C Clause 15.250 (d)(4) / 15.209 [Reference 4.1.1 of this report]

### 5.3.2 Configuration of EUT

The EUT was placed on a 0.8 metres high turntable. The front edge of the EUT was initially positioned facing the antenna. The EUT was measured at a distance of 3 metres. The EUT was rotated in all three orthogonal planes. Radiated Emissions testing was performed with a fully charged battery. The EUT was operated in TX1 mode.

### 5.3.3 Test procedure

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

### 5.3.4 Test equipment

LPE364, E743, NSA-M, ZSW1, E412, E411

See Section 9 for more details

### 5.3.5 Test results

Temperature of test environment 12°C  
Humidity of test environment 60%  
Pressure of test environment 101 kPa

Band	5925-7250 MHz
Power Level	15.5 dBm
Channel Spacing	Single Channel
Mod Scheme	UWB
Single channel	6500 MHz

Plot refs
13917-5 Rad 1 VHF Horiz
13917-5 Rad 1 VHF Vert
13917-5 Rad 1 UHF Horiz
13917-5 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	164.730	30.4	24.9	-18.6
2	214.611	37.0	31.5	-12.0
3	351.290	34.0	28.6	-17.4
4	451.665	36.2	31.1	-14.9
5	621.665	41.5	36.8	-9.2
6	915.000	36.9	31.5	-14.5

**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	214.702	32.2	26.3	-17.2
2	355.894	31.6	25.5	-20.5
3	459.894	37.7	30.5	-15.5
4	613.054	36.2	31.0	-15.0
5	630.051	34.7	28.8	-17.2
6	918.050	36.9	31.3	-14.7

Note: signals measured above were generic signals present whether UWB was transmitting or not. Peak detector "Max held" Analyser plots against the Quasi-Peak / Average limit line(s) can be found in Section 6 of this report.

**LIMITS:**

15.209 limits are applicable in the restricted bands of 15.205 with the relevant detector. 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 ±5.6dB

## 5.4 Radiated emissions above 960 MHz

### 5.4.1 Test methods

Test Requirements:	47 CFR Part 15C Clause 15.250 (d)(1) / 15.250 (d)(2) / 15.209 [Reference 4.1.1 of this report]
Test Method:	ANSI C63.10 Clause 10.3 [Reference 4.1.3 of this report]
Limits:	47 CFR Part 15C Clause 15.250 (d)(1) / 15.250 (d)(2) / 15.209 [Reference 4.1.1 of this report]

### 5.4.2 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 1 metre. The EUT was rotated in all three orthogonal planes. Radiated Emissions testing was performed with a fully charged battery

The EUT was operated in TX1 mode.

### 5.4.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment listed 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 1m was used between the test range 960MHz and 12.5GHz and a 0.3m distance was used in the test range 12.5 and 40GHz. Measurements were made using an RMS detector and a 1 MHz RBW was used except in the frequency ranges of 1164 – 1240 MHz and 1559 – 1610 MHz where a 1 kHz RBW was used as per 47 CFR Part 15C Clause 15.250(d)(2).

Note: As per 47 CFR Part 15C Clause 15.250(d)(5), Emissions from digital circuitry used to enable the operation of the transmitter may comply with the limits in 47 CFR Part 15C Clause 15.209.

During emissions tests over the frequency range 960 – 1990 MHz the limit was approached / exceeded. In order to demonstrate the emissions were associated to the digital circuitry and not radiated from the transmitter, the UWB antenna was unsoldered from the board and a second measurement was performed. Where no difference in the emission profile was observed, the emissions were assessed to 15.209 Limits. Please refer to the plots in section 6.

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

Tests were performed using test Site B.

### 5.4.4 Test equipment

CAL07, E330, E331, E411, E412, E428, E429, E433, E452, E453, E580, E602, E642, E717, E725, E755, E856, E904, F119, F225, P168, TMS78, TMS79

See Section 9 for more details

**5.4.5 Test results**

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

Setup Table

Band	5925-7250 MHz
Power Level	15.5 dBm
Channel Spacing	Single Channel
Mod Scheme	UWB
Single channel	6500 MHz

Spurious Frequency (MHz)	Applicable FCC 15.250 Limit / 15.209 limit (dBuV/m)	Measured Average Level (dBuV/m)	Difference to Average Limit (dB)	EUT Polarisation	Antenna Polarisation	Antenna Polarisation
12980	33.9	21.4	-12.5	Side	Horiz	Horiz
14430	54	29.1	-24.9	Side	Vert	Vert
14430	54	28.8	-25.2	Side	Horiz	Horiz
16835	54	24.9	-29.1	Side	Vert	Vert
16835	54	23.3	-30.7	Side	Horiz	Horiz

Note: Only emissions within 20dB of the 47 CFR Part 15C Clause 15.250 Limit (or where appropriate the 47 CFR Part 15C Clause 15.209 limits) have been included. Signals found at 14430 and 16835 MHz were related to ZigBee transmitter operating at 2405MHz and as such have been referenced against 15.209 limits for indication only. ZigBee radio was simultaneously transmitting for tests. see RN report 01-13917-2-23 for ZigBee radio test requirements and radiated emissions.

Plot reference table	
13917-5 Radiated Emissions 960 - 1610 MHz Horiz	
13917-5 Radiated Emissions 960 - 1610 MHz Vert	
13917-5 Radiated Emissions 1610 - 1990 MHz Horiz	
13917-5 Radiated Emissions 1610 - 1990 MHz Vert	
13917-5 Radiated Emissions 1990 - 3100 MHz Horiz	
13917-5 Radiated Emissions 1990 - 3100 MHz Vert	
13917-5 Radiated Emissions 1990 - 3100 MHz ZigBee ON Horiz	
13917-5 Radiated Emissions 1990 - 3100 MHz ZigBee ON Vert	
13917-5 Radiated Emissions 3100 - 5925 MHz Horiz	
13917-5 Radiated Emissions 3100 - 5925 MHz Vert	
13917-5 Radiated Emissions 5925 - 7250 MHz Horiz	
13917-5 Radiated Emissions 5925 - 7250 MHz Vert	
13917-5 Radiated Emissions 7250 - 10600 MHz Horiz	
13917-5 Radiated Emissions 7250 - 10600 MHz Vert	
13917-5 Radiated Emissions 10.6 - 12.5 GHz Horiz	
13917-5 Radiated Emissions 10.6 - 12.5 GHz Vert	
13917-5 Radiated Emissions 12.5 - 15 GHz @0.3m horiz	
13917-5 Radiated Emissions 12.5 - 15 GHz @0.3m vert	
13917-5 Radiated Emissions 15 - 18 GHz @0.3m horiz	
13917-5 Radiated Emissions 15 - 18 GHz @0.3m vert	
13917-5 Radiated Emissions 18 - 22 GHz @0.3m horiz	
13917-5 Radiated Emissions 18 - 22 GHz @0.3m vert	
13917-5 Radiated Emissions 22 - 26 GHz @0.3m horiz	
13917-5 Radiated Emissions 22 - 26 GHz @0.3m vert	
13917-5 Radiated Emissions 26 - 26.5 GHz @0.3m horiz	



Plot reference table	
13917-5 Radiated Emissions 26 - 26.5 GHz @0.3m vert	
13917-5 Radiated Emissions 26.5 - 30 GHz @0.3m horiz	
13917-5 Radiated Emissions 26.5 - 30 GHz @0.3m vert	
13917-5 Radiated Emissions 30 - 33 GHz @0.3m horiz	
13917-5 Radiated Emissions 30 - 33 GHz @0.3m vert	
13917-5 Radiated Emissions 33 - 36 GHz @0.3m horiz	
13917-5 Radiated Emissions 33 - 36 GHz @0.3m vert	
13917-5 Radiated Emissions 36 - 40 GHz @0.3m horiz	
13917-5 Radiated Emissions 36 - 40 GHz @0.3m vert	
13917-5 Radiated Emissions 1.164 - 1.202 GHz @1m horiz	
13917-5 Radiated Emissions 1.164 - 1.202 GHz @1m vert	
13917-5 Radiated Emissions 1.202 - 1.24 GHz @1m horiz	
13917-5 Radiated Emissions 1.202 - 1.24 GHz @1m vert	
13917-5 Radiated Emissions 1.559 - 1.61 GHz @1m horiz	
13917-5 Radiated Emissions 1.559 - 1.61 GHz @1m vert	

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

**LIMITS:**

47 CFR Part 15C Clause 15.250 (d)(1)

Frequency in MHz	EIRP in dBm	Equivalent in dBuV/m @ 3 metres
960-1610	-75.3	19.9
1610-1990	-63.3	31.9
1990-3100	-61.3	33.9
3100-5925	-51.3	43.9
5925-7250	-41.3	53.9
7250-10600	-51.3	43.9
Above 10600	-61.3	33.9

In addition to the radiated emission limits specified in the table in paragraph (above), transmitters operating under the provisions of this section shall not exceed the following RMS average limits when measured using a resolution bandwidth of no less than 1 kHz:

47 CFR Part 15C Clause 15.250 (d)(2)

Frequency in MHz	EIRP in dBm	Equivalent in dBuV/m @ 3 metres
1164-1240	-85.3	9.9
1559-1610	-85.3	9.9

47 CFR Part 15C Clause 15.209 Average Limit: 54dBuV/m at 3m.

These results show that the EUT has PASSED this test.

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

960 – 18 GHz ±3.5dB, 18 – 26.5 GHz ±3.9dB, 26.5 – 40 GHz ±3.9dB

## 5.5 Radiated emissions 150 kHz - 30 MHz

### 5.5.1 Test methods

Test Requirements: 47 CFR Part 15C Clause 15.209 [Reference 4.1.1 of this report]  
Test Method: ANSI C63.10 Clause 6.4 [Reference 4.1.3 of this report]  
Limits: 47 CFR Part 15C Clause 15.209 [Reference 4.1.1 of this report]

### 5.5.2 Configuration of EUT

The EUT was placed on a 0.8 metres high turntable. The front edge of the EUT was initially positioned facing the antenna. The EUT was measured at a distance of 3 metres. The EUT was rotated in all three orthogonal planes. Radiated Emissions testing was performed with a fully charged battery. The EUT was operated in TX1 mode.

### 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 (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.

### 5.5.4 Test equipment

TMS81, ZSW1, E412, E411

See Section 9 for more details

### 5.5.5 Test results

Temperature of test environment 12°C  
Humidity of test environment 60%  
Pressure of test environment 101kPa

Band	5925-7250 MHz
Power Level	15.5 dBm
Channel Spacing	Single Channel
Mod Scheme	UWB
Single channel	6500 MHz

Plot refs
13917-5 Rad 1 150k-30MHz Para
13917-5 Rad 1 150k-30MHz Perp

Note: No emissions observed within 20dB 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.

#### LIMITS:

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

## 5.6 Radiated emissions 9 - 150 kHz

### 5.6.1 Test methods

Test Requirements:	47 CFR Part 15C Clause 15.209 [Reference 4.1.1 of this report]
Test Method:	ANSI C63.10 Clause 6.4 [Reference 4.1.3 of this report]
Limits:	47 CFR Part 15C Clause 15.209 [Reference 4.1.1 of this report]

### 5.6.2 Configuration of EUT

The EUT was placed on a 0.8 metres high turntable. The front edge of the EUT was initially positioned facing the antenna. The EUT was measured at a distance of 3 metres. The EUT was rotated in all three orthogonal planes. Radiated Emissions testing was performed with a fully charged battery. The EUT was operated in TX1 mode.

### 5.6.3 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.

### 5.6.4 Test equipment

TMS81, ZSW1, E412, E411

See Section 9 for more details

### 5.6.5 Test results

Temperature of test environment	12°C
Humidity of test environment	60%
Pressure of test environment	101kPa

Band	5925-7250 MHz
Power Level	15.5 dBm
Channel Spacing	Single Channel
Mod Scheme	UWB
Single channel	6500 MHz

Plot refs
13917-5 Rad 1 9k-150kHz Para
13917-5 Rad 1 9k-150kHz Perp

Note: No emissions observed within 20dB 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.

#### LIMITS:

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

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:  
UE70 9kHz to 150kHz ±3.76dB

## 5.7 AC power line conducted emissions

### 5.7.1 Test methods

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

### 5.7.2 Configuration of EUT

The EUT was placed inside the charging station along with a second test unit and this was positioned on a wooden table 0.8m above the ground plane and connected to a LISN via a 1m mains cable.

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

For final test the EUT was operated in mode TX1.

### 5.7.3 Test procedure

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

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

Tests were performed in Test Site F.

### 5.7.4 Test equipment

E150, E035, ZSW1, E412, E411

See Section 9 for more details

### 5.7.5 Test results

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

Band	5925-7250 MHz
Power Level	15.5 dBm
Channel Spacing	Single Channel
Mod Scheme	UWB
Single channel	6500 MHz

Plot refs	
13917-5 Cond 1 AC Live 150k-30M Average	
13917-5 Cond 1 AC Live 150k-30M Quasi-Peak	
13917-5 Cond 1 AC Neutral 150k-30M Average	
13917-5 Cond 1 AC Neutral 150k-30M Quasi-Peak	

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

Signal No.	Freq (MHz)	Peak Amp (dBuV)	QP Amp (dBuV)	QP -Lim (dB)	AV Amp (dBuV)	AV -Lim (dB)
1	0.156	48.8	47.9	-17.8	37.0	-18.7
2	0.187	43.0	42.0	-22.2	32.4	-21.8
3	0.343	44.1	43.5	-15.6	42.0	-7.1
4	0.374	43.2	42.5	-15.9	41.6	-6.8
5	0.374	43.4	42.3	-16.1	41.5	-6.9
6	19.935	38.9	37.1	-22.9	34.7	-15.3

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

Signal No.	Freq (MHz)	Peak Amp (dBuV)	QP Amp (dBuV)	QP -Lim (dB)	AV Amp (dBuV)	AV -Lim (dB)
1	0.156	48.8	47.9	-17.8	37.3	-18.4
2	0.343	44.0	43.5	-15.6	41.9	-7.2
3	0.374	43.2	42.4	-16.0	41.6	-6.8
4	0.467	33.9	33.0	-23.6	31.5	-15.1
5	19.798	32.7	29.1	-30.9	22.0	-28.0
6	19.932	39.9	38.6	-21.4	36.6	-13.4
7	20.201	39.1	37.5	-22.5	34.7	-15.3

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

**LIMITS:**

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

These results show that the EUT has PASSED this test.

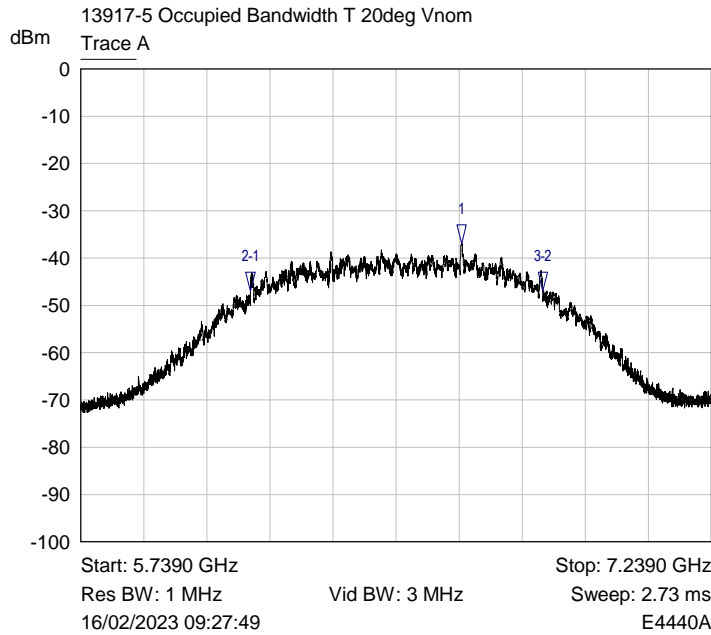
The uncertainty gives a 95% confidence interval in the measurement. Expanded uncertainty (K=2) is as follows:

UE71 150kHz to 30MHz ±3.4dB

## 6 Plots/Graphical results

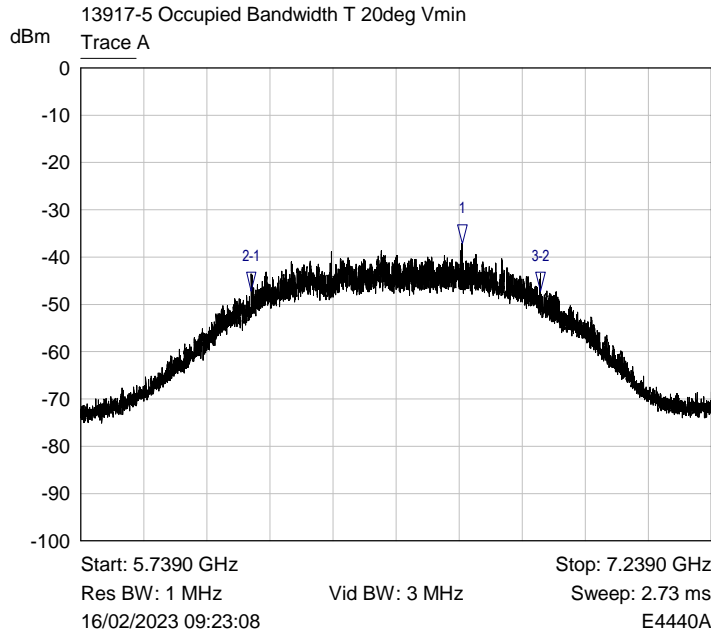
### 6.1 10dB Bandwidth

RF Parameters: Band 5925-7250 MHz, Power 15.5 dBm, Channel Spacing Single Channel, Modulation UWB, Channel 6500 MHz (Span set to 6489 MHz Centre)



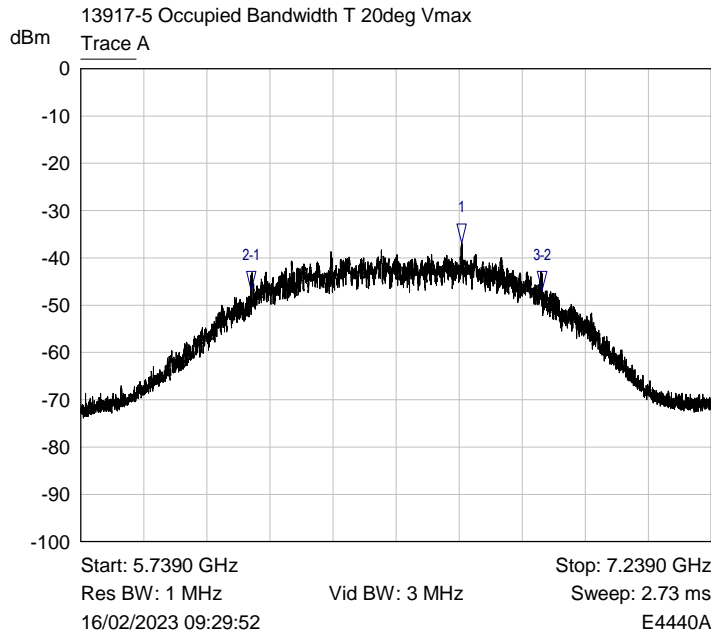
Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	6.6446 GHz	-37.00 dBm	
2-1 ▽	Trace A	-501.8337 MHz	-10.00 dB	
3-2 ▽	Trace A	694.2359 MHz	0.00 dB	

Nom temp (20°C) Nom Voltage



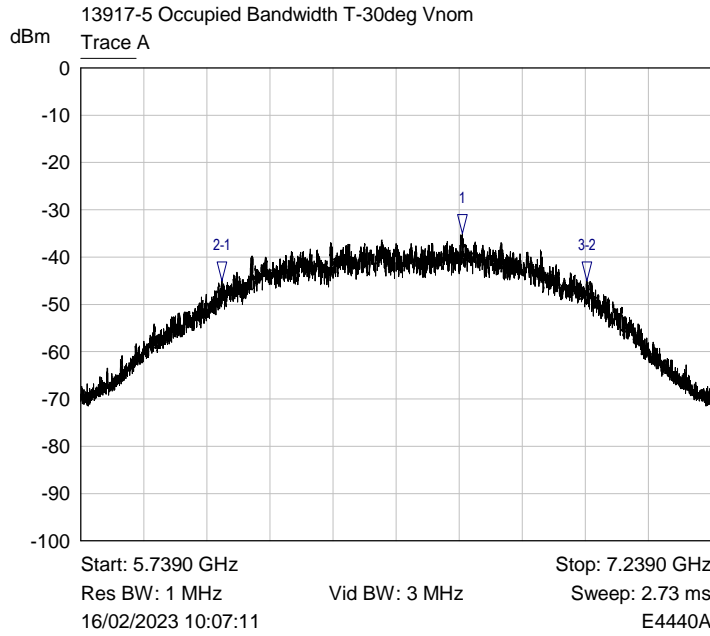
Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	6.6457 GHz	-37.13 dBm	
2-1 ▽	Trace A	-501.1130 MHz	-10.00 dB	
3-2 ▽	Trace A	687.7943 MHz	-0.00 dB	

Nom temp (20°C) Min Voltage



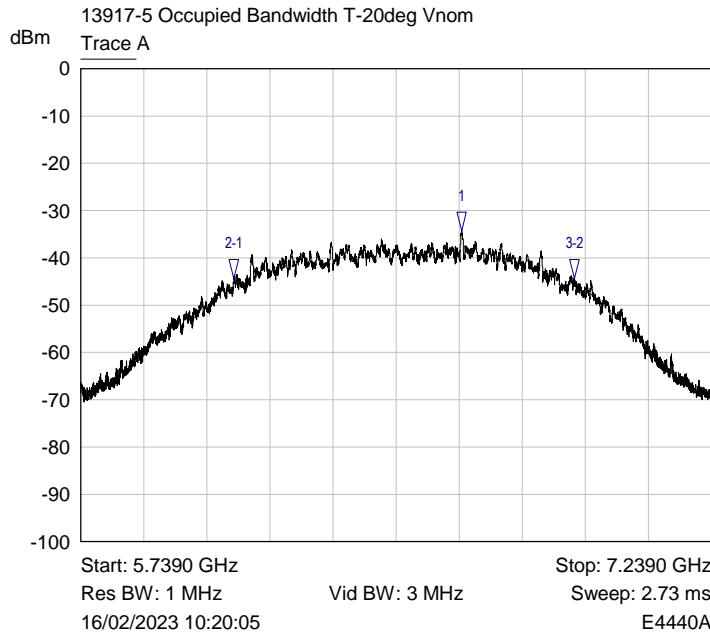
Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	6.6451 GHz	-36.83 dBm	
2-1 ▽	Trace A	-501.9789 MHz	-10.00 dB	
3-2 ▽	Trace A	693.6006 MHz	-0.00 dB	

Nom temp (20°C) Max Voltage



Mkr	Trace	X-Axis	Value	Notes
1 ▾	Trace A	6.6466 GHz	-35.06 dBm	
2-1 ▾	Trace A	-572.2304 MHz	-10.00 dB	
3-2 ▾	Trace A	867.9819 MHz	-0.00 dB	

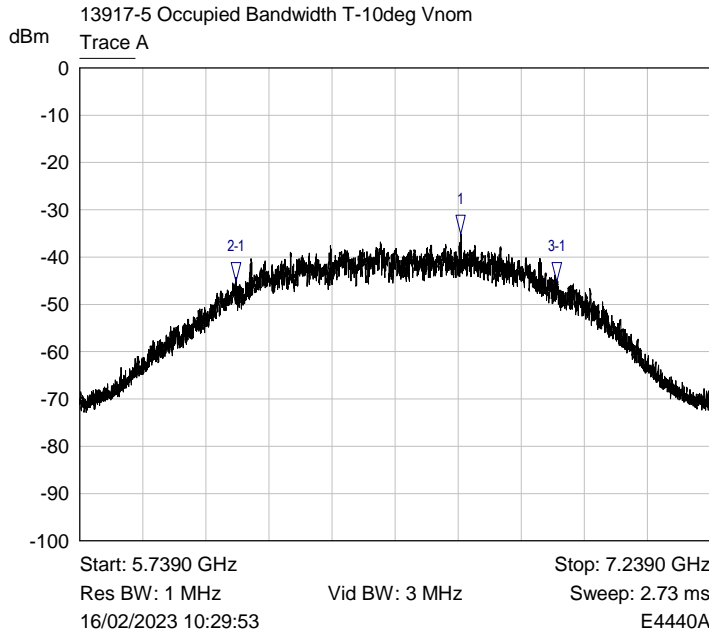
-30°C Nom Voltage



Mkr	Trace	X-Axis	Value	Notes
1 ▾	Trace A	6.6449 GHz	-34.38 dBm	
2-1 ▾	Trace A	-541.7613 MHz	-10.00 dB	
3-2 ▾	Trace A	809.9504 MHz	-0.00 dB	

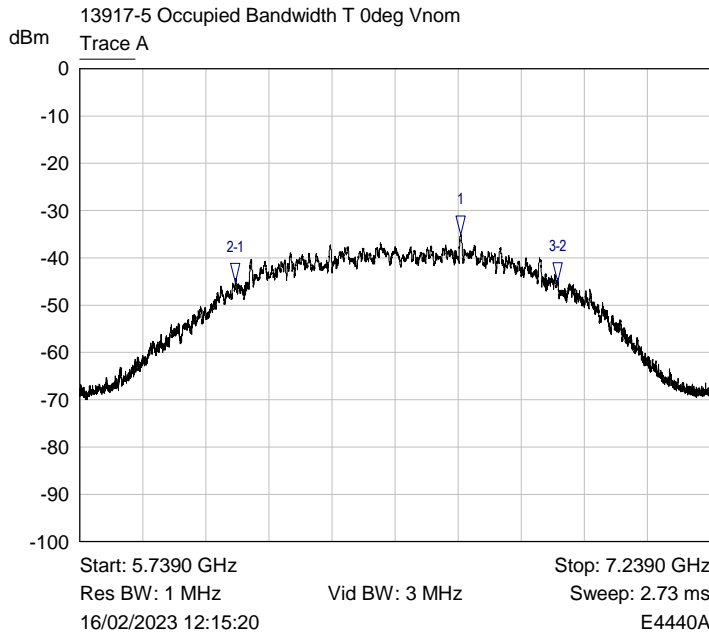
-20°C Nom Voltage





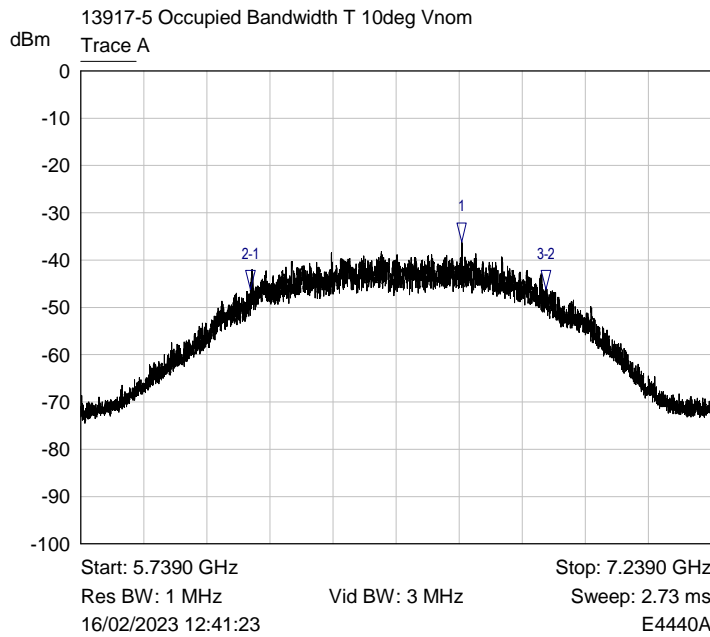
Mkr	Trace	X-Axis	Value	Notes
1 ▾	Trace A	6.6455 GHz	-35.13 dBm	
2-1 ▾	Trace A	-536.1003 MHz	-10.00 dB	
3-1 ▾	Trace A	228.7749 MHz	-10.00 dB	

-10°C Nom Voltage



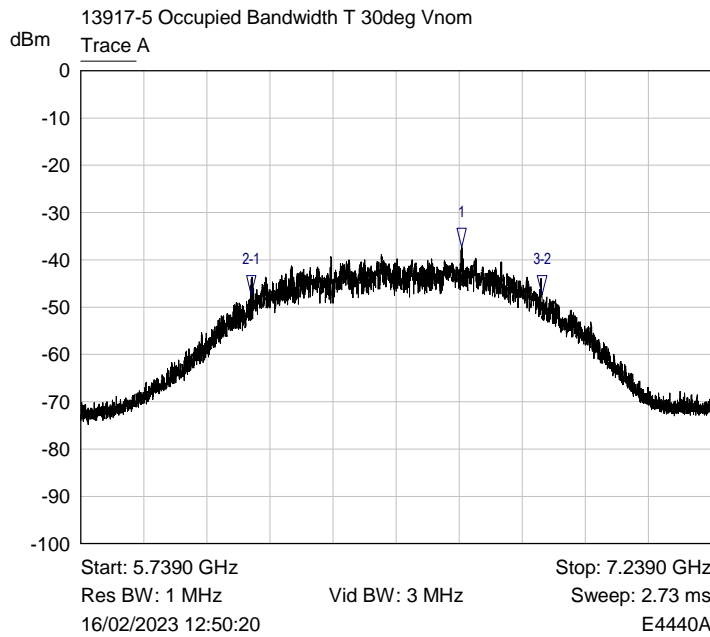
Mkr	Trace	X-Axis	Value	Notes
1 ▾	Trace A	6.6451 GHz	-35.09 dBm	
2-1 ▾	Trace A	-536.0524 MHz	-10.00 dB	
3-2 ▾	Trace A	766.1442 MHz	-0.00 dB	

0°C Nom Voltage



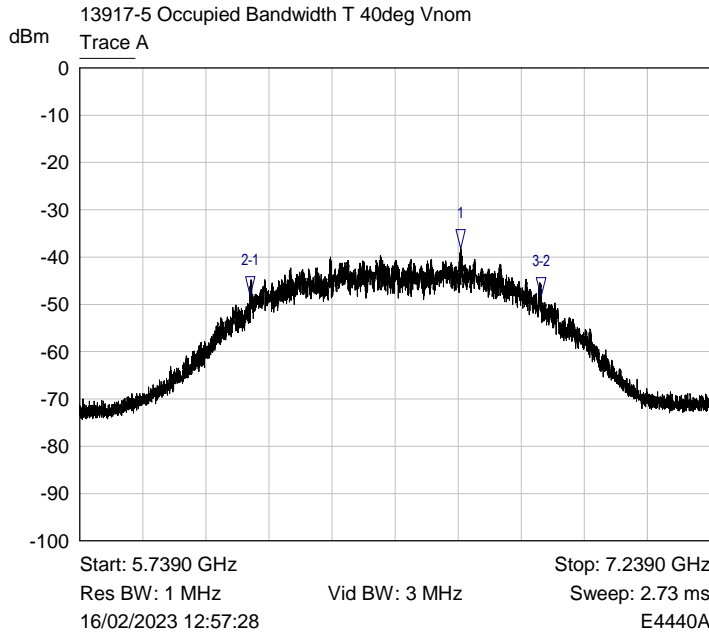
Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	6.6453 GHz	-36.11 dBm	
2-1 ▽	Trace A	-502.4680 MHz	-10.00 dB	
3-2 ▽	Trace A	703.1892 MHz	-0.00 dB	

10°C Nom Voltage



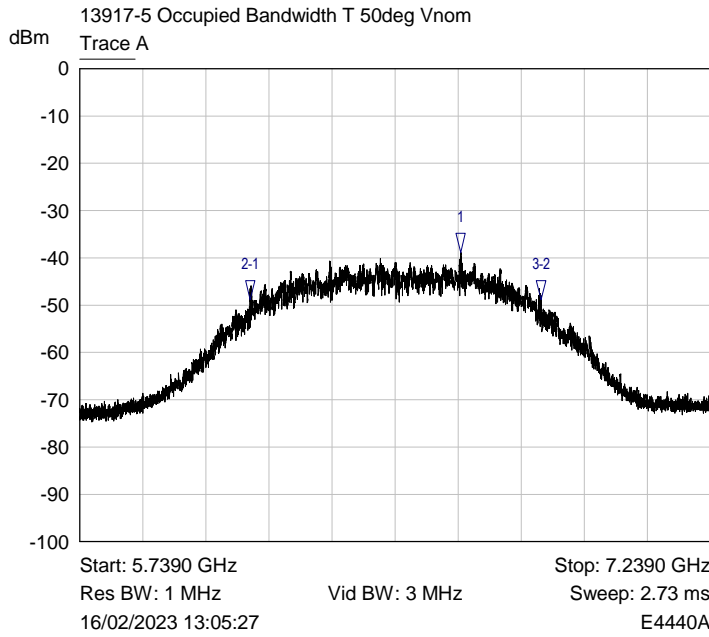
Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	6.6449 GHz	-37.40 dBm	
2-1 ▽	Trace A	-501.7804 MHz	-10.00 dB	
3-2 ▽	Trace A	691.8204 MHz	0.00 dB	

30°C Nom Voltage



Mkr	Trace	X-Axis	Value	Notes
1 ▾	Trace A	6.6448 GHz	-38.22 dBm	
2-1 ▾	Trace A	-501.6128 MHz	-10.00 dB	
3-2 ▾	Trace A	692.9273 MHz	0.00 dB	

40°C Nom Voltage

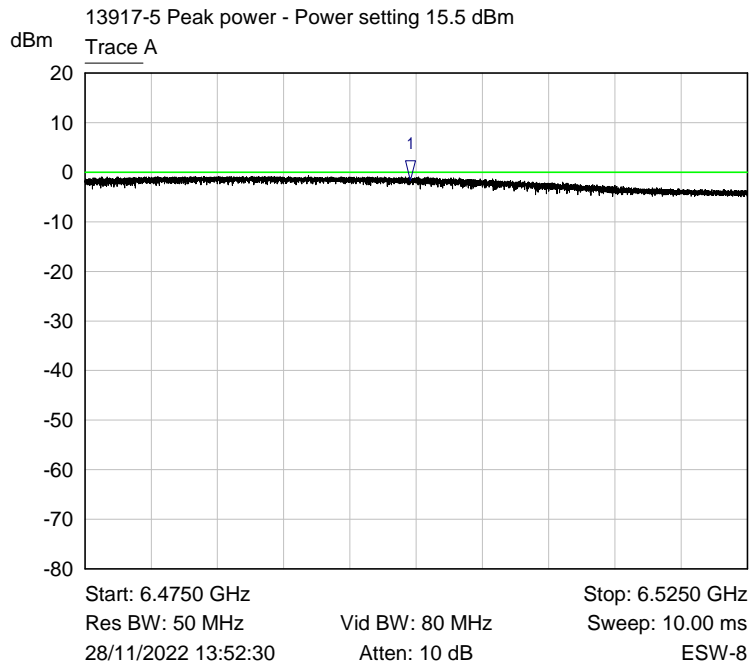


Mkr	Trace	X-Axis	Value	Notes
1 ▾	Trace A	6.6442 GHz	-38.80 dBm	
2-1 ▾	Trace A	-500.4278 MHz	-10.00 dB	
3-2 ▾	Trace A	691.9027 MHz	-0.00 dB	

50°C Nom Voltage

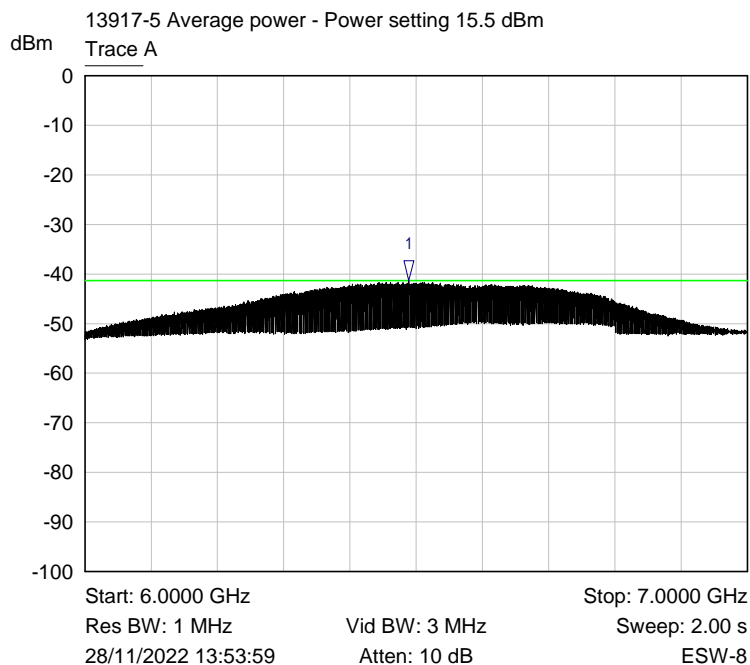
## 6.2 Peak & Average EIRP

RF Parameters: Band 5925-7250 MHz, Power 15.5 dBm, Channel Spacing Single Channel, Modulation UWB, Channel 6500 MHz



Mkr	Trace	X-Axis	Value	Notes
1 ▾	Trace A	6.4995 GHz	-1.60 dBm	

Peak Plot Max held

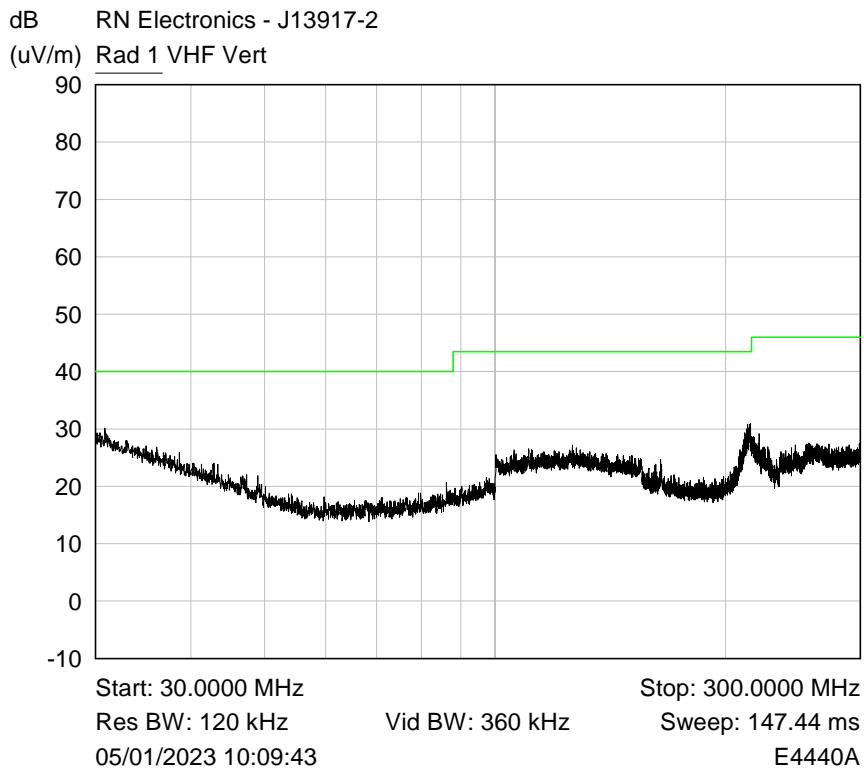
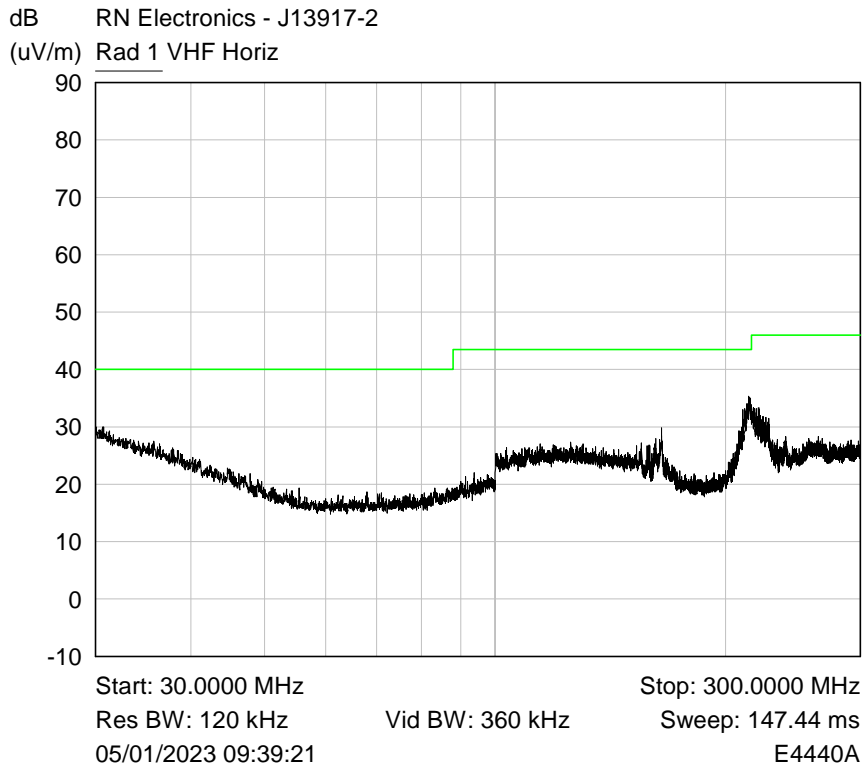


Mkr	Trace	X-Axis	Value	Notes
1 ▾	Trace A	6.4892 GHz	-41.37 dBm	

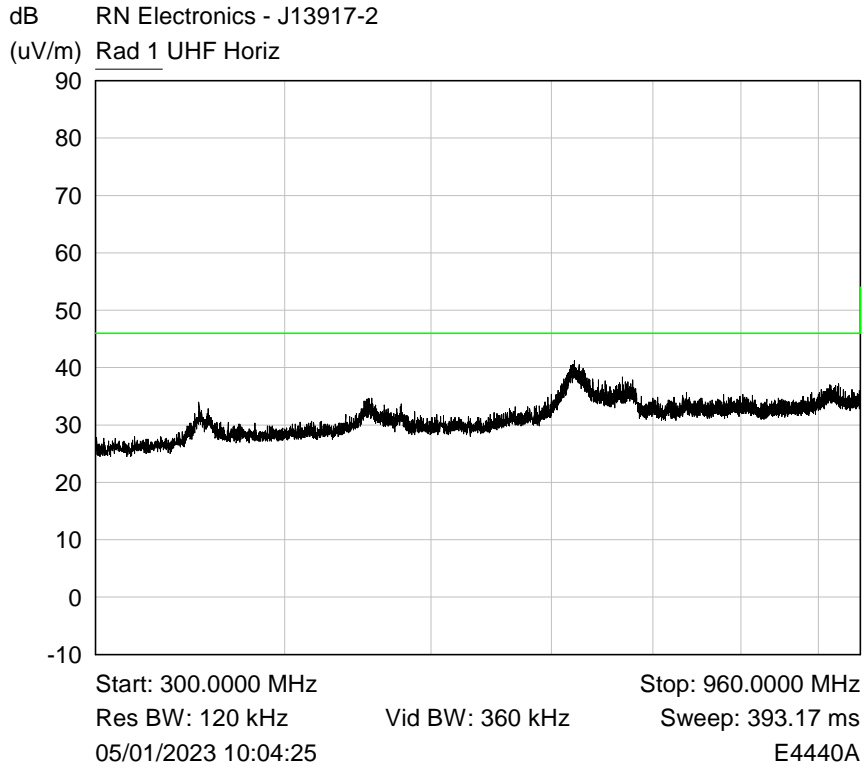
AV RMS plot 1ms per point sweep time

### 6.3 Radiated emissions 30 - 960 MHz

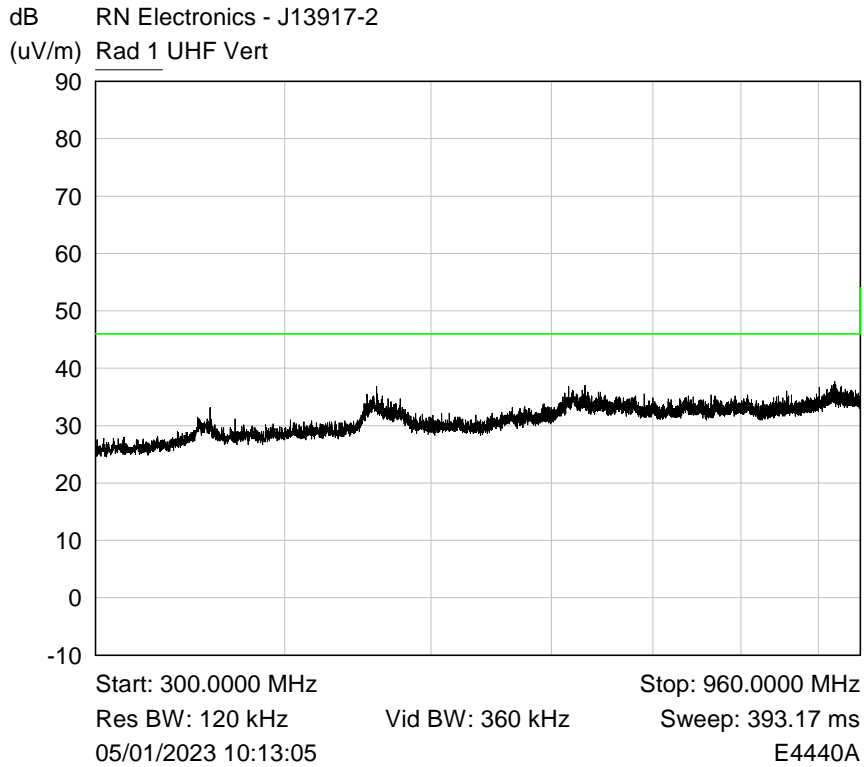
RF Parameters: Band 5925-7250 MHz, Power 15.5 dBm, Channel Spacing Single Channel, Modulation UWB, Channel 6500 MHz



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



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

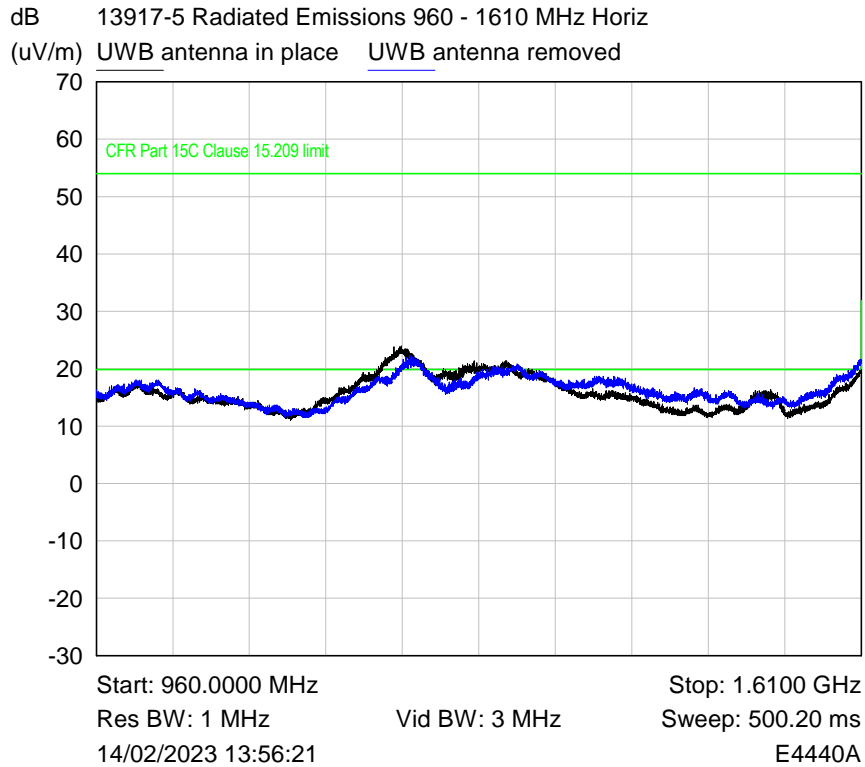


Plot of Peak emissions for UHF Horizontal against the QP limit line.

### 6.4 Radiated emissions above 960 MHz

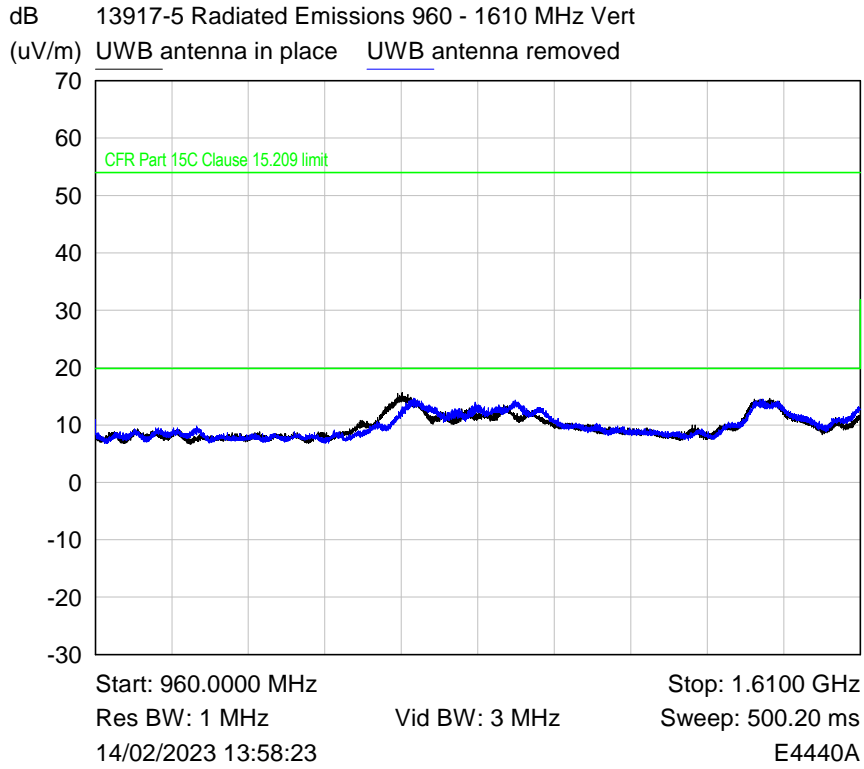
Note: All emissions plots were taken with the antenna fitted for the entire test range, the unit was then taken out of the test chamber and the antenna unsoldered, care was taken to try and position the EUT back in the exact same/correct position, before any plots with antenna removed were re-maximised and re-plotted as a second trace.

RF Parameters: Band 5925-7250 MHz, Power 15.5 dBm, Channel Spacing Single Channel, Modulation UWB, Channel 6500 MHz



Note: As per CFR Part 15C Clause 15.250(d)(5), Emissions from digital circuitry used to enable the operation of the transmitter may comply with the limits in CFR Part 15C Clause 15.209.

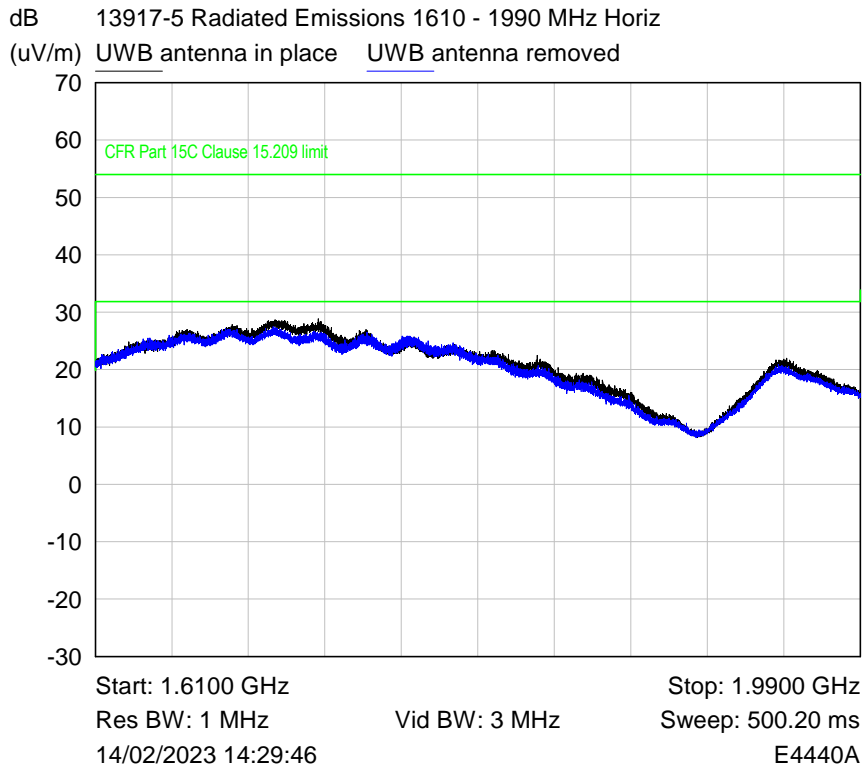
During emissions tests over the frequency range 960 – 1990 MHz the limit was approached / exceeded. In order to demonstrate the emissions were associated to the digital circuitry and not radiated from the transmitter, the UWB antenna was unsoldered from the board and a second measurement was performed. Where no difference in the emission profile was observed, the emissions were assessed to 15.209 Limits.



Note: As per CFR Part 15C Clause 15.250(d)(5), Emissions from digital circuitry used to enable the operation of the transmitter may comply with the limits in CFR Part 15C Clause 15.209.

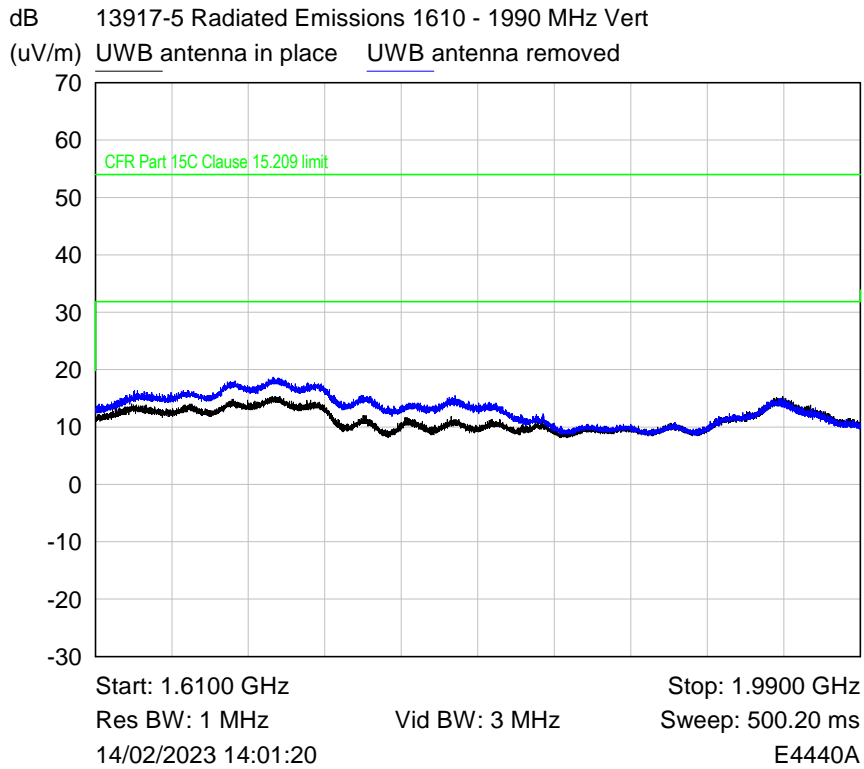
During emissions tests over the frequency range 960 – 1990 MHz the limit was approached / exceeded. In order to demonstrate the emissions were associated to the digital circuitry and not radiated from the transmitter, the UWB antenna was unsoldered from the board and a second measurement was performed. Where no difference in the emission profile was observed, the emissions were assessed to 15.209 Limits.





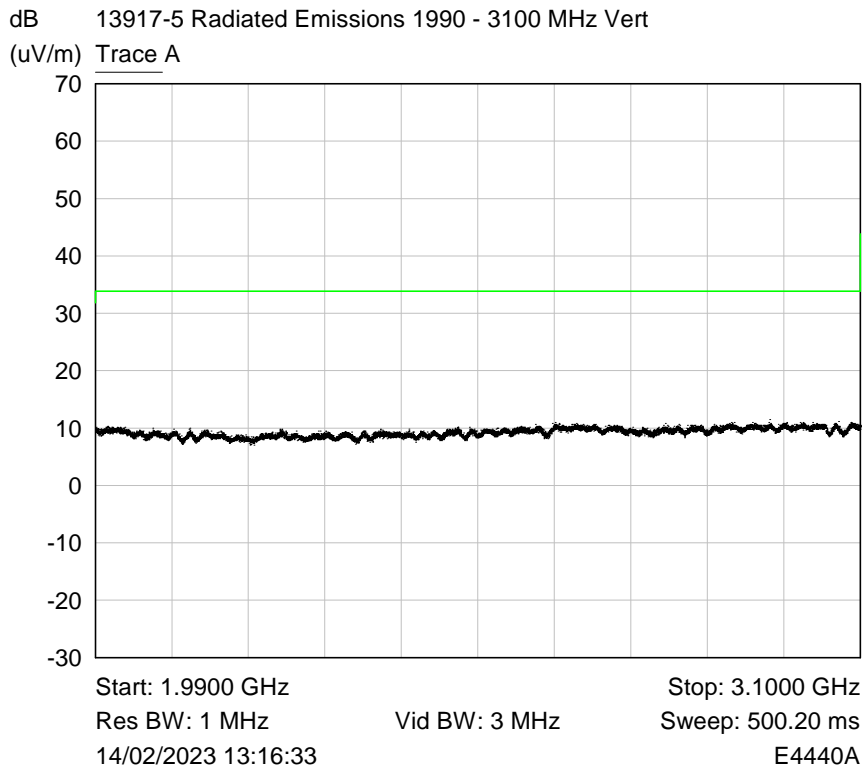
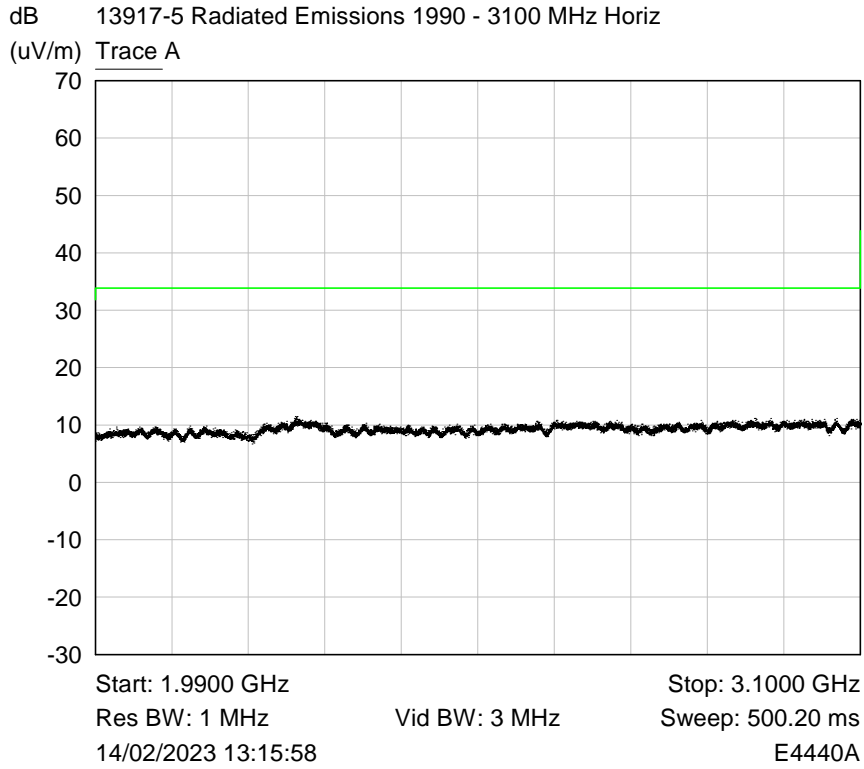
Note: As per CFR Part 15C Clause 15.250(d)(5), Emissions from digital circuitry used to enable the operation of the transmitter may comply with the limits in CFR Part 15C Clause 15.209.

During emissions tests over the frequency range 960 – 1990 MHz the limit was approached / exceeded. In order to demonstrate the emissions were associated to the digital circuitry and not radiated from the transmitter, the UWB antenna was unsoldered from the board and a second measurement was performed. Where no difference in the emission profile was observed, the emissions were assessed to 15.209 Limits.

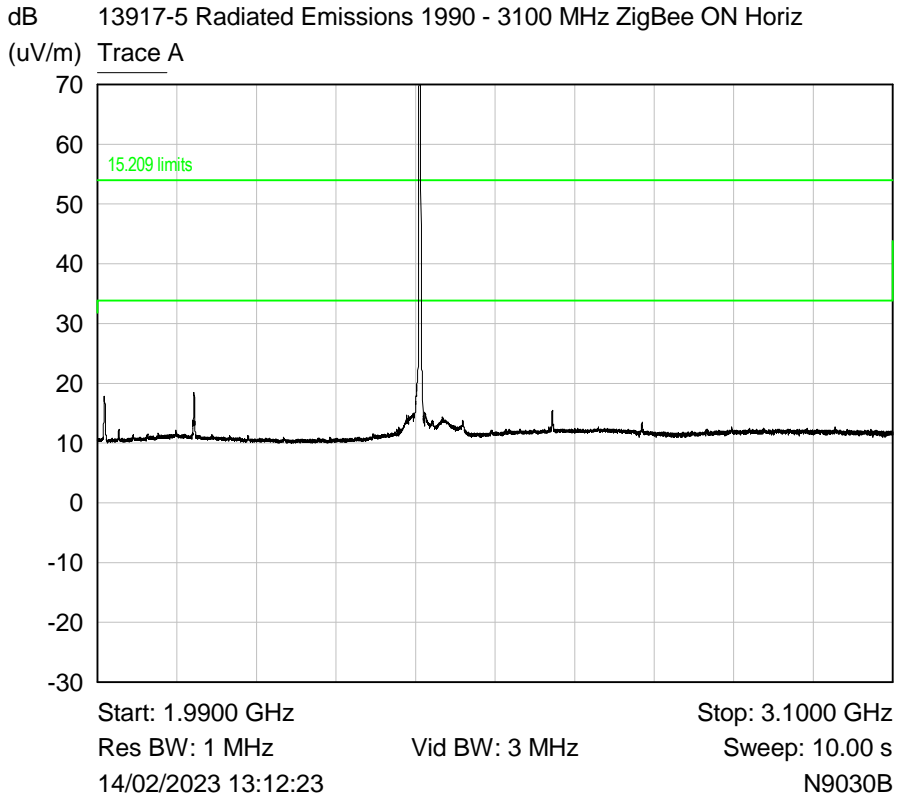


Note: As per CFR Part 15C Clause 15.250(d)(5), Emissions from digital circuitry used to enable the operation of the transmitter may comply with the limits in CFR Part 15C Clause 15.209.

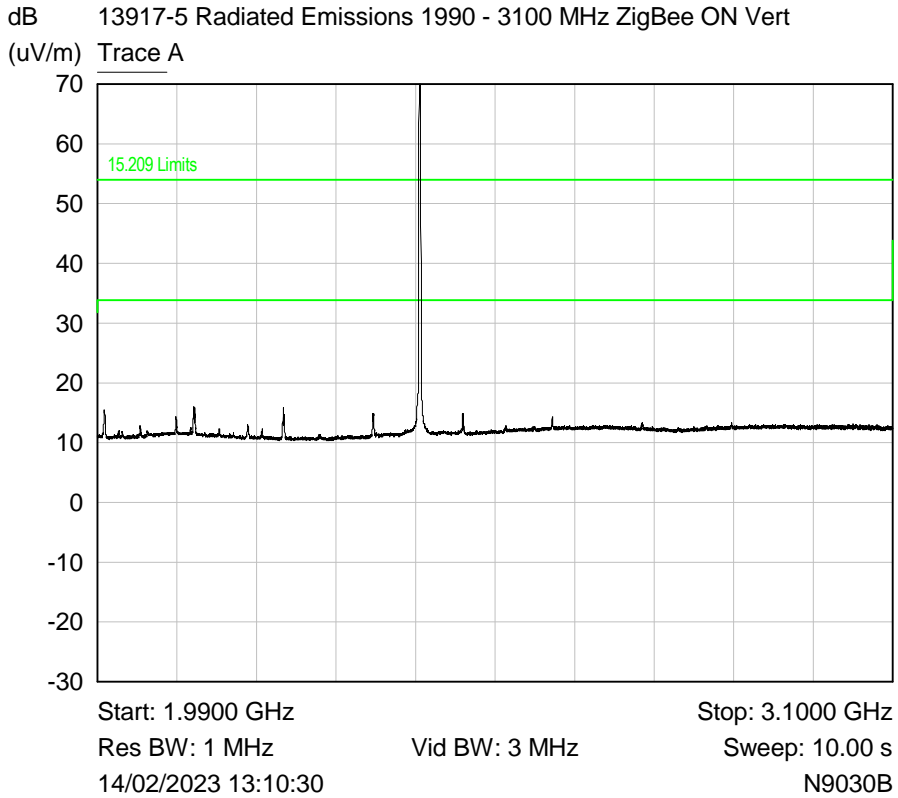
During emissions tests over the frequency range 960 – 1990 MHz the limit was approached / exceeded. In order to demonstrate the emissions were associated to the digital circuitry and not radiated from the transmitter, the UWB antenna was unsoldered from the board and a second measurement was performed. Where no difference in the emission profile was observed, the emissions were assessed to 15.209 Limits.



**Additional plots showing ZigBee emission fundamental on with UWB**



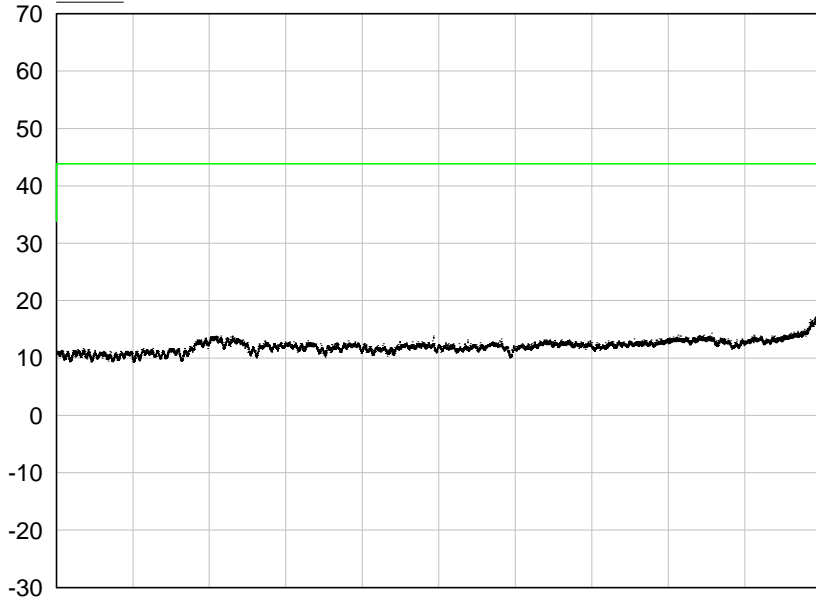
ZigBee fundamental shown on plot and associated emissions assessed to 15.209 limits and not within 20dB of those limits, see RN report 01-13917-2-23. UWB limits not applied to ZigBee emissions.



ZigBee fundamental shown on plot and associated emissions assessed to 15.209 limits and not within 20dB of those limits, see RN report 01-13917-2-23. UWB limits not applied to ZigBee emissions.

dB 13917-5 Radiated Emissions 3100 - 5925 MHz Horiz

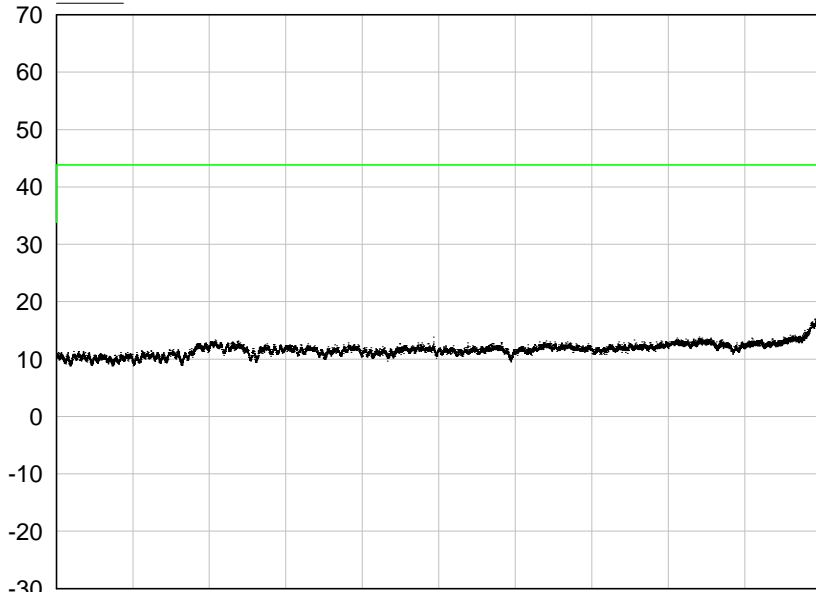
(uV/m) Trace A



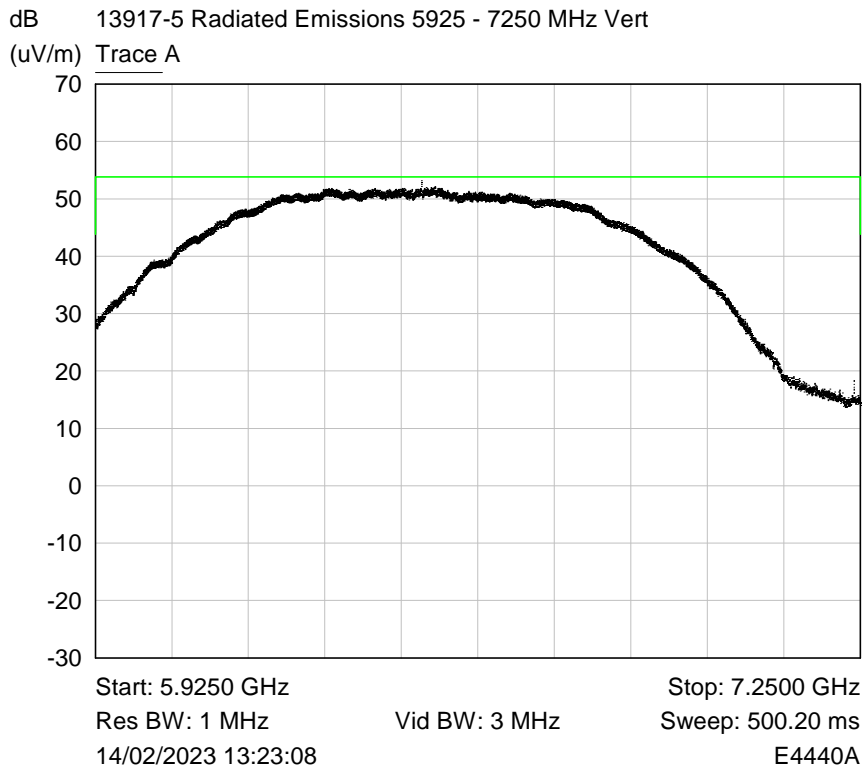
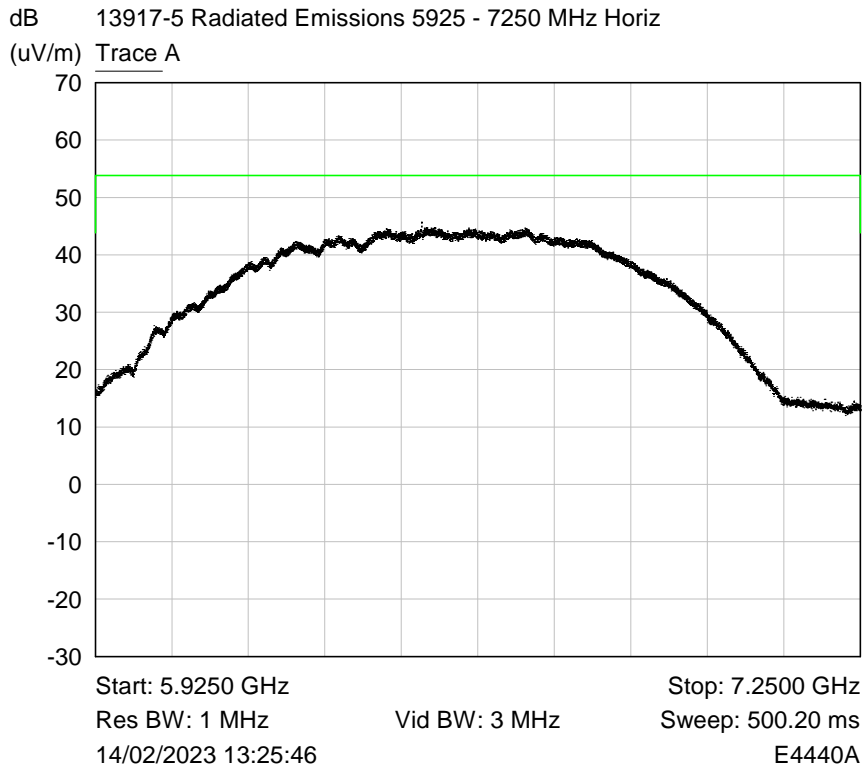
Start: 3.1000 GHz Stop: 5.9250 GHz  
Res BW: 1 MHz Vid BW: 3 MHz Sweep: 500.20 ms  
14/02/2023 13:17:51 E4440A

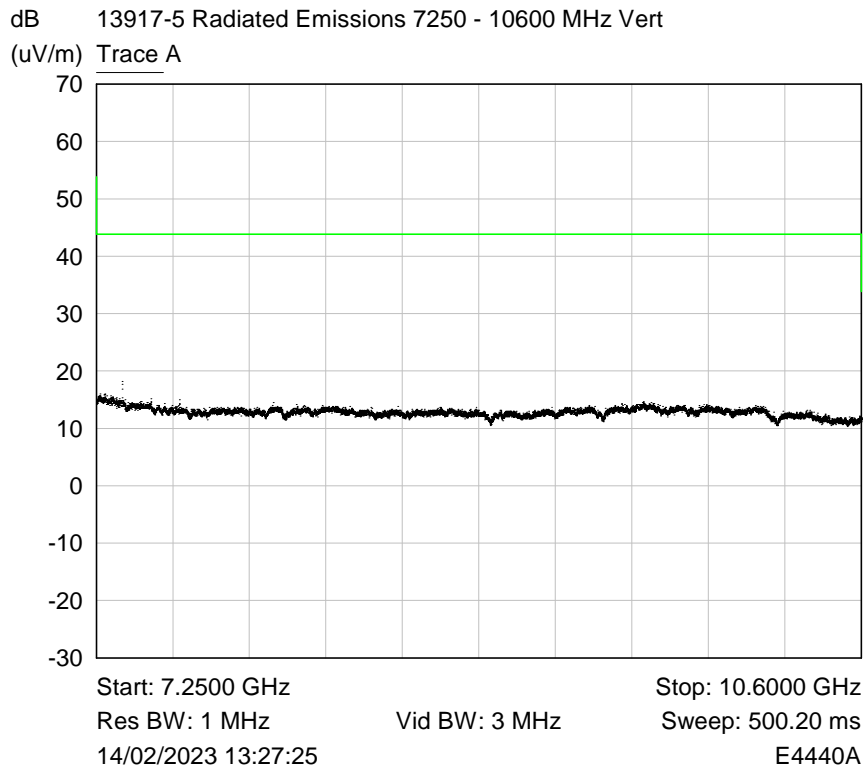
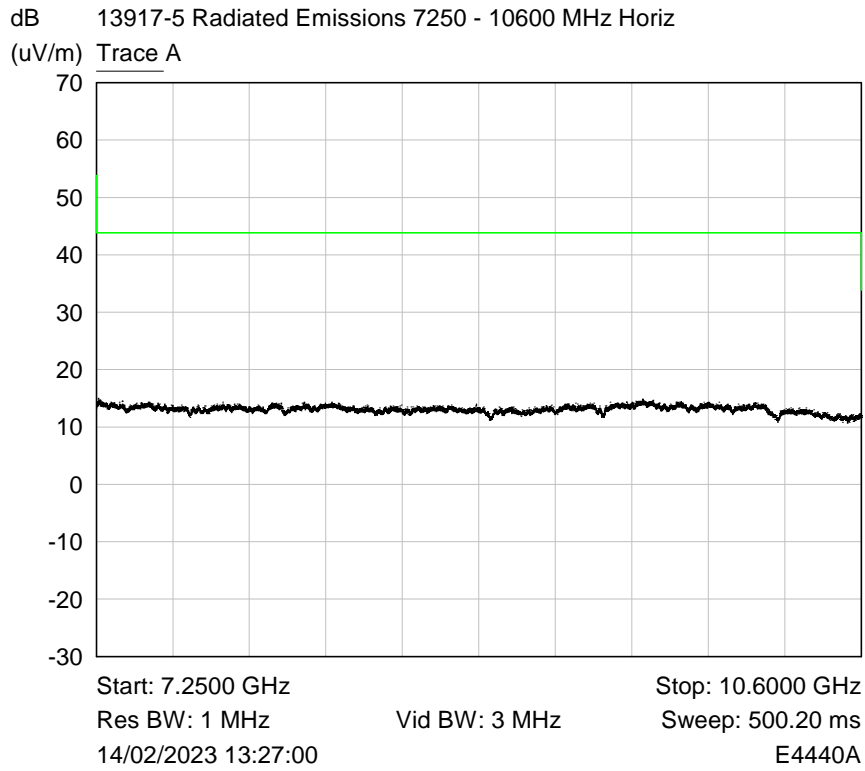
dB 13917-5 Radiated Emissions 3100 - 5925 MHz Vert

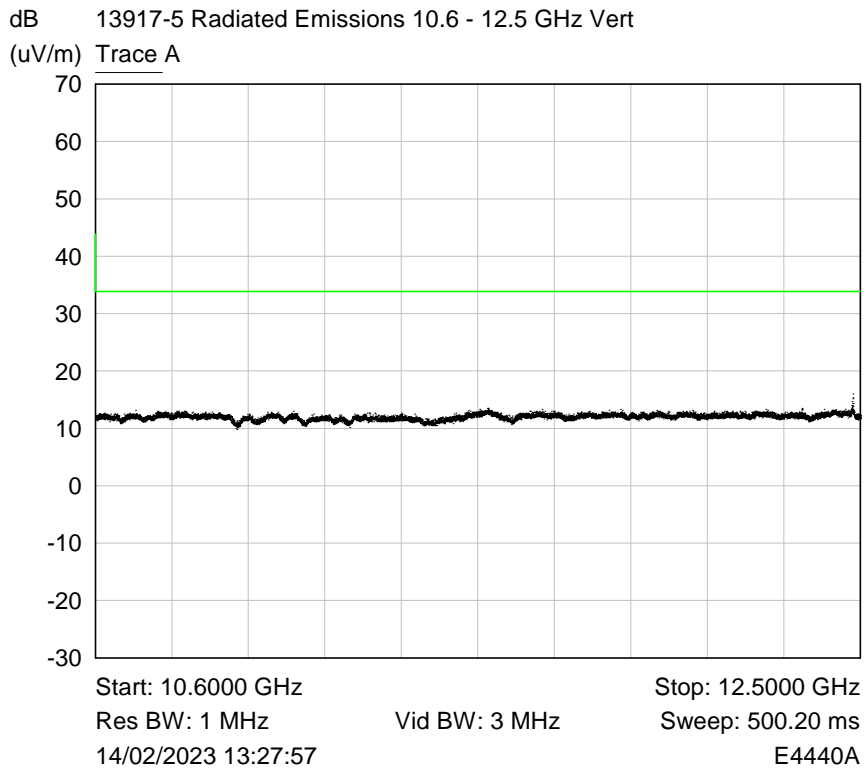
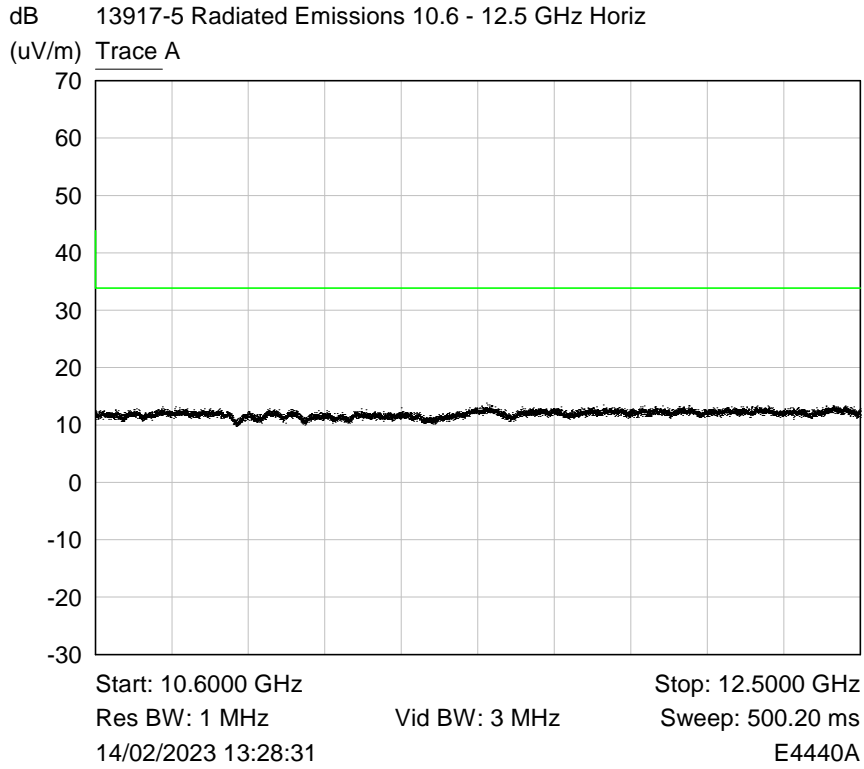
(uV/m) Trace A



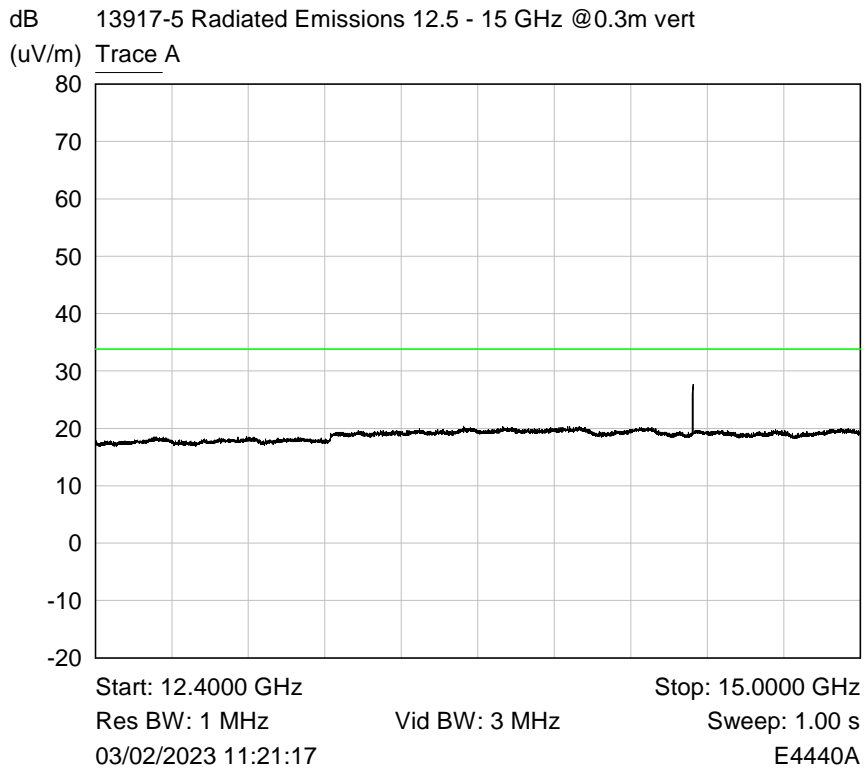
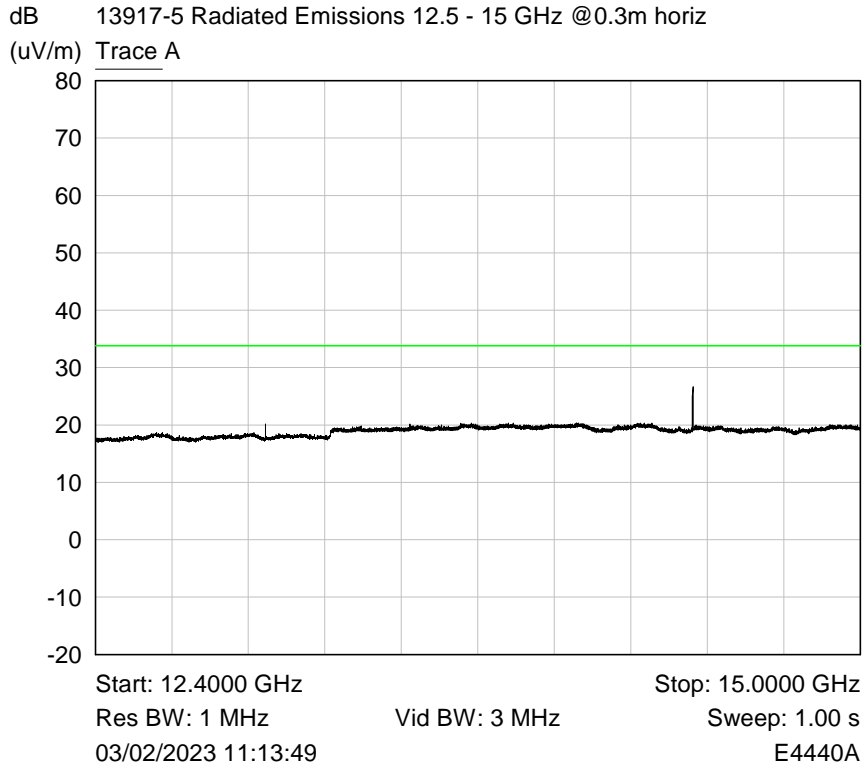
Start: 3.1000 GHz Stop: 5.9250 GHz  
Res BW: 1 MHz Vid BW: 3 MHz Sweep: 500.20 ms  
14/02/2023 13:17:07 E4440A





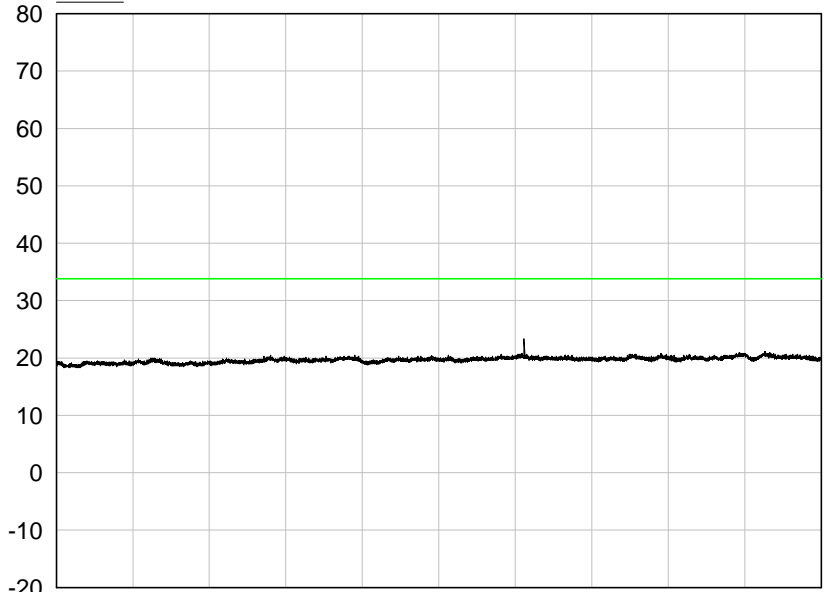






dB 13917-5 Radiated Emissions 15 - 18 GHz @0.3m horiz

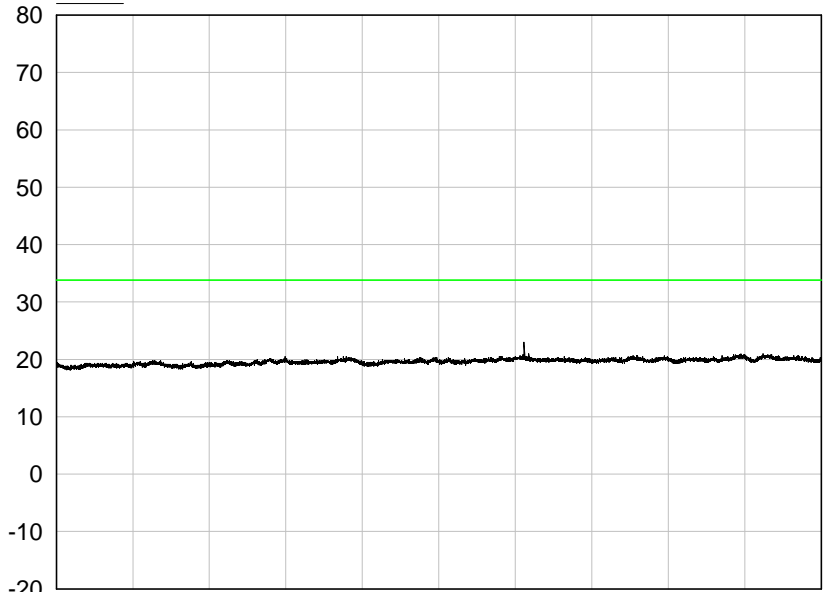
(uV/m) Trace A



Start: 15.0000 GHz Stop: 18.0000 GHz  
Res BW: 1 MHz Vid BW: 3 MHz Sweep: 1.00 s  
03/02/2023 11:15:59 E4440A

dB 13917-5 Radiated Emissions 15 - 18 GHz @0.3m vert

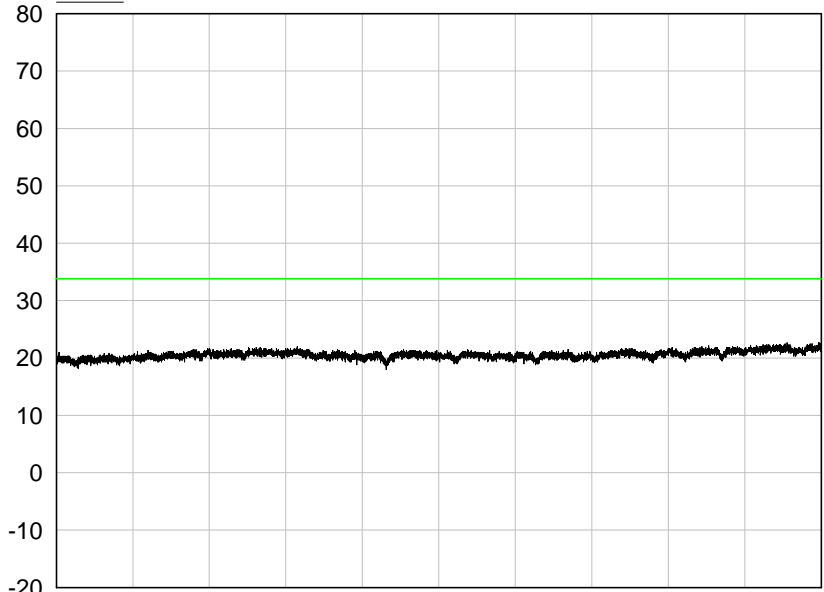
(uV/m) Trace A



Start: 15.0000 GHz Stop: 18.0000 GHz  
Res BW: 1 MHz Vid BW: 3 MHz Sweep: 1.00 s  
03/02/2023 11:18:59 E4440A

dB 13917-5 Radiated Emissions 18 - 22 GHz @0.3m horiz

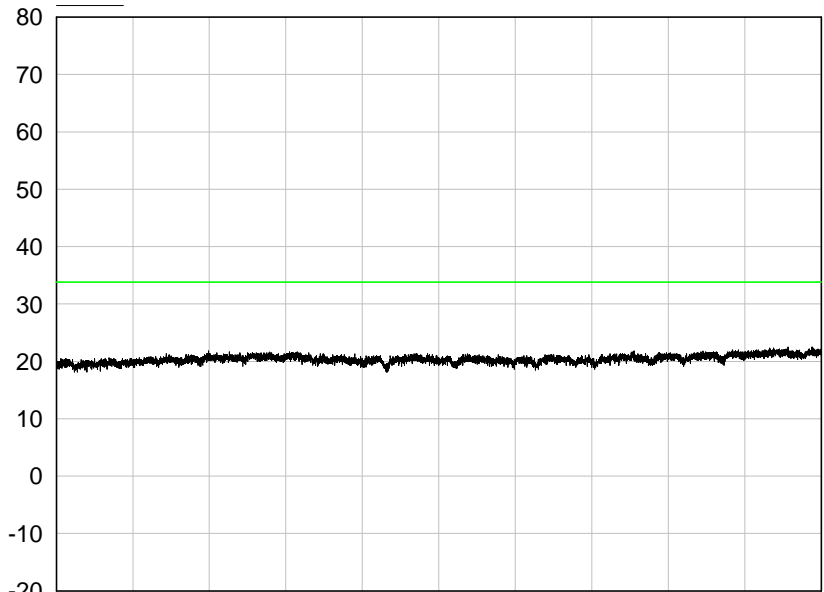
(uV/m) Trace A



Start: 18.0000 GHz Stop: 22.0000 GHz  
Res BW: 1 MHz Vid BW: 3 MHz Sweep: 1.00 s  
02/02/2023 14:22:56 E4440A

dB 13917-5 Radiated Emissions 18 - 22 GHz @0.3m vert

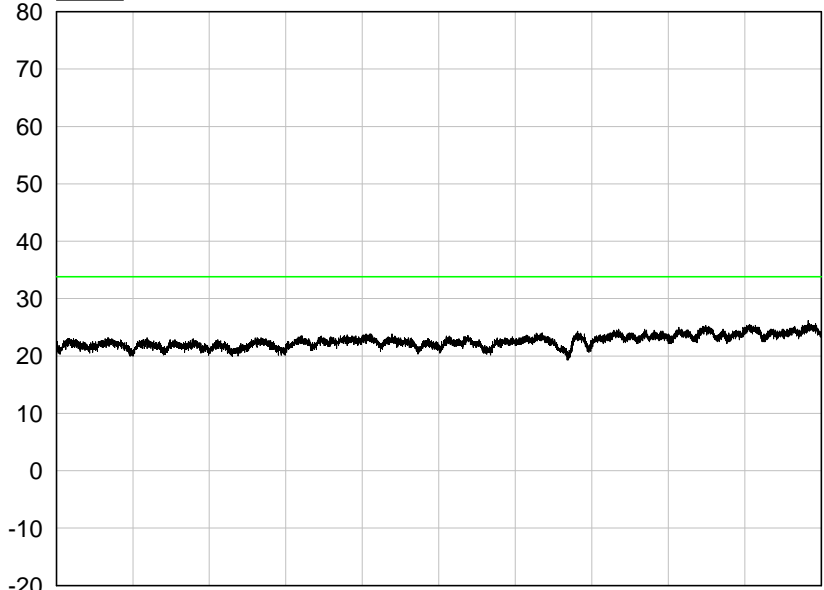
(uV/m) Trace A



Start: 18.0000 GHz Stop: 22.0000 GHz  
Res BW: 1 MHz Vid BW: 3 MHz Sweep: 1.00 s  
02/02/2023 13:18:56 E4440A

dB 13917-5 Radiated Emissions 22 - 26 GHz @0.3m horiz

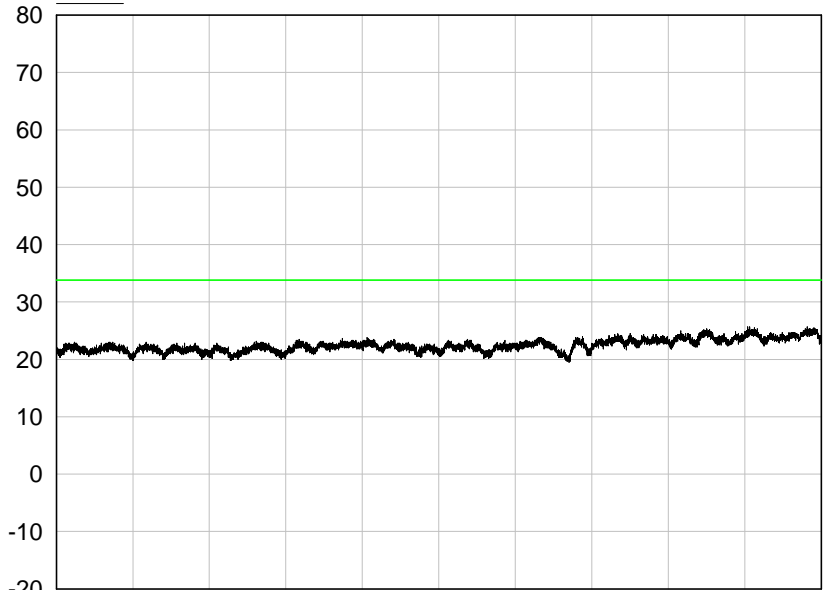
(uV/m) Trace A



Start: 22.0000 GHz Stop: 26.0000 GHz  
Res BW: 1 MHz Vid BW: 3 MHz Sweep: 1.00 s  
02/02/2023 14:23:38 E4440A

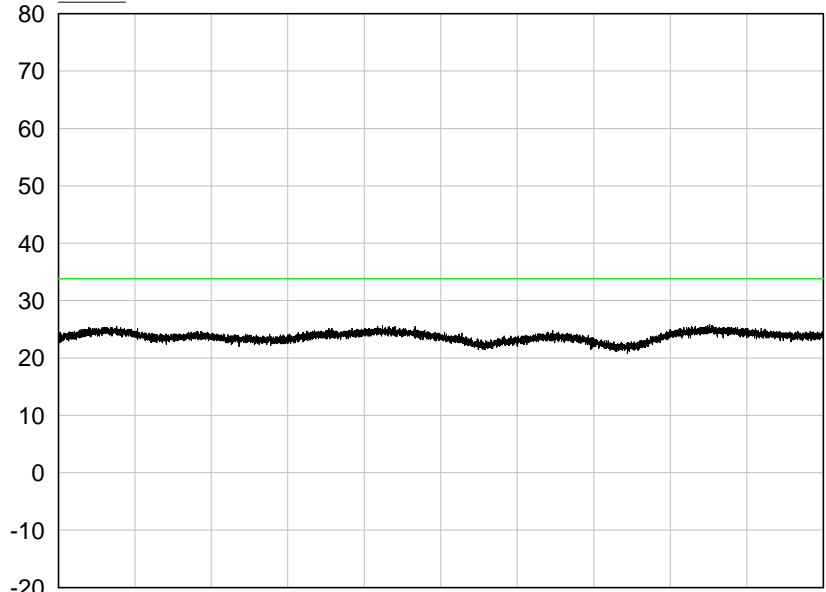
dB 13917-5 Radiated Emissions 22 - 26 GHz @0.3m vert

(uV/m) Trace A



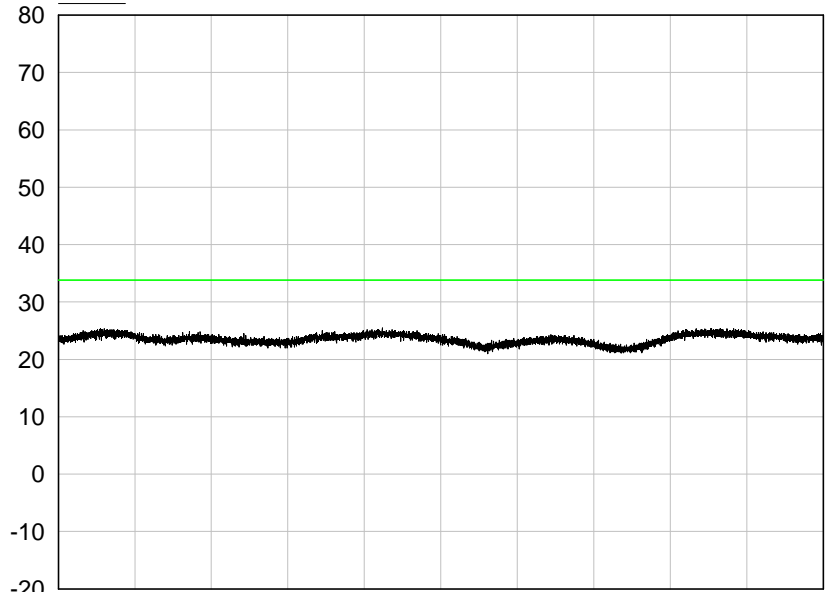
Start: 22.0000 GHz Stop: 26.0000 GHz  
Res BW: 1 MHz Vid BW: 3 MHz Sweep: 1.00 s  
02/02/2023 13:22:59 E4440A

dB 13917-5 Radiated Emissions 26 - 26.5 GHz @0.3m horiz  
(uV/m) Trace A



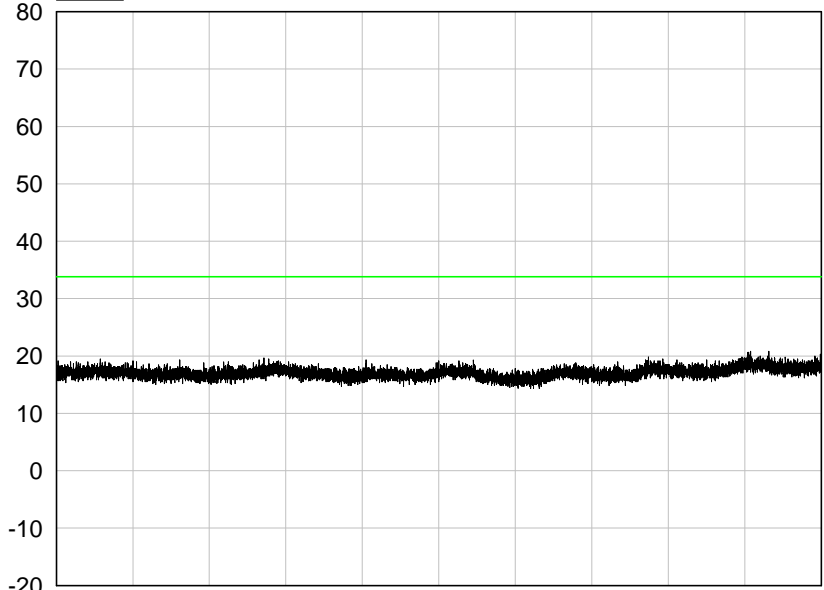
Start: 26.0000 GHz Stop: 26.5000 GHz  
Res BW: 1 MHz Vid BW: 3 MHz Sweep: 1.00 s  
02/02/2023 14:24:38 E4440A

dB 13917-5 Radiated Emissions 26 - 26.5 GHz @0.3m vert  
(uV/m) Trace A



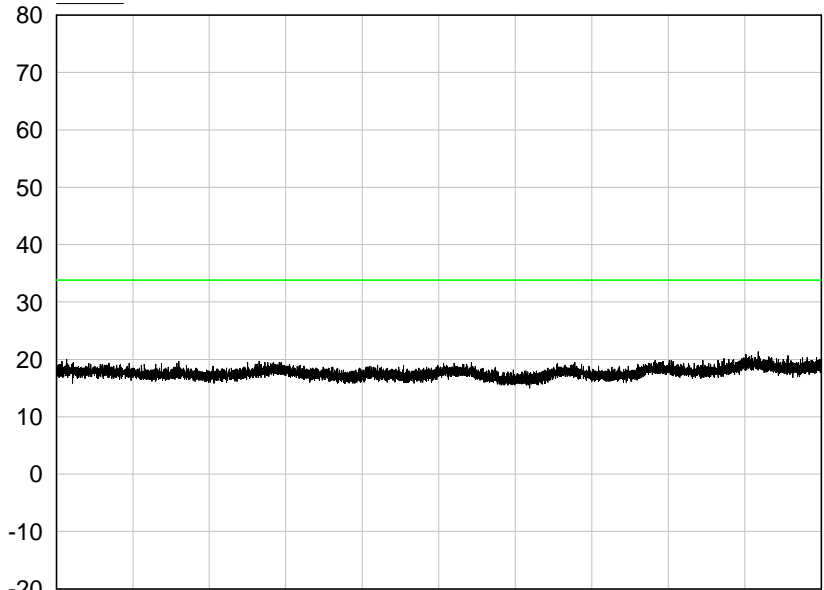
Start: 26.0000 GHz Stop: 26.5000 GHz  
Res BW: 1 MHz Vid BW: 3 MHz Sweep: 1.00 s  
02/02/2023 13:25:57 E4440A

dB 13917-5 Radiated Emissions 26.5 - 30 GHz @0.3m horiz  
(uV/m) Trace A



Start: 26.5000 GHz Stop: 30.0000 GHz  
Res BW: 1 MHz Vid BW: 3 MHz Sweep: 1.00 s  
03/02/2023 09:22:37 N9030B

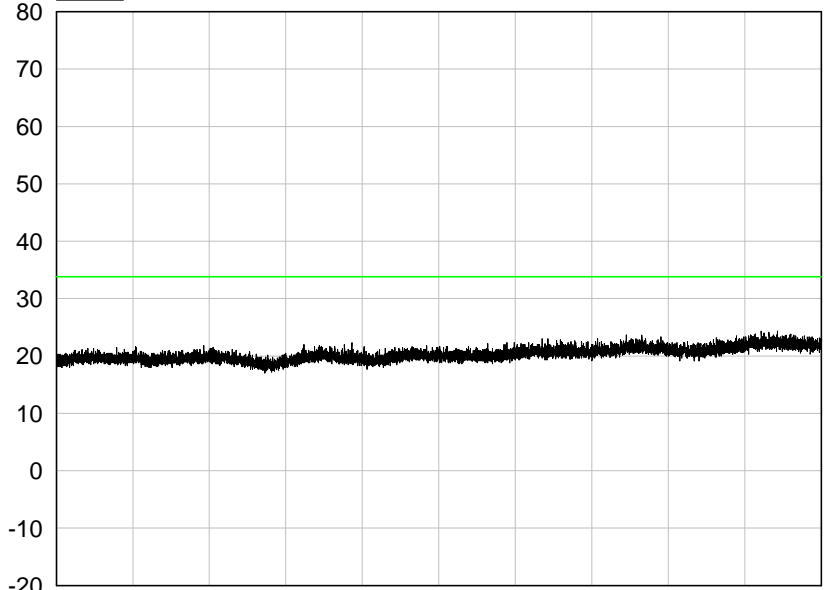
dB 13917-5 Radiated Emissions 26.5 - 30 GHz @0.3m vert  
(uV/m) Trace A



Start: 26.5000 GHz Stop: 30.0000 GHz  
Res BW: 1 MHz Vid BW: 3 MHz Sweep: 1.00 s  
03/02/2023 09:17:38 N9030B

dB 13917-5 Radiated Emissions 30 - 33 GHz @0.3m horiz

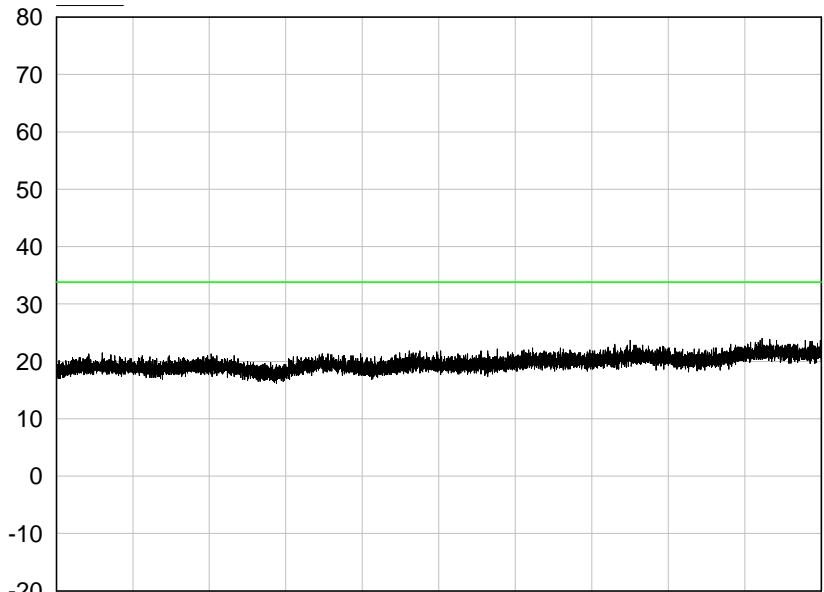
(uV/m) Trace A



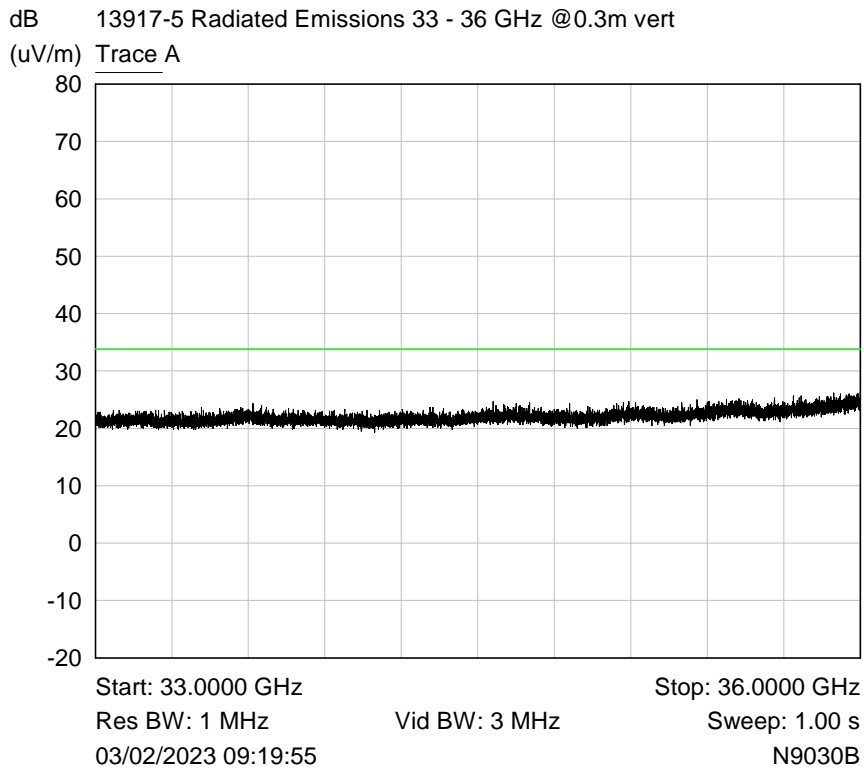
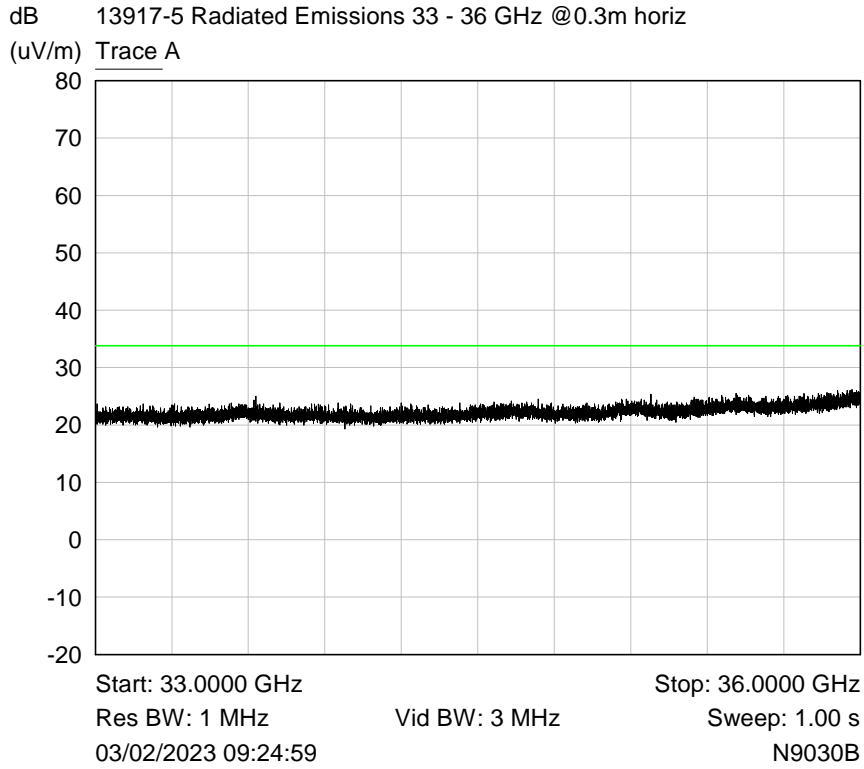
Start: 30.0000 GHz Stop: 33.0000 GHz  
Res BW: 1 MHz Vid BW: 3 MHz Sweep: 1.00 s  
03/02/2023 09:23:55 N9030B

dB 13917-5 Radiated Emissions 30 - 33 GHz @0.3m vert

(uV/m) Trace A



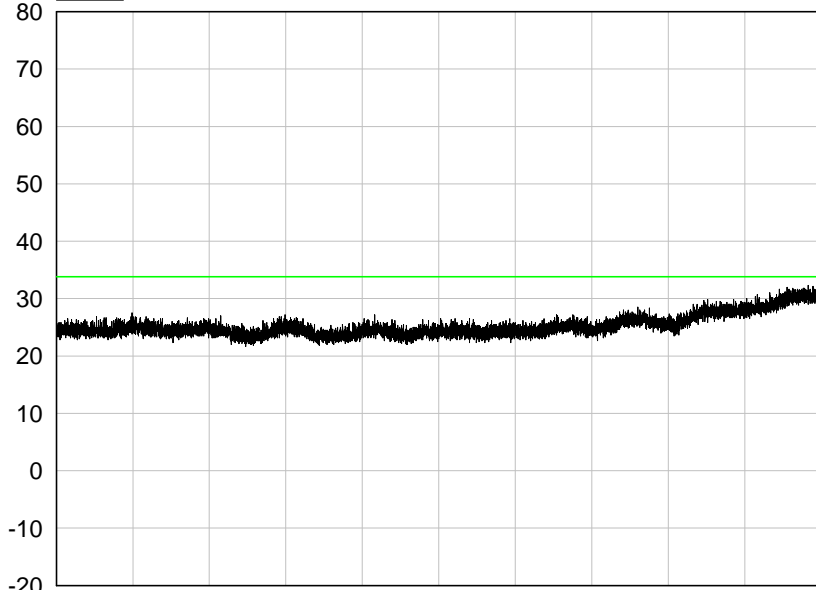
Start: 30.0000 GHz Stop: 33.0000 GHz  
Res BW: 1 MHz Vid BW: 3 MHz Sweep: 1.00 s  
03/02/2023 09:18:39 N9030B





dB 13917-5 Radiated Emissions 36 - 40 GHz @0.3m horiz

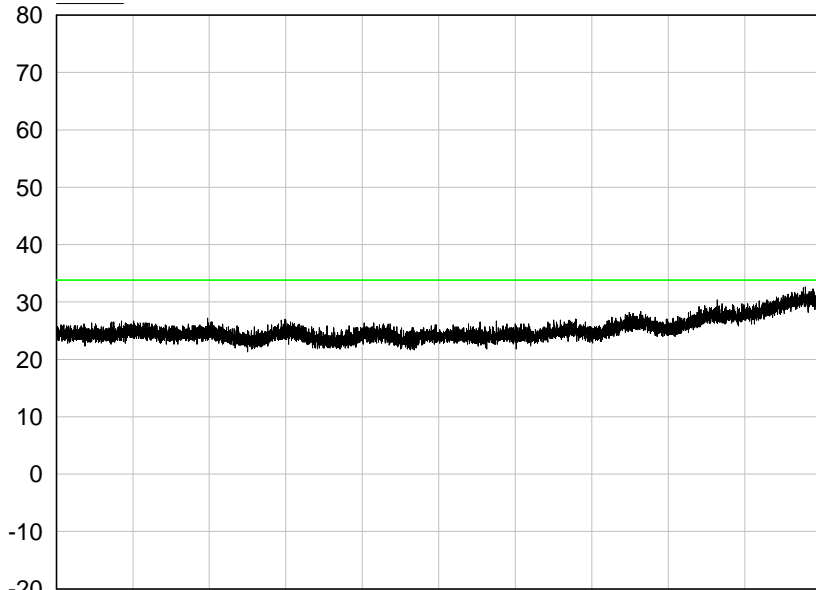
(uV/m) Trace A



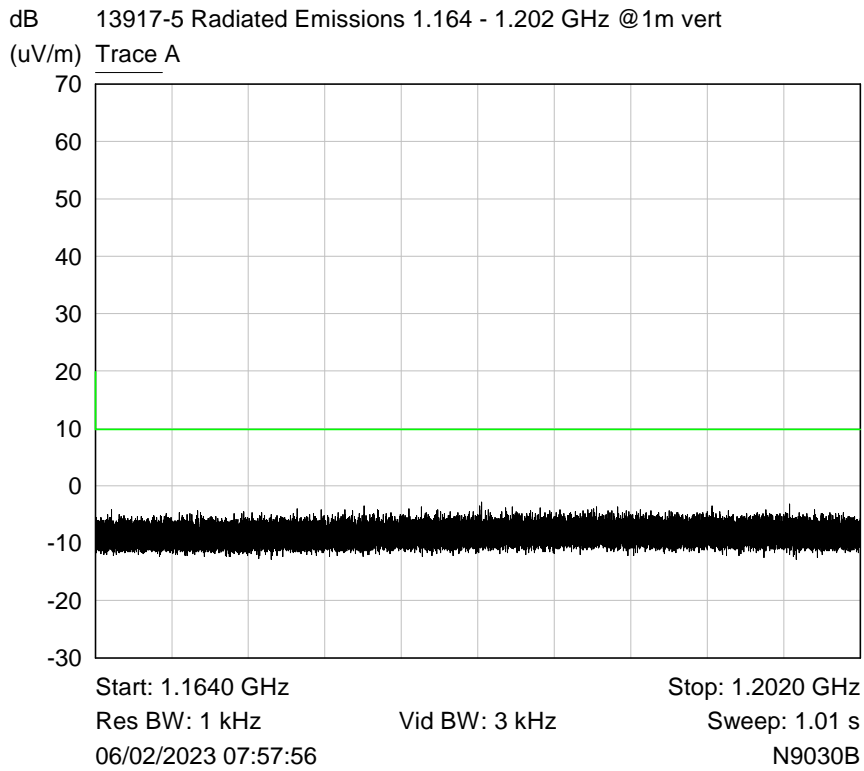
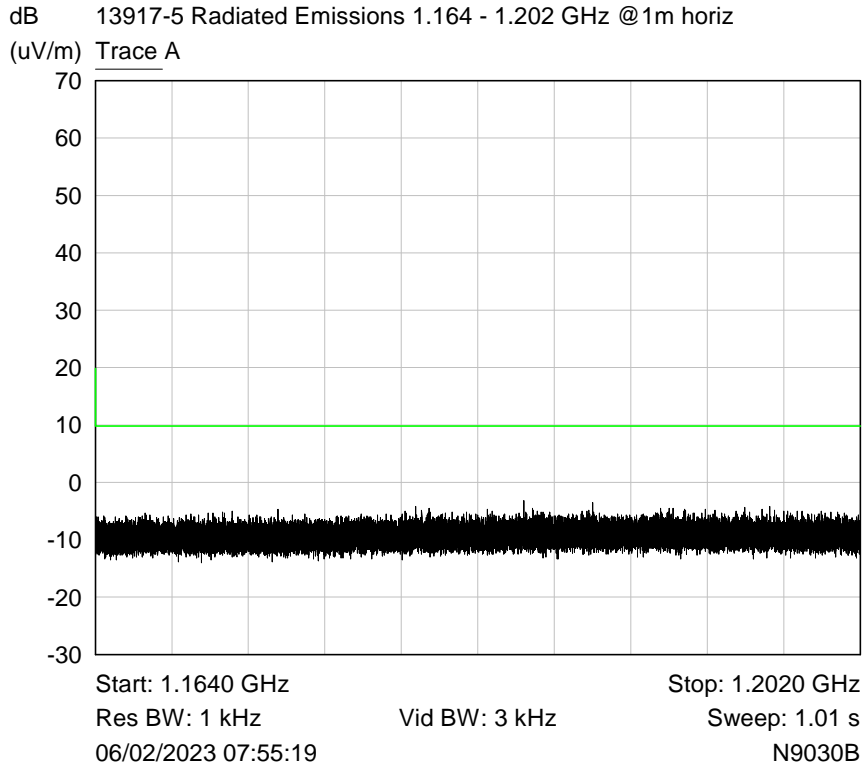
Start: 36.0000 GHz Stop: 40.0000 GHz  
Res BW: 1 MHz Vid BW: 3 MHz Sweep: 1.00 s  
03/02/2023 09:25:47 N9030B

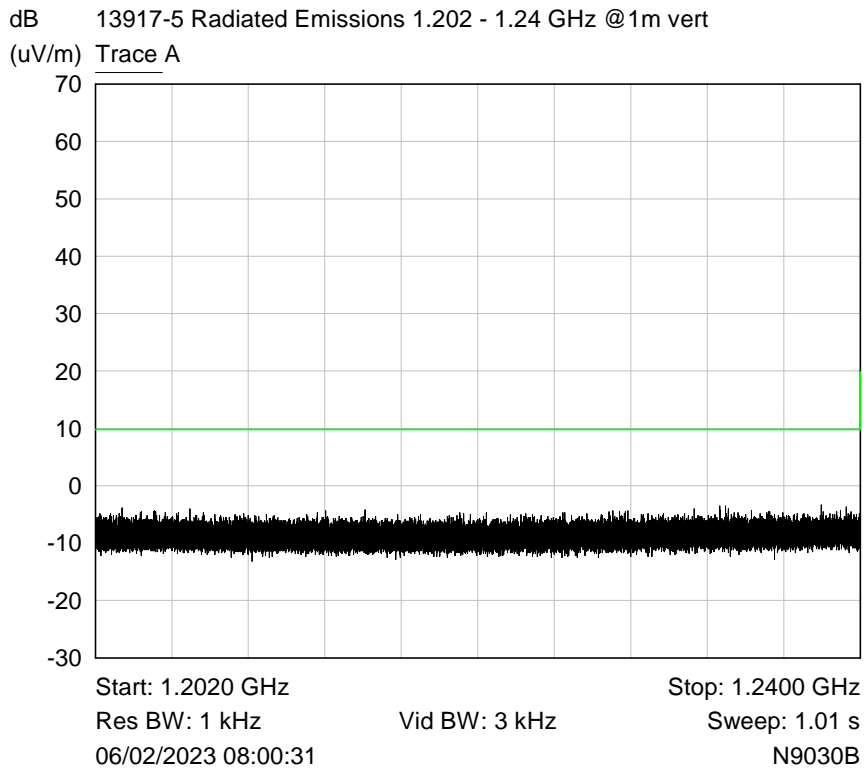
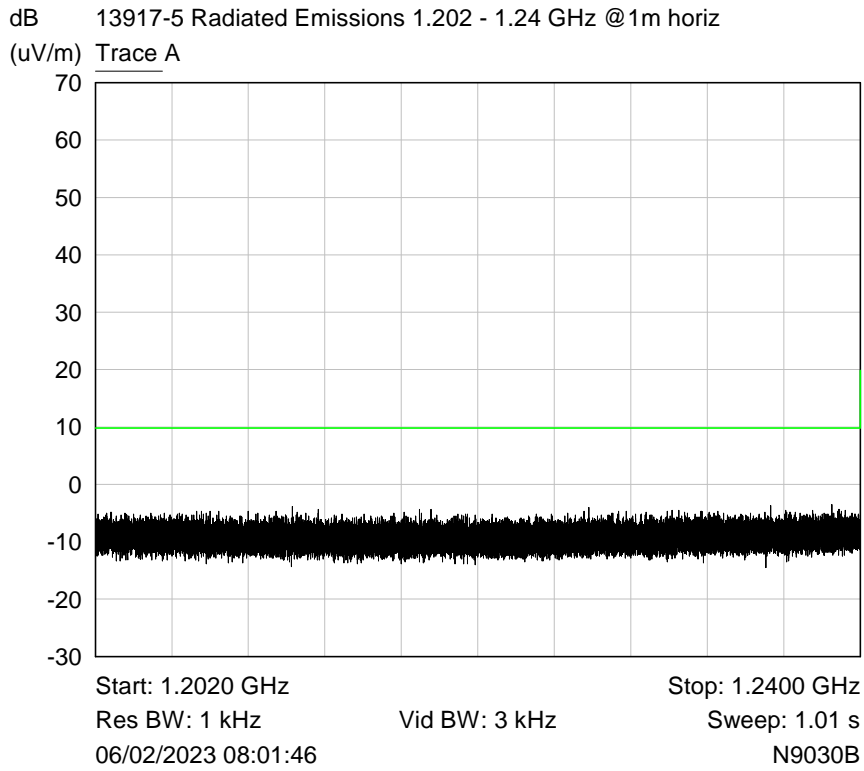
dB 13917-5 Radiated Emissions 36 - 40 GHz @0.3m vert

(uV/m) Trace A



Start: 36.0000 GHz Stop: 40.0000 GHz  
Res BW: 1 MHz Vid BW: 3 MHz Sweep: 1.00 s  
03/02/2023 09:20:49 N9030B

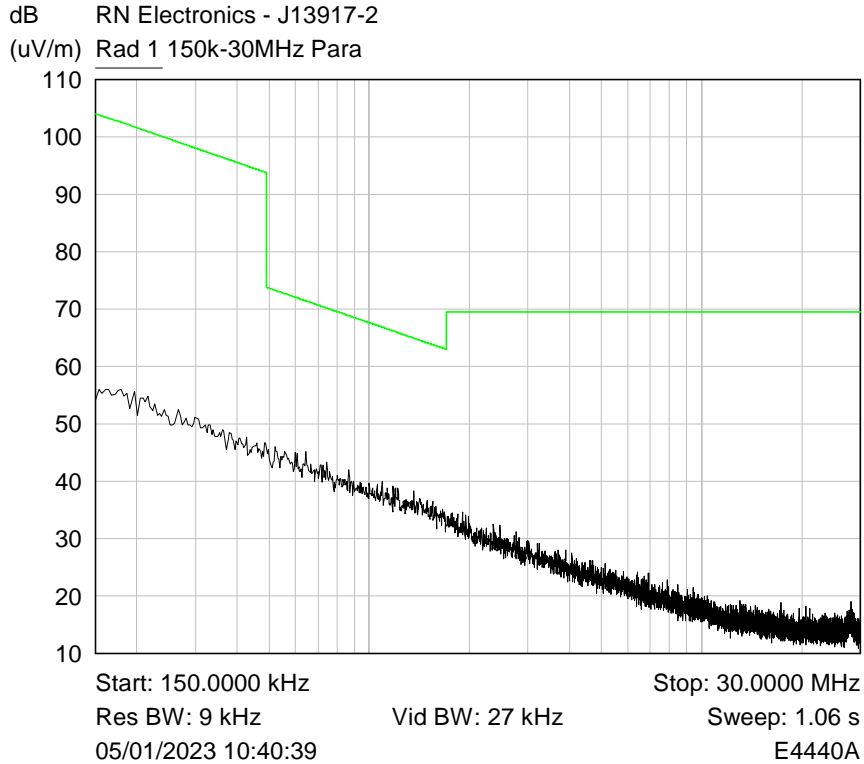




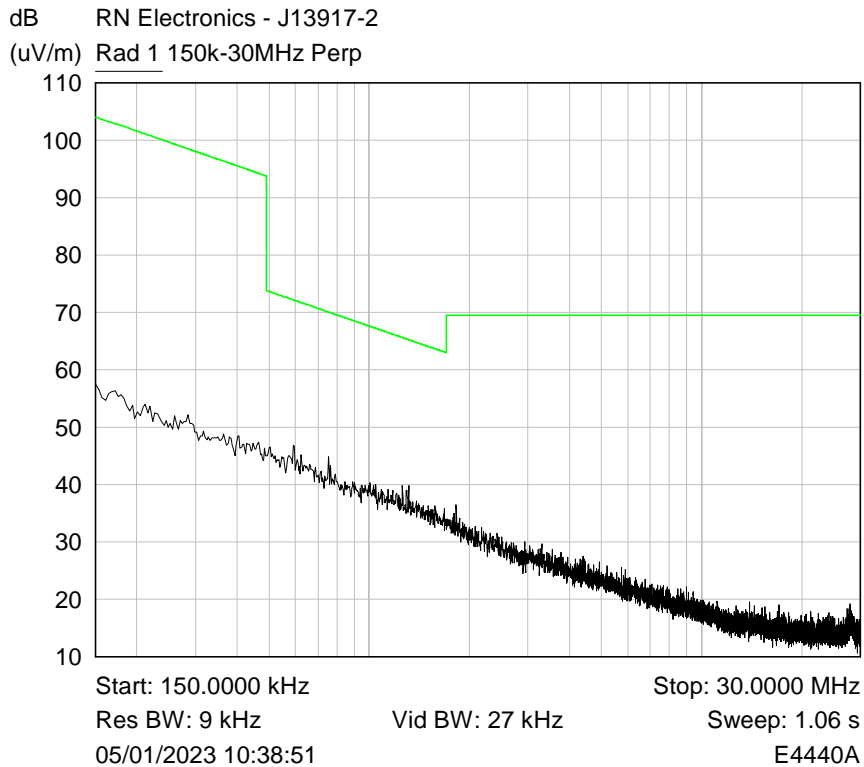


### 6.5 Radiated emissions 150 kHz - 30 MHz

RF Parameters: Band 5925-7250 MHz, Power 15.5 dBm, Channel Spacing Single Channel, Modulation UWB, Channel 6489 MHz



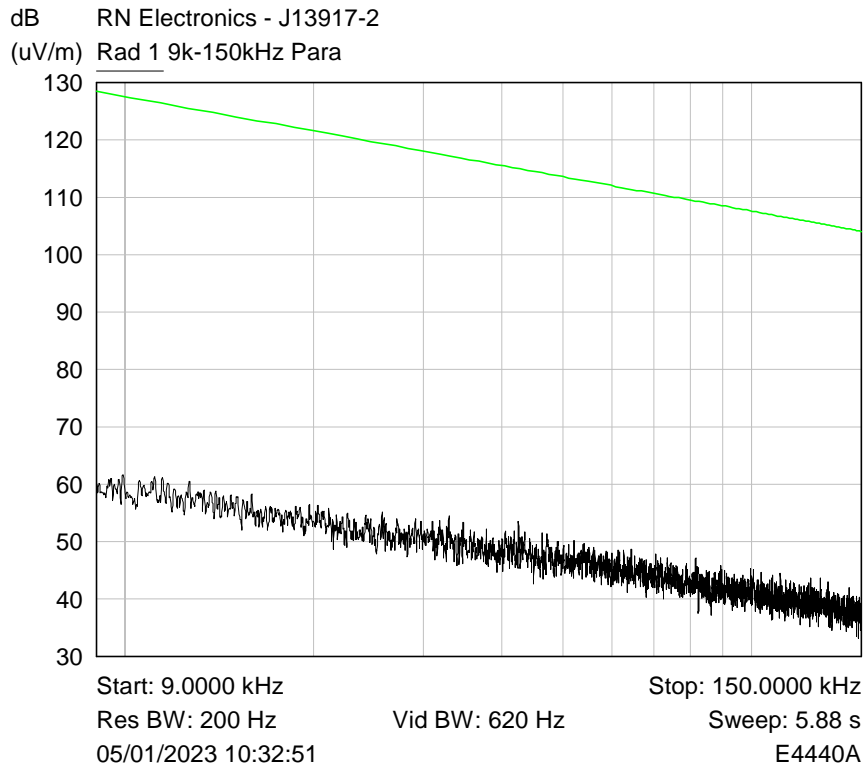
Plot of 150kHz-30MHz Parallel



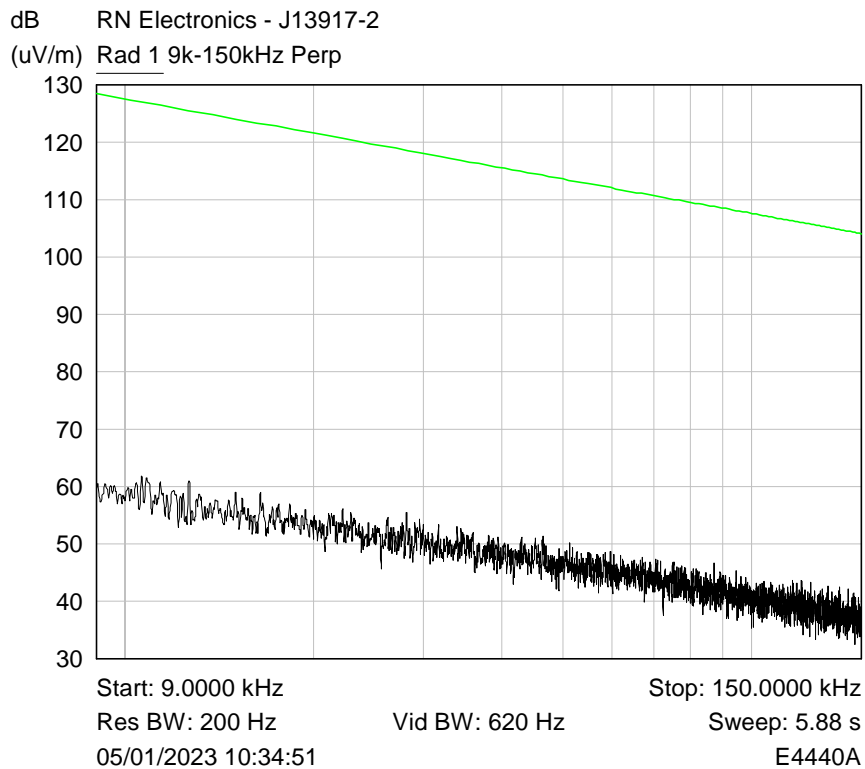
Plot of 150kHz-30MHz Perpendicular

## 6.6 Radiated emissions 9 - 150 kHz

RF Parameters: Band 5925-7250 MHz, Power 15.5 dBm, Channel Spacing Single Channel, Modulation UWB, Channel 6489 MHz



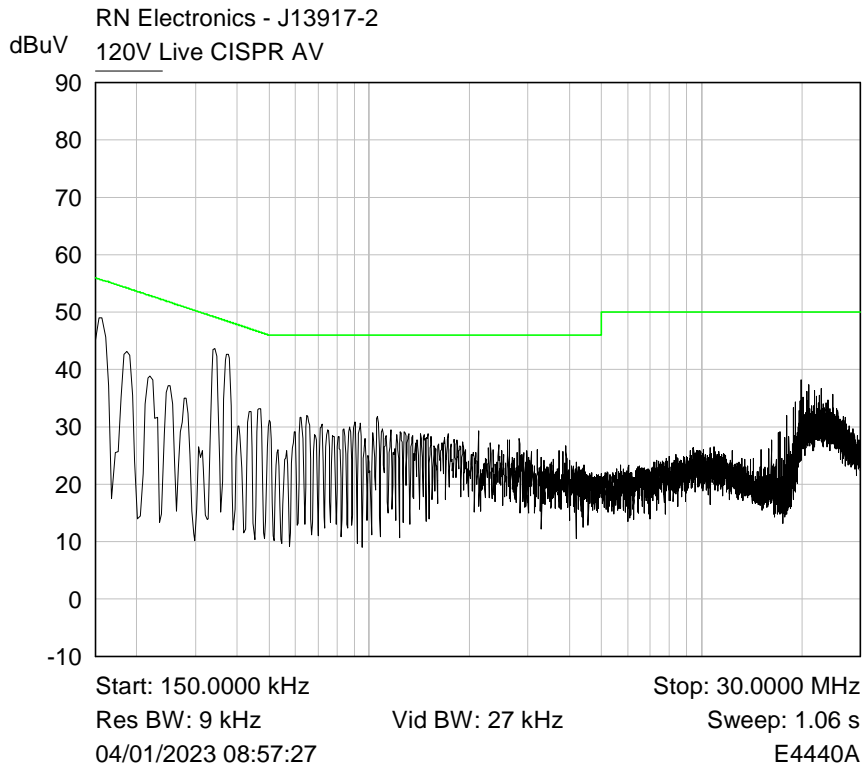
Plot of 9k-150kHz Parallel



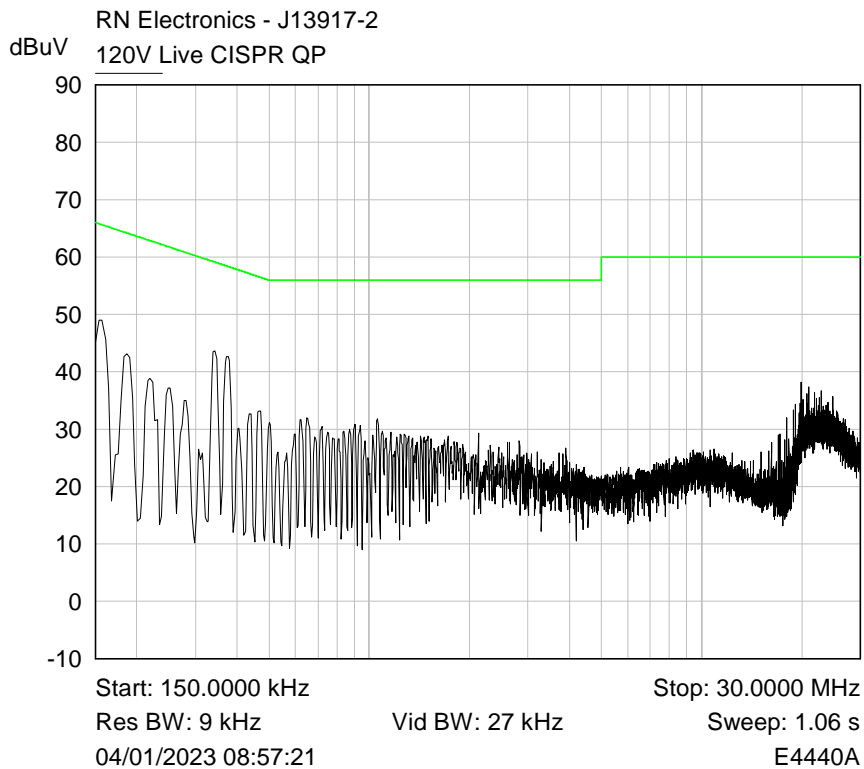
Plot of 9k-150kHz Perpendicular

## 6.7 AC power line conducted emissions

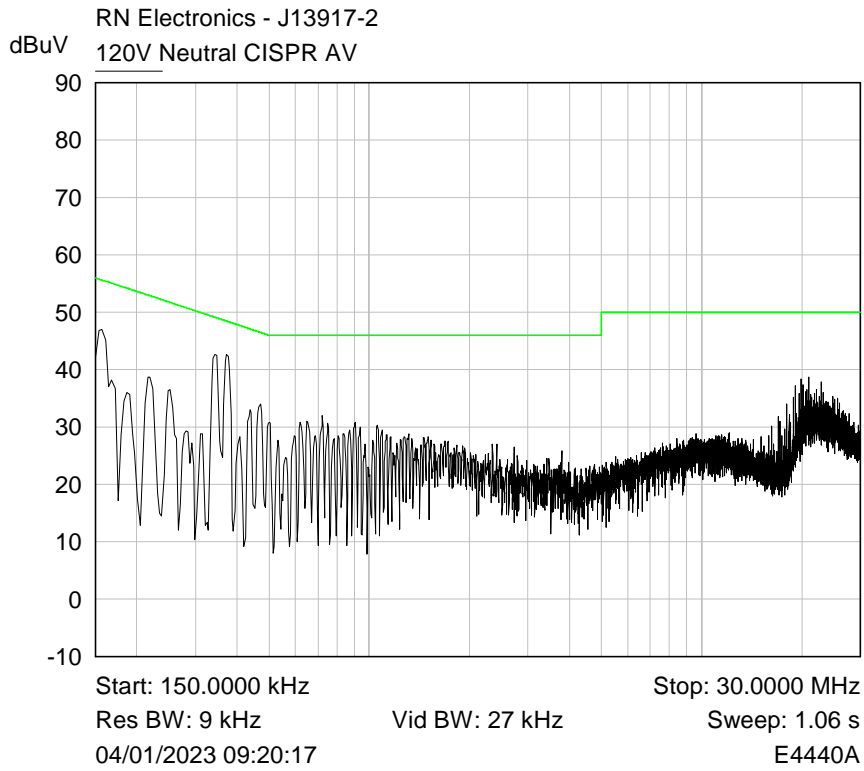
RF Parameters: Band 5925-7250 MHz, Power 15.5 dBm, Channel Spacing Single Channel, Modulation UWB, Channel 6489 MHz



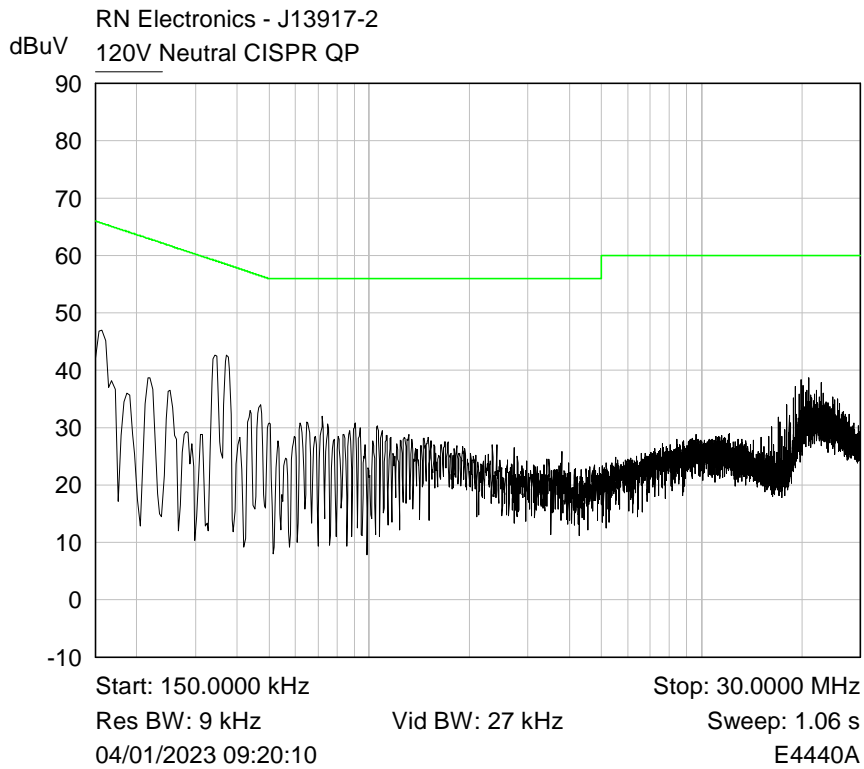
Plot of Live150k-30M Average



Plot of Live150k-30M Quasi-Peak



Plot of Neutral150k-30M Average



Plot of Neutral150k-30M Quasi-Peak



## 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  $\mu\text{V}/\text{m}$  at a specified distance), whereas the measured values are expressed as peak, quasi peak or average values in  $\text{dB}\mu\text{V}/\text{m}$  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  $500 \mu\text{V}/\text{m}$  equates to  $20.\log(500) = 54 \text{ dB } \mu\text{V}/\text{m}$ .

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

(c) limit of  $30 \mu\text{V}/\text{m}$  at 30m, but below 30MHz, equates to  $20.\log(30) + 40.\log(30/3) = 69.5 \text{ dB}\mu\text{V}/\text{m}$  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:**  $E_{\text{Linear}} = 10^{((E_{\log} - 120)/20)}$

And therefore equation 21 transposed is:  $E_{\log} = 20 \times \text{Log}(E_{\text{Linear}}) + 120$

Where:

$E_{\text{Linear}}$  is the field strength of the emission in  $\text{V}/\text{m}$

$E_{\log}$  is the field strength of the emissions in  $\text{dB}\mu\text{V}/\text{m}$

**Equation 22:**  $\text{EIRP} = E_{\text{Meas}} + 20\log(d_{\text{Meas}}) - 104.7$

Where:

EIRP is equivalent isotropically radiated power in dBm

$E_{\text{Meas}}$  is the field strength of the emission at the measurement distance in  $\text{dB}\mu\text{V}/\text{m}$

$d_{\text{Meas}}$  is the measurement distance in metres

**Equation 25:**  $\text{PD} = \text{EIRP}_{\text{Linear}} / 4\pi d^2$

And therefore equation 25 transposed is:  $\text{EIRP}_{\text{Linear}} = \text{PD} \times 4\pi d^2$

Where:

PD is the power density at distance specified by the limit, in  $\text{W}/\text{m}^2$

$\text{EIRP}_{\text{Linear}}$  is the equivalent isotropically radiated power in Watts

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

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

And therefore equation 26 transposed is:  $E_{\text{Spec limit}} = \sqrt{(\text{PD} \times 377)}$

Where:

PD is the power density at distance specified by the limit, in  $\text{W}/\text{m}^2$

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

**Example:**

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

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

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

And

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

And

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

## 8 Photographs

No photos included due to confidentiality requested by client towards FCC certification.

### 8.1 Radiated emission diagrams

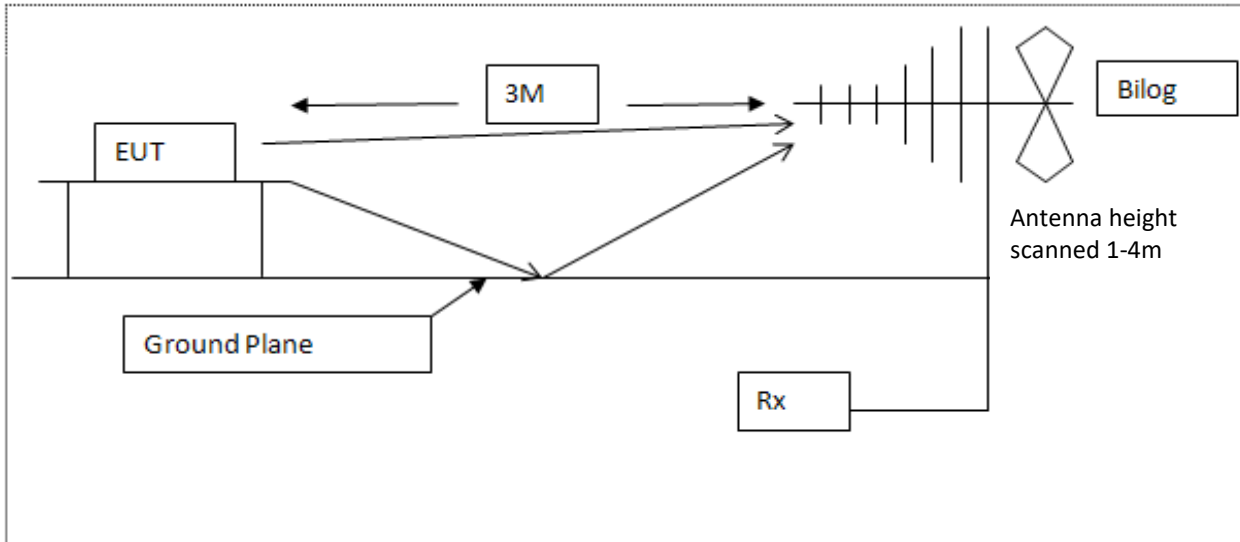


Diagram of the radiated emissions test setup 30 - 1000 MHz

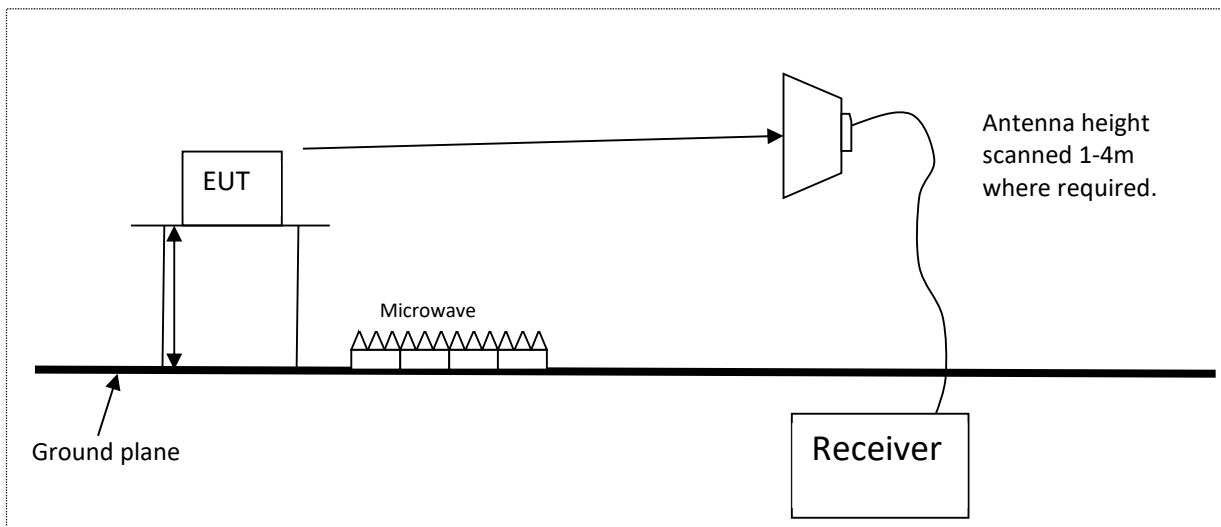


Diagram of the radiated emissions test setup above 1GHz

## 8.2 AC powerline conducted emission diagram

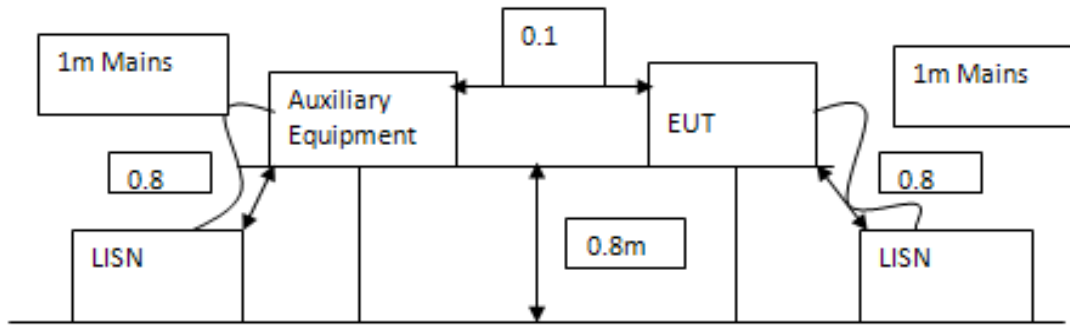


Diagram of the AC conducted emissions test setup

## 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
CAL07	MWX221	Cable N Type to SMA Blue 2m	Junflon	#16-Dec-2022	6 months
E035	11947A	Transient Limiter 9kHz - 200MHz	Hewlett Packard	#16-Dec-2022	12 months
E150	MN2050	LISN 13A	Chase	25-Apr-2022	12 months
E227	6632A	PSU System DC Power Supply	Hewlett Packard	21-Mar-2022	12 months
E268	BHA 9118	Horn Antenna 1 - 18 GHz	Schaffner	02-Apr-2022	12 months
E330	2224-20	Horn Antenna 26.5-40GHz	Flann (FMI)	22-Apr-2022	12 months
E331	22093-KF20	Horn Antenna 26.5-40GHz	Flann (FMI)	22-Apr-2022	12 months
E411	N9039A	9 kHz - 1 GHz RF Filter Section	Agilent Technologies	07-Jul-2022	12 months
E412	E4440A	PSA 3 Hz - 26.5 GHz	Agilent Technologies	21-Jun-2022	24 months
E428	HF906	Horn Antenna 1 - 18 GHz	Rohde & Schwarz	02-Apr-2022	12 months
E429	-	Filter Box 5 Switch Filters 0.91 GHz - 16.3 GHz	RN Electronics	23-Aug-2022	12 months
E433	MG3693A	Signal Generator 2 GHz - 30 GHz	Anritsu	03-Oct-2022	12 months
E434	G3RUH	10 MHz GPS Disciplined Oscillator	G3RUH - James Miller	06-Mar-2023	12 months
E452	22240-20	Horn Std Gain 26.4 - 40.1 GHz	Flann (FMI)	#18-Jan-2023	12 months
E453	20240-20-AA	Horn Std Gain 17.6 - 26.7 GHz	Flann (FMI)	25-May-2022	12 months
E580	24240	Horn Std Gain 40GHz - 60 GHz	Flann (FMI)	22-Apr-2022	12 months
E602	MG3692A	Signal Generator 10 MHz - 20 GHz	Anritsu	02-Mar-2023	12 months
E642	E4440A	PSA 3 Hz - 26.5 GHz	Agilent Technologies	#06-Dec-2022	24 months
E717	-	Horn Std Gain 50-75GHz	-	22-Apr-2022	12 months
E725	6610.42	Attenuator 10dB 40GHz	Suhner	29-Mar-2022	12 months
E743	2017 4/2dB	Attenuator 4/2dB 30-1000MHz	RN Electronics	15-Mar-2023	12 months
E755	N9030B	PXA Signal Analyser 3 Hz to 50 GHz	Keysight Technologies	03-Aug-2022	12 months
E856	N9039A	9 kHz - 1 GHz RF Filter Section	Agilent Technologies	#06-Dec-2022	12 months
E904	5086-7805	Pre-Amplifier 1GHz - 26.5GHz	Hewlett Packard	04-Mar-2022	12 months
F119	AA40-10H	Attenuator 2.92mm 10dB 40GHz	AtlanTecRF	07-Oct-2022	12 months
F225	JS4-26004000-40-8P	Pre Amplifier 26.5GHz to 40GHz 2.92mm	Miteq	20-Apr-2022	12 months
H079	ESW8	Spectrum Analyser	Rohde & Schwarz	#25-Nov-2022	12 months
LPE364	CBL6112A	Antenna BiLog 30MHz - 2GHz	Chase Electronics Ltd	28-Mar-2022	24 months
N579	71043	Frequency Standard Distribution	-	#19-Dec-2022	12 months
NSA-M	NSA - M	NSA - Site M	RN Electronics	29-Nov-2021	36 months
P168	LT30-2	PSU 30V 2A	Farnell	21-Jun-2022	12 months
TMS38	VMT04/140	Environmental Oven	Heraeus Votsch	13-Mar-2023	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	25-May-2022	12 months
TMS80	206-3722	Digital Thermometer & K Probe	RS Components	03-Nov-2022	12 months
TMS81	6502	Antenna Active Loop	EMCO	22-Jul-2021	24 months
ZSW1	V2.5.2	Measurement Software Suite	RN Electronics	Not applicable	

# 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	XT2173-3	Smartphone	Motorola	ZY22FCH44T
2	1801A-ELC-6L	Battery charger	Salunda	3
3	GST120A24	Battery charger PSU	Mean Well	ECO51A6911

### 10.2 RN Electronics supplied equipment

RN No.	Model No.	Description	Manufacturer	Serial No
P260	36V5	PSU 36V 5A	Kingshill	205

## 11 Condition of the equipment tested

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

### 11.1 Modifications before test

No modifications were made before test by RN Electronics Ltd.

### 11.2 Modifications during test

No modifications were made during test by RN Electronics Ltd.



## 12 Description of test sites

Site A	Radio Laboratory and Anechoic Chamber
Site B	Semi-Anechoic Chamber and Control Room FCC Registration No. 293246, ISED Registration No. 5612A-4
Site C	Transient Laboratory
Site D	Screened Room (Conducted Immunity)
Site E	Screened Room (Control Room for Site D)
Site F	Screened Room (Conducted Emissions)
Site G	Screened Room (Control Room for Site H)
Site H	3m Semi-Anechoic Chamber (indoor OATS) FCC Registration No. 293246, ISED Registration No. 5612A-2, VCCI Registration No. 4065
Site J	Transient Laboratory
Site K	Screened Room (Control Room for Site M)
Site M	3m Semi-Anechoic Chamber (indoor OATS) FCC Registration No. 293246, ISED Registration No. 5612A-3
Site N	Radio Laboratory
Site Q	Fully-Anechoic Chamber
Site OATS	3m and 10m Open Area Test Site FCC Registration No. 293246, ISED Registration No. 5612A-1
Site R	Screened Room (Conducted Immunity)
Site S	Safety Laboratory
Site T	Transient Laboratory

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

## 13 Abbreviations and units

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

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