Radio Test Report

Sensys Gatso Netherlands

T-Series + RT4.1

19-900555

47 CFR Part 15.245 Effective Date 1st October 2023
FDS: Part 15 Field Disturbance Sensor
Test Date: 29th April 2024 to 3rd May 2024
Report Number: 05-14250-1-24 Issue 01

The testing was carried out by Kiwa Electrical Compliance, 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 14250-1

The equipment noted below has been fully tested by Kiwa Electrical Compliance 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:	T-Series + RT4.1
Model Number:	19-900555
Unique Serial Number:	202008008907
Applicant:	Sensys Gatso Netherlands, Claes Tillyweg 2 Haarlem Noord-Holland 2031 CW Netherlands
Full measurement results are detailed in Report Number:	05-14250-1-24 Issue 01
Test Standards:	47 CFR Part 15.245 Effective Date 1st October 2023 FDS: Part 15 Field Disturbance Sensor

NOTE:
Certain tests were performed based upon applicant's declarations. For details refer to section 3 of this report.

DEVIATIONS:
No deviations have been applied.

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

Date of Test: 29th April 2024 to 3rd May 2024

Test Engineer:
Graham Blake

Graham Blake
Digitally signed by: Graham Blake
DN: CN = Graham Blake email = graham.blake@kiwa.com C = GB OU = Kiwa Electrical Compliance
Date: 2024.06.14 13:58:50 Z

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Radio Approvals manager

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Customer Representative:

ilac-MRA UKAS TESTING 2360

1 Contents

2 Equipment under test (EUT)

2.1 Equipment specification

Applicant	Sensys Gatso Netherlands Claes Tillyweg 2 Haarlem Noord-Holland 2031 CW Netherlands	
Manufacturer of EUT	Sensys Gatso Netherlands	
Full Name of EUT	T-Series + RT4.1	
Model Number of EUT	19-900555	
Serial Number of EUT	202008008907	
Date Received	29th April 2024	
Date of Test:	29th April 2024 to 3rd May 2024	
Purpose of Test	To demonstrate design compliance to the relevant rules of Chapter 47 of the Code of Federal Regulations.	
Date Report Issued	14th June 2024	
Main Function	Traffic Enforcement system	
Information Specification	Height	375 mm
	Width	375 mm
	Depth	210 mm
	Weight	14 kg
	Voltage	12VDC
	Current	6.5 Amp
EUT Supplied PSU	Manufacturer	Meanwell
	Model number	GST90A12
	Serial number	SC291H1
	Input voltage	100 - 240 VAC
	Input current	1.3 Amp
	Output	12 VDC 6.67 Amp

2.2 Configurations for testing

General Parameters	
EUT Normal use position	Pole mounted
Choice of model(s) for type tests	Sample
Antenna details	Planar radar 12 dBi gain
Antenna port	No
Baseband Data port (yes/no)?	No
Highest Signal generated in EUT	24.164 GHz
Lowest Signal generated in EUT	Not declared
Hardware Version (HVIN)	Not applicable
Software Version	US-RD160038-6.4
Firmware Version (FVIN)	Not applicable
Type of Equipment	Radar
Technology Type	FMCW Radar
Geo-location (yes/no)	No
TX Parameters	
Alignment range – transmitter	24.089 - 24.164 GHz
EUT Declared Modulation Parameters	FMCW
EUT Declared Power level	19.5 dBm
EUT Declared Signal Bandwidths	61 MHz
EUT Declared Channel Spacing's	Single frequency
EUT Declared Duty Cycle	96%
Unmodulated carrier available?	Yes
Declared frequency stability	25 ppm
RX Parameters	
Alignment range – receiver	24.089 - 24.164 GHz
EUT Declared RX Signal Bandwidth	61 MHz
FCC Parameters	
FCC Transmitter Class	FDS: Part 15 Field Disturbance Sensor

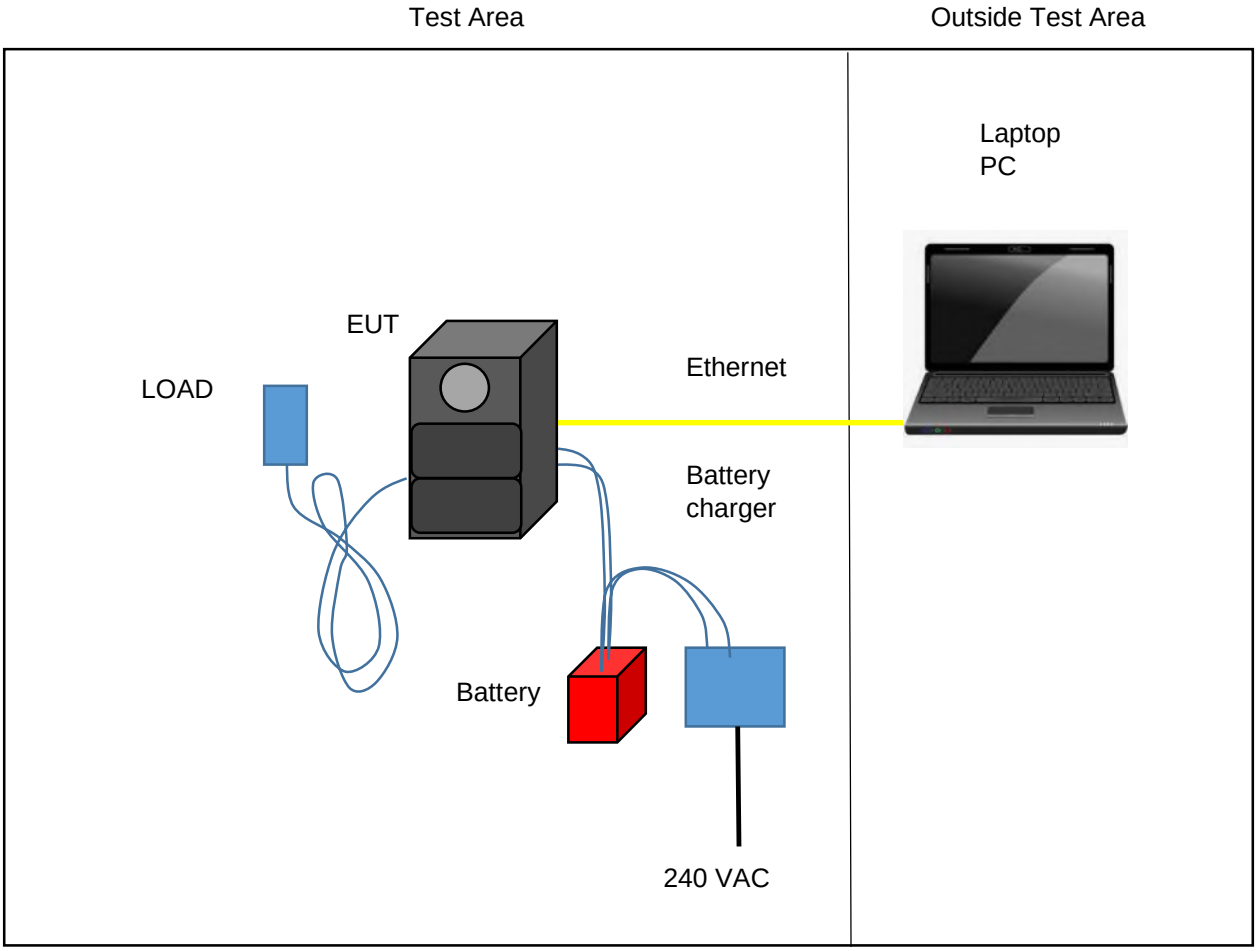
2.3 Functional description

System includes an RF module (RT4.1) an Ethernet port, I/O and a DC ports. The EUT radar is a FMCW radar and is used for speed detection of vehicles. The EUT incorporates a traffic camera, FMCW radar, infrared flash and a computer to create a traffic enforcement system. The EUT operates in the frequency band 24.075 - 24.175 GHz.

2.4 Modes of operation

Mode Reference	Description	Used for testing
TX LOW	FMCW stopped. Transmitting continuously at 24089 MHz with modulation.	Yes
TX MID	FMCW stopped. Transmitting continuously at 24125 MHz with modulation.	Yes
TX HIGH	FMCW stopped. Transmitting continuously at 24164 MHz with modulation.	Yes
FMCW	Transmitting whilst sweeping across the whole band (normal operation)	Yes

2.5 Emissions configuration



The unit was powered from a fully charged 12 Volt battery. A laptop PC was connected to the EUT using a screened Ethernet cable. The I/O was populated with a supplied cable; excess cable length was bundled. Using terminal software, the PC was used to configure the EUT to allow permanent transmit modes of device, FMCW sweep was stopped on the top, middle and bottom frequencies of the sweep range, and normal FMCW sweep mode was used, as stated within section 2.4 of this report.

For AC conducted emissions tests, an off the shelf mains to 12VDC adapter was used to power the EUT. The adapter was powered using a 120 VAC 60 Hz power source.
The transmit mode was confirmed as 92.3% duty cycle and the power settings for each stopped sweep channel and the sweep were as stated below:-

Low Channel (24089 MHz) Power level = Setting 2
Mid Channel (24125 MHz) Power level = Setting 2
High Channel (24164 MHz) Power level = Setting 2
FMCW sweeping Power level = 2

2.5.1 Signal leads

Port Name	Cable Type	Connected
Network	Screened Ethernet	Yes
Power	2-core	Yes
I/O	Screened Ethernet	Yes

3 Summary of test results

The T-Series + RT4.1, 19-900555 was tested for compliance to the following standard:

47 CFR Part 15.245 Effective Date 1st October 2023
FDS: Part 15 Field Disturbance Sensor

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

Title	References	Results
Transmitter Tests		
1. AC power line conducted emissions	47 CFR Part 15C Part 15.207	PASSED
2. Radiated emissions 9 - 150 kHz	47 CFR Part 15C Part 15.209	PASSED
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 15.245 & 15.209	PASSED
5. Radiated emissions above 1 GHz	47 CFR Part 15C Part 15.245 & 15.209	PASSED[1]
6. Effective radiated power field strength	47 CFR Part 15C Part 15.245()	PASSED
7. Occupied bandwidth	47 CFR Part 15C Part 15.215(c)	PASSED
8. Band Edge Compliance	47 CFR Part 15C Part 15.245 & 15.209	PASSED
9. Duty cycle	47 CFR Part 15C Part 15.35(c)	NOT APPLICABLE[2]

[1] Spectrum investigated up to a frequency of 100GHz based on highest declared channel/ signal generated in equipment of 24.175 GHz.

[2] No limits apply. Duty cycle of test mode confirmed as 92.3 %.

4 Specifications

The tests were performed and operated in accordance with Kiwa Electrical Compliance procedures and the relevant standards listed below.

4.1 Relevant standards

Ref.	Standard Number	Version	Description
4.1.1	47 CFR Part 15C	2023	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.

5 Tests, methods and results

5.1 AC power line conducted emissions

5.1.1 Test methods

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

5.1.2 Configuration of EUT

The EUT was placed on a wooden table 0.8m above the ground plane and an off the shelf mains power supply was connected to a LISN via a 1m mains cable. A 120 VAC 60 Hz power source was used to provide mains power. The EUT was connected to a laptop PC via an Ethernet cable.

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

In a pre-test the EUT was assessed in all modes, it was found that there was no discernible difference between modes/stopped frequencies and therefore for final test the EUT was operated in TX MID mode.

5.1.3 Test procedure

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

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

Tests were performed in Test Site F.

5.1.4 Test equipment

E150, E035, ZSW1, E642, E856, TMS937, TMS938

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	24075-24175 MHz
Power Level	Power setting 2
Channel Spacing	Single channel
Mod Scheme	FMCW (Stopped)
Mid Channel	24125 MHz

Plot refs
14250-1 Cond 1 AC Live 150k-30M Average
14250-1 Cond 1 AC Live 150k-30M Quasi-Peak
14250-1 Cond 1 AC Neutral 150k-30M Average
14250-1 Cond 1 AC Neutral 150k-30M Quasi-Peak

Table of signals measured for Cond 1 AC Live 150 kHz - 30MHz

Signal No.	Freq (MHz)	Peak Amp (dBuV)	QP Amp (dBuV)	QP -Lim (dB)	AV Amp (dBuV)	AV -Lim (dB)
1	0.162	43.1	38.5	-26.9	23.1	-32.3
2	0.375	38.7	34.5	-23.9	24.1	-24.3
3	0.539	35.5	29.2	-26.8	19.7	-26.3
4	0.911	35.9	30.6	-25.4	21.3	-24.7
5	1.014	35.1	30.6	-25.4	21.0	-25.0
6	1.014	33.6	30.2	-25.8	21.0	-25.0

Table of signals measured for Cond 1 AC Neutral 150 kHz - 30MHz

Signal No.	Freq (MHz)	Peak Amp (dBuV)	QP Amp (dBuV)	QP -Lim (dB)	AV Amp (dBuV)	AV -Lim (dB)
1	0.157	44.8	41.6	-24.0	34.8	-20.8
2	0.248	40.3	37.4	-24.4	23.4	-28.4
3	0.378	39.9	36.8	-21.5	23.9	-24.4
4	0.632	38.1	33.9	-22.1	20.8	-25.2

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

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 15.209/15.245 [Reference 4.1.1 of this report]

5.2.2 Configuration of EUT

The EUT was placed on a 0.8 metres high turntable. The front edge of the EUT was initially positioned facing the antenna. The EUT was measured at a distance of 3 metres. The EUT was rotated in all three orthogonal planes. Radiated Emissions testing was performed whilst powered from a 12 Volt battery and charger.

In a pre-test the EUT was assessed in all modes, it was found that there was no discernible difference between modes/stopped frequencies and therefore for final test the EUT was operated in TX MID mode.

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

Band	24075-24175 MHz
Power Level	Power setting 2
Channel Spacing	Single channel
Mod Scheme	FMCW (Stopped)
Mid channel	24125 MHz

Plot refs
14250-1 Rad 1 9k-150kHz Para
14250-1 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. No signals were observed within 25dB of limits.

LIMITS:
15.209 limits are applicable in the restricted bands of 15.205 with the relevant detector.
15.245() other emissions, outside the intentional band, must be attenuated by at least 50dB from the level of the fundamental or meet the general limits of 15.209 whichever is the lesser attenuation.
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 15.209/15.245 [Reference 4.1.1 of this report]

5.3.2 Configuration of EUT

The EUT was placed on a 0.8 metres high turntable. The front edge of the EUT was initially positioned facing the antenna. The EUT was measured at a distance of 3 metres. The EUT was rotated in all three orthogonal planes. Radiated Emissions testing was performed whilst powered from a 12 Volt battery and charger.

In a pre-test the EUT was assessed in all modes, it was found that there was no discernible difference between modes/stopped frequencies and therefore for final test the EUT was operated in TX MID mode.

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

Band	24075-24175 MHz
Power Level	Power setting 2
Channel Spacing	Single channel
Mod Scheme	FMCW (Stopped)
Mid channel	24125 MHz

Plot refs
14250-1 Rad 1 150k-30MHz Para
14250-1 Rad 1 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. No signals were observed within 25dB of limits.

LIMITS:
15.209 limits are applicable in the restricted bands of 15.205 with the relevant detector.
15.245() other emissions, outside the intentional band, must be attenuated by at least 50dB from the level of the fundamental or meet the general limits of 15.209 whichever is the lesser attenuation.
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 15.245 & 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 15.209/15.245 [Reference 4.1.1 of this report]

5.4.2 Configuration of EUT

The EUT was placed on a 0.8 metres high turntable. The front edge of the EUT was initially positioned facing the antenna. The EUT was measured at a distance of 3 metres. The EUT was rotated in all three orthogonal planes. Radiated Emissions testing was performed whilst powered from a 12 Volt battery and charger.

In a pre-test the EUT was assessed in all modes, it was found that there was no discernible difference between modes/stopped frequencies and therefore for final test the EUT was operated in TX MID mode.

5.4.3 Test procedure

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

LPE364, E743, NSA-M, ZSW1, E624, E411

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

Band	24075-24175 MHz
Power Level	Power setting 2
Channel Spacing	Single channel
Mod Scheme	FMCW (Stopped)
Mid channel	24125 MHz

Plot refs
14250-1 Rad 1 VHF Horiz
14250-1 Rad 1 VHF Vert
14250-1 Rad 1 UHF Horiz
14250-1 Rad 1 UHF Vert

Table of signals measured for Rad 1 Horizontal Sig List

Signal No.	Freq (MHz)	Peak Amp (dBuV/m)	QP Amp (dBuV/m)	QP -Lim (dB)
1	119.995	35.5	33.3	-10.2
2	199.989	40.0	38.6	-4.9
3	254.997	35.1	33.1	-12.9
4	271.997	39.1	38.0	-8.0
5	288.997	37.0	34.9	-11.1
6	305.996	41.8	40.8	-5.2
7	339.996	37.5	36.0	-10.0
8	407.995	36.0	33.9	-12.1
9	441.995	42.3	41.0	-5.0
10	639.997	42.6	40.7	-5.3
11	968.436	45.6	39.7	-14.3

Table of signals measured for Rad 1 Vertical Sig List

Signal No.	Freq (MHz)	Peak Amp (dBuV/m)	QP Amp (dBuV/m)	QP -Lim (dB)
1	120.002	33.7	30.9	-12.6
2	200.001	36.6	35.1	-8.4
3	271.997	34.5	32.8	-13.2
4	288.997	36.1	34.5	-11.5
5	305.996	42.3	41.5	-4.5
6	339.996	38.7	37.5	-8.5
7	407.995	36.4	33.6	-12.4
8	441.995	41.0	39.4	-6.6
9	964.810	47.6	43.6	-10.4

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

LIMITS:
15.209 limits are applicable in the restricted bands of 15.205 with the relevant detector.
15.245() other emissions, outside the intentional band, must be attenuated by at least 50dB 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 15.245 & 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 15.245 & 15.209 [Reference 4.1.1 of this report]

5.5.2 Configuration of EUT

The EUT was placed on a 1.5 metres high turntable. The front edge of the EUT was initially positioned facing the antenna. The EUT was measured at a distance of 3 metres. The EUT was rotated in all three orthogonal planes. Radiated Emissions testing was performed whilst powered from a 12 Volt battery and charger.

The EUT was operated in TX LOW, TX MID and TX HIGH modes.

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 scanned and used at heights where the whole of the EUT was contained within the main beam, and emissions were maximised. 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, 0.3m was used in the test range 18 - 40GHz and 0.1m was used in test range 40 – 100 GHz.

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

Tests were performed using Test Site M.

5.5.4 Test equipment

E136, E296-2, E296-4, E296-5, E330, E411, E503, E520, E580, E624, E718, E755, F230, F231, H070, H071, TMS82

See Section 9 for more details

5.5.5 Test results

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

Setup Table

Band	24075-24175 MHz
Power Level	Power setting 2
Channel Spacing	Single channel
Mod Scheme	FMCW (Stopped)
Low channel	24.089 GHz

Spurious Frequency (MHz)	Measured Peak Level (dBµV/m)	Difference to Peak Limit (dB)	Measured Average Level (dBµV/m)	Difference to Average Limit (dB)	EUT Polarisation	Antenna Polarisation
1002.986	43.8	-30.2	38.5	-15.5	Upright	Horizontal
2133.304	52.3	-34.8	49.4	-17.7	Upright	Horizontal
12044.762	53.4	-20.6	49.8	-4.2	Upright	Vertical
12044.764	54.2	-19.8	51.1	-2.9	Upright	Horizontal
23689.504	58.6	-15.4	52.3	-1.7	Upright	Horizontal
23889.63	56.3	-17.7	46.2	-7.8	Upright	Horizontal
24039.488	68.7	-18.4	64.1	-3	Upright	Horizontal
48178	52.2	-34.9	48.5	-18.6	Upright	Vertical
48178	56.5	-30.6	55.3	-11.8	Side	Horizontal

Setup Table

Band	24075-24175 MHz
Power Level	Maximum
Channel Spacing	Power setting 2
Mod Scheme	FMCW (Stopped)
Mid channel	24.125 GHz

Spurious Frequency (MHz)	Measured Peak Level (dBµV/m)	Difference to Peak Limit (dB)	Measured Average Level (dBµV/m)	Difference to Average Limit (dB)	EUT Polarisation	Antenna Polarisation
1002.986	43.8	-30.2	38.5	-15.5	Upright	Horizontal
2133.304	52.3	-34.8	49.4	-17.7	Upright	Horizontal
12062.259	54.5	-19.5	51.6	-2.4	Upright	Horizontal
12062.26	53.3	-20.7	49.7	-4.3	Side	Vertical
23689.5	58.6	-15.4	52.3	-1.7	Upright	Horizontal
23689.53	58.6	-15.4	52.3	-1.7	Upright	Horizontal
24489.5	59.3	-27.8	52.4	-14.7	Upright	Horizontal
48250	54.0	-33.1	49	-18.1	Upright	Vertical
48250	55.9	-31.2	52.3	-14.8	Side	Horizontal

Plots
14250-1 Rad 1 1-2GHz Horiz
14250-1 Rad 1 1-2GHz Vert
14250-1 Rad 1 2-5GHz Horiz
14250-1 Rad 1 2-5GHz Vert
14250-1 Rad 1 5-6GHz Horiz
14250-1 Rad 1 5-6GHz Vert
14250-1 Rad 1 6upto10GHz Horiz
14250-1 Rad 1 6upto10GHz Vert
14250-1 Rad 2 10upto12_5GHz Horiz
14250-1 Rad 2 10upto12_5GHz Vert
14250-1 Radiated Emissions Mid channel 12.5 - 15 GHz Horizontal
14250-1 Radiated Emissions Mid channel 12.5 - 15 GHz Vert
14250-1 Radiated Emissions Mid channel 15- 18 GHz Horizontal
14250-1 Radiated Emissions Mid channel 15- 18 GHz Horizontal
14250-1 Radiated Emissions Mid channel 18 - 23 GHz Vert
14250-1 Radiated Emissions Mid channel 18 - 23 GHz Horizontal
14250-1 Rad 2 Mid channel 23 - 24.05 GHz Vert
14250-1 Rad 2 Mid channel 23 - 24.05 GHz Horiz
14250-1 Rad 2 Mid channel 24.2 - 26.5 GHz Vert
14250-1 Rad 2 Mid channel 24.2 - 26.5 GHz Horiz
14250-1 TX Radiated emissions, Mid channel 26.5 - 30 GHz Horizontal
14250-1 TX Radiated emissions, Mid channel 26.5 - 30 GHz Vertical
14250-1 TX Radiated emissions, Mid channel 30 - 35 GHz Horizontal
14250-1 TX Radiated emissions, Mid channel 30 - 35 GHz Vertical
14250-1 TX Radiated emissions, Mid channel 35 - 40 GHz Horizontal
14250-1 TX Radiated emissions, Mid channel 35 - 40 GHz Vertical
14250-1 TX Radiated emissions, Mid channel 40 - 45 GHz Horizontal
14250-1 TX Radiated emissions, Mid channel 40 - 45 GHz Vertical
14250-1 TX Radiated emissions, Mid channel 45 - 50 GHz Horizontal
14250-1 TX Radiated emissions, Mid channel 45 - 50 GHz Vertical
14250-1 TX Radiated emissions, Mid channel 50 - 55 GHz Horizontal
14250-1 TX Radiated emissions, Mid channel 50 - 55 GHz Vertical
14250-1 TX Radiated emissions, Mid channel 55 - 60 GHz Horizontal
14250-1 TX Radiated emissions, Mid channel 55 - 60 GHz Vertical
14250-1 TX Radiated emissions, Mid channel 60 - 65 GHz Horizontal

14250-1 TX Radiated emissions, Mid channel 60 - 65 GHz Vertical
14250-1 TX Radiated emissions, Mid channel 65 - 70 GHz Horizontal
14250-1 TX Radiated emissions, Mid channel 65 - 70 GHz Vertical
14250-1 TX Radiated emissions, Mid channel 70 - 75 GHz Horizontal
14250-1 TX Radiated emissions, Mid channel 70 - 75 GHz Vertical
14250-1 TX Radiated emissions, Mid channel 75 - 80 GHz Horizontal
14250-1 TX Radiated emissions, Mid channel 75 - 80 GHz Vertical
14250-1 TX Radiated emissions, Mid channel 80 - 85 GHz Horizontal
14250-1 TX Radiated emissions, Mid channel 80 - 85 GHz Vertical
14250-1 TX Radiated emissions, Mid channel 85 - 90 GHz Horizontal
14250-1 TX Radiated emissions, Mid channel 85 - 90 GHz Vertical
14250-1 TX Radiated emissions, Mid channel 90 - 95 GHz Horizontal
14250-1 TX Radiated emissions, Mid channel 90 - 95 GHz Vertical
14250-1 TX Radiated emissions, Mid channel 95 - 100 GHz Horizontal
14250-1 TX Radiated emissions, Mid channel 95 - 100 GHz Vertical

Setup Table

Band	24075-24175 MHz
Power Level	Maximum
Channel Spacing	Power setting 2
Mod Scheme	FMCW (Stopped)
High channel	24.164 GHz

Spurious Frequency (MHz)	Measured Peak Level (dBµV/m)	Difference to Peak Limit (dB)	Measured Average Level (dBµV/m)	Difference to Average Limit (dB)	EUT Polarisation	Antenna Polarisation
1002.986	43.8	-30.2	38.5	-15.5	Upright	Horizontal
2133.304	52.3	-34.8	49.4	-17.7	Upright	Horizontal
12081.754	53.3	-20.7	49.6	-4.4	Upright	Horizontal
23763.5	59.5	-14.5	52.8	-1.2	Upright	Horizontal
23963.47	55.4	-18.6	45.4	-8.6	Upright	Horizontal
24213.478	67.5	-19.6	64.6	-2.5	Upright	Horizontal
24563.47	58.8	-28.3	51.9	-15.2	Upright	Horizontal
48328	51.1	-36.0	47.8	-19.3	Upright	Vertical
48328	55.4	-31.7	50.6	-16.5	Side	Horizontal

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 (FMCW stopped) 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.
15.245() other emissions, outside the intentional band, must be attenuated by at least 50dB 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 – 60 GHz ±3.9dB, 60 – 110 GHz ±4.4dB

5.6 Effective radiated power field strength

5.6.1 Test methods

Test Requirements: 47 CFR Part 15C Part 15.245(b) [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 15.245(b) & 15.209(a) [Reference 4.1.1 of this report]

5.6.2 Configuration of EUT

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

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. Plots were taken in the maximised field strength positions.

Tests were performed in test site M.

5.6.4 Test equipment

E136, E411, E624, TMS82

See Section 9 for more details

5.6.5 Test results

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

Band	24075-24175 MHz
Power Level	Power setting 2
Channel Spacing	Single channel
Mod Scheme	FMCW (stopped)
Low channel	24089 MHz
Mid channel	24125 MHz
High channel	24164 MHz

	Low channel	Mid channel	High channel
Peak Level (dBµV/m) @ 3m	117.5	117.4	117.1
Plot reference	14250-1 ERP LOW	14250-1 ERP MID	14250-1 ERP HIGH
Antenna Polarisation	Horiz	Horiz	Horiz
EUT Polarisation	Upright	Upright	Upright
Margin (dB)	-10.5	-10.6	-10.9

LIMITS:
15.245(b) 24075 – 24175 MHz, Maximum field strength of fundamental 2500 mV/m @ 3 metres (128 dBuV/m @ 3 metres)

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: ±3.9dB

5.7 Occupied bandwidth

5.7.1 Test methods

Test Requirements:	47 CFR Part 15C Part 15.215(c) [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 15.215(c) [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 FMCW mode.

5.7.3 Test procedure

Tests were made in accordance with FCC Part 15 using the measuring equipment noted below. A 1 MHz RBW, 3x VBW and max hold settings were used for the 20 dB bandwidth.

Tests were performed using Test Site M.

5.7.4 Test equipment

E755, E927, F231, TMS82

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	101kPa

Band	24075-24175 MHz
Power Level	Power setting 2
Channel Spacing	Single channel
Mod Scheme	FMCW
Single channel	24129 MHz

	Low channel
20dB Bandwidth (MHz) at Nominal Temp & Volts	80.673
Plot for 20dB bandwidth	14250-1 OBW
FLOW (MHz)	24086.512
FHIGH (MHz)	24167.186
Low band edge Frequency (MHz)	24075
High band edge Frequency (MHz)	24175
Remains within Band	YES

LIMITS:
The 20dB bandwidth of the emission must be contained within the designated frequency band (24.075 – 24.175 GHz).

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 %

5.8 Band Edge Compliance

5.8.1 Test methods

Test Requirements:	47 CFR Part 15C Part 15.245 & 15.209 [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 15.209/15.245 [Reference 4.1.1 of this report]

5.8.2 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 TX LOW, TX MID, TX HIGH and FMCW modes.

5.8.3 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. Maximum fundamental Field strength results were used to determine the 50dBc emissions level per 15.245(b)(3).

Tests were performed using Test Site M.

5.8.4 Test equipment

E136, E411, E624, TMS82

See Section 9 for more details

5.8.5 Test results

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

Band	24075-24175 MHz
Power Level	Power setting 2
Channel Spacing	Single channel
Mod Scheme	FMCW
Single channel	24125 MHz

Max Field strength measured for 50dBc limit (dBuV/m @3m)	117.5
50dB below fundamental level (Average limit, dBuV/m @3m)	67.5
Peak limit 20dB above Average limit, dBuV/m @3m	87.5

Authorised Band Edge	Low channel	High channel
Peak Level (dBµV/m @3m)	79.6	83.1
Authorised Band Edge Plot reference	14250-1 Band Edge sweeping - PEAK	
Average Level (dBµV/m @3m)	55.7	56.6
Average Plot reference	14250-1 Band Edge sweeping - AVERAGE	

Restricted Band Edge	Low channel	High channel
Restricted Band Edge Plot reference	Please refer to radiated emission plots	

Band	24075-24175 MHz
Power Level	Power setting 2
Channel Spacing	Single channel
Mod Scheme	FMCW
Low channel	24089 MHz
High channel	24164 MHz

Max Field strength measured for 50dBc limit (dBuV/m @3m)	117.5
50dB below fundamental level (Average limit, dBuV/m @3m)	67.5
Peak limit 20dB above Average limit, dBuV/m @3m	87.5

Authorised Band Edge	Low channel	High channel
Peak Level (dBµV/m @3m)	80.7	82.0
Authorised Band Edge Plot reference	14250-1 BAND EDGE - PEAK- STOPPED PWR 2	
Average Level (dBµV/m @3m)	61.1	63.8
Average Plot reference	14250-1 BAND EDGE - AVERAGE - STOPPED PWR 2	

Restricted Band Edge	Low channel	High channel
Restricted Band Edge Plot reference	Please refer to radiated emission plots	

LIMITS:
Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in § 15.209, whichever is the lesser attenuation.

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

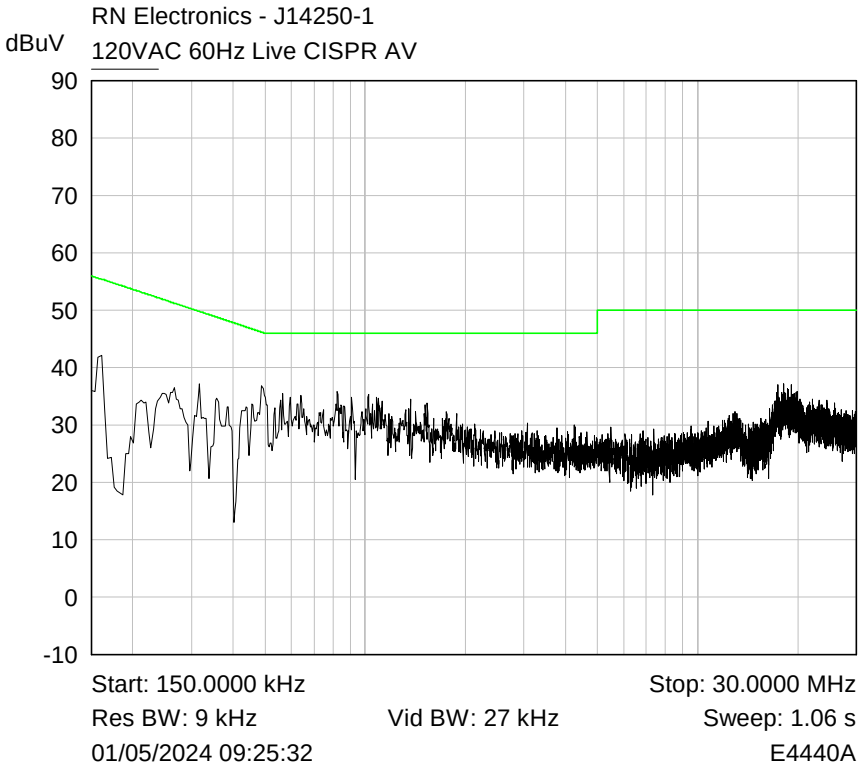
5.9 Duty cycle

NOT APPLICABLE: No limits apply.

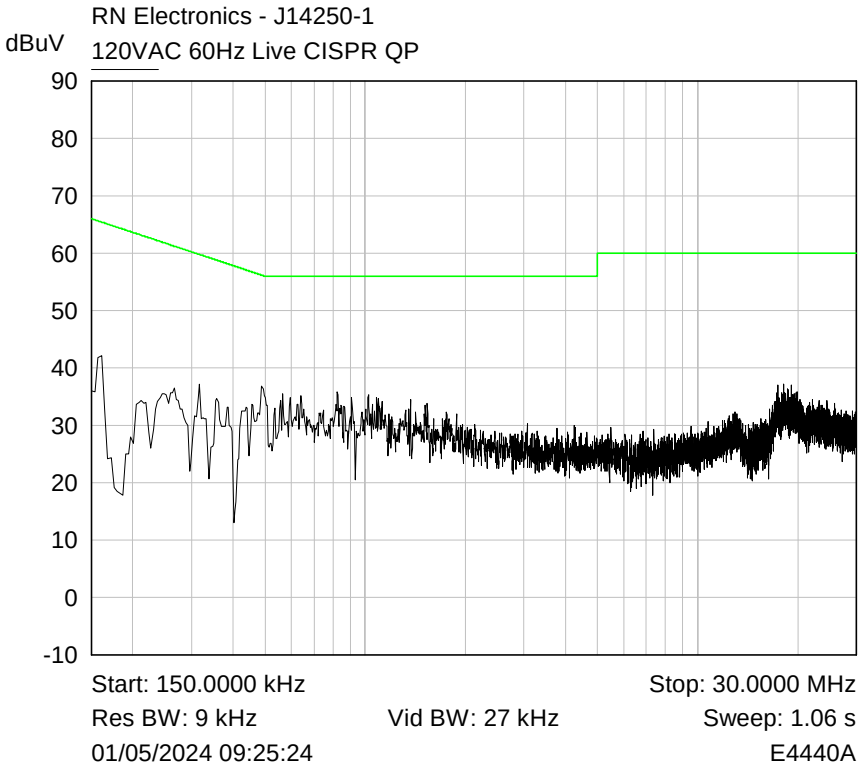
6 Plots/Graphical results

6.1 AC power line conducted emissions

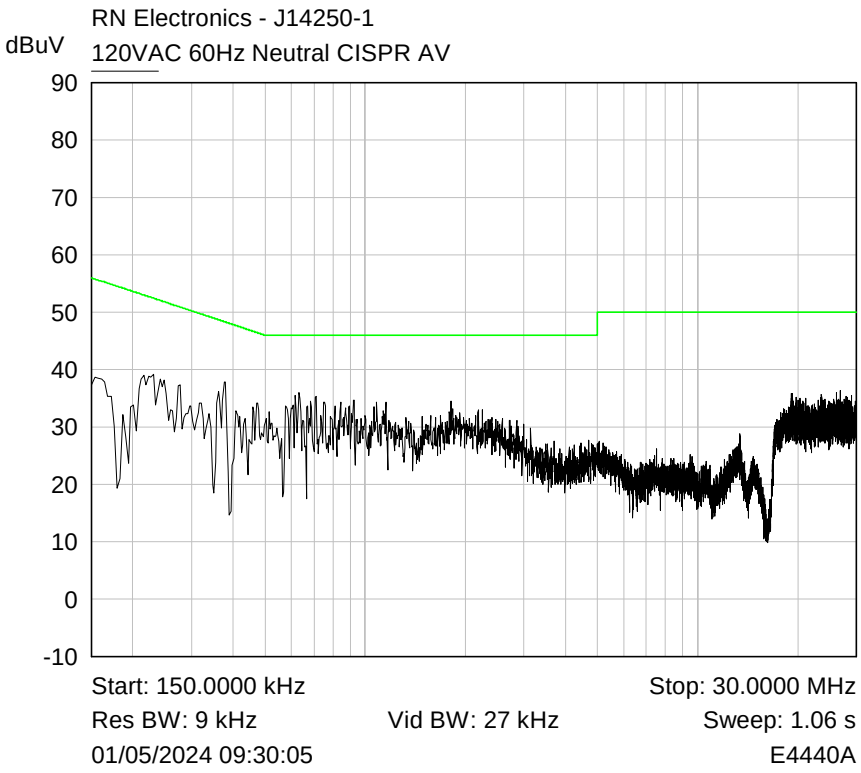
RF Parameters: Band 24075-24175 MHz, Power setting 2, Single channel, Modulation FMCW, Channel 24125 MHz



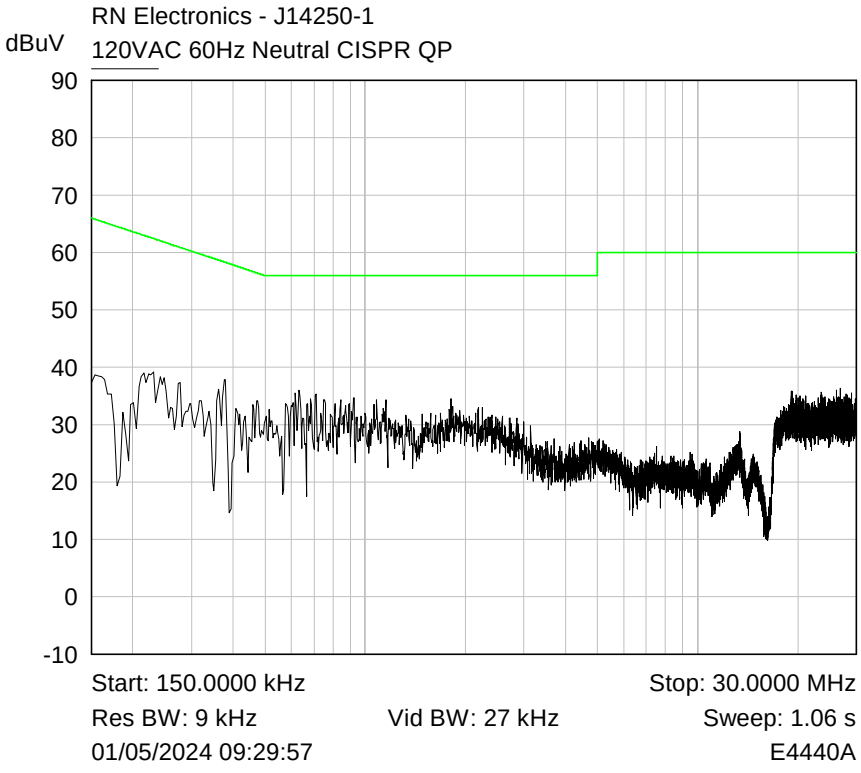
Plot of Live150k-30M Average



Plot of Live150k-30M Quasi-Peak



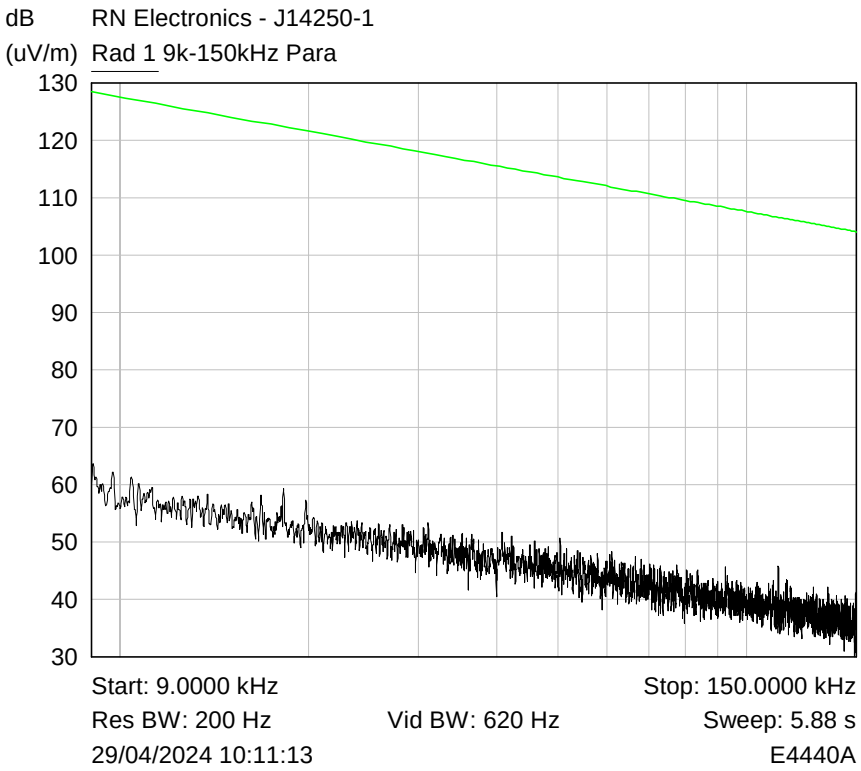
Plot of Neutral150k-30M Average



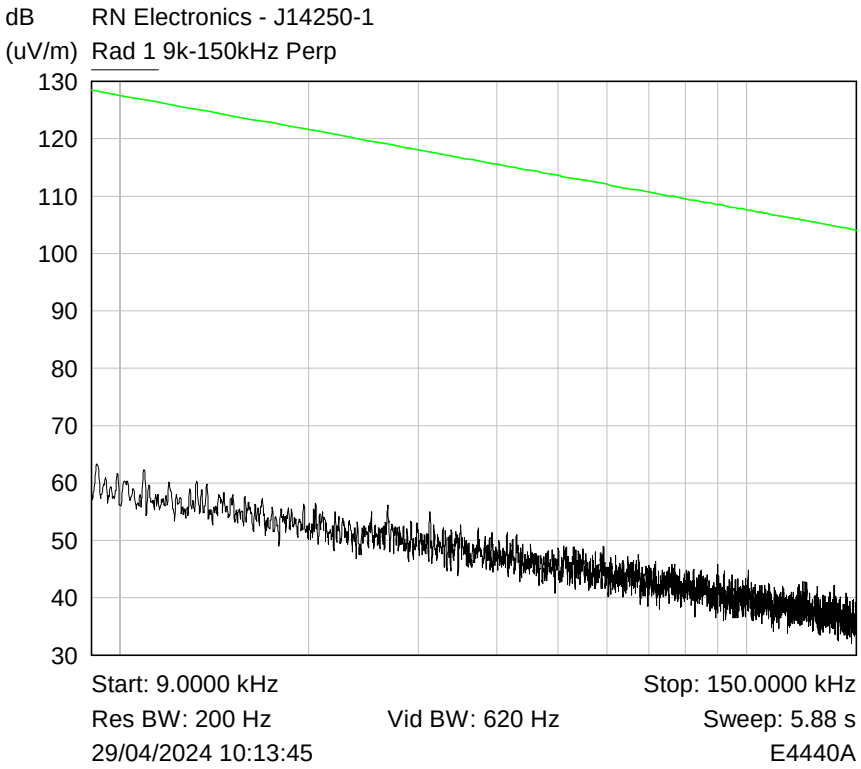
Plot of Neutral150k-30M Quasi-Peak

6.2 Radiated emissions 9 - 150 kHz

RF Parameters: Band 24075-24175 MHz, Power setting 2, Single channel, Modulation FMCW, Channel 24125 MHz



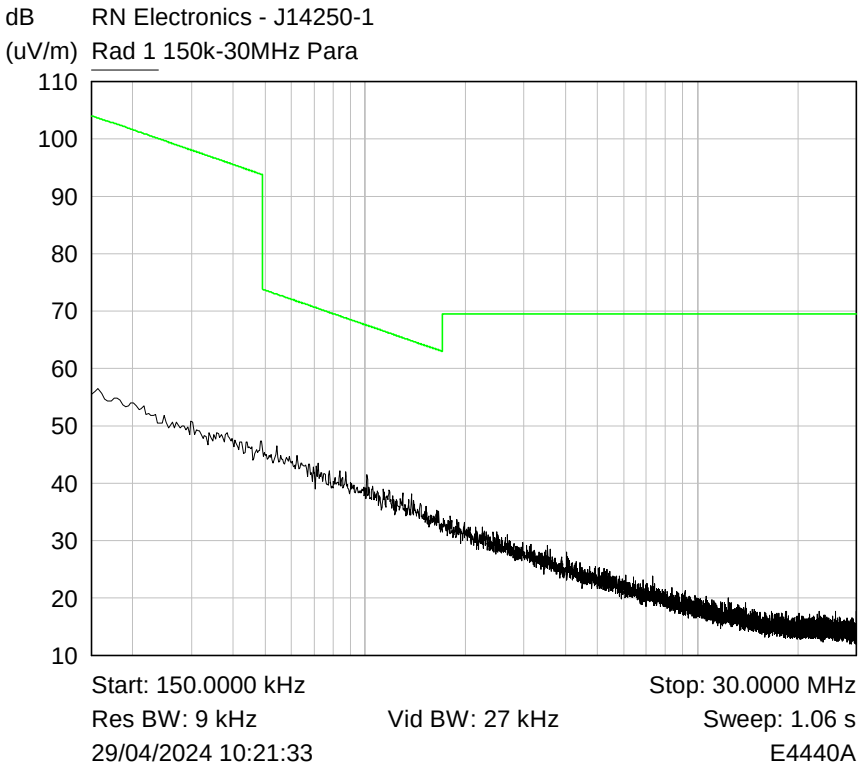
Plot of 9k-150kHz Parallel



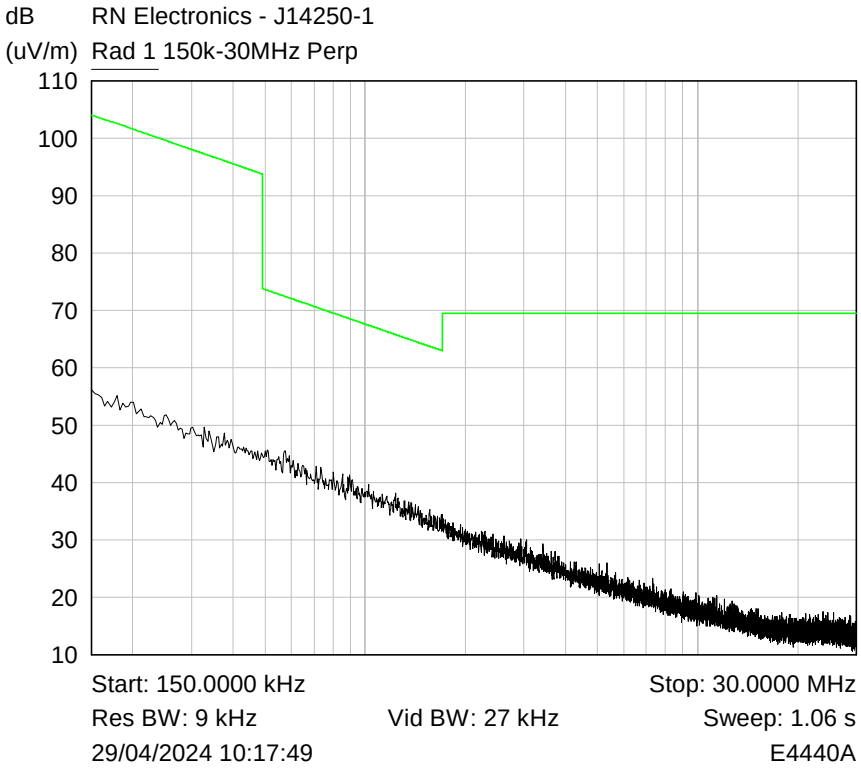
Plot of 9k-150kHz Perpendicular

6.3 Radiated emissions 150 kHz - 30 MHz

RF Parameters: Band 24075-24175 MHz, Power setting 2, Single channel, Modulation FMCW, Channel 24125 MHz



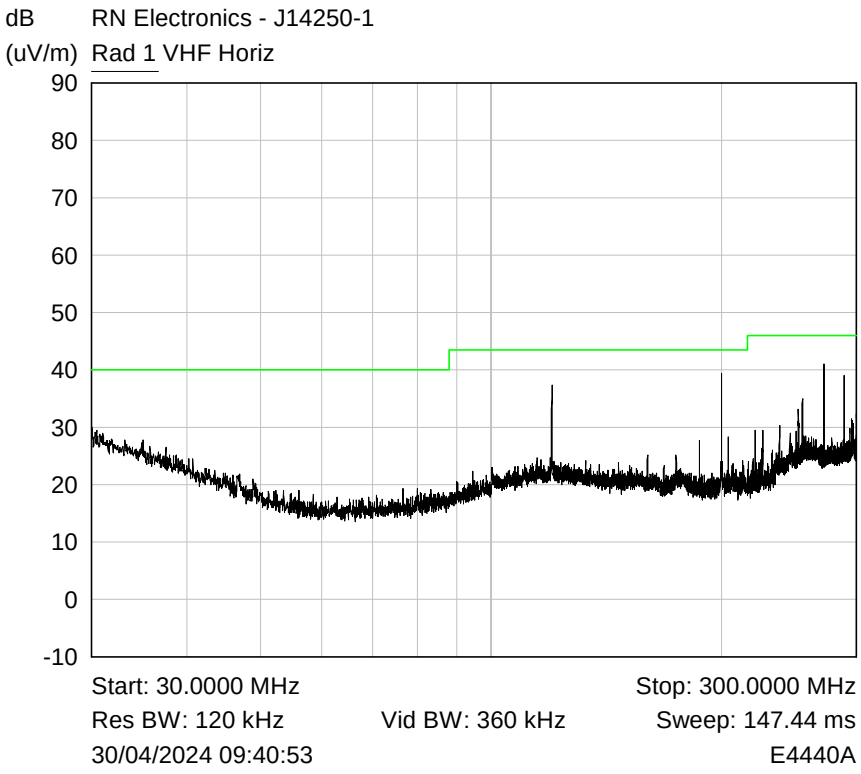
Plot of 150kHz-30MHz Parallel



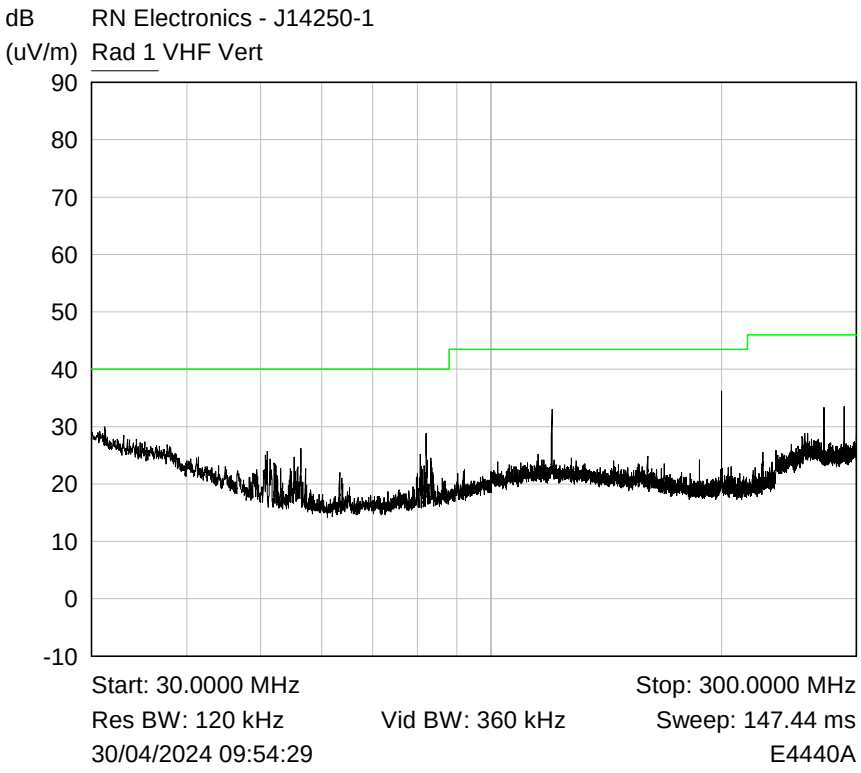
Plot of 150kHz-30MHz Perpendicular

6.4 Radiated emissions 30 MHz -1 GHz

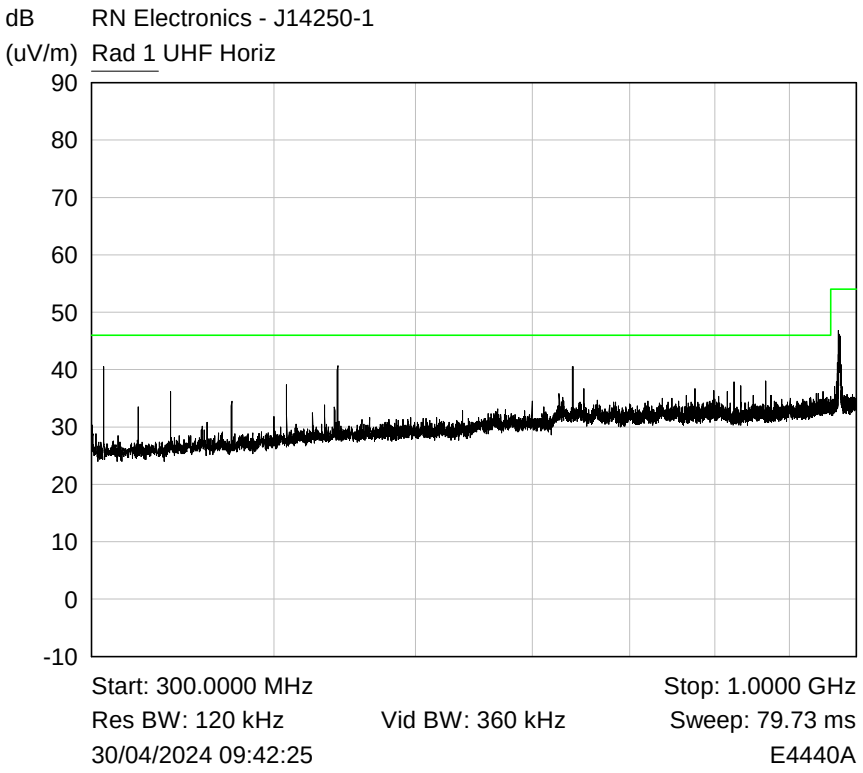
RF Parameters: Band 24075-24175 MHz, Power setting 2, Single channel, Modulation FMCW, Channel 24125 MHz



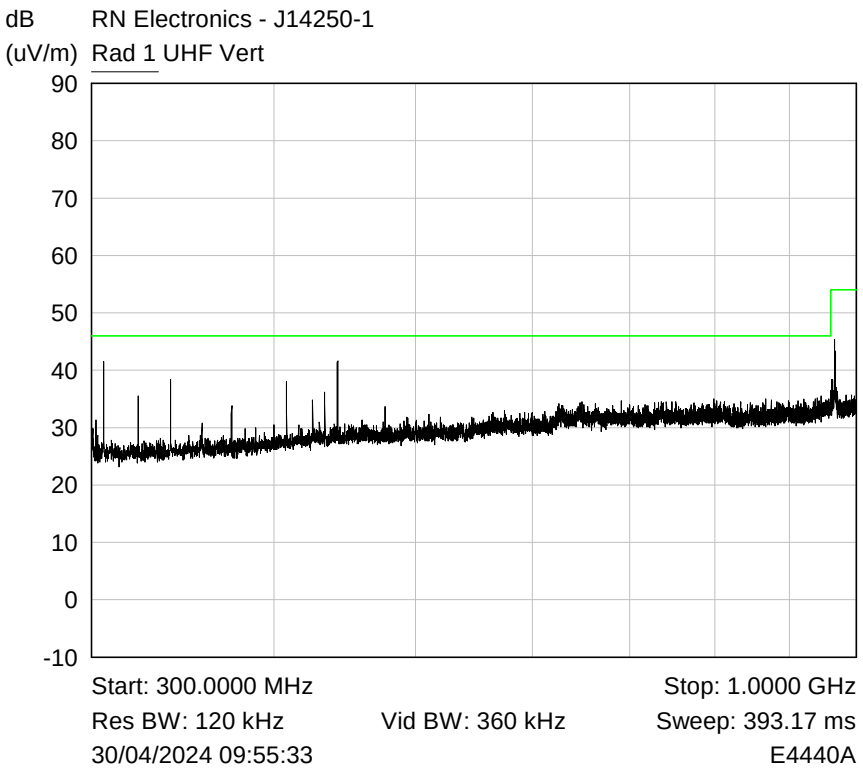
Plot of Peak emissions for VHF Horizontal against the QP limit line.



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



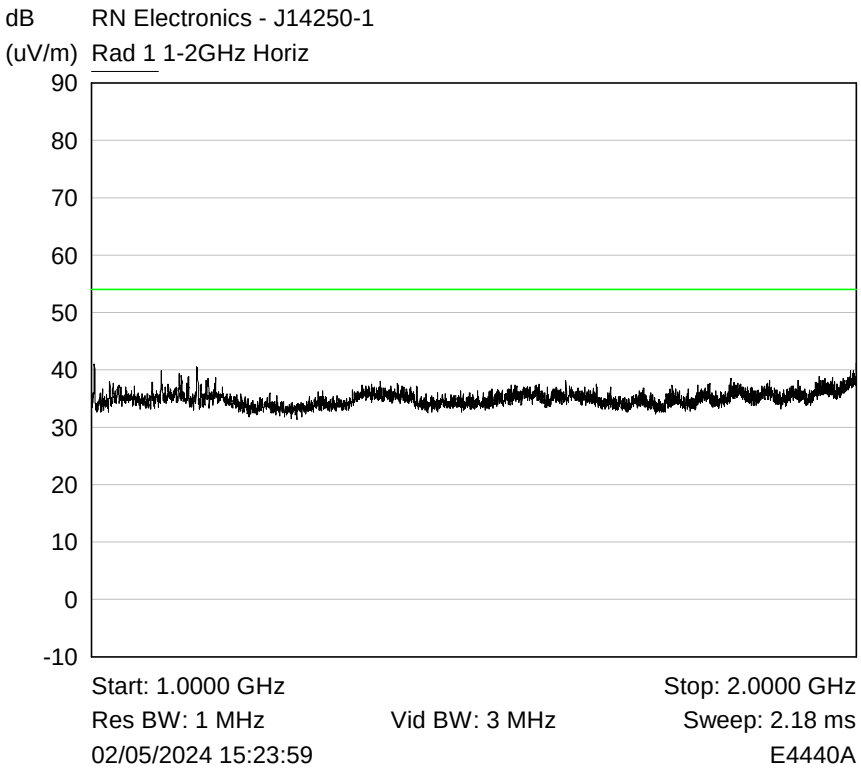
Plot of Peak emissions for UHF Horizontal against the QP limit line.

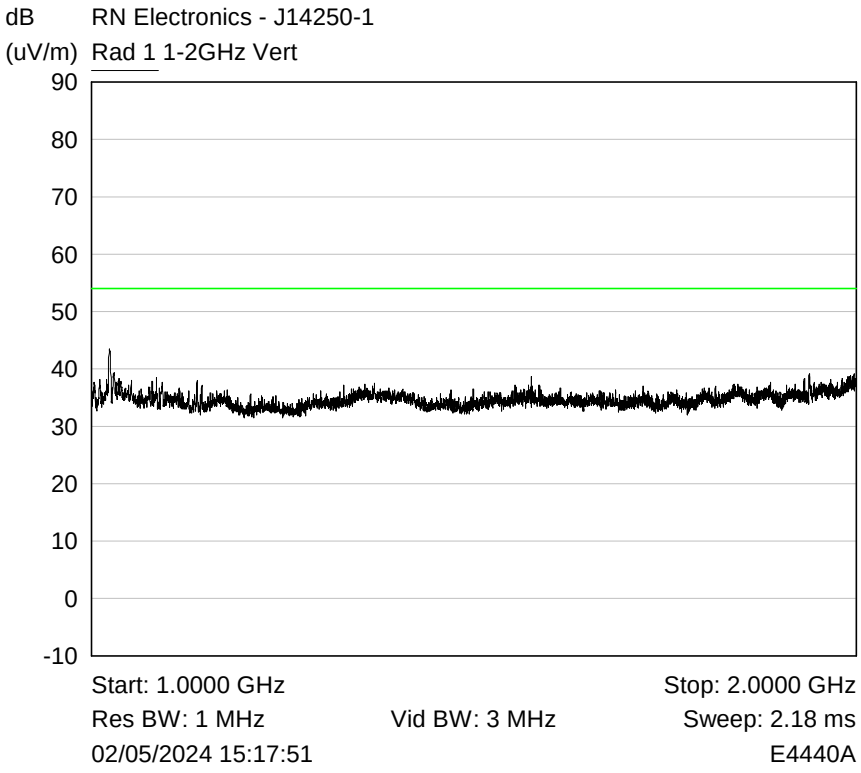


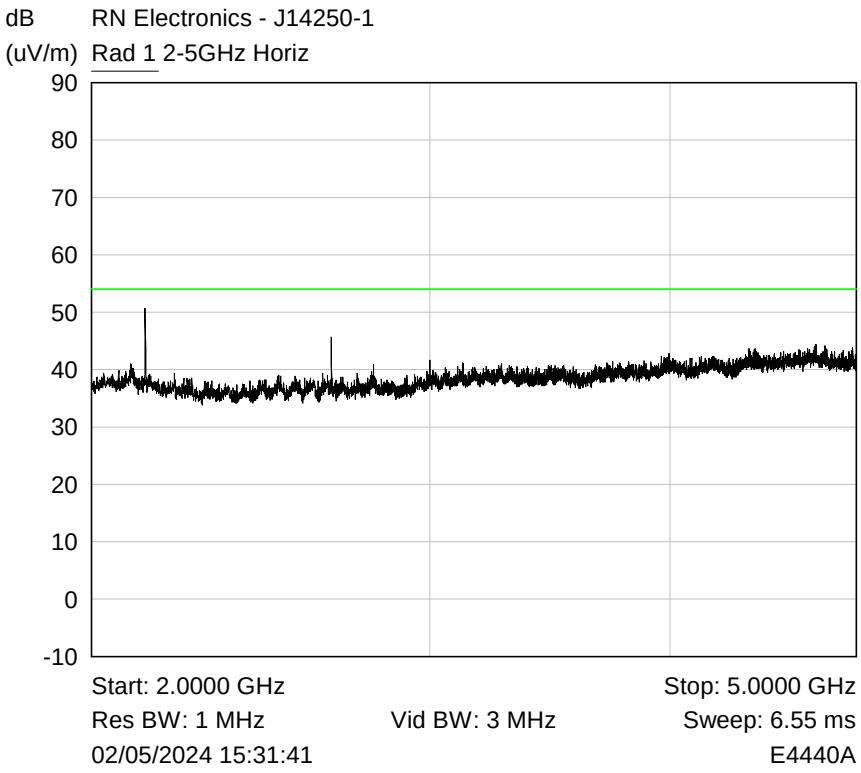
Plot of Peak emissions for UHF Vertical against the QP limit line.

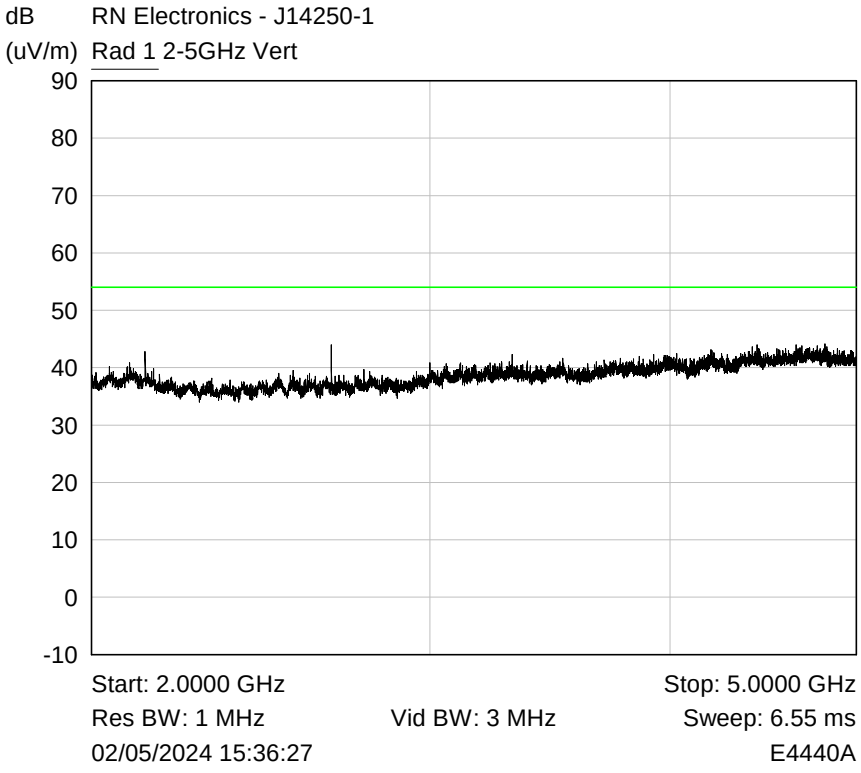
6.5 Radiated emissions above 1 GHz

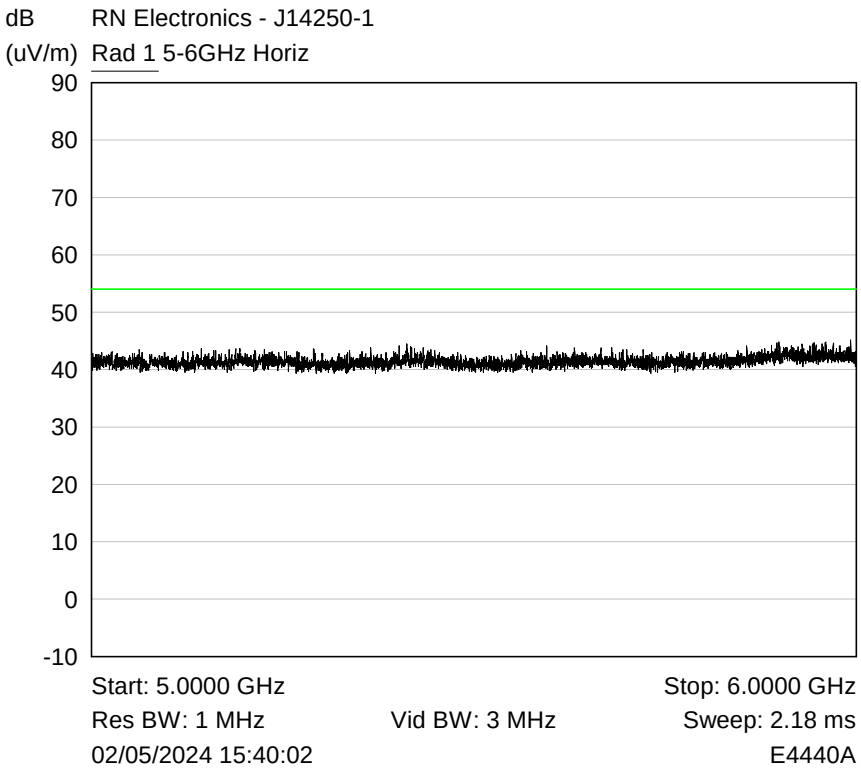
RF Parameters: Band 24075-24175 MHz, Power setting 2, Channel Spacing Power setting 2, Modulation FMCW, Channel 24.125 GHz

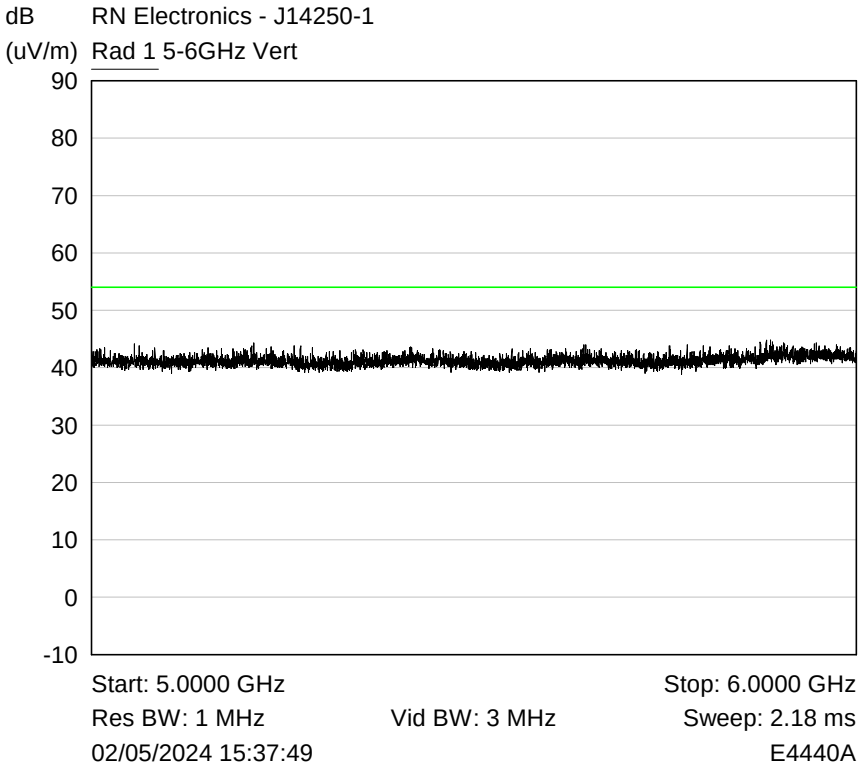


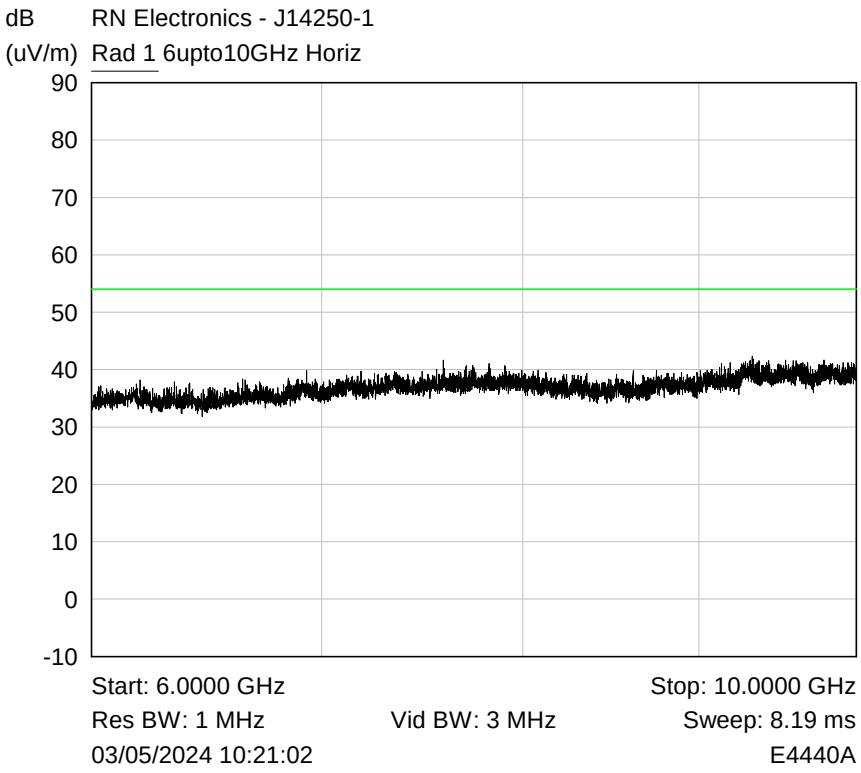


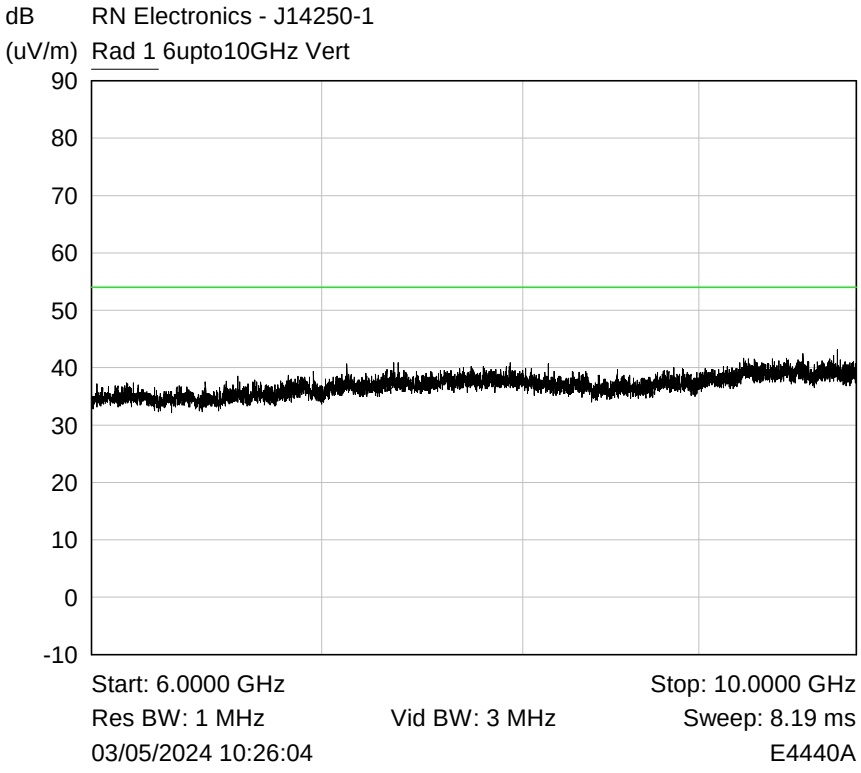

dB
(uV/m)
RN Electronics - J14250-1
Rad 1 2-5GHz Horiz
90
80
70
60
50
40
30
20
10
0
-10
Start: 2.0000 GHz
Stop: 5.0000 GHz
Res BW: 1 MHz
Vid BW: 3 MHz
Sweep: 6.55 ms
02/05/2024 15:31:41
E4440A

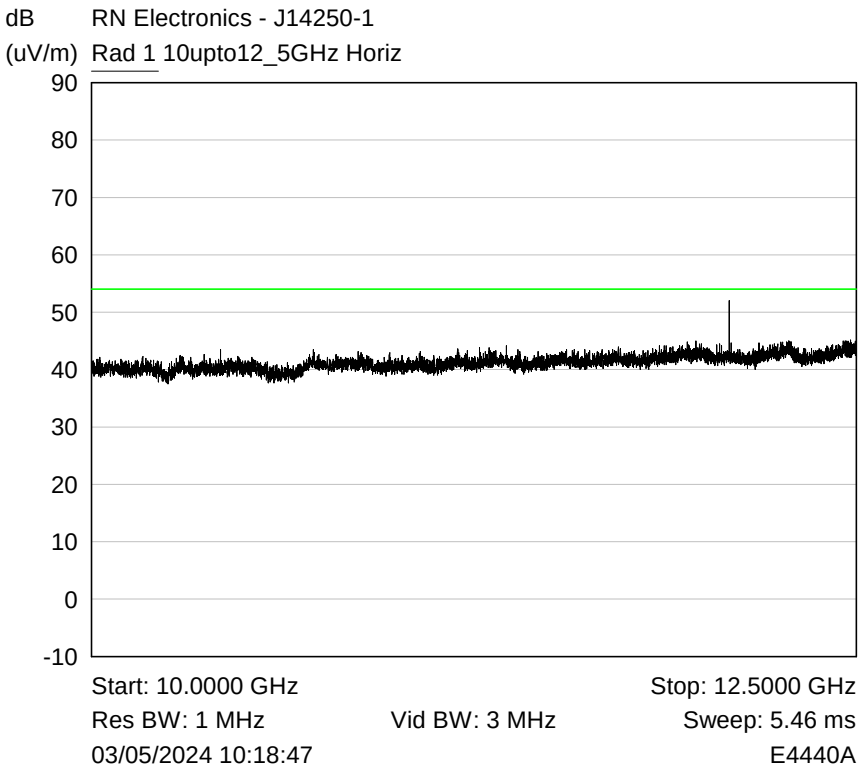

dB
(uV/m)
RN Electronics - J14250-1
Rad 1 2-5GHz Vert
90
80
70
60
50
40
30
20
10
0
-10
Start: 2.0000 GHz
Stop: 5.0000 GHz
Res BW: 1 MHz
Vid BW: 3 MHz
Sweep: 6.55 ms
02/05/2024 15:36:27
E4440A

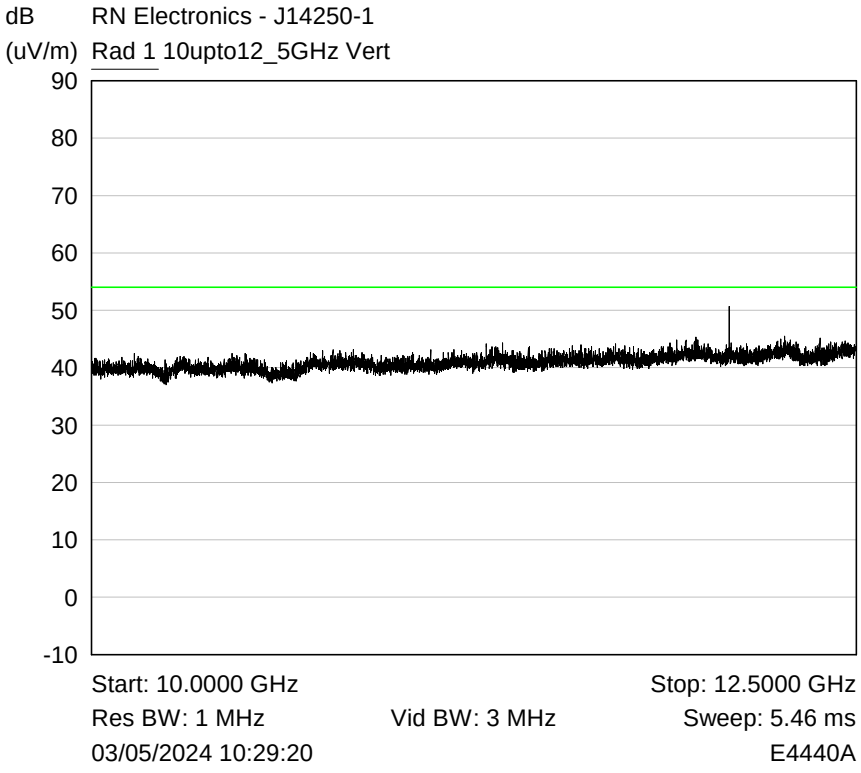

dB
(uV/m)
RN Electronics - J14250-1
Rad 1 5-6GHz Horiz
90
80
70
60
50
40
30
20
10
0
-10
Start: 5.0000 GHz
Stop: 6.0000 GHz
Res BW: 1 MHz
Vid BW: 3 MHz
Sweep: 2.18 ms
02/05/2024 15:40:02
E4440A

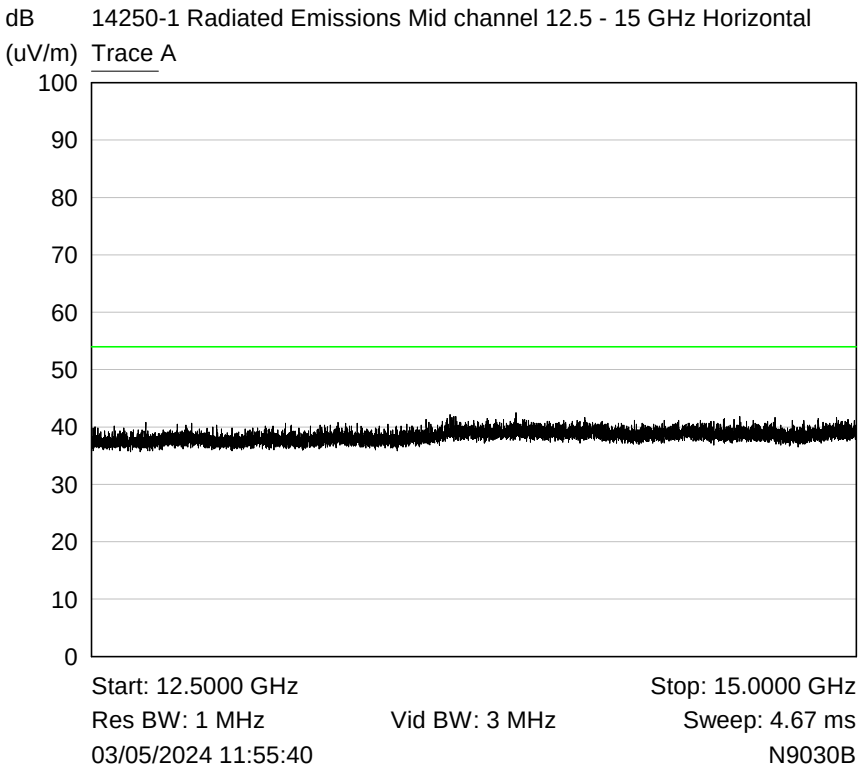

dB
(uV/m)
RN Electronics - J14250-1
Rad 1 5-6GHz Vert
90
80
70
60
50
40
30
20
10
0
-10
Start: 5.0000 GHz
Stop: 6.0000 GHz
Res BW: 1 MHz
Vid BW: 3 MHz
Sweep: 2.18 ms
02/05/2024 15:37:49
E4440A

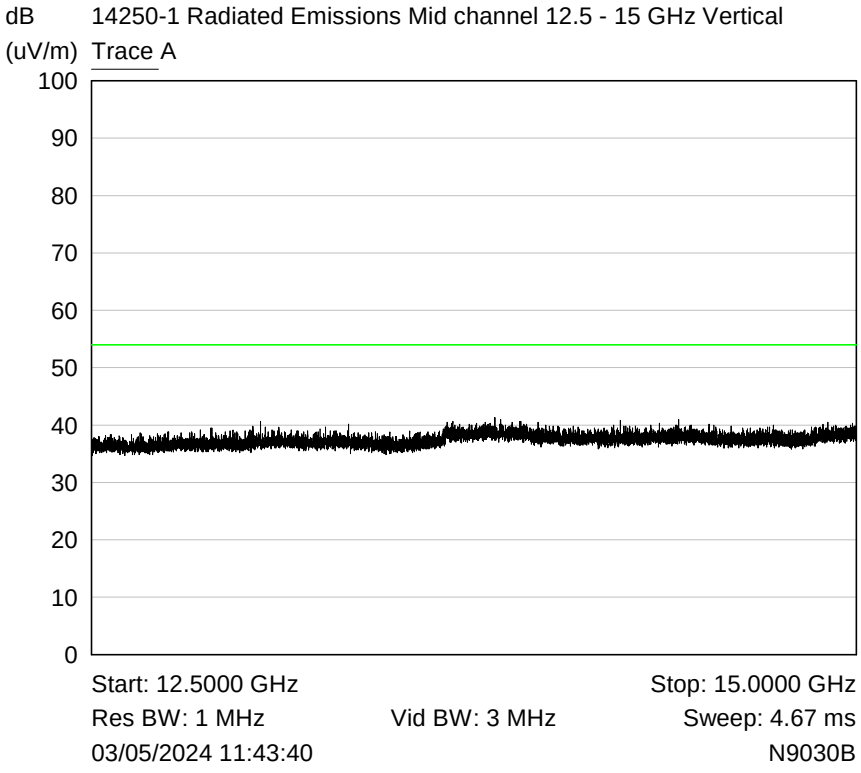

dB
(uV/m)
RN Electronics - J14250-1
Rad 1 6upto10GHz Horiz
90
80
70
60
50
40
30
20
10
0
-10
Start: 6.0000 GHz
Stop: 10.0000 GHz
Res BW: 1 MHz
Vid BW: 3 MHz
Sweep: 8.19 ms
03/05/2024 10:21:02
E4440A

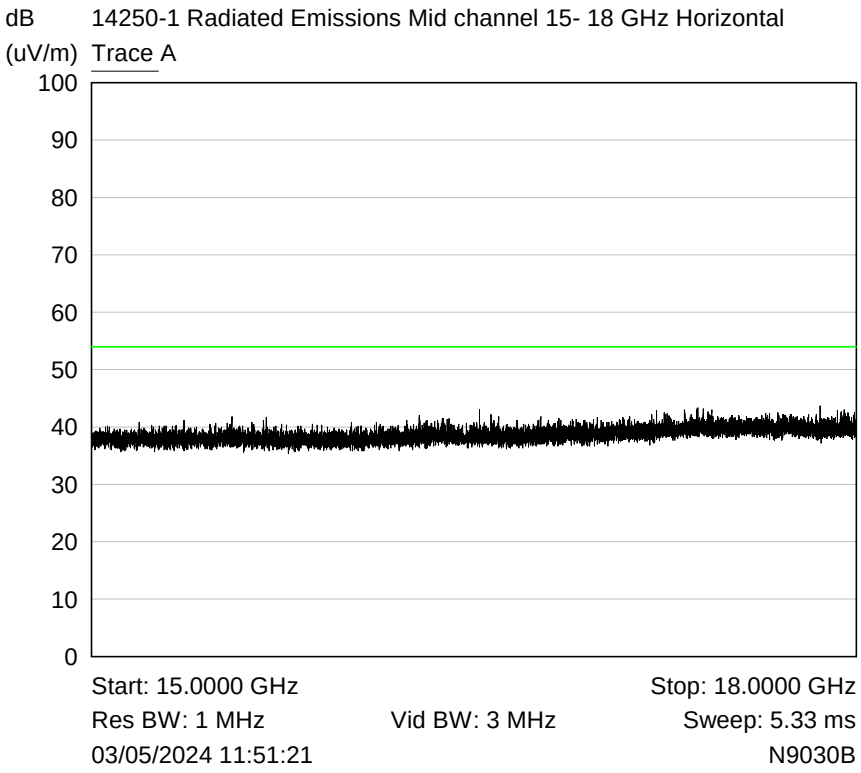

dB
(uV/m)
RN Electronics - J14250-1
Rad 1 6upto10GHz Vert
90
80
70
60
50
40
30
20
10
0
-10
Start: 6.0000 GHz
Stop: 10.0000 GHz
Res BW: 1 MHz
Vid BW: 3 MHz
Sweep: 8.19 ms
03/05/2024 10:26:04
E4440A

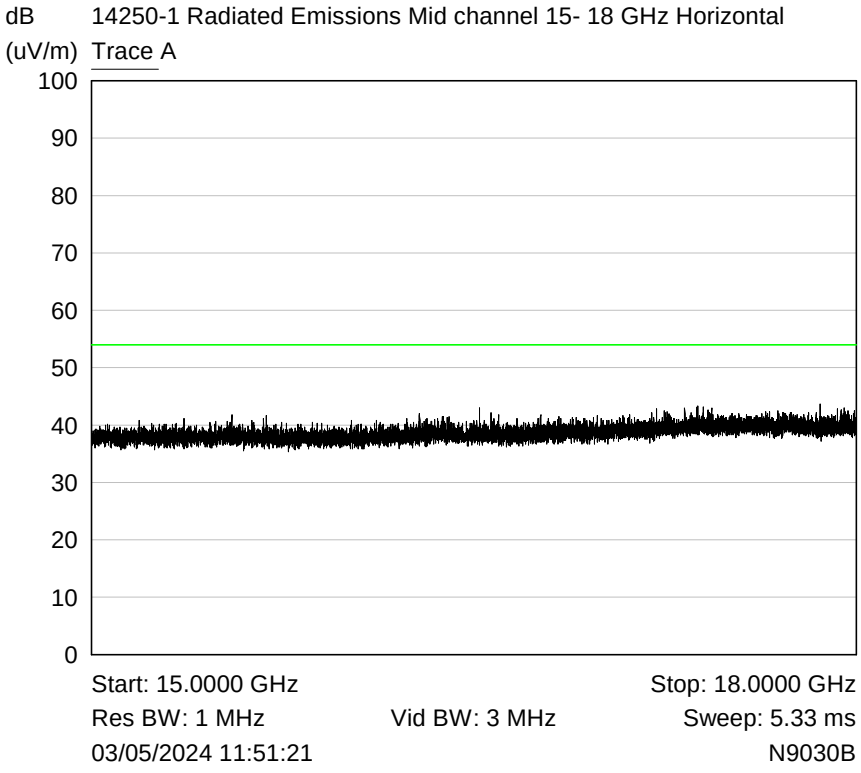

dB
(uV/m)
RN Electronics - J14250-1
Rad 1 10upto12_5GHz Horiz
90
80
70
60
50
40
30
20
10
0
-10
Start: 10.0000 GHz
Stop: 12.5000 GHz
Res BW: 1 MHz
Vid BW: 3 MHz
Sweep: 5.46 ms
03/05/2024 10:18:47
E4440A

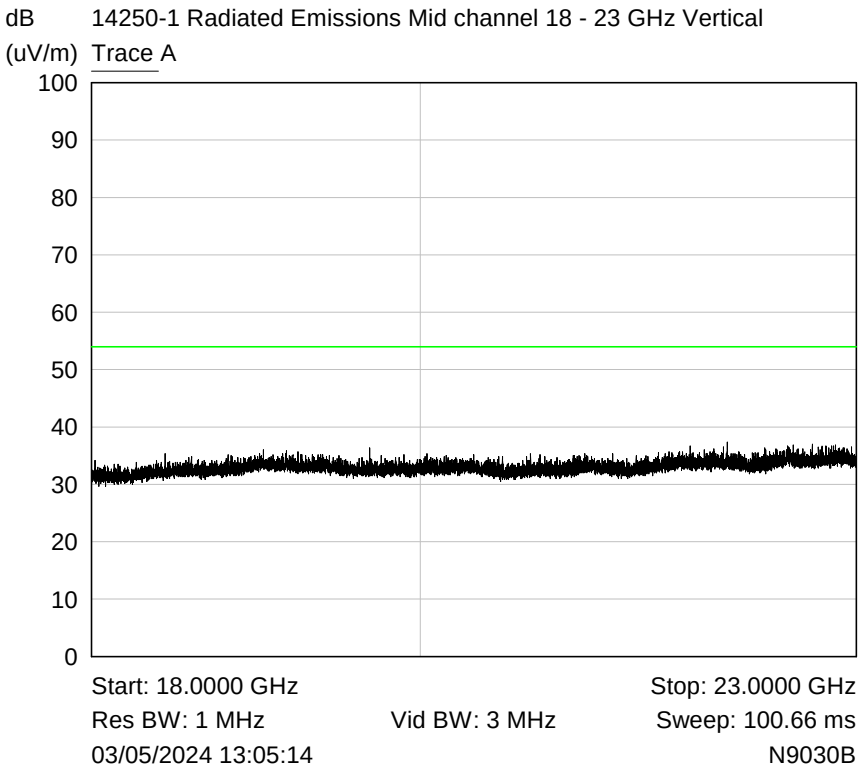

dB
(uV/m)
RN Electronics - J14250-1
Rad 1 10upto12_5GHz Vert
90
80
70
60
50
40
30
20
10
0
-10
Start: 10.0000 GHz
Stop: 12.5000 GHz
Res BW: 1 MHz
Vid BW: 3 MHz
Sweep: 5.46 ms
03/05/2024 10:29:20
E4440A

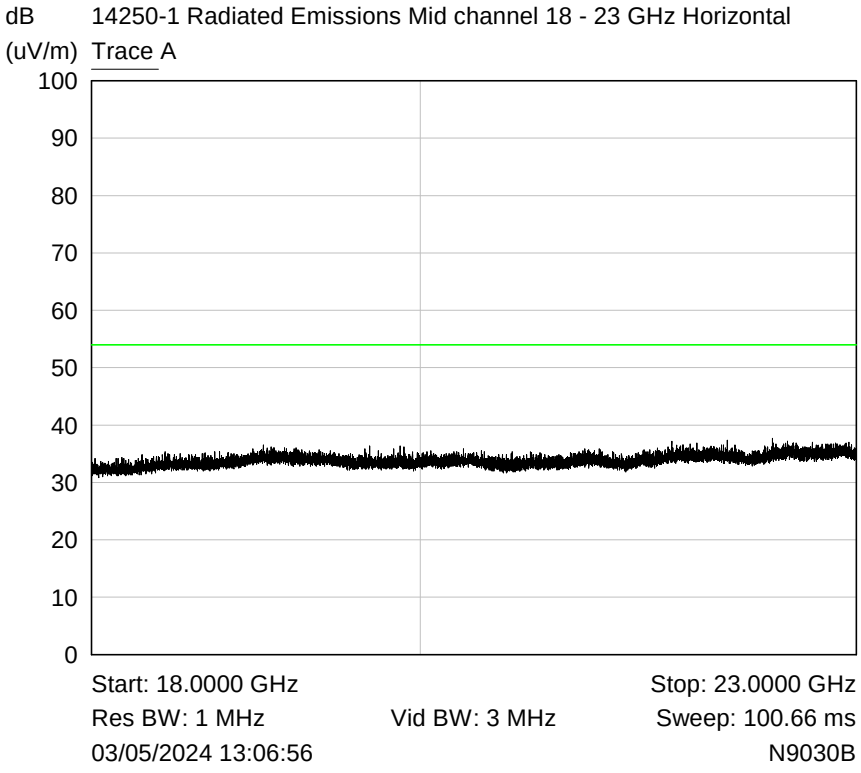


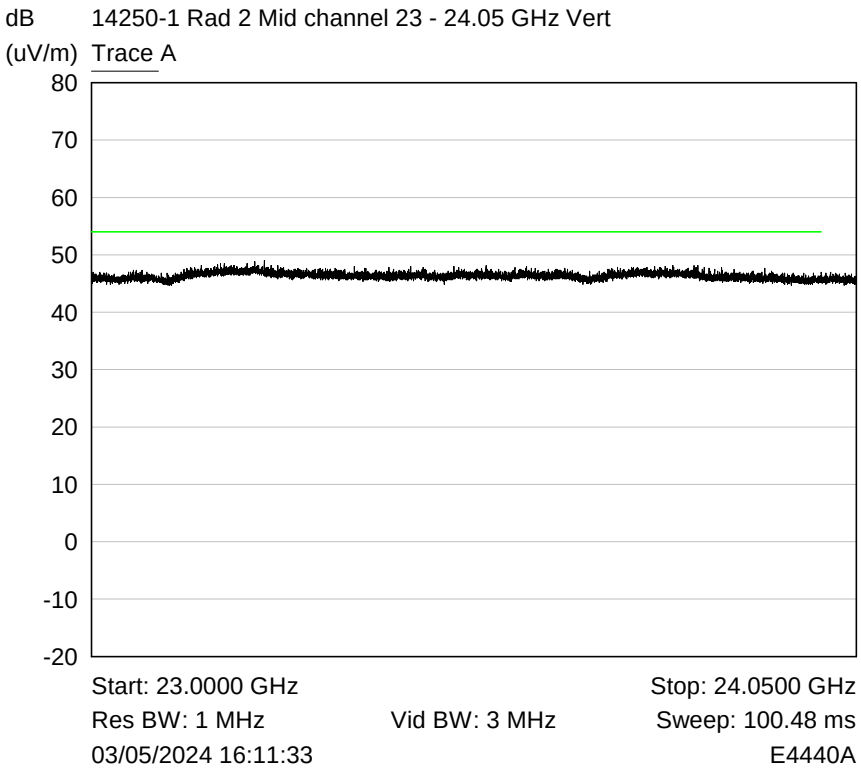


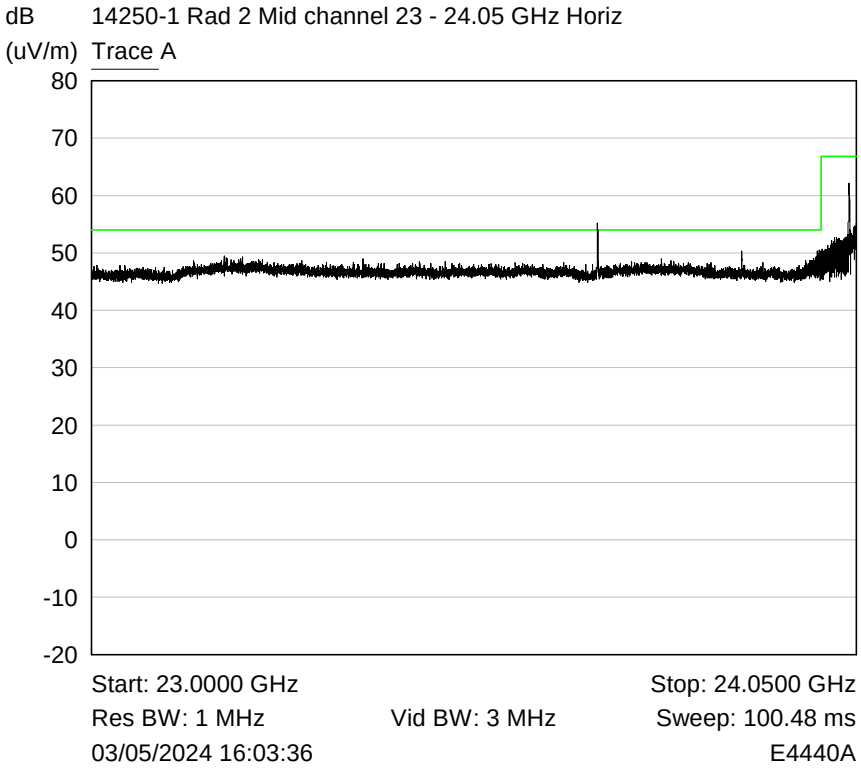


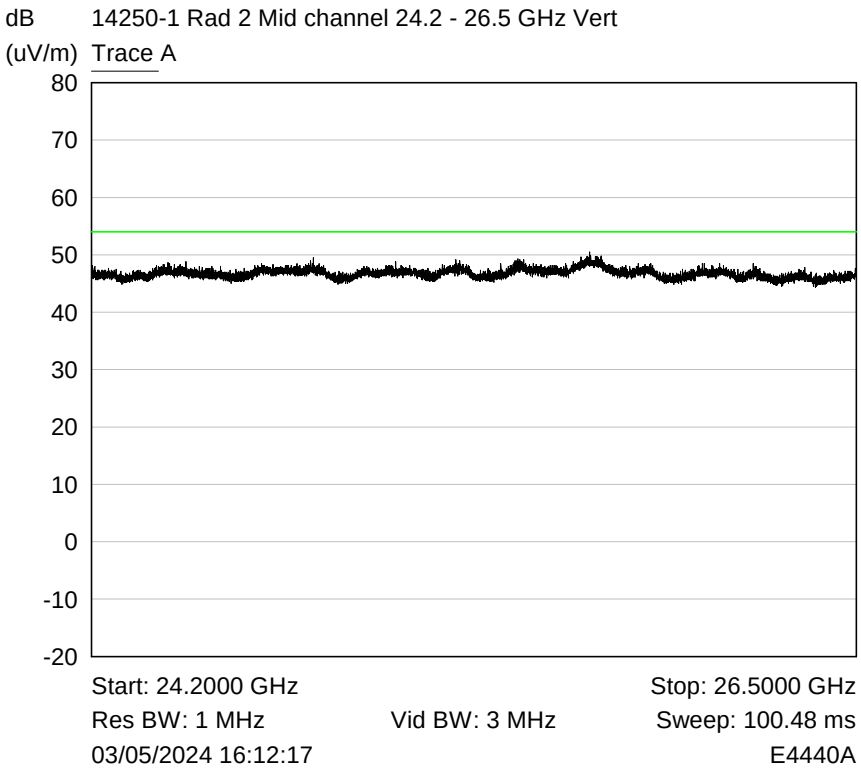


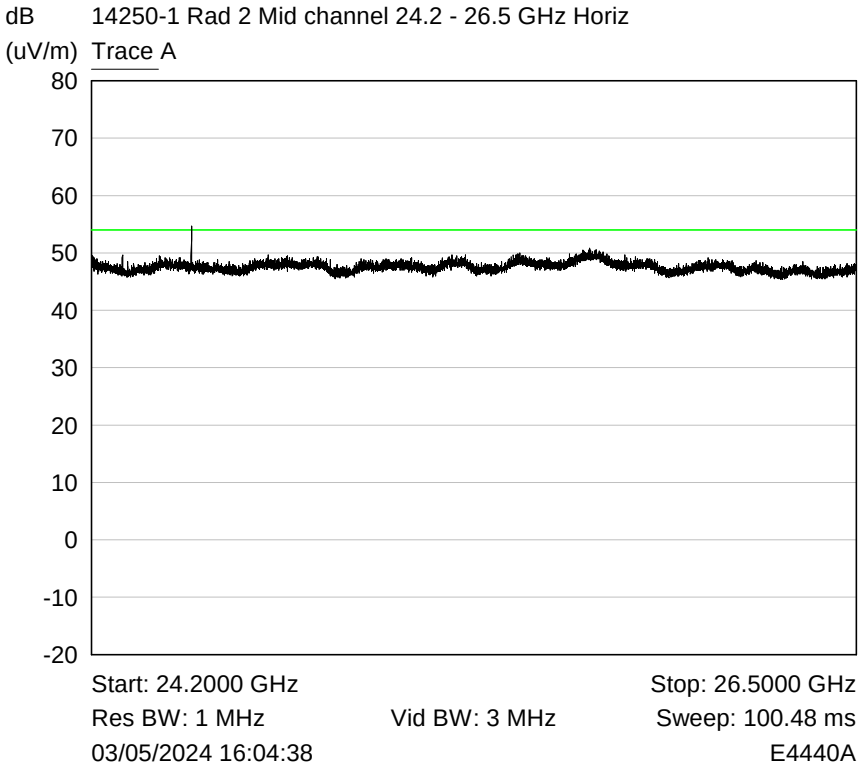

dB
(uV/m)
14250-1 Radiated Emissions Mid channel 18 - 23 GHz Vertical
Trace A
100
90
80
70
60
50
40
30
20
10
0
Start: 18.0000 GHz
Stop: 23.0000 GHz
Res BW: 1 MHz
Vid BW: 3 MHz
Sweep: 100.66 ms
03/05/2024 13:05:14
N9030B

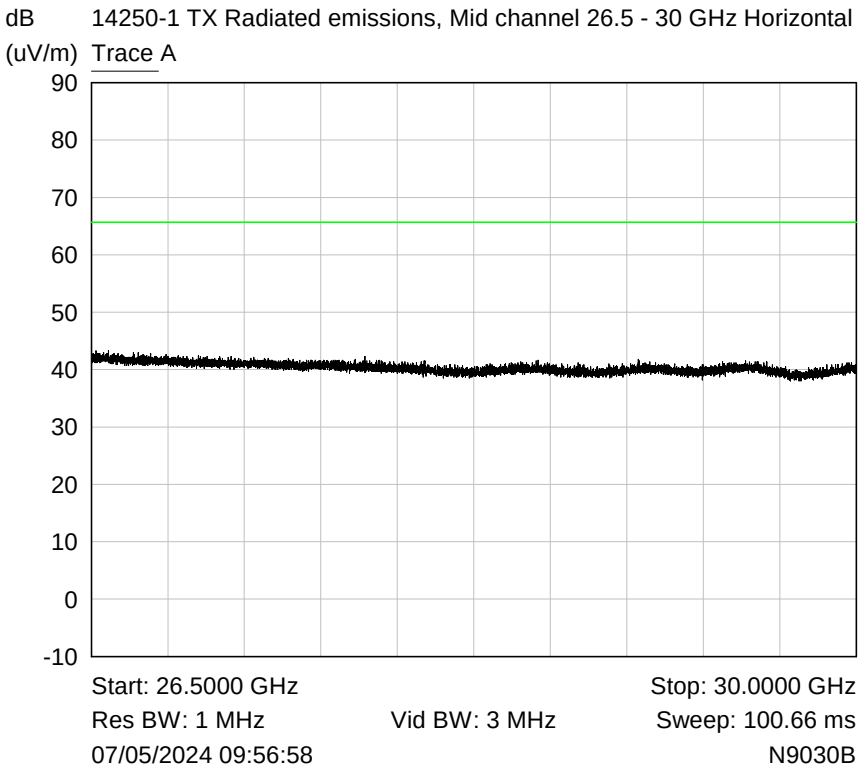

dB
(uV/m)
14250-1 Radiated Emissions Mid channel 18 - 23 GHz Horizontal
Trace A
100
90
80
70
60
50
40
30
20
10
0
Start: 18.0000 GHz
Stop: 23.0000 GHz
Res BW: 1 MHz
Vid BW: 3 MHz
Sweep: 100.66 ms
03/05/2024 13:06:56
N9030B

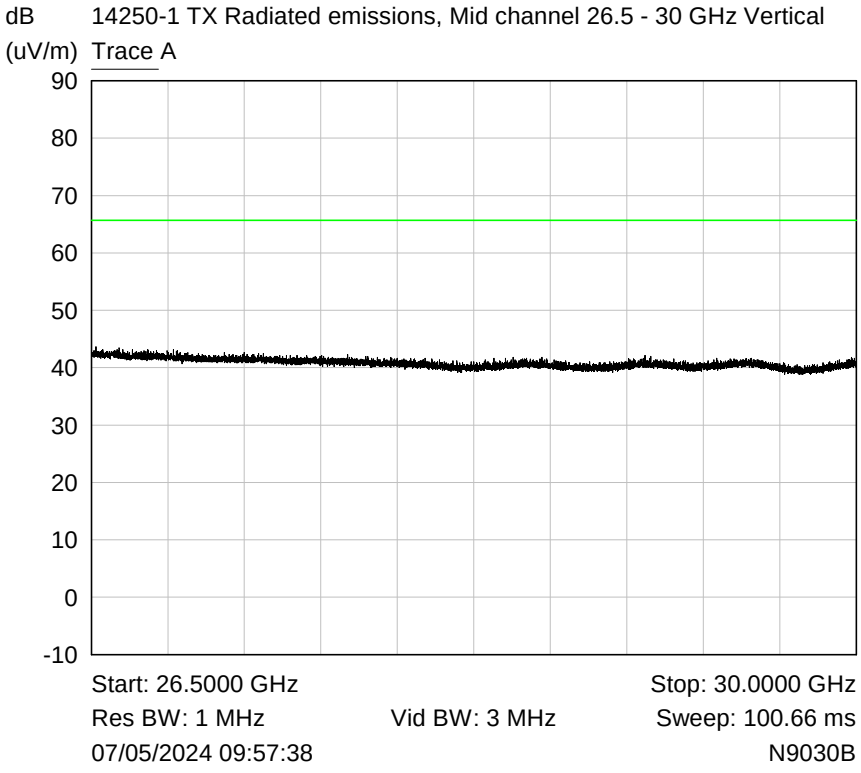

dB
(uV/m)
14250-1 Rad 2 Mid channel 23 - 24.05 GHz Vert
Trace A
80
70
60
50
40
30
20
10
0
-10
-20
Start: 23.0000 GHz
Stop: 24.0500 GHz
Res BW: 1 MHz
Vid BW: 3 MHz
Sweep: 100.48 ms
03/05/2024 16:11:33
E4440A

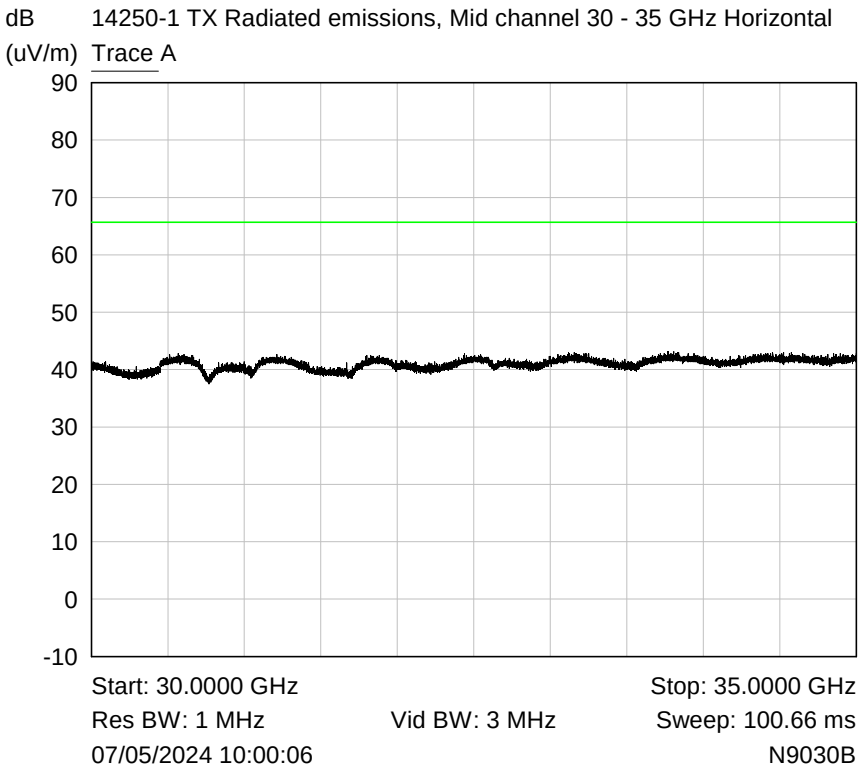

dB
(uV/m)
14250-1 Rad 2 Mid channel 23 - 24.05 GHz Horiz
Trace A
80
70
60
50
40
30
20
10
0
-10
-20
Start: 23.0000 GHz
Stop: 24.0500 GHz
Res BW: 1 MHz
Vid BW: 3 MHz
Sweep: 100.48 ms
03/05/2024 16:03:36
E4440A

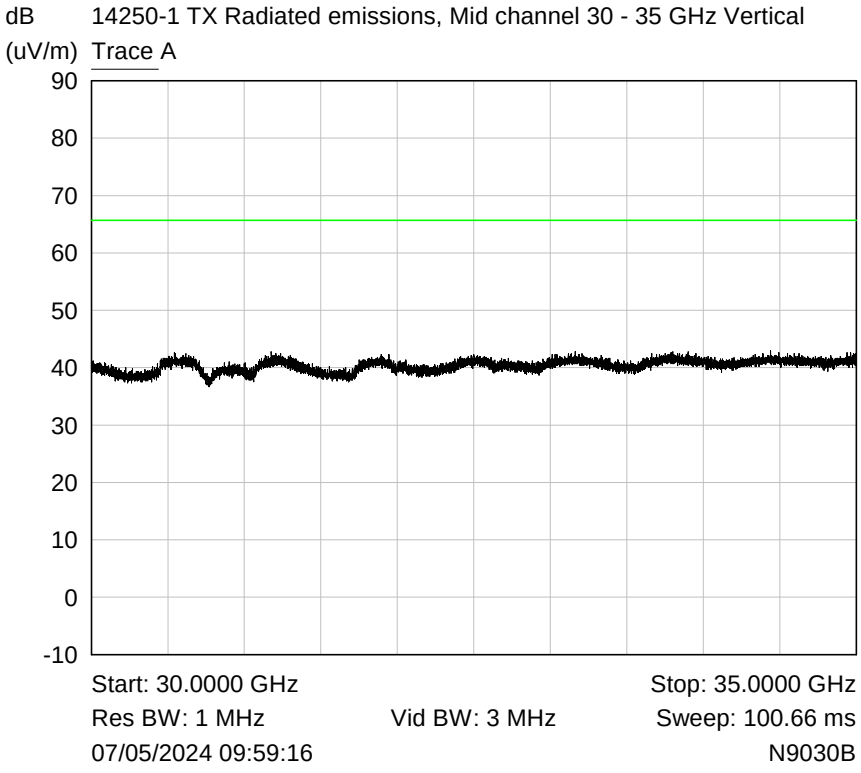

dB
(uV/m)
14250-1 Rad 2 Mid channel 24.2 - 26.5 GHz Vert
Trace A
80
70
60
50
40
30
20
10
0
-10
-20
Start: 24.2000 GHz
Stop: 26.5000 GHz
Res BW: 1 MHz
Vid BW: 3 MHz
Sweep: 100.48 ms
03/05/2024 16:12:17
E4440A

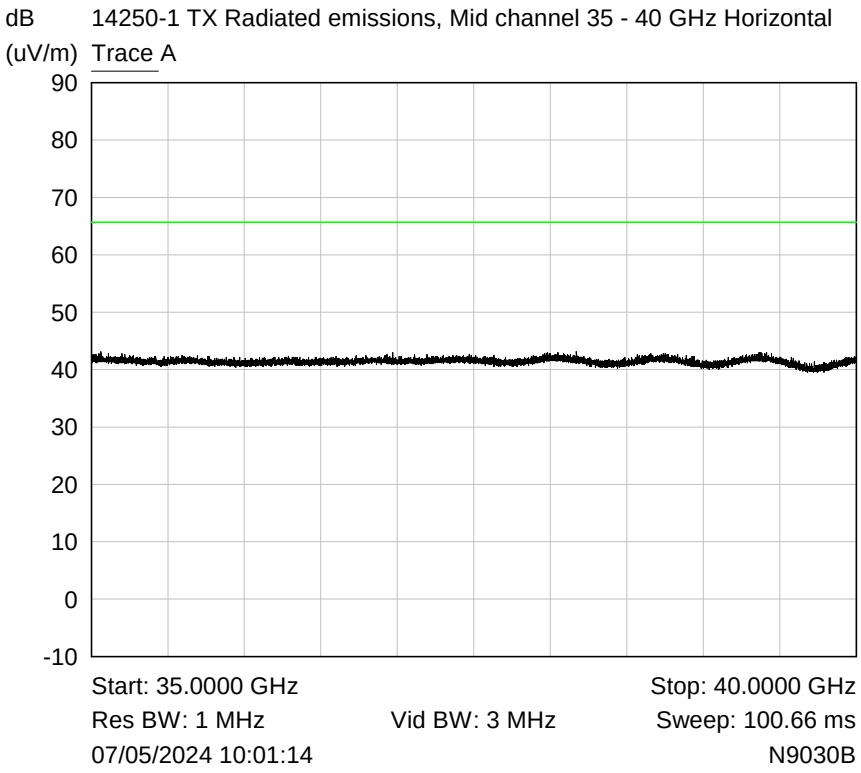

dB
(uV/m)
14250-1 Rad 2 Mid channel 24.2 - 26.5 GHz Horiz
Trace A
80
70
60
50
40
30
20
10
0
-10
-20
Start: 24.2000 GHz
Stop: 26.5000 GHz
Res BW: 1 MHz
Vid BW: 3 MHz
Sweep: 100.48 ms
03/05/2024 16:04:38
E4440A

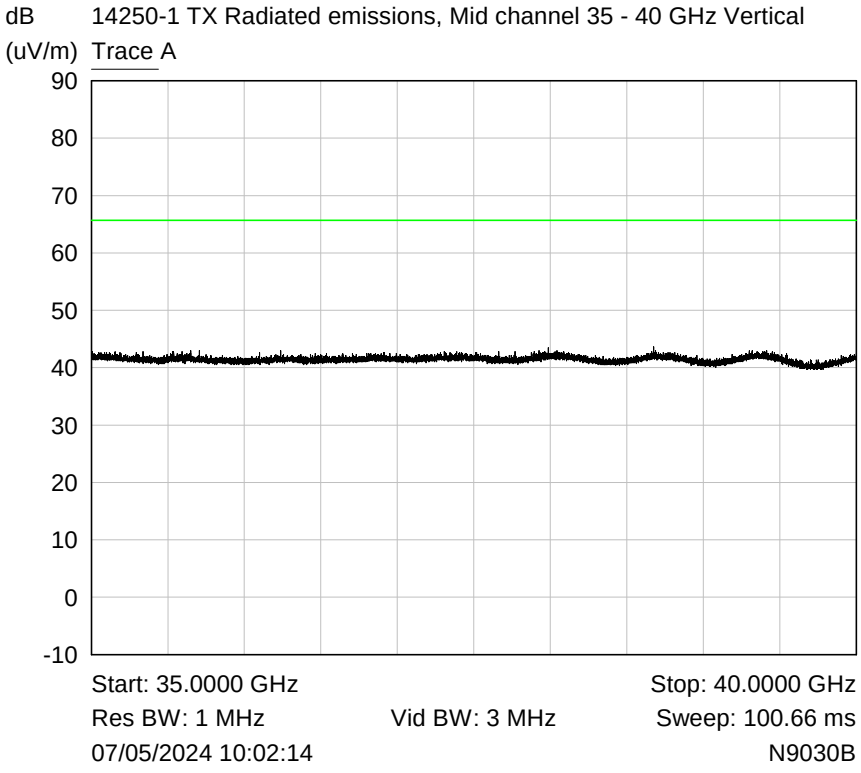


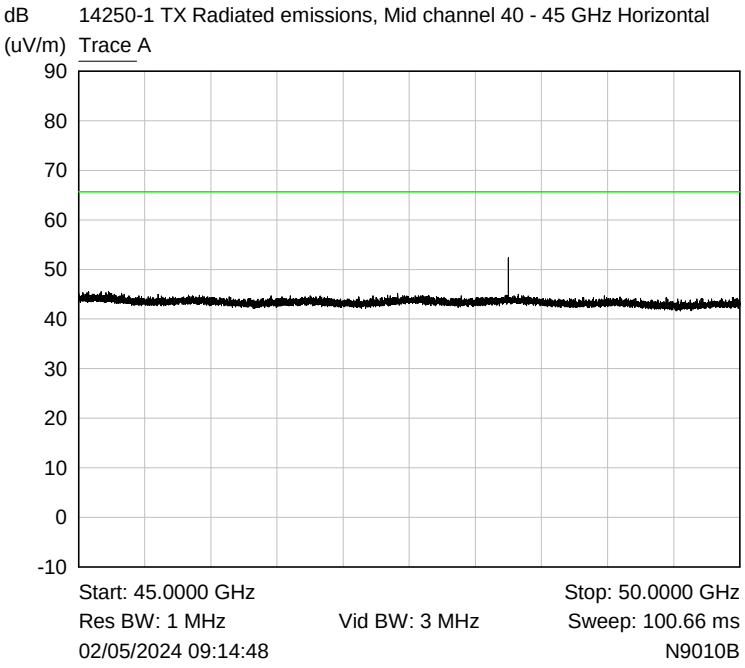


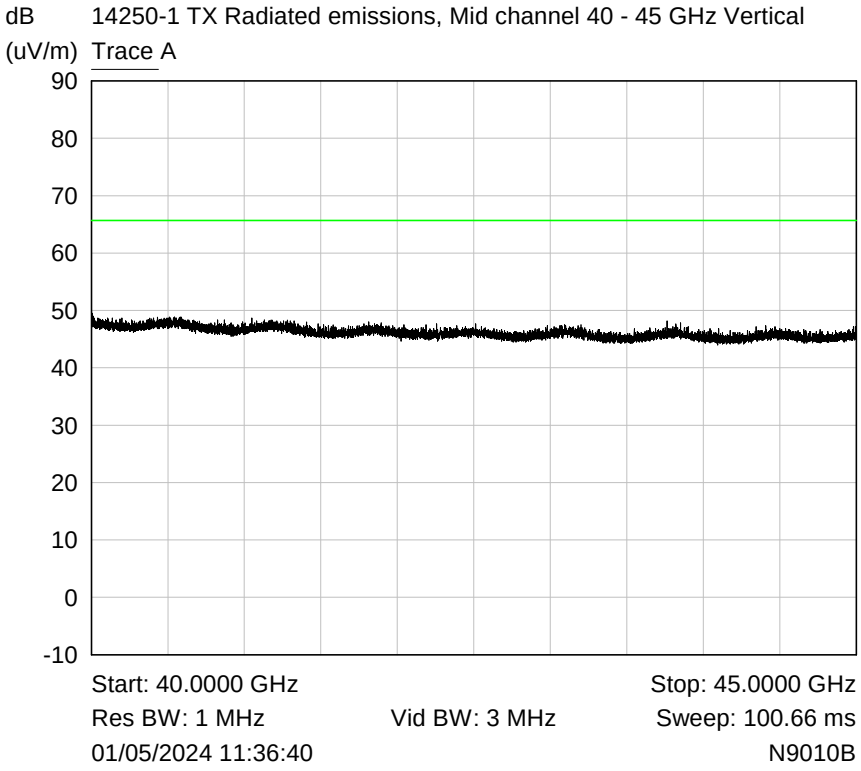


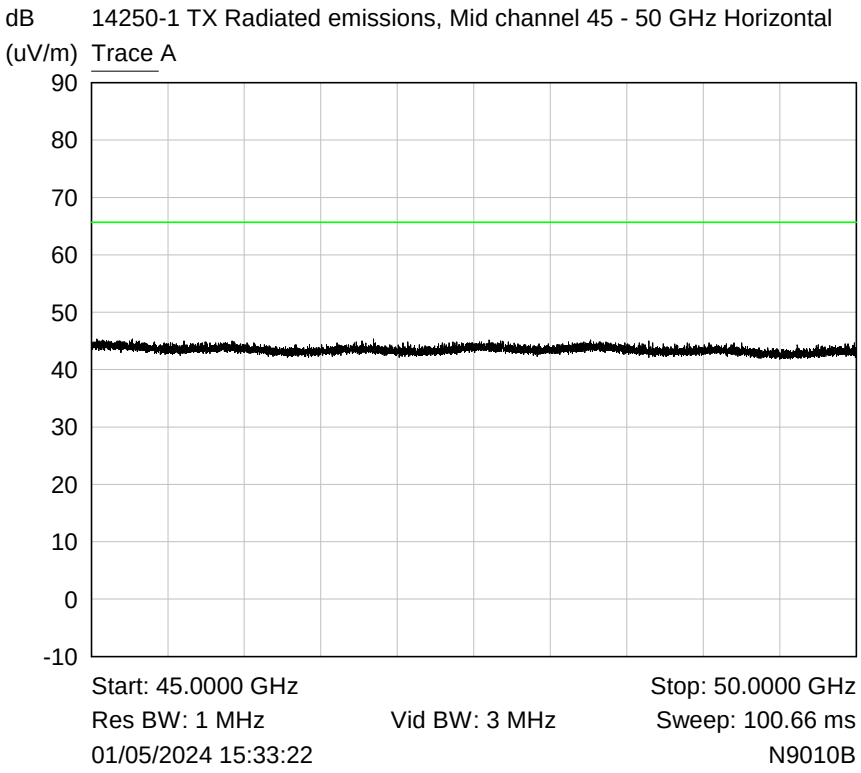


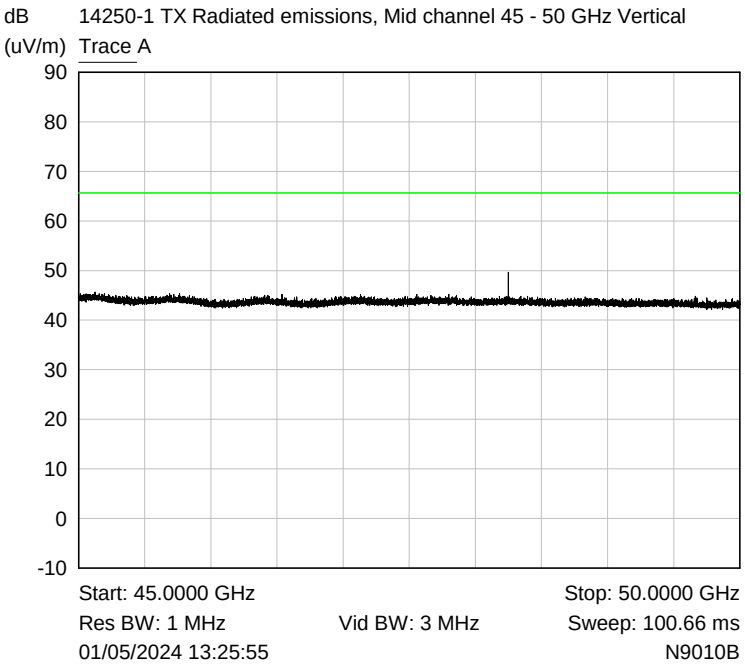


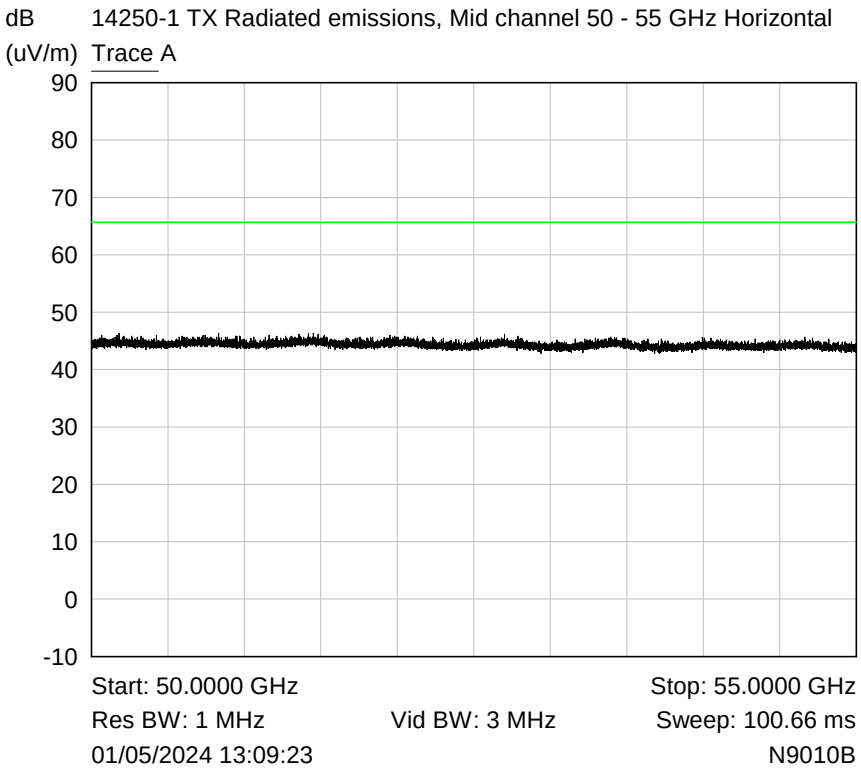


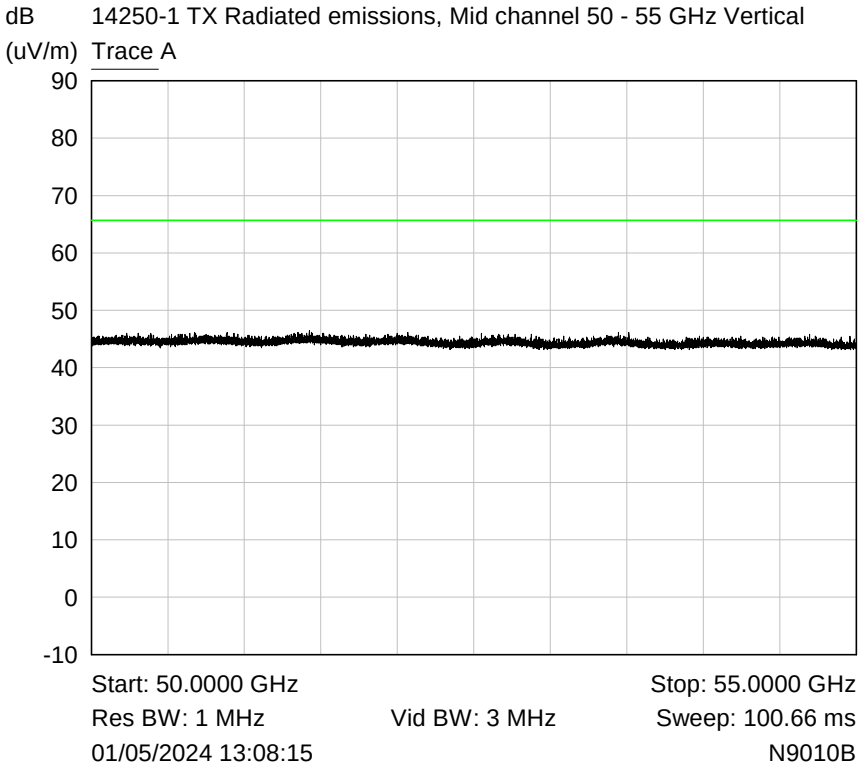


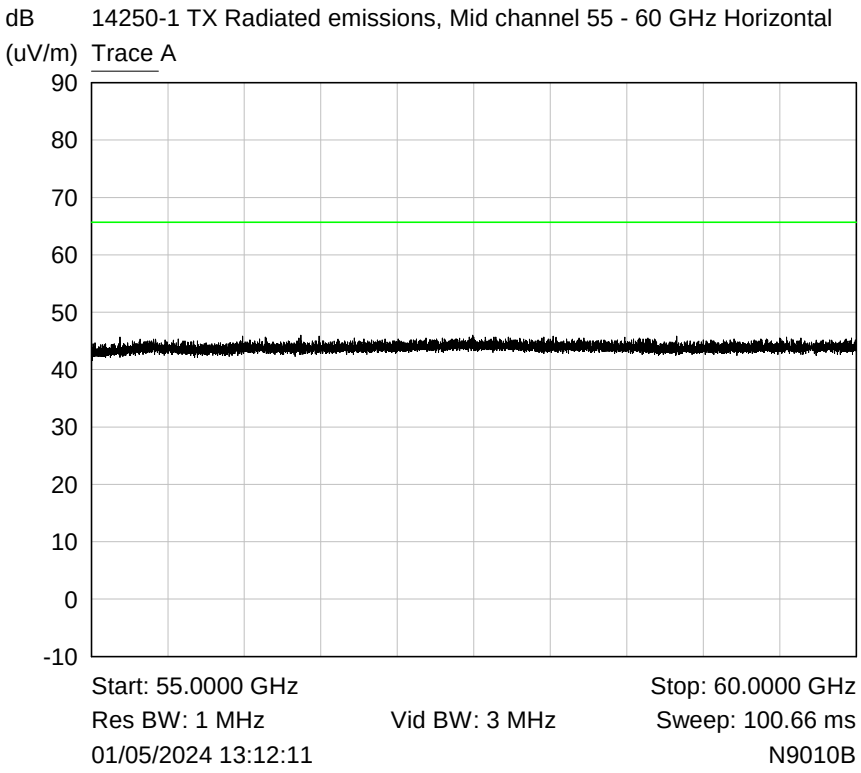


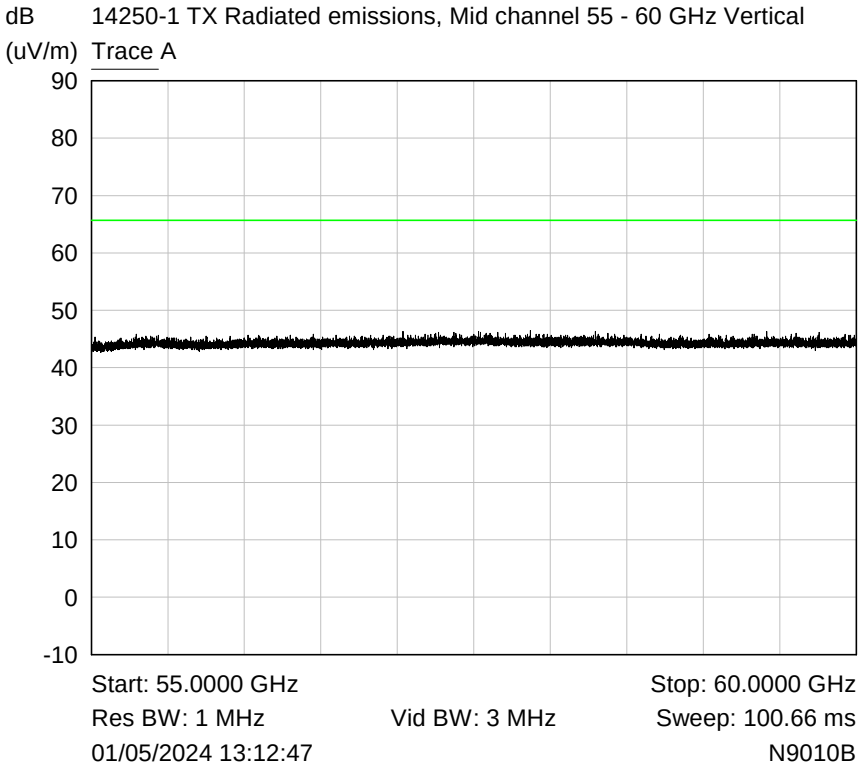


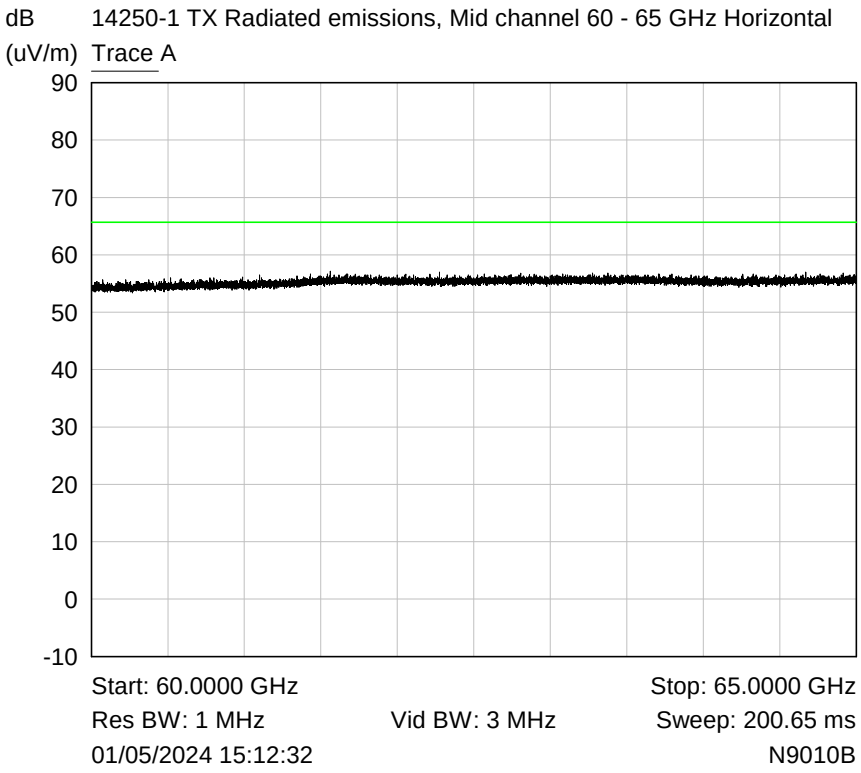


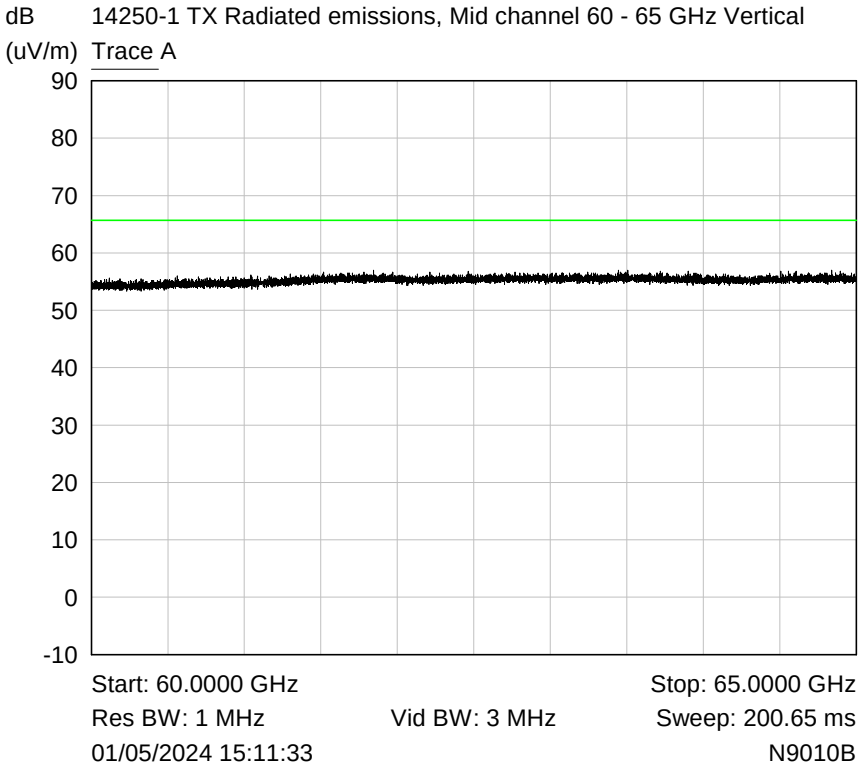


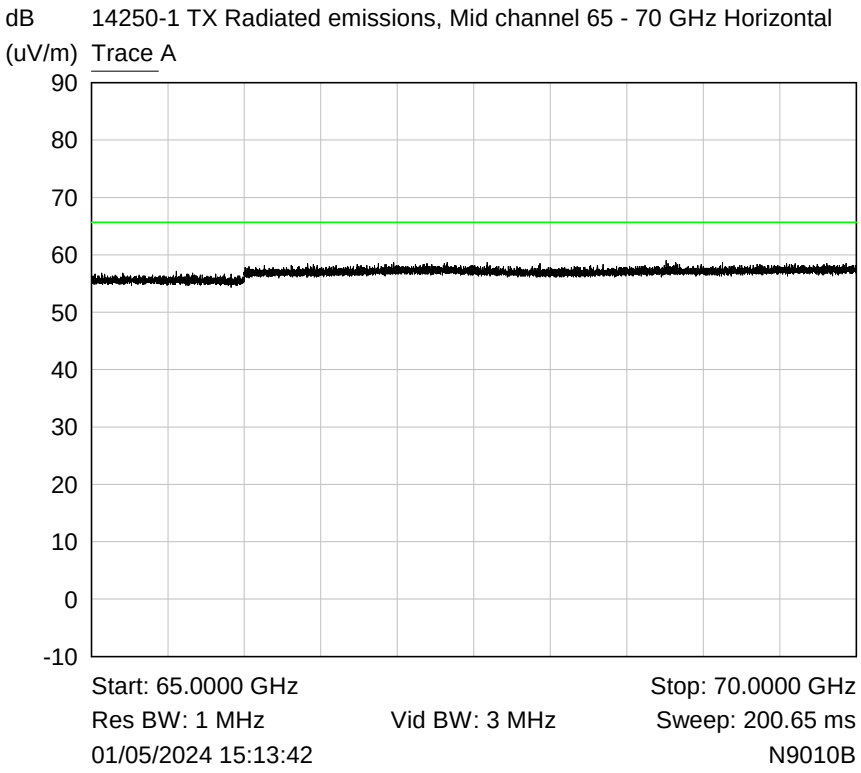


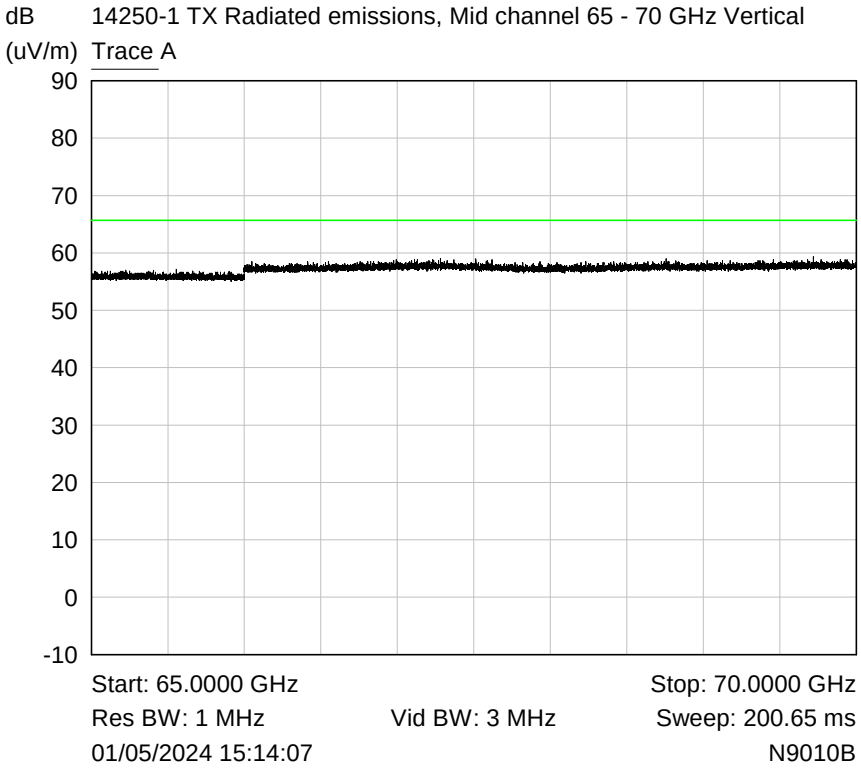


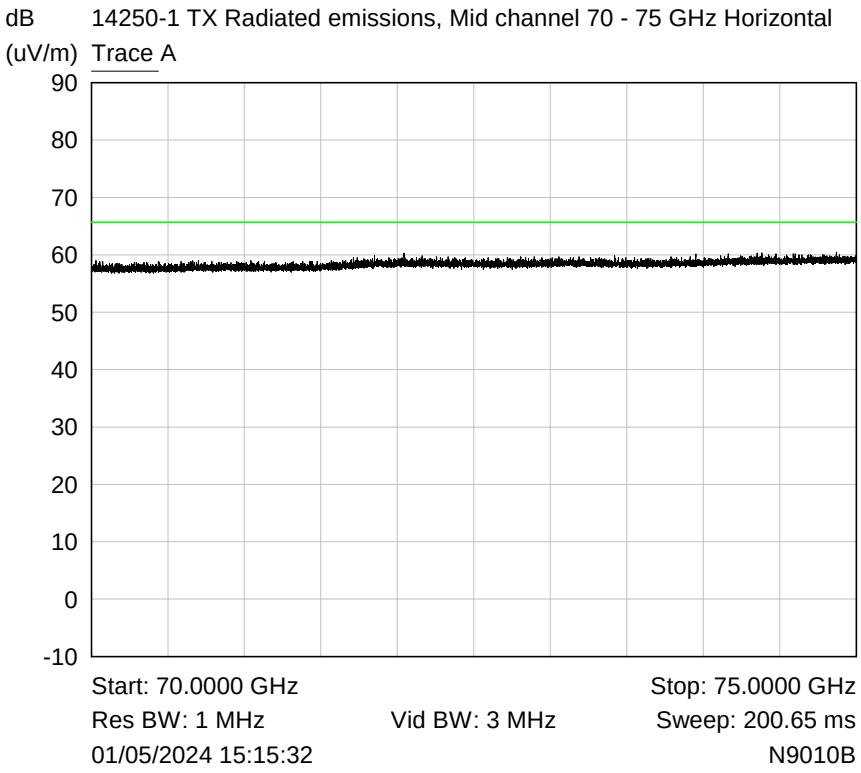


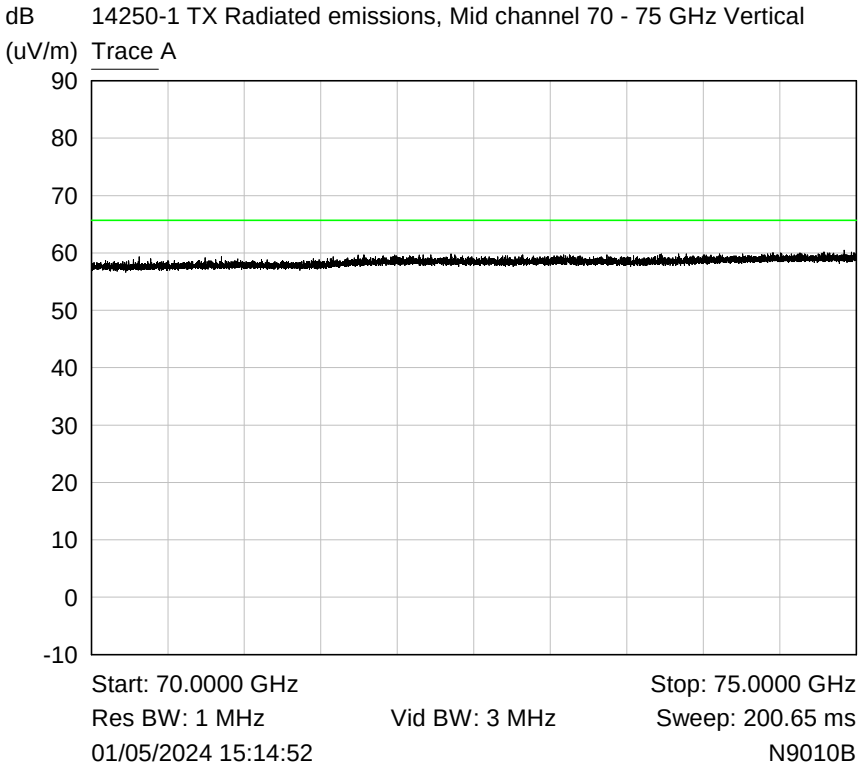


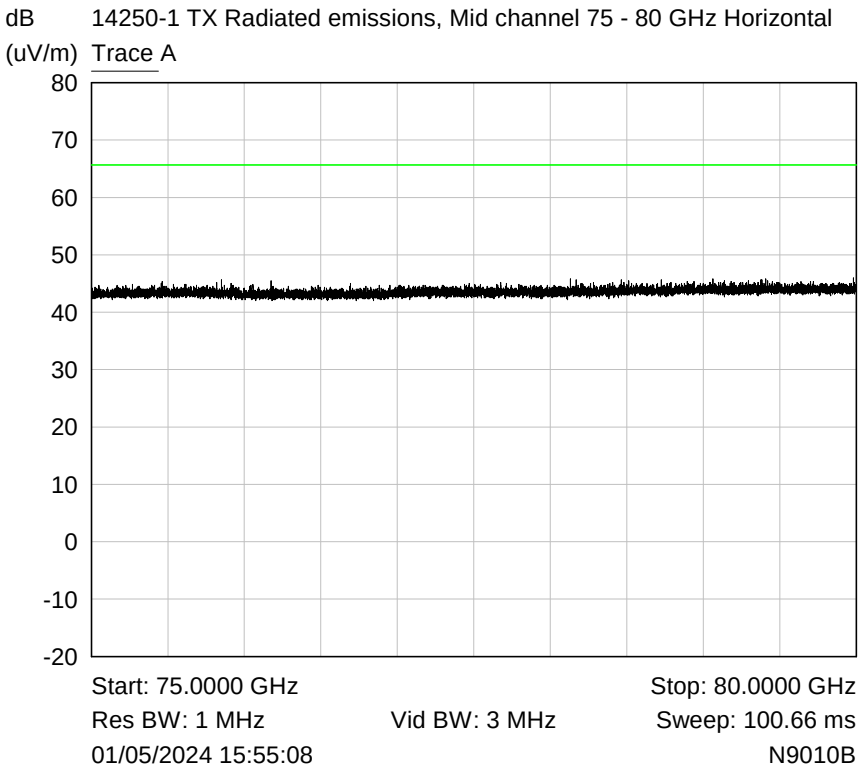


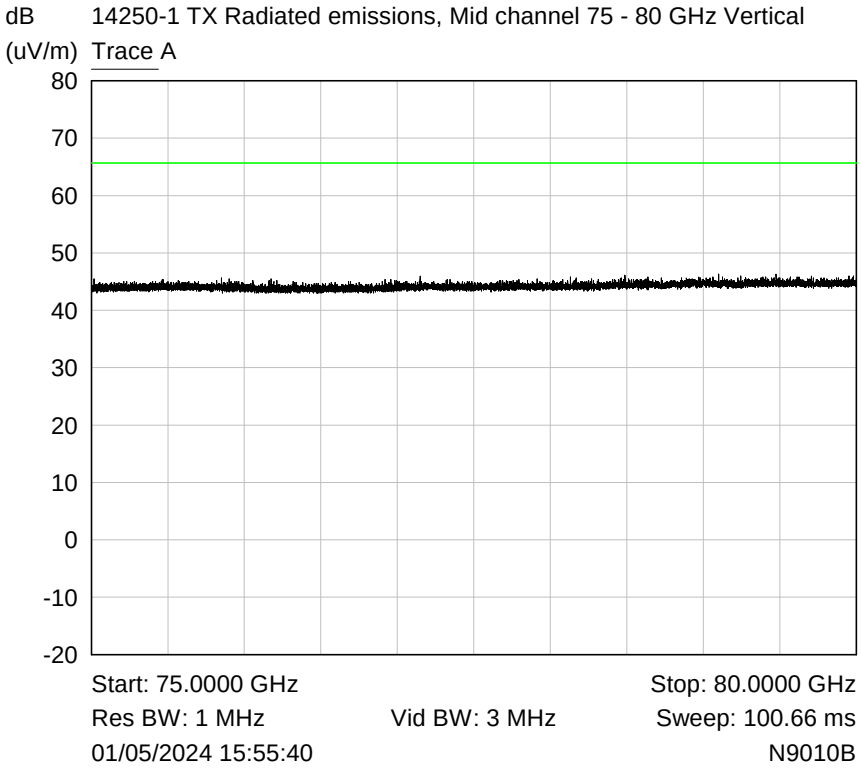

dB
(uV/m)
14250-1 TX Radiated emissions, Mid channel 65 - 70 GHz Horizontal
Trace A
90
80
70
60
50
40
30
20
10
0
-10
Start: 65.0000 GHz
Stop: 70.0000 GHz
Res BW: 1 MHz
Vid BW: 3 MHz
Sweep: 200.65 ms
01/05/2024 15:13:42
N9010B

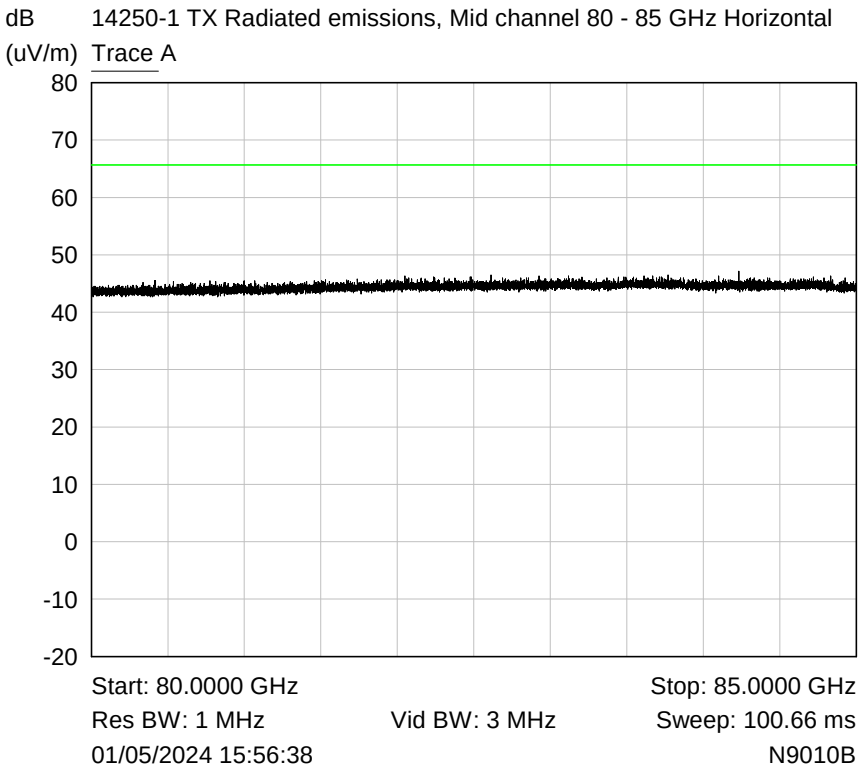

dB
(uV/m)
14250-1 TX Radiated emissions, Mid channel 65 - 70 GHz Vertical
Trace A
90
80
70
60
50
40
30
20
10
0
-10
Start: 65.0000 GHz
Stop: 70.0000 GHz
Res BW: 1 MHz
Vid BW: 3 MHz
Sweep: 200.65 ms
01/05/2024 15:14:07
N9010B

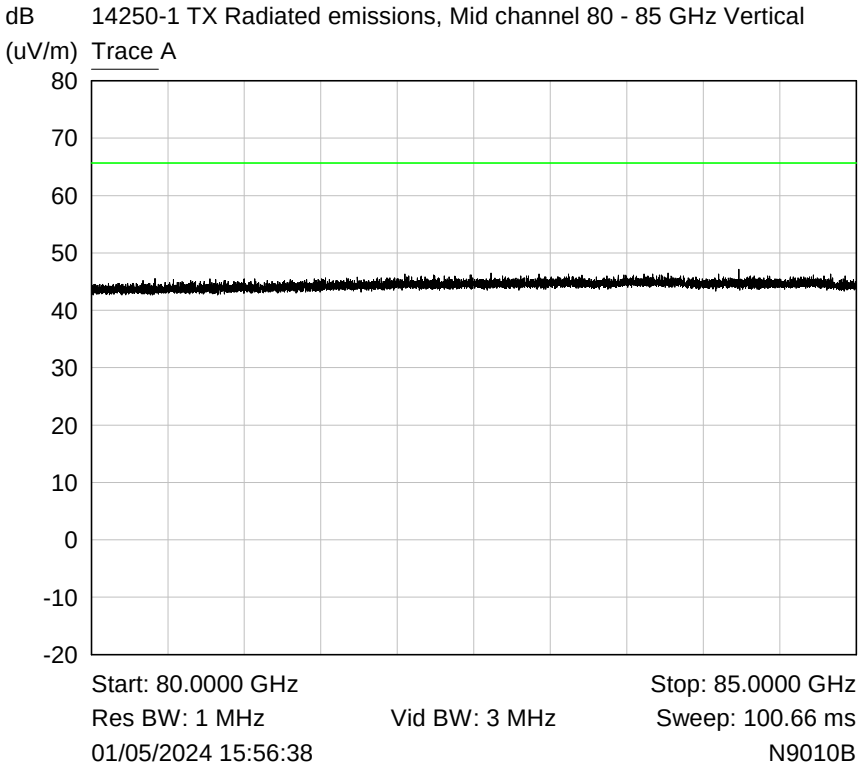


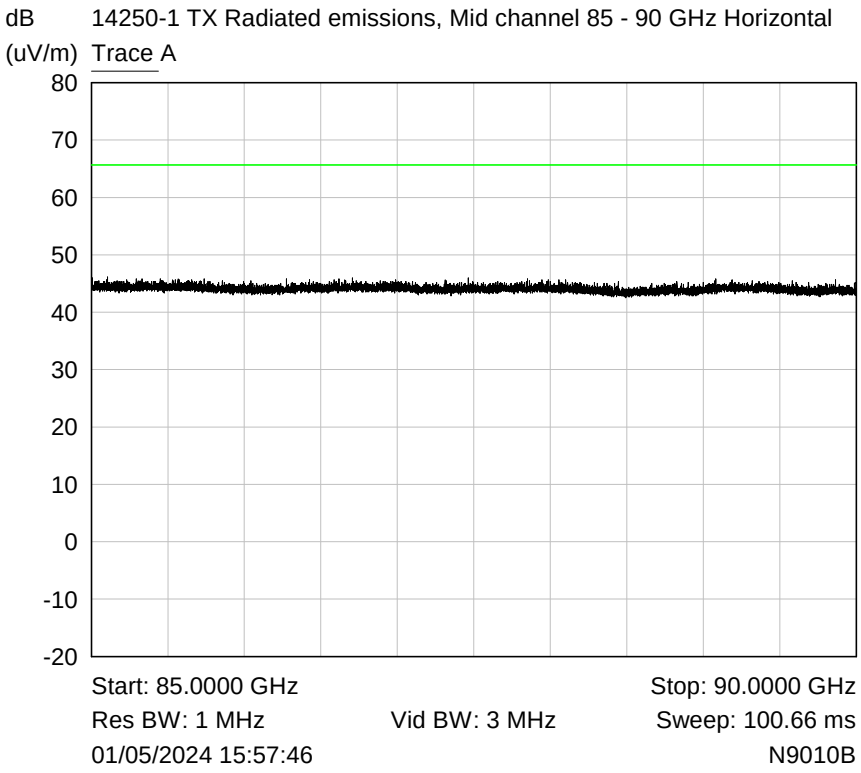


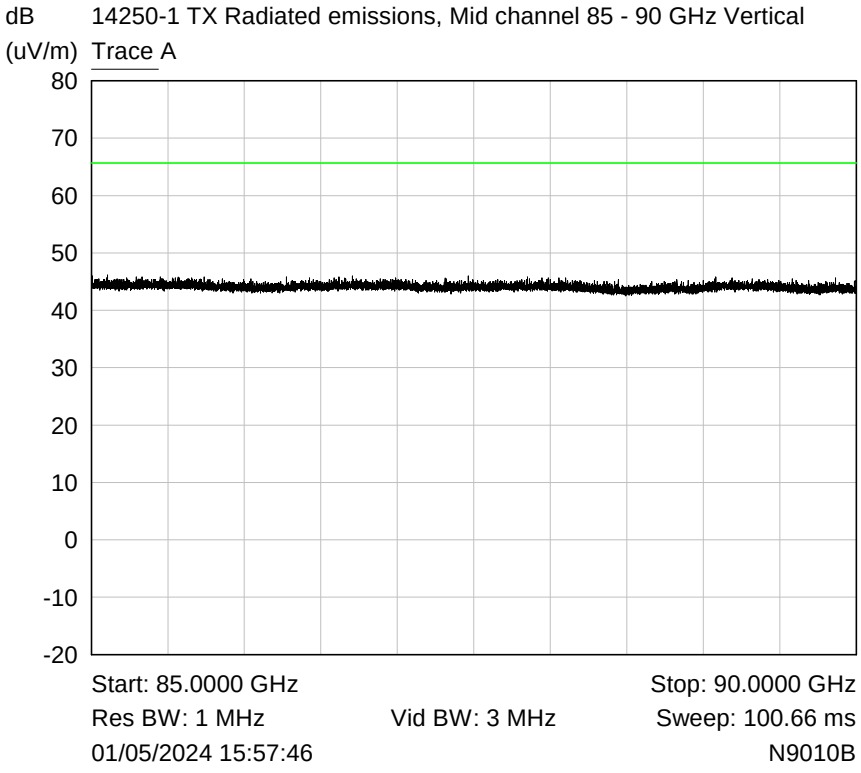


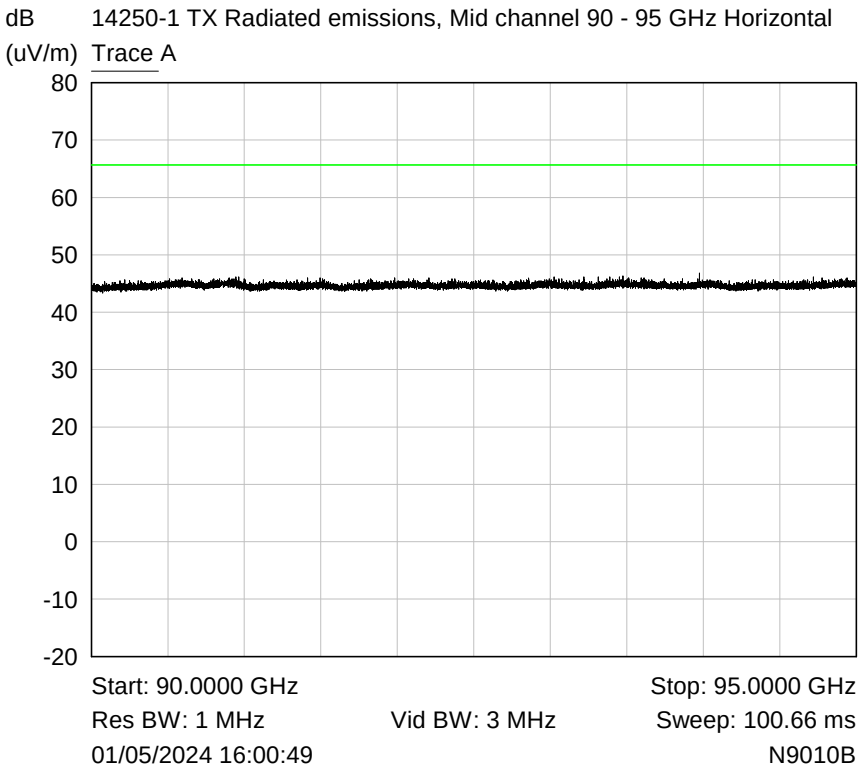


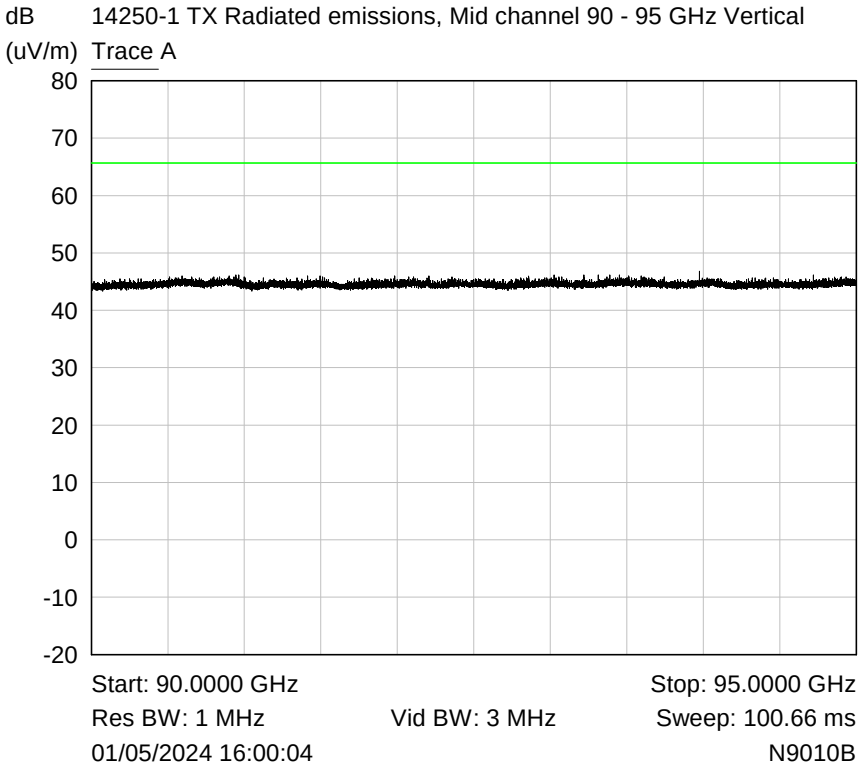


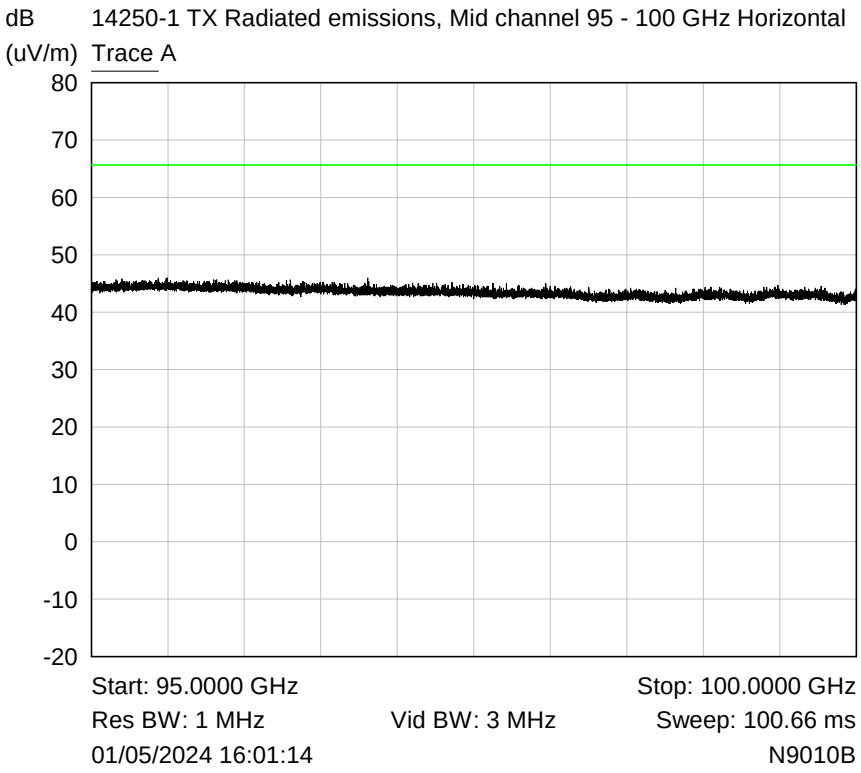


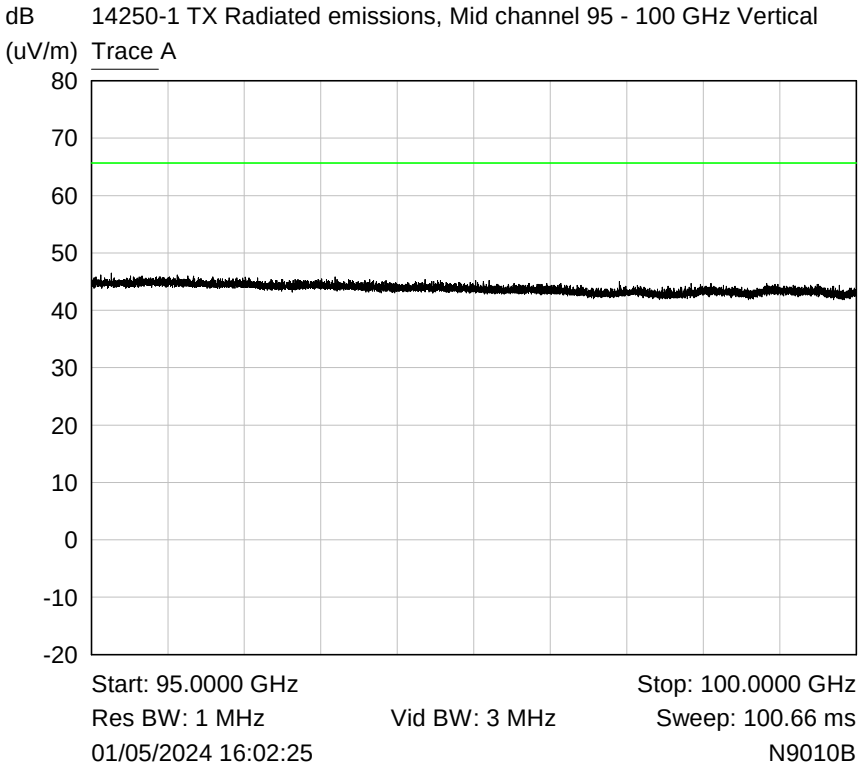






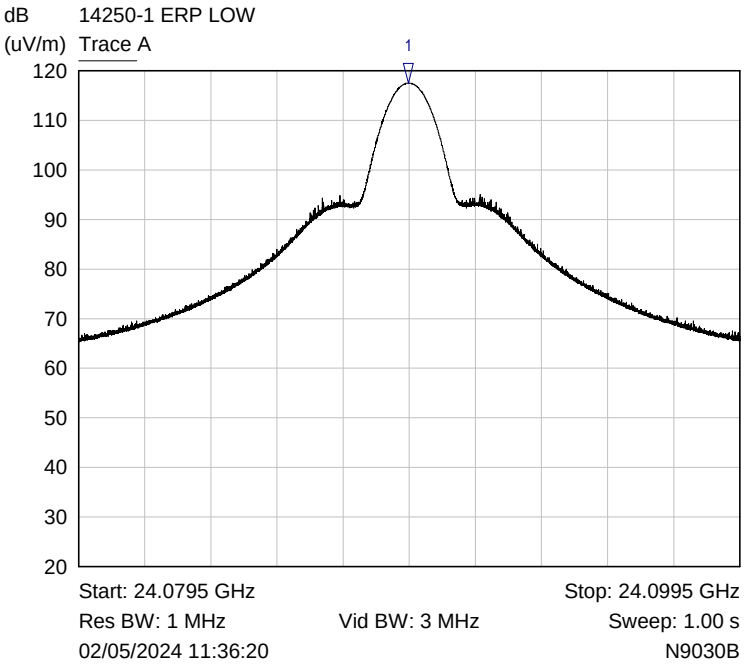






6.6 Effective radiated power field strength

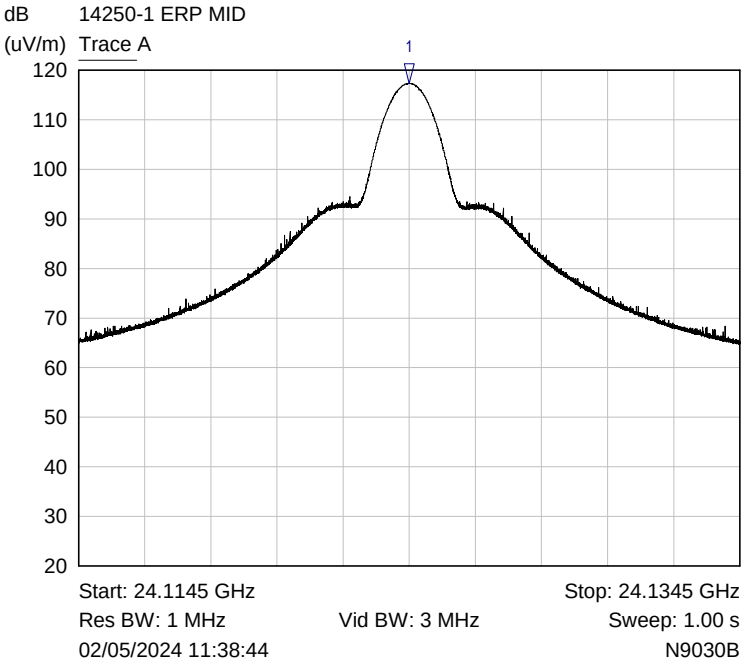
RF Parameters: Band 24075-24175 MHz, Power Setting 2, Modulation FMCW (stopped), Channel 24089 MHz



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	24.0895 GHz	117.54 dB(uV/m)	

Plot of Horiz polarisation and EUT in Upright position

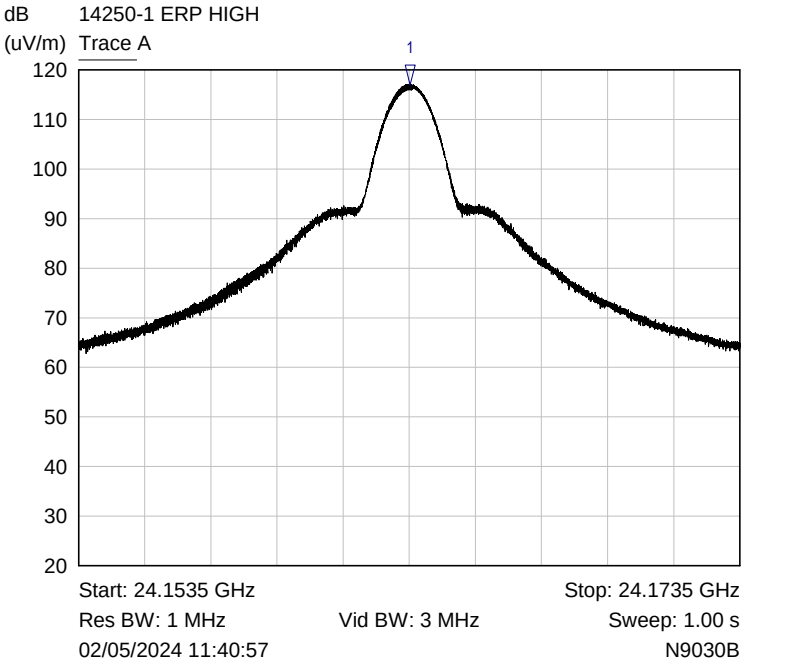
RF Parameters: Band 24075-24175 MHz, Power Setting 2, Modulation FMCW (stopped), Channel 24125 MHz



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	24.1245 GHz	117.36 dB(uV/m)	

Plot of Horiz polarisation and EUT in Upright position

RF Parameters: Band 24075-24175 MHz, Power Setting 2, Modulation FMCW (stopped), Channel 24164 MHz

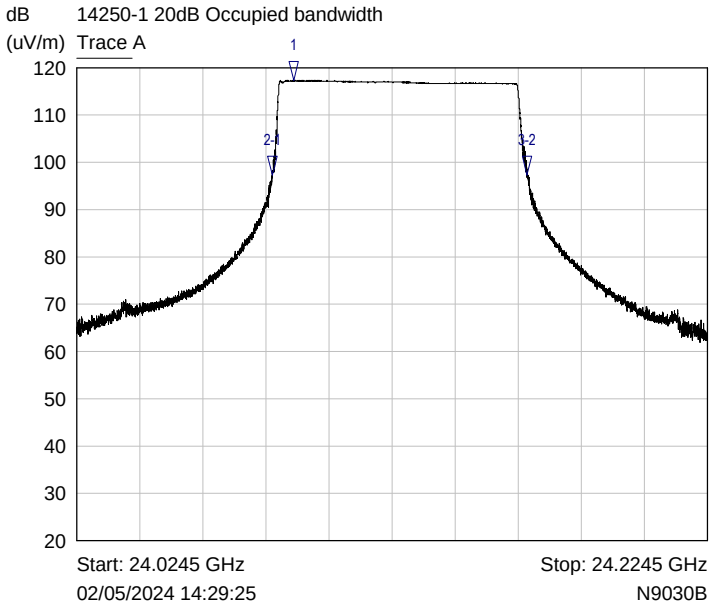


Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	24.1635 GHz	117.08 dB(uV/m)	

Plot of Horiz polarisation and EUT in Upright position

6.7 Occupied bandwidth

RF Parameters: Band 24075-24175 MHz, Power Setting 2, Modulation FMCW

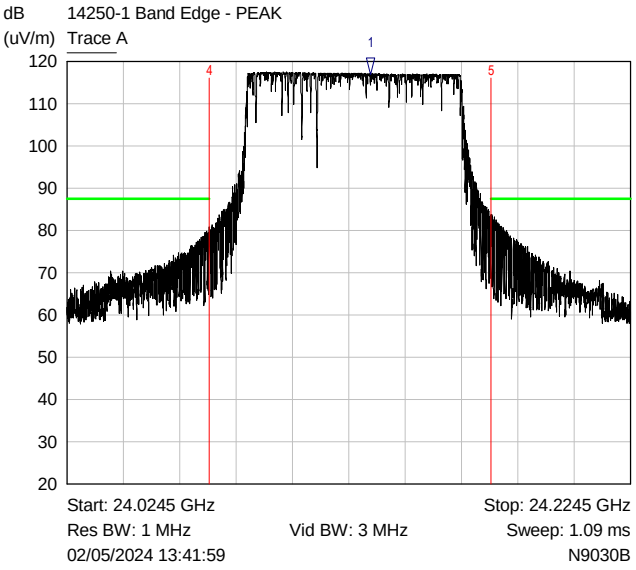


Mkr	Trace	X-Axis	Value	Notes
1	Trace A	24.0932 GHz	117.35 dB(uV/m)	
2-1	Trace A	-6.6726 MHz	-20.00 dB	
3-2	Trace A	80.6731 MHz	-0.00 dB	

Plot for 20dB bandwidth

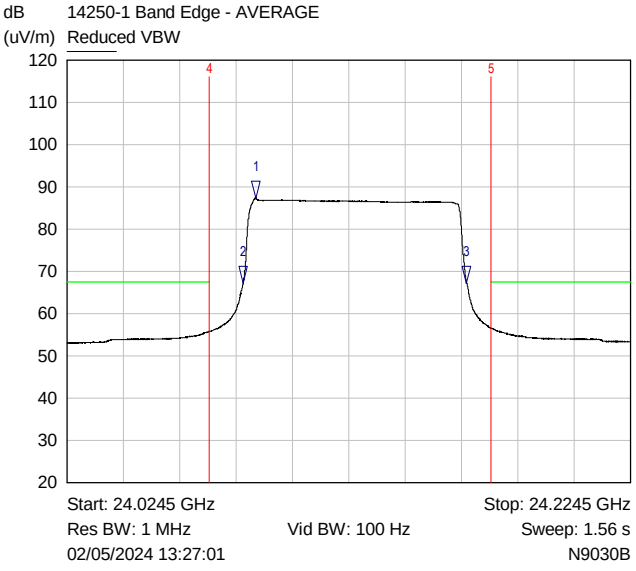
6.8 Band Edge Compliance

RF Parameters: Band 24075-24175 MHz, Power Setting 2, Modulation FMCW



Mkr	Trace	X-Axis	Value	Notes
1	Trace A	24.1324 GHz	116.90 dB(uV/m)	
2	Trace A	24.0868 GHz	-188.77 dB(uV/m)	
3-1	Trace A	31.6772 MHz	87.14 dB	
4	Trace A	24.0750 GHz	77.34 dB(uV/m)	Lower Band Edge
5	Trace A	24.1750 GHz	83.13 dB(uV/m)	Upper Band Edge

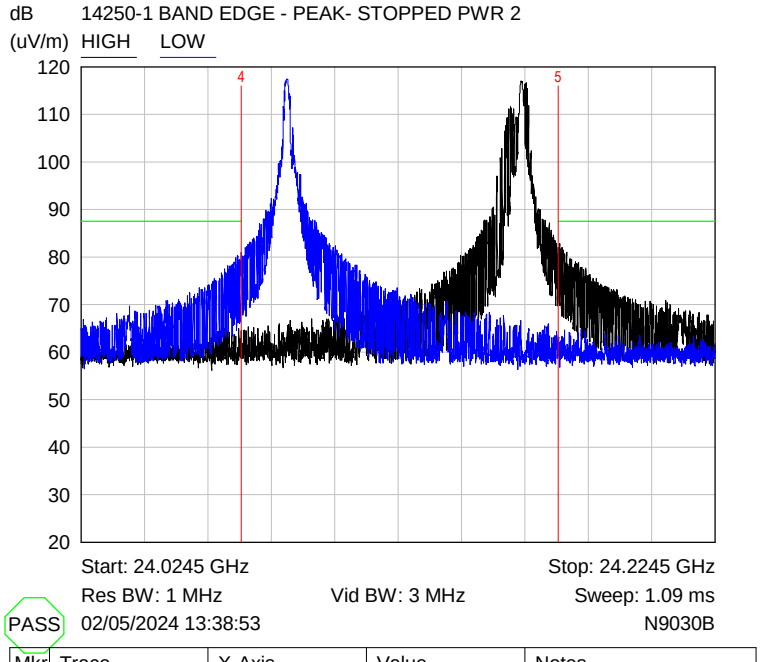
Authorised Band Edge Plot



Mkr	Trace	X-Axis	Value	Notes
1	Reduced VBW	24.0914 GHz	87.27 dB(uV/m)	
2	Reduced VBW	24.0870 GHz	67.27 dB(uV/m)	
3	Reduced VBW	24.1664 GHz	67.27 dB(uV/m)	
4	Reduced VBW	24.0750 GHz	55.72 dB(uV/m)	
5	Reduced VBW	24.1750 GHz	56.58 dB(uV/m)	

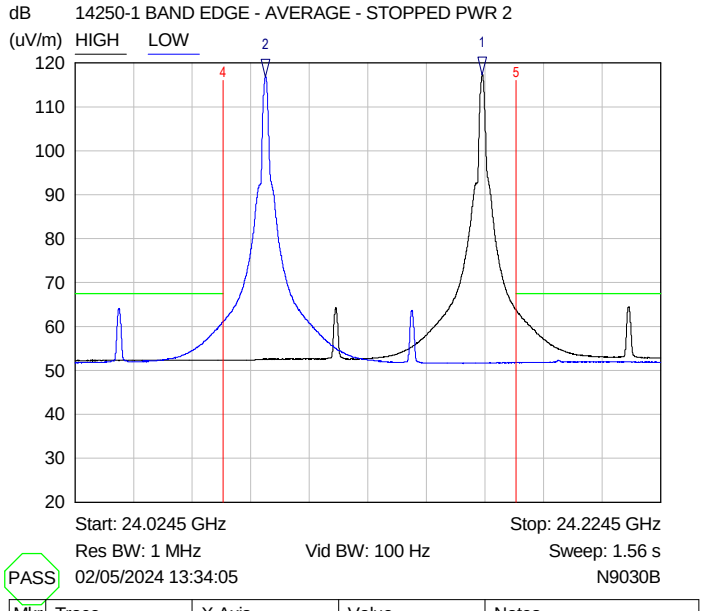
Authorised Band Edge Plot

RF Parameters: Band 24075-24175 MHz, Power Setting 2, Modulation FMCW (stopped), Channel 24089 and 24164 MHz



Mkr	Trace	X-Axis	Value	Notes
4	LOW	24.0750 GHz	80.69 dB(uV/m)	Lower Band Edge
5	HIGH	24.1750 GHz	82.01 dB(uV/m)	Upper Band Edge

Authorised Band Edge Plot



Mkr	Trace	X-Axis	Value	Notes
1 ▽	HIGH	24.1635 GHz	117.32 dB(uV/m)	
2 ▽	LOW	24.0896 GHz	116.90 dB(uV/m)	
4 |	LOW	24.0750 GHz	61.06 dB(uV/m)	Lower Band Edge
5 |	HIGH	24.1750 GHz	63.84 dB(uV/m)	Upper Band Edge

Authorised Band Edge Plot

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. Kiwa Electrical Compliance calibrate the test set-up to account for any path losses, antenna gains, etc. so that the value read at the receiver relates directly to the absolute value required, except that it is expressed in dB relative to one microVolt and may need to take account of any alternative measuring distance used. Examples:

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

(b) limit of 300 μV/m at 10m equates to 20.log (300 . 10/3) = 60 dB μV/m at 3m

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

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

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

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

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

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

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

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

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

Example:
Radiated spurious emissions limit at 3metres of $90pW/cm^2$.

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

Equation 25 transposed: $0.9 \times 10^{-6} \times 4 \times \pi \times 3^2 = 0.0001017876$ W
And
Equation 26 transposed: $E_{Spec\ limit} = \sqrt{(0.9x10^{-6} \times 377)} = 0.01842$ V/m.
And
Equation 21 transposed: $E_{Log} = 20Log(0.01842) +120 = 85.3dB\mu V/m$ @ 3m.

8 Photographs

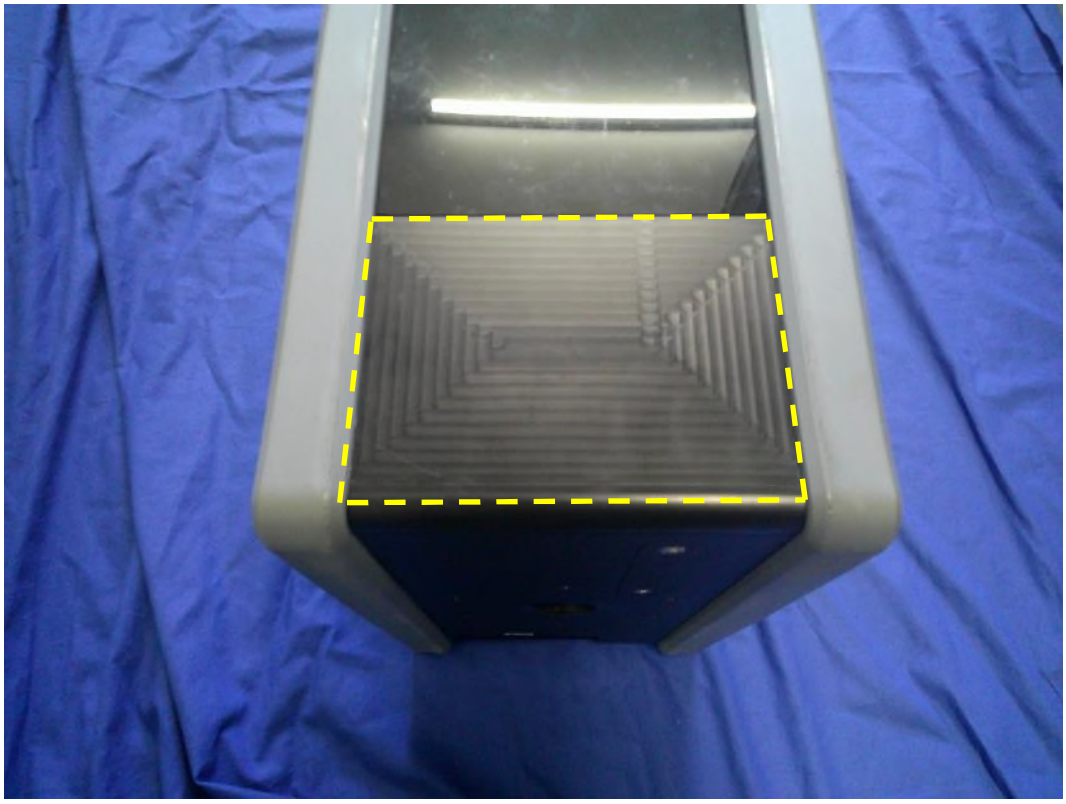
8.1 EUT Front View

8.2 EUT Reverse Angle

8.3 EUT Left side View

8.4 EUT Right side View

8.5 EUT Antenna



Shows the location of the antenna array (highlighted)

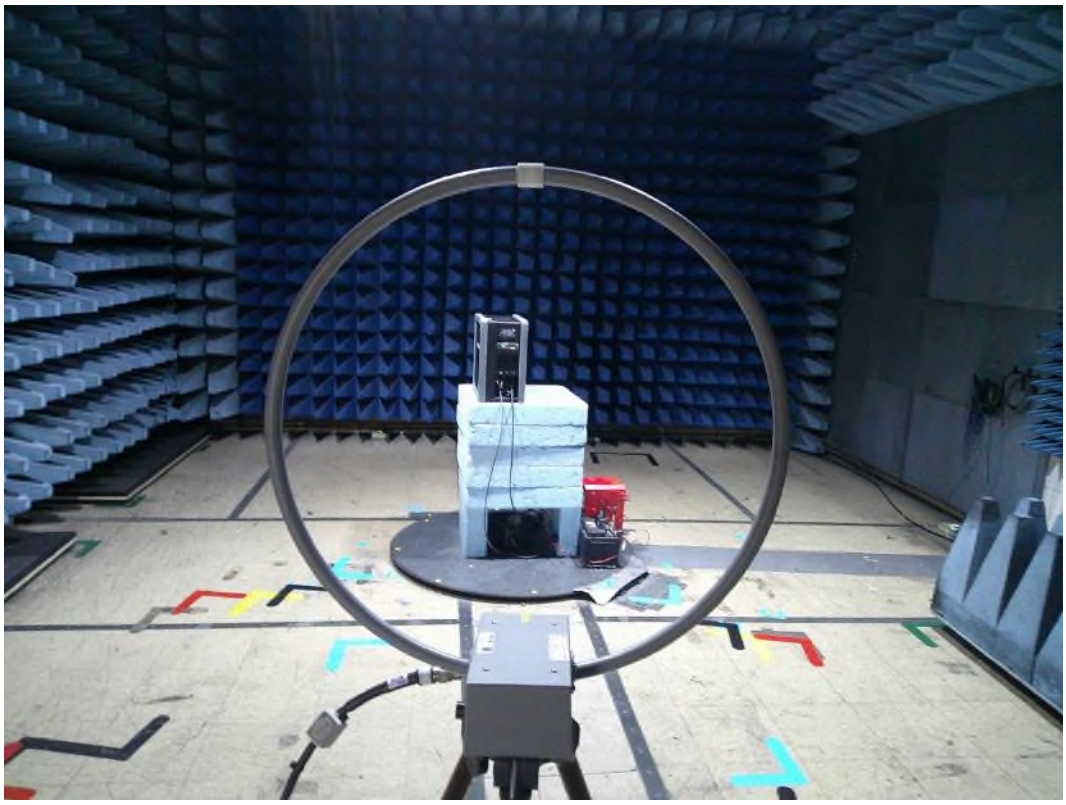
8.6 EUT Display & Controls

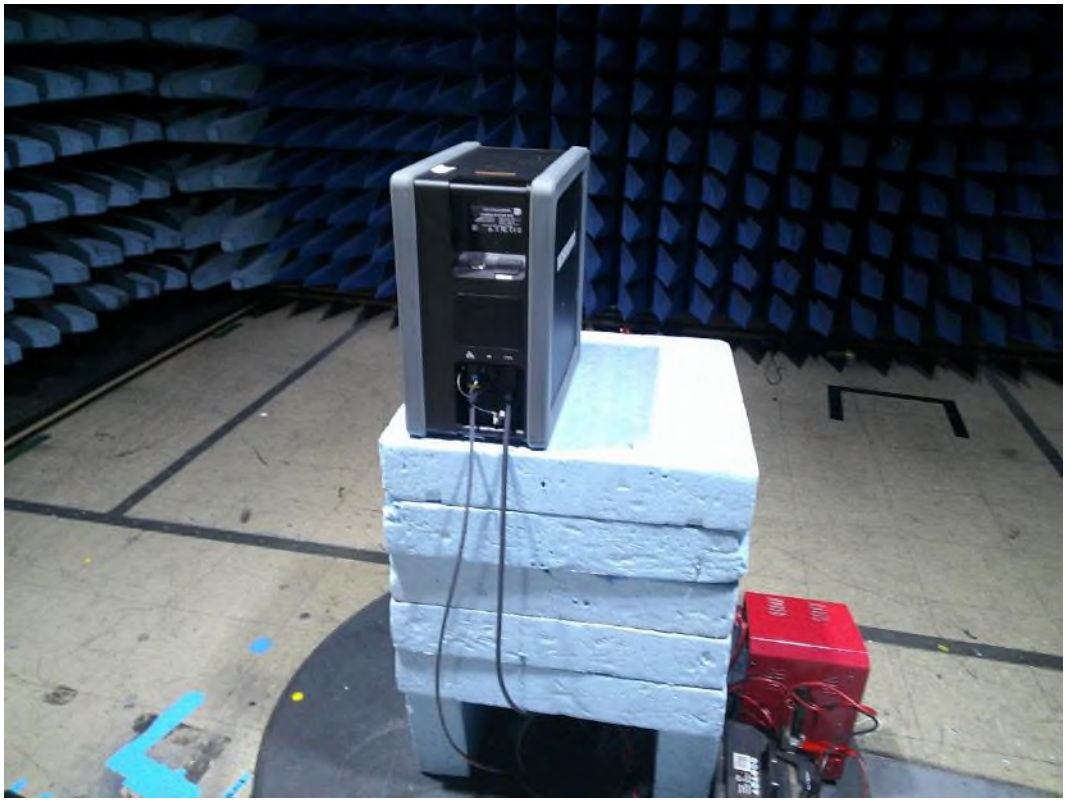
8.7 EUT Internal photos

No internal photos shown, due to confidentiality.

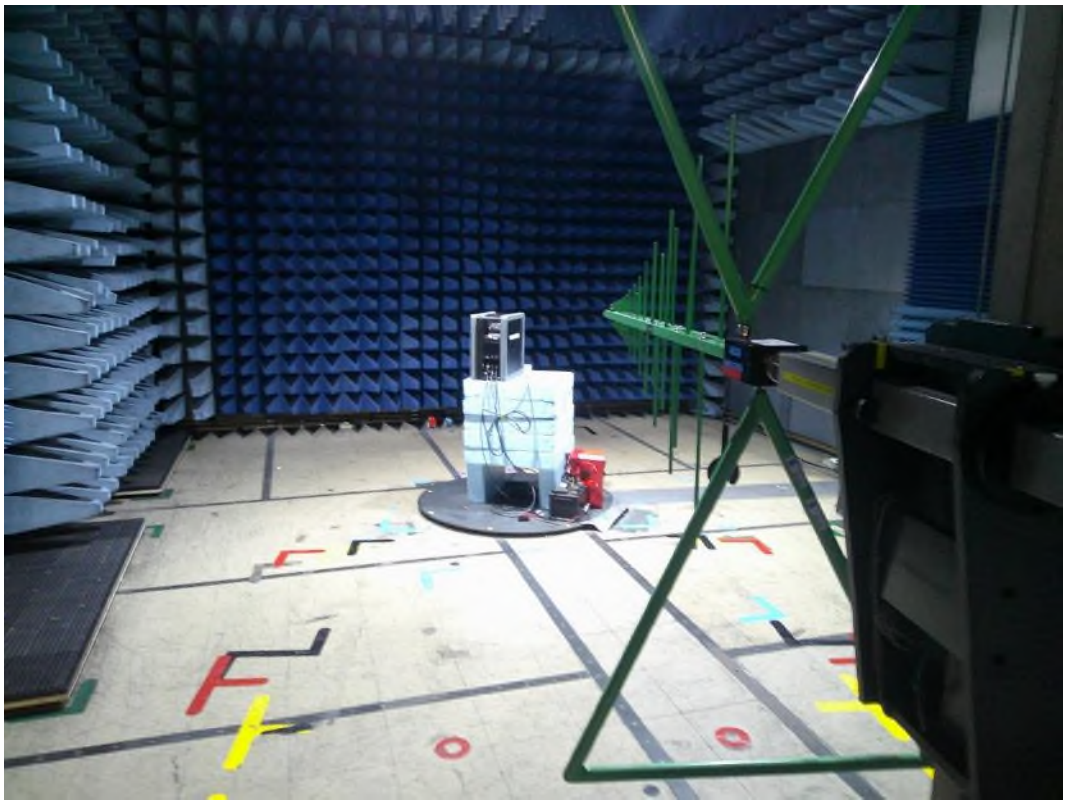
8.8 EUT ID Label

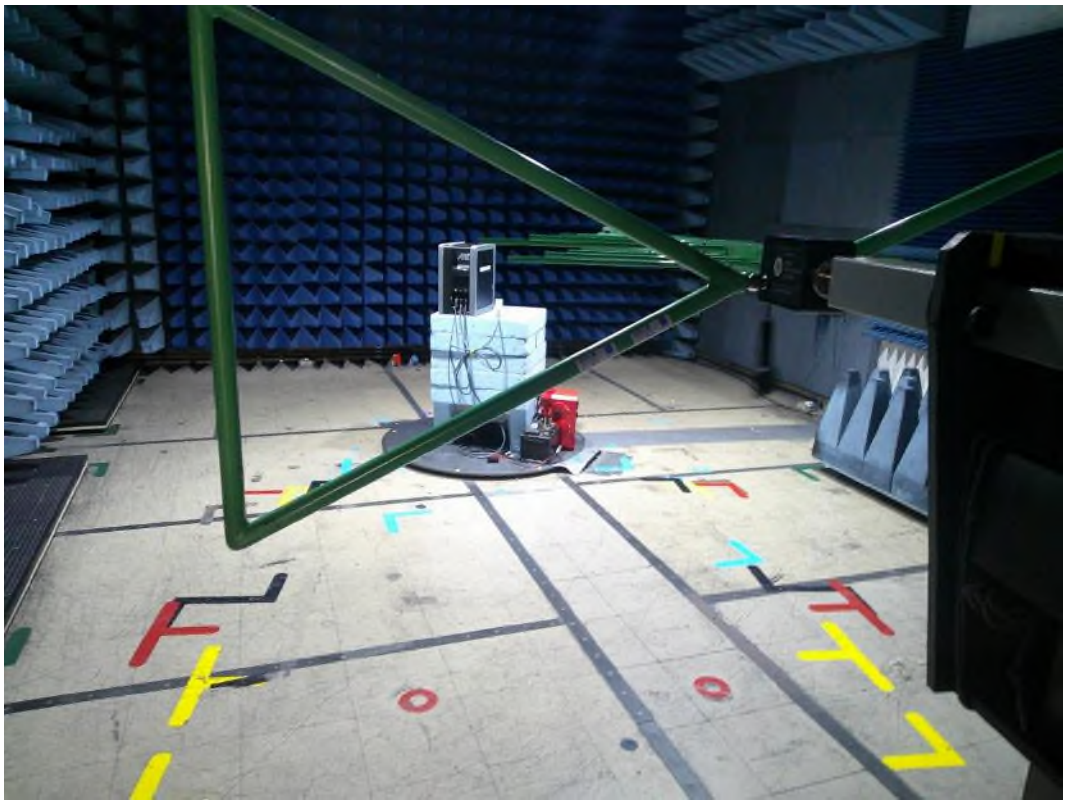
8.9 Radiated emissions 150 kHz - 30 MHz

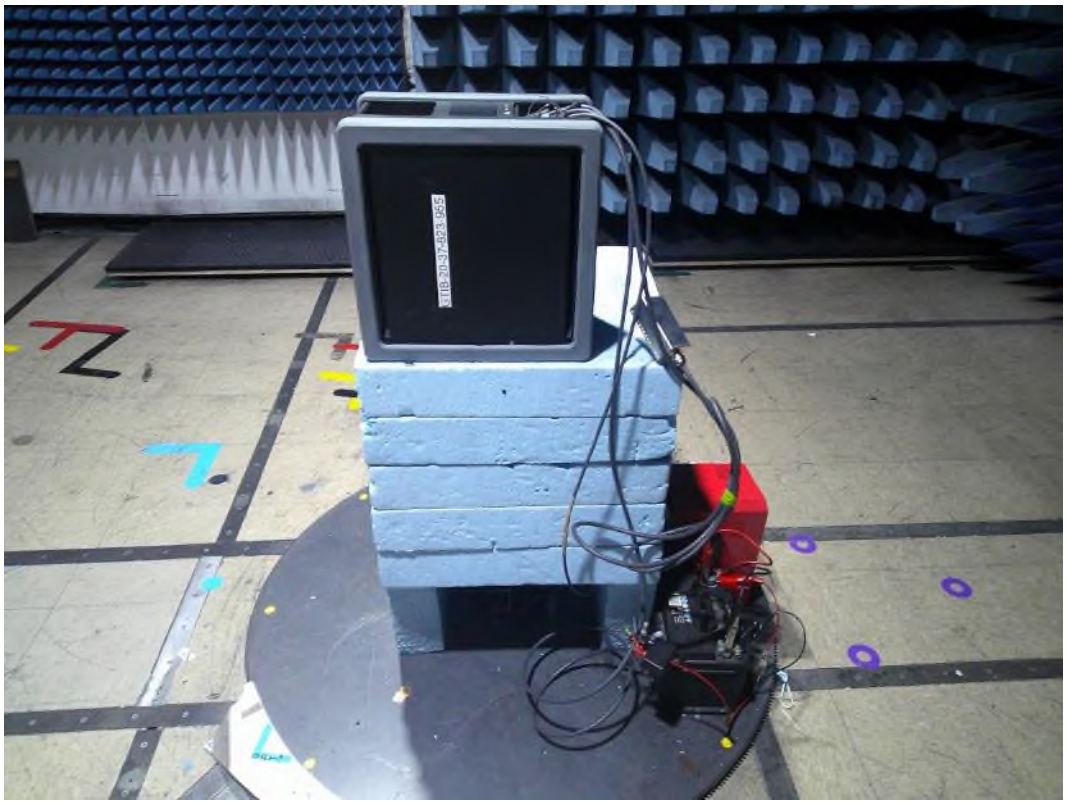




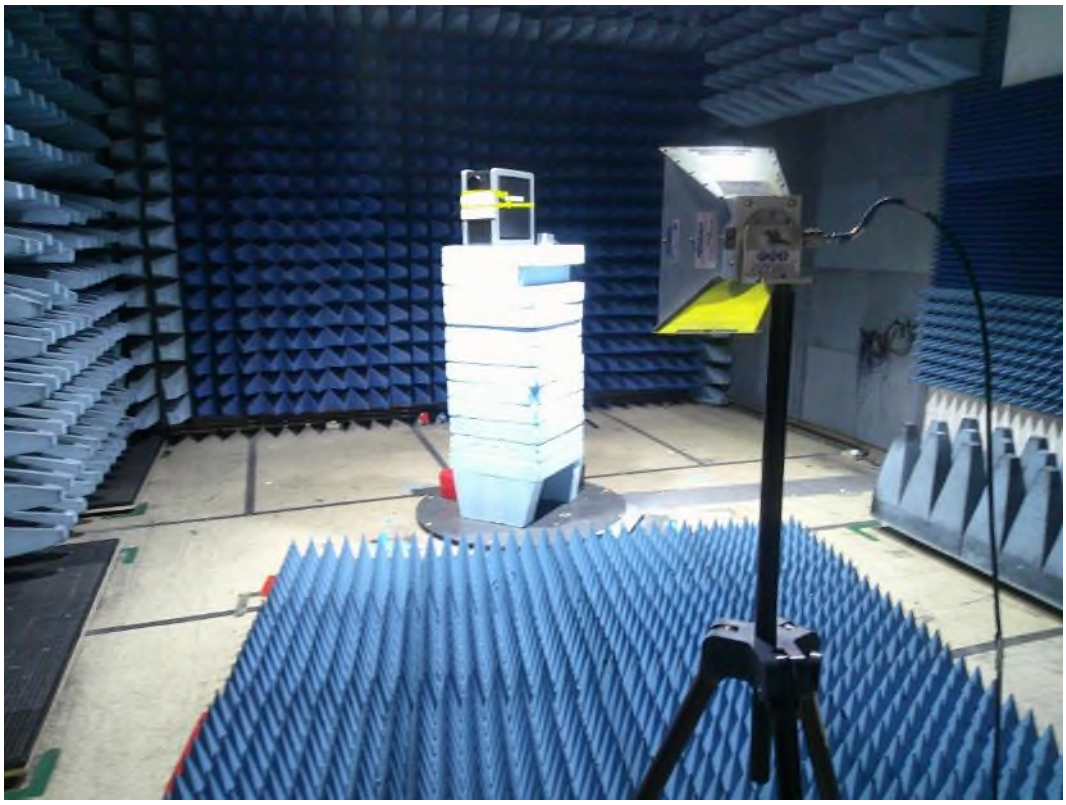
8.10 Radiated emissions 30 MHz -1 GHz

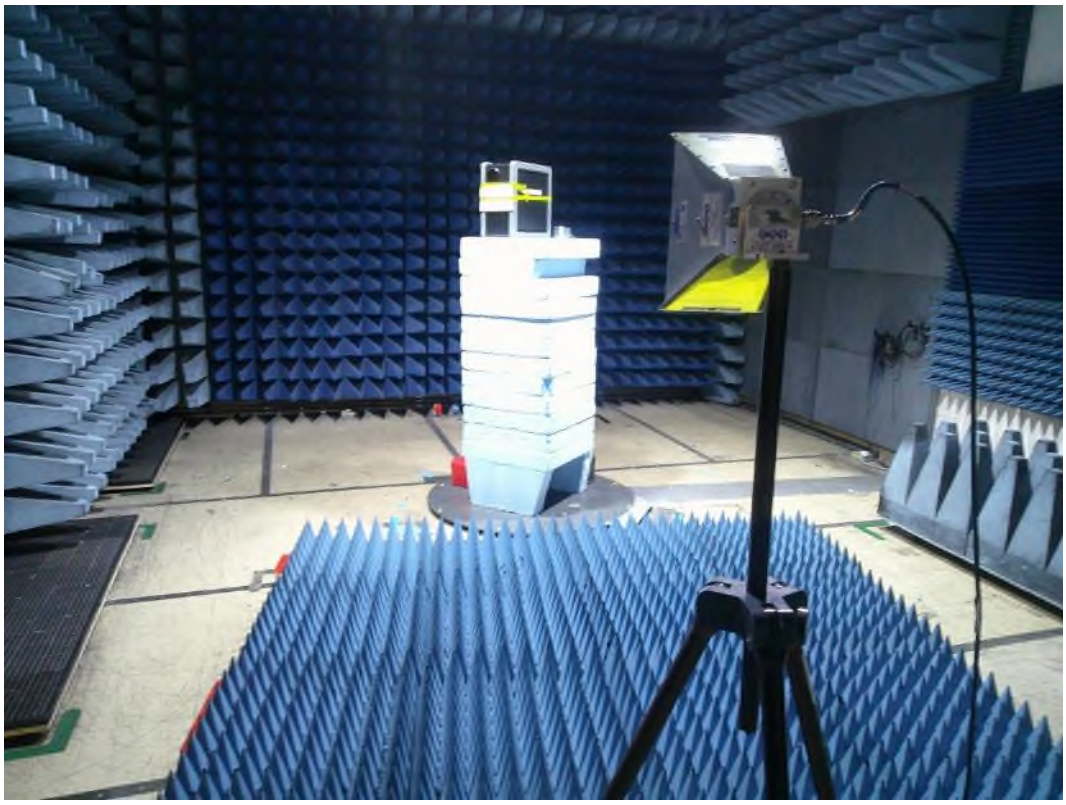


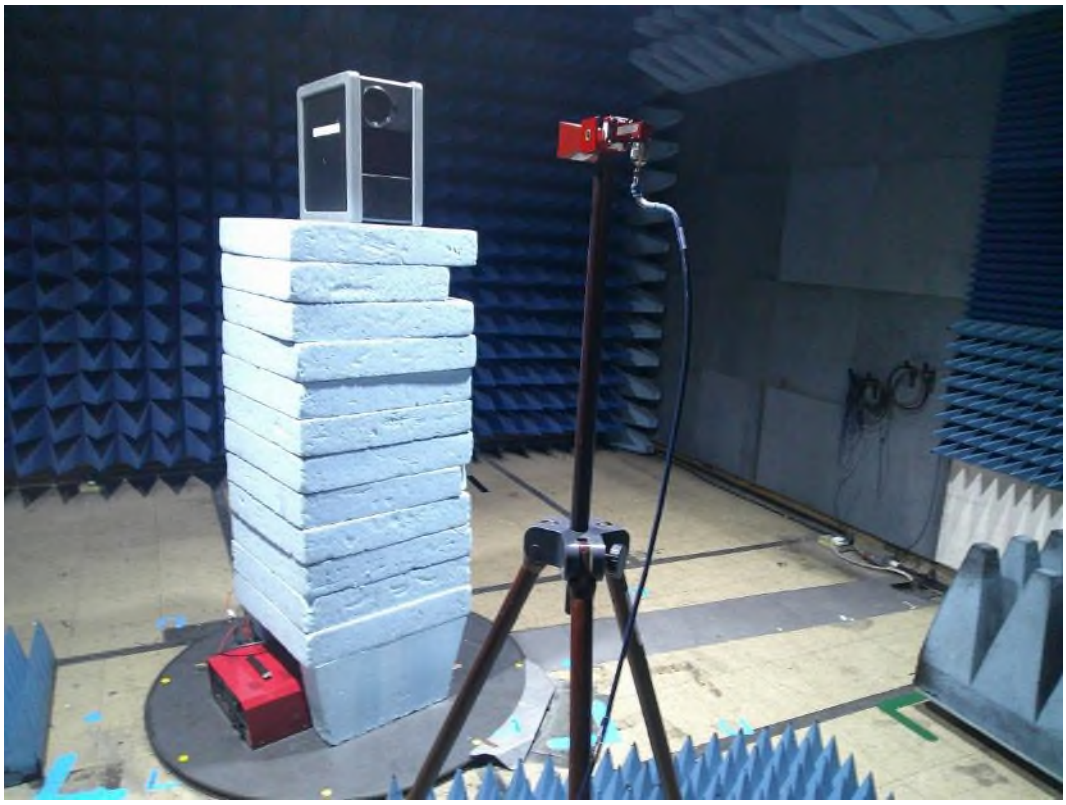


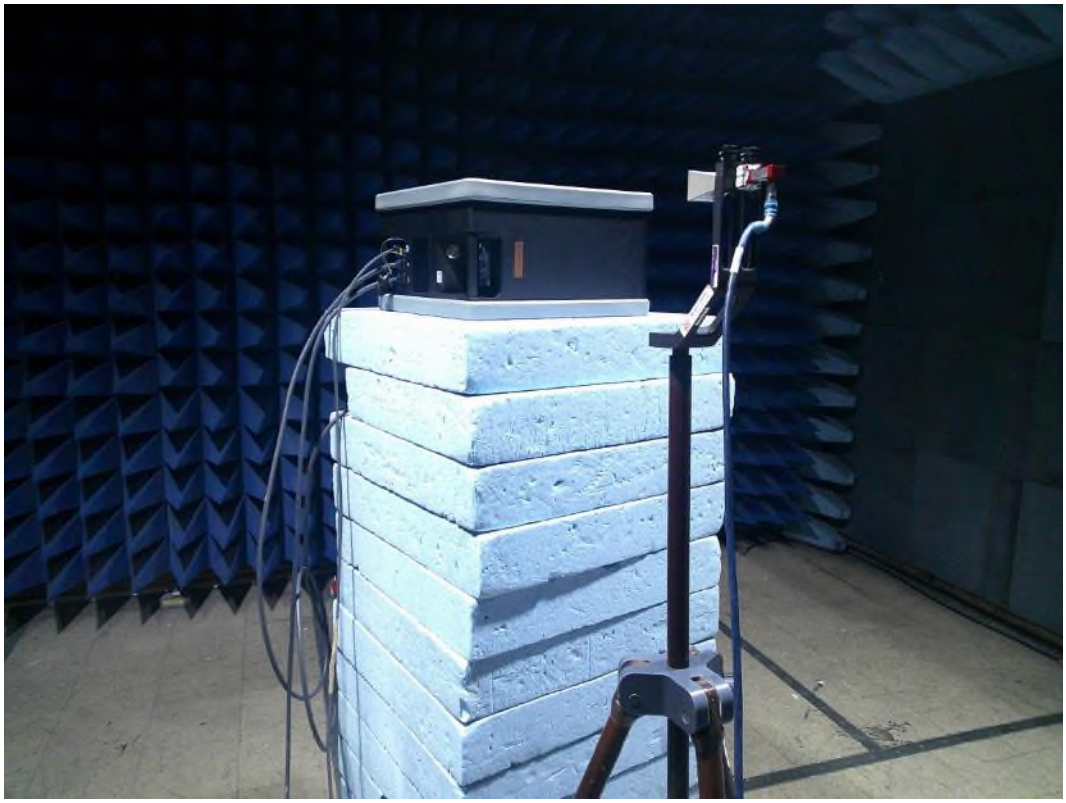


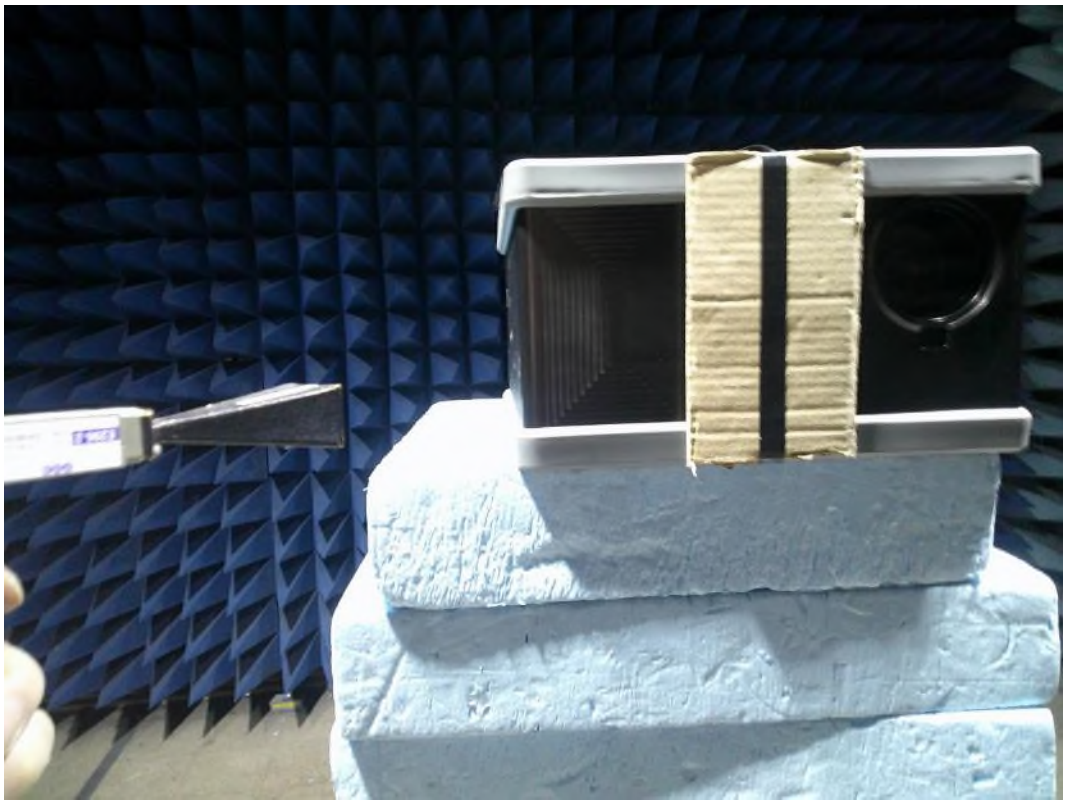
8.11 Radiated emissions above 1 GHz

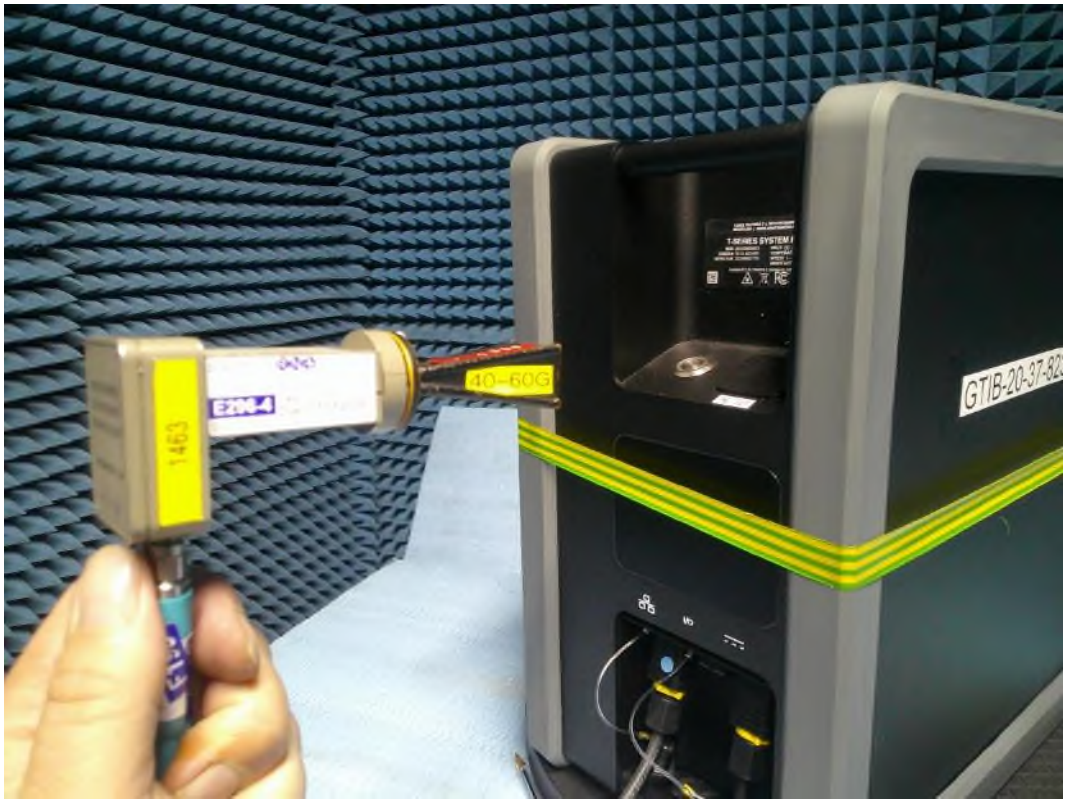


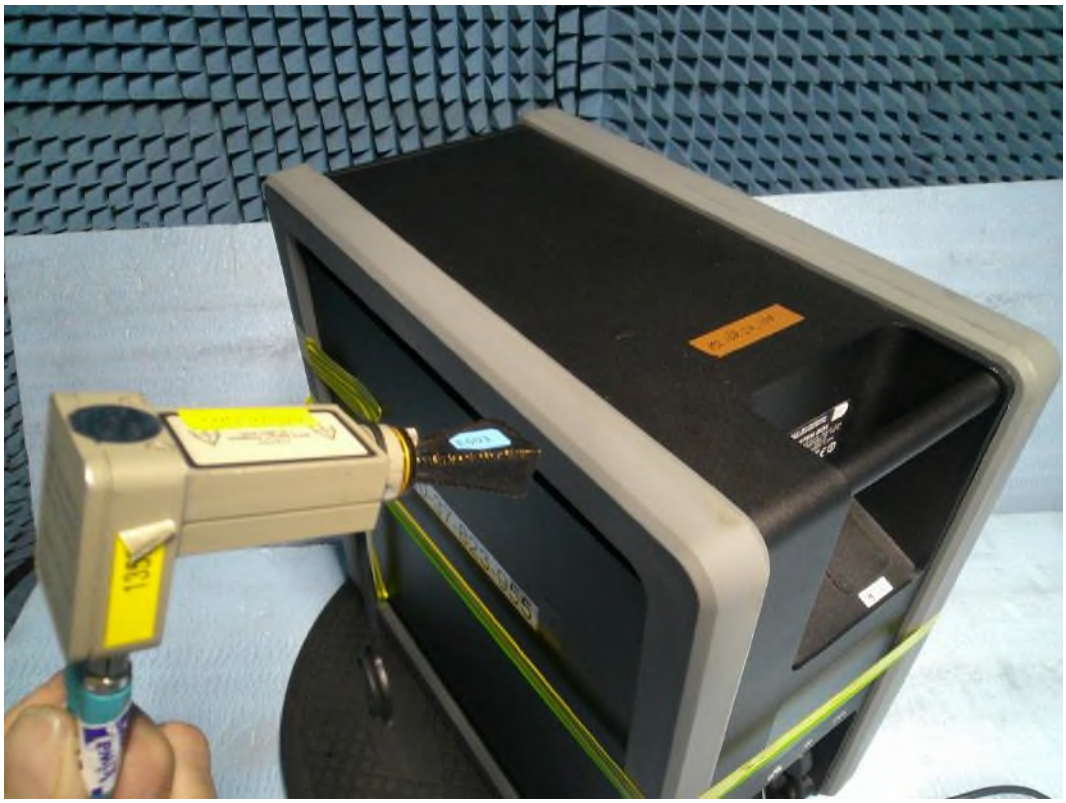









40-60G
1463




H070
GTIB-20-37-823-955

8.12 Radiated emission diagrams

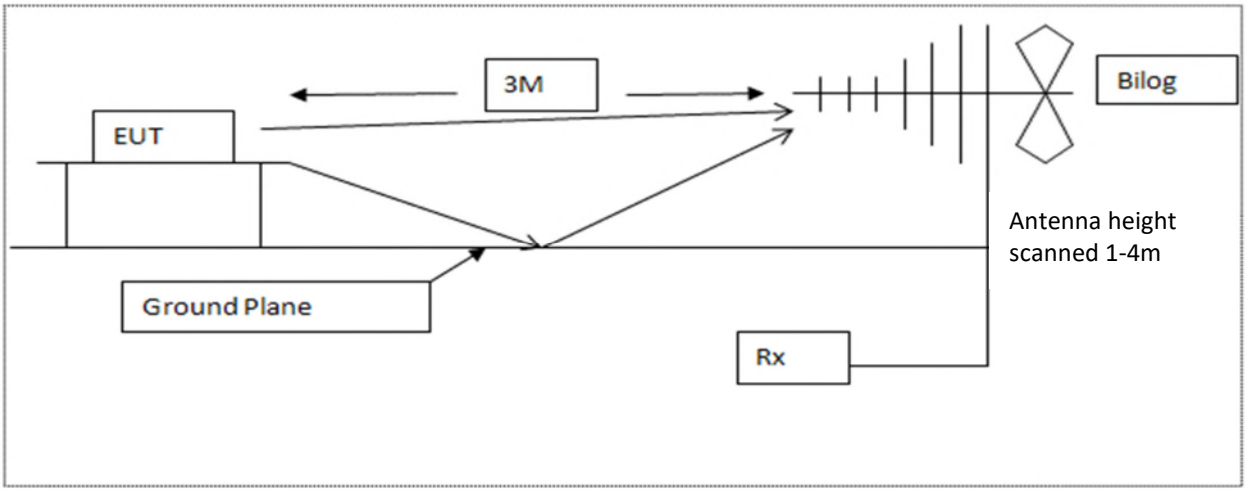


Diagram of the radiated emissions test setup 30 - 1000 MHz

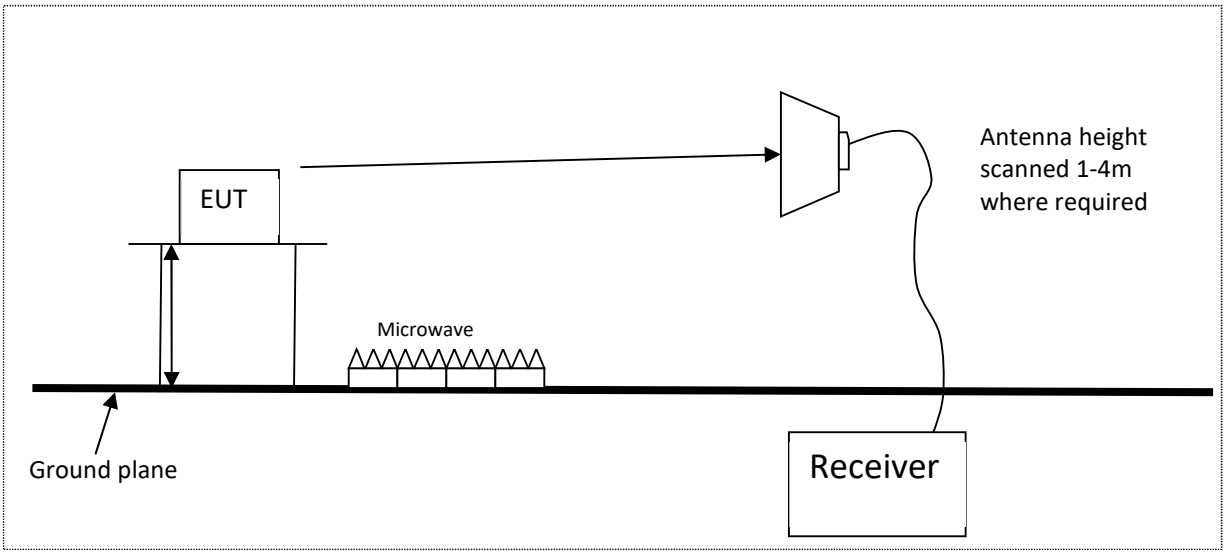


Diagram of the radiated emissions test setup above 1GHz

8.13 AC powerline conducted emission diagram

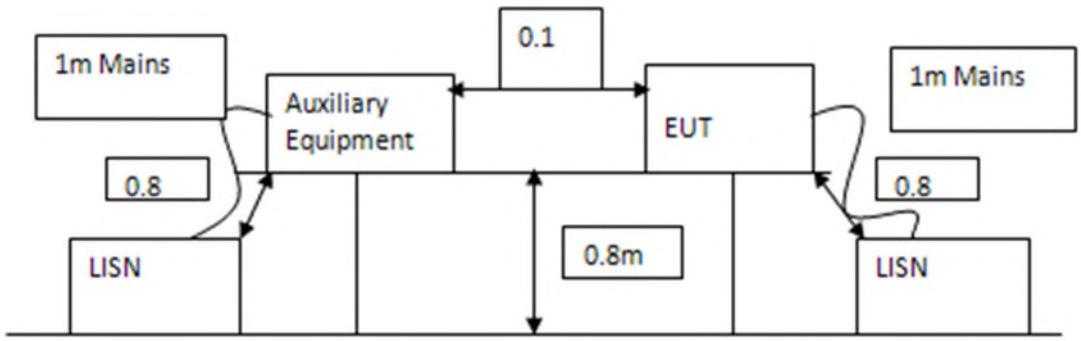


Diagram of the AC conducted emissions test setup

9 Test equipment calibration list

The following is a list of the test equipment used by Kiwa Electrical Compliance 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.

KEC No.	Model No.	Description	Manufacturer	Calibration date	Cal period
E035	11947A	Transient Limiter 9kHz - 200MHz	Hewlett Packard	03-Jan-2024	12 months
E136	3105	Horn Antenna 1 - 12.5 GHz	EMCO	#15-May-2024	12 months
E150	MN2050	LISN 13A	Chase	#03-May-2023	12 months
E296-2	11970A	Harmonic Mixer 26.5-40GHz	Hewlett Packard	20-Jun-2023	12 months
E296-4	11970U	Harmonic Mixer 40-60GHz	Hewlett Packard	07-Jul-2023	24 months
E296-5	11970V	Harmonic Mixer 50-75GHz	Hewlett Packard	05-Jul-2023	24 months
E330	2224-20	Horn Antenna 26.5-40GHz	Flann (FMI)	04-Apr-2024	12 months
E411	N9039A	9 kHz - 1 GHz RF Filter Section	Agilent Technologies	05-Jul-2023	12 months
E503	2524-20	Horn Antenna 50-75GHz	Flann (FMI)	04-Apr-2024	12 months
E520	MD4A	Diplexor IF DC-2.5GHz, LO 5-20GHz	Pacific Millimeter Products	08-Apr-2024	12 months
E580	24240	Horn Std Gain 40GHz - 60 GHz	Flann (FMI)	04-Apr-2024	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	20-Feb-2024	24 months
E718		Horn Std Gain 75-110GHz		04-Apr-2024	12 months
E743	2017 4/2dB	Attenuator 4/2dB 30-1000MHz	RN Electronics	22-Feb-2024	12 months
E755	N9030B	PXA Signal Analyser 3 Hz to 50 GHz	Keysight Technologies	14-Aug-2023	12 months
E856	N9039A	9 kHz - 1 GHz RF Filter Section	Agilent Technologies	22-Mar-2024	12 months
E927	BW-S6-2W263+	Attenuator SMA 6dB 26GHz	Mini-Circuits	04-Jan-2024	12 months
F230	3160-08	Horn Std Gain 12.4 - 18 GHz	ETS-Lindgren	#24-May-2023	12 months
F231	3160-09	Horn Std Gain 18 - 26.5 GHz	ETS-Lindgren	#23-May-2023	12 months
H070	M1970W	Waveguide Harmonic Mixer 75 - 110 GHz	Keysight Technologies	09-Oct-2023	12 months
H071	N9010B	EXA Signal Analyser 10 Hz to 44 GHz	Keysight Technologies	12-Dec-2022	24 months
LPE364	CBL6112A	Antenna BiLog 30MHz - 2GHz	Chase Electronics Ltd	28-Mar-2022	36 months
NSA-M	NSA - M	NSA - Site M	RN Electronics	29-Nov-2021	36 months
TMS81	6502	Antenna Active Loop	EMCO	17-Aug-2023	24 months
TMS82	8449B	Pre-Amplifier 1GHz - 26.5GHz	Agilent Technologies	08-Jan-2024	12 months
TMS937	CCN1000	Mains Flicker	Schaffner	31-Aug-2022	24 months
TMS938	NSG1007	AC Power Source 3kVA	Schaffner	31-Aug-2022	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

No customer equipment was supplied.

10.2 Kiwa Electrical Compliance supplied equipment

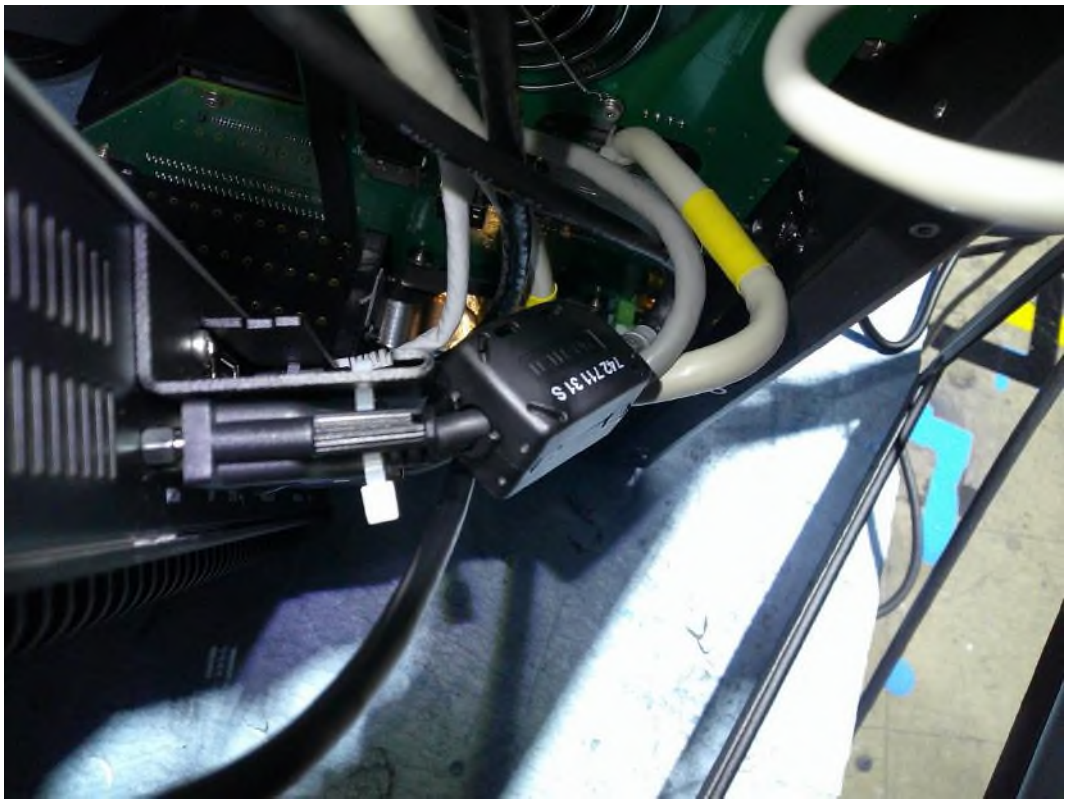
KEC No.	Model No.	Description	Manufacturer	Serial No
I257	R830-13C	Laptop Toshiba Portege	Toshiba	9C086680H

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

Test	Modification	Time of modification	Photo Reference
TX Rad Em Field strength 30M-1G	In order to comply with the spurious emissions limit a ferrite was added to the EUT D-type connector. Please refer to photograph.	Before testing	MOD1,jpg
TX Spurious Rad Em Above 1GHz	In order to comply with the spurious emissions limit a screening cover was added to the reverse side of the antenna array assembly. Please refer to photograph.	Before testing	INT2,jpg



Photograph shows the ferrite fitted to the EUTs PCI connector. Wurth Elektronik part number 74271131S

Photograph shows the aluminium screening cover which was added to the reverse side of the antenna array assembly.

11.2 Modifications during test

No modifications were made during test by Kiwa Electrical Compliance.

12 Description of test sites

Site A Radio Laboratory and Anechoic Chamber

Site B Semi-Anechoic Chamber and Control Room
FCC Registration No. 654321, ISED Registration No. 5612A-4

Site C Transient Laboratory

Site D Screened Room (Conducted Immunity)

Site E Screened Room (Control Room for Site D)

Site F Screened Room (Conducted Emissions)

Site G Screened Room (Control Room for Site H)

Site H 3m Semi-Anechoic Chamber (indoor OATS)
FCC Registration No. 654321, ISED Registration No. 5612A-2, VCCI Registration No. 4065

Site J Transient Laboratory

Site K Screened Room (Control Room for Site M)

Site M 3m Semi-Anechoic Chamber (indoor OATS)
FCC Registration No. 654321, ISED Registration No. 5612A-3

Site N Radio Laboratory

Site Q Fully-Anechoic Chamber

Site OATS 3m and 10m Open Area Test Site
FCC Registration No. 654321, ISED Registration No. 5612A-1

Site R Screened Room (Conducted Immunity)

Site S Safety Laboratory

Site T Transient Laboratory

CAB identifier as issued by Innovation, Science and Economic Development Canada is UK0002
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 Repetition Frequency
PSD	Power Spectral Density
PSU	Power Supply Unit
pW	picoWatts
QAM	Quadrature Amplitude Modulation
QP	Quasi Peak
QPSK	Quadrature Phase Shift Keying
RBW	Resolution 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 ======