
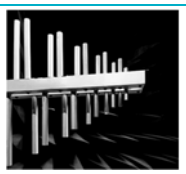


TEST REPORT

Test report no.: 1-8318-24-01-02_TR1-R02

Testing laboratory

cetecom advanced GmbH
Untertuerkheimer Strasse 6 – 10
66117 Saarbruecken / Germany
Phone: + 49 681 5 98 - 0
Fax: + 49 681 5 98 - 9075
Internet: https://cetecomadvanced.com
e-mail: mail@cetecomadvanced.com

Accredited Testing Laboratory:
The testing laboratory (area of testing) is accredited according to DIN EN ISO/IEC 17025 (2018-03) by the Deutsche Akkreditierungsstelle GmbH (DAkkS).
The accreditation is valid for the scope of testing procedures as stated in the accreditation certificate with the registration number:
D-PL-12047-01-00.
ISED Testing Laboratory Recognized Listing Number: DE0001
FCC designation number: DE0002

Applicant

Hormann LLC
450 Airport Road
Sparta, TN38583 / USA
Phone: -/-
Contact: Jürgen Heuving
e-mail: j.heuving@hormann.us

Manufacturer

Hörmann KG Antriebstechnik
Michaelisstr. 1
33803 Steinhagen / GERMANY
Contact: Martin Schmidt
e-mail: m.schmidt.ast@hoermann.de

Test standard/s

FCC - Title 47 CFR Part 15	FCC - Title 47 of the Code of Federal Regulations; Chapter I; Part 15 - Radio frequency devices
RSS - 210 Issue 11	Spectrum Management and Telecommunications Radio Standards Specification - Licence-Exempt Radio Apparatus: Category I Equipment
RSS - Gen Issue 5 incl. Amendment 1 & 2	Spectrum Management and Telecommunications Radio Standards Specification - General Requirements for Compliance of Radio Apparatus

For further applied test standards please refer to section 3 of this test report.

Test Item

Kind of test item:	**Handsender**
Model name:	**HSE4-315-MC**
FCC ID:	**2BML5HSE4-315**
ISED certification number:	**4205A-HSE4315**
Frequencies:	315 MHz; 426 MHz; 469 MHz
Technology tested:	Proprietary
Antenna:	Integrated antenna
Power supply:	2.5 V to 3.2 V DC by Li battery
Temperature range:	0°C to +60°C

This test report is electronically signed and valid without handwritten signature. For verification of the electronic signatures, the public keys can be requested at the testing laboratory.

Test report authorized:

On behalf of

cn=Joachim Wolsdorfer, o=cetecom advanced GmbH, ou=WLD-230605, email=joachim.wolsdorfer@cetecomadvanced.com, c=DE
2025.02.19 13:34:28 +01'00'

Christoph Schneider
Lab Manager
Radio Labs

Test performed:

cn=Tobias Wittenmeier, o=cetecom advanced GmbH, ou=WIT-230601, email=tobias.wittenmeier@cetecomadvanced.com, c=DE
2025.02.19 13:31:19 +01'00'

Tobias Wittenmeier
Testing Manager
Radio Labs

1 Table of contents

2 General information

2.1 Notes and disclaimer

The test results of this test report relate exclusively to the test item specified in this test report. cetecom advanced GmbH does not assume responsibility for any conclusions and generalizations drawn from the test results with regard to other specimens or samples of the type of the equipment represented by the test item.
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This test report replaces the test report with the number 1-8318-24-01-02_TR1-R01 and dated 2025-02-07.

2.2 Application details

Date of receipt of order:	2024-07-18
Date of receipt of test item:	2024-04-10
Start of test:*	2024-04-16
End of test:*	2024-10-01
Person(s) present during the test:	-/-

*Date of each measurement, if not shown in the plot, can be requested. Dates are stored in the measurement software.

2.3 Test laboratories sub-contracted

None

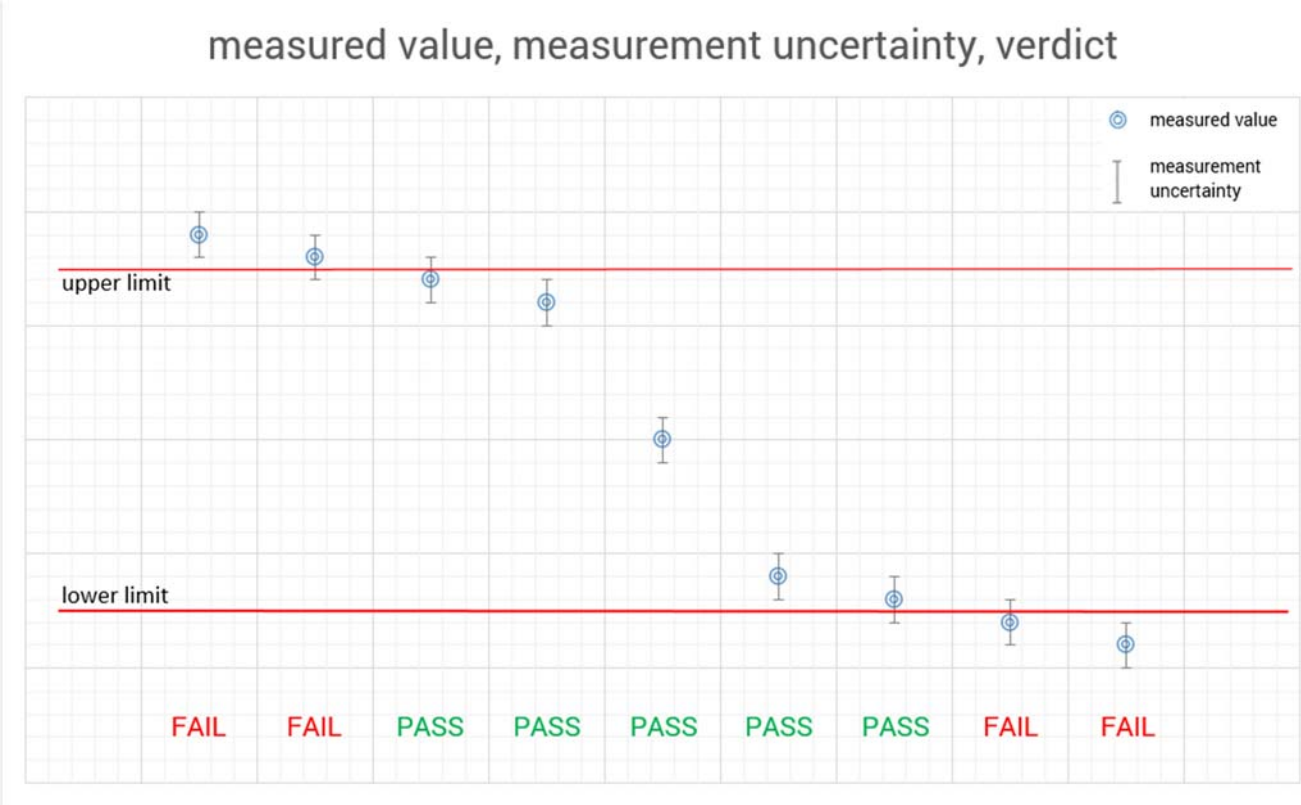
3 Test standard/s, references and accreditations

Test standard	Date	Description
FCC - Title 47 CFR Part 15		FCC - Title 47 of the Code of Federal Regulations; Chapter I; Part 15 - Radio frequency devices
RSS - 210 Issue 11	25.06.2024	Spectrum Management and Telecommunications Radio Standards Specification - Licence-Exempt Radio Apparatus: Category I Equipment
RSS - Gen Issue 5 incl. Amendment 1 & 2	February 2021	Spectrum Management and Telecommunications Radio Standards Specification - General Requirements for Compliance of Radio Apparatus

Guidance	Version	Description
ANSI C63.4a-2017	-/-	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
ANSI C63.10-2020	-/-	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

4 Reporting statements of conformity – decision rule

Only the measured values related to their corresponding limits will be used to decide whether the equipment under test meets the requirements of the test standards listed in chapter 3.
The measurement uncertainty is mentioned in this test report, see chapter 9, but is not taken into account - neither to the limits nor to the measurement results. Measurement results with a smaller margin to the corresponding limits than the measurement uncertainty have a potential risk of more than 5% that the decision might be wrong."



5 Test environment

Temperature	:	T_{nom} T_{max} T_{min}	+22 °C during room temperature tests No tests under extreme conditions required. No tests under extreme conditions required.
Relative humidity content	:		55 %
Barometric pressure	:		1021 hpa
Power supply	:	V_{nom} V_{max} V_{min}	3.0 V DC by Li battery No tests under extreme conditions required.V No tests under extreme conditions required.

6 Test item

6.1 General description

Kind of test item	:	Handsender
Model name	:	HSE4-315-MC
HMN	:	-/-
PMN	:	HSE4-315-MC
HVIN	:	HSE4-315-MC
FVIN	:	EE002945-00.ag
S/N serial number	:	21050021
Hardware status	:	-/-
Software status	:	-/-
Firmware status	:	-/-
Frequencies	:	315 MHz; 426 MHz; 469 MHz
Type of radio transmission Use of frequency spectrum	: :	Modulated carrier
Type of modulation	:	FSK, OOK
Number of channels	:	4
Antenna	:	Integrated antenna
Power supply	:	2.5 V to 3.2 V DC by Li battery
Temperature range	:	0°C to +60°C

6.2 Additional information

The content of the following annexes is defined in the QA. It may be that not all of the listed annexes are necessary for this report, thus some values in between may be missing.

Test setup and EUT photos are included in test report: 1-8318-24-01-01_TR1-A101-R01
1-8318-24-01-01_TR1-A102-R01
1-8318-24-01-01_TR1-A103-R01

7 Description of the test setup

Typically, the calibrations of the test apparatus are commissioned to and performed by an accredited calibration laboratory. The calibration intervals are determined in accordance with the DIN EN ISO/IEC 17025. In addition to the external calibrations, the laboratory executes comparison measurements with other calibrated test systems or effective verifications. Weekly chamber inspections and range calibrations are performed. Where possible, RF generating and signaling equipment as well as measuring receivers and analyzers are connected to an external high-precision 10 MHz reference (GPS-based or rubidium frequency standard).

In order to simplify the identification of the equipment used at some special tests, some items of test equipment and ancillaries can be provided with an identifier or number in the equipment list below (Lab/Item).

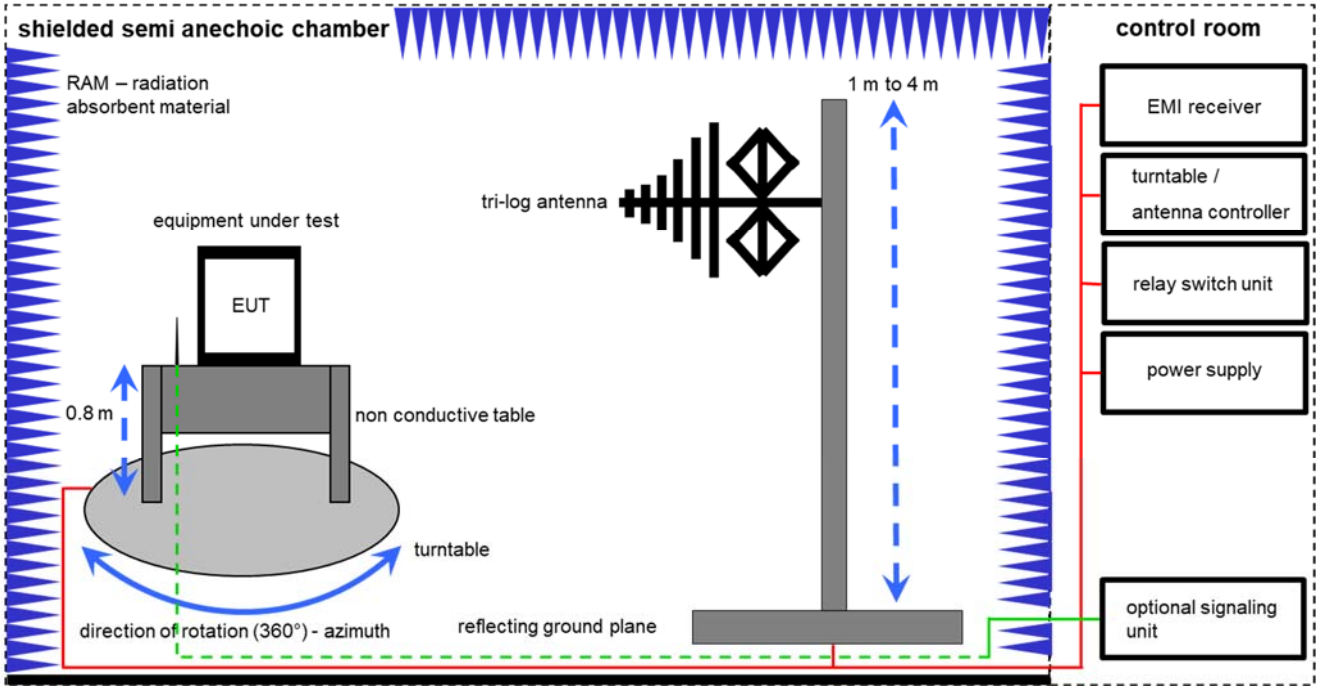
Each block diagram listed can contain several test setup configurations. All devices belonging to a test setup are identified with the same letter syntax. For example: Column Setup and all devices with an A.

Agenda: Kind of Calibration

k/cal	calibration / calibrated	EK	limited calibration
Ne/cnn	not required (k, ev, izw, zw not required)	zw	cyclical maintenance (external cyclical maintenance)
Ev/chk	periodic self verification	izw	internal cyclical maintenance
Ve	long-term stability recognized	g	blocked for accredited testing
vlkl!	Attention: extended calibration interval		
NK!	Attention: not calibrated	*)	next calibration ordered / currently in progress
cpu	check prior usage		

7.1 Shielded semi anechoic chamber

The radiated measurements are performed in vertical and horizontal plane in the frequency range from 30 MHz to 1 GHz in semi-anechoic chambers. The EUT is positioned on a non-conductive support with a height of 0.80 m above a conductive ground plane that covers the whole chamber. The receiving antennas are conform to specifications ANSI C63. These antennas can be moved over the height range between 1.0 m and 4.0 m in order to search for maximum field strength emitted from EUT. The measurement distances between EUT and receiving antennas are indicated in the test setups for the various frequency ranges. For each measurement, the EUT is rotated in all three axes until the maximum field strength is received. The wanted and unwanted emissions are received by spectrum analyzers where the detector modes and resolution bandwidths over various frequency ranges are set according to requirement ANSI C63.



Measurement distance: tri-log antenna 10 meter
EMC32 software version: 10.59.00

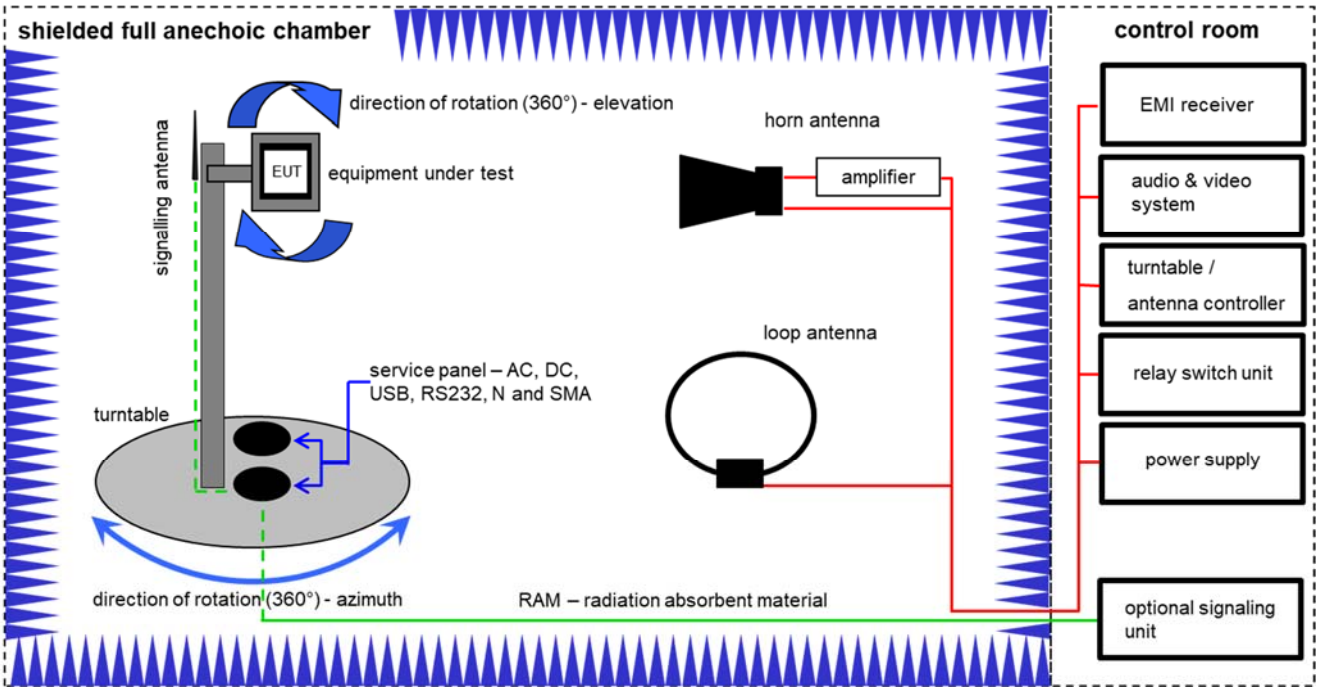
FS = UR + CL + AF
(FS-field strength; UR-voltage at the receiver; CL-loss of the cable; AF-antenna factor)

Example calculation:
FS [dBµV/m] = 12.35 [dBµV/m] + 1.90 [dB] + 16.80 [dB/m] = 31.05 [dBµV/m] (35.69 µV/m)

Equipment table:

No.	Setup	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	A	Switch-Unit	3488A	HP	2719A14505	300000368	ev	-/-	-/-
2	A	Semi anechoic chamber	3000023	MWB AG		300000551	ne	-/-	-/-
3	A	Analyzer-Reference-System (Harmonics and Flicker)	ARS 16/1	SPS	A3509 07/0 0205	300003314	NK!	-/-	-/-
4	A	Antenna Tower	Model 2175	ETS-Lindgren	64762	300003745	izw	-/-	-/-
5	A	Positioning Controller	Model 2090	ETS-Lindgren	64672	300003746	izw	-/-	-/-
6	A	Turntable Interface-Box	Model 105637	ETS-Lindgren	44583	300003747	izw	-/-	-/-
7	A	TRILOG Broadband Test-Antenna 30 MHz - 3 GHz	VULB9163	Schwarzbeck Mess - Elektronik	318	300003696	vlKl!	31.01.2024	31.01.2026
8	A	Turntable	2089-4.0	EMCO		300004394	ne	-/-	-/-
9	A	PC	TecLine	F+W		300004388	ne	-/-	-/-
10	A	EMI Test Receiver	ESR3	Rohde & Schwarz	102587	300005771	k	06.12.2023	31.12.2024

7.2 Shielded fully anechoic chamber



Measurement distance: horn antenna 3 meter; loop antenna 3 meter

FS = UR + CA + AF
(FS-field strength; UR-voltage at the receiver; CA-loss of the signal path; AF-antenna factor)

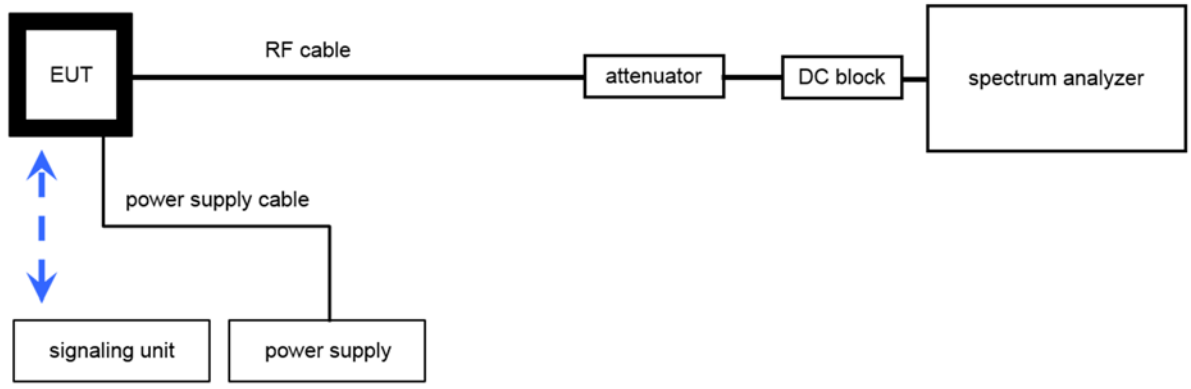
Example calculation:
FS [dBµV/m] = 40.0 [dBµV/m] + (-35.8) [dB] + 32.9 [dB/m] = 37.1 [dBµV/m] (71.61 µV/m)

Equipment table:

No.	Setup	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	B	Double-Ridged Waveguide Horn Antenna 1-18.0GHz	3115	EMCO	8812-3088	300001032	vlKl!	10.10.2023	31.10.2025
2	A	Active Loop Antenna 9 kHz to 30 MHz	6502	EMCO	2210	300001015	vlKl!	02.08.2023	31.08.2025
3	A,B	Anechoic chamber	FAC 3/5m	MWB / TDK	87400/02	300000996	ev	-/-	-/-
4	A,B	Switch / Control Unit	3488A	HP	*	300000199	ne	-/-	-/-
5	B	Highpass Filter	WHKX2.9/18G-12SS	Wainwright	1	300003492	ev	-/-	-/-
6	A,B	EMI Test Receiver 20Hz- 26,5GHz	ESU26	R&S	100037	300003555	k	11.12.2023	31.12.2024
7	B	Highpass Filter	WHK1.1/15G-10SS	Wainwright	3	300003255	ev	-/-	-/-
8	B	Highpass Filter	WHKX7.0/18G-8SS	Wainwright	19	300003790	ne	-/-	-/-
9	B	Broadband Amplifier 0.5-18 GHz	CBLU5184540	CERNEX	22049	300004481	ev	-/-	-/-
10	A,B	4U RF Switch Platform	L4491A	Agilent Technologies	MY50000037	300004509	ne	-/-	-/-
11	A,B	NEXIO EMV-Software	BAT EMC V2022.0.32.0	Nexio		300004682	ne	-/-	-/-
12	A,B	TRILOG Broadband Test-Antenna 30 MHz - 3 GHz	VULB9163	Schwarzbeck Mess - Elektronik	01029	300005379	vlKl!	09.10.2023	31.10.2025

7.3 Conducted measurements

Conducted measurements normal conditions



OP = AV + CA
(OP-output power; AV-analyzer value; CA-loss signal path)

Example calculation:
OP [dBm] = 6.0 [dBm] + 11.7 [dB] = 17.7 [dBm] (58.88 mW)

Equipment table:

No.	Setup	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	A	Loop Antenna		ZEG TS Steinfurt		400001208	ev	-/-	-/-
2	A	RF Cable BNC	RG58	Huber & Suhner		400001209	ev	-/-	-/-
3	A	Signal analyzer	FSV30	Rohde&Schwarz	104365	300005923	k	13.12.2023	31.12.2024

8 Sequence of testing

8.1 Sequence of testing radiated spurious 9 kHz to 30 MHz

Setup

- The equipment is set up to simulate normal operation mode as described in the user manual or defined by the manufacturer.
- If the EUT is a tabletop system, it is placed on a table with 0.8 m height.
- If the EUT is a floor standing device, it is placed directly on the turn table.
- Auxiliary equipment and cables are positioned to simulate normal operation conditions as described in ANSI C 63.4.
- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.
- Measurement distance is 3 m (see ANSI C 63.4) – see test details.
- EUT is set into operation.

Premeasurement*

- The turntable rotates from 0° to 315° using 45° steps.
- The antenna height is 1 m.
- At each turntable position the analyzer sweeps with positive-peak detector to find the maximum of all emissions.

Final measurement

- Identified emissions during the pre-measurement are maximized by the software by rotating the turntable from 0° to 360°.
- Loop antenna is rotated about its vertical axis for maximum response at each azimuth about the EUT. (For certain applications, the loop antenna plane may also need to be positioned horizontally at the specified distance from the EUT)
- The final measurement is done in the position (turntable and elevation) causing the highest emissions with quasi-peak (as described in ANSI C 63.4).
- Final levels, frequency, measuring time, bandwidth, turntable position, correction factor, margin to the limit and limit will be recorded. A plot with the graph of the premeasurement and the limit is stored.

*)Note: The sequence will be repeated three times with different EUT orientations.

8.2 Sequence of testing radiated spurious 30 MHz to 1 GHz

Setup

- The equipment is set up to simulate normal operation mode as described in the user manual or defined by the manufacturer.
- If the EUT is a tabletop system, a table with 0.8 m height is used, which is placed on the ground plane.
- If the EUT is a floor standing device, it is placed on the ground plane with insulation between both.
- Auxiliary equipment and cables are positioned to simulate normal operation conditions as described in ANSI C 63.4.
- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.
- Measurement distance is 10 m or 3 m (see ANSI C 63.4) – see test details.
- EUT is set into operation.

Premeasurement

- The turntable rotates from 0° to 315° using 45° steps.
- The antenna is polarized vertical and horizontal.
- The antenna height changes from 1 m to 3 m.
- At each turntable position, antenna polarization and height the analyzer sweeps three times in peak to find the maximum of all emissions.

Final measurement

- The final measurement is performed for at least six highest peaks according to the requirements of the ANSI C63.4.
- Based on antenna and turntable positions at which the peak values are measured the software maximize the peaks by changing turntable position ± 45° and antenna height between 1 and 4 m.
- The final measurement is done with quasi-peak detector (as described in ANSI C 63.4).
- Final levels, frequency, measuring time, bandwidth, antenna height, antenna polarization, turntable angle, correction factor, margin to the limit and limit are recorded. A plot with the graph of the premeasurement with marked maximum final results and the limit is stored.

8.3 Sequence of testing radiated spurious 1 GHz to 5 GHz

Setup

- The equipment is set up to simulate normal operation mode as described in the user manual or defined by the manufacturer.
- If the EUT is a tabletop system, a 2-axis positioner with 1.5 m height is used.
- If the EUT is a floor standing device, it is placed directly on the turn table.
- Auxiliary equipment and cables are positioned to simulate normal operation conditions as described in ANSI C 63.4.
- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.
- Measurement distance is 3 m (see ANSI C 63.4) – see test details.
- EUT is set into operation.

Premeasurement

- The turntable rotates from 0° to 315° using 45° steps.
- The antenna is polarized vertical and horizontal.
- The antenna height is 1.5 m.
- At each turntable position and antenna polarization the analyzer sweeps with positive peak detector to find the maximum of all emissions.

Final measurement

- The final measurement is performed for at least six highest peaks according to the requirements of the ANSI C63.4.
- Based on antenna and turntable positions at which the peak values are measured the software maximizes the peaks by rotating the turntable from 0° to 360°. This measurement is repeated for different EUT-table positions (0° to 150° in 30°-steps) and for both antenna polarizations.
- The final measurement is done in the position (turntable, EUT-table and antenna polarization) causing the highest emissions with Peak and RMS detector (as described in ANSI C 63.4).
- Final levels, frequency, measuring time, bandwidth, turntable position, EUT-table position, antenna polarization, correction factor, margin to the limit and limit are recorded. A plot with the graph of the premeasurement with marked maximum final results and the limit is stored.

9 Summary of measurement results

☒	No deviations from the technical specifications were ascertained
☐	There were deviations from the technical specifications ascertained
☐	This test report is only a partial test report. The content and verdict of the performed test cases are listed below.

TC Identifier	Description	Verdict	Date	Remark
RF-Testing	CFR Part 15 RSS 210, Issue 11	Passed	2025-02-19	-/-

Test Specification Clause	Test Case	Temperature Conditions	Power Source Voltages	C	NC	NA	NP	Remark
§ 15.35 (c)/ RSS-GEN	Timing of the transmitter (Duty cycle correction factor)	Nominal	Nominal	☒	☐	☐	☐	-/-
§ 15.231 (a) (1)/ RSS-210 Issue 11	Switch off time	Nominal	Nominal	☒	☐	☐	☐	-/-
§ 15.231 (3) (c)/ RSS-210 Issue 11	Emission Bandwidth	Nominal	Nominal	☒	☐	☐	☐	-/-
§ 15.231 (b)/ RSS-210 Issue11	Fieldstrength of Fundamental	Nominal	Nominal	☒	☐	☐	☐	-/-
§ 15.209/ RSS-210 Issue 11	Fieldstrength of harmonics and spurious	Nominal	Nominal	☒	☐	☐	☐	-/-

Note: NA = Not Applicable; NP = Not Performed

10 Measurement results

10.1 Timing of the transmitter

Measurement:

Measurement parameter	
Detector:	Peak
Sweep time:	See plots
Resolution bandwidth:	See plots
Video bandwidth:	See plots
Span:	Zero
Trace-Mode:	Single sweep
Test setup	See chapter 7.3A
Measurement uncertainty	See chapter 9

Limits:

FCC	IC
(c) Unless otherwise specified, e.g. Section 15.255(b), when the radiated emission limits are expressed in terms of the average value of the emission, and pulsed operation is employed, the measurement field strength shall be determined by averaging over one complete pulse train, including blanking intervals, as long as the pulse train does not exceed 0.1 seconds. As an alternative (provided the transmitter operates for longer than 0.1 seconds) or in cases where the pulse train exceeds 0.1 seconds, the measured field strength shall be determined from the average absolute voltage during a 0.1 second interval during which the field strength is at its maximum value. The exact method of calculating the average field strength shall be submitted with any application for certification or shall be retained in the measurement data file for equipment subject to notification or verification.	

Result OOK mode:

Transmit time (Tx on) = 88.1 (Plot 1)
Tx on + Tx off = 100ms (Plot 1)

The peak-to-average correction factor is calculated with 20Log [Tx on/(Tx on + Tx off)].
Hereby the peak-to-average correction factor is -1.1dB

Result FSK mode (valid for all FSK frequencies):

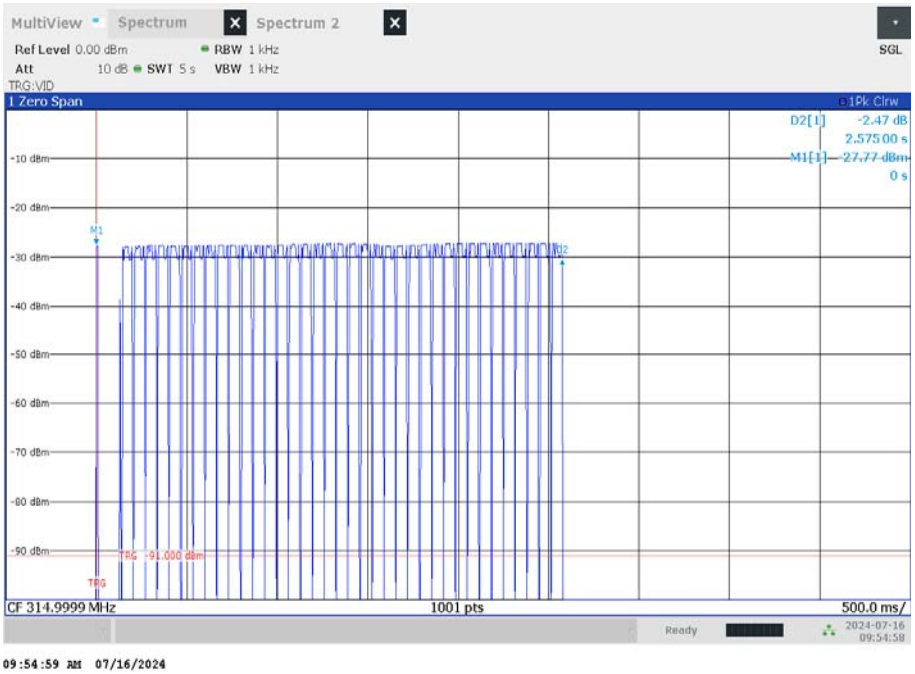
Transmit time (Tx on) = 3ms (Plot 1)
Tx on + Tx off = 100ms (Plot 1)

The peak-to-average correction factor is calculated with 20Log [Tx on/(Tx on + Tx off)].
Hereby the peak-to-average correction factor is -30.5dB

Plots OOK mode:

Plot 1: Transmit burst

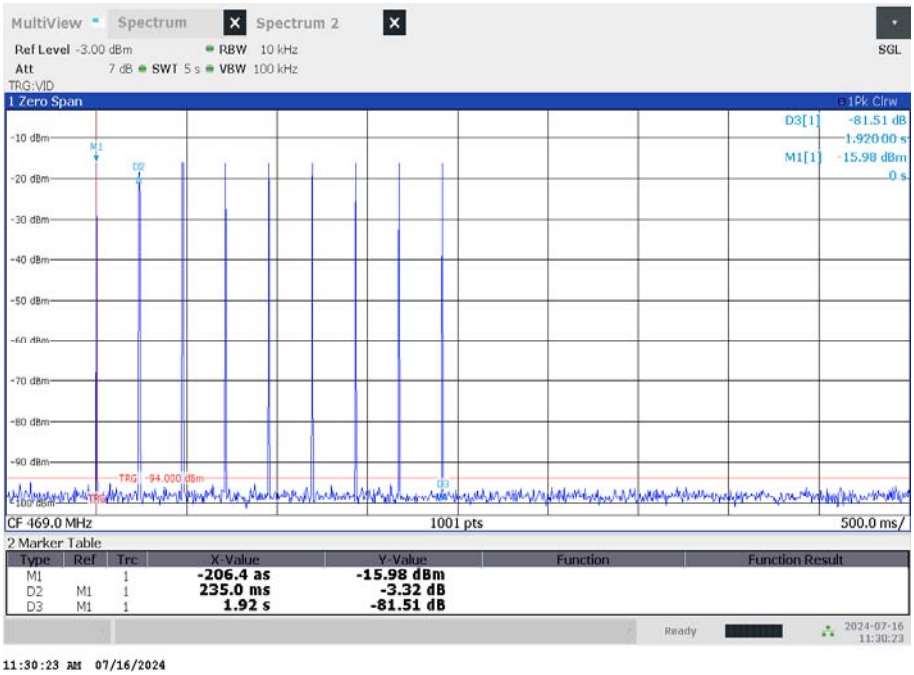
Plot 2: Timing of the transmitter



Plots FSK mode (valid for all FSK frequencies):

Plot 1: Transmit burst

Plot 2: Timing of the transmitter



10.2 Switch off time

Measurement:

Measurement parameter	
Detector:	Peak
Sweep time:	Depends on the pulse train
Resolution bandwidth:	1 MHz
Video bandwidth:	3 MHz
Span:	Zero
Trace-Mode:	Single sweep
Test setup	See chapter 7.3A
Measurement uncertainty	See chapter 9

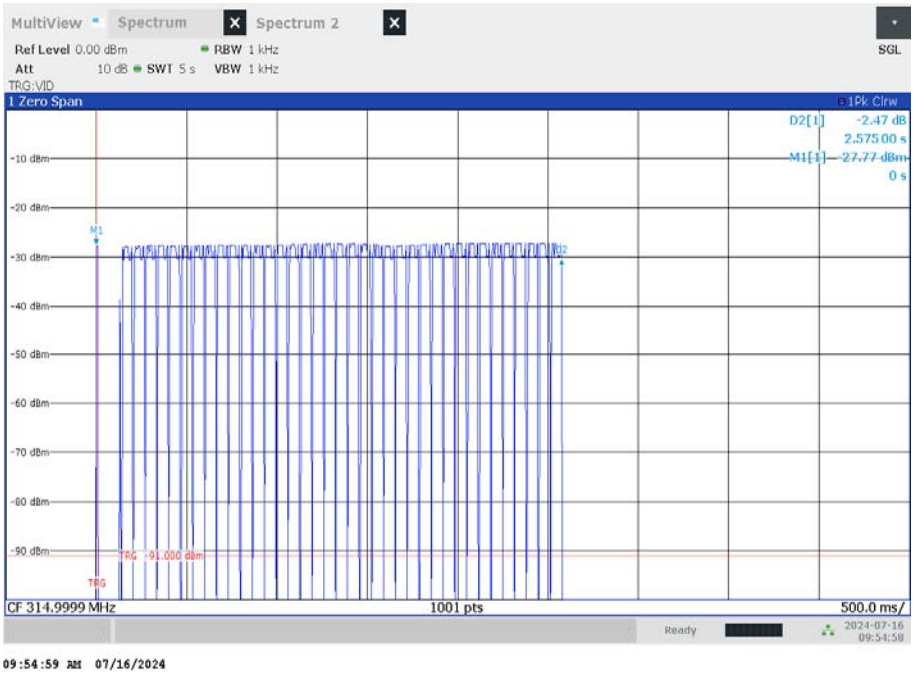
Limits:

FCC	IC
A manually operated transmitter shall employ a switch that will automatically deactivate the transmitter within not more than 5 seconds of being released.	

Results: see Plots!

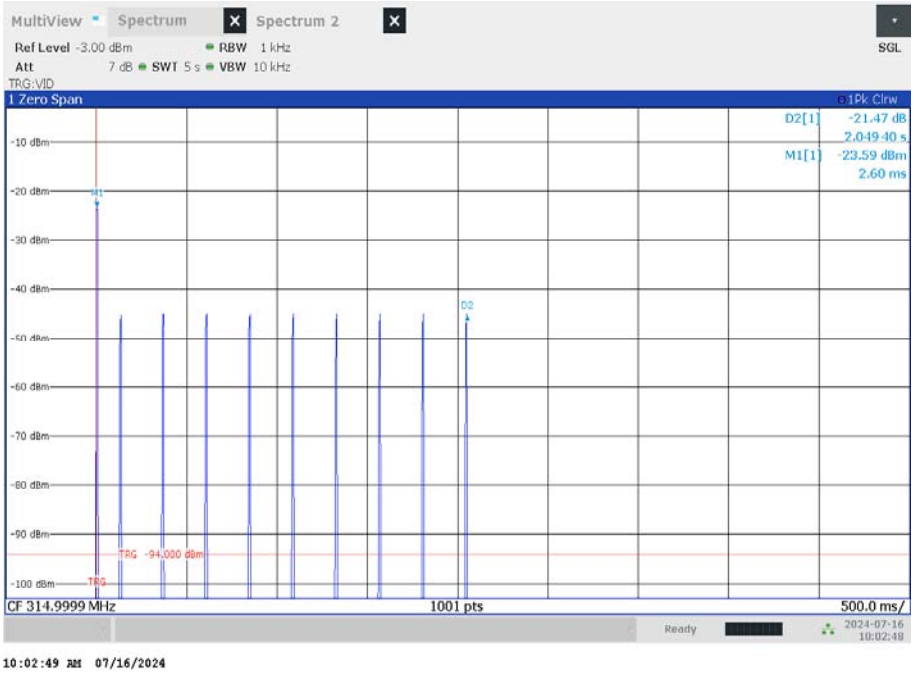
Results:

Plot 1: TX on time OOK mode



The EUT automatically ceases transmission within 2.6s after releasing the switch.

Plot 2: TX on time FSK mode (valid for all FSK frequencies)



The EUT automatically ceases transmission within 2.05 s after releasing the switch.

10.3 Emission bandwidth

Measurement:

Measurement of the 99 % bandwidth of the modulated signal

Measurement parameter	
Detector:	Peak
Sweep time:	Auto
Resolution bandwidth:	1% to 5% of the OBW
Video bandwidth:	3 x RBW
Span:	See plots
Trace-Mode:	Max. hold

Limits:

FCC	IC
The OBW shall not be wider than 0.25% of the centre frequency.	

Result:

315 MHz OOK

99% emission bandwidth	Limit
5.79 kHz	787.5 kHz

315 MHz FSK

99% emission bandwidth	Limit
214.18 kHz	787.5 kHz

426 MHz FSK

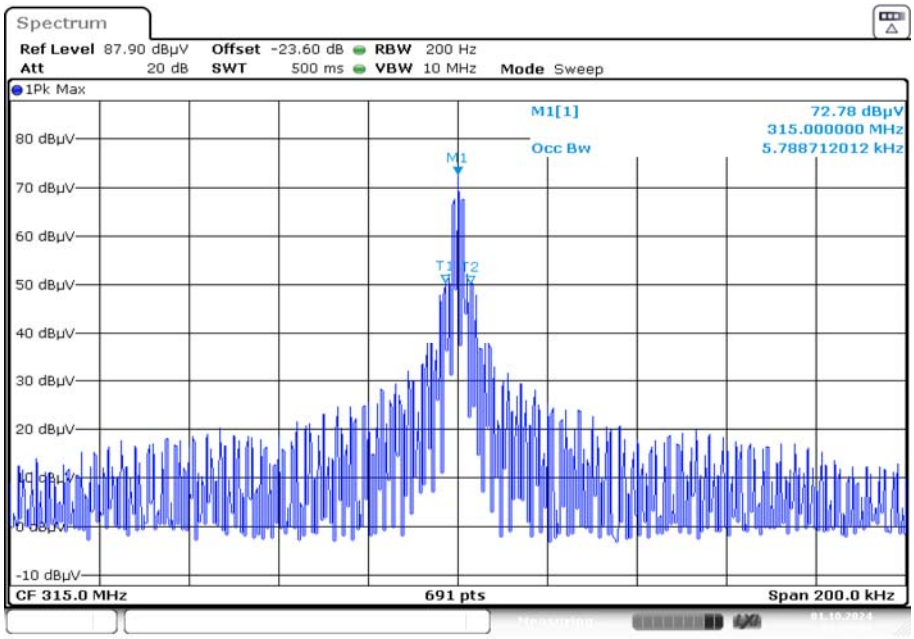
99% emission bandwidth	Limit
214.18 kHz	1065.0 kHz

469 MHz FSK

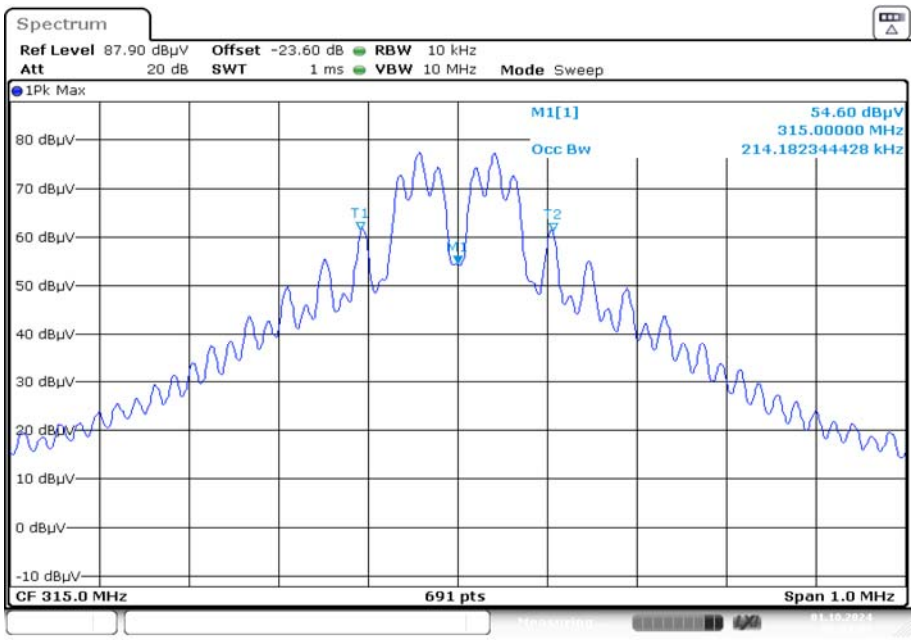
99% emission bandwidth	Limit
215.63 kHz	1172.5 kHz

Plots 99% emission bandwidth:

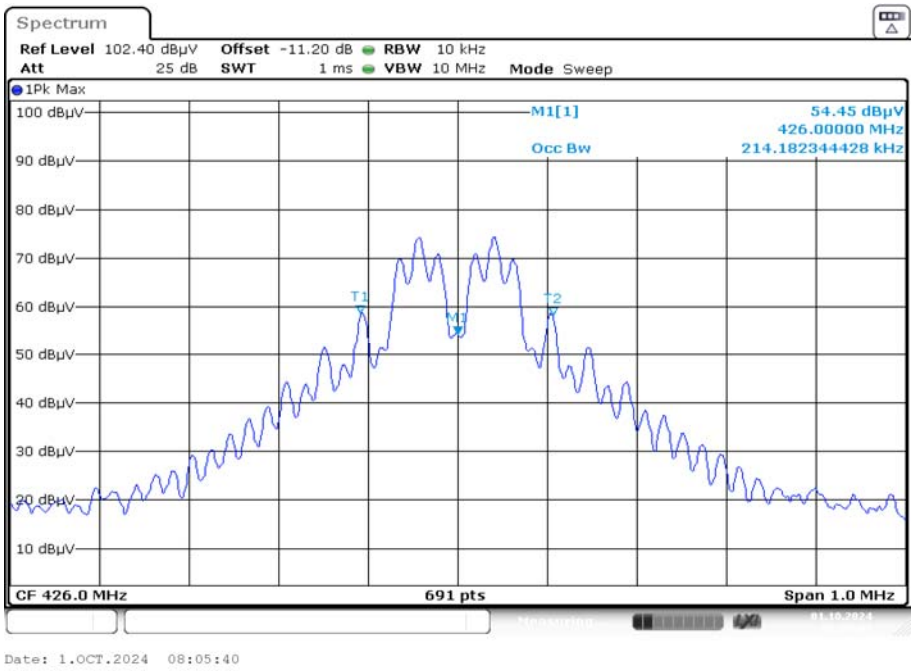
Plot 1: 315 MHz OOK



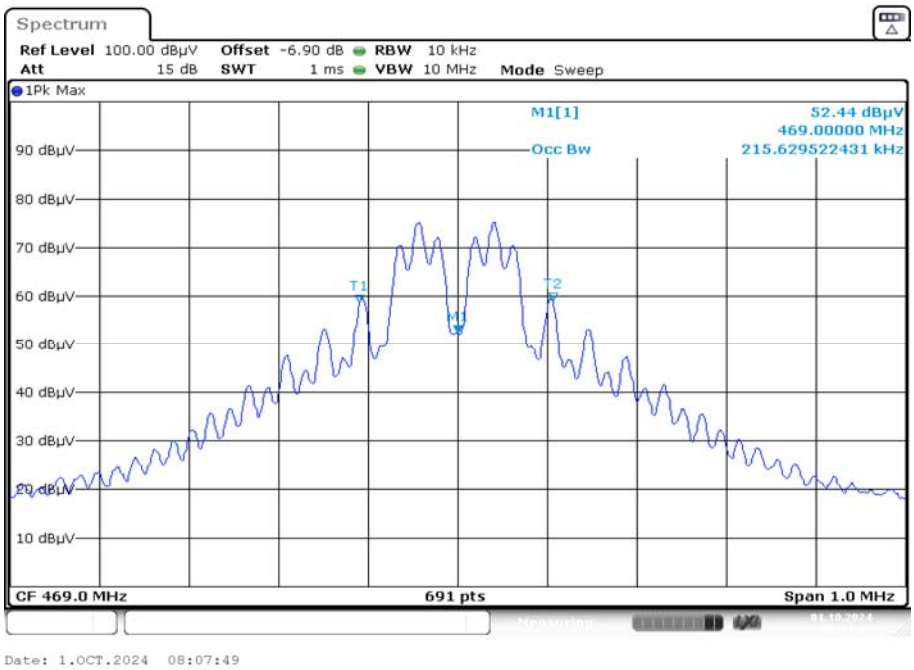
Plot 2: 315 MHz FSK



Plot 3: 426 MHz FSK



Plot 4: 469 MHz FSK



10.4 Field strength of the fundamental

Measurement:

Measurement parameter	
Detector:	Peak / pulse averaging / quasi peak
Sweep time:	Auto
Resolution bandwidth:	120 kHz
Video bandwidth:	3 x RBW
Span:	Zero
Trace-Mode:	Max. hold
Test setup	See chapter 7.1A
Measurement uncertainty	See chapter 9

Limits:

FCC		IC
Field strength of the fundamental. In addition to the provisions of Section 15.205, the field strength of emissions from intentional radiators operated under this Section shall not exceed the following:		
Fundamental Frequency (MHz)	**Field strength of Fundamental (µV/m)**	**Measurement distance (m)**
40.66 – 40.70	2,250	3
70-130	1,250	3
130-174	1,250 to 3,750	3
174-260	3,750	3
260-470	3,750 to 12,500	3
Above 470	12,500	3

Where F is the frequency in MHz, the formulas for calculating the maximum permitted fundamental field strengths are as follows:

- for the band 130-174 MHz, µV/m at 3 meters = 56.81818(F) - 6136.3636;
- for the band 260-470 MHz, µV/m at 3 meters = 41.6667(F) - 7083.3333.

Result:

TEST CONDITIONS		MAXIMUM POWER (dBµV/m at 3 m distance)		
Frequency		315 MHz OOK	315 MHz OOK	Limit
Mode		Peak	Average	
T_{nom}	V_{nom}	76.0	74.9*	75.62

TEST CONDITIONS		MAXIMUM POWER (dBµV/m at 3 m distance)		
Frequency		315 MHz FSK	315 MHz FSK	Limit
Mode		Peak	Average	
T_{nom}	V_{nom}	82.0	51.5*	75.62

TEST CONDITIONS		MAXIMUM POWER (dBµV/m at 3 m distance)		
Frequency		426 MHz FSK	426 MHz FSK	Limit
Mode		Peak	Average	
T_{nom}	V_{nom}	86.3	55.8*	80.56

TEST CONDITIONS		MAXIMUM POWER (dBµV/m at 3 m distance)		
Frequency		469 MHz FSK	469 MHz FSK	Limit
Mode		Peak	Average	
T_{nom}	V_{nom}	78.5	48.0*	81.91

* Calculated from 10 meter to 3 meter with 10.46 dB
*Value recalculated from Peak-to-Average correction factor described in 6.1

10.5 Field strength of the harmonics and spurious

Measurement:

Measurement parameter	
Detector:	Peak / average / quasi peak
Sweep time:	Auto
Resolution bandwidth:	200 Hz / 9 kHz / 120 kHz
Video bandwidth:	3 x RBW
Span:	See plots
Trace-Mode:	Max. hold
Test setup	See chapter 7.1A & 7.2A,B
Measurement uncertainty	See chapter 9

Limits: Part 15.231

In addition to the provisions of Section 15.205, the field strength of emissions from intentional radiators operated under this Section shall not exceed the following:

FCC		IC
FCC Part 15.231		
Fundamental Frequency (MHz)	**Field strength of spurious (µV/m)**	**Measurement distance (m)**
40.66 – 40.70	225	3
70-130	125	3
130-174	125 to 375	3
174-260	375	3
260-470	375 to 1,250	3
Above 470	1,250	3

Spurious emissions shall be attenuated to the average (or, alternatively, CISPR quasi-peak) limits shown in this table or to the general limits shown in Section 15.209, whichever limit permits a higher field strength.

FCC		
FCC Part 15.209		
Frequency (MHz)	**Field strength (µV/m)**	**Measurement distance (m)**
0.009 – 0.490	2400/F(kHz)	300
0.490 – 1.705	24000/F(kHz)	30
1.705 – 30	30	30
30 – 88	100	3
88 – 216	150	3
216 – 960	200	3
above 960	500	3

IC		
Frequency (MHz)	Field strength (µA/m)	Measurement distance (m)
0.009 – 0.490	6.37/F (F in kHz)	300
0.490 – 1.705	63.7/F (F in kHz)	30
1.705 – 30	0.08 (-22 dBµA/m)	30

Results: Spurious emissions within the restricted bands (Part15.205 & 15.209)

Fundamental Frequency	Spurious Frequency	Detector	Limit max. allowed [dBµV/m]	Amplitude of emission [dBµV/m]
315 MHz OOK	All emissions were more than 10 dB below the limit.			
315 MHz FSK	1575 MHz	Peak	74	51.3
		AVG	54	20.8
426 MHz FSK	All emissions were more than 10 dB below the limit.			
469 MHz FSK	1407 MHz	Peak	74	52.3
		AVG	54	21.8

For emissions below 1 GHz, see table below the plots.

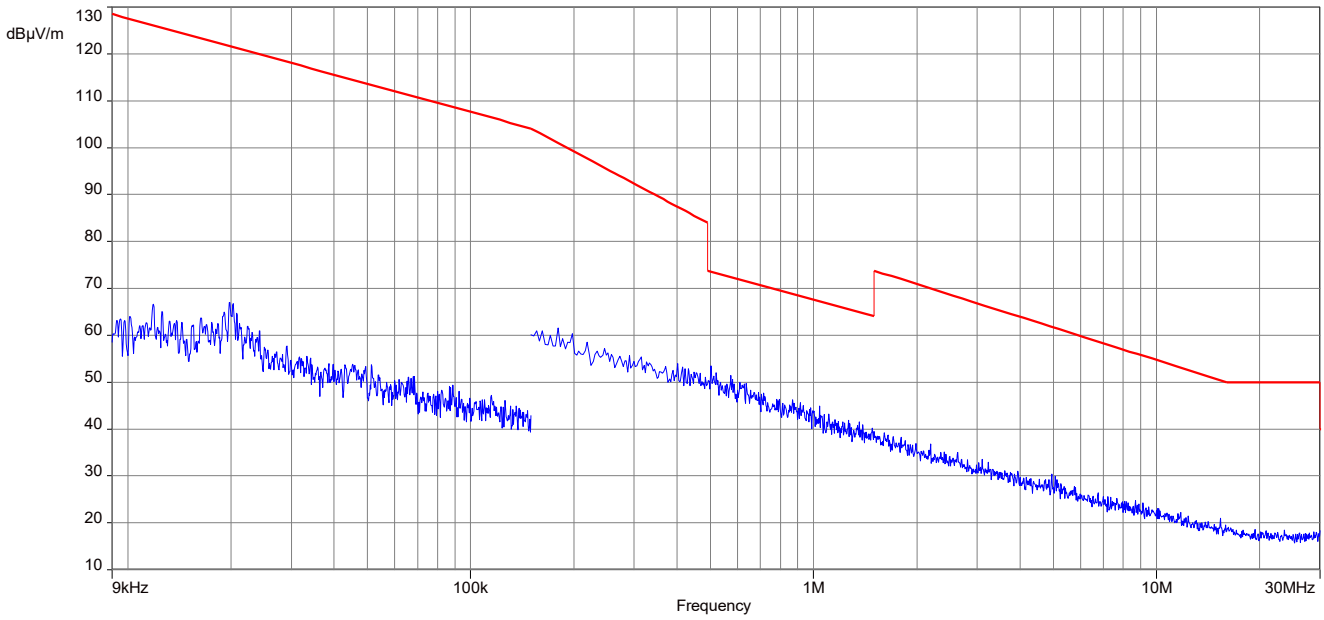
Results: Spurious emissions outside the restricted bands (Part15.231)

Fundamental Frequency	Spurious Frequency	Detector	Limit max. allowed [dBµV/m]	Amplitude of emission [dBµV/m]
All frequencies	All emissions were more than 10 dB below the limit.			

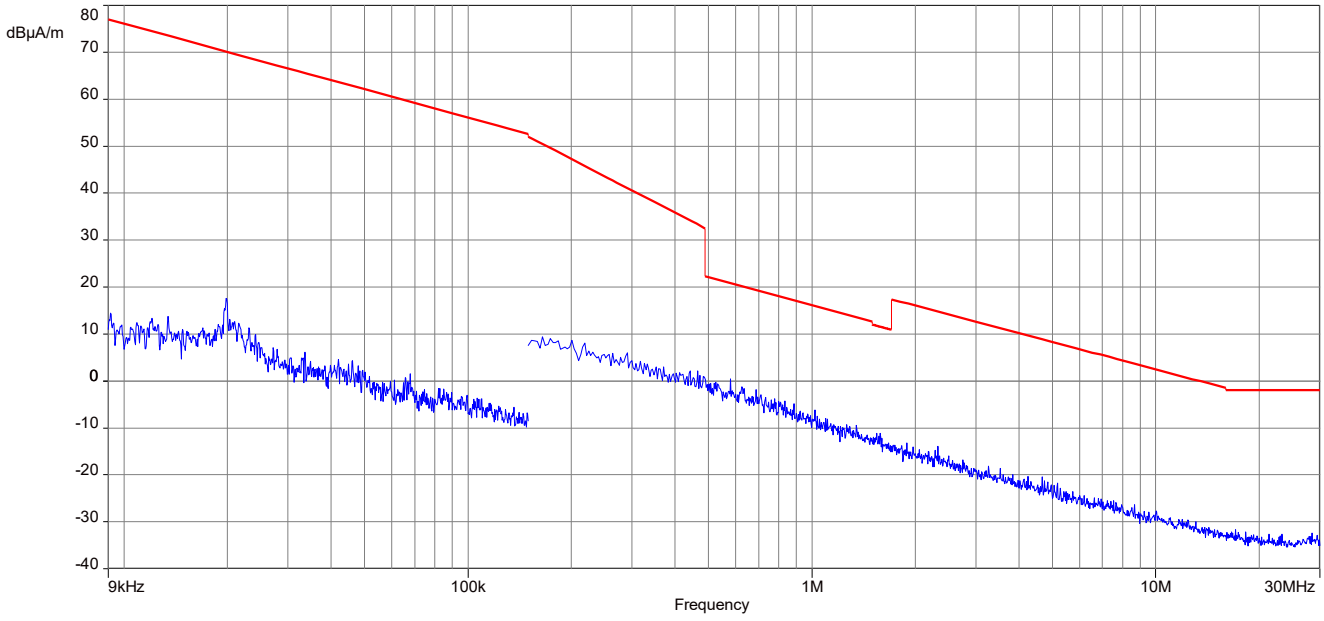
For emissions below 1 GHz, see table below the plots.

Plots 315 MHz OOK:

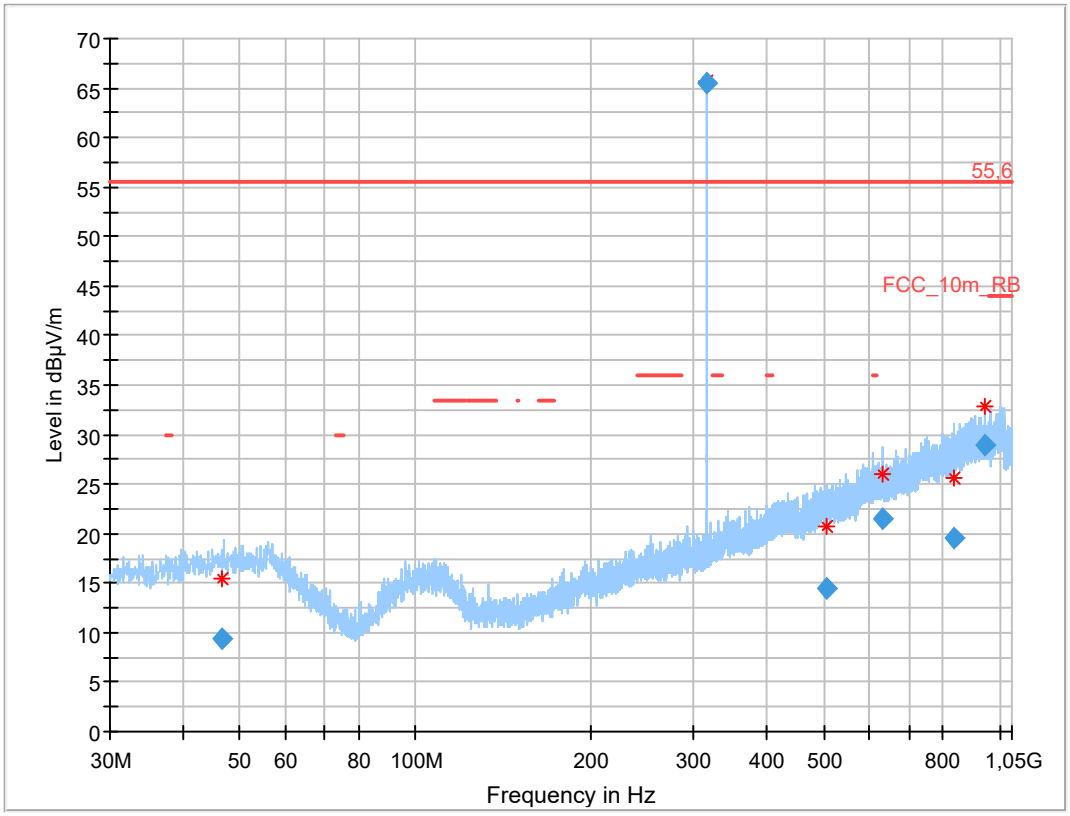
Plot 1: 9 kHz to 30 MHz FCC



Plot 2: 9 kHz to 30 MHz IC



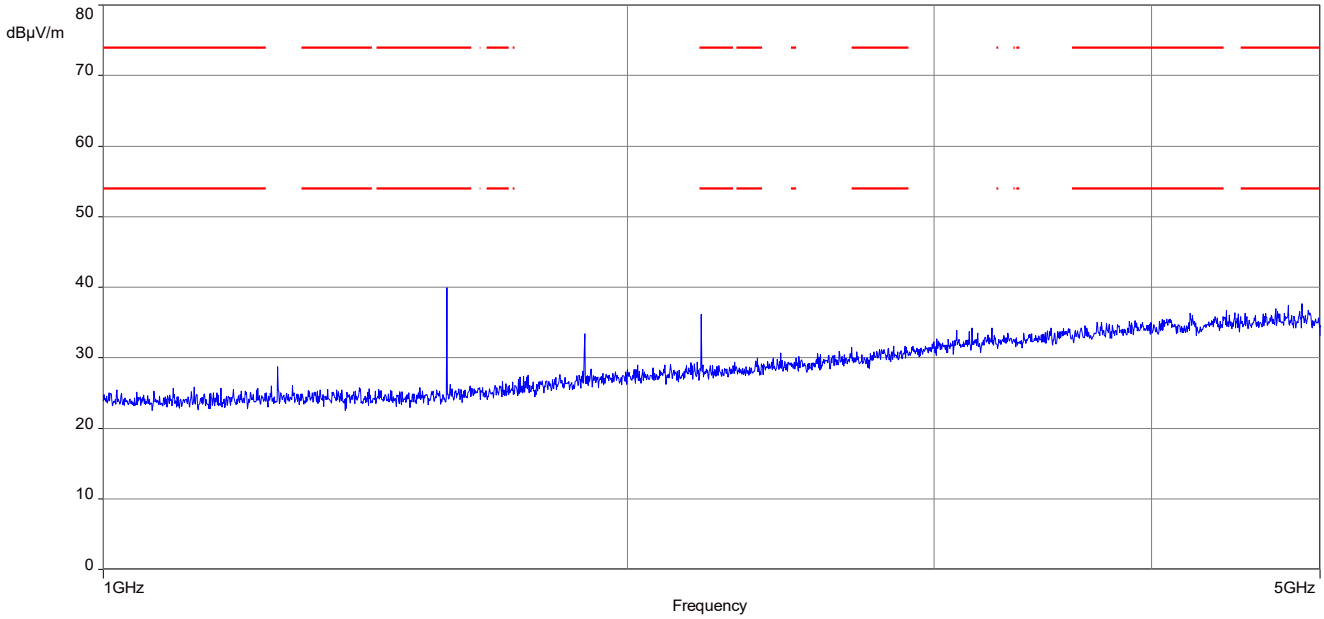
Plot 3: 30 MHz to 1000 MHz, vertical & horizontal polarisation



Final_Result

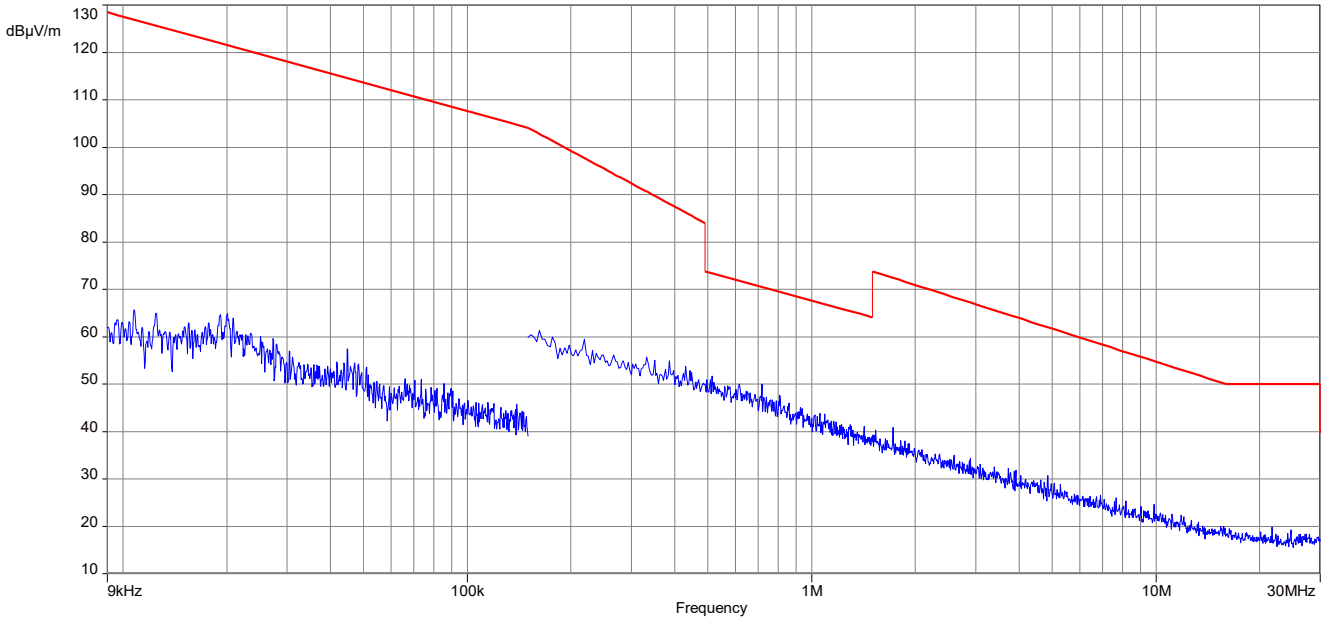
Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
46.797	9.37	---	---	1000	120.0	400.0	V	246	15
315.000	65.48	---	---	1000	120.0	280.0	H	286	16
505.475	14.46	---	---	1000	120.0	290.0	V	90	20
630.016	21.44	---	---	1000	120.0	243.0	V	0	22
837.783	19.51	---	---	1000	120.0	232.0	H	13	24
945.013	28.95	---	---	1000	120.0	306.0	H	45	25

Plot 4: 1000 MHz to 5 GHz, vertical & horizontal polarisation

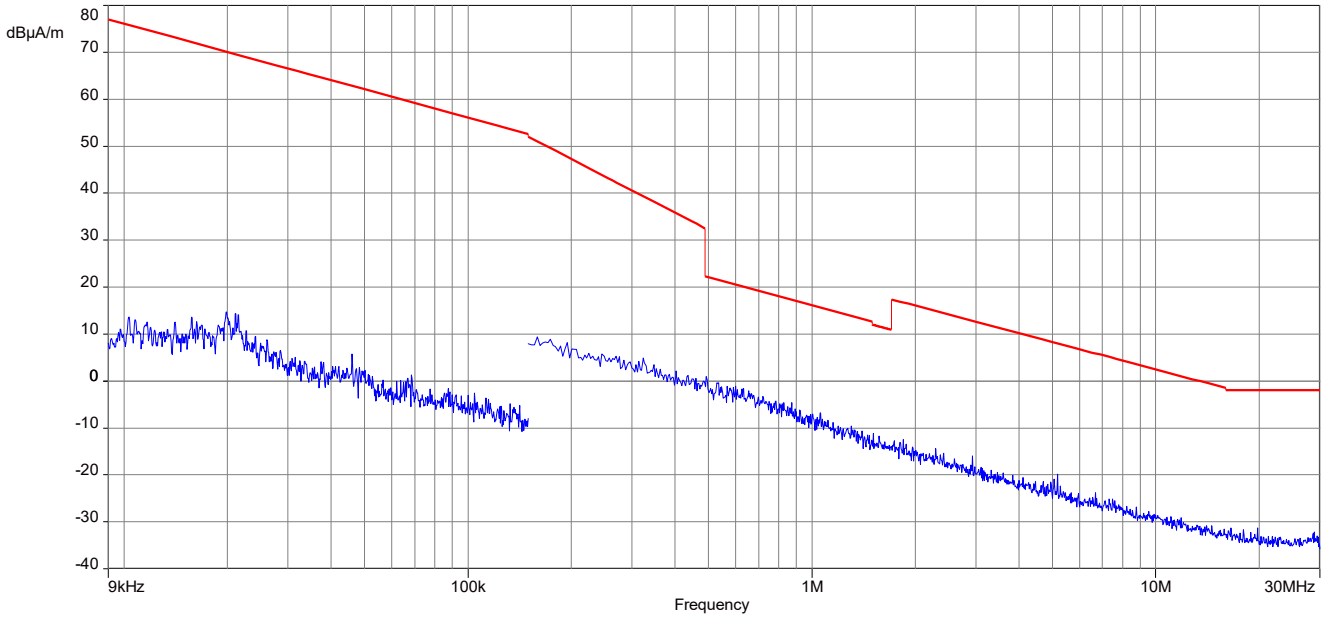


Plots 315 MHz FSK:

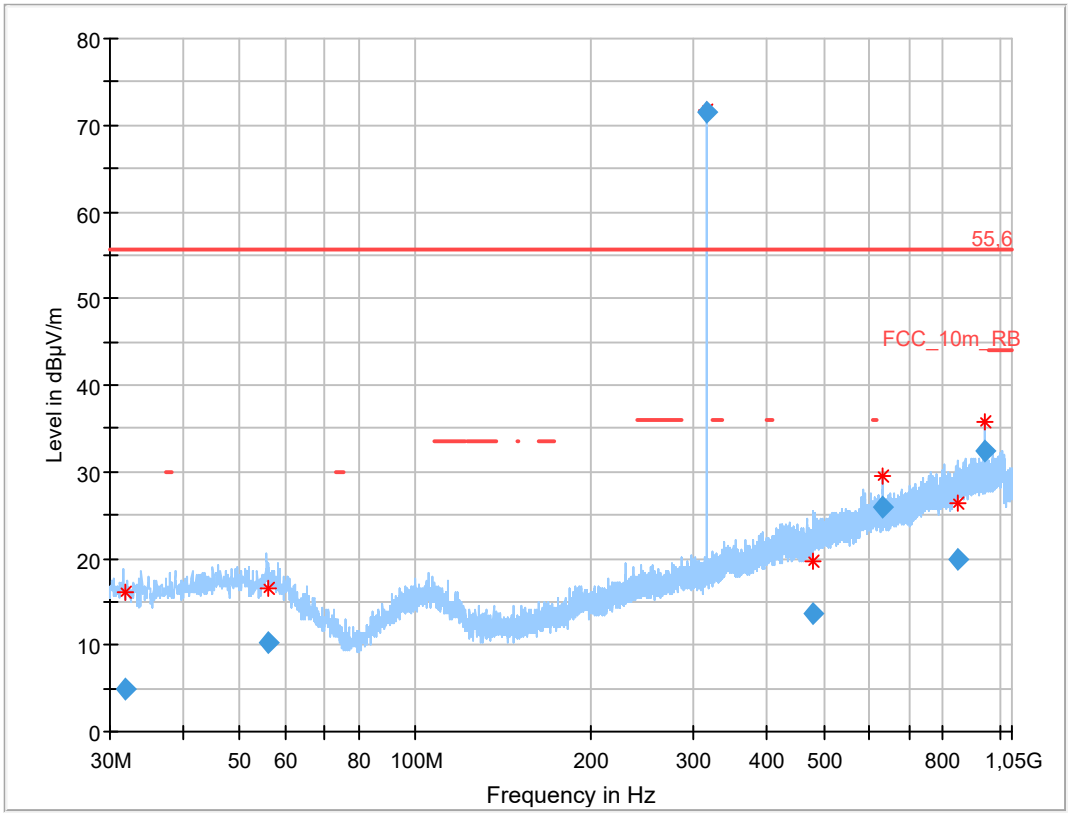
Plot 1: 9 kHz to 30 MHz FCC



Plot 2: 9 kHz to 30 MHz IC



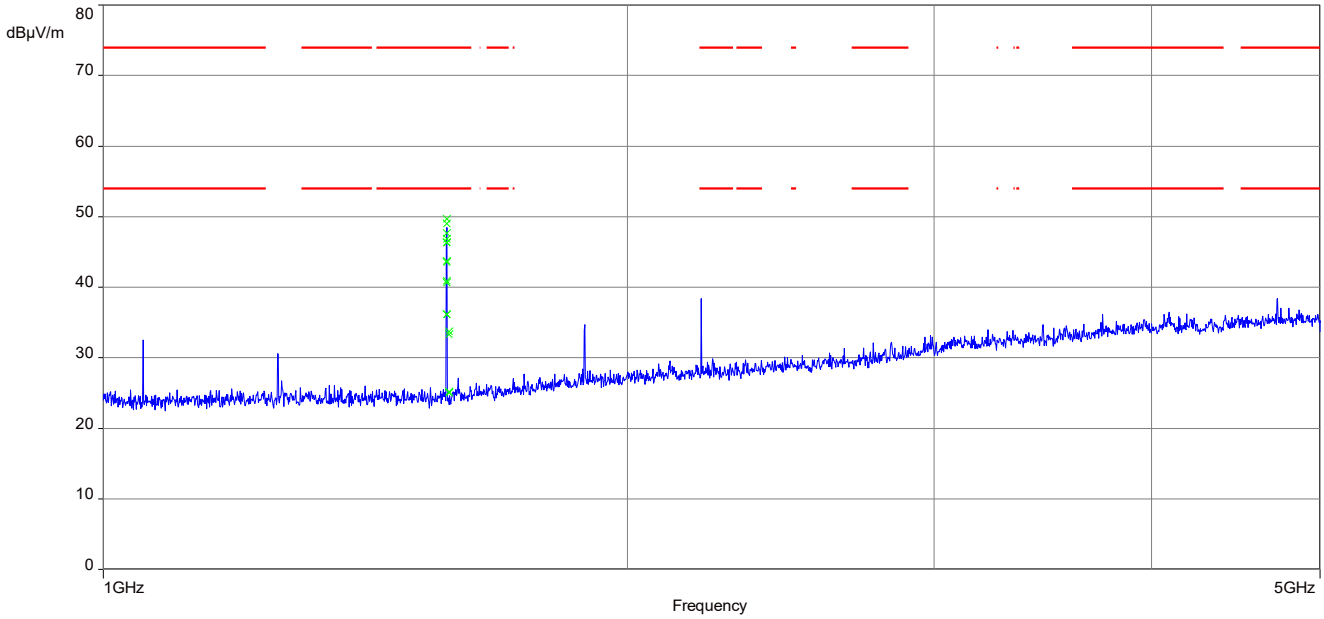
Plot 3: 30 MHz to 1000 MHz, vertical & horizontal polarisation



Final_Result

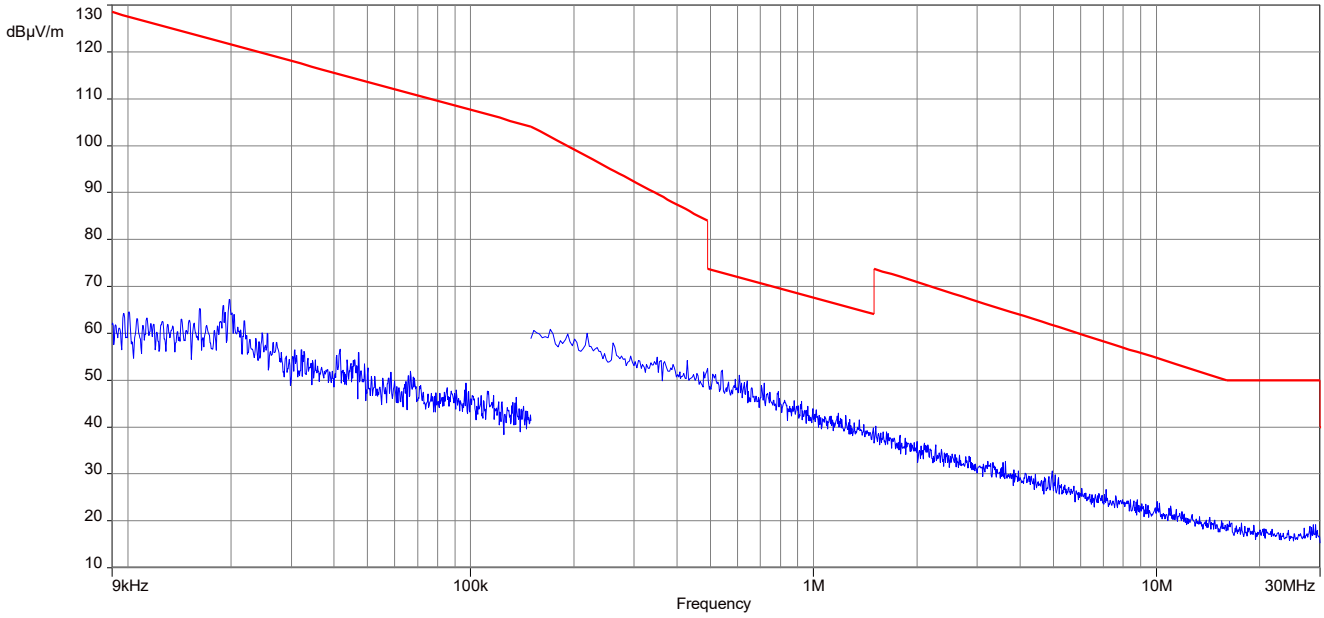
Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
31.792	4.95	30.0	25.1	1000	120.0	127.0	V	136	13
56.090	10.19	30.0	19.8	1000	120.0	200.0	V	180	16
315.043	71.52	36.0	-35.5	1000	120.0	287.0	H	283	16
478.246	13.74	36.0	22.3	1000	120.0	347.0	H	180	19
630.097	25.82	36.0	10.2	1000	120.0	272.0	V	45	22
847.656	19.93	36.0	16.1	1000	120.0	193.0	H	45	24
944.889	32.36	36.0	3.6	1000	120.0	300.0	H	81	25

Plot 4: 1000 MHz to 5 GHz, vertical & horizontal polarisation

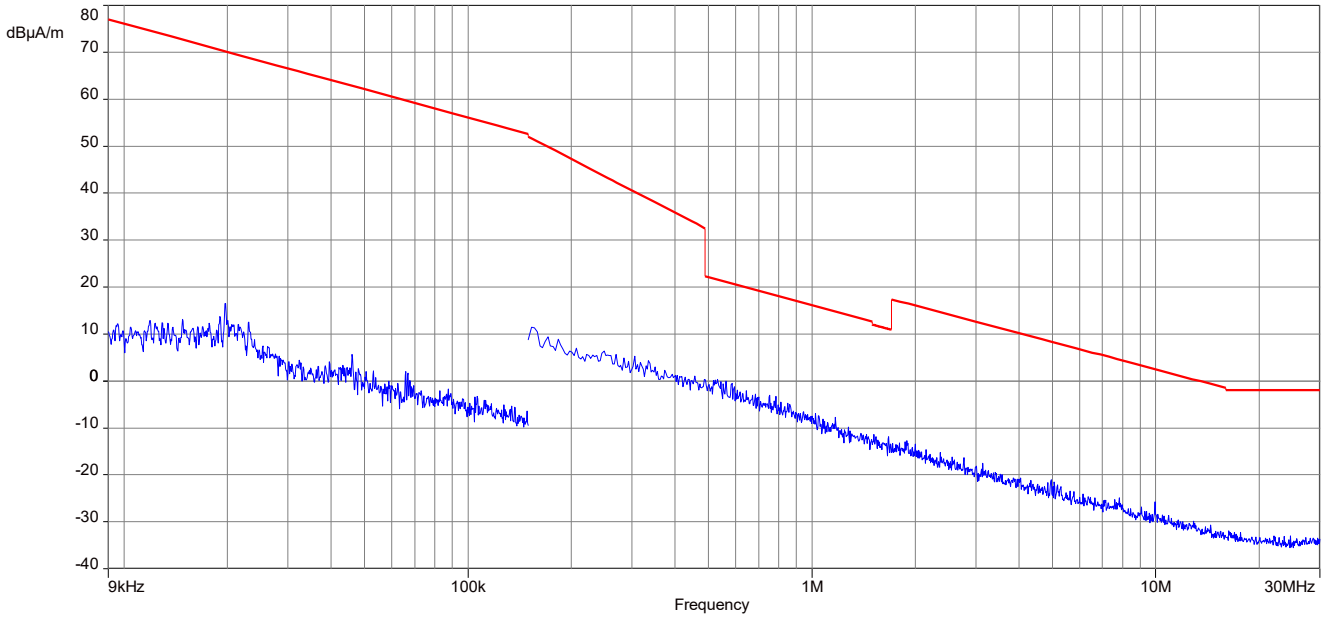


Plots 426 MHz FSK:

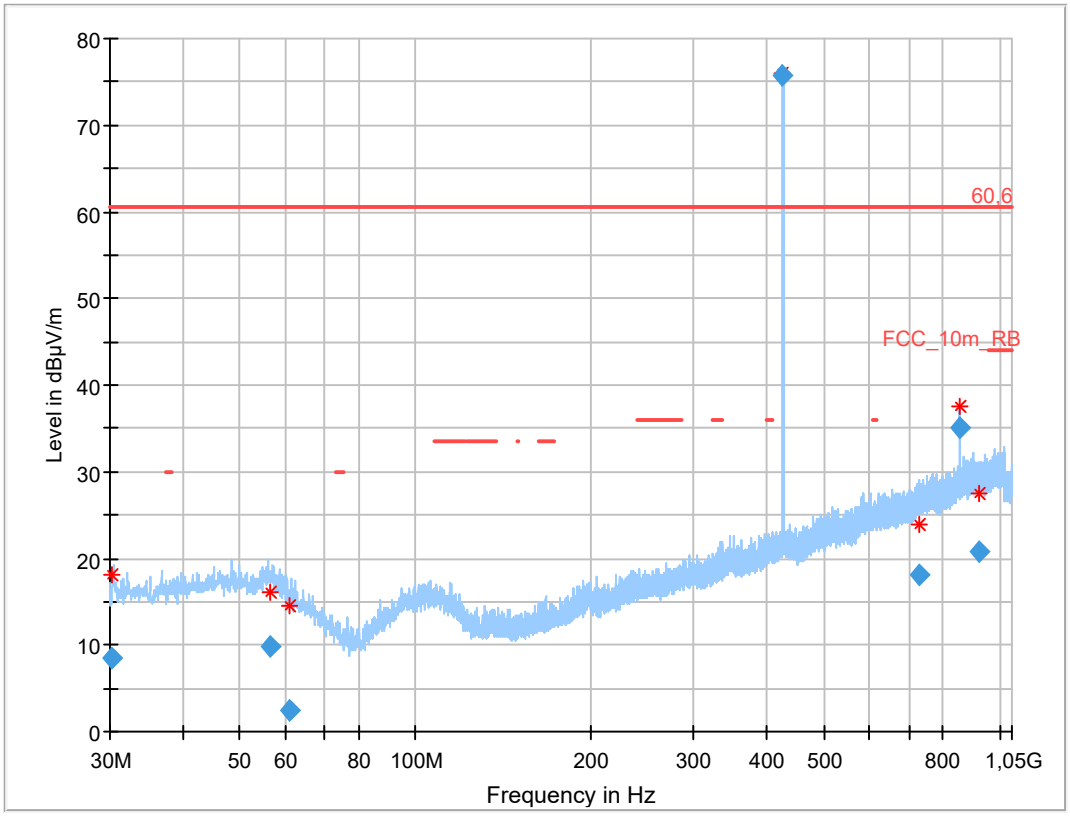
Plot 1: 9 kHz to 30 MHz FCC



Plot 2: 9 kHz to 30 MHz IC



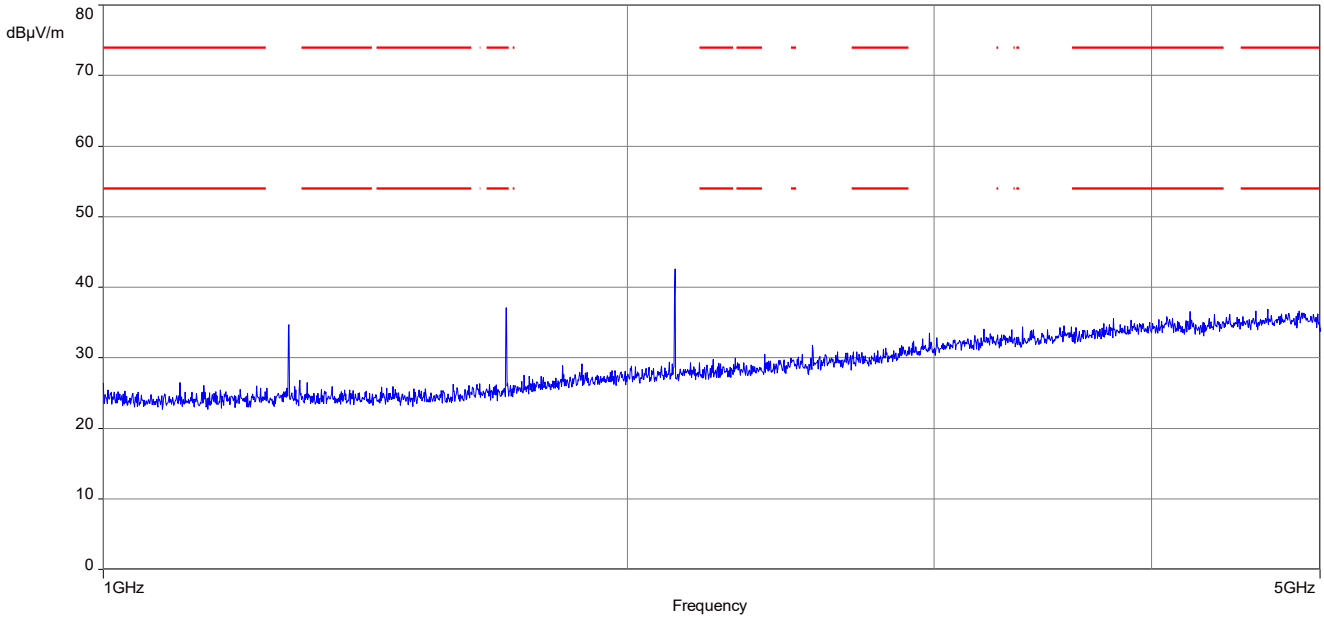
Plot 3: 30 MHz to 1000 MHz, vertical & horizontal polarisation



Final_Result

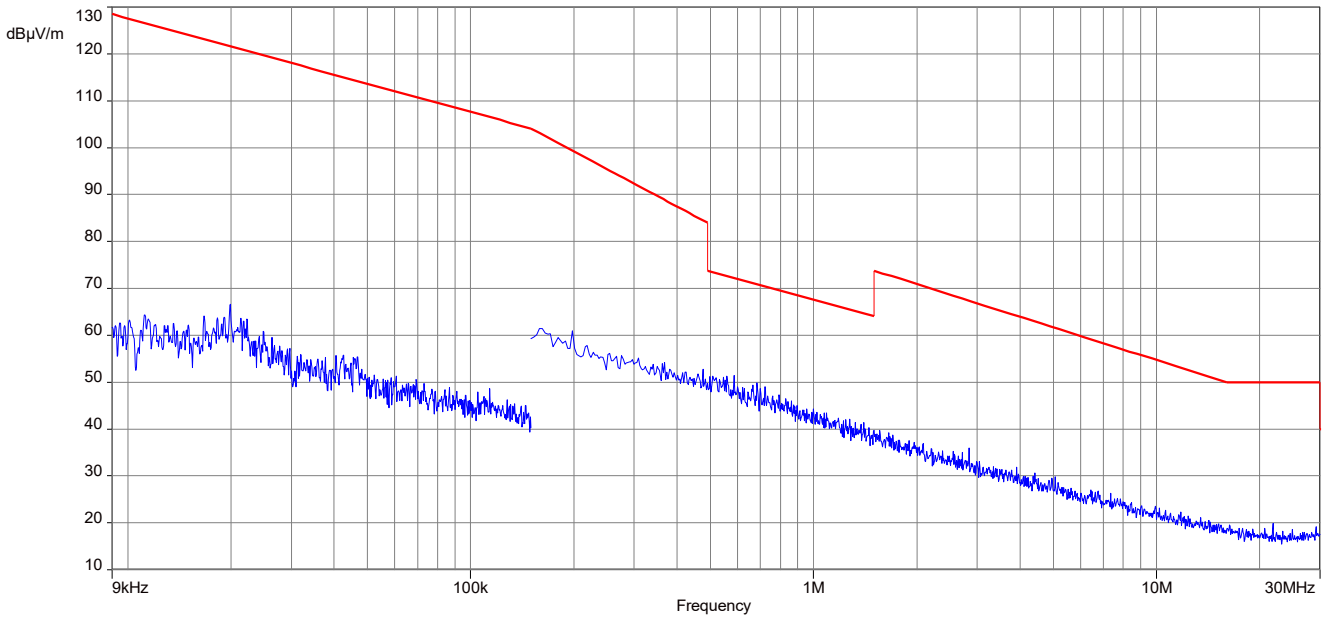
Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
30.275	8.49	---	---	1000	120.0	139.0	H	225	13
56.280	9.81	---	---	1000	120.0	200.0	H	320	16
60.812	2.38	---	---	1000	120.0	232.0	V	225	14
425.958	75.80	---	---	1000	120.0	207.0	H	62	19
730.906	18.07	---	---	1000	120.0	200.0	H	116	23
851.899	35.05	---	---	1000	120.0	109.0	H	81	25
922.921	20.74	---	---	1000	120.0	146.0	H	166	25

Plot 4: 1000 MHz to 5 GHz, vertical & horizontal polarisation

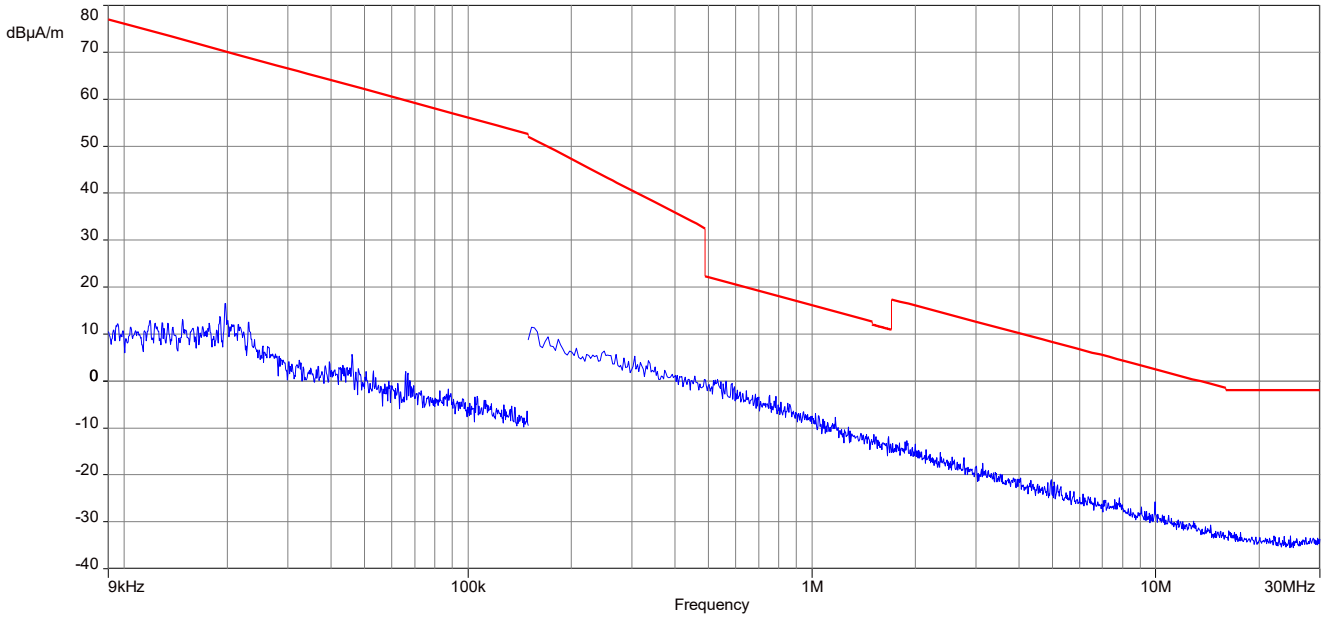


Plots 469 MHz OOK:

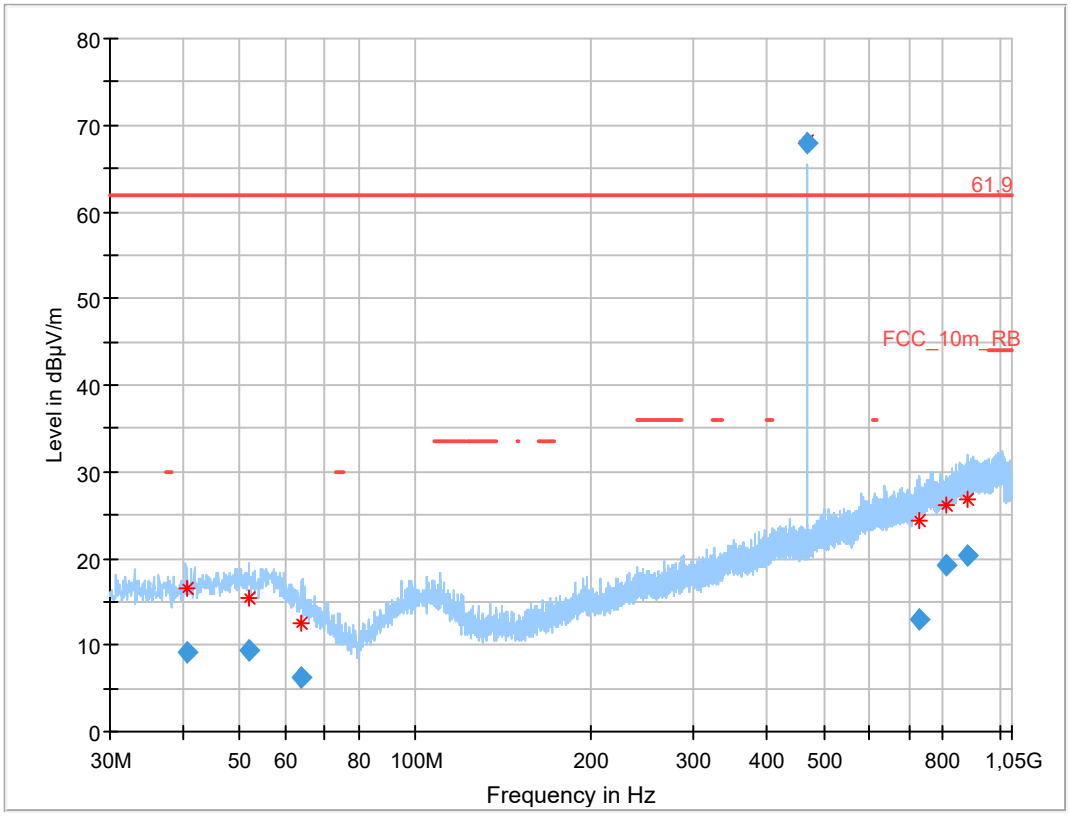
Plot 1: 9 kHz to 30 MHz FCC



Plot 2: 9 kHz to 30 MHz IC



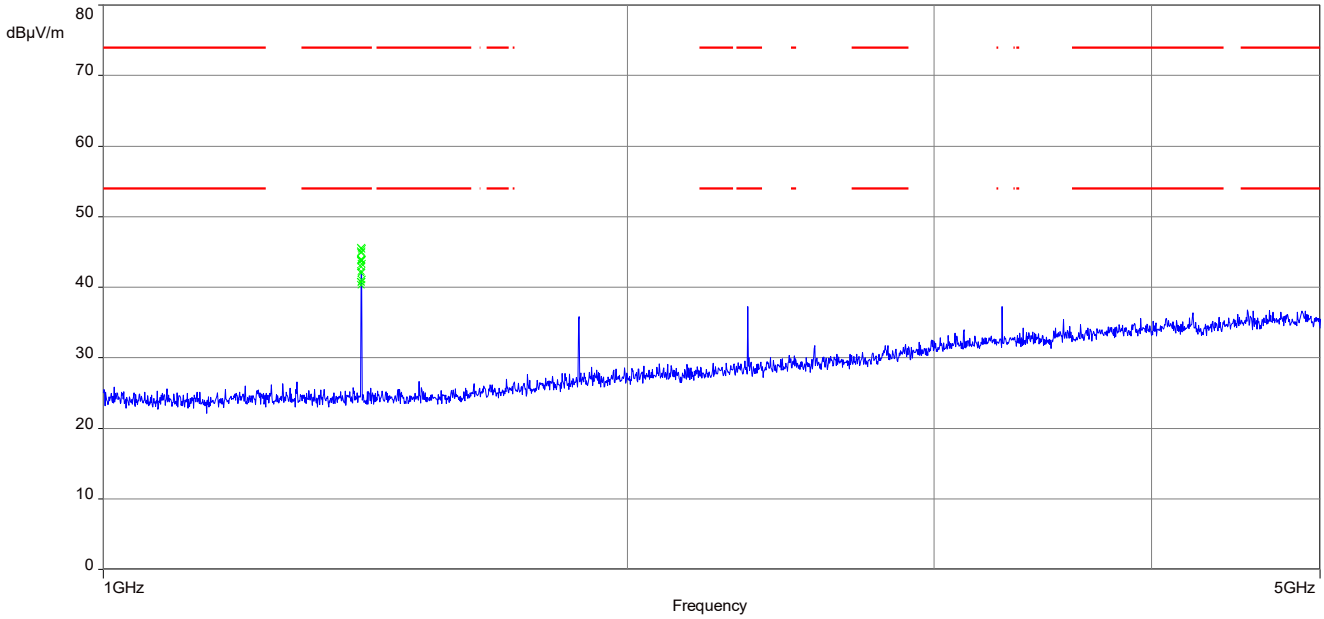
Plot 3: 30 MHz to 1000 MHz, vertical & horizontal polarisation



Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
40.611	9.12	---	---	1000	120.0	382.0	H	225	14
51.725	9.32	---	---	1000	120.0	400.0	H	90	15
63.879	6.30	---	---	1000	120.0	200.0	H	-12	12
469.042	68.00	---	---	1000	120.0	204.0	H	40	19
727.528	13.07	---	---	1000	120.0	200.0	V	225	23
812.719	19.13	---	---	1000	120.0	187.0	H	270	24
878.823	20.43	---	---	1000	120.0	195.0	H	45	25

Plot 4: 1000 MHz to 5 GHz, vertical & horizontal polarisation



11 Observations

No observations except those reported with the single test cases have been made.

12 Glossary

AVG	Average
C	Compliant
C/N_0	Carrier to noise-density ratio, expressed in dB-Hz
CAC	Channel availability check
CW	Clean wave
DC	Duty cycle
DFS	Dynamic frequency selection
DSSS	Dynamic sequence spread spectrum
DUT	Device under test
EN	European Standard
ETSI	European Telecommunications Standards Institute
EMC	Electromagnetic Compatibility
EUT	Equipment under test
FCC	Federal Communications Commission
FCC ID	Company Identifier at FCC
FHSS	Frequency hopping spread spectrum
FVIN	Firmware version identification number
GNSS	Global Navigation Satellite System
GUE	GNSS User Equipment
HMN	Host marketing name
HVIN	Hardware version identification number
HW	Hardware
IC	Industry Canada
Inv. No.	Inventory number
MC	Modulated carrier
NA	Not applicable
NC	Not compliant
NOP	Non occupancy period
NP	Not performed
OBW	Occupied bandwidth
OC	Operating channel
OCW	Operating channel bandwidth
OFDM	Orthogonal frequency division multiplexing
OOB	Out of band
OP	Occupancy period
PER	Packet error rate
PMN	Product marketing name
PP	Positive peak
QP	Quasi peak
RLAN	Radio local area network
S/N or SN	Serial number
SW	Software
UUT	Unit under test
WLAN	Wireless local area network

13 Document history

Version	Applied changes	Date of release
R01	Initial release	2025-02-07
R02	Editorial corrections	2025-02-19

################################ END OF TEST REPORT ################################