
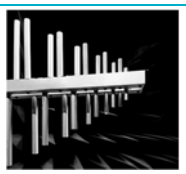


TEST REPORT

Test report no.: 1-9234-24-03-02_TR1-R03

DAkkS Deutsche Akkreditierungsstelle D-PL-12047-01-00

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

ROBERT BOSCH GmbH
Auf der Breit 4
76227 Karlsruhe / GERMANY
Phone: +49(721)942-2132
Contact: Serdar Derikesen
e-mail: serdar.derikesen@bosch.com

Manufacturer

ROBERT BOSCH GmbH
Auf der Breit 4
76227 Karlsruhe / GERMANY

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:	**Tire pressure sensor**
Model name:	**Fix variant Model Name: PTM1A** **Flex variant Model Name: PTM1B**
FCC ID:	**2BNMXPTM1**
ISED certification number:	**33637-PTM1**
Frequency:	260 MHz -470 MHz (315 MHz and 433.92 MHz TX frequencies)
Technology tested:	Proprietary
Antenna:	Integrated antenna
Power supply:	2.2 V to 3.3 V DC by Li battery
Temperature range:	-40°C to +120°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:

cn=Christoph Schneider, o=cetecom advanced GmbH, ou=SND-230601, email=christoph.schneider@cetecomadvanced.com, c=DE
2025.05.28 15:23:48 +02'00'

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
2025.05.28 15:14:32 +02'00'

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 is electronically signed and valid without handwritten signature. For verification of the electronic signatures, the public keys can be requested at the testing laboratory.
This test report replaces the test report with the number 1-9234-24-03-02_TR1-R02 and dated 2025-05-13.

2.2 Application details

Date of receipt of order:	2025-01-31
Date of receipt of test item:	2025-03-03
Start of test:*	2025-03-03
End of test:*	2025-03-12
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

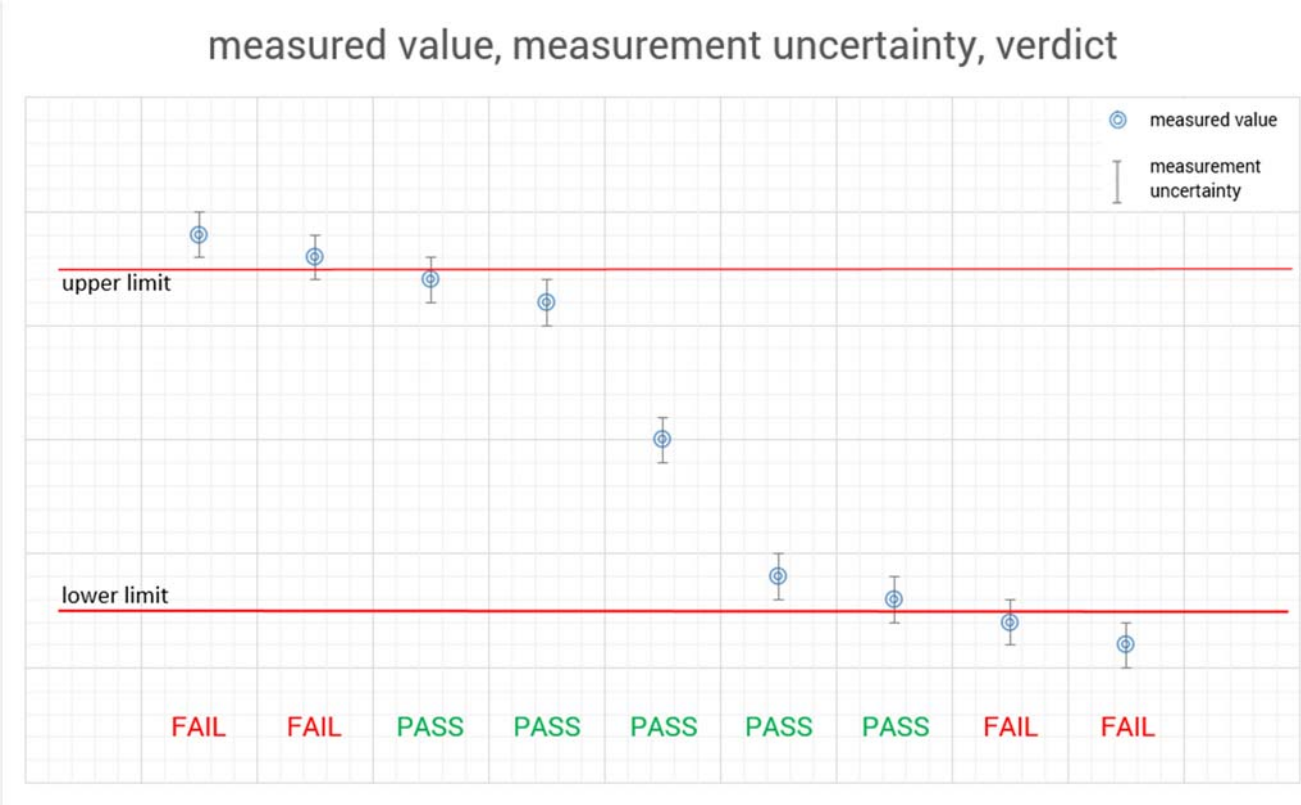
3 Test standard/s, references and accreditations

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. No tests under extreme conditions required.

6 Test item

6.1 General description

Kind of test item	:	Tire pressure sensor
Model name	:	Fix variant Model Name: PTM1A Flex variant Model Name: PTM1B
HMN	:	-/-
PMN	:	QUICK FIT+
HVIN	:	Fix variant: PTM1A Flex variant: PTM1B
FVIN	:	-/-
S/N serial number	:	Fix variant: 0502CD8D47D30273014067 Flex variant: 0273014069CD8D45F60402
Hardware status	:	-/-
Software status	:	NG_8888_FD0400.uvs
Firmware status	:	-/-
Frequency	:	260 MHz -470 MHz (315 MHz and 433.92 MHz TX frequencies)
Type of radio transmission Use of frequency spectrum	: :	Modulated carrier
Type of modulation	:	FSK, ASK
Number of channels	:	2
Antenna	:	Integrated antenna
Power supply	:	2.2 V to 3.3 V DC by Li battery
Temperature range	:	-40°C to +120°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: 1-9234-24-03-01_TR1-A101-R01
1-9234-24-03-01_TR1-A102-R01
1-9234-24-03-01_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).

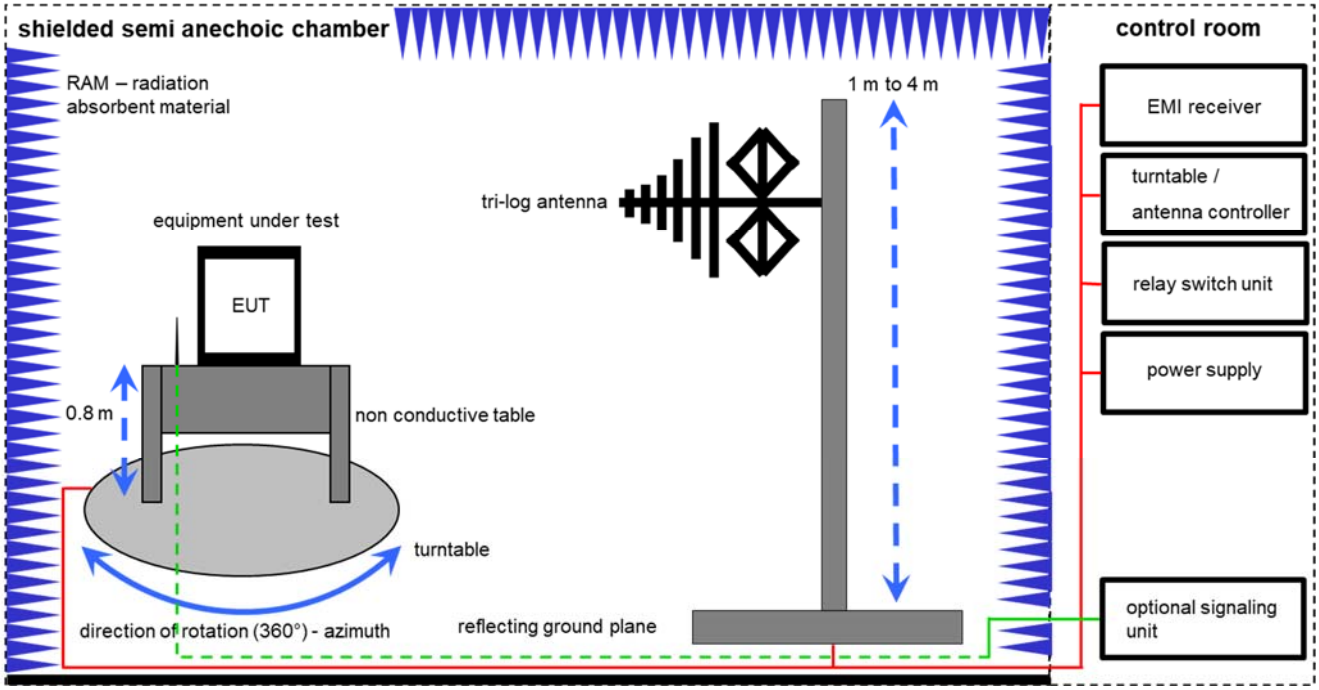
Each block diagram listed can contain several test setup configurations. All devices belonging to a test setup are identified with the same letter syntax. For example: Column Setup and all devices with an A.

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

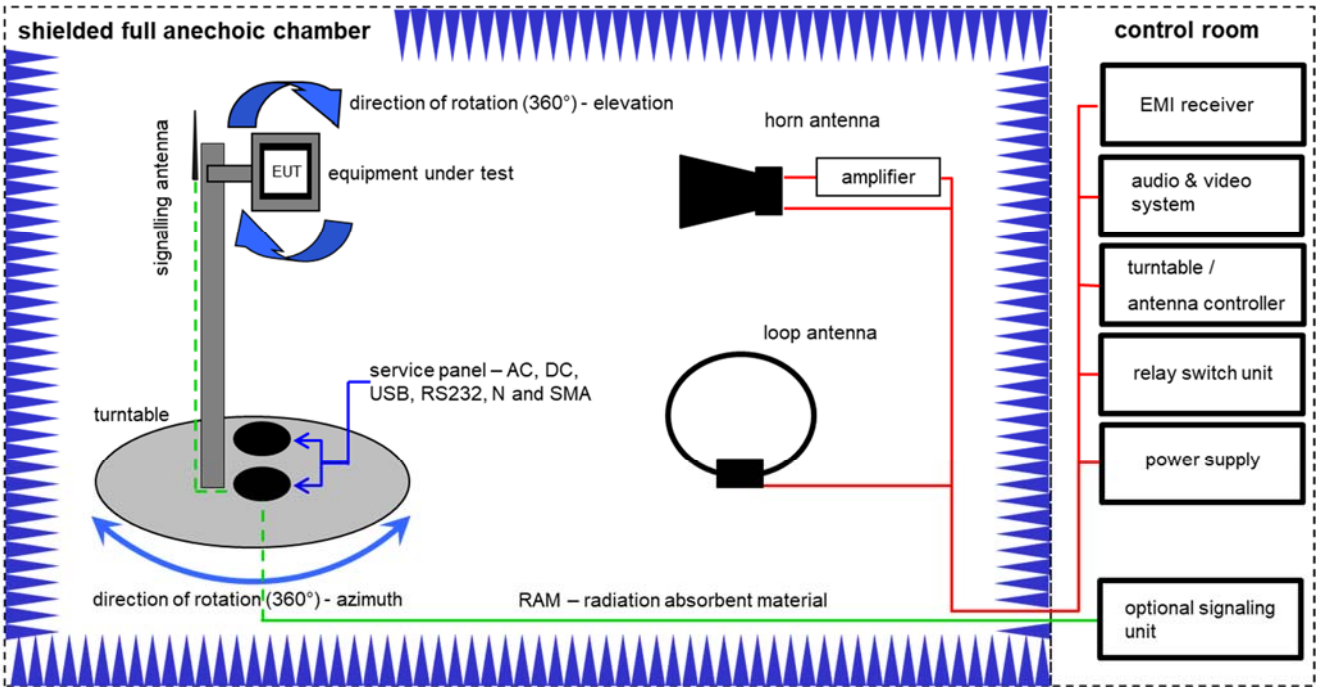
FS = UR + CL + AF
(FS-field strength; UR-voltage at the receiver; CL-loss of the cable; AF-antenna factor)

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	Semi anechoic chamber	Semi anechoic chamber 3000023	MEC Import: MWB AG		40797	cnn	-/-	-/-
2	A	TRILOG Broadband Test-Antenna 30 MHz - 3 GHz	TRILOG Broadband Test-Antenna 30 MHz - 3 GHz VULB9163	Schwarzbeck Mess-Elektronik OHG / Schönau	371	40798	cal	11.07.2024	11.07.2026
3	A	Turntable	Turntable 2089-4.0	EMCO Elektronik GmbH / Gilching		40799	cnn	-/-	-/-
4	A	Analyzer-Impedence-System	Analyzer-Impedence-System AIS16/1	MEC Import: Spitzenberger + Spies GmbH & Co. KG	UO2076 07/0 1023	40808	cal	19.10.2023	31.10.2025
5	A	Switch-Unit	Switch-Unit 3488A	Hewlett Packard	2719A14505	50160	cpu	-/-	-/-
6	A	Antenna Tower	Antenna Tower 2175	ETS-Lindgren Gmbh / Taufkirchen	64762	50279	cnn	-/-	-/-
7	A	Positioning Controller	Positioning Controller 2090	ETS-Lindgren Gmbh / Taufkirchen	64672	50280	cnn	-/-	-/-
8	A	EMI Test Receiver	EMI Test Receiver ESR3	Rohde & Schwarz Messgerätebau GmbH / Memmingen	102587	50417	cal	05.12.2024	05.12.2025

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)

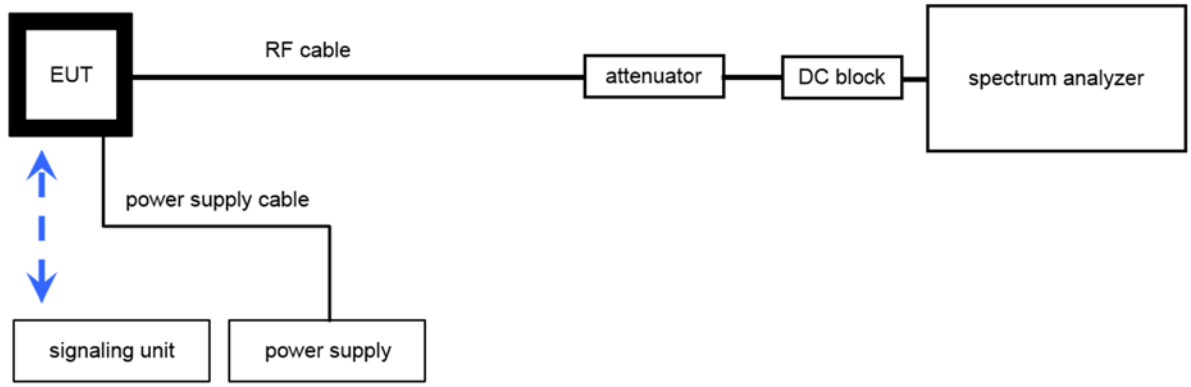
Example calculation:
FS [dBµV/m] = 40.0 [dBµV/m] + (-35.8) [dB] + 32.9 [dB/m] = 37.1 [dBµV/m] (71.61 µV/m)

Equipment table:

No.	Setup	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	A	Double-Ridged Waveguide Horn Antenna	Double-Ridged Waveguide Horn Antenna 3115	EMCO Elektronik GmbH / Gilching	8812-3088	40341	cal	10.10.2023	31.10.2025
2	A	Anechoic chamber	Anechoic chamber FAC 3/5m	MEC Import: MWB / TDK	87400/02	40349	cpu	-/-	-/-
3	A	Switch / Control Unit	Switch / Control Unit 3488A	Hewlett Packard	*	40350	cnn	-/-	-/-
4	A	Broadband Amplifier 0.5-18 GHz	Broadband Amplifier 0.5-18 GHz CBLU5184540	MEC Import: CERNEX	22049	40373	cpu	-/-	-/-
5	A	4U RF Switch Platform	4U RF Switch Platform L4491A	Agilent Technologies Deutschland GmbH / Böblingen	MY50000037	40375	cnn	-/-	-/-
6	A	NEXIO EMV-Software	NEXIO EMV-Software BAT EMC V2022.0.32.0	MEC Import: Nexio	-/-	40383	cnn	-/-	-/-
7	A	Active Loop Antenna	Active Loop Antenna 6502	EMCO Elektronik GmbH / Gilching	2210	50044	cal	02.08.2023	02.08.2025
8	A	EMI Test Receiver	EMI Test Receiver ESU26	Rohde & Schwarz Messgerätebau GmbH / Memmingen	100037	50254	cal	10.12.2024	10.12.2025

7.3 RF 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	Signal analyzer	Signal analyzer FSV30	Rohde & Schwarz Messgerätebau GmbH / Memmingen	104365	40319	cal	10.12.2024	10.12.2025
2	A	Loop Antenna	Loop Antenna	MEC Import: ZEG TS Steinfurt	-/-	40841	cpu	-/-	-/-
3	A	RF Cable BNC	RF Cable BNC RG58	Huber & Suhner GmbH / Unterhaching	-/-	40842	cpu	-/-	-/-
4	A	Signal analyzer	Signal analyzer FSW26	Rohde & Schwarz Messgerätebau GmbH / Memmingen	101455	40114	cal	09.12.2024	09.12.2025

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 12.75 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 Measurement uncertainty

Measurement uncertainty	
Test case	**Uncertainty**
Occupied bandwidth	± used RBW
Field strength of the fundamental	± 3 dB
Field strength of the harmonics and spurious	± 3 dB
Conducted limits	± 2.6 dB

10 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 RSS-Gen, Issue 5	See table!	2025-05-28	-/-

Test specification clause	Test case	Temperature conditions	Power source voltages	C	NC	NA	NP	Remark
§ 15.35 (c) RSS-Gen, Issue 5	Timing of the transmitter (Duty cycle correction factor)	Nominal	Nominal	No restriction				-/-
§ 15.231 (e) RSS-210 Issue 11	Periodic operation time	Nominal	Nominal	☒	☐	☐	☐	-/-
§ 15.231 (b) (3) (c) RSS-210 Issue 11	Emission bandwidth	Nominal	Nominal	☒	☐	☐	☐	-/-
§ 15.231 (b) RSS-210 Issue 11	Fieldstrength of Fundamental	Nominal	Nominal	☒	☐	☐	☐	-/-
§ 15.209 RSS-210 Issue 11	Fieldstrength of harmonics and spurious	Nominal	Nominal	☒	☐	☐	☐	-/-

Note: C = Compliant; NC = Not compliant; NA = Not applicable; NP = Not performed

10.1 Additional comments

Reference documents: none

Special test descriptions: The radiated tests were performed with two different housing variants containing the equal hardware setup:

Short housing variant

Long housing variant:

Comparison:

11 Measurement results

11.1 Timing of the transmitter

Measurement:

Measurement parameter	
Detector:	Peak
Sweep time:	Depends on the pulse train
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: FSK modulation 315 MHz

Transmit time (Tx on)	=	12.6 ms	(Plot 1)
Tx on + Tx off	=	100 ms	(Plot 2)

The peak-to-average correction factor is calculated with 20Log [Tx on/(Tx on + Tx off)].
Hereby the peak-to-average correction factor is -18.0 dB

Result: ASK modulation 315 MHz

Transmit time (Tx on)	=	28.5 ms	(Plot 3)
Tx on + Tx off	=	100 ms	(Plot 4)

The peak-to-average correction factor is calculated with 20Log [Tx on/(Tx on + Tx off)].
Hereby the peak-to-average correction factor is -10.9

Result: FSK modulation 433.92 MHz

Transmit time (Tx on)	=	12.5 ms	(Plot 5)
Tx on + Tx off	=	100 ms	(Plot 6)

The peak-to-average correction factor is calculated with 20Log [Tx on/(Tx on + Tx off)].
Hereby the peak-to-average correction factor is -18.1 dB

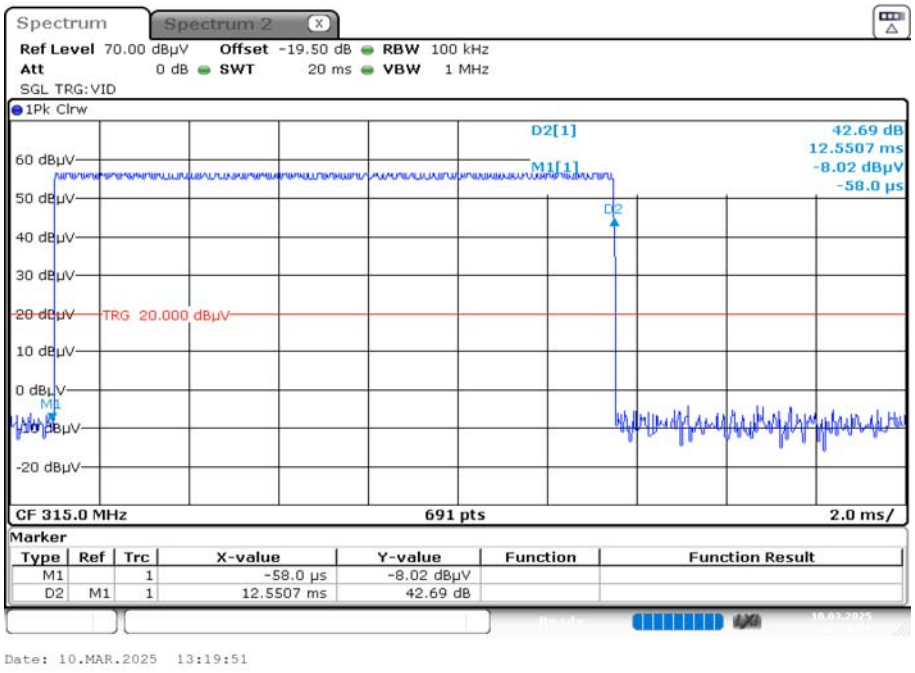
Result: ASK modulation 433.92 MHz

Transmit time (Tx on)	=	28.5 ms	(Plot 7)
Tx on + Tx off	=	100 ms	(Plot 8)

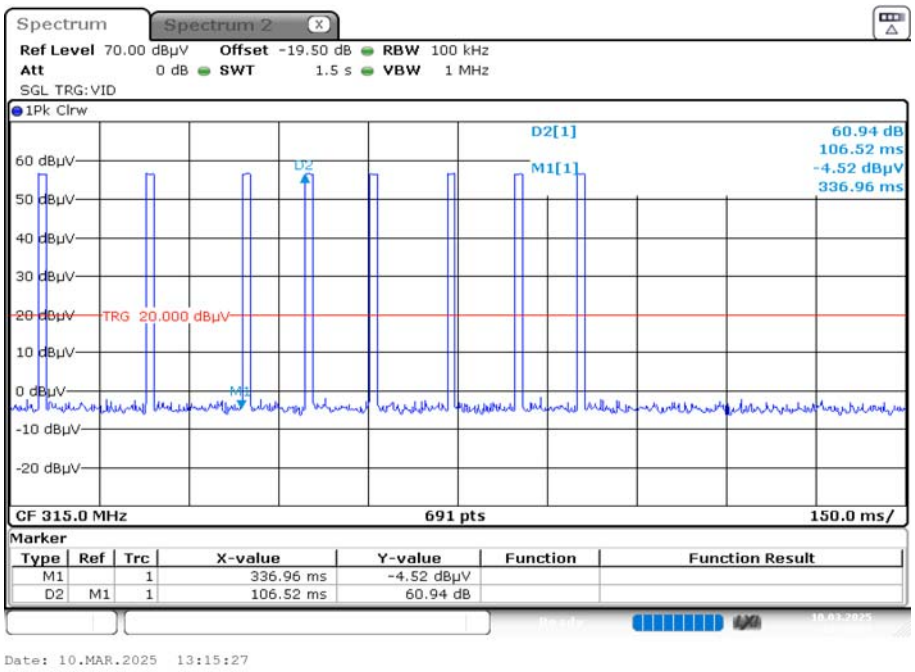
The peak-to-average correction factor is calculated with 20Log [Tx on/(Tx on + Tx off)].
Hereby the peak-to-average correction factor is -10.9

Result:

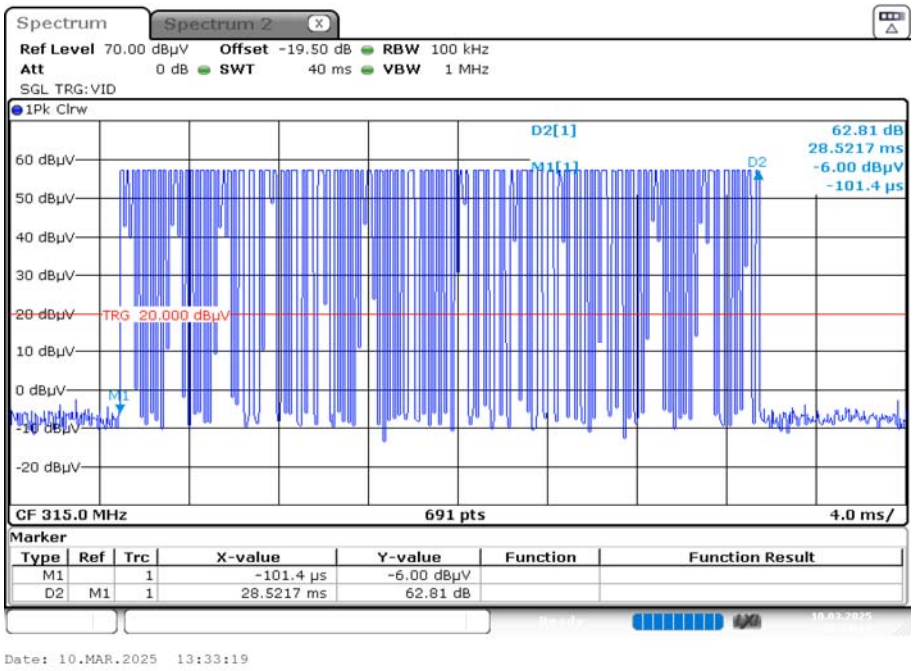
Plot 1: Transmit burst, FSK modulation, 315 MHz



Plot 2: Timing of the transmitter within 100ms (worst case), FSK modulation, 315 MHz

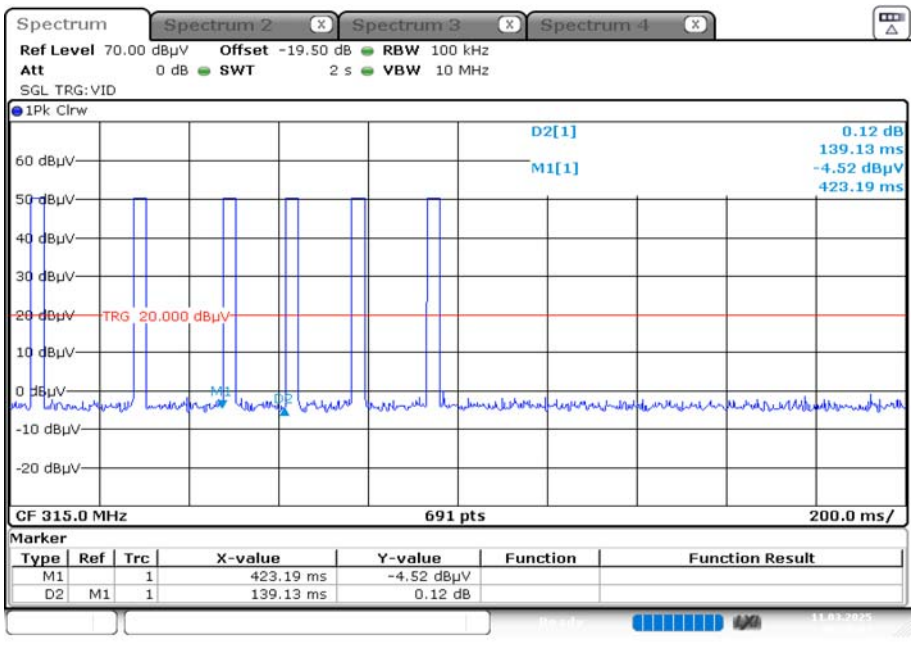


Plot 3: Transmit burst, ASK modulation



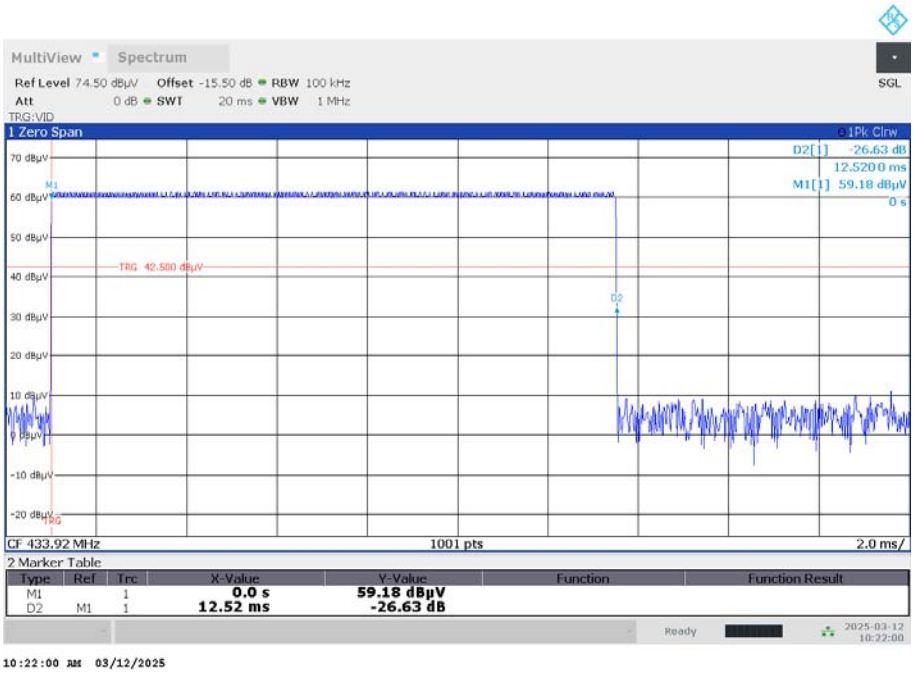
Date: 10.MAR.2025 13:33:19

Plot 4: Timing of the transmitter within 100ms (worst case), ASK modulation

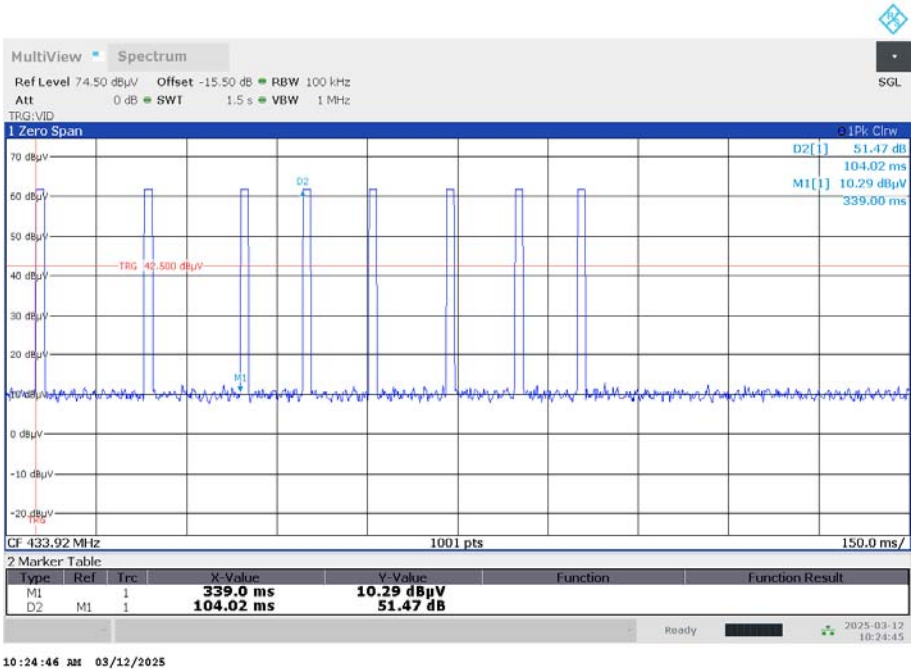


Date: 11.MAR.2025 08:20:43

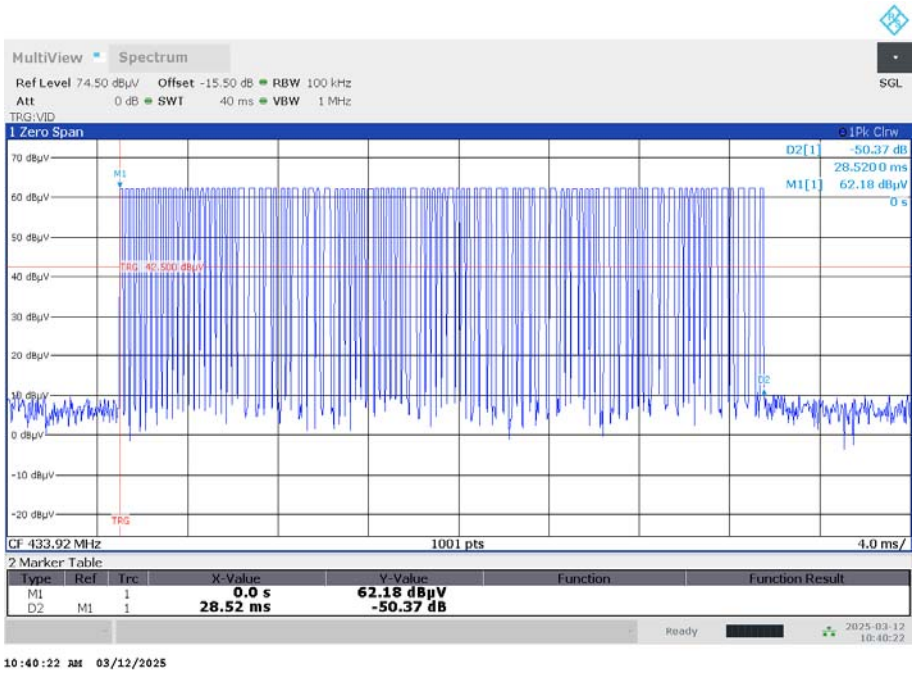
Plot 5: Transmit burst, FSK modulation, 433.92



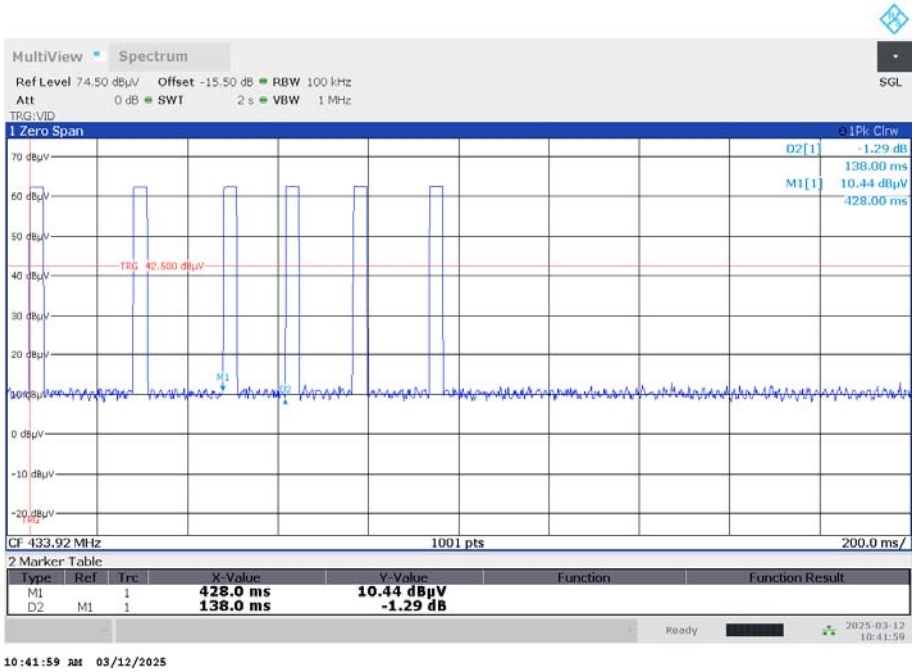
Plot 6: Timing of the transmitter within 100ms (worst case), FSK modulation, 433.92



Plot 7: Transmit burst, ASK modulation, 433.92



Plot 8: Timing of the transmitter within 100ms (worst case), ASK modulation, 433.92



11.2 Periodic operation time

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
§15.231 (e): One pulse train must be less than 1s and the silent period between two transmissions must be at least 30 times of the transmission time without being less than 10s.	

Results FSK modulation:

Pulse train length @ 315 MHz
917.4 ms

Silent period length @ 315 MHz
30.3 s

Pulse train length @ 433.92 MHz
913.5 ms

Silent period length @ 433.92 MHz
30.1 s

Results ASK modulation:

Pulse train length @ 315 MHz
913.04 ms

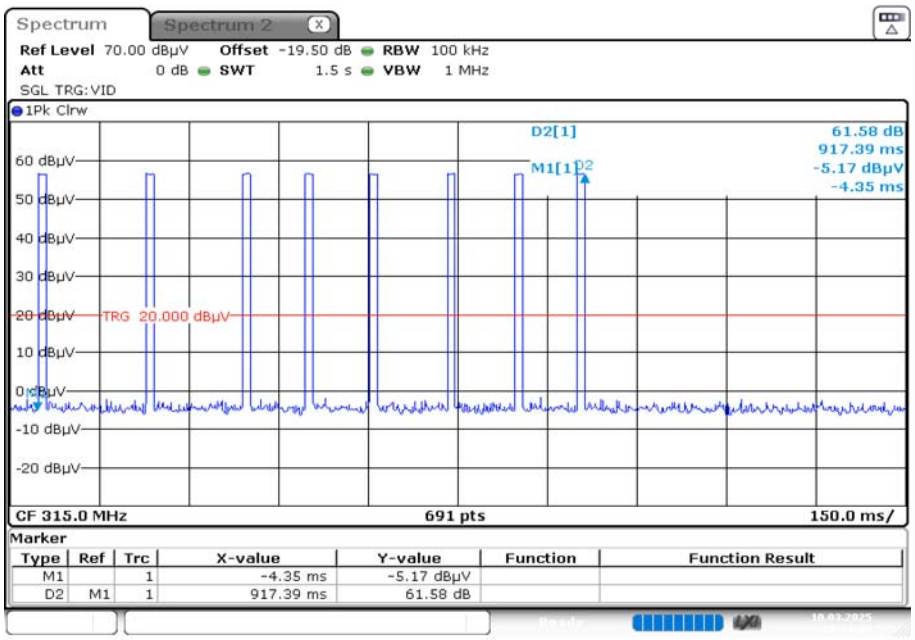
Silent period length @ 315 MHz
31.1 s

Pulse train length @ 433.92 MHz
914.5 ms

Silent period length @ 433.92 MHz
30.2 s

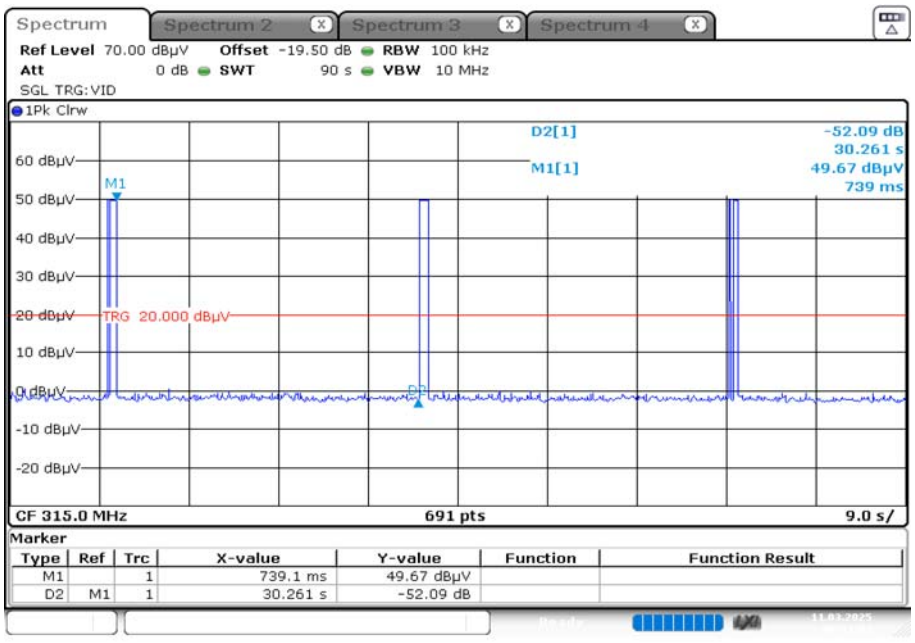
Plots FSK modulation:

Plot 1: 315 MHz, Pulse train length <1s



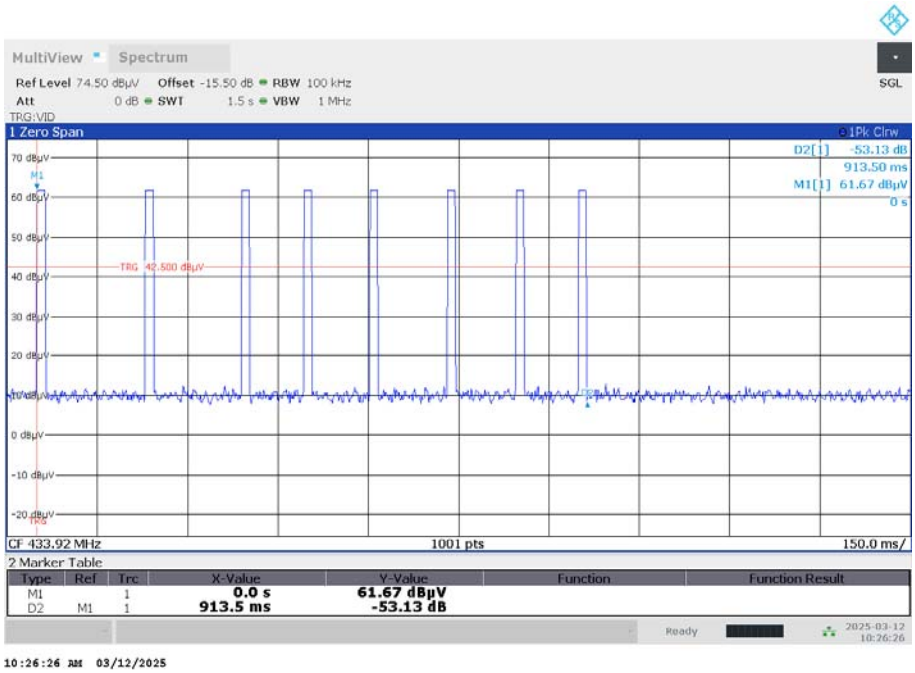
Date: 10.MAR.2025 13:14:07

Plot 2: 315 MHz, Silent period > 30*917.4 ms = 27.52 s and < 10s

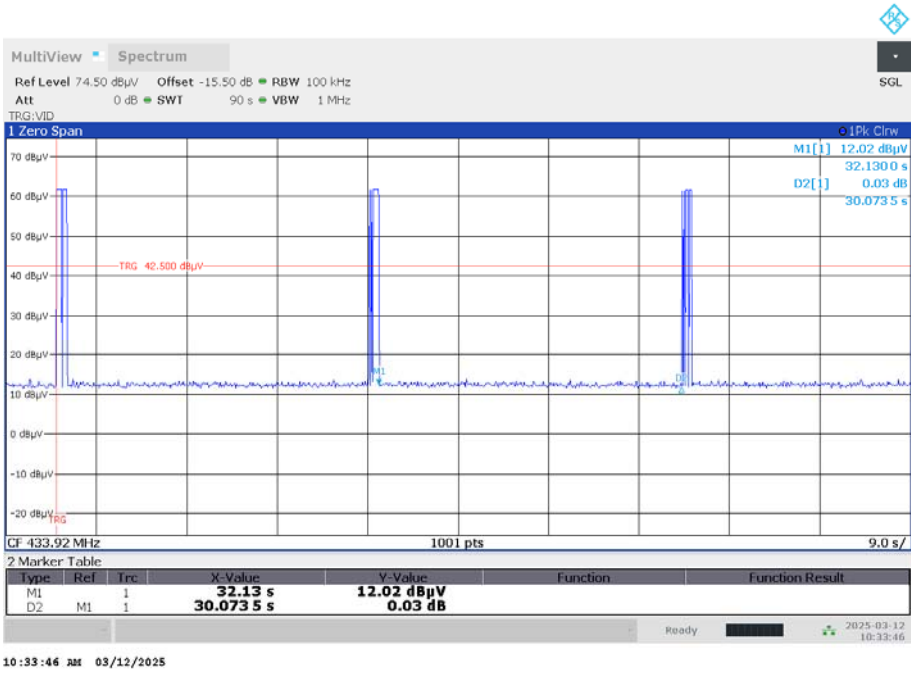


Date: 11.MAR.2025 08:11:32

Plot 3: 433.92 MHz, Pulse train length <1s

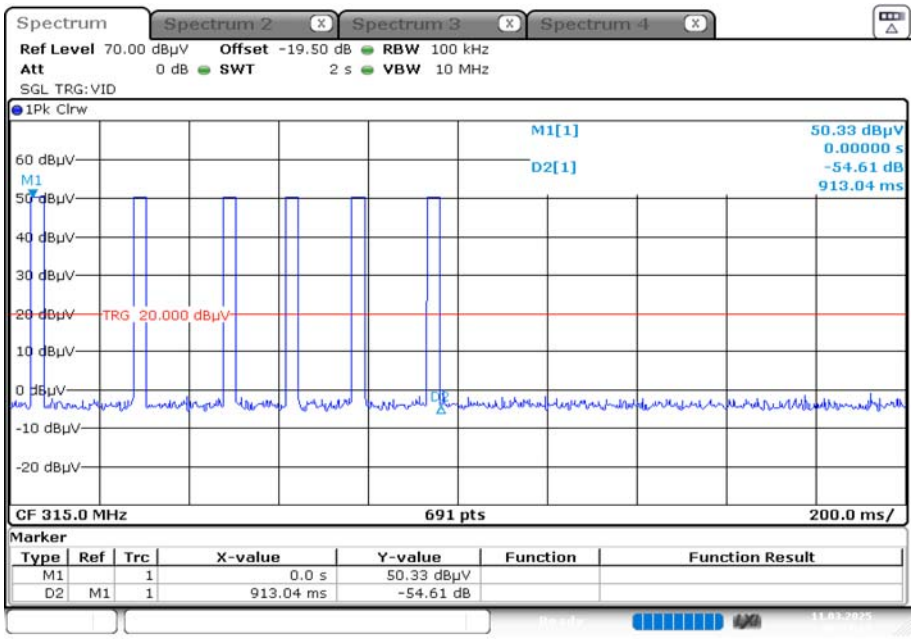


Plot 4: 433.92 MHz, Silent period > 30*913.5 ms = 27.41 s and < s 10

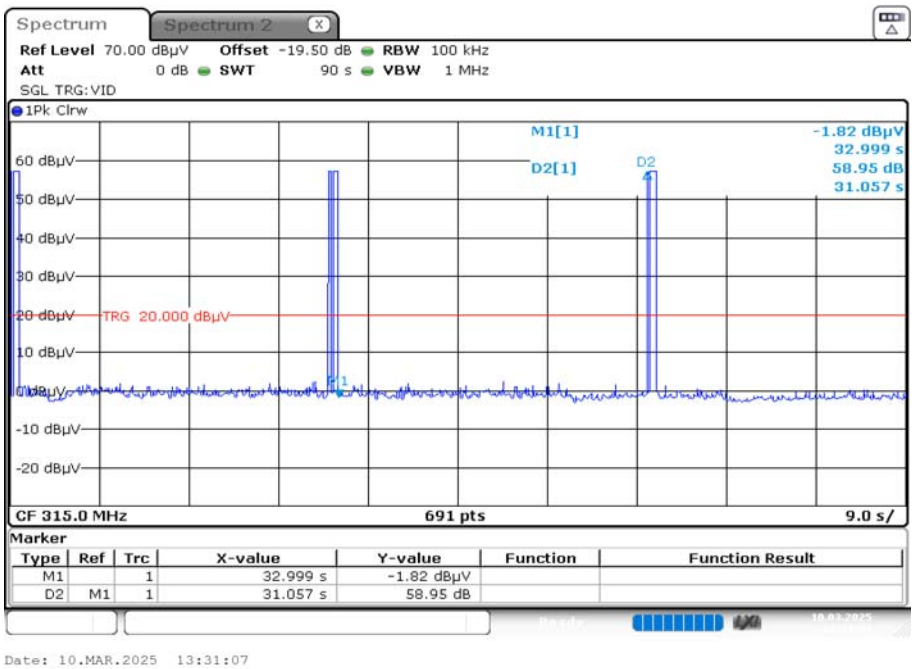


Plots ASK modulation:

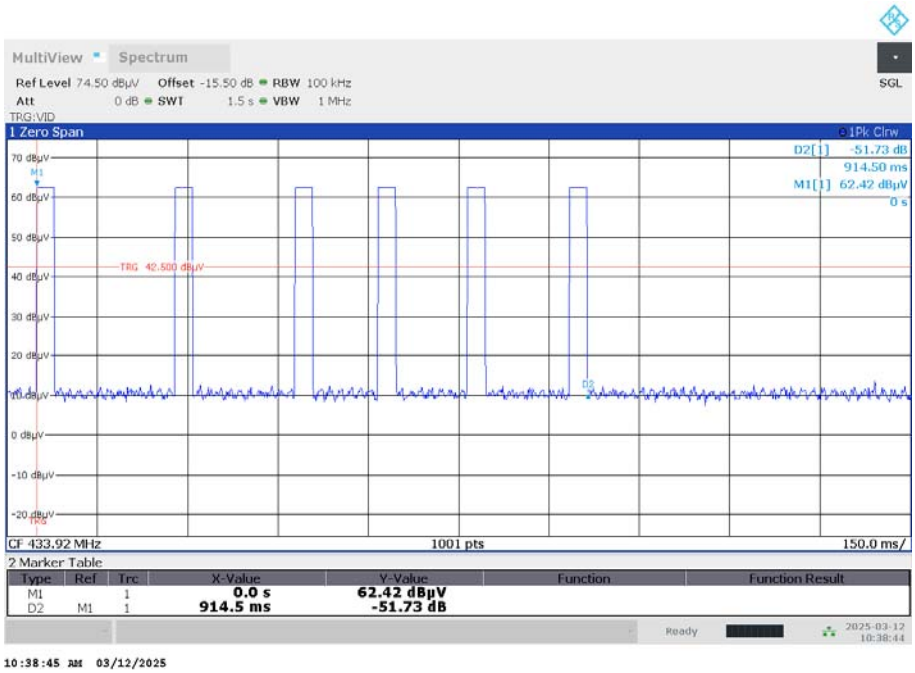
Plot 1: 315 MHz, Pulse train length <1s



Plot 2: 315 MHz, Silent period > 30*913.04 ms = 27.40 s and < 10s



Plot 3: 433.92 MHz, Pulse train length <1s



Plot 4: 433.92 MHz, Silent period > 30*917.4 ms = 27.44s and < 10s

11.3 Emission bandwidth

Measurement:

Measurement of the 99 % bandwidth of the modulated signal

Measurement parameter	
Detector:	Peak
Sweep time:	Depends on the signal
Resolution bandwidth:	1% to 5% of the OBW
Video bandwidth:	3 x RBW
Span:	Depends on the signal
Trace-Mode:	Max. hold
Test setup	See chapter 7.3A
Measurement uncertainty	See chapter 9

Limits:

FCC	IC
The OBW shall not be wider than 0.25% of the centre frequency, maximum 787.5 kHz @ 315 MHz.	

Result 99% OBW:

99% emission bandwidth FSK modulation, 315 MHz
143.27 kHz

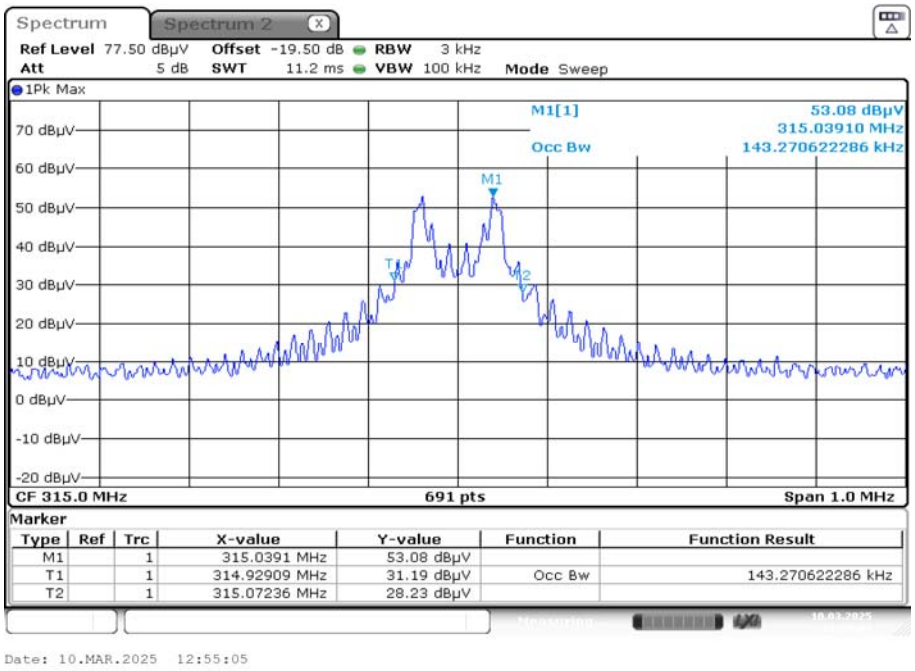
99% emission bandwidth FSK modulation, 433.92 MHz
142.21 kHz

99% emission bandwidth ASK modulation, 315 MHz
57.89 kHz

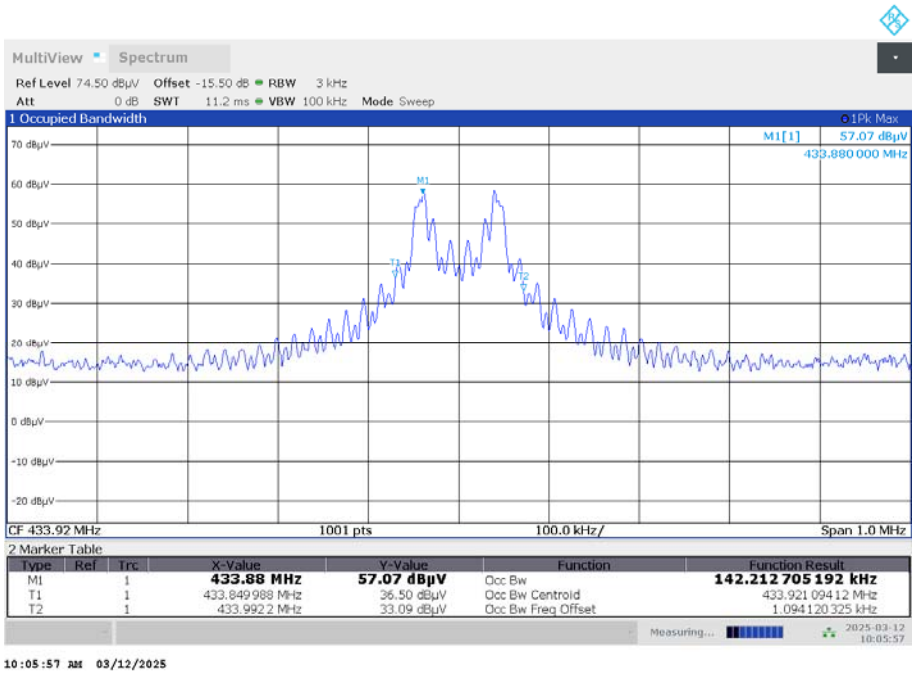
99% emission bandwidth ASK modulation, 433.92 MHz
59.61 kHz

Plots:

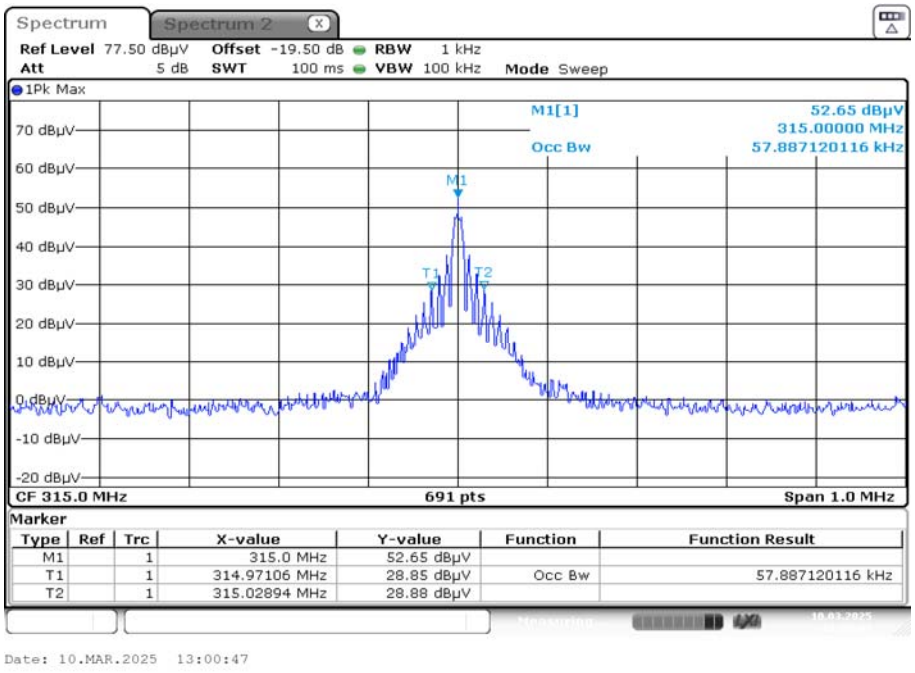
Plot 1: Emissions bandwidth FSK modulation, 315 MHz



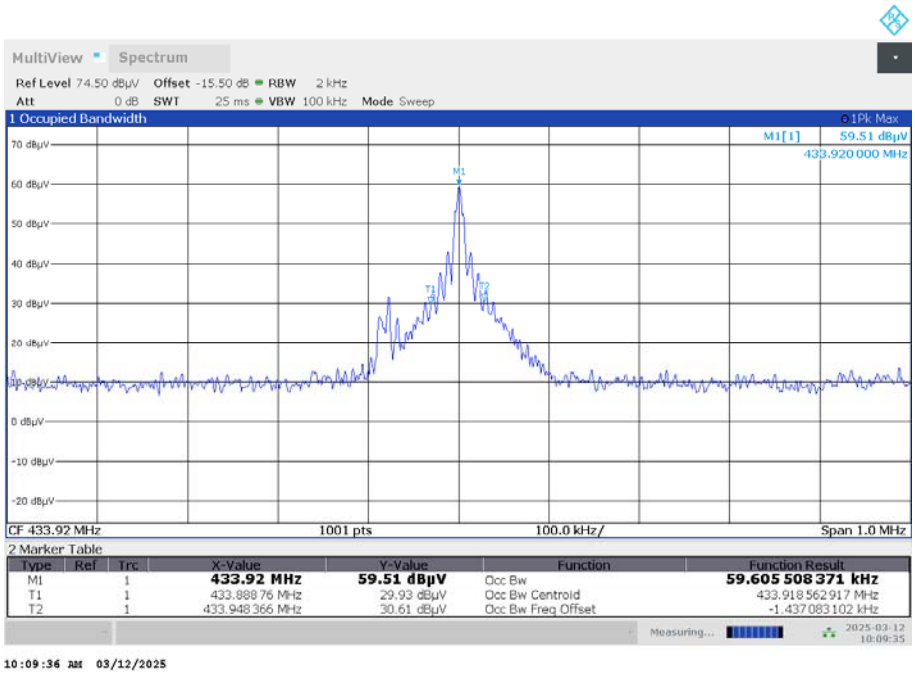
Plot 2: Emissions bandwidth FSK modulation, 433.92 MHz



Plot 3: Emissions bandwidth ASK modulation, 315 MHz



Plot 4: Emissions bandwidth ASK modulation, 433.92 MHz



11.4 Field strength of the fundamental

Measurement:

Measurement parameter	
Detector:	Peak / pulse averaging
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 15.231 (e), 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	1,000	3
70-130	500	3
130-174	500 to 1500	3
174-260	1,500	3
260-470	1,500 to 5,000	3
Above 470	5,000	3

Result: FSK modulation short housing variant

TEST CONDITIONS		MAXIMUM POWER (dBµV/m at 3 m distance)	
Frequency		315 MHz	315 MHz
Mode		Peak	Average
T_{nom}	V_{nom}	68.1	50.1*
Limit @ 315 MHz		**2416.7 µV/m (67.67 dBµV/m) Average**	

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

TEST CONDITIONS		MAXIMUM POWER (dBµV/m at 3 m distance)	
Frequency		433.92 MHz	433.92 MHz
Mode		Peak	Average
T_{nom}	V_{nom}	72.2	54.1*
Limit @ 433.92 MHz		**4398.67 µV/m (72.87 dBµV/m)Average**	

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

Result: ASK modulation short housing variant

TEST CONDITIONS		MAXIMUM POWER (dBµV/m at 3 m distance)	
Frequency		315 MHz	315 MHz
Mode		Peak	Average
T_{nom}	V_{nom}	67.3	56.4*
Limit @ 315 MHz		**2416.7 µV/m (67.67 dBµV/m) Average**	

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

TEST CONDITIONS		MAXIMUM POWER (dBµV/m at 3 m distance)	
Frequency		433.92 MHz	433.92 MHz
Mode		Peak	Average
T_{nom}	V_{nom}	72.5	61.6*
Limit @ 433.92 MHz		**4398.67 µV/m (72.87 dBµV/m)Average**	

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

Result: FSK modulation long housing variant

TEST CONDITIONS		MAXIMUM POWER (dBµV/m at 3 m distance)	
Frequency		315 MHz	315 MHz
Mode		Peak	Average
T_{nom}	V_{nom}	67.4	49.4*
Limit @ 315 MHz		**2416.7 µV/m (67.67 dBµV/m) Average**	

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

TEST CONDITIONS		MAXIMUM POWER (dBµV/m at 3 m distance)	
Frequency		433.92 MHz	433.92 MHz
Mode		Peak	Average
T_{nom}	V_{nom}	70.3	52.2*
Limit @ 433.92 MHz		**4398.67 µV/m (72.87 dBµV/m)Average**	

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

Result: ASK modulation long housing variant

TEST CONDITIONS		MAXIMUM POWER (dBµV/m at 3 m distance)	
Frequency		315 MHz	315 MHz
Mode		Peak	Average
T_{nom}	V_{nom}	66.6	55.7*
Limit @ 315 MHz		**2416.7 µV/m (67.67 dBµV/m) Average**	

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

TEST CONDITIONS		MAXIMUM POWER (dBµV/m at 3 m distance)	
Frequency		433.92 MHz	433.92 MHz
Mode		Peak	Average
T_{nom}	V_{nom}	70.0	59.1*
Limit @ 433.92 MHz		**4398.67 µV/m (72.87 dBµV/m)Average**	

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

11.5 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 7.3A
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		
FCC Part 15.231 (e)		
Fundamental Frequency (MHz)	**Field strength of spurious (µV/m)**	**Measurement distance (m)**
40.66 – 40.70	100	3
70-130	50	3
130-174	50 - 150	3
174-260	150	3
260-470	150 to 500	3
Above 470	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

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		IC
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

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]
All frequencies and modulations	-/-	Peak	74	No emissions detected.
		AVG	54	

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

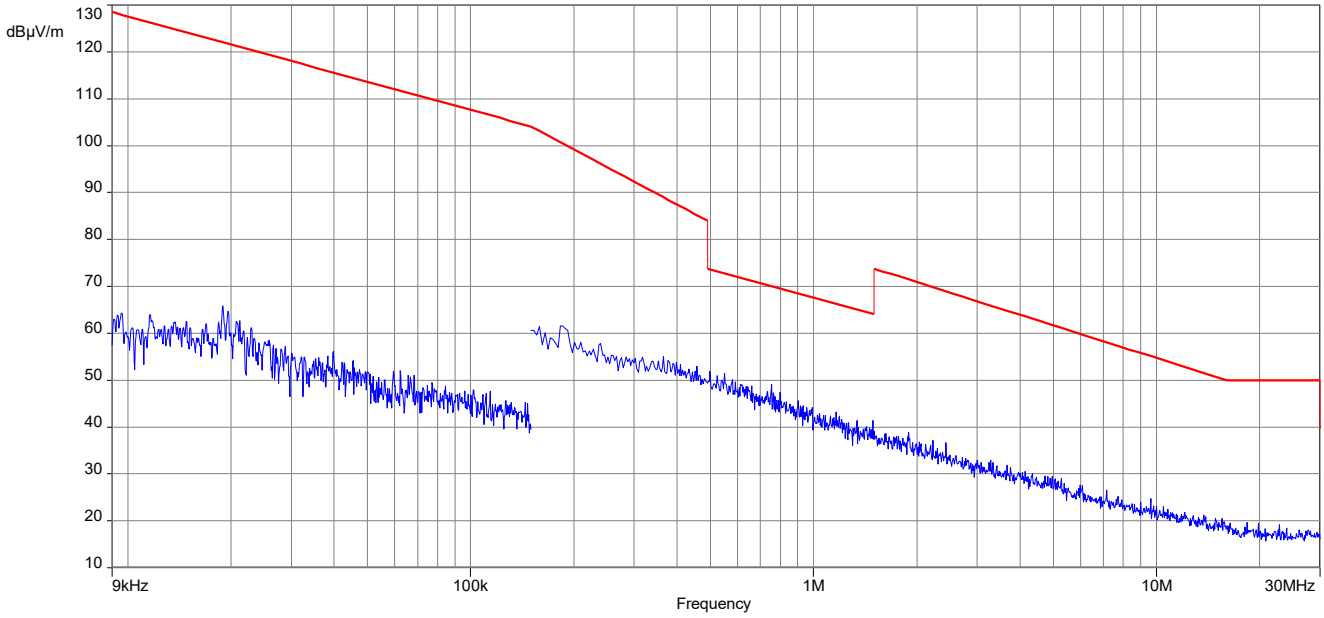
Results: Spurious emissions outside the restricted bands (Part15.231)

Fundamental Frequency	Spurious Frequency	Detector	Limit max. allowed [dBµV/m]	Amplitude of emission [dBµV/m]
All frequencies and modulations	-/-	Peak	-/-	No emissions detected.
		AVG	62	

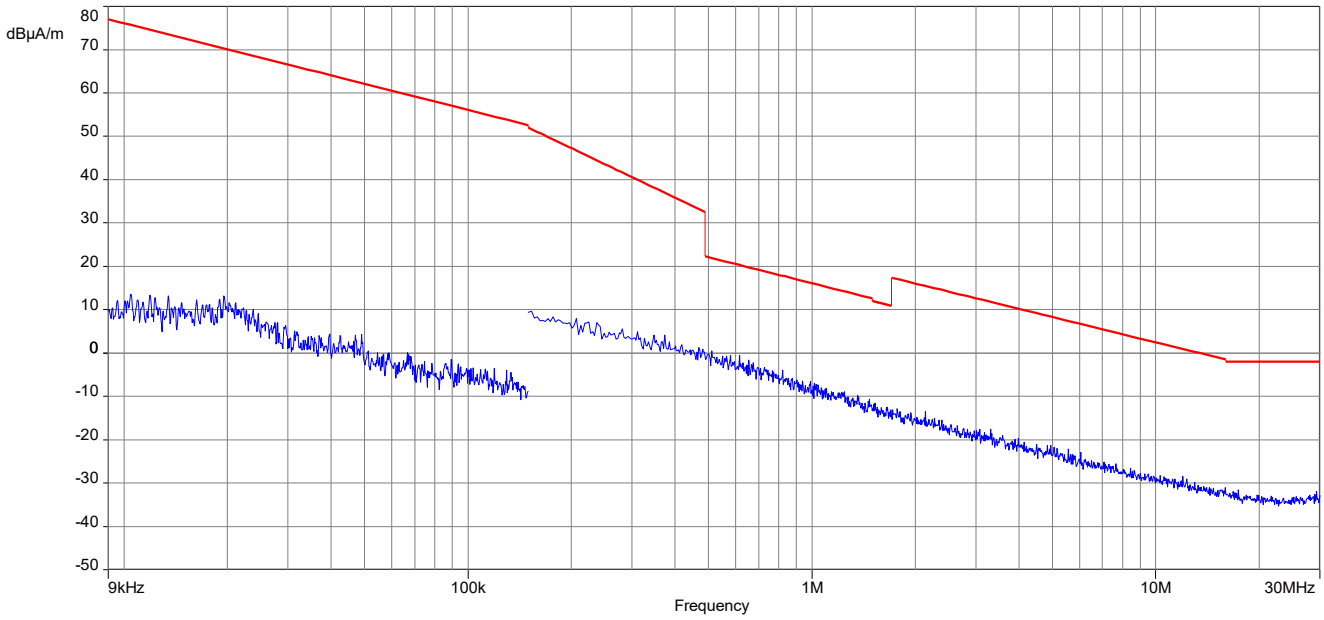
For emissions below 1 GHz, see table below the plots.

Plots: Short housing variant

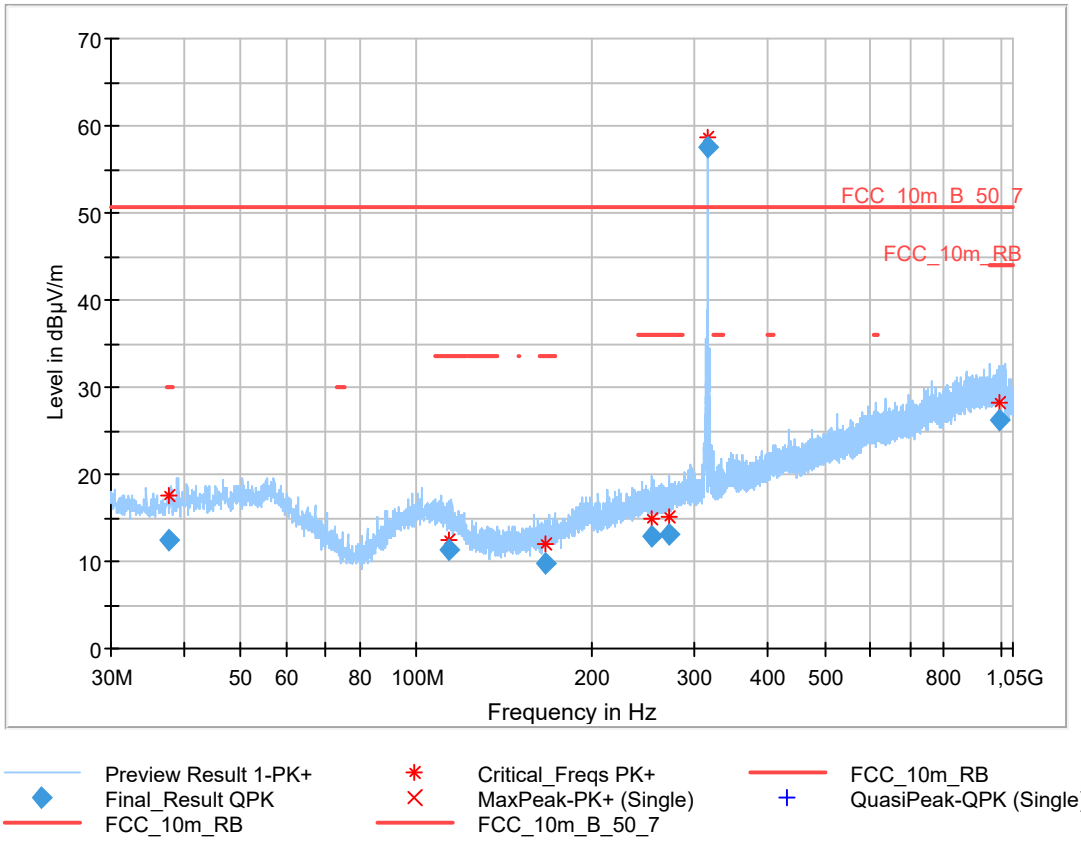
Plot 1: 9 kHz to 30 MHz FCC, FSK modulation, 315 MHz



Plot 2: 9 kHz to 30 MHz IC, FSK modulation, 315 MHz



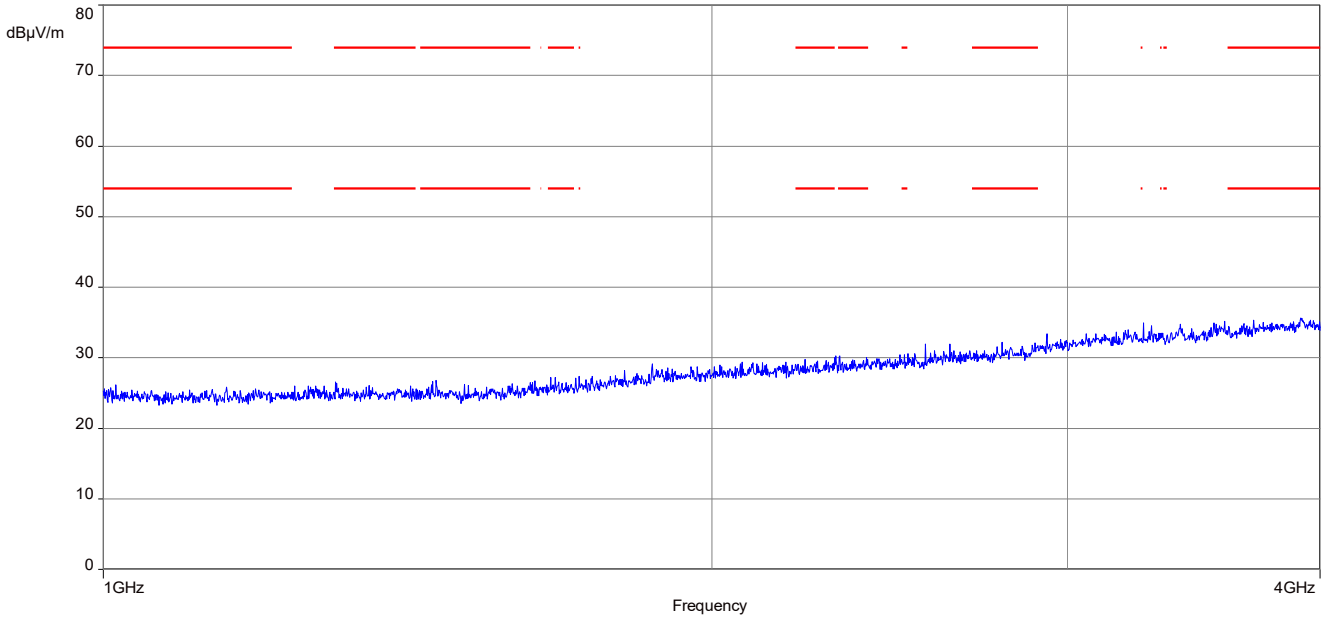
Plot 3: 30 MHz to 1000 MHz, vertical & horizontal polarisation, FSK modulation, 315 MHz



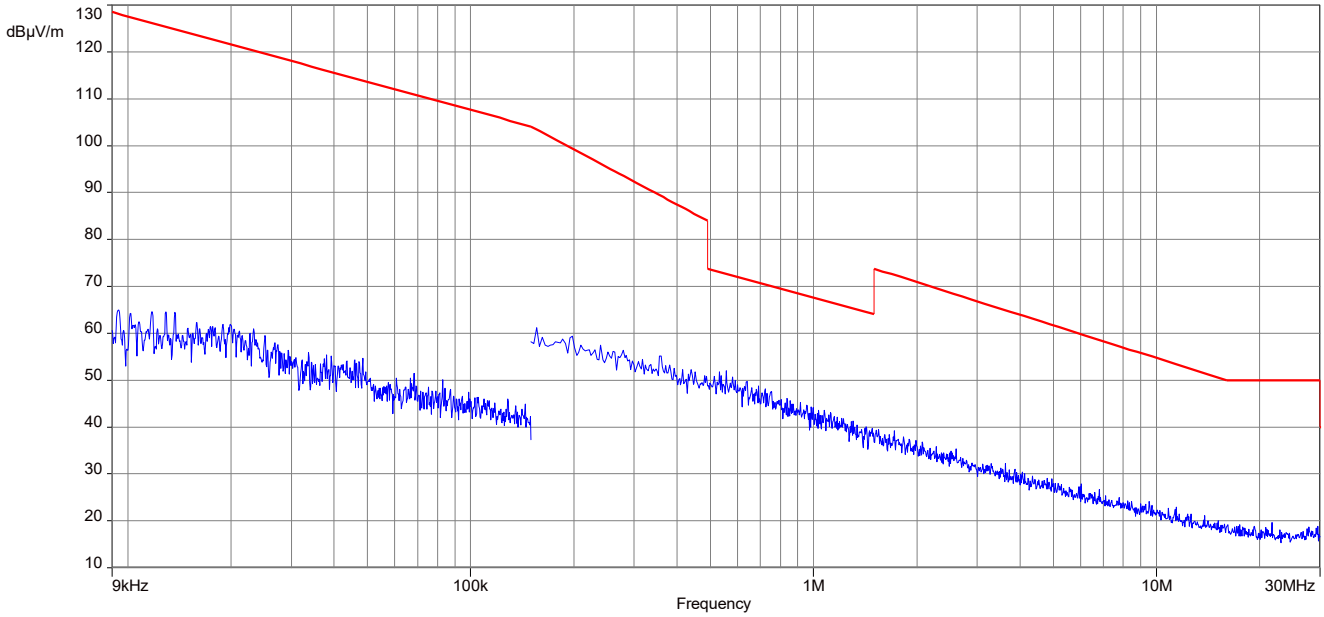
Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
37.611	12.36	30.0	17.6	1000	120.0	143.0	H	184	14
113.536	11.23	33.5	22.3	1000	120.0	200.0	H	291	13
166.548	9.70	33.5	23.8	1000	120.0	149.0	H	96	11
253.146	12.84	36.0	23.2	1000	120.0	279.0	H	139	14
270.771	13.09	36.0	22.9	1000	120.0	400.0	H	-24	14
995.213	26.24	44.0	17.8	1000	120.0	400.0	V	0	26

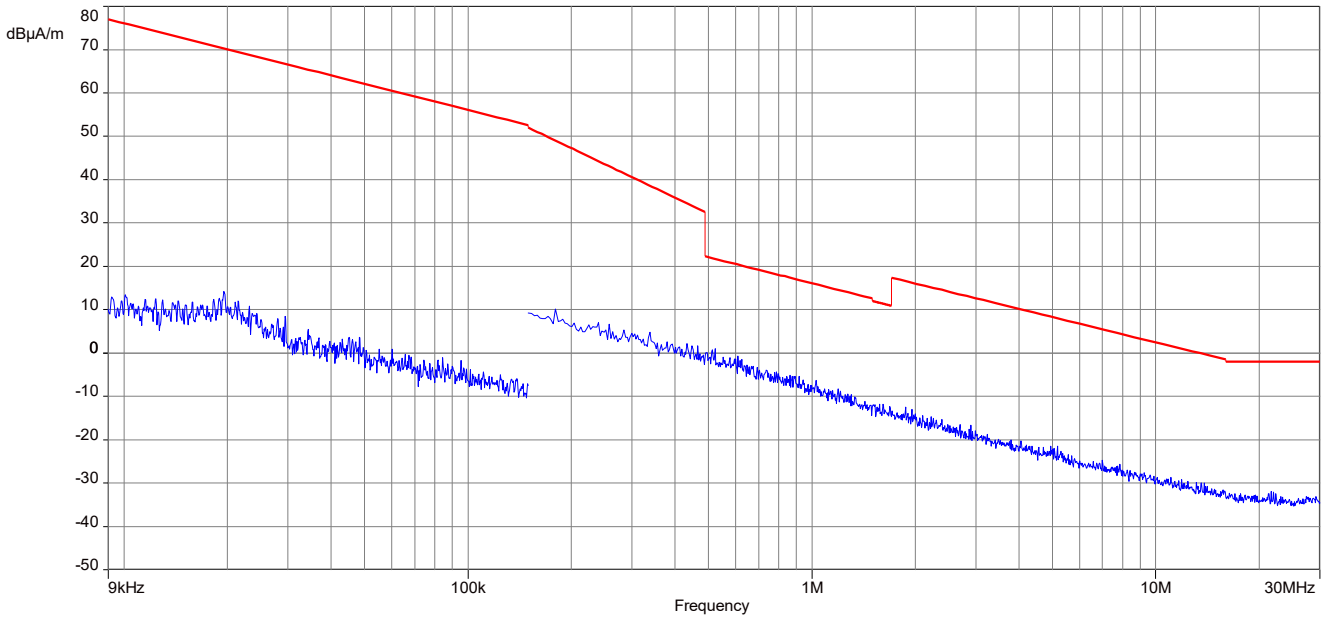
Plot 4: 1000 MHz to 4000 MHz, vertical & horizontal polarisation, FSK modulation, 315 MHz



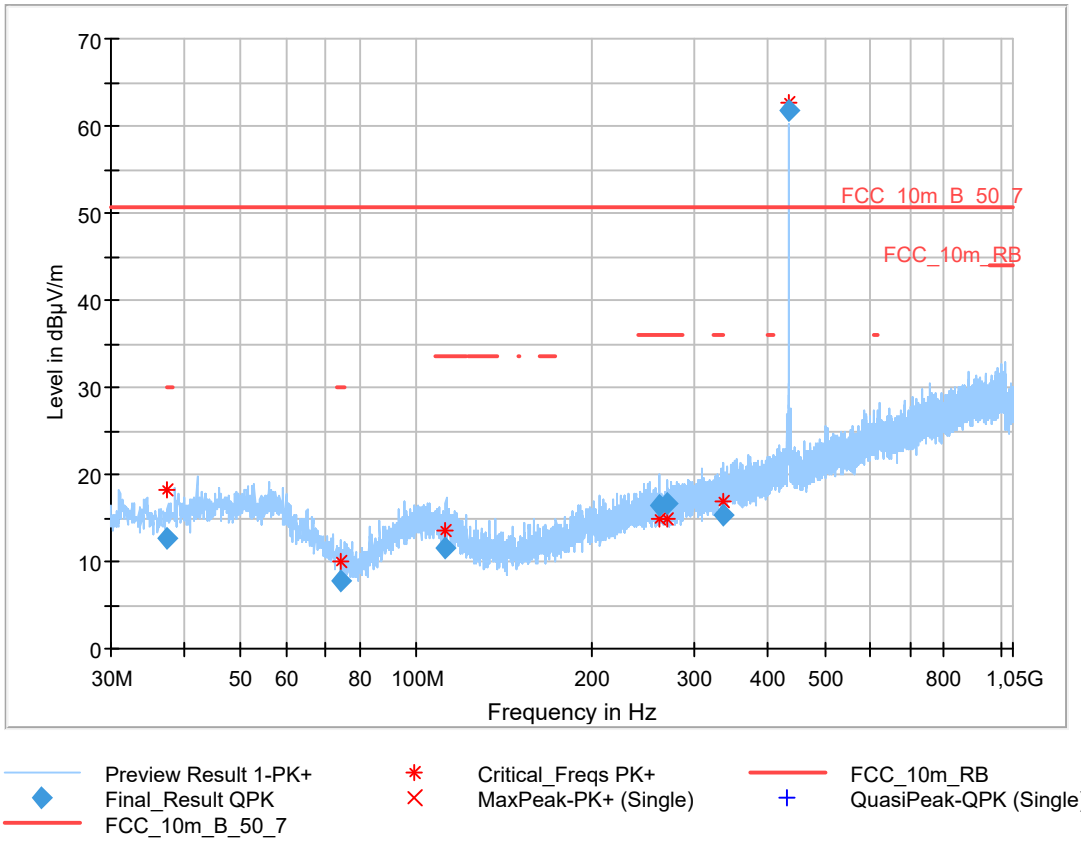
Plot 5: 9 kHz to 30 MHz FCC, FSK modulation, 433.92 MHz



Plot 6: 9 kHz to 30 MHz IC, FSK modulation, 433.92 MHz



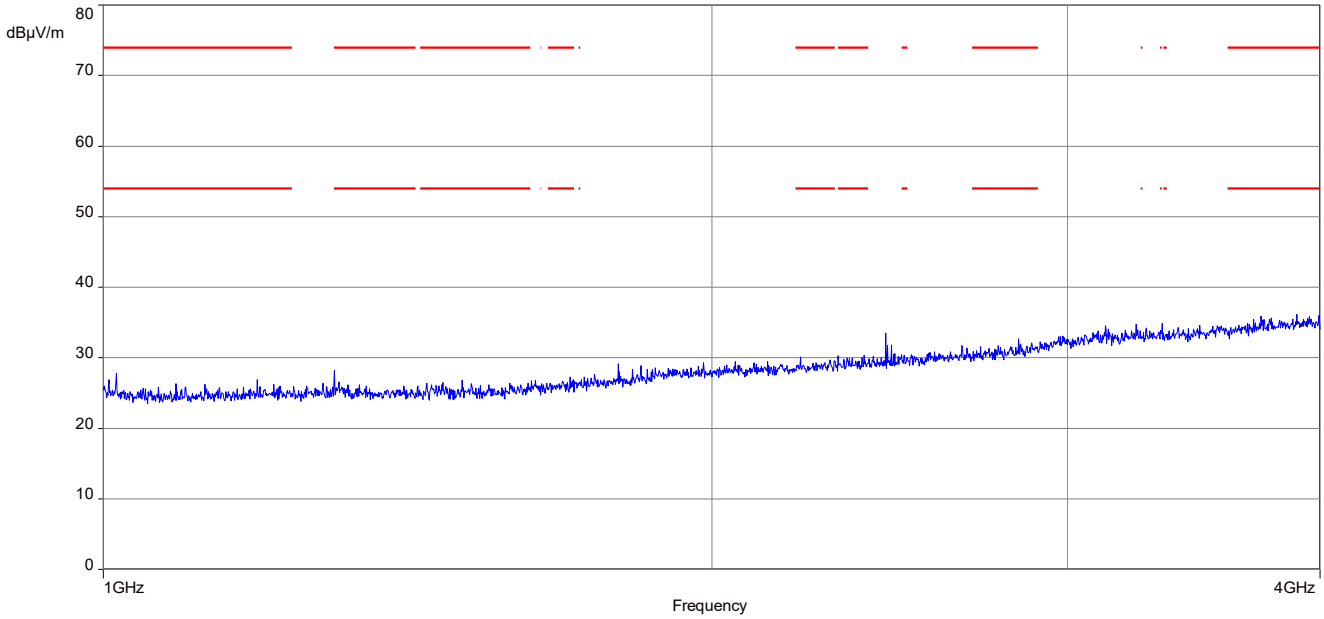
Plot 7: 30 MHz to 1000 MHz, vertical & horizontal polarisation, FSK modulation , 433.92 MHz



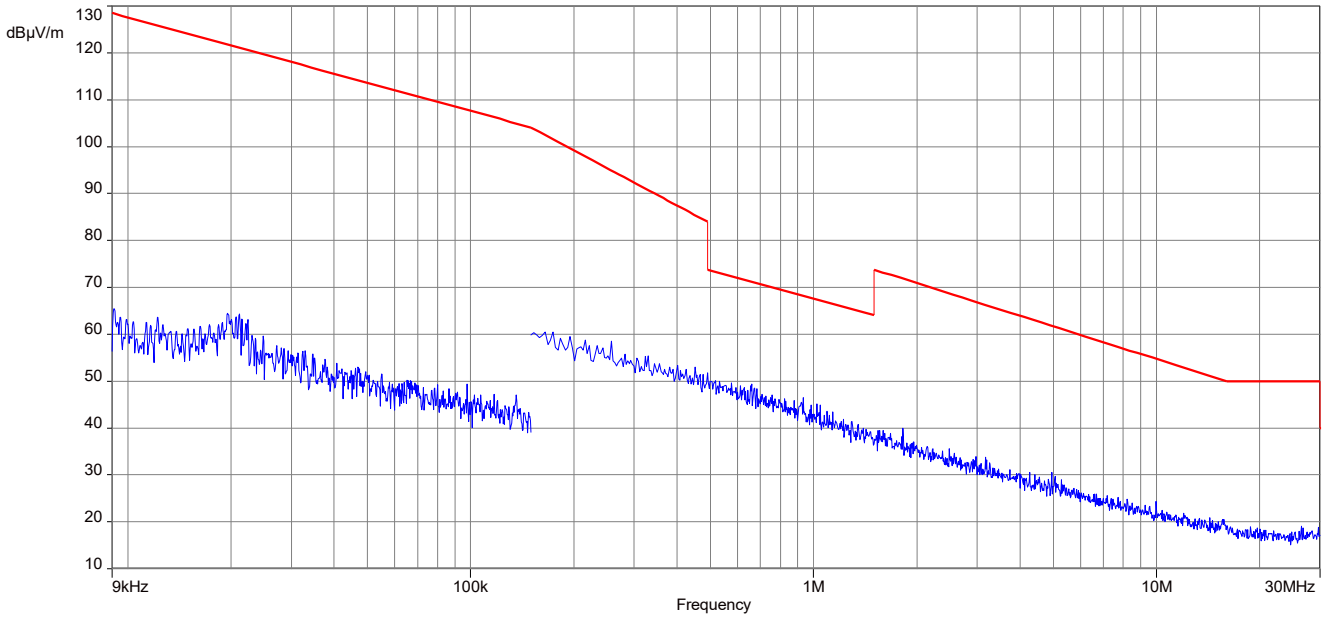
Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
37.502	12.58	30.0	17.4	1000	120.0	170.0	H	22	14
74.353	7.76	30.0	22.2	1000	120.0	124.0	H	158	9
111.986	11.57	33.5	21.9	1000	120.0	170.0	H	-8	13
260.022	16.49	36.0	19.5	1000	120.0	102.0	V	94	14
269.237	16.64	36.0	19.4	1000	120.0	108.0	V	77	14
334.002	15.33	36.0	20.7	1000	120.0	170.0	V	252	16

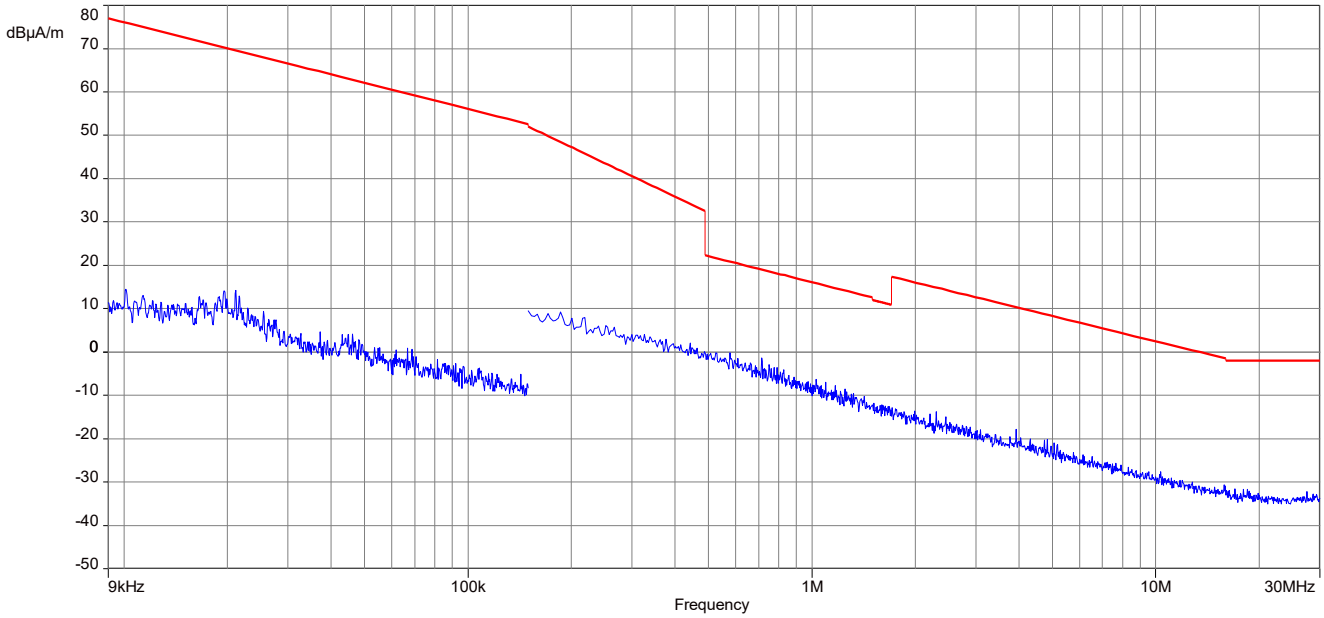
Plot 8: 1000 MHz to 4000 MHz, vertical & horizontal polarisation, FSK modulation, 433.92 MHz



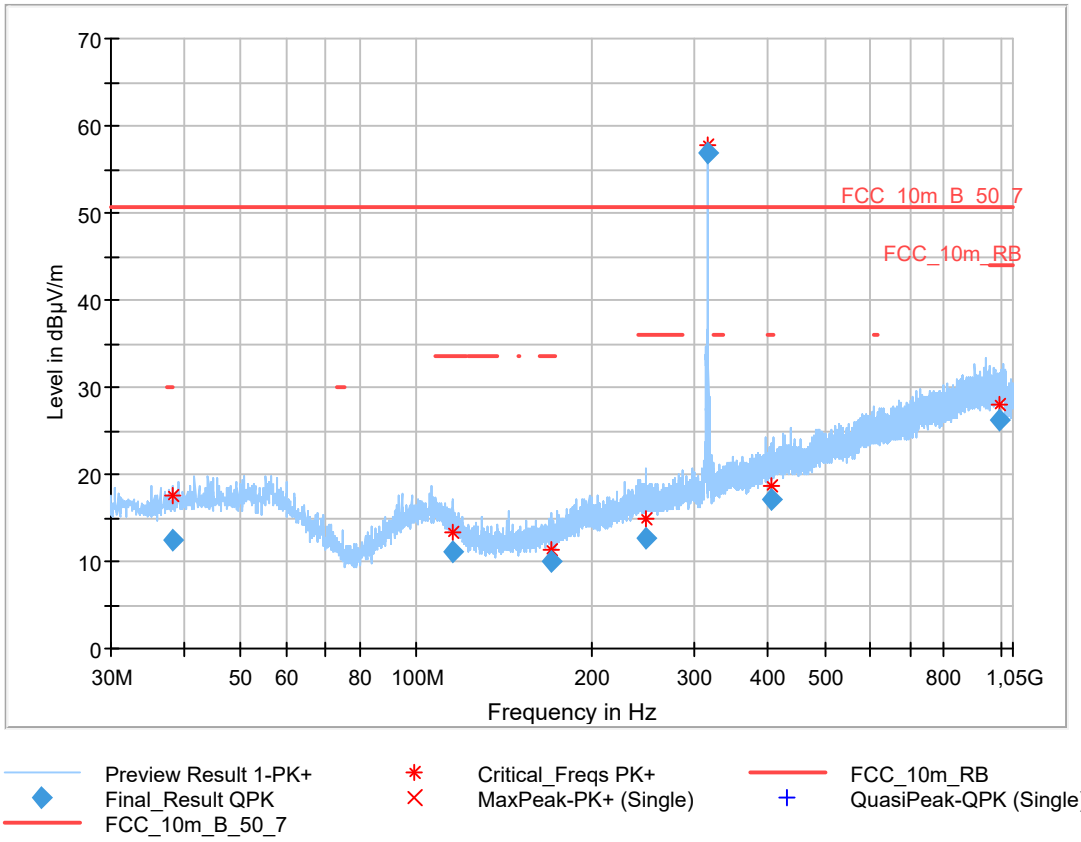
Plot 9: 9 kHz to 30 MHz FCC, ASK modulation, 315 MHz



Plot 10: 9 kHz to 30 MHz IC, ASK modulation, 315 MHz



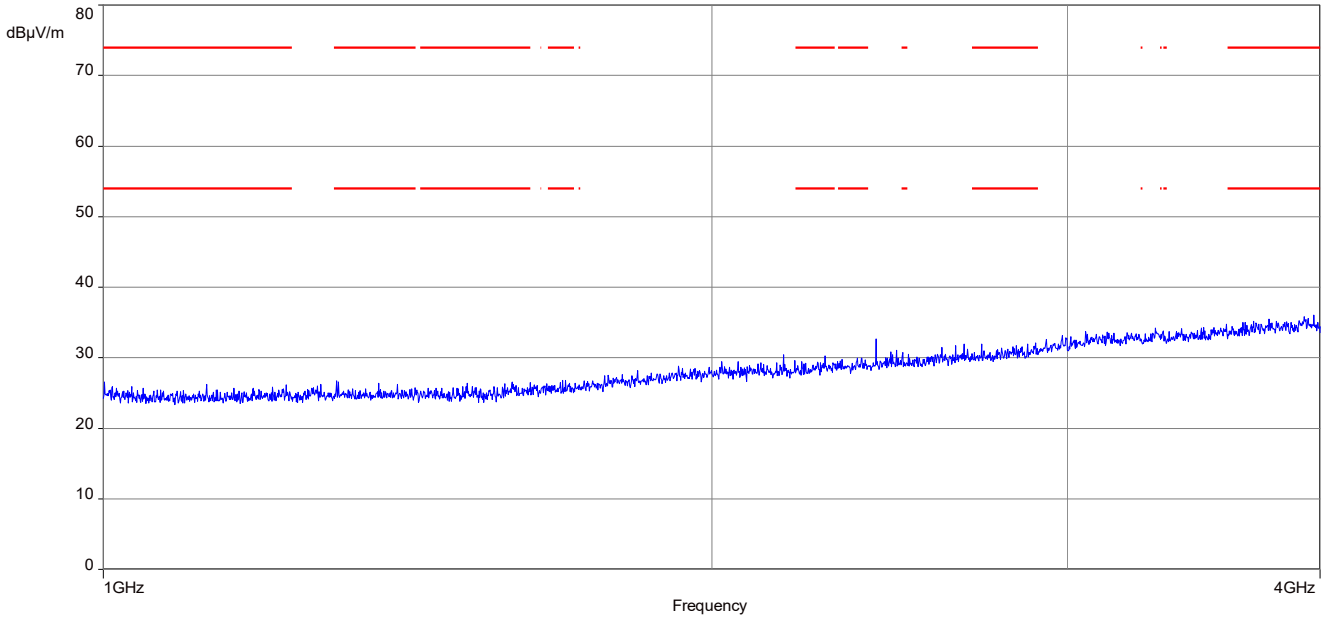
Plot 11: 30 MHz to 1000 MHz, vertical & horizontal polarisation, ASK modulation, 315 MHz



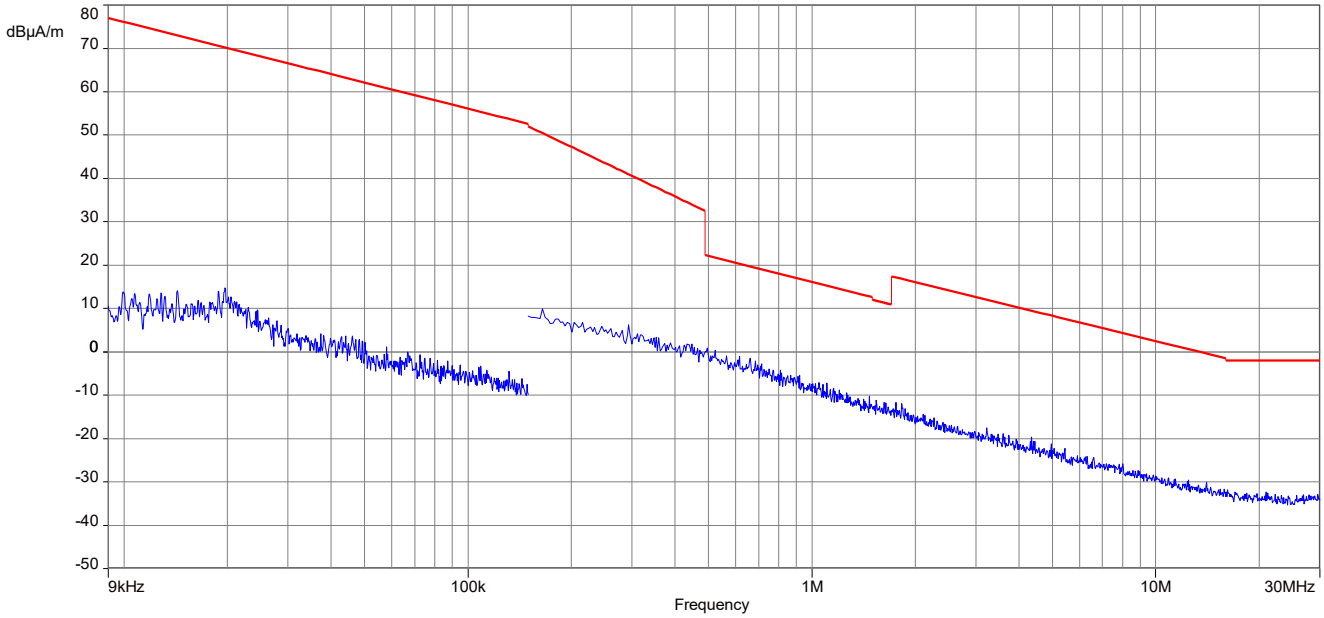
Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
38.160	12.41	30.0	17.6	1000	120.0	400.0	H	337	14
115.171	11.07	33.5	22.4	1000	120.0	343.0	H	285	12
170.379	9.90	33.5	23.6	1000	120.0	200.0	H	337	11
247.188	12.76	36.0	23.2	1000	120.0	316.0	V	336	14
406.315	17.14	36.0	18.9	1000	120.0	400.0	V	236	18
995.069	26.28	44.0	17.7	1000	120.0	200.0	H	336	26

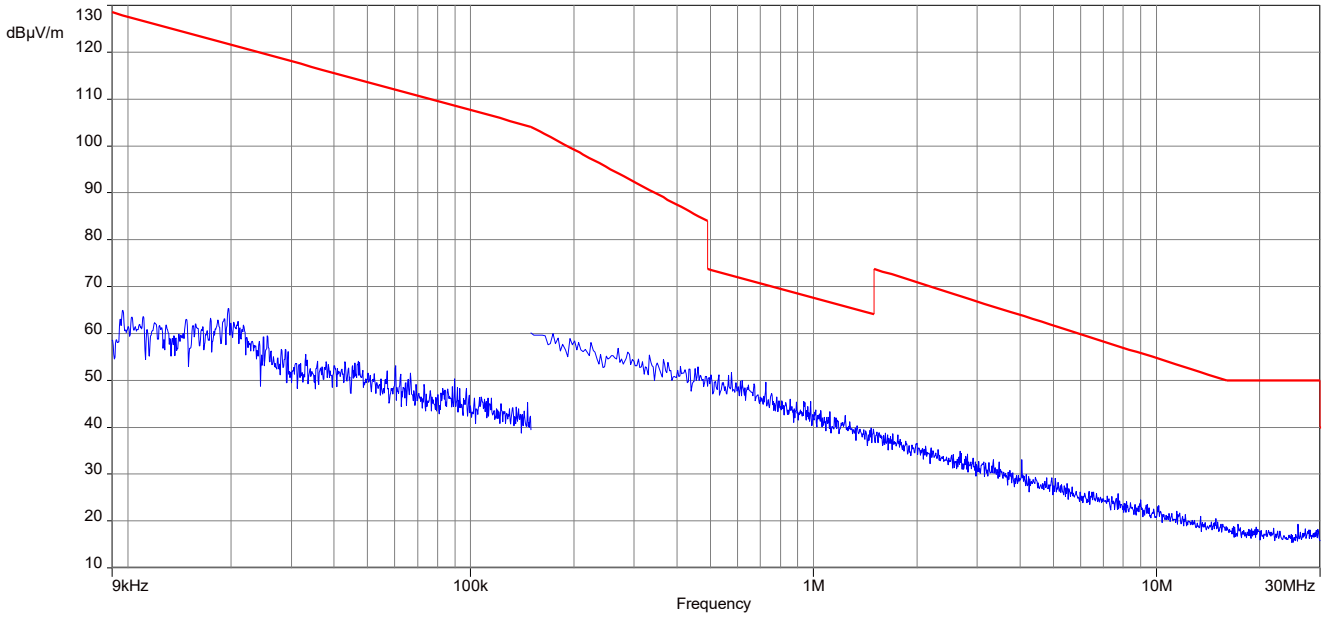
Plot 12: 1000 MHz to 4000 MHz, vertical & horizontal polarisation, ASK modulation, 315 MHz



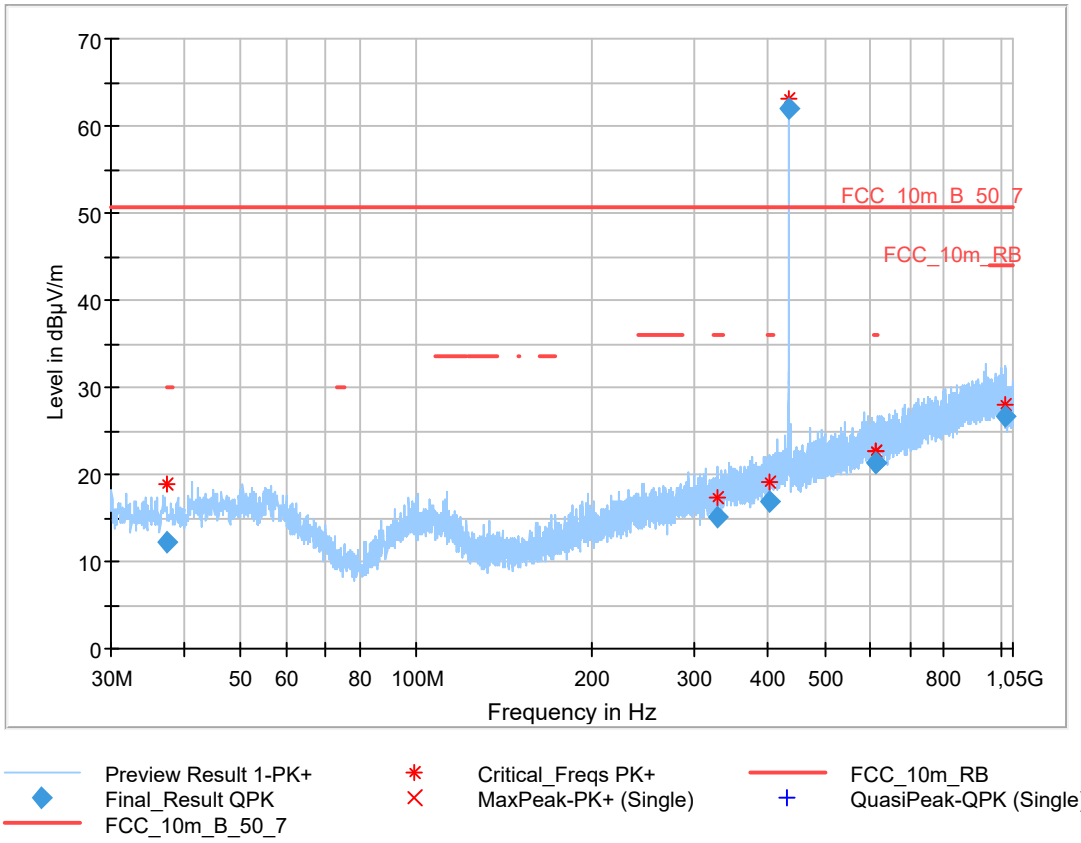
Plot 13: 9 kHz to 30 MHz FCC, ASK modulation, 433.92 MHz



Plot 14: 9 kHz to 30 MHz IC, ASK modulation, 433.92 MHz



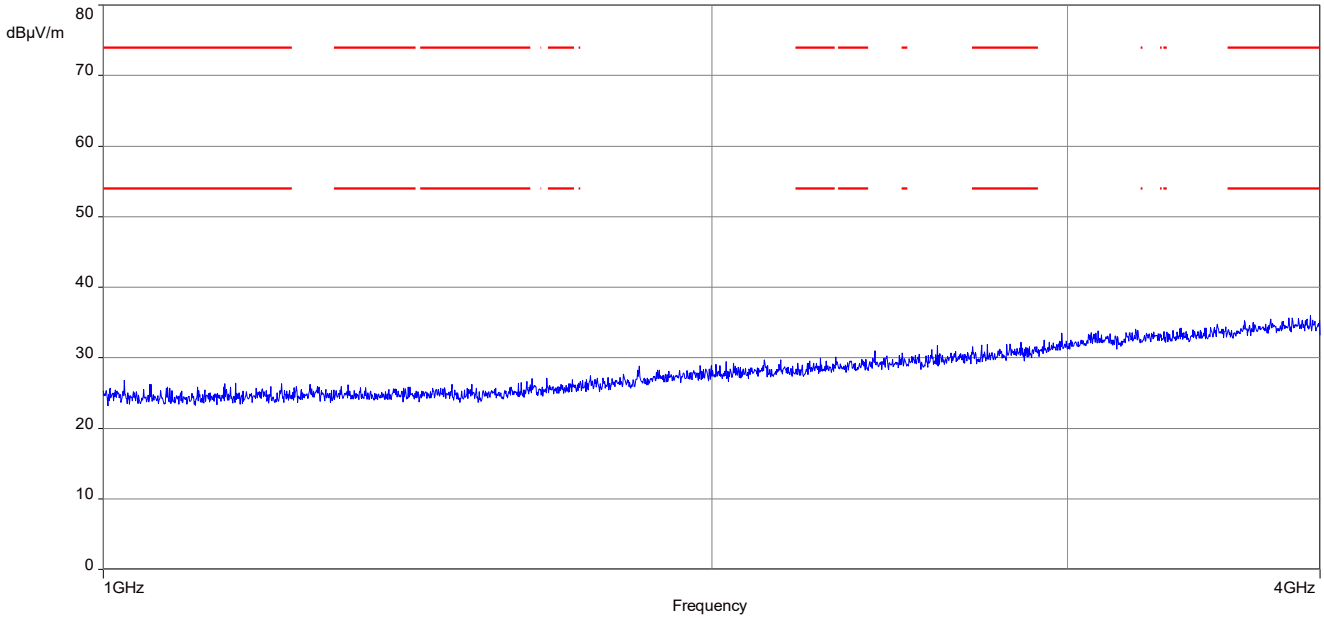
Plot 15: 30 MHz to 1000 MHz, vertical & horizontal polarisation, ASK modulation, 433.92 MHz



Final_Result

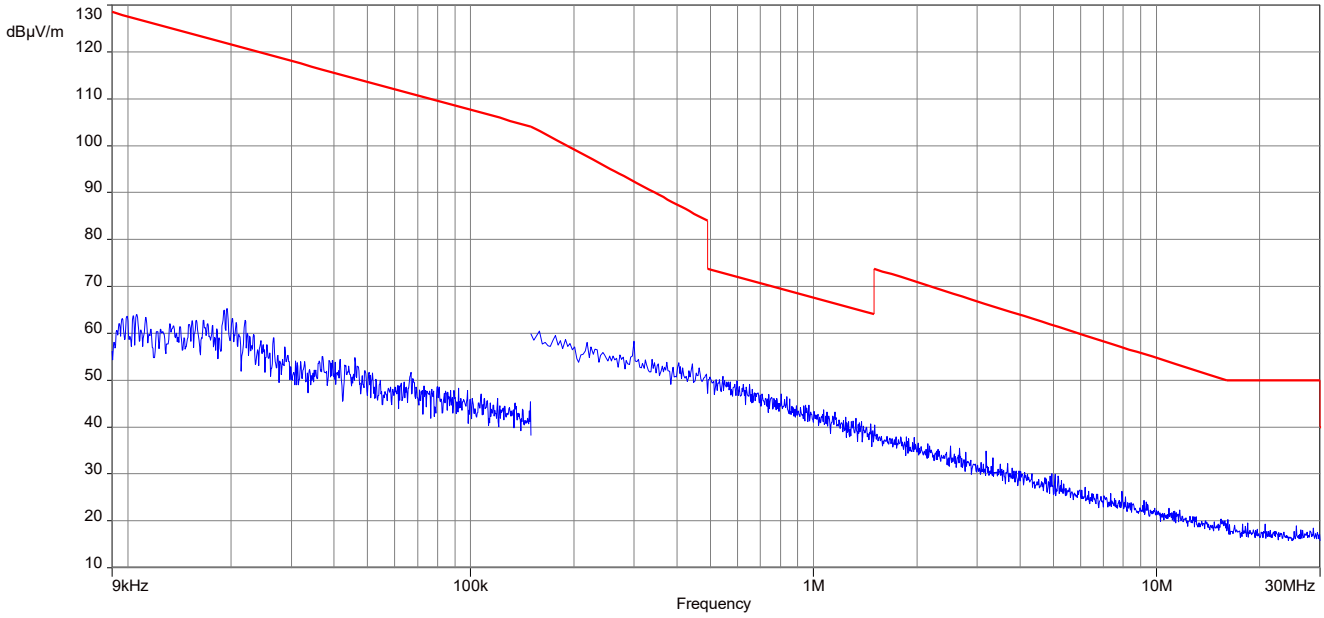
Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
37.410	12.33	---	---	1000	120.0	132.0	H	22	14
327.972	15.16	36.0	20.8	1000	120.0	170.0	V	164	16
402.796	16.88	36.0	19.1	1000	120.0	170.0	V	161	18
610.731	21.25	36.0	14.8	1000	120.0	170.0	H	285	22
613.861	21.36	36.0	14.6	1000	120.0	170.0	H	112	22
1016.184	26.68	44.0	17.3	1000	120.0	170.0	H	176	26

Plot 16: 1000 MHz to 4000 MHz, vertical & horizontal polarisation, ASK modulation, 433.92 MHz

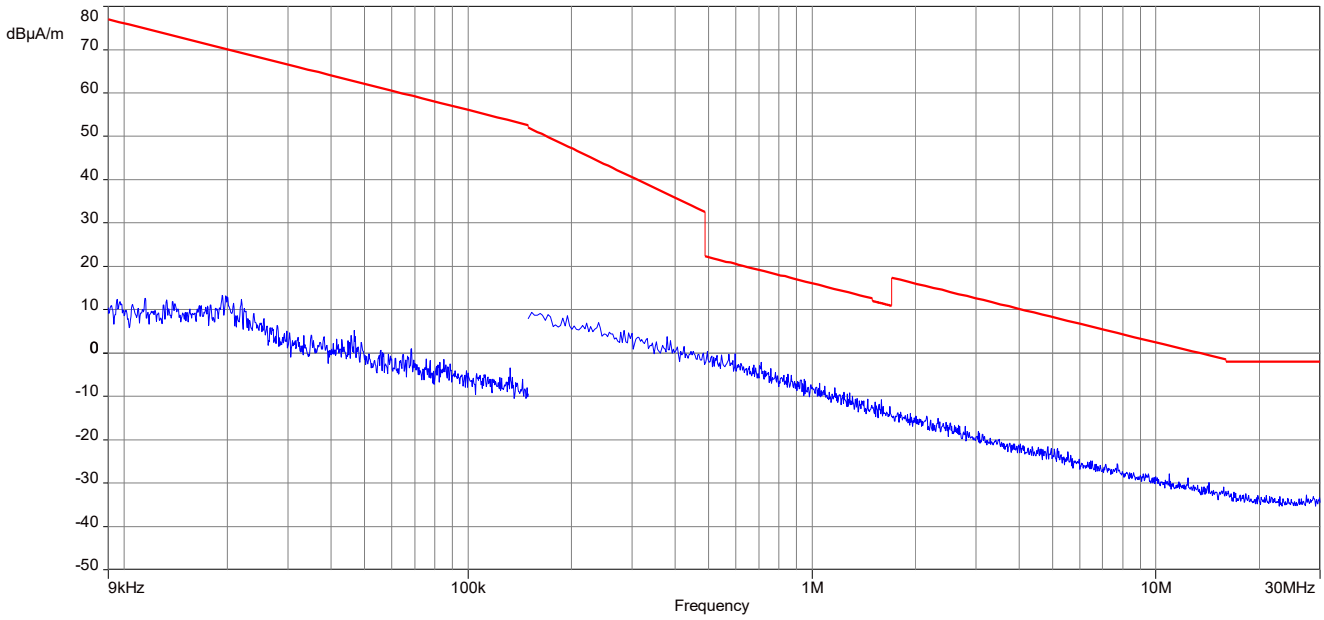


Plots: Long housing variant (only FSK modulation measured for verification, no emissions were detected)

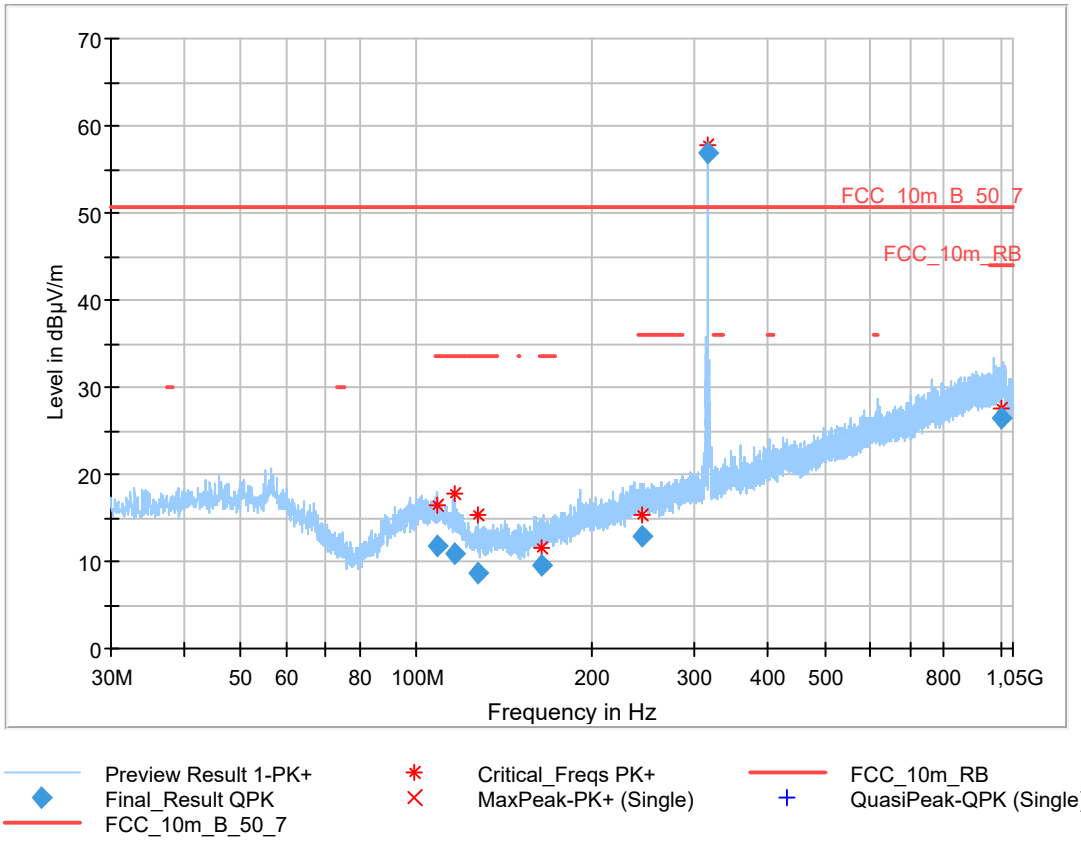
Plot 1: 9 kHz to 30 MHz FCC, FSK modulation, 315 MHz



Plot 2: 9 kHz to 30 MHz IC, FSK modulation, 315 MHz



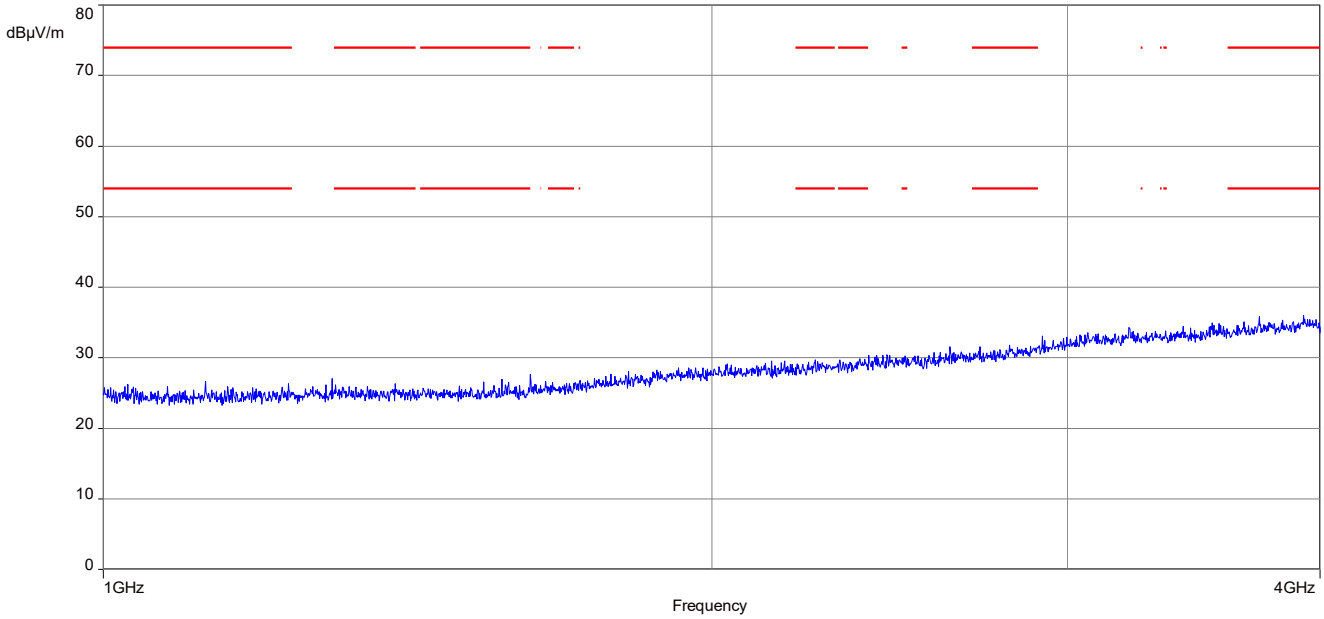
Plot 3: 30 MHz to 1000 MHz, vertical & horizontal polarisation, FSK modulation, 315 MHz



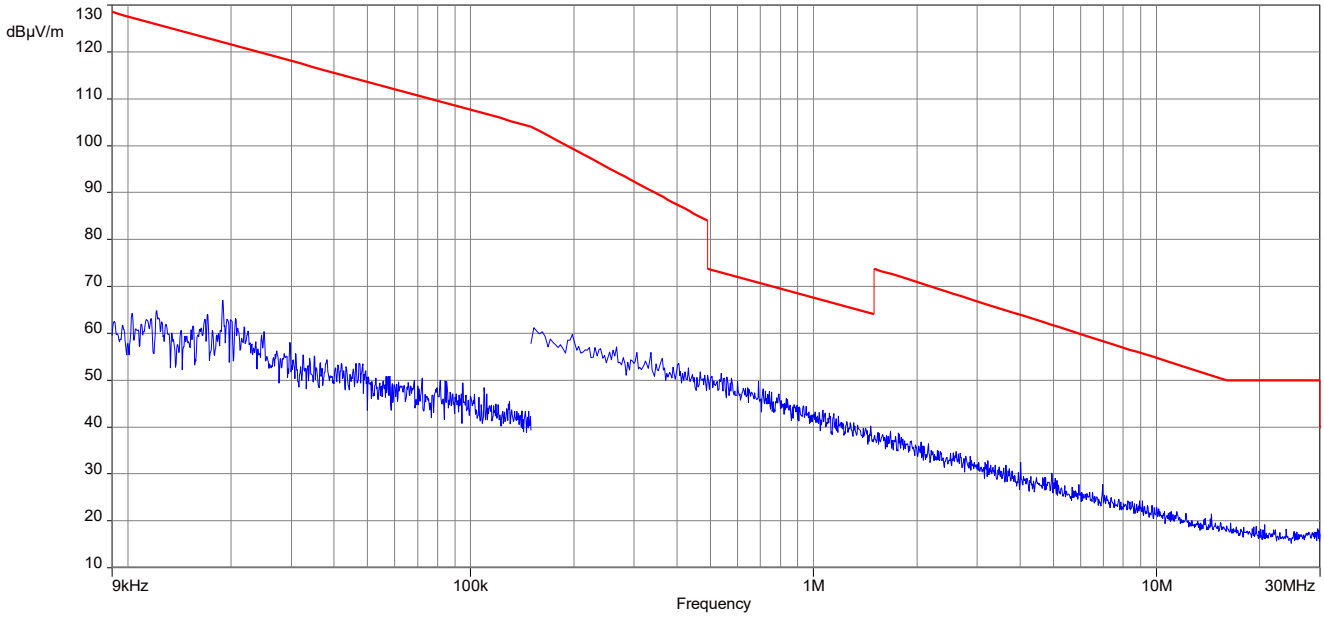
Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
108.385	11.86	33.5	21.6	1000	120.0	200.0	V	170	13
116.263	10.88	33.5	22.6	1000	120.0	400.0	V	12	12
127.518	8.72	33.5	24.8	1000	120.0	200.0	H	170	10
163.703	9.52	33.5	24.0	1000	120.0	120.0	V	86	11
244.306	12.98	36.0	23.0	1000	120.0	200.0	V	45	14
1005.458	26.42	44.0	17.6	1000	120.0	215.0	H	45	26

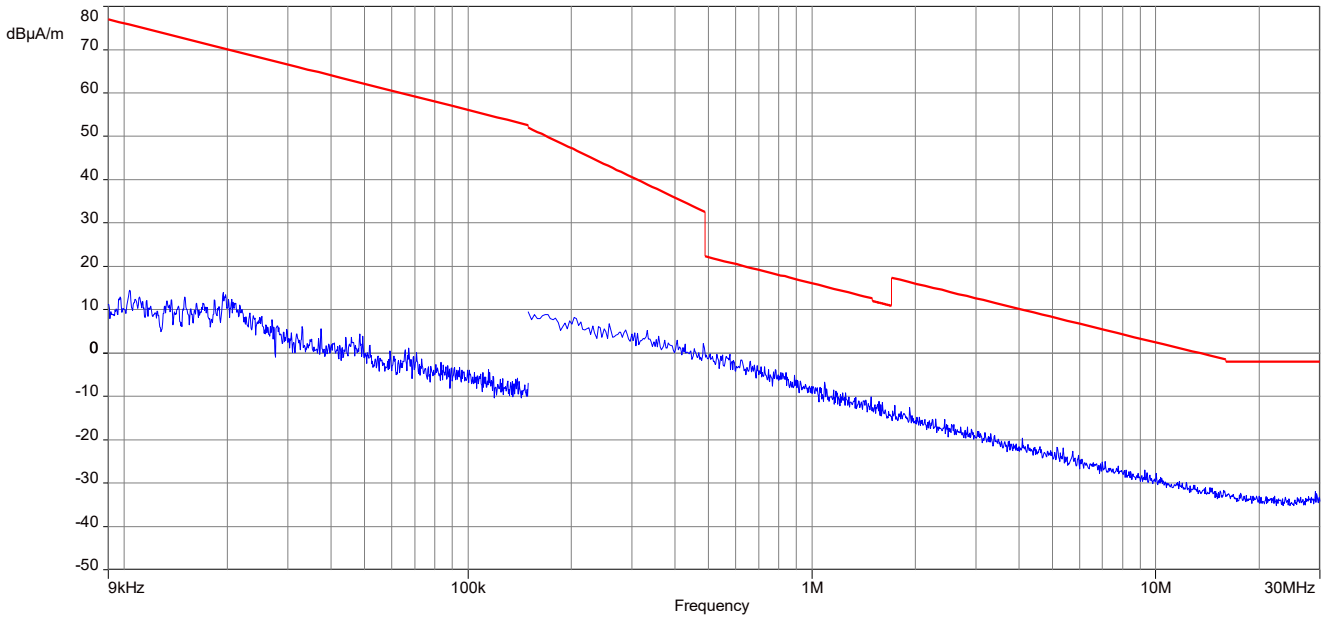
Plot 4: 1000 MHz to 4000 MHz, vertical & horizontal polarisation, FSK modulation, 315 MHz



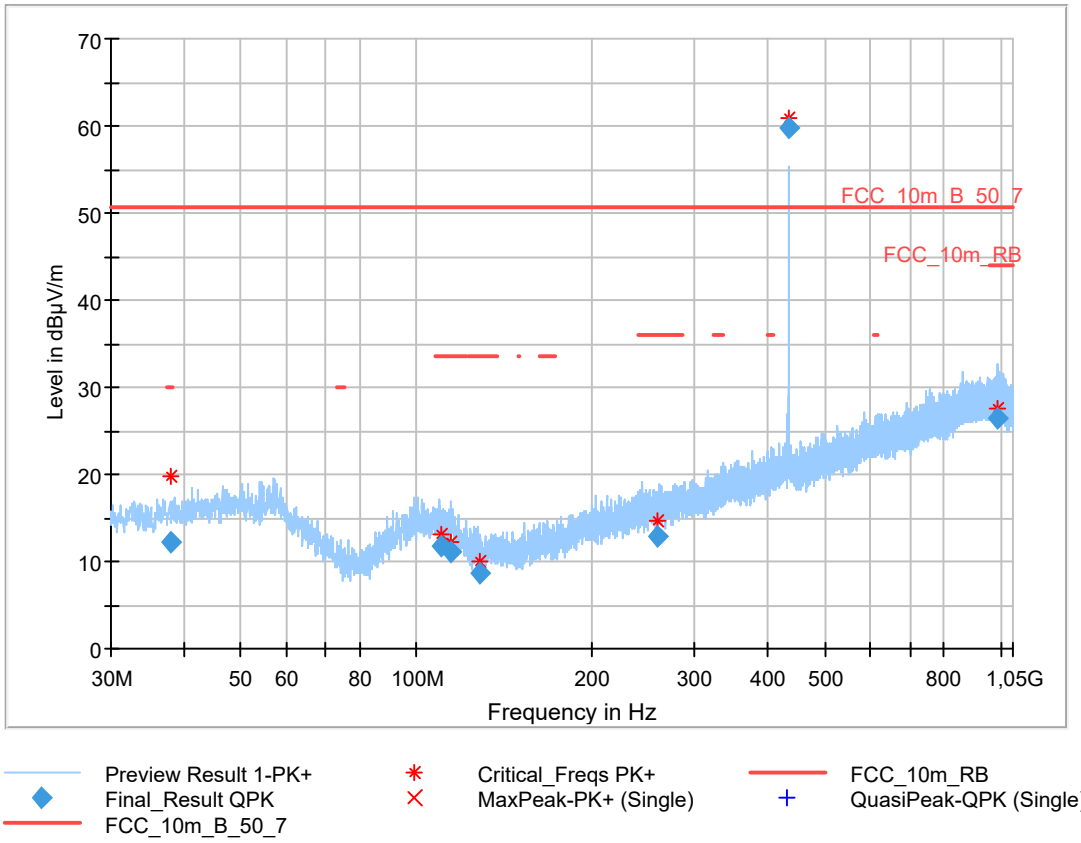
Plot 5: 9 kHz to 30 MHz FCC, FSK modulation, 433.92 MHz



Plot 6: 9 kHz to 30 MHz IC, FSK modulation, 433.92 MHz



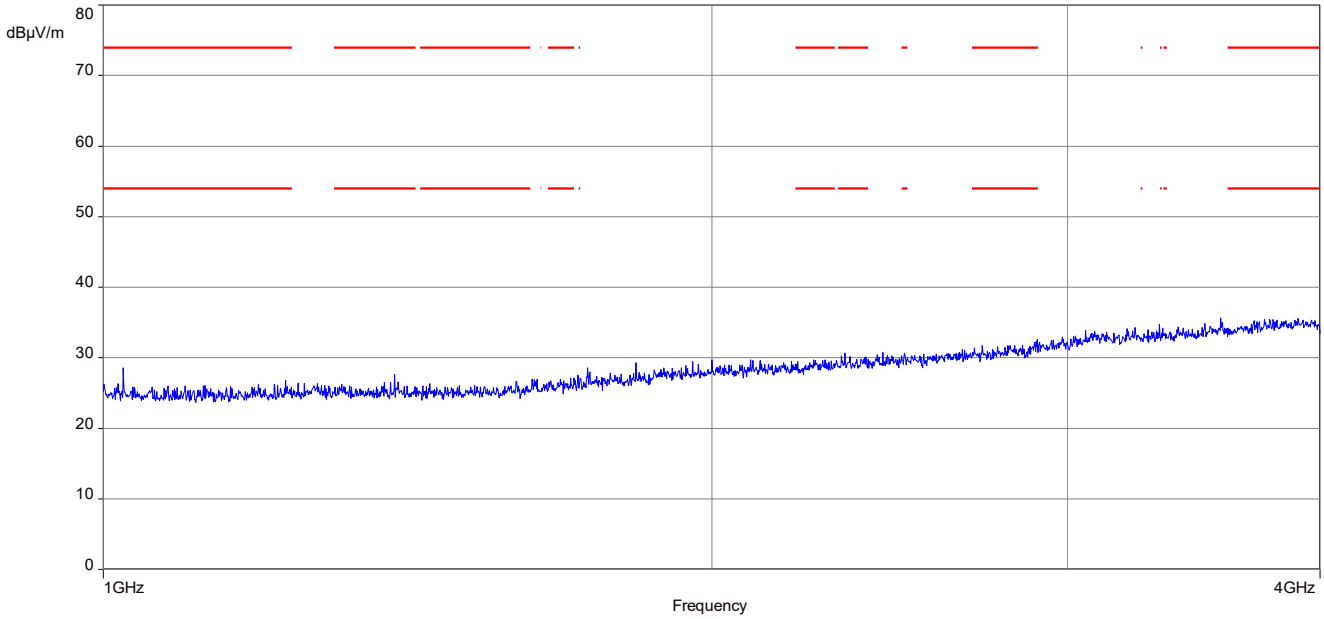
Plot 7: 30 MHz to 1000 MHz, vertical & horizontal polarisation, FSK modulation, 433.92 MHz



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)
37.876	12.33	30.0	17.7	1000	120.0	170.0	V	-6	14
110.312	11.78	33.5	21.7	1000	120.0	170.0	V	280	13
114.215	11.11	33.5	22.4	1000	120.0	164.0	H	94	13
128.000	8.66	33.5	24.8	1000	120.0	134.0	H	12	10
259.409	12.88	36.0	23.1	1000	120.0	102.0	H	292	14
990.901	26.40	44.0	17.6	1000	120.0	170.0	V	282	26

Plot 8: 1000 MHz to 4000 MHz, vertical & horizontal polarisation, FSK modulation, 433.92 MHz



12 Observations

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

13 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

14 Document history

Version	Applied changes	Date of release
R01	Initial release	2025-05-09
R02	PMN added and editorial corrections	2025-05-13
R03	Editorial corrections and correct timing plot added	2025-05-28

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