

TEST REPORT

Test report no.: 1-2329-26-02-02_TR1-R01



Deutsche
Akkreditierungsstelle
D-PL-12047-01-00

Testing laboratory

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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

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Manufacturer

Pepperl+Fuchs SE

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68307 Mannheim / 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 - 247 Issue 4

Digital Transmission Systems (DTSS), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices

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: UHF RFID reader for USA and Canada

Model name: IUH1-F720-V1-FR2-02

FCC ID: 2AXZAIUR1F720

ISED certification number: 7037A-IUR1F720

Frequency: 902 MHz – 928 MHz

Technology tested: RFID

Antenna: Integrated circular polarized patch antenna

Power supply: 18 V to 30 V DC by external power supply

Temperature range: -25°C to +70°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.

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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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2.2 Application details

Date of receipt of order:	2026-02-10
Date of receipt of test item:	2026-05-13
Start of test:*	2026-05-26
End of test:*	2026-06-29
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

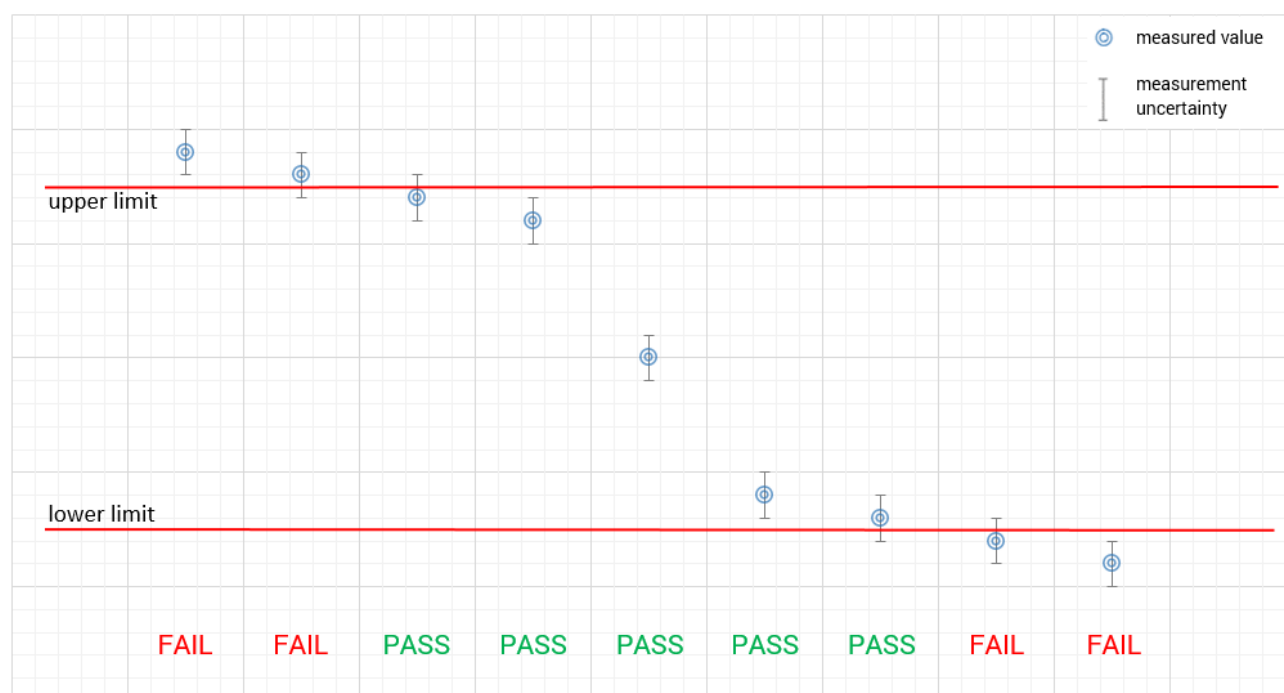
Test standard	Date	Description
FCC - Title 47 CFR Part 15		FCC - Title 47 of the Code of Federal Regulations; Chapter I; Part 15 - Radio frequency devices
RSS - 247 Issue 4	july 2025	Digital Transmission Systems (DTSS), Frequency Hopping Systems (FHSS) and Licence-Exempt Local Area Network (LE-LAN) Devices
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
ANSI/USEMCSC C63.10a-2024 Amendment 1	2024-08-08	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices Amendment 1
ANSI/USEMCSC C63.10a-2024 Amendment 1 Errata	2024-11-18	Errata to American National Standard for Procedures for Compliance Testing of Unlicensed Wireless Devices Amendment 1 Correction Sheet

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."

measured value, measurement uncertainty, verdict



5 Test environment

Temperature	:	T_{nom} T_{max} T_{min}	+22 °C during room temperature tests +70 °C during high temperature tests -25 °C during low temperature tests
Relative humidity content	:		55 %
Barometric pressure	:		1021 hpa
Power supply	:	V_{nom} V_{max} V_{min}	24.0 V DC by external power supply 30 V DC 18 V DC

6 Test item

6.1 General description

Kind of test item	:	UHF RFID reader for USA and Canada
Model name	:	IUH1-F720-V1-FR2-02
HMN	:	-/-
PMN	:	IUH1-F720-V1-FR2-02
HVIN	:	IUR1F720
FVIN	:	18-34788
S/N serial number	:	Rad. 40000204308782 cond. 40000204308783
Hardware status	:	#70165801
Software status	:	N/A
Firmware status	:	18-34788
Frequency band	:	902 MHz – 928 MHz
Type of radio transmission	:	FHSS
Use of frequency spectrum	:	
Type of modulation	:	PR-ASK
Number of channels	:	50
Antenna	:	Integrated circular polarized patch antenna
Power supply	:	18 V to 30 V DC by external power supply
Temperature range	:	-25°C to +70°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:

1-2329-26-02-01_TR1-A101-R01
1-2329-26-02-01_TR1-A102-R01
1-2329-26-02-01_TR1-A103-R01

7 Description of the test setup

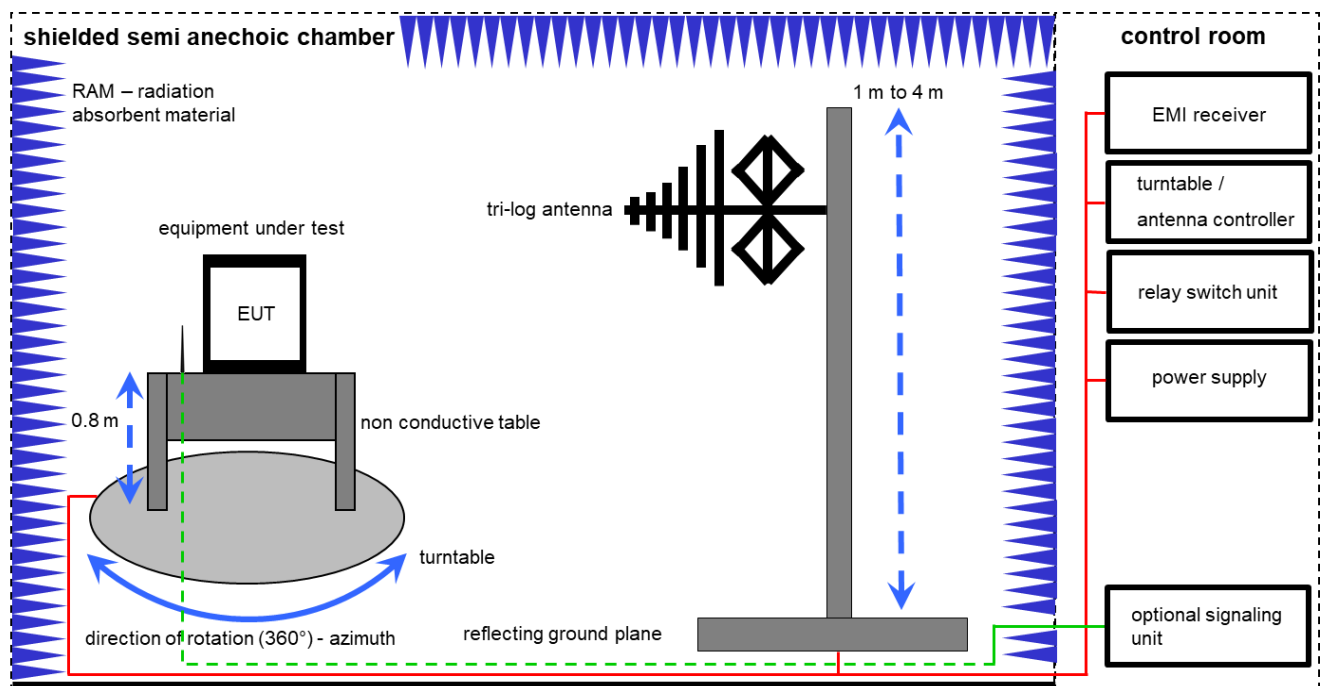
Typically, the calibrations of the test apparatus are commissioned to and performed by an accredited calibration laboratory. The calibration intervals are determined in accordance with the DIN EN ISO/IEC 17025. In addition to the external calibrations, the laboratory executes comparison measurements 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.

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)

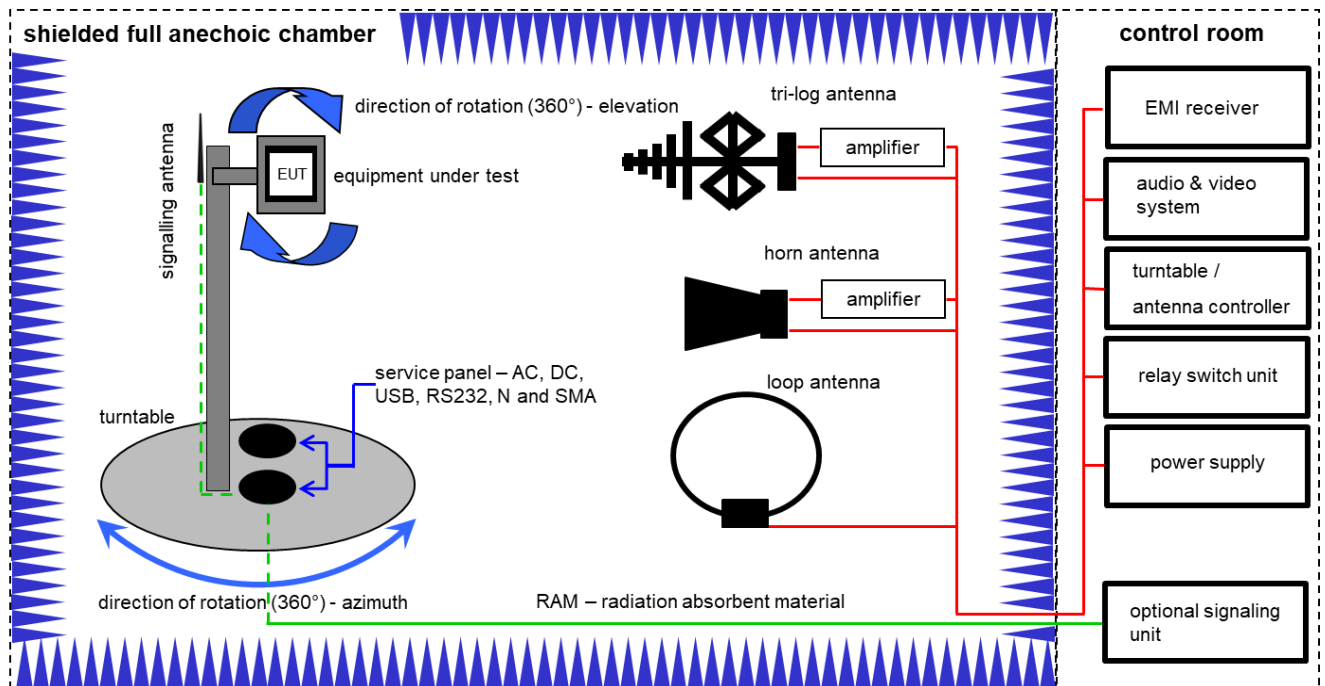
Example calculation:

$$FS [dB\mu V/m] = 12.35 [dB\mu V/m] + 1.90 [dB] + 16.80 [dB/m] = 31.05 [dB\mu V/m] (35.69 \mu V/m)$$

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	Antenna Tower	Model 2175	ETS-Lindgren	64762	300003745	izw	-/-	-/-
4	A	Positioning Controller	Model 2090	ETS-Lindgren	64672	300003746	izw	-/-	-/-
5	A	Turntable Interface-Box	Model 105637	ETS-Lindgren	44583	300003747	izw	-/-	-/-
6	A	TRILOG Broadband Antenna	TRILOG Broadband Antenna VULB9163	Schwarzbeck MESS-ELEKTRONIK OHG / Schönaun	216	50226	cal	05.09.2025	30.09.2027
7	A	Turntable	2089-4.0	EMCO	-/-	300004394	ne	-/-	-/-
8	A	PC	TecLine	F+W	-/-	300004388	ne	-/-	-/-
9	A	EMI Test Receiver	EMI Test Receiver ESR3 9kHz-3.6GHz	Rohde & Schwarz Messgerätebau GmbH / Memmingen	102587	50417	cal	08.12.2025	31.12.2026
10	A	DC power supply, 60Vdc, 50A, 1200 W	6032A	HP	2920A04466	300000580	ne	-/-	-/-

7.2 Shielded fully anechoic chamber



Measurement distance: tri-log antenna and 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)

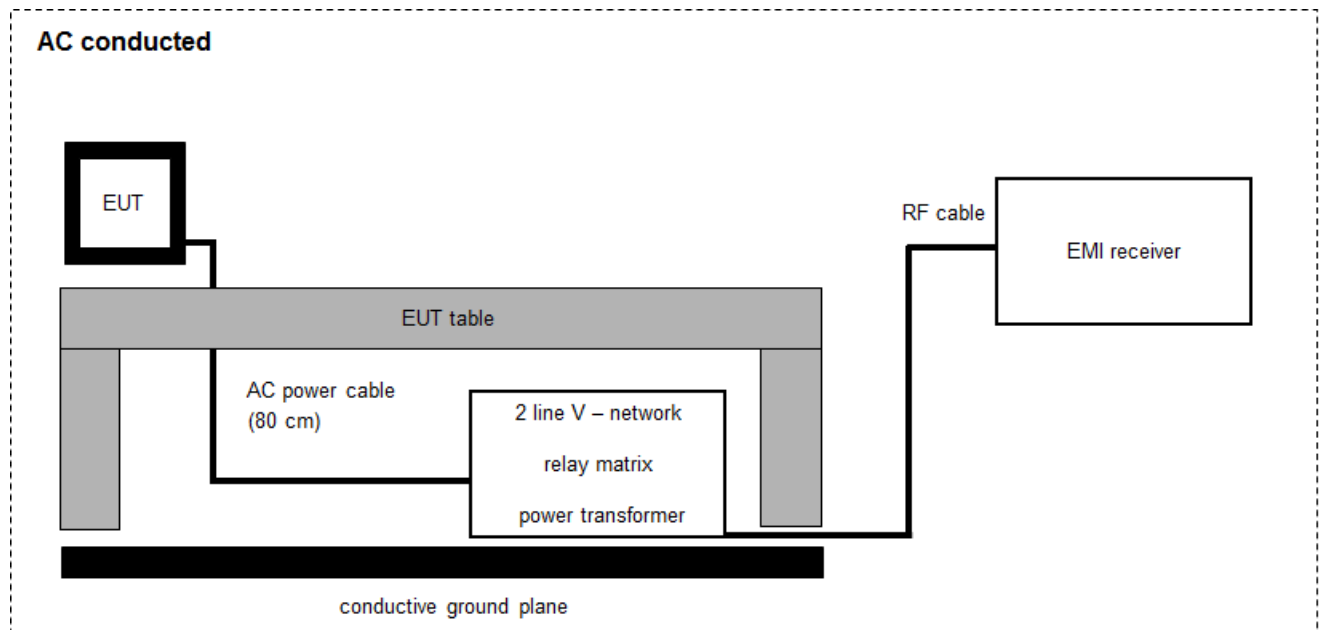
Example calculation:

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,B,C	Anechoic chamber	FAC 3/5m	MWB / TDK	87400/02	300000996	ev	-/-	-/-
2	A,B,C	EMI Test Receiver	EMI Test Receiver ESU26	Rohde & Schwarz Messgerätebau GmbH / Memmingen	100037	50254	cal	11.12.2025	31.12.2026
3	A,B,C	4U RF Switch Platform	L4491A	Agilent Technologies	MY50000037	300004509	ne	-/-	-/-
4	A,B,C	NEXIO EMV-Software	BAT EMC V2022.0.32.0	Nexio		300004682	ne	-/-	-/-
5	B	TRILOG Broadband Antenna	TRILOG Broadband Antenna VULB9163	Schwarzbeck MESS-ELEKTRONIK OHG / Schönaun	216	50226	cal	05.09.2025	30.09.2027
6	C	Double-Ridged Waveguide Horn Antenna	Double-Ridged Waveguide Horn Antenna 3115	EMCO Elektronik GmbH / Gilching	9107-3696	40342	cal	15.04.2025	30.04.2027
7	C	Highpass Filter	WHK1.1/15G-10SS	Wainwright	3	300003255	ev	-/-	-/-
8	A	Active Loop Antenna	Active Loop Antenna 6502	EMCO Elektronik GmbH / Gilching	2210	50044	cal	07.07.2025	31.07.2027
9	C	Broadband Amplifier 0.5-18 GHz	CBLU5184540	CERNEX	22049	300004481	ev	-/-	-/-
10	A,B,C	Power Supply	Power Supply HMP2020	Rohde & Schwarz Messgerätebau GmbH / Memmingen	120579	40408	cal	03.12.2025	31.12.2027

7.3 AC conducted



$$FS = UR + CF + VC$$

(FS-field strength; UR-voltage at the receiver; CR-loss of the cable and filter; VC-correction factor of the ISN)

Example calculation:

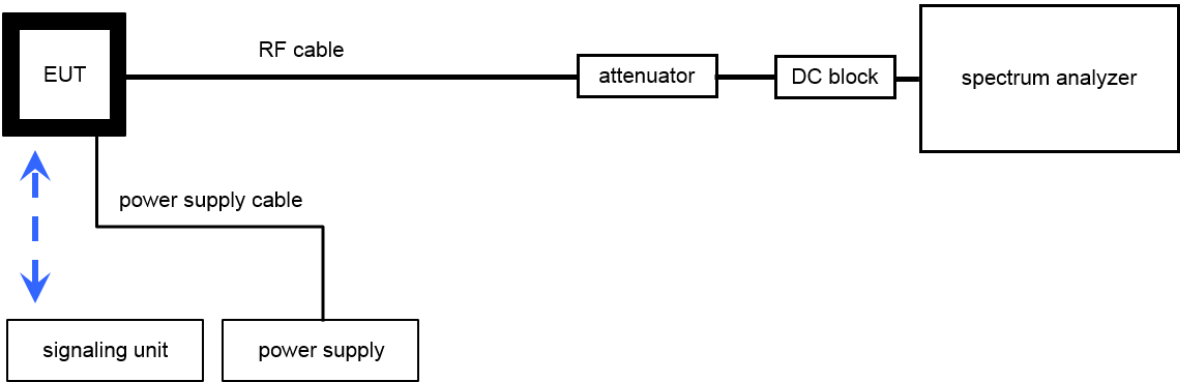
$$FS [dB\mu V/m] = 37.62 [dB\mu V/m] + 9.90 [dB] + 0.23 [dB] = 47.75 [dB\mu V/m] \quad (244.06 \mu V/m)$$

Equipment table:

No.	Setup	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	A	Two-Line V-Network (LISN)	Two-Line V-Network (LISN) ESH3-Z5	Rohde & Schwarz Messgerätebau GmbH / Memmingen	892475/017	50005	cal	09.12.2025	31.12.2027
2	A	RF-Filter-section	85420E	HP	3427A00162	300002214	NK!	-/-	-/-
3	A	Hochpass 150 kHz	EZ-25	R&S	100010	300003798	ev	-/-	-/-
4	A	PC	TecLine	F+W	-/-	300003532	ne	-/-	-/-
5	A	Analyzer-Impedance-System	Analyzer-Impedance-System AIS16/1	MEC Import: Spitzenberger + Spies GmbH & Co. KG	U02076 07/0 1023	40808	cal	09.12.2025	31.12.2027
6	A	EMI Test Receiver	EMI Test Receiver ESR3 9kHz-3.6GHz	Rohde & Schwarz Messgerätebau GmbH / Memmingen	102981	40332	cal	05.12.2025	31.12.2026

7.4 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	Power Supply	HMP2020	Rohde & Schwarz	101961	300006102	k	05.12.2024	05.12.2026
2	A	Signal analyzer	FSW26	Rohde & Schwarz	101371	300005697	k	07.01.2026	31.01.2027

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 $\pm 45^\circ$ 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 18 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
Antenna gain	± 3 dB
Carrier frequency separation	± 21.5 kHz
Number of hopping channels	-/-
Spectrum bandwidth	± 21.5 kHz absolute; ± 15.0 kHz relative
Maximum output power	± 1 dB
Detailed conducted spurious emissions @ the band edge	± 1 dB
Band edge compliance radiated	± 3 dB
Spurious emissions conducted	± 3 dB
Spurious emissions radiated below 30 MHz	± 3 dB
Spurious emissions radiated 30 MHz to 1 GHz	± 4.1 dB
Spurious emissions radiated 1 GHz to 12.75 GHz	± 3.7 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 - 247, Issue 4	Passed	2026-08-11	-/-

Test specification clause	Test case	Temperature conditions	Power source voltages	Mode	C	NC	NA	NP	Remark
§15.247(b)(4) RSS - 247 / 6.2.2.2	Antenna gain	Nominal	Nominal	PR-ASK	☒	☐	☐	☐	-/-
§15.247(a)(1) RSS - 247 / 6.2.1	Carrier frequency separation	Nominal	Nominal	PR-ASK	☒	☐	☐	☐	-/-
§15.247(a)(1) RSS - 247 / 6.2.2.1	Number of hopping channels	Nominal	Nominal	PR-ASK	☒	☐	☐	☐	-/-
§15.247(a)(1) (iii) RSS - 247 / 6.2.2.1	Time of occupancy (dwell time)	Nominal	Nominal	PR-ASK	☒	☐	☐	☐	-/-
§15.247(a)(1) RSS - 247 / 6.2.2.1	Spectrum bandwidth of a FHSS system bandwidth	Nominal	Nominal	PR-ASK	☒	☐	☐	☐	-/-
§15.247(b)(2) RSS - 247 / 6.2.2.2	Maximum output power	Nominal	Nominal	PR-ASK	☒	☐	☐	☐	-/-
§15.247(d) RSS - 247 / 6.6	Detailed spurious emissions @ the band edge - conducted	Nominal	Nominal	PR-ASK	☒	☐	☐	☐	-/-
§15.205 RSS - 247 / 6.6 RSS - Gen	Band edge compliance radiated	Nominal	Nominal	PR-ASK	☒	☐	☐	☐	-/-
§15.247(d) RSS - 247 / 6.6	Spurious emissions conducted	Nominal	Nominal	PR-ASK	☒	☐	☐	☐	-/-
§15.209(a) RSS - Gen	Spurious emissions radiated below 30 MHz	Nominal	Nominal	PR-ASK	☒	☐	☐	☐	-/-
§15.247(d) RSS - 247 / 6.6 §15.109 RSS - Gen	Spurious emissions radiated 30 MHz to 1 GHz	Nominal	Nominal	PR-ASK	☒	☐	☐	☐	-/-
§15.247(d) RSS - 247 / 6.6 §15.109 RSS - Gen	Spurious emissions radiated above 1 GHz	Nominal	Nominal	PR-ASK	☒	☐	☐	☐	-/-
§15.107(a) §15.207	Conducted emissions below 30 MHz (AC conducted)	Nominal	Nominal	PR-ASK	☒	☐	☐	☐	-/-

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

11 RF measurements

11.1 Additional comments

Reference documents: 1-9305_26-02 Customer Questionnaire_IUH1-F720-V1-FR2-02____v001

Special test descriptions: Mess-Guide_007

Configuration descriptions: Parameter_Prueflabor_FR2_004

Test mode: ☒ Special software is used. EUT testmode provided by customer

12 Measurement results

12.1 Antenna gain

Description:

The antenna gain of the complete system is calculated by the difference of radiated power in EIRP and the conducted power of the module.

Measurement parameters	
Detector	Peak
Sweep time	Auto
Resolution bandwidth	1 MHz
Video bandwidth	3 MHz
Span	5 MHz
Trace mode	max hold
Test setup	see sub clause 7.2 B (radiated) see sub clause 7.4 A (conducted)
Measurement uncertainty	see sub clause 9

Limits:

FCC	ISED
Antenna gain	
The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.	

Results:

	902.75 MHz	914.75 MHz	927.25 MHz
Conducted power	28.77 dBm	28.82 dBm	28.59 dBm
Radiated power (EIRP)	32.10 dBm	32.73 dBm	31.62 dBm
Gain Calculated	3.33 dBi	3.91 dBi	3.03 dBi

12.2 Carrier Frequency Separation

Description:

Measurement of the carrier frequency separation of a hopping system. The carrier frequency separation is constant for all modulation-modes. We use DBPSK-modulation to show compliance. EUT in hopping mode.

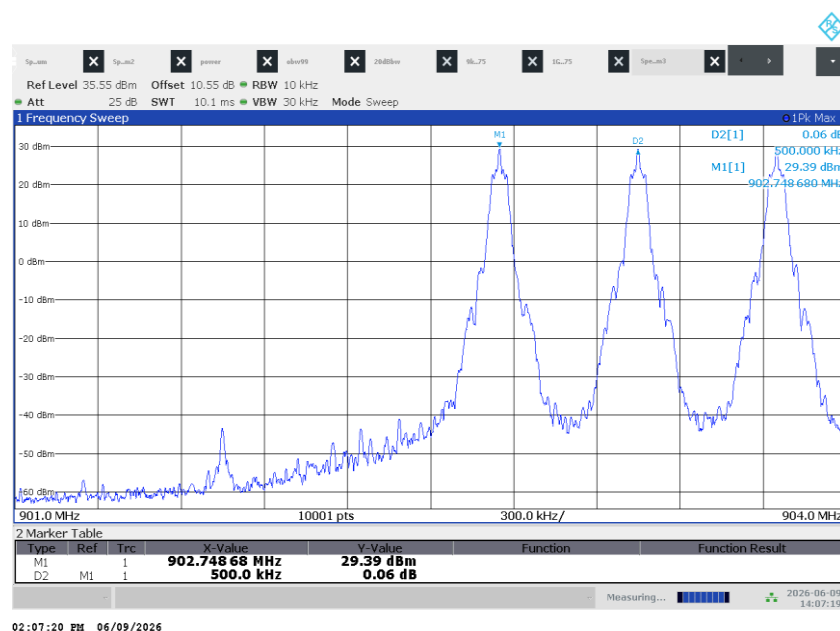
Measurement parameters	
Detector	Peak
Sweep time	Auto
Resolution bandwidth	10 kHz
Video bandwidth	30 kHz
Span	see plots
Trace mode	max hold
Test setup	see sub clause 7.4 A
Measurement uncertainty	see sub clause 9

Limits:

FCC	ISED
Carrier frequency separation	
Minimum 25 kHz or two-thirds of the 20 dB bandwidth of the hopping system whichever is greater. The two-thirds of the 20 dB bandwidth for IC is only valid for the ISM band 2400 – 2483.5 MHz.	

Result: The channel separation is 500 kHz

Plot: frequency separation



12.3 Number of Hopping Channels

Description:

Measurement of the total number of used hopping channels. The number of hopping channels is constant for all modulation-modes. We use DBPSK -modulation to show compliance. EUT in hopping mode.

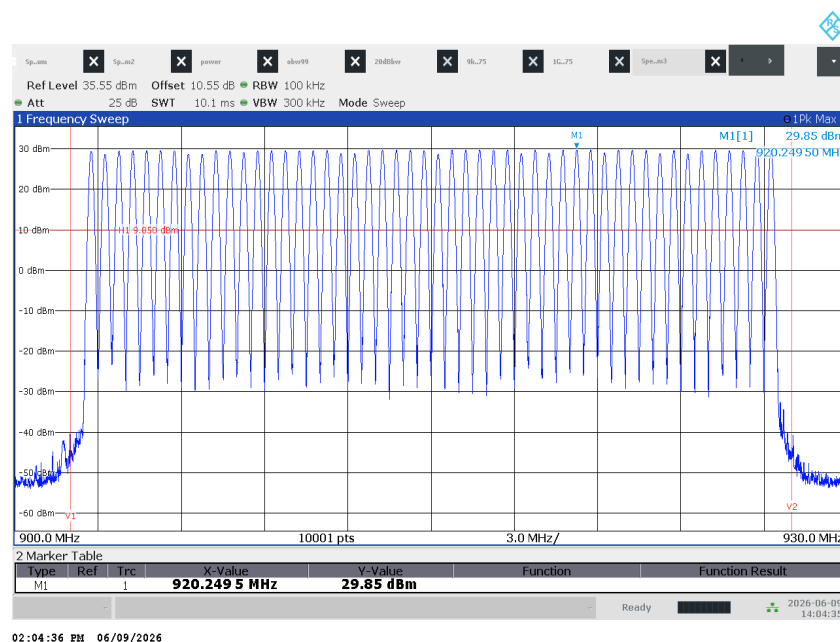
Measurement parameters	
Detector	Peak
Sweep time	Auto
Resolution bandwidth	see plot
Video bandwidth	see plot
Span	see plot
Trace mode	max hold
Test setup	see sub clause 7.4 A
Measurement uncertainty	see sub clause 9

Limits:

FCC	ISED
Number of hopping channels	
At least 25 non overlapping hopping channels. If the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping channels.	

Result: in summary the EUT uses 50 channels.

Plot: number of channels



12.4 Average Time of Occupancy (dwell time)

Description:

The measurement is performed in zero span mode to show that none of the 54 used channels is allocated more than 0.4 seconds within a 10 seconds interval (54 channels times 0.4s).

Limits:

FCC	ISED
Average time of occupancy	
For frequency hopping systems operating in the 902-928 MHz band: If the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within 10 second period.	

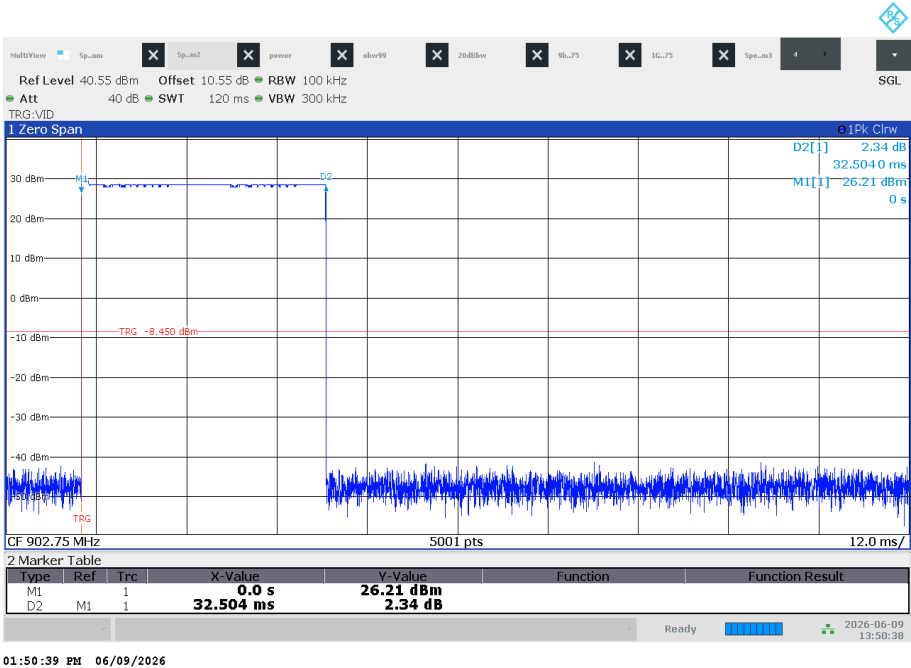
Result: The time slot length is = 32.5 ms
Number of hops / channel @ 20s = 10

Within 20 s period, the average time of occupancy in 20 s:

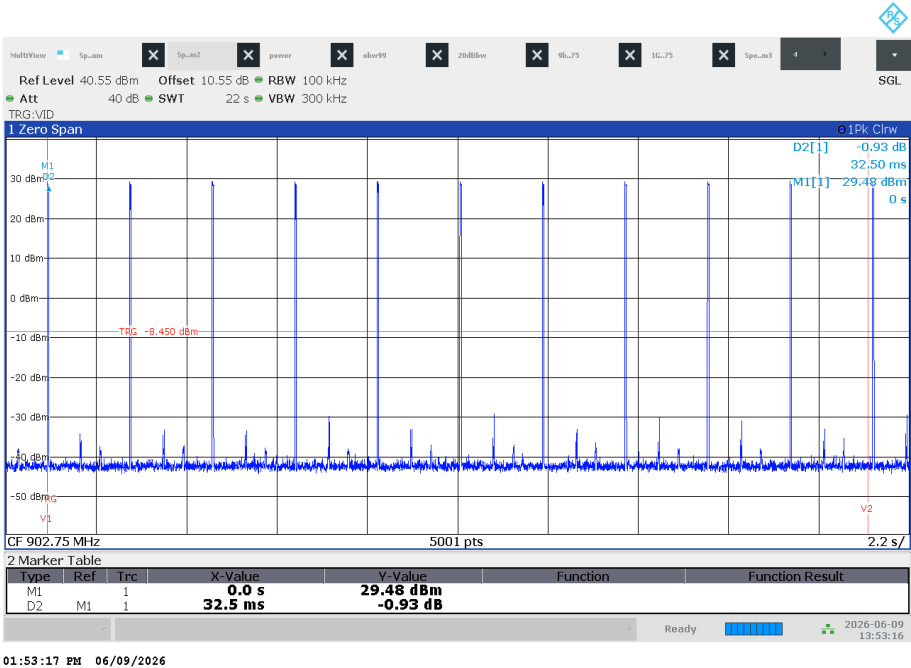
→ The average time of occupancy = 320.5 ms

Plots:

Plot 1: Time slot length = 32.5 ms



Plot 2: hops / channel @ 20s = 10



12.5 Spectrum bandwidth of a FHSS system

Description:

Measurement of the 20dB bandwidth and 99% bandwidth of the modulated signal. The measurement is performed according to the "Measurement Guidelines" (DA 00-705, March 30, 2000). EUT in single channel mode.

Measurement parameters	
Detector	Peak
Sweep time	Auto
Resolution bandwidth	3 kHz
Video bandwidth	> 3x RBW
Span	see plots
Trace mode	max hold
Test setup	see sub clause 7.4 A
Measurement uncertainty	see sub clause 9

Limits:

FCC	ISED
Spectrum bandwidth of a FHSS system	
50 channels: < 250 kHz 25 channels: < 500 kHz	

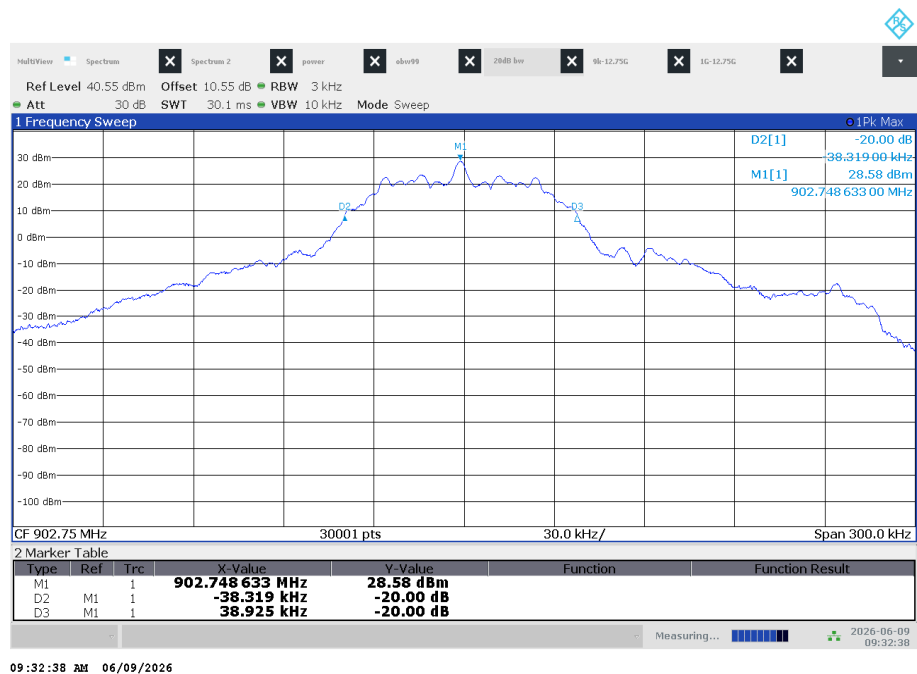
Result:

Test Conditions		20dB bandwidth		
		902.75 MHz	914.75 MHz	927.25 MHz
T_{nom}	V_{nom}	77.24 kHz	76.34 kHz	76.44 kHz

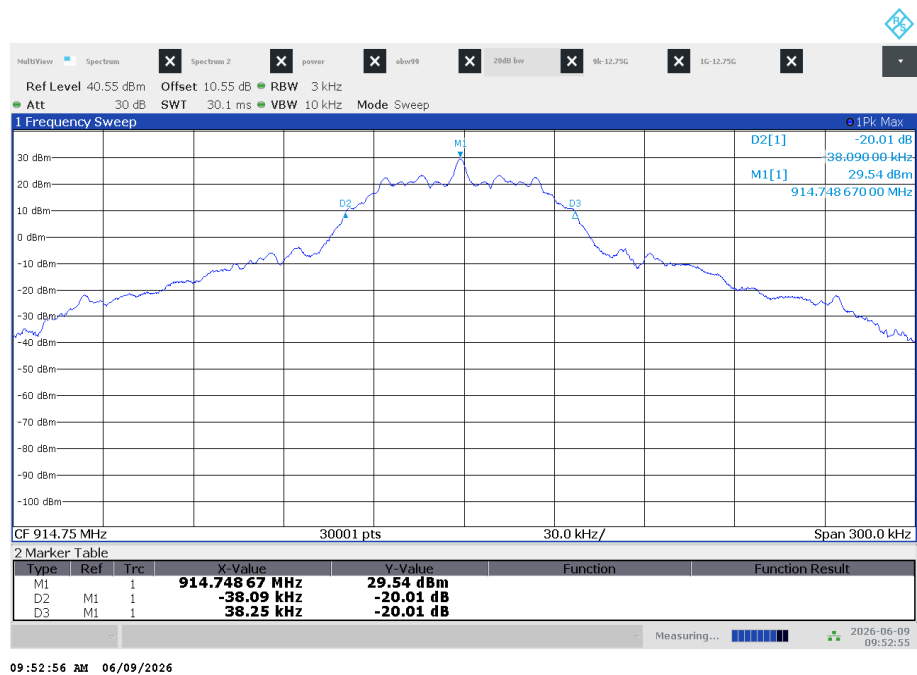
Test Conditions		99% bandwidth		
		902.75 MHz	914.75 MHz	927.25 MHz
T_{nom}	V_{nom}	72.61 kHz	72.43 kHz	72.43 kHz

12.5.1 Plots 20dB bandwidth:

Plot 1: 902.75 MHz



Plot 2: 914.75 MHz



Plot 3: 927.25 MHz



12.5.2 Plots 99% bandwidth:

Plot 1: 902.75 MHz



Plot 2: 914.75 MHz



Plot 3: 927.25 MHz



12.6 Maximum Output Power

Measurement:

Measurement parameter	
Detector:	Peak
Sweep time:	Auto
Resolution bandwidth:	1 MHz
Video bandwidth:	3 MHz
Span:	5 MHz
Trace-Mode:	max Hold
Used equipment:	see chapter 7.2B, 7.4A
Measurement uncertainty:	see chapter 9

Limits:

FCC	ISED
Maximum Output Power Conducted	
For frequency hopping systems operating in the 902–928 MHz band: 1 watt (30 dBm) for systems employing at least 50 hopping channels; and, 0.25 watts (24 dBm) for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section, and the e.i.r.p. shall not exceed 4 W (36 dB).	

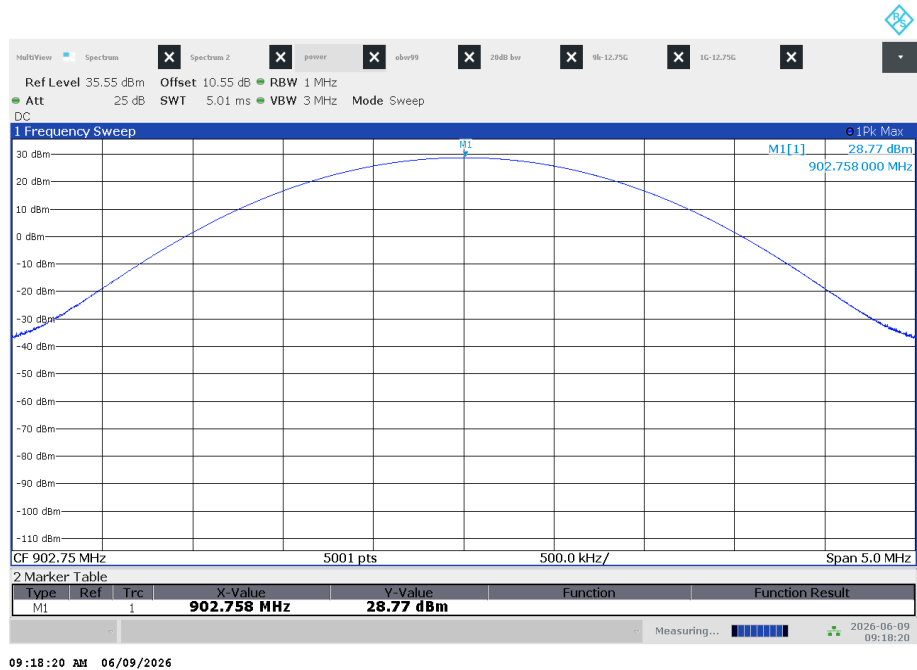
Result:

Test Conditions		Maximum Output Power Conducted		
		902.75 MHz	914.75 MHz	927.25 MHz
T_{nom}	V_{nom}	28.77 dBm	28.82 dBm	28.59 dBm

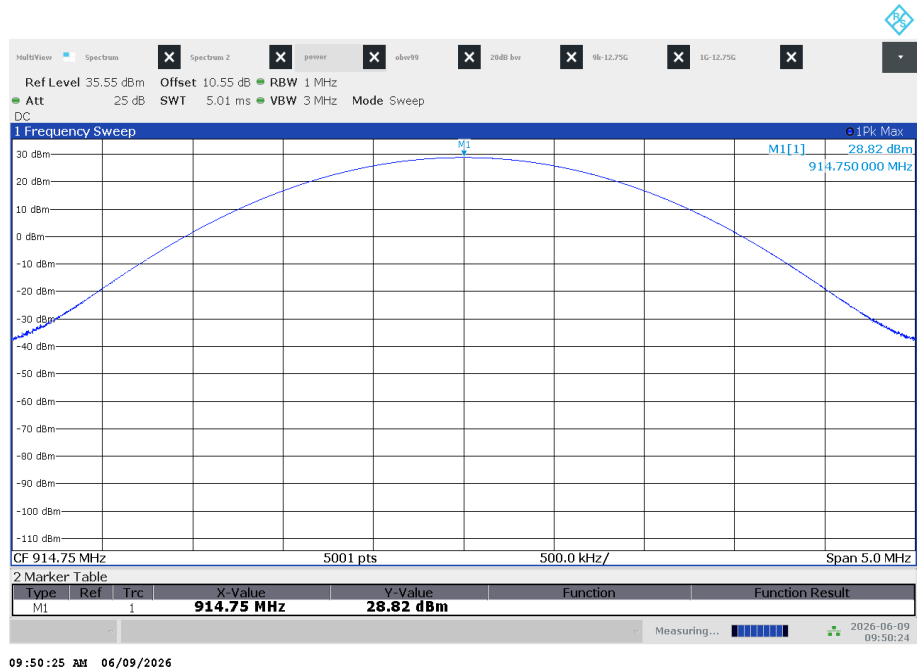
Test Conditions		EIRP		
		902.75 MHz	914.75 MHz	927.25 MHz
T_{nom}	V_{nom}	32.10 dBm	32.73 dBm	31.62 dBm

Plots:

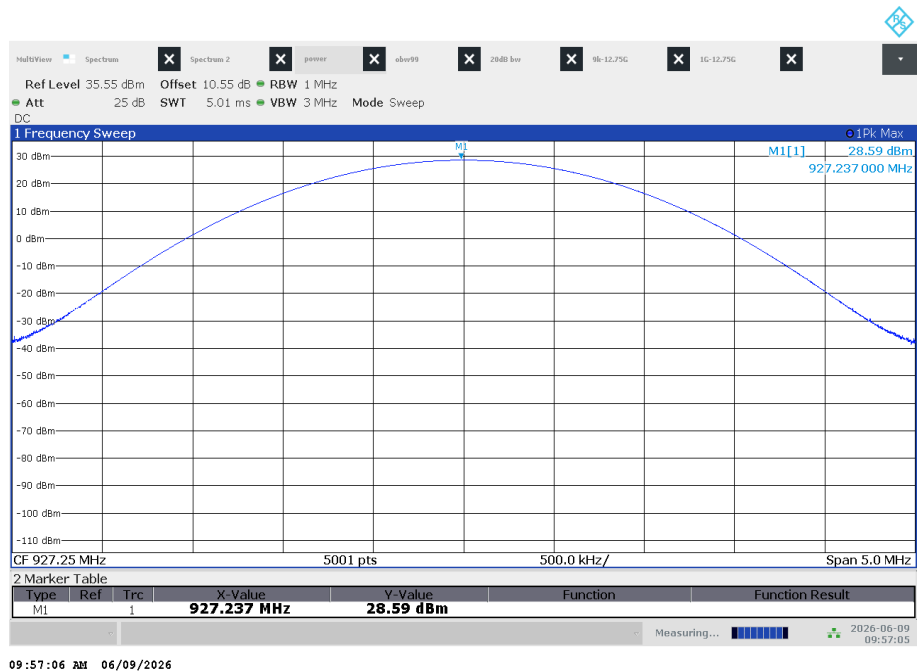
Plot 1: 902.75 MHz



Plot 2: 914.75 MHz



Plot 3: 927.25 MHz



12.7 Detailed spurious emissions @ the band edge – conducted and radiated

Description:

Measurement of the conducted band edge compliance. EUT is measured at the lower and upper band edge in single channel and hopping mode. The measurement is repeated for all modulations.

Measurement parameters	
Detector	Peak
Sweep time	Auto
Resolution bandwidth	100 kHz
Video bandwidth	300 kHz / 500 kHz
Span	lower band edge: 902 MHz upper band edge: 928 MHz
Trace mode	max. hold
Test setup	see sub clause 7.4 A
Measurement uncertainty	see sub clause 9

Limits:

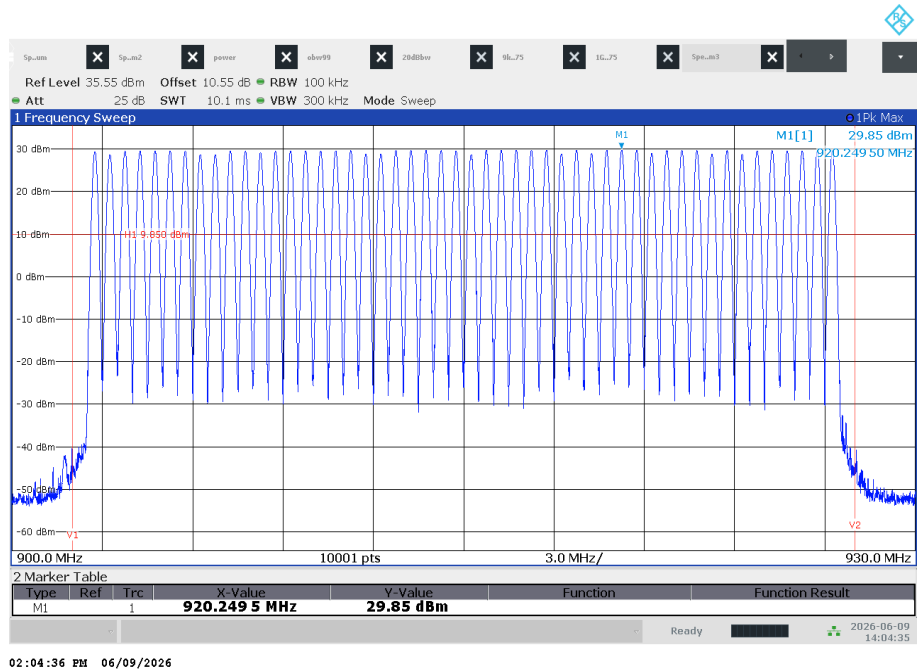
FCC	ISED
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required.	

Results conducted:

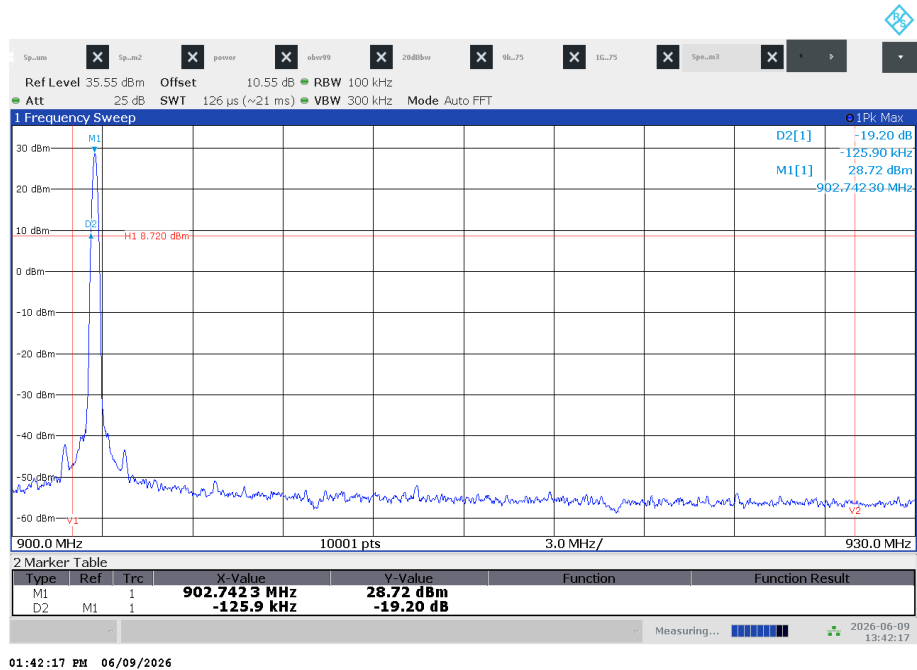
Scenario	Spurious band edge conducted		
Modulation	902.75 MHz	914.75 MHz	927.25 MHz
lower band edge – hopping on	> 20 dB	> 20 dB	> 20 dB
upper band edge – hopping on	> 20 dB	> 20 dB	> 20 dB
lower band edge – hopping off	> 20 dB	> 20 dB	> 20 dB
upper band edge – hopping off	> 20 dB	> 20 dB	> 20 dB

Plots:

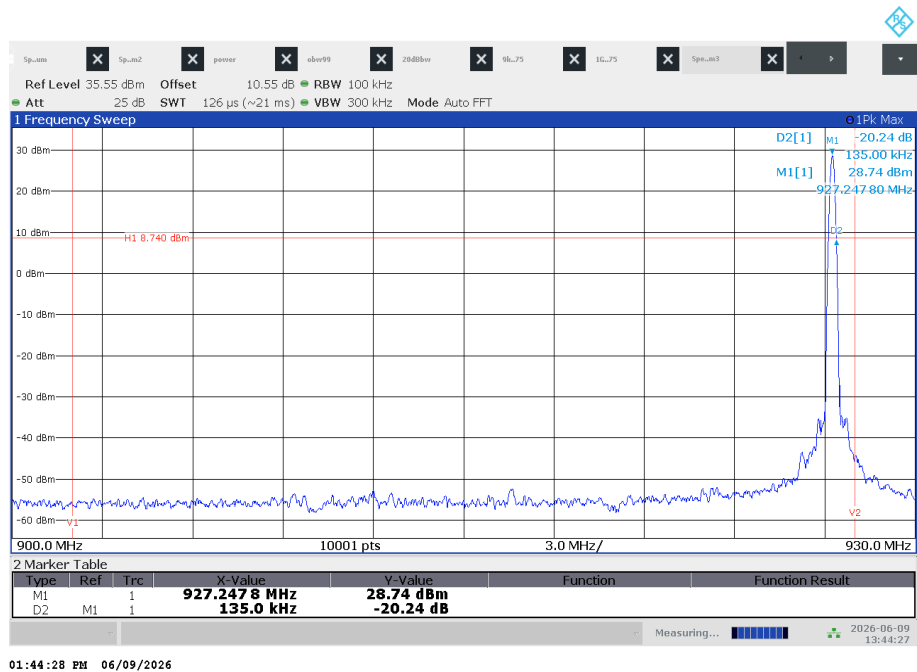
Plot 1: 20 dB – hopping on



Plot 2: 20 dB – hopping off – tx 902.75 MHz



Plot 3: 20 dB – hopping off – tx 927.25 MHz



12.8 Spurious Emissions Conducted

Description:

Measurement of the conducted spurious emissions in transmit mode. The EUT is set to single channel mode. The measurement is repeated for 902.75 MHz, 914.75 MHz and 927.25 MHz

Measurement:

Measurement parameter	
Detector:	Peak
Sweep time:	Auto
Video bandwidth:	F < 1 GHz: 1 MHz F > 1 GHz: 1 MHz
Resolution bandwidth:	F < 1 GHz: 100 kHz F > 1 GHz: 100 kHz
Span:	9 kHz to 12.75 GHz
Trace-Mode:	max Hold
Used equipment:	see chapter 7.4 A
Measurement uncertainty:	see chapter 9

Limits:

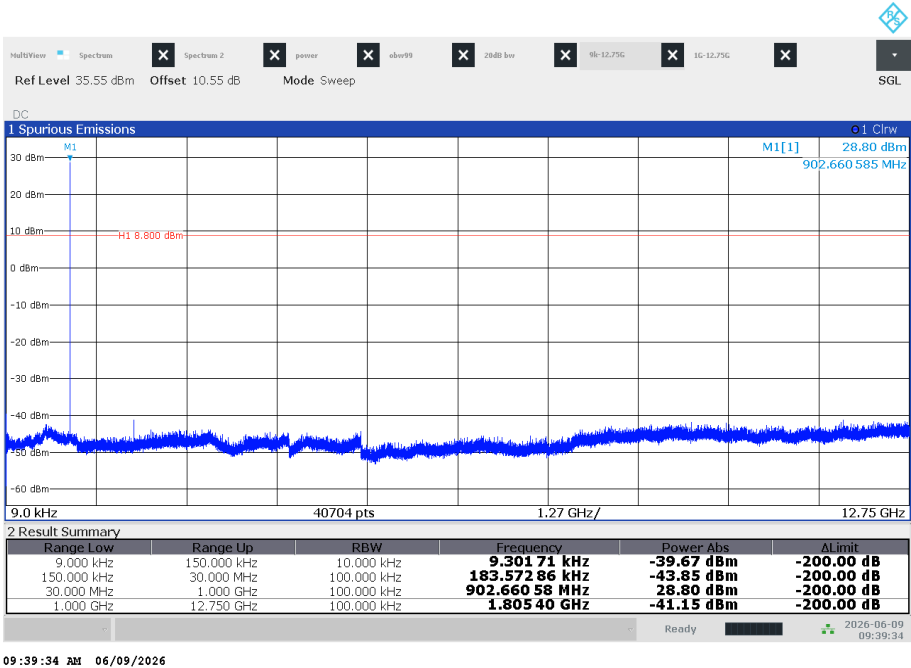
FCC	ISED
TX spurious emissions conducted	
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required	

Result:

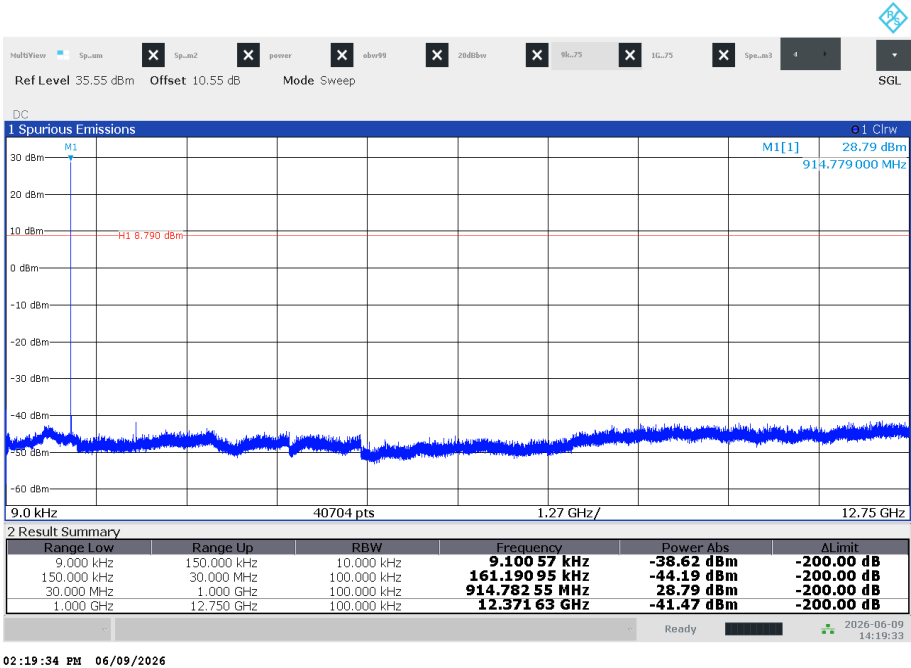
Emission Limitation					
Frequency [MHz]		Amplitude of emission [dBm]	Limit max. allowed emission power	actual attenuation below frequency of operation [dB]	Results
902.75			24 dBm		Operating frequency
No emissions detected!			-20 dBc		
914.75			24 dBm		Operating frequency
No emissions detected!			-20 dBc		
927.25			24 dBm		Operating frequency
No emissions detected!			-20 dBc		

Plots:

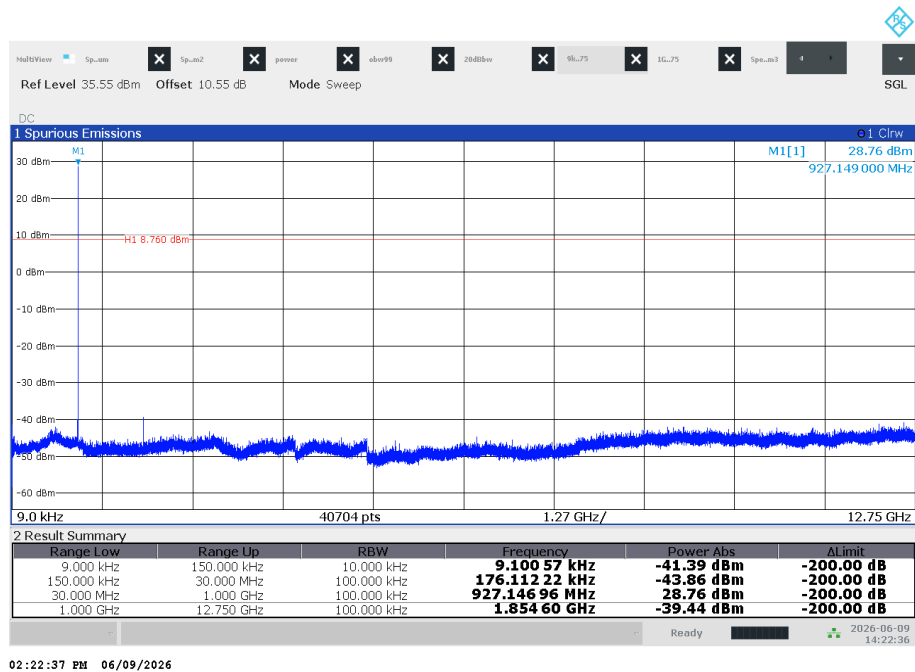
Plot 1: tx:902.75 MHz, 9 kHz – 12.75 GHz



Plot 2: tx:914.75 MHz, 9 kHz – 12.75 GHz



Plot 3: tx:927.25 MHz, 1 GHz – 12.75 GHz



12.9 Spurious Emissions Radiated < 30 MHz

Description:

Measurement of the radiated spurious emissions in transmit mode below 30 MHz. The EUT is set to single channel mode and the transmit channels are 00; 39 and 78. The measurement is performed in the mode with the highest output power. The limits are recalculated to a measurement distance of 3 m according the ANSI C63.10.

Measurement:

Measurement parameter	
Detector:	Peak / Quasi Peak
Sweep time:	Auto
Video bandwidth:	F < 150 kHz: 200 Hz F > 150 kHz: 9 kHz
Resolution bandwidth:	F < 150 kHz: 1 kHz F > 150 kHz: 100 kHz
Span:	9 kHz to 30 MHz
Trace-Mode:	max Hold
Used equipment:	see chapter 7.2 A
Measurement uncertainty:	see chapter 9

Limit:

FCC		
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 (29.5 dBμV/m)	30
30 – 88	100 (40 dBμV/m)	3
88 – 216	150 (43.5 dBμV/m)	3
216 – 960	200 (46 dBμV/m)	3

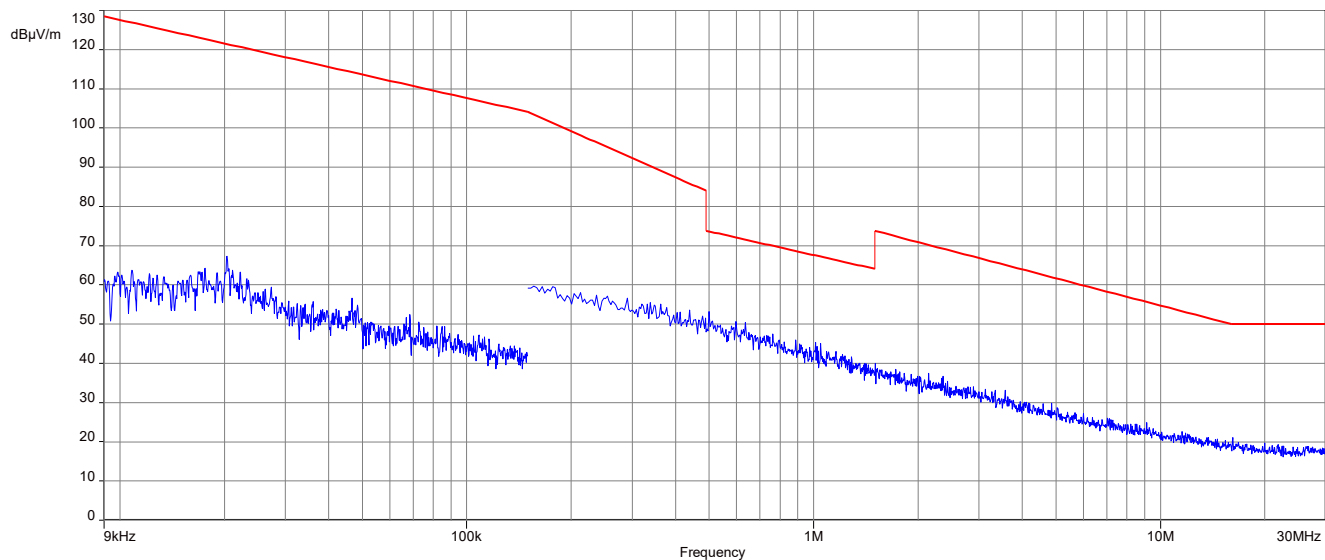
ISED		
Frequency (MHz)	Field strength (μA/m)	Measurement distance (m)
0.009 – 0.490	6.37/F (F in kHz)	300
0.490 – 1.705	63.7/F (F in kHz)	30
1.705 – 30	0.08 (-22 dBμA/m)	30

Result:

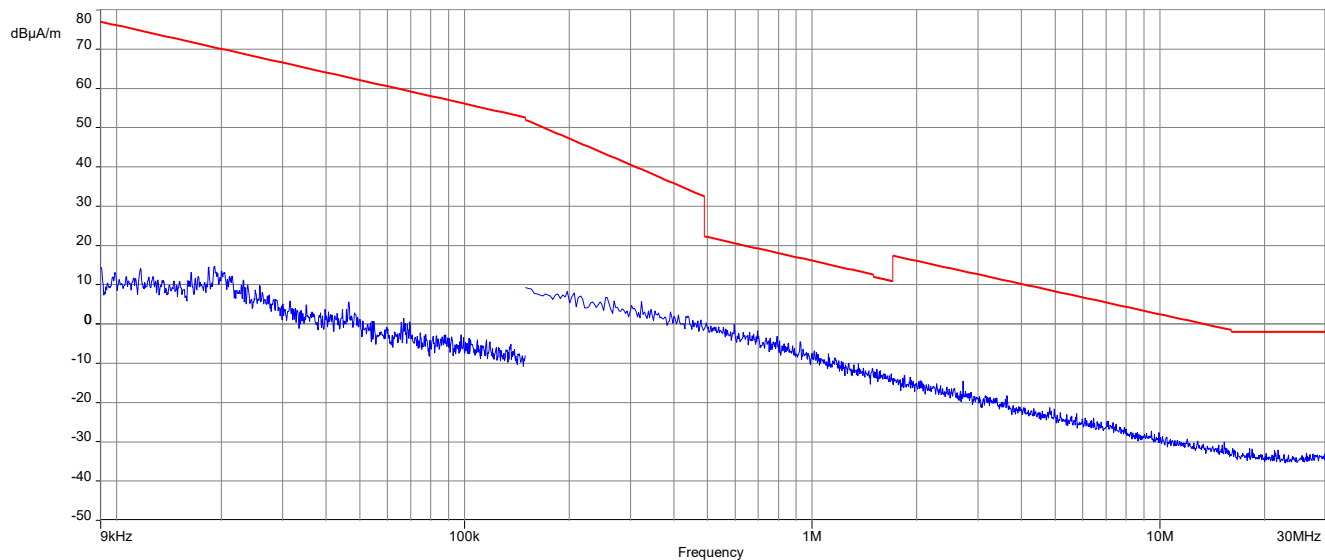
SPURIOUS EMISSIONS LEVEL								
902.75 MHz			914.75 MHz			927.25 MHz		
Frequency	Detector	Level	Frequency	Detector	Level	Frequency	Detector	Level
All emissions were more than 10 dB below the limit.								

Plots:

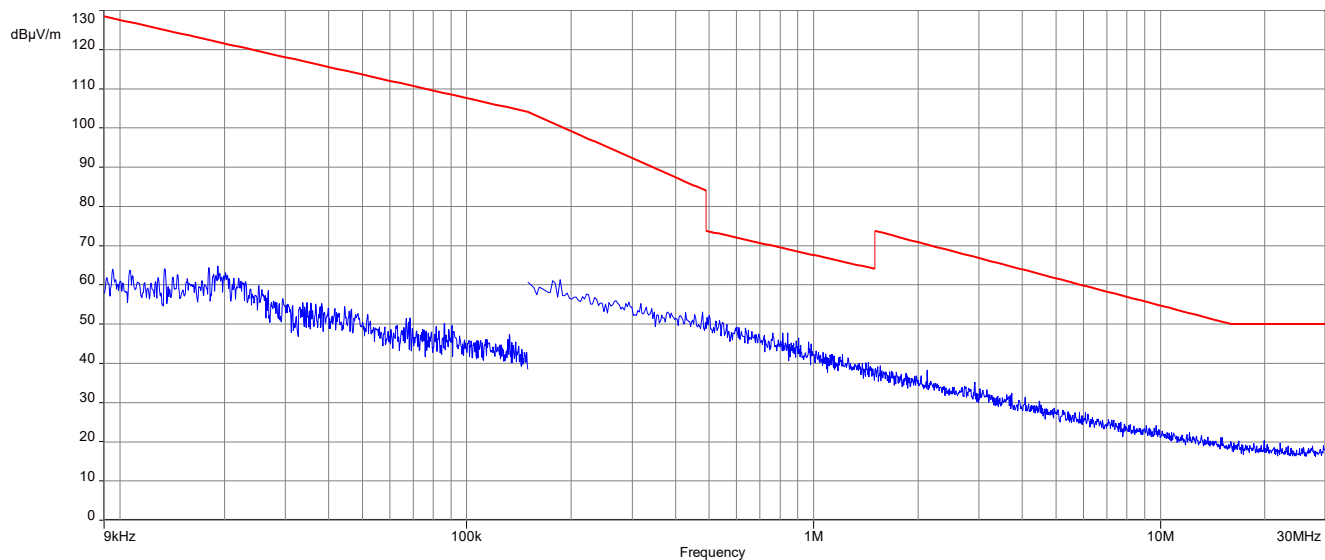
Plot 1: TX 902.75 MHz, FCC



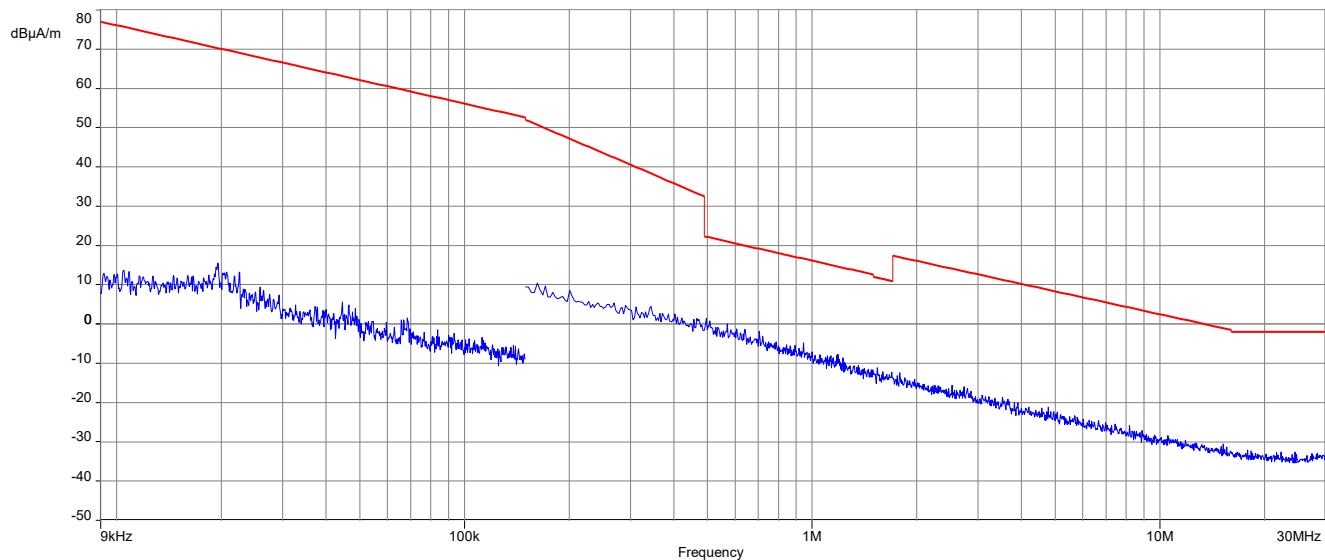
Plot 2: TX 902.75 MHz, ISED



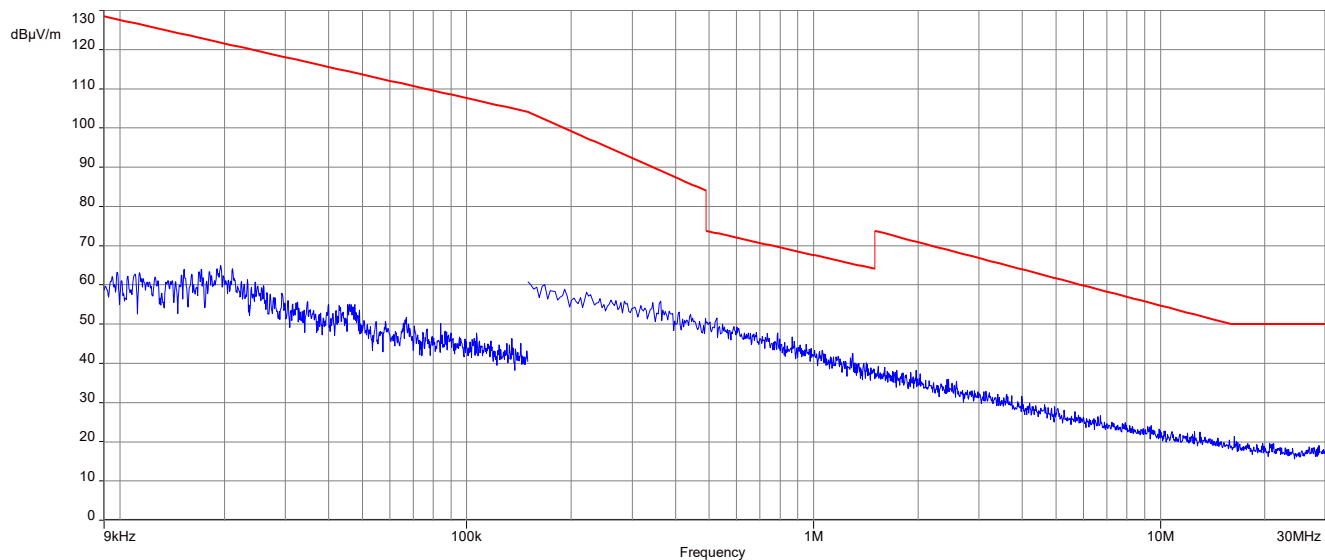
Plot 3: TX 914.75 MHz, FCC



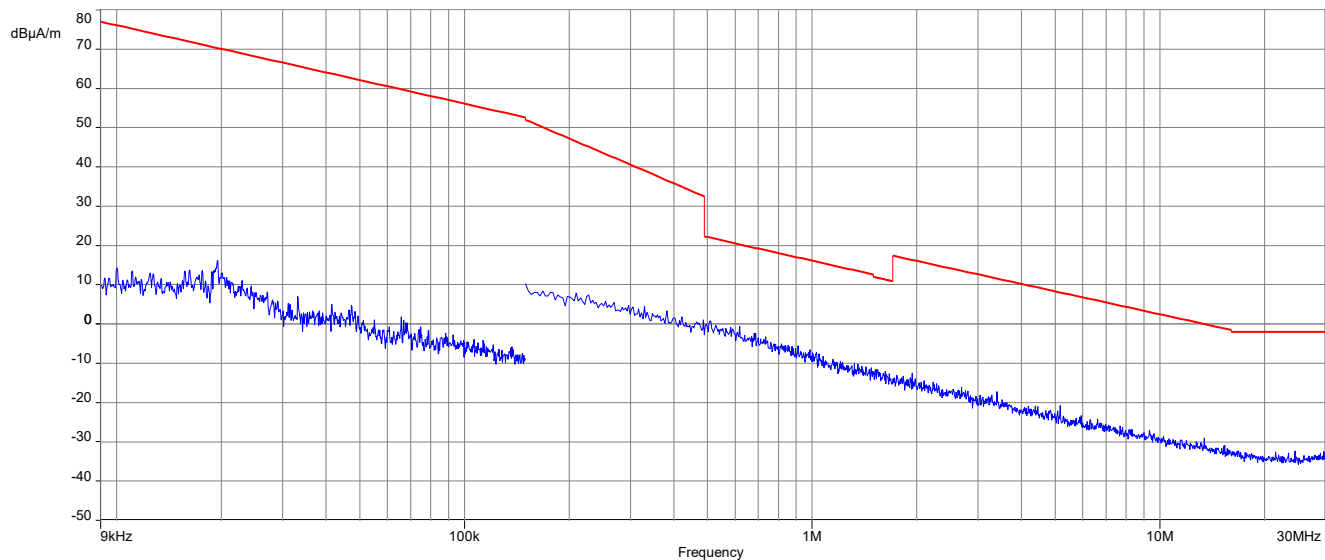
Plot 4: TX 914.75 MHz, ISSED



Plot 5: TX 927.25 MHz, FCC



Plot 6: TX 927.25 MHz, ISED



12.10 Spurious Emissions Radiated > 30 MHz

12.10.1 Spurious emissions radiated 30 MHz to 1 GHz

Description:

Measurement of the radiated spurious emissions in transmit mode. The measurement is performed at channel low, mid and high.

Measurement:

Measurement parameters	
Detector	Peak / Quasi Peak
Sweep time	Auto
Resolution bandwidth	3 x VBW
Video bandwidth	120 kHz
Span	30 MHz to 1 GHz
Trace mode	max hold
Measured modulation	PR-ASK
Test setup	see sub clause 7.1 A
Measurement uncertainty	see sub clause 9

Limits:

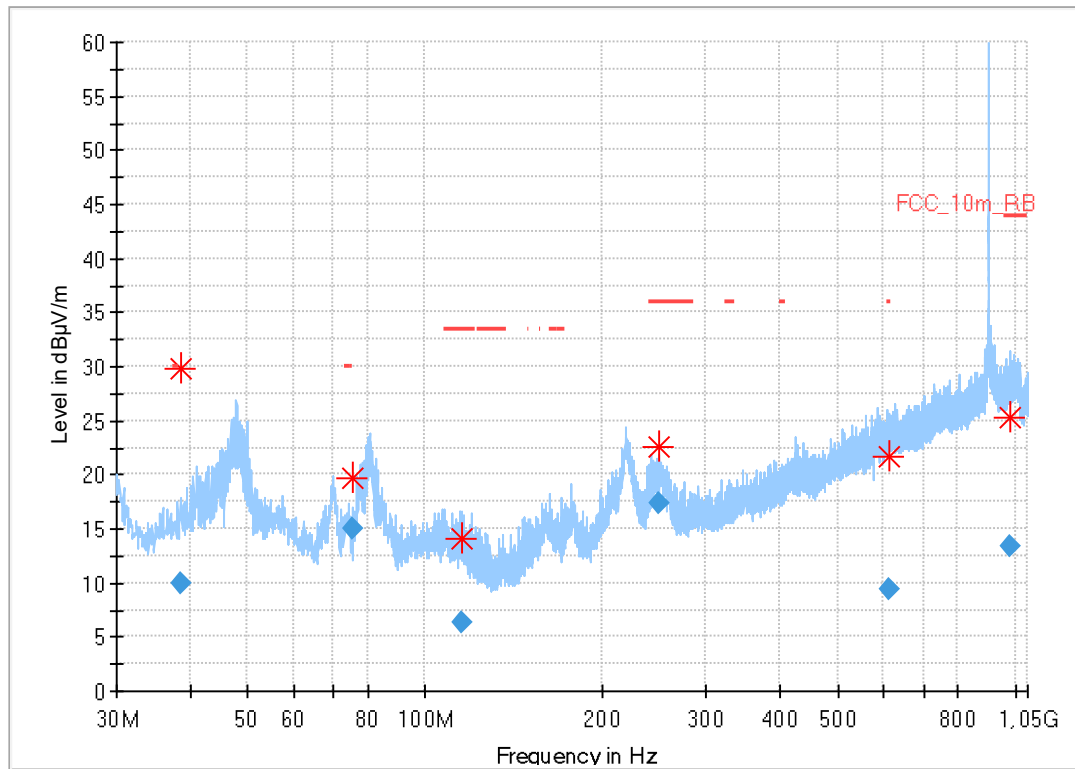
FCC		ISED
Band-edge Compliance of conducted and radiated emissions		
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).		
Frequency (MHz)	Field Strength (dBµV/m)	Measurement distance
30 - 88	30.0	10
88 - 216	33.5	10
216 - 960	36.0	10
Above 960	54.0	3

Result:

See result table below the plots.

Plots:

Plot 1: tx:902.75 MHz, 30 MHz – 1 GHz, horizontal & vertical polarisation



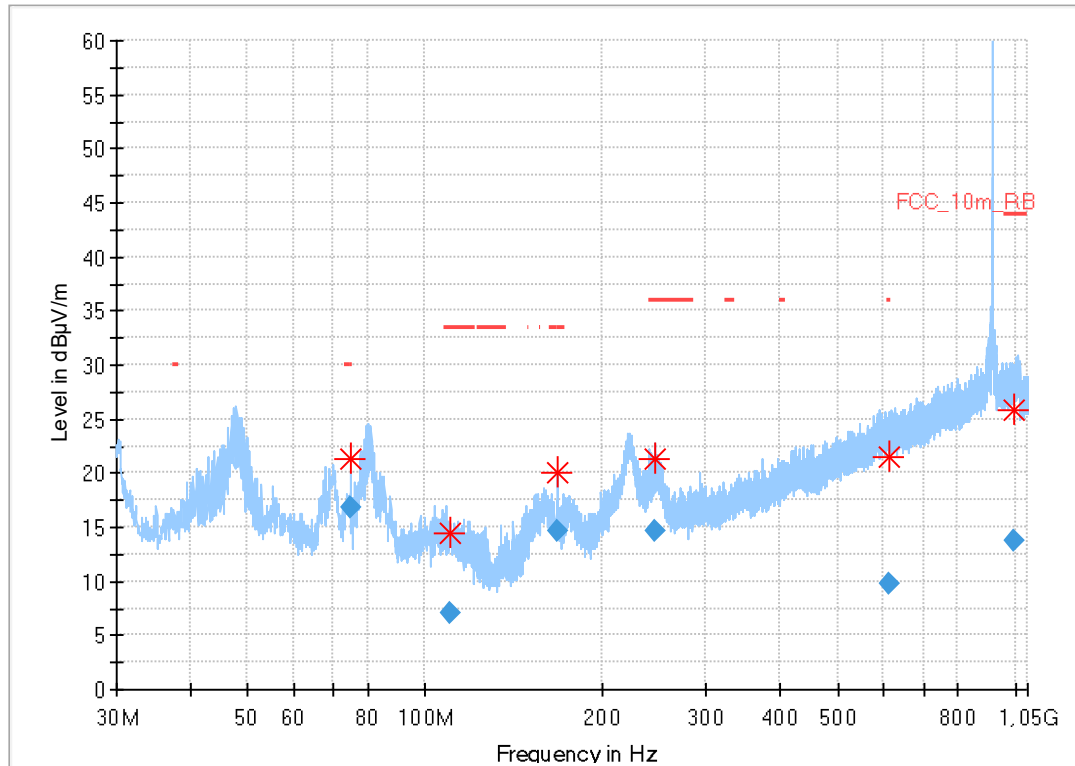
Comment

*carrier suppressed with notch filter

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)
38.511480	9.98	---	---	1000.0	120.000	400.0	V	79.0	13.3
75.569280	15.02	---	---	1000.0	120.000	337.0	V	315.0	8.1
115.104600	6.29	33.50	27.21	1000.0	120.000	200.0	V	275.0	12.0
248.814720	17.32	36.00	18.68	1000.0	120.000	400.0	V	196.0	13.7
613.074000	9.34	36.00	26.66	1000.0	120.000	227.0	H	143.0	21.6
977.403720	13.29	44.00	30.71	1000.0	120.000	161.0	V	108.0	25.2

Plot 2: tx:914.75 MHz, 30 MHz – 1 GHz, horizontal & vertical polarisation



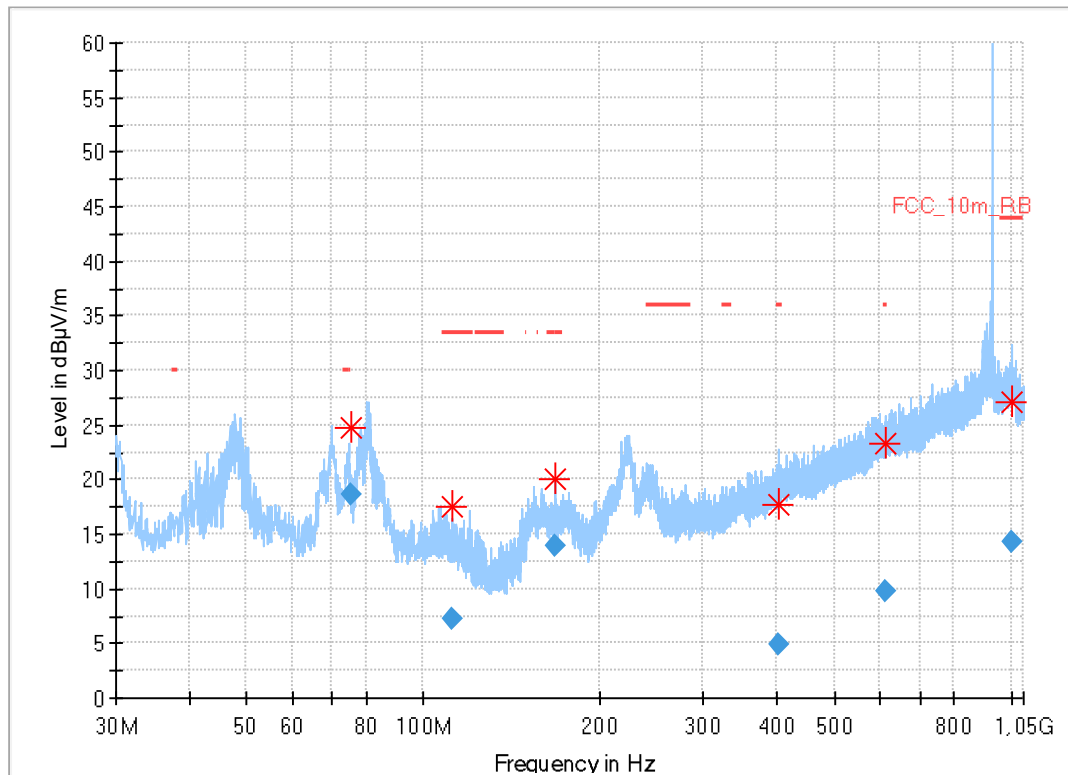
Comment

*carrier suppressed with notch filter

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)
74.552280	16.77	30.00	13.23	1000.0	120.000	244.0	V	292.0	8.4
110.116800	6.98	33.50	26.52	1000.0	120.000	200.0	V	238.0	12.7
167.958360	14.67	33.50	18.83	1000.0	120.000	137.0	V	63.0	10.2
244.455600	14.71	36.00	21.29	1000.0	120.000	200.0	V	203.0	13.5
612.673080	9.70	36.00	26.30	1000.0	120.000	200.0	V	180.0	21.6
999.223800	13.80	44.00	30.20	1000.0	120.000	400.0	H	65.0	25.4

Plot 3: tx:927.25 MHz, 30 MHz – 1 GHz, horizontal & vertical polarisation



Comment

*carrier suppressed with notch filter

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)
75.540480	18.64	---	---	1000.0	120.000	400.0	V	294.0	8.1
112.111560	7.24	33.50	26.26	1000.0	120.000	400.0	V	91.0	12.4
168.085920	13.99	33.50	19.51	1000.0	120.000	180.0	V	125.0	10.2
402.337320	4.81	36.00	31.19	1000.0	120.000	221.0	H	48.0	17.6
613.555680	9.75	36.00	26.25	1000.0	120.000	289.0	V	325.0	21.6
1006.16844	14.23	44.00	29.77	1000.0	120.000	267.0	H	90.0	25.4

12.10.2 Spurious emissions radiated above 1 GHz

Description:

Measurement of the radiated spurious emissions in transmit mode. The measurement is performed in the mode with the highest output power.

Measurement parameters	
Detector	Peak / RMS
Sweep time	Auto
Resolution bandwidth	1 MHz
Video bandwidth	3 x RBW
Span	1 GHz to 10 GHz
Trace mode	max hold
Measured modulation	PR-ASK
Test setup	see sub clause 7.2 C (1 GHz – 10 GHz)
Measurement uncertainty	see sub clause 9

The modulation with the highest output power was used to perform the transmitter spurious emissions. If spurious were detected a re-measurement was performed on the detected frequency with each modulation.

Limits:

ANSI C63.10
The average emission shall be determined by using Video averaging (VBW = 10 Hz). If the dwell time of the hopping signal is less than 100 ms (per channel), the VBW=10 Hz reading may be adjusted by a factor: $F = 20 \log (\text{dwell time} / 100 \text{ ms})$

FCC		ISED	
TX spurious emissions radiated			
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).			
§15.209			
Frequency	Field strength		Measurement distance
Above 960 MHz	54.0 dBµV/m		3 m

Result:

For radiated spurious emission the limits of 15.209 applies for all frequencies mentioned in 15.205. According to FCC Public Notice DA 00-705 (ANSI C63.10) the average emission shall be determined by using Video averaging (VBW = 10 Hz). If the dwell time of the hopping signal is less than 100 ms (per channel), the VBW=10 Hz reading may be adjusted by a factor:

dwell time= 32.5 ms

$$F = 20 \cdot \log (\text{dwell time}/100 \text{ ms})$$

$$F = 20 \cdot \log \frac{32.5}{100} = -9.76 \text{ dB}$$

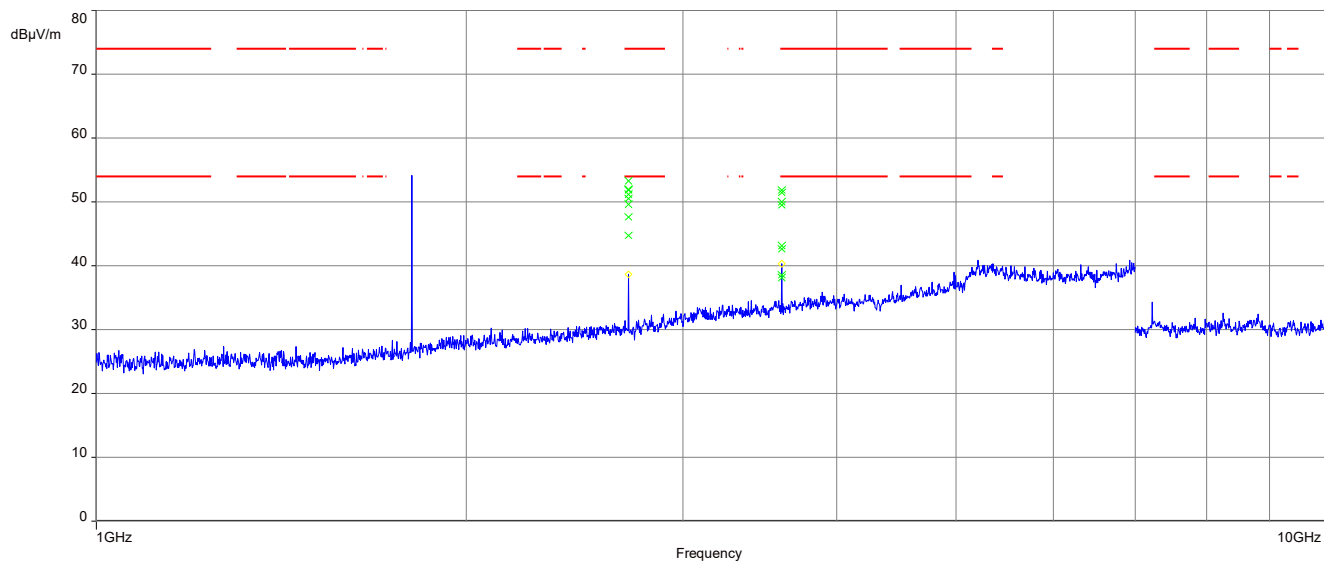
One pulse train is 32.5 ms so the correction factor is -9.76 (see plots in chapter 12.4)

TX spurious emissions radiated [dBμV/m]								
902.75 MHz			914.75 MHz			927.25 MHz		
F [MHz]	Detector	Level [dBμV/m]	F [MHz]	Detector	Level [dBμV/m]	F [MHz]	Detector	Level [dBμV/m]
2708.2	Peak	53.32	2744.2	Peak	56.86	2781.4	Peak	50.56
	AVG	51.88		AVG*	47.10		AVG	35.31
3611.2	Peak	51.88	-/-	Peak	-/-	-/-	Peak	-/-
	AVG	42.68		AVG	-/-		AVG	-/-
-/-	Peak	-/-	-/-	Peak	-/-	-/-	Peak	-/-
	AVG	-/-		AVG	-/-		AVG	-/-
-/-	Peak	-/-	-/-	Peak	-/-	-/-	Peak	-/-
	AVG	-/-		AVG	-/-		AVG	-/-

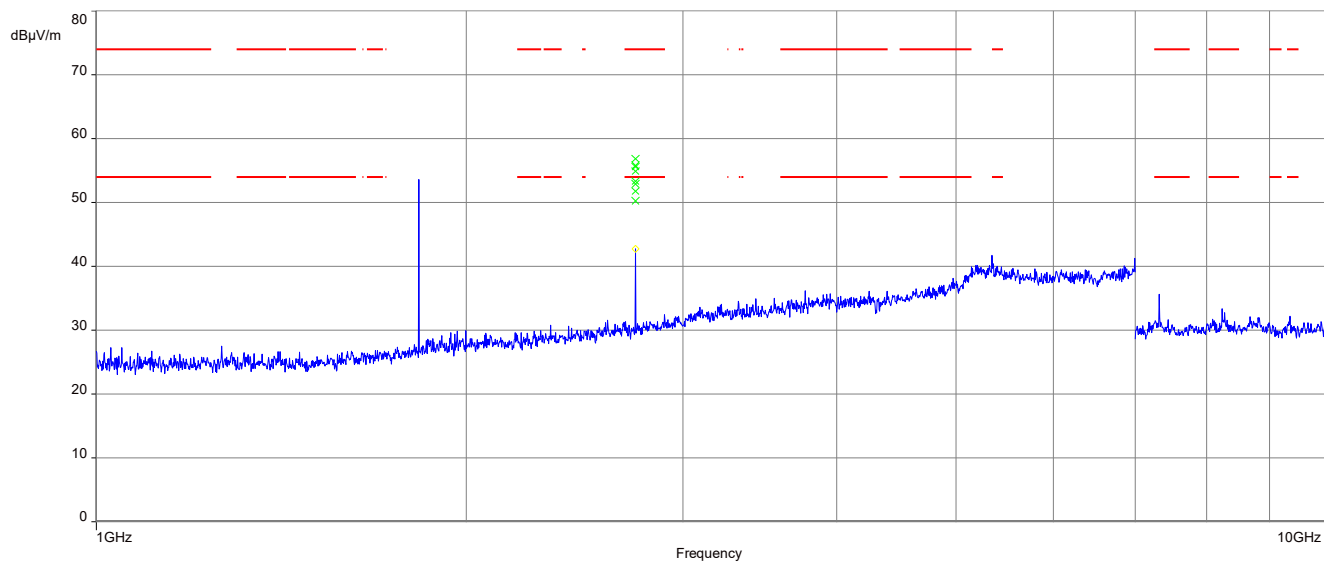
* peak to average factor -9.76 dB

Plots:

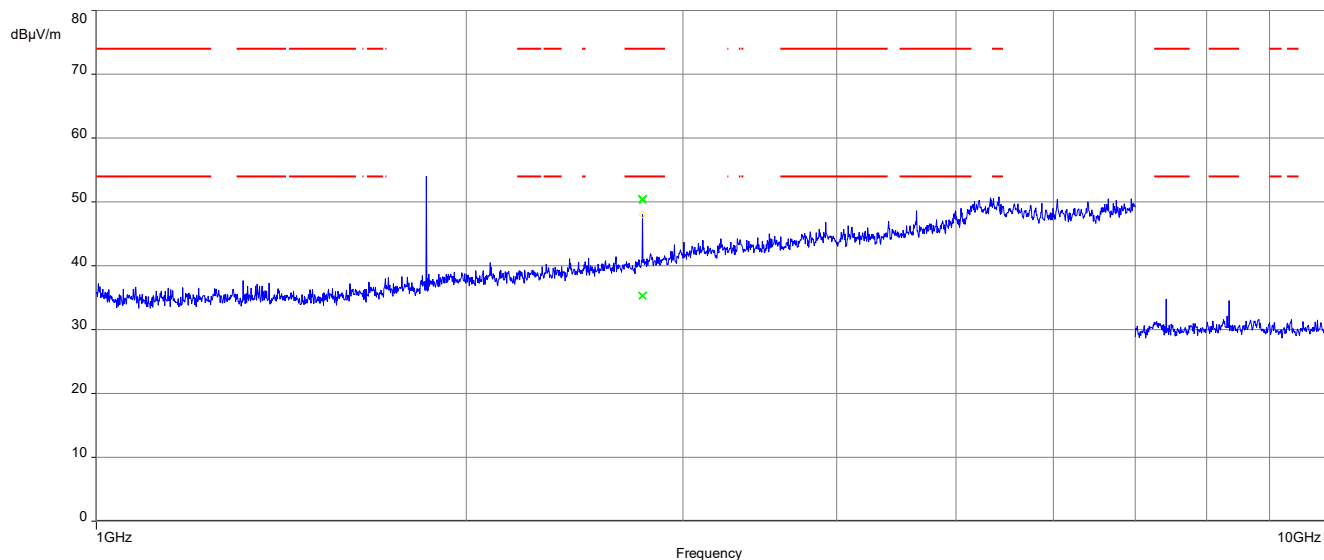
Plot 1: tx:902.75 MHz, 1 GHz – 10 GHz, horizontal & vertical polarisation



Plot 2: tx:914.75 MHz, 1 GHz – 10 GHz, horizontal & vertical polarisation



Plot 3: tx:927.25 MHz, 1 GHz – 10 GHz, horizontal & vertical polarisation



12.11 Spurious emissions conducted below 30 MHz (AC conducted)

Description:

Measurement of the conducted spurious emissions in transmit mode below 30 MHz. The EUT is set to single channel mode and the transmit frequency is 915.75 MHz. According KDB 174176 the antenna port was terminated with 50 Ohm. This measurement is representative for all channels and modes. Both power lines, phase and neutral line, are measured. Found peaks are remeasured with average and quasi peak detection to show compliance to the limits.

Measurement parameters	
Detector	Peak - Quasi peak / average
Sweep time	Auto
Resolution bandwidth	F < 150 kHz: 200 Hz F > 150 kHz: 9 kHz
Video bandwidth	F < 150 kHz: 1 kHz F > 150 kHz: 100 kHz
Span	9 kHz to 30 MHz
Trace mode	Max hold
Measured modulation	PR-ASK
Test setup	See sub clause 7.3 A
Measurement uncertainty	See sub clause 9

Limits:

FCC		ISED
TX spurious emissions conducted < 30 MHz		
Frequency (MHz)	Quasi-peak (dBµV/m)	Average (dBµV/m)
0.15 – 0.5	66 to 56*	56 to 46*
0.5 – 5	56	46
5 – 30.0	60	50

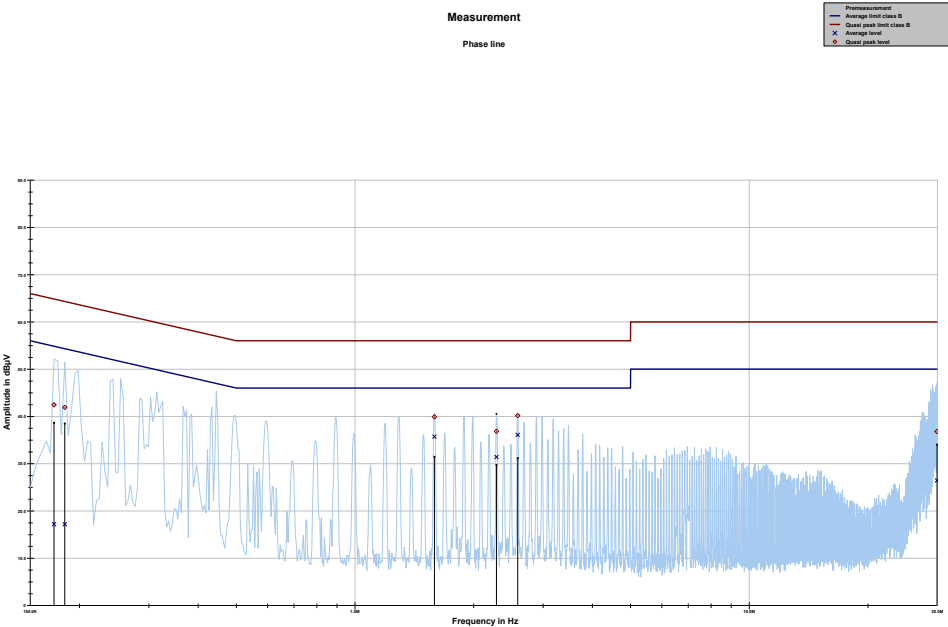
*Decreases with the logarithm of the frequency

Results:

See result table below the plots.

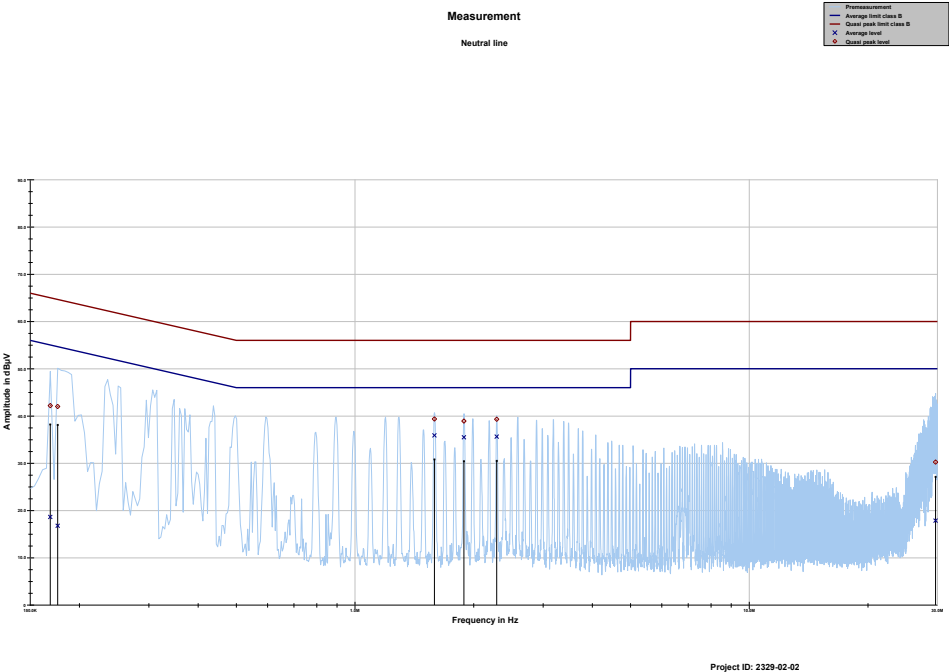
12.11.1 Plots 120 V AC/60 Hz:

Plot 1: 150 kHz to 30 MHz, phase line



Frequency	Quasi peak level	Margin quasi peak	Limit QP	Average level	Margin Average	Limit AV
MHz	dBµV	dB	dBµV	dBµV	dB	dBµV
0.172387	42.46	22.39	64.845	17.17	38.19	55.360
0.183581	41.92	22.40	64.322	17.18	37.86	55.041
1.590262	39.91	16.09	56.000	35.71	10.29	46.000
2.284275	36.85	19.15	56.000	31.41	14.59	46.000
2.586506	40.19	15.81	56.000	36.11	9.89	46.000
29.944031	36.80	23.20	60.000	26.45	23.55	50.000

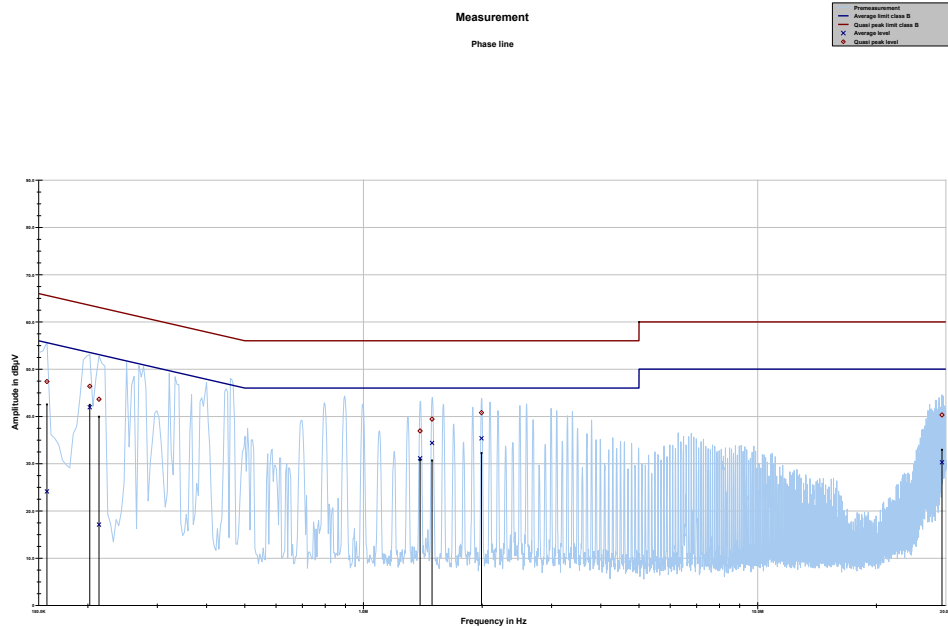
Plot 2: 150 kHz to 30 MHz, neutral line



Frequency	Quasi peak level	Margin quasi peak	Limit QP	Average level	Margin Average	Limit AV
MHz	dBµV	dB	dBµV	dBµV	dB	dBµV
0.168656	42.20	22.83	65.026	18.64	36.83	55.467
0.176119	42.02	22.65	64.667	16.77	38.48	55.254
1.590262	39.37	16.63	56.000	35.89	10.11	46.000
1.888762	38.93	17.07	56.000	35.50	10.50	46.000
2.288006	39.32	16.68	56.000	35.64	10.36	46.000
29.682844	30.26	29.74	60.000	17.87	32.13	50.000

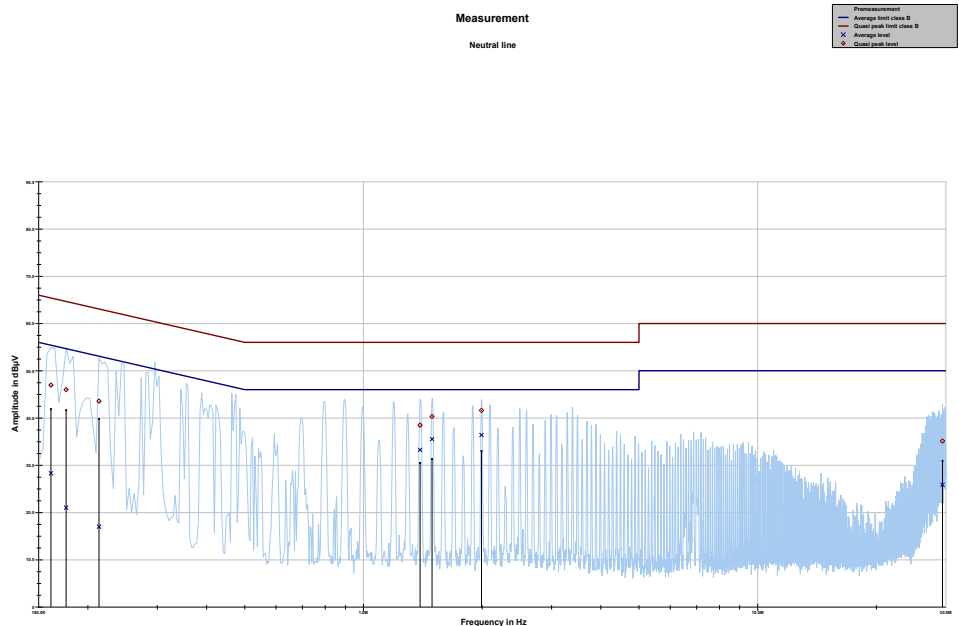
12.11.2 Plots 240 V AC/60 Hz:

Plot 1: 150 kHz to 30 MHz, phase line



Frequency	Quasi peak level	Margin quasi peak	Limit QP	Average level	Margin Average	Limit AV
MHz	dBµV	dB	dBµV	dBµV	dB	dBµV
0.157463	47.38	18.22	65.597	24.12	31.66	55.787
0.202237	46.38	17.14	63.518	41.93	12.57	54.508
0.213431	43.64	19.43	63.071	17.10	37.09	54.188
1.392506	36.92	19.08	56.000	31.14	14.86	46.000
1.493250	39.43	16.57	56.000	34.38	11.62	46.000
1.993237	40.78	15.22	56.000	35.36	10.64	46.000
29.343300	40.31	19.69	60.000	30.28	19.72	50.000

Plot 2: 150 kHz to 30 MHz, neutral line



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Frequency	Quasi peak level	Margin quasi peak	Limit QP	Average level	Margin Average	Limit AV
MHz	dBµV	dB	dBµV	dBµV	dB	dBµV
0.161194	46.96	18.44	65.402	28.28	27.40	55.680
0.176119	46.00	18.67	64.667	21.03	34.23	55.254
0.213431	43.57	19.51	63.071	17.01	37.17	54.188
1.392506	38.47	17.53	56.000	33.26	12.74	46.000
1.493250	40.34	15.66	56.000	35.53	10.47	46.000
1.993237	41.60	14.40	56.000	36.40	9.60	46.000
29.429119	35.12	24.88	60.000	25.87	24.13	50.000

13 Glossary

AVG	Average
C	Compliant
C/N₀	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	2026-08-11

END OF TEST REPORT