

TEST REPORT

Test report no.: 1-9457-25-02-05_TR1-R02



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

VILPE Oy

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65610 Mustasaari / FINLAND

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

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

Test Item

Kind of test item: controller device for Vilpe roof fan connected via LoRa

Model name: MCU-2

FCC ID: 2BOAS-T20105

Frequency: 902.0 – 928.0 MHz

Technology tested: proprietary

Antenna: Integrated antenna

Power supply: 10 V to 10 V DC, by external power supply

Temperature range: -30°C to +60°C

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

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1 Table of contents

1	Table of contents.....	2
2	General information.....	3
2.1	Notes and disclaimer.....	3
2.2	Application details.....	3
2.3	Test laboratories sub-contracted.....	3
3	Test standard/s, references and accreditations.....	4
4	Reporting statements of conformity – decision rule.....	5
5	Test environment.....	6
6	Test item.....	6
6.1	General description.....	6
6.2	Additional information.....	6
7	Description of the test setup.....	7
7.1	Shielded semi anechoic chamber.....	8
7.2	shielded fully anechoic chamber.....	10
7.3	Conducted measurements.....	12
7.4	AC conducted.....	13
8	Sequence of testing.....	14
8.1	Sequence of testing radiated spurious 9 kHz to 30 MHz.....	14
8.2	Sequence of testing radiated spurious 30 MHz to 1 GHz.....	15
8.3	Sequence of testing radiated spurious 1 GHz to 10 GHz.....	16
9	Measurement uncertainty.....	17
10	Summary of measurement results.....	18
11	RF measurements.....	19
11.1	Additional comments.....	19
12	Measurement results.....	20
12.1	Maximum output power.....	20
12.2	Antenna gain.....	22
12.3	Power spectral density.....	23
12.4	Spectrum bandwidth – 6 dB bandwidth and 99% bandwidth.....	25
12.5	Detailed spurious emissions @ the band edge – conducted and radiated.....	27
12.6	Spurious Emissions Conducted.....	30
12.7	Spurious Emissions Radiated < 30 MHz.....	32
12.8	Spurious Emissions Radiated > 30 MHz.....	34
12.8.1	Spurious emissions radiated 30 MHz to 1 GHz.....	34
12.8.2	Spurious emissions radiated above 1 GHz.....	36
12.9	Conducted limits.....	38
13	Glossary.....	43
14	Document history.....	44

2 General information

2.1 Notes and disclaimer

The test results of this test report relate exclusively to the test item specified in this test report. cetecom advanced GmbH does not assume responsibility for any conclusions and generalizations drawn from the test results with regard to other specimens or samples of the type of the equipment represented by the test item.

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This test report replaces the test report with the number 1-9457-25-02-05_TR1-R01 and dated 2025-10-16.

2.2 Application details

Date of receipt of order:	2025-04-01
Date of receipt of test item:	2025-04-02
Start of test:*	2025-04-09
End of test:*	2025-10-09
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

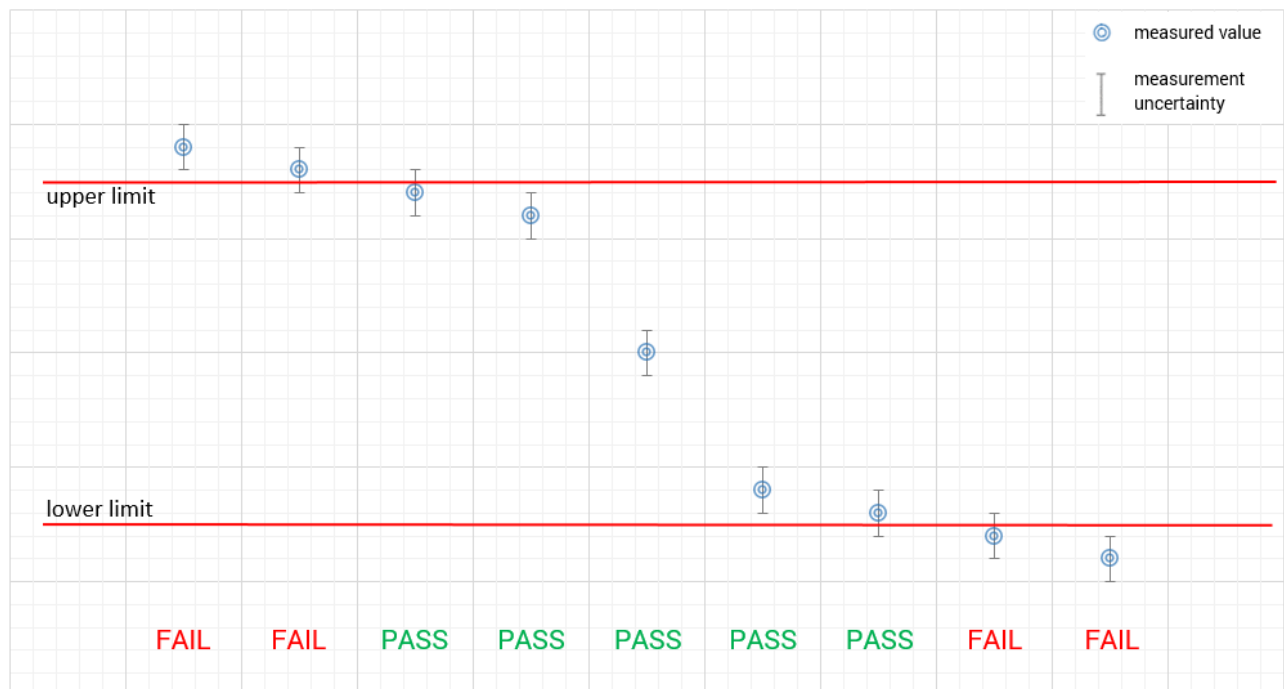
Guidance	Version	Description
ANSI C63.4a-2017	-/-	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
ANSI C63.10-2020	-/-	American National Standard of Procedures for Compliance Testing of 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."

measured value, measurement uncertainty, verdict



5 Test environment

Temperature :	T_{nom} T_{max} T_{min}	+22 °C during room temperature tests +60 °C during high temperature tests -30 °C during low temperature tests all tests performed at room temperature
Relative humidity content :		55 %
Barometric pressure :		1021 hpa
Power supply :	V_{nom} V_{max} V_{min}	10 V DC, by external power supply 10 V DC 10 V DC all tests performed with nominal voltage

6 Test item

6.1 General description

Kind of test item :	controller device for Vilpe roof fan connected via LoRa
Model name :	MCU-2
S/N serial number :	N127701ZZK5
Hardware status :	V2.2a
Software status :	-/-
Firmware status :	V2.0
Frequency band :	902.0 – 928.0 MHz
Type of radio transmission :	modulated carrier
Use of frequency spectrum :	
Type of modulation :	LoRa
Number of channels :	1
Antenna :	Integrated antenna
Power supply :	10 V to 10 V DC, by external power supply
Temperature range :	-30°C to +60°C

6.2 Additional information

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

Test setup and EUT photos are included in test report:

1-9457-25-02-01_TR1-A101-R01
1-9457-25-02-01_TR1-A102-R01
1-9457-25-02-01_TR1-A103-R01

7 Description of the test setup

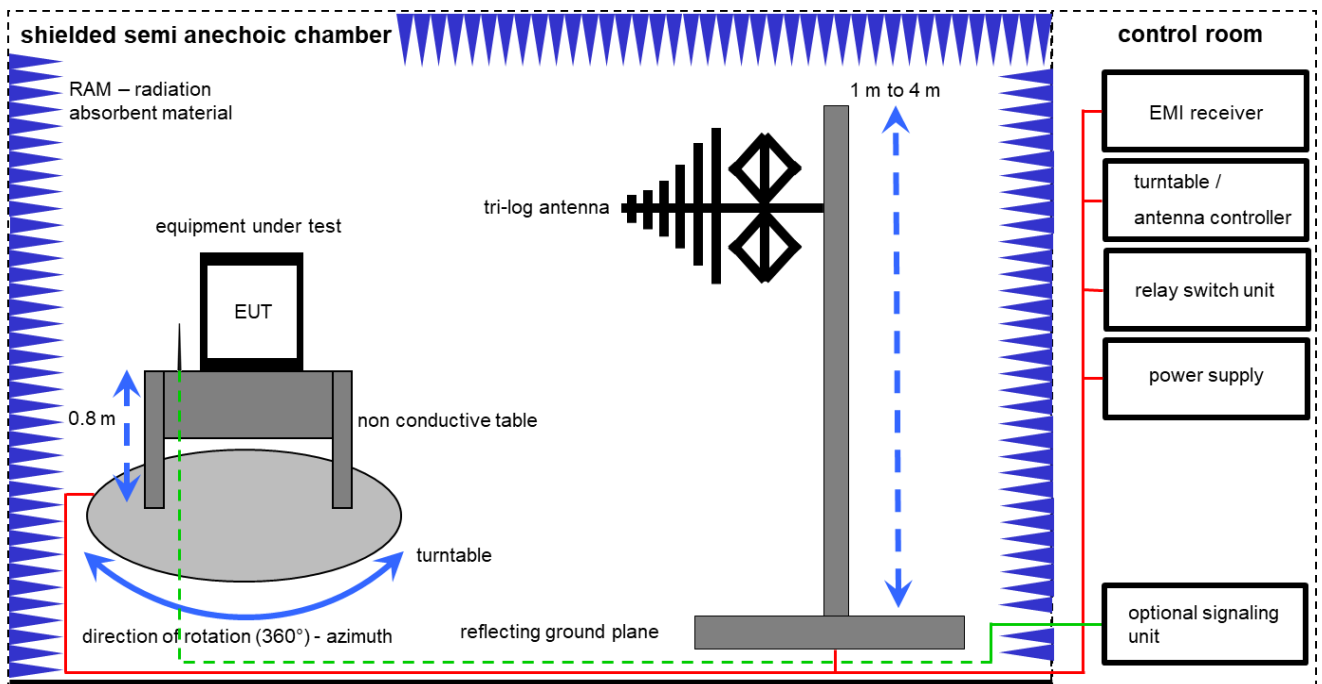
Typically, the calibrations of the test apparatus are commissioned to and performed by an accredited calibration laboratory. The calibration intervals are determined in accordance with the DIN EN ISO/IEC 17025. In addition to the external calibrations, the laboratory executes comparison measurements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

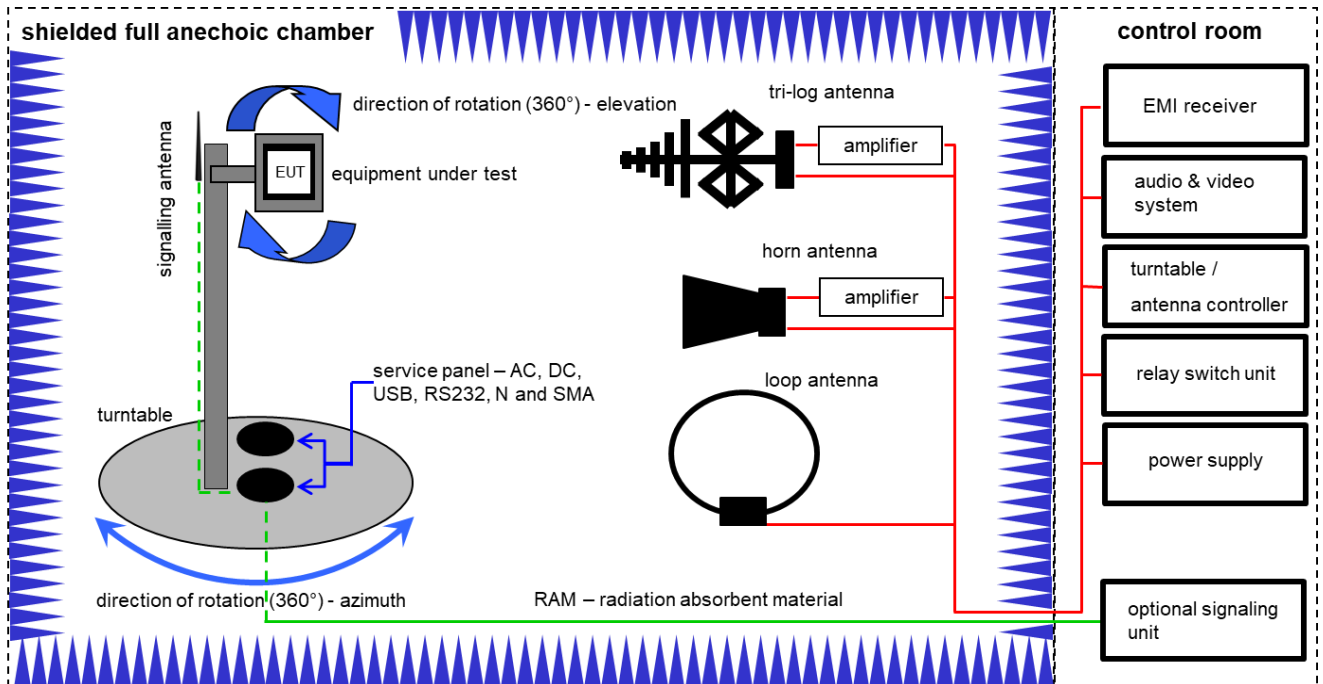
Example calculation:

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

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 Test-Antenna 30 MHz - 3 GHz	VULB9163	Schwarzbeck Mess - Elektronik	318	300003696	vIKI!	31.01.2024	30.01.2026
7	A	Turntable	2089-4.0	EMCO	-/-	300004394	ne	-/-	-/-
8	A	PC	TecLine	F+W	-/-	300004388	ne	-/-	-/-
9	A	EMI Test Receiver	ESR3	Rohde & Schwarz	102587	300005771	k	06.12.2024	31.12.2025

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:

$FS [dB\mu V/m] = 40.0 [dB\mu V/m] + (-35.8) [dB] + 32.9 [dB/m] = 37.1 [dB\mu V/m] (71.61 \mu V/m)$

$OP = AV + D - G + CA$

(OP-radiated output power; AV-analyzer value; D-free field attenuation of measurement distance; G-antenna gain+amplifier gain; CA-loss signal path)

Example calculation:

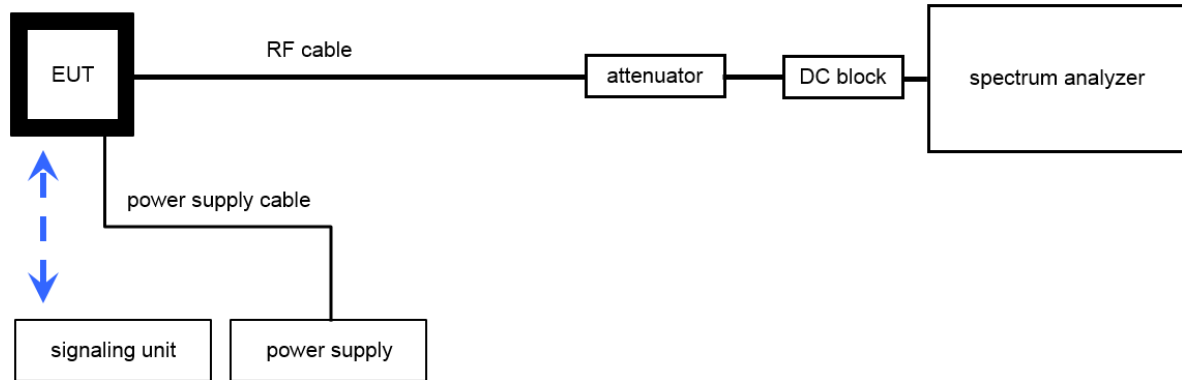
$OP [dBm] = -39.0 [dBm] + 57.0 [dB] - 12.0 [dBi] + (-36.0) [dB] = -30 [dBm] (1 \mu W)$

Equipment table:

No.	Setup	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	A,B,C	EMI Test Receiver 9kHz-26,5GHz	EMI Test Receiver 9kHz-26,5GHz ESR26	Rohde & Schwarz Messgerätebau GmbH / Memmingen	101376	40301	cal	10.12.2024	10.12.2025
2	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
3	C	Highpass Filter	Highpass Filter WHK1.1/15G-10SS	Wainwright Instruments GmbH / Andechs	37	40362	cnn	-/-	-/-
4	C	Broadband Amplifier 0.5-18 GHz	Broadband Amplifier 0.5-18 GHz CBLU5184540	CERNEX	22050	40374	cpu	-/-	-/-
5	A,B,C	4U RF Switch Platform	4U RF Switch Platform L4491A	Agilent Technologies Deutschland GmbH / Böblingen	MY50000032	40376	cnn	-/-	-/-
6	A,B,C	NEXIO EMV- Software	NEXIO EMV- Software BAT EMC V2022.0.32.0	Nexio	-/-	40383	cnn	-/-	-/-
7	A,B,C	Anechoic chamber	Anechoic chamber	TDK	-/-	40385	cnn	-/-	-/-
8	B	TRILOG Broadband Antenna	TRILOG Broadband Antenna VULB9163	Schwarzbeck Mess- Elektronik OHG / Schönau	318	50284	cal	31.01.2024	31.01.2026
9	A	Active Loop Antenna	Active Loop Antenna 6502	EMCO Elektronik GmbH / Gilching	2210	50044	cal	07.07.2025	07.07.2027

7.3 Conducted measurements

Conducted measurements normal conditions



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

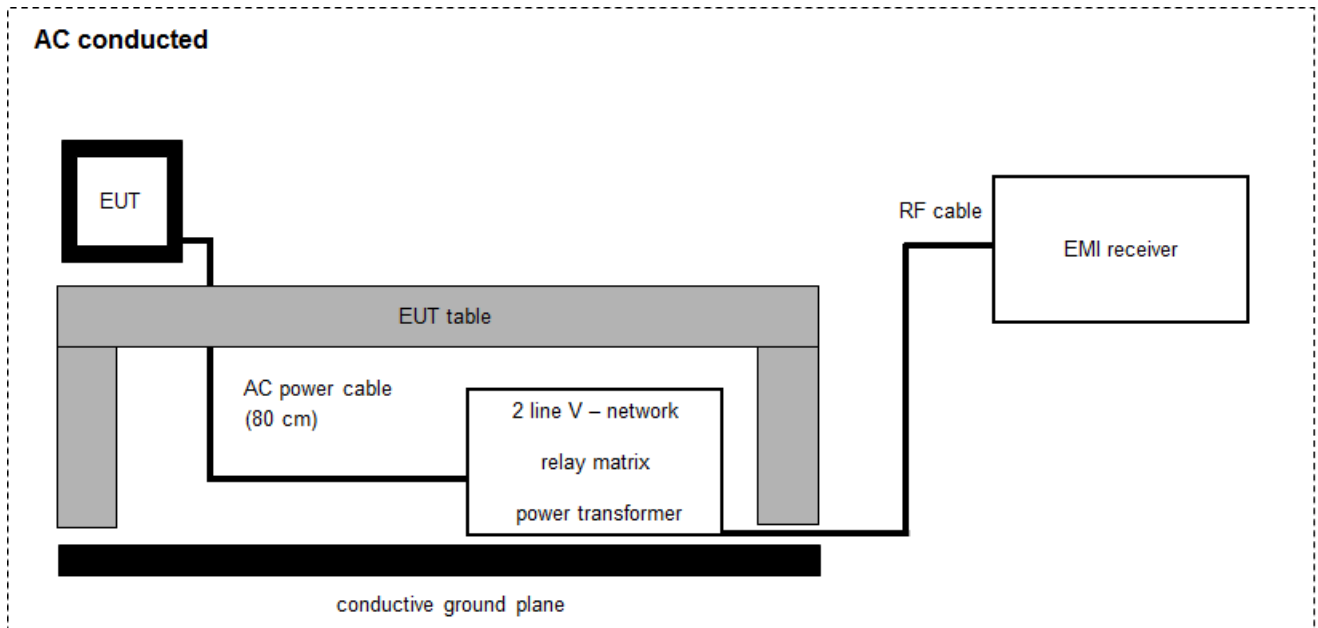
Example calculation:

$OP [dBm] = 6.0 [dBm] + 11.7 [dB] = 17.7 [dBm] (58.88 \text{ mW})$

Equipment table:

No.	Setup	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	A	Signal analyzer	FSW26	Rohde & Schwarz	101455	300004528	k	09.12.2024	31.12.2025
2	A	Power Supply	HMP2020	Rohde & Schwarz	102219	300006192	k	04.12.2024	31.12.2025

7.4 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:

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

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) 9 kHz to 30 MHz	ESH3-Z5	Rohde & Schwarz	892475/017	300002209	vKI!	12.12.2023	31.12.2025
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	AIS16/1	Spitzenberger + Spies GmbH & Co. KG	UO2076 07/0 1023	400001751	k	19.10.2023	31.10.2025
6	A	EMI Test Receiver 3.6 GHz	ESR3	Rohde & Schwarz	102981	300006318	k	03.12.2024	31.12.2025
7	A	Attenuator	WA81-30-33	Weinschel Associates	A145	300005327	ev	-/-	-/-

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 10 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.

Test specification clause	Test case	Temperature conditions	Power source voltages	Mode	C	NC	NA	NP	Remark
§15.247(b)(4)	Antenna gain	Nominal	Nominal	TX single channel	☒	☐	☐	☐	-/-
§15.247(e)	Power spectral density	Nominal	Nominal	TX single channel	☒	☐	☐	☐	-/-
§15.247(a)(2)	Spectrum bandwidth 6dB bandwidth	Nominal	Nominal	TX single channel	☒	☐	☐	☐	-/-
§15.247(b)(3)	Maximum output power	Nominal	Nominal	TX single channel	☒	☐	☐	☐	-/-
§15.205	Band edge compliance conducted	Nominal	Nominal	TX single channel	☒	☐	☐	☐	-/-
§15.205	Band edge compliance radiated	Nominal	Nominal	TX single channel	☒	☐	☐	☐	-/-
§§15.247(d)	TX spurious emissions conducted	Nominal	Nominal	TX single channel	☒	☐	☐	☐	-/-
§15.247(d)	TX spurious emissions radiated	Nominal	Nominal	TX single channel	☒	☐	☐	☐	-/-
§15.109	RX spurious emissions radiated	Nominal	Nominal	RX	☐	☐	☒	☐	-/-
§15.209(a)	TX spurious emissions radiated < 30 MHz	Nominal	Nominal	TX single channel	☒	☐	☐	☐	-/-

11 RF measurements

11.1 Additional comments

Reference documents: none

Special test descriptions: Vilpe US FCC test samples 2025 ver 2

Configuration descriptions: none

12 Measurement results

12.1 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
Measurement method	According to ANSI C63.10-2020 11.9.1.1 Maximum peak conducted output power
Used equipment:	See chapter 7.3 A
Measurement uncertainty:	See chapter 9

Limits:

FCC
1 watt (30 dBm) Maximum Output Power Conducted

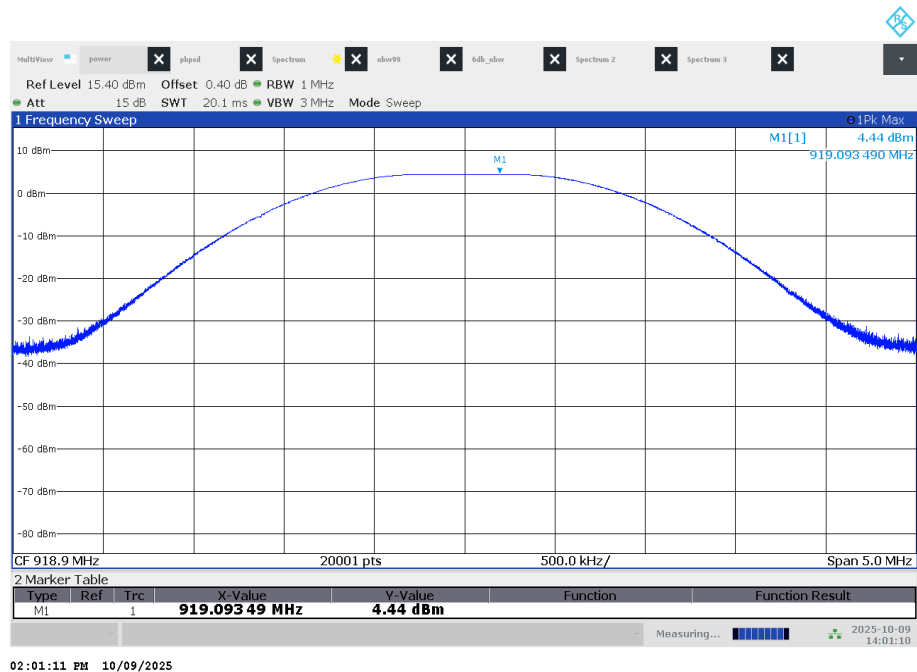
Result:

Test Conditions		Maximum Output Power Conducted
		tx 918.9 MHz
T_{nom}	V_{nom}	4.44 dBm

Test Conditions		Maximum Output Power ERP
		tx 918.9 MHz
T_{nom}	V_{nom}	9.46 dBm

Plots:

Plot 1: tx 918.9 MHz



12.2 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:

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 7.3 A (conducted)
Measurement uncertainty	See sub clause 9

Limits:

FCC
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:

	tx 918.9 MHz
Conducted power	4.44 dBm
Radiated power (e.i.r.p)	11.61 dBm
Gain (Calculated)	7.17 dBi

12.3 Power spectral density

Description:

Measurement of the power spectral density of a digital modulated system. The measurement is repeated at the lowest, middle and highest channel.

Measurement:

Measurement parameter	
Detector:	Peak
Sweep time:	Auto
Video bandwidth:	3 kHz
Resolution bandwidth:	3 kHz
Span:	1.5 MHz
Trace-Mode:	Max Hold
Measurement method	According to ANSI C63.10-2020 11.10.2 Method PKPSD
Test setup	See sub clause 7.3 A
Measurement uncertainty	See sub clause 9

Limits:

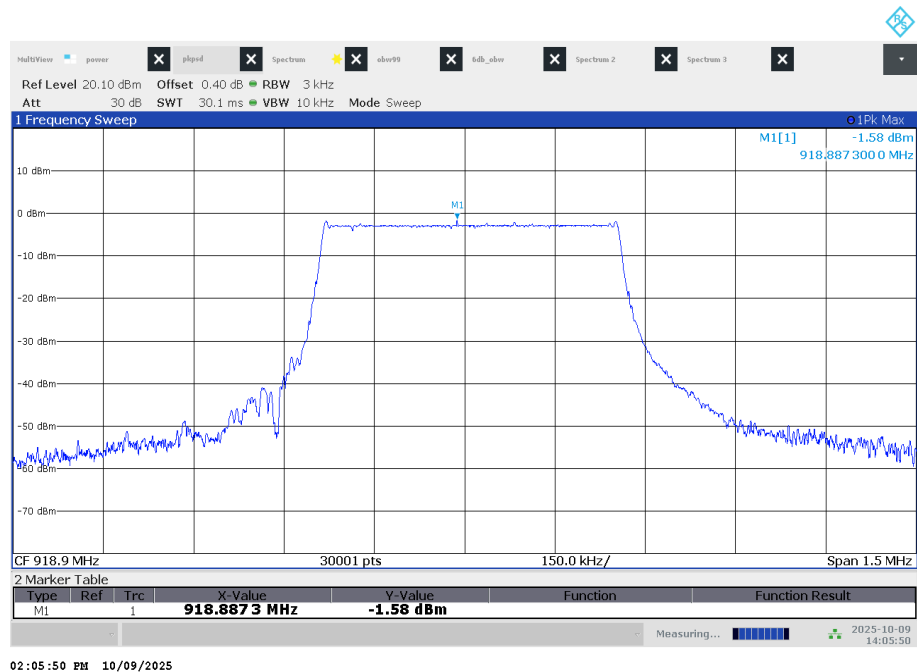
FCC
Power Spectral Density
The transmitter power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission or over 1.0 second if the transmission exceeds 1.0-second duration.

Results:

Power Spectral density
tx 918.9 MHz
-1.58 dBm / 3 kHz

Plots:

Plot 1: tx 918.9 MHz



12.4 Spectrum bandwidth – 6 dB bandwidth and 99% bandwidth

Description:

Measurement of the 6 dB bandwidth of the modulated signal.

Measurement:

Measurement parameter	
Detector:	Peak
Sweep time:	Auto
Resolution bandwidth:	99% OBW: 1% - 5% Of the OBW 6 dB BW: 100 kHz
Video bandwidth:	$\geq 3 \times \text{RBW}$
Span:	See plots
Trace-Mode:	Max Hold
Measurement method	According to ANSI C63.10-2020 11.8 DTS bandwidth
Test setup	See sub clause 7.3 A
Measurement uncertainty	See sub clause 9

Limits:

FCC
Spectrum Bandwidth – 6 dB Bandwidth
The minimum 6 dB bandwidth shall be at least 500 kHz.

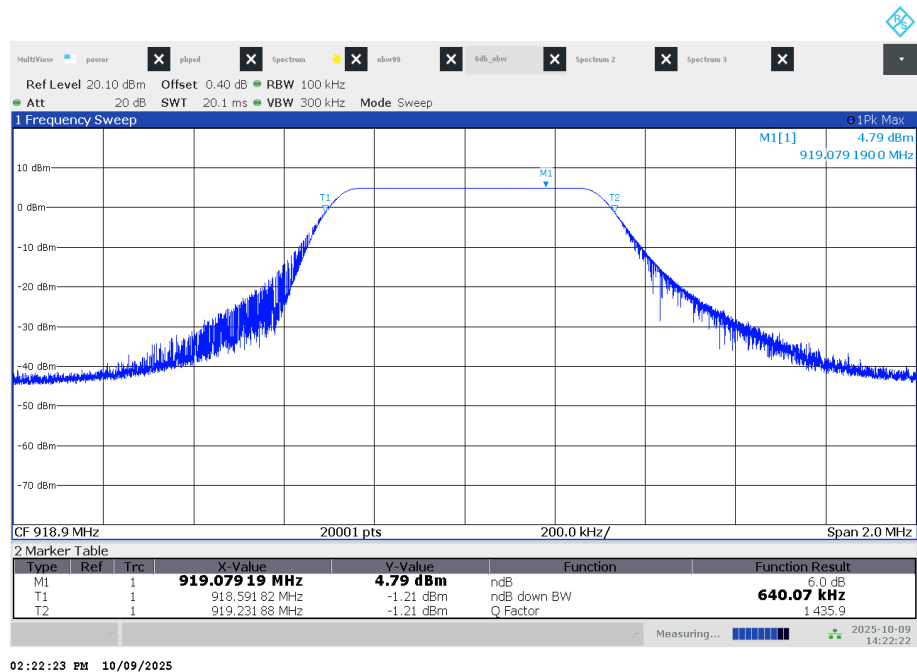
Results:

Test Conditions		6 dB Bandwidth
		tx 918.9 MHz
T_{nom}	V_{nom}	640.07 kHz

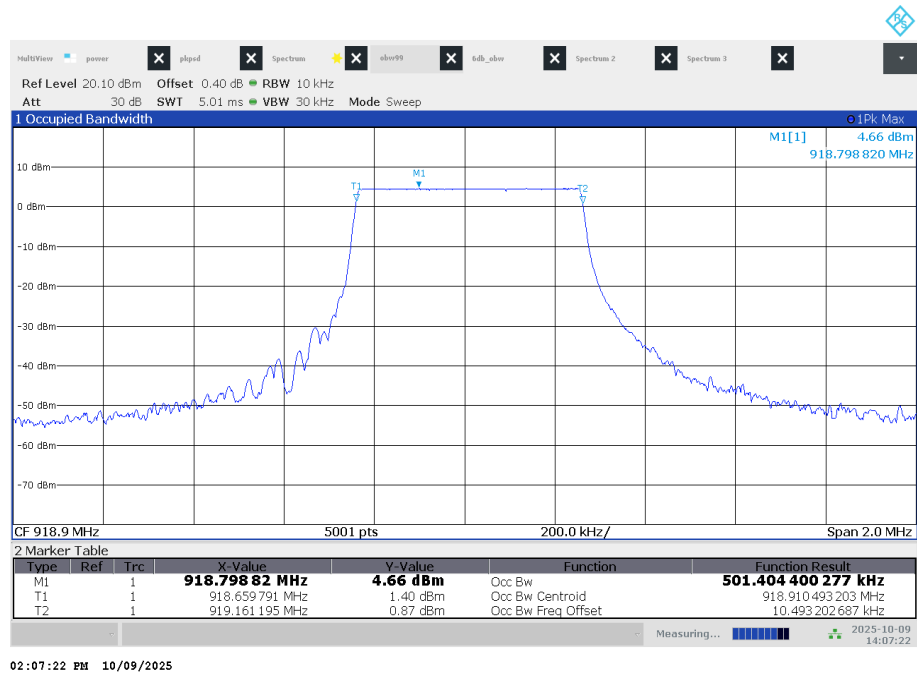
Test Conditions		99% Bandwidth
		tx 918.9 MHz
T_{nom}	V_{nom}	501.40 kHz

Plots:

Plot 1: 918.9 MHz, 6 dB-BW



Plot 2: 918.9 MHz, 99%OBW



12.5 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 mode.

Measurement:

Measurement parameters	
Detector	Peak
Sweep time	Auto
Resolution bandwidth	100 kHz
Video bandwidth	300 kHz
Span	Lower Band Edge: 902 MHz Upper Band Edge: 928 MHz
Trace mode	Max hold
Test setup	See sub clause 7.3 A
Measurement uncertainty	See sub clause 9

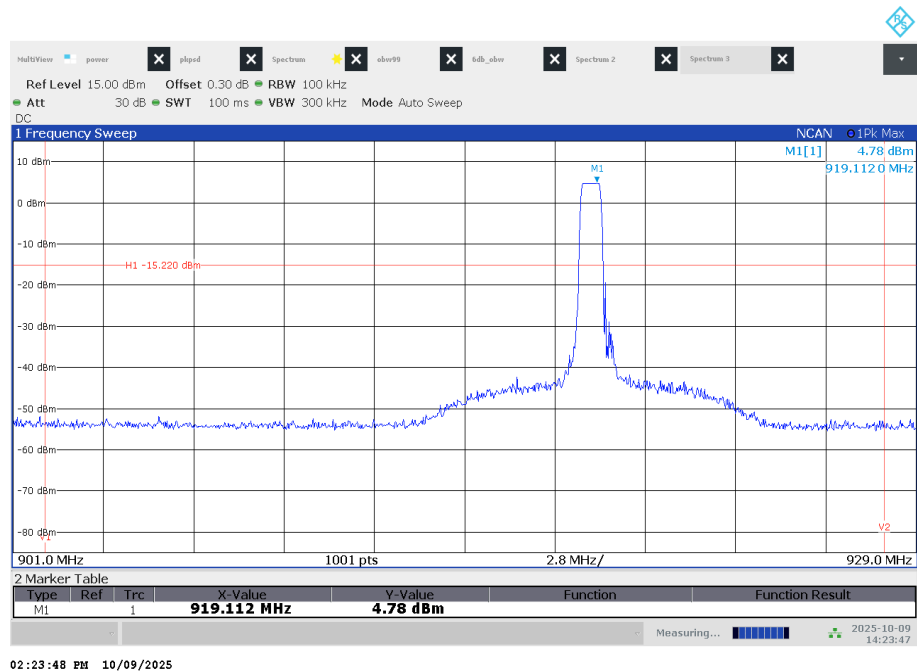
Limits:

FCC
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	tx 918.9 MHz	-/-	-/-
lower band edge – single channel mode tx 918.9 MHz	> 20 dB	-/-	-/-
upper band edge – single channel mode tx 918.9 MHz	> 20 dB	-/-	-/-

Plot: tx 918.9 MHz



No restricted band in the range ± 2 channel bandwidths of the Band-edges of the specified emission band! (608 MHz – 614 MHz and 960 MHz – 1240 MHz).

Section 15.205 Restricted bands of operation.

(a) Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090 - 0.110	16.42 - 16.423	399.9 - 410	4.5 - 5.15
¹ 0.495 - 0.505	16.69475 - 16.69525	608 - 614	5.35 - 5.46
2.1735 - 2.1905	16.80425 - 16.80475	960 - 1240	7.25 - 7.75
4.125 - 4.128	25.5 - 25.67	1300 - 1427	8.025 - 8.5
4.17725 - 4.17775	37.5 - 38.25	1435 - 1626.5	9.0 - 9.2
4.20725 - 4.20775	73 - 74.6	1645.5 - 1646.5	9.3 - 9.5
6.215 - 6.218	74.8 - 75.2	1660 - 1710	10.6 - 12.7
6.26775 - 6.26825	108 - 121.94	1718.8 - 1722.2	13.25 - 13.4
6.31175 - 6.31225	123 - 138	2200 - 2300	14.47 - 14.5
8.291 - 8.294	149.9 - 150.05	2310 - 2390	15.35 - 16.2
8.362 - 8.366	156.52475 - 156.52525	2483.5 - 2500	17.7 - 21.4
8.37625 - 8.38675	156.7 - 156.9	2690 - 2900	22.01 - 23.12
8.41425 - 8.41475	162.0125 - 167.17	3260 - 3267	23.6 - 24.0
12.29 - 12.293	167.72 - 173.2	3332 - 3339	31.2 - 31.8
12.51975 - 12.52025	240 - 285	3345.8 - 3358	36.43 - 36.5
12.57675 - 12.57725	322 - 335.4	3600 - 4400	(²)
13.36 - 13.41			

12.6 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 low, mid and high channel.

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 7.3A
Measurement uncertainty:	See chapter 9

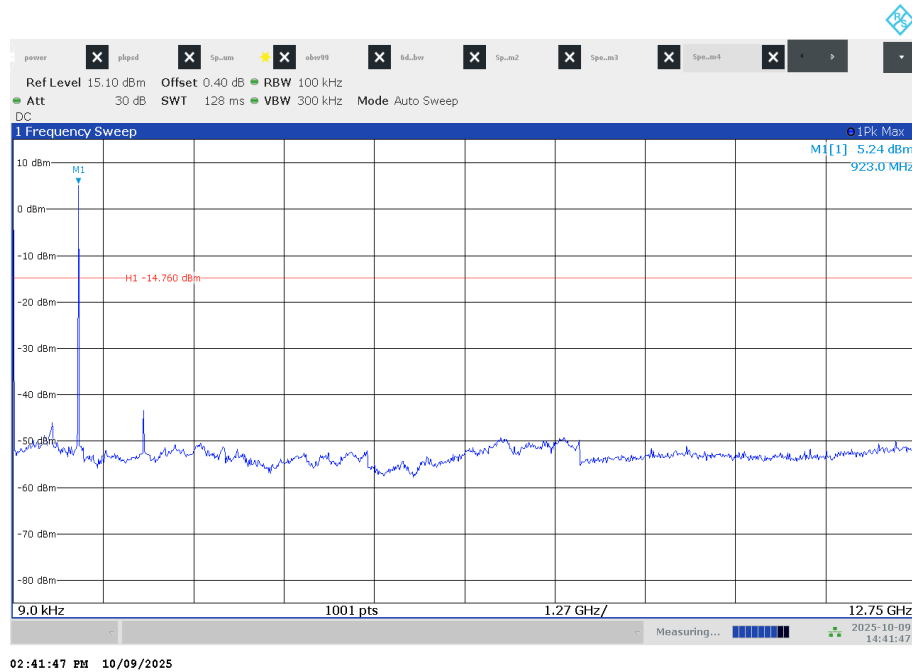
Limits:

FCC
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
918.9			24 dBm	-/-	Operating frequency
			-20 dBc	No emissions detected!	

Plot: tx 918.9 MHz, 9 kHz – 12.75 GHz



12.7 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: 1 kHz F > 150 kHz: 100 kHz
Resolution bandwidth:	F < 150 kHz: 200 Hz F > 150 kHz: 9 kHz
Span:	9 kHz to 30 MHz
Trace-Mode:	Max Hold
Used equipment:	See chapter 7.2 A
Measurement uncertainty:	See chapter 9

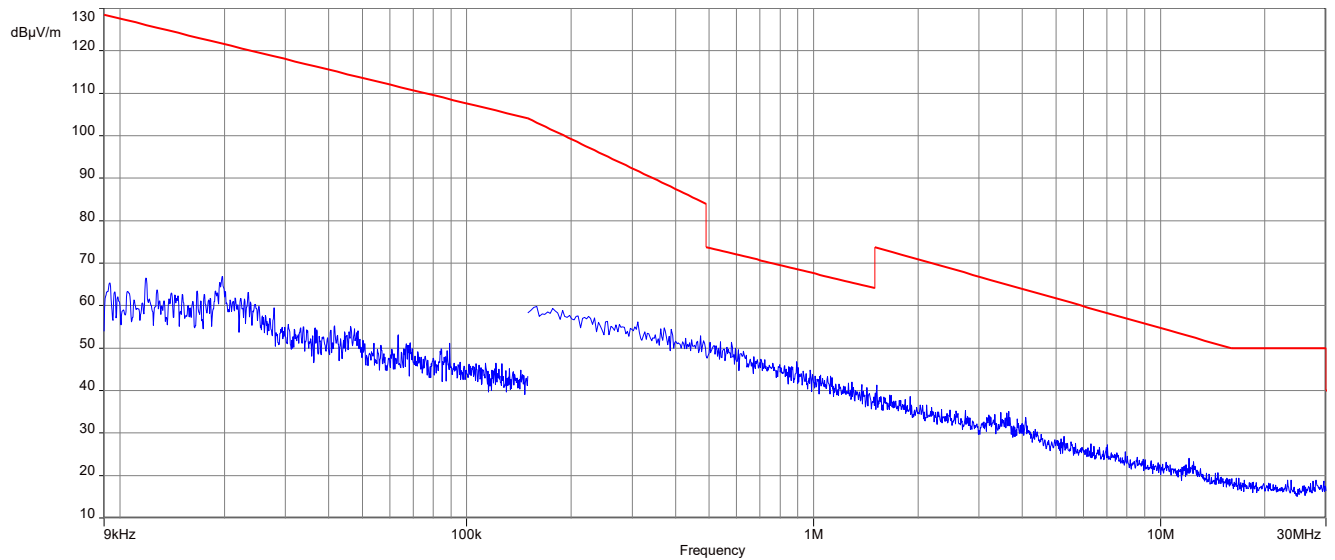
Limits:

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 – 30.0	30	30

Result:

Spurious emission level		
tx 918.9 MHz		
Frequency / MHz	Detector	Level / (dBμV/m)
no peaks detected		
-/-	-/-	-/-

Plot 1: tx 918.9 MHz FCC



12.8 Spurious Emissions Radiated > 30 MHz

12.8.1 Spurious emissions radiated 30 MHz to 1 GHz

Description:

Measurement of the radiated spurious emissions in transmit mode. The measurement is performed at 918.9 MHz

Measurement:

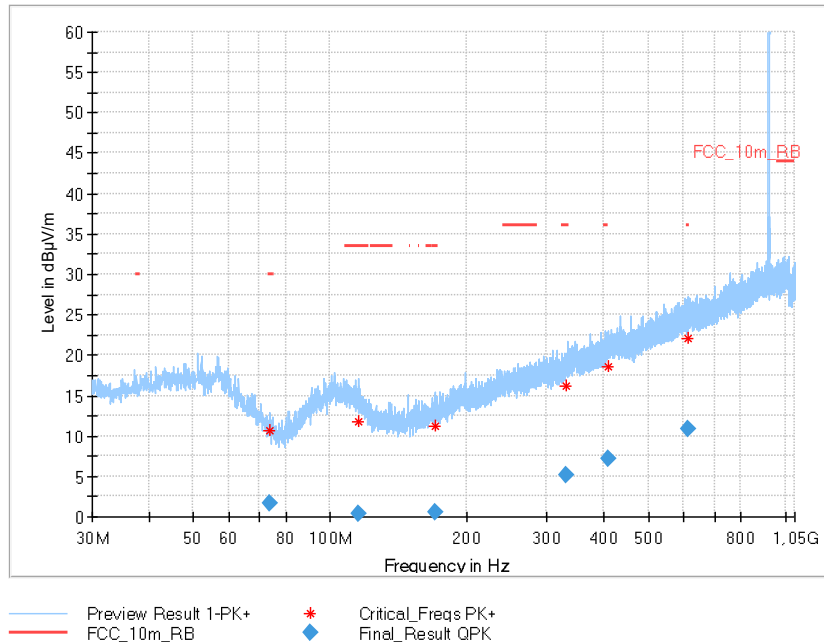
Measurement parameters	
Detector	Peak / Quasi Peak
Sweep time	Auto
Resolution bandwidth	3 x VBW
Video bandwidth	120 kHz
Span	30 MHz to 1 GHz
Trace mode	Max hold
Measured modulation	DSSS
Test setup	See sub clause 7.1 A
Measurement uncertainty	See sub clause 9

Limits:

FCC		
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 / (dB μ V/m)	Measurement distance / m
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 plot.

Plot: 30 MHz – 1 GHz, horizontal & vertical polarisation, tx 918.9 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)
73.739	1.60	30.0	28.4	1000	120.0	360.0	V	78	9
115.609	0.32	33.5	33.2	1000	120.0	313.0	V	315	12
170.232	0.50	33.5	33.0	1000	120.0	400.0	H	135	11
331.114	5.14	36.0	30.9	1000	120.0	290.0	V	212	16
409.978	7.20	36.0	28.8	1000	120.0	281.0	H	183	18
609.561	10.81	36.0	25.2	1000	120.0	358.0	H	261	22

12.8.2 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:

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
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:

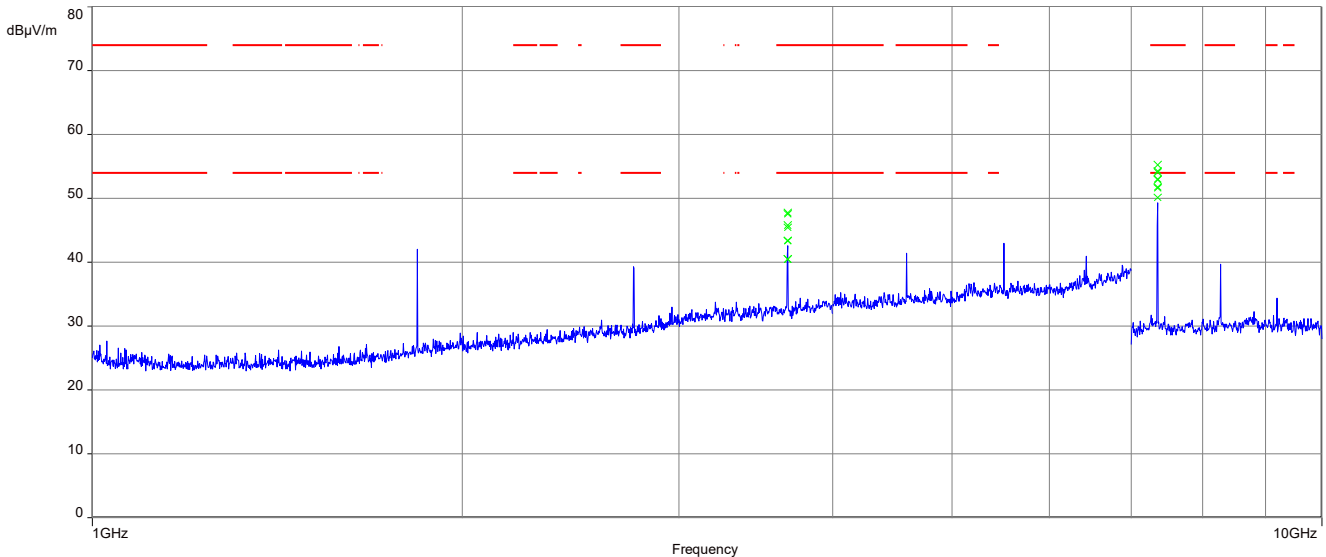
ANSI C63.10
The average emission shall be determined by using Video averaging (VBW = 10 Hz). If the dwell time of the hopping signal is less than 100 ms (per channel), the VBW=10 Hz reading may be adjusted by a factor: $F = 20\log(\text{dwell time}/100 \text{ ms})$

FCC		
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 / MHz	Field strength / (dBμV/m)	Measurement distance / m
Above 960	54.0	3

Result:

TX spurious emissions radiated								
tx 918.9 MHz			Middle channel			Highest channel		
Frequency / MHz	Detector	Level / (dBµV/m)	Frequency / MHz	Detector	Level / (dBµV/m)	Frequency / MHz	Detector	Level / (dBµV/m)
3676.3	Peak	47.61	-/-	Peak	-/-	-/-	Peak	-/-
	AVG	43.43		AVG	-/-		AVG	-/-
7351.3	Peak	55.23						
	AVG	44.82						

Plot: 1 GHz – 10 GHz, horizontal & vertical polarisation 918.9 MHz



12.9 Conducted limits

Measurement:

Measurement of the conducted spurious emissions for an intentional radiator that is designed to be connected to the public utility (AC) power line. Measurement performed according to ANSI C63.10, chapter 6.2

Measurement parameters	
Detector:	Quasi peak / average or peak (worst case – pre-scan)
Resolution bandwidth:	F < 150 kHz: 200 Hz F > 150 kHz: 9 kHz
Video bandwidth:	F < 150 kHz: 1 kHz F > 150 kHz: 100 kHz
Trace mode:	Max hold
Used equipment:	See chapter 7.4A
Measurement uncertainty:	See chapter 9

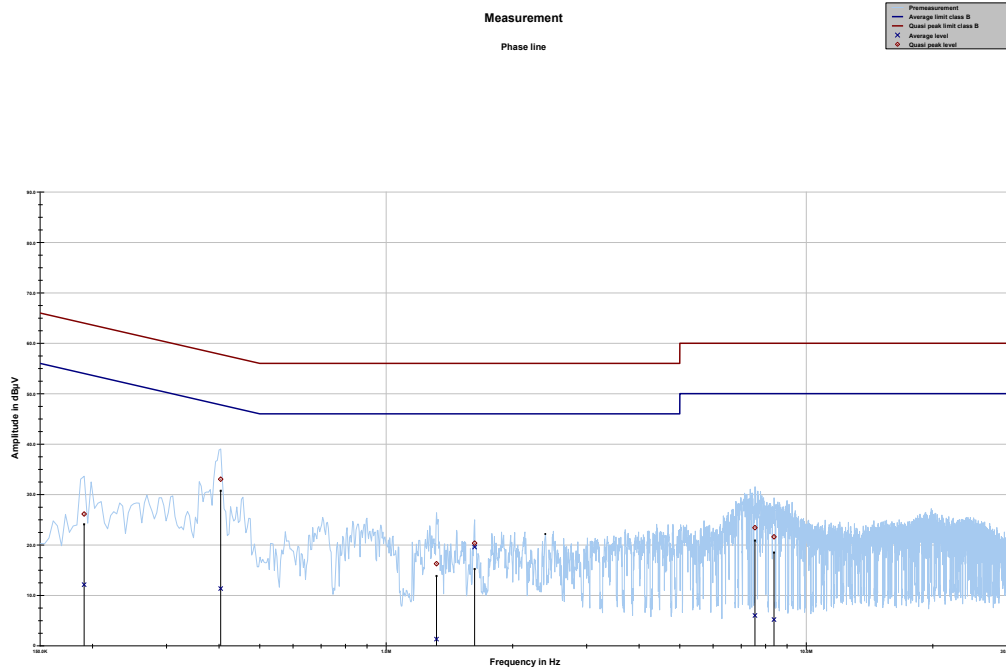
Limits:

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 – 30.0	30	30

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

Result:

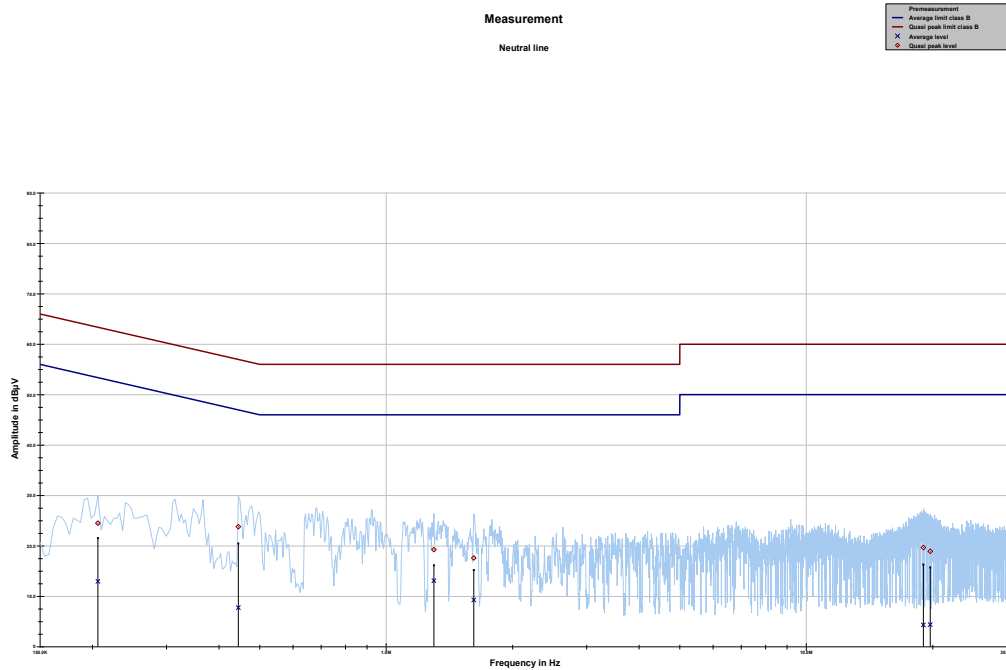
see table below plots

Plots AC 120V/60Hz:**Plot 1:** 150 kHz to 30 MHz, phase line

Project ID: 1-9457/25-02-05

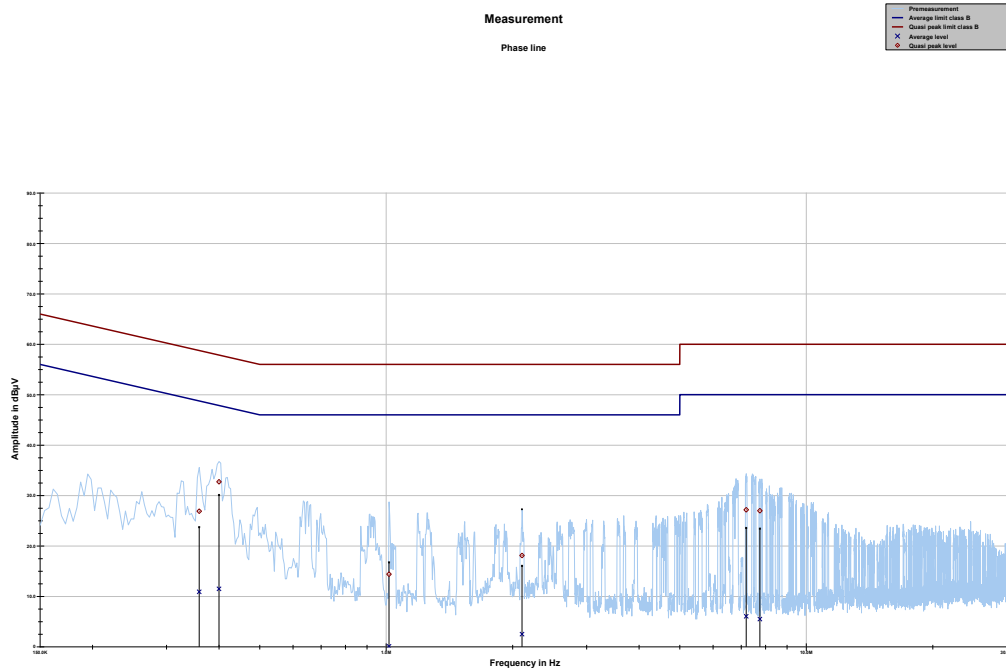
Frequency	Quasi peak level	Margin quasi peak	Limit QP	Average level	Margin average	Limit AV
MHz	dBµV	dB	dBµV	dBµV	dB	dBµV
0.191044	26.13	37.86	63.991	12.11	42.72	54.827
0.403725	33.03	24.75	57.776	11.34	37.41	48.751
1.317881	16.27	39.73	56.000	1.31	44.69	46.000
1.623844	20.35	35.65	56.000	19.58	26.42	46.000
7.549069	23.41	36.59	60.000	6.01	43.99	50.000
8.381137	21.61	38.39	60.000	5.20	44.80	50.000

Plot 2: 150 kHz to 30 MHz, neutral line



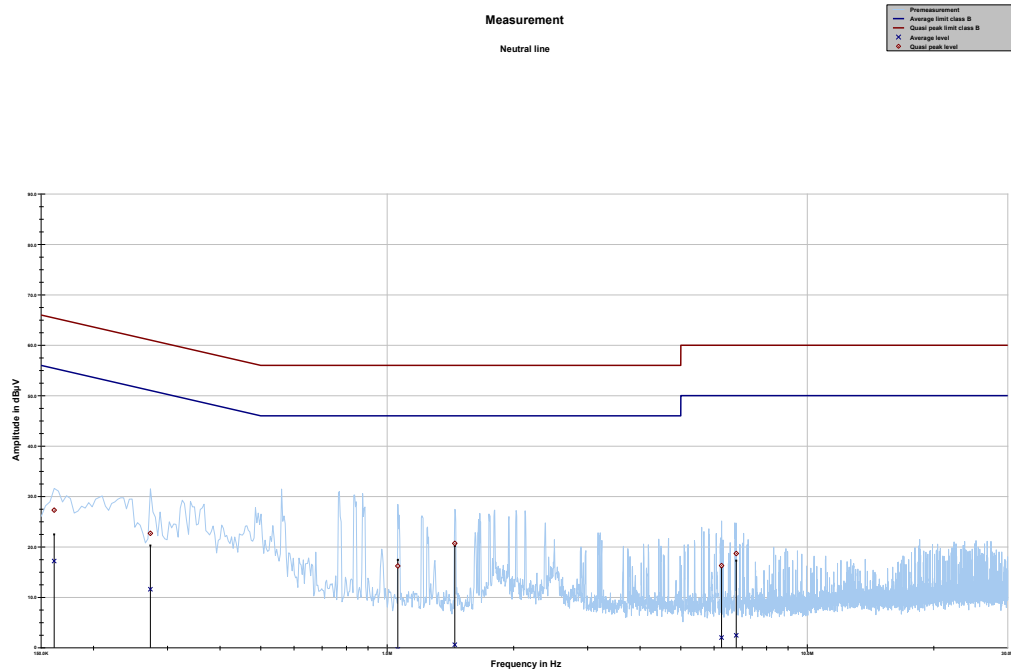
Project ID: 1-9457/25-02-05

Frequency	Quasi peak level	Margin quasi peak	Limit QP	Average level	Margin Average	Limit AV
MHz	dBµV	dB	dBµV	dBµV	dB	dBµV
0.205969	24.51	38.86	63.366	12.97	41.43	54.401
0.444769	23.80	33.17	56.972	7.76	39.82	47.578
1.299225	19.26	36.74	56.000	13.09	32.91	46.000
1.616381	17.61	38.39	56.000	9.28	36.72	46.000
19.000275	19.67	40.33	60.000	4.33	45.67	50.000
19.727869	18.94	41.06	60.000	4.39	45.61	50.000

Plots AC 240V/60Hz:**Plot 1: 150 kHz to 30 MHz, phase line**

Project ID: 1-9457/25-02-05

Frequency	Quasi peak level	Margin quasi peak	Limit QP	Average level	Margin average	Limit AV
MHz	dBμV	dB	dBμV	dBμV	dB	dBμV
0.358950	26.88	31.87	58.753	10.90	39.13	50.030
0.399994	32.72	25.13	57.854	11.49	37.36	48.857
1.015650	14.39	41.61	56.000	0.09	45.91	46.000
2.105175	18.10	37.90	56.000	2.51	43.49	46.000
7.194600	27.17	32.83	60.000	6.05	43.95	50.000
7.754288	26.98	33.02	60.000	5.50	44.50	50.000

Plot 2: 150 kHz to 30 MHz, neutral line

Project ID: 1-9457/25-02-05

Frequency	Quasi peak level	Margin quasi peak	Limit QP	Average level	Margin Average	Limit AV
MHz	dBµV	dB	dBµV	dBµV	dB	dBµV
0.161194	27.30	38.10	65.402	17.20	38.48	55.680
0.273131	22.70	38.32	61.022	11.60	40.88	52.482
1.060425	16.23	39.77	56.000	-0.32	46.32	46.000
1.448475	20.70	35.30	56.000	0.60	45.40	46.000
6.250594	16.29	43.71	60.000	2.02	47.98	50.000
6.776700	18.69	41.31	60.000	2.47	47.53	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	Combination of Grantee Code and Equipment Product Code
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
ISED	Innovation, Science and Economic Development 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	2025-10-16
R02	FCC ID changed	2025-11-03

END OF TEST REPORT