
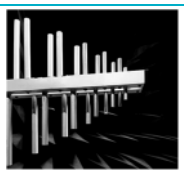
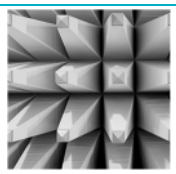

TEST REPORT

Test report no.: 24-1-0014701T010_TR1-R01

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://www.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

Abel Sensors
Noordeinde 30
2611KH Delft / NETHERLANDS
Phone: +31 15 202 30 39
Contact: Ronald Bolijn
e-mail: r.bolijn@abelsensors.com

Manufacturer

Abel Sensors
Noordeinde 30
2611KH Delft / NETHERLANDS

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	Licence-Exempt Radio Apparatus: Category I Equipment Annex J: Devices operating in the band 57-71 GHz

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

Test Item

Kind of test item:	**Fill Level Sensor**
Model name:	**RAD-SEN-05**
FCC ID:	**2BN57-RADSEN05**
IC:	**33673-RADSEN05**
Frequency:	61-61.5 GHz
Technology tested:	RADAR (long-range)
Antenna:	Integrated antenna
Power supply:	Integrated battery
Temperature range:	-20°C to +50°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:

Thomas Vogler
cn=Thomas Vogler, o=cetecom advanced GmbH, ou=VOG-230609, email=thomas.vogler@cetecomadvanced.com, c=DE
2025.05.20 14:58:16 +02'00'

Thomas Vogler
Lab Manager
Radio Communications

Test performed:

Christian Lorenz
CN = Christian Lorenz email = christian.lorenz@cetecomadvanced.com C = DE O = cetecom advanced GmbH OU = RC8G
2025.05.20 14:39:05 +02'00'

Christian Lorenz
Lab Manager
Radio Communications

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.

2.2 Application details

Date of receipt of order:	2025-03-17
Date of receipt of test item:	2025-02-18
Start of test:*	2025-03-18
End of test:*	2025-04-30
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 Involved test locations

	Saarbruecken lab		Essen lab
☐	Untertuerkheimer Str. 6-10 66117 Saarbruecken Germany	☒	Im Teelbruch 116 45219 Essen Germany

2.4 Test laboratories sub-contracted

None

2.5 Laboratory listings and recognitions

	Saarbruecken	Essen
FCC	DE0002	DE0003
ISED	DE0001 3462C	DE0001 3462D

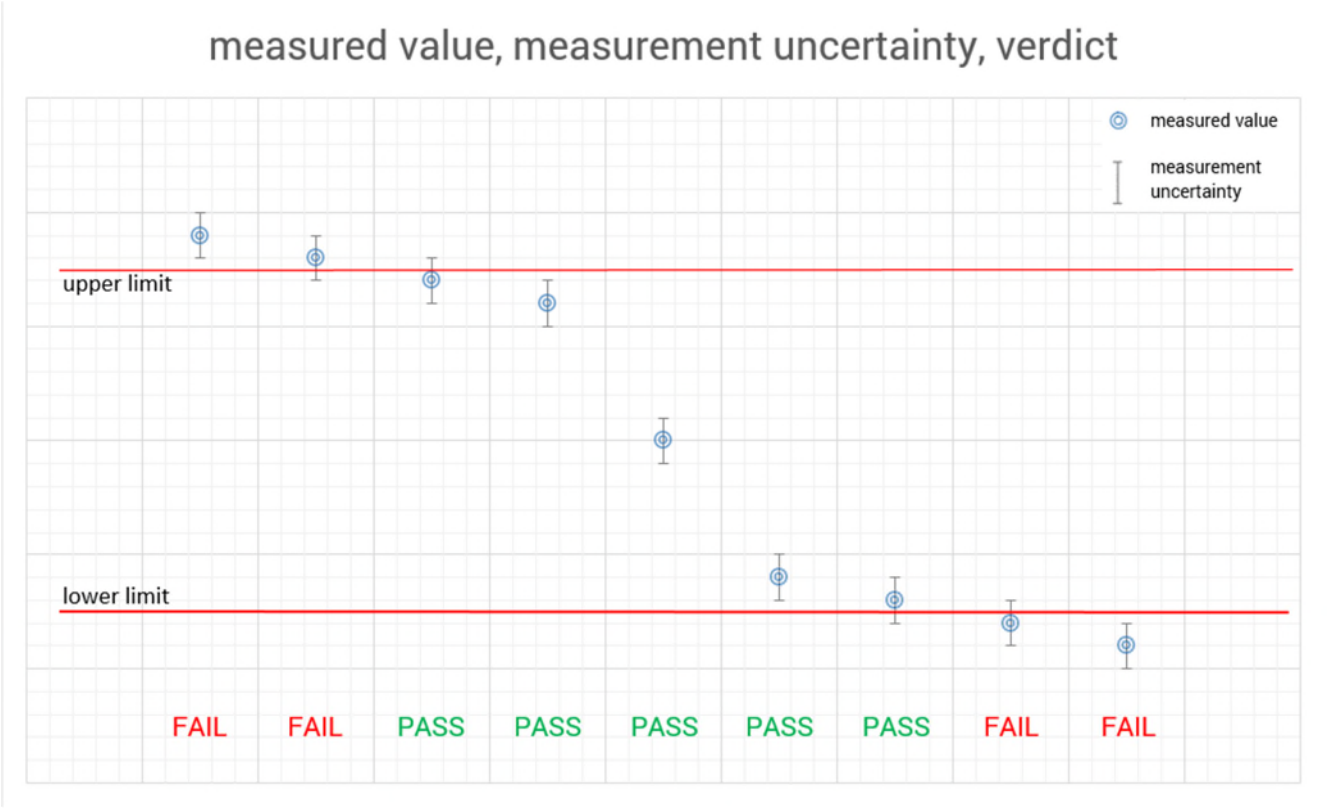
3 Test standard/s, references and accreditations

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	2024-June-25	Licence-Exempt Radio Apparatus: Category I Equipment Annex J: Devices operating in the band 57-71 GHz
RSS-Gen., Issue 5	2018-April	General Requirements for Compliance of Radio Apparatus

Guidance	Version	Description
ANSI C63.4-2014	-/-	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
ANSI C63.10-2020	-/-	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
57-71 GHz (60 GHz) frequency band	V01	364244 D01 Meas 15.255 Radars v01: RADAR DEVICES CERTIFYING UNDER THE PROVISIONS OF §15.255

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 +50 °C during high temperature tests -20 °C during low temperature tests
Relative humidity content	:		49 %
Barometric pressure	:		990 hPa to 1010 hPa
Power supply	:	V_{nom} V_{max} V_{min}	3.6 V DC 3.3 V DC 3.8 V DC *Note: For time-consuming pre-scans (noted at the respective plots) 3.6 V DC is applied by an external power supply at the designated feed point agreed with the customer. All critical final measurements are performed with 3.6 V DC by power supply unit.*

6 Test item

6.1 General description

Kind of test item	:	Fill Level Sensor
Model name	:	RAD-SEN-05
HMN	:	--
PMN	:	SMARTSILO
HVIN	:	rad7972
FVIN	:	--
S/N serial number	:	AEA43B48D8
Power setting		--
Hardware status	:	rad7972 with RADAR absorber on the RADAR ASIC (IWR8643)
Software status	:	4.7.1-54
Firmware status	:	N/A
Frequency band	:	61.0-61.5 GHz FCC: §15.255(c)(2)(v) / IC: J3.2(a)
Type of radio transmission Use of frequency spectrum	: :	--
Type of modulation	:	FMCW
Number of channels/ modes	:	1 nominal range of operation with Op.Mode 1 (long-range)
Antenna	:	Integrated antenna
Power supply	:	Integrated battery (Tests performed with attached wires and nominal voltage)
Temperature range	:	-20°C to +50°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:

- 24-1-0014701T010_TR1-A101-R01 (External photographs of EUT)
- 24-1-0014701T010_TR1-A102-R01 (Internal photographs of EUT)
- 24-1-0014701T010_TR1-A103-R01 (Test set-up photographs)
- Note: The referenced photos show EUT delivered by the customer in this project, not necessarily the exact one used for the specific tests. EUT identification shown in the photos may differ.

Additional measurement reports:

- 24-1-0014701T010_TR1-A201-R01

Additional declarations (manufacturer's declarations, declarations of conformity, etc.):

- none

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).

Agenda: Kind of Calibration

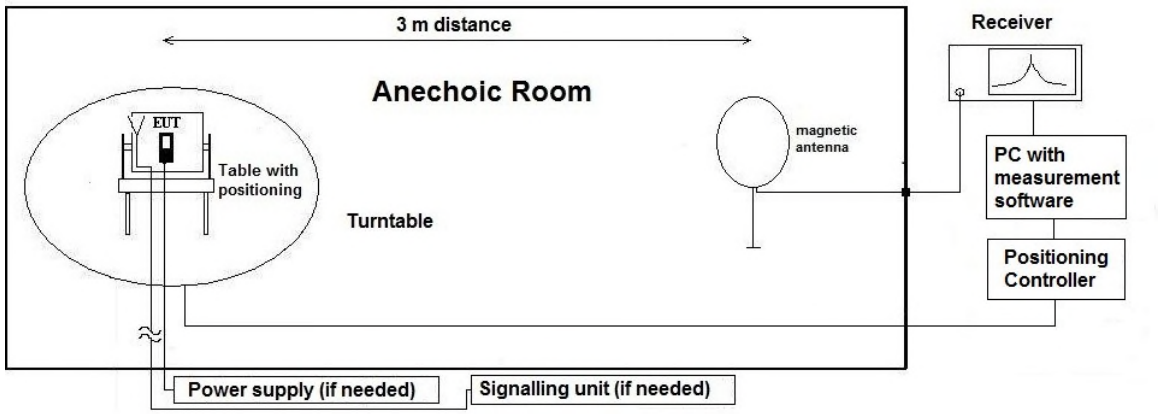
k/cal	calibration / calibrated	EK	limited calibration
Ne/cnn	not required (k, ev, izw, zw not required)	zw	cyclical maintenance (external cyclical maintenance)
Ev/chk	periodic self verification	izw	internal cyclical maintenance
Ve	long-term stability recognized	g	blocked for accredited testing
vlkl!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

7.1 Shielded semi anechoic chamber

Evaluating the radiated field emissions are done first by an exploratory emission measurement and a final measurement for most critical frequencies determined.

The loop antenna was placed at 1 m height above ground plane and 3 m measurement distance from set-up for investigations. Because of reduced measurement distance, correction data were applied, as stated in sub-chapter "correction factors". The tests are performed in the semi-anechoic room recognized by the regulatory commission and absorbers placed between EUT and measurement antenna.

Schematic:



Testing method:

The measurement is made according to relevant reference clauses:
(See Tables *Summary of Test Results* and *Summary of Test Methods*)

Exploratory, preliminary measurements
The EUT and it's associated accessories are placed on a non-conductive position manipulator (tipping device) of 0.8 m height which is placed on the turntable. By rotating the turntable (step 90°, range 0°to 360°) and the EUT itself either on 3-orthogonal axis (portable equipment) or 2-orthogonal axis (defined operational position of EUT), the emission spectrum was recorded.

The loop antenna was moved at least to 2-perpendicular axes (antenna vector in direction of EUT and parallel to EUT) in order to maximize the emissions. The results are documented in a diagram. Critical frequencies (low margin to limit) are saved within a data reduction table for further investigations. If various operating modes are supported, further investigations are made to find the worst-case. Also the interconnection cables and equipment position were varied in order to maximize the emissions.

Final measurement on critical frequencies
Based on the exploratory measurements, the most critical frequencies are re-measured by maintaining the EUT's worst-case operation mode, cable position, etc.

First a frequency zoom around the critical frequency is done to locate the frequency more precisely. After this step, for all identified critical frequencies, the maximum peak was determined.

Following parameters were varied: the turntable angle continuously in the range 0 to 360 degree, the EUT itself either over 1 (defined usage position) or 2-orthogonal axis (not defined usage position for portable equipment).

On the determined worst-case position, a final measurement with necessary bandwidth and detector according standard has been carried out.

Formula:

$E_C = E_R + AF + C_L + D_F - G_A$

$M = L_T - E_C$

AF = Antenna factor
C_L = Cable loss
D_F = Distance correction factor (if used)
E_C = Electrical field – corrected value
E_R = Receiver reading
G_A = Gain of pre-amplifier (if used)
L_T = Limit
M = Margin

All units are dB-units, positive margin means value is below limit.

Sample calculation

Raw-Value [dBuV/m]	Antenna factor	Distance Correction [dB]	Cable Loss	Preamplifier	Resulting correction value [dB]	Final result [dBuV/m]	Remarks
19.83	18.9	-70.75	0.18	--	-51.67	-31.83	30 to 3 m correction used according ANSI C63.10-2020

Remark: This calculation is based on an example general value at 458 kHz, frequency not related to this project

Correction factors due to reduced meas. distance (f < 30 MHz):

The used correction factors when the measurement distance is reduced compared to regulatory measurement distance, are calculated according Extrapolation formulas valid for EUT's with maximum dimension of 0.625xLambda. Formula 2+3+4 as presented in ANSI C63.10, Chapter 6.4.4 are used for the calculations of proper extrapolation factors

Frequency Range	F [kHz/MHz]	Lambda [m]	Far-Field Point [m]	Distance Limit accord. 15.209 [m]	1st Condition (dmeas < Dnear-field)	2nd Condition (Limit distance bigger dnear-field)	Distance Correction accord. Formula
kHz	9	33333.33	5305.17	300	fullfilled	not fullfilled	-80.00
	10	30000.00	4774.65		fullfilled	not fullfilled	-80.00
	20	15000.00	2387.33		fullfilled	not fullfilled	-80.00
	30	10000.00	1591.55		fullfilled	not fullfilled	-80.00
	40	7500.00	1193.66		fullfilled	not fullfilled	-80.00
	50	6000.00	954.93		fullfilled	not fullfilled	-80.00
	60	5000.00	795.78		fullfilled	not fullfilled	-80.00
	70	4285.71	682.09		fullfilled	not fullfilled	-80.00
	80	3750.00	596.83		fullfilled	not fullfilled	-80.00
	90	3333.33	530.52		fullfilled	not fullfilled	-80.00
	100	3000.00	477.47		fullfilled	not fullfilled	-80.00
	125	2400.00	381.97		fullfilled	not fullfilled	-80.00
	200	1500.00	238.73		fullfilled	fullfilled	-78.02
	300	1000.00	159.16		fullfilled	fullfilled	-74.49
	400	750.00	119.37		fullfilled	fullfilled	-72.00
	490	612.24	97.44		fullfilled	fullfilled	-70.23
	500	600.00	95.49	30	fullfilled	not fullfilled	-40.00
	600	500.00	79.58		fullfilled	not fullfilled	-40.00
	700	428.57	68.21		fullfilled	not fullfilled	-40.00
	800	375.00	59.68		fullfilled	not fullfilled	-40.00
	900	333.33	53.05		fullfilled	not fullfilled	-40.00
MHz	1.00	300.00	47.75		fullfilled	not fullfilled	-40.00
	1.59	188.50	**30.00**		fullfilled	not fullfilled	-40.00
	2.00	150.00	23.87		fullfilled	fullfilled	-38.02
	3.00	100.00	15.92		fullfilled	fullfilled	-34.49
	4.00	75.00	11.94		fullfilled	fullfilled	-32.00
	5.00	60.00	9.55		fullfilled	fullfilled	-30.06
	6.00	50.00	7.96		fullfilled	fullfilled	-28.47
	7.00	42.86	6.82		fullfilled	fullfilled	-27.13
	8.00	37.50	5.97		fullfilled	fullfilled	-25.97
	9.00	33.33	5.31		fullfilled	fullfilled	-24.95
	10.00	30.00	4.77		fullfilled	fullfilled	-24.04
	10.60	28.30	4.50		fullfilled	fullfilled	-23.53
	11.00	27.27	4.34		fullfilled	fullfilled	-23.21
	12.00	25.00	3.98		fullfilled	fullfilled	-22.45
	13.56	22.12	3.52		fullfilled	fullfilled	-21.39
	15.00	20.00	3.18		fullfilled	fullfilled	-20.51
	15.92	18.85	**3.00**		fullfilled	fullfilled	-20.00
	17.00	17.65	2.81		not fullfilled	fullfilled	-20.00
	18.00	16.67	2.65		not fullfilled	fullfilled	-20.00
	20.00	15.00	2.39		not fullfilled	fullfilled	-20.00
	21.00	14.29	2.27		not fullfilled	fullfilled	-20.00
	23.00	13.04	2.08		not fullfilled	fullfilled	-20.00
	25.00	12.00	1.91		not fullfilled	fullfilled	-20.00

	27.00	11.11	1.77		not fullfilled	fullfilled	-20.00
	29.00	10.34	1.65		not fullfilled	fullfilled	-20.00
	30.00	10.00	1.59		not fullfilled	fullfilled	-20.00

Measurement Location

Test site	☐ SAC 1: #225911
	☐ SAC 3: #120901

Equipment table:

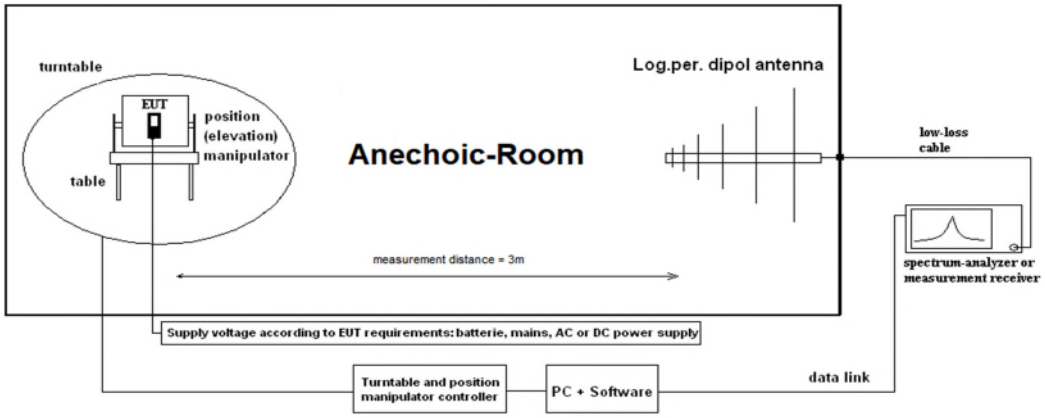
No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
11111	NO Data	Digital Multimeter	Digital Multimeter Fluke 112	Fluke Deutschland GmbH / Glottertal	81650455	20341	cal	13.05.2024	13.05.2026
2	NO Data	Semi Anechoic Chamber	Semi Anechoic Chamber SAC3	ETS-Lindgren Gmbh / Taufkirchen	without	20442	chk	24.10.2024	24.10.2025
3	NO Data	Filter Matrix	Filter Matrix SAC3	cetecom advanced GmbH / Essen	without	20482	cnn	-/-	-/-
4	NO Data	EMI Test Receiver	EMI Test Receiver ESU26	Rohde & Schwarz Messgerätebau GmbH / Memmingen	100362	20620	cal	15.05.2024	15.05.2025
5	NO Data	Power Supply EA3632A	Power Supply EA3632A	Agilent Technologies Deutschland GmbH / Böblingen	75305850	20885	cnn	-/-	-/-
6	NO Data	Loop Antenna	Loop Antenna HFH2-Z2	Rohde & Schwarz Messgerätebau GmbH / Memmingen	872096/61	20979	cal	16.09.2024	16.09.2027

7.2 Radiated field strength emissions 30 MHz – 1000 MHz

Description of the general test setup and methodology, see below example:

Evaluating the emissions have to be done first by an exploratory emissions measurement and a final measurement for most critical frequencies. The tests are performed in a CISPR 16-1-4:2010 compliant Semi-Anechoic Chamber (SAC) recognized by the regulatory commission. The measurement distance was set to 3 meters for frequencies up to 1 GHz. A logarithmic periodic antenna is used for the frequency range 30 MHz to 1 GHz.

Schematic:



Measurement method/steps:

The measurement is made according to relevant reference clauses:
(See Tables *Summary of Test Results* and *Summary of Test Methods*)

Exploratory, preliminary measurements
The EUT and its associated accessories are placed on a non-conductive position manipulator (tipping device) of 0.8 m height which is placed on the turntable. By rotating the turntable (range 0° to 360°, step 90°) and the EUT itself either on 2-orthogonal axis (or 3-axis) the emission spectrum and it's characteristics were recorded with an EMI-receiver, broadband antenna and software.

Measurement antenna: horizontal and vertical, heights: 1,0 m and 1,82 m as worst case determined by an exploratory emission measurement. The results are documented in a diagram. Critical frequencies (low margin to limit) are saved within a table for further investigations. If various operating modes are supported, further investigations are carried out to find the worst case of them. Also, the interconnection cables and equipment position were varied in order to maximize the emissions.

Final measurement on critical frequencies
Based on the exploratory measurements, the most critical frequencies are re-measured by maintaining the EUT's worst-case operation mode, cable position, etc. either on 10m OATS or 3m semi-anechoic room.
First a frequency zoom around the critical frequency is done to locate the frequency more precisely. After this step, for all identified critical frequencies, the maximum peak was determined.

Following parameters were varied: the turntable angle continuously in the range 0 to 360 degree, the EUT itself either over 1 (defined usage position) or 2-orthogonal axis (not defined usage position for portable equipment). The measurement antenna height is varied between 1 m and 4 m for maximum search. The measurements are performed for horizontal and vertical measurement antenna polarization.
On the determined worst-case position, a final measurement with necessary bandwidth and detector according the standard has been carried out.

Formula:

$E_C = E_R + AF + C_L + D_F - G_A$ (1)

$M = L_T - E_C$ (2)

AF = Antenna factor

C_L = Cable loss
D_F = Distance correction factor (if used)
E_C = Electrical field – corrected value
E_R = Receiver reading
G_A = Gain of pre-amplifier (if used)
L_T = Limit
M = Margin

All units are dB-units, positive margin means value is below limit.

Sample calculation

Raw-Value [dBuV/m]	Antenna factor	Distance Correction [dB]	Cable Loss	Preamplifier	Resulting correction value [dB]	Final result [dBuV/m]	Remarks
32.7	22.25	--	3.1	--	25.35	58.05	--

Remark: This calculation is based on an general example value at 800.4 MHz, not related to the concrete measurements within this project.

Measurement Location

Test site	☒ SAC 1: #225911
	☐ SAC 3: #120901

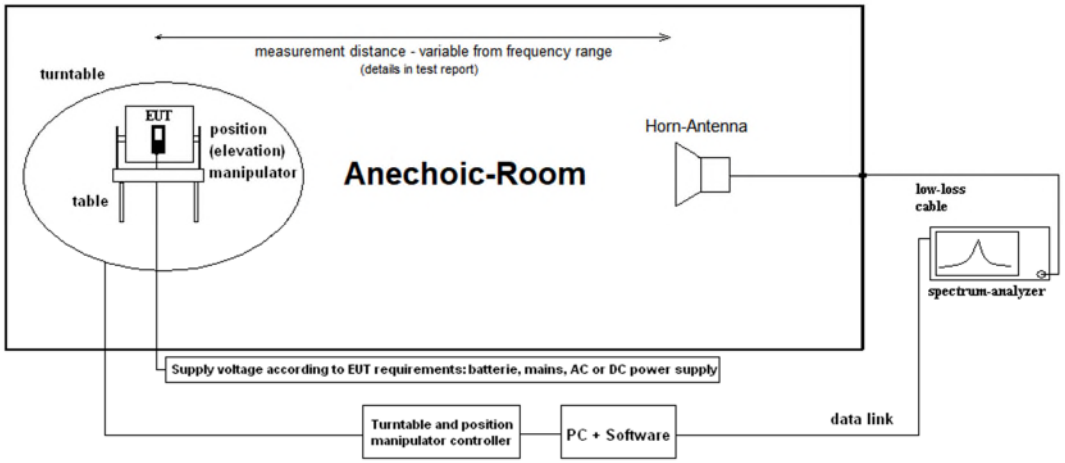
Equipment table:

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
7	NO Data	EMI Test Receiver	EMI Test Receiver ESU40	Rohde & Schwarz Messgerätebau GmbH / Memmingen	100285	25311	cal	14.05.2024	14.05.2026
8	NO Data	Open Switch and control Platform	Open Switch and control Platform OSP120	Rohde & Schwarz Messgerätebau GmbH / Memmingen	101542-rV	25352	cpu	-/-	-/-
9	NO Data	Ultrabroadband Antenna	Ultrabroadband Antenna HL562E	Rohde & Schwarz Messgerätebau GmbH / Memmingen	100824	25357	cal	17.01.2024	17.01.2027
10	NO Data	Semi Anechoic Chamber	Semi Anechoic Chamber SAC1	Albatross Projects GmbH / Nattheim	P27281-016	25358	cal	12.08.2022	12.08.2032
11	NO Data	Antenna Mast	Antenna Mast BAM 4.5-P	maturo GmbH / Pfreimd	BAM 4.5-P/091/1779 1115	25360	cnn	-/-	-/-
12	NO Data	Controller	Controller NCD	maturo GmbH / Pfreimd	NCD/202/17 791115	25361	cnn	-/-	-/-
13	NO Data	Test Table	Test Table PTT1.5x1.0x 0.8-S_127	maturo GmbH / Pfreimd	without	25362	cnn	-/-	-/-
14	NO Data	Turn Table	Turn Table TT4.0-4t	maturo GmbH / Pfreimd	TT4.0-4t/553/1779 1115	25363	cnn	-/-	-/-
15	NO Data	Measurement Software	Measurement Software EMC32 [SAC1]	Rohde & Schwarz Messgerätebau GmbH / Memmingen	v10.60.20	25376	cnn	-/-	-/-

7.3 Shielded fully anechoic chamber (1GHz to 18GHz - FAC 2)

Evaluating the emissions have to be done first by an exploratory emissions measurement and a final measurement for most critical frequencies. The tests are performed in a CISPR 18-1-4:2010 compliant fully anechoic room (FAR) recognized by the regulatory commission. Typical distances are set to 3 meter for frequencies up to 15 GHz, 2 meter up to 18 GHz and 1m up to 50GHz. Otherwise specified in the diagram. Horn antennas are used for frequency range 1 GHz to 50 GHz. The EUT is aligned within 3 dB beam width of the measurement antenna.

Schematic:



Measurement method/steps:

The measurement is made according to relevant reference clauses:
(See Tables *Summary of Test Results* and *Summary of Test Methods*)

Exploratory, preliminary measurements
The EUT and its associated accessories are placed on a non-conductive position manipulator (tipping device) of 1.55 m height which is placed on the turntable. By rotating the turntable (range 0° to 360°, step 15°) and the EUT itself either on 3-orthogonal axis (portable equipment) or 2-orthogonal axis (defined operational position of EUT) the emission spectrum and it's characteristics was recorded with an EMI-receiver, broadband antenna and software.
The measurements are performed in horizontal and vertical polarization of the measurement antennas. The results are documented in a diagram. Critical frequencies (low margin to limit) are saved within a table for further investigations. If various operating modes are supported, further investigations are made to find the worst-case of them. Also the interconnection cables and equipment position were varied in order to maximize the emissions.

Final measurement on critical frequencies
Based on the exploratory measurements, the most critical frequencies are re-measured by maintaining the EUT's worst-case operation mode, cable position, etc.

First a frequency zoom around the critical frequency is done to locate the frequency more precisely. After this step, for all identified critical frequencies, the maximum peak was determined.

Following parameters were varied: the turntable angle continuously in the range 0 to 360 degree, the EUT itself over one or two axis for defined EUT position and the measurement antenna height for EUT with large dimensions or three axis scan for portable/small equipment. This is performed for both measurement antenna polarization: horizontal and vertical.

On the determined worst-case position, a final measurement with necessary bandwidth and detector according standard has been carried out.

Formula for EIRP measurements

$P_{EIRP} = P_{MEAS} + C_L + FSL - G_A$ (1)

P_{MEAS} = measured power at instrument
M = Margin
L_T = Limit

FSL = Free Space loss = Function(frequency, measurement distance)

$M = L_T - P_{EIRP}$

C_L= cable loss
G_A = Gain of pre-amplifier (if used)

All units are dB-units, positive margin means value is below limit.

Sample calculation

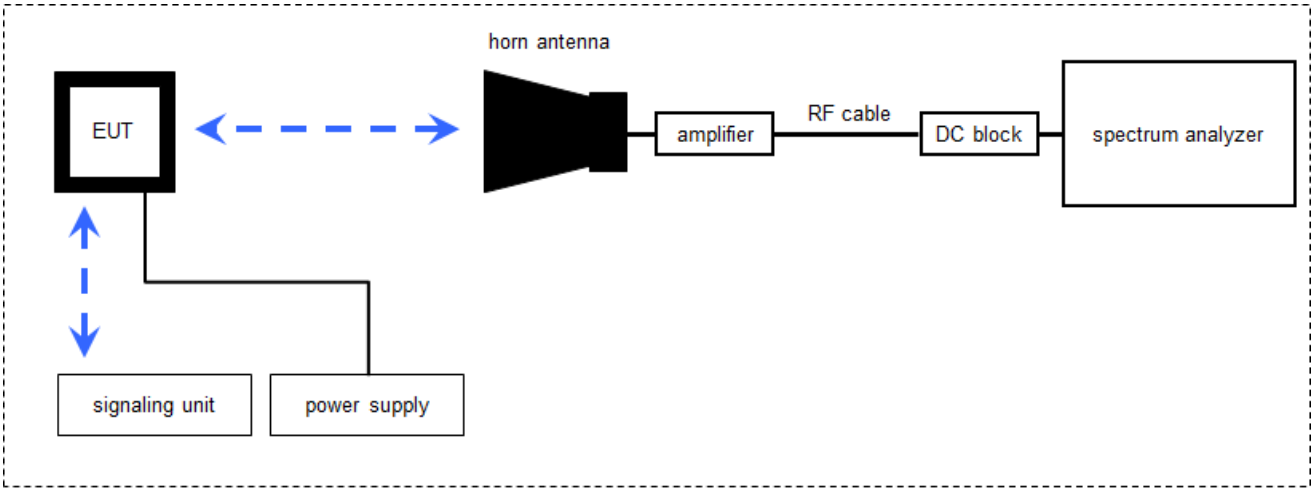
Raw-Value [dBuV/m]	Antenna factor	Distance Correction [dB]	Cable Loss + Preamplifier	Resulting correction value [dB]	Final result [dBuV/m]	Remarks
29.37	41.20	--	24.28	16.92	46.3	CableLoss and PreAmp data in one data correction file

Remark: This calculation is based on an general example value at 10 GHz, not related to the concrete measurements within this project.

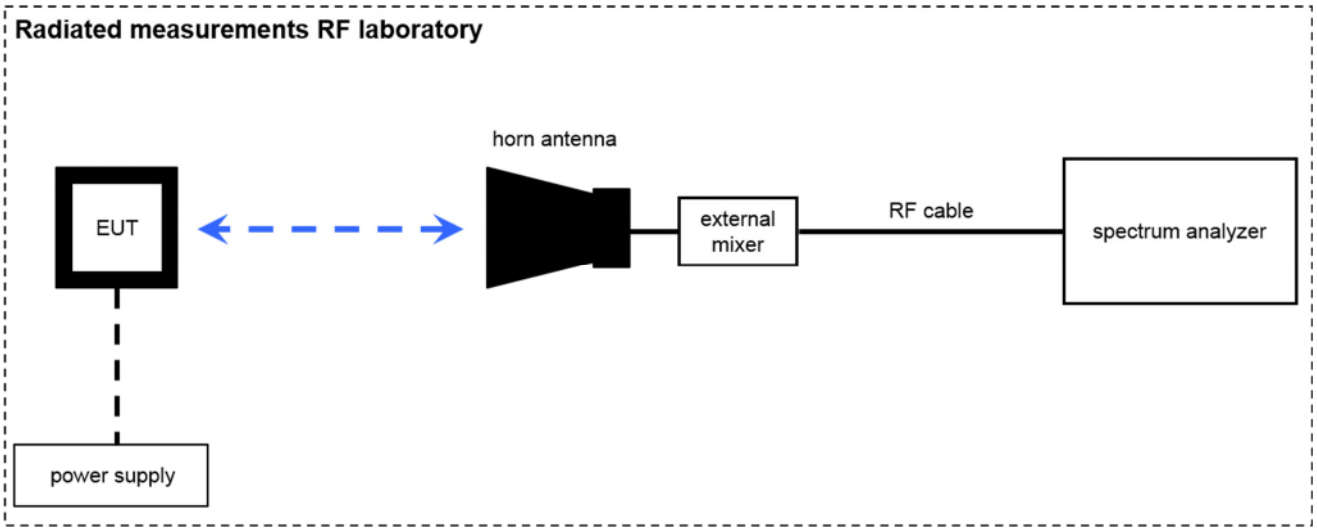
Equipment table (FAC2):

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
16	NO Data	Double-Ridged Waveguide Horn Antenna	Double-Ridged Waveguide Horn Antenna 3115 (Meas 1)	EMCO Elektronik GmbH / Gilching	9012-3629	20133	cal	22.05.2023	22.05.2026
17	NO Data	DC - Power Supply 40A	DC - Power Supply 40A NGPE 40/40	Rohde & Schwarz Messgerätebau GmbH / Memmingen	448	20354	cpu	05.03.2008	-/-
18	NO Data	Fully Anechoic Chamber	Fully Anechoic Chamber 2	ETS-Lindgren Gmbh / Taufkirchen	without	20412	chk	15.03.2024	15.03.2025
19	NO Data	JS44-18004000-40-8P	JS44-18004000-40-8P Verstärker	Miteq Inc.	1750117	20879	chk	18.10.2024	18.10.2026
20	NO Data	Phase Amplitude Stable Cable Assembly	Phase Amplitude Stable Cable Assembly DC-40GHz	RF-Lambda Europe GmbH	AC19040001	20913	cnn	-/-	-/-
21	NO Data	Signal- and Spectrum Analyzer	Signal- and Spectrum Analyzer FSW50	Rohde & Schwarz Messgerätebau GmbH / Memmingen	101929	20972	cal	19.03.2025	19.03.2026

7.4 Radiated measurements > 18 GHz



7.5 Radiated measurements > 50 GHz



Measurement distance: horn antenna e.g. 75 cm

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

Example calculation:
FS [dBµV/m] = 40.0 [dBµV/m] + (-60.1) [dB] + 36.74 [dB/m] = 16.64 [dBµV/m] (6.79 µV/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] = -59.0 [dBm] + 44.0 [dB] - 20.0 [dBi] + 5.0 [dB] = -30 [dBm] (1 µW)

Note: conversion loss of mixer is already included in analyzer value.

Equipment table (FAC2 – below 40GHz):

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
16	NO Data	Double-Ridged Waveguide Horn Antenna	Double-Ridged Waveguide Horn Antenna 3115 (Meas 1)	EMCO Elektronik GmbH / Gilching	9012-3629	20133	cal	22.05.2023	22.05.2026
17	NO Data	DC - Power Supply 40A	DC - Power Supply 40A NGPE 40/40	Rohde & Schwarz Messgerätebau GmbH / Memmingen	448	20354	cpu	05.03.2008	-/-
18	NO Data	Fully Anechoic Chamber	Fully Anechoic Chamber 2	ETS-Lindgren Gmbh / Taufkirchen	without	20412	chk	15.03.2024	15.06.2025
19	NO Data	JS44-18004000-40-8P	JS44-18004000-40-8P Verstärker	Miteq Inc.	1750117	20879	chk	18.10.2024	18.10.2026
20	NO Data	Phase Amplitude Stable Cable Assembly	Phase Amplitude Stable Cable Assembly DC-40GHz	RF-Lambda Europe GmbH	AC19040001	20913	cnn	-/-	-/-
21	NO Data	Signal- and Spectrum Analyzer	Signal- and Spectrum Analyzer FSW50	Rohde & Schwarz Messgerätebau GmbH / Memmingen	101929	20972	cal	19.03.2025	19.03.2026
22	NO Data	DRG Horn Antenna	DRG Horn Antenna SAS-574	A.H. Systems, Inc. / Chatsworth	383	25457	cal	28.03.2022	28.06.2025

Equipment table (FAC2 – from 50GHz up):

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1111	--	Harmonic Mixer	FS-Z140	Rohde & Schwarz Messgerätebau GmbH / Memmingen	101004		cal	16.06.2023	16.06.2026
2	--	Harmonic Mixer	FS-Z110	Rohde & Schwarz Messgerätebau GmbH / Memmingen	101468		cal	01.06.2023	01.06.2026
3	--	Harmonic Mixer	FS-Z75	Rohde & Schwarz Messgerätebau GmbH / Memmingen	101022		cal	08.06.2022	08.06.2025
4	--	Signal- and Spectrum Analyzer	Signal- and Spectrum	Rohde & Schwarz Messgerätebau	104023		cal	30.07.2024	30.07.2025

			Analyzer FSW67	GmbH / Memmingen					
5	--	Harmonic Mixer	Harmonic Mixer FS-Z220	RPG-Radiometer Physics GmbH / Meckenheim	101009		cal	24.05.2024	24.05.2027
6	--	Pickett-Potter Horn Antenna	Pickett-Potter Horn Antenna FH-PP 140-220	RPG-Radiometer Physics GmbH / Meckenheim	010011		chk	09.10.2024	09.10.2026
7		Pickett-Potter Horn Antenna	Pickett-Potter Horn Antenna FH-PP 075	RPG-Radiometer Physics GmbH / Meckenheim	10006	P/N: 2581	chk	16.10.2024	16.10.2026
8		Pickett-Potter Horn Antenna	Pickett-Potter Horn Antenna FH-PP 140	RPG-Radiometer Physics GmbH / Meckenheim	10008		chk	09.10.2024	09.10.2026
9		Pickett-Potter Horn Antenna	Pickett-Potter Horn Antenna FH-PP 110	RPG-Radiometer Physics GmbH / Meckenheim	10014		chk	22.03.2024	22.03.2026
10		Entfernungsmesser Zamo	Entfernungsmesser Zamo	Robert Bosch Power Tools GmbH / Stuttgart	421007339		cnn	-/-	-/-

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 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.

8.4 Sequence of testing radiated spurious above 18 GHz

Setup

- The equipment is set up to simulate normal operation mode as described in the user manual or defined by the manufacturer.
- 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.
- The measurement distance is as appropriate (e.g. 0.5 m).
- The EUT is set into operation.

Premeasurement

- The test antenna is handheld and moved carefully over the EUT to cover the EUT's whole sphere and different polarizations of the antenna.

Final measurement

- The final measurement is performed at the position and antenna orientation causing the highest emissions with Peak and RMS detector (as described in ANSI C 63.4).
- Final levels, frequency, measuring time, bandwidth, correction factor, margin to the limit and limit are recorded. A plot with the graph of the premeasurement and the limit is stored.

8.5 Sequence of testing radiated spurious above 50 GHz with external mixers

Setup

- The equipment is set up to simulate normal operation mode as described in the user manual or defined by the manufacturer.
- 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.
- The measurement distance is as appropriate for far field (e.g. 0.25 m).
- The EUT is set into operation.

Premeasurement

- The test antenna with external mixer is handheld and moved carefully over the EUT to cover the EUT's whole sphere and different polarizations of the antenna.
- Caution is taken to reduce the possible overloading of the external mixer.

Final measurement

- The final measurement is performed at the position and antenna orientation causing the highest emissions with Peak and RMS detector (as described in ANSI C 63.4).
- As external mixers may generate false images care is taken to ensure that any emission measured by the spectrum analyzer does indeed originate in the EUT. Signal identification feature of spectrum analyzer is used to eliminate false mixer images (i.e., it is not the fundamental emission or a harmonic falling precisely at the measured frequency).
- Final levels, frequency, measuring time, bandwidth, correction factor, margin to the limit and limit are recorded. A plot with the graph of the premeasurement and the limit is stored.

9 Measurement uncertainty (Essen Lab location)

Issue No.	Measurement type	References	Frequency range of measurement Start [MHz]	Stop [MHz]	Calculated Uncertainty based on confidence level of 95.54%	Remarks
1	Magnetic field strength	EN/FCC/ISED/JP	0,009	30	4,86	Magnetic loop antenna, Pre-amp on
2	RF-Output power (eirp) Unwanted emissions (eirp) [dB]	EN,FCC/ISED, JP	30	100	4,57	without Pre-Amp
			30	100	4,91	with PreAmp
			100	1000	4,02	without Pre-Amp
			100	1000	4,26	with PreAmp
			1000	18000	4,36	without Pre-Amp
			1000	18000	5,23	with PreAmp
			18000	33000	4,92	Schwarzbeck BBHA9170 (#20302) Antenna set-up non-mixer set-up)
			33000	50000	4,17	Set-up for Q-Band (WR-22), non-mixer set-up
			40000	60000	4,69	Set-up U-Band (WR-19), non-mixer set-up
			50000	75000	4,06	External Mixer set-up V-Band (WR-15)
			75000	110000	4,17	External Mixer set-up W-Band (WR-6)
			90000	140000	5,49	External Mixer set-up F-Band (WR-8)
			140000	225000	6,22	External Mixer set-up G-Band (WR-5)
			225000	325000	7,04	External Mixer set-up (WR-3)
			325000	500000	8,84	External Mixer set-up (WR-2.2)
3	Radiated Blocking [dB]	EN	1000	18000	2,85	Typical set-up with microwave generator and antenna, value for 7GHz calculated
			18000	33000	4,66	Typical set-up with microwave generator and antenna
			33000	50000	3,48	WR-22 set-up
			50000	75000	3,73	WR-15 set-up
			75000	110000	4,26	WR-6 set-up
4	Frequency Error UWB/FMCW [kHz]	EN, FCC,JP, ISED	116000	123000	279,87	Calculated for 123GHz carrier (FMCW)
			40000	77000	276,19	calculated for 77 GHz (FMCW) carrier
	Frequency error [Hz]		6000	7000	33,92	calculated for 6.5GHz UWB Ch.5
			11	14	20,76	calculated for 13.56MHz carrier
6	Conducted emissions AC-mains	EN/FCC/ISED	0,009	30	3,57	general EMI-measurements on AC/DC ports

10 Far field consideration for measurements above 18 GHz

Far field distance calculation:

$D_{ff} = 2 \times D^2/\lambda$

with
D_{ff} Far field distance
D Antenna dimension
λ wavelength

Spurious emission measurements:

Spurious emission measurements: OOB and Spurious area					
Antenna frequency range in GHz f_{START} / f_{STOP}	Highest measured frequency in GHz	D in m	λ in m	D_{ff} in m	D_{MEAS} in m
18 / 40	40	0,045	0,0075	0,54	1,0
U-BAND					
40 / 50	50	0,0384	0,006	0,49	1,0
V-BAND					
50 / 75	75	0,03072	0,004	0,47	1.0
W-BAND					
75 / 110	110	0,020757	0,002727273	0,32	1.0
F-BAND					
110 / 140	110	0,016696	0,002142857	0,26	0.50
G-BAND					
140 / 200	200	0,01066	0,0015	0,15	0.25

In-Band measurements:

IN-BAND measurements. OBW, Power					
Antenna frequency range in GHz f_{START} / f_{STOP}	Highest measured frequency in GHz	D in m	λ in m	D_{ff} in m	D_{MEAS} in m
V-BAND					
60,875 / 61,625	61,625	0,03072	0,004868154	0,39	0,5

11 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	FCC 47 CFR Part 15 (dated 2023-08-23) ISED RSS-210 J (Issue 11), RSS-Gen (Issue 5)	see below	2025-05-20	-/-

Test specification clause	Test case	Temperature conditions	Power supply	Pass	Fail	NA	NP	Remark
47 CFR 15.215(b) & (c), 47 CFR 15.255(f) RSS-210 J.2 & J.3, RSS-210 J.6	**Occupied bandwidth & Frequency stability**	Nominal Extreme	Nominal Extreme	☒	☐	☐	☐	complies
47 CFR 15.255(b)(3) & (c) RSS-210 J.3	**Radiated power (EIRP)**	Nominal	Nominal	☒	☐	☐	☐	complies
47 CFR 15.255(c)(2) 47 CFR 15.255(e) RSS-210 J.3.2 & J.3.3	**Peak transmitter conducted output power**	Nominal	Nominal	☐	☐	☒	☐	--
47 CFR 15.255(b)(3), 47 CFR 15.255(c) RSS-210 J.3.2	**Time domain requirements**	Nominal	Nominal	☐	☐	☒	☐	--
47 CFR 15.255(d) RSS-210 J.4	**Spurious emissions radiated**	Nominal	Nominal	☒	☐	☐	☐	complies
47 CFR 15.207 RSS-Gen 8.8	**Conducted emissions < 30 MHz (AC power line)**	Nominal	Nominal	☐	☐	☒	☐	Battery powered equipment

Note: NA = Not applicable; NP = Not performed

12 Additional comments

Reference documents:

- None (or e.g. Document incl. antenna gain information in terms of data sheets and/or test reports (from customer))

Special test descriptions:

- "Program and test instructions for certification_FCC.pdf"

Configuration descriptions:

- None

Test devices (EUT):

- EUT1: The normal operation mode (intended use) is used: none
- EUT2: The below described test mode is used: see chapter 7.1
- EUT3: The below described Stop-Modes are used: none

Associated equipment (AE):

- AE1: Notebook 24-1-00147S11, Lenovo Thinkpad and Python Scripts with JSON settings
- AE2: ST32-Link-01 V2
- ABEL-Programmer-02 (24-1-0147S13)

Normal operation modes (NM):

Abbreviation	Name	Features
NM_1	--	--

Additional test modes: ☐ No test modes available

☒ Special test modes/special software (see description below)

Description of special test modes as declared by customer:

- Cycle-Time reduced to 33ms in order to facilitate measurements. This is considered not a valuable operating mode for certification. It's designated in the test report as TM1-Mode

Details on test mode settings:
According to the customer's instructions, the following steps and commands were used to configure the test modes:

- Long-Range mode: „radar_settings_v5_long_61GHz_Continuous_sampling.json"

Software provided by the manufacturer:

- Python scripts and JSON setting files

13 Basic information of the DUT & selection of applicable rule parts

Basic information of the DUT:

General: see chapter "X Test item"

Operation condition:

☐ Operation on aircraft (47 CFR 15.255(b) / RSS-210 J.2)

- ☐ Unmanned aircraft (47 CFR 15.255(b)(3)) / Unmanned air vehicles (UAVs) (RSS-210 J.2)
- ☐ Not unmanned aircraft

☒ No operation on aircraft

Note: Operation under the provisions of this section is not permitted for equipment used on satellites (47 CFR 15.255(a)).

Note: The devices certified under this annex J are not permitted to be used on satellites (RSS-210 J.2).

Kind of DUT:

☐ Devices other than field disturbance sensors and other than fixed point-to-point transmitters located outdoors

☐ Fixed point-to-point transmitters located outdoors

☒ Field disturbance sensors/radars

- ☐ Pulsed field disturbance sensors/radars
- ☐ Other than pulsed field disturbance sensors/radars

Frequency band:

☐ Operating within band 59.3 – 71.0 GHz (47 CFR 15.255(b)(2)(iii)) (RSS-210 J.2(b)(iv))

☐ Operating within band 60 – 64 GHz (47 CFR 15.255(b)(3)) (RSS-210 J.2(d)(i))

☐ Operating within band 57 – 71 GHz (47 CFR 15.255(c)(1) / (c)(2)) (RSS-210 J.3.2 / J.3.3)

☐ Operating within band 57.0 – 59.4 GHz (47 CFR 15.255(c)(2)(i)) (RSS-210 J.3.2(b)(i))

☐ Operating within band 57.0 – 61.56 GHz (47 CFR 15.255(c)(2)(ii)) (RSS-210 J.3.2(b)(ii))

☒ Operating within band 57 – 64 GHz (47 CFR 15.255(c)(2)(iii) / (c)(3)) (RSS-210 J.3.2(b)(iii) / J.3.2(c))

☒ Operating within band 61.0 – 61.5 GHz (47 CFR 15.255(c)(2)(v)) (RSS-210 J.3.2(a))

Note: See results in chapter 14.1

Selection of applicable rule parts:

Applicable rule parts and limits depend on the basic information of the DUT (see chapter 13).
The comparison of the basic information of the DUT with the rule parts lead to the following conclusions:

Rule Part	Applicable?	
	Yes	No
47 CFR 15.255:		
(a) **General:** Operation under the provisions of this section is not permitted for equipment used on **satellites**.	☒	
(b) **Operation on aircraft:** Operation on aircraft is permitted under the following conditions:	☐	☒
(1) When the aircraft is on the ground.	☐	☐
(2) While airborne, only in closed exclusive on-board communication networks within the aircraft, with the following exceptions:	☐	☐
(i) Equipment shall not be used in wireless avionics intra-communication (WAIC) applications where external structural sensors or external cameras are mounted on the outside of the aircraft structure.	☐	☐
(ii) Except as permitted in paragraph (b)(3) of this section, equipment shall not be used on aircraft where there is little attenuation of RF signals by the body/fuselage of the aircraft.	☐	☐
(iii) **Field disturbance sensor/radar** devices may only operate in the frequency band **59.3–71.0 GHz** while installed in passengers' personal portable electronic equipment (e.g., smartphones, tablets) and shall comply with paragraph (b)(2)(i) of this section, and relevant requirements of paragraphs (c)(2) through (c)(4) of this section.	☐	☐
(3) **Field disturbance sensors/radar** devices deployed on **unmanned aircraft** may operate within the frequency band **60–64 GHz**, provided that the transmitter not exceed 20 dBm peak EIRP. The sum of continuous transmitter off-times of at least two milliseconds shall equal at least 16.5 milliseconds within any contiguous interval of 33 milliseconds. Operation shall be limited to a maximum of 121.92 meters (400 feet) above ground level.	☐	☐
(c) **Radiated power limits:** Within the **57–71 GHz band**, emission levels shall not exceed the following equivalent isotropically radiated power (EIRP):	☐	
(1) **Devices other than field disturbance sensors** shall comply with one of the following power limits, as measured during the transmit interval:	☐	☒
(i) The average power of any emission shall not exceed 40 dBm and the peak power of any emission shall not exceed 43 dBm; or	☐	☒
(ii) For **fixed point-to-point transmitters located outdoors**, the average power of any emission shall not exceed 82 dBm, and shall be reduced by 2 dB for every dB that the antenna gain is less than 51 dBi. The peak power of any emission shall not exceed 85 dBm, and shall be reduced by 2 dB for every dB that the antenna gain is less than 51 dBi.	☐	☒
(A) The provisions in this paragraph (c) for reducing transmit power based on antenna gain shall not require that the power levels be reduced below the limits specified in paragraph (c)(1)(i) of this section.	☐	☐
(B) The provisions of § 15.204(c)(2) and (4) that permit the use of different antennas of the same type and of equal or less directional gain do not apply to intentional radiator systems operating under this provision. In lieu thereof, intentional radiator systems shall be certified using the specific antenna(s) with which the system will be marketed and operated. Compliance testing shall be performed using the highest gain and the lowest gain antennas for which certification is sought and with the intentional radiator operated at its maximum available output power level. The responsible party, as defined in § 2.909 of this chapter, shall supply a list of acceptable antennas with the application for certification.	☐	☐

(2) **Field disturbance sensors/radars** shall not exceed −10 dBm peak conducted output power and 10 dBm peak EIRP except that field disturbance sensors/radars that limit their operation to all or part of the specified frequency band may operate without being subject to a transmitter conducted output power limit if they operate in compliance with paragraph (b)(3) of this section or with one or more of the provisions below:	☒	☐
(i) **57.0–59.4 GHz**: the peak EIRP level shall not exceed 20 dBm for **indoor operation** or 30 dBm for **outdoor operation**;	☐	☒
(ii) **57.0–61.56 GHz**: the peak EIRP shall not exceed 3 dBm except that the peak EIRP shall not exceed 20 dBm if the sum of continuous transmitter off-times of at least two milliseconds equals at least 16.5 milliseconds within any contiguous interval of 33 milliseconds;	☐	☒
(iii) **57.0–64.0 GHz:**	☐	☒
(A) The peak EIRP shall not exceed 14 dBm, and the sum of continuous transmitter off-times of at least two milliseconds shall equal at least 25.5 milliseconds within any contiguous interval of 33 milliseconds, except as specific in paragraph (c)(2)(iii)(B) of this section;	☐	☒
(B) The peak EIRP shall not exceed 20 dBm, and the sum of continuous transmitter off-times of at least two milliseconds shall equal at least 16.5 milliseconds within any contiguous interval of 33 milliseconds when operated outdoors:	☐	☒
(1) As part of a **temporary or permanently fixed application**; or	☐	☒
(2) When being used in **vehicular applications to perform specific tasks of moving something or someone, except for in-cabin applications**;	☐	☒
(iv) A **field disturbance sensor** may operate in any of the modes in the above sub-sections so long as the device operates in only one mode at any time and does so for at least 33 milliseconds before switching to another mode.	☐	☒
(v) **61.0–61.5 GHz:** For **field disturbance sensors/radars** that occupy 500 MHz bandwidth or less that are contained wholly **within the frequency band 61.0–61.5 GHz**, the average power of any emission, measured during the transmit interval, shall not exceed 40 dBm, and the peak power of any emission shall not exceed 43 dBm. In addition, the average power of any emission **outside of the 61.0–61.5 GHz band**, measured during the transmit interval, but still within the 57–71 GHz band, shall not exceed 10 dBm, and the peak power of any emission shall not exceed 13 dBm.	☒	☐
(3) For **pulsed field disturbance sensors/radars** operating in the 57–64 GHz band that have a maximum pulse duration of 6 ns, the average EIRP shall not exceed 13 dBm and the transmit duty cycle shall not exceed 10% during any 0.3 µs time window. In addition, the average integrated EIRP within the frequency band **61.5–64.0 GHz** shall not exceed 5 dBm in any 0.3 µs time window. Peak emissions shall not exceed 20 dB above the maximum permitted average emission limit applicable to the equipment under test. The radar bandwidth is the frequency band bounded by the points that are 10 dB below the highest radiated emission, as based on the complete transmission system including the antenna	☐	☒
(4) The provisions in § 15.35(b) and (c) that require emissions to be averaged over a 100 millisecond period and that limits the peak power to 20 dB above the average limit do not apply to devices operating under paragraphs (c)(2) and (3) of this section.	☒	☐
(d) Limits on spurious emissions:	☒	
(1) The power density of any emissions outside the 57–71 GHz band shall consist solely of spurious emissions.	☒	
(2) Radiated emissions below 40 GHz shall not exceed the general limits in § 15.209.	☒	
(3) Between 40 GHz and 200 GHz, the level of these emissions shall not exceed 90 pW/cm^2 at a distance of 3 meters.	☒	
(4) The levels of the spurious emissions shall not exceed the level of the fundamental emission.	☒	
(e) Limits on transmitter conducted output power.	☐	☒

(1) Except as specified in paragraph (e)(2) of this section, the peak transmitter conducted output power of **devices other than field disturbance sensors/radars** shall not exceed 500 mW. Depending on the gain of the antenna, it may be necessary to operate the intentional radiator using a lower peak transmitter output power in order to comply with the EIRP limits specified in paragraph (c) of this section.	☐	☒
(2) **Devices other than field disturbance sensors/radars** with an emission bandwidth of less than 100 megahertz must limit their peak transmitter conducted output power to the product of 500 mW times their emission bandwidth divided by 100 megahertz. For the purposes of this paragraph, emission bandwidth is defined as the instantaneous frequency range occupied by a steady state radiated signal with modulation, outside which the radiated power spectral density never exceeds 6 dB below the maximum radiated power spectral density in the band, as measured with a 100 kilohertz resolution bandwidth spectrum analyzer. The center frequency must be stationary during the measurement interval, even if not stationary during normal operation (e.g., for frequency hopping devices).	☐	☒
(f) Frequency stability: Fundamental emissions must be contained within the frequency bands specified in this section during all conditions of operation. Equipment is presumed to operate over the temperature range −20 to + 50 degrees Celsius with an input voltage variation of 85% to 115% of rated input voltage, unless justification is presented to demonstrate otherwise.	☒	
(g) Radio frequency radiation exposure: Radio frequency devices operating under the provisions of this part are subject to the radio frequency radiation exposure requirements specified in §§ 1.1307(b), 1.1310, 2.1091, and 2.1093 of this chapter, as appropriate. Applications for equipment authorization of mobile or portable devices operating under this section must contain a statement confirming compliance with these requirements. Technical information showing the basis for this statement must be submitted to the Commission upon request.	☒	
(h) Group installation: Any transmitter that has received the necessary FCC equipment authorization under the rules of this chapter may be mounted in a group installation for simultaneous operation with one or more other transmitter(s) that have received the necessary FCC equipment authorization, without any additional equipment authorization. However, no transmitter operating under the provisions of this section may be equipped with external phase-locking inputs that permit beam-forming arrays to be realized.	☐	
(i) Compliance measurement: Measurement procedures that have been found to be acceptable to the Commission in accordance with § 2.947 of this chapter may be used to demonstrate compliance.	☒	
(1) For purposes of demonstrating compliance with this section, corrections to the transmitter conducted output power may be made due to the antenna and circuit loss.	☒	
(2) Compliance measurements of **frequency-agile field disturbance sensors/radars** shall be performed with any related frequency sweep, step, or hop function activated.	☒	☐
47 CFR 15.215		
(c) Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§ 15.217 through 15.257 and in subpart E of this part, must be designed to ensure that the **20 dB bandwidth of the emission**, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated. In the case of intentional radiators operating under the provisions of subpart E, the emission bandwidth may span across multiple contiguous frequency bands identified in that subpart. The requirement to contain the designated bandwidth of the emission within the specified frequency band includes the effects from frequency sweeping, frequency hopping and other modulation techniques that may be employed as well as the frequency stability of the transmitter over expected variations in temperature and supply voltage. If a frequency stability is not specified in the regulations, it is recommended that the fundamental emission be kept within at least the central 80% of the permitted band in order to minimize the possibility of out-of-band operation.	☒	

47 CFR 15.209	☒	
47 CFR 15.207		
(a) Except as shown in paragraphs (b) and (c) of this section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the table of this paragraph (see chapter 14.6), as measured using a 50 µH/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.	☐	
(c) Measurements to demonstrate compliance with the conducted limits are not required for devices which **only employ battery power** for operation and which do not operate from the AC power lines or contain provisions for operation while connected to the AC power lines. Devices that include, or make provisions for, the use of battery chargers which permit operating while charging, AC adapters or battery eliminators or that connect to the AC power lines indirectly, obtaining their power through another device which is connected to the AC power lines, shall be tested to demonstrate compliance with the conducted limits.	☒	☐

Rule Part	Applicable? Yes	No
RSS-210 J:	☒	
J.2 Restrictions: The devices certified under this annex are not permitted to be used on **satellites**.	☒	
Devices used on **aircraft** are permitted under the following conditions:	☐	☒
(a) Except as allowed in J.2(b), devices are only to be used when the aircraft is on the ground.	☐	☐
(b) Devices used **in-flight** are subject to the following restrictions:	☐	☐
(i) they shall be used within closed, exclusive on-board, communication networks within the aircraft	☐	☐
(ii) they shall not be used in wireless avionics intra-communication (WAIC) applications where external structural sensors or external cameras are mounted on the outside of the aircraft structure	☐	☐
(iii) they shall not be used on aircraft equipped with a body/fuselage that provides little or no RF attenuation except when installed on unmanned air vehicles (UAVs) and complying with J.2(d)	☐	☐
(iv) devices operating in the **59.3-71.0 GHz** band shall not be used except if they meet all of the following conditions: (1) they are FDS (2) they are installed within personal portable electronic devices (3) they comply with the relevant requirements in J.3.2(a), J.3.2(b) and J.3.2(c)	☐	☐
(c) Devices' user manuals shall include text indicating restrictions shown in J.2(a) and J.2(b).	☐	☐
(d) FDS devices deployed on **UAVs** shall comply with all of the following conditions: (i) they operate in the **60-64 GHz band** (ii) the UAVs limit their altitude operation to the regulations established by Transport Canada (e.g. altitudes below 122 metres above ground) (iii) they comply with J.3.2(d)	☐	☐
J.3 Emission limits within the band 57-71 GHz This section specifies the emission limits inside the allocated band.	☒	
J.3.1 General Within the band 57-71 GHz, the power of any emissions shall be measured during the transmission interval and shall comply with the limits in this section. For the purpose of this annex, the terms "average e.i.r.p." and "peak e.i.r.p." refer to e.i.r.p. with transmitter output power measured in terms of average value or peak value, respectively.	☒	
J.3.2 Emission limits for FDS **FDS** devices operating in the 57-71 GHz band shall not exceed −10 dBm peak transmitter conducted output power and 10 dBm peak e.i.r.p. The following exceptions apply:	☐	☐
(a) FDS devices that occupy a **bandwidth of 500 MHz or less** and where this bandwidth is contained wholly within the frequency band **61.0-61.5 GHz** shall comply with the following limits: the equipment shall not exceed 40 dBm average e.i.r.p. and 43 dBm peak e.i.r.p. in the 61.0-61.5 GHz band. In addition, the average and peak e.i.r.p. of any emission outside of the band 61.0-61.5 GHz, but still within the band 57-71 GHz, shall not exceed 10 dBm average e.i.r.p. and 13 dBm peak e.i.r.p.	☒	☐
(b) FDS devices may operate in any mode as indicated in J.3.2(b)(i) and J.3.2(b)(ii), as long as they operate in only one of these modes for at least 33 ms before switching to another mode.	☐	☒
(i) FDS devices operating in the **57.0-59.4 GHz** band shall comply with one of the following limits, depending on the operating condition of the device:	☐	☐
(1) the peak e.i.r.p. shall not exceed 20 dBm for **indoor usage** (devices operating and situated in or designed to be used in, or carried within the interior of a building)	☐	☐

(2) the peak e.i.r.p. for **outdoor usage** (devices operating, situated in, designed to be used in, or carried in open air) shall not exceed 30 dBm	☐	☐
(ii) FDS devices operating in the **57.0-61.56 GHz** band shall have the peak e.i.r.p. not exceeding 3 dBm or, if the sum of continuous transmitter off-times of at least 2 ms equals at least 16.5 ms within any contiguous interval of 33 ms, the peak e.i.r.p. shall not exceed 20 dBm.	☐	☒
(iii) FDS operating in the **57.0-64.0 GHz** band shall comply with one of the following limits, depending on the operating condition of the device:	☐	☒
(1) the peak e.i.r.p. shall not exceed **14 dBm** and the sum of continuous transmitter off-times of at least 2 ms shall equal at least 25.5 ms within any contiguous interval of 33 ms	☐	☒
(2) for devices employed for **outdoor operation** (temporary or permanently fixed application) or vehicular uses (excluding in-cabin applications and operations), the peak e.i.r.p. shall not exceed **20 dBm** and the sum of continuous transmitter off-times of at least 2 ms shall equal at least 16.5 ms within any contiguous interval of 33 ms	☐	☒
(c) For **pulsed FDS** devices operating in the 57-64 GHz band that have a maximum pulse duration of 6 ns:	☐	☒
(i) the average e.i.r.p. shall not exceed 13 dBm and the transmit duty cycle shall not exceed 10% during any 0.3 µs time window	☐	☐
(ii) the average integrated e.i.r.p. within the 61.5-64.0 GHz band shall not exceed 5 dBm in any 0.3 µs time window	☐	☐
(iii) peak emissions shall not exceed 20 dB above the maximum permitted average emission limit applicable to the device	☐	☐
(iv) the bandwidth is the frequency band bounded by the points that are 10 dB below the highest radiated emission, as based on the complete transmission system including the antenna	☐	☐
(v) For FDS devices **installed on UAVs**, their peak e.i.r.p. shall not exceed 20 dBm and the sum of continuous transmitter off-times of at least 2 ms shall equal at least 16.5 ms within any contiguous interval of 33 ms. See also J.2(d).	☐	☐
J.3.3 Emission limits for devices other than FDS Following are the conditions for devices other than FDS:	☐	☒
(a) Except when J.3.3(b) applies, the average e.i.r.p. of any emission shall not exceed 40 dBm and the peak e.i.r.p. of any emission shall not exceed 43 dBm.	☐	☐
(b) For **fixed point-to-point equipment located outdoors**:	☐	☐
(i) The average e.i.r.p. of any emission shall not exceed 82 dBm minus 2 dB for every dB the antenna gain is less than 51 dBi. The peak e.i.r.p. of any emission shall not exceed 85 dBm minus 2 dB for every dB the antenna gain is less than 51 dBi.	☐	☐
(ii) The provisions for reducing the transmit power based on the antenna gain, as per J.3.3(b)(i), shall not require that the power levels be reduced below the limits specified in J.3.3(a).	☐	☐
(iii) Compliance testing shall be performed using the highest gain and the lowest gain antennas with which the equipment is certified. Further, this equipment shall not be marketed and operated with antennas other than those listed in the certification application with which the equipment is certified.	☐	☐
(c) Except as specified in J.3.3(d), the peak transmitter conducted output power shall not exceed 500 mW. Depending on the gain of the antenna, it may be necessary to operate the intentional radiator using a lower peak transmitter output power in order to comply with the e.i.r.p. limits specified in J.3.3(a) and J.3.3(b).	☐	☐
(d) For devices with an **emission bandwidth less than 100 MHz**, the peak transmitter conducted output power (PTCOP) shall be less than or equal to the product of 500 mW times their emission bandwidth divided by 100 MHz. For the purpose of J.3.3(d), emission bandwidth is the instantaneous frequency range occupied by a steady radiated signal with modulation, outside which the radiated power spectral density is 6 dB below the maximum radiated power spectral density in the band, as measured	☐	☐

with a 100 kHz resolution bandwidth. The centre frequency shall be stationary during the measurement interval, even if not stationary during normal operation (e.g. for frequency hopping devices).		
J.4 Spurious emissions Any emissions outside the band 57-71 GHz shall consist solely of spurious emissions and shall not exceed: (a) the fundamental emission levels (b) the general field strength limits specified in RSS-Gen, General Requirements for Compliance of Radio Apparatus, for emissions below 40 GHz (c) the general field strength limits specified in RSS-Gen, General Requirements for Compliance of Radio Apparatus, for emissions below 40 GHz	☒	
J.5 Measurement requirements Following are the measurement requirements for emissions:	☒	
(a) Emissions shall be measured up to 200 GHz.	☒	
(b) **Conducted measurement** for emissions above 40 GHz are permitted provided the antenna characteristics can be determined accurately.	☐	☐
(c) Compliance measurements of **frequency-agile FDS** shall be performed with any related frequency sweep, step, or hop function activated.	☒	☐
(d) Corrections to the **transmitter conducted output power** may be considered due to the antenna and cabling loss.	☐	☒
(e) The provisions of RSS-Gen requiring the application of a peak limit that is 20 dB above the average limit shall not apply to devices subject to **J.3.2(a) and J.3.2(b).**	☒	☐
(a) The provisions of RSS-Gen requiring averaging over a time interval of 0.1 seconds shall not apply to devices subject to **J.3.2(a), J.3.2(b) and J.3.2(c).**	☒	☐
J.6 Transmitter frequency stability Fundamental emissions shall be contained within the frequency bands specified in this annex during all conditions of operation when tested at the temperature and voltage variations specified for the frequency stability measurement in RSS-Gen.	☒	
J.7 Group installations Any transmitter that is certified under this annex may be mounted in a group installation for simultaneous operation with one or more certified transmitters, without any additional equipment authorization. However, no transmitter operating under the provisions of this annex shall be equipped with external phase-locking inputs that permit beam-forming arrays to be realized.	☐	
RSS-Gen	☒	
6.7 Occupied bandwidth (or 99% emission bandwidth) and x dB bandwidth The occupied bandwidth or the "99% emission bandwidth" is defined as the frequency range between two points, one above and the other below the carrier frequency, within which 99% of the total transmitted power of the fundamental transmitted emission is contained. The occupied bandwidth shall be reported for all equipment in addition to the specified bandwidth required in the applicable RSSs. […]	☒	
8.8 AC power-line conducted emissions limits Unless stated otherwise in the applicable RSS, **for radio apparatus that are designed to be connected to the public utility AC power network**, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the range 150 kHz to 30 MHz shall not exceed the limits in table 4, as measured using a 50 µH / 50 Ω line impedance stabilization network. […]	☐	
8.9 Transmitter emission limits	☒	

14 Measurement results

14.1 Occupied bandwidth & emission bandwidth & frequency stability

Description:

Measurement of the bandwidth and the frequency stability of the wanted signal (fundamental emission) under temperature and supply voltage variations.

Limits and provisions:

Selection of applicable rule parts: see 13

Bandwidth & Applicable limits of designated frequency band			
Applicable	**Rule part**	**Method of bandwidth measurement**	**Limit of designated frequency band**
☐	15.255(b)(2)(iii) RSS-210 J.3.2(b)(iv)	20 dB bandwidth or 99% bandwidth 99% bandwidth	59.3 - 71.0 GHz
☐	15.255(b)(3) RSS-210 J.2(d)(i)	20 dB bandwidth or 99% bandwidth 99% bandwidth	60 - 64 GHz
☐	15.255(c)(1)(i) RSS-210 J.3.3(a)	20 dB bandwidth or 99% bandwidth 99% bandwidth	57 - 71 GHz
☐	15.255(c)(1)(ii) RSS-210 J.3.3(b)	20 dB bandwidth or 99% bandwidth 99% bandwidth	57 - 71 GHz
☐	15.255(c)(2) RSS-210 J.3.2	20 dB bandwidth or 99% bandwidth 99% bandwidth	57 - 71 GHz
☐	15.255(c)(2)(i) RSS-210 J.3.2(b)(i)	20 dB bandwidth or 99% bandwidth 99% bandwidth	57.0 - 59.4 GHz
☐	15.255(c)(2)(ii) RSS-210 J.3.2(b)(ii)	20 dB bandwidth or 99% bandwidth 99% bandwidth	57.0 - 61.56 GHz
☐	15.255(c)(2)(iii) RSS-210 J.3.2(b)(iii)	20 dB bandwidth or 99% bandwidth 99% bandwidth	57.0 - 64.0 GHz
☒	15.255(c)(2)(v) RSS-210 J.3.2(a)	20 dB bandwidth or 99% bandwidth 99% bandwidth	61.0 - 61.5 GHz
☐	15.255(c)(3) RSS-210 J.3.2(c)	10 dB bandwidth	57 - 64 GHz
☐	15.255(e)(2) RSS-210 J.3.3(d)	6 dB emission bandwidth (EBW_{6dB})	None (required for calculation in chapter 14.3)

Note:

- Definition of 6dB emission bandwidth (15.255(e)(2)): the instantaneous frequency range occupied by a steady state radiated signal with modulation, outside which the radiated power spectral density never exceeds 6 dB below the maximum radiated power spectral density in the band, as measured with a 100 kilohertz resolution bandwidth spectrum analyzer. The center frequency must be stationary during the measurement interval, even if not stationary during normal operation (e.g., for frequency hopping devices).
- Definition of 6dB emission bandwidth (RSS-210 J.3.3(d)): the instantaneous frequency range occupied by a steady radiated signal with modulation, outside which the radiated power spectral density is 6 dB below the maximum radiated power spectral density in the band, as measured with a 100 kHz resolution bandwidth. The centre frequency shall be stationary during the measurement interval, even if not stationary during normal operation (e.g. for frequency hopping devices).

Measurement:

Measurement parameter	
Detector:	Pos-Peak
Resolution bandwidth:	1 MHz
Video bandwidth:	3 MHz
Trace-Mode:	Max Hold

Measurement procedures:

- Bandwidth: ANSI C63.10-2020 6.9 / 9.3 / 9.4
- Frequency stability: ANSI C63.10-2020 6.8 / 9.5

Measurement results:

99% bandwidth at normal conditions:

EUT	Mode	Test condition	f_L [GHz]	f_H [GHz]	Bandwidth [MHz]
2	TM1	T_{nom} / V_{nom}	61.004	61.495	490.935

Frequency stability (15.255(f) / RSS-210 J.6):

Mode for frequency stability tests: TM1 (Mode with the widest bandwidth, ANSI C63.10-2020 5.6.2.2)

Bandwidth measurement for frequency stability tests: 99% bandwidth

Test condition	Frequency f_L [GHz]	Frequency f_H [GHz]	Bandwidth [MHz]
-20 °C / V_{nom}	61.005	61.496	490.838
-10 °C / V_{nom}	61.005	61.496	490.714
0 °C / V_{nom}	61.005	61.495	490.451
10 °C / V_{nom}	61.005	61.495	490.580
20 °C / $V_{nom = 3.3V DC}$	61.004	61.495	490.935
20 °C / $V_{min = 3.6V}$ DC	61.004	61.495	490.835
20 °C / $V_{max=3.8V DC}$	61.004	61.495	490.752
30 °C / V_{nom}	61.004	61.495	490.625
40 °C / V_{nom}	61.004	61.494	490.633
50 °C / V_{nom}	61.004	61.495	490.575

Note:

- Detailed measurement results: see measurement report 24-1-0014701T010_TR1-A201-R01, Chapter 1.3

Verdict: Compliant

14.2 Radiated power (EIRP)

Description:

Measurement of the maximum radiated E.I.R.P. of the wanted signal.

Limits and provisions:

Selection of applicable rule parts: see 13

Applicable limits of radiated power (EIRP)			
Applicable	**Rule part**	**Limit average EIRP**	**Limit peak EIRP**
☐	15.255(b)(3) RSS-210 J.3.2(a)	none	20 dBm
☐	15.255(c)(1)(i) RSS-210 J.3.3(a)	40 dBm (see note 1)	43 dBm
☐	15.255(c)(1)(ii) RSS-210 J.3.3(b)	Calculation depending on EUT antenna gain (see note 1, 2.1 & 2.3)	Depending on EUT antenna gain (see note 1, 2.2 & 2.3)
☐	15.255(c)(2) RSS-210 J.3.2	none	10 dBm
☐	15.255(c)(2)(i) RSS-210 J.3.2(b)(i)	none	20 dBm (indoor) 30 dBm (outdoor)
☐	15.255(c)(2)(ii) RSS-210 J.3.2(b)(ii)	none	3 dBm (general) 20 dBm (+ off-time requirement)
☐	15.255(c)(2)(iii)(A) RSS-210 J.3.2(b)(iii)(1)	none	14 dBm (+ off-time requirement)
☐	15.255(c)(2)(iii)(B) RSS-210 J.3.2(b)(iii)(2)	none	20 dBm (+ off-time requirement)
☒	**15.255(c)(2)(v) RSS-210 J.3.2(a)**	**40 dBm (within 61-61.5 GHz) (see note 1)** **10 dBm (outside 61-61.5 GHz, but within 57-71GHz) (see note 1)**	**43 dBm (within 61.0-61.5 GHz)** **13 dBm (outside 61-61.5 GHz, but within 57-71GHz)**
☐	15.255(c)(3) RSS-210 J.3.2(c)	13 dBm (average EIRP during any 0.3 µs time window) (+ time domain requirement) 5 dBm (average integrated EIRP within 61.5–64.0 GHz in any 0.3 µs time window)	applicable average limit + 20 dB

Note:

1. Measured during the transmit interval
2. Calculation depending on EUT antenna gain:
   - 2.1. The average power of any emission shall not exceed 82 dBm, and shall be reduced by 2 dB for every dB that the antenna gain is less than 51 dBi.
   - 2.2. The peak power of any emission shall not exceed 85 dBm, and shall be reduced by 2 dB for every dB that the antenna gain is less than 51 dBi.
   - 2.3. Reducing the transmit power based on the antenna gain shall not require that the power levels be reduced below the limits specified in 15.255(c)(1)(i)/J.3.3(a).

Calculation of limit (depending on EUT antenna gain G_{EUT}, if G_{EUT} < 51 dBi):

- EUT antenna gain G_{EUT}
- Limit average EIRP = (82 – 2(51-G_{EUT})) dBm
- Limit peak EIRP = (85 – 2(51-G_{EUT})) dBm

Measurement:

Spectrum analyzer:

Measurement parameter		
Detector:	Pos-Peak	RMS
Resolution bandwidth:	50 MHz	1 MHz
Video bandwidth:	80 MHz	3 MHz
Trace-Mode:	Max Hold	Max-Hold + Channel power function

Measurement procedures:

- Fundamental emission using a spectrum analyzer: ANSI C63.10-2020 9.8

Measurement results In-Band (61-61.5GHz)::

Parameter		Measurement result				Limit
		EUT 2				
		TM1	--	--	--	dBm
Peak EIRP ($P_{Peak,EIRP}$)	[dBm]	31.29	-/-	-/-	-/-	43
Average EIRP during whole cycle time ($P_{avg\text{-}cycle}$)	[dBm]	27.02	-/-	-/-	-/-	40
Correction due Operational Duty-Cycle (note 2+3)	[dB]	2.52	-/-	-/-	-/-	--
Average EIRP during transmit intervall ($P_{avg\text{-}TX}$)	[dBm]	29.54	-/-	-/-	-/-	40

Notes:

1. Test conditions: T_{nom} / V_{nom} and both measurement antenna polarisations
2. Details about calculations see annex 201, chapter 1.1
3. Detailed measurement results: see measurement report 24-1-0014701T010_TR1-A201-R01

Measurement results Outside Band 61-61.5GHz but inside 57-71GHz:

Diagram no.	Channel no.	Frequency of channel [GHz]	Op.Mode	Frequency range of measurement	Measured emission value			Limits EIRP [dBm]		Margin [dB]		Verdict
					Frequency [GHz]	Value PK [dBm]	AV Value [dBm]	PK	AV	PK	AV	
TID007a_01 (PK) TID007a_02 (AV)	Nominal	61,25	TM1	57-61 GHz	60,99	-7,10	-4,11	13	10	20,10	14,11	Passed
TID007a_03 (PK) TID007a_04 (AV)	Nominal	61,25	TM1	61.5-71 GHz	61,50	-9,00	0,16	13	10	22,00	9,84	Passed
TID007b_04 (PK) TID007b_05 (AV)	Nominal	61,25	TM1	57-61 GHz	60,9900	11,27	-3,34	13	10	1,73	13,34	Passed
TID007b_06 (PK) TID007b_07 (AV)	Nominal	61,25	TM1	61.5 -71 GHz	61,5000	10,51	0,39	13	10	2,49	9,61	Passed

Notes:

4. Test conditions: T_{nom} / V_{nom} and both measurement antenna polarisations
5. Detailed measurement results: see measurement report 24-1-0014701T010_TR1-A201-R01
6. For average value, channel power function was used with proper settings for integration bandwidth. For details pls. check corresponding diagram.

Verdict: Compliant

14.3 Peak transmitter conducted output power

Description:

Measurement or calculation of the transmitter conducted output power.

Limits and provisions:

Selection of applicable rule parts: see 13

Applicable limits of peak transmitter conducted output power		
Applicable	**Rule part**	**Limit peak transmitter conducted output power**
☐	15.255(c)(2) RSS-210 J.3.2	-10 dBm
☐	15.255(e)(1) RSS-210 J.3.3(c)	500 mW
☐	15.255(e)(2) RSS-210 J.3.3(d)	500 mW * (EBW_{6dB}/100 MHz)
☒	other	none

Note:

- EBW_{6dB} (6 dB emission bandwidth): see chapter 14.1

Results: --

Note: For this Rule Part not applicable

Verdict: N/A

14.4 Time domain requirements: Continuous transmitter off-times & transmit duty cycle

Description:

Measurement of the time domain parameter.

Limits and provisions:

Selection of applicable rule parts: see 13

Applicable time domain requirements		
Applicable	**Rule part**	**Time domain requirement**
☐	15.255(b)(3) RSS- 210 J.3.2(d)	sum of continuous transmitter off-times of at least two milliseconds shall equal at least 16.5 milliseconds within any contiguous interval of 33 milliseconds
☐	15.255(c)(2)(ii) RSS- 210 J.3.2(b)(ii)	Peak EIRP ≤ 3 dBm: none
		Peak EIRP ≤ 20 dBm: sum of continuous transmitter off-times of at least two milliseconds equals at least 16.5 milliseconds within any contiguous interval of 33 milliseconds
☐	15.255(c)(2)(iii)(A) RSS- 210 J.3.2(b)(iii)(1)	sum of continuous transmitter off-times of at least two milliseconds shall equal at least 25.5 milliseconds within any contiguous interval of 33 milliseconds
☐	15.255(c)(2)(iii)(B) RSS- 210 J.3.2(b)(iii)(2)	sum of continuous transmitter off-times of at least two milliseconds shall equal at least 16.5 milliseconds within any contiguous interval of 33 milliseconds
☐	15.255(c)(3) RSS- 210 J.3.2(c)	maximum pulse duration of 6 ns; transmit duty cycle shall not exceed 10% during any 0.3 µs time window
☒	other	none

Note:

- Continuous transmitter off-times:
  Off-times are only taken into account if they are larger than the specified minimum value (e.g. 2 ms).
  Off-times smaller than the specified minimum value are not considered when checking the specified limit (e.g. "at least 25.5 ms within any contiguous interval of 33 ms").

Measurement:

Measurement parameter	
Detector:	Pos-Peak (RF-Detector)
Video bandwidth:	Video bandwidth:

Measurement results: not applicable for rule part where EUT operates

Verdict: N/A

14.5 Spurious emissions radiated

Description:

Measurement of the radiated spurious emissions.

Limits and provisions:

Selection of applicable rule parts: see 13

47CFR Part 15.209(a) RSS-Gen 8.9		
Frequency (MHz)	Field strength (microvolts/meter) Magnetic field strength (H-Field) (µA/m)	Measurement distance (meters)
0.009 – 0.490	2400/F(kHz) 6.37/F (F in kHz)	300
0.490 – 1.705	24000/F(kHz) 63.7/F (F in kHz)	30
1.705 – 30.0	30 0.08	30
Frequency (MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
30 – 88	100	3
88 – 216	150	3
216 – 960	200	3
Above 960	500	3
47 CFR 15.255(d) RSS-210 J.4		
Frequency (GHz)	Power density [pW/cm2]	Equivalent isotropically radiated power: EIRP [dBm]
Below 40	See §15.209 See RSS-Gen 8.9	-/-
40 - 200	90 @ distance of 3 m	-10
The power density of any emissions outside the 57-71 GHz band shall consist solely of spurious emissions.		
The levels of the spurious emissions shall not exceed the level of the fundamental emission.		
47 CFR 15.255(i)(2) RSS-210 J.5(c)		
Compliance measurements of frequency-agile field disturbance sensors/radars shall be performed with any related frequency sweep, step, or hop function activated.		
47 CFR 15.33(a)(3)		
If the intentional radiator operates at or above 30 GHz: to the fifth harmonic of the highest fundamental frequency or to 200 GHz, whichever is lower, unless specified otherwise elsewhere in the rules.		
RSS-210 J.5(a)		

Emissions shall be measured up to 200 GHz.

Limit conversion (ANSI C63.10-2020 9.2.3):

EIRP[dBm] = 10 × log(4 × π × d² × 1000 × PD[W/m²])

- Power density at the distance specified by the limit: PD [W/m²]
- Equivalent isotropically radiated power: EIRP [dBm]
- Distance at which the power density limit is specified: d [m]

According to this formula, an emission limit of PD = 90 pW/cm² at a distance of d = 3 m corresponds to an equivalent isotropically radiated power of EIRP = -10 dBm.

Measurement parameter for range above 30MHz:

Measurement parameter	
Detector:	Quasi Peak / Pos-Peak / RMS
Resolution bandwidth:	F < 1 GHz: 100 kHz F > 1 GHz: 1 MHz
Video bandwidth:	F < 1 GHz: 300 kHz F > 1 GHz: 3 MHz
Trace-Mode:	Max Hold

14.5.1 Measurement results frequency range 9kHz to 30MHz

Diagram no.	Channel no.	Frequency of channel [GHz]	Op.Mode	Frequency range of measurement	Measured emission value			Limits [dBµV/m]			Margin [dB]			Verdict
					Frequency (as Frequency-range left)	Value PK/QP [dBuV/m]	AV Value [dBuV/m]	QP	PK	AV	QP	PK	AV	
TID015_01	Nominal	61.25	TM1	**9 - 90 kHz**	16,92	--	22,83	--	--	43,01	--	--	20,18	Passed
	Nominal	61.25	TM1	90 - 110 kHz	110,00	-42,50	--	26,8			69,3	69,3	--	Passed
	Nominal	61.25	TM1	**110 - 490 kHz**	490,00	--	-30,00	--	--	13,78	--	--	43,78	Passed
	Nominal	61.25	TM1	490 - 1705 kHz	1705,00	0,83	--	22,9	--	--	22,1	22,1	--	Passed
	Nominal	61,25	TM1	1.705 - 30 MHz	22,84	20,25	--	29,6	--	--	9,3	9,3	--	Passed

Remark: EUT standing axis

Diagram no.	Channel no.	Frequency of channel [GHz]	Op.Mode	Frequency range of measurement	Measured emission value			Limits [dBµV/m]			Margin [dB]			Verdict
					Frequency (as Frequency-range left)	Value PK/QP [dBuV/m]	AV Value [dBuV/m]	QP	PK	AV	QP	PK	AV	
TID015_02	Nominal	61.25	TM1	**9 - 90 kHz**	17,08	--	-23,66	--	--	42,93	--	--	66,59	Passed
	Nominal	61.25	TM1	90 - 110 kHz	110,00	-40,00	--	26,8			66,8	66,8	--	Passed
	Nominal	61.25	TM1	**110 - 490 kHz**	490,00	--	-30,00	--	--	13,78	--	--	43,78	Passed
	Nominal	61.25	TM1	490 - 1705 kHz	1705,00	2,50	--	22,9	--	--	20,4	20,4	--	Passed
	Nominal	61,25	TM1	1.705 - 30 MHz	21,08	19,52	--	29,6	--	--	10,0	10,0	--	Passed

Remark: EUT laying axis

14.5.2 Measurement results frequency range 30MHz to 1GHz

Diagram no.	Channel no.	Frequency of channel [GHz]	Op.Mode	Frequency range of measurement	Measured emission value			Limits [dBµV/m]			Margin [dB]			Verdict
					Frequency [MHz]	Value PK/QP [dBuV/m]	AV Value [dBuV/m]	QP	PK	AV	QP	PK	AV	
TID014_01	Nominal	61.25	TM1	30 - 88 MHz	47,11	24,12	--	40,0	--	--	15,9	--	--	Passed
	Nominal	61,25	TM1	88 - 216 MHz	106,32	39,81	--	43,5	--	--	3,7	--	--	Passed
	Nominal	61,25	TM1	216 - 960 MHz	460,26	39,96	--	46,0	--	--	6,0	--	--	Passed
	Nominal	61,25	TM1	960M - 1GHz	--	31,00	--	54,0	--	--	23,0	--	--	Passed
Remark: pls. see diagrams in annex 201														

Remark: EUT standing axis

Diagram no.	Channel no.	Frequency of channel [GHz]	Op.Mode	Frequency range of measurement	Measured emission value			Limits [dBµV/m]			Margin [dB]			Verdict
					Frequency [MHz]	Value PK/QP [dBuV/m]	AV Value [dBuV/m]	QP	PK	AV	QP	PK	AV	
TID014_02	Nominal	61.25	TM1	30 - 88 MHz	--	27,00	--	40,0	--	--	13,0	--	--	Passed
	Nominal	61,25	TM1	88 - 216 MHz	121,41	43,48	--	43,5	--	--	0,02	--	--	Passed
	Nominal	61,25	TM1	216 - 960 MHz	459,51	41,50	--	46,0	--	--	4,5	--	--	Passed
	Nominal	61,25	TM1	960M - 1GHz	--	28,00	--	54,0	--	--	26,0	--	--	Passed
Remark: pls. see diagrams in annex 201														

Remark: EUT laying axis

14.5.3 Measurement results frequency range 1GHz to 40GHz

Diagram no.	Channel no.	Frequency of channel [GHz]	Op.Mode	Frequency range of measurement	Measured emission value			Limits [dBµV/m]			Margin [dB]			Verdict
					Frequency [GHz]	Value PK/QP [dBuV/m]	AV Value [dBuV/m]	QP	PK	AV	QP	PK	AV	
TID016a_01	Nominal	61,25	TM1	1 - 12.4 GHz	--	61,52	47,65	--	74	54	--	12,48	6,35	Passed
TID016b_01 TID016b_03		61,25	TM1		2,40	46,19	34,83	--	74	54	--	27,81	19,17	Passed
TID017a_04 TID017a_06	Nominal	61,25	TM1	12.4 -18 GHz	14,40	58,39	49,95	--	74	54	--	15,61	4,05	Passed
TID017b_01 TID017b_03		61,25	TM1		14,40	58,26	49,62	--	74	54	--	15,74	4,38	Passed
TID013a TID013a_02	Nominal	61,25	TM1	18 - 30GHz	28,80	55,41	48,94	--	74	54	--	18,59	5,06	Passed
TID013b TID013b_04		61,25	TM1		28,80	58,80	49,17	--	74	54	--	15,20	4,83	Passed
TID012a	Nominal	61,25	TM1	30 - 40 GHz	38,85	60,56	47,09	--	74	54	--	13,44	6,91	Passed
TID012b		61,25	TM1		38,72	61,41	47,18	--	74	54	--	12,59	6,82	Passed

Remark: pls. see diagrams in annex 201

14.5.4 Measurement results frequency range 40GHz to 200GHz

Diagram no.	Channel no.	Frequency of channel [GHz]	Op.Mode	Frequency range of measurement	Measured emission value		Limit [dBm]	Margin [dB]	Verdict
					Frequency [GHz]	RMS Value [dBm]			
TID011a	Nominal	61,25	TM1	40 - 50 GHz	--	-34,71	-10	24,71	Passed
TID011b		61,25	TM1		--	-34,68	-10	24,68	Passed
TID007a	Nominal	61,25	TM1	50 - 75 GHz	--	-31,00	-10	21,00	Passed
TID007b + TID007b_01 to_03		61,25	TM1		--	-29,50	-10	19,50	Passed
TID008a	Nominal	61,25	TM1	75 -110 GHz	--	-32,36	-10	22,36	Passed
TID008b TID008b_01		61,25	TM1		--	-29,45	-10	19,45	Passed
TID009a	Nominal	61,25	TM1	110 - 140 GHz	--	-22,41	-10	12,41	Passed
TID009b		61,25	TM1		--	-22,40	-10	12,40	Passed
TID010a	Nominal	61,25	TM1	140 - 200 GHz	--	-20,31	-10	10,31	Passed
TID010b		61,25	TM1		--	-20,25	-10	10,25	Passed

Remark: pls. see diagrams in annex 201

Verdict: Compliant

14.6 Conducted emissions < 30 MHz (AC power line)

Description:

Measurement of the conducted spurious emissions in transmit mode below 30 MHz. Both power lines, phase and neutral line, are measured. Found peaks are re-measured with average and quasi peak detection to show compliance to the limits.

Limits and provisions:

Selection of applicable rule parts: see 13

47 CFR 15.207(a) RSS-Gen 8.8		
Frequency of emission (MHz)	**Conducted limit (dBµV)**	
	Quasi-peak	**Average**
0.15 – 0.5	66 to 56*	56 to 46*
0.5 – 5	56	46
5 – 30	60	50

* Decreases with the logarithm of the frequency

Measurement:

Parameter	
Detector:	Peak - Quasi Peak / Average
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

Measurement results:

The device only employs battery power for operation (as declared by manufacturer).
DC wires has been soldered just to establish a stable power source during long duration emission tests.

Verdict: Not applicable

15 Glossary

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

16 Document history

Version	Applied changes	Date of release
-/-	Initial release	2025-05-14

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