
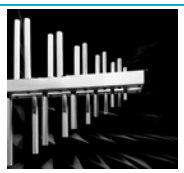
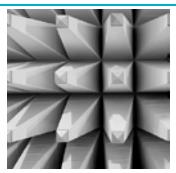

CTC advanced
member of RWTÜV group

Bundesnetzagentur

BNetzA-CAB-02/21-102

TEST REPORT

Test report no.: 1-0596/20-01-08-A

Testing laboratory

CTC advanced GmbH
Untertuerkheimer Strasse 6 – 10
66117 Saarbruecken / Germany
Phone: + 49 681 5 98 - 0
Fax: + 49 681 5 98 - 9075
Internet: https://www.ctcadvanced.com
e-mail: mail@ctcadvanced.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 starting with the registration number: D-PL-12076-01.

Applicant

m&h Inprocess Messtechnik GmbH
Am Langholz 11
88289 Waldburg / GERMANY
Phone: -/-
Contact: Max Schweigert
e-mail: max.schweigert@hexagon.com

Manufacturer

m&h Inprocess Messtechnik GmbH
Am Langholz 11
88289 Waldburg / GERMANY

Test standard/s

FCC - Title 47 CFR Part 15	FCC - Title 47 of the Code of Federal Regulations; Chapter I; Part 15 - Radio frequency devices
RSS - 247 Issue 2	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence - Exempt Local Area Network (LE-LAN) Devices

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

Test Item

Kind of test item:	**Radio Wave Probe**
Model name:	**LS-R-4.8**
FCC ID:	**MFFLSR48**
IC:	**5782A-LSR48**
Frequency:	UNII band I: 5150 MHz to 5250 MHz
Technology tested:	WLAN
Antenna:	Integrated antenna
Power supply:	14.8 V DC by battery (4x IMR26650)
Temperature range:	+10°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:

cn=Michael Dorongovski, o=CTC Advanced GmbH, ou=RCE-201118, email=Michael.Dorongovski@ctcadvanced.com, c=DE
2021.03.25 16:44:07 +01'00'

Michael Dorongovski
Lab Manager
Radio Communications

Test performed:

p.o.

cn=David Lang, o=CTC advanced GmbH, ou=LNG-161129, email=david.lang@ctcadvanced.com, c=DE
2021.03.25 17:05:59 +01'00'

Andreas Kurzkurt
Testing 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. CTC 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 1-0596/20-01-08 and dated 2021-03-03.

2.2 Application details

Date of receipt of order:	2020-10-13
Date of receipt of test item:	2021-02-01
Start of test:*	2021-02-15
End of test:*	2021-02-23
Person(s) present during the test:	-/-

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

2.3 Test laboratories sub-contracted

None

3 Test standard/s, references and accreditations

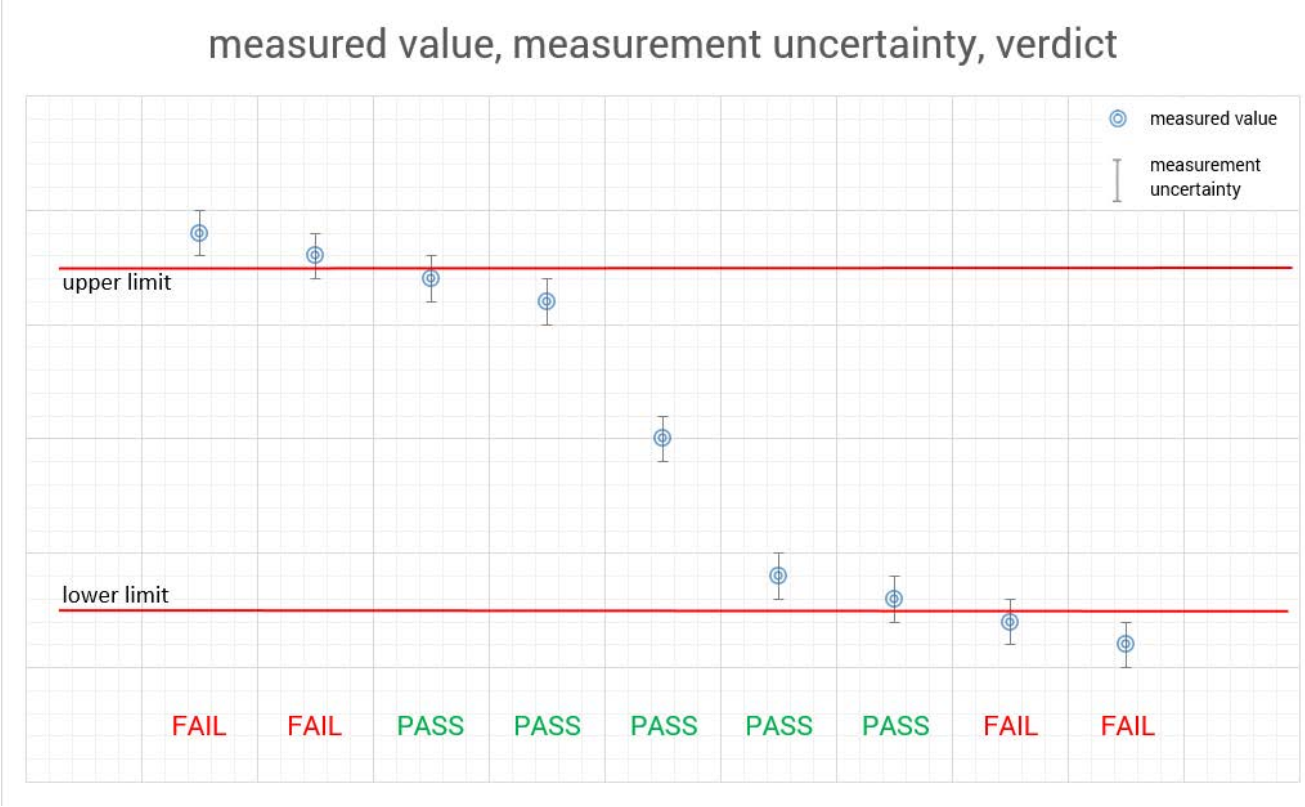
Test standard	Date	Description
FCC - Title 47 CFR Part 15		FCC - Title 47 of the Code of Federal Regulations; Chapter I; Part 15 - Radio frequency devices
RSS - 247 Issue 2	February 2017	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence - Exempt Local Area Network (LE-LAN) Devices
RSS - Gen Issue 5 incl. Amendment 1	March 2019	Spectrum Management and Telecommunications Radio Standards Specification - General Requirements for Compliance of Radio Apparatus

Guidance	Version	Description
KDB 789033 D02	v02r01	Guidelines for Compliance Testing of Unlicensed National Information Infrastructure (U-NII) Devices - Part 15, Subpart E
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 C63.10-2013	-/-	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

Accreditation	Description
D-PL-12076-01-04	Telecommunication and EMC Canada https://www.dakks.de/as/ast/d/D-PL-12076-01-04e.pdf
D-PL-12076-01-05	Telecommunication FCC requirements https://www.dakks.de/as/ast/d/D-PL-12076-01-05e.pdf

4 Reporting statements of conformity – decision rule

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



5 Test environment

Temperature	:	T_{nom} T_{max} T_{min}	22 °C during room temperature tests No tests under extreme temperature conditions required No tests under extreme temperature conditions required
Relative humidity content	:		35 %
Barometric pressure	:		Not relevant for this kind of testing
Power supply	:	V_{nom} V_{max} V_{min}	14.8 V DC by battery (4x IMR26650) No tests under extreme voltage conditions required No tests under extreme voltage conditions required

6 Test item

6.1 General description

Kind of test item	:	Radio Wave Probe
Model name	:	LS-R-4.8
HMN	:	-/-
PMN	:	LS-R-4.8
HVIN	:	02
FVIN	:	-/-
S/N serial number	:	Rad. 40001 Cond. Lantronix Evaluation board S/N 0080A3889072
Hardware status	:	0
Software status	:	1.0
Firmware status	:	1.0
Frequency band	:	UNII band I: 5150 MHz to 5250 MHz
Type of radio transmission Use of frequency spectrum	: :	OFDM
Type of modulation	:	CCK, (D)BPSK, (D)QPSK, 16 – QAM, 64 – QAM
Number of channels	:	4 with 20 MHz channel bandwidth
Antenna	:	Integrated antenna
Power supply	:	14.8 V DC by battery (4x IMR26650)
Temperature range	:	+10°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: 1-0596/20-01-01_AnnexA
1-0596/20-01-01_AnnexD

7 Description of the test setup

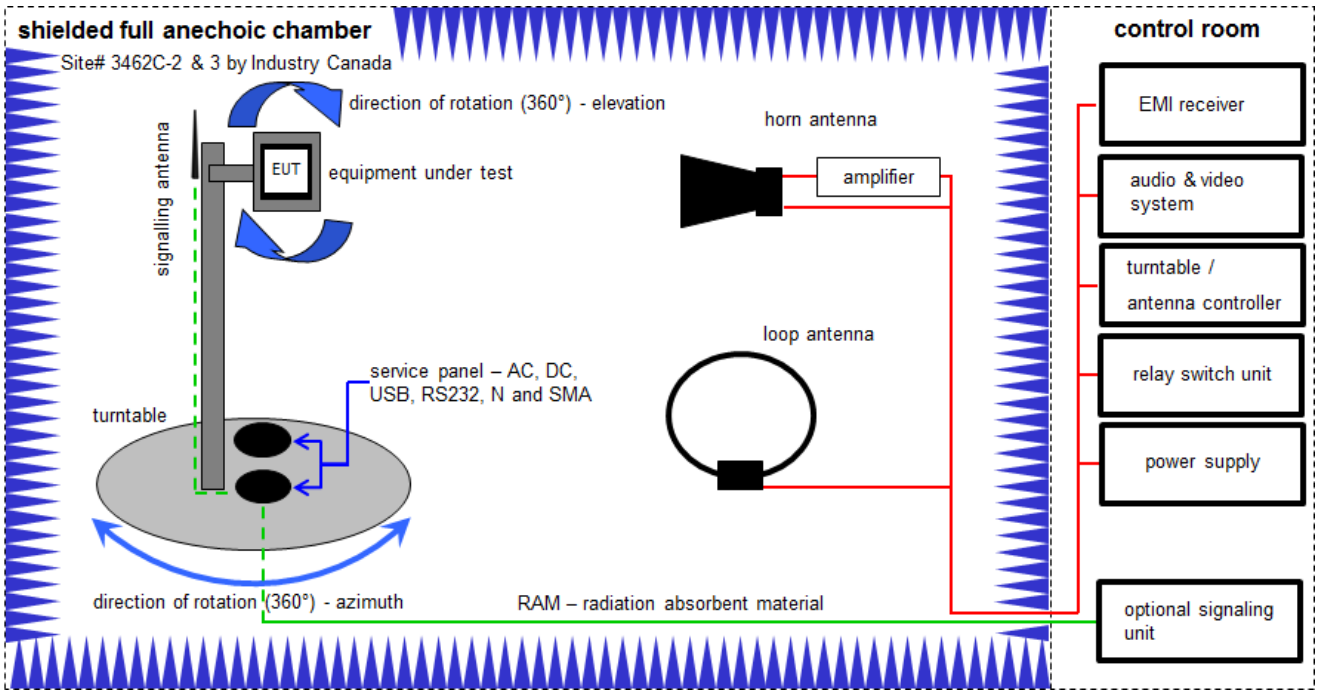
Typically, the calibrations of the test apparatus are commissioned to and performed by an accredited calibration laboratory. The calibration intervals are determined in accordance with the DIN EN ISO/IEC 17025. In addition to the external calibrations, the laboratory executes comparison measurements 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	calibration / calibrated	EK	limited calibration
ne	not required (k, ev, izw, zw not required)	zw	cyclical maintenance (external cyclical maintenance)
ev	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

7.1 Radiated measurements chamber C

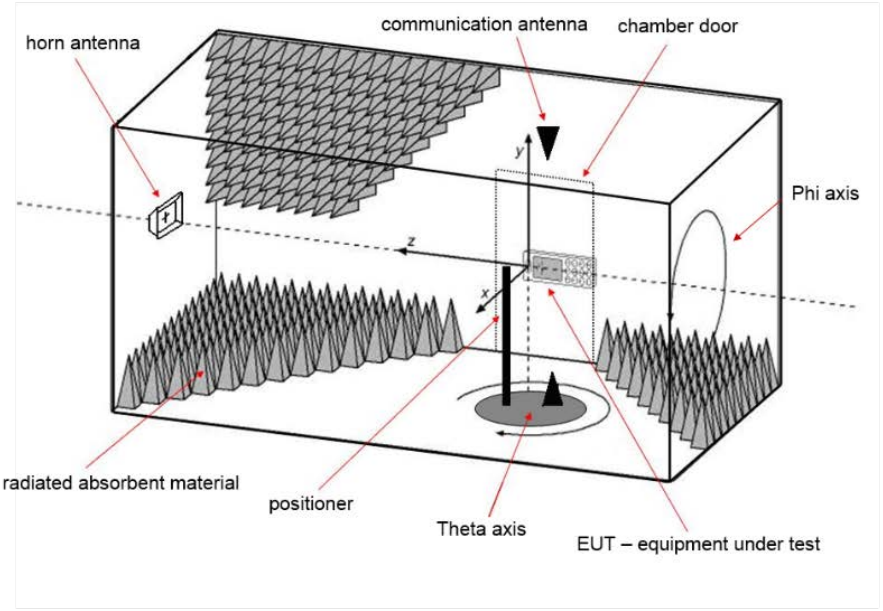


Equipment table:

No.	Lab / Item	Equipment	Type	Manufact.	Serial No.	INV. No Cetecom	Kind of Calibration	Last Calibration	Next Calibration
1	A, B	Anechoic chamber	FAC 3/5m	MWB / TDK	87400/02	300000996	ev	-/-	-/-
2	A	Double-Ridged Waveguide Horn Antenna 1-18.0GHz	3115	EMCO	9107-3697	300001605	vIKI!	27.02.2019	26.02.2021
3	B	Active Loop Antenna 9 kHz to 30 MHz	6502	EMCO	2210	300001015	vIKI!	13.06.2019	12.06.2021
4	A, B	Switch / Control Unit	3488A	HP	*	300000199	ne	-/-	-/-
5	A, B	EMI Test Receiver 20Hz- 26,5GHz	ESU26	R&S	100037	300003555	k	11.12.2020	10.12.2021
6	A	Highpass Filter	WHK1.1/15G-10SS	Wainwright	3	300003255	ev	-/-	-/-
7	A	Highpass Filter	WHKX7.0/18G-8SS	Wainwright	19	300003790	ne	-/-	-/-
8	A	Broadband Amplifier 0.5-18 GHz	CBLU5184540	CERNEX	22049	300004481	ev	-/-	-/-
9	A, B	4U RF Switch Platform	L4491A	Agilent Technologies	MY50000037	300004509	ne	-/-	-/-
10	A, B	NEXIO EMV-Software	BAT EMC V3.19.1.21	EMCO		300004682	ne	-/-	-/-
11	A, B	PC	ExOne	F+W		300004703	ne	-/-	-/-
12	A	RF-Amplifier	AMF-6F06001800-30-10P-R	NARDA-MITEQ Inc	2011572	300005241	ev	-/-	-/-

7.2 Shielded fully anechoic chamber

OTA – over the air performance



EM Quest software version: 1.0.7.0

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)

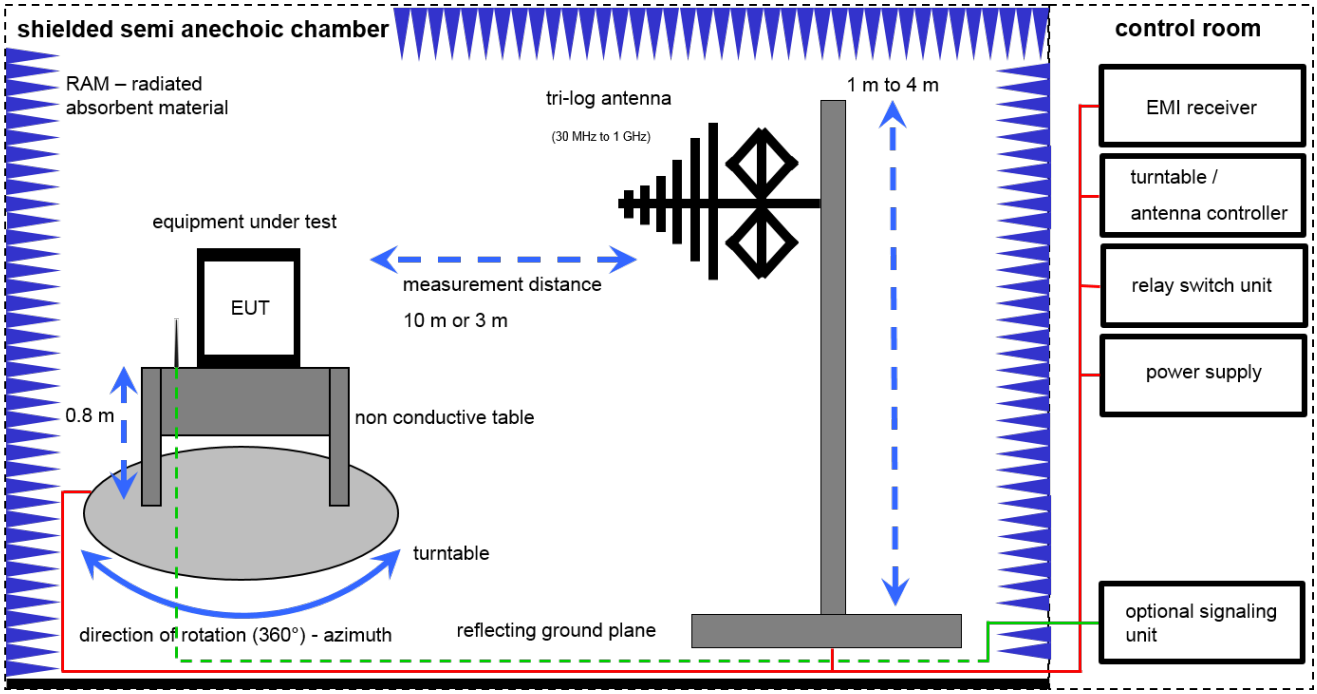
Example calculation:
OP [dBm] = -40.0 [dBm] + 49.9 [dB] – 12.4 [dBi] + 9 [dB] = 6.5 [dBm] (4.47 mW)

Equipment table:

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	A	Switch Unit	TS-RSP	R&S	100155	300003281	ev	-/-	-/-
2	A	CTIA-Chamber	CTIA-Chamber AMS 8500	ETS-Lindgren Finnland		300003327	ne	-/-	-/-
3	A	CTIA-Chamber - Positioning Equipment	CTIA-Chamber - Positioning Equipment	EMCO/2		300003328	ne	-/-	-/-
4	A	CTIA-Chamber - Software	CTIA-Chamber - Software	EMCO/2		300003328	ne	-/-	-/-
5	A	CTIA-Chamber - Antenna	3164-04	EMCO/2	00041915	300003328	ne	-/-	-/-
6	A	Spectrum Analyzer 9kHz - 30 GHz	FSP30	R&S	100623	300003464	vlKl!	09.12.2020	08.12.2022

7.3 Radiated measurements chamber F

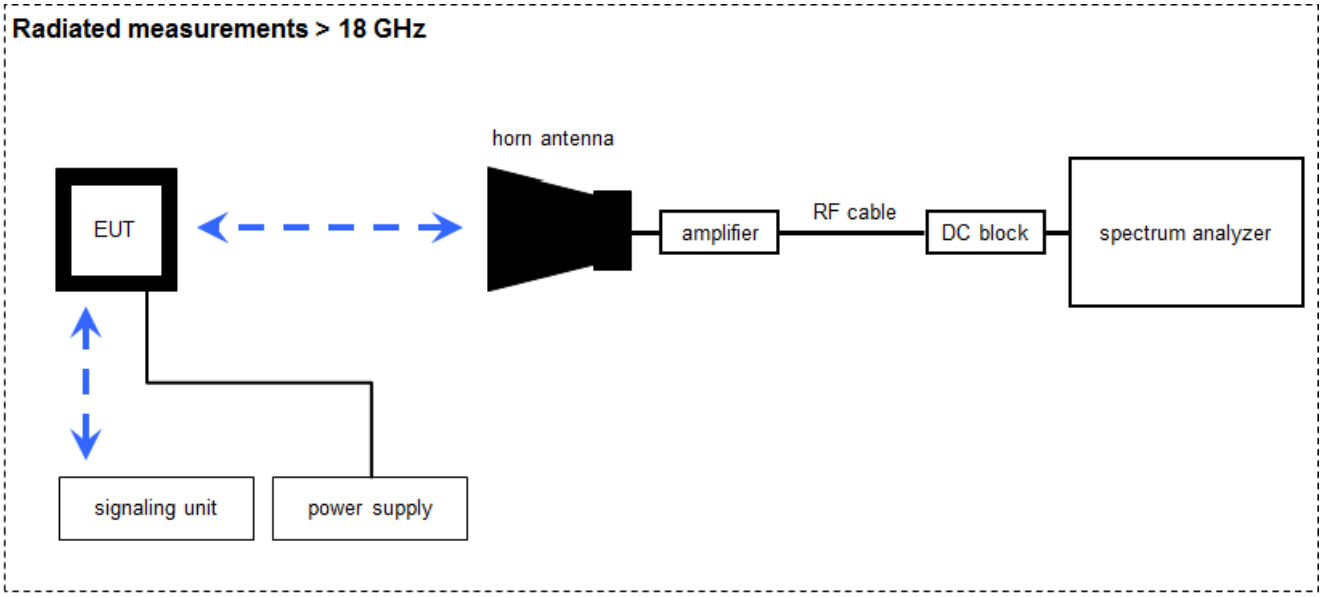
The radiated measurements are performed in vertical and horizontal plane in the frequency range from 9 kHz to 1 GHz in semi-anechoic chambers. The EUT is positioned on a non-conductive support with a height of 0.80 m above a conductive ground plane that covers the whole chamber. The receiving antennas are confirmed with 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.



Equipment table:

No.	Lab / Item	Equipment	Type	Manufact.	Serial No.	INV. No Cetecom	Kind of Calibration	Last Calibration	Next Calibration
1	A	Switch-Unit	3488A	HP	2719A14505	300000368	ev	-/-	-/-
2	A	Meßkabine 1	HF-Absorberhalle	MWB AG 300023	-/-	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	01029	300005379	vlKl!	02.07.2019	01.07.2021
7	A	EMI Test Receiver	ESR3	Rohde & Schwarz	102587	300005771	k	10.12.2020	09.06.2022

7.4 Radiated measurements > 18 GHz



Measurement distance: horn antenna 50 cm

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)

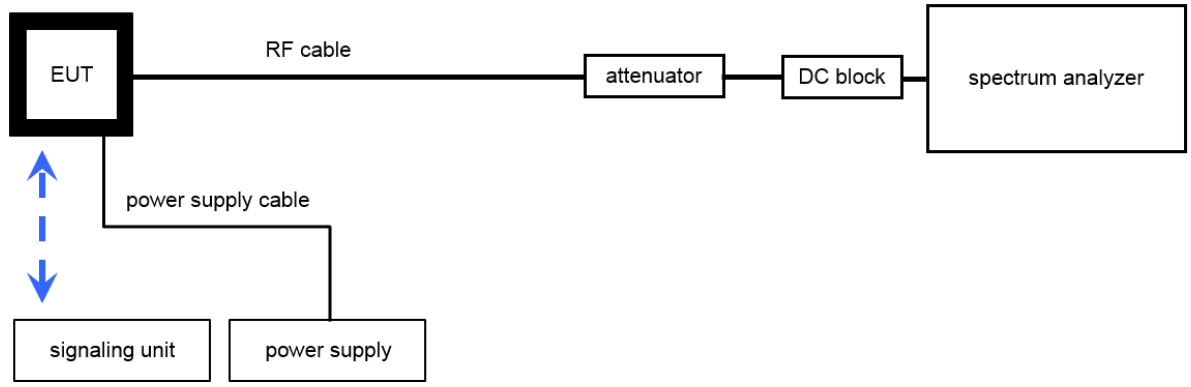
Example calculation:
OP [dBm] = -59.0 [dBm] + 44.0 [dB] - 20.0 [dBi] + 5.0 [dB] = -30 [dBm] (1 µW)

Equipment table:

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	A	Std. Gain Horn Antenna 18.0-26.5 GHz	638	Narda	01096	300000486	vIKI!	21.01.2020	20.01.2022
2	A+B	Signal Analyzer 40 GHz	FSV40	R&S	101042	300004517	k	07.12.2020	06.12.2021
3	A+B	RF-Cable	ST18/SMAm/SMAm /48	Huber & Suhner	Batch no. 600918	400001182	ev	-/-	-/-
4	A+B	DC-Blocker 0.1-40 GHz	8141A	Inmet		400001185	ev	-/-	-/-
5	A	Microwave System Amplifier, 0.5-26.5 GHz	83017A	HP	00419	300002268	ev	-/-	-/-
6	B	Std. Gain Horn Antenna 26.5-40.0 GHz	V637	Narda	82-16	300000510	vIKI!	23.01.2020	22.01.2022
7	B	Broadband Low Noise Amplifier 18-50 GHz	CBL18503070-XX	CERNEX	19338	300004273	ev	-/-	-/-

7.5 Conducted measurements with spectrum analyzer

Conducted measurements normal conditions



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

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

Equipment table:

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	A	DC-Blocker 0.1-40 GHz	8141A	Inmet	-/-	400001185	ev	-/-	-/-
2	A	Signal Analyzer 40 GHz	FSV40	R&S	101042	300004517	k	07.12.2020	06.12.2021
3	A	PC Tester R005	Intel Core i3 3220/3,3 GHz, Prozessor	-/-	2V2403033A4523	300004589	ne	-/-	-/-
4	A	RF-Cable	ST18/SMAm/SMAm/60	Huber & Suhner	Batch no. 606844	400001181	ev	-/-	-/-
5	A	Coax Attenuator 10 dB 2W 0-40 GHz	MCL BW-K10-2W44+	Mini Circuits	-/-	400001186	ev	-/-	-/-
6	A	Synchron Power Meter	SPM-4	CTC	1	300005580	ev	-/-	-/-
7	A	Tester Software RadioStar	Version 1.0.0.X	CTC advanced GmbH	0001	400001380	ne	-/-	-/-

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.

9 Measurement uncertainty

Measurement uncertainty		
Test case	**Uncertainty**	
Antenna gain	± 3 dB	
Power spectral density	± 1.56 dB	
DTS bandwidth	± 100 kHz (depends on the used RBW)	
Occupied bandwidth	± 100 kHz (depends on the used RBW)	
Maximum output power conducted	± 1.56 dB	
Detailed spurious emissions @ the band edge - conducted	± 1.56 dB	
Band edge compliance radiated	± 3 dB	
Spurious emissions conducted	> 3.6 GHz	± 1.56 dB
	> 7 GHz	± 1.56 dB
	> 18 GHz	± 2.31 dB
	≥ 40 GHz	± 2.97 dB
Spurious emissions radiated below 30 MHz	± 3 dB	
Spurious emissions radiated 30 MHz to 1 GHz	± 3 dB	
Spurious emissions radiated 1 GHz to 12.75 GHz	± 3.7 dB	
Spurious emissions radiated above 12.75 GHz	± 4.5 dB	
Spurious emissions conducted below 30 MHz (AC conducted)	± 2.6 dB	

10 Summary of measurement results

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

TC Identifier	Description	Verdict	Date	Remark
RF-Testing	CFR Title 47 Part 15 RSS 247, Issue 2	See table	2021-03-25	-/-

Test specification clause	Test case	C	NC	NA	NP	Remark
-/-	Output power verification (cond.)	-/-				Declared
-/-	Antenna gain	-/-				-/-
U-NII Part 15	Duty cycle	-/-				-/-
§15.407(a) RSS - 247 (6.2.x.1)	Maximum output power (conducted & radiated)	☒	☐	☐	☐	-/-
§15.407(a) RSS - 247 (6.2.x.1)	Power spectral density	☒	☐	☐	☐	-/-
RSS - 247 (6.2.4.1)	Spectrum bandwidth 6dB bandwidth	-/-				-/-
§15.407(a) RSS - 247 (6.2.x.2)	Spectrum bandwidth 26dB bandwidth	☒	☐	☐	☐	-/-
RSS Gen clause 6.6	Spectrum bandwidth 99% bandwidth	☒	☐	☐	☐	-/-
§15.205 RSS - 247 (6.2.x.2)	Band edge compliance radiated	☒	☐	☐	☐	-/-
§15.407(b) RSS - 247 (6.2.x.2)	TX spurious emissions radiated	☒	☐	☐	☐	-/-
§15.109 RSS-Gen	RX spurious emissions radiated	☐	☐	☒	☐	-/-
§15.209(a) RSS-Gen	Spurious emissions radiated < 30 MHz	☒	☐	☐	☐	-/-
§15.107(a) §15.207	Spurious emissions conducted emissions< 30 MHz	☐	☐	☒	☐	-/-
§15.407 RSS - 247 (6.3)	DFS	☐	☐	☒	☐	-/-

Notes:

C:	Compliant	NC:	Not compliant	NA:	Not applicable	NP:	Not performed

11 Additional comments

Reference documents: 1-0596_20-01-08_log1_conducted.pdf
Customer Questionnaire WLAN_Probe_01.pdf,
Testinstructions_NormalOperation_0.pdf,
TestsoftwareInstructions_0.pdf
Continuous_Mode_SW_Load_procedures.pdf
Hexagon_Test_Ch36.txt
tx_80211a_start_new.txt
tx_80211n20_start_new.txt

Special test descriptions: None

Configuration descriptions: Antenna gain measurements performed with test mode firmware "ltrx_bcm4390x_mfgtestldr_3.0.0.0R3.signed.rom" and configuration script "Hexagon_Test_Ch36.txt"
Conducted and radiated tests performed with test mode firmware "ltrx_bcm4390x_mfgtestldr_3.0.0.0R3.signed.rom" and configuration scripts "tx_80211a_start_new.txt" and "tx_80211n20_start_new.txt"

EUT selection:
☒ Only one device available
☐ Devices selected by the customer
☐ Devices selected by the laboratory (Randomly)

Provided channels:

Channels with 20 MHz channel bandwidth:

U-NII-1 & U-NII-2A (5150 MHz to 5250 MHz & 5250 MHz to 5350 MHz) channel number & center frequency								
channel	**36**	**40**	44	**48**	-/-	-/-	-/-	-/-
f_c / MHz	**5180**	**5200**	5220	**5240**	-/-	-/-	-/-	-/-

Note: The channels used for the tests were marked in bold in the list.

Test mode:

☐ No test mode available.
Iperf is used to transmit data to a companion device

☒ Special software is used.
EUT is transmitting pseudo random data by itself

Antennas and transmit operating modes:

☒ Operating mode 1 (single antenna)
- Equipment with 1 antenna,
- Equipment with 2 diversity antennas operating in switched diversity mode by which at any moment in time only 1 antenna is used,
- Smart antenna system with 2 or more transmit/receive chains, but operating in a mode where only 1 transmit/receive chain is used)

☐ Operating mode 2 (multiple antennas, no beamforming)
- Equipment operating in this mode contains a smart antenna system using two or more transmit/receive chains simultaneously but without beamforming.

☐ Operating mode 3 (multiple antennas, with beamforming)
- Equipment operating in this mode contains a smart antenna system using two or more transmit/receive chains simultaneously with beamforming.
  In addition to the antenna assembly gain (G), the beamforming gain (Y) may have to be taken into account when performing the measurements.

12 Measurement results

12.1 Antenna gain

Description:

Measurement of the conducted output power @ 3 MHz RBW and radiated output power @ 3 MHz RBW.

Measurement:

Measurement parameter	
Detector:	Positive peak
Sweep time:	Auto
Resolution bandwidth (RBW):	3 MHz
Video bandwidth (VBW):	3 MHz
Span:	40 MHz
Trace mode:	Maximum hold
Measurement uncertainty:	See sub clause
Test setup:	See chapter 7.2 – A (radiated) See chapter 7.5 – A (conducted)

Result:

OFDM	Antenna gain		
	5180 MHz	5200 MHz	5240 MHz
conducted power for gain calculation	5.6 dBm	7.3 dBm	4.9 dBm
radiated power for gain calculation	7.3 dBm	7.6 dBm	8.1 dBm
calculated antenna gain	1.7 dBi	0.3 dBi	3.2 dBi

12.2 Duty cycle

Description:

The duty cycle is necessary to compute the maximum power during an actual transmission. The shown plots and values are to show an example of the measurement procedure. The real value is measured direct during the power measurement or power density measurement. The correction value is shown in each plot of these measurements.

Measurement:

Measurement parameter	
According to: KDB789033 D02, B.	
External result file(s)	1-0596_20-01-08_log1_conducted.pdf FCC Part 15.407 Max Output Power and PSD
Used test setup:	See chapter 7.5 – A
Measurement uncertainty:	See chapter 9

12.3 Maximum output power

12.3.1 Maximum output power according to FCC requirements

Description:

Measurement of the maximum output power conducted

Measurement:

Measurement parameter	
According to: KDB789033 D02, E.2.e.	
External result file(s)	1-0596_20-01-08_log1_conducted.pdf FCC Part 15.407 Max Output Power and PSD
Used test setup:	See chapter 7.5 – A
Measurement uncertainty:	See chapter 9

Limits:

Radiated output power	Conducted output power for mobile equipment
Conducted power + 6 dBi antenna gain	250mW 5.150-5.250 GHz The lesser one of 250mW or 11 dBm + 10 log Bandwidth 5.250-5.350 GHz 250mW or 11 dBm + 10 log Bandwidth 5.470-5.725 GHz (where Bandwidth is the 26dB Bandwidth [MHz]) 1W 5.725-5.85 GHz

Results:

a	Maximum output power conducted [dBm]		
	U-NII-1 (5150 MHz to 5250 MHz)		
	Lowest channel	Middle channel	Highest channel
	13.6	14.5	12.9

Results:

n/ac HT20	Maximum output power conducted [dBm]		
	U-NII-1 (5150 MHz to 5250 MHz)		
	Lowest channel	Middle channel	Highest channel
	12.5	13.4	11.9

12.3.2 Maximum output power according to IC requirements

Description:

Measurement of the maximum output power conduced + radiated

Measurement:

Measurement parameter	
External result file(s)	1-0596_20-01-08_log1_conducted.pdf ISED Max Output Power and PSD
Used test setup:	See chapter 7.5 – A
Measurement uncertainty:	See chapter 9

Limits:

Radiated output power	Conducted output power for mobile equipment
The lesser one of 200 mW or 10 dBm + 10 log Bandwidth 5.150-5.250 GHz 1 W or 17 dBm + 10 log Bandwidth 5.250-5.350 GHz 1 W or 17 dBm + 10 log Bandwidth 5.470-5.725 GHz (where Bandwidth is the 99% Bandwidth [MHz]) Conducted power + 6dBi antenna gain 5.725-5.825 GHz	The lesser one of 250mW or 11 dBm + 10 log Bandwidth 5.250-5.350 GHz 250mW or 11 dBm + 10 log Bandwidth 5.470-5.725 GHz (where Bandwidth is the 99% Bandwidth [MHz]) 1W 5.725-5.825 GHz

Results:

a	Maximum output power [dBm]		
	U-NII-1 (5150 MHz to 5250 MHz)		
	Lowest channel	Middle channel	Highest channel
	Conducted		
	13.6	14.4	12.9
	Radiated (calculated – see chapter antenna gain)		
	15.3	14.7	16.1

Results:

n/ac HT20	Maximum output power [dBm]		
	U-NII-1 (5150 MHz to 5250 MHz)		
	Lowest channel	Middle channel	Highest channel
	Conducted		
	12.4	13.4	11.8
	Radiated (calculated – see chapter antenna gain)		
	14.1	13.7	15.0

12.4 Power spectral density

12.4.1 Power spectral density according to FCC requirements

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	
According to: KDB789033 D02, F.	
External result file(s)	1-0596_20-01-08_log1_conducted.pdf FCC Part 15.407 Max Output Power and PSD
Used test setup:	See chapter 7.5 – A
Measurement uncertainty:	See chapter 9

Limits:

Power Spectral Density
power spectral density conducted ≤ 11 dBm in any 1 MHz band (band 5150 – 5250 MHz)

Results:

	Power spectral density (dBm/1MHz or dBm/500kHz)		
	U-NII-1 (5150 MHz to 5250 MHz)		
a	Lowest channel	Middle channel	Highest channel
	2.3	3.1	1.6

Results:

	Power spectral density (dBm/1MHz or dBm/500kHz)		
	U-NII-1 (5150 MHz to 5250 MHz)		
n/ac HT20	Lowest channel	Middle channel	Highest channel
	0.8	1.7	0.0

12.4.2 Power spectral density according to IC requirements

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	
External result file(s)	1-0596_20-01-08_log1_conducted.pdf ISED Max Output Power and PSD
Used test setup:	See chapter 7.5 – A
Measurement uncertainty:	See chapter 9

Limits:

Power Spectral Density
power spectral density e.i.r.p. ≤ 10 dBm in any 1 MHz band (band 5150 – 5250 MHz) power spectral density conducted ≤ 11 dBm in any 1 MHz band (band 5250 – 5350 MHz) power spectral density conducted ≤ 11 dBm in any 1 MHz band (band 5470 – 5725 MHz) power spectral density conducted ≤ 30 dBm in any 500 kHz band (band 5725 – 5850 MHz)

Results:

a	Power spectral density (dBm/1MHz or dBm/500kHz)		
	U-NII-1 (5150 MHz to 5250 MHz)		
	Lowest channel	Middle channel	Highest channel
	Conducted		
	2.3	3.1	1.6
	Radiated (calculated – see chapter antenna gain)		
	4.0	3.4	4.8

Results:

n/ac HT20	Power spectral density (dBm/1MHz or dBm/500kHz)		
	U-NII-1 (5150 MHz to 5250 MHz)		
	Lowest channel	Middle channel	Highest channel
	Conducted		
	0.7	1.6	0.0
	Radiated (calculated – see chapter antenna gain)		
	2.4	1.9	3.2

12.5 Spectrum bandwidth / 26 dB bandwidth

Description:

Measurement of the 26 dB bandwidth of the modulated signal.

Measurement:

Measurement parameter	
According to: KDB789033 D02, C.1.	
External result file(s)	1-0596_20-01-08_log1_conducted.pdf FCC Part 15.407 & ISED Bandwidths
Used test setup:	see chapter 7.5 – A
Measurement uncertainty:	See chapter 9

Limits:

Spectrum Bandwidth – 26 dB Bandwidth
IC: Any unwanted emissions that fall into the band 5250-5350 MHz shall be attenuated below the channel power by at least 26 dB, when measured using a resolution bandwidth between 1 and 5% of the occupied bandwidth (i.e. 99% bandwidth), above 5250 MHz. The 26 dB bandwidth may fall into the 5250-5350 MHz band; however, if the occupied bandwidth also falls within the 5250-5350 MHz band, the transmission is considered as intentional and the devices shall comply with all requirements in the band 5250-5350 MHz including implementing dynamic frequency selection (DFS) and TPC, on the portion of the emission that resides in the 5250-5350 MHz band. **FCC:** Radar Detection Function of Dynamic Frequency Selection (DFS). U-NII devices operating with any part of its 26 dB emission bandwidth in the 5.25-5.35 GHz and 5.47-5.725 GHz bands shall employ a DFS radar detection mechanism to detect the presence of radar systems and to avoid co-channel operation with radar systems.

Results:

a	26 dB bandwidth (MHz)		
	U-NII-1 (5150 MHz to 5250 MHz)		
	Lowest channel	Middle channel	Highest channel
	21.4	21.4	21.4
	Lowest frequency		Highest frequency
	5169.4		5250.7

Results:

n/ac HT20	26 dB bandwidth (MHz)		
	U-NII-1 (5150 MHz to 5250 MHz)		
	Lowest channel	Middle channel	Highest channel
	21.8	21.7	21.8
	Lowest frequency		Highest frequency
	5169.3		5250.9

12.6 Occupied bandwidth / 99% emission bandwidth

Description:

Measurement of the 99% bandwidth of the modulated signal acc. RSS-GEN.

Measurement:

Measurement parameter	
External result file(s)	1-0596_20-01-08_log1_conducted.pdf FCC Part 15.407 & ISED Bandwidths
Test setup:	See sub clause 7.5 – A
Measurement uncertainty:	See chapter 9

Usage:

-/-	IC
OBW is necessary for Emission Designator	

Results:

a	99% bandwidth (kHz)		
	U-NII-1 (5150 MHz to 5250 MHz)		
	Lowest channel	Middle channel	Highest channel
	16.833	16.733	16.783

Results:

n/ac HT20	99% bandwidth (kHz)		
	U-NII-1 (5150 MHz to 5250 MHz)		
	Lowest channel	Middle channel	Highest channel
	18.082	18.082	18.082

12.7 Band edge compliance radiated

Description:

Measurement of the radiated band edge compliance. The EUT is turned in the position that results in the maximum level at the band edge. Then a sweep over the corresponding restricted band is performed. The EUT is set to the lowest channel for the lower restricted band and to the highest channel for the upper restricted band. Measurement distance is 3m.

Measurement:

Measurement parameter	
Detector:	Peak / RMS
Sweep time:	Auto
Resolution bandwidth:	1 MHz
Video bandwidth:	≥ 3 x RBW
Span:	See plots!
Trace mode:	Max Hold
Test setup:	See sub clause 7.1 – A
Measurement uncertainty:	See chapter 9

Limits:

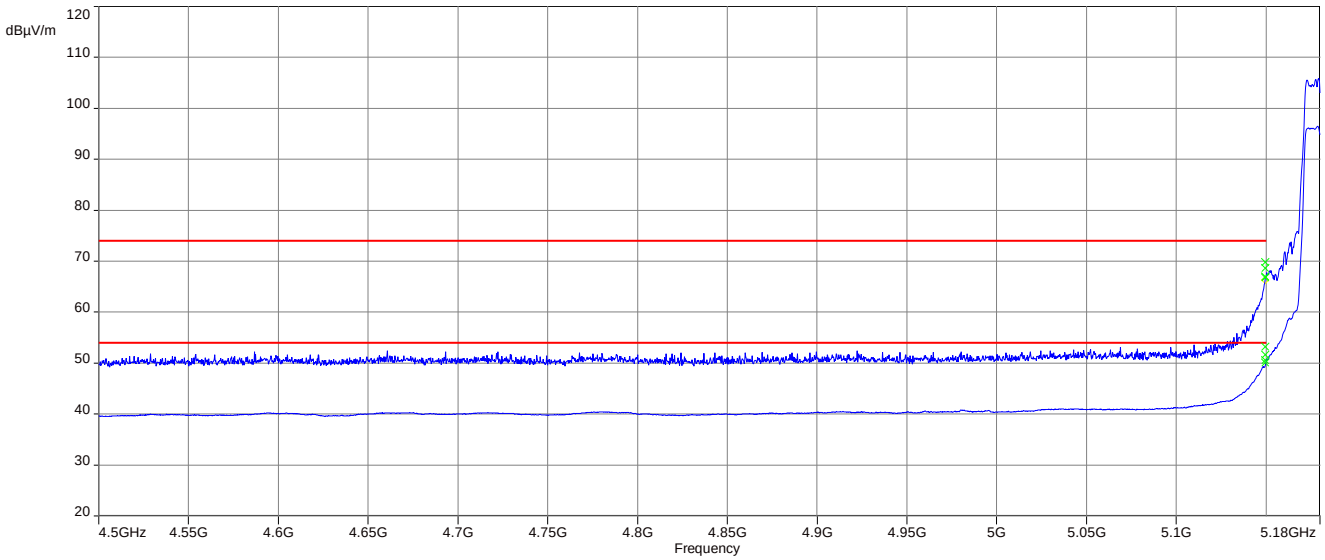
Band Edge Compliance Radiated
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within 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 Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 5.205(c)).
74 dBµV/m (peak) 54 dBµV/m (average)

Result:

Scenario	Band Edge Compliance Radiated [dBµV/m]
band edge	< 74 dBµV/m (peak) < 54 dBµV/m (average)

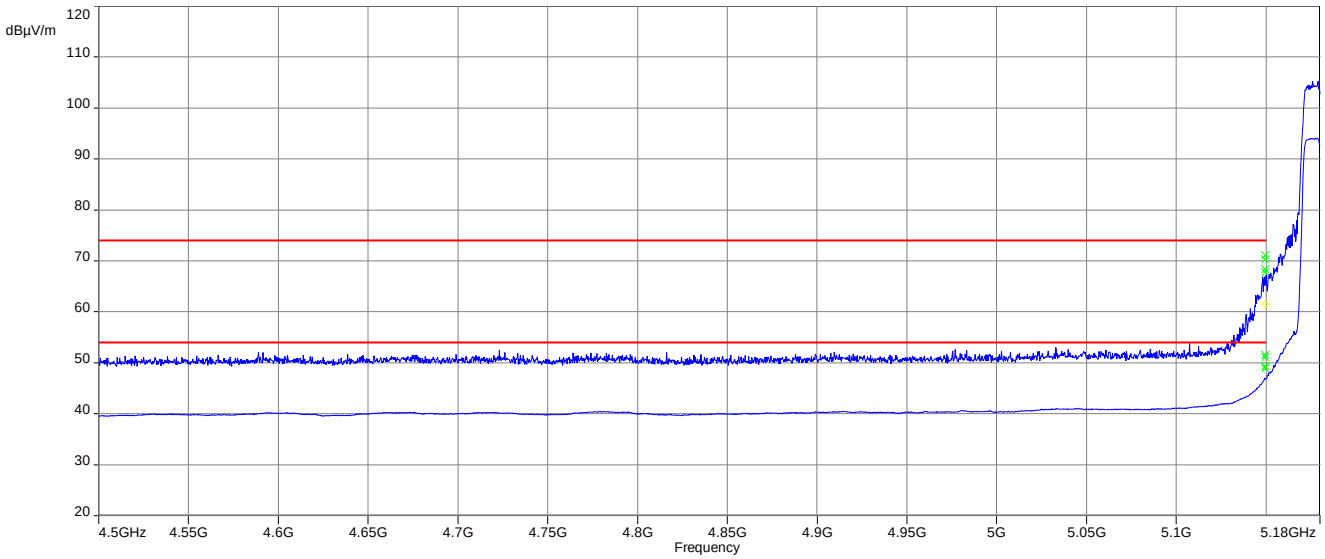
Plots:

Plot 1: lower band edge; U-NII-1; lowest channel; 20 MHz channel bandwidth a-Mode



Plots:

Plot 2: lower band edge; U-NII-1; lowest channel; 20 MHz channel bandwidth n20-Mode



12.8 Spurious emissions radiated below 30 MHz

Description:

Measurement of the radiated spurious emissions in transmit mode below 30 MHz. The limits are re-calculated to a measurement distance of 3 m with 40 dB/decade according CFR Part 2.

Measurement:

Measurement parameter	
Detector:	Peak / Quasi Peak
Sweep time:	Auto
Video bandwidth:	F < 150 kHz: 200 Hz F > 150 kHz: 9 kHz
Resolution bandwidth:	F < 150 kHz: 1 kHz F > 150 kHz: 100 kHz
Span:	9 kHz to 30 MHz
Trace mode:	Max Hold
Test setup:	See sub clause 7.1 – B
Measurement uncertainty:	See chapter 9

Limits:

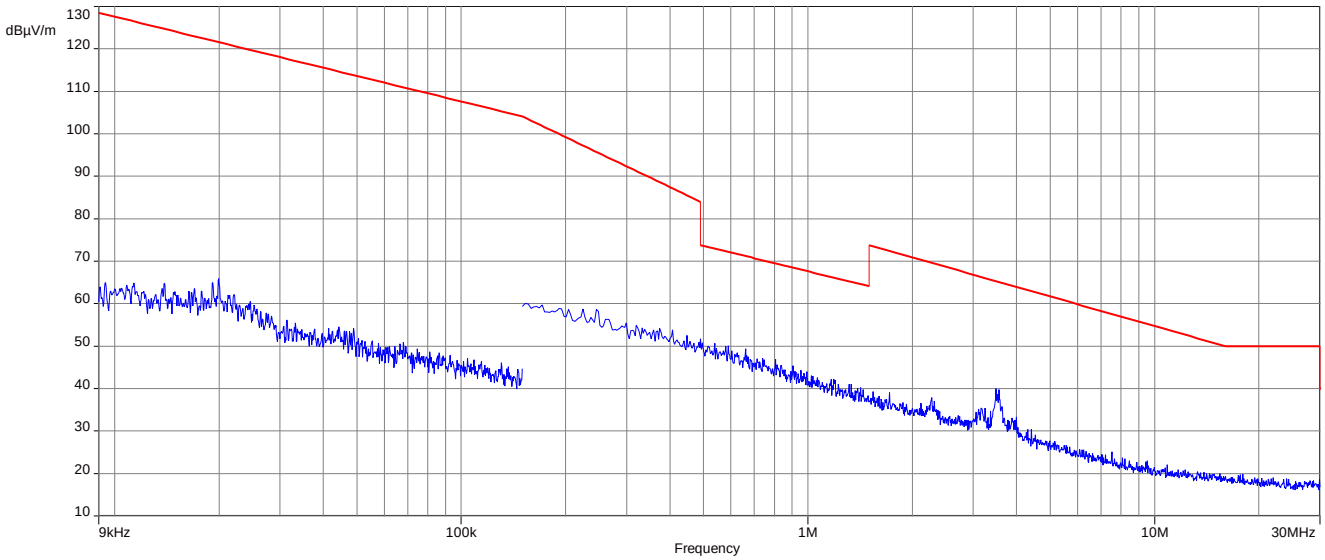
Spurious Emissions Radiated < 30 MHz		
Frequency (MHz)	Field Strength (dBµV/m)	Measurement distance
0.009 – 0.490	2400/F(kHz)	300
0.490 – 1.705	24000/F(kHz)	30
1.705 – 30.0	30	30

Results:

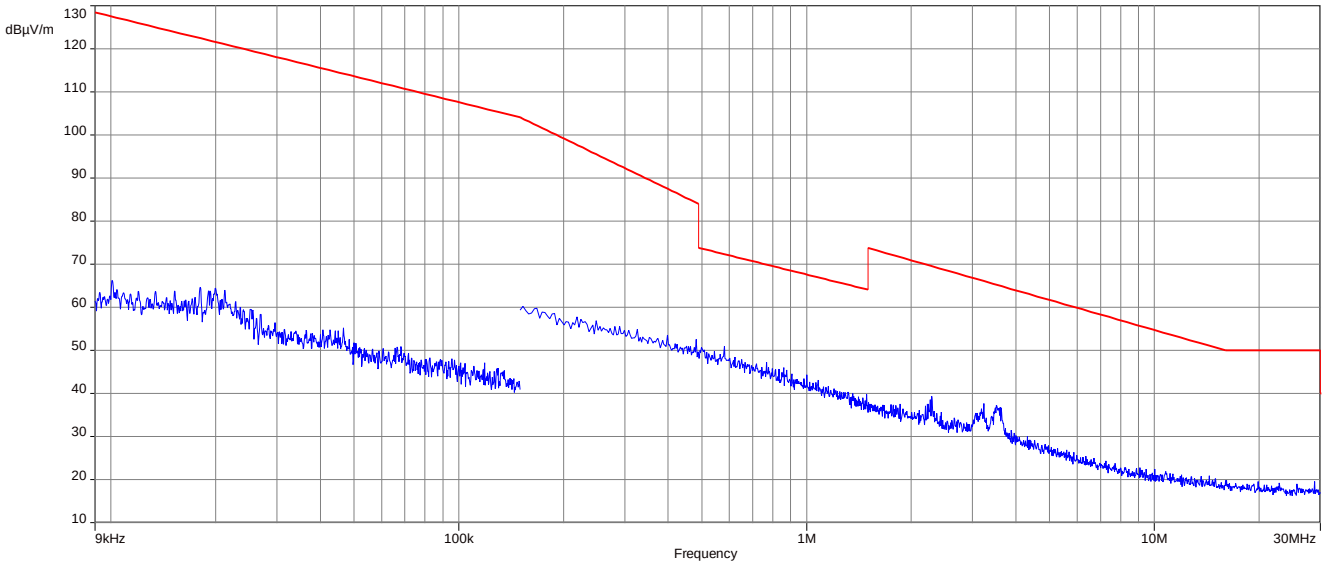
Spurious Emissions Radiated < 30 MHz [dBµV/m]		
F [MHz]	Detector	Level [dBµV/m]
All detected emissions are more than 20 dB below the limit.		

Plots: 20 MHz channel bandwidth

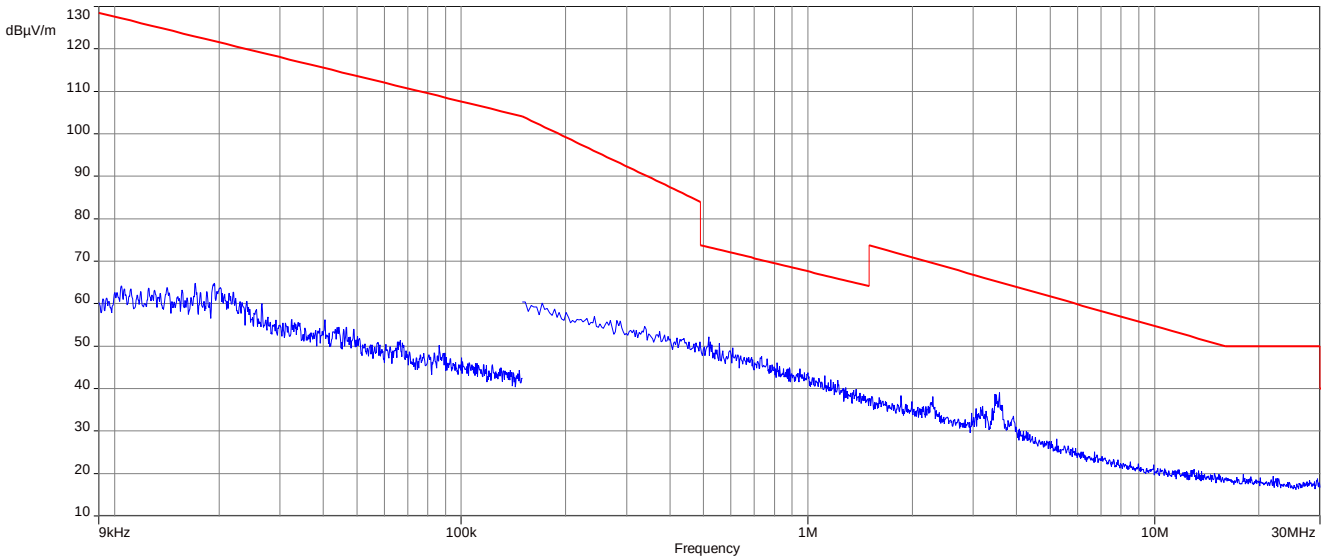
Plot 1: 9 kHz to 30 MHz, U-NII-1; lowest channel



Plot 2: 9 kHz to 30 MHz, U-NII-1; mid channel



Plot 3: 9 kHz to 30 MHz, U-NII-1; highest channel



12.9 Spurious emissions radiated 30 MHz to 1 GHz

Description:

Measurement of the radiated spurious emissions and cabinet radiations below 1 GHz.

Measurement:

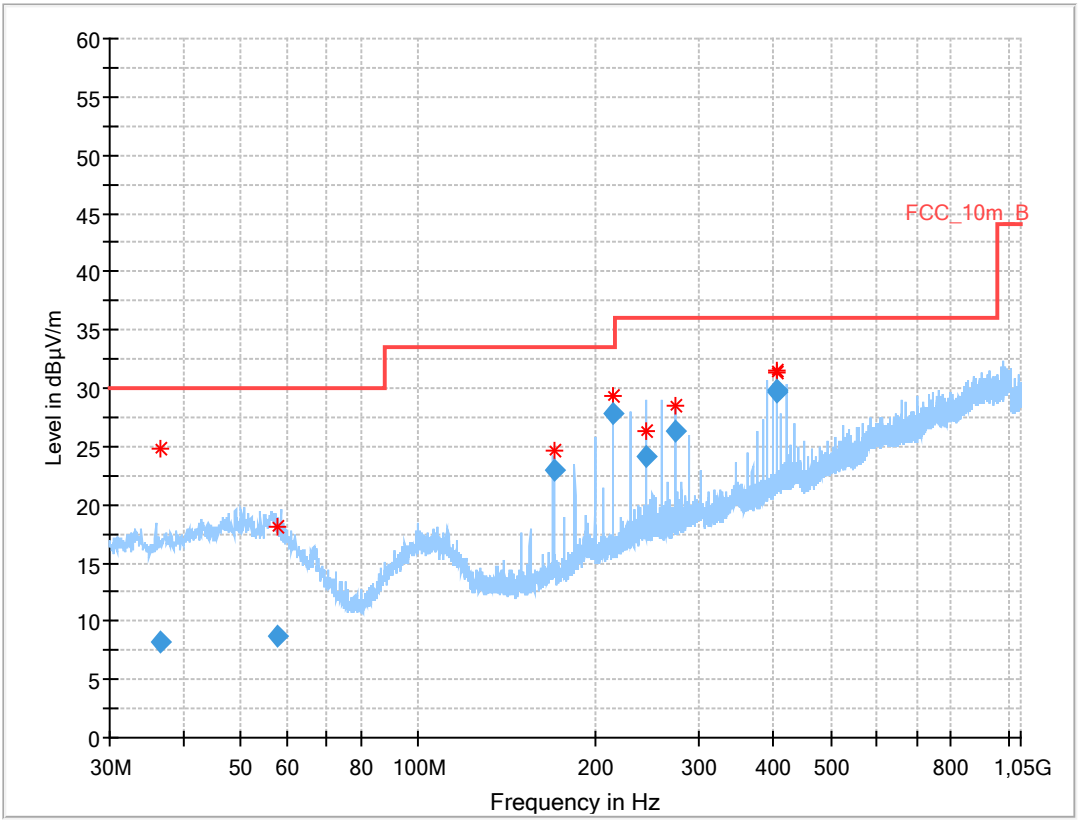
Measurement parameter	
Detector:	Quasi Peak
Sweep time:	Auto
Resolution bandwidth:	120 kHz
Video bandwidth:	500 kHz
Span:	30 MHz to 1 GHz
Test setup:	See sub clause 7.3 – A
Measurement uncertainty:	See chapter 9

Limits:

TX Spurious Emissions Radiated		
§15.209		
Frequency (MHz)	Field Strength (dBµV/m)	Measurement distance
30 - 88	30.0	10
88 – 216	33.5	10
216 – 960	36.0	10
Above 960	54.0	3
§15.407		
Outside the restricted bands!	-27 dBm / MHz	

Plots: 20 MHz channel bandwidth

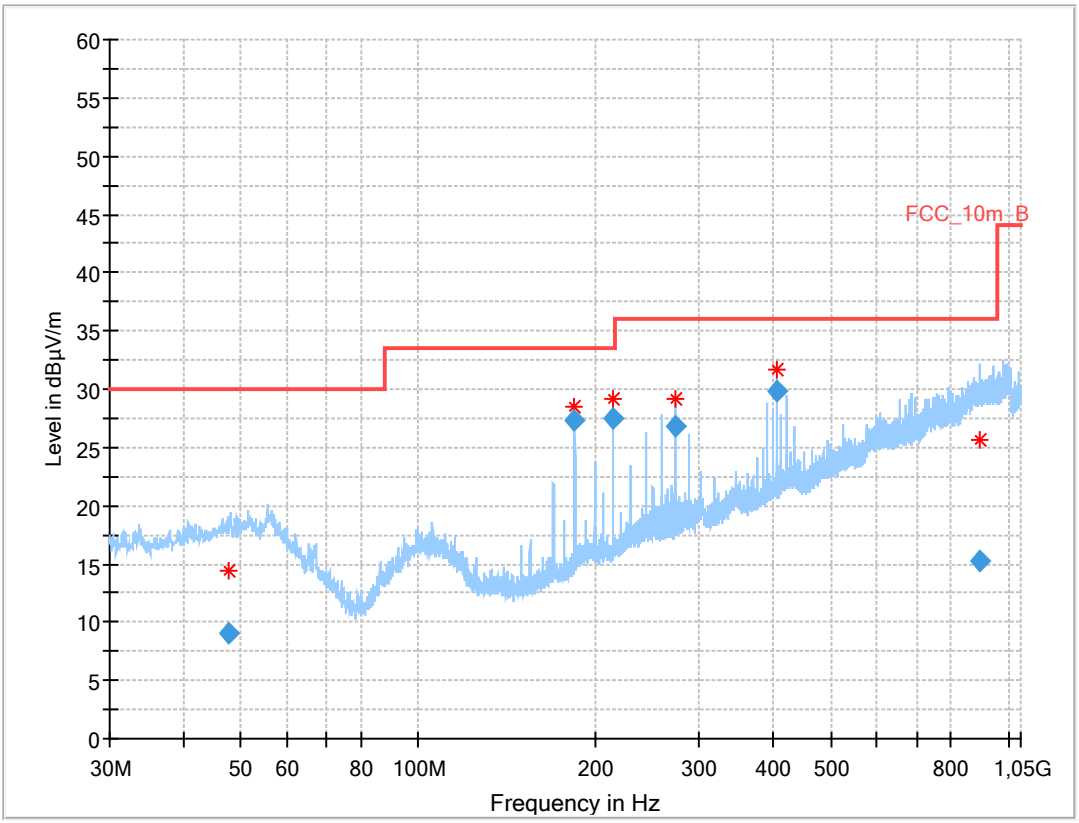
Plot 1: 30 MHz to 1 GHz; vertical & horizontal polarization; U-NII-1; lowest channel



Results:

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
36.453	8.18	30.0	21.8	1000	120.0	400.0	V	225	13
57.869	8.72	30.0	21.3	1000	120.0	311.0	H	0	14
169.570	22.88	33.5	10.6	1000	120.0	362.0	H	-6	10
213.812	27.76	33.5	5.7	1000	120.0	383.0	H	5	12
243.297	24.14	36.0	11.9	1000	120.0	385.0	H	135	13
272.788	26.33	36.0	9.7	1000	120.0	323.0	H	172	14
405.496	29.87	36.0	6.1	1000	120.0	200.0	H	3	17
405.501	29.71	36.0	6.3	1000	120.0	203.0	H	171	17

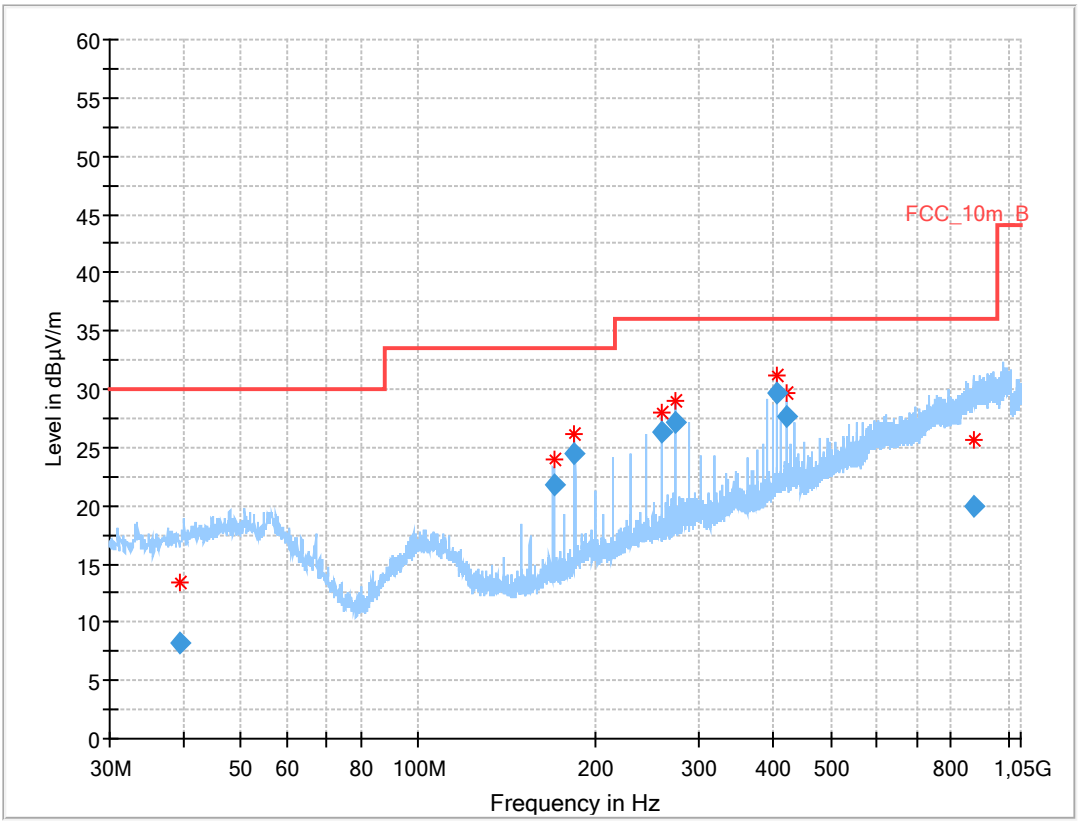
Plot 2: 30 MHz to 1 GHz; vertical & horizontal polarization; U-NII-1; mid channel



Results:

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
47.606	9.04	30.0	21.0	1000	120.0	200.0	V	324	14
184.317	27.35	33.5	6.2	1000	120.0	370.0	H	182	10
213.809	27.54	33.5	6.0	1000	120.0	373.0	H	186	12
272.787	26.83	36.0	9.2	1000	120.0	331.0	H	174	14
405.499	29.87	36.0	6.1	1000	120.0	212.0	H	184	17
892.547	15.22	36.0	20.8	1000	120.0	200.0	V	-45	24

Plot 3: 30 MHz to 1 GHz; vertical & horizontal polarization; U-NII-1; highest channel



Results:

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
39.566	8.24	30.0	21.8	1000	120.0	291.0	H	90	13
169.577	21.87	33.5	11.6	1000	120.0	400.0	H	187	10
184.306	24.48	33.5	9.0	1000	120.0	368.0	H	184	10
258.041	26.28	36.0	9.7	1000	120.0	400.0	H	200	13
272.785	27.12	36.0	8.9	1000	120.0	327.0	H	196	14
405.504	29.62	36.0	6.4	1000	120.0	204.0	H	193	17
420.255	27.67	36.0	8.3	1000	120.0	235.0	H	17	17
871.862	20.01	36.0	16.0	1000	120.0	200.0	V	-45	23

12.10 Spurious emissions radiated 1 GHz to 40 GHz

Description:

Measurement of the radiated spurious emissions and cabinet radiations from 1 GHz to 40 GHz.

Measurement:

Measurement parameter	
Detector:	Quasi Peak below 1 GHz (alternative Peak) Peak above 1 GHz / RMS
Sweep time:	Auto
Resolution bandwidth:	1 MHz
Video bandwidth:	3 MHz
Span:	1 GHz to 40 GHz
Trace mode:	Max Hold / Average with 100 counts + 20 log (1 / X) for duty cycle lower than 100 %
Test setup:	See sub clause 7.1 – A See sub clause 7.4 – A See sub clause 7.4 – B
Measurement uncertainty:	See chapter 9

Limits:

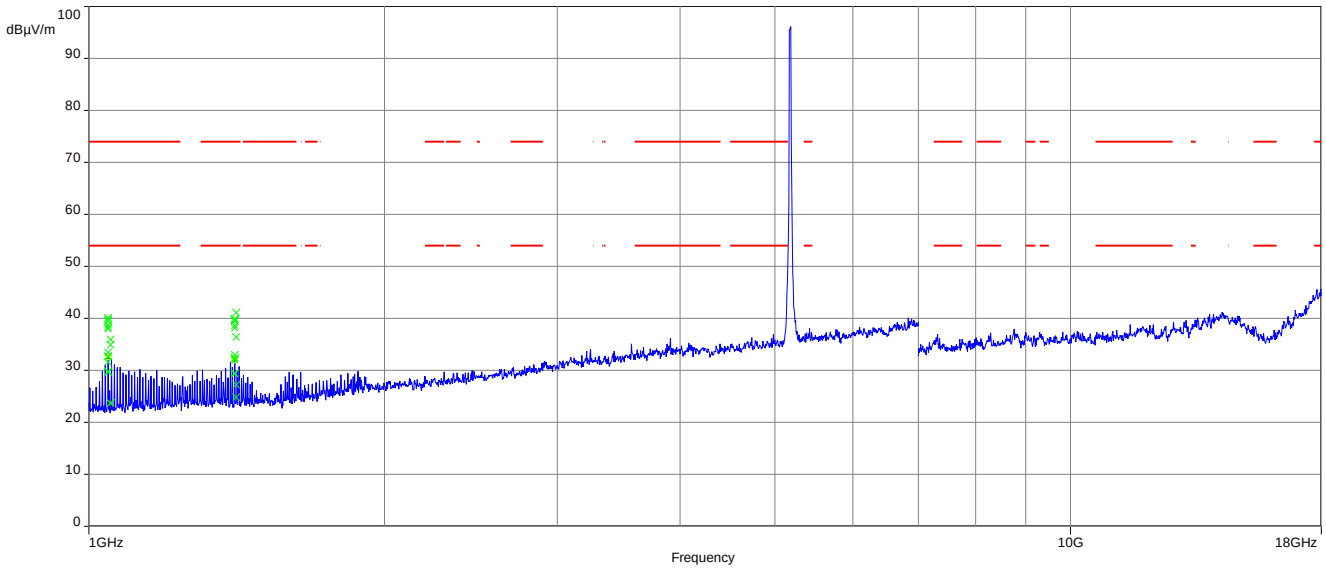
TX Spurious Emissions Radiated		
§15.209		
Frequency (MHz)	Field Strength (dBµV/m)	Measurement distance
Above 960	54.0	3
§15.407		
Outside the restricted bands!	-27 dBm / MHz	

Results: 20 MHz channel bandwidth

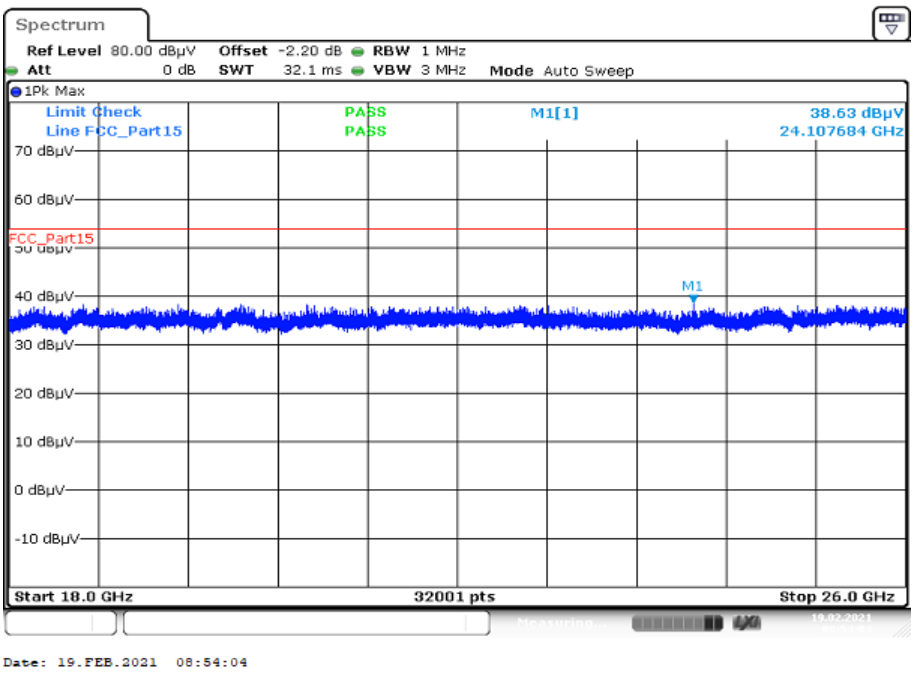
TX Spurious Emissions Radiated [dBµV/m] / dBm								
U-NII-1 (5150 MHz to 5250 MHz)								
Lowest channel			Middle channel			Highest channel		
F [MHz]	Detector	Level [dBµV/m]	F [MHz]	Detector	Level [dBµV/m]	F [MHz]	Detector	Level [dBµV/m]
1046.8	Peak	40.1	-/-	Peak	-/-	4295.2	Peak	45.9
	AVG	33.5		AVG	-/-		AVG	34.0
1412.8	Peak	41.1	-/-	Peak	-/-	-/-	Peak	-/-
	AVG	33.0		AVG	-/-		AVG	-/-
For emissions above 18 GHz please take look at the plots.			For emissions above 18 GHz please take look at the plots.			For emissions above 18 GHz please take look at the plots.		

Plots: 20 MHz channel bandwidth

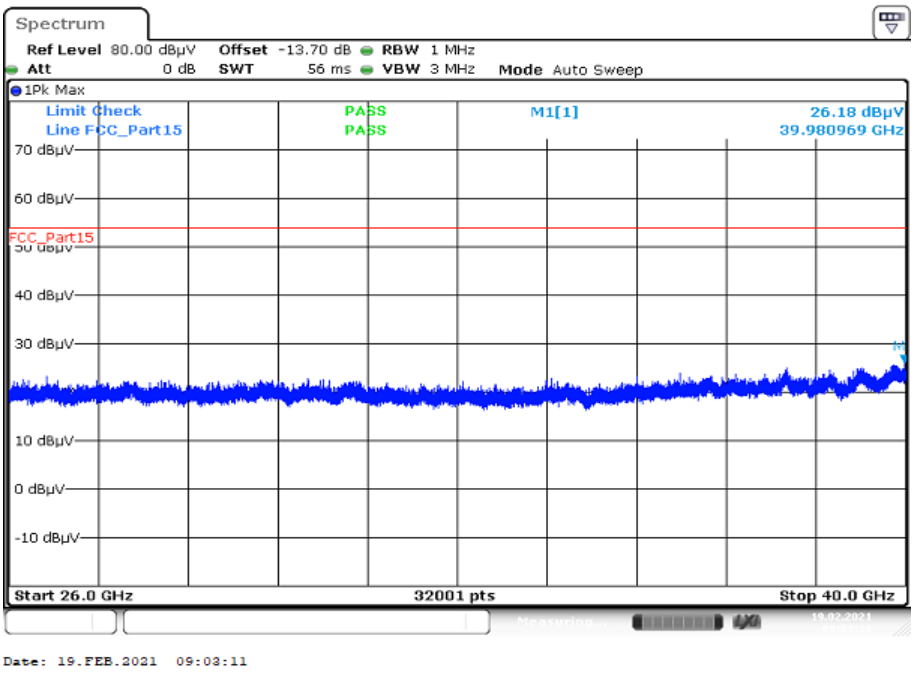
Plot 1: 1 GHz to 18 GHz; vertical & horizontal polarization; U-NII-1; lowest channel



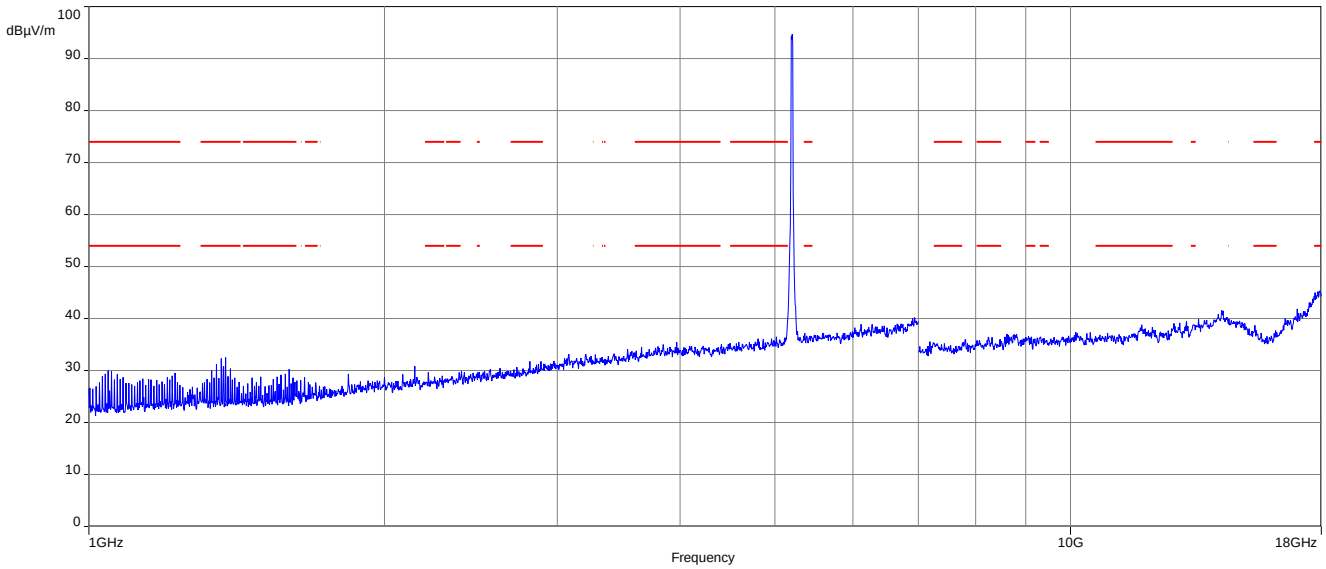
Plot 2: 18 GHz to 26 GHz; vertical & horizontal polarization; U-NII-1; lowest channel



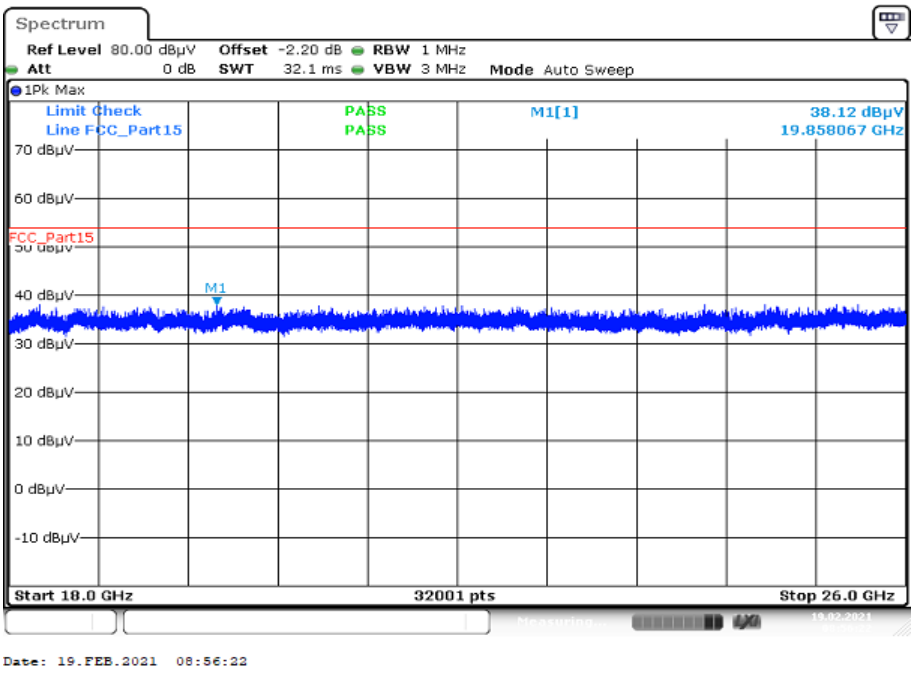
Plot 3: 26 GHz to 40 GHz; vertical & horizontal polarization; U-NII-1; lowest channel



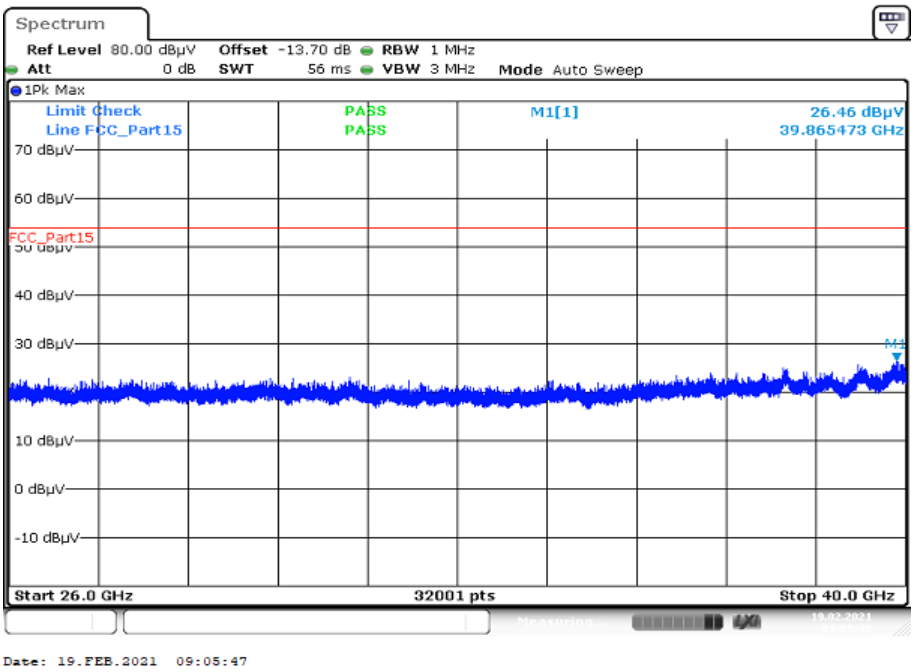
Plot 4: 1 GHz to 18 GHz; vertical & horizontal polarization; U-NII-1; mid channel



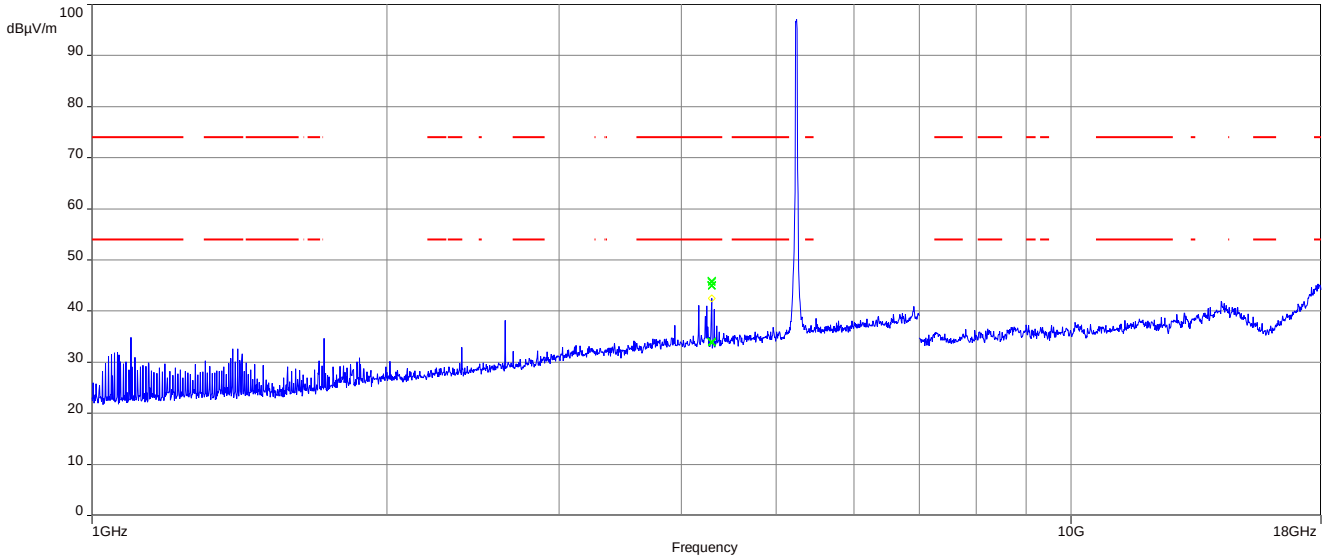
Plot 5: 18 GHz to 26 GHz; vertical & horizontal polarization; U-NII-1; mid channel



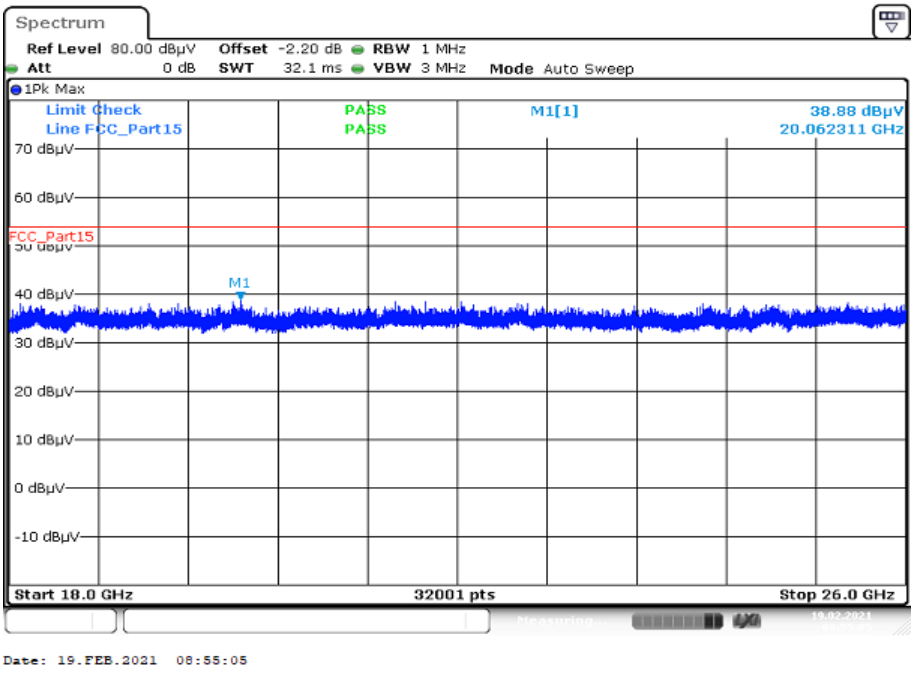
Plot 6: 26 GHz to 40 GHz; vertical & horizontal polarization; U-NII-1; mid channel



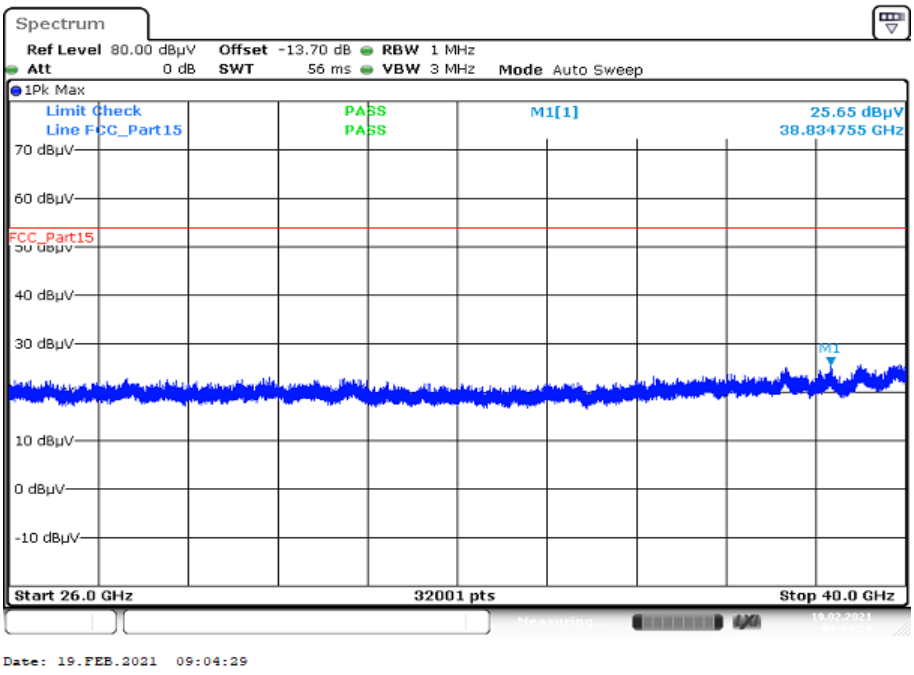
Plot 7: 1 GHz to 18 GHz; vertical & horizontal polarization; U-NII-1; highest channel



Plot 8: 18 GHz to 26 GHz; vertical & horizontal polarization; U-NII-1; highest channel



Plot 9: 26 GHz to 40 GHz; vertical & horizontal polarization; U-NII-1; highest channel



13 Observations

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

14 Glossary

EUT	Equipment under test
DUT	Device under test
UUT	Unit under test
GUE	GNSS User Equipment
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
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
C/N_0	Carrier to noise-density ratio, expressed in dB-Hz

15 Document history

Version	Applied changes	Date of release
-/-	Initial release	2021-03-03
A	HVIN changed	2021-03-25

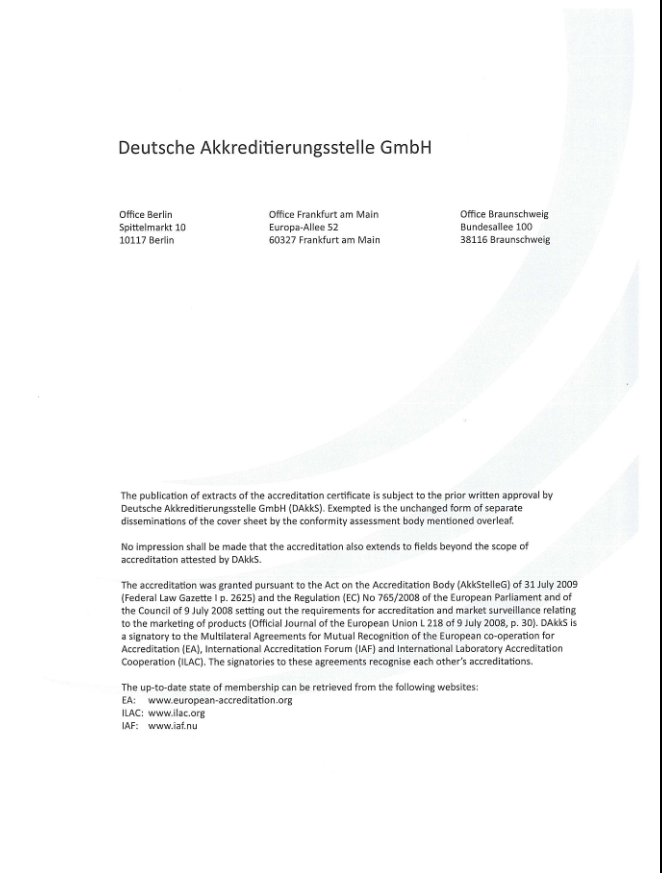
16 Accreditation Certificate – D-PL-12076-01-04

first page	last page
	

Note: The current certificate annex is published on the website (link see below) of the Accreditation Body DAkkS or may be received by CTC advanced GmbH on request

https://www.dakks.de/as/ast/d/D-PL-12076-01-04e.pdf

17 Accreditation Certificate – D-PL-12076-01-05

first page	last page
	

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