

TEST REPORT

BNetzA-CAB-02/21-102

Test report no.: 1-1654/20-01-02-B

Testing laboratory

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Accredited Testing Laboratory:

The testing laboratory (area of testing) is accredited according to DIN EN ISO/IEC 17025 (2018-03) by the Deutsche Akkreditierungsstelle GmbH (DAkkS)

The accreditation is valid for the scope of testing procedures as stated in the accreditation certificate starting with the registration number: D-PL-12076-01.

Applicant

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Manufacturer

Westermo Neratec AG

Rosswiesstrasse 29

8608 Bubikon / SWITZERLAND

Test standard/s

FCC - Title 47 CFR Part 90

FCC - Title 47 of the Code of Federal Regulations; Chapter I; Part 90 - Private Land Mobile Radio Services

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

Test Item

Kind of test item: WLAN Accesspoint

Model name: Ibex-RT-320-LV

FCC ID: 2AEJD-3623-0720

IC: 9301A-36230720

Frequency: 4940 MHz to 4990 MHz band;
Tested frequencies: 4950 MHz, 4965 MHz & 4980 MHz

Technology tested: IEEE 802.11 a (WLAN)

Antenna: two external antennas

Power supply: 16.0 V to 30.0 V DC via external power supply

Temperature range: -40°C to +70°C

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

Test report authorized:



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1 Table of contents

1	Table of contents	2
2	General information	3
2.1	Notes and disclaimer	3
2.2	Application details	3
2.3	Test laboratories sub-contracted	3
3	Test standard/s, references and accreditations	4
4	Reporting statements of conformity – decision rule	5
5	Test environment	6
6	Test item.....	6
6.1	General description	6
6.2	Additional information	6
7	Description of the test setup.....	7
7.1	Shielded fully anechoic chamber.....	8
7.2	Radiated measurements > 18 GHz.....	9
7.3	Conducted measurements WLAN EN test system	10
7.4	AC conducted emissions.....	11
8	Measurement uncertainty	12
9	Summary of measurement results	13
10	Additional information and comments	14
11	Additional EUT parameter	15
12	Measurement results.....	16
12.1	Antenna gain.....	16
12.2	Identify worst case data rate	16
12.3	Occupied Bandwidth – 99% Emission Bandwidth	17
12.4	Transmitter Output Power	18
12.5	Power Spectral Density	20
12.6	Ratio of Peak Excursion	22
12.7	Emission Mask	24
12.8	Frequency Stability.....	25
12.9	Spurious Emissions at Antenna Terminals	27
12.10	Spurious Emissions (radiated above 30 MHz).....	28
12.11	Spurious emissions conducted below 30 MHz (AC conducted).....	33
13	Observations.....	36
14	Glossary	36
15	Document history	37
16	Accreditation Certificate – D-PL-12076-01-04	37
17	Accreditation Certificate – D-PL-12076-01-05	38

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 1-1654/20-01-02-A and dated 2021-05-19.

2.2 Application details

Date of receipt of order: 2021-01-04

Date of receipt of test item: 2021-04-07

Start of test:* 2021-04-08

End of test:* 2021-05-18

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 90	-/-	FCC - Title 47 of the Code of Federal Regulations; Chapter I; Part 90 - Private Land Mobile Radio Services
RSS - 111 Issue 5	September 2014	Broadband Public Safety Equipment Operating in the Band 4940-4990 MHz
RSS - Gen Issue 5 incl. Amendment 1 & 2	February 2021	Spectrum Management and Telecommunications Radio Standards Specification - General Requirements for Compliance of Radio Apparatus

Guidance	Version	Description
ANSI C63.26-2015	-/-	American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Services
SP 4940 MHz	-/-	Spectrum Utilization Policy, Technical and Licensing Requirements for Broadband Public Safety in the Band 4940–4990 MHz

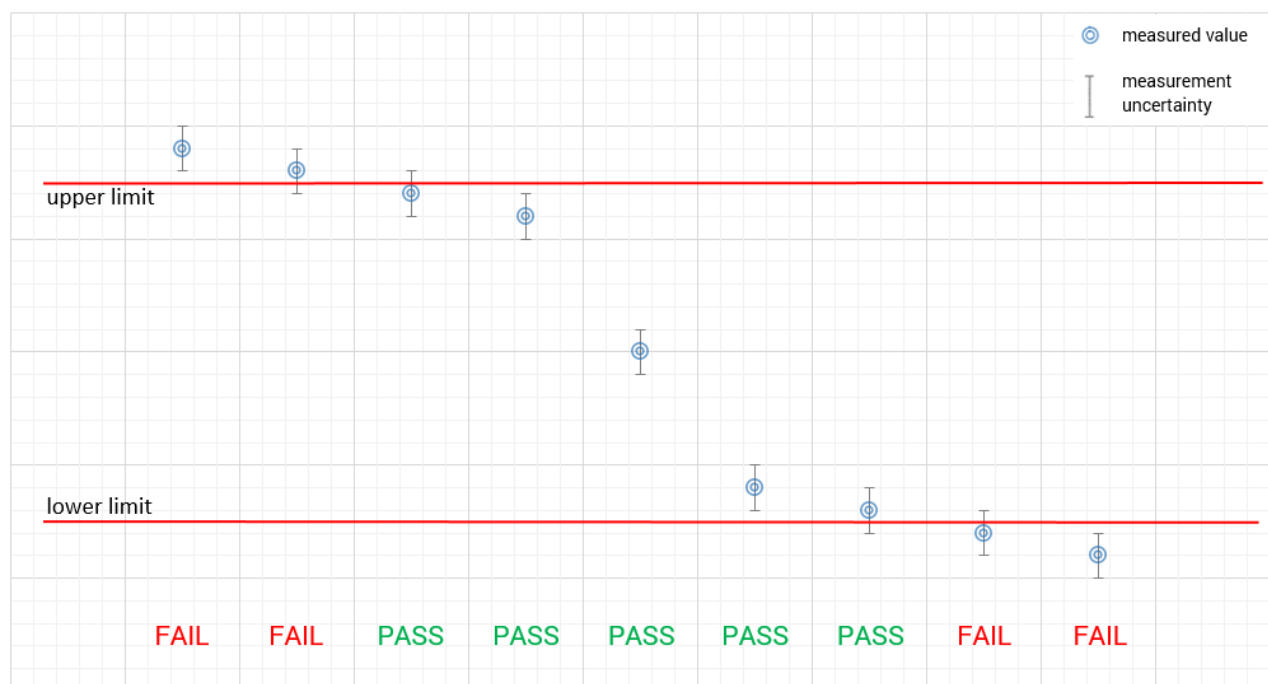
Accreditation	Description
D-PL-12076-01-04	Telecommunication and EMC Canada https://www.dakks.de/as/ast/d/D-PL-12076-01-04e.pdf  
D-PL-12076-01-05	Telecommunication FCC requirements https://www.dakks.de/as/ast/d/D-PL-12076-01-05e.pdf  

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 8, but is not taken into account - neither to the limits nor to the measurement results. Measurement results with a smaller margin to the corresponding limits than the measurement uncertainty have a potential risk of more than 5% that the decision might be wrong."

measured value, measurement uncertainty, verdict



5 Test environment

Temperature :	T_{nom} T_{max} T_{min}	+20 °C during room temperature tests +70 °C during high temperature tests -40 °C during low temperature tests
Relative humidity content :		55 %
Barometric pressure :		1021 hpa
Power supply :	V_{nom} V_{max} V_{min}	20.0 V DC via external power supply 30.0 V 16.0 V

6 Test item

6.1 General description

Kind of test item :	WLAN Accesspoint
Model name :	Ibex-RT-320-LV
HMN :	-/-
PMN :	Ibex-RT-320-LV
HVIN :	Ibex-RT-320-LV
FVIN :	6.6
S/N serial number :	622
Hardware status :	V02
Software status :	N/A
Firmware status :	6.6
Frequency band :	4940 MHz to 4990 MHz band; Tested frequencies: 4950 MHz, 4965 MHz & 4980 MHz
Type of radio transmission :	OFDM
Use of frequency spectrum :	
Type of modulation :	(D)BPSK, (D)QPSK, 16 – QAM, 64 – QAM
Number of channels :	7
Antenna :	two external antennas; 2x Huber and Suhner Type: 1356.17.0010, P/N 84012128 with 12 dBi antenna gain
Power supply :	16.0 V to 30.0 V DC via external power supply AC Adapter: CUI INC SMI24-24-V-P6 (100-240V~50-60Hz 0.58A / 24 V DC 1A)
Temperature range :	-40°C to +70°C

6.2 Additional information

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

Test setup and EUT photos are included in test report:

- 1-1654/20-01-01_AnnexA
- 1-1654/20-01-01_AnnexB
- 1-1654/20-01-01_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).

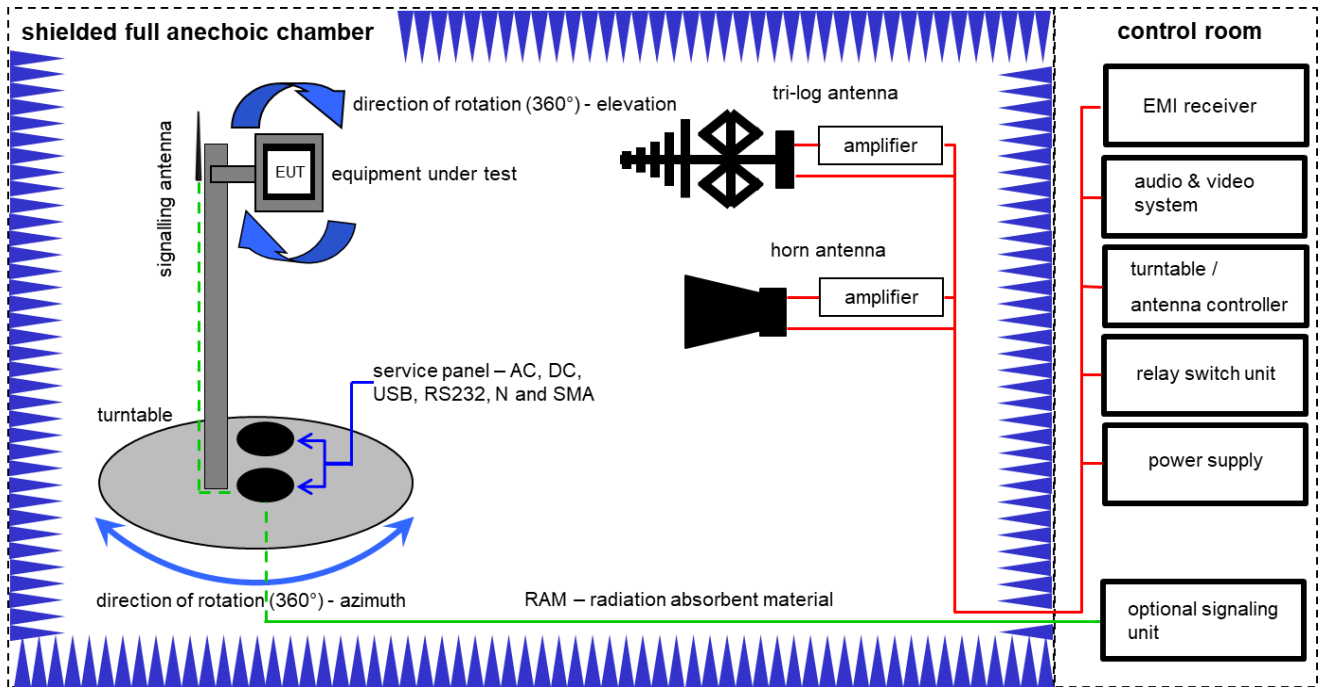
In order to simplify the identification of the equipment used at some special tests, some items of test equipment and ancillaries can be provided with an identifier or number in the equipment list below (Lab/Item).

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

Agenda: Kind of Calibration

k	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 Shielded fully anechoic chamber



Measurement distance: tri-log antenna and horn antenna 3 meter; loop antenna 3 meter

$$OP = AV + D - G + CA$$

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

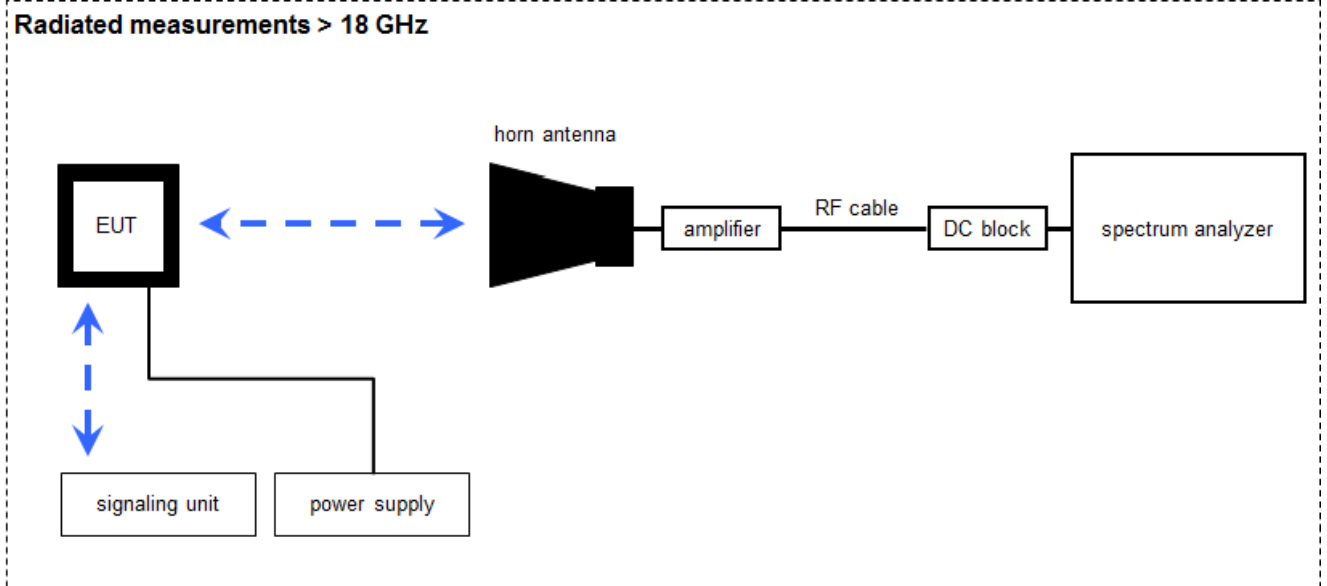
Example calculation:

$$OP \text{ [dBm]} = -65.0 \text{ [dBm]} + 50 \text{ [dB]} - 20 \text{ [dBi]} + 5 \text{ [dB]} = -30 \text{ [dBm]} (1 \text{ }\mu\text{W})$$

Equipment table:

No.	Setup	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	A	Double-Ridged Waveguide Horn Antenna 1-18.0GHz	3115	EMCO	9107-3696	300001604	vIKI!	12.03.2021	11.03.2023
2	A	Highpass Filter	WHK1.1/15G-10SS	Wainwright	37	400000148	ne	-/-	-/-
3	A	Highpass Filter	WHKX7.0/18G-8SS	Wainwright	18	300003789	ne	-/-	-/-
4	A	4U RF Switch Platform	L4491A	Agilent Technologies	MY50000032	300004510	ne	-/-	-/-
5	A, B	Computer	Intel Core i3 3220/3,3 GHz, Prozessor	-/-	2V2403033A54 21	300004591	ne	-/-	-/-
6	A	Highpass Filter	WHKX2.6/18G-10SS	Wainwright	12	300004651	ne	-/-	-/-
7	A	NEXIO EMV-Software	BAT EMC V3.20.0.17	EMCO		300004682	ne	-/-	-/-
8	A	Anechoic chamber		TDK		300003726	ne	-/-	-/-
9	A	EMI Test Receiver 9kHz-26,5GHz	ESR26	Rohde & Schwarz	101376	300005063	k	09.12.2020	08.12.2021
10	A	RF-Amplifier	AMF-6F06001800-30-10P-R	NARDA-MITEQ Inc	2011571	300005240	ev	-/-	-/-
11	A	TRILOG Broadband Test-Antenna 30 MHz - 3 GHz	VULB9163	Schwarzbeck Mess - Elektronik	01029	300005379	vIKI!	02.07.2019	01.07.2021

7.2 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:

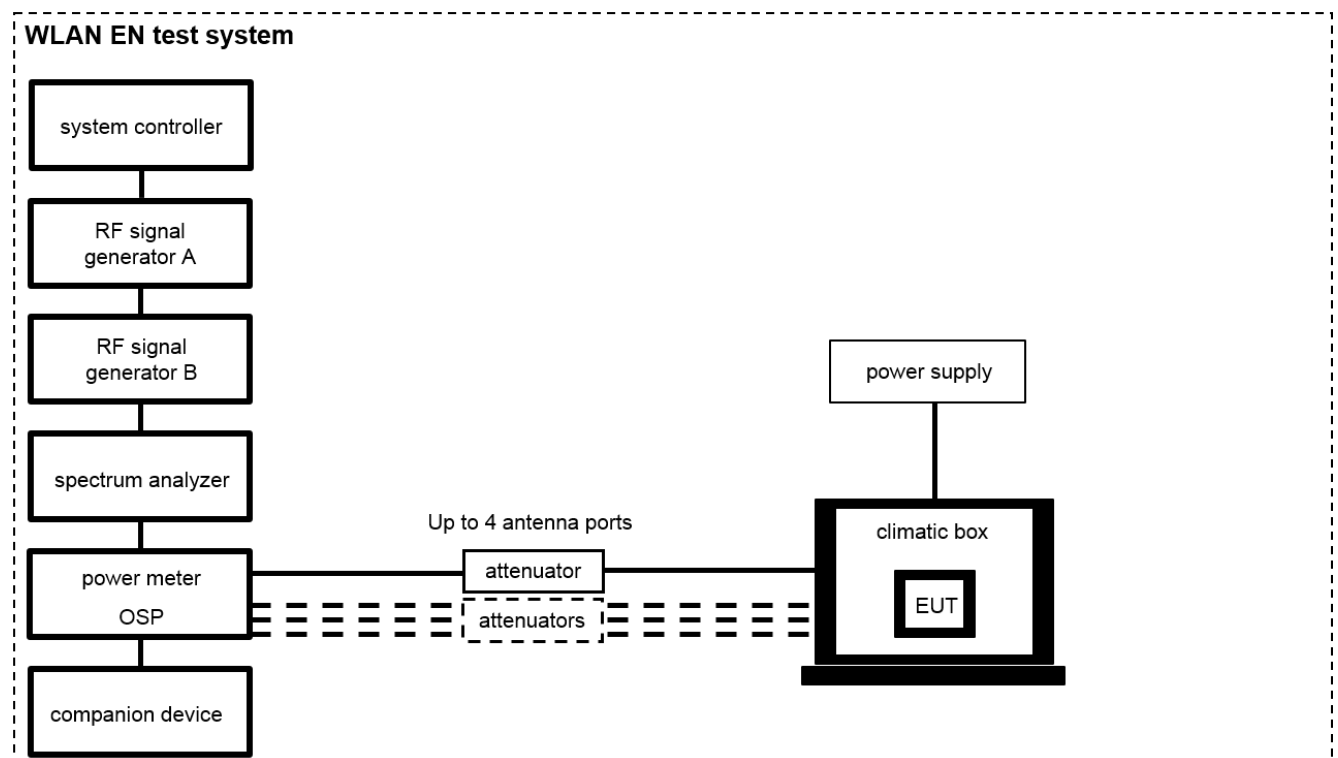
$$OP \text{ [dBm]} = -59.0 \text{ [dBm]} + 44.0 \text{ [dB]} - 20.0 \text{ [dBi]} + 5.0 \text{ [dB]} = -30 \text{ [dBm]} \text{ (1 } \mu\text{W)}$$

Equipment table:

No.	Setup	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	A	Synthesized Sweeper 10 MHz - 40 GHz	83640A	HP	3119A00458	300002266	vIKI!	13.12.2019	12.12.2021
2	A	Std. Gain Horn Antenna 18.0-26.5 GHz	638	Narda	01096	300000486	vIKI!	21.01.2020	20.01.2022
3	A	Std. Gain Horn Antenna 26.5-40.0 GHz	V637	Narda	82-16	300000510	vIKI!	23.01.2020	22.01.2022
4	A	Broadband Low Noise Amplifier 18-50 GHz	CBL18503070-XX	CERNEX	19338	300004273	ev	-/-	-/-
5	A	Signal Analyzer 40 GHz	FSV40	Rohde & Schwarz	101042	300004517	k	07.12.2020	06.12.2021
6	A	RF-Cable	ST18/SMAM/SMAM /48	Huber & Suhner	Batch no. 600918	400001182	ev	-/-	-/-
7	A	DC-Blocker 0.1-40 GHz	8141A	Inmet		400001185	ev	-/-	-/-

7.3 Conducted measurements WLAN EN test system

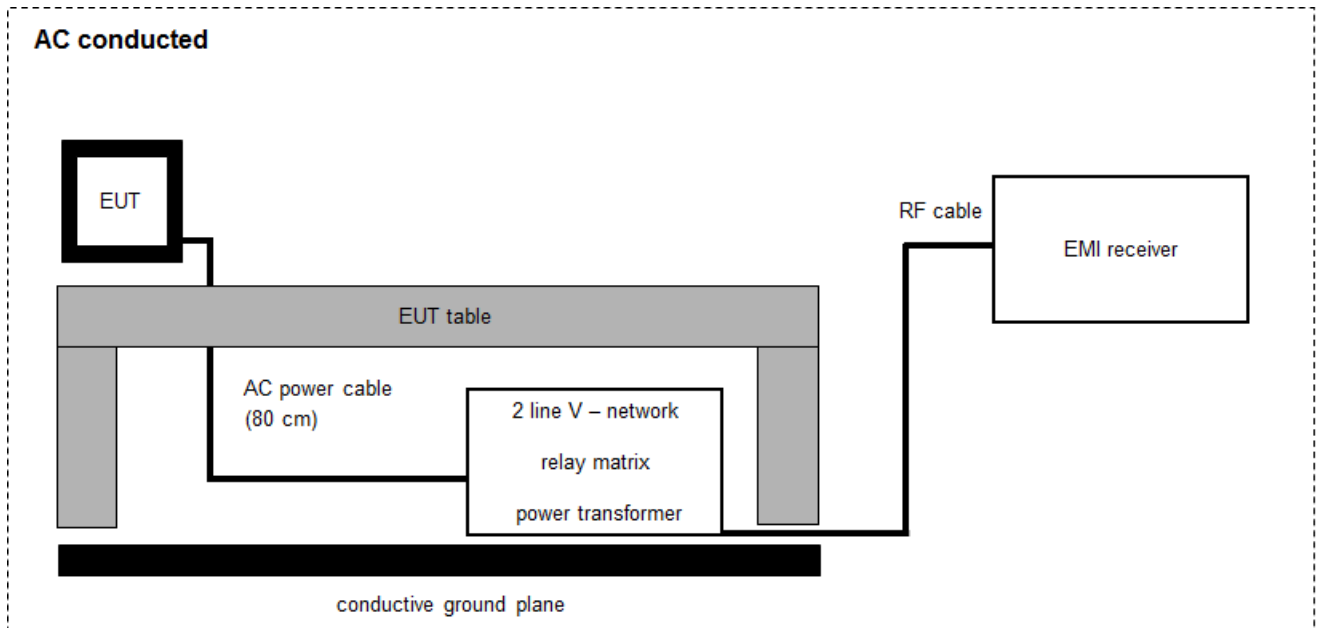
The EUT's RF signal is coupled out by the antenna connector which is supplied by the manufacturer. The signal is first 10dB attenuated before it is power divided (~6dB loss per branch). One of the signal paths is connected to the companion device, the other one is connected to the spectrum analyzer. The losses for all signal paths are first checked within a calibration. The measurement readings on the signaling unit/spectrum analyzer are corrected by the specific test set-up loss. The attenuator, power divider, signaling unit and the spectrum analyzer are impedance matched on 50 Ohm.



Equipment table:

No.	Setup	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	B	Temperature Test Chamber	VT 4002	Heraeus Voetsch	521/84193	300003889	ev	08.05.2020	07.05.2022
2	A, B	Signal Analyzer 40 GHz	FSV40	Rohde & Schwarz	101353	300004819	k	12.01.2021	11.01.2022
3	A	Control-PC of OSP	exone Variety		060931P1302P00109	300004869	ne	-/-	-/-
4	A, B, C	RF-Cable WLAN-Tester Port 1	ST18/SMAm/SMAm /36	Huber & Suhner	Batch no. 601494	400001216	g	-/-	-/-
5	A, B	RF-Cable WLAN-Tester Analyzer	ST18/SMAm/SMAm /36	Huber & Suhner	Batch no. 54876	400001220	ev	-/-	-/-
6	A, B	Tester Software RadioStar (C.BER2 for BT Conformance)	Version 1.0.0.X	CTC advanced GmbH	0001	400001380	ne	-/-	-/-
7	B	DC Power Supply	HMP2020	Rohde & Schwarz	102219	300005264	vKI!	09.12.2020	08.12.2022
8	C	OSP Power Sensors	OSP-B157W8	Rohde & Schwarz	100948	300005566	k	16.12.2020	15.12.2021

7.4 AC conducted emissions



$$FS = UR + CF + VC$$

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

Example calculation:

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

Equipment table:

No.	Setup	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	A	Two-line V-Network (LISN) 9 kHz to 30 MHz	ESH3-Z5	Rohde & Schwarz	892475/017	300002209	vIKI!	11.12.2019	10.12.2021
2	A	RF-Filter-section	85420E	HP	3427A00162	300002214	NK!	-/-	-/-
3	A	EMI Test Receiver	ESCI 3	R&S	100083	300003312	k	09.12.2020	08.12.2021
4	A	Analyzer-Reference-System (Harmonics and Flicker)	ARS 16/1	SPS	A3509 07/0 0205	300003314	vIKI!	17.01.2020	16.01.2022
5	A	Hochpass 150 kHz	EZ-25	R&S	100010	300003798	ev	-/-	-/-
6	A	PC	TecLine	F+W		300003532	ne	-/-	-/-

8 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	

9 Summary of measurement results

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

TC Identifier	Description	Verdict	Date	Remark
RF-Testing	CFR Part 2, CFR Part 90, RSS-111	See table!	2021-05-21	-/-

Test specification clause	Test case	Guideline	Temperature conditions	Power source voltages	Mode	C	NC	NA	NP	Remark
	Antenna gain	-/-	-/-	-/-	OFDM	Declared by manufacturer				-/-
§2.1049, RSS-111 5.2	Occupied Bandwidth	-/-	Nominal	Nominal	OFDM	☒	☐	☐	☐	-/-
§90.1215 (a)(1), §90.1215 (c), RSS-111 4.1	Output Power	-/-	Nominal	Nominal	OFDM	☒	☐	☐	☐	-/-
§90.1215 (a)(2), §90.1215 (d), RSS-111 4.2	Power Spectral Density	-/-	Nominal	Nominal	OFDM	☒	☐	☐	☐	-/-
§90.1215 (e), RSS-111 5.4	Ratio of Peak Excursion	-/-	Nominal	Nominal	OFDM	☒	☐	☐	☐	-/-
§90.210, RSS-111 4.3	Emission masks	-/-	Nominal	Nominal	OFDM	☒	☐	☐	☐	-/-
§90.213, RSS-111 5.2	Frequency Stability	-/-	Nominal	Nominal	OFDM	☒	☐	☐	☐	-/-
§90.209, §90.1213	Bandwidth limitations	-/-	Nominal	Nominal	OFDM	☒	☐	☐	☐	-/-
§90.210, RSS-111 4.3	TX spurious emissions rad. 30 MHz to 40 GHz		Nominal	Nominal	OFDM	☒	☐	☐	☐	-/-
§15.107(a) §15.207	Conducted emissions < 30 MHz	-/-	Nominal	Nominal	OFDM	☒	☐	☐	☐	-/-

Notes:

C	Compliant	NC	Not compliant	NA	Not applicable	NP	Not performed
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10 Additional information and comments

Reference documents: Configuration_Instruction_RT-320-LV.pdf (2021-01-08)

Co-applicable documents: 1-1654_20-01-02_Annex_MR_A1.pdf
1-1654_20-01-02_Annex_MR_A2.pdf

Special test descriptions: None

Configuration descriptions: Data rate and power setting used for testing:

Modulation / Data rate	Power setting (tp)
IEEE 802.11a / 6 Mbit/s	13

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:

Center Frequency (MHz)	Channel Nos. employed	Lower Frequency (MHz)	Upper Frequency (MHz)
4950	1 to 8*	4940	4960
4955	6 to 9	4945	4965
4960	7 to 10	4950	4970
4965	8 to 11	4955	4975
4970	9 to 12	4960	4980
4975	10 to 13	4965	4985
4980	11 to 18*	4970	4990

Note: The frequencies used for the tests are marked in bold in the list.

11 Additional EUT parameter

- Test mode:
- ☐ No test mode available
Iperf was used to ping another device with the largest support packet size
- ☒ Test mode available
Special software is used.
EUT is transmitting pseudo random data by itself
- Modulation types:
- ☒ Wide Band Modulation (None Hopping – e.g. DSSS, OFDM)
- ☐ Frequency Hopping Spread Spectrum (FHSS)
- 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

As declared by manufacturer (see referenced documents).

12.2 Identify worst case data rate

Description:

All modes of the module will be measured with an average power meter or spectrum analyzer to identify the maximum transmission power.

In further tests only the identified worst case modulation scheme or bandwidth will be measured and this mode is used as representative mode for all other modulation schemes.

Measurement:

Measurement parameter	
RMS Power Sensor	
Test setup	See chapter 7.3 C
Measurement uncertainty	See chapter 8

Results:

Modulation (Data rate) / Output Power @ 4965 MHz (dBm)	
OFDM / a – mode / 6Mbit/s	10.83*
OFDM / a – mode / 9Mbit/s	10.77
OFDM / a – mode / 12Mbit/s	10.69
OFDM / a – mode / 18Mbit/s	10.30
OFDM / a – mode / 24Mbit/s	10.30
OFDM / a – mode / 36Mbit/s	10.08
OFDM / a – mode / 48Mbit/s	9.90
OFDM / a – mode / 54Mbit/s	9.76

Note:

*Based on the highest output power over all data rates 6Mbit/s mode was used to perform the measurements.

No path loss data applied to the above values. Relative measurements for worst case data rate identification.

12.3 Occupied Bandwidth – 99% Emission Bandwidth

Description:

The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated.

Measurement:

Measurement parameter	
Detector	Peak
Sweep time	Auto
Resolution bandwidth	1 MHz
Video bandwidth	3 MHz
Span	30 MHz / 50 MHz
Measurement procedure	Measurement of the 99% bandwidth using the integration function of the analyzer
Trace mode	Single count with 2500 counts
External result file(s)	1-1654_20-01-02_Annex_MR_A1.pdf ~ §90.209 Bandwidth limitations / 99%BW - 6 MBit/s OFDM
Test setup	See chapter 7.3 A
Measurement uncertainty	See chapter 8

Usage:

FCC	ISED
The OBW of the transmitter must remain within the borders of the frequency band as specified.	

Results:

antenna port 1	99% emission bandwidth / kHz		
	lowest channel	middle channel	highest channel
OFDM / a – mode	18669	18741	18741

Plots: See external result files

12.4 Transmitter Output Power

Description:

Measurement of the maximum conducted RMS output power. The measurements are performed using the data rate identified in the previous chapter.

Measurement:

Measurement parameter	
Detector:	RMS
Sweep time:	$\geq 10 * (\text{swp points}) * (\text{total on/off time})$
Resolution bandwidth:	1 MHz
Video bandwidth:	≥ 3 MHz
Span:	> EBW
Trace mode:	Max hold
Analyzer function	Band power / channel power Interval > 99% OBW
Used test setup:	See chapter 7.3 A
Measurement uncertainty:	See chapter 8
External result file(s)	1-1654_20-01-02_Annex_MR_A1.pdf ~ §90.205 Output Power and Power Density - 6 MBit/s OFDM 1-1654_20-01-02_Annex_MR_A2.pdf ~ §90.205 Output Power and Power Density - 6 MBit/s OFDM

Limits:

FCC / ISSED		
Channel bandwidth (MHz)	Low power maximum conducted output power (dBm)	High power maximum conducted output power (dBm)
1	7	20
5	14	27
10	17	30
15	18.8	31.8
20	20	33
Conducted limit with an gain of 12 dBi = 17 dBm		

Note:

As per §90.1215 (a) (2) and SP4940 (7) the declared antenna gain of 12 dBi results in a reduced conducted output power limit of 17 dBm (20 dBm – (12dBi – 9 dBi)).

A Duty Cycle correction factor of $10 \times \log(0.969) = 0.13\text{dB}$ is considered in the subsequent results.

Results:

antenna port 1	maximum output power / dBm		
	lowest channel	middle channel	highest channel
Output power conducted OFDM / a – mode	11.61	10.95	11.5

antenna port 2	maximum output power / dBm		
	lowest channel	middle channel	highest channel
Output power conducted OFDM / a – mode	12.06	12.63	11.72

antenna port 1 + 2 calculated	maximum output power / dBm		
	lowest channel	middle channel	highest channel
Output power conducted OFDM / a – mode	14.85	14.88	14.62

Plots: See external result files

12.5 Power Spectral Density

Description:

Measurement of the peak power spectral density of a digital modulated system. The PSD shows the strength of the variations as a function of the frequency. The measurement is repeated for both modulations at the lowest, middle and highest channel.

Measurement:

Measurement parameter	
Detector	RMS (ISED) / Peak (FCC) - calculated
Sweep time	60s
Resolution bandwidth	1 MHz
Video bandwidth	3 MHz
Span	> 1.5 x 99% BW
External result file(s)	1-1654_20-01-02_Annex_MR_A1.pdf ~ §90.205 Output Power and Power Density - 6 MBit/s OFDM 1-1654_20-01-02_Annex_MR_A2.pdf ~ §90.205 Output Power and Power Density - 6 MBit/s OFDM
Test setup	See chapter 7.3 A
Measurement uncertainty	See chapter 8

Limits:

FCC / ISED	
Low power maximum conducted output power (dBm)	High power maximum conducted output power (dBm)
8 dBm / MHz	21 dBm / MHz
Conducted limit with an gain of 12 dBi = 5 dBm / MHz	

Note:

As per §90.1215 (a) (2) and SP4940 (7) the declared antenna gain of 12 dBi results in a reduced conducted output power limit of 5 dBm/MHz (8 dBm/MHz – (12dBi – 9 dBi)).

Results: antenna port 1

measured	power spectral density (dBm / MHz)		
	Lowest channel	Middle channel	Highest channel
OFDM / a – mode (RMS)	0.1	-0.4	0.2

Results: antenna port 2

measured	power spectral density (dBm / MHz)		
	Lowest channel	Middle channel	Highest channel
OFDM / a – mode (RMS)	0.8	1.4	0.2

Results: antenna port 1 + 2 (sum power)

calculated	power spectral density (dBm / MHz)		
	Lowest channel	Middle channel	Highest channel
OFDM / a – mode (RMS)	3.5	3.6	3.2

Plots: See external result files

12.6 Ratio of Peak Excursion

Description:

The ratio of the peak excursion of the modulation envelope (measured using a peak hold function) to the maximum conducted output power shall not exceed 13 dB across any 1 MHz bandwidth or the emission bandwidth whichever is less.

Measurement:

Measurement parameter	
Detector	RMS / Peak
Sweep time	60s
Resolution bandwidth	1 MHz
Video bandwidth	3 MHz
Span	> 1.5 x 99% BW
External result file(s)	1-1654_20-01-02_Annex_MR_A1.pdf ~ §90.1215(e) Peak Excursion - 6 MBit/s OFDM
Test setup	See chapter 7.3 A
Measurement uncertainty	See chapter 8

Limits:

Low power maximum conducted output power (dBm)	High power maximum conducted output power (dBm)
FCC / ISSED	
13 dB across any 1 MHz bandwidth	

Results: antenna port 1

measured	power spectral density (dBm / MHz)		
	Lowest channel	Middle channel	Highest channel
OFDM / a – mode (Peak)	10.3	10.2	10.5
OFDM / a – mode (RMS)	0.1	- 0.4	0.2
Peak to RMS Ratio	10.2	10.6	10.3

Results: antenna port 2

measured	power spectral density (dBm / MHz)		
	Lowest channel	Middle channel	Highest channel
OFDM / a – mode (Peak)	11.0	12.0	10.5
OFDM / a – mode (RMS)	0.8	1.4	0.2
Peak to RMS Ratio	10.2	10.6	10.3

Plots: See external result files

12.7 Emission Mask

Description:

The zero dB reference is measured relative to the highest average power of the fundamental emission measured across the designated channel bandwidth using a resolution bandwidth of at least one percent of the occupied bandwidth of the fundamental emission and a video bandwidth of 30 kHz.

Measurement:

Measurement parameter	
Detector	RMS
Sweep time	30s
Resolution bandwidth	200 kHz
Video bandwidth	500 kHz
External result file(s)	1-1654_20-01-02_Annex_MR_A1.pdf ~ §90.210 Emission masks - 6 MBit/s OFDM, 1-1654_20-01-02_Annex_MR_A2.pdf ~ §90.210 Emission masks - 6 MBit/s OFDM
Test setup	See chapter 7.3 A
Measurement uncertainty	See chapter 8

Limits:

FCC and ISED
For high power transmitters (greater than 20 dBm) operating in the 4940-4990 MHz frequency band, the power spectral density of the emissions must be attenuated below the output power of the transmitter as follows:
On any frequency removed from the assigned frequency between 0-45% of the authorized bandwidth (BW): 0 dB.
On any frequency removed from the assigned frequency between 45-50% of the authorized bandwidth: $56.8 \log (\% \text{ of (BW)/45})$ dB.
On any frequency removed from the assigned frequency between 50-55% of the authorized bandwidth: $26 + 14.5 \log (\% \text{ of (BW)/50})$ dB.
On any frequency removed from the assigned frequency between 55-100% of the authorized bandwidth: $32 + 3.1 \log (\% \text{ of (BW)/55})$ dB.
On any frequency removed from the assigned frequency between 100-150% of the authorized bandwidth: $40 + 5.7 \log (\% \text{ of (BW)/100})$ dB.
On any frequency removed from the assigned frequency between above 150% of the authorized bandwidth: 50 dB or $55 + 10 \log (P)$ dB, whichever is the lesser attenuation.
Where (P) is the output power in watts.

Plots: See external result files

12.8 Frequency Stability

Description:

Frequency Stability vs. Temperature: The equipment under test was connected to an external AC power supply and the RF output was connected to the Spectrum Analyzer. The EUT was placed inside the temperature chamber.

After the temperature stabilized for approximately 20 minutes, the frequency output was recorded from the Spectrum Analyzer.

Measurement:

Measurement parameter	
Detector	Peak
Sweep time	Auto
Resolution bandwidth	300 Hz
Video bandwidth	300 Hz
Span	200 kHz
Test setup	See chapter 7.3 B
Measurement uncertainty	See chapter 8

Limits:

FCC
As per footnote ¹⁰ Except for DSRCS equipment in the 5850-5925 MHz band, frequency stability is to be specified in the station authorization. Frequency stability for DSRCS equipment in the 5850-5925 MHz band is specified in subpart M of the applicable standard.

ISED
The applicant shall ensure frequency stability by showing that the occupied bandwidth is maintained within the band of operation when tested at the temperature and supply voltage variations specified for the frequency stability measurement.

Results: antenna port 1

OFDM / a – mode @ 4965 MHz	Frequency Deviation	
Temperature (°C)	Deviation (kHz)	Deviation (ppm)
70	11	2
60	21	4
50	27	5
40	24	5
30	19	4
20	5	1
10	16	3
0	35	7
-10	50	10
-20	53*	11
-30	51	10
-40	44	9

OFDM / a – mode @ 4965 MHz	Frequency Deviation	
Voltage DC (V)	Deviation (kHz)	Deviation (ppm)
20.4 (85% of Vnom)	18	4
27.6 (115% of Vnom)	17	3

* Maximum frequency deviation

Note: Adding the maximum determined frequency deviation of **53 kHz** to the outermost frequencies of the emission bandwidth reported in section 13.3 (Occupied Bandwidth) shows that under all environmental conditions the emission bandwidth of the transmitter remains within the assigned frequency and channel.

12.9 Spurious Emissions at Antenna Terminals

Description:

The zero dB reference is measured relative to the highest average power of the fundamental emission measured across the designated channel bandwidth using a resolution bandwidth of at least one percent of the occupied bandwidth of the fundamental emission and a video bandwidth of 30 kHz.

Measurement:

Measurement parameter	
Detector	RMS
Sweep time	600s
Resolution bandwidth	200 kHz
Video bandwidth	30 kHz
External result file(s)	1-1654_20-01-02_Annex_MR_A1.pdf ~ §2.1051 / §90.210 Spurious emissions at antenna terminals - 6 MBit/s OFDM 1-1654_20-01-02_Annex_MR_A2.pdf ~ §2.1051 / §90.210 Spurious emissions at antenna terminals - 6 MBit/s OFDM
Test setup	See chapter 7.3
Measurement uncertainty	See chapter 8

Limits:

FCC / ISED
For high power transmitters (greater than 20 dBm) operating in the 4940-4990 MHz frequency band, the power spectral density of the emissions must be attenuated below the output power of the transmitter as follows:
On any frequency removed from the assigned frequency between above 150% of the authorized bandwidth: 50 dB or $55 + 10 \log (P)$ dB, whichever is the lesser attenuation.
Where (P) is the output power in watts.

Plots: See external result files

12.10 Spurious Emissions (radiated above 30 MHz))

Description:

The zero dB reference is measured relative to the highest average power of the fundamental emission measured across the designated channel bandwidth using a resolution bandwidth of at least one percent of the occupied bandwidth of the fundamental emission and a video bandwidth of 30 kHz.

Measurement:

Measurement parameter	
Detector	Peak / RMS
Sweep time	Auto
Resolution bandwidth	200 kHz
Video bandwidth	30 kHz
Span	30 MHz to 40 GHz
Trace mode	Max Hold
Test setup	See chapter 7.1 A & 7.2 A
Measurement uncertainty	See chapter 8

Limits:

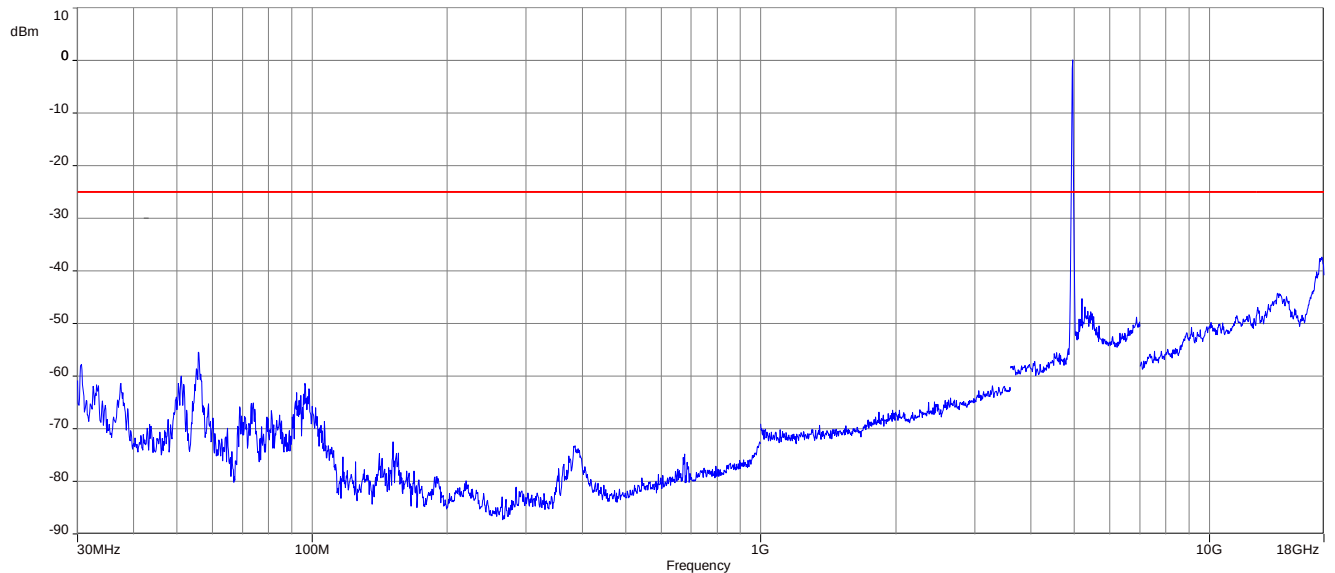
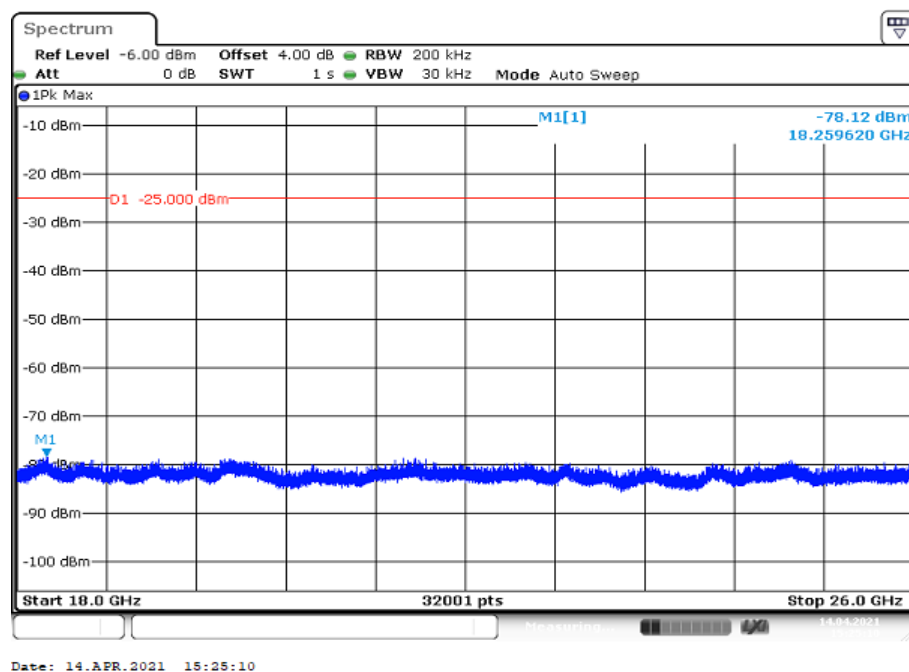
FCC
For high power transmitters (greater than 20 dBm) operating in the 4940-4990 MHz frequency band, the power spectral density of the emissions must be attenuated below the output power of the transmitter as follows:
On any frequency removed from the assigned frequency between above 150% of the authorized bandwidth: 50 dB or $55 + 10 \log (P)$ dB, whichever is the lesser attenuation.
Where (P) is the output power in watts.

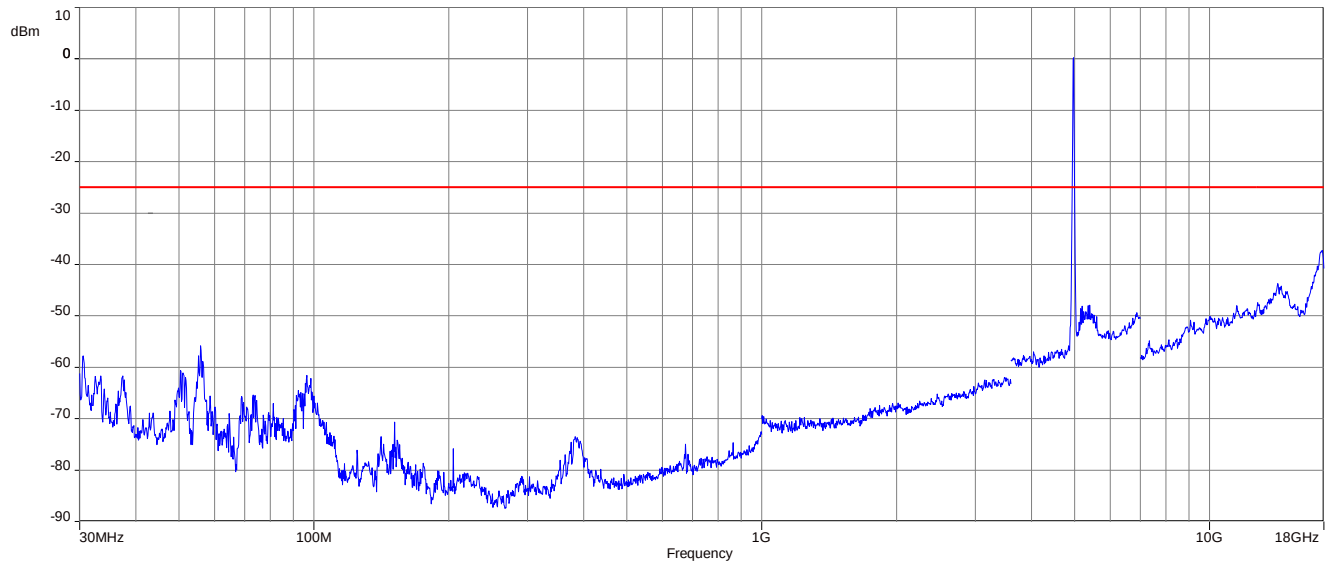
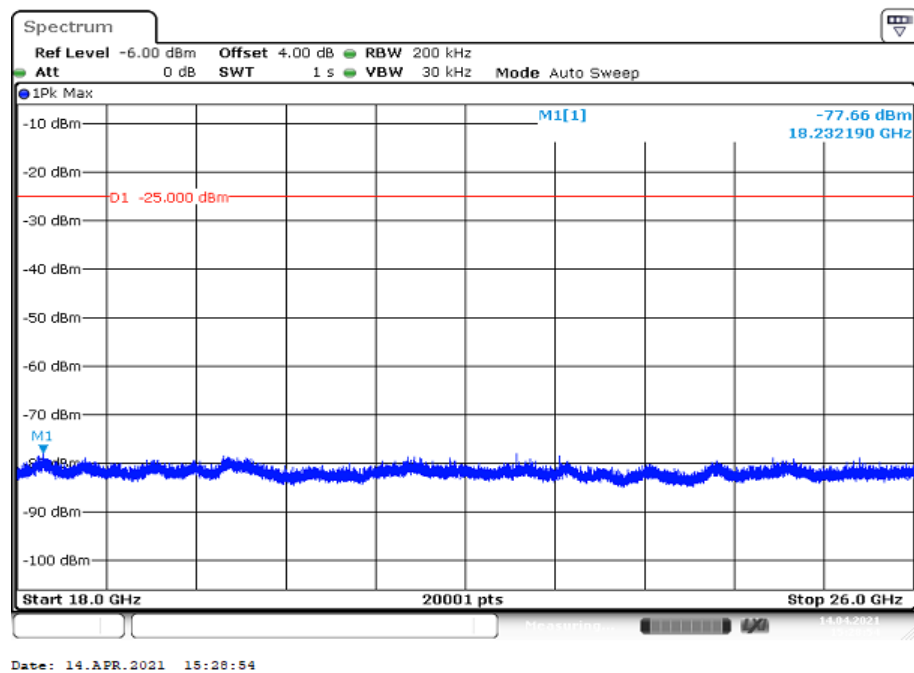
Note:

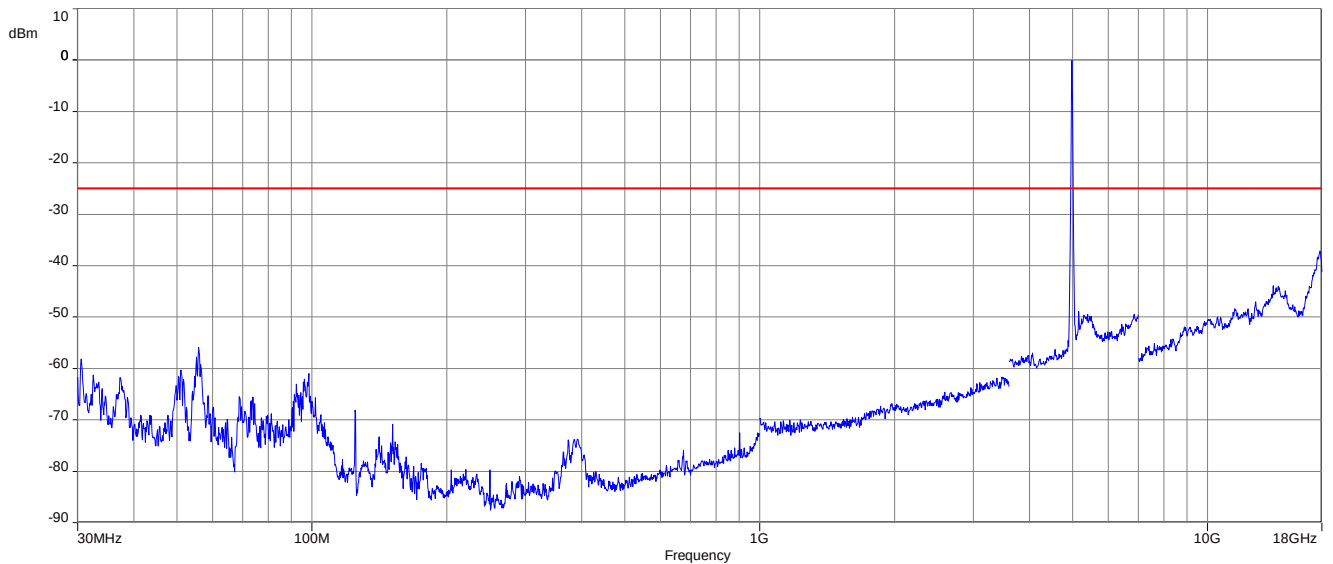
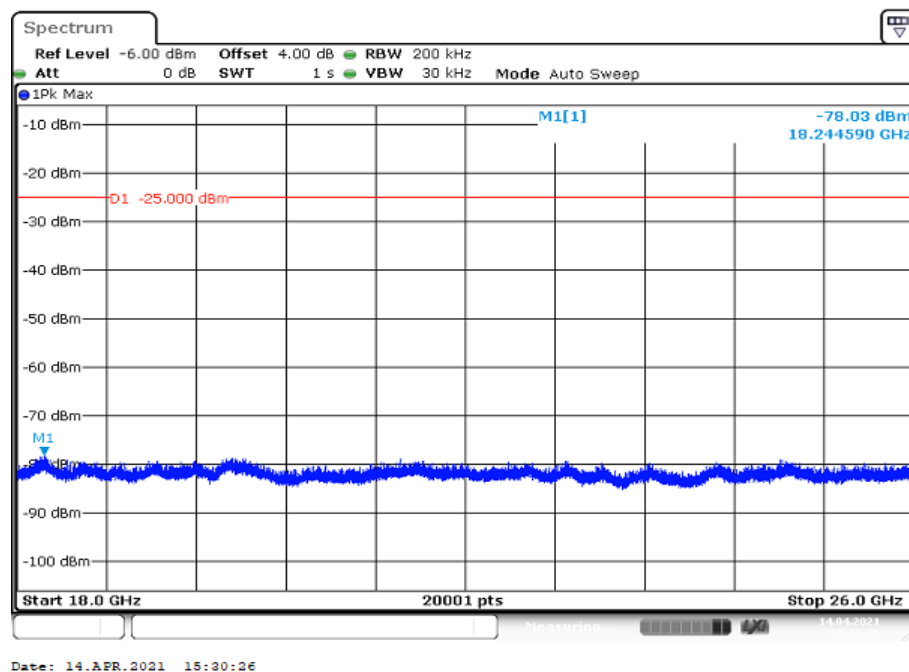
The limit for radiated measurements was calculated with (P) representing the calculated sum power over all antenna terminals.

Results: OFDM (20 MHz nominal channel bandwidth)

TX spurious emissions radiated / dBm								
lowest channel			middle channel			highest channel		
f / MHz	Detector	Level / dBm	f / MHz	Detector	Level / dBm	f / MHz	Detector	Level / dBm
All detected emissions are more than 20 dB below the limit.			All detected emissions are more than 20 dB below the limit.			All detected emissions are more than 20 dB below the limit.		

Plots: OFDM**Plot 1:** Lowest channel, 30 MHz to 18 GHz, vertical & horizontal polarization**Plot 2:** Lowest channel, 18 GHz to 40 GHz, vertical & horizontal polarization, peak & average

Plot 2: Middle channel, 30 MHz to 18 GHz, vertical & horizontal polarization**Plot 3:** Middle channel, 18 GHz to 40 GHz, vertical & horizontal polarization, peak & average

Plot 5: Highest channel, 30 MHz to 18 GHz, vertical & horizontal polarization**Plot 6:** Highest channel, 18 GHz to 40 GHz, vertical & horizontal polarization, peak & average

12.11 Spurious emissions conducted below 30 MHz (AC conducted)

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.

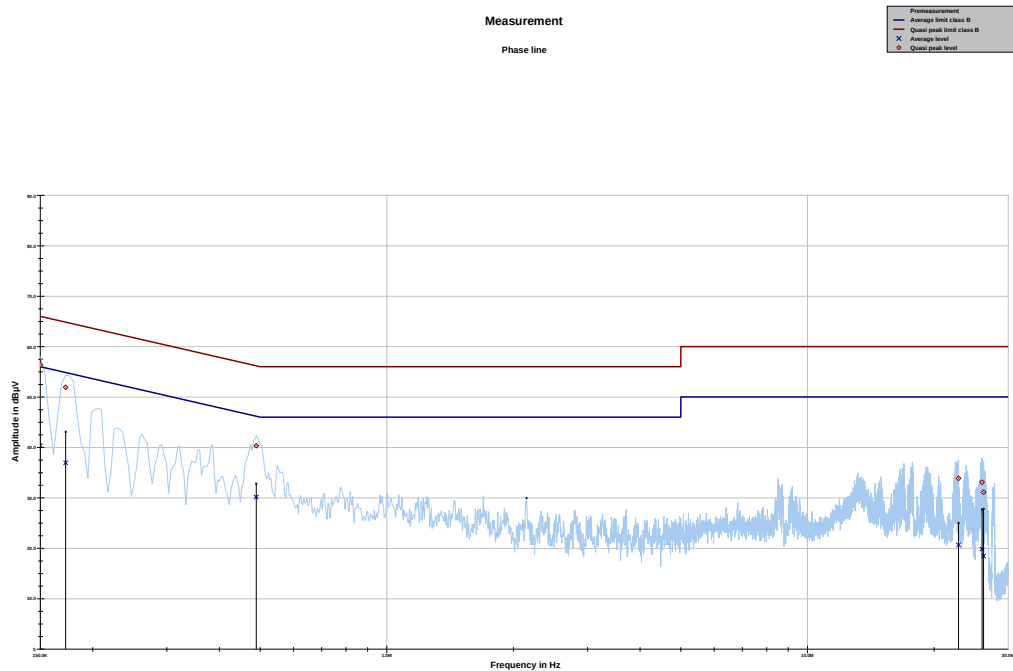
Measurement:

Measurement parameter	
Detector	Peak - Quasi Peak / Average
Sweep time	Auto
Resolution bandwidth	F < 150 kHz: 200 Hz F > 150 kHz: 9 kHz
Video bandwidth	F < 150 kHz: 1 kHz F > 150 kHz: 100 kHz
Span	9 kHz to 30 MHz
Trace mode	Max. hold
Test setup	See chapter 7.4
Measurement uncertainty	See chapter 8

Limits:

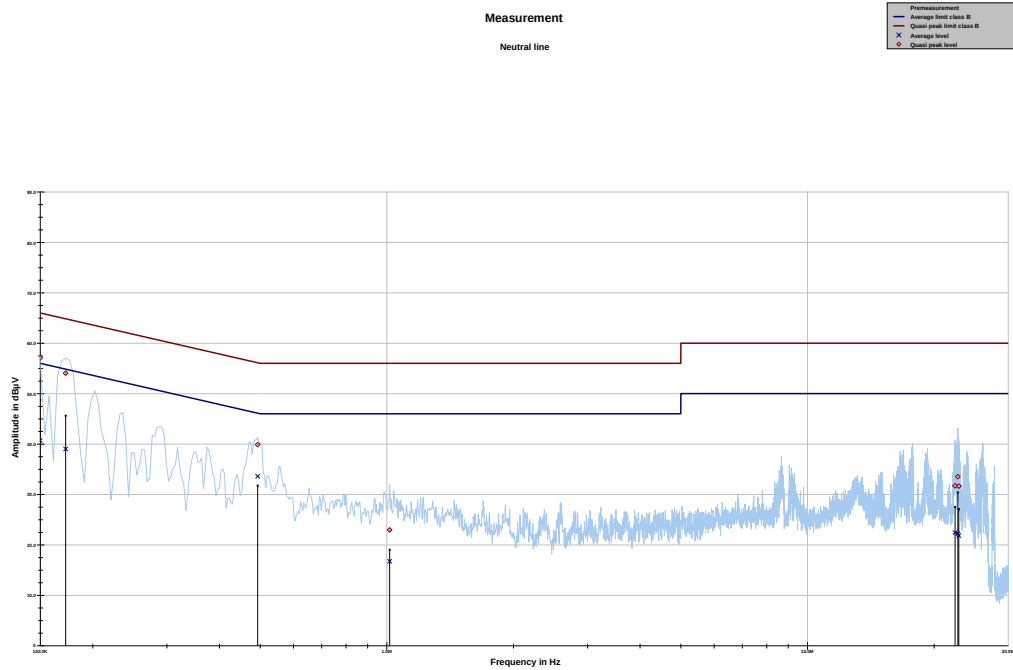
FCC		ISED
Frequency / MHz)	Quasi-Peak / (dB μ V / m)	Average / (dB μ V / m)
0.15 – 0.5	66 to 56*	56 to 46*
0.5 – 5	56	46
5 – 30.0	60	50

*Decreases with the logarithm of the frequency

Plots:**Plot 1:** 150 kHz to 30 MHz, phase line

Project ID: 1654

Frequency	Quasi peak level	Margin quasi peak	Limit QP	Average level	Margin average	Limit AV
MHz	dBµV	dB	dBµV	dBµV	dB	dBµV
0.150000	56.37	9.63	66.000	40.37	15.63	56.000
0.172387	51.92	12.93	64.845	36.95	18.41	55.360
0.489544	40.32	15.85	56.176	30.16	16.14	46.299
22.858387	33.86	26.14	60.000	20.67	29.33	50.000
26.000100	33.09	26.91	60.000	19.83	30.17	50.000
26.223975	31.10	28.90	60.000	18.43	31.57	50.000

Plot 2: 150 kHz to 30 MHz, neutral line

Frequency	Quasi peak level	Margin quasi peak	Limit QP	Average level	Margin Average	Limit AV
MHz	dBµV	dB	dBµV	dBµV	dB	dBµV
0.150000	57.09	8.91	66.000	40.70	15.30	56.000
0.172387	54.06	10.78	64.845	39.01	16.35	55.360
0.493275	39.88	16.23	56.112	33.60	12.59	46.192
1.015650	22.97	33.03	56.000	16.74	29.26	46.000
22.436756	31.71	28.29	60.000	22.43	27.57	50.000
22.776300	33.54	26.46	60.000	22.21	27.79	50.000
22.891969	31.64	28.36	60.000	21.85	28.15	50.000

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
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

15 Document history

Version	Applied changes	Date of release
-/-	Initial release	2021-04-20
A	Conducted Emissions on AC Mains added (12.11)	2021-05-19
B	Editorial changes	2021-05-21

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

first page	last page
 Deutsche Akkreditierungsstelle GmbH Entrusted according to Section 8 subsection 1 AkkStelleG in connection with Section 1 subsection 1 AkkStelleGBV Signatory to the Multilateral Agreements of EA, ILAC and IAF for Mutual Recognition Accreditation  The Deutsche Akkreditierungsstelle GmbH attests that the testing laboratory CTC advanced GmbH Untertürkheimer Straße 6-10, 66117 Saarbrücken is competent under the terms of DIN EN ISO/IEC 17025:2018 to carry out tests in the following fields: Telecommunication (TC) and Electromagnetic Compatibility (EMC) for Canadian Standards The accreditation certificate shall only apply in connection with the notice of accreditation of 09.06.2020 with the accreditation number D-PL-12076-01. It comprises the cover sheet, the reverse side of the cover sheet and the following annex with a total of 07 pages. Registration number of the certificate: D-PL-12076-01-04 Frankfurt am Main, 09.06.2020 by order:  Head of Division The certificate together with its annex reflects the status at the time of the date of issue. The current status of the scope of accreditation can be found in the database of accredited bodies of Deutsche Akkreditierungsstelle GmbH. https://www.dakks.de/en/content/accredited-bodies-dakks See notes overleaf.	Deutsche Akkreditierungsstelle GmbH Office Berlin Spittelmarkt 10 10117 Berlin Office Frankfurt am Main Europa-Allee 52 60327 Frankfurt am Main Office Braunschweig Bundesallee 100 38116 Braunschweig The publication of extracts of the accreditation certificate is subject to the prior written approval by Deutsche Akkreditierungsstelle GmbH (DAkKS). Exempted is the unchanged form of separate disseminations of the cover sheet by the conformity assessment body mentioned overleaf. No impression shall be made that the accreditation also extends to fields beyond the scope of accreditation attested by DAkKS. The accreditation was granted pursuant to the Act on the Accreditation Body (AkkStelleG) of 31 July 2009 (Federal Law Gazette I p. 2625) and the Regulation (EC) No 765/2008 of the European Parliament and of the Council of 9 July 2008 setting out the requirements for accreditation and market surveillance relating to the marketing of products (Official Journal of the European Union L 218 of 9 July 2008, p. 30). DAkKS is a signatory to the Multilateral Agreements for Mutual Recognition of the European co-operation for Accreditation (EA), International Accreditation Forum (IAF) and International Laboratory Accreditation Cooperation (ILAC). The signatories to these agreements recognise each other's accreditations. The up-to-date state of membership can be retrieved from the following websites: EA: www.european-accreditation.org ILAC: www.ilac.org IAF: www.iaf.nu

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

first page	last page
 Deutsche Akkreditierungsstelle GmbH Entrusted according to Section 8 subsection 1 AkkStelleG in connection with Section 1 subsection 1 AkkStelleGBV Signatory to the Multilateral Agreements of EA, ILAC and IAF for Mutual Recognition Accreditation  The Deutsche Akkreditierungsstelle GmbH attests that the testing laboratory CTC advanced GmbH Untertürkheimer Straße 6-10, 66117 Saarbrücken is competent under the terms of DIN EN ISO/IEC 17025:2018 to carry out tests in the following fields: Telecommunication (FCC Requirements) The accreditation certificate shall only apply in connection with the notice of accreditation of 09.06.2020 with the accreditation number D-PL-12076-01. It comprises the cover sheet, the reverse side of the cover sheet and the following annex with a total of 05 pages. Registration number of the certificate: D-PL-12076-01-05 Frankfurt am Main, 09.06.2020 by order: Dipl.-Ing. (FH) Ralf Egner Head of Division The certificate together with its annex reflects the status at the time of the date of issue. The current status of the scope of accreditation can be found in the database of accredited bodies of Deutsche Akkreditierungsstelle GmbH. https://www.dakks.de/en/content/accredited-bodies-dakks See notes reversed.	Deutsche Akkreditierungsstelle GmbH Office Berlin Spittelmarkt 10 10117 Berlin Office Frankfurt am Main Europa-Allee 52 60327 Frankfurt am Main Office Braunschweig Bundesallee 100 38116 Braunschweig The publication of extracts of the accreditation certificate is subject to the prior written approval by Deutsche Akkreditierungsstelle GmbH (DAkkS). Exempted is the unchanged form of separate disseminations of the cover sheet by the conformity assessment body mentioned overleaf. No impression shall be made that the accreditation also extends to fields beyond the scope of accreditation attested by DAkkS. The accreditation was granted pursuant to the Act on the Accreditation Body (AkkStelleG) of 31 July 2009 (Federal Law Gazette I p. 2625) and the Regulation (EC) No 765/2008 of the European Parliament and of the Council of 9 July 2008 setting out the requirements for accreditation and market surveillance relating to the marketing of products (Official Journal of the European Union L 218 of 9 July 2008, p. 30). DAkkS is a signatory to the Multilateral Agreements for Mutual Recognition of the European co-operation for Accreditation (EA), International Accreditation Forum (IAF) and International Laboratory Accreditation Cooperation (ILAC). The signatories to these agreements recognise each other's accreditations. The up-to-date state of membership can be retrieved from the following websites: EA: www.european-accreditation.org ILAC: www.ilac.org IAF: www.iaf.nu

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END OF TEST REPORT