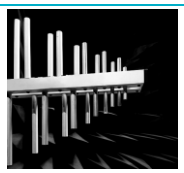
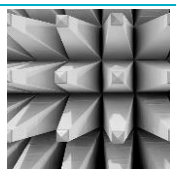




CTC advanced member of RWTÜV group

Bundesnetzagentur

BNetzA-CAB-02/21-102

TEST REPORT

Test report no.: 1-8866/19-03-02-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: http://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 (2005) 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

ROBERT BOSCH GmbH
Daimlerstr. 6
71229 Leonberg / GERMANY
Phone: +49 711 811-0
Contact: Florian Maier
e-mail: Florian.Maier2@de.bosch.com
Phone: +49 711 811-14964

Manufacturer

ROBERT BOSCH GmbH
Daimlerstr. 6
71229 Leonberg / 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:	**OBU**
Model name:	**NRCS2P**
FCC ID:	**NF3-NRCS2P**
IC:	**3887A-NRCS2P**
Frequency:	2400 MHz to 2483.5 MHz DTS band
Technology tested:	WLAN
Antenna:	external antennas
Power supply:	13.5 V DC via car battery
Temperature range:	-40°C to +85°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=Marco Bertolino, o=CTC advanced GmbH, ou=BTL-161128, email=Marco.Bertolino@ctcadvanced.com, c=DE
2020.07.02 12:33:09 +02'00'

Marco Bertolino
Lab Manager
Radio Communications & EMC

Test performed:

cn=David Lang, o=CTC advanced GmbH, ou=LNG-161129, email=david.lang@ctcadvanced.com, c=DE
2020.07.02 12:15:08 +02'00'

David Lang
Lab Manager
Radio Communications & EMC

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.
The test report may only be reproduced or published in full. Reproduction or publication of extracts from the report requires the prior written approval of CTC advanced GmbH.
The testing service provided by CTC advanced GmbH has been rendered under the current "General Terms and Conditions for CTC advanced GmbH".
CTC advanced GmbH will not be liable for any loss or damage resulting from false, inaccurate, inappropriate or incomplete product information provided by the customer.
Under no circumstances does the CTC advanced GmbH test report include any endorsement or warranty regarding the functionality, quality or performance of any other product or service provided.
Under no circumstances does the CTC advanced GmbH test report include or imply any product or service warranties from CTC advanced GmbH, including, without limitation, any implied warranties of merchantability, fitness for purpose, or non-infringement, all of which are expressly disclaimed by CTC advanced GmbH.
All rights and remedies regarding vendor's products and services for which CTC advanced GmbH has prepared this test report shall be provided by the party offering such products or services and not by CTC advanced GmbH.
In no case this test report can be considered as a Letter of Approval.

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.

This test report replaces the test report with the number 1-8866/19-03-02 and dated 2020-06-22.

2.2 Application details

Date of receipt of order:	2020-01-21
Date of receipt of test item:	2020-01-27
Start of test:	2020-01-27
End of test:	2020-02-18
Person(s) present during the test:	Florian Maier

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 558074 D01	v05r02	GUIDANCE FOR COMPLIANCE MEASUREMENTS ON DIGITAL TRANSMISSION SYSTEM, FREQUENCY HOPPING SPREAD SPECTRUM SYSTEM, AND HYBRID SYSTEM DEVICES OPERATING UNDER SECTION 15.247 OF THE FCC RULES
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-12076-01-04.pdf
D-PL-12076-01-05	Telecommunication FCC requirements https://www.dakks.de/as/ast/d/D-PL-12076-01-05.pdf

4 Test environment

Temperature	:	T_{nom} T_{max} T_{min}	+23 °C during room temperature tests No testing under extreme temperature conditions required! No testing under extreme temperature conditions required!
Relative humidity content	:		40 %
Barometric pressure	:		1018 hpa
Power supply	:	V_{nom} V_{max} V_{min}	13.5 V DC via car battery No testing under extreme voltage conditions required! No testing under extreme voltage conditions required!

5 Test item

5.1 General description

Kind of test item	:	OBU
Model name	:	NRCS2P
HMN	:	N/A
PMN	:	Remote Park Assist
HVIN	:	NRCS2P
S/N serial number	:	Rad. #2 ctc #251 Cond. #1 ctc #251
Hardware status	:	C3-Sample
Firmware status	:	md5 sum: 2be124542345bc15299f9d55593e2523
Frequency band	:	2400 MHz to 2483.5 MHz DTS band
Type of radio transmission Use of frequency spectrum	: :	DSSS, OFDM
Type of modulation	:	CCK, (D)BPSK, (D)QPSK, 16 – QAM, 64 – QAM
Number of channels	:	11
Antenna	:	external antennas; Antenna assembly 1: A 223 905 55 03 A-MID SDARS Antenna assembly 2: A 223 905 12 05 A-MID HAF (partially tested) Note: According to the customer, both antenna assemblies as referred to above contain an identical antenna element for the frequency range tested. The differences between those assemblies are the arrangement of other antenna elements used by other technologies and the form factor of the housing. Therefore, only partial tests were performed on antenna assembly 2.
Power supply	:	13.5 V DC via car battery
Temperature range	:	-40°C to +85°C

5.2 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: 1-8866/19-03-01_AnnexA
1-8866/19-03-01_AnnexB
1-8866/19-03-01_AnnexD

6 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).

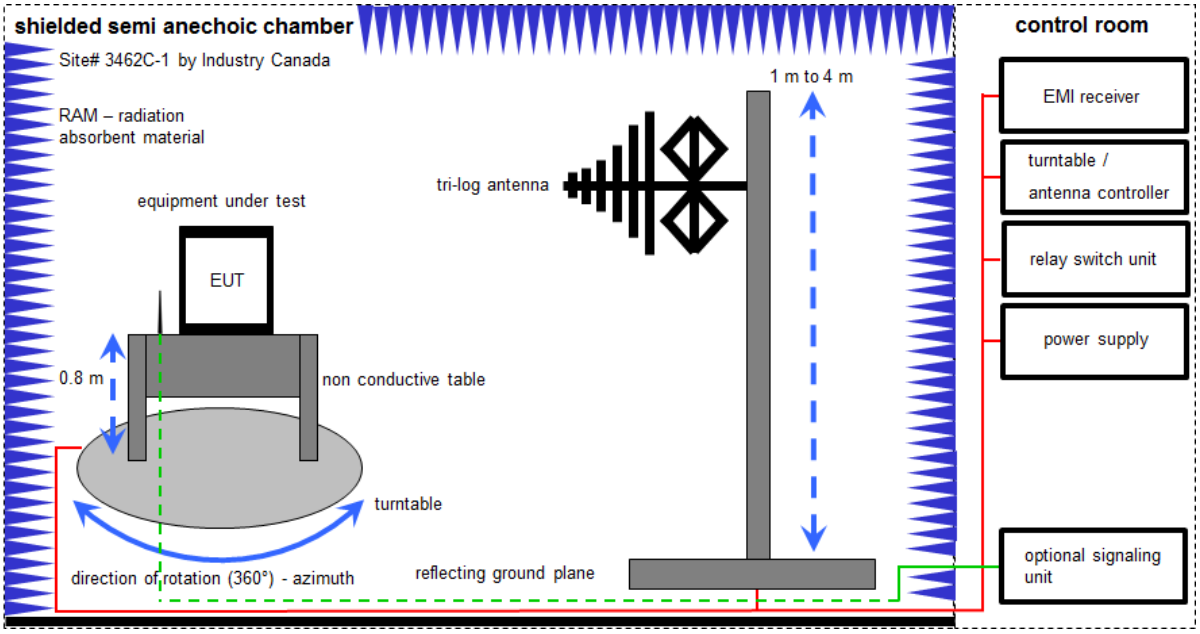
In order to simplify the identification of the equipment used at some special tests, some items of test equipment and ancillaries can be provided with an identifier or number in the equipment list below (Lab/Item).

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

6.1 Shielded semi anechoic chamber

The radiated measurements are performed in vertical and horizontal plane in the frequency range from 30 MHz to 1 GHz in semi-anechoic chambers. The EUT is positioned on a non-conductive support with a height of 0.80 m above a conductive ground plane that covers the whole chamber. The receiving antennas are conform to specifications ANSI C63. These antennas can be moved over the height range between 1.0 m and 4.0 m in order to search for maximum field strength emitted from EUT. The measurement distances between EUT and receiving antennas are indicated in the test setups for the various frequency ranges. For each measurement, the EUT is rotated in all three axes until the maximum field strength is received. The wanted and unwanted emissions are received by spectrum analyzers where the detector modes and resolution bandwidths over various frequency ranges are set according to requirement ANSI C63.



Measurement distance: tri-log antenna 10 meter
EMC32 software version: 10.30.0

FS = UR + CL + AF
(FS-field strength; UR-voltage at the receiver; CL-loss of the cable; AF-antenna factor)

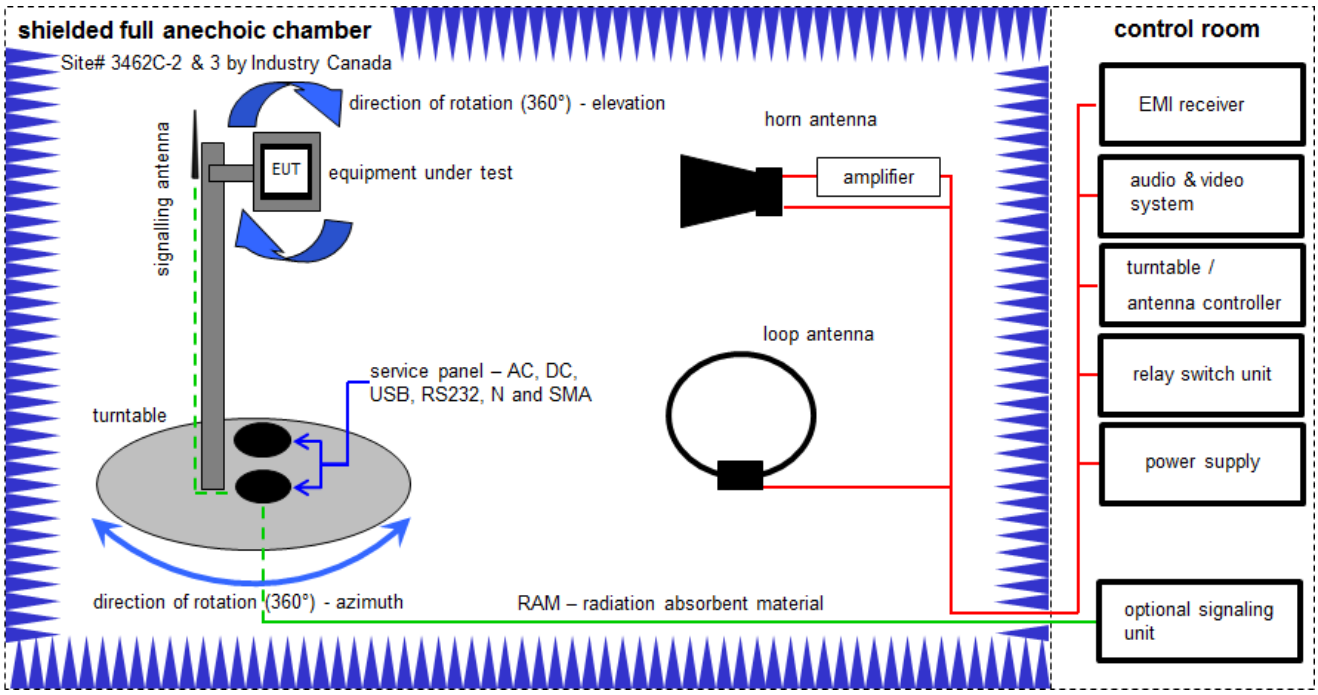
Example calculation:
FS [dBµV/m] = 12.35 [dBµV/m] + 1.90 [dB] + 16.80 [dB/m] = 31.05 [dBµV/m] (35.69 µV/m)

Equipment table:

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	A	DC power supply, 60Vdc, 50A, 1200 W	6032A	HP	2920A04466	300000580	ne	-/-	-/-
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	295	300003787	vIKI!	19.02.2019	18.02.2021

7	A	Double Ridge Broadband Horn Antenna 1-10 GHz	BBHA9120 B	Schwarzbeck	188	300003896	vIKI!	25.04.2018	24.04.2020
8	A	EMI Test Receiver	ESR3	Rohde & Schwarz	102587	300005771	k	21.05.2019	20.05.2020

6.2 Shielded fully anechoic chamber



Measurement distance: horn antenna 3 meter; loop antenna 3 meter / 1 meter

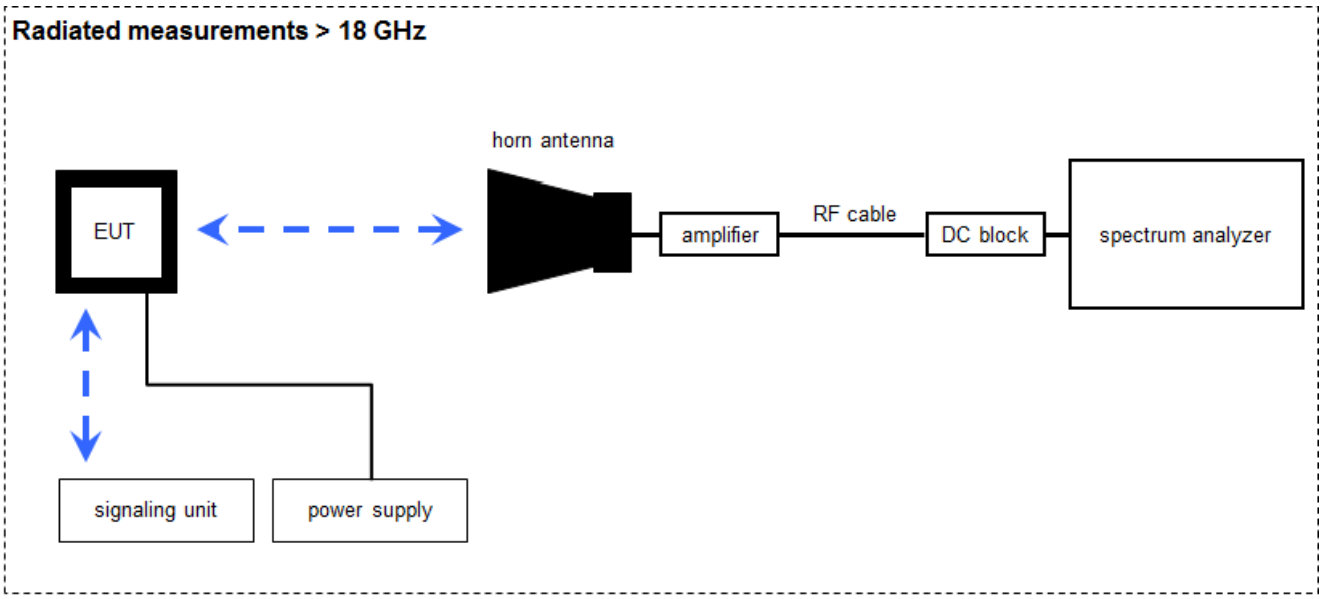
FS = UR + CA + AF
(FS-field strength; UR-voltage at the receiver; CA-loss of the signal path; AF-antenna factor)

Example calculation:
FS [dBµV/m] = 40.0 [dBµV/m] + (-35.8) [dB] + 32.9 [dB/m] = 37.1 [dBµV/m] (71.61 µV/m)

Equipment table:

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	A+B+C +D	DC power supply, 60Vdc, 50A, 1200 W	6032A	HP	2818A03450	300001040	vIKI!	12.12.2017	11.12.2020
2	A+B+C +D	Anechoic chamber	FAC 3/5m	MWB / TDK	87400/02	300000996	ev	-/-	-/-
3	A+B+C	Double-Ridged Waveguide Horn Antenna 1-18.0GHz	3115	EMCO	9107-3697	300001605	vIKI!	27.02.2019	26.02.2021
4	A+B+C +D	Switch / Control Unit	3488A	HP	*	300000199	ne	-/-	-/-
5	B	Band Reject filter	WRCG2400/2483-2375/2505-50/10SS	Wainwright	11	300003351	ev	-/-	-/-
6	A+B+C +D	EMI Test Receiver 20Hz- 26,5GHz	ESU26	R&S	100037	300003555	k	11.12.2019	10.12.2020
7	A+B	Highpass Filter	WHK1.1/15G-10SS	Wainwright	3	300003255	ev	-/-	-/-
8	A+B	Highpass Filter	WHKX7.0/18G-8SS	Wainwright	19	300003790	ne	-/-	-/-
9	A+B	Broadband Amplifier 0.5-18 GHz	CBLU5184540	CERNEX	22049	300004481	ev	-/-	-/-
10	A+B+C +D	4U RF Switch Platform	L4491A	Agilent Technologies	MY50000037	300004509	ne	-/-	-/-
11	A+B+C +D	Switch-Unit	3488A	HP	2719A14505	300000368	ev	-/-	-/-
12	A+B+C +D	NEXIO EMV-Software	BAT EMC V3.19.1.9	EMCO	-/-	300004682	ne	-/-	-/-
13	D	Active Loop Antenna 9 kHz to 30 MHz	6502	EMCO	2210	300001015	vIKI!	13.06.2019	12.06.2021

6.3 Radiated measurements > 18 GHz



Measurement distance: horn antenna 50 cm

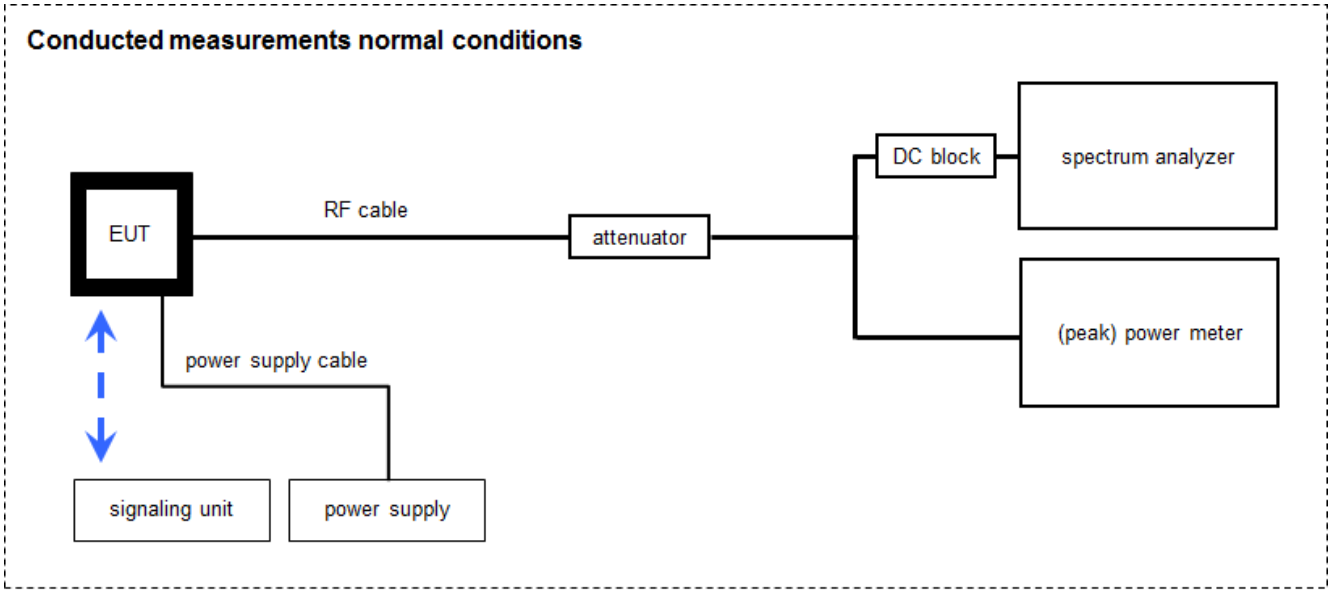
OP = AV + D - G + CA
(OP-radiated output power; AV-analyzer value; D-free field attenuation of measurement distance; G-antenna gain+amplifier gain; CA-loss signal path)

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	Microwave System Amplifier, 0.5-26.5 GHz	83017A	HP	00419	300002268	ev	-/-	-/-
2	A	Std. Gain Horn Antenna 18.0-26.5 GHz	638	Narda	8205	300002442	NK!	-/-	-/-
3	A	Signal Analyzer 40 GHz	FSV40	R&S	101042	300004517	k	17.12.2019	16.12.2020
4	A	RF-Cable	ST18/SMAm/SMAm /48	Huber & Suhner	Batch no. 600918	400001182	ev	-/-	-/-
5	A	RF-Cable	ST18/SMAm/SMAm /48	Huber & Suhner	Batch no. 127377	400001183	ev	-/-	-/-
6	A	DC-Blocker 0.1-40 GHz	8141A	Inmet	-/-	400001185	ev	-/-	-/-
7	A	DC Power Supply	HMP2020	Rohde & Schwarz	102850	300005517	vIKI!	12.12.2019	11.12.2021

6.4 Conducted measurements with peak power meter & spectrum analyzer



WLAN tester version: 1.1.13; LabView2015

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+B	Hygro-Thermometer	-/-, 5-45°C, 20-100%rF	Thies Clima	-/-	400000108	ev	11.05.2018	10.05.2020
2	A+B	PC Tester R005	Intel Core i3 3220/3,3 GHz, Prozessor	-/-	2V2403033A4523	300004589	ne	-/-	-/-
3	A+B	Teststand	Teststand Custom Sequence Editor	National Instruments GmbH	-/-	300004590	ne	-/-	-/-
4	A+B	RF-Cable	ST18/SMAm/SMAm/60	Huber & Suhner	Batch no. 606844	400001181	ev	-/-	-/-
5	A+B	Coax Attenuator 10 dB 2W 0-40 GHz	MCL BW-K10-2W44+	Mini Circuits	-/-	400001186	ev	-/-	-/-
6	A+B	Synchron Power Meter	SPM-4	CTC	1	300005580	ev	-/-	-/-
7	A+B	DC-Blocker	WA7046	Weinschel Associates	-/-	400001310	ev	-/-	-/-
8	A+B	DC Power Supply	HMP2020	Rohde & Schwarz	102850	300005517	vIKI!	12.12.2019	11.12.2021
9	A	USB Wideband Power Sensor (50MHz - 18GHz)	U2021XA	Keysight	MY591900010	300005802	k	11.12.2019	10.12.2020
10	B	Signal Analyzer 40 GHz	FSV40	R&S	101042	300004517	k	17.12.2019	16.12.2020

7 Sequence of testing

7.1 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.

7.2 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.

7.3 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.

7.4 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 Measurement uncertainty

Measurement uncertainty		
Test case	**Uncertainty**	
Antenna gain	± 3 dB	
Power spectral density	± 1.15 dB	
DTS bandwidth	± 100 kHz (depends on the used RBW)	
Occupied bandwidth	± 100 kHz (depends on the used RBW)	
Maximum output power conducted	± 1.15 dB	
Detailed spurious emissions @ the band edge - conducted	± 1.15 dB	
Band edge compliance radiated	± 3 dB	
Spurious emissions conducted	> 3.6 GHz	± 1.15 dB
	> 7 GHz	± 1.15 dB
	> 18 GHz	± 1.89 dB
	≥ 40 GHz	± 3.12 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 15 RSS - 247, Issue 2	See table!	2020-07-02	-/-

Test specification clause	Test case	Guideline	Temperature & power source conditions	Mode	C	NC	NA	NP	Remark
§15.247(b)(4) RSS - 247 / 5.4 (f)(ii)	Antenna gain	-/-	Nominal	DSSS	-/-				-/-
§15.35	Duty cycle	-/-	Nominal	DSSS OFDM	-/-				-/-
§15.247(e) RSS - 247 / 5.2 (b)	Power spectral density	KDB 558074 DTS clause: 8.4	Nominal	DSSS OFDM	☒	☐	☐	☐	-/-
§15.247(a)(2) RSS - 247 / 5.2 (a)	DTS bandwidth	KDB 558074 DTS clause: 8.2	Nominal	DSSS OFDM	☒	☐	☐	☐	-/-
RSS Gen clause 4.6.1	Occupied bandwidth	-/-	Nominal	DSSS OFDM	☒	☐	☐	☐	-/-
§15.247(b)(3) RSS - 247 / 5.4 (d)	Maximum output power	KDB 558074 DTS clause: 8.3.1.3	Nominal	DSSS OFDM	☒	☐	☐	☐	-/-
§15.247(d) RSS - 247 / 5.5	Detailed spurious emissions @ the band edge – cond.	-/-	Nominal	DSSS OFDM	☒	☐	☐	☐	-/-
§15.205 RSS - 247 / 5.5 RSS - Gen	Band edge compliance cond. & rad.	KDB 558074 DTS clause: 8.7.3	Nominal	DSSS OFDM	☒	☐	☐	☐	-/-
§15.247(d) RSS - 247 / 5.5	TX spurious emissions cond.	KDB 558074 DTS clause: 8.5	Nominal	DSSS OFDM	☒	☐	☐	☐	-/-
§15.209(a) RSS-Gen	TX spurious emissions rad. below 30 MHz	-/-	Nominal	DSSS OFDM	☒	☐	☐	☐	-/-
§15.247(d) RSS - 247 / 5.5 RSS-Gen	TX spurious emissions rad. 30 MHz to 1 GHz	-/-	Nominal	DSSS OFDM	☒	☐	☐	☐	-/-
§15.247(d) RSS - 247 / 5.5 RSS-Gen	TX spurious emissions rad. above 1 GHz	-/-	Nominal	DSSS OFDM	☒	☐	☐	☐	-/-
§15.109 RSS-Gen	RX spurious emissions rad. 30 MHz to 1 GHz	-/-	Nominal	RX / idle	☒	☐	☐	☐	-/-
§15.109 RSS-Gen	RX spurious emissions rad. above 1 GHz	-/-	Nominal	RX / idle	☒	☐	☐	☐	-/-
§15.107(a) §15.207	Conducted emissions < 30 MHz	-/-	Nominal	DSSS OFDM	☐	☐	☒	☐	Vehicular use only!

Notes:

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

10 Additional information and comments

Reference documents:

WiFi_RF_Tool_v0_1_170529 (002)
2018-09-20 SK - 223 Übersicht Antennenmodul v30 export
2019-02 Antennenmodul HAF mit Antennenbezeichnung.jpg
2019-02 Antennenmodul mit Bezeichnung.jpg
WLAN Testmodes.txt

Co-applicable documents:

1-8866/19-03-02_log1_conducted.pdf

Special test descriptions:

The applicant uses some modified power settings (decreased values) for some operating modes. These modifications will be implemented in the default settings of the modules used for the endproducts by the module manufacturer. The used settings are listed below:.

b-mode:
./myftm -a 1 -M 4 -c 2 -f 2412 -r 1 -t 3
./myftm -a 1 -M 4 -c 2 -f 2437 -r 1 -t 3
./myftm -a 1 -M 4 -c 2 -f 2462 -r 1 -t 3

g-mode:
./myftm -a 1 -M 0 -c 0 -p 12 -f 2412 -r 4 -t 3
./myftm -a 1 -M 0 -c 2 -f 2437 -r 4 -t 3
./myftm -a 1 -M 0 -c 0 -p 11 -f 2462 -r 4 -t 3

n20-mode:
./myftm -a 1 -M 1 -c 0 -p 13 -f 2412 -r 15 -t 3
./myftm -a 1 -M 1 -c 2 -f 2437 -r 15 -t 3
./myftm -a 1 -M 1 -c 0 -p 11 -f 2462 -r 15 -t 3

Rx-mode:
./myftm -a 1 -M 4 -c 2 -f 2412 -r 1 -x 1

Configuration descriptions:

None

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:

channel number & center frequency													
channel	**1**	2	3	4	5	**6**	7	8	9	10	**11**	12	13
f_c / MHz	**2412**	2417	2422	2427	2432	**2437**	2442	2447	2452	2457	**2462**	2467	2472

Note: The channels 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

Description:

The antenna gain of the complete system is calculated by the difference of radiated power (@ 3 MHz) in EIRP and the conducted power (@ 3 MHz) of the module.

Measurement:

Measurement parameter	
Detector	Peak
Sweep time	Auto
Resolution bandwidth	3 MHz
Video bandwidth	3 MHz / 10 MHz
Trace mode	Max hold
Test setup	See sub clause 6.4 (conducted) See sub clause 6.2 (radiated)
Measurement uncertainty	See chapter 8

Measurement parameters	
External result file(s)	1-8866/19-03-02_log1_conducted.pdf
Test setup	See sub clause 6.4 - B (conducted) See sub clause 6.2 - C (radiated)
Measurement uncertainty	See sub clause 8

Limits:

FCC	IC
6 dBi / > 6 dBi output power and power density reduction required	

Results: Antenna 1

antenna port 1	lowest channel	middle channel	highest channel
Conducted power / dBm Measured with DSSS modulation	-0.3	-0.1	0.1
Radiated power / dBm Measured with DSSS modulation	6.4	7.3	7.4
Gain [dBi] / Calculated	6.7	7.4	7.3

Note: Gain Calculation based on measurements with Bluetooth LE test signal.

Results: Antenna 2

antenna port 1	**lowest channel**	**middle channel**	**highest channel**
Conducted power / dBm Measured with DSSS modulation	-0.3	-0.1	0.1
Radiated power / dBm Measured with DSSS modulation	5.4	6.7	7.7
Gain [dBi] / Calculated	5.7	6.8	7.6

Note: Gain Calculation based on measurements with Bluetooth LE test signal.

12.2 Identify worst case data rate

Worst case data rate or modulation scheme declared by the manufacturer.

Modulation scheme / bandwidth	
DSSS / b – mode	1 Mbit/s
OFDM / g – mode	6 Mbit/s
OFDM / n HT20 – mode	MCS0

12.3 Maximum output power

Description:

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

Measurement:

Measurement parameter	
According to DTS clause: 8.3.1.3	
Peak power meter	
External result file(s)	1-8866/19-03-02_log1_conducted.pdf
Test setup	See chapter 6.4 - A
Measurement uncertainty	See chapter 8

Limits:

FCC	IC
Conducted 1.0 W / 30 dBm with an antenna gain of max. 6 dBi	
Conducted limit with an gain of 7.6 dBi = 28.4 dBm	

Results:

antenna port 1	maximum output power / dBm		
	lowest channel	middle channel	highest channel
Output power conducted DSSS / b – mode	14.7	14.5	14.6
Output power conducted OFDM / g – mode	17.5	20.0	16.2
Output power conducted OFDM / n HT20 – mode	18.6	20.0	16.1

12.4 Duty cycle

Description:

Measurement of the timing behavior.

Measurement:

Measurement parameter	
Detector	Peak
Sweep time	Depends on the signal see plot
Resolution bandwidth	10 MHz
Video bandwidth	10 MHz
Trace mode	Max hold
External result file(s)	1-8866/19-03-02_log1_conducted.pdf
Test setup	See chapter 6.4 - B
Measurement uncertainty	See chapter 8

Limits:

FCC	IC
No limitation!	

Results:

T_{nom}	V_{nom}	lowest channel	middle channel	highest channel
DSSS / b – mode		99 % / 0.0 dB	99 % / 0.0 dB	99 % / 0.0 dB
OFDM / g – mode		99 % / 0.0 dB	99 % / 0.0 dB	99 % / 0.0 dB
OFDM / n HT20 – mode		99 % / 0.0 dB	99 % / 0.0 dB	99 % / 0.0 dB

12.5 Peak 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	
According to DTS clause: 8.4	
Detector	Positive Peak
Sweep time	Auto
Resolution bandwidth	100 kHz
Video bandwidth	300 kHz
Span	30 MHz
Trace mode	Max. hold (allow trace to fully stabilize)
External result file(s)	1-8866/19-03-02_log1_conducted.pdf
Test setup	See chapter 6.4 - B
Measurement uncertainty	See chapter 8

Limits:

FCC	IC
8 dBm / 3 kHz (conducted)	
Conducted limit with an gain of 7.6 dBi = 6.4 dBm / 3kHz	

Results: antenna port 1

Formula for PKPSD calculation: $PKPSD_{calculated}=PKPSD_{measured}+10*log(3kHz/RBW_{measured}[kHz])$

calculated	peak power spectral density / dBm @ 3 kHz		
	Lowest channel	Middle channel	Highest channel
DSSS / b – mode	-10.5	-9.6	-9.8
OFDM / g – mode	-15.9	-12.7	-16.3
OFDM / n HT20 – mode	-15.0	-13.7	-16.1

12.6 6 dB DTS bandwidth

Description:

Measurement of the 6 dB bandwidth of the modulated signal.

Measurement:

Measurement parameter	
According to DTS clause: 8.2	
Detector	Peak
Sweep time	Auto
Resolution bandwidth	100 kHz
Video bandwidth	500 kHz
Span	30 MHz / 50 MHz
Trace mode	Single count with 200 counts
External result file(s)	1-8866/19-03-02_log1_conducted.pdf
Test setup	See chapter 6.4 - B
Measurement uncertainty	See chapter 8

Limits:

FCC	IC
Systems using digital modulation techniques may operate in the 2400–2483.5 MHz band. The minimum 6 dB bandwidth shall be at least 500 kHz.	

Results:

antenna port 1	6 dB DTS bandwidth / kHz		
	lowest channel	middle channel	highest channel
DSSS / b – mode	8044	8032	8032
OFDM / g – mode	16276	16280	17152
OFDM / n HT20 – mode	16884	16884	16920

12.7 Occupied bandwidth – 99% emission bandwidth

Description:

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

Measurement:

Measurement parameter	
Detector	Peak
Sweep time	Auto
Resolution bandwidth	300 kHz
Video bandwidth	1 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 200 counts
External result file(s)	1-8866/19-03-02_log1_conducted.pdf
Test setup	See chapter 6.4 - B
Measurement uncertainty	See chapter 8

Usage:

-/-	IC
OBW is necessary for Emission Designator	

Results:

antenna port 1	99% emission bandwidth / kHz		
	lowest channel	middle channel	highest channel
DSSS / b – mode	13027	13051	13079
OFDM / g – mode	16782	16798	17866
OFDM / n HT20 – mode	17858	17858	17866

12.8 Occupied bandwidth – 20 dB bandwidth

Description:

Measurement of the 20 dB bandwidth of the modulated carrier.

Measurement:

Measurement parameter	
Detector	Peak
Sweep time	Auto
Resolution bandwidth	100 kHz
Video bandwidth	500 kHz
Span	30 MHz / 50 MHz
Trace mode	Single count with min. 200 counts
External result file(s)	1-8866/19-03-02_log1_conducted.pdf
Test setup	See chapter 6.4 - B
Measurement uncertainty	See chapter 8

Usage:

-/-	IC
Within the used band!	

Results:

antenna port 1	20 dB bandwidth / MHz		
	lowest channel	middle channel	highest channel
DSSS / b – mode	15244	15252	15280
OFDM / g – mode	19048	18984	20172
OFDM / n HT20 – mode	20260	20220	20316

12.9 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. The measurement is repeated for all modulations. Measurement distance is 3 meter.

Measurement:

	Measurement parameter for peak measurements	Measurement parameter for average measurements
		According to DTS clause: 8.7.3
Detector	Peak	RMS
Sweep time	Auto	Auto
Resolution bandwidth	1 MHz	100 kHz
Video bandwidth	1 MHz	300 kHz
Span	See plot	2 MHz
Trace mode	Max. hold	RMS Average over 101 sweeps
Analyzer function	-/-	Band power function (Compute the power by integrating the spectrum over 1 MHz)
Test setup	See chapter 6.2 - C	
Measurement uncertainty	See chapter 8	

Limits:

FCC	IC
74 dBµV/m @ 3 m (Peak) 54 dBµV/m @ 3 m (AVG)	

Results: Antenna 1

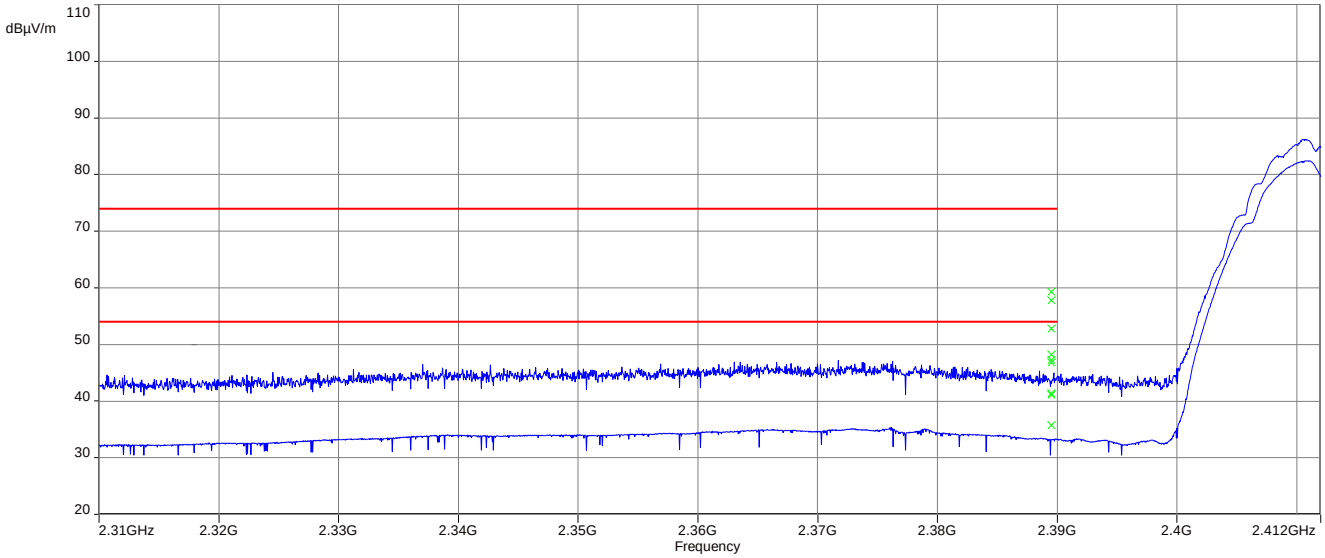
band edge compliance radiated / (dBµV / m) @ 3 m			
	DSSS	OFDM g-Mode (20 MHz nominal channel bandwidth)	OFDM n20-Mode (20 MHz nominal channel bandwidth)
Lower band edge	59.3 (Peak) 48.2 (AVG)	67.2 (Peak) 51.0 (AVG)	66.3 (Peak) 52.5 (AVG)
Upper band edge	58.1 (Peak) 46.9 (AVG)	61.2 (Peak) 48.2 (AVG)	63.4 (Peak) 50.0 (AVG)

Results: Antenna 2

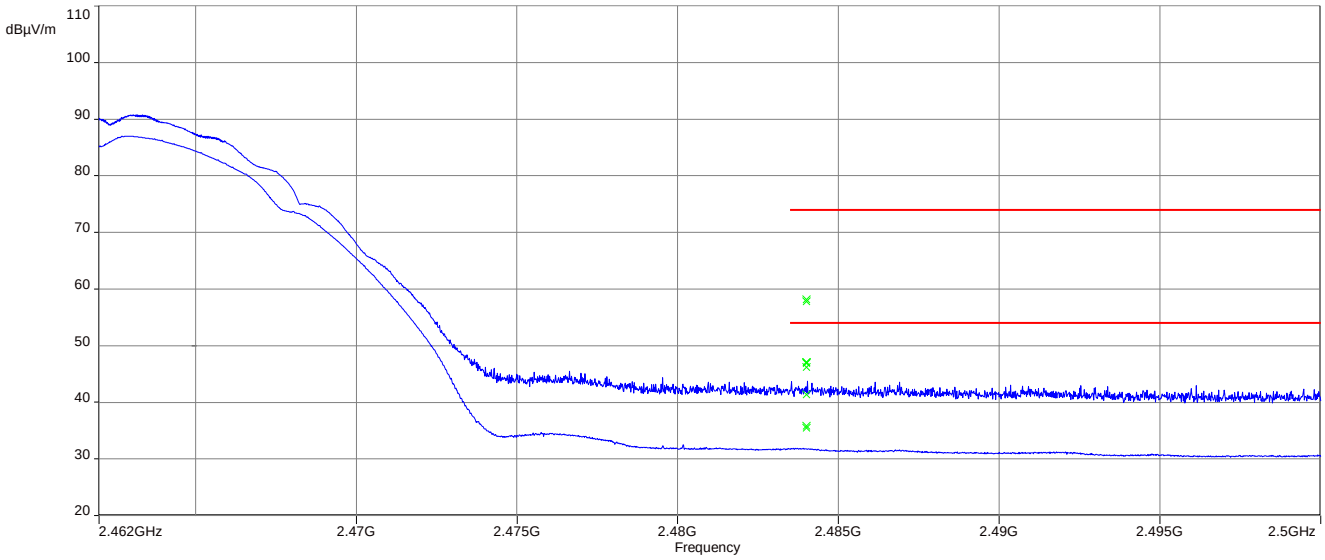
	OFDM g-Mode (20 MHz nominal channel bandwidth)	OFDM n20-Mode (20 MHz nominal channel bandwidth)
Lower band edge	63.5 (Peak) 49.2 (AVG)	65.4 (Peak) 52.1 (AVG)
Upper band edge	58.8 (Peak) 46.8 (AVG)	61.3 (Peak) 48.8 (AVG)

Plots: DSSS - peak / average – Antenna 1

Plot 1: TX mode, lower band edge, vertical & horizontal polarization

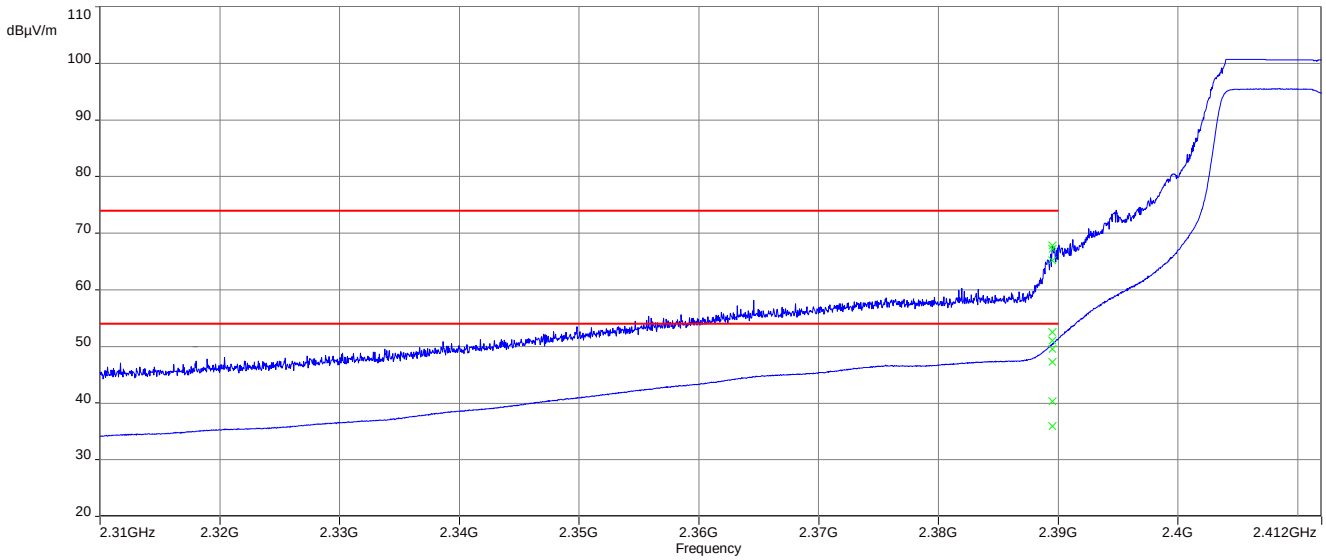


Plot 2: TX mode, upper band edge, vertical & horizontal polarization

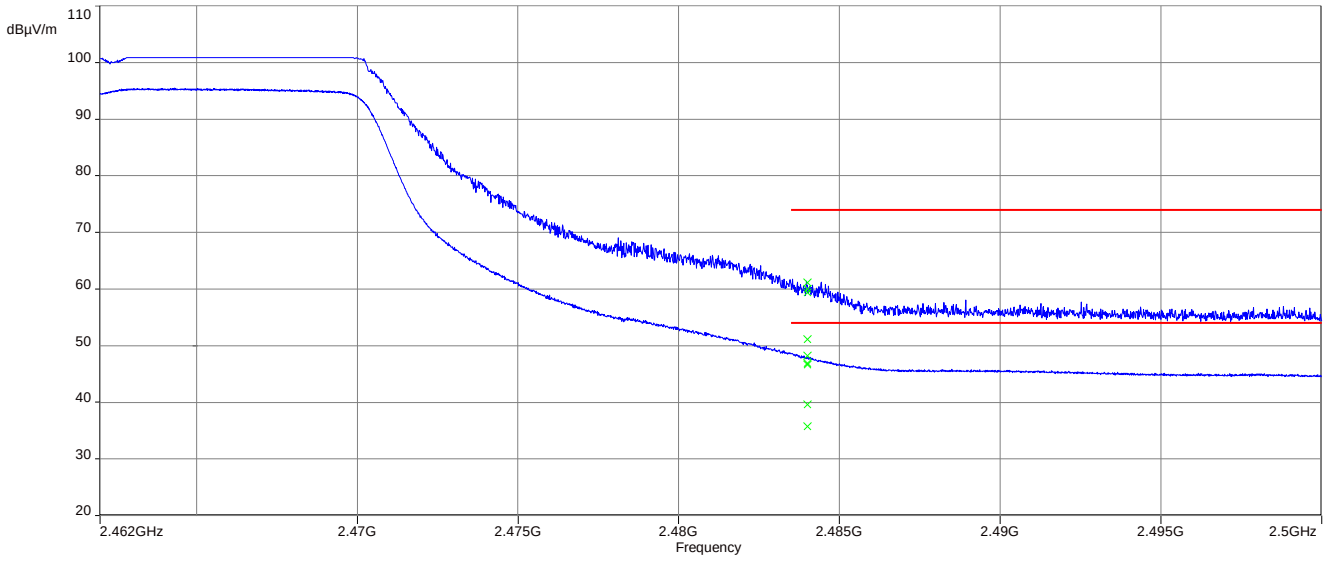


Plots: OFDM g-Mode (20 MHz bandwidth) - peak / average – Antenna 1

Plot 1: TX mode, lower band edge, vertical & horizontal polarization

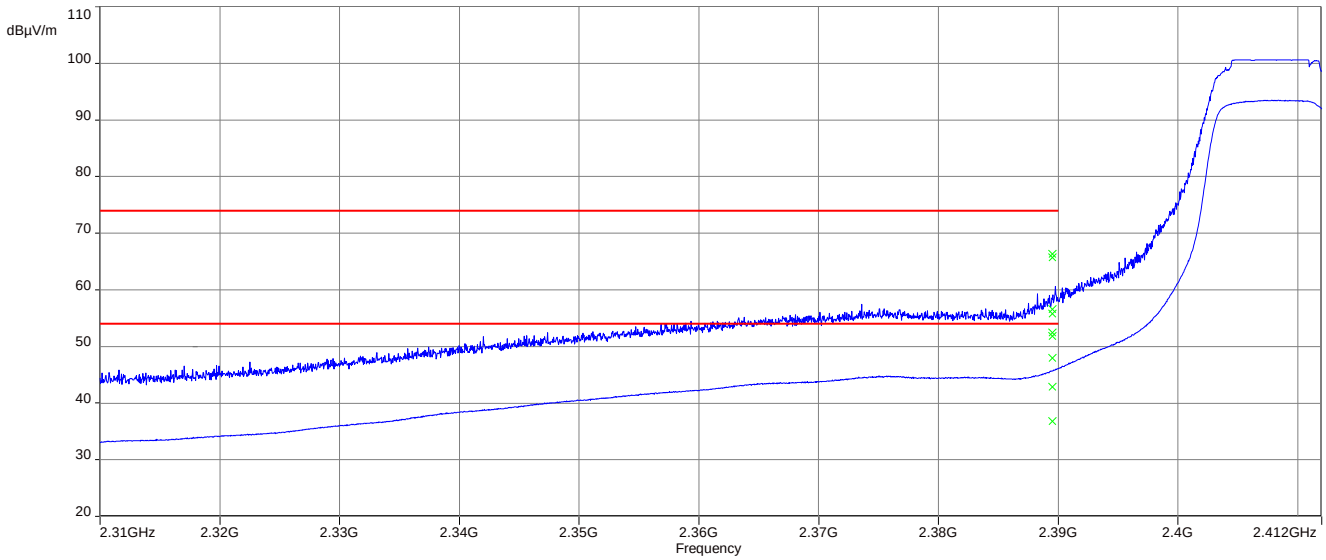


Plot 2: TX mode, upper band edge, vertical & horizontal polarization

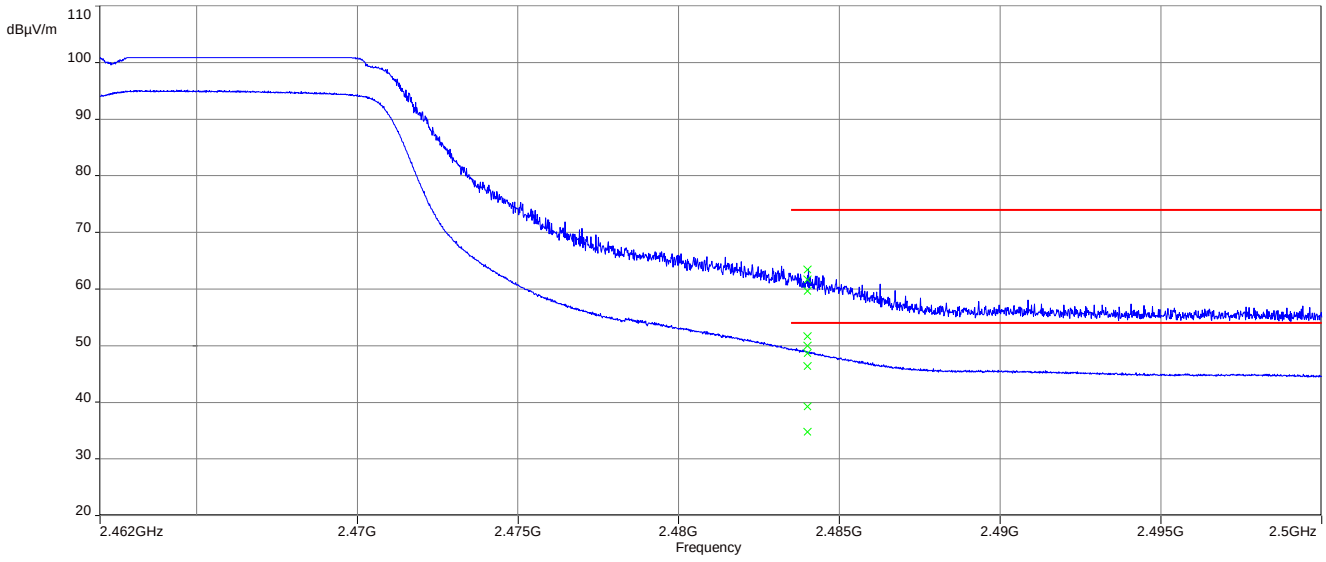


Plots: OFDM n20-Mode (20 MHz bandwidth) - peak / average – Antenna 1

Plot 1: TX mode, lower band edge, vertical & horizontal polarization

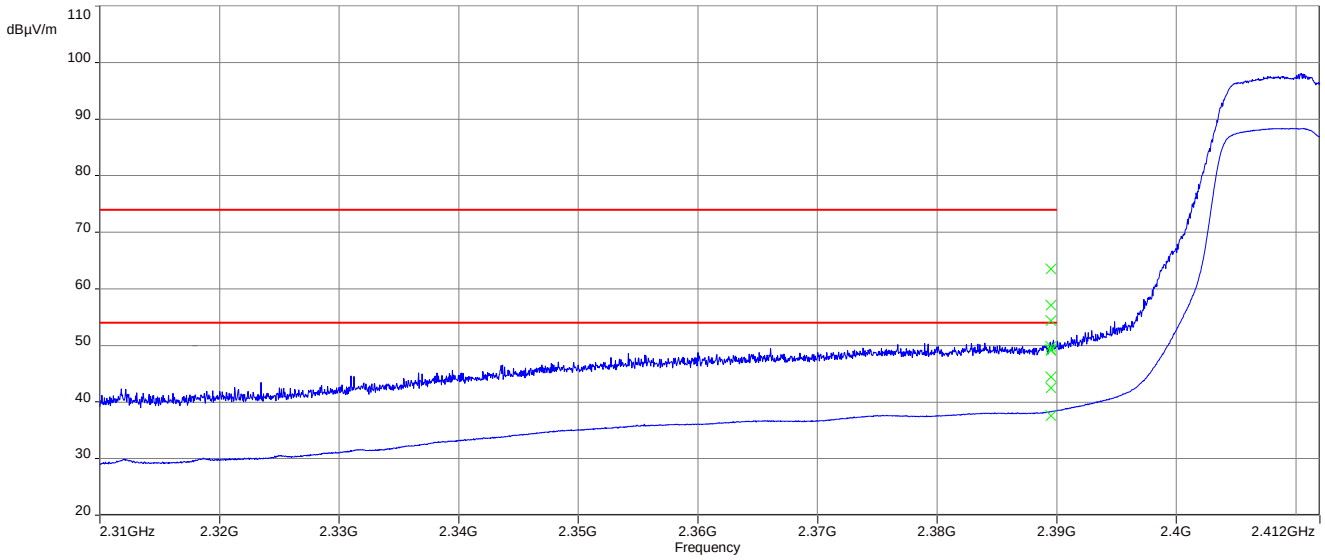


Plot 2: TX mode, upper band edge, vertical & horizontal polarization

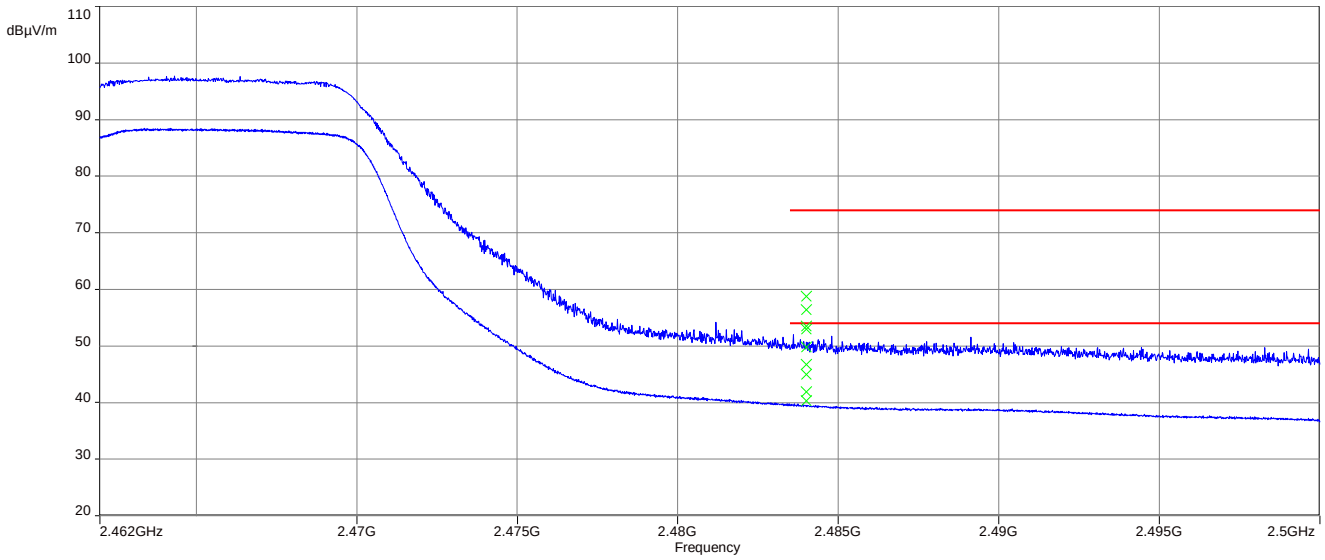


Plots: OFDM g-Mode (20 MHz bandwidth) - peak / average – Antenna 2

Plot 1: TX mode, lower band edge, vertical & horizontal polarization

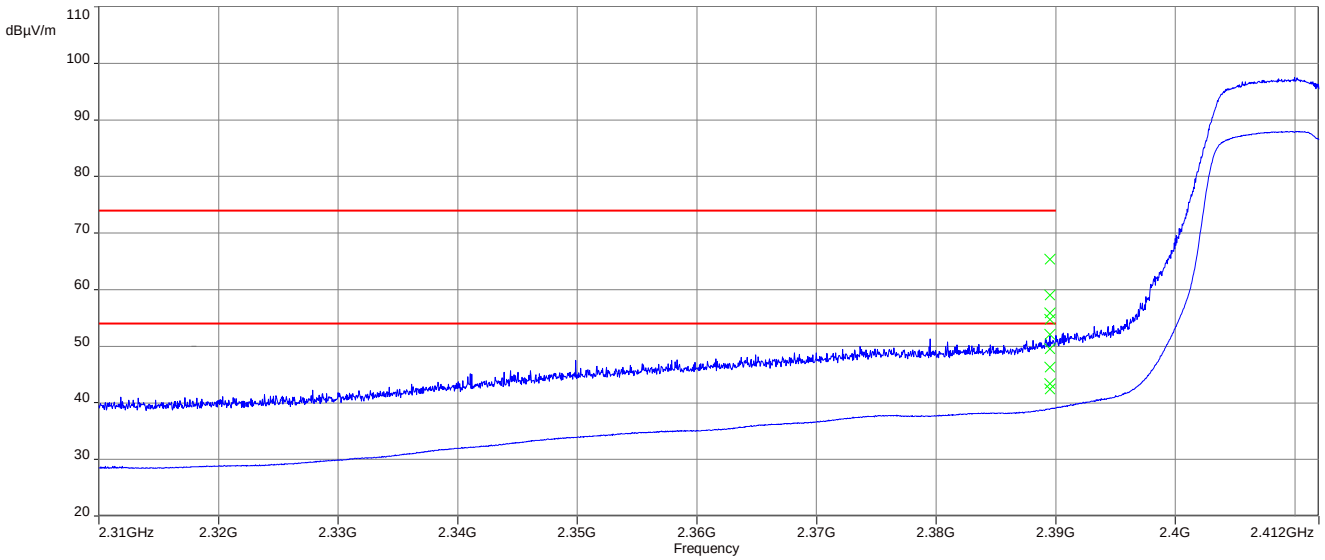


Plot 2: TX mode, upper band edge, vertical & horizontal polarization

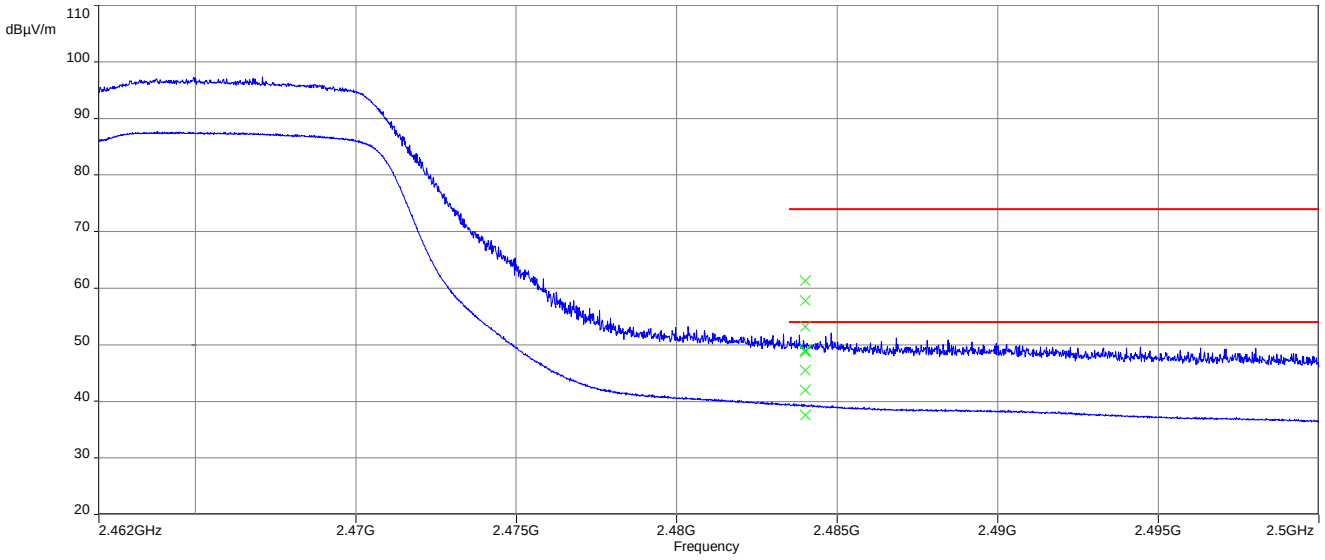


Plots: OFDM n20-Mode (20 MHz bandwidth) - peak / average – Antenna 2

Plot 1: TX mode, lower band edge, vertical & horizontal polarization



Plot 2: TX mode, upper band edge, vertical & horizontal polarization



12.10 Band edge compliance conducted

Description:

Measurement of the radiated band edge compliance with a conducted test setup.

Measurement:

Measurement parameter for measurements				
According to DTS clause: 8.7.3 and clause 12.2.2				
Detector	RMS			
Sweep time	Auto			
Resolution bandwidth	100 kHz			
Video bandwidth	300 kHz			
Span	2 MHz			
	lower band edge	2388 MHz	to	2390 MHz
	upper band edge	2483.5 MHz	to	2485.5 MHz
Trace mode	Trace average with 200 counts			
External result file(s)	1-8866/19-03-02_log1_conducted.pdf			
Test setup	See chapter 6.4 - B			
Measurement uncertainty	See chapter 8			

Limits:

FCC	IC
-41.26 dBm	

Results:

antenna port 1	**band edge compliance / dBm (gain calculation)**			
Modulation:	DSSS / b – mode	OFDM / g – mode	OFDM / n HT20 – mode	OFDM / n HT40 – mode
Max. lower band edge power conducted	-52.4	-50.1	-49.8	-/-
Antenna gain / dBi	6.7			
Max. lower band edge power radiated	-45.7	43.4	-43.1	-/-
Max. upper band edge power conducted	-53.2	-50.6	-50.8	-/-
Antenna gain / dBi	7.6			
Max. upper band edge power radiated	-45.6	-43.0	-43.2	-/-

Note: Worst case antenna gain used for calculation.

12.11 Spurious emissions conducted

Description:

Measurement of the conducted spurious emissions in transmit mode. The measurement is performed at the lowest; the middle and the highest channel. The measurement is repeated for all modulations.

Measurement:

Measurement parameter	
Detector	Peak
Sweep time	Auto
Resolution bandwidth	100 kHz
Video bandwidth	500 kHz
Span	9 kHz to 25 GHz
Trace mode	Max Hold
External result file(s)	1-8866/19-03-02_log1_conducted.pdf
Test setup	See chapter 6.4 - B
Measurement uncertainty	See chapter 8

Limits:

FCC	IC
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 30 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required	

Results: DSSS / b – mode

TX spurious emissions conducted					
f [MHz]		amplitude of emission [dBm]	limit max. allowed emission power	actual attenuation below frequency of operation [dB]	results
Lowest channel		1.9	30 dBm		Operating frequency
All detected emissions are below the -20 dBc & -30 dBc criteria.			-20 dBc (peak) -30 dBc (average)		compliant
Middle channel		1.9	30 dBm		Operating frequency
All detected emissions are below the -20 dBc & -30 dBc criteria.			-20 dBc (peak) -30 dBc (average)		compliant
Highest channel		2.5	30 dBm		Operating frequency
All detected emissions are below the -20 dBc & -30 dBc criteria.			-20 dBc (peak) -30 dBc (average)		compliant

Results: OFDM / g – mode

TX spurious emissions conducted					
f [MHz]		amplitude of emission [dBm]	limit max. allowed emission power	actual attenuation below frequency of operation [dB]	results
Lowest channel		-1.2	30 dBm		Operating frequency
All detected emissions are below the -20 dBc & -30 dBc criteria.			-20 dBc (peak) -30 dBc (average)		compliant
Middle channel		1.0	30 dBm		Operating frequency
All detected emissions are below the -20 dBc & -30 dBc criteria.			-20 dBc (peak) -30 dBc (average)		compliant
Highest channel		-2.0	30 dBm		Operating frequency
All detected emissions are below the -20 dBc & -30 dBc criteria.			-20 dBc (peak) -30 dBc (average)		compliant

Results: OFDM / n HT20 – mode

TX spurious emissions conducted					
f [MHz]		amplitude of emission [dBm]	limit max. allowed emission power	actual attenuation below frequency of operation [dB]	results
Lowest channel		-0.2	30 dBm		Operating frequency
All detected emissions are below the -20 dBc & -30 dBc criteria.			-20 dBc (peak) -30 dBc (average)		compliant
Middle channel		1.3	30 dBm		Operating frequency
All detected emissions are below the -20 dBc & -30 dBc criteria.			-20 dBc (peak) -30 dBc (average)		compliant
Highest channel		-2.4	30 dBm		Operating frequency
All detected emissions are below the -20 dBc & -30 dBc criteria.			-20 dBc (peak) -30 dBc (average)		compliant

12.12 Spurious emissions radiated below 30 MHz

Description:

Measurement of the radiated spurious emissions in transmit mode below 30 MHz. The limits are recalculated 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
Resolution bandwidth	F < 150 kHz: 200 Hz F > 150 kHz: 9 kHz
Video bandwidth	F < 150 kHz: 1 kHz F > 150 kHz: 100 kHz
Span	9 kHz to 30 MHz
Trace mode	Max Hold
Measured modulation	☒ DSSS b – mode ☒ OFDM g – mode ☒ OFDM n HT20 – mode ☐ OFDM n HT40 – mode
Test setup	See chapter 6.2 - D
Measurement uncertainty	See chapter 8

Limits:

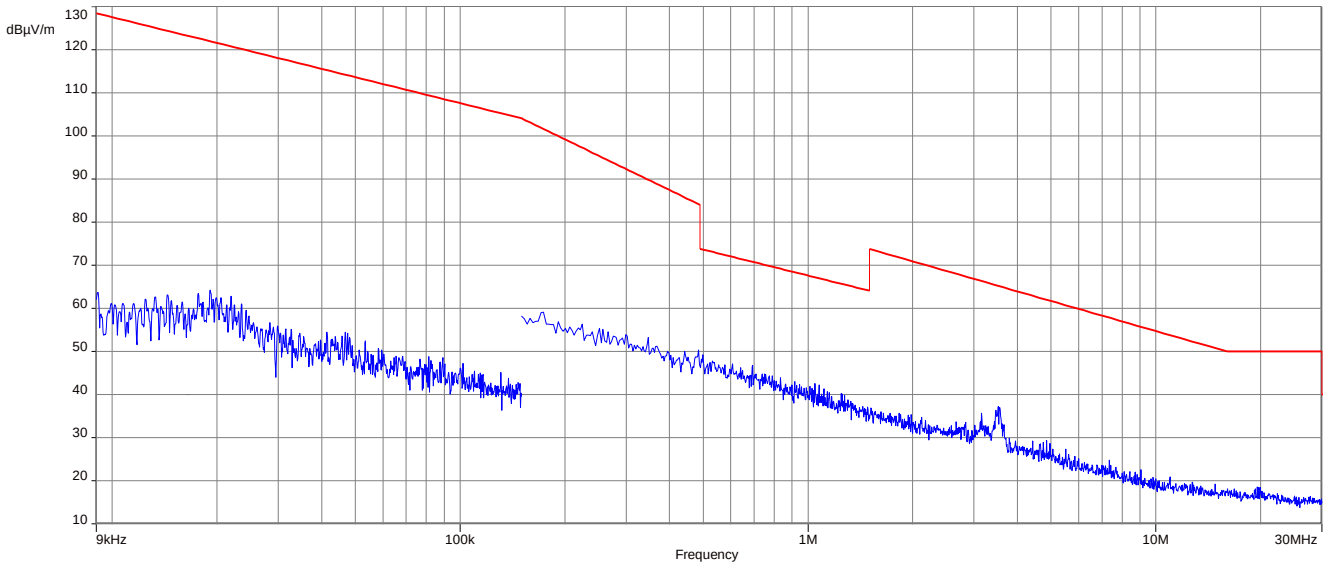
FCC		IC
Frequency / MHz	Field Strength / (dBµV / m)	Measurement distance / m
0.009 – 0.490	2400/F(kHz)	300
0.490 – 1.705	24000/F(kHz)	30
1.705 – 30.0	30	30

Results:

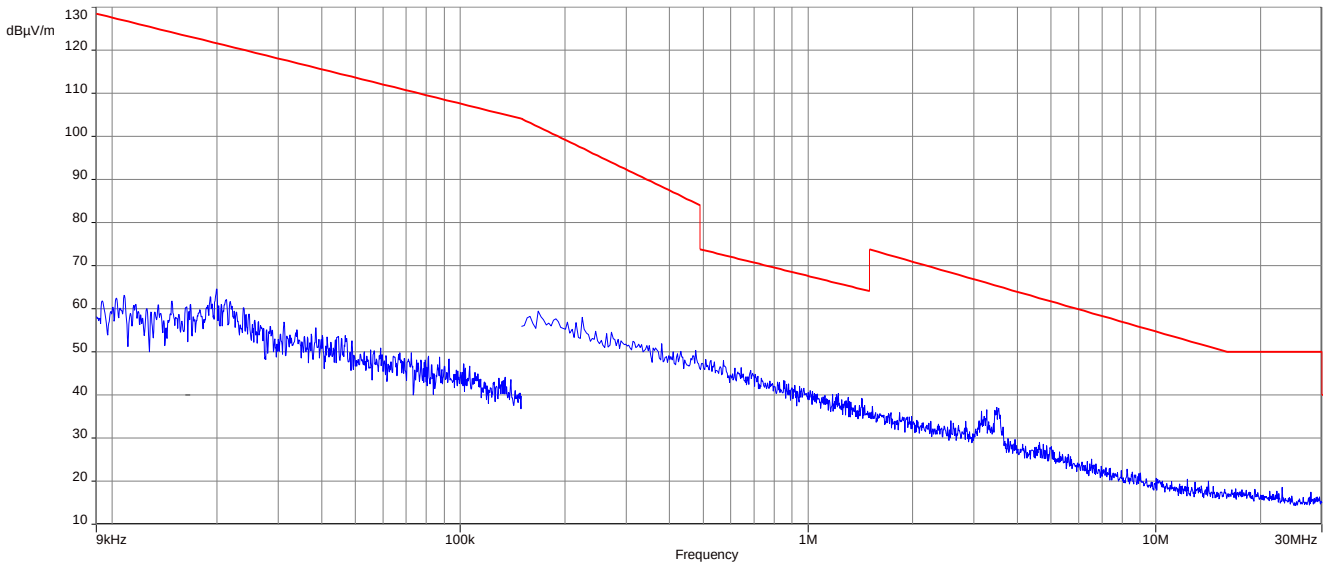
TX spurious emissions radiated < 30 MHz / (dBµV / m) @ 3 m		
Frequency / MHz	Detector	Level / (dBµV / m)
All detected peaks are more than 20 dB below the limit.		

Plots: DSSS – Antenna 1

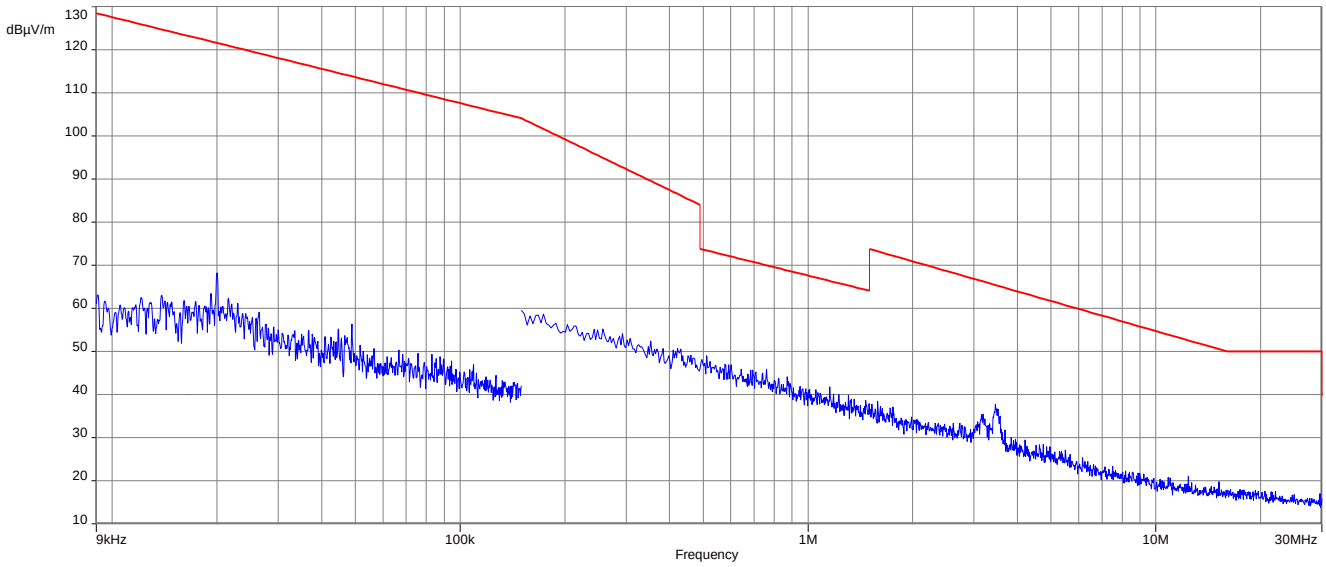
Plot 1: 9 kHz to 30 MHz, lowest channel



Plot 2: 9 kHz to 30 MHz, middle channel

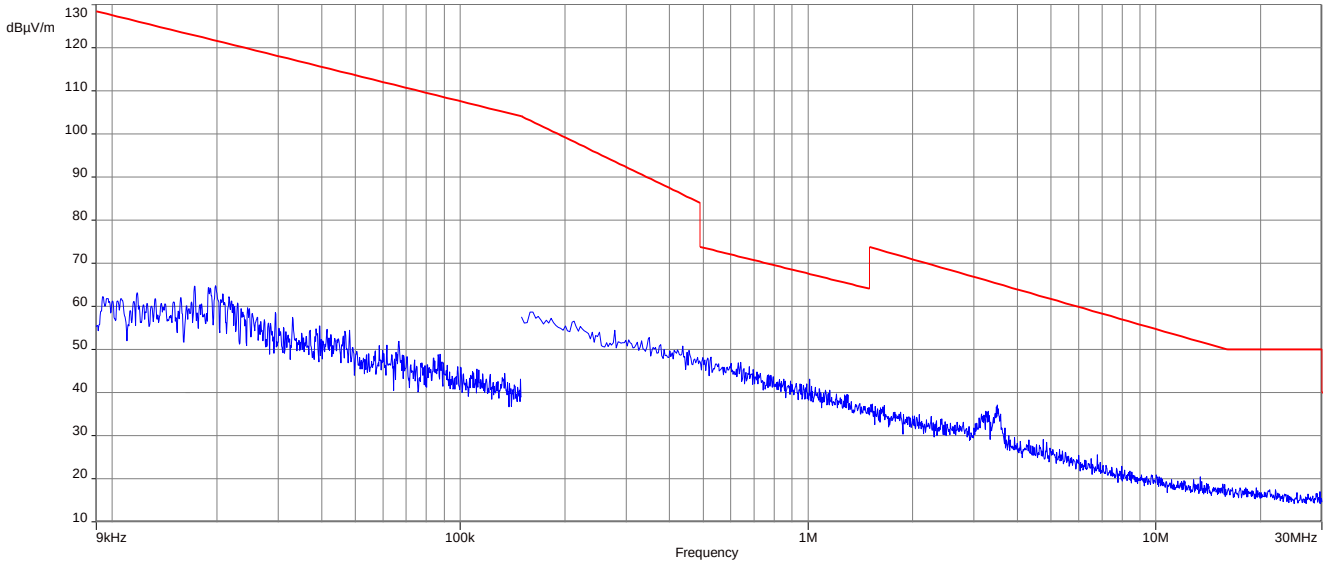


Plot 3: 9 kHz to 30 MHz, highest channel

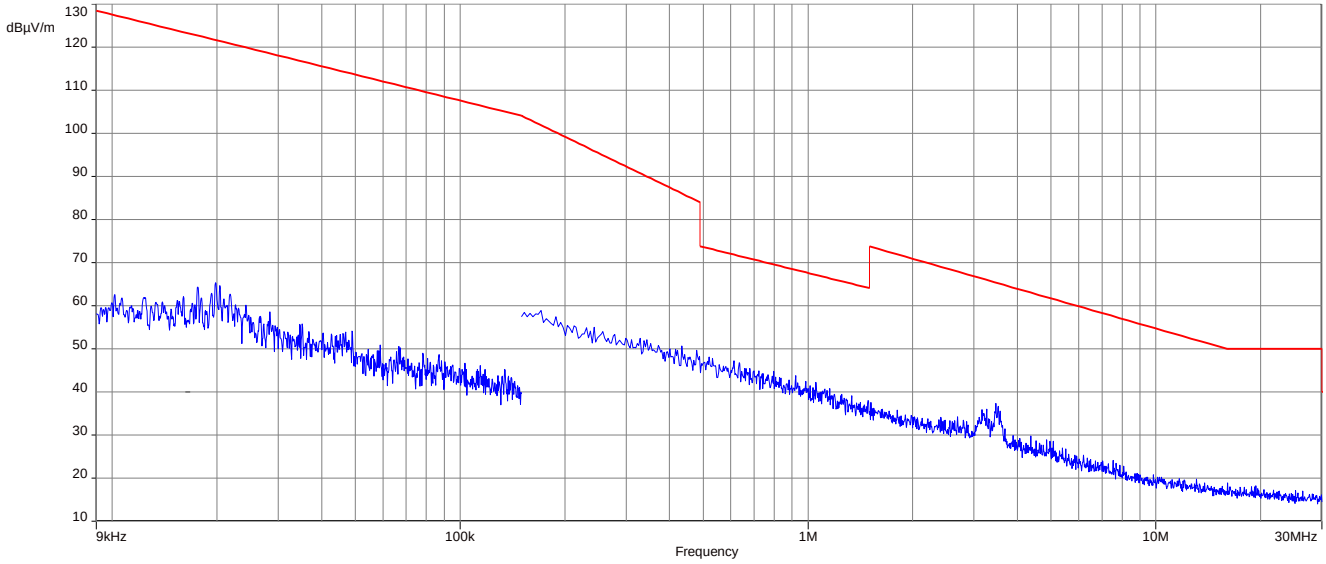


Plots: OFDM g-Mode (20 MHz nominal channel bandwidth) – Antenna 1

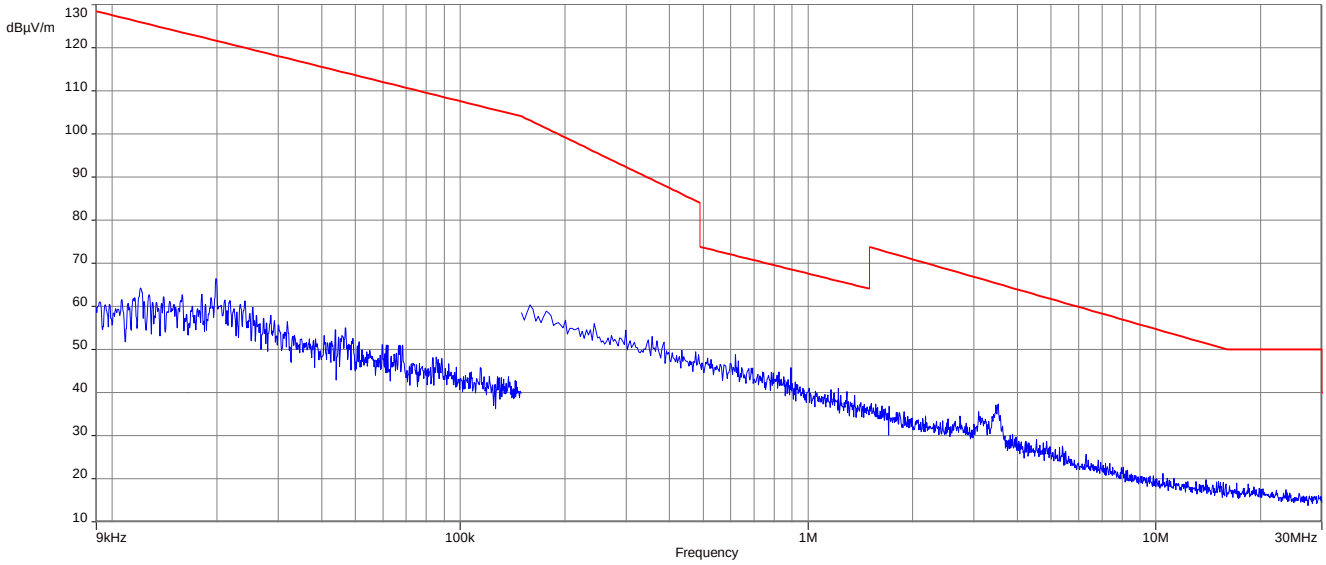
Plot 1: 9 kHz to 30 MHz, lowest channel



Plot 2: 9 kHz to 30 MHz, middle channel

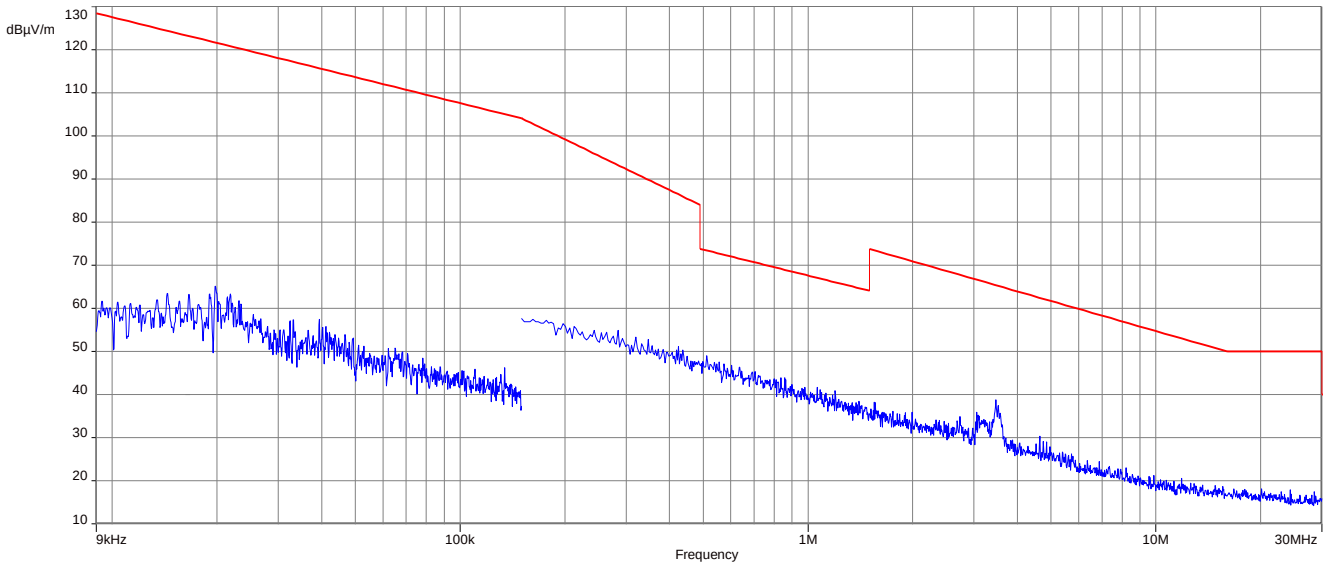


Plot 3: 9 kHz to 30 MHz, highest channel

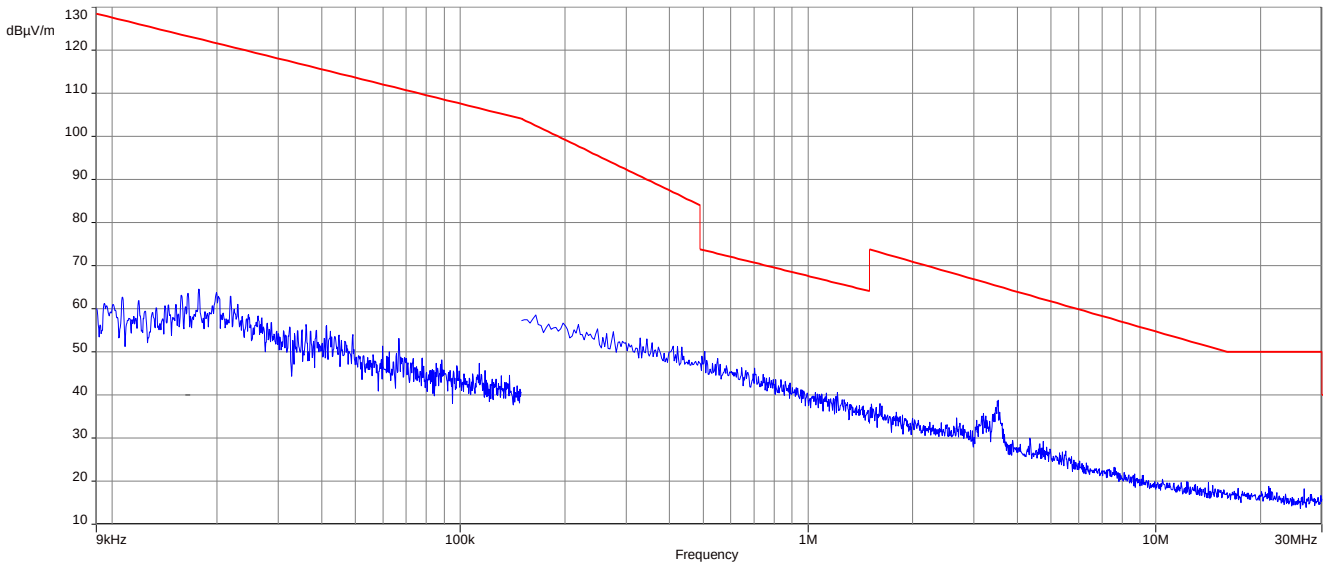


Plots: OFDM n20-Mode (20 MHz nominal channel bandwidth) – Antenna 1

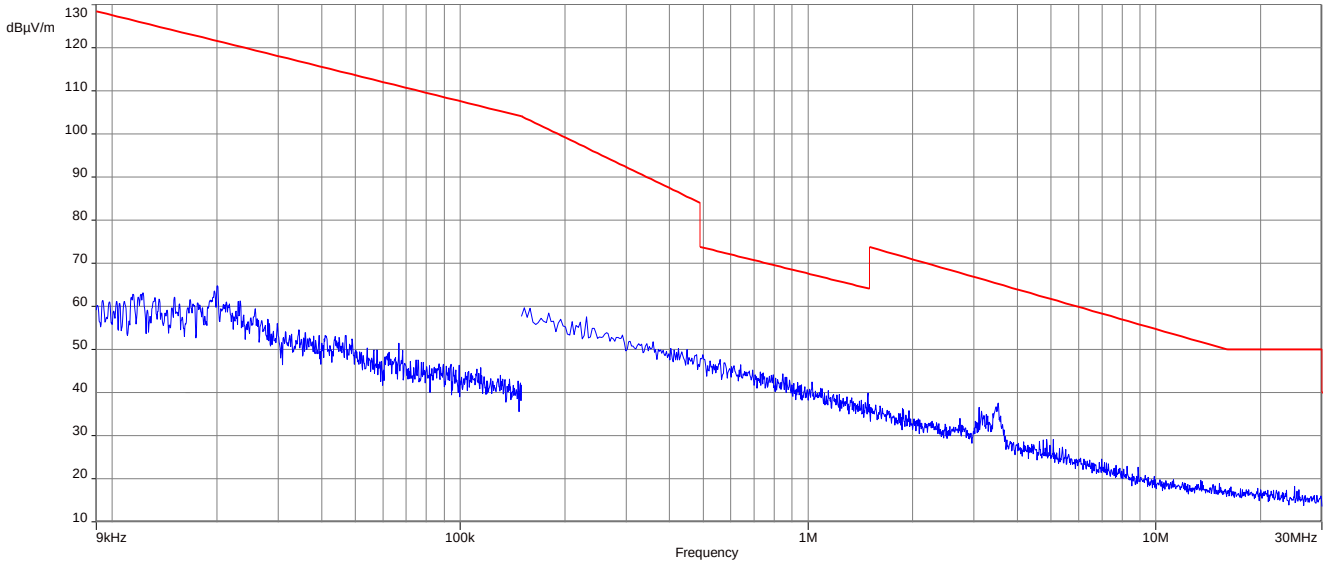
Plot 1: 9 kHz to 30 MHz, lowest channel



Plot 2: 9 kHz to 30 MHz, middle channel

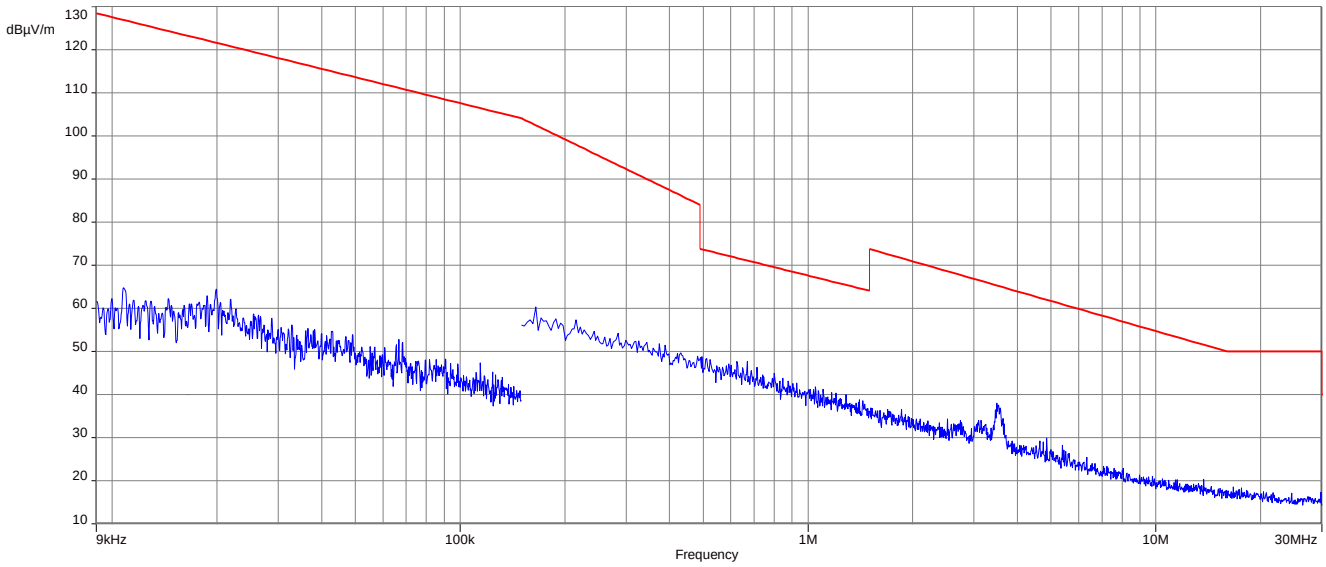


Plot 3: 9 kHz to 30 MHz, highest channel

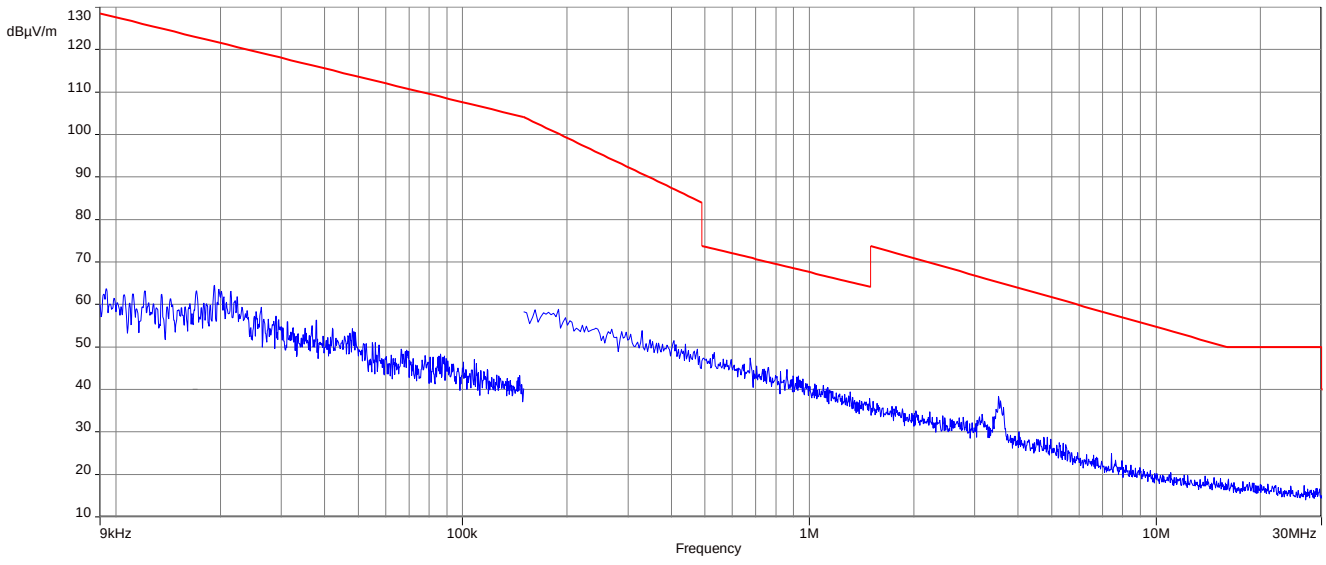


Plots: OFDM n20-Mode (20 MHz nominal channel bandwidth) – Antenna 2

Plot 1: 9 kHz to 30 MHz, lowest channel



Plot 2: 9 kHz to 30 MHz, highest channel



12.13 Spurious emissions radiated 30 MHz to 1 GHz

Description:

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

Measurement:

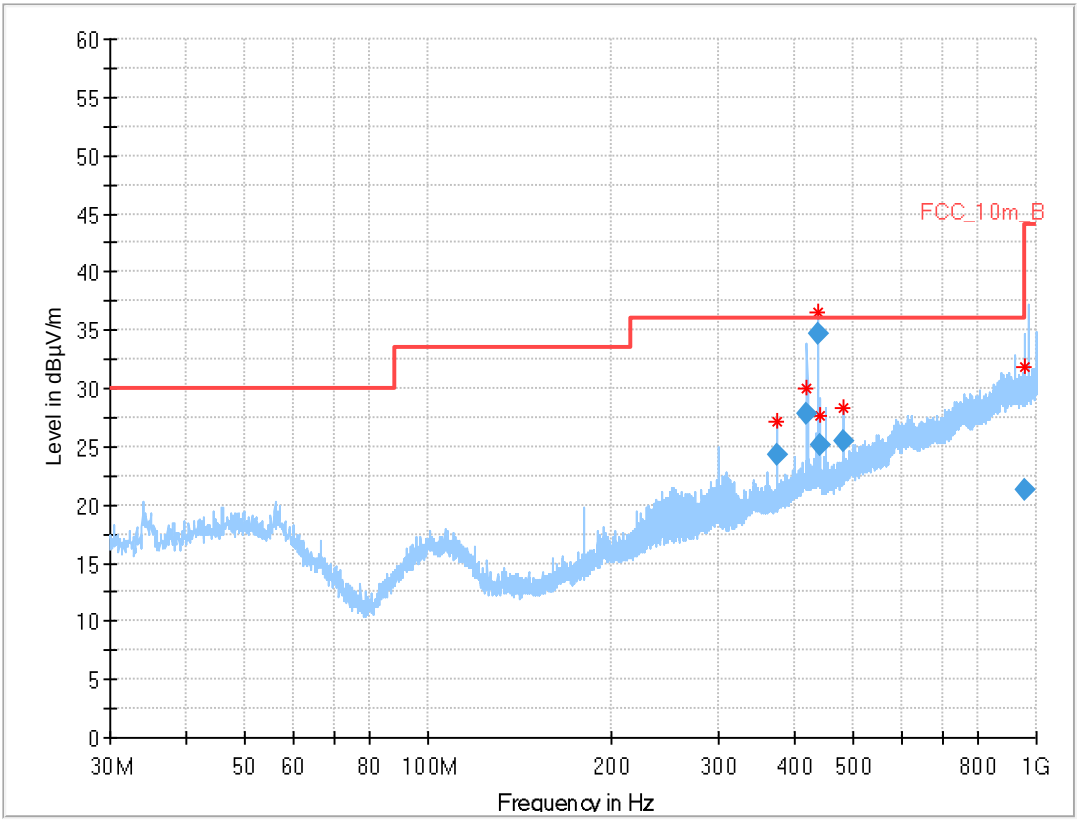
Measurement parameter	
Detector	Peak / Quasi Peak
Sweep time	Auto
Resolution bandwidth	120 kHz
Video bandwidth	3 x RBW
Span	30 MHz to 1 GHz
Trace mode	Max Hold
Measured modulation	☒ DSSS b – mode ☒ OFDM g – mode ☒ OFDM n HT20 – mode ☐ OFDM n HT40 – mode ☒ RX / Idle – mode
Test setup	See chapter 6.1 - A
Measurement uncertainty	See chapter 8

Limits:

FCC	IC	
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).		
Frequency / MHz	Field Strength / (dBµV / m)	Measurement distance / m
30 – 88	30.0	10
88 – 216	33.5	10
216 – 960	36.0	10

Plot: DSSS – Antenna 1

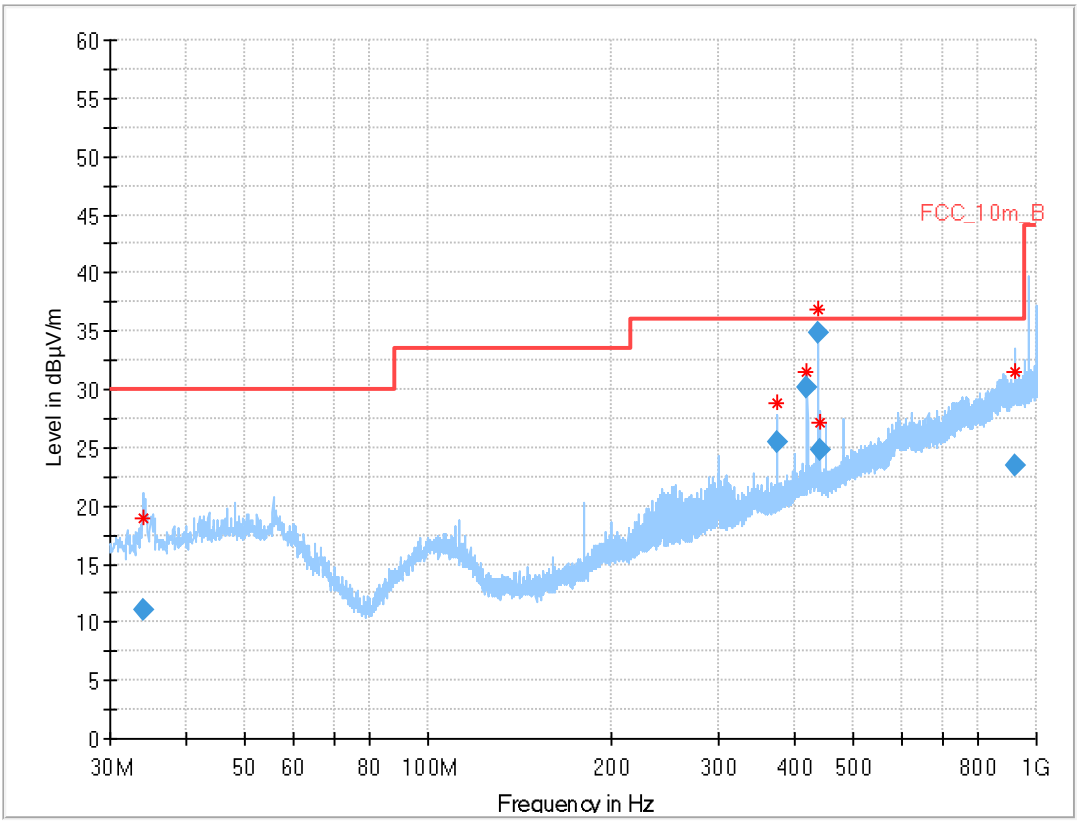
Plot 1: 30 MHz to 1 GHz, vertical & horizontal polarization, lowest channel



Final results:

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
374.988	24.26	36.0	11.7	1000	120	98.0	V	354	16
419.989	27.78	36.0	8.2	1000	120	101.0	V	54	17
437.491	34.67	36.0	1.3	1000	120	98.0	V	104	17
440.005	25.15	36.0	10.9	1000	120	105.0	V	114	17
479.997	25.55	36.0	10.5	1000	120	101.0	V	324	18
959.696	21.32	36.0	14.7	1000	120	133.0	H	295	24

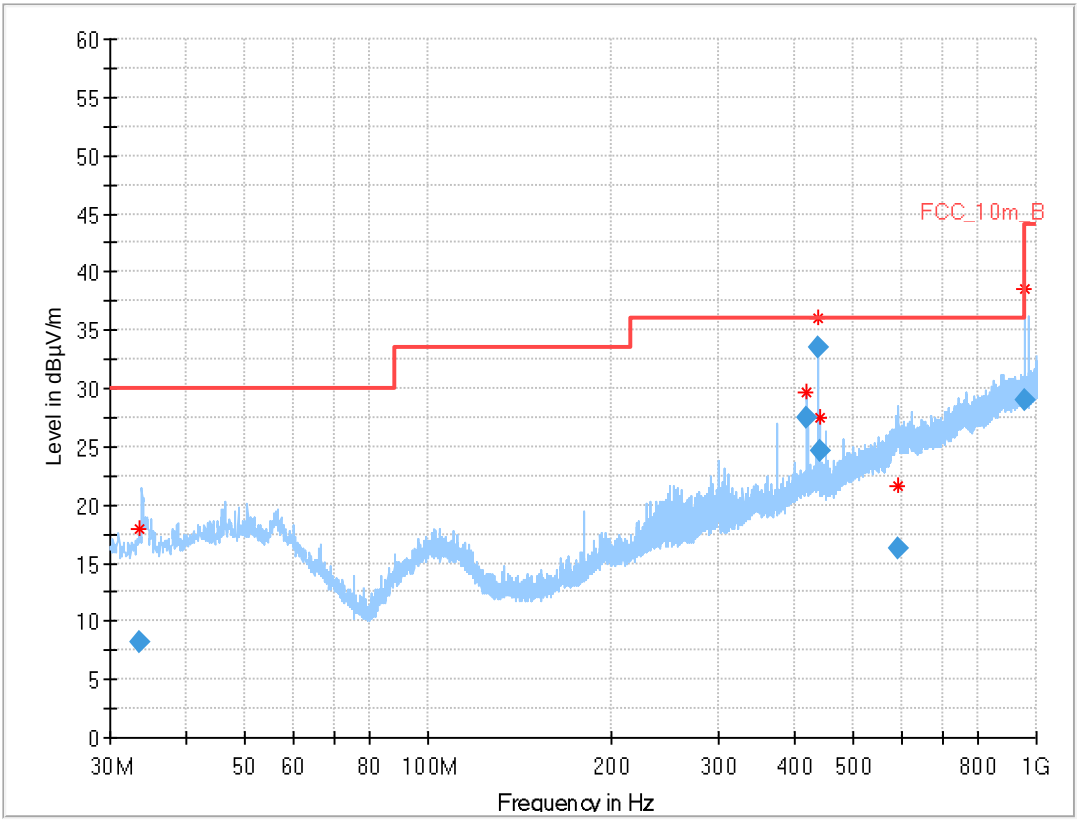
Plot 2: 30 MHz to 1 GHz, vertical & horizontal polarization, middle channel



Final results:

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
34.013	11.04	30.0	19.0	1000	120	118.0	V	108	12
374.999	25.48	36.0	10.5	1000	120	98.0	V	48	16
420.003	30.13	36.0	5.9	1000	120	98.0	V	224	17
437.496	34.89	36.0	1.1	1000	120	101.0	V	97	17
439.993	24.84	36.0	11.2	1000	120	101.0	V	355	17
922.175	23.41	36.0	12.6	1000	120	109.0	H	245	24

Plot 3: 30 MHz to 1 GHz, vertical & horizontal polarization, highest channel

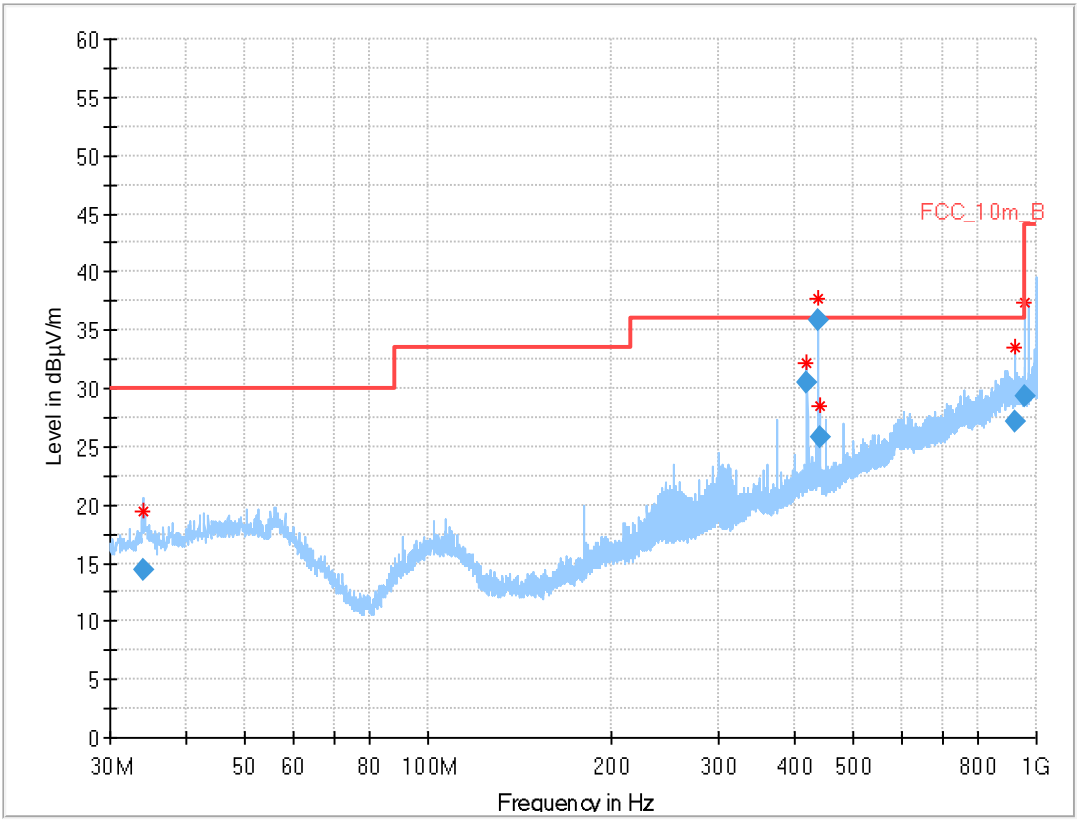


Final results:

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
33.592	8.24	30.0	21.8	1000	120	113.0	V	0	12
419.997	27.54	36.0	8.5	1000	120	101.0	V	0	17
437.490	33.48	36.0	2.5	1000	120	107.0	V	355	17
439.991	24.58	36.0	11.4	1000	120	105.0	V	355	17
590.556	16.22	36.0	19.8	1000	120	123.0	H	206	20
959.701	29.01	36.0	7.0	1000	120	98.0	H	244	24

Plot: OFDM g-Mode – Antenna 1

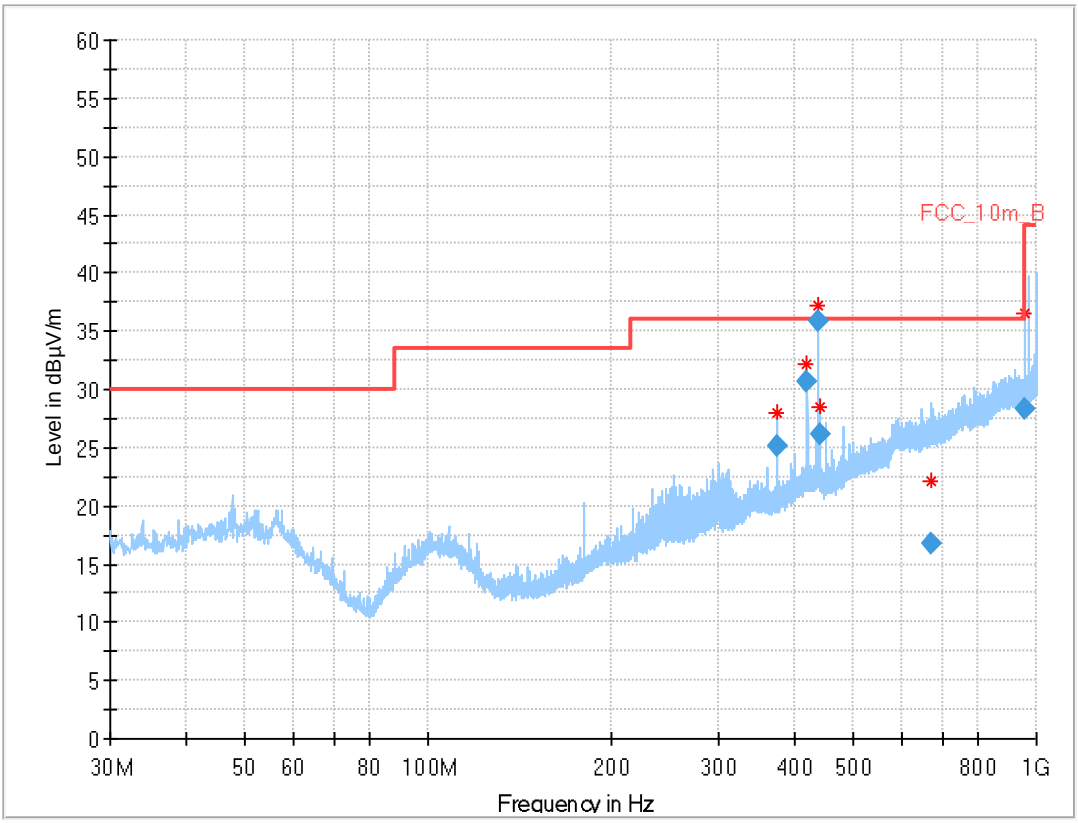
Plot 1: 30 MHz to 1 GHz, vertical & horizontal polarization, lowest channel



Final results:

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
33.987	14.33	30.0	15.7	1000	120	126.0	V	36	12
420.000	30.50	36.0	5.5	1000	120	101.0	V	231	17
437.492	35.86	36.0	0.1	1000	120	101.0	V	247	17
439.998	25.83	36.0	10.2	1000	120	101.0	V	214	17
922.232	27.11	36.0	8.9	1000	120	107.0	H	240	24
959.677	29.35	36.0	6.7	1000	120	116.0	H	278	24

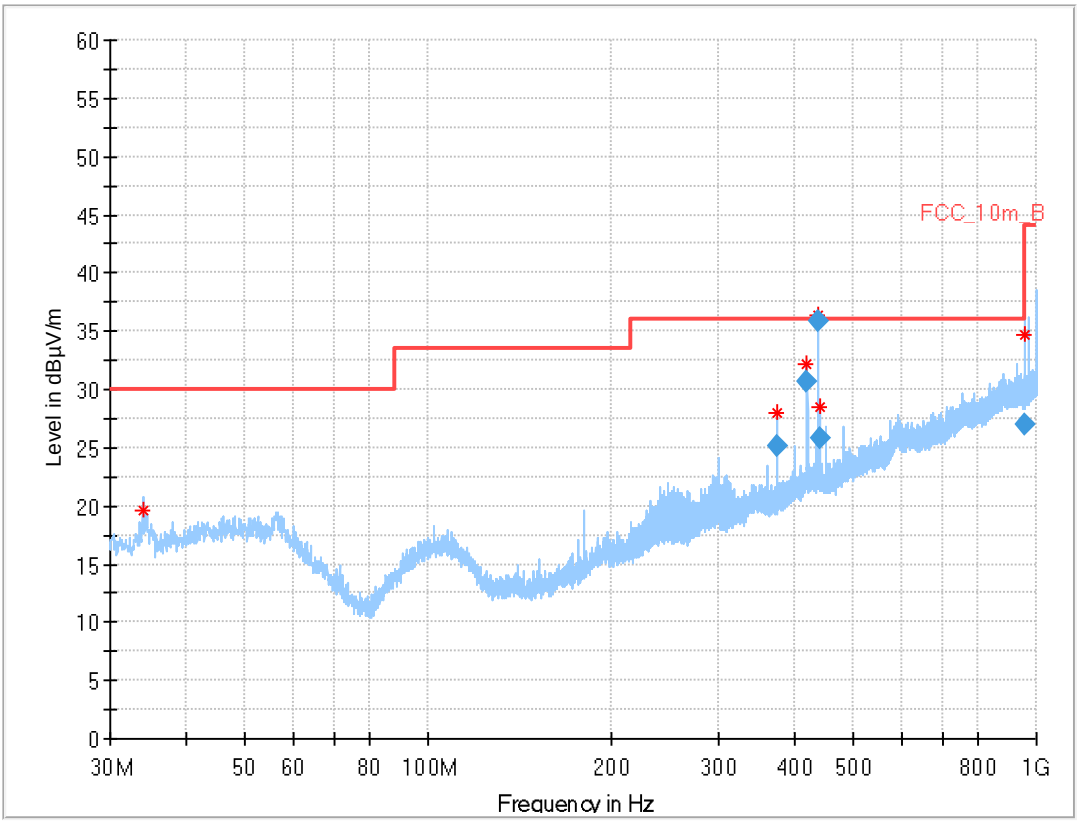
Plot 2: 30 MHz to 1 GHz, vertical & horizontal polarization, middle channel



Final results:

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
374.984	25.16	36.0	10.8	1000	120	98.0	V	65	16
419.998	30.67	36.0	5.3	1000	120	101.0	V	235	17
437.490	35.90	36.0	0.1	1000	120	101.0	V	219	17
439.986	26.07	36.0	9.9	1000	120	103.0	V	251	17
673.419	16.75	36.0	19.3	1000	120	156.0	V	311	21
959.683	28.30	36.0	7.7	1000	120	106.0	H	334	24

Plot 3: 30 MHz to 1 GHz, vertical & horizontal polarization, highest channel

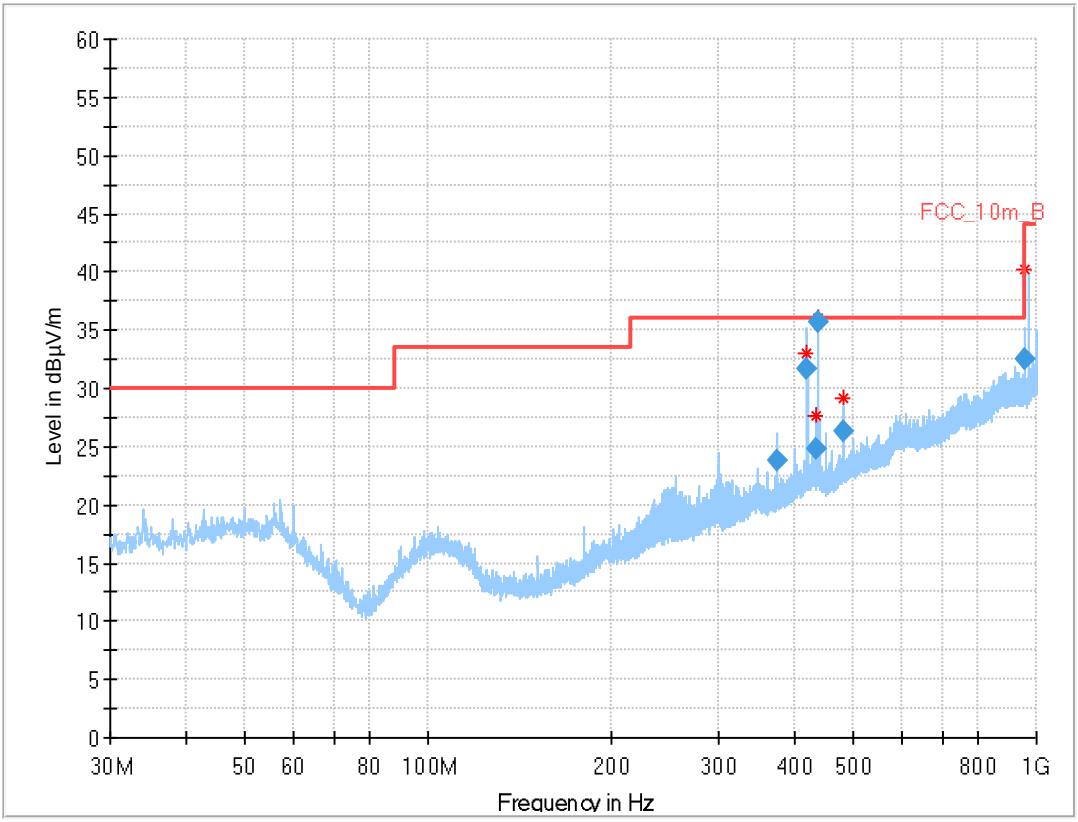


Final results:

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
---	10.98	30.0	19.0	1000	120	122.0	V	311	12
374.996	25.18	36.0	10.8	1000	120	105.0	V	21	16
420.000	30.66	36.0	5.3	1000	120	102.0	V	236	17
437.491	35.84	36.0	0.2	1000	120	101.0	V	225	17
439.994	25.89	36.0	10.1	1000	120	102.0	V	215	17
959.669	26.91	36.0	9.1	1000	120	114.0	H	339	24

Plot: OFDM n20-Mode – Antenna 1

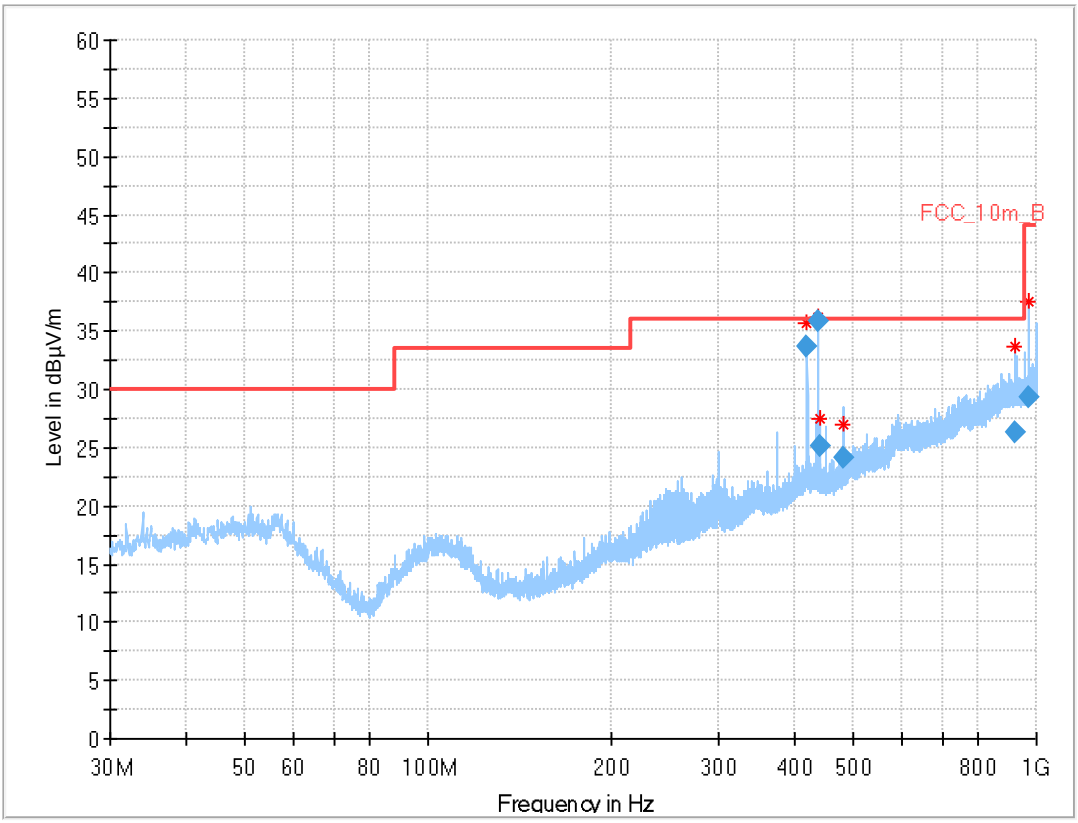
Plot 1: 30 MHz to 1 GHz, vertical & horizontal polarization, lowest channel



Final results:

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
374.998	23.87	36.0	12.1	1000	120	101.0	V	235	16
419.991	31.71	36.0	4.3	1000	120	102.0	V	135	17
433.349	24.81	36.0	11.2	1000	120	101.0	V	229	17
437.495	35.69	36.0	0.3	1000	120	98.0	V	229	17
479.993	26.34	36.0	9.7	1000	120	98.0	V	42	18
959.658	32.57	36.0	3.4	1000	120	107.0	H	241	24

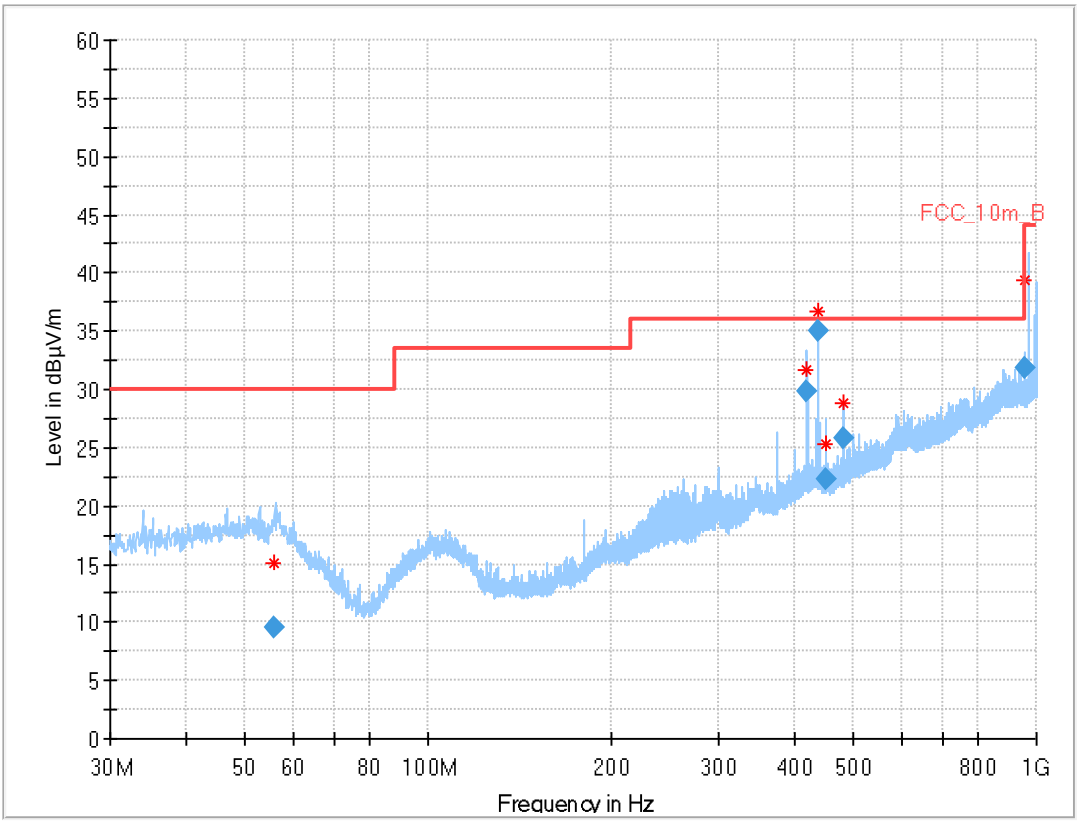
Plot 2: 30 MHz to 1 GHz, vertical & horizontal polarization, middle channel



Final results:

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
420.000	33.62	36.0	2.4	1000	120	98.0	V	235	17
437.491	35.85	36.0	0.2	1000	120	101.0	V	235	17
439.988	25.09	36.0	10.9	1000	120	104.0	V	229	17
480.003	24.14	36.0	11.9	1000	120	101.0	V	235	18
922.219	26.32	36.0	9.7	1000	120	129.0	H	246	24
972.191	29.35	44.0	14.7	1000	120	110.0	H	140	24

Plot 3: 30 MHz to 1 GHz, vertical & horizontal polarization, highest channel

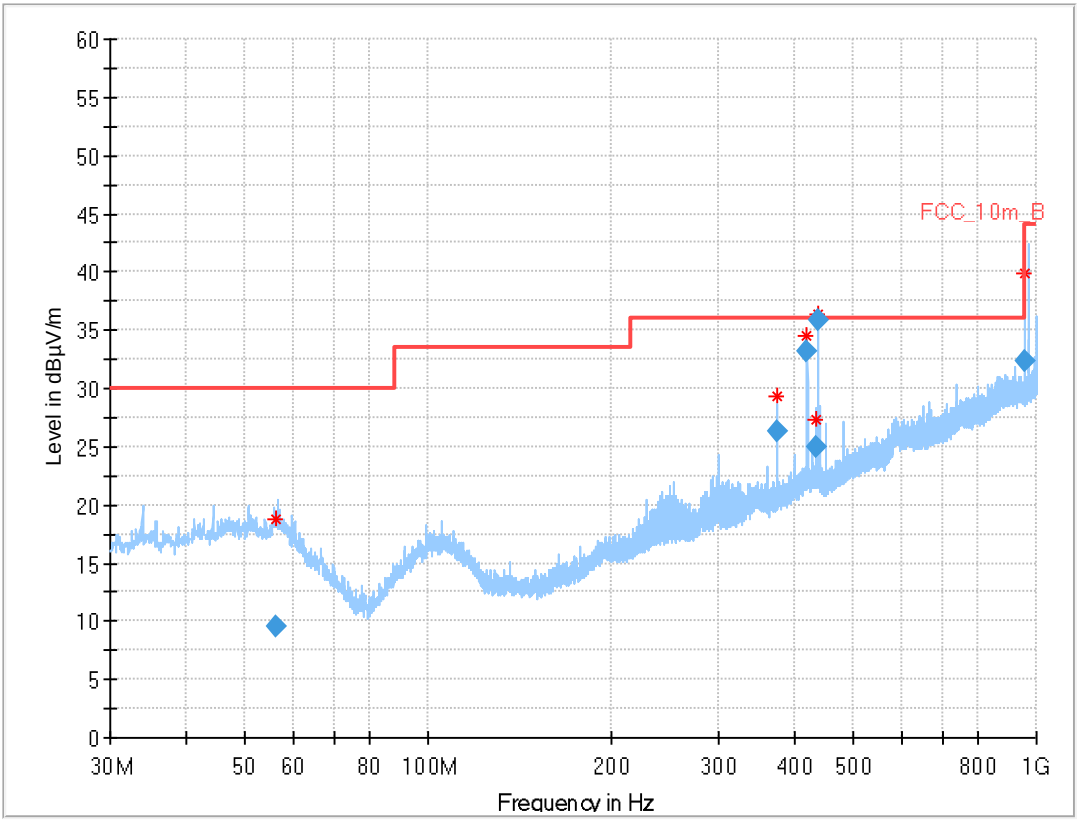


Final results:

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
55.977	9.55	30.0	20.5	1000	120	110.0	V	295	15
419.994	29.83	36.0	6.2	1000	120	101.0	V	105	17
437.496	35.11	36.0	0.9	1000	120	98.0	V	230	17
449.992	22.36	36.0	13.6	1000	120	98.0	V	220	17
480.000	25.82	36.0	10.2	1000	120	101.0	V	38	18
959.651	31.92	36.0	4.1	1000	120	160.0	V	175	24

Plot: RX / Idle mode – Antenna 1

Plot 1: 30 MHz to 1 GHz, vertical & horizontal polarization

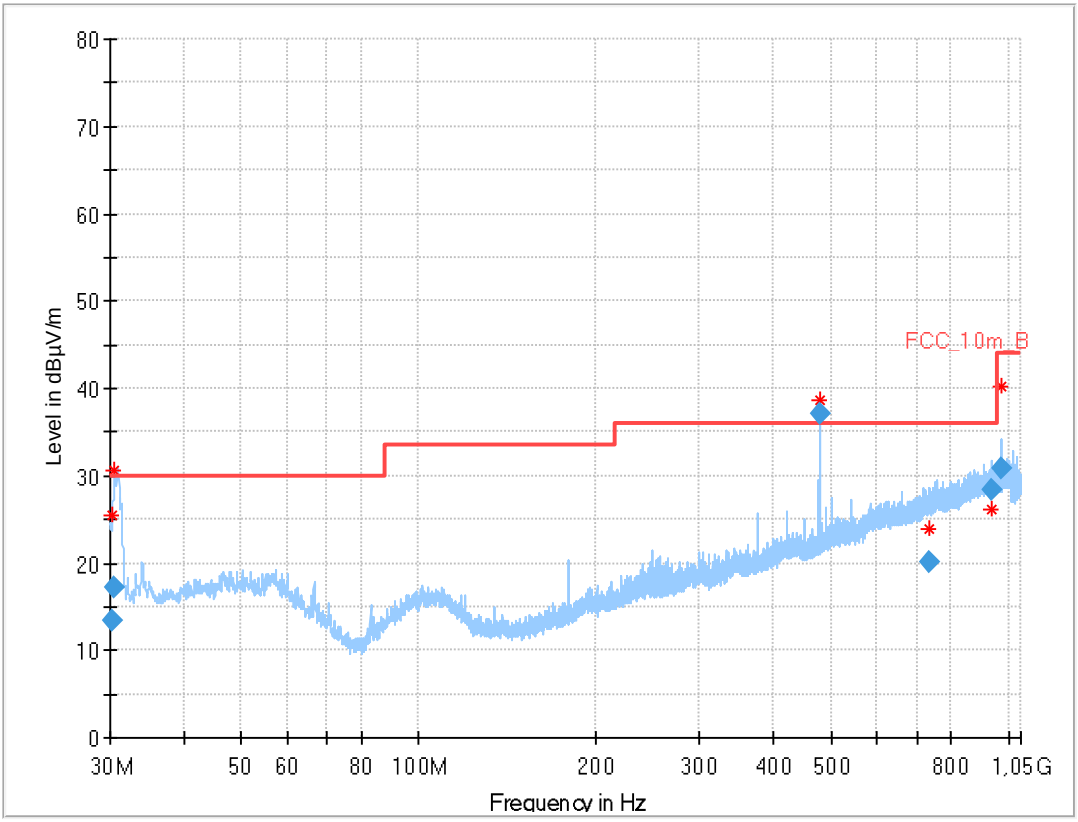


Final results:

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
56.117	9.57	30.0	20.4	1000	120	160.0	H	304	15
374.988	26.28	36.0	9.7	1000	120	98.0	V	196	16
420.007	33.15	36.0	2.9	1000	120	98.0	V	196	17
433.320	25.00	36.0	11.0	1000	120	104.0	V	234	17
437.503	35.94	36.0	0.1	1000	120	98.0	V	225	17
959.687	32.28	36.0	3.7	1000	120	114.0	H	244	24

Plot: OFDM n20-Mode – Antenna 2

Plot 1: 30 MHz to 1 GHz, vertical & horizontal polarization, middle channel



Final results:

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
30.286	13.33	30.0	16.7	1000	120	116.0	V	292	12
30.517	17.15	30.0	12.9	1000	120	116.0	V	253	12
*480.004	37.12*	36.0	-1.1*	1000	120	100.0	V	176	18
735.054	20.15	36.0	15.9	1000	120	170.0	H	158	22
935.804	28.39	36.0	7.6	1000	120	134.0	V	249	24
972.207	30.93	44.0	13.1	1000	120	170.0	V	99	24

*Peak exceeding limit is outside the restriced bands

12.14 Spurious emissions radiated above 1 GHz

Description:

Measurement of the radiated spurious emissions above 1 GHz in transmit mode and receiver / idle mode.

Measurement:

Measurement parameter	
Detector	Peak / RMS
Sweep time	Auto
Resolution bandwidth	1 MHz
Video bandwidth	3 x RBW
Span	1 GHz to 26 GHz
Trace mode	Max Hold
Measured modulation	☒ DSSS b – mode ☒ OFDM g – mode ☒ OFDM n HT20 – mode ☐ OFDM n HT40 – mode ☒ RX / Idle – mode
Test setup	See chapter 6.2 - A & 6.3 - A
Measurement uncertainty	See chapter 8

Limits:

FCC	IC	
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 30 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).		
Frequency / MHz	Field Strength / (dBµV / m)	Measurement distance / m
Above 960	54.0 (AVG)	3
	74.0 (peak)	

Results: DSSS – Antenna 1

TX spurious emissions radiated / dBµV/m @ 3 m								
lowest channel			middle channel			highest channel		
f / MHz	Detector	Level / dBµV/m	f / MHz	Detector	Level / dBµV/m	f / MHz	Detector	Level / dBµV/m
2375.8	Peak	59.4	All detected emissions are more than 20 dB below the limit.			All detected emissions are more than 20 dB below the limit.		
	AVG	48.1						

Results: OFDM g-mode (20 MHz nominal channel bandwidth) – Antenna 1

TX spurious emissions radiated / dBµV/m @ 3 m								
lowest channel			middle channel			highest channel		
f / MHz	Detector	Level / dBµV/m	f / MHz	Detector	Level / dBµV/m	f / MHz	Detector	Level / dBµV/m
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.		

Results: OFDM n20-mode (20 MHz nominal channel bandwidth) – Antenna 1

TX spurious emissions radiated / dBµV/m @ 3 m								
lowest channel			middle channel			highest channel		
f / MHz	Detector	Level / dBµV/m	f / MHz	Detector	Level / dBµV/m	f / MHz	Detector	Level / dBµV/m
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.		

Results: OFDM n20-mode (20 MHz nominal channel bandwidth) – Antenna 2

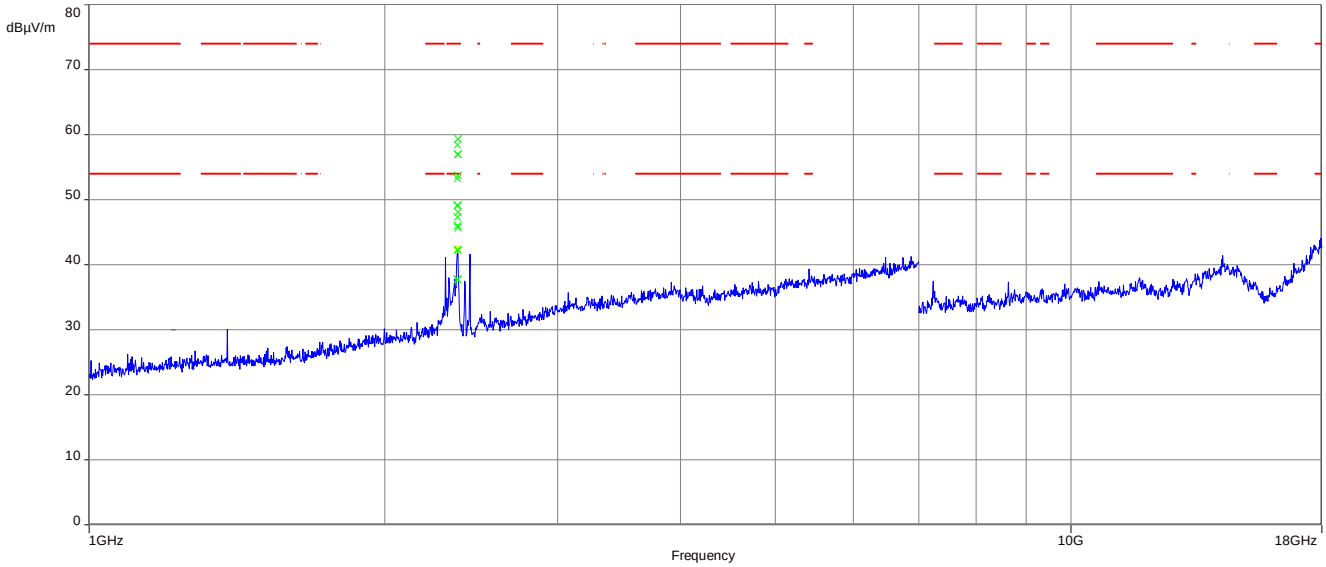
TX spurious emissions radiated / dBµV/m @ 3 m								
lowest channel			middle channel			highest channel		
f / MHz	Detector	Level / dBµV/m	f / MHz	Detector	Level / dBµV/m	f / MHz	Detector	Level / dBµV/m
All detected emissions are more than 20 dB below the limit.			Not tested!			All detected emissions are more than 20 dB below the limit.		

Results: RX / idle – mode – Antenna 1

TX spurious emissions radiated / dBµV/m @ 3 m		
f / MHz	Detector	Level / dBµV/m
All detected emissions are more than 20 dB below the limit.		

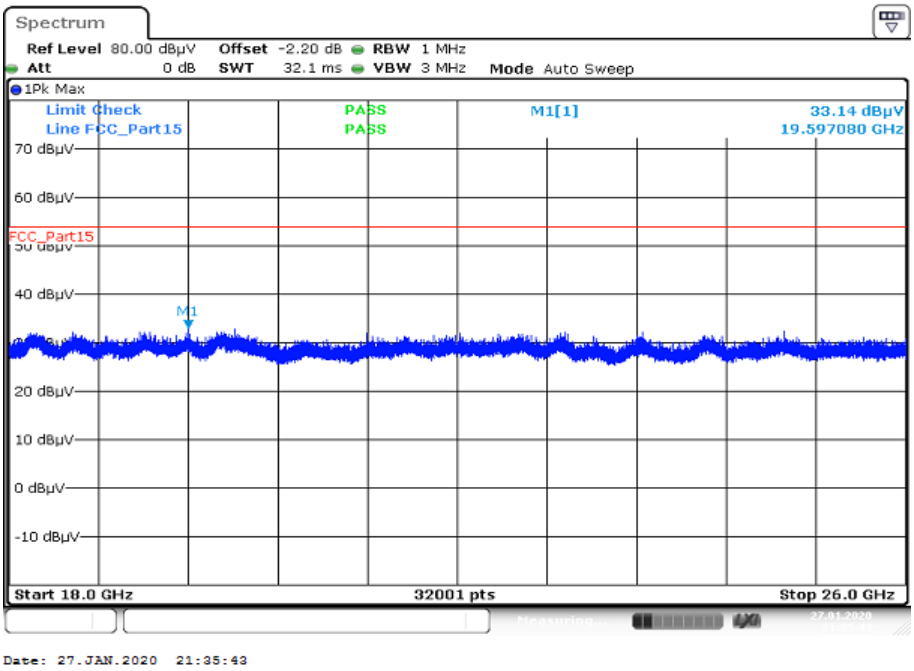
Plots: DSSS – Antenna 1

Plot 1: Lowest channel, 1 GHz to 18 GHz, vertical & horizontal polarization

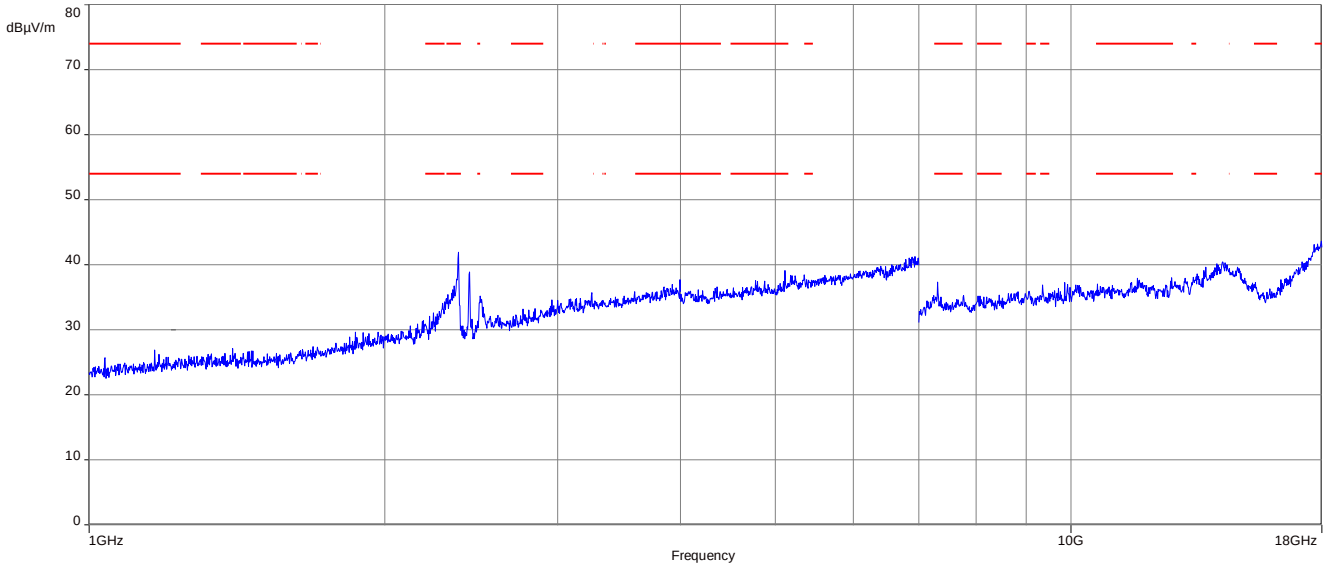


The carrier signal is notched with a 2.4 GHz band rejection filter.

Plot 2: Lowest channel, 18 GHz to 26 GHz, vertical & horizontal polarization

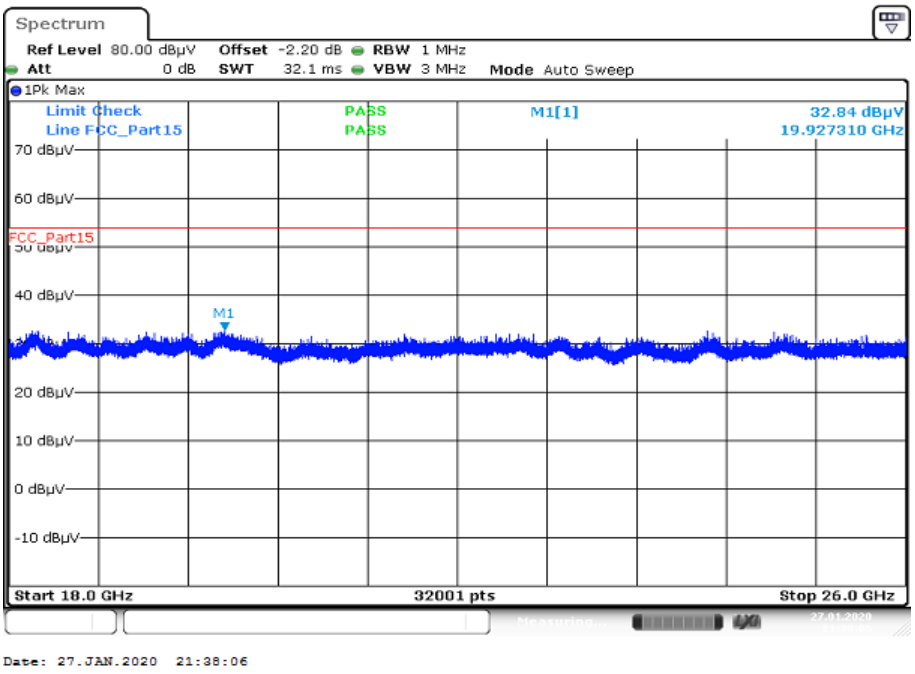


Plot 4: Middle channel, 1 GHz to 18 GHz, vertical & horizontal polarization

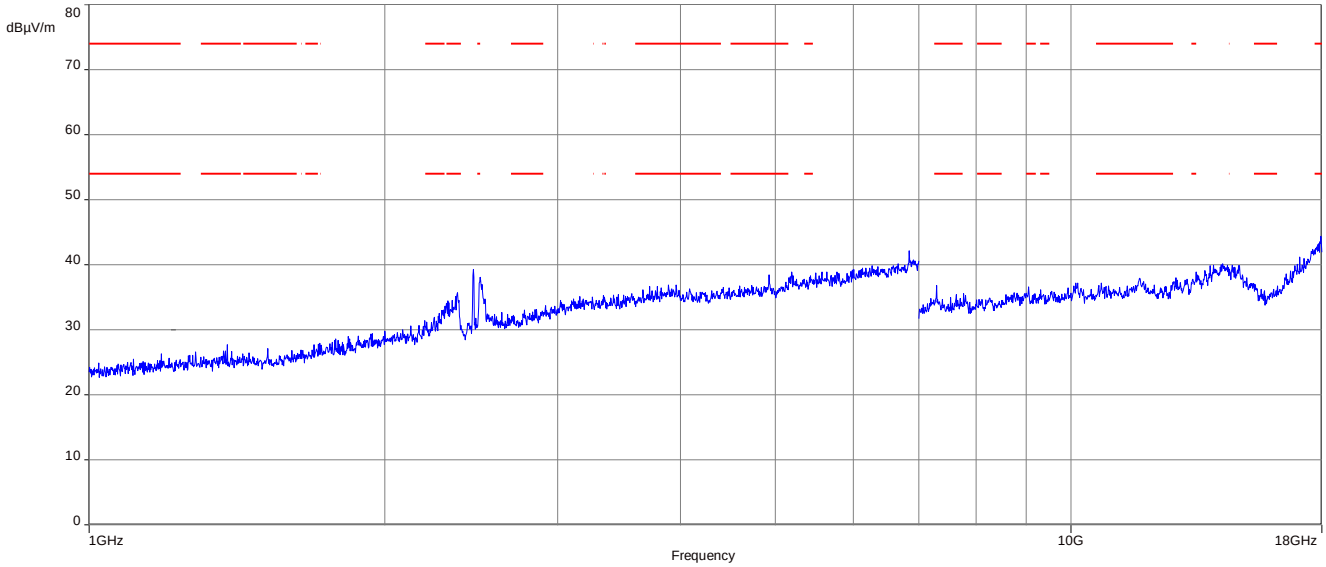


The carrier signal is notched with a 2.4 GHz band rejection filter.

Plot 6: Middle channel, 18 GHz to 26 GHz, vertical & horizontal polarization

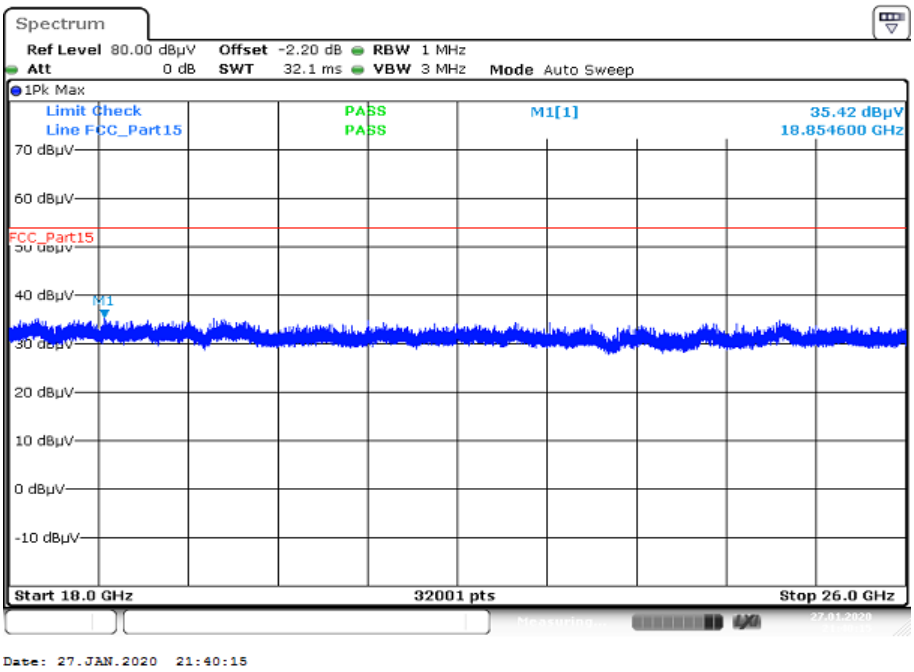


Plot 7: Highest channel, 1 GHz to 18 GHz, vertical & horizontal polarization



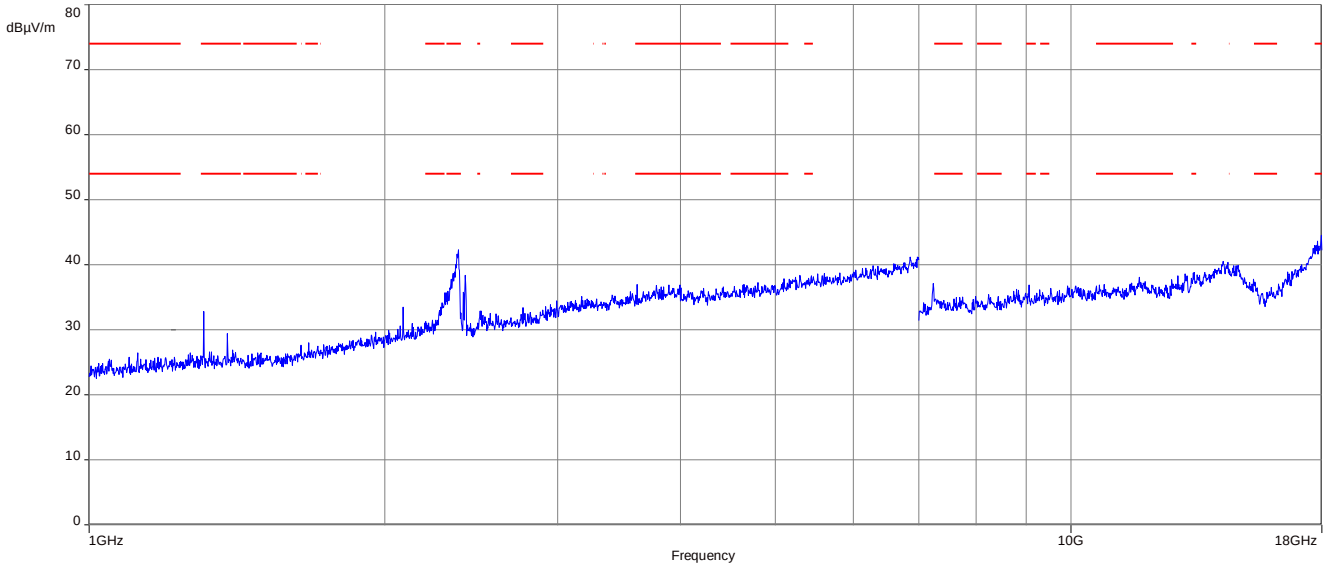
The carrier signal is notched with a 2.4 GHz band rejection filter.

Plot 9: Highest channel, 18 GHz to 26 GHz, vertical & horizontal polarization



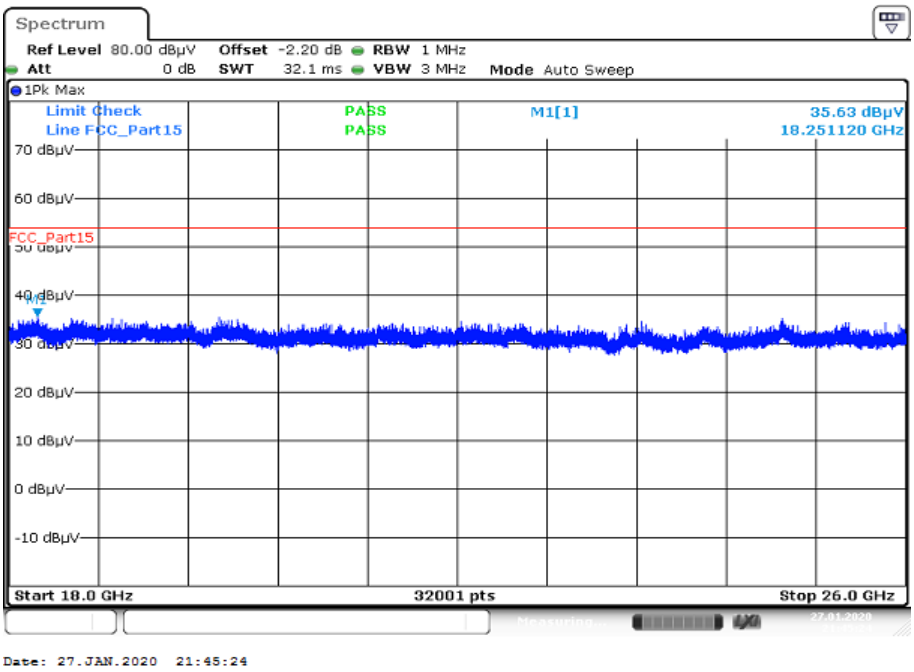
Plots: OFDM g-Mode (20 MHz bandwidth) – Antenna 1

Plot 1: Lowest channel, 1 GHz to 18 GHz, vertical & horizontal polarization

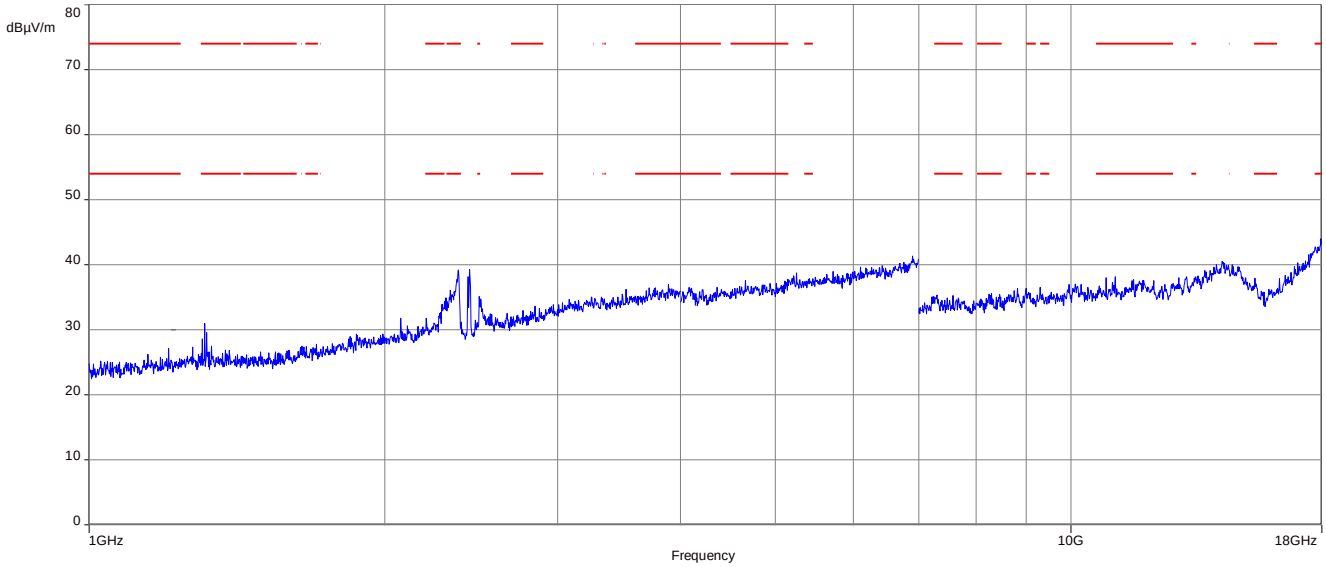


The carrier signal is notched with a 2.4 GHz band rejection filter.

Plot 3: Lowest channel, 18 GHz to 26 GHz, vertical & horizontal polarization

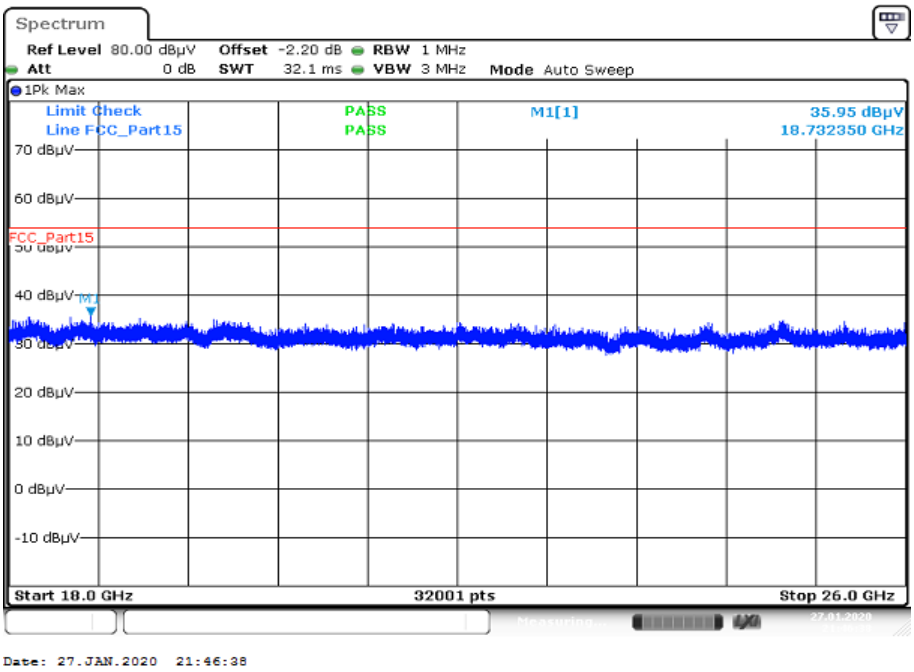


Plot 4: Middle channel, 1 GHz to 18 GHz, vertical & horizontal polarization

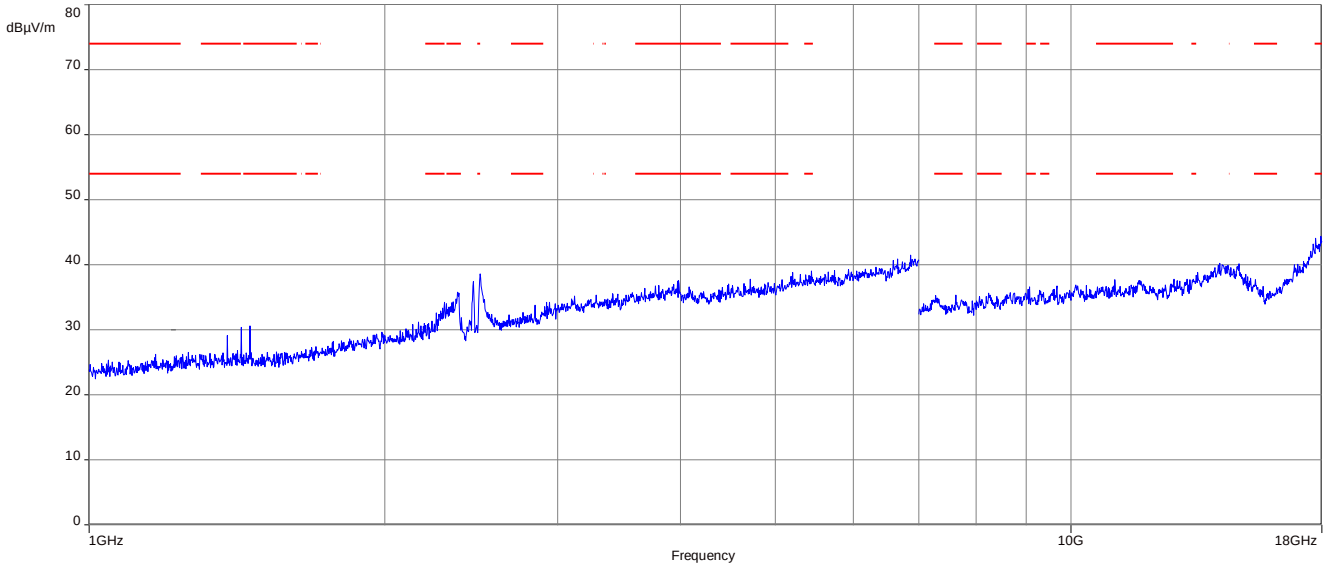


The carrier signal is notched with a 2.4 GHz band rejection filter.

Plot 6: Middle channel, 18 GHz to 26 GHz, vertical & horizontal polarization

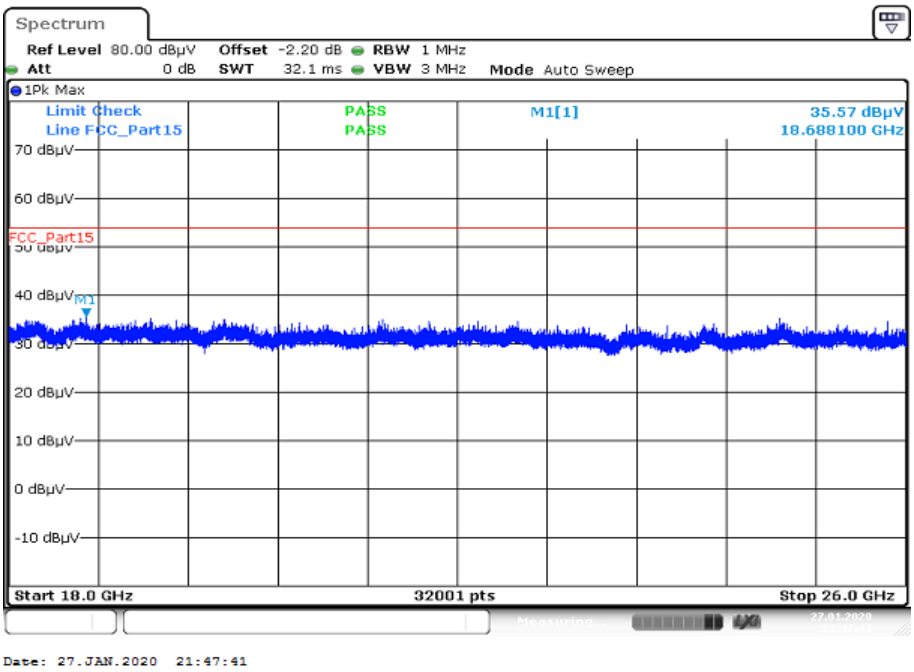


Plot 7: Highest channel, 1 GHz to 18 GHz, vertical & horizontal polarization



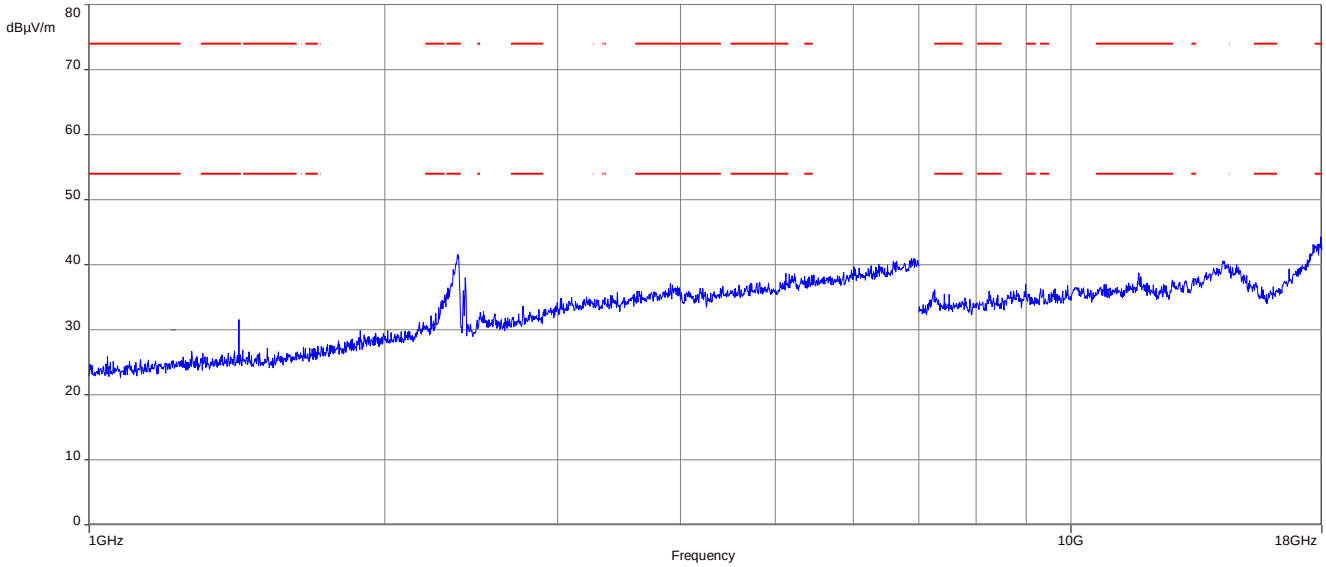
The carrier signal is notched with a 2.4 GHz band rejection filter.

Plot 9: Highest channel, 18 GHz to 26 GHz, vertical & horizontal polarization



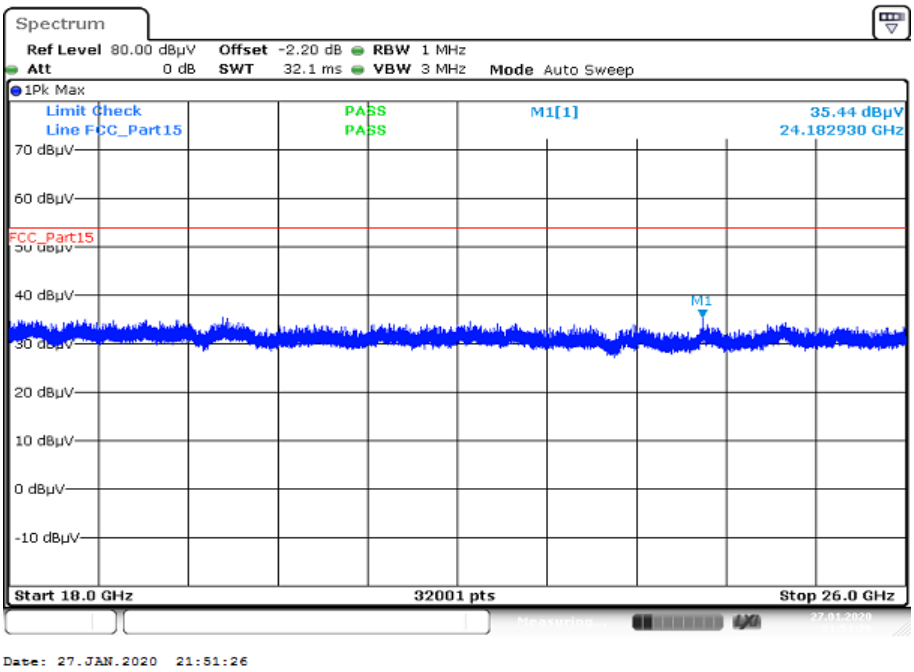
Plots: OFDM n20-Mode (20 MHz bandwidth) – Antenna 1

Plot 1: Lowest channel, 1 GHz to 18 GHz, vertical & horizontal polarization

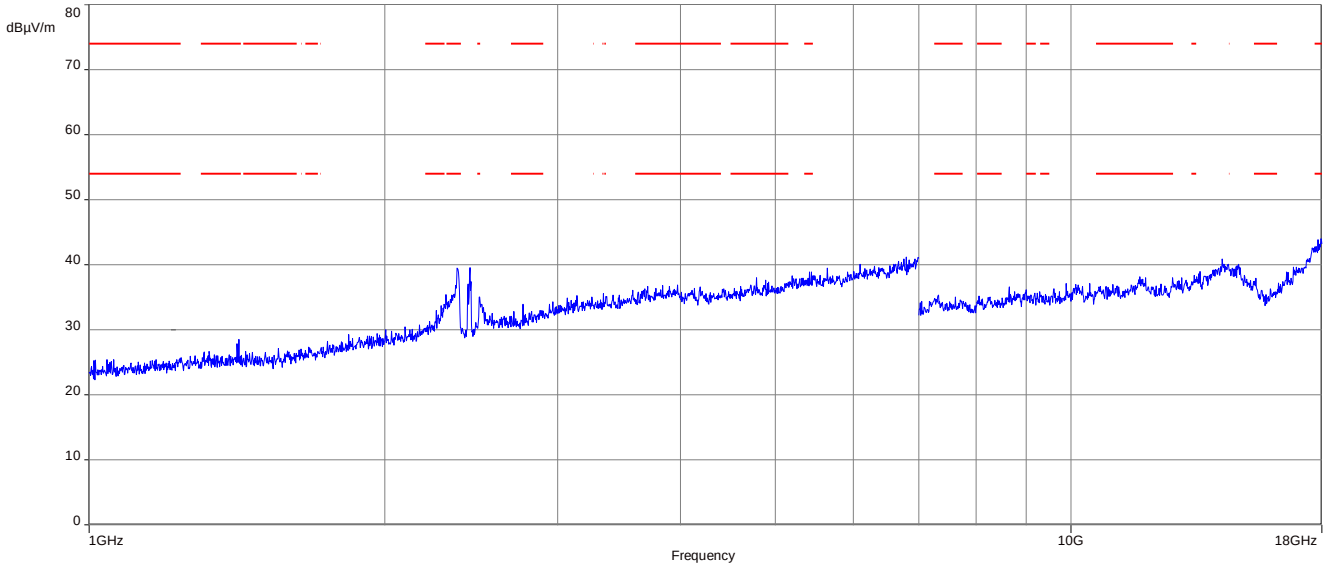


The carrier signal is notched with a 2.4 GHz band rejection filter.

Plot 3: Lowest channel, 18 GHz to 26 GHz, vertical & horizontal polarization

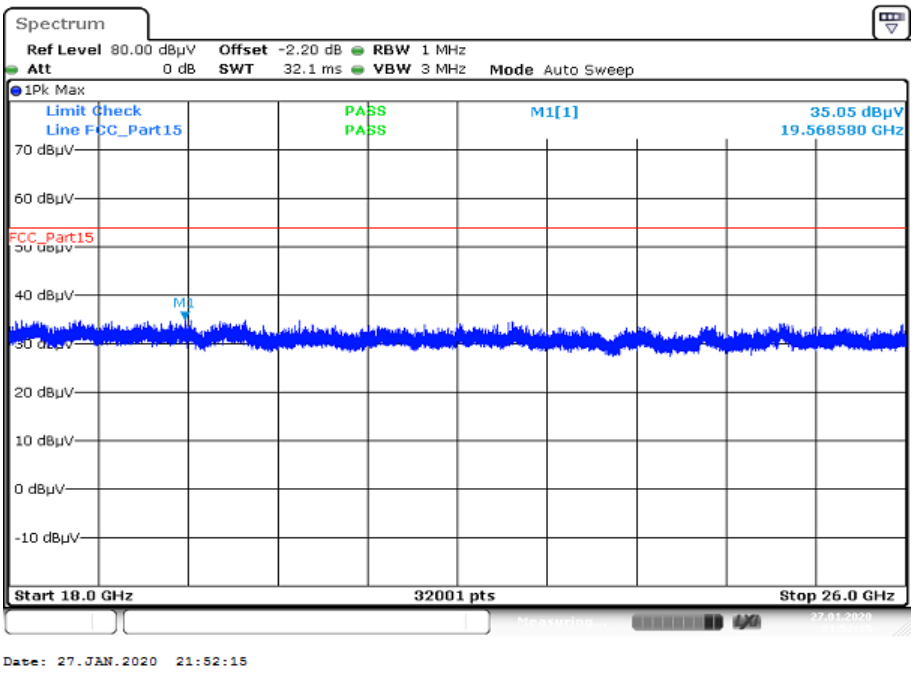


Plot 4: Middle channel, 1 GHz to 18 GHz, vertical & horizontal polarization

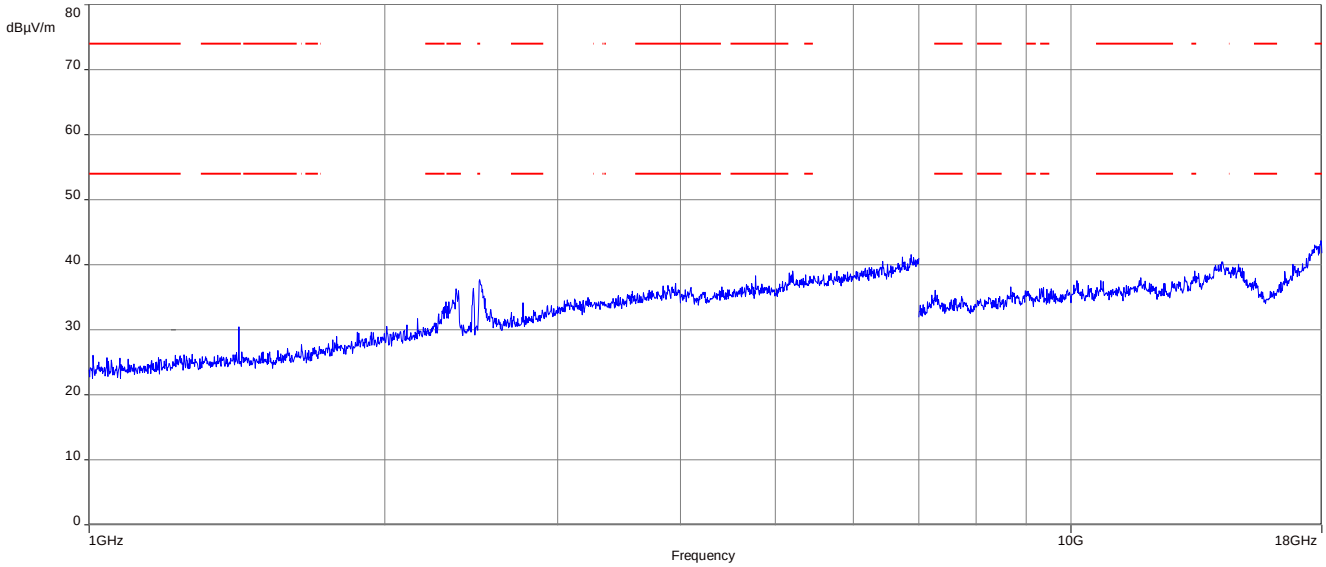


The carrier signal is notched with a 2.4 GHz band rejection filter.

Plot 6: Middle channel, 18 GHz to 26 GHz, vertical & horizontal polarization

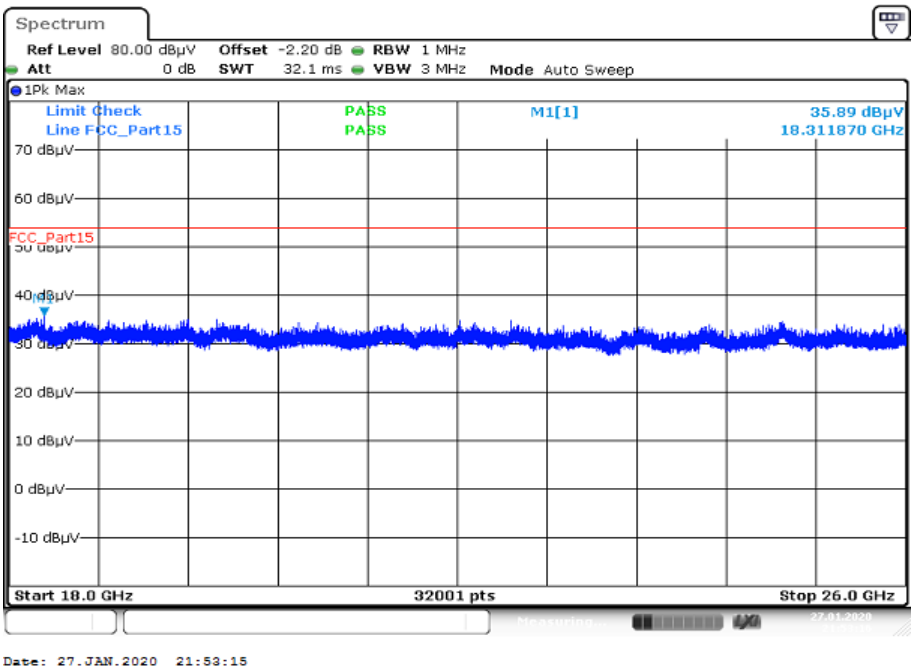


Plot 7: Highest channel, 1 GHz to 18 GHz, vertical & horizontal polarization



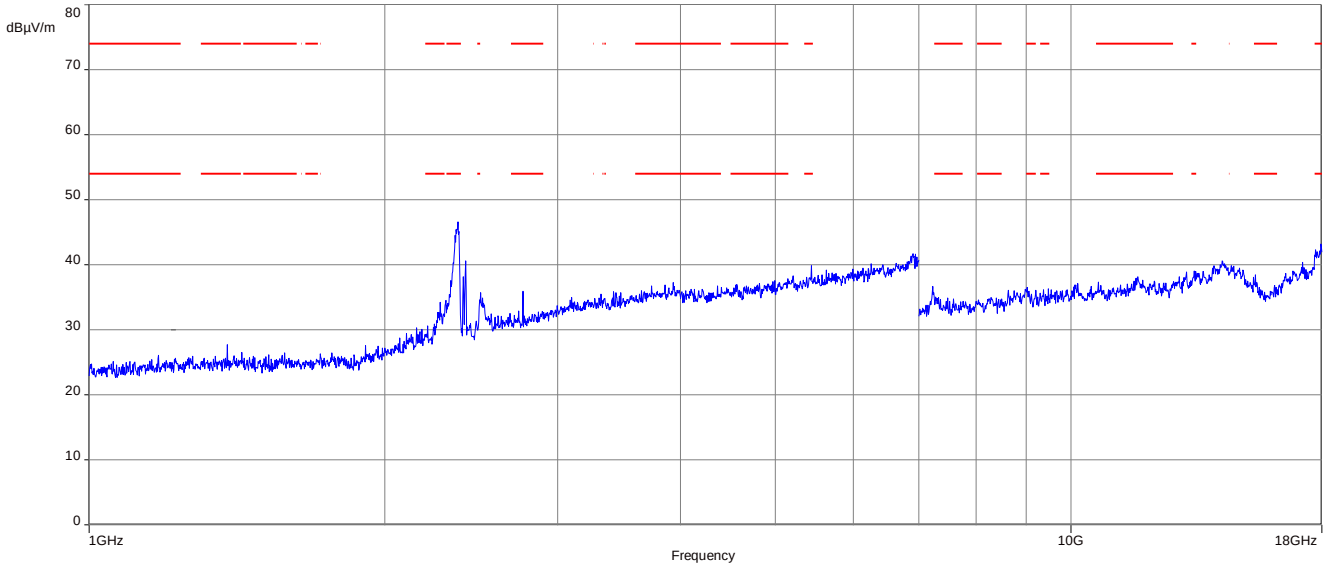
The carrier signal is notched with a 2.4 GHz band rejection filter.

Plot 9: Highest channel, 18 GHz to 26 GHz, vertical & horizontal polarization



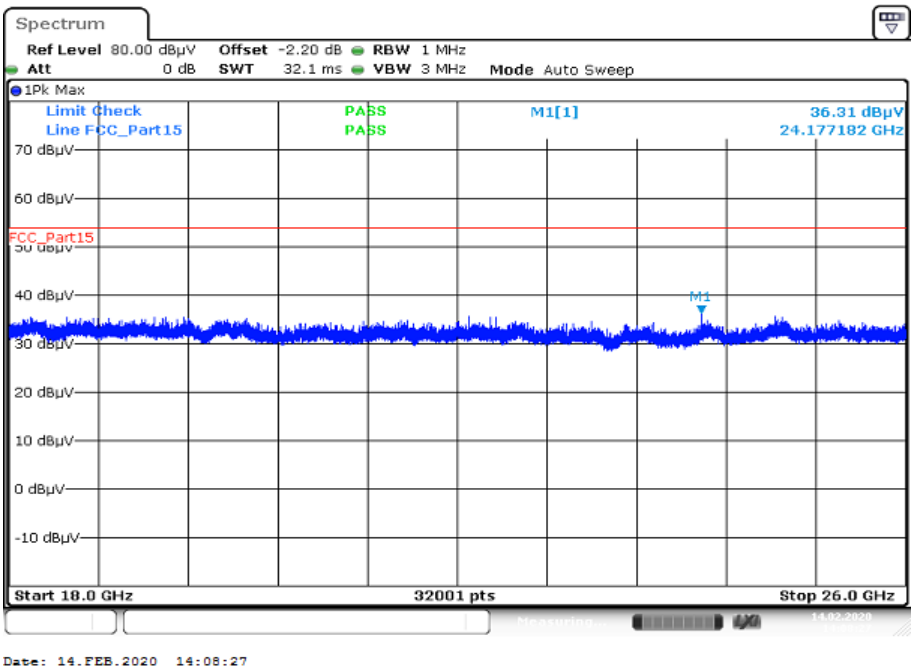
Plots: OFDM n20-Mode (20 MHz bandwidth) – Antenna 2

Plot 1: Lowest channel, 1 GHz to 18 GHz, vertical & horizontal polarization

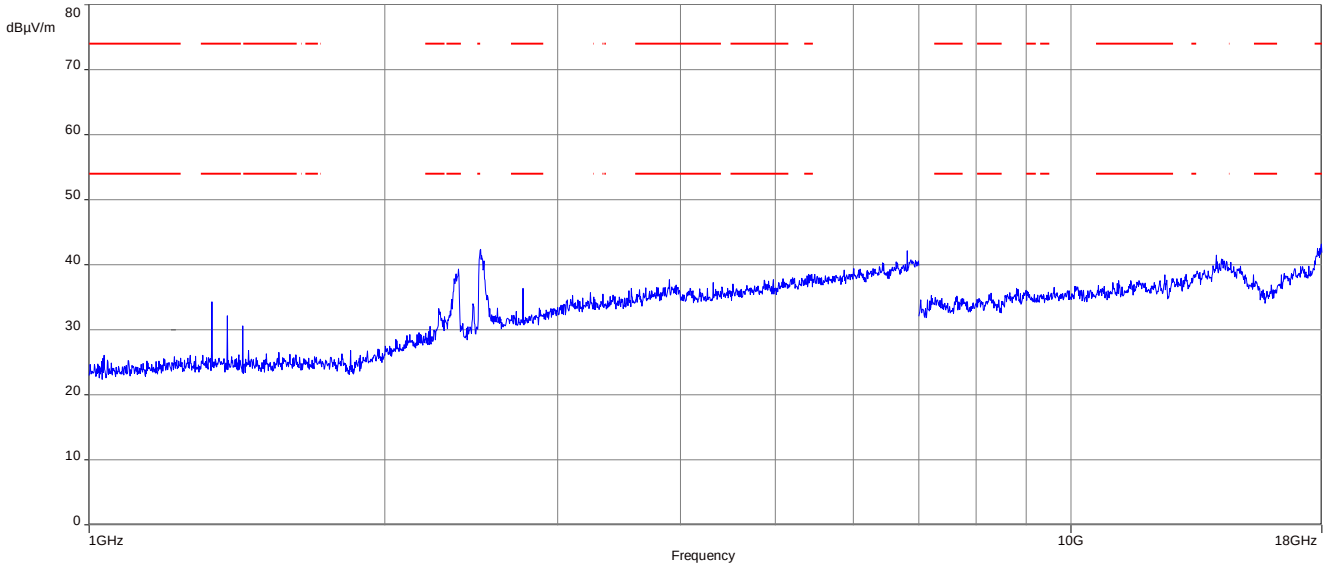


The carrier signal is notched with a 2.4 GHz band rejection filter.

Plot 2: Lowest channel, 18 GHz to 26 GHz, vertical & horizontal polarization

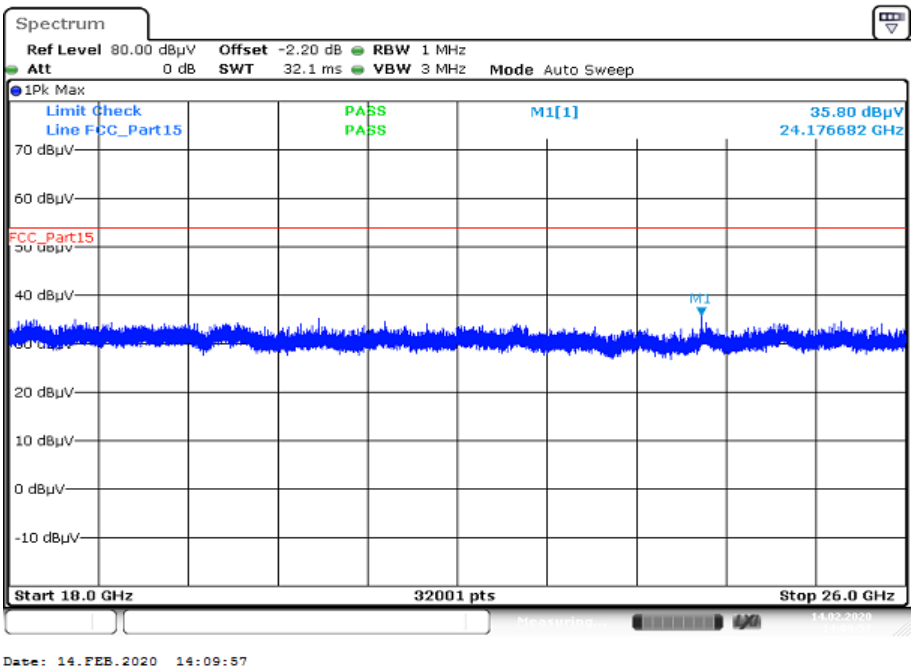


Plot 1: Highest channel, 1 GHz to 18 GHz, vertical & horizontal polarization



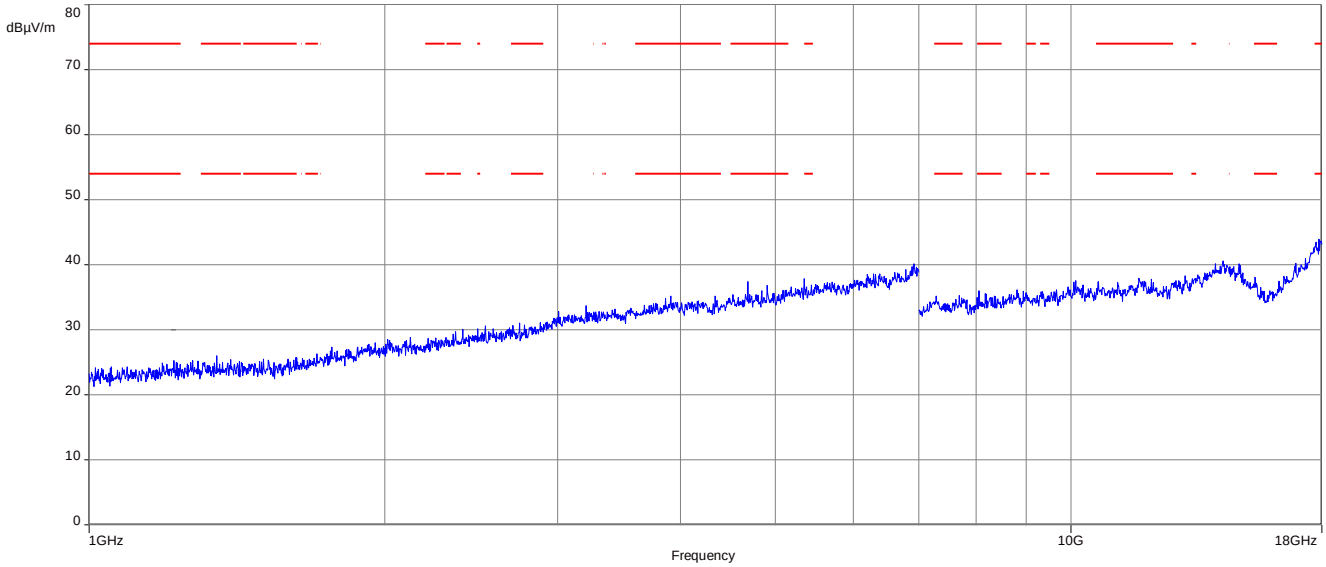
The carrier signal is notched with a 2.4 GHz band rejection filter.

Plot 2: Highest channel, 18 GHz to 26 GHz, vertical & horizontal polarization

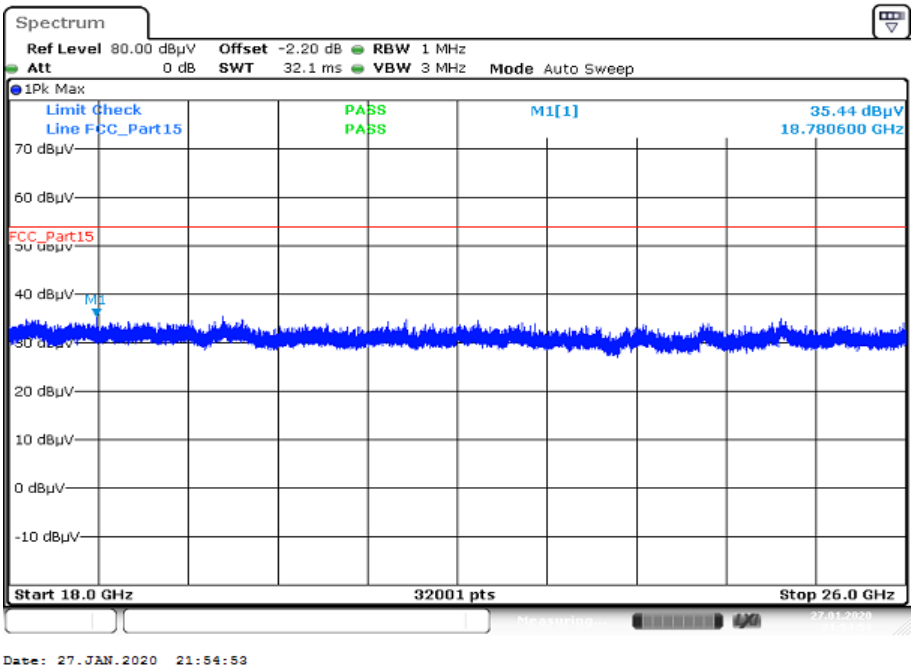


Plots: RX / idle mode – Antenna 1

Plot 1: 1 GHz to 18 GHz, vertical & horizontal polarization



Plot 2: 18 GHz to 26 GHz, vertical & horizontal polarization



13 Observations

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

Annex A Glossary

EUT	Equipment under test
DUT	Device under test
UUT	Unit under test
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

Annex B Document history

Version	Applied changes	Date of release
-/-	Initial release	2020-06-22
A	Added PMN and channel number	2020-07-02

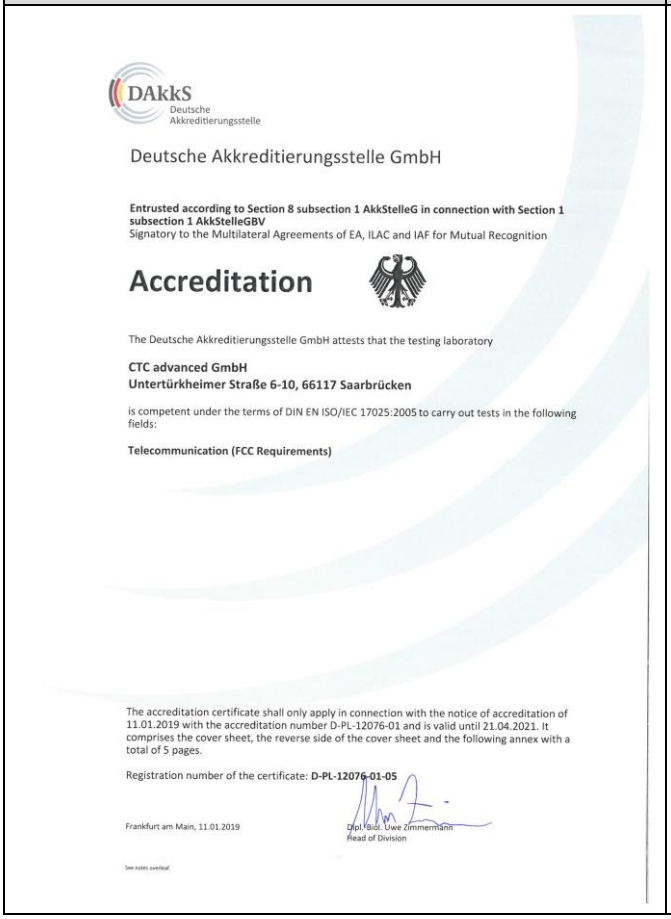
Annex C Accreditation Certificate – D-PL-12076-01-04

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-12076-01-04.pdf

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

first page	last page
	

DAkkS Deutsche Akkreditierungsstelle

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 17025:2005 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 11.01.2019 with the accreditation number D-PL-12076-01 and is valid until 21.04.2021. It comprises the cover sheet, the reverse side of the cover sheet and the following annex with a total of 5 pages.

Registration number of the certificate: **D-PL-12076-01-05**

Frankfurt am Main, 11.01.2019

Dipl.-Biol. Uwe Zimmermann
Head of Division

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 dissemination 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

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-12076-01-05.pdf

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