
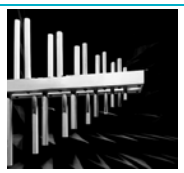
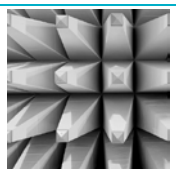

TEST REPORT

Test report no.: 1-8376-24-01-06_TR1-R02

DAkkS Deutsche Akkreditierungsstelle D-PL-12047-01-00

Testing laboratory

cetecom advanced GmbH
Untertuerkheimer Strasse 6 – 10
66117 Saarbruecken / Germany
Phone: + 49 681 5 98 - 0
Fax: + 49 681 5 98 - 9075
Internet: https://cetecomadvanced.com
e-mail: mail@cetecomadvanced.com

Accredited Testing Laboratory:
The testing laboratory (area of testing) is accredited according to DIN EN ISO/IEC 17025 (2018-03) by the Deutsche Akkreditierungsstelle GmbH (DAkkS).
The accreditation is valid for the scope of testing procedures as stated in the accreditation certificate with the registration number:
D-PL-12047-01-00.
ISED Testing Laboratory Recognized Listing Number: DE0001
FCC designation number: DE0002

Applicant

HYDAC Filter Systems GmbH
Justus-von-Liebig-Straße , Werk 20
66280 Sulzbach / GERMANY
Phone: -/-
Contact: Andreas Wilhelm
e-mail: Andreas.Wilhelm@hydac.com

Manufacturer

HYDAC Filter Systems GmbH
Justus-von-Liebig-Straße , Werk 20
66280 Sulzbach / 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

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

Test Item

Kind of test item:	**Contamination Sensor**
Model name:	**CS15xx-0, CS15xx-1**
FCC ID:	**2BL77–49322FS**
ISED certification number:	**33231-49322FS**
Frequency:	2400.0 MHz to 2483.5 MHz
Technology tested:	WLAN
Antenna:	Integrated antenna
Power supply:	18.0 V to 32.0 V by external DC
Temperature range:	-30°C to +80°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=cetecom advanced GmbH, ou=BTL-230530, email=marco.bertolino@cetecomadvanced.com, c=DE
2025.04.04 13:06:56 +02'00'

Marco Bertolino
Supervisor Radio Services
Radio Labs

Test performed:

cn=René Oelmann, o=cetecom advanced GmbH, ou=OEL-230530, email=rene.oelmann@cetecomadvanced.com, c=DE
2025.04.04 12:53:23 +02'00'

René Oelmann
Lab Manager
Radio Labs

1 Table of contents

2 General information

2.1 Notes and disclaimer

The test results of this test report relate exclusively to the test item specified in this test report. cetecom advanced GmbH does not assume responsibility for any conclusions and generalizations drawn from the test results with regard to other specimens or samples of the type of the equipment represented by the test item.
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This test report replaces the test report with the number 1-8376-24-01-06_TR1-R01 and dated 2024-11-26.

2.2 Application details

Date of receipt of order:	2024-08-07
Date of receipt of test item:	2024-09-11
Start of test:*	2024-09-11
End of test:*	2024-11-08
Person(s) present during the test:	Mr. Ulbrich, Mr. Germann

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

2.3 Test laboratories sub-contracted

None

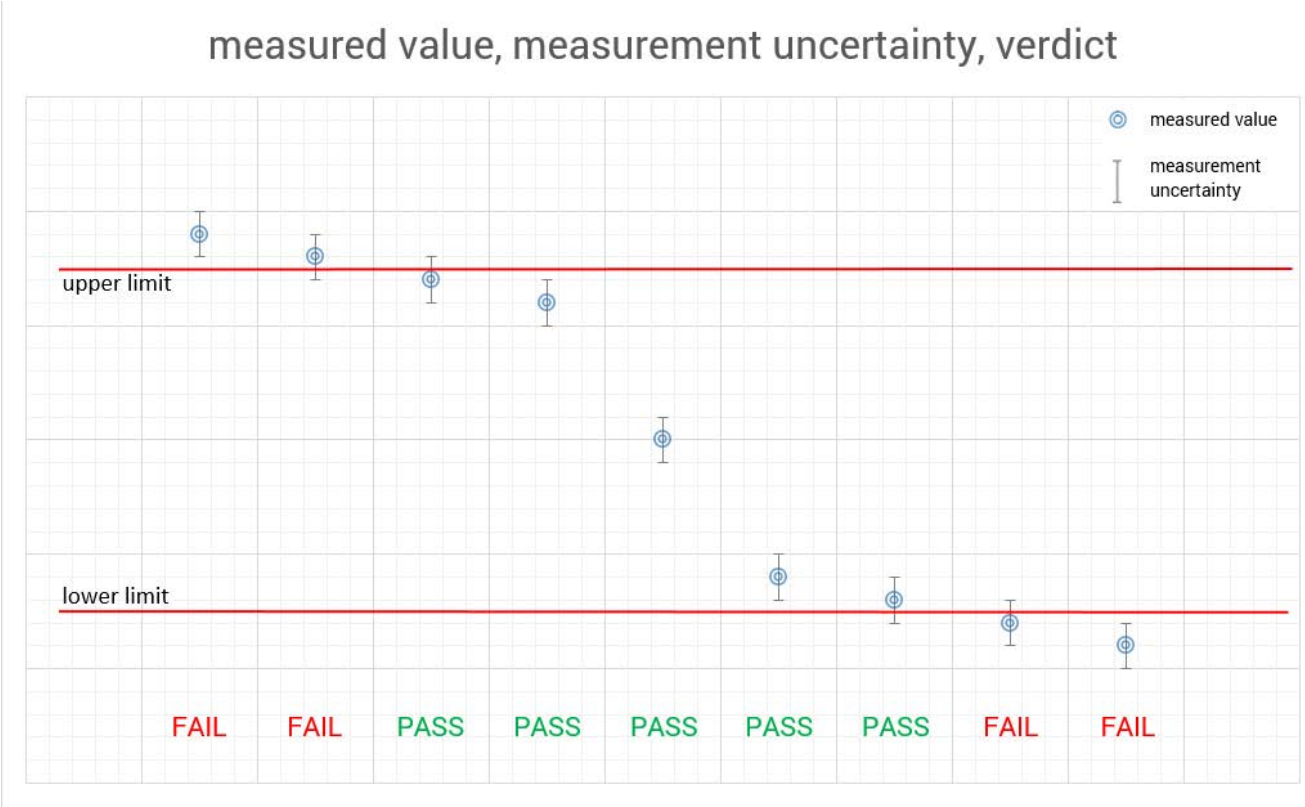
3 Test standard/s, references and accreditations

Test standard	Date	Description
FCC - Title 47 CFR Part 15	-/-	FCC - Title 47 of the Code of Federal Regulations; Chapter I; Part 15 - Radio frequency devices
RSS - 247 Issue 3	August 2023	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence - Exempt Local Area Network (LE-LAN) Devices
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
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

4 Reporting statements of conformity – decision rule

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



5 Test environment

Temperature	:	T_{nom} T_{max} T_{min}	+22 °C during room temperature tests No tests under extreme environmental conditions required. No tests under extreme environmental conditions required.
Relative humidity content	:		55 %
Barometric pressure	:		1021 hpa
Power supply	:	V_{nom} V_{max} V_{min}	24.0 V by external DC No tests under extreme environmental conditions required. No tests under extreme environmental conditions required.

6 Test item

6.1 General description

Kind of test item	:	Contamination Sensor
Model name	:	CS15xx-0, CS15xx-1
HMN	:	-/-
PMN	:	CS1500
HVIN	:	CS1510; CS1520; CS1512; CS1522
FVIN	:	-/-
S/N serial number	:	CS15XX-0: Prototyp 1 CS15XX-1: Prototyp 2
Hardware status	:	B.1 / C.3
Software status	:	V00.12
Firmware status	:	ESP32_RFTest_190_8cac24c_20230710
Frequency band	:	2400.0 MHz to 2483.5 MHz
Type of radio transmission Use of frequency spectrum	: :	DSSS, OFDM
Type of modulation	:	(D)BPSK, (D)QPSK, 16 – QAM, 64 – QAM
Number of channels	:	11
Antenna	:	Integrated antenna
Power supply	:	18.0 V to 32.0 V by external DC
Temperature range	:	-30°C to +80°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: 1-8376-24-01-01_TR1-A101-R01
1-8376-24-01-01_TR1-A102-R01
1-8376-24-01-01_TR1-A103-R01

7 Description of the test setup

Typically, the calibrations of the test apparatus are commissioned to and performed by an accredited calibration laboratory. The calibration intervals are determined in accordance with the DIN EN ISO/IEC 17025. In addition to the external calibrations, the laboratory executes comparison measurements with other calibrated test systems or effective verifications. Weekly chamber inspections and range calibrations are performed. Where possible, RF generating and signaling equipment as well as measuring receivers and analyzers are connected to an external high-precision 10 MHz reference (GPS-based or rubidium frequency standard).

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

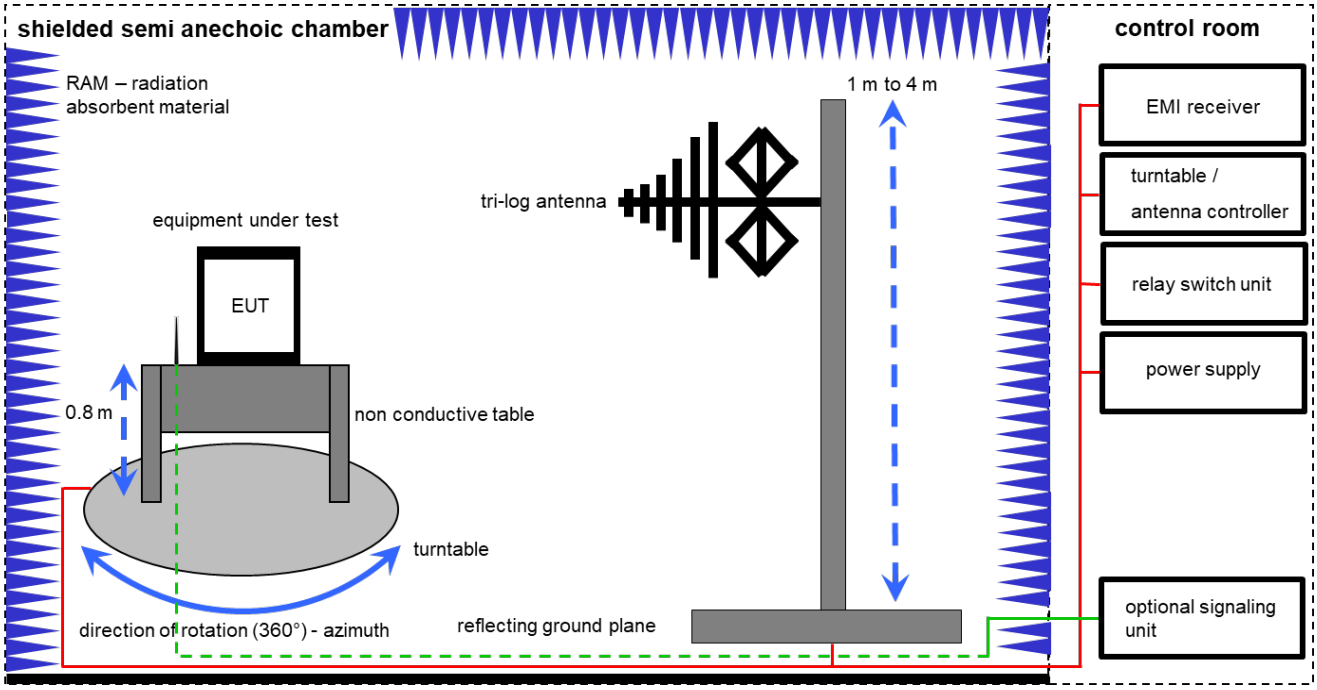
Each block diagram listed can contain several test setup configurations. All devices belonging to a test setup are identified with the same letter syntax. For example: Column Setup and all devices with an A.

Agenda: Kind of Calibration

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

7.1 Shielded semi anechoic chamber

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



Measurement distance: tri-log antenna 10 meter
EMC32 software version: 10.59.00

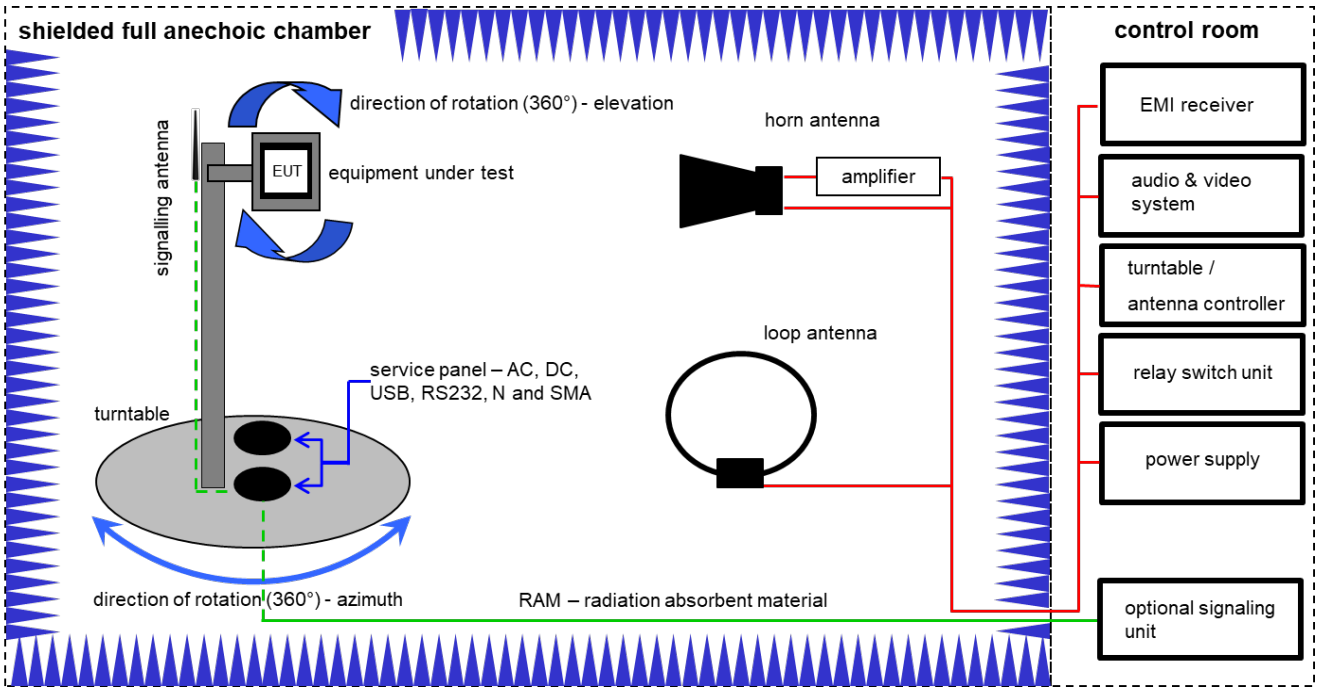
FS = UR + CL + AF
(FS-field strength; UR-voltage at the receiver; CL-loss of the cable; AF-antenna factor)

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

Equipment table:

No.	Setup	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	A	Switch-Unit	3488A	HP	2719A14505	300000368	ev	-/-	-/-
2	A	Semi anechoic chamber	3000023	MWB AG	-/-	300000551	ne	-/-	-/-
3	A	Antenna Tower	Model 2175	ETS-Lindgren	64762	300003745	izw	-/-	-/-
4	A	Positioning Controller	Model 2090	ETS-Lindgren	64672	300003746	izw	-/-	-/-
5	A	Turntable Interface-Box	Model 105637	ETS-Lindgren	44583	300003747	izw	-/-	-/-
6	A	TRILOG Broadband Test-Antenna 30 MHz - 3 GHz	VULB9163	Schwarzbeck Mess - Elektronik	216	300003288	vlKl!	31.08.2023	31.08.2025
7	A	Turntable	2089-4.0	EMCO	-/-	300004394	ne	-/-	-/-
8	A	PC	TecLine	F+W	-/-	300004388	ne	-/-	-/-
9	A	EMI Test Receiver	ESR3	Rohde & Schwarz	102587	300005771	k	06.12.2023	31.12.2024

7.2 Shielded fully anechoic chamber



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

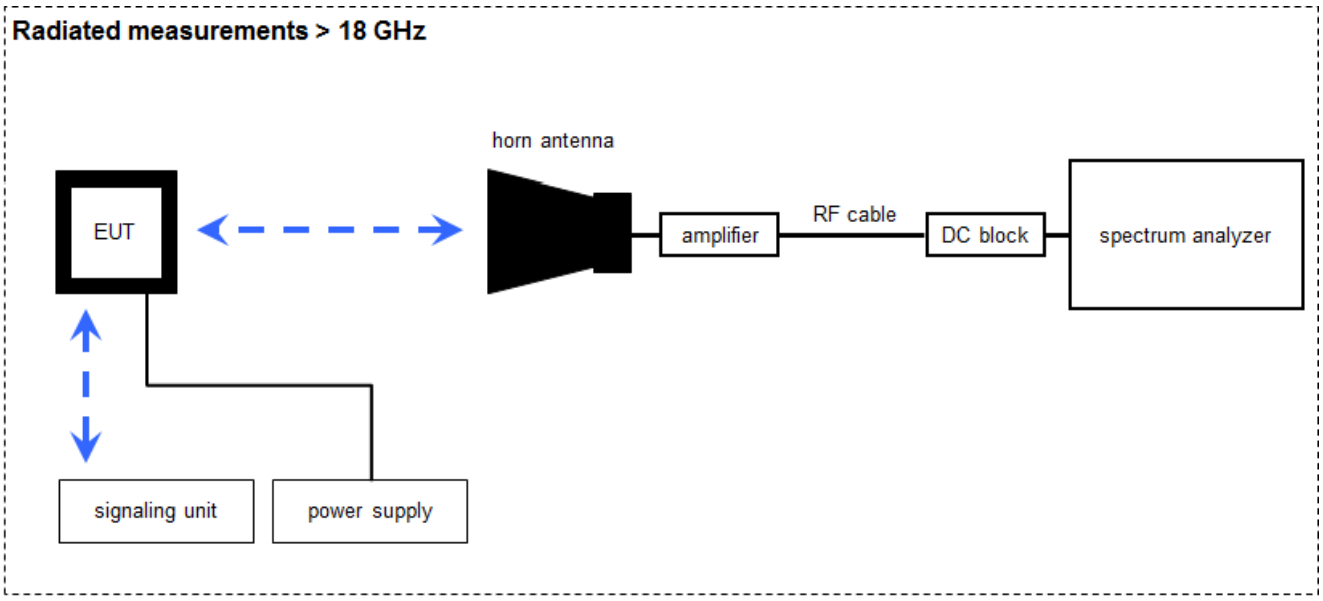
FS = UR + CA + AF
(FS-field strength; UR-voltage at the receiver; CA-loss of the signal path; AF-antenna factor)

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.	Setup	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	A, B, C	Double-Ridged Waveguide Horn Antenna 1-18.0GHz	3115	EMCO	9107-3696	300001604	vIKI!	20.03.2023	19.03.2025
2	C	Active Loop Antenna 9 kHz to 30 MHz	6502	EMCO	2210	300001015	vIKI!	02.08.2023	31.08.2025
3	B	Highpass Filter	WHK1.1/15G-10SS	Wainwright	37	400000148	ne	-/-	-/-
4	B	Highpass Filter	WHKX7.0/18G-8SS	Wainwright	18	300003789	ne	-/-	-/-
5	B	Band Reject Filter	WRCG2400/2483-2375/2505-50/10SS	Wainwright	26	300003792	ne	-/-	-/-
6	A, B, C	Broadband Amplifier 0.5-18 GHz	CBLU5184540	CERNEX	22051	300004483	ev	-/-	-/-
7	A, B, C	4U RF Switch Platform	L4491A	Agilent Technologies	MY50000032	300004510	ne	-/-	-/-
8	A, B, C	Computer	Intel Core i3 3220/3,3 GHz, Prozessor	-/-	2V2403033A5421	300004591	ne	-/-	-/-
9	A, B, C	NEXIO EMV-Software	BAT EMC V2022.0.22.0	Nexio	-/-	300004682	ne	-/-	-/-
10	A, B, C	Anechoic chamber	-/-	TDK	-/-	300003726	ne	-/-	-/-
11	A, B, C	EMI Test Receiver 20Hz – 26,5GHz	ESU26	R&S	100037	300003555	k	11.12.2023	31.12.2024
12	B	RF-Amplifier	AMF-6F06001800-30-10P-R	NARDA-MITEQ Inc	2011571	300005240	ev	-/-	-/-

7.3 Radiated measurements > 18 GHz



Measurement distance: horn antenna 50 cm

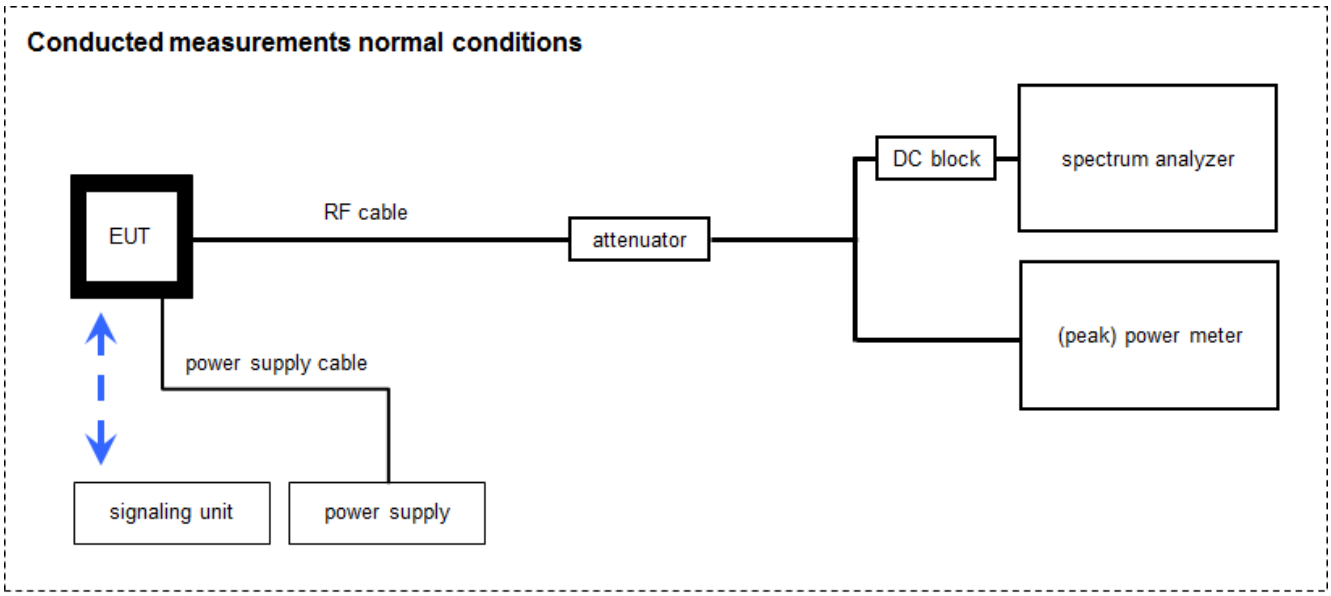
FS = UR + CA + AF
(FS-field strength; UR-voltage at the receiver; CA-loss signal path & distance correction; AF-antenna factor)

Example calculation:
FS [dBµV/m] = 40.0 [dBµV/m] + (-60.1) [dB] + 36.74 [dB/m] = 16.64 [dBµV/m] (6.79 µV/m)

Equipment table:

No.	Setup	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	k	24.01.2024	23.01.2026
3	A	Signal analyzer	FSV40	Rohde&Schwarz	101042	300004517	k	06.12.2023	31.12.2024
4	A	RF-Cable	ST18/SMAm/SMAm /48	Huber & Suhner	Batch no. 600918	400001182	ev	-/-	-/-
5	A	DC-Blocker 0.1-40 GHz	8141A	Inmet	-/-	400001185	ev	-/-	-/-

7.4 Conducted measurements with peak power meter & spectrum analyzer



WLAN tester version: 1.1.13; LabView2015

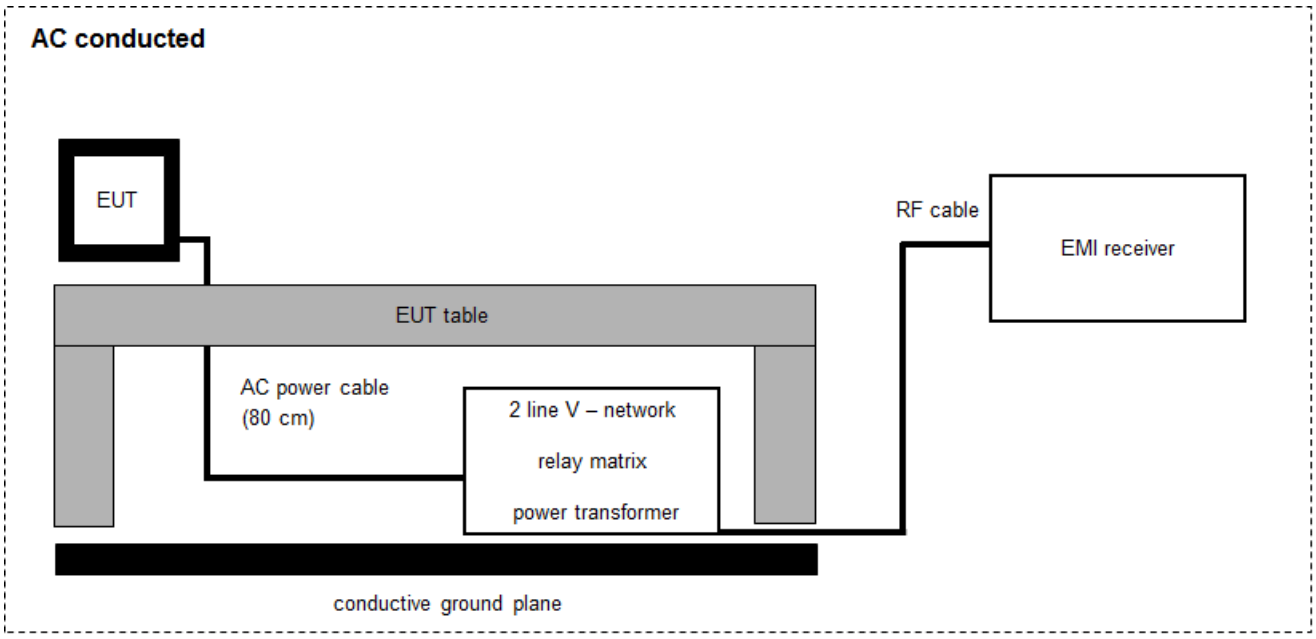
OP = AV + CA
(OP-output power; AV-analyzer value; CA-loss signal path)

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

Equipment table:

No.	Setup	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	A, B	Switch / Control Unit (including DC-Block, Splitter)	3488A	HP	-/-	300000929	ne	-/-	-/-
2	A	Signal analyzer	FSV30	Rohde&Schwarz	1321.3008K30/ 103170	300004855	vIKI!	09.12.2022	31.12.2024
3	A, B	USB-GPIB-Interface	82357B	Agilent Technologies	MY54323070	300004852	ne	-/-	-/-
4	A, B	Tester Software C.BER	Version 5.0	cetecom advanced GmbH	0001	400001379	ne	-/-	-/-
5	A, B	Switch matrix	RSM 1.1	cetecom advanced GmbH	31534892	400001456	ev	20.09.2023 19.09.2024	19.09.2024 19.09.2025
6	B	USB Wideband Power Sensor (50MHz - 18GHz)	U2021XA	Keysight	MY591900010	300005802	k	07.12.2023	31.12.2024

7.5 AC conducted



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

Example calculation:
FS [dBµV/m] = 37.62 [dBµV/m] + 9.90 [dB] + 0.23 [dB] = 47.75 [dBµV/m] (244.06 µV/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	vlKl!	12.12.2023	31.12.2025
2	A	RF-Filter-section	85420E	HP	3427A00162	300002214	NK!	-/-	-/-
3	A	Analyzer-Reference-System (Harmonics and Flicker)	ARS 16/1	SPS	A3509 07/0 0205	300003314	NK!	-/-	-/-
4	A	Hochpass 150 kHz	EZ-25	R&S	100010	300003798	ev	-/-	-/-
5	A	PC	TecLine	F+W	-/-	300003532	ne	-/-	-/-
6	A	Netzsimulation 1600/2000 A	ACS-1600-PS	-/-	2002-001247-0	300006074	ev	-/-	-/-
7	A	EMI Test Receiver 3.6 GHz	ESR3	Rohde & Schwarz	102981	300006318	k	08.12.2023	31.12.2024

8 Sequence of testing

8.1 Sequence of testing radiated spurious 9 kHz to 30 MHz

Setup

- The equipment is set up to simulate normal operation mode as described in the user manual or defined by the manufacturer.
- If the EUT is a tabletop system, it is placed on a table with 0.8 m height.
- If the EUT is a floor standing device, it is placed directly on the turn table.
- Auxiliary equipment and cables are positioned to simulate normal operation conditions as described in ANSI C 63.4.
- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.
- Measurement distance is 3 m (see ANSI C 63.4) – see test details.
- EUT is set into operation.

Premeasurement*

- The turntable rotates from 0° to 315° using 45° steps.
- The antenna height is 1 m.
- At each turntable position the analyzer sweeps with positive-peak detector to find the maximum of all emissions.

Final measurement

- Identified emissions during the pre-measurement are maximized by the software by rotating the turntable from 0° to 360°.
- Loop antenna is rotated about its vertical axis for maximum response at each azimuth about the EUT. (For certain applications, the loop antenna plane may also need to be positioned horizontally at the specified distance from the EUT)
- The final measurement is done in the position (turntable and elevation) causing the highest emissions with quasi-peak (as described in ANSI C 63.4).
- Final levels, frequency, measuring time, bandwidth, turntable position, correction factor, margin to the limit and limit will be recorded. A plot with the graph of the premeasurement and the limit is stored.

*)Note: The sequence will be repeated three times with different EUT orientations.

8.2 Sequence of testing radiated spurious 30 MHz to 1 GHz

Setup

- The equipment is set up to simulate normal operation mode as described in the user manual or defined by the manufacturer.
- If the EUT is a tabletop system, a table with 0.8 m height is used, which is placed on the ground plane.
- If the EUT is a floor standing device, it is placed on the ground plane with insulation between both.
- Auxiliary equipment and cables are positioned to simulate normal operation conditions as described in ANSI C 63.4.
- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.
- Measurement distance is 10 m or 3 m (see ANSI C 63.4) – see test details.
- EUT is set into operation.

Premeasurement

- The turntable rotates from 0° to 315° using 45° steps.
- The antenna is polarized vertical and horizontal.
- The antenna height changes from 1 m to 3 m.
- At each turntable position, antenna polarization and height the analyzer sweeps three times in peak to find the maximum of all emissions.

Final measurement

- The final measurement is performed for at least six highest peaks according to the requirements of the ANSI C63.4.
- Based on antenna and turntable positions at which the peak values are measured the software maximize the peaks by changing turntable position ± 45° and antenna height between 1 and 4 m.
- The final measurement is done with quasi-peak detector (as described in ANSI C 63.4).
- Final levels, frequency, measuring time, bandwidth, antenna height, antenna polarization, turntable angle, correction factor, margin to the limit and limit are recorded. A plot with the graph of the premeasurement with marked maximum final results and the limit is stored.

8.3 Sequence of testing radiated spurious 1 GHz to 18 GHz

Setup

- The equipment is set up to simulate normal operation mode as described in the user manual or defined by the manufacturer.
- If the EUT is a tabletop system, a 2-axis positioner with 1.5 m height is used.
- If the EUT is a floor standing device, it is placed directly on the turn table.
- Auxiliary equipment and cables are positioned to simulate normal operation conditions as described in ANSI C 63.4.
- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.
- Measurement distance is 3 m (see ANSI C 63.4) – see test details.
- EUT is set into operation.

Premeasurement

- The turntable rotates from 0° to 315° using 45° steps.
- The antenna is polarized vertical and horizontal.
- The antenna height is 1.5 m.
- At each turntable position and antenna polarization the analyzer sweeps with positive peak detector to find the maximum of all emissions.

Final measurement

- The final measurement is performed for at least six highest peaks according to the requirements of the ANSI C63.4.
- Based on antenna and turntable positions at which the peak values are measured the software maximizes the peaks by rotating the turntable from 0° to 360°. This measurement is repeated for different EUT-table positions (0° to 150° in 30°-steps) and for both antenna polarizations.
- The final measurement is done in the position (turntable, EUT-table and antenna polarization) causing the highest emissions with Peak and RMS detector (as described in ANSI C 63.4).
- Final levels, frequency, measuring time, bandwidth, turntable position, EUT-table position, antenna polarization, correction factor, margin to the limit and limit are recorded. A plot with the graph of the premeasurement with marked maximum final results and the limit is stored.

8.4 Sequence of testing radiated spurious above 18 GHz

Setup

- The equipment is set up to simulate normal operation mode as described in the user manual or defined by the manufacturer.
- Auxiliary equipment and cables are positioned to simulate normal operation conditions as described in ANSI C 63.4.
- The AC power port of the EUT (if available) is connected to a power outlet.
- The measurement distance is as appropriate (e.g. 0.5 m).
- The EUT is set into operation.

Premeasurement

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

Final measurement

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

9 Measurement uncertainty

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

10 Summary of measurement results

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

TC Identifier	Description	Verdict	Date	Remark
RF-Testing	CFR Part 15 RSS - 247, Issue 3	See table!	2025-04-04	-/-

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

Notes:

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

11 Additional information and comments

Reference documents: DATA SHEET PCB type antenna ANTX100P001B24003

Co-applicable documents: 1-8376_24-01-06_TR1-A201-R1.pdf

Special test descriptions: Power settings:

Channel	1 / 6 / 11
DSSS / b – mode	0 / 0 / 0
OFDM / g – mode	6 / 0 / 0
OFDM / n HT20 – mode	6 / 0 / 0
OFDM / n HT40 – mode	18 / 10 / 20

Configuration descriptions: There are two different variants of the device: CS15xx-0 and CS15xx-1
The variant CS15xx-0 was tested completely. Partial radiated tests were additionally performed on CS15xx-1.

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

Channels with 40 MHz channel bandwidth:

channel number & center frequency													
channel	-/-	-/-	**3**	4	5	**6**	7	8	**9**	10	11	-/-	-/-
f_c / MHz	-/-	-/-	**2422**	2427	2432	**2437**	2442	2447	**2452**	2457	2462	-/-	-/-

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

12 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.*

13 Measurement results

13.1 Antenna gain

Description:

The antenna gain of the device is declared by manufacturer based on an antenna diagram.

Limits:

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

Results:

antenna port 1	lowest channel	middle channel	highest channel
Gain [dBi]	4.0	4.4	4.1

13.2 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	
Detector	Peak
Sweep time	Auto
Resolution bandwidth	3 MHz
Video bandwidth	3 MHz
Trace mode	Max hold
Test setup	See chapter 7.4 setup A
Measurement uncertainty	See chapter 9

Results:

Modulation scheme / bandwidth	
DSSS / b – mode	1 Mbit/s
OFDM / g – mode	6 Mbit/s
OFDM / n HT20 – mode	MCS0
OFDM / n HT40 – mode	MCS0

13.3 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)	1-8376_24-01-06_TR1-A201-R1.pdf
Test setup	See chapter 7.4 setup B
Measurement uncertainty	See chapter 9

Limits:

FCC	ISED
Conducted 1.0 W / 30 dBm with an antenna gain of max. 6 dBi	

Results:

antenna port 1	maximum output power / dBm		
	lowest channel	middle channel	highest channel
Output power conducted DSSS / b – mode	19.4	19.6	19.4
Output power conducted OFDM / g – mode	21.9	22.4	22.2
Output power conducted OFDM / n HT20 – mode	21.9	22.1	21.9
Output power conducted OFDM / n HT40 – mode	19.2	19.9	18.5

13.4 Duty cycle

Description:

Measurement of the timing behavior.

Measurement:

Measurement parameter	
Detector	Peak
Resolution bandwidth	10 MHz
Video bandwidth	10 MHz
Trace mode	Max hold
Test setup	See chapter 7.4 setup A
Measurement uncertainty	See chapter 9

Limits:

FCC	ISED
No limitation!	

Results:

T_{nom}	V_{nom}	lowest channel	middle channel	highest channel
DSSS / b – mode		100%	100%	100%
OFDM / g – mode		100%	100%	100%
OFDM / n HT20 – mode		100%	100%	100%
OFDM / n HT40 – mode		100%	100%	100%

13.5 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.

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)	1-8376_24-01-06_TR1-A201-R1.pdf
Test setup	See chapter 7.4 setup A
Measurement uncertainty	See chapter 9

Limits:

FCC	ISED
8 dBm / 3 kHz (conducted)	

Results: antenna port 1

measured	peak power spectral density / dBm @ 3 kHz		
	Lowest channel	Middle channel	Highest channel
DSSS / b – mode	-6.9	-6.6	-6.9
OFDM / g – mode	-15.4	-13.9	-13.9
OFDM / n HT20 – mode	-15.0	-13.2	-13.5
OFDM / n HT40 – mode	-19.3	-17.6	-19.6

13.6 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)	1-8376_24-01-06_TR1-A201-R1.pdf
Test setup	See chapter 7.4 setup A
Measurement uncertainty	See chapter 9

Limits:

FCC	ISED
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	9084	9088	9084
OFDM / g – mode	16368	16380	16368
OFDM / n HT20 – mode	17080	16952	17064
OFDM / n HT40 – mode	33304	33272	33288

13.7 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)	1-8376_24-01-06_TR1-A201-R1.pdf
Test setup	See chapter 7.4 setup A
Measurement uncertainty	See chapter 9

Usage:

-/-	ISED
OBW is necessary for Emission Designator	

Results:

antenna port 1	99% emission bandwidth / kHz		
	lowest channel	middle channel	highest channel
DSSS / b – mode	13055	13043	13003
OFDM / g – mode	16630	16758	16738
OFDM / n HT20 – mode	17358	17410	17398
OFDM / n HT40 – mode	34309	34397	34421

13.8 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)	1-8376_24-01-06_TR1-A201-R1.pdf
Test setup	See chapter 7.4 setup A
Measurement uncertainty	See chapter 9

Usage:

-/-	ISED
The complete bandwidth has to be within the frequency range of the band.	

Results:

antenna port 1	20 dB bandwidth / MHz		
	lowest channel	middle channel	highest channel
DSSS / b – mode	15216	15168	15164
OFDM / g – mode	18292	18304	18264
OFDM / n HT20 – mode	19040	19028	19060
OFDM / n HT40 – mode	37904	37920	38032

13.9 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. 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	3 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 7.2 setup A	
Measurement uncertainty	See chapter 9	

Limits:

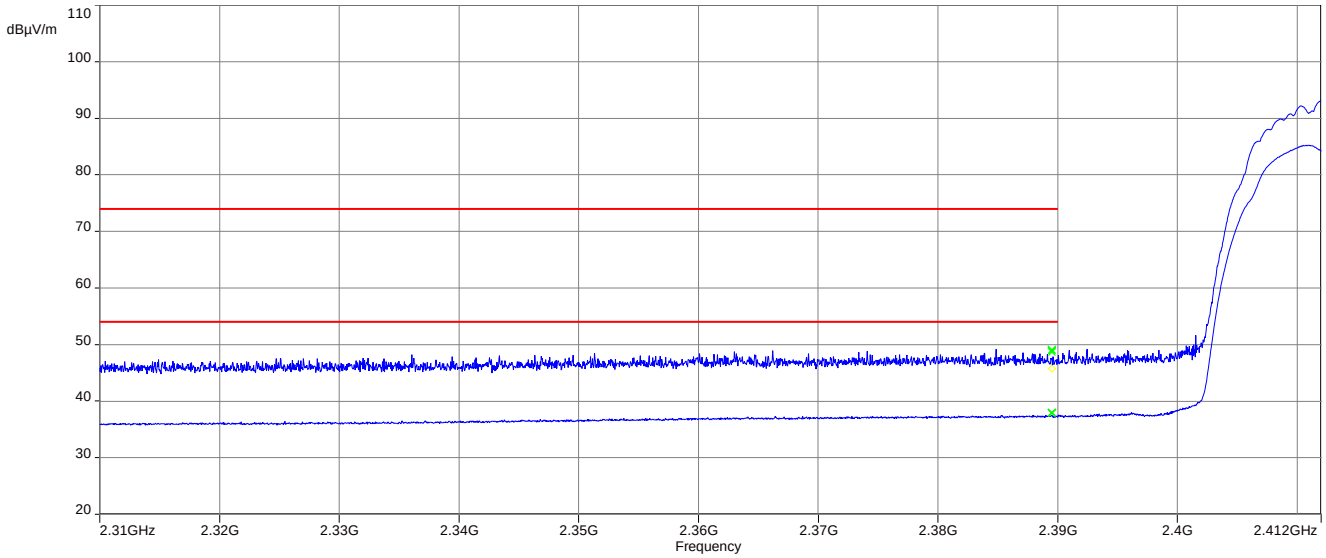
FCC	ISED
74 dBµV/m @ 3 m (Peak) 54 dBµV/m @ 3 m (AVG)	

Results CS15xx-0:

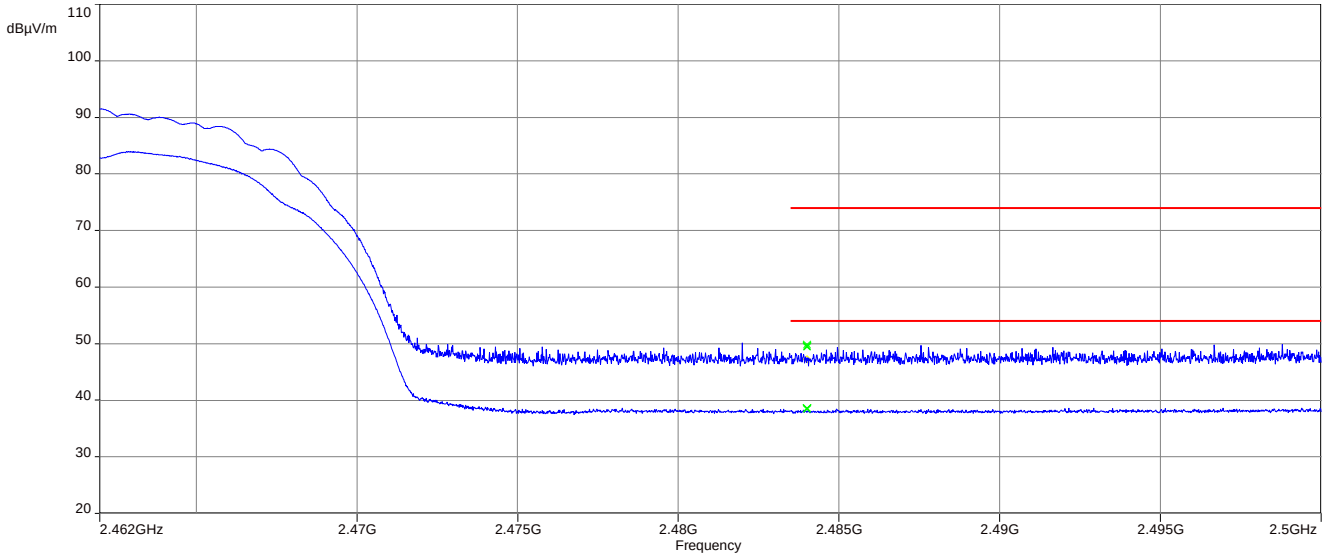
band edge compliance radiated / (dBµV / m) @ 3 m			
	DSSS / b – mode	OFDM / g – mode	OFDM / n HT20 – mode
Lower band edge	49.1 (Peak) 38.0 (AVG)	55.9 (Peak) 42.9 (AVG)	59.8 (Peak) 43.1 (AVG)
Upper band edge	49.9 (Peak) 38.6 (AVG)	55.9 (Peak) 42.1 (AVG)	58.1 (Peak) 42.2 (AVG)
	OFDM / n HT40 – mode	-/-	-/-
Lower band edge	61.2 (Peak) 43.9 (AVG)	-/-	-/-
Upper band edge	58.6 (Peak) 44.4 (AVG)	-/-	-/-

Plots: DSSS - peak / average

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

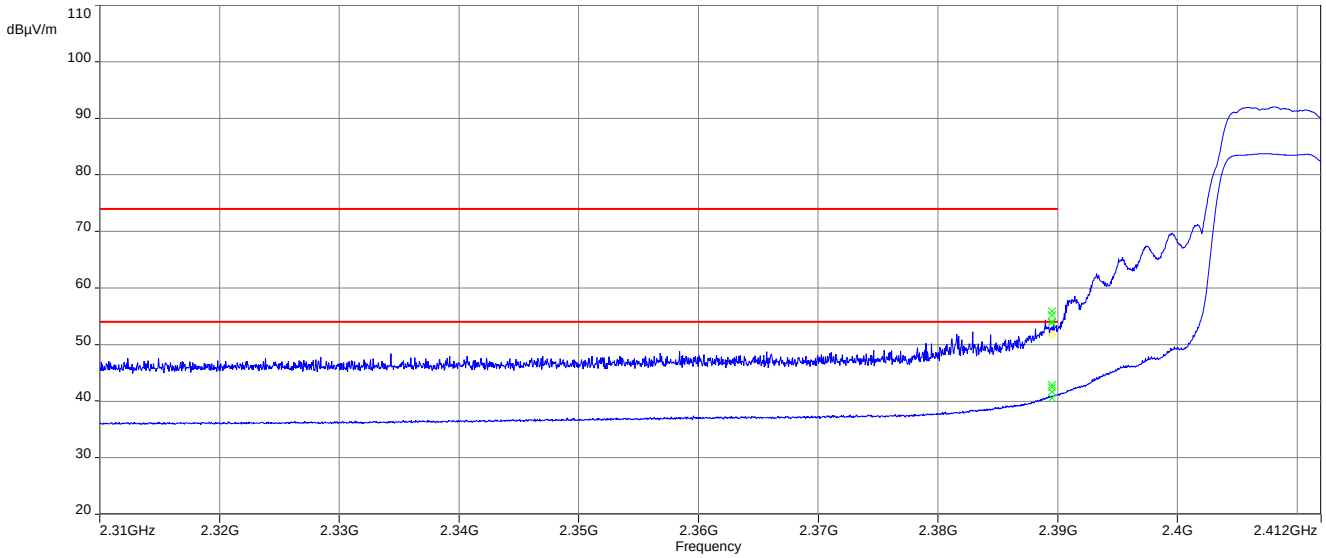


Plot 2: TX mode, upper band edge, vertical & horizontal polarization

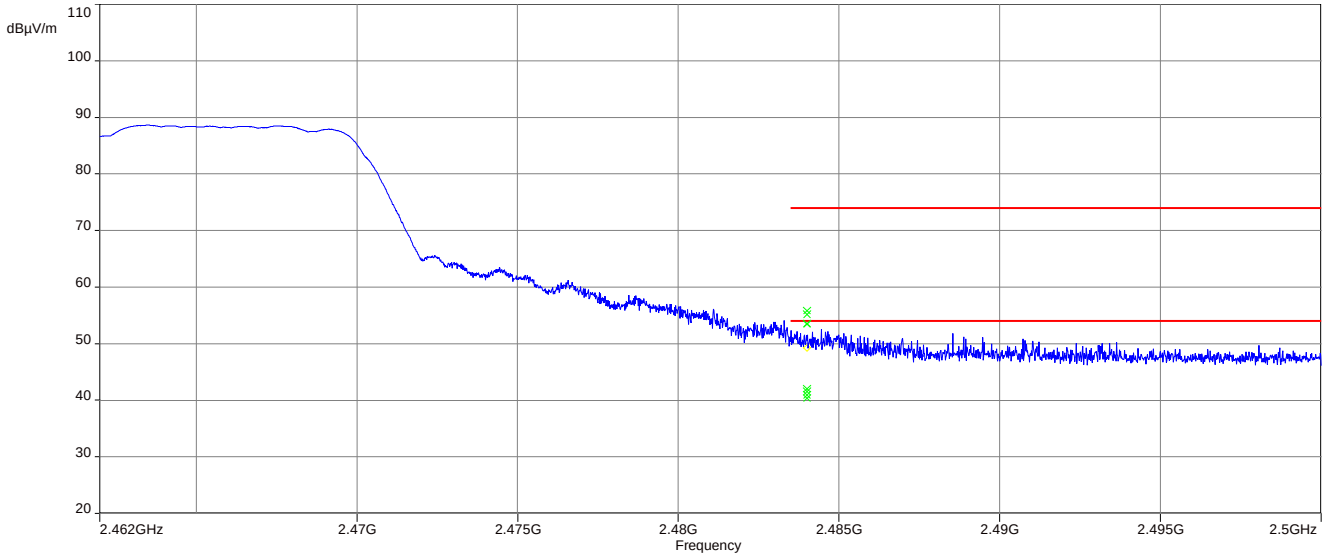


Plots: OFDM / g – mode - peak / average

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

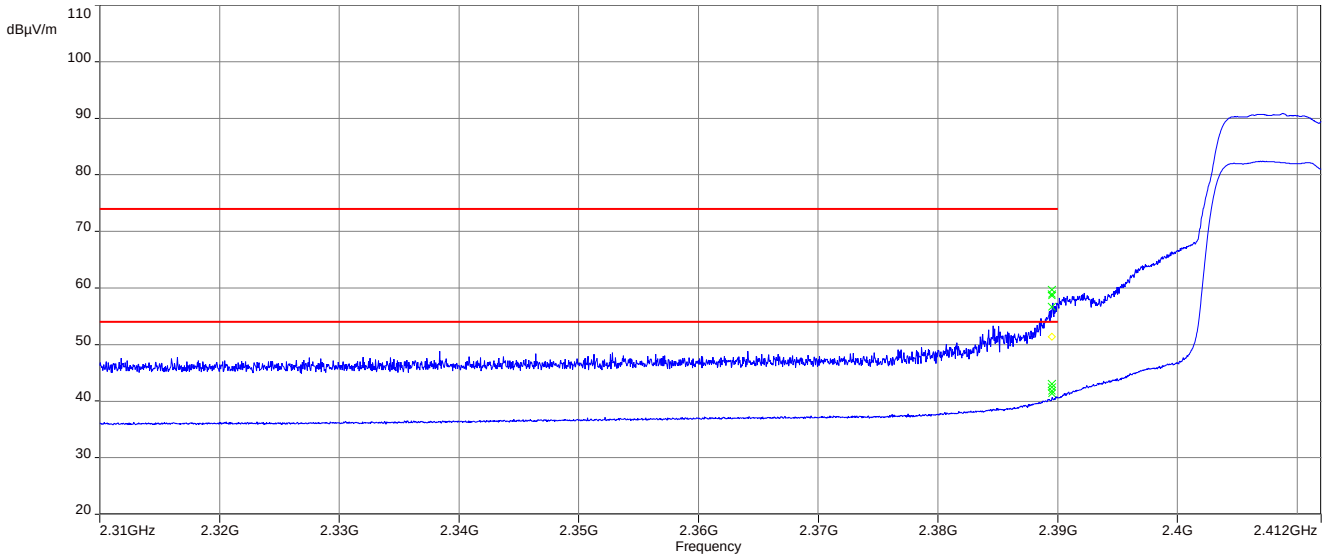


Plot 2: TX mode, upper band edge, vertical & horizontal polarization

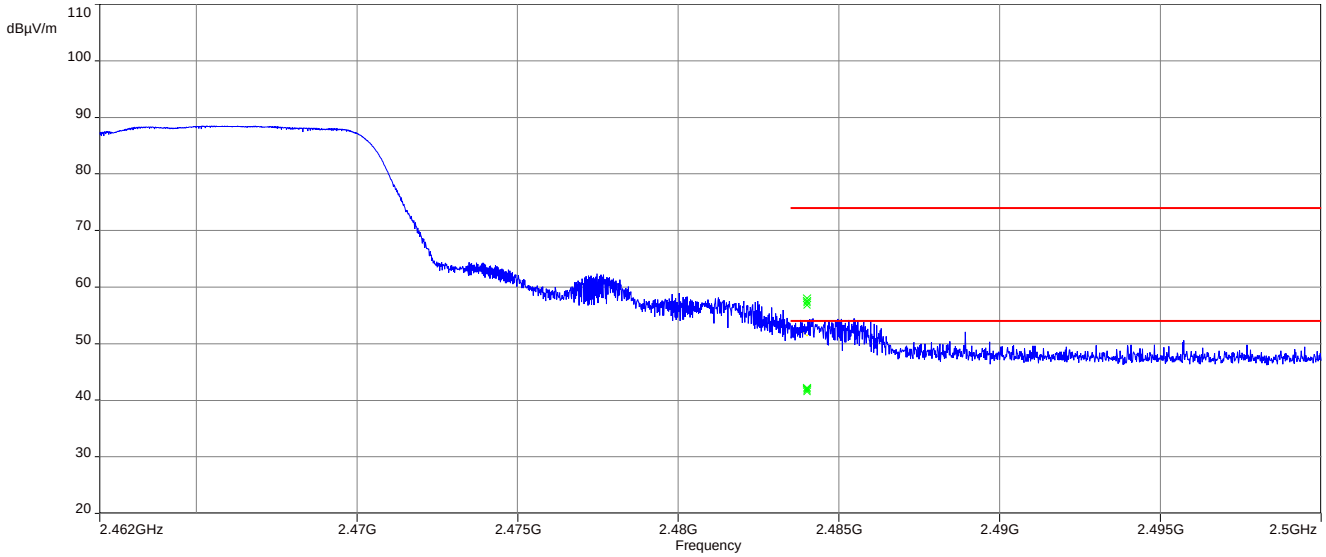


Plots: OFDM / n HT20 – mode - peak / average

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

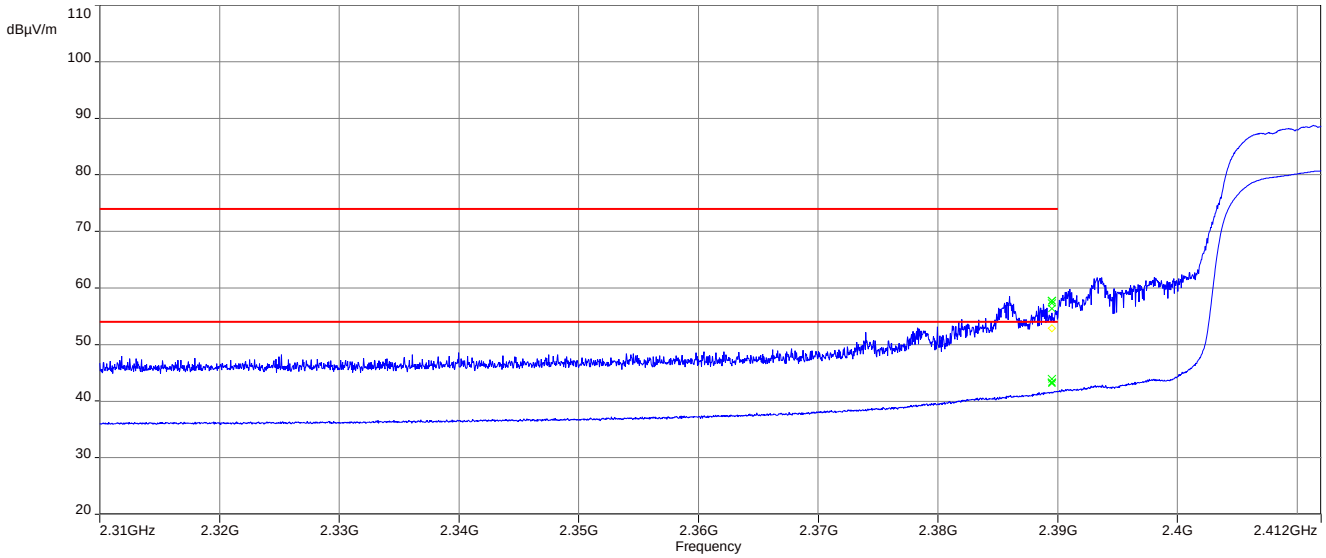


Plot 2: TX mode, upper band edge, vertical & horizontal polarization

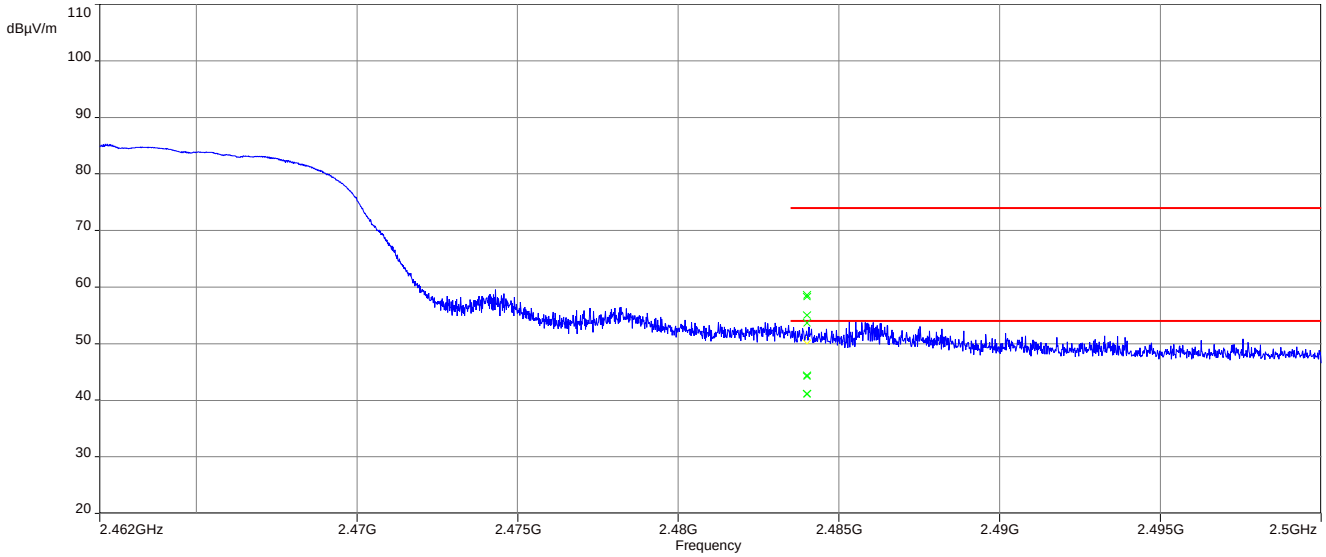


Plots: OFDM / n HT40 - mode peak / average

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



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

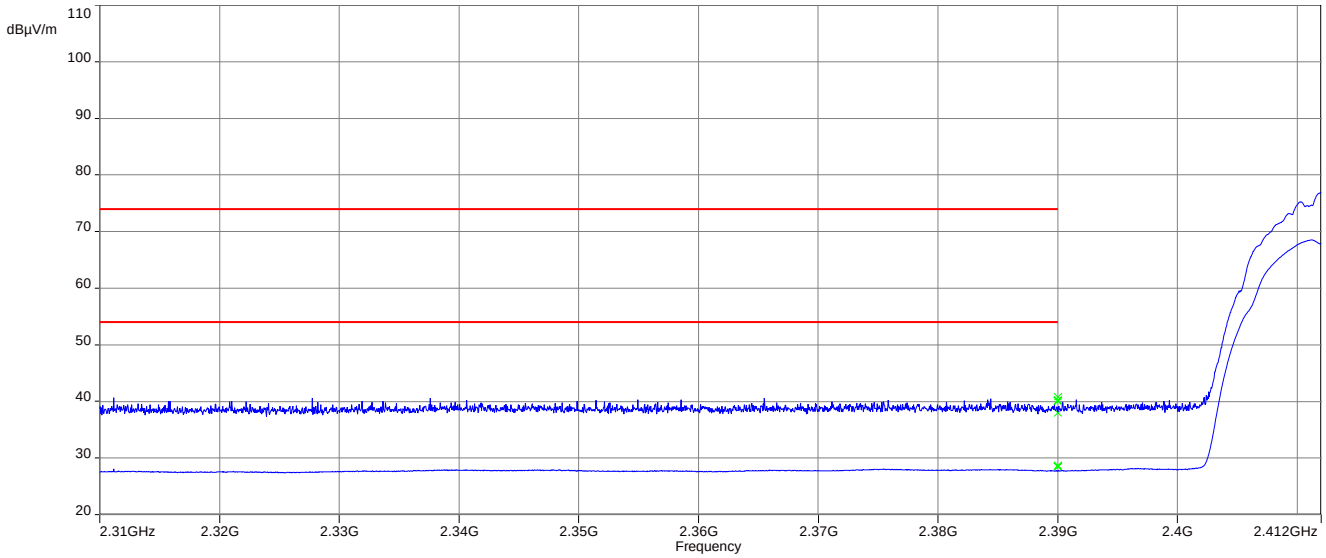


Results CS15xx-1:

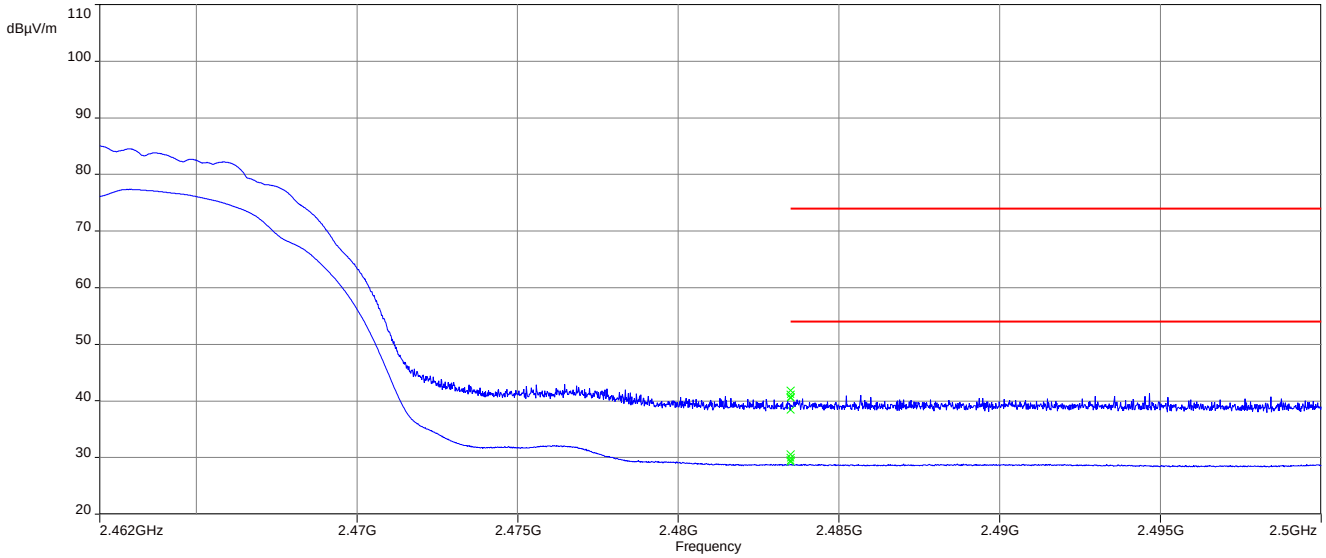
band edge compliance radiated / (dBµV / m) @ 3 m			
	DSSS / b – mode	OFDM / n HT20 – mode	OFDM / n HT40 – mode
Lower band edge	40.8 (Peak) 28.7 (AVG)	45.0 (Peak) 30.4 (AVG)	40.6 (Peak) 29.1 (AVG)
Upper band edge	41.9 (Peak) 30.5 (AVG)	51.6 (Peak) 35.0 (AVG)	45.7 (Peak) 31.8 (AVG)

Plots: DSSS - peak / average

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

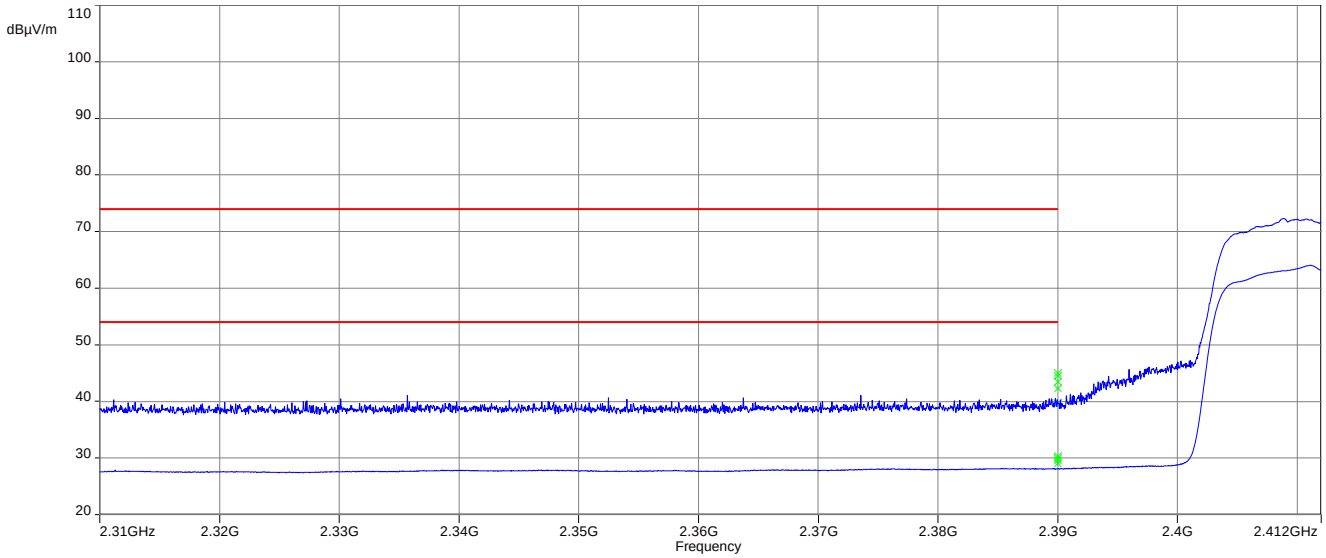


Plot 2: TX mode, upper band edge, vertical & horizontal polarization

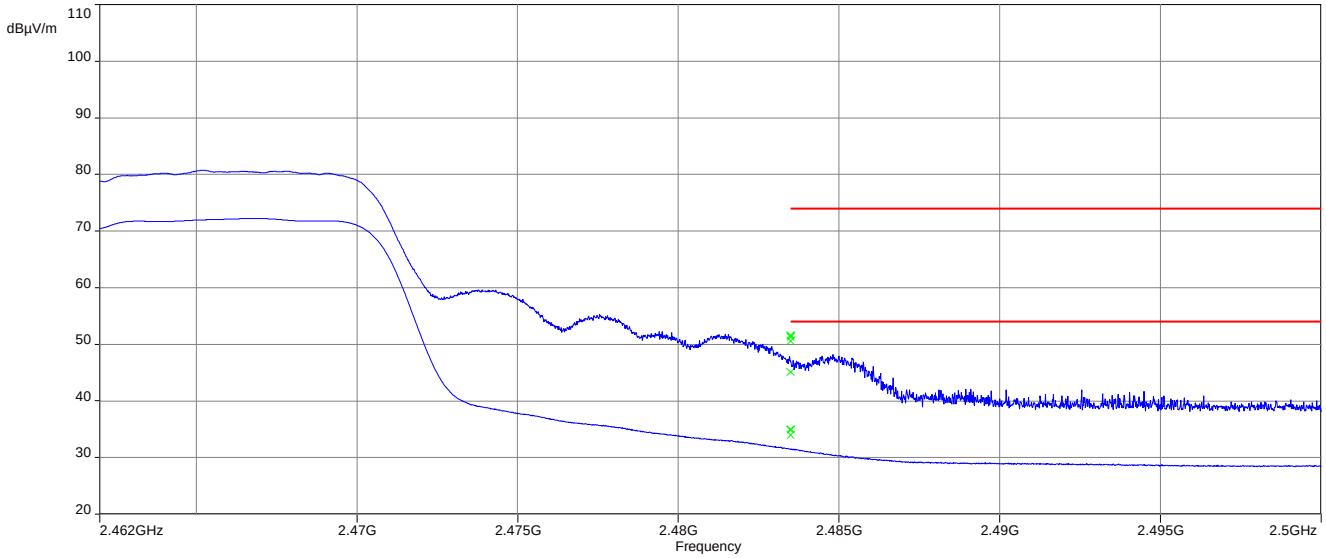


Plots: OFDM / n HT20 – mode - peak / average

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

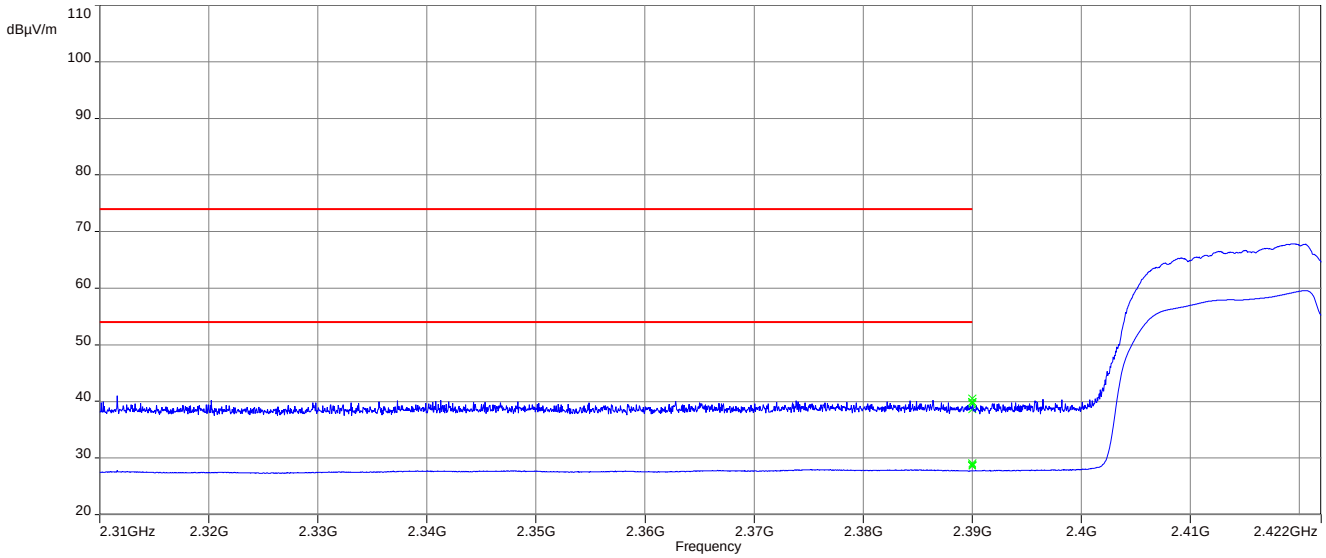


Plot 2: TX mode, upper band edge, vertical & horizontal polarization

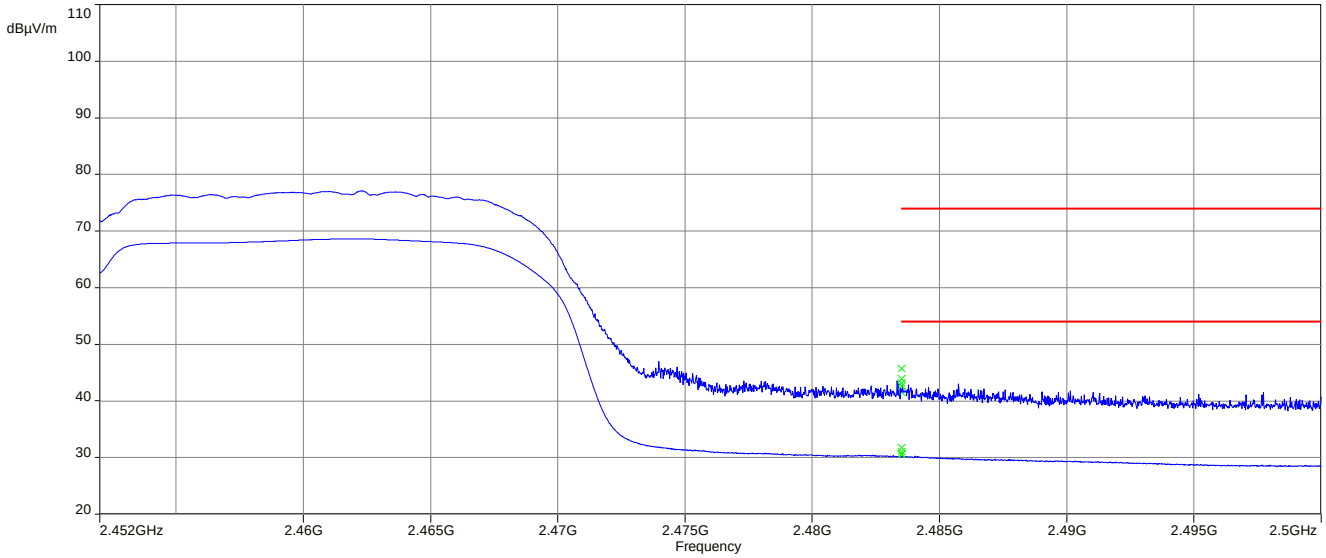


Plots: OFDM / n HT40 – mode - peak / average

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



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



13.10 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.

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)	1-8376_24-01-06_TR1-A201-R1.pdf
Test setup	See chapter 7.4 setup A
Measurement uncertainty	See chapter 9

Limits:

FCC	ISED
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; antenna port 1

Compliant (See log file)

Results: OFDM / g – mode; antenna port 1

Compliant (See log file)

Results: OFDM / n HT20 – mode; antenna port 1

Compliant (See log file)

Results: OFDM / n HT40 – mode; antenna port 1

Compliant (See log file)

13.11 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 7.2 setup C
Measurement uncertainty	See chapter 9

Limits:

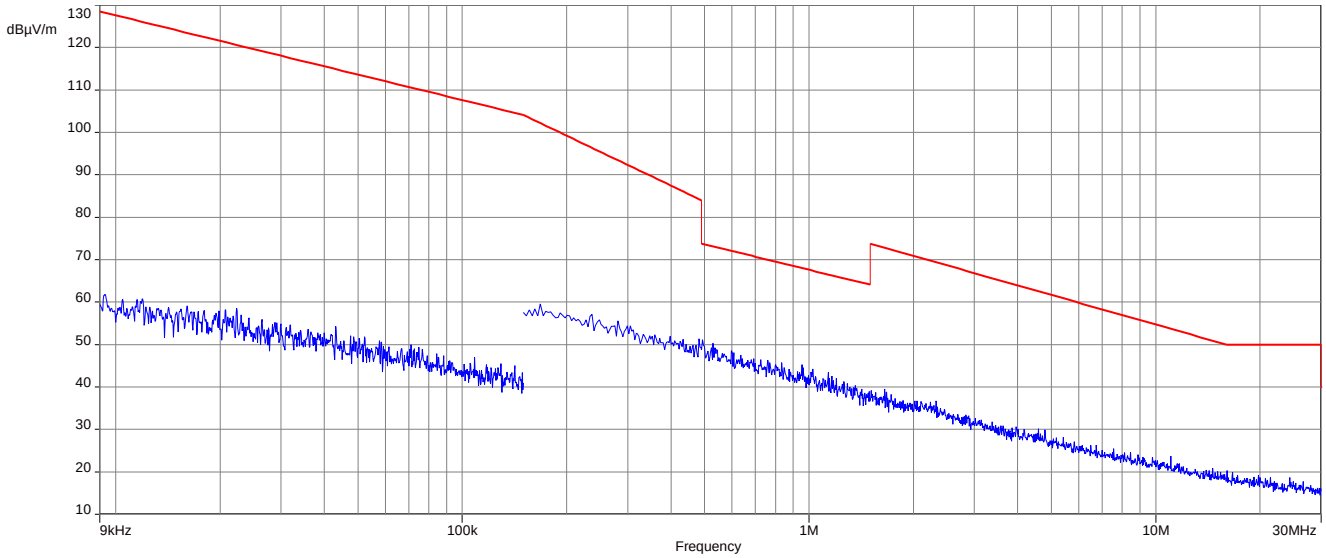
FCC		ISED
Frequency / MHz	Field Strength / (µV / m)	Measurement distance / m
0.009 – 0.490	2400/F(kHz)	300
0.490 – 1.705	24000/F(kHz)	30
1.705 – 30.0	30	30

Results CS15xx-0:

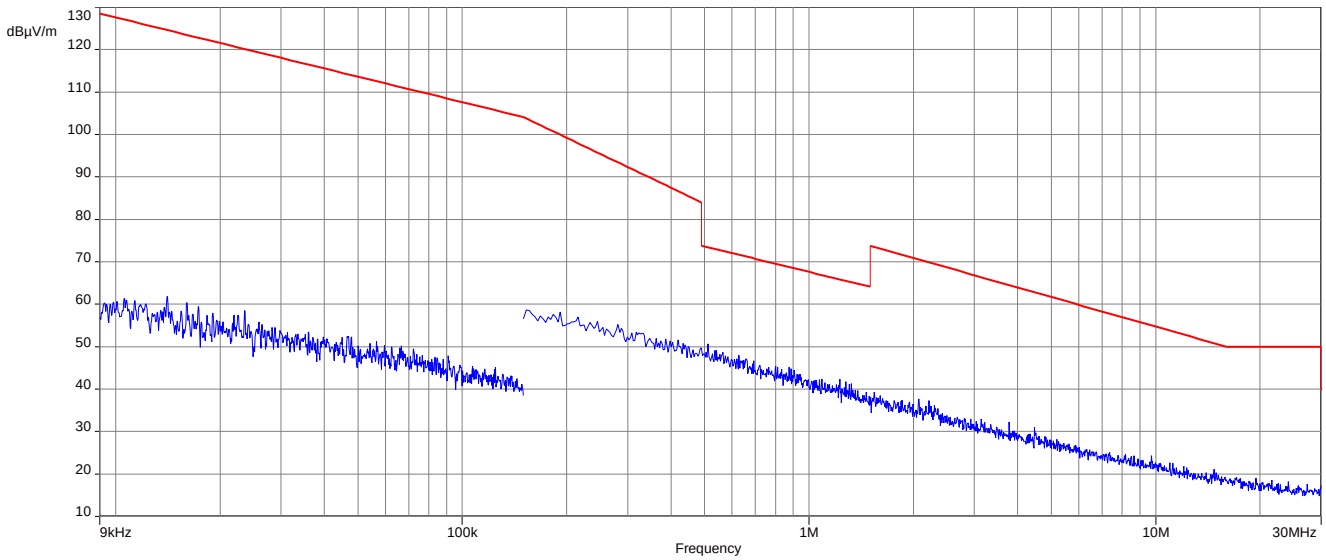
TX spurious emissions radiated < 30 MHz / (dBµV / m) @ 3 m		
Frequency / MHz	Detector	Level / (dBµV / m)
All detected peaks are more than 20 dB below the limit.		
-/-	-/-	-/-

Plots: DSSS

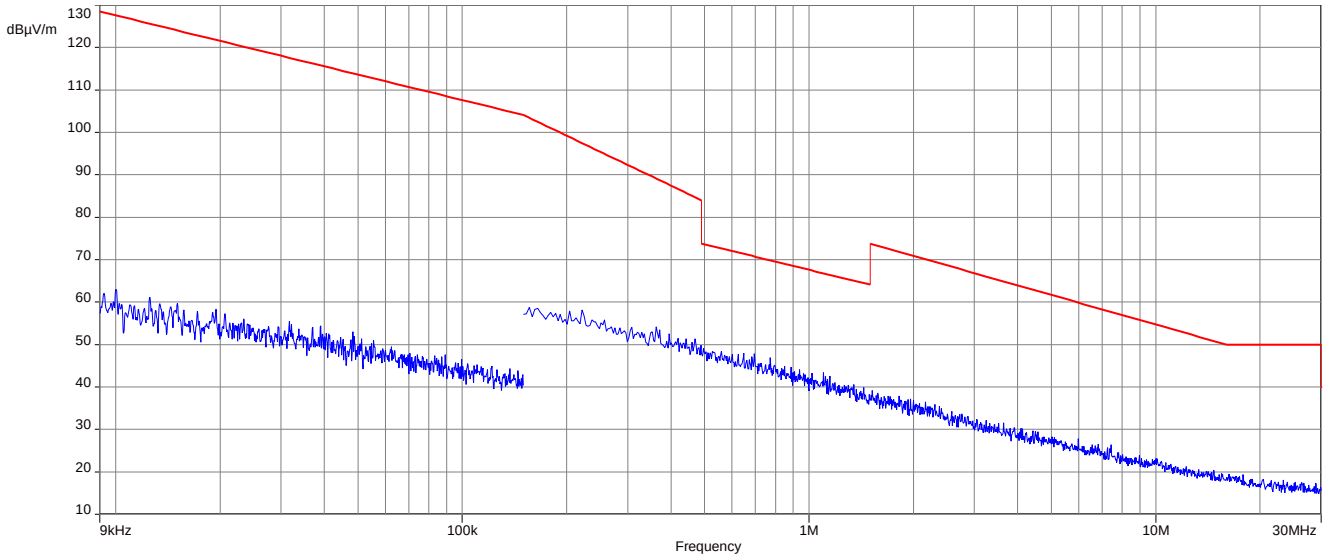
Plot 1: 9 kHz to 30 MHz, lowest channel



Plot 2: 9 kHz to 30 MHz, middle channel

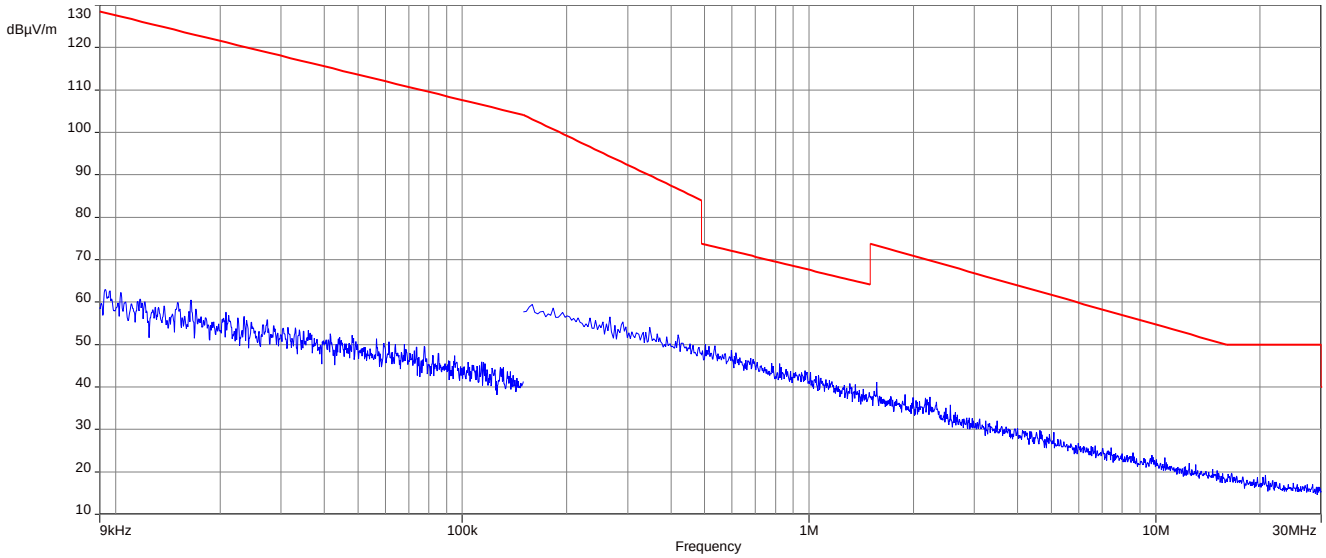


Plot 3: 9 kHz to 30 MHz, highest channel

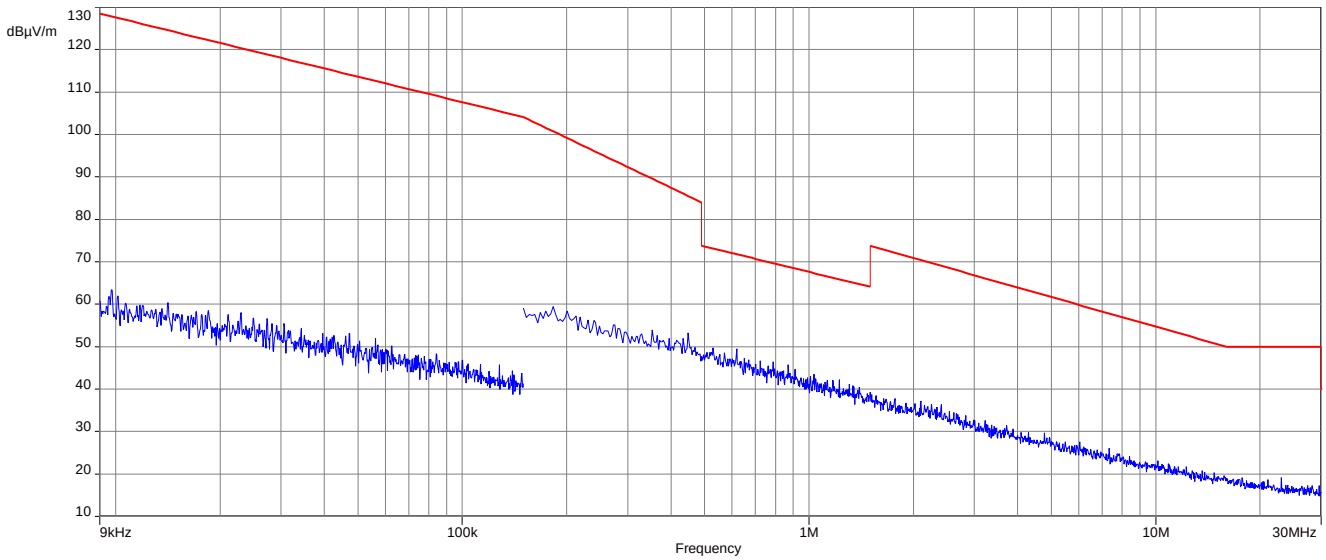


Plots: OFDM (20 MHz nominal channel bandwidth)

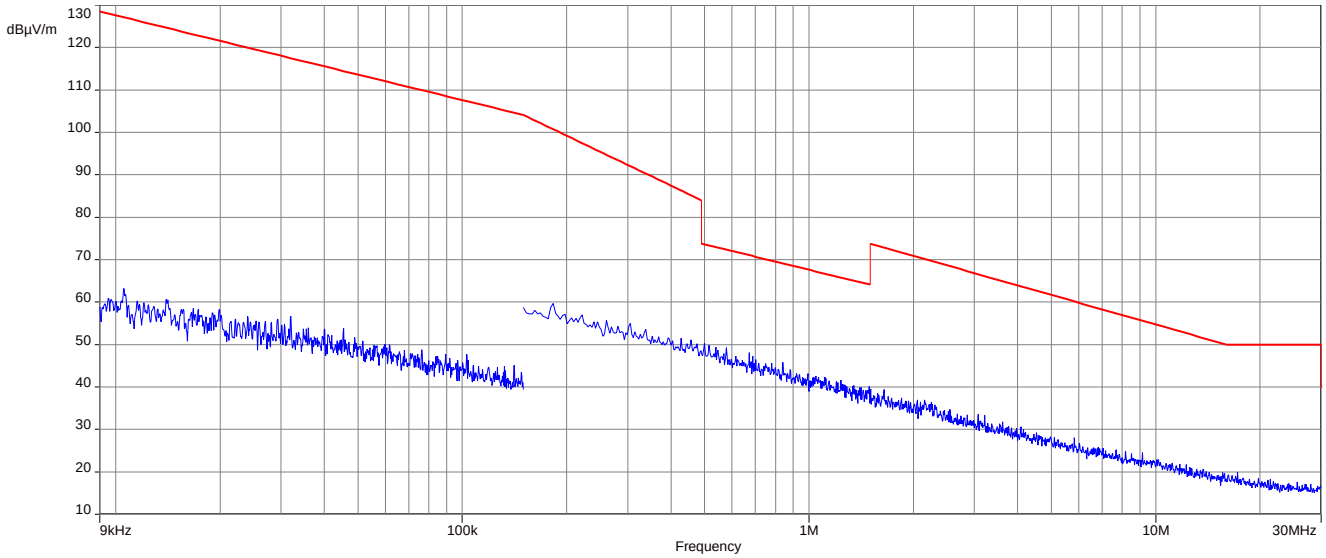
Plot 1: 9 kHz to 30 MHz, lowest channel



Plot 2: 9 kHz to 30 MHz, middle channel

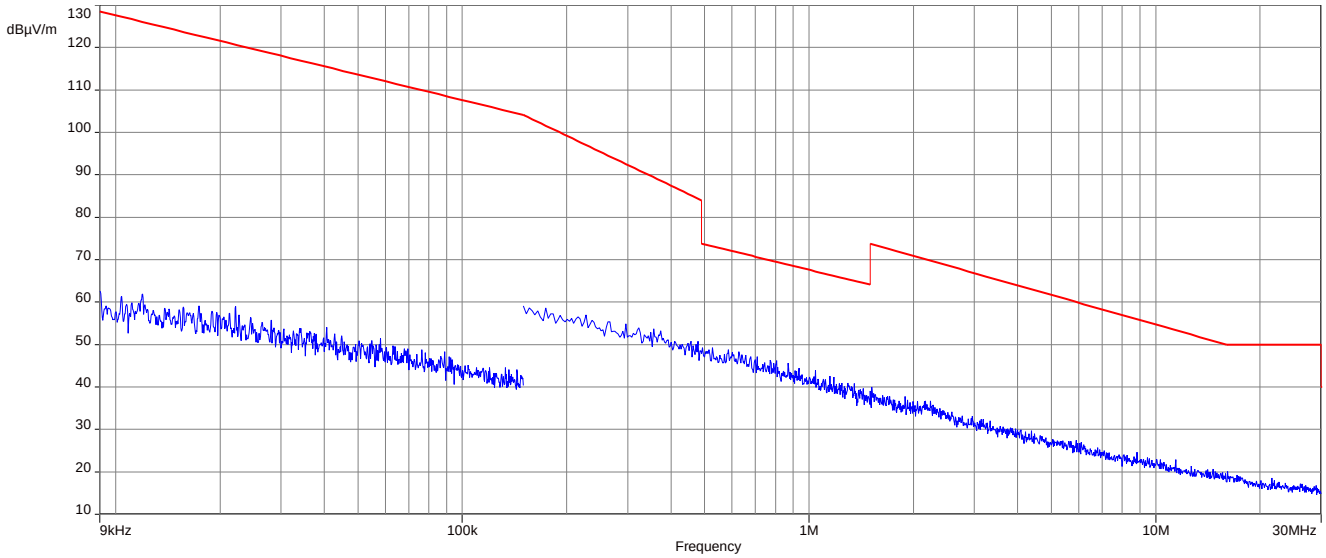


Plot 3: 9 kHz to 30 MHz, highest channel

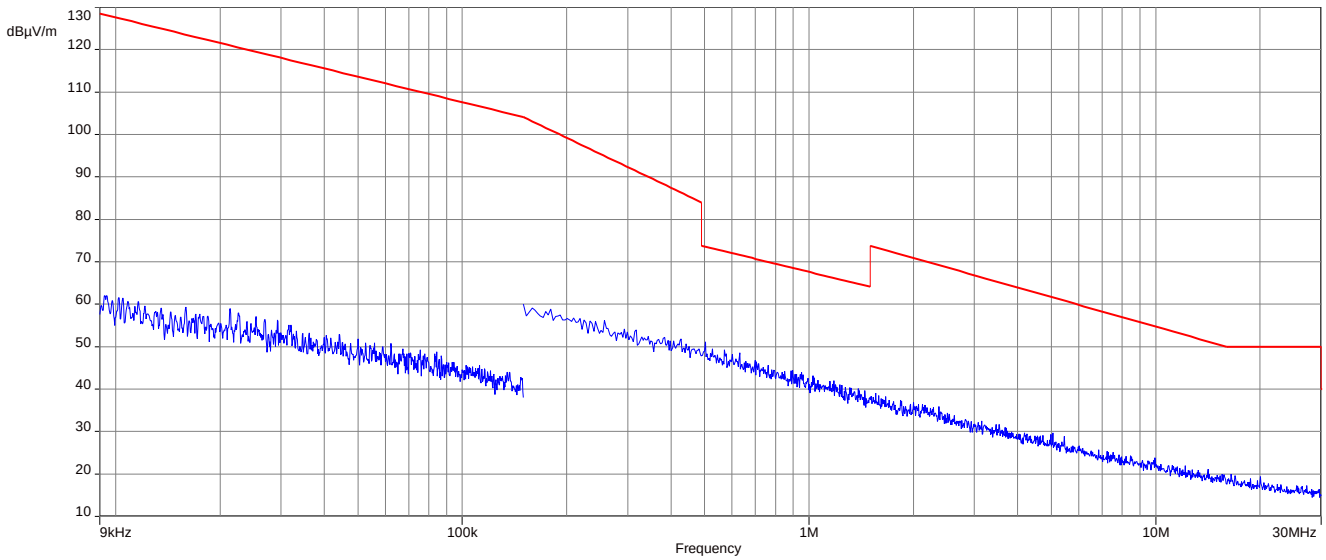


Plots: OFDM (40 MHz nominal channel bandwidth)

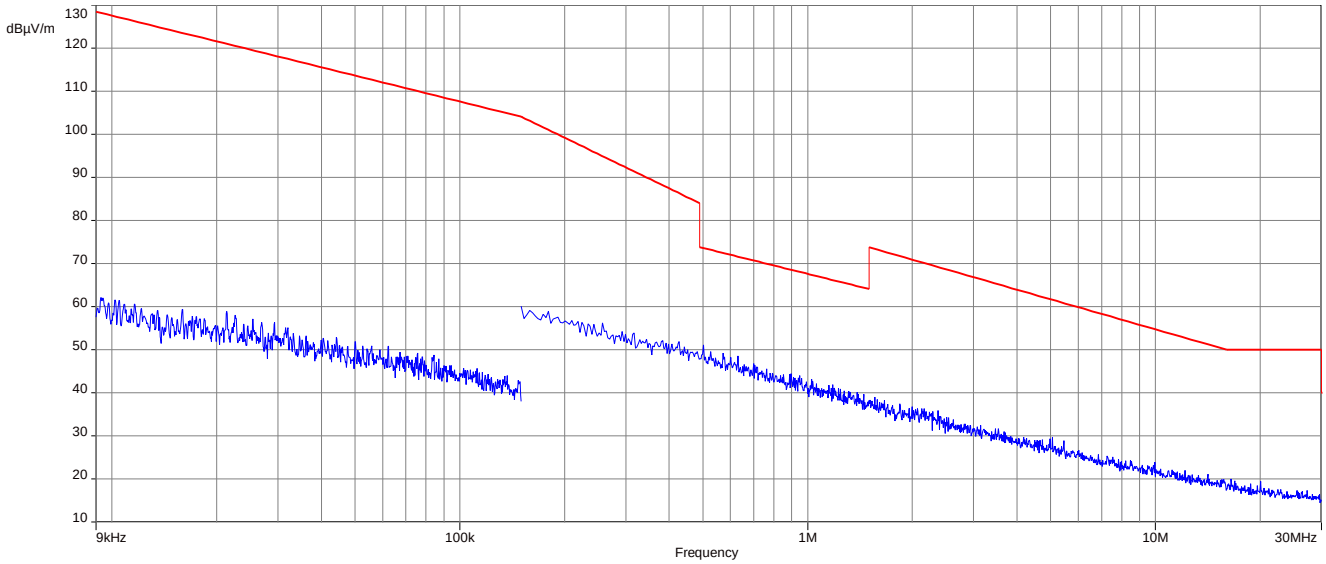
Plot 1: 9 kHz to 30 MHz, lowest channel



Plot 2: 9 kHz to 30 MHz, middle channel



Plot 3: 9 kHz to 30 MHz, highest channel

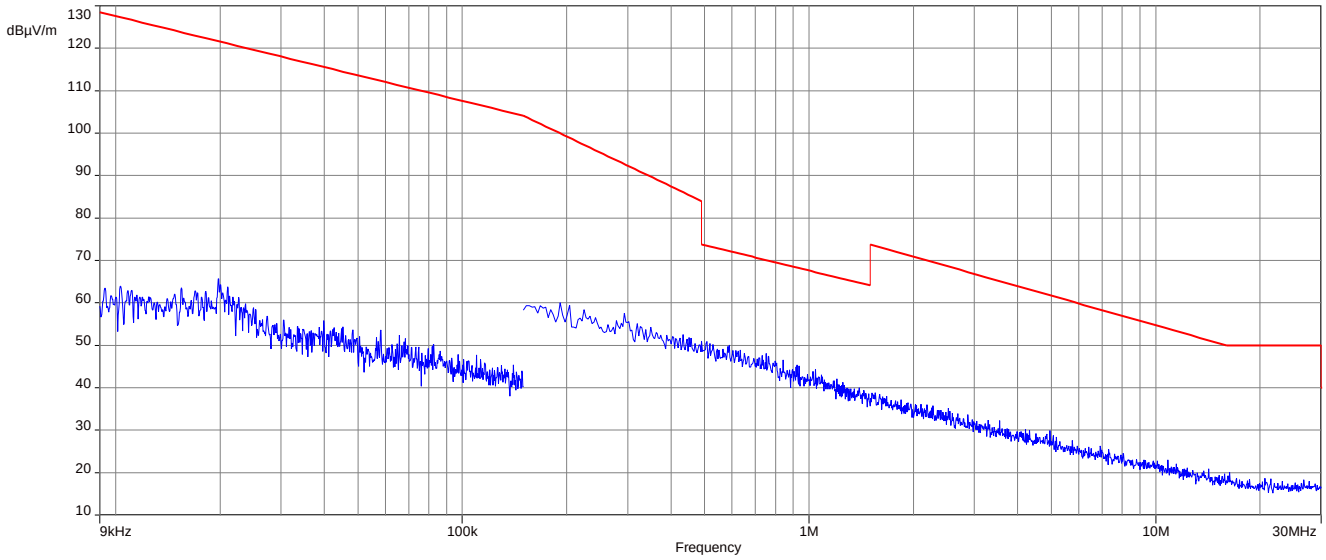


Results CS15xx-1:

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.		
-/-	-/-	-/-

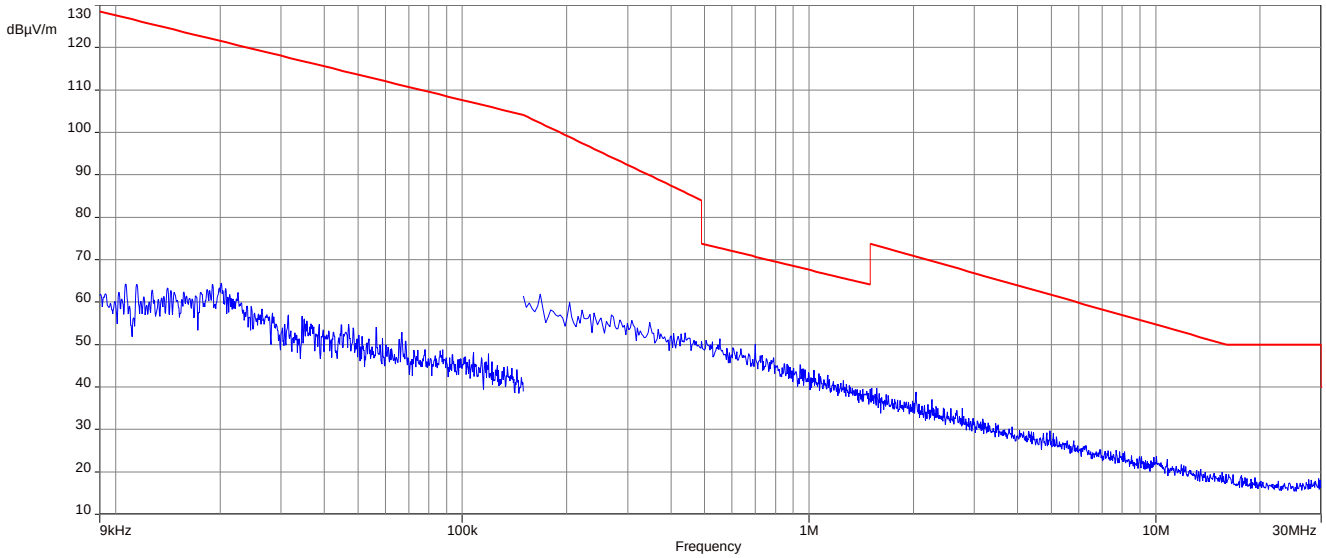
Plots: DSSS

Plot 1: 9 kHz to 30 MHz, valid for all channels



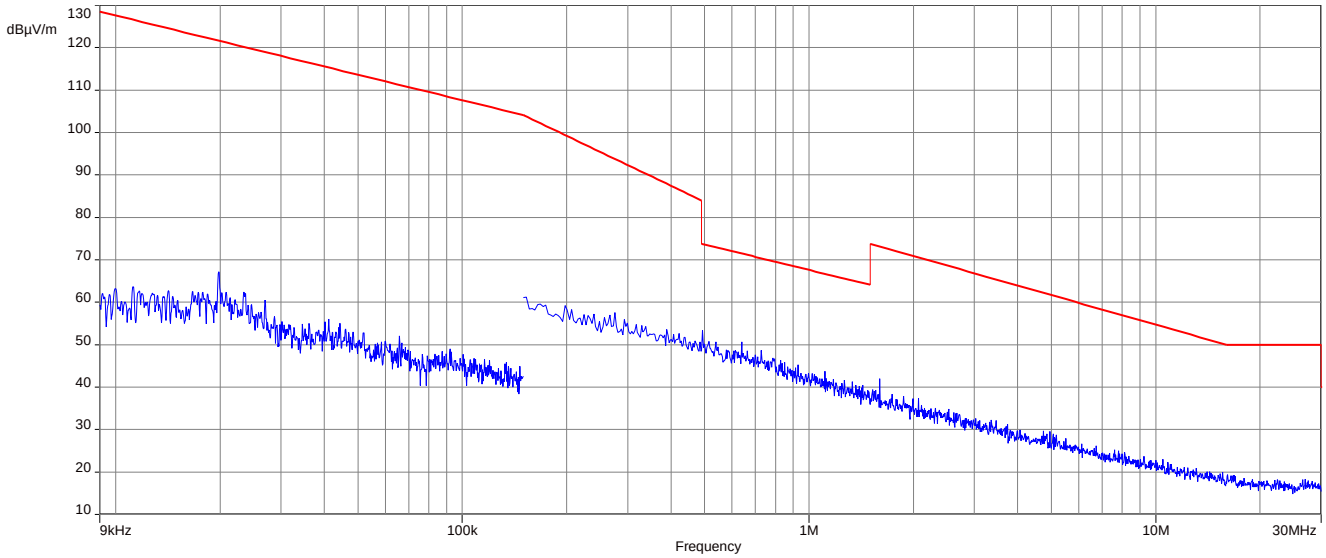
Plots: OFDM (20 MHz nominal channel bandwidth)

Plot 1: 9 kHz to 30 MHz, valid for all channels



Plots: OFDM (40 MHz nominal channel bandwidth)

Plot 1: 9 kHz to 30 MHz, valid for all channels



13.12 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
Test setup	See chapter 7.1 setup A
Measurement uncertainty	See chapter 9

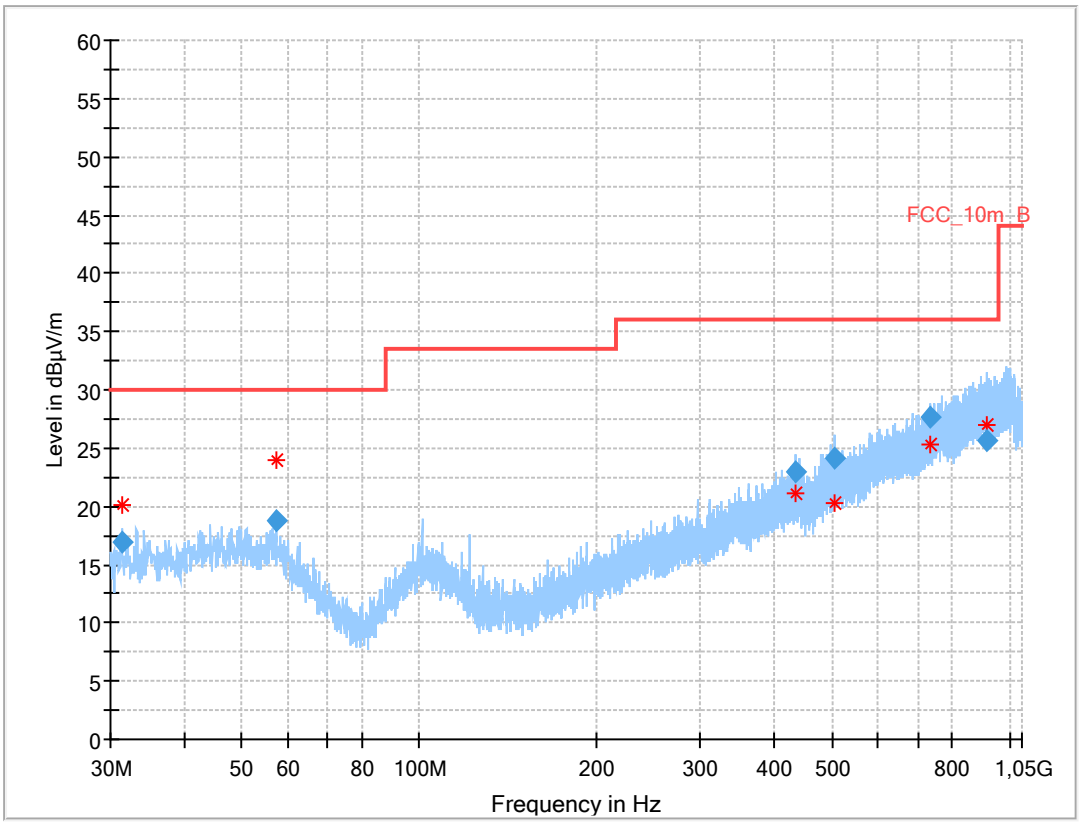
Limits:

FCC	ISED	
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

Results CS15xx-0:

Plot: DSSS

Plot 1: 30 MHz to 1 GHz, vertical & horizontal polarization, valid for all channels

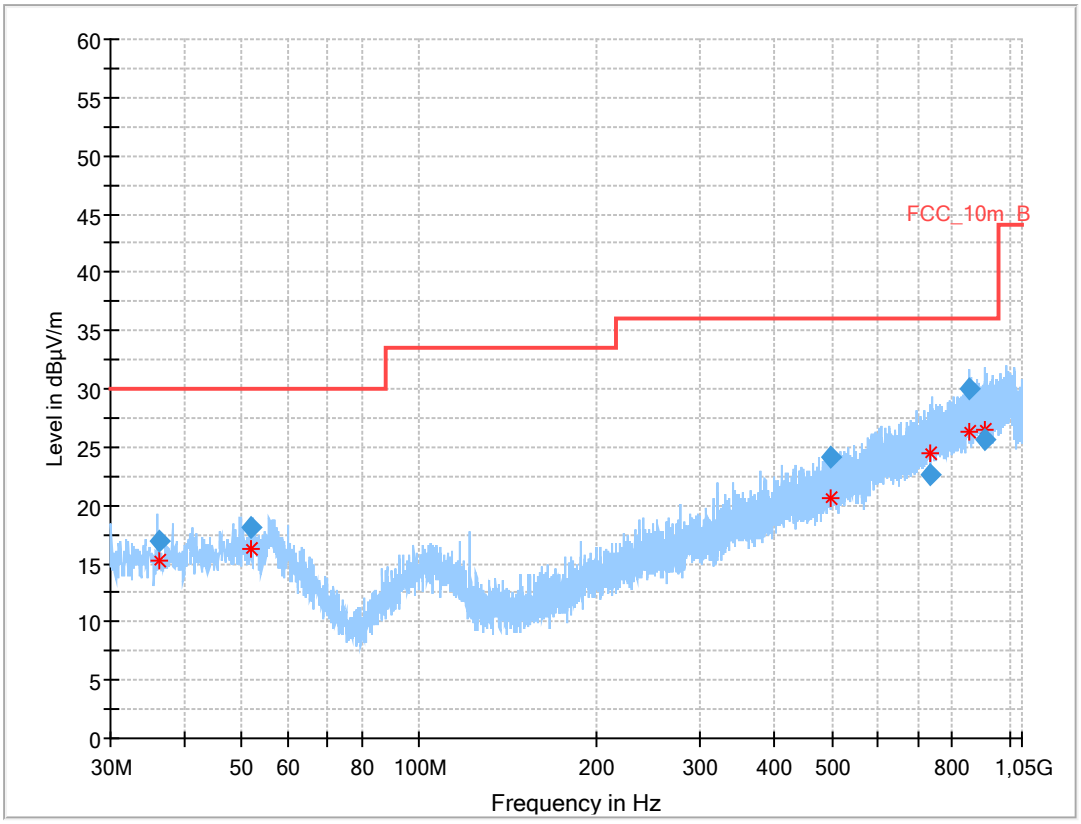


Final results:

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
31.370	16.92	30.0	13.1	1000	120.0	137.0	H	232	13
57.185	18.81	30.0	11.2	1000	120.0	195.0	V	142	15
435.557	23.02	36.0	13.0	1000	120.0	123.0	V	142	19
505.304	24.13	36.0	11.9	1000	120.0	102.0	V	142	20
735.942	27.66	36.0	8.3	1000	120.0	195.0	V	232	23
913.486	25.67	36.0	10.3	1000	120.0	195.0	H	-2	25

Plot: OFDM (20 MHz nominal channel bandwidth)

Plot 1: 30 MHz to 1 GHz, vertical & horizontal polarization, valid for all channels

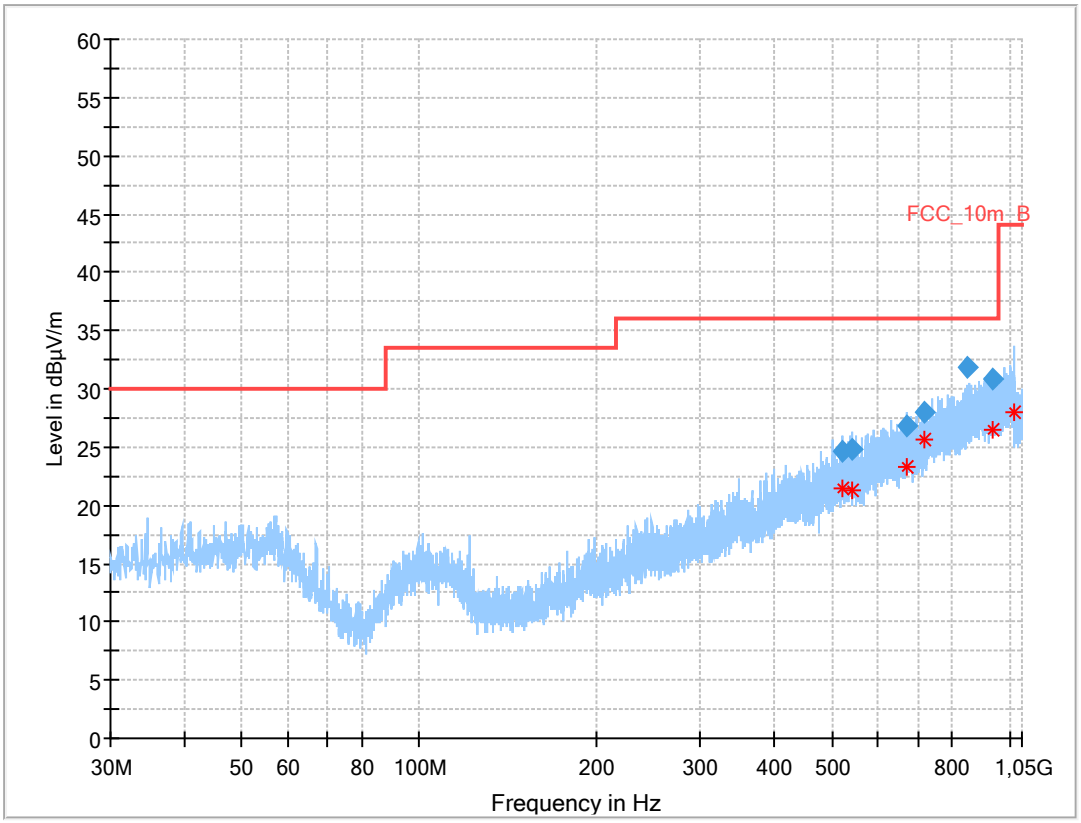


Final results:

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
36.155	17.01	30.0	13.0	1000	120.0	195.0	V	238	13
51.936	18.16	30.0	11.8	1000	120.0	195.0	V	120	15
496.863	24.14	36.0	11.9	1000	120.0	195.0	V	142	20
735.671	22.65	36.0	13.4	1000	120.0	137.0	V	52	23
855.357	29.93	36.0	6.1	1000	120.0	139.0	H	37	25
910.740	25.69	36.0	10.3	1000	120.0	98.0	H	53	25

Plot: OFDM (40 MHz nominal channel bandwidth)

Plot 1: 30 MHz to 1 GHz, vertical & horizontal polarization, valid for all channels



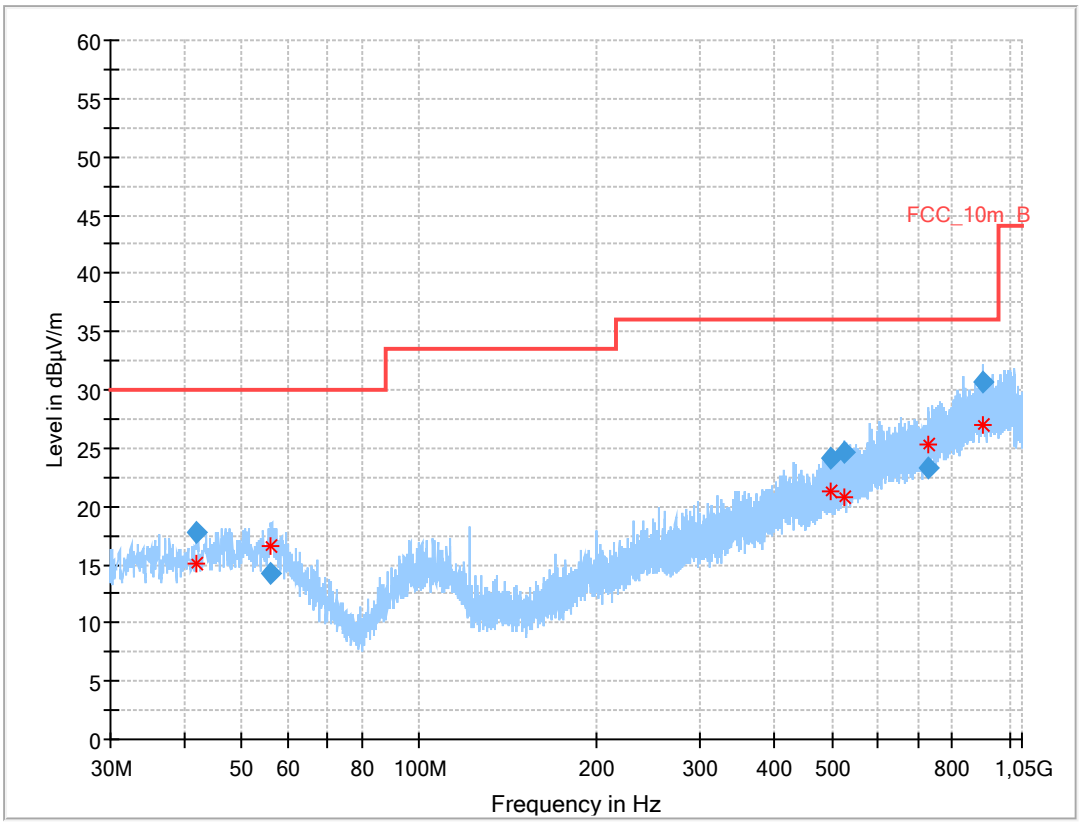
Final results:

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
521.155	24.56	36.0	11.4	1000	120.0	195.0	H	142	20
540.841	24.80	36.0	11.2	1000	120.0	195.0	H	86	20
672.400	26.79	36.0	9.2	1000	120.0	138.0	V	142	22
719.648	28.06	36.0	7.9	1000	120.0	108.0	H	232	23
939.181	30.85	36.0	5.2	1000	120.0	195.0	H	142	25
849.614	31.82	44.0	12.2	1000	120.0	195.0	H	142	26

Results CS15xx-1:

Plot: DSSS

Plot 1: 30 MHz to 1 GHz, vertical & horizontal polarization, valid for all channels

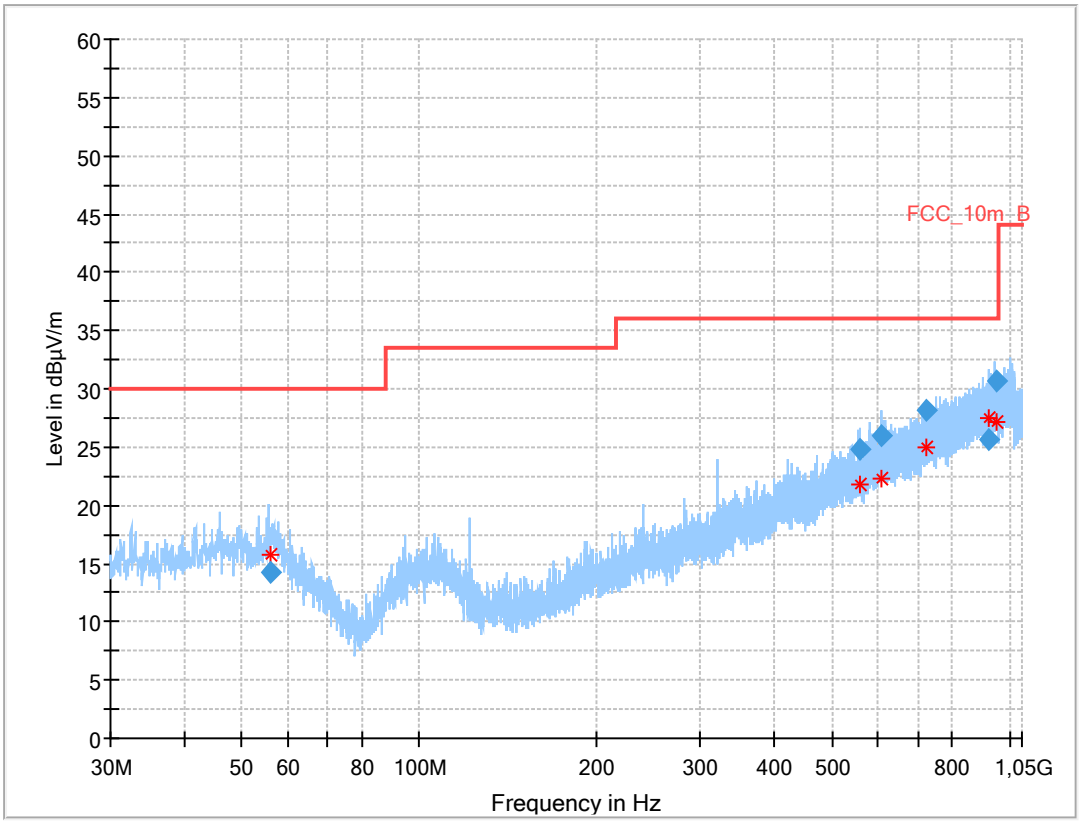


Final results:

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
41.950	17.70	30.0	12.3	1000	120.0	195.0	H	52	15
56.030	14.32	30.0	15.7	1000	120.0	163.0	V	62	16
497.184	24.12	36.0	11.9	1000	120.0	195.0	H	156	20
523.566	24.61	36.0	11.4	1000	120.0	105.0	H	-3	20
728.831	23.31	36.0	12.7	1000	120.0	195.0	H	193	23
904.102	30.65	36.0	5.4	1000	120.0	195.0	H	232	25

Plot: OFDM (20 MHz nominal channel bandwidth)

Plot 1: 30 MHz to 1 GHz, vertical & horizontal polarization, valid for all channels

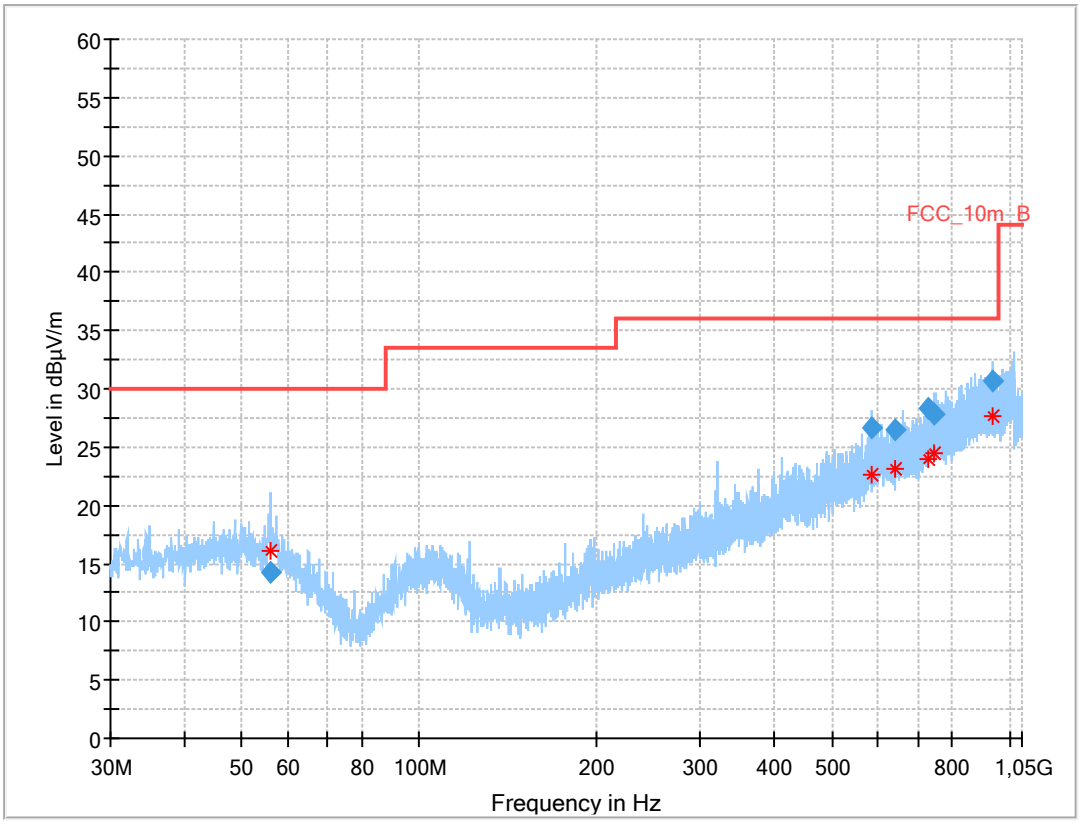


Final results:

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
56.106	14.19	30.0	15.8	1000	120.0	184.0	H	142	16
556.733	24.88	36.0	11.1	1000	120.0	121.0	H	52	20
604.803	25.90	36.0	10.1	1000	120.0	190.0	V	-35	22
723.486	28.10	36.0	7.9	1000	120.0	110.0	H	142	23
924.767	25.58	36.0	10.4	1000	120.0	106.0	H	-12	25
947.481	30.68	36.0	5.3	1000	120.0	195.0	V	-37	25

Plot: OFDM (40 MHz nominal channel bandwidth)

Plot 1: 30 MHz to 1 GHz, vertical & horizontal polarization, valid for all channels



Final results:

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
55.879	14.22	30.0	15.8	1000	120.0	179.0	H	211	16
584.526	26.70	36.0	9.3	1000	120.0	177.0	H	52	21
639.911	26.46	36.0	9.5	1000	120.0	195.0	V	-37	22
726.805	28.31	36.0	7.7	1000	120.0	145.0	H	10	23
743.302	27.86	36.0	8.1	1000	120.0	105.0	H	232	23
936.707	30.71	36.0	5.3	1000	120.0	195.0	V	6	25

13.13 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
Test setup	See chapter 7.2 setup B & 7.3 setup A
Measurement uncertainty	See chapter 9

Limits:

FCC	ISED	
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 CS15xx-0:

Results: DSSS

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
4824	Peak	51.1	4874	Peak	50.6	4924	Peak	52.7
	AVG	43.9		AVG	43.0		AVG	45.7
-/-	Peak	-/-	-/-	Peak	-/-	-/-	Peak	-/-
	AVG	-/-		AVG	-/-		AVG	-/-

Results: OFDM (20 MHz nominal channel bandwidth)

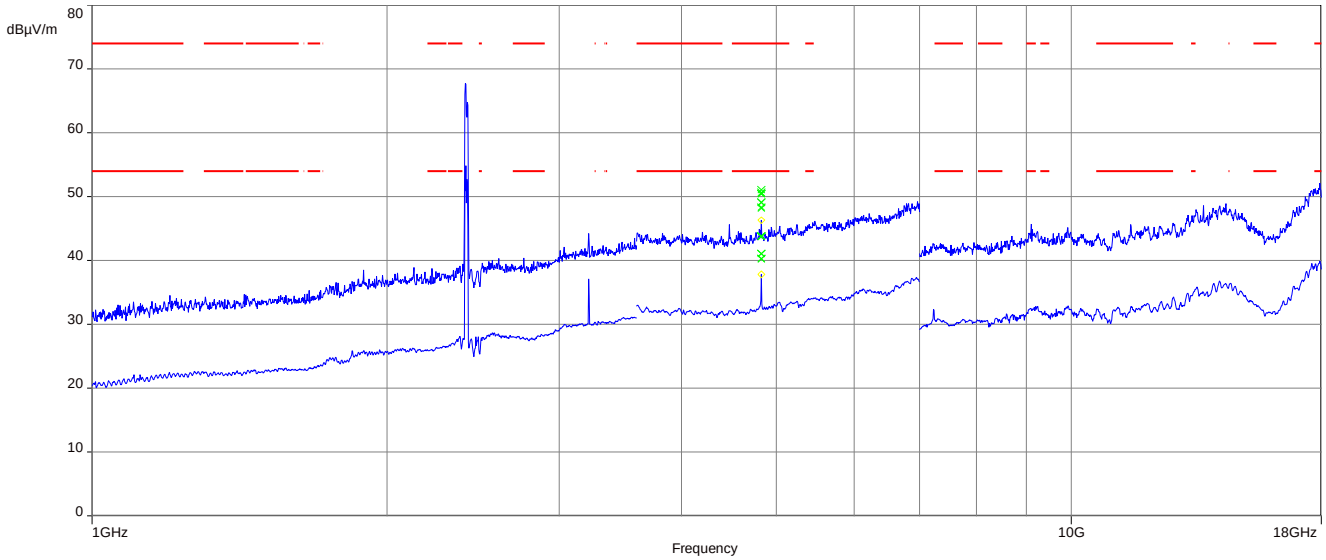
TX spurious emissions radiated / dBµV/m @ 3 m								
lowest channel			middle channel			highest channel		
f / MHz	Detector	Level / dBµV/m	f / MHz	Detector	Level / dBµV/m	f / MHz	Detector	Level / dBµV/m
All detected emissions are more than 20 dB below the limit.			All detected emissions are more than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

Results: OFDM (40 MHz nominal channel bandwidth)

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.		
-/-	Peak	-/-	-/-	Peak	-/-	-/-	Peak	-/-
	AVG	-/-		AVG	-/-		AVG	-/-

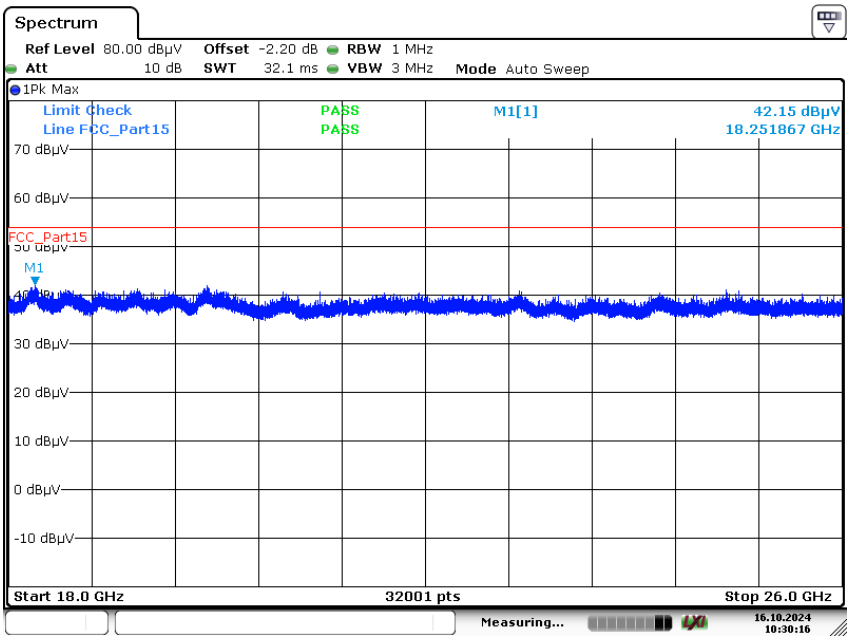
Plots: DSSS

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



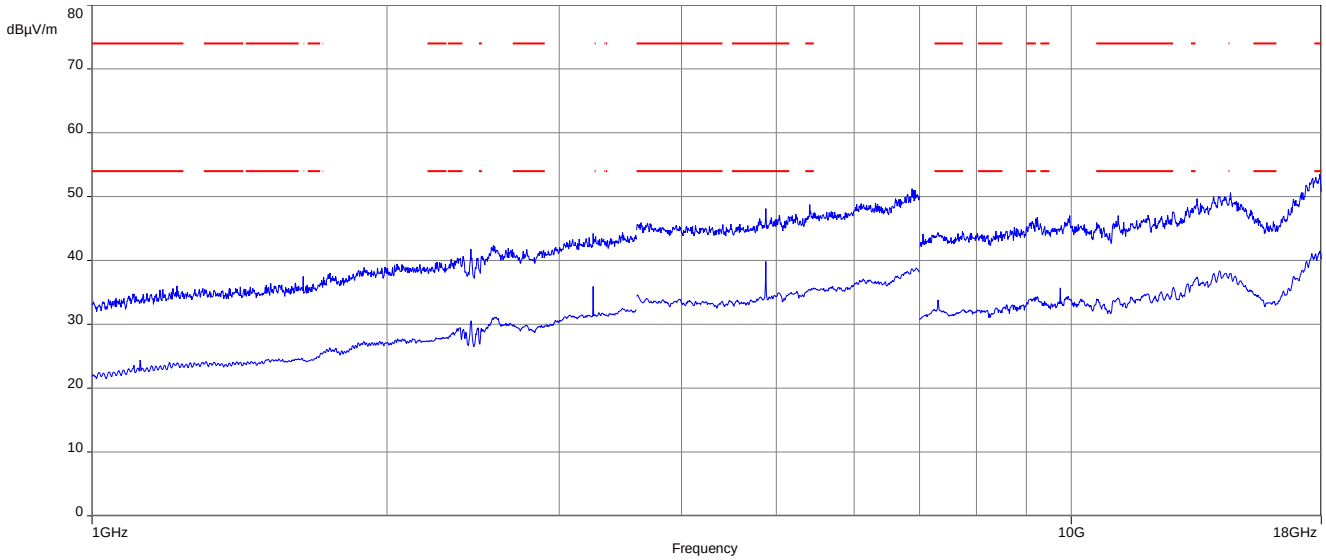
The carrier signal is notched with a 2.4 GHz band rejection filter.

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



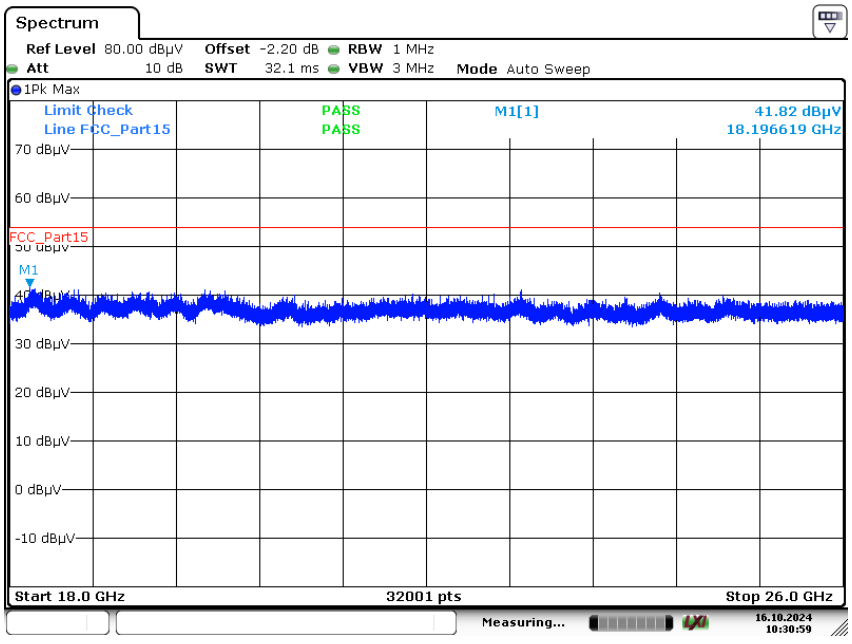
Date: 16.OCT.2024 10:30:17

Plot 3: Middle channel, 1 GHz to 18 GHz, vertical & horizontal polarization



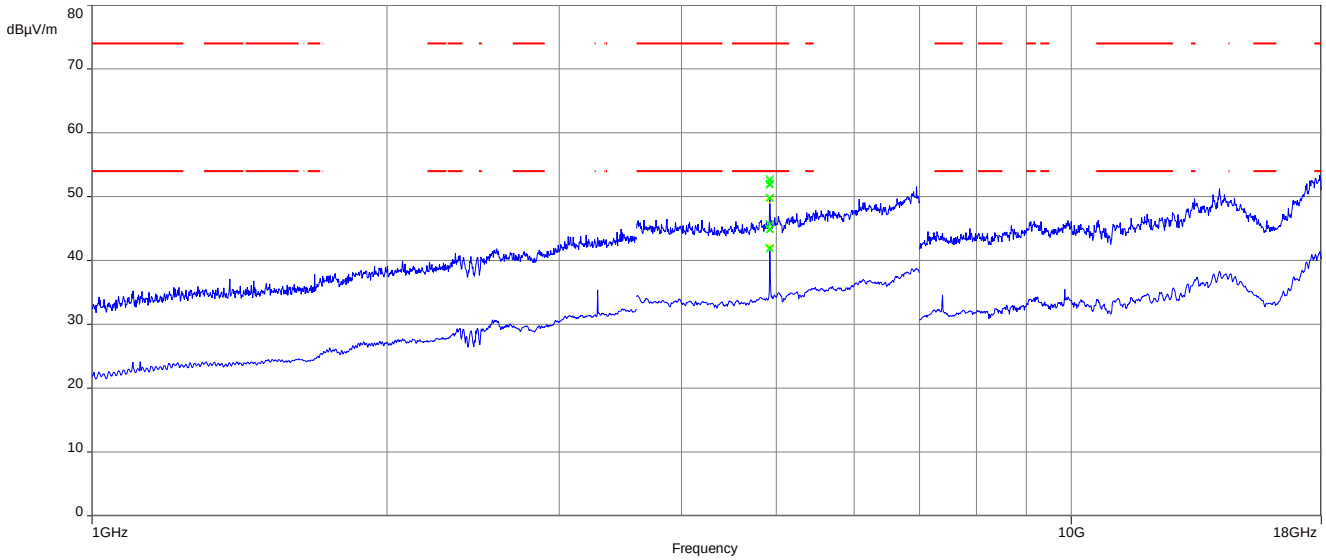
The carrier signal is notched with a 2.4 GHz band rejection filter.

Plot 4: Middle channel, 18 GHz to 26 GHz, vertical & horizontal polarization



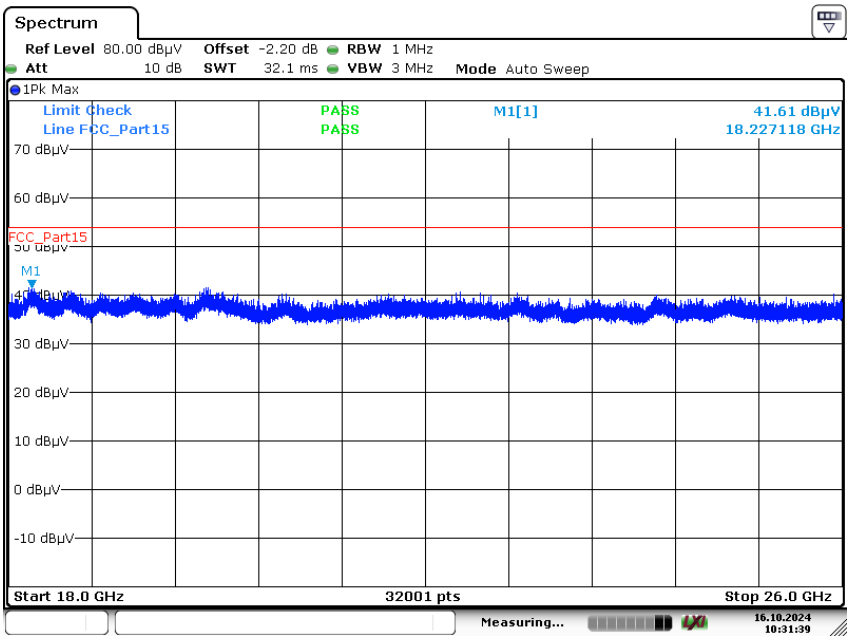
Date: 16.OCT.2024 10:30:59

Plot 5: Highest channel, 1 GHz to 18 GHz, vertical & horizontal polarization



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

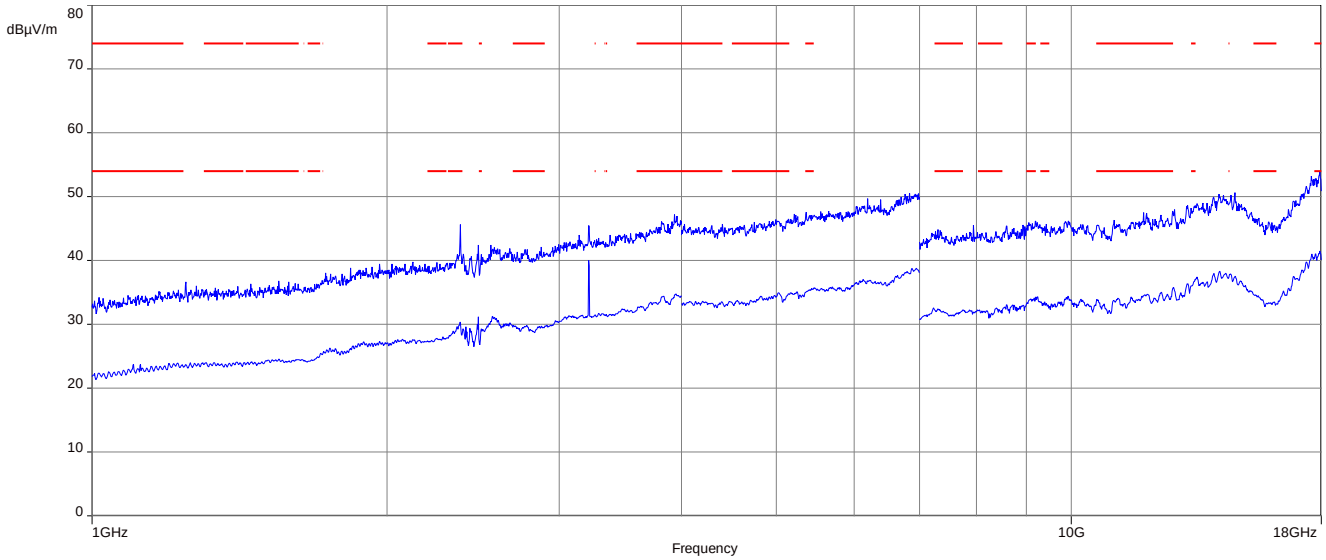
Plot 6: Highest channel, 18 GHz to 26 GHz, vertical & horizontal polarization



Date: 16.OCT.2024 10:31:39

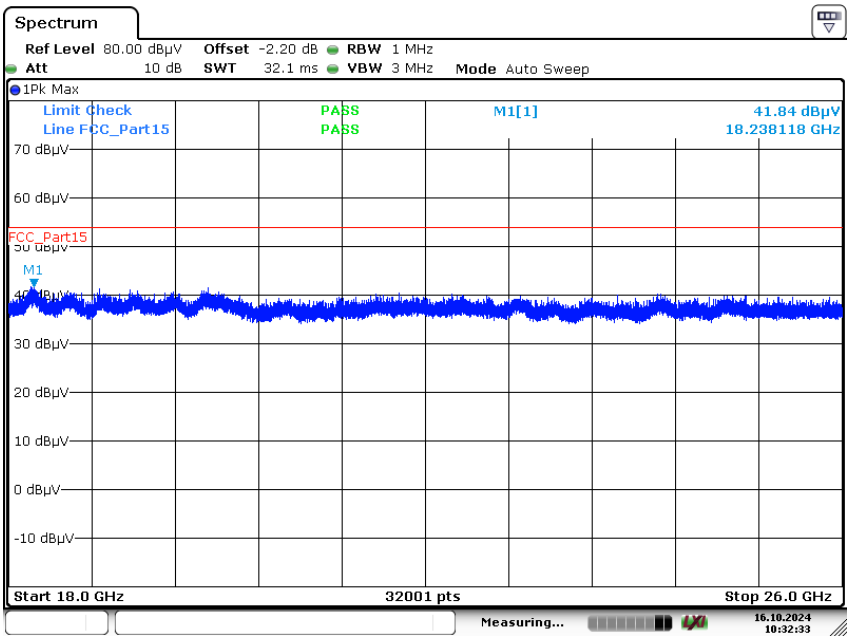
Plots: OFDM (20 MHz bandwidth)

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



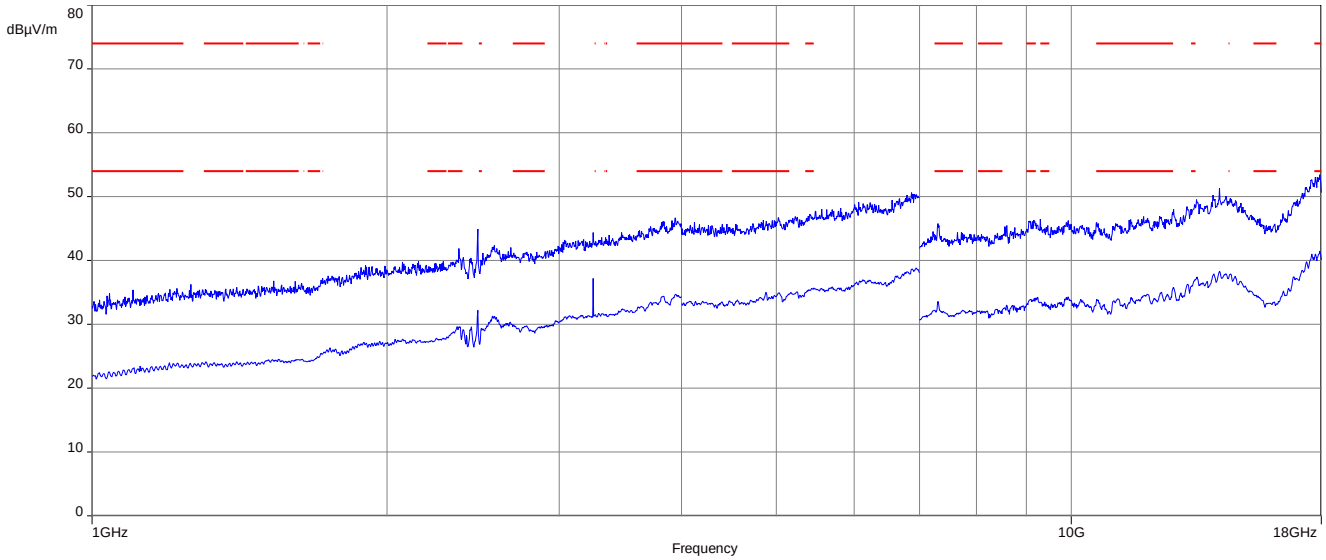
The carrier signal is notched with a 2.4 GHz band rejection filter.

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



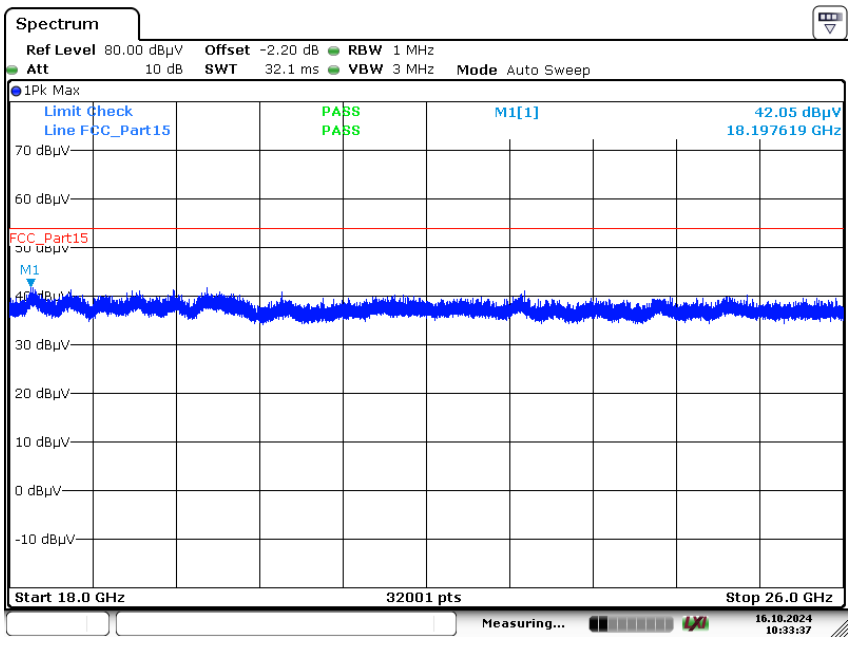
Date: 16.OCT.2024 10:32:33

Plot 3: Middle channel, 1 GHz to 18 GHz, vertical & horizontal polarization



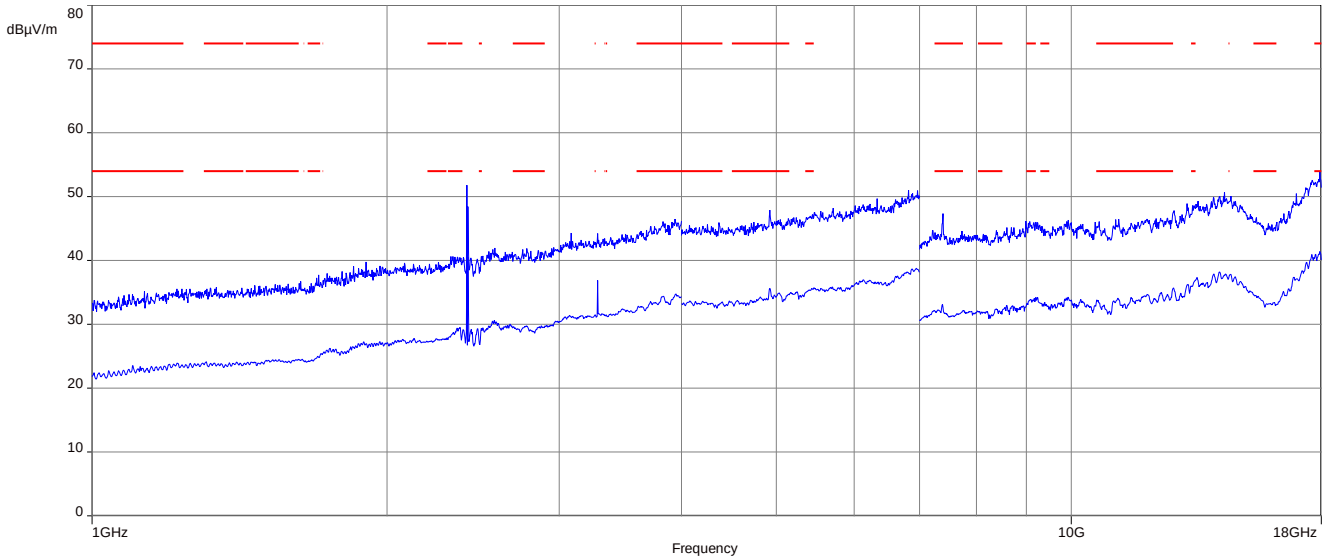
The carrier signal is notched with a 2.4 GHz band rejection filter.

Plot 4: Middle channel, 18 GHz to 26 GHz, vertical & horizontal polarization



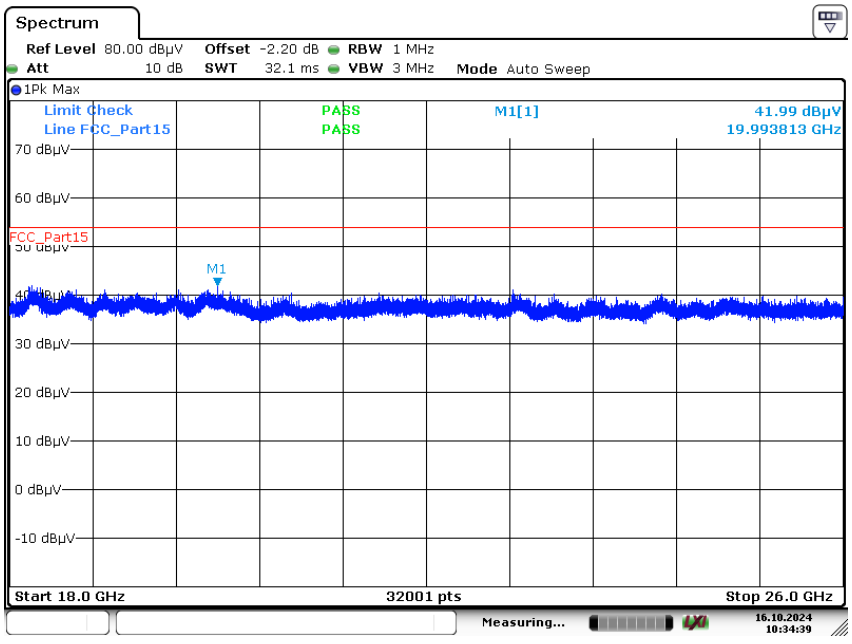
Date: 16.OCT.2024 10:33:37

Plot 5: Highest channel, 1 GHz to 18 GHz, vertical & horizontal polarization



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

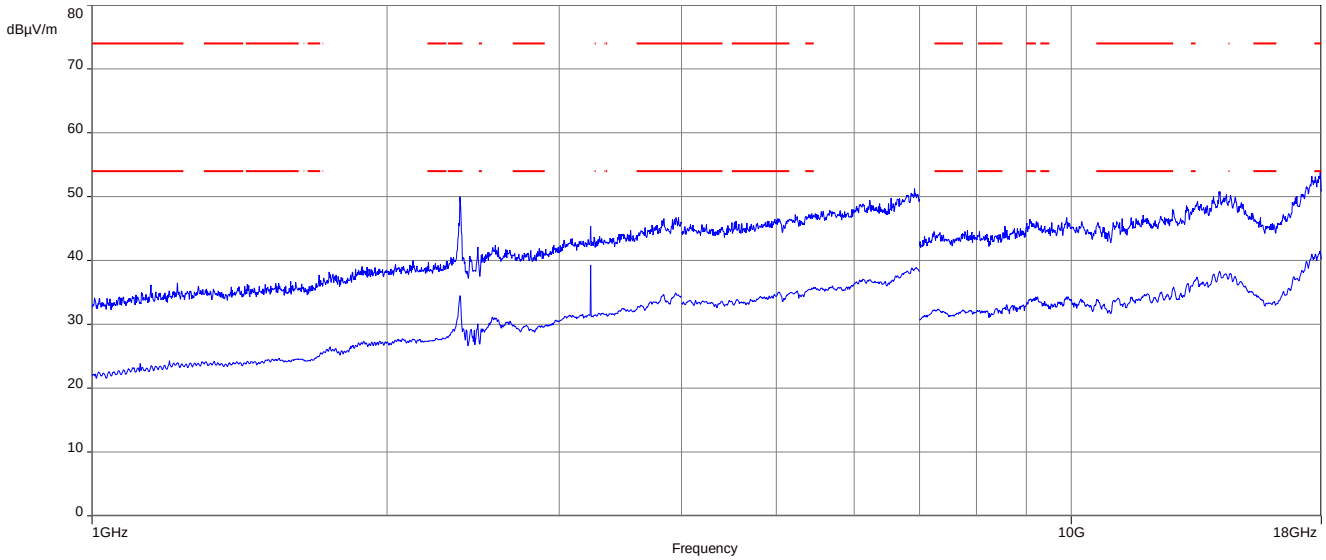
Plot 6: Highest channel, 18 GHz to 26 GHz, vertical & horizontal polarization



Date: 16.OCT.2024 10:34:39

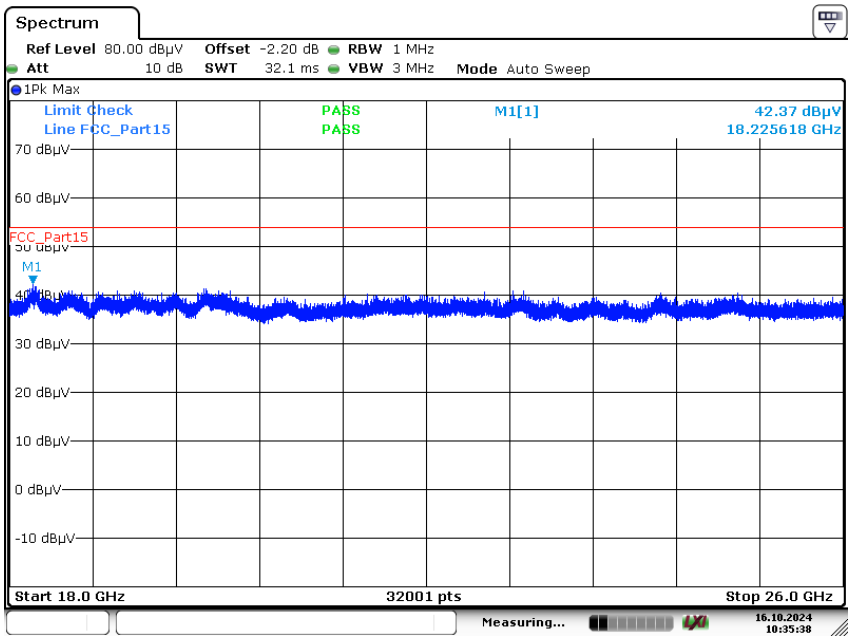
Plots: OFDM (40 MHz bandwidth)

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

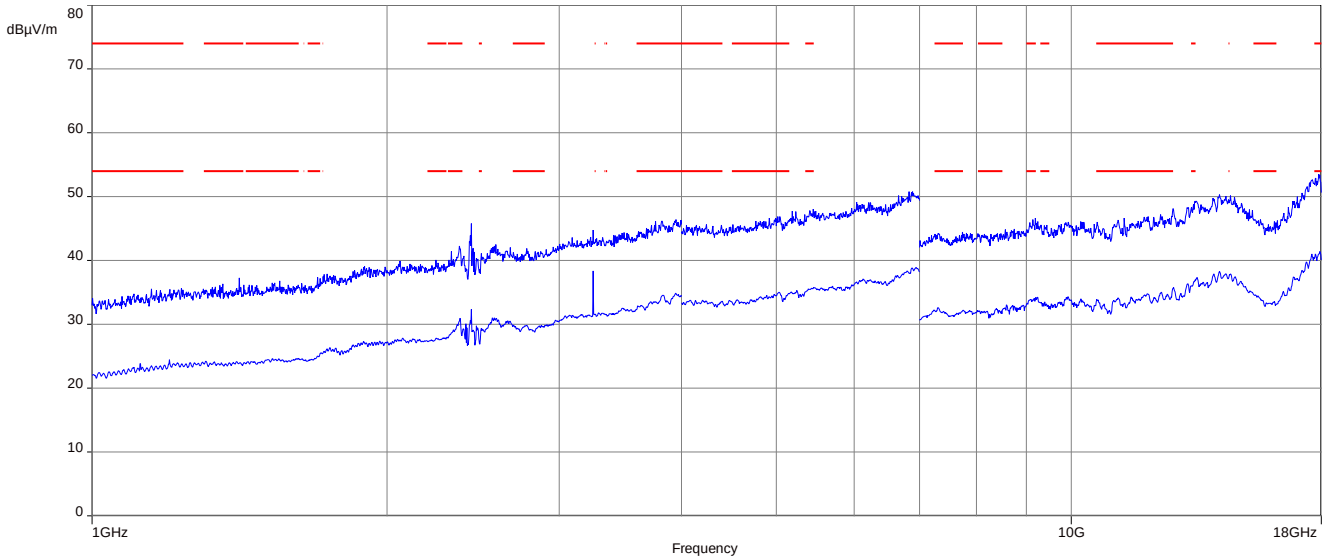


The carrier signal is notched with a 2.4 GHz band rejection filter.

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

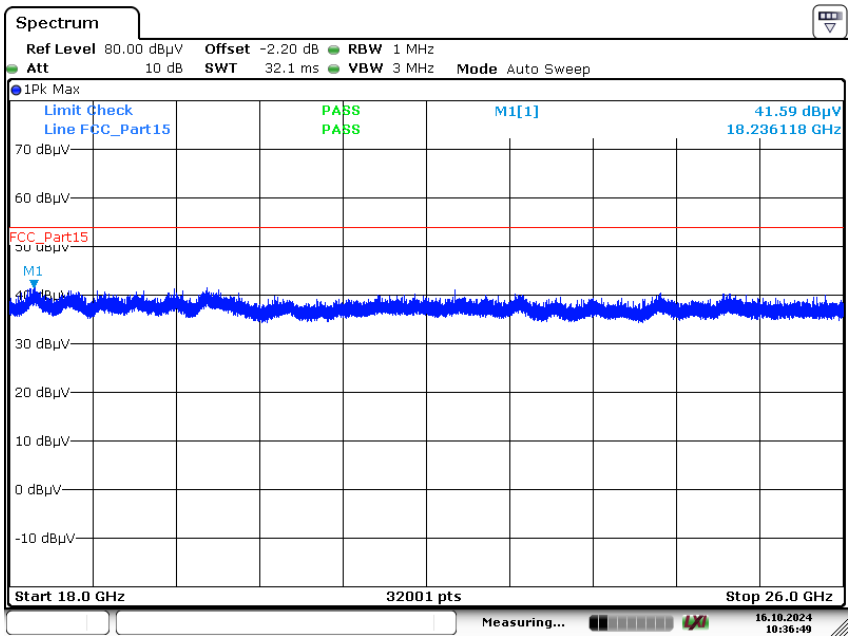


Plot 3: Middle channel, 1 GHz to 18 GHz, vertical & horizontal polarization



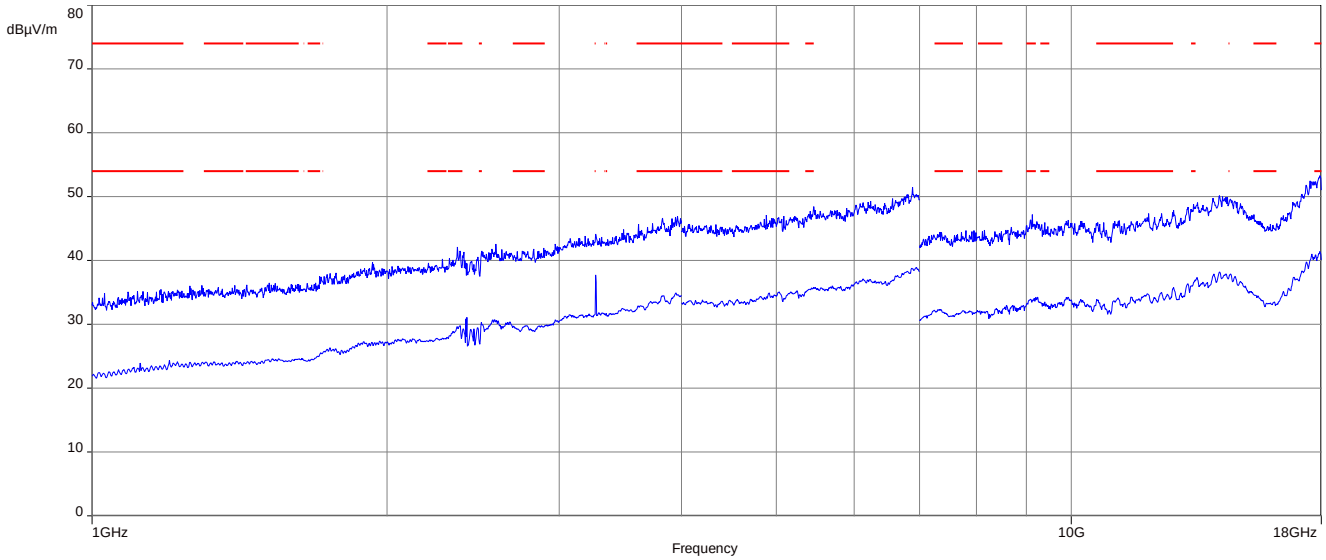
The carrier signal is notched with a 2.4 GHz band rejection filter.

Plot 4: Middle channel, 18 GHz to 26 GHz, vertical & horizontal polarization



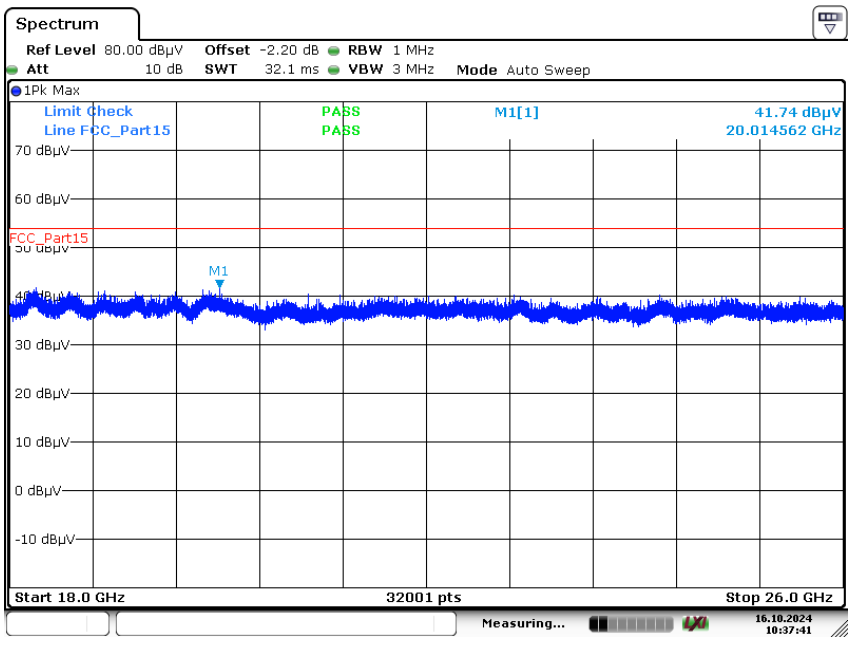
Date: 16.OCT.2024 10:36:49

Plot 5: Highest channel, 1 GHz to 18 GHz, vertical & horizontal polarization



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

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



Date: 16.OCT.2024 10:37:41

Results CS15xx-1:

Results: DSSS

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.		
-/-	Peak	-/-	-/-	Peak	-/-	-/-	Peak	-/-
	AVG	-/-		AVG	-/-		AVG	-/-

Results: OFDM (20 MHz nominal channel bandwidth)

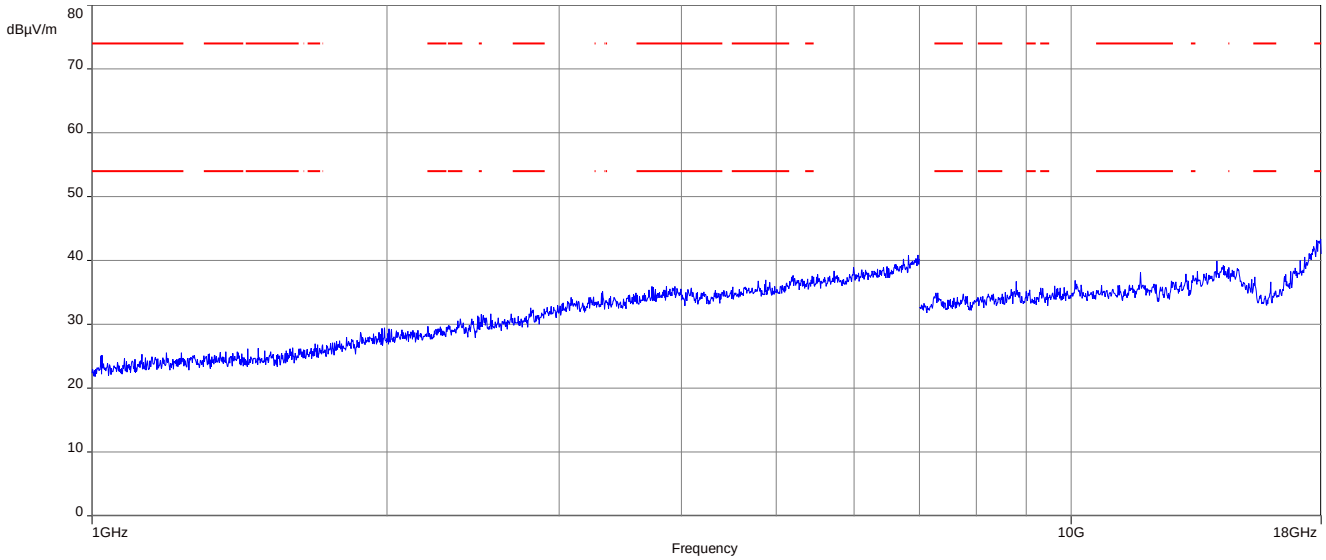
TX spurious emissions radiated / dBµV/m @ 3 m								
lowest channel			middle channel			highest channel		
f / MHz	Detector	Level / dBµV/m	f / MHz	Detector	Level / dBµV/m	f / MHz	Detector	Level / dBµV/m
All detected emissions are more than 20 dB below the limit.			All detected emissions are more than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

Results: OFDM (40 MHz nominal channel bandwidth)

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.		
-/-	Peak	-/-	-/-	Peak	-/-	-/-	Peak	-/-
	AVG	-/-		AVG	-/-		AVG	-/-

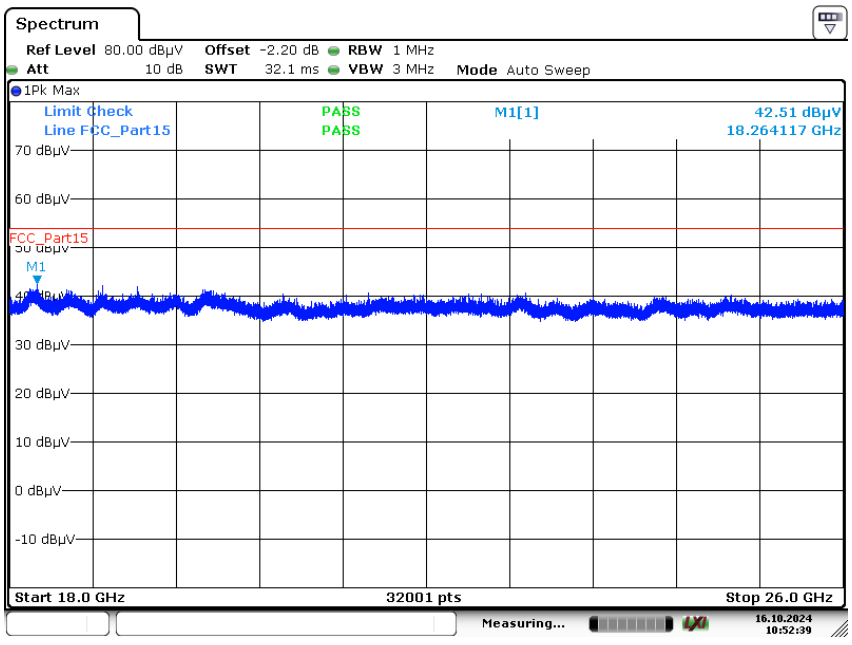
Plots: DSSS

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



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

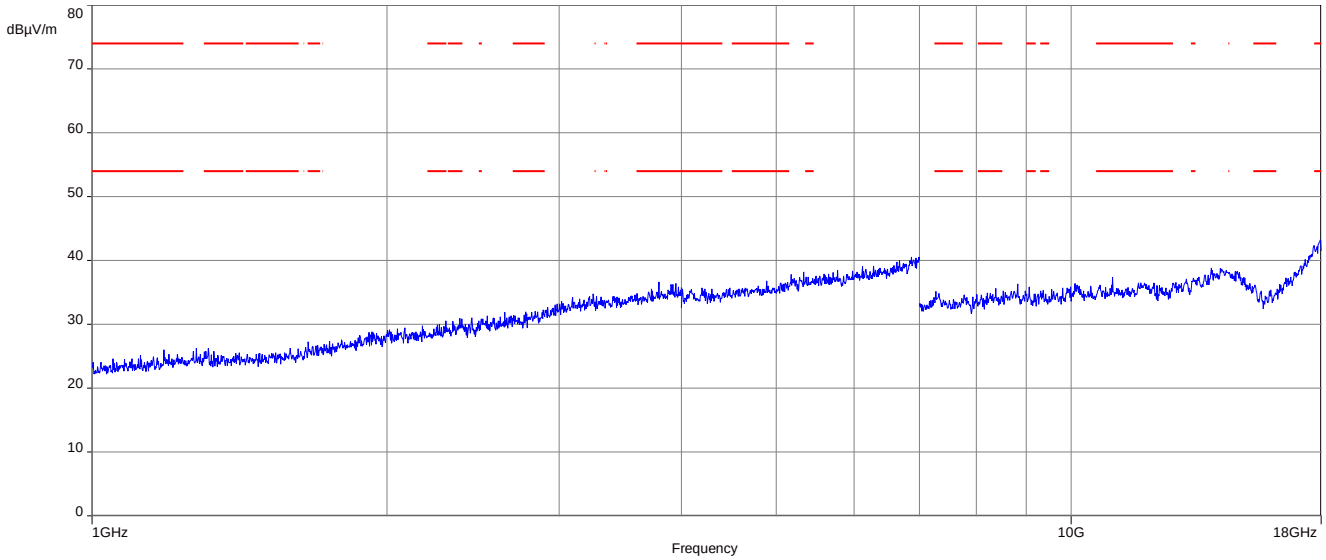
Plot 2: Mid channel, 18 GHz to 26 GHz, vertical & horizontal polarization



Date: 16.OCT.2024 10:52:39

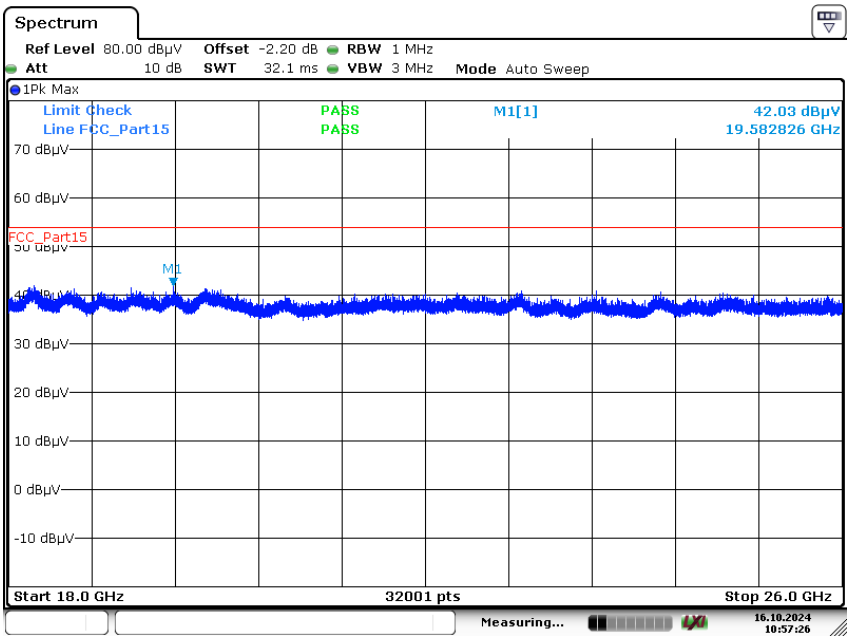
Plots: OFDM (20 MHz bandwidth)

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



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

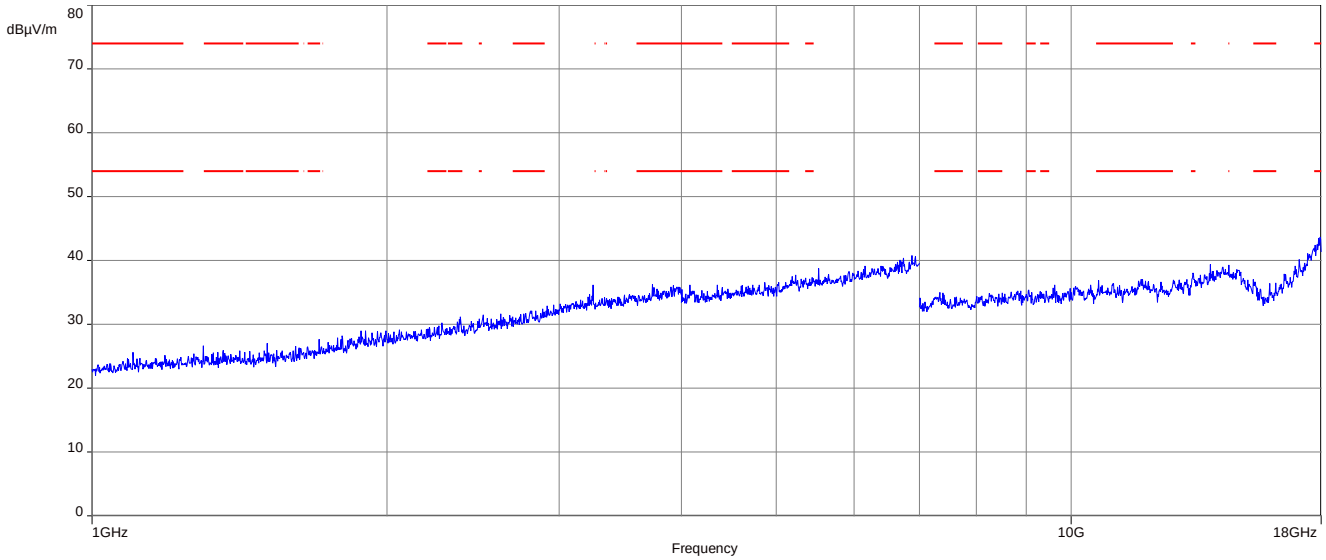
Plot 2: Mid channel, 18 GHz to 26 GHz, vertical & horizontal polarization



Date: 16.OCT.2024 10:57:26

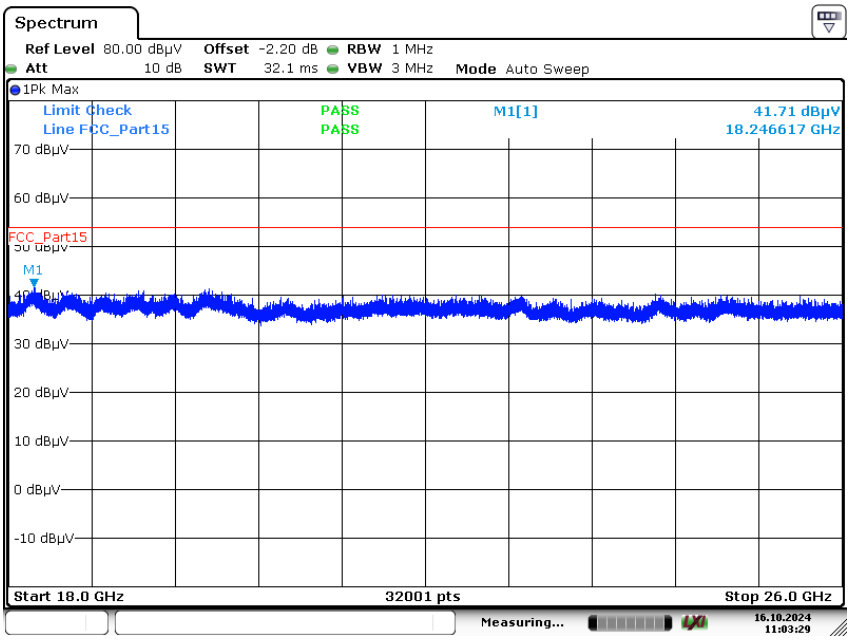
Plots: OFDM (40 MHz bandwidth)

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



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

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



Date: 16.OCT.2024 11:03:29

13.14 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 7.5 setup A
Measurement uncertainty	See chapter 9

Limits:

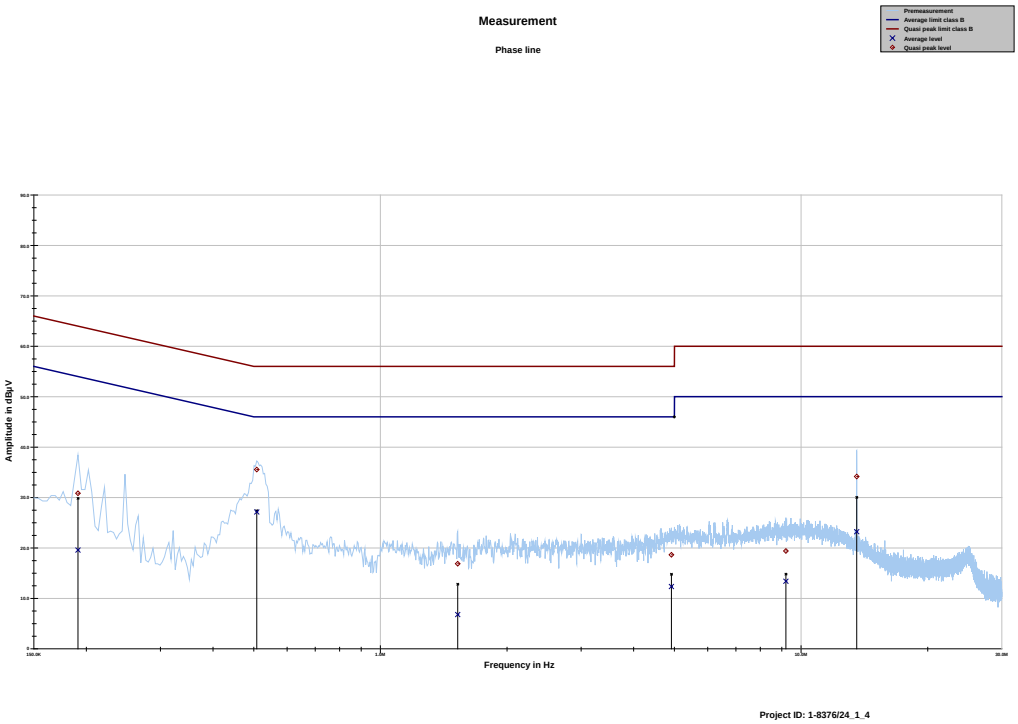
FCC		ISED
Frequency / MHz)	Quasi-Peak / (dBµV / m)	Average / (dBµV / m)
0.15 – 0.5	66 to 56*	56 to 46*
0.5 – 5	56	46
5 – 30.0	60	50

*Decreases with the logarithm of the frequency

Results CS15xx-0:

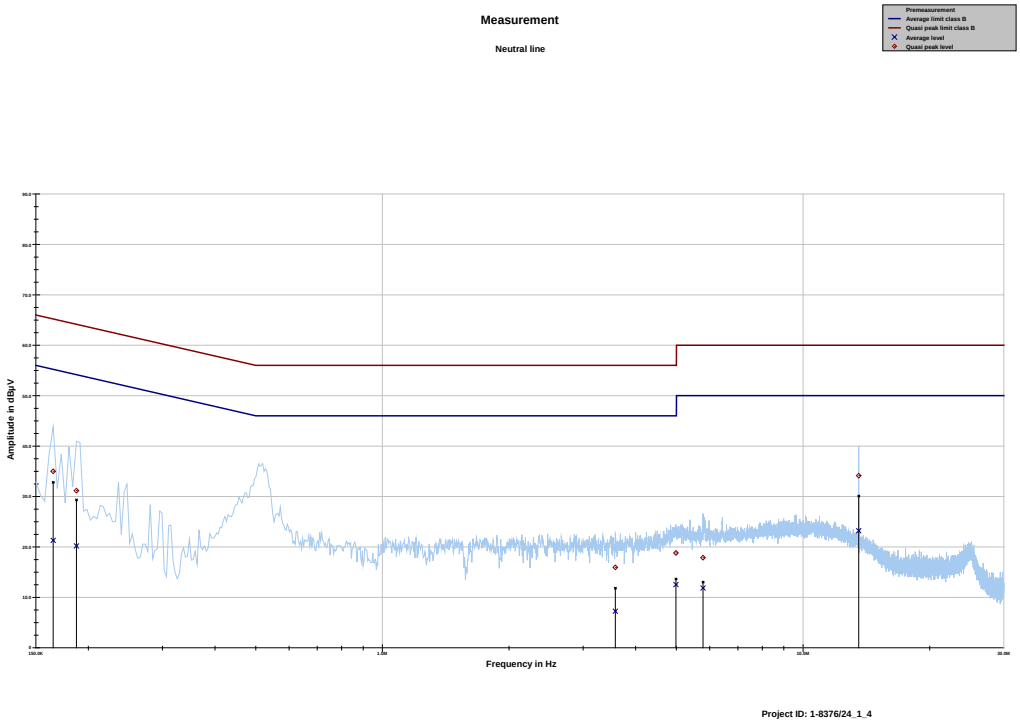
Plots:

Plot 1: 150 kHz to 30 MHz, phase line



Frequency	Quasi peak level	Margin quasi peak	Limit QP	Average level	Margin average	Limit AV
MHz	dBµV	dB	dBµV	dBµV	dB	dBµV
0.191044	30.83	33.16	63.991	19.58	35.25	54.827
0.508200	35.54	20.46	56.000	27.13	18.87	46.000
1.526831	16.86	39.14	56.000	6.78	39.22	46.000
4.918538	18.64	37.36	56.000	12.33	33.67	46.000
9.202013	19.39	40.61	60.000	13.40	36.60	50.000
13.560113	34.17	25.83	60.000	23.22	26.78	50.000

Plot 2: 150 kHz to 30 MHz, neutral line

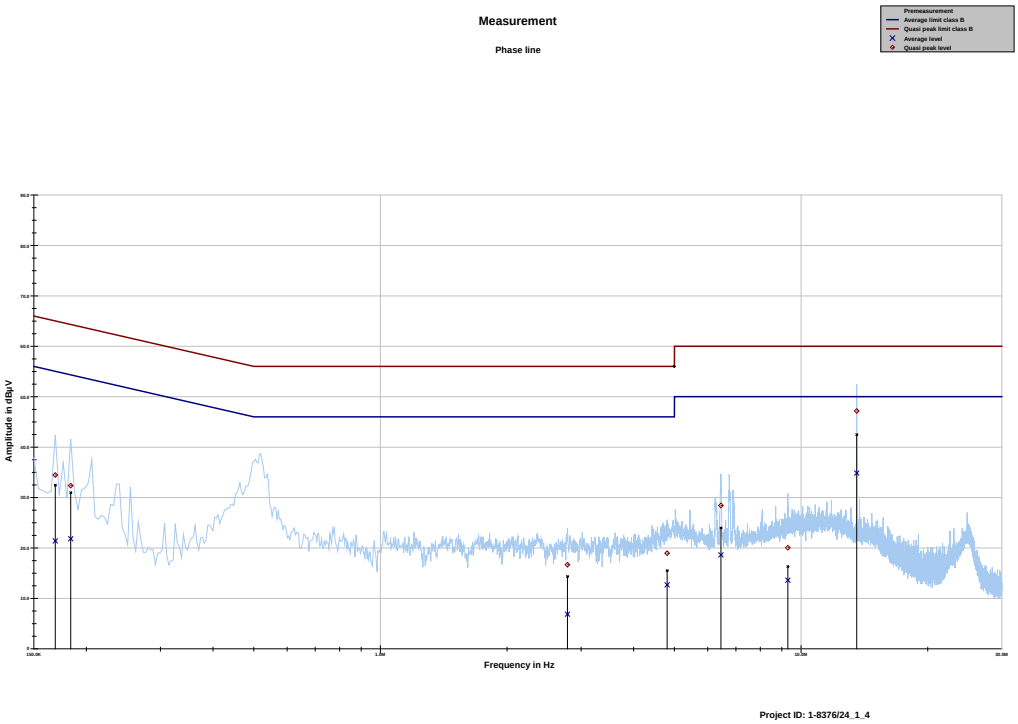


Frequency	Quasi peak level	Margin quasi peak	Limit QP	Average level	Margin Average	Limit AV
MHz	dBµV	dB	dBµV	dBµV	dB	dBµV
0.164925	35.00	30.21	65.212	21.30	34.27	55.574
0.187312	31.15	33.01	64.155	20.19	34.74	54.934
3.579019	15.93	40.07	56.000	7.24	38.76	46.000
4.985700	18.80	37.20	56.000	12.53	33.47	46.000
5.784187	17.86	42.14	60.000	11.85	38.15	50.000
13.560113	34.13	25.87	60.000	23.19	26.81	50.000

Results CS15xx-1:

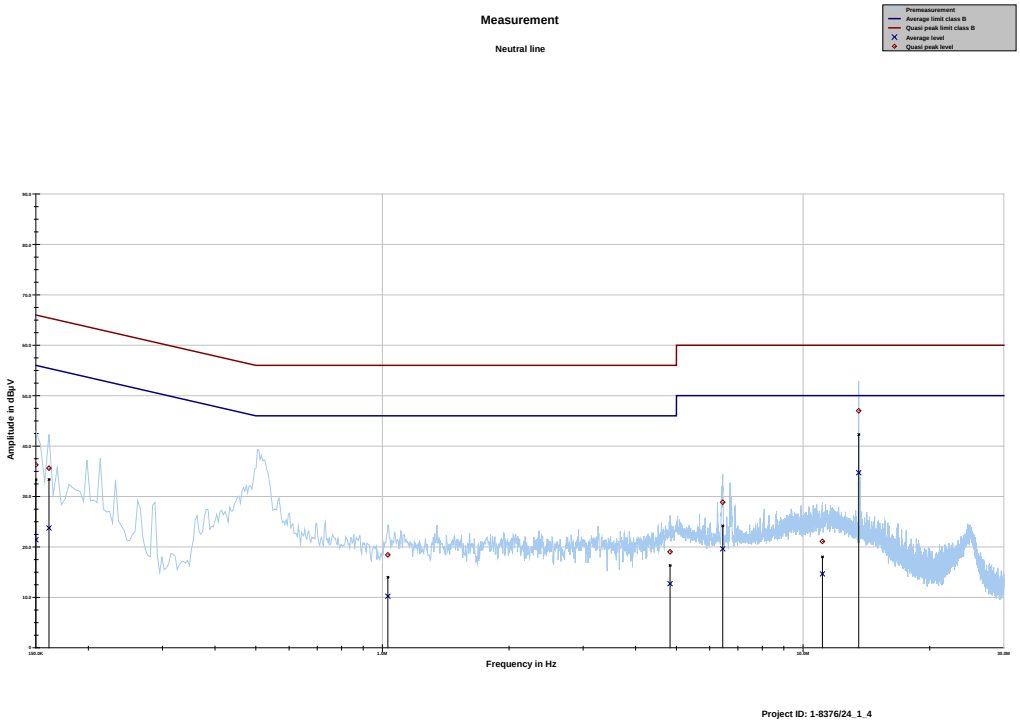
Plots:

Plot 1: 150 kHz to 30 MHz, phase line



Frequency	Quasi peak level	Margin quasi peak	Limit QP	Average level	Margin average	Limit AV
MHz	dBµV	dB	dBµV	dBµV	dB	dBµV
0.168656	34.46	30.56	65.026	21.38	34.09	55.467
0.183581	32.35	31.98	64.322	21.81	33.23	55.041
2.784263	16.67	39.33	56.000	6.85	39.15	46.000
4.802869	18.95	37.05	56.000	12.67	33.33	46.000
6.448350	28.43	31.57	60.000	18.61	31.39	50.000
9.302756	20.03	39.97	60.000	13.60	36.40	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	36.29	29.71	66.000	21.41	34.59	56.000
0.161194	35.62	29.78	65.402	23.75	31.93	55.680
1.030575	18.41	37.59	56.000	10.21	35.79	46.000
4.828988	19.02	36.98	56.000	12.72	33.28	46.000
6.440887	28.87	31.13	60.000	19.61	30.39	50.000
11.119875	21.09	38.91	60.000	14.65	35.35	50.000

14 Observations

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

15 Glossary

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

16 Document history

Version	Applied changes	Date of release
R01	Initial Release	2025-04-04
R02	Updated HVIN and PMN	2025-04-04

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