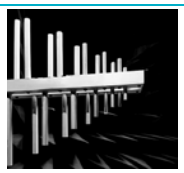
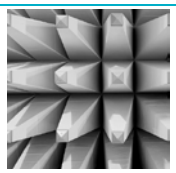




CTC advanced
member of RWTÜV group

Bundesnetzagentur

BNetzA-CAB-02/21-102

TEST REPORT

Test report no.: 1-1524/20-01-02-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: https://www.ctcadvanced.com
e-mail: mail@ctcadvanced.com

Accredited Testing Laboratory:
The testing laboratory (area of testing) is accredited according to DIN EN ISO/IEC 17025 (2018-03) by the Deutsche Akkreditierungsstelle GmbH (DAkkS)
The accreditation is valid for the scope of testing procedures as stated in the accreditation certificate starting with the registration number: D-PL-12076-01.

Applicant

VOGO
101 place Pierre Duhem – Immeuble Les Centuries II
3400 Montpellier / FRANCE
Phone: +33 6 43 78 76 85
Contact: Pascal Saguin
e-mail: p.saguin@vogo.fr

Manufacturer

VOGO
Parc Technologique des Fontaines – Activillage 3A
38190 Bernin / FRANCE

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:	**DIGITAL AUDIO TRANSCEIVER**
Model name:	**VO8364AA (VOKKERO ELITE 915 Terminal)**
FCC ID:	**2AU6N-VO8364AA**
IC:	**25704-VO8364AA**
Frequency:	DTS band 902 – 928 MHz
Technology tested:	Proprietary DTS/FHSS
Antenna:	Integrated antenna
Power supply:	3.7 V DC by lithium battery
Temperature range:	-20°C to +55°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=Christoph Schneider, o=CTC advanced GmbH, ou=SND-161128, email=Christoph.Schneider@ctcadvanced.com, c=DE
2021.01.21 15:27:38 +01'00'

Christoph Schneider
Lab Manager
Radio Communications

Test performed:

p.o.

cn=Michael Dorongovski, o=CTC Advanced GmbH, ou=RCE-201118, email=Michael.Dorongovski@ctcadvanced.com, c=DE
2021.01.21 13:51:51 +01'00'

Tobias Wittenmeier
Testing Manager
Radio Communications

1 Table of contents

2 General information

2.1 Notes and disclaimer

The test results of this test report relate exclusively to the test item specified in this test report. CTC advanced GmbH does not assume responsibility for any conclusions and generalizations drawn from the test results with regard to other specimens or samples of the type of the equipment represented by the test item.
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 1-1524/20-01-02 and dated 2021-01-15.

2.2 Application details

Date of receipt of order:	2020-11-17
Date of receipt of test item:	2020-11-30
Start of test:*	2020-12-01
End of test:*	2021-01-15
Person(s) present during the test:	-/-

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

2.3 Test laboratories sub-contracted

None

3 Test standard/s, references and accreditations

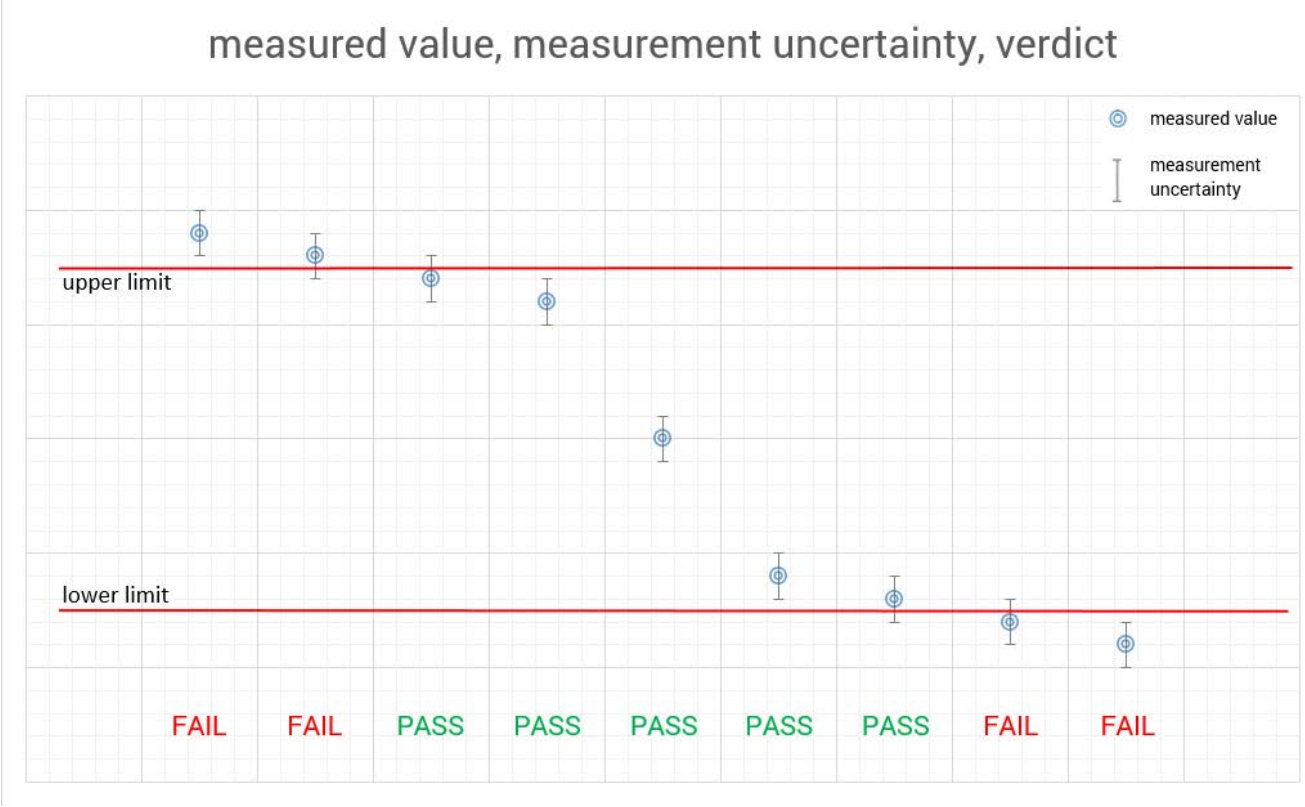
Test standard	Date	Description
FCC - Title 47 CFR Part 15		FCC - Title 47 of the Code of Federal Regulations; Chapter I; Part 15 - Radio frequency devices
RSS - 247 Issue 2	February 2017	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence - Exempt Local Area Network (LE-LAN) Devices

Guidance	Version	Description
ANSI C63.4-2014	-/-	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
ANSI C63.10-2013	-/-	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

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

4 Reporting statements of conformity – decision rule

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



5 Test environment

Temperature	:	T_{nom} T_{max} T_{min}	+22 °C during room temperature tests No tests under extreme 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}	3.7 V DC by lithium battery 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	:	DIGITAL AUDIO TRANSCEIVER
Model name	:	VO8364AA (VOKKERO ELITE 915 Terminal)
HMN	:	n/a
PMN	:	Vokkero ELITE 915 terminal
HVIN	:	VO8364AA
FVIN	:	V01-07.00-07.00
S/N serial number	:	Rad. I2045000038 Cond. I2045000009
Hardware status	:	Batch 001191
Software status	:	production
Firmware status	:	production
Frequency band	:	DTS band 915.4 MHz to 927.4 MHz FHSS band 915.42 MHz to 927.42 MHz
Type of radio transmission Use of frequency spectrum	: :	DTS FHSS
Type of modulation	:	GFSK
Number of channels	:	DTS: 15 FHSS: 25/26
Antenna	:	Integrated antenna
Power supply	:	3.7 V DC by lithium battery
Temperature range	:	-20°C to +55°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: 1-1524/20-01-01_AnnexA
1-1524/20-01-01_AnnexB
1-1524/20-01-01_AnnexD

7 Description of the test setup

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

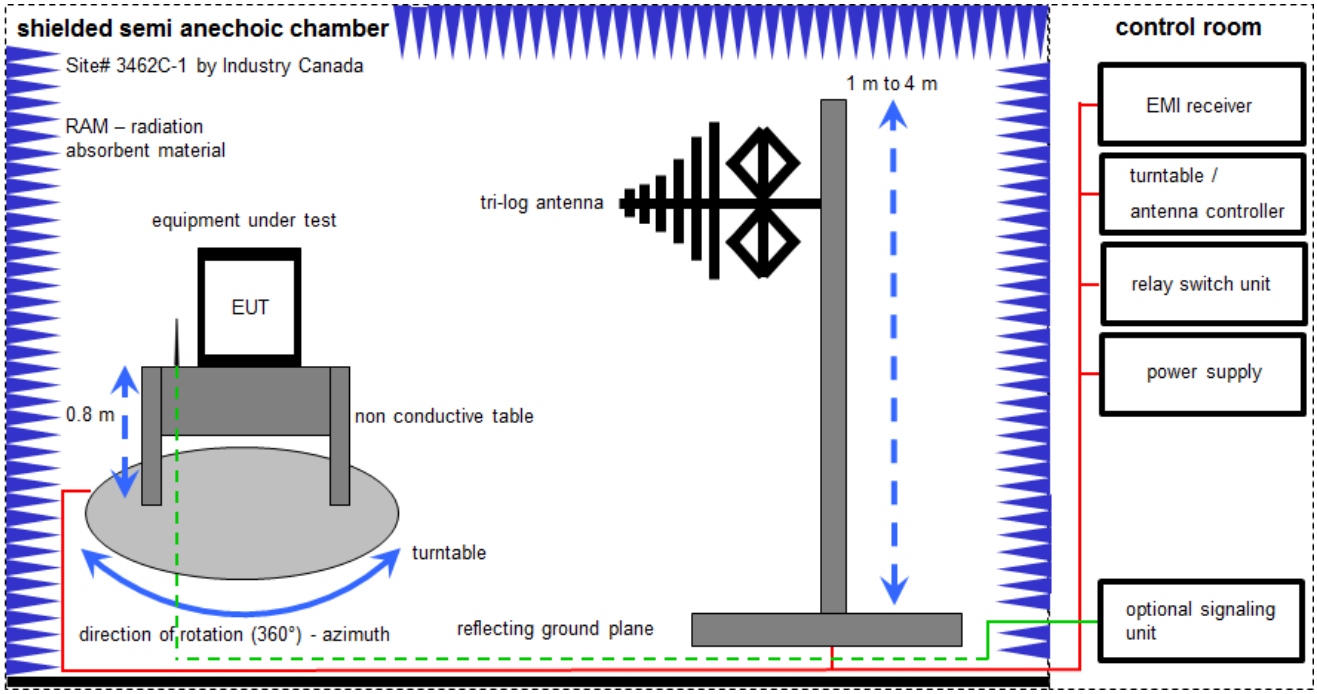
In order to simplify the identification of the equipment used at some special tests, some items of test equipment and ancillaries can be provided with an identifier or number in the equipment list below (Lab/Item).

Agenda: Kind of Calibration

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

7.1 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

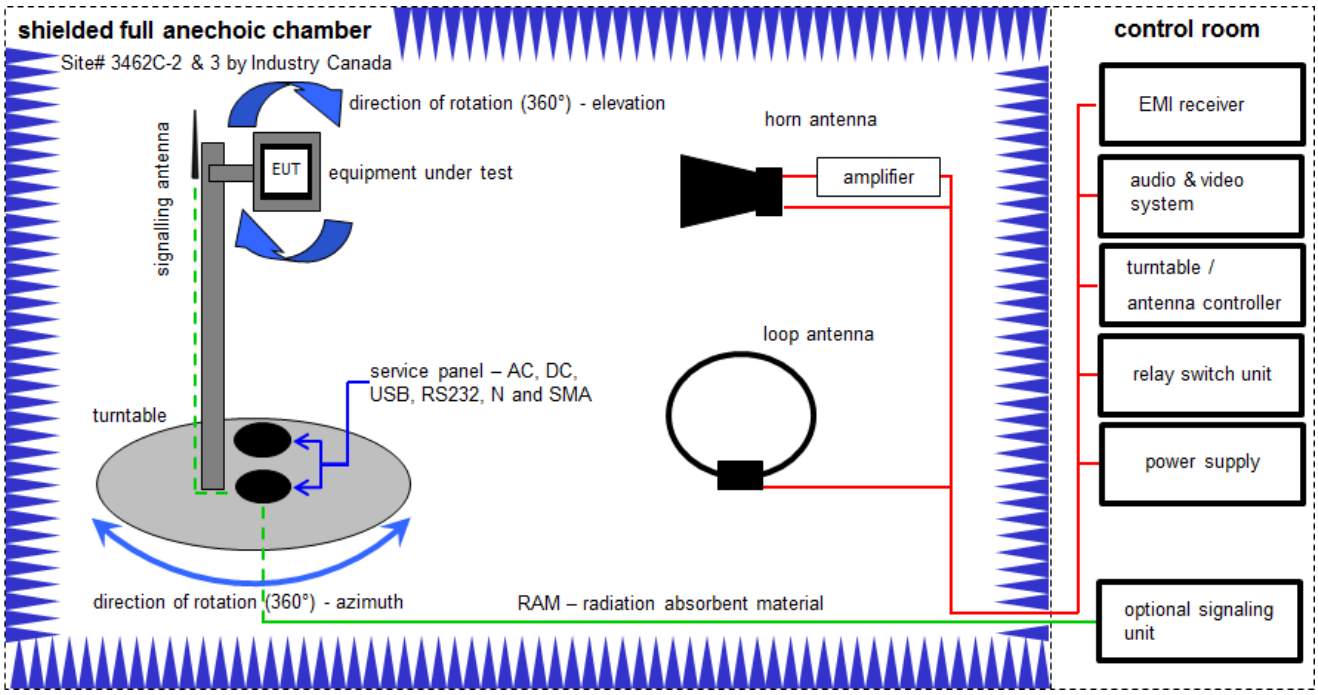
FS = UR + CL + AF
(FS-field strength; UR-voltage at the receiver; CL-loss of the cable; AF-antenna factor)

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.	Lab / Item	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	64672	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	Turntable	2089-4.0	EMCO		300004394	ne	-/-	-/-
8	A	PC	TecLine	F+W	2210	300004388	ne	-/-	-/-
9	A	EMI Test Receiver	ESR3	Rohde & Schwarz	102587	300005771	k	10.12.2020	09.06.2022

7.2 Shielded fully anechoic chamber



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

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

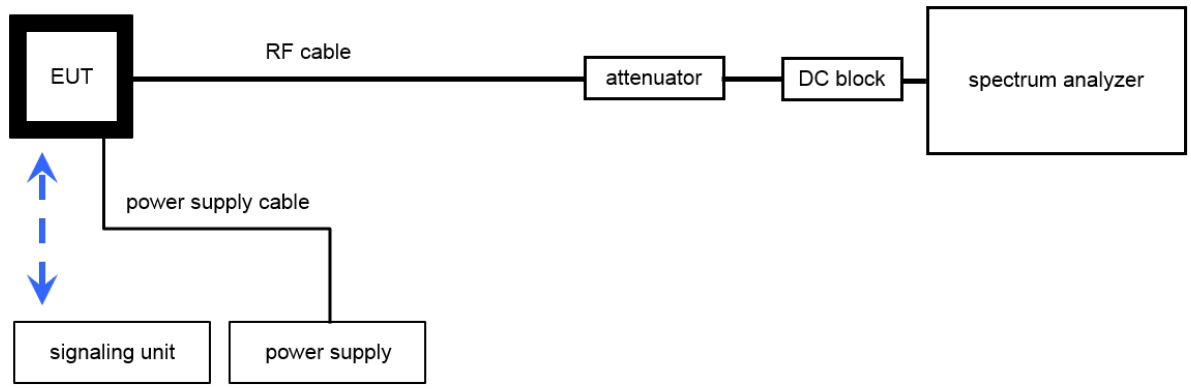
Example calculation:
FS [dBµV/m] = 40.0 [dBµV/m] + (-35.8) [dB] + 32.9 [dB/m] = 37.1 [dBµV/m] (71.61 µV/m)

Equipment table:

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	A	Active Loop Antenna 9 kHz to 30 MHz	6502	EMCO	2210	300001015	vIKI!	13.06.2019	12.06.2021
2	B	Highpass Filter	WHK1.1/15G-10SS	Wainwright	37	400000148	ne	-/-	-/-
3	B	Broadband Amplifier 0.5-18 GHz	CBLU5184540	CERNEX	22050	300004482	ev	-/-	-/-
4	A,B	4U RF Switch Platform	L4491A	Agilent Technologies	MY50000032	300004510	ne	-/-	-/-
5	A,B	Computer	Intel Core i3 3220/3,3 GHz, Prozessor		2V2403033A5421	300004591	ne	-/-	-/-
6	A,B	NEXIO EMV-Software	BAT EMC V3.20.0.13	EMCO		300004682	ne	-/-	-/-
7	A,B	Anechoic chamber		TDK		300003726	ne	-/-	-/-
8	A,B	EMI Test Receiver 9kHz-26,5GHz	ESR26	R&S	101376	300005063	k	09.12.2020	08.12.2021

7.3 Conducted measurements

Conducted measurements normal conditions



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

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

Equipment table:

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	A	Signal- and Spectrum Analyzer 2 Hz - 26 GHz	FSW26	R&S	101455	300004528	k	11.12.2020	10.12.2021
2	A	Loop Antenna		ZEG TS Steinfurt		400001208	ev	-/-	-/-
3	A	RF-Cable SRD021 No. 1	Enviroflex 316 D	Huber & Suhner		400001311	ev	-/-	-/-

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.

9 Measurement uncertainty

Measurement uncertainty	
Test case	**Uncertainty**
Antenna gain	± 3 dB
Carrier frequency separation	± 21.5 kHz
Number of hopping channels	-/-
Spectrum bandwidth	± 21.5 kHz absolute; ± 15.0 kHz relative
Maximum output power	± 1 dB
Detailed conducted spurious emissions @ the band edge	± 1 dB
Band edge compliance radiated	± 3 dB
Spurious emissions conducted	± 3 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

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.

10.1 Part 1: FHSS

TC Identifier	Description	Verdict	Date	Remark
RF-Testing	CFR Part 15 RSS - 247, Issue 2	Passed	2021-01-21	-/-

Test specification clause	Test case	Temperature conditions	Power source voltages	Mode	C	NC	NA	NP	Remark
§15.247(b)(4) RSS - 247 / 5.4 (d)	Antenna gain	Nominal	Nominal	TX single channel	☒	☐	☐	☐	-/-
§15.247(a)(1) RSS - 247 / 5.1 (b)	Carrier frequency separation	Nominal	Nominal	TX hopping	☒	☐	☐	☐	-/-
§15.247(a)(1) RSS - 247 / 5.1 (d)	Number of hopping channels	Nominal	Nominal	TX hopping	☒	☐	☐	☐	-/-
§15.247(a)(1) (iii) RSS - 247 / 5.1 (d)	Time of occupancy (dwell time)	Nominal	Nominal	TX hopping	☒	☐	☐	☐	-/-
§15.247(a)(1) RSS - 247 / 5.1 (a)	Spectrum bandwidth of a FHSS system bandwidth	Nominal	Nominal	TX single channel	☒	☐	☐	☐	-/-
§15.247(b)(1) RSS - 247 / 5.4 (a)	Maximum output power	Nominal	Nominal	TX single channel	☒	☐	☐	☐	-/-
§15.247(d) RSS - 247 / 5.5	Detailed spurious emissions @ the band edge - conducted	Nominal	Nominal	TX hopping	☒	☐	☐	☐	-/-
§15.205 RSS - 247 / 5.5 RSS - Gen	Band edge compliance radiated	Nominal	Nominal	-/-	☒	☐	☐	☐	-/-
§15.247(d) RSS - 247 / 5.5	Spurious emissions conducted	Nominal	Nominal	TX single channel	☒	☐	☐	☐	-/-
§15.209(a) RSS - Gen	Spurious emissions radiated below 30 MHz	Nominal	Nominal	TX single channel	☒	☐	☐	☐	-/-
§15.247(d) RSS - 247 / 5.5 §15.109 RSS - Gen	Spurious emissions radiated 30 MHz to 1 GHz	Nominal	Nominal	TX single channel	☒	☐	☐	☐	-/-
§15.247(d) RSS - 247 / 5.5 §15.109 RSS - Gen	Spurious emissions radiated above 1 GHz	Nominal	Nominal	TX single channel	☒	☐	☐	☐	-/-
§15.107(a) §15.207	Conducted emissions below 30 MHz (AC conducted)	Nominal	Nominal	TX hybrid	☐	☐	☒	☐	-/-

Note: C = Compliant; NC = Not compliant; NA = Not applicable; NP = Not performed

10.2 Part 2: DTS

Test specification clause	Test case	Temperature conditions	Power source voltages	Mode	C	NC	NA	NP	Remark
§15.247(b)(4) RSS - 247 / 5.4 (d)	Antenna gain	Nominal	Nominal	TX single channel	☒	☐	☐	☐	-/-
§15.247(e) RSS - 247 / 5.2 (b)	Power spectral density	Nominal	Nominal	TX single channel	☒	☐	☐	☐	-/-
§15.247(a)(2) RSS Gen clause 4.6.1	Spectrum bandwidth 6dB bandwidth	Nominal	Nominal	TX single channel	☒	☐	☐	☐	-/-
§15.247(b)(3) RSS - 247 / 5.4 (d)	Maximum output power	Nominal	Nominal	TX single channel	☒	☐	☐	☐	-/-
§15.205 RSS - 247 / 5.5 RSS - Gen	Band edge compliance conducted	Nominal	Nominal	TX single channel	☒	☐	☐	☐	-/-
§15.205 RSS - 247 / 5.5 RSS - Gen	Band edge compliance radiated	Nominal	Nominal	-/-	☒	☐	☐	☐	-/-
§§15.247(d) RSS - 247 / 5.5	TX spurious emissions conducted	Nominal	Nominal	TX single channel	☒	☐	☐	☐	-/-
§15.247(d) RSS - 247 / 5.5 §15.109 RSS - Gen	TX spurious emissions radiated	Nominal	Nominal	TX single channel	☒	☐	☐	☐	-/-
§15.209(a) RSS-Gen	TX spurious emissions radiated < 30 MHz	Nominal	Nominal	TX single channel	☐	☐	☒	☐	-/-

11 RF measurements

11.1 Additional comments

Reference documents: VOKKERO ELITE 915 TERMINAL VO8364AA - OPERATIONAL AND PRODUCT DESCRIPTION.pdf

Special test descriptions: As the frequencies and bandwidths of DTS and FHSS modes are very similar, the radiated spurious emissions tests were completely performed on the FHSS mode, as the FHSS mode has a higher output power and represents the worst case. For DTS mode only radiated emissions tests on one channel were performed.
The device supports two slightly different hopping tables. The only difference between hopping table 1 and 2 are the lowest channel and the total number of hopping channels (26 for H1 and 25 for H2). Therefore conducted FHSS tests were performed on 4 channels.

Configuration descriptions:

FHSS: 26 channels or 25 channels with a nominal bandwidth of 210 kHz and 375 kHz channel spacing.

lowest channel 915.42 MHz (lowest channel for hopping table 1)

lowest channel 915.795 MHz (lowest channel for hopping table 1)

middle channel 921.42 MHz
highest channel 927.42 MHz

these channels were tested in part 1 of this test report.

DTS: 15 channels with 500 kHz nominal bandwidth and 800 kHz channel

Spacing.
lowest channel 915.4 MHz,
middle channel 921.8 MHz,
highest channel 927.4 MHz;

these channels were tested in part 2 of this test report.

Power level setting for DTS during tests: PALevel 2 (32)

Test mode:

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

Hopping tables overview:

	H1	H2
Min	**915.795**	**915.42**
Max	**927.42**	**927.42**
1	927.045	925.17
2	916.545	926.67
3	918.42	919.545
4	922.17	923.67
5	923.295	922.92
6	925.17	915.42
7	921.42	921.42
8	915.795	924.795
9	925.545	916.545
10	918.795	915.795
11	926.67	921.045
12	921.795	919.17
13	916.17	918.045
14	918.045	922.17
15	922.545	916.92
16	925.92	917.67
17	920.295	927.42
18	917.67	916.17
19	920.67	918.795
20	927.42	923.295
21	924.42	924.045
22	923.67	918.42
23	916.92	927.045
24	924.045	921.795
25	926.295	924.42
26	917.295	

12 Measurement results Part 1 FHSS

12.1 Antenna gain

Description:

The antenna gain of the complete system is calculated by the difference of radiated power in EIRP and the conducted power of the module.

Measurement:

Measurement parameters	
Detector	Peak
Sweep time	Auto
Resolution bandwidth	1 MHz
Video bandwidth	3 MHz
Span	5 MHz
Trace mode	Max hold
Test setup	See sub clause 7.2 B (radiated) See sub clause 7.3 A (conducted)
Measurement uncertainty	See sub clause 9

Limits:

FCC	IC
Antenna gain	
The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.	

Results:

	915.420 MHz	915.795 MHz	921.420 MHz	927.42 MHz
Conducted power / dBm	21.57	21.50	23.06	18.13
EIRP / dBm	22.96	24.99	23.07	21.15
Gain / dBi (Calculated)	1.39	3.49	0.01	3.02

12.2 Carrier Frequency Separation

Description:

Measurement of the carrier frequency separation of a hopping system. EUT in hopping mode.

Measurement:

Measurement parameters	
Detector	Peak
Sweep time	Auto
Resolution bandwidth	See plots
Video bandwidth	See plots
Span	See plots
Trace mode	Max hold
Test setup	See sub clause 7.3 A
Measurement uncertainty	See sub clause 9

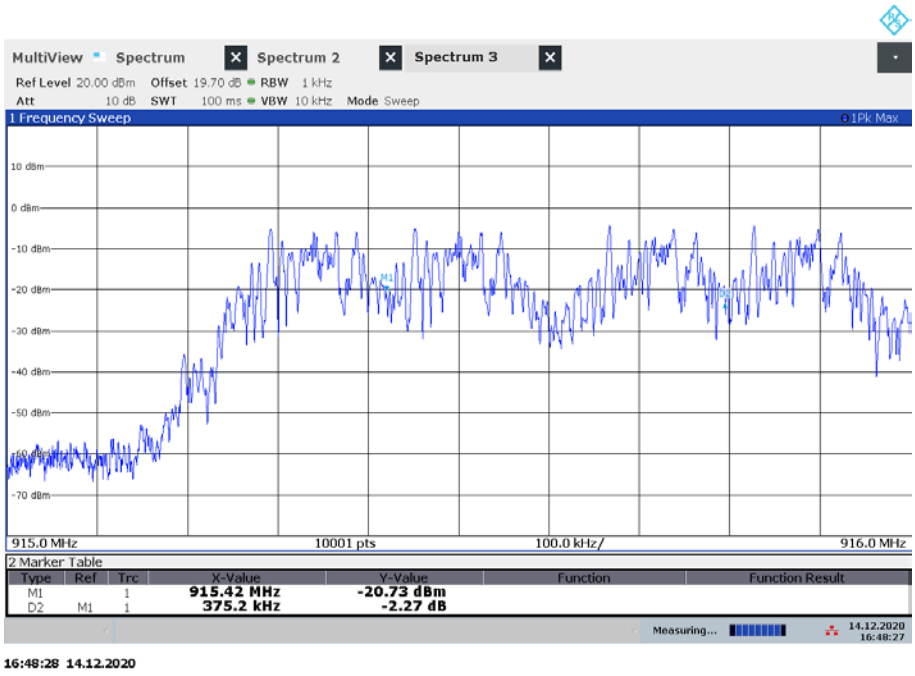
Limits:

FCC	IC
Carrier frequency separation	
Minimum 25 kHz or two-thirds of the 20 dB bandwidth of the hopping system whichever is greater. The two-thirds of the 20 dB bandwidth for IC is only valid for the ISM band 2400 – 2483.5 MHz.	

Result: The channel separation is 375 kHz.

Plots:

Plot 1: Frequency separation



12.3 Number of Hopping Channels

Description:

Measurement of the total number of used hopping channels. EUT in hopping mode.

Measurement:

Measurement parameters	
Detector	Peak
Sweep time	Auto
Resolution bandwidth	See plots
Video bandwidth	See plots
Span	See plots
Trace mode	Max hold
Test setup	See sub clause 7.3 A
Measurement uncertainty	See sub clause 9

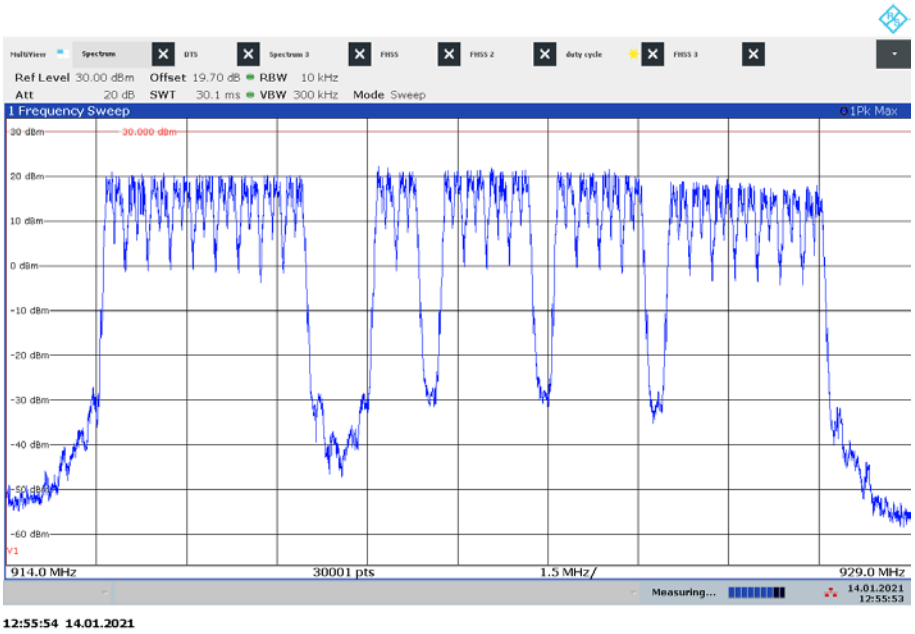
Limits:

FCC	IC
Number of hopping channels	
At least 25 non overlapping hopping channels. If the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping channels.	

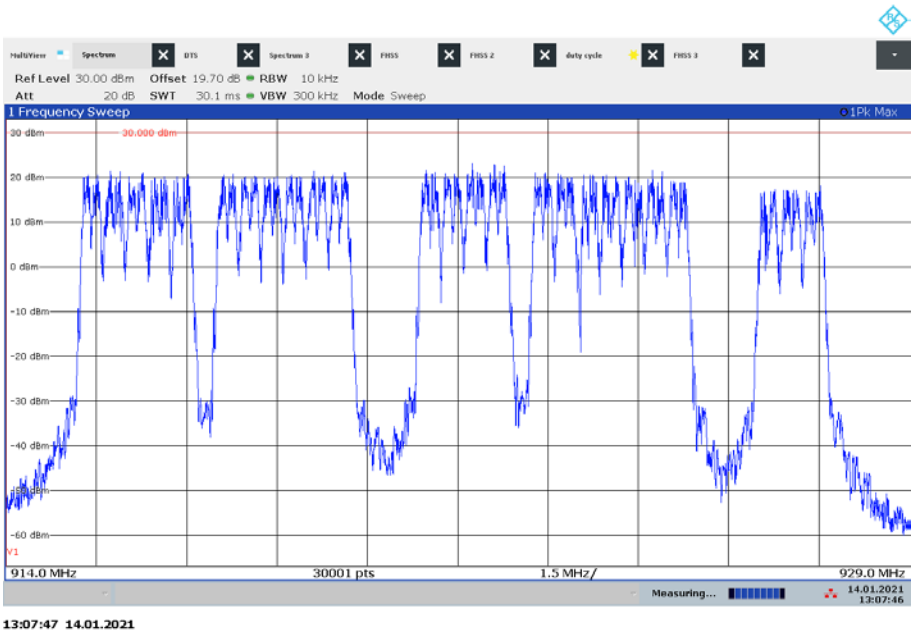
Result: The EUT uses H1: 26 channels
H2: 25 channels.

Plots:

Plot 1: Number of channels H1, 26 channels



Plot 1: Number of channels H2, 25 channels



12.4 Average Time of Occupancy (dwell time)

Measurement:

The measurement is performed in zero span mode to show that none of the 25 used channels is allocated more than 0.4 seconds within a 10 seconds interval (25 channels times 0.4s).

Limits:

FCC	IC
Average time of occupancy	
For frequency hopping systems operating in the 902-928 MHz band: If the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within 10 second period.	

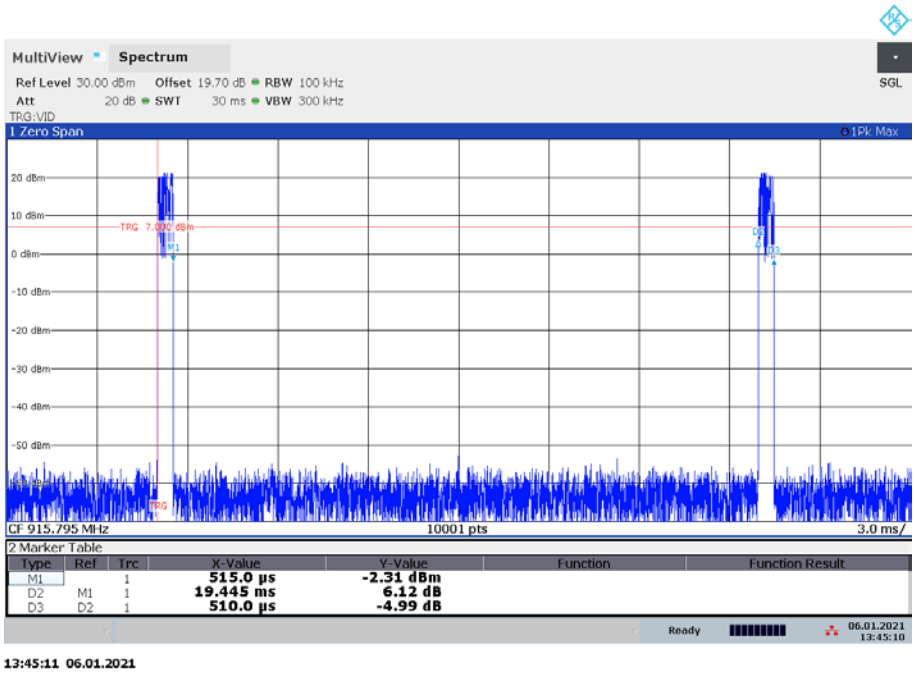
Result: The time slot length is 515 µs
Number of hops / channel @ 10s = 20

Within 10 s period, the average time of occupancy is 10.3 ms

→ The average time of occupancy = **10.3 ms**

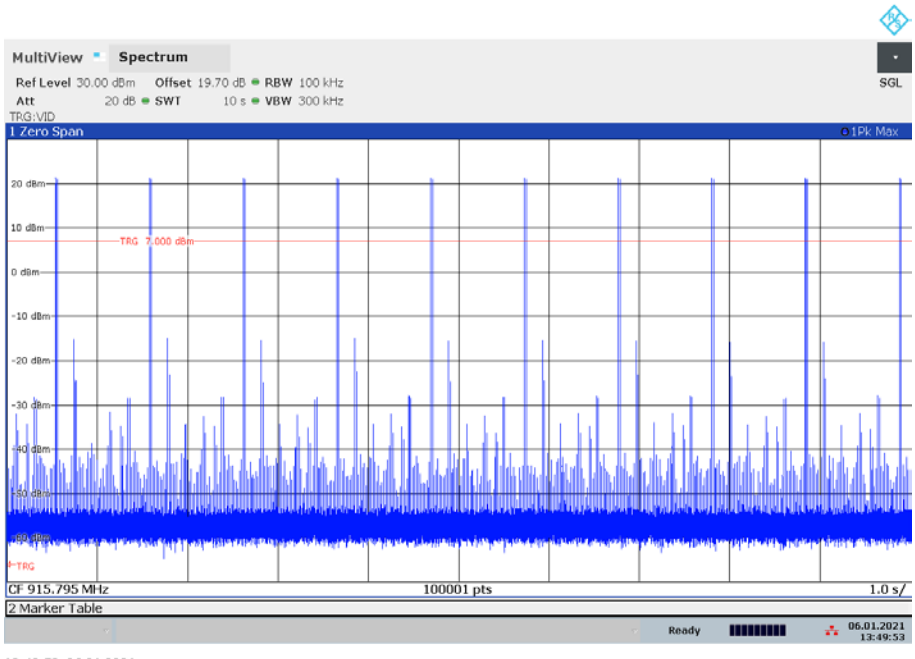
Plots:

Plot 1: Time slot length = 515 µs



13:45:11 06.01.2021

Plot 2: hops / channel @ 10s = 20



13:49:53 06.01.2021

12.5 Spectrum bandwidth of a FHSS system

Description:

Measurement of the 20dB bandwidth and 99% bandwidth of the modulated signal. The measurement is performed according to the "Measurement Guidelines" (DA 00-705, March 30, 2000). EUT in single channel mode.

Measurement:

Measurement parameters	
Detector	Peak
Sweep time	Auto
Resolution bandwidth	5 kHz
Video bandwidth	100 kHz
Span	See plots
Trace mode	Max hold
Test setup	See sub clause 7.3 A
Measurement uncertainty	See sub clause 9

Limits:

FCC	IC
Spectrum bandwidth of a FHSS system	
The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.	

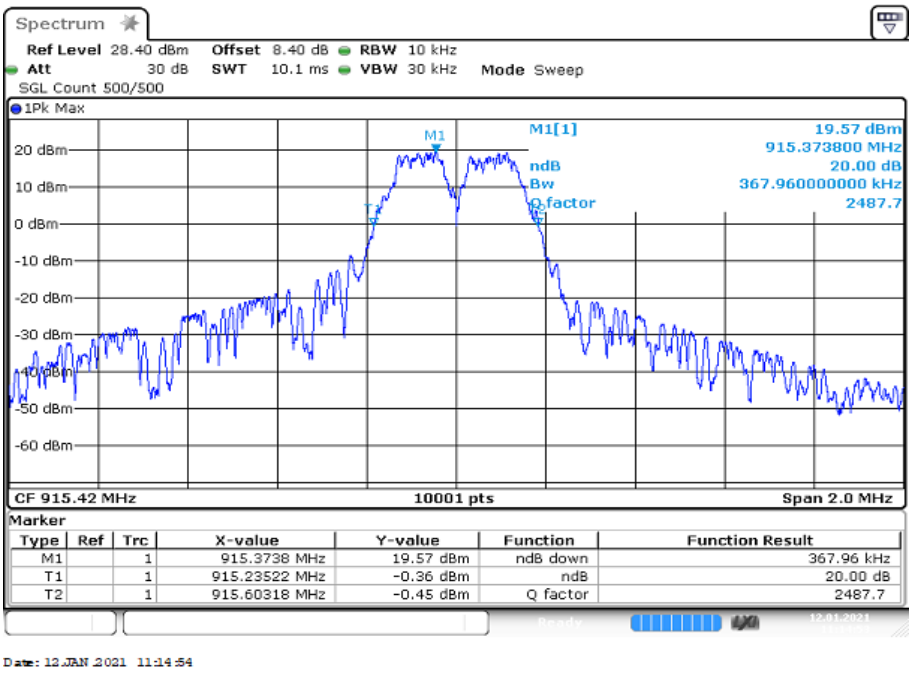
Result:

Test Conditions		20dB Bandwidth / kHz			
		915.420 MHz	915.795 MHz	921.420 MHz	927.42 MHz
T_{nom}	V_{nom}	368.0	366.26	364.0	364.26

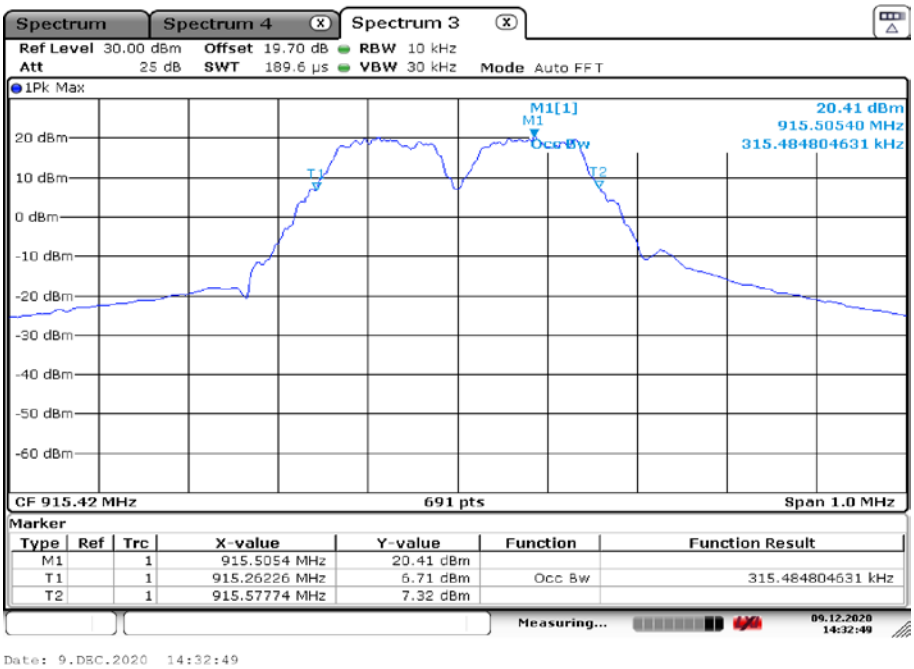
Test Conditions		99% Bandwidth / kHz			
		915.420 MHz	915.795 MHz	921.420 MHz	927.42 MHz
T_{nom}	V_{nom}	315.49	312.59	314.04	317.31

Plots:

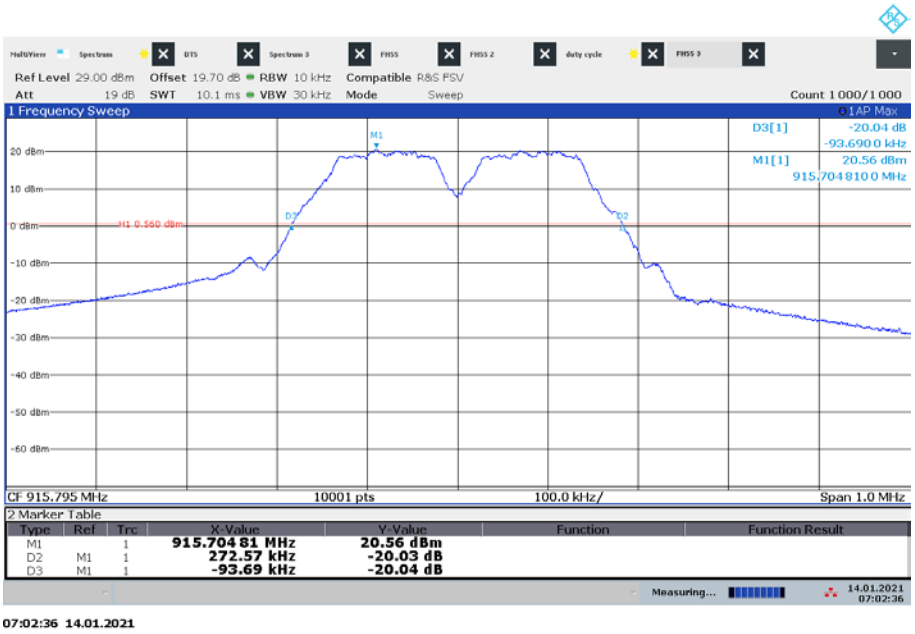
Plot 1: 915.420 MHz, 20 dB-BW



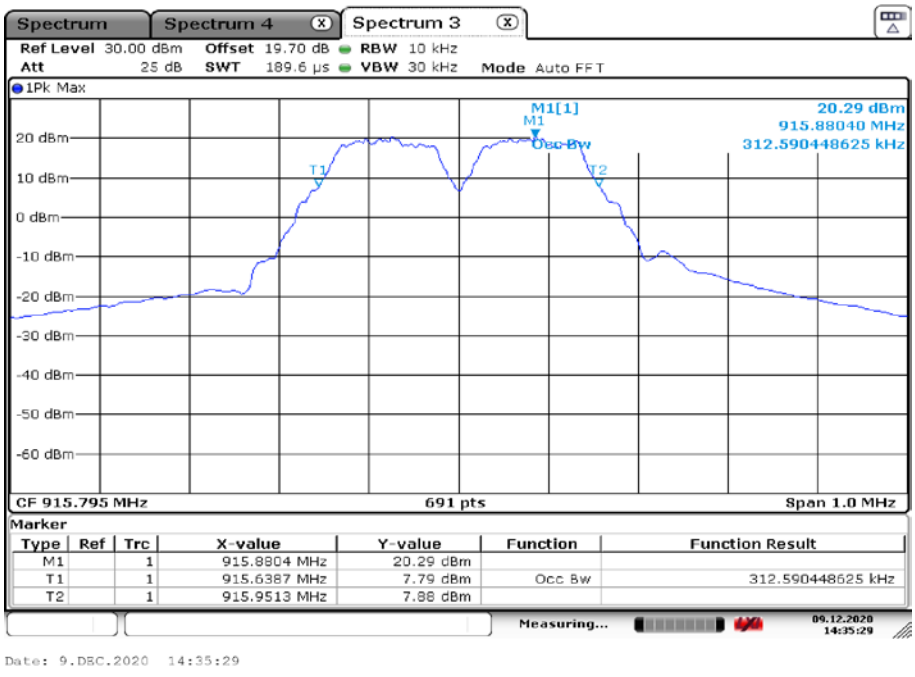
Plot 2: 915.420 MHz, 99%OBW



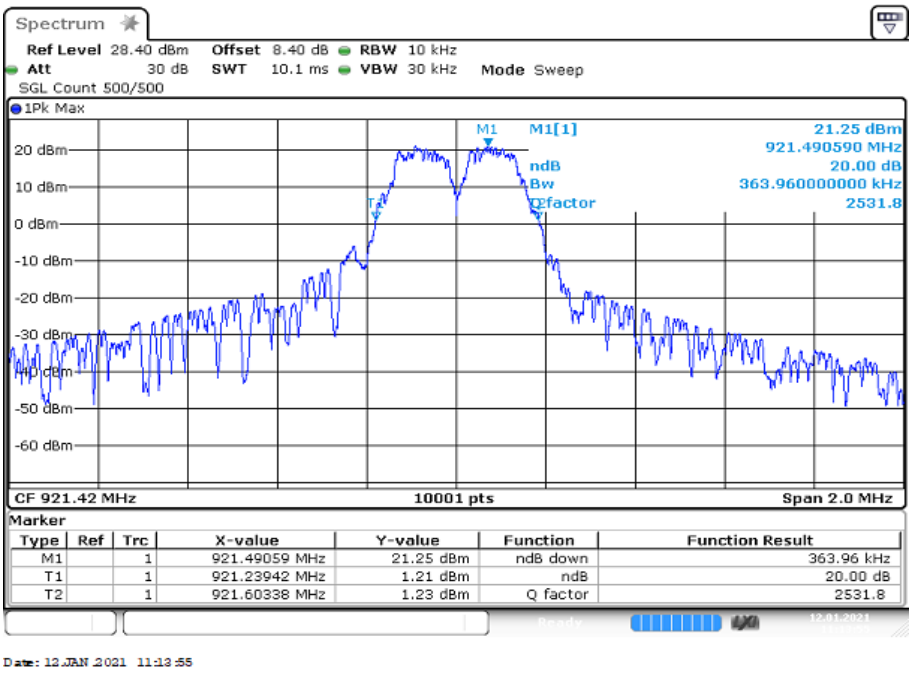
Plot 3: 915.795 MHz, 20 dB-BW



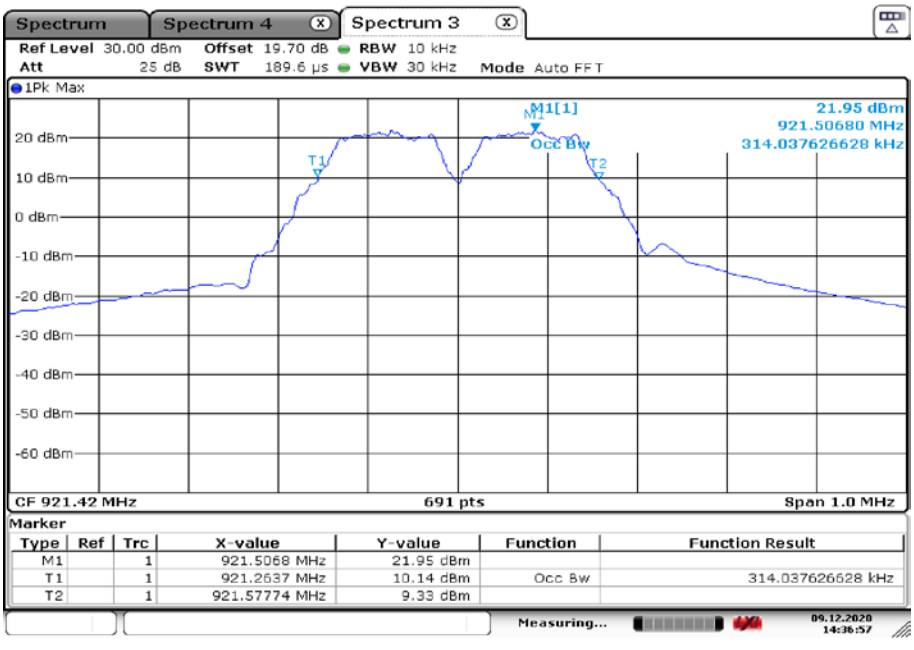
Plot 4: 915.795 MHz, 99%OBW



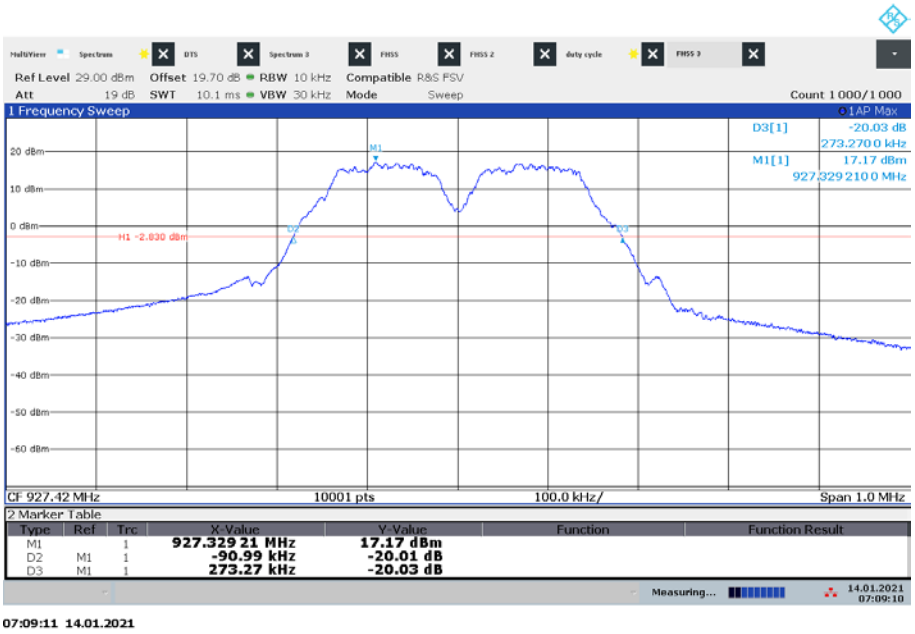
Plot 5: 921.420 MHz, 20 dB-BW



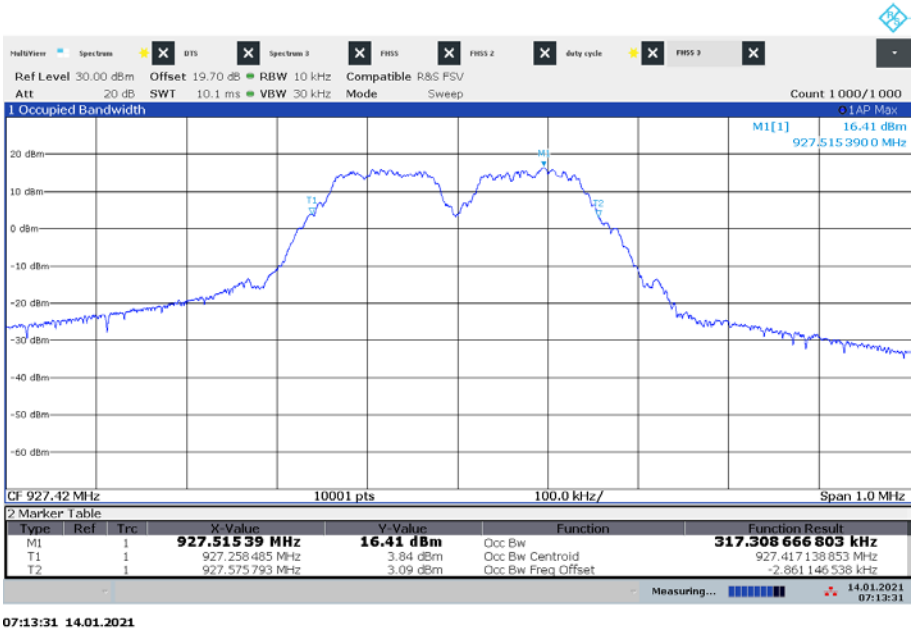
Plot 6: 921.420 MHz, 99%OBW



Plot 7: 927.42 MHz, 20 dB-BW



Plot 8: 927.42 MHz, 99%OBW



12.6 Maximum Output Power

Measurement:

Measurement parameter	
Detector:	Peak
Sweep time:	Auto
Resolution bandwidth:	1 MHz
Video bandwidth:	3 MHz
Span:	5 MHz
Trace-Mode:	Max Hold
Used equipment:	See chapter 7.2 B, 7.3 A
Measurement uncertainty:	See chapter 9

Limits:

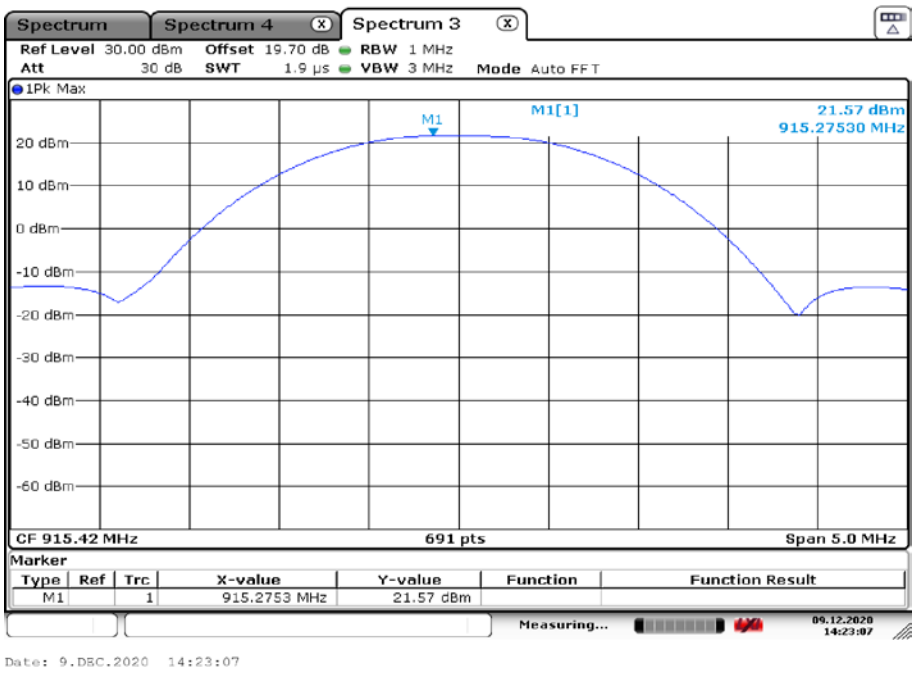
FCC	IC
Maximum Output Power Conducted	
For frequency hopping systems operating in the 902–928 MHz band: 1 watt (30 dBm) for systems employing at least 50 hopping channels; and, 0.25 watts (24 dBm) for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.	
Maximum e.i.r.p.	
-/-	For FHSs operating in the band 902-928 MHz, the maximum e.i.r.p. shall not exceed 4 W if the hopset uses 50 or more hopping channels; the maximum e.i.r.p. shall not exceed 1 W if the hopset uses less than 50 hopping channels.

Result:

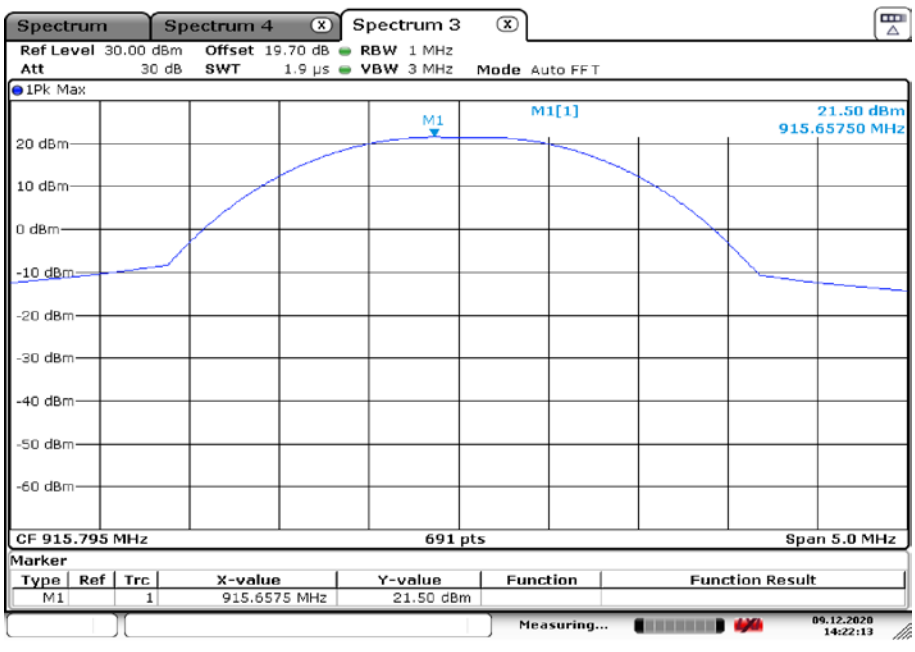
Test Conditions		Maximum Output Power Conducted / dBm			
		915.420 MHz	915.795 MHz	921.420 MHz	927.42 MHz
T_{nom}	V_{nom}	21.57	21.50	23.06	18.29

Plots:

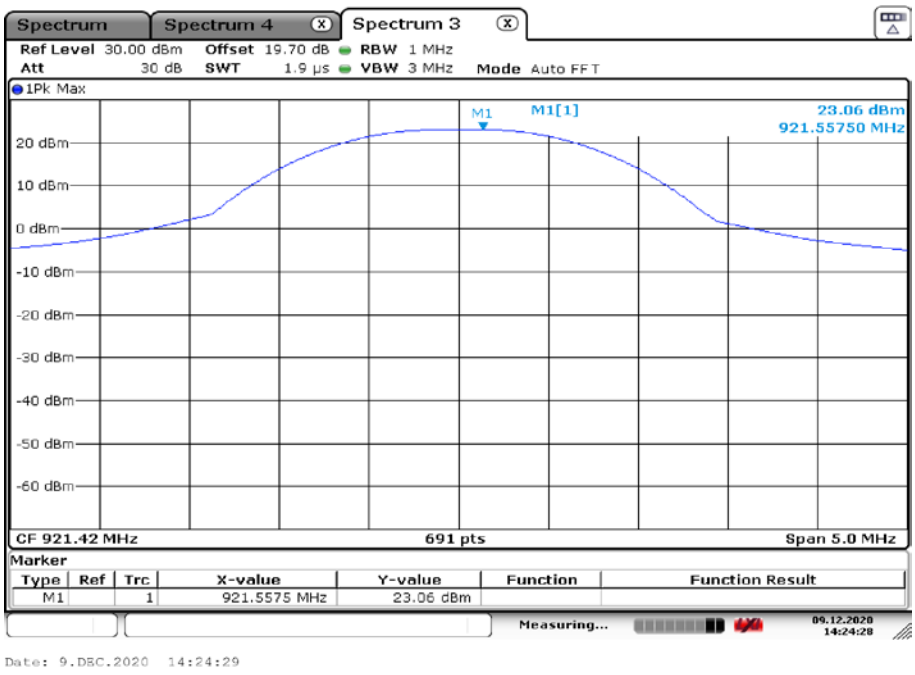
Plot 1: 915.420 MHz



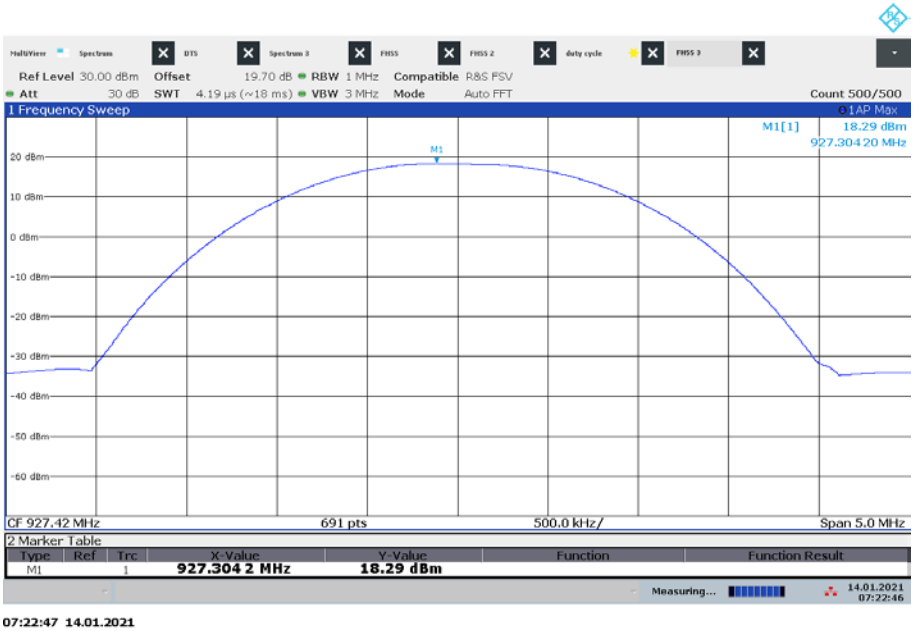
Plot 2: 915.795 MHz



Plot 3: 921.420



Plot 4: 927.42



12.7 Detailed spurious emissions @ the band edge – conducted and radiated

Description:

Measurement of the conducted band edge compliance. EUT is measured at the lower and upper band edge in single channel mode.

Measurement:

Measurement parameters	
Detector	Peak
Sweep time	Auto
Resolution bandwidth	100 kHz
Video bandwidth	300 kHz
Span	Lower Band Edge: 902 MHz Upper Band Edge: 928 MHz
Trace mode	Max hold
Test setup	See sub clause 7.3 A
Measurement uncertainty	See sub clause 9

Limits:

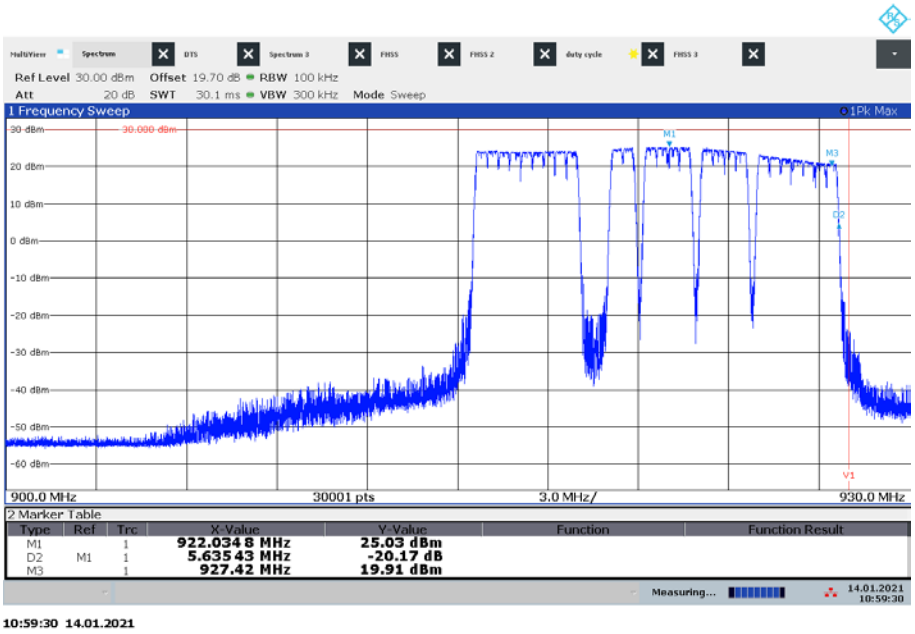
FCC	IC
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains 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.	

Results conducted:

Scenario	Spurious band edge conducted	
Modulation	lowest channel	highest channel
Lower band edge – hopping on	> 20 dB	> 20 dB
Upper band edge – hopping on	> 20 dB	> 20 dB
Lower band edge – hopping off	> 20 dB	> 20 dB
Upper band edge – hopping off	> 20 dB	> 20 dB

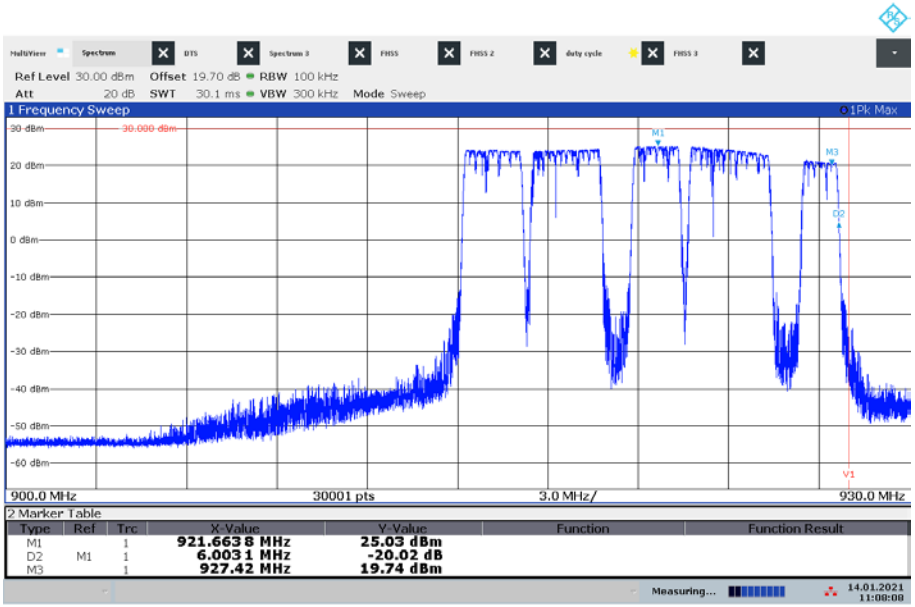
Plots:

Plot 1: 20 dB – hopping on, upper band edge, hopping table H1



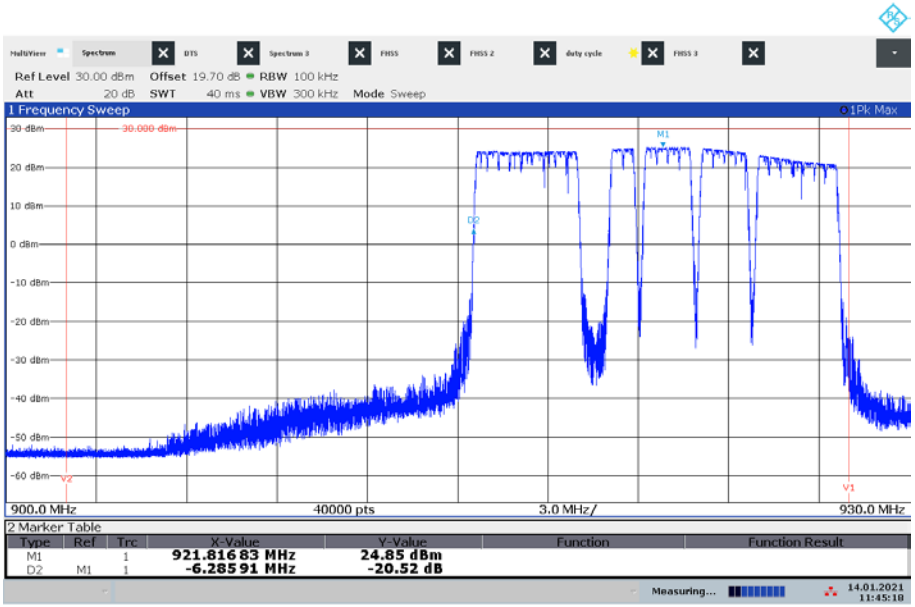
10:59:30 14.01.2021

Plot 2: 20 dB – hopping on, upper band edge, hopping table H2

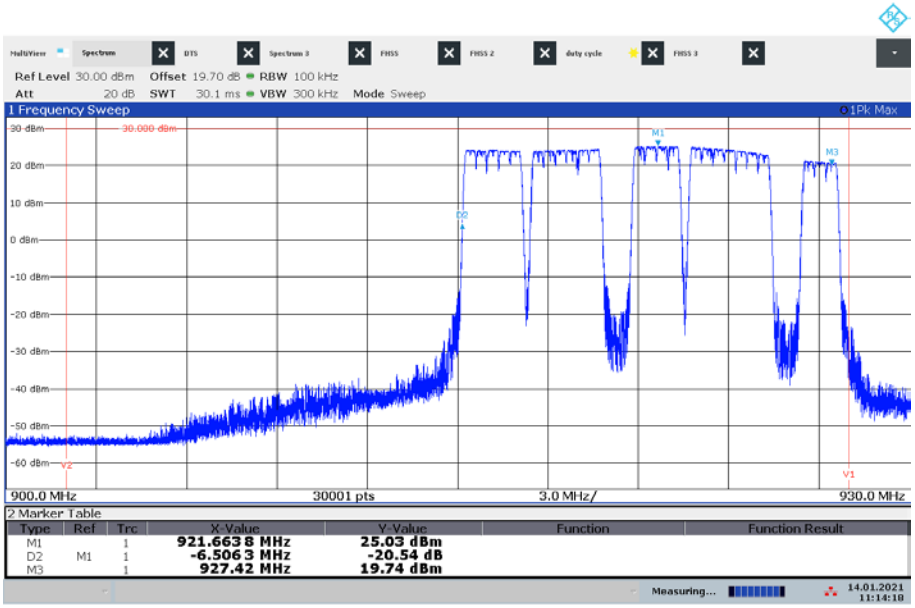


11:08:09 14.01.2021

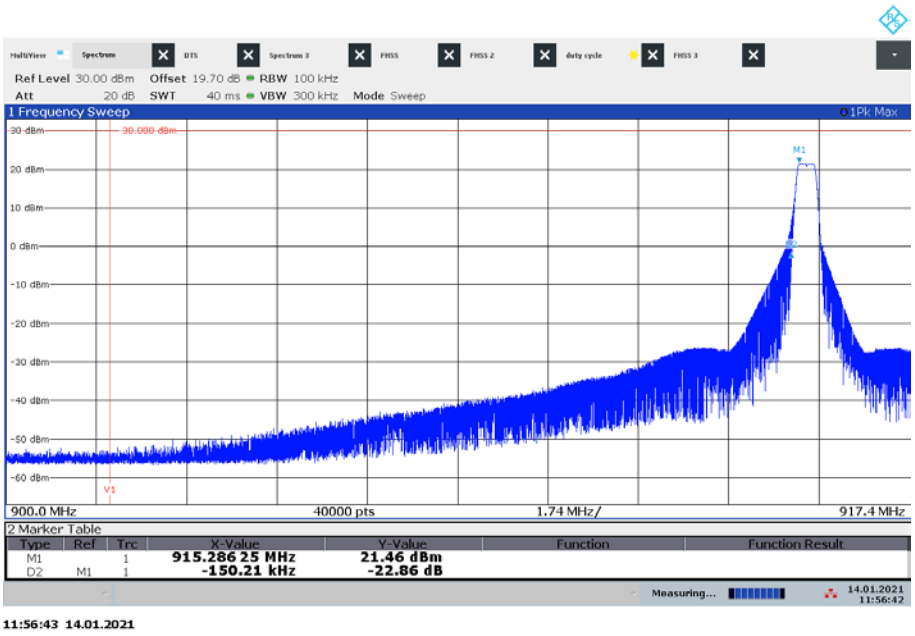
Plot 3: 20 dB – hopping on, lower band edge, hopping table H1



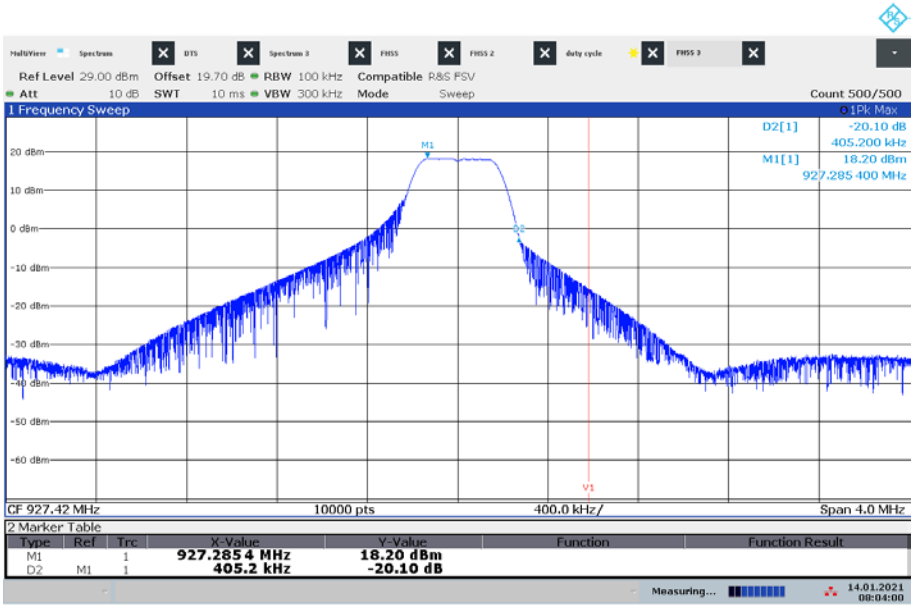
Plot 4: 20 dB – hopping on, lower band edge, hopping table H2



Plot 5: 20 dB – hopping off, lowest channel 915.42



Plot 6: 20 dB – hopping off, highest channel



Results radiated:

No restricted band in the range ± 2 channel bandwidths of the Band-edges of the specified emission band! (608 MHz – 614 MHz and 960 MHz – 1240 MHz).

Section 15.205 Restricted bands of operation.

(a) Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090 - 0.110	16.42 - 16.423	399.9 - 410	4.5 - 5.15
[1]0.495 - 0.505	16.69475 - 16.69525	608 - 614	5.35 - 5.46
2.1735 - 2.1905	16.80425 - 16.80475	960 - 1240	7.25 - 7.75
4.125 - 4.128	25.5 - 25.67	1300 - 1427	8.025 - 8.5
4.17725 - 4.17775	37.5 - 38.25	1435 - 1626.5	9.0 - 9.2
4.20725 - 4.20775	73 - 74.6	1645.5 - 1646.5	9.3 - 9.5
6.215 - 6.218	74.8 - 75.2	1660 - 1710	10.6 - 12.7
6.26775 - 6.26825	108 - 121.94	1718.8 - 1722.2	13.25 - 13.4
6.31175 - 6.31225	123 - 138	2200 - 2300	14.47 - 14.5
8.291 - 8.294	149.9 - 150.05	2310 - 2390	15.35 - 16.2
8.362 - 8.366	156.52475 - 156.52525	2483.5 - 2500	17.7 - 21.4
8.37625 - 8.38675	156.7 - 156.9	2690 - 2900	22.01 - 23.12
8.41425 - 8.41475	162.0125 - 167.17	3260 - 3267	23.6 - 24.0
12.29 - 12.293	167.72 - 173.2	3332 - 3339	31.2 - 31.8
12.51975 - 12.52025	240 - 285	3345.8 - 3358	36.43 - 36.5
12.57675 - 12.57725	322 - 335.4	3600 - 4400	([2])
13.36 - 13.41			

12.8 Spurious Emissions Conducted

Description:

Measurement of the conducted spurious emissions in transmit mode. The EUT is set to single channel mode. The measurement is repeated for low, mid and high channel.

Measurement:

Measurement parameter	
Detector:	Peak
Sweep time:	Auto
Video bandwidth:	F < 1 GHz: 1 MHz F > 1 GHz: 1 MHz
Resolution bandwidth:	F < 1 GHz: 100 kHz F > 1 GHz: 100 kHz
Span:	9 kHz to 12.75 GHz
Trace-Mode:	Max Hold
Used equipment:	See chapter 7.3A
Measurement uncertainty:	See chapter 9

Limits:

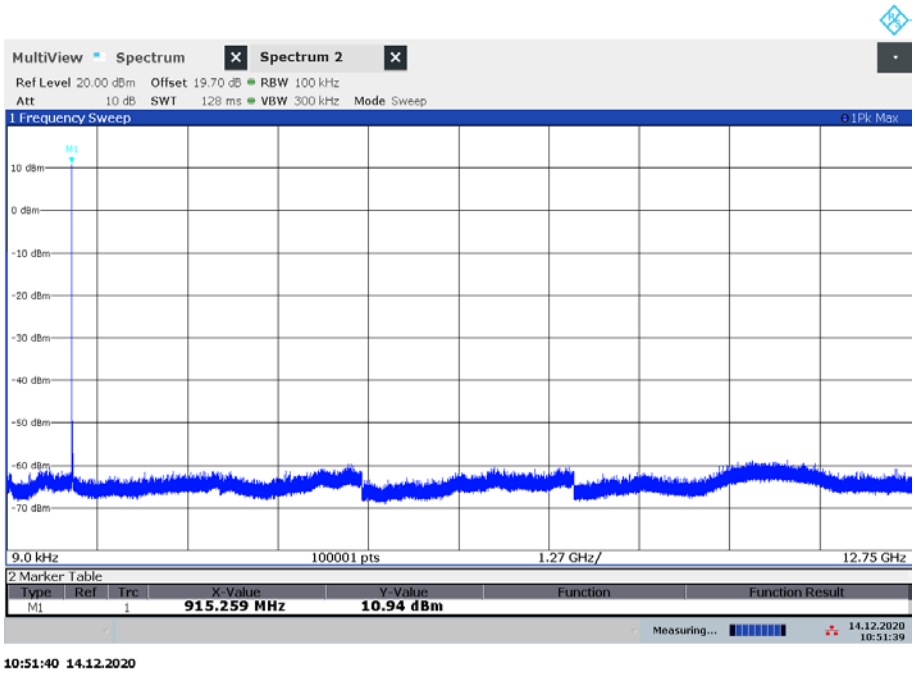
FCC	IC
TX spurious emissions conducted	
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth 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	

Result:

Emission Limitation					
Frequency / MHz		Amplitude of emission / dBm	Limit max. allowed emission power	actual attenuation below frequency of operation / dB	Results
915.420			24 dBm		Operating frequency
			-20 dBc	No emissions detected!	
915.795			24 dBm		Operating frequency
			-20 dBc	No emissions detected!	
921.420			24 dBm		Operating frequency
			-20 dBc	No emissions detected!	
927.420			24 dBm		Operating frequency
1846.81			-20 dBc	70.76	

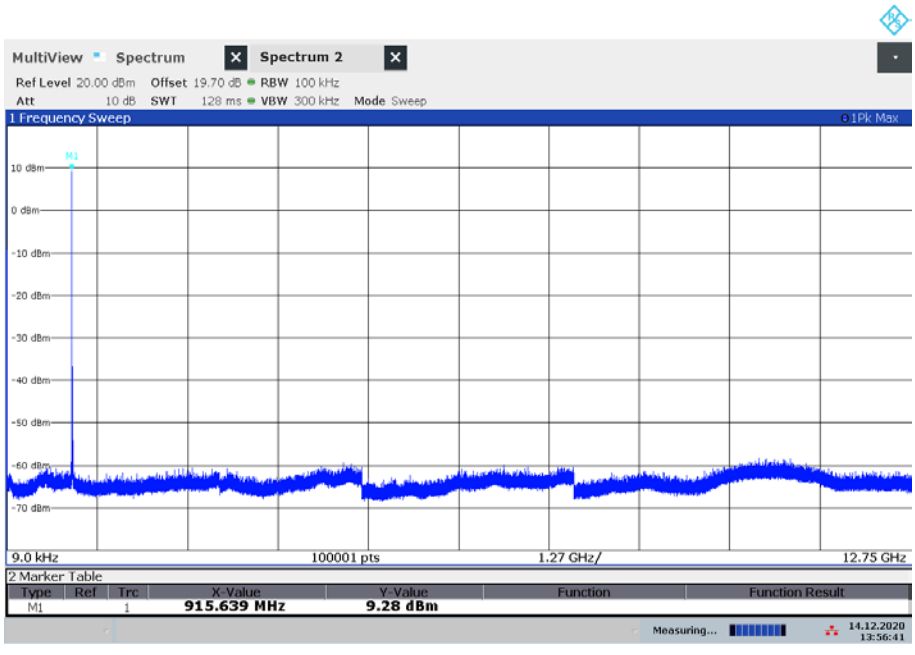
Plots:

Plot 1: 915.420 MHz, 9 kHz – 12.75 GHz



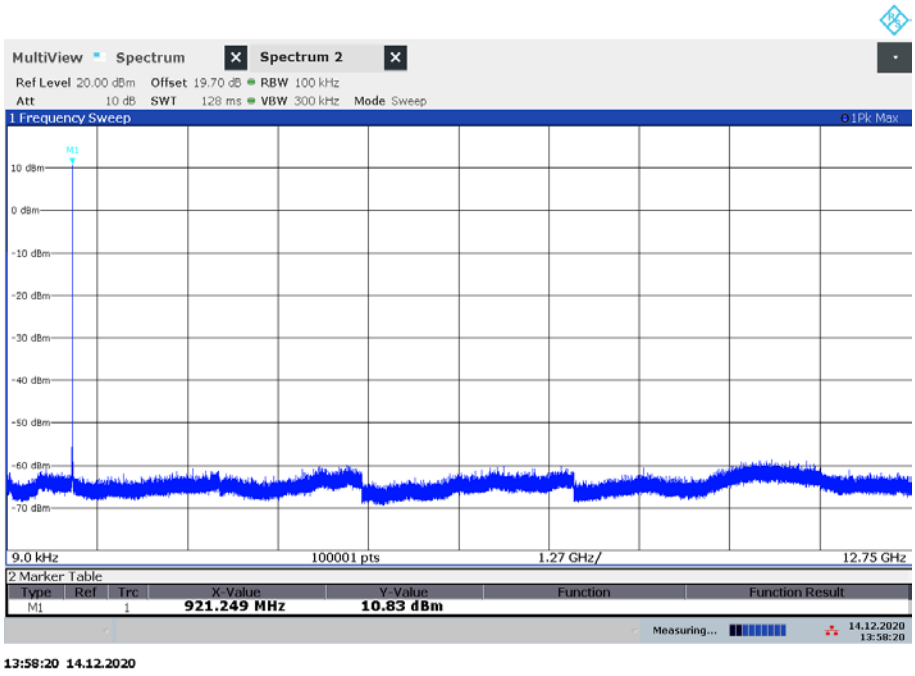
10:51:40 14.12.2020

Plot 2: 915.795 MHz, 9 kHz – 12.75 GHz



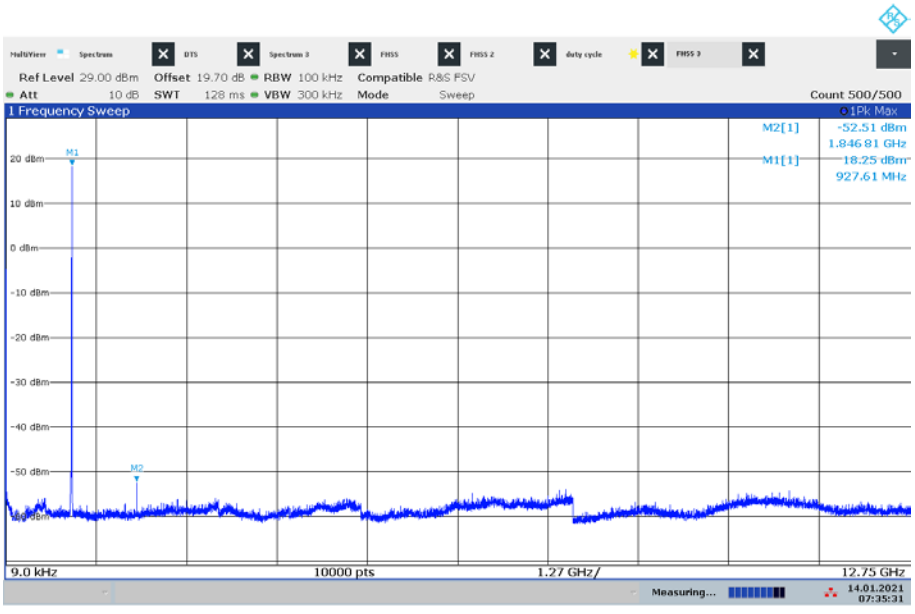
13:56:42 14.12.2020

Plot 3: 921.420 MHz, 9 kHz – 12.75 GHz



13:58:20 14.12.2020

Plot 4: 927.420 MHz, 9 kHz – 12.75 GHz



07:35:32 14.01.2021

12.9 Spurious Emissions Radiated < 30 MHz

Description:

Measurement of the radiated spurious emissions in transmit mode below 30 MHz. The EUT is set to single channel mode and the transmit channels are 00; 39 and 78. The measurement is performed in the mode with the highest output power. The limits are recalculated to a measurement distance of 3 m according the ANSI C63.10.

Measurement:

Measurement parameter	
Detector:	Peak / Quasi Peak
Sweep time:	Auto
Video bandwidth:	F < 150 kHz: 200 Hz F > 150 kHz: 9 kHz
Resolution bandwidth:	F < 150 kHz: 1 kHz F > 150 kHz: 100 kHz
Span:	9 kHz to 30 MHz
Trace-Mode:	Max Hold
Used equipment:	See chapter 7.2 A
Measurement uncertainty:	See chapter 9

Limits:

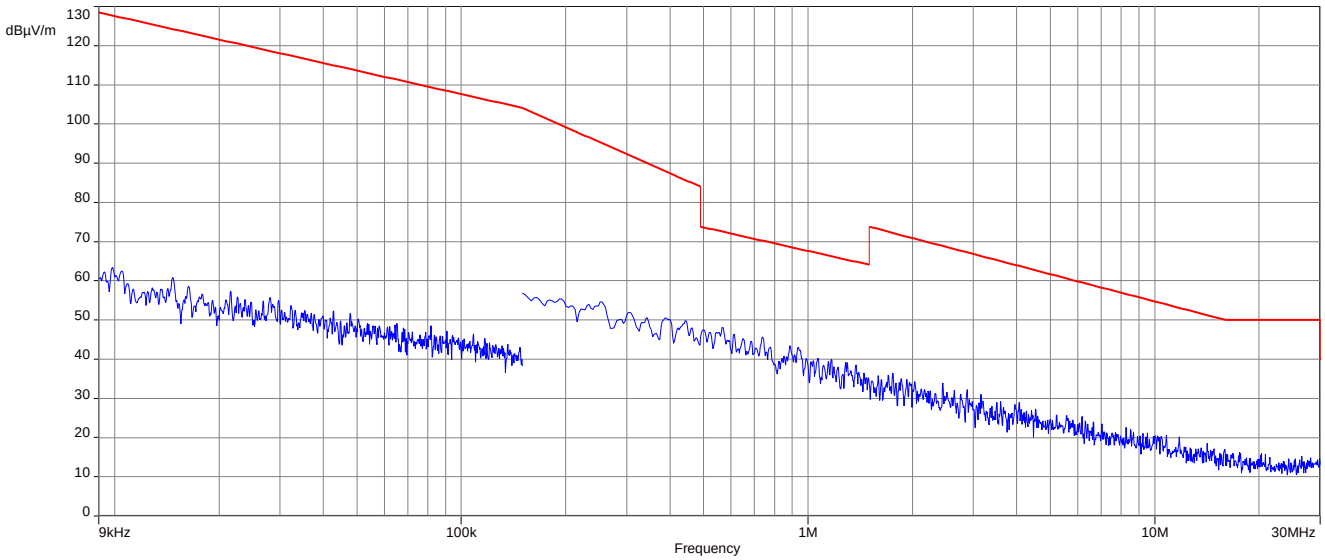
FCC		IC
TX spurious emissions radiated < 30 MHz		
Frequency / MHz	Field strength / (dBµV/m)	Measurement distance
0.009 – 0.490	2400/F(kHz)	300
0.490 – 1.705	24000/F(kHz)	30
1.705 – 30.0	30	30

Result:

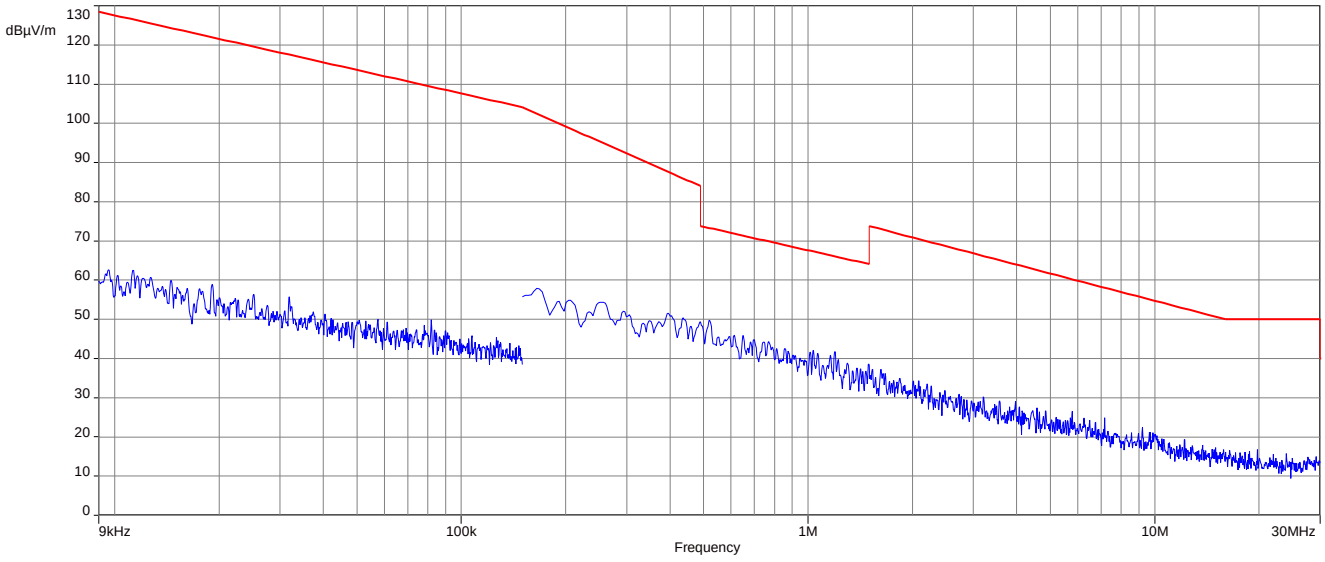
Spurious emission level			
Channel Frequency	**Spurious Frequency**	**Detector**	**Level**
915.420 MHz	No Peaks detected!		
915.795 MHz	No Peaks detected!		
921.420 MHz	No Peaks detected!		
927.42 MHz	No Peaks detected!		

Plots:

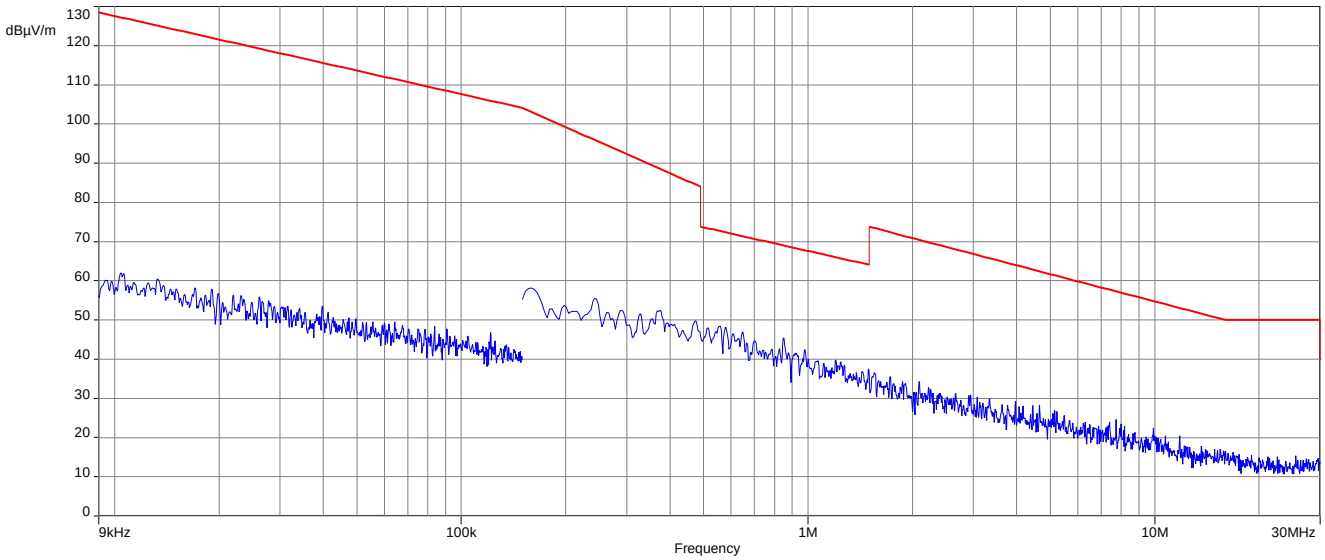
Plot 1: TX-Mode 915.420 MHz



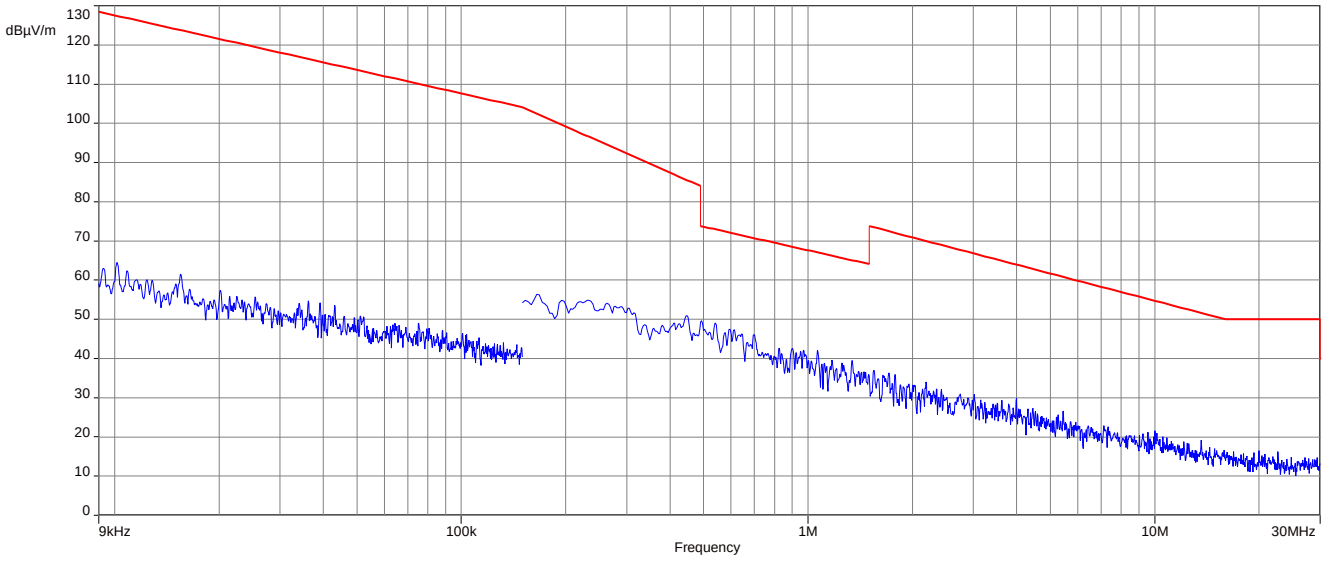
Plot 2: TX-Mode 915.795 MHz



Plot 3: TX-Mode 921.420 MHz



Plot 4: TX-Mode 927.42 MHz



12.10 Spurious Emissions Radiated > 30 MHz

12.10.1 Spurious emissions radiated 30 MHz to 1 GHz

Description:

Measurement of the radiated spurious emissions in transmit mode. The measurement is performed at channel low, mid and high.

Measurement:

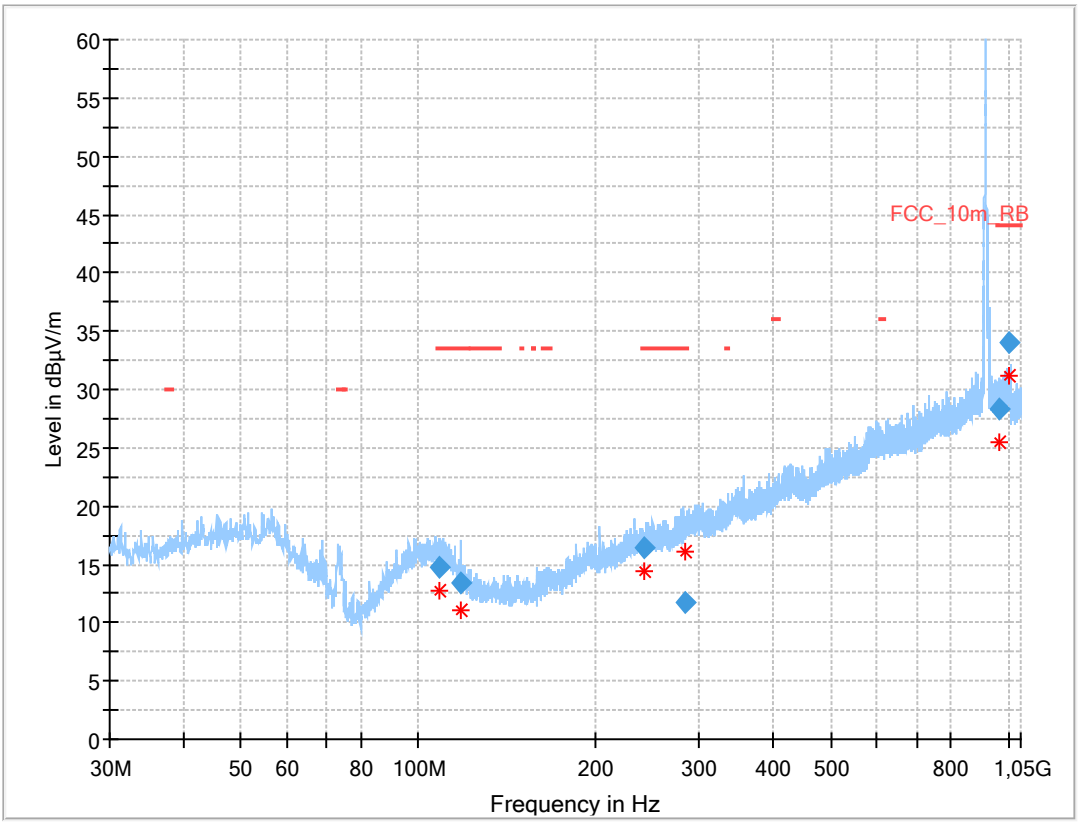
Measurement parameters	
Detector	Peak / Quasi Peak
Sweep time	Auto
Resolution bandwidth	3 x VBW
Video bandwidth	120 kHz
Span	30 MHz to 1 GHz
Trace mode	Max hold
Measured modulation	FHSS single channel mode
Test setup	See sub clause 7.1 A
Measurement uncertainty	See sub clause 9

Limits:

FCC	IC	
Band-edge Compliance of conducted and radiated emissions		
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, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §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
Above 960	54.0	3

Result: See result table below the plots.

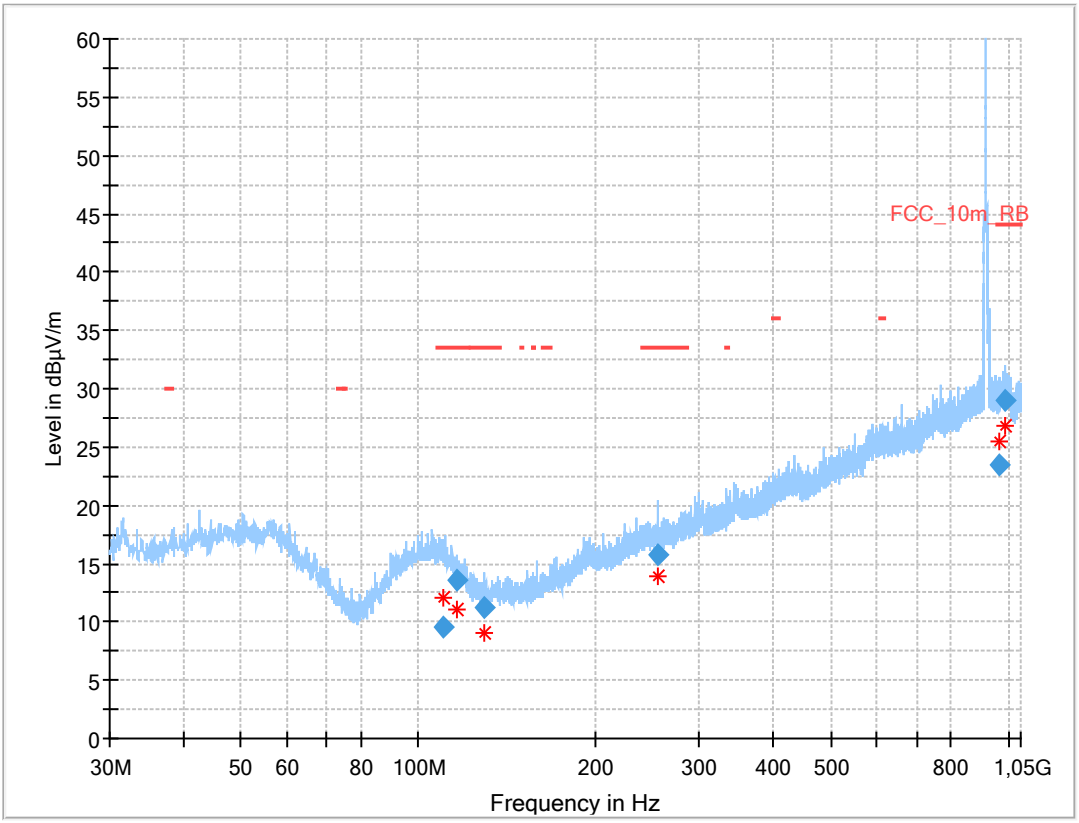
Plot 1: 30 MHz – 1 GHz, horizontal & vertical polarisation 915.420 MHz



Final results:

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
108.968	14.67	33.5	18.8	1000	120.0	114.0	V	292	12
118.383	13.34	33.5	20.2	1000	120.0	170.0	H	-22	11
242.393	16.43	33.5	17.1	1000	120.0	170.0	H	157	13
282.589	11.68	33.5	21.8	1000	120.0	170.0	V	247	14
964.785	28.35	44.0	15.7	1000	120.0	170.0	H	67	24
1006.829	33.98	44.0	10.0	1000	120.0	170.0	V	157	24

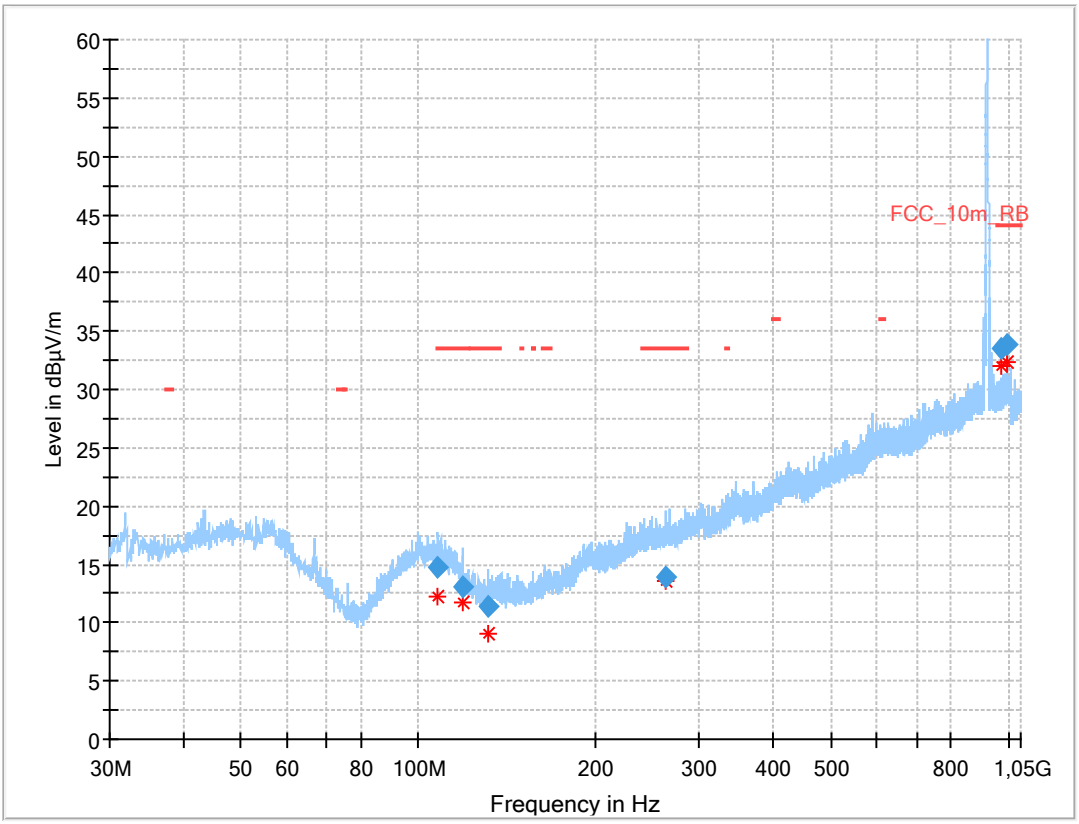
Plot 2: 30 MHz – 1 GHz, horizontal & vertical polarisation 915.795 MHz



Final results:

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
110.496	9.60	33.5	23.9	1000	120.0	170.0	H	292	12
116.646	13.53	33.5	20.0	1000	120.0	105.0	V	-22	11
129.730	11.27	33.5	22.2	1000	120.0	157.0	H	67	9
254.129	15.83	33.5	17.7	1000	120.0	137.0	V	67	13
966.981	23.48	44.0	20.5	1000	120.0	101.0	H	157	24
986.166	29.01	44.0	15.0	1000	120.0	153.0	H	22	24

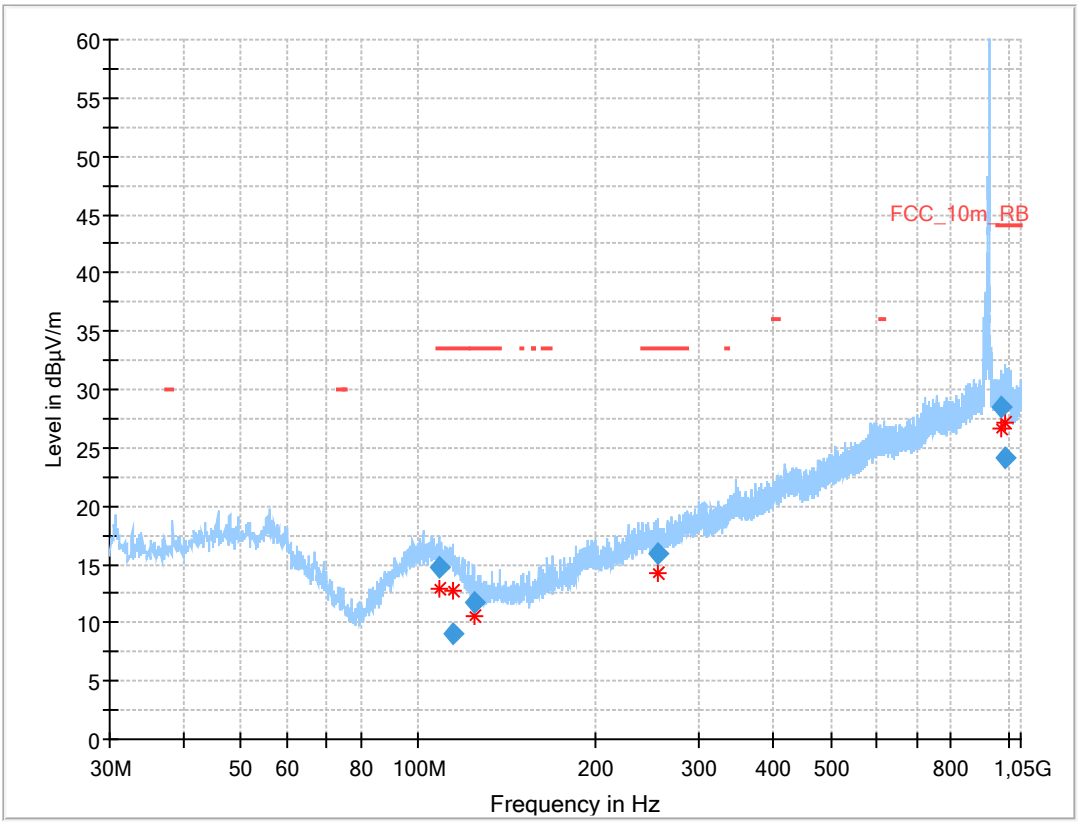
Plot 3: 30 MHz – 1 GHz, horizontal & vertical polarisation 921.420 MHz



Final results:

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
108.155	14.76	33.5	18.7	1000	120.0	107.0	H	175	12
118.678	13.14	33.5	20.4	1000	120.0	105.0	V	67	11
131.094	11.48	33.5	22.0	1000	120.0	170.0	V	67	9
263.164	13.85	33.5	19.7	1000	120.0	170.0	V	-22	13
973.848	33.47	44.0	10.5	1000	120.0	170.0	V	67	24
998.836	33.93	44.0	10.1	1000	120.0	170.0	V	22	24

Plot 4: 30 MHz – 1 GHz, horizontal & vertical polarisation 927.42 MHz



Final results:

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
108.811	14.75	33.5	18.8	1000	120.0	170.0	V	202	12
114.607	9.07	33.5	24.4	1000	120.0	162.0	V	157	12
124.271	11.66	33.5	21.8	1000	120.0	110.0	H	68	9
254.606	15.86	33.5	17.6	1000	120.0	170.0	H	157	13
970.407	28.48	44.0	15.5	1000	120.0	170.0	V	-22	24
989.482	24.08	44.0	19.9	1000	120.0	170.0	H	-22	24

12.10.2 Spurious emissions radiated above 1 GHz

Description:

Measurement of the radiated spurious emissions in transmit mode. The measurement is performed in the mode with the highest output power.

Measurement:

Measurement parameters	
Detector	Peak / RMS
Sweep time	Auto
Resolution bandwidth	1 MHz
Video bandwidth	3 x RBW
Span	1 GHz to 12.75 GHz
Trace mode	Max hold
Measured modulation	FHSS single channel mode
Test setup	See sub clause 7.2 B
Measurement uncertainty	See sub clause 9

The modulation with the highest output power was used to perform the transmitter spurious emissions. If spurious were detected a re-measurement was performed on the detected frequency with each modulation.

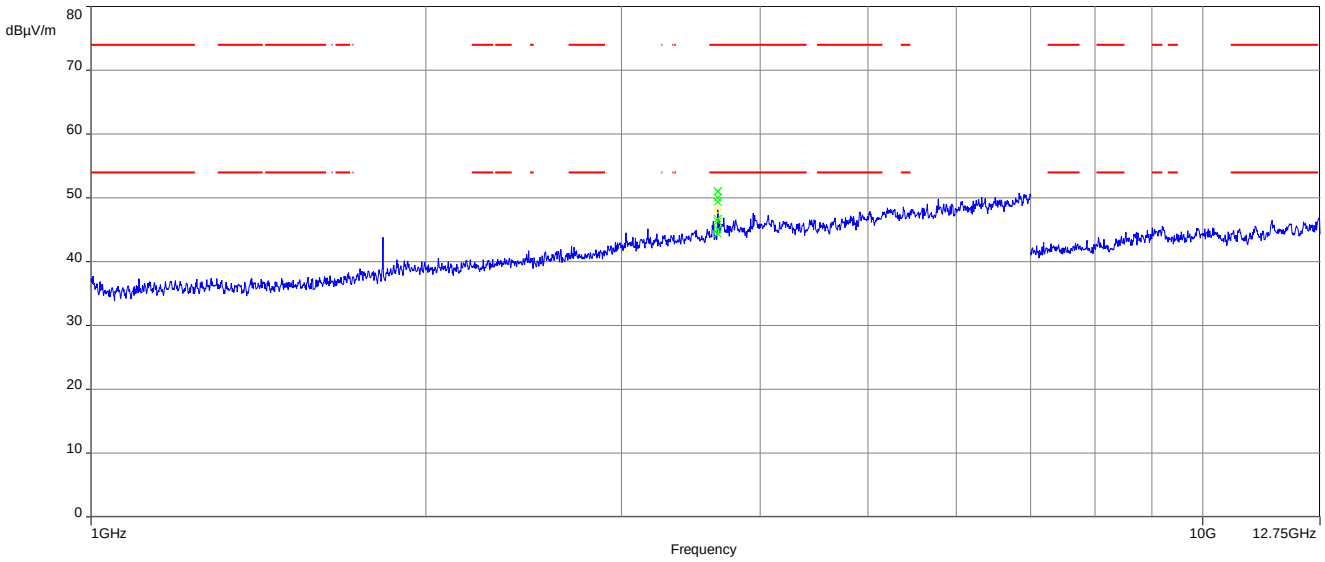
Limits:

FCC		IC
TX spurious emissions radiated		
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).		
§15.209		
Frequency / MHz	Field strength / (dBµV/m)	Measurement distance / m
Above 960	54.0	3

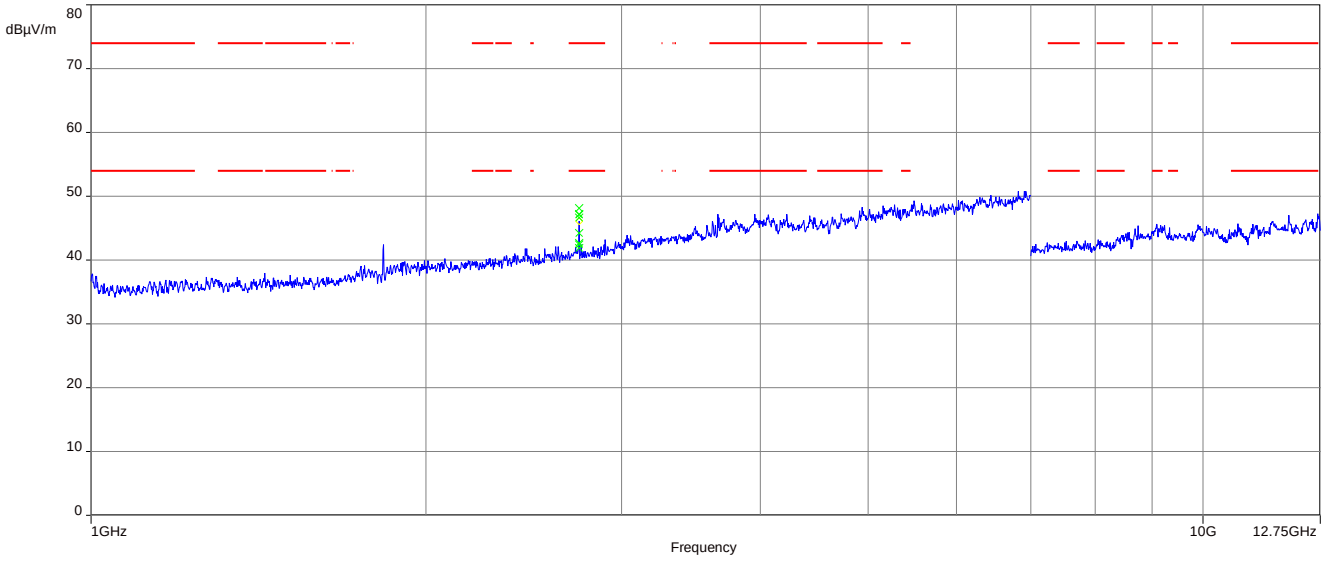
Result:

TX spurious emissions radiated			
Channel Frequency	**Spurious Frequency**	**Detector**	**Level**
915.420 MHz	3661.6 MHz	Peak	51.05 dBµV/m
	-/-	-/-	-/-
915.795 MHz	2747.8 MHz	Peak	48.13 dBµV/m
	-/-	-/-	-/-
921.420 MHz	3685.6 MHz	Peak	52.19 dBµV/m
	-/-	-/-	-/-
927.420 MHz	3710.8 MHz	Peak	51.86 dBµV/m
	-/-	-/-	-/-

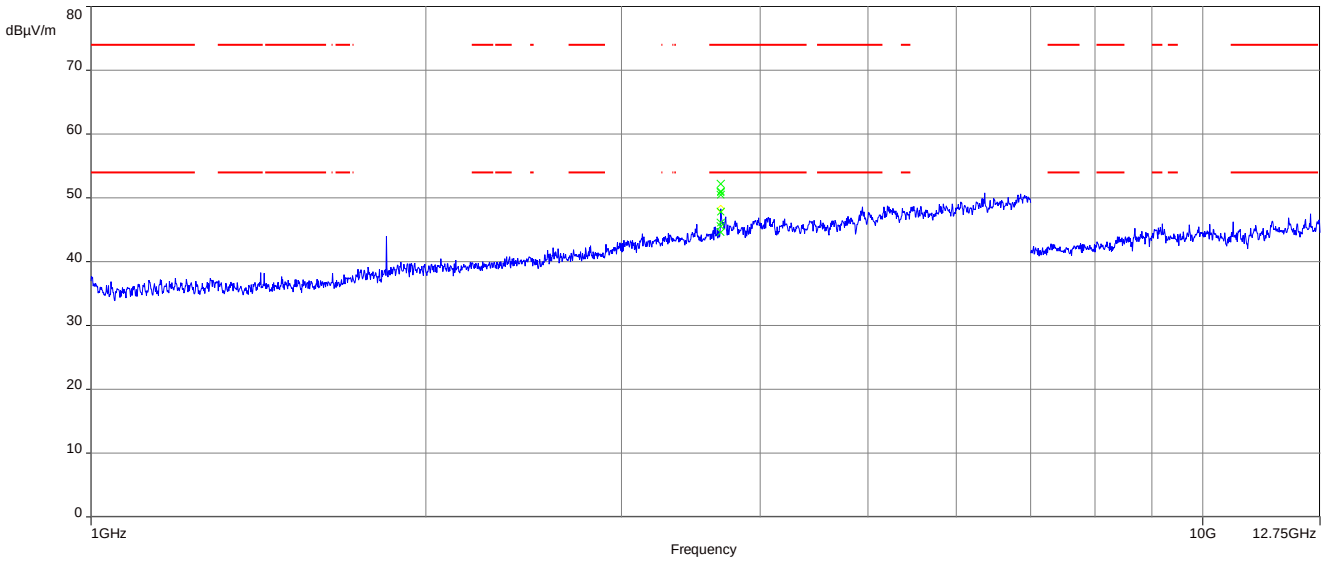
Plot 1: 1 GHz – 12.75 GHz, horizontal & vertical polarisation 915.420 MHz



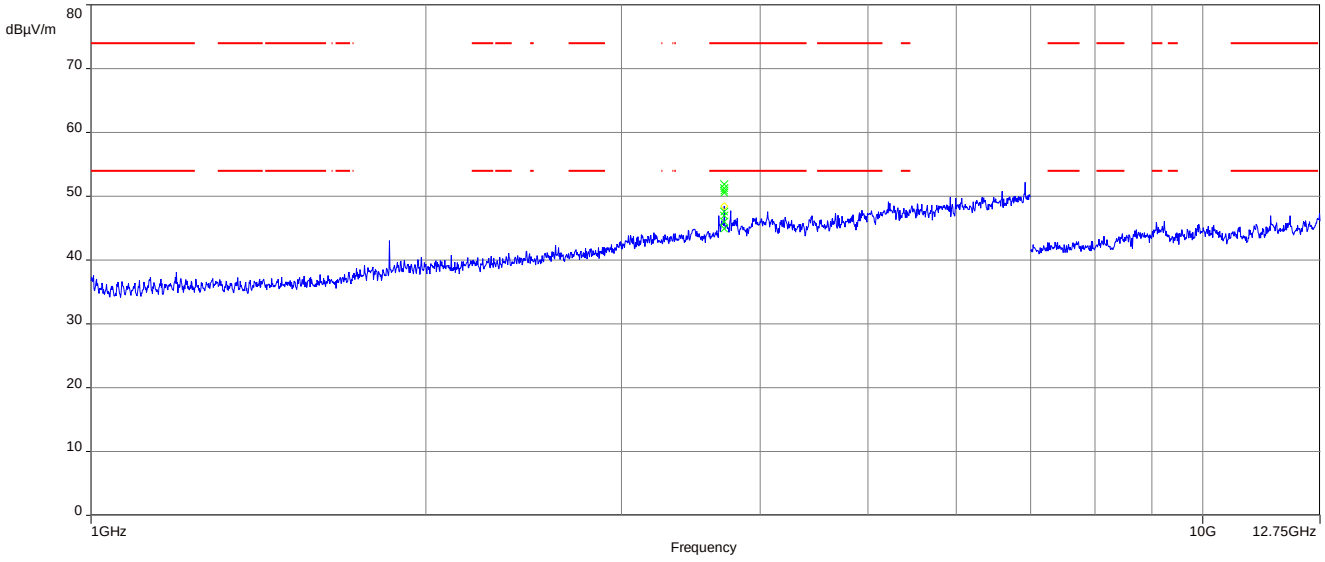
Plot 2: 1 GHz – 12.75 GHz, horizontal & vertical polarisation 915.795 MHz



Plot 3: 1 GHz – 12.75 GHz, horizontal & vertical polarisation 921.420 MHz



Plot 4: 1 GHz – 12.75 GHz, horizontal & vertical polarisation 927.42 MHz



13 Measurement results Part 2 DTS

13.1 Maximum output power

Measurement:

Measurement parameter	
Detector:	Peak
Sweep time:	Auto
Resolution bandwidth:	1 MHz
Video bandwidth:	3 MHz
Span:	5 MHz
Trace-Mode:	Max Hold
Measurement method	According to ANSI C63.10-2013 11.9.2.2.2 Method AVGSA-1
Used equipment:	See chapter 7.3 A
Measurement uncertainty:	See chapter 9

Limits:

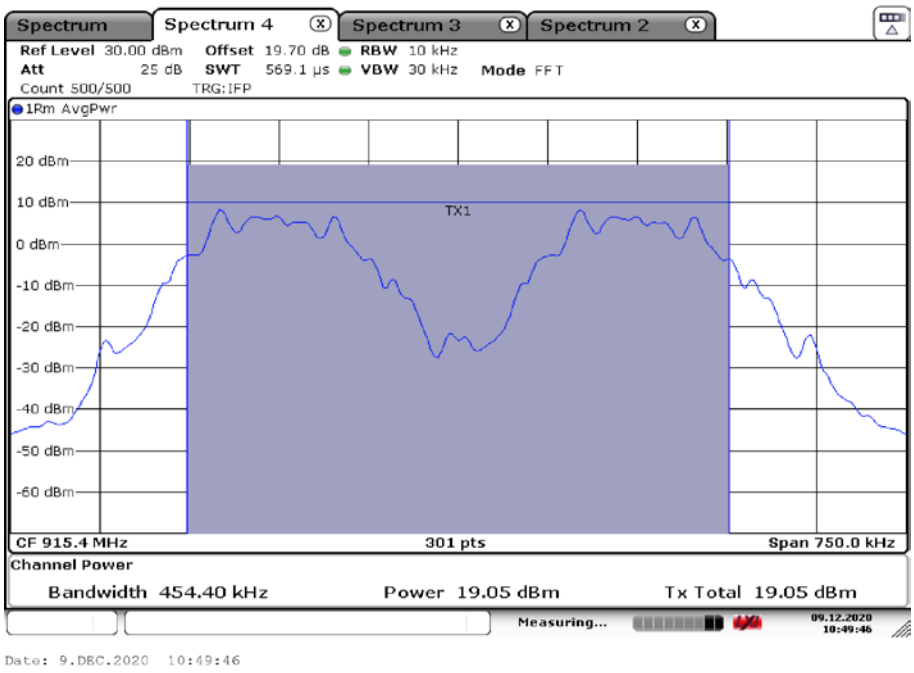
FCC	IC
1 watt (30 dBm) Maximum Output Power Conducted	

Result:

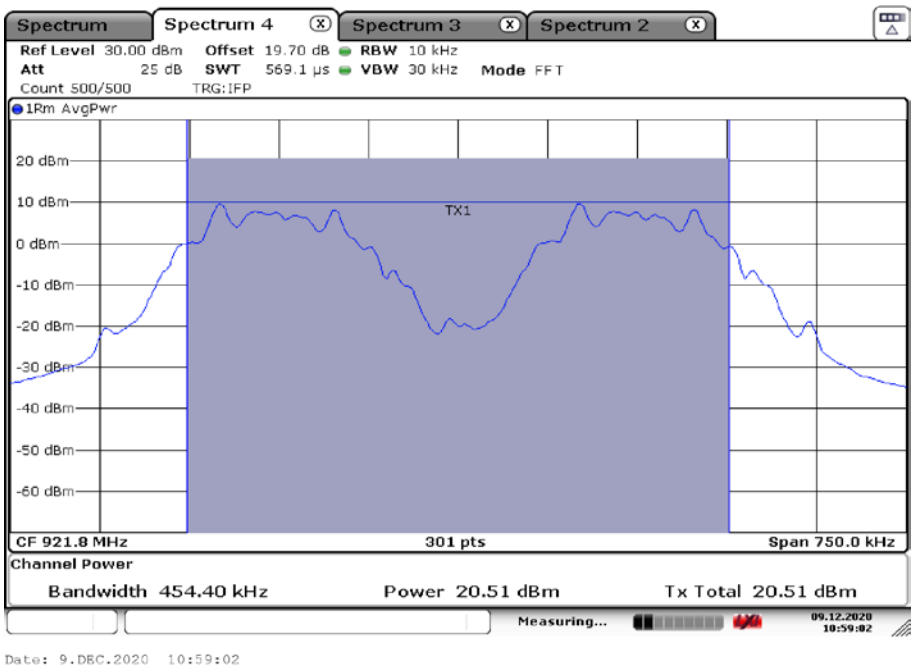
Test Conditions		Maximum Output Power Conducted / dBm		
		915.4 MHz	921.8 MHz	927.4 MHz
T_{nom}	V_{nom}	19.05	20.51	15.97

Plots:

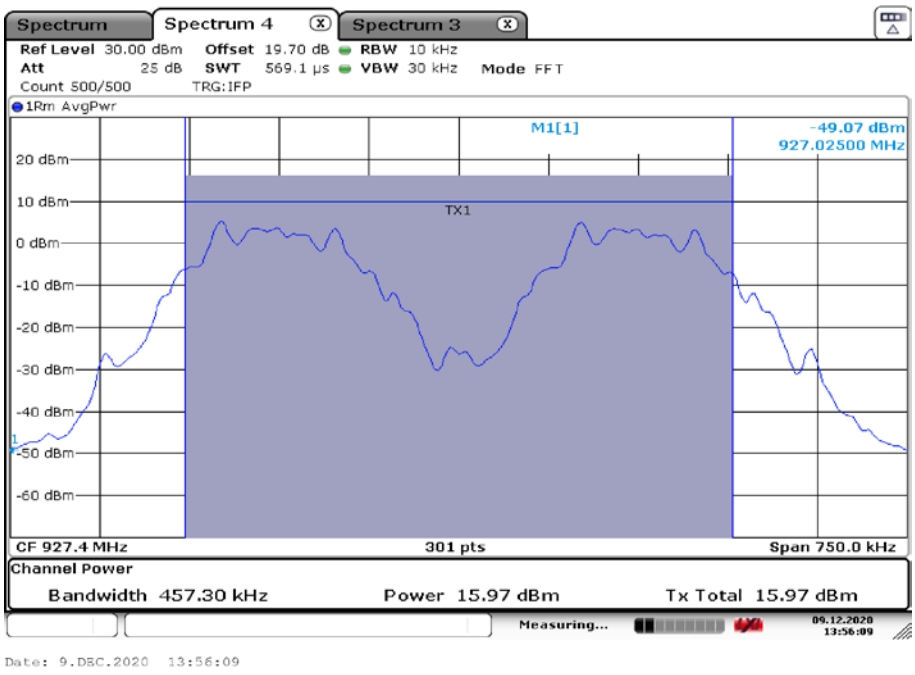
Plot 1: Low Channel



Plot 2: Middle Channel



Plot 3: High Channel



13.2 Power spectral density

Description:

Measurement of the power spectral density of a digital modulated system. The measurement is repeated at the lowest, middle and highest channel.

Measurement:

Measurement parameter	
Detector:	RMS
Sweep time:	auto
Video bandwidth:	3 kHz
Resolution bandwidth:	10 kHz
Span:	750 kHz
Trace-Mode:	average
Measurement method	According to ANSI C63.10-2013 11.10.3 Method AVGPSD-1
Test setup	See sub clause 7.3 A
Measurement uncertainty	See sub clause 9

Limits:

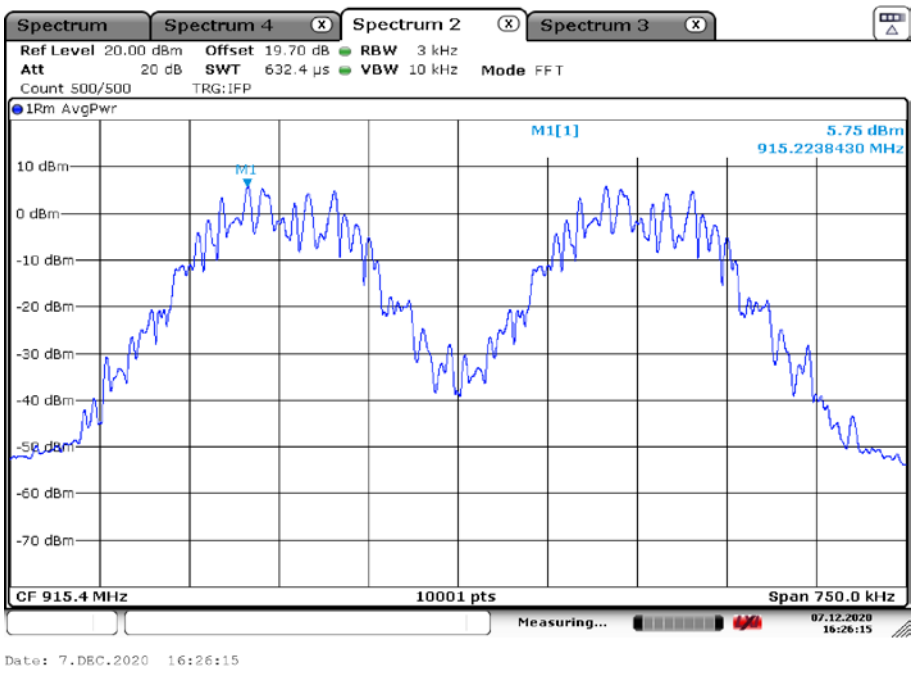
FCC	IC
Power Spectral Density	
The transmitter power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission or over 1.0 second if the transmission exceeds 1.0-second duration.	

Results:

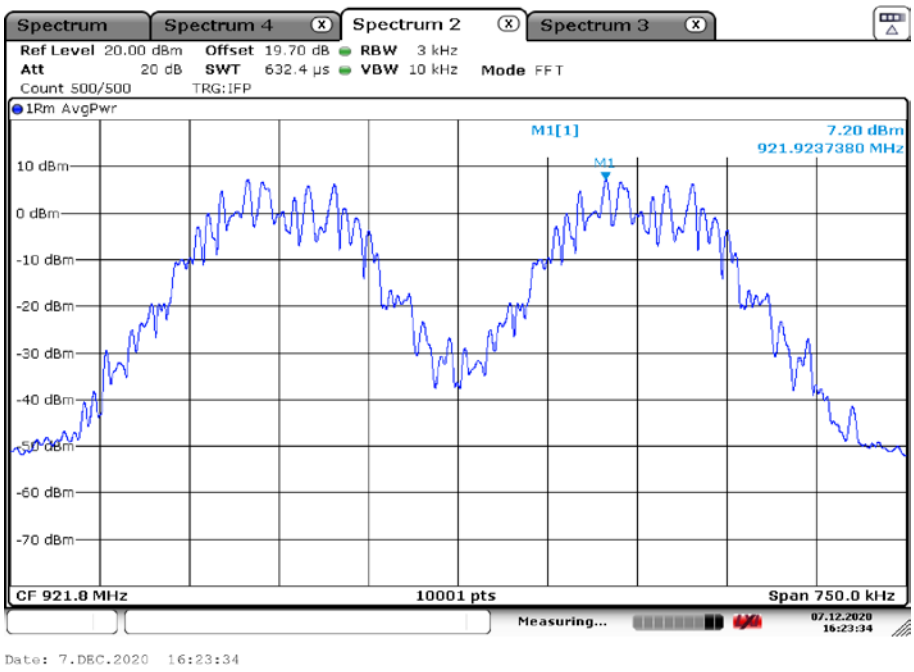
Modulation		Power Spectral density / (dBm/3kHz)		
Channel		915.4 MHz	921.8 MHz	927.4 MHz
T_{nom}	V_{nom}	5.75	7.20	2.57

Plots:

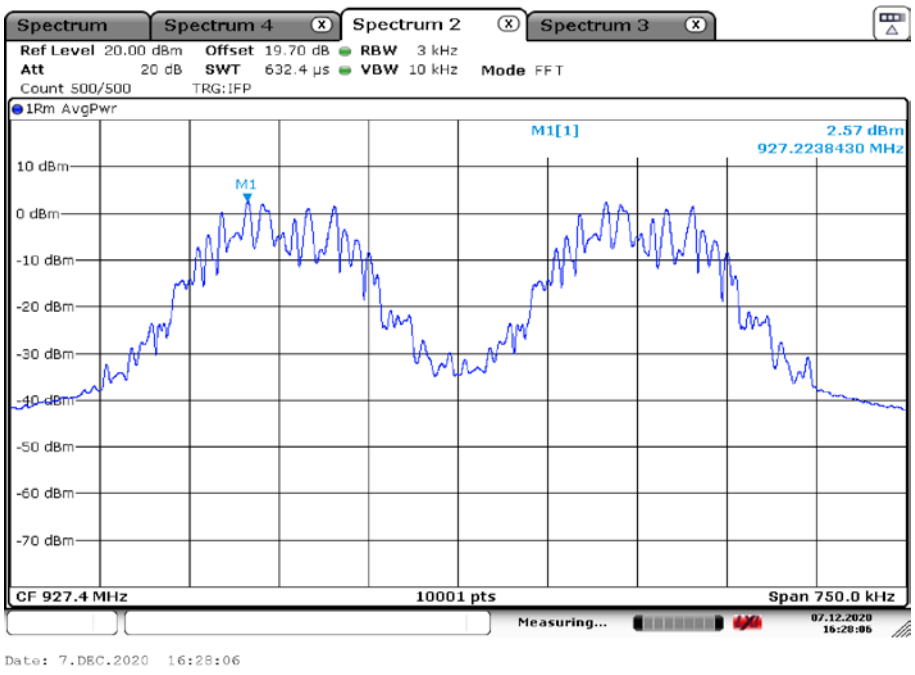
Plot 1: Low Channel



Plot 2: Middle Channel



Plot 3: High Channel



13.3 Spectrum bandwidth – 6 dB bandwidth and 99% bandwidth

Description:

Measurement of the 6 dB bandwidth of the modulated signal.

Measurement:

Measurement parameter	
Detector:	Peak
Sweep time:	Auto
Resolution bandwidth:	99% OBW: 1% - 5% 0f the OBW 6 dB BW: 100 kHz
Video bandwidth:	≥ 3 x RBW
Span:	See plots
Trace-Mode:	Max Hold
Measurement method	According to ANSI C63.10-2013 11.8 DTS bandwidth
Test setup	See sub clause 7.3 A
Measurement uncertainty	See sub clause 9

Limits:

FCC	IC
Spectrum Bandwidth – 6 dB Bandwidth	
The minimum 6 dB bandwidth shall be at least 500 kHz.	

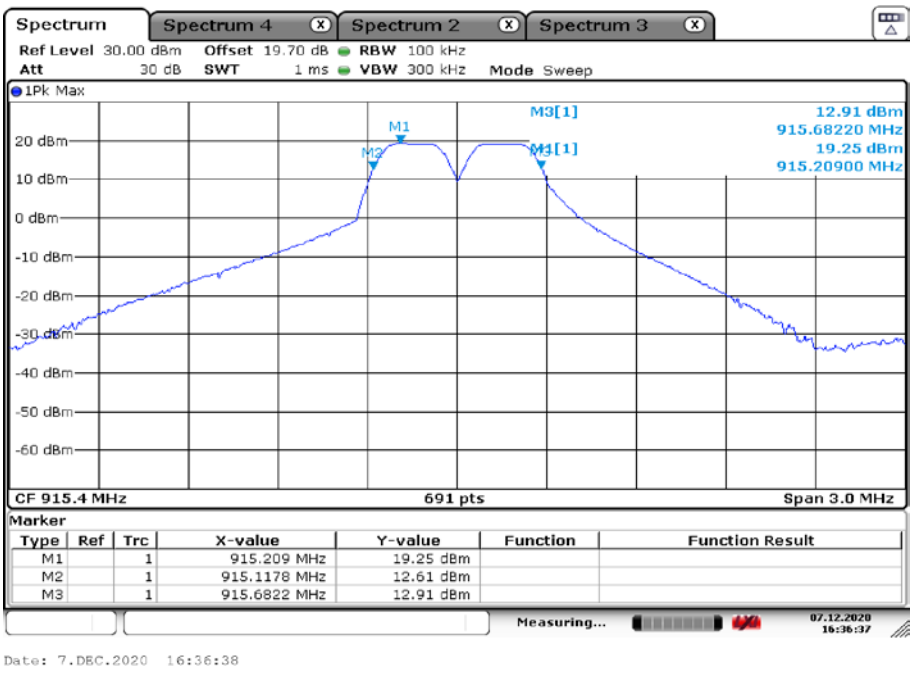
Results:

Test Conditions		6 dB Bandwidth / kHz		
		915.4 MHz	921.8 MHz	927.4 MHz
T_{nom}	V_{nom}	564.4	564.2	564.4

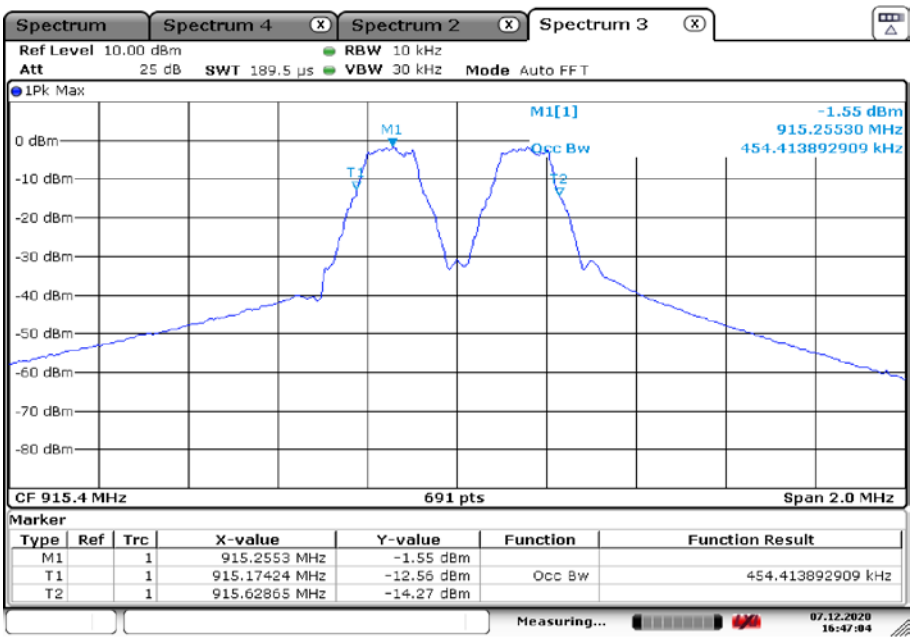
Test Conditions		99% Bandwidth / kHz		
		915.4 MHz	921.8 MHz	927.4 MHz
T_{nom}	V_{nom}	454.4	454.4	457.3

Plots:

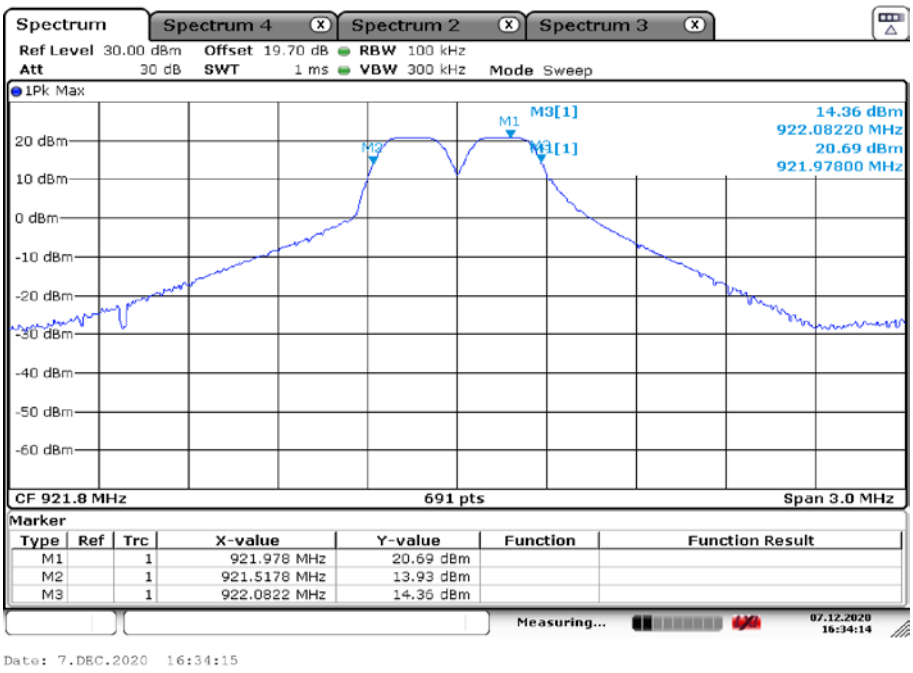
Plot 1: Low Channel, 6 dB-BW



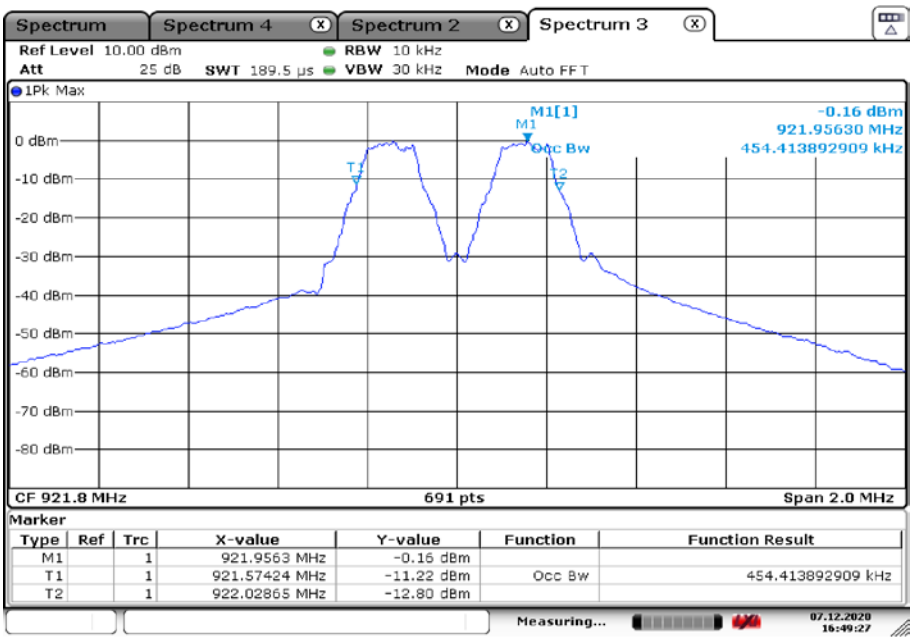
Plot 2: Low Channel, 99%OBW



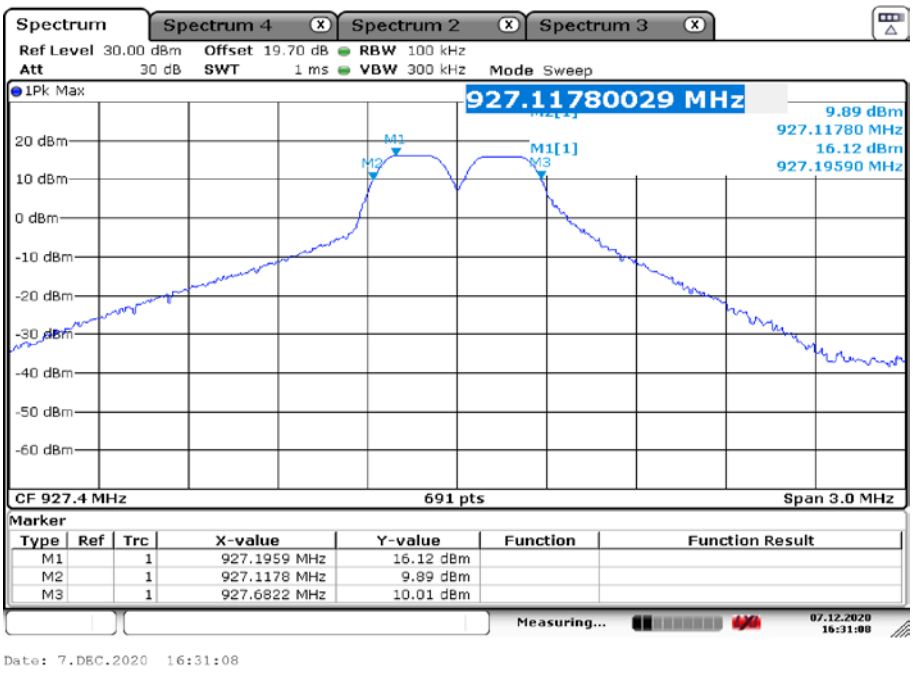
Plot 3: Middle Channel, 6 dB-BW



Plot 4: Middle Channel, 99%OBW

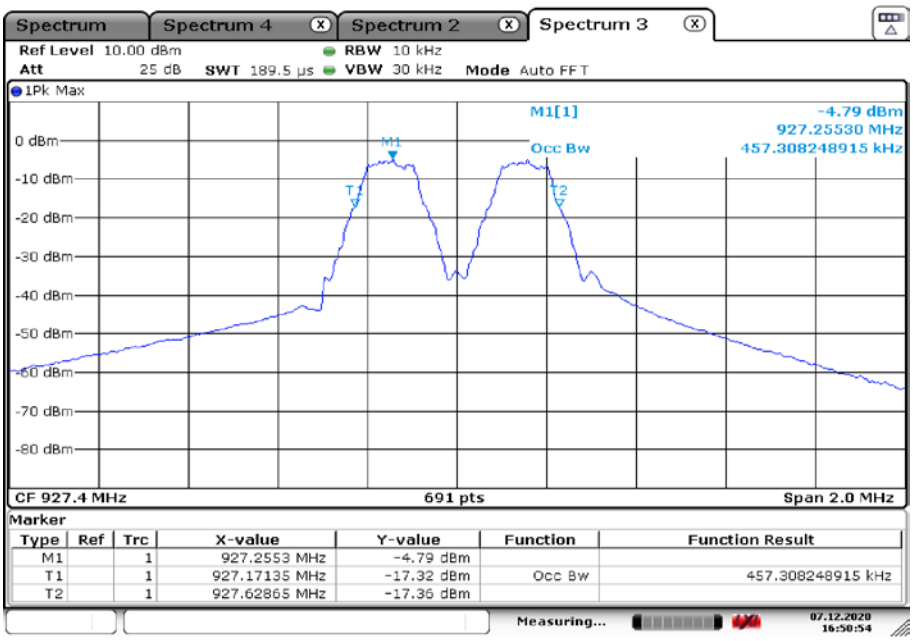


Plot 5: High Channel, 6 dB-BW



Date: 7.DEC.2020 16:31:08

Plot 6: High Channel, 99%OBW



Date: 7.DEC.2020 16:50:54

13.4 Detailed spurious emissions @ the band edge – conducted and radiated

Description:

Measurement of the conducted band edge compliance. EUT is measured at the lower and upper band edge in single channel mode.

Measurement:

Measurement parameters	
Detector	Peak
Sweep time	Auto
Resolution bandwidth	100 kHz
Video bandwidth	300 kHz
Span	Lower Band Edge: 902 MHz Upper Band Edge: 928 MHz
Trace mode	Max hold
Test setup	See sub clause 7.3 A
Measurement uncertainty	See sub clause 9

Limits:

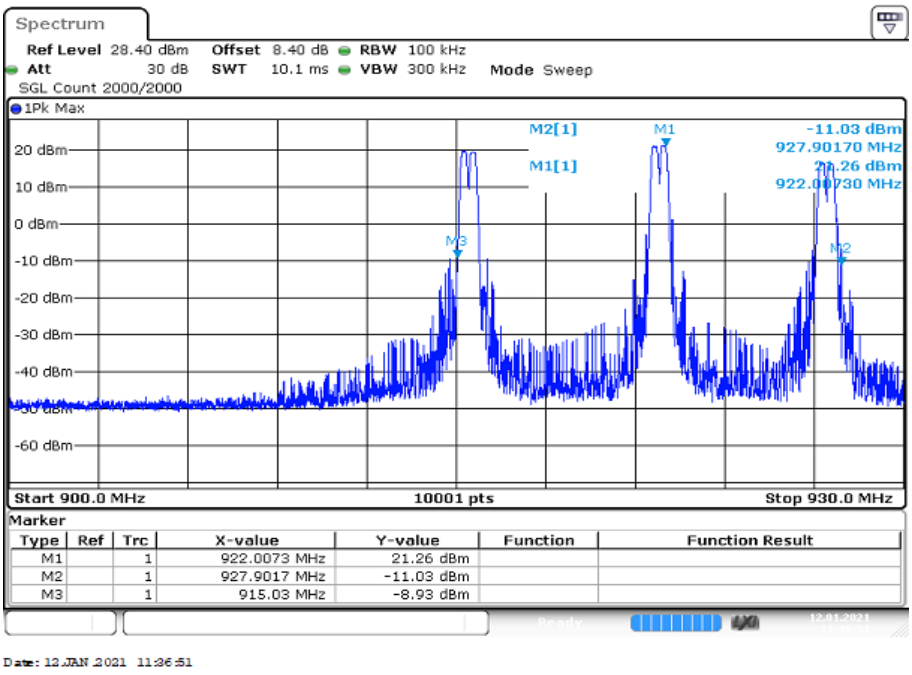
FCC	IC
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains 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.	

Results conducted:

Scenario	Spurious band edge conducted / dB	
Modulation	lowest channel	highest channel
Lower band edge – single channel mode	> 30 dB	> 30 dB
Upper band edge – single channel mode	> 30 dB	> 30 dB

Plots:

Plot 1: lowest and highest channel



Results radiated:

No restricted band in the range ± 2 channel bandwidths of the Band-edges of the specified emission band! (608 MHz – 614 MHz and 960 MHz – 1240 MHz).

Section 15.205 Restricted bands of operation.

(a) Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090 - 0.110	16.42 - 16.423	399.9 - 410	4.5 - 5.15
[1]0.495 - 0.505	16.69475 - 16.69525	608 - 614	5.35 - 5.46
2.1735 - 2.1905	16.80425 - 16.80475	960 - 1240	7.25 - 7.75
4.125 - 4.128	25.5 - 25.67	1300 - 1427	8.025 - 8.5
4.17725 - 4.17775	37.5 - 38.25	1435 - 1626.5	9.0 - 9.2
4.20725 - 4.20775	73 - 74.6	1645.5 - 1646.5	9.3 - 9.5
6.215 - 6.218	74.8 - 75.2	1660 - 1710	10.6 - 12.7
6.26775 - 6.26825	108 - 121.94	1718.8 - 1722.2	13.25 - 13.4
6.31175 - 6.31225	123 - 138	2200 - 2300	14.47 - 14.5
8.291 - 8.294	149.9 - 150.05	2310 - 2390	15.35 - 16.2
8.362 - 8.366	156.52475 - 156.52525	2483.5 - 2500	17.7 - 21.4
8.37625 - 8.38675	156.7 - 156.9	2690 - 2900	22.01 - 23.12
8.41425 - 8.41475	162.0125 - 167.17	3260 - 3267	23.6 - 24.0
12.29 - 12.293	167.72 - 173.2	3332 - 3339	31.2 - 31.8
12.51975 - 12.52025	240 - 285	3345.8 - 3358	36.43 - 36.5
12.57675 - 12.57725	322 - 335.4	3600 - 4400	([2])
13.36 - 13.41			

13.5 Spurious Emissions Conducted

Description:

Measurement of the conducted spurious emissions in transmit mode. The EUT is set to single channel mode. The measurement is repeated for low, mid and high channel.

Measurement:

Measurement parameter	
Detector:	Peak
Sweep time:	Auto
Video bandwidth:	F < 1 GHz: 1 MHz F > 1 GHz: 1 MHz
Resolution bandwidth:	F < 1 GHz: 100 kHz F > 1 GHz: 100 kHz
Span:	9 kHz to 12.75 GHz
Trace-Mode:	Max Hold
Used equipment:	See chapter 7.3A
Measurement uncertainty:	See chapter 9

Limits:

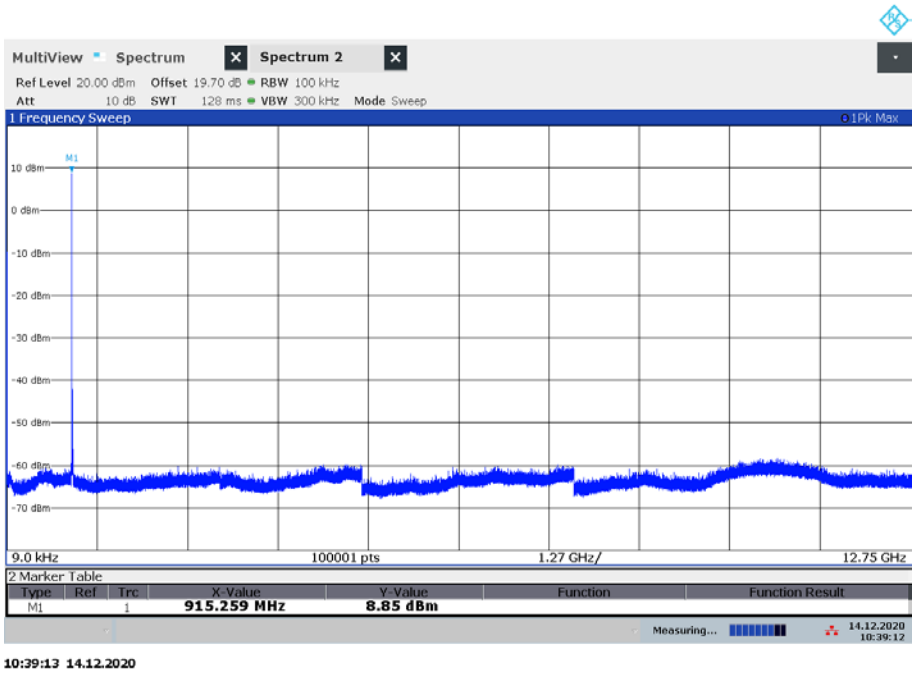
FCC	IC
TX spurious emissions conducted	
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth 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	

Result:

Emission Limitation					
Frequency / MHz		Amplitude of emission / dBm	Limit max. allowed emission power	actual attenuation below frequency of operation / dB	Results
915.4			24 dBm		Operating frequency
			-30 dBc	No emissions detected!	
921.8			24 dBm		Operating frequency
			-30 dBc	No emissions detected!	
927.4			24 dBm		Operating frequency
			-30 dBc	No emissions detected!	

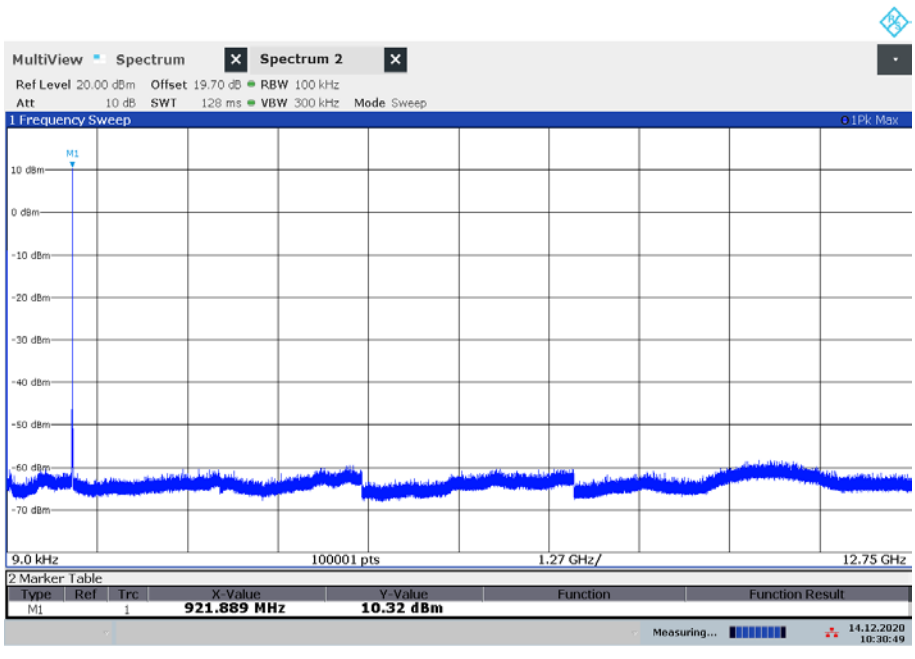
Plots:

Plot 1: Low channel, 9 kHz – 12.75 GHz



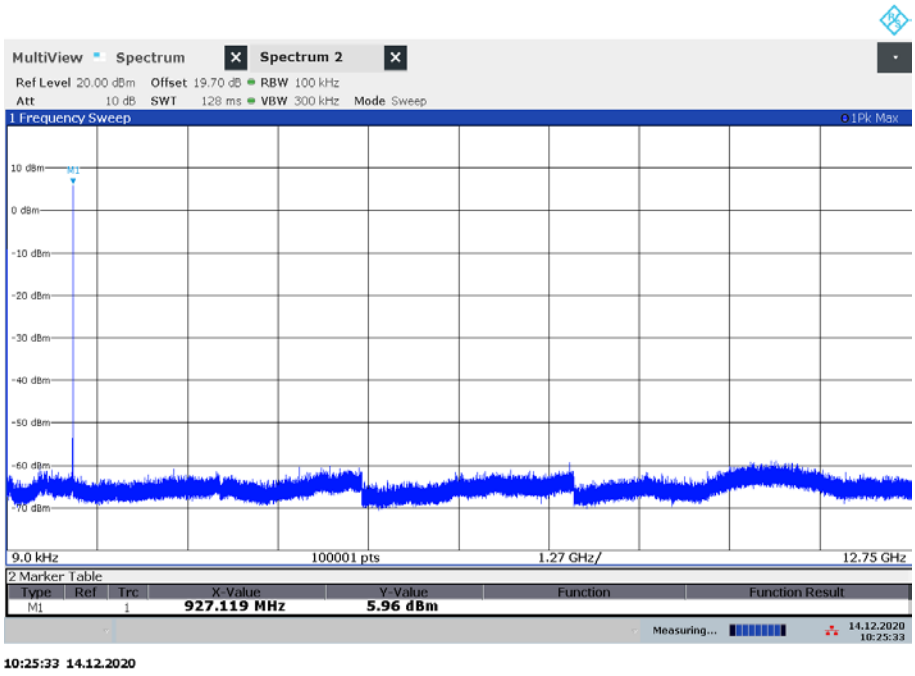
10:39:13 14.12.2020

Plot 2: Middle channel, 9 kHz – 12.75 GHz



10:30:50 14.12.2020

Plot 3: High channel, 9 kHz – 12.75 GHz



13.6 Spurious Emissions Radiated < 30 MHz

Description:

Measurement of the radiated spurious emissions in transmit mode below 30 MHz. The EUT is set to single channel mode and the transmit channels are 00; 39 and 78. The measurement is performed in the mode with the highest output power. The limits are recalculated to a measurement distance of 3 m according the ANSI C63.10.

Measurement:

Measurement parameter	
Detector:	Peak / Quasi Peak
Sweep time:	Auto
Video bandwidth:	F < 150 kHz: 200 Hz F > 150 kHz: 9 kHz
Resolution bandwidth:	F < 150 kHz: 1 kHz F > 150 kHz: 100 kHz
Span:	9 kHz to 30 MHz
Trace-Mode:	Max Hold
Used equipment:	See chapter 7.2 A
Measurement uncertainty:	See chapter 9

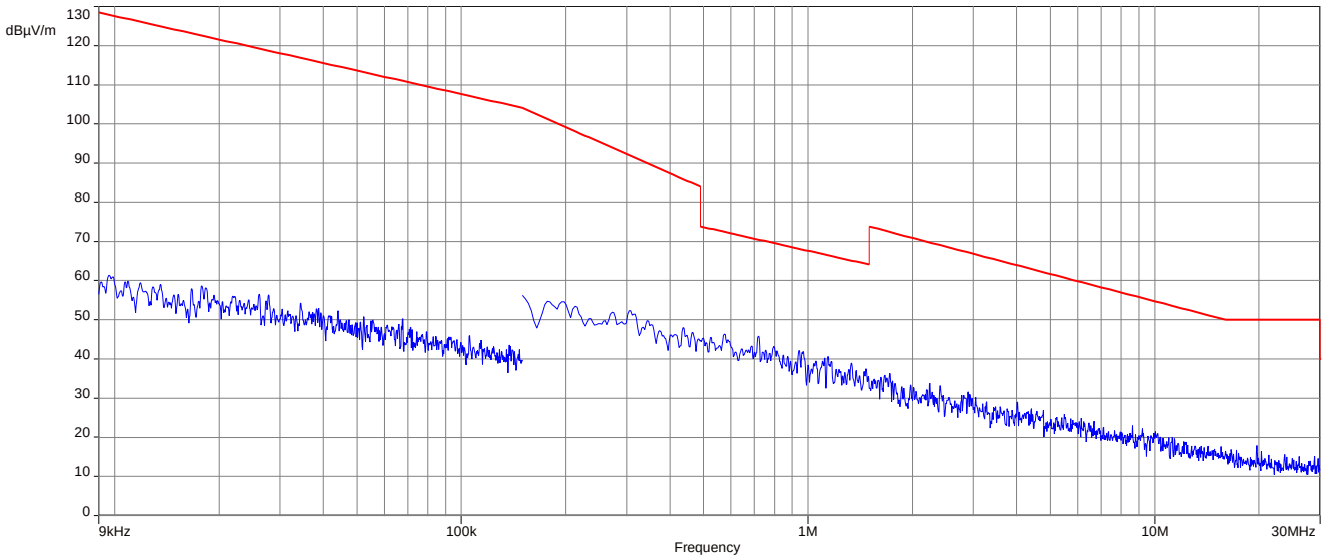
Limits:

FCC		IC
TX spurious emissions radiated < 30 MHz		
Frequency (MHz)	Field strength (dBµV/m)	Measurement distance
0.009 – 0.490	2400/F(kHz)	300
0.490 – 1.705	24000/F(kHz)	30
1.705 – 30.0	30	30

Result:

Spurious emission level								
-/-			mid channel			-/-		
Frequency / MHz	Detector	Level / (dBµV/m)	Frequency / MHz	Detector	Level / (dBµV/m)	Frequency / MHz	Detector	Level / (dBµV/m)
			No Peaks detected!					

Plot 1: TX-Mode mid channel



13.7 Spurious Emissions Radiated > 30 MHz

13.7.1 Spurious emissions radiated 30 MHz to 1 GHz

Description:

Measurement of the radiated spurious emissions in transmit mode. The measurement is performed at channel low, mid and high.

Measurement:

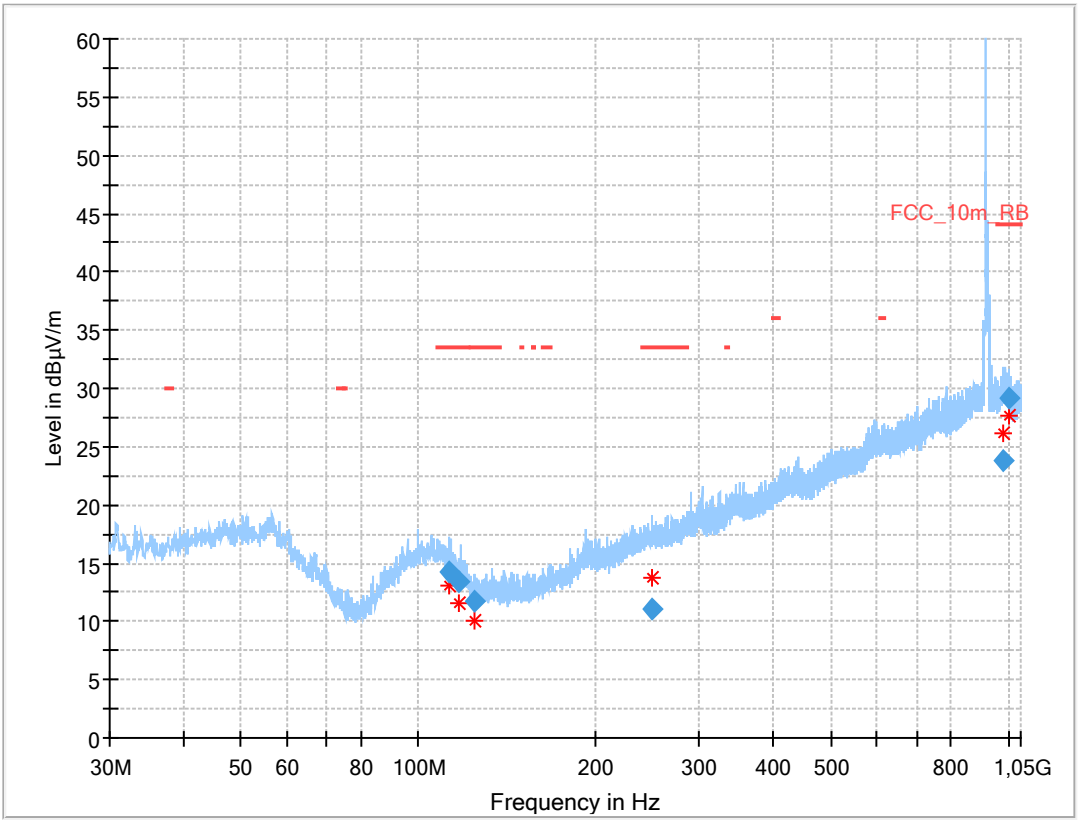
Measurement parameters	
Detector	Peak / Quasi Peak
Sweep time	Auto
Resolution bandwidth	3 x VBW
Video bandwidth	120 kHz
Span	30 MHz to 1 GHz
Trace mode	Max hold
Measured modulation	DTS
Test setup	See sub clause 7.1 A
Measurement uncertainty	See sub clause 9

Limits:

FCC	IC	
Band-edge Compliance of conducted and radiated emissions		
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, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §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
Above 960	54.0	3

Result: See result table below the plots.

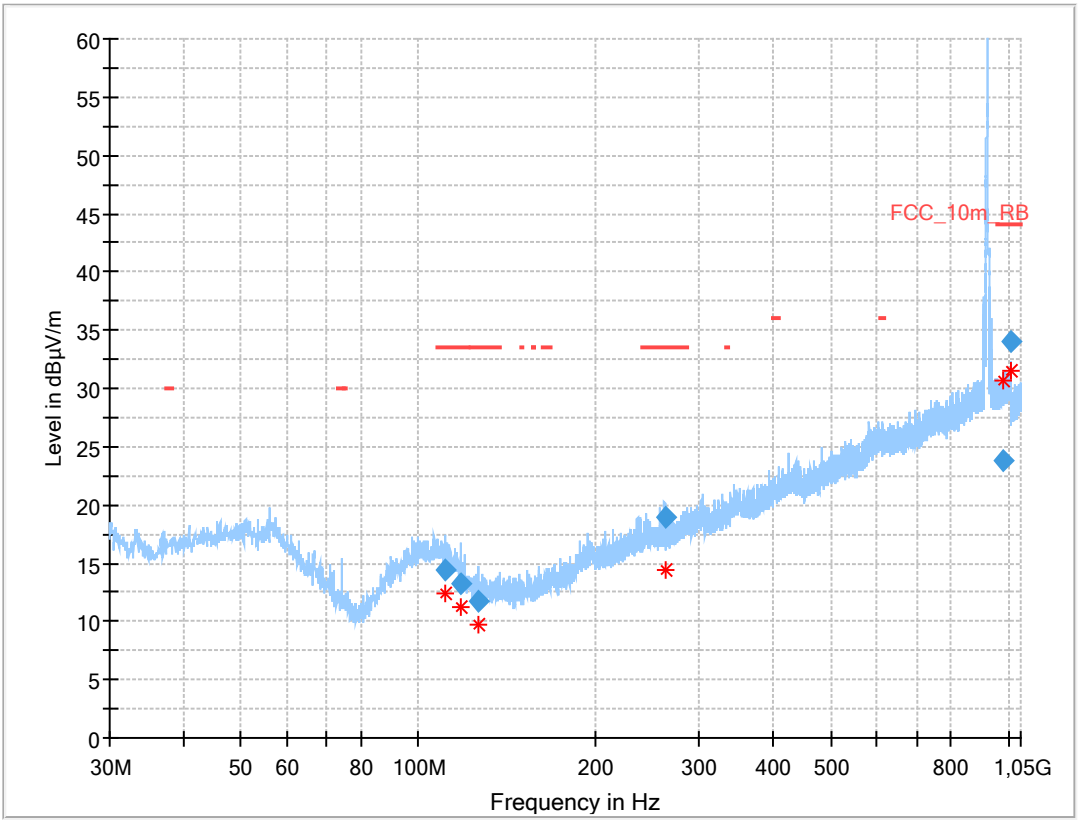
Plot 1: 30 MHz – 1 GHz, horizontal & vertical polarisation (lowest channel)



Final results:

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
113.002	14.23	33.5	19.3	1000	120.0	170.0	H	83	12
117.432	13.33	33.5	20.2	1000	120.0	170.0	V	247	11
124.741	11.66	33.5	21.8	1000	120.0	170.0	V	247	9
249.590	11.01	33.5	22.5	1000	120.0	145.0	V	247	13
979.208	23.77	44.0	20.2	1000	120.0	107.0	V	-22	24
1003.685	29.14	44.0	14.9	1000	120.0	118.0	H	157	24

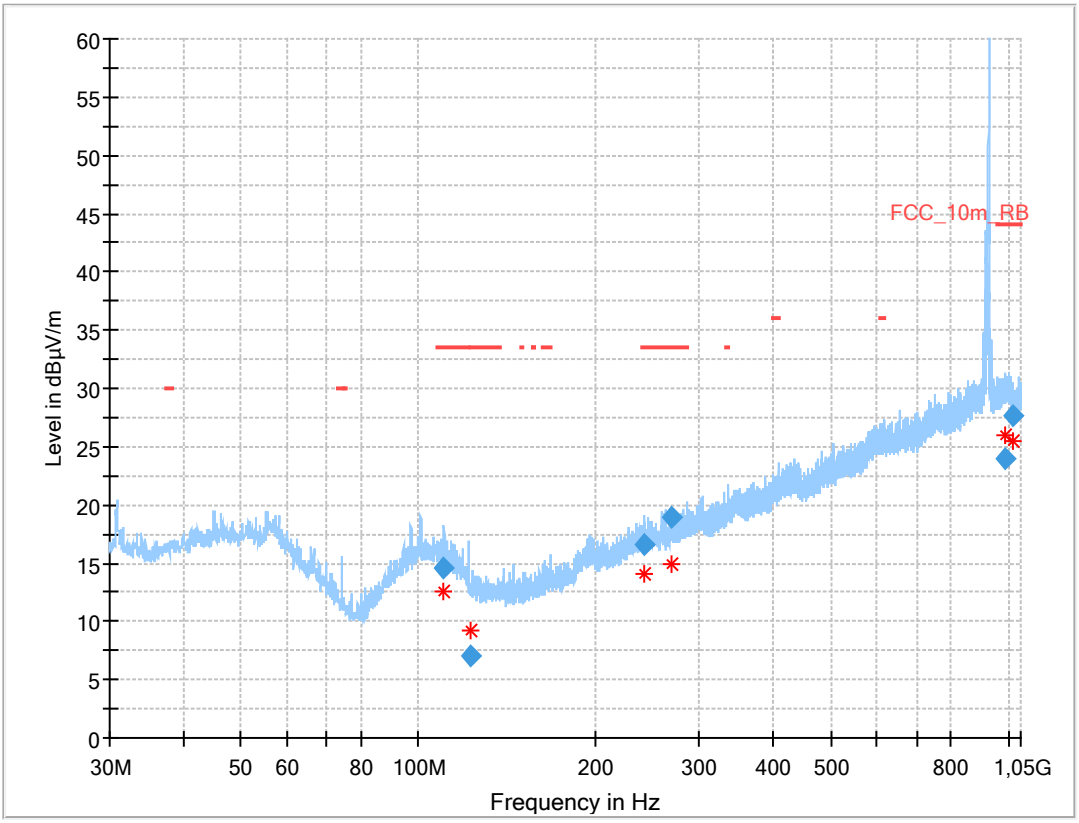
Plot 2: 30 MHz – 1 GHz, horizontal & vertical polarisation (middle channel)



Final results:

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
111.384	14.43	33.5	19.1	1000	120.0	132.0	H	104	12
118.444	13.16	33.5	20.3	1000	120.0	132.0	V	67	11
126.148	11.68	33.5	21.8	1000	120.0	170.0	H	247	9
261.825	18.89	33.5	14.6	1000	120.0	170.0	H	92	13
980.156	23.78	44.0	20.2	1000	120.0	170.0	V	-22	24
1009.181	34.08	44.0	9.9	1000	120.0	170.0	V	157	24

Plot 3: 30 MHz – 1 GHz, horizontal & vertical polarisation (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/m)
110.497	14.60	33.5	18.9	1000	120.0	118.0	H	157	12
122.251	7.10	---	---	1000	120.0	170.0	H	79	10
240.852	16.51	33.5	17.0	1000	120.0	170.0	H	112	13
269.375	18.96	33.5	14.5	1000	120.0	170.0	H	82	13
984.761	24.02	44.0	20.0	1000	120.0	110.0	H	112	24
1021.779	27.71	44.0	16.3	1000	120.0	170.0	V	261	25

13.7.2 Spurious emissions radiated above 1 GHz

Description:

Measurement of the radiated spurious emissions in transmit mode. The measurement is performed in the mode with the highest output power.

Measurement:

Measurement parameters	
Detector	Peak / RMS
Sweep time	Auto
Resolution bandwidth	1 MHz
Video bandwidth	3 x RBW
Span	1 GHz to 12.75 GHz
Trace mode	Max hold
DTS, FHSS Hybrid	DTS
Test setup	See sub clause 7.2 B (1 GHz – 12.75 GHz)
Measurement uncertainty	See sub clause 9

The modulation with the highest output power was used to perform the transmitter spurious emissions. If spurious were detected a re-measurement was performed on the detected frequency with each modulation.

Limits:

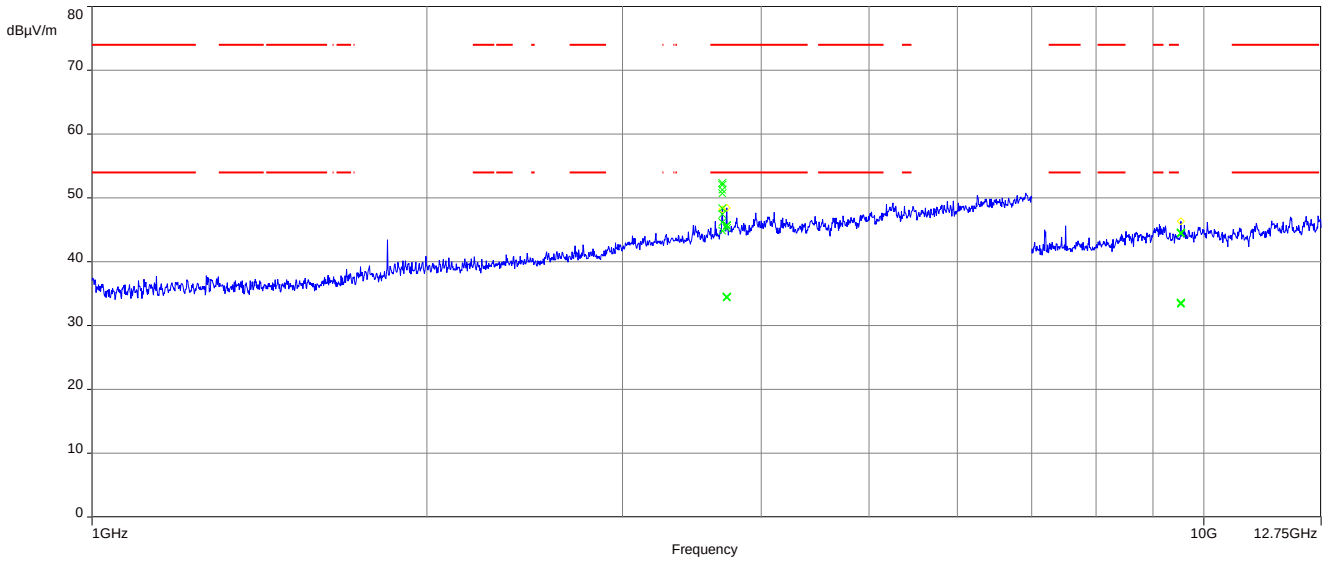
FCC		IC
TX spurious emissions radiated		
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).		
§15.209		
Frequency / MHz	Field strength / (dBµV/m)	Measurement distance / m
Above 960	54.0	3

Result:

Spurious emission level								
-/-			mid channel			-/-		
Frequency / MHz	Detector	Level / (dBµV/m)	Frequency / MHz	Detector	Level / (dBµV/m)	Frequency / MHz	Detector	Level / (dBµV/m)
			No Peaks detected!					

Plots:

Plot 1: 1 GHz – 12.75 GHz, horizontal & vertical polarisation (middle channel)



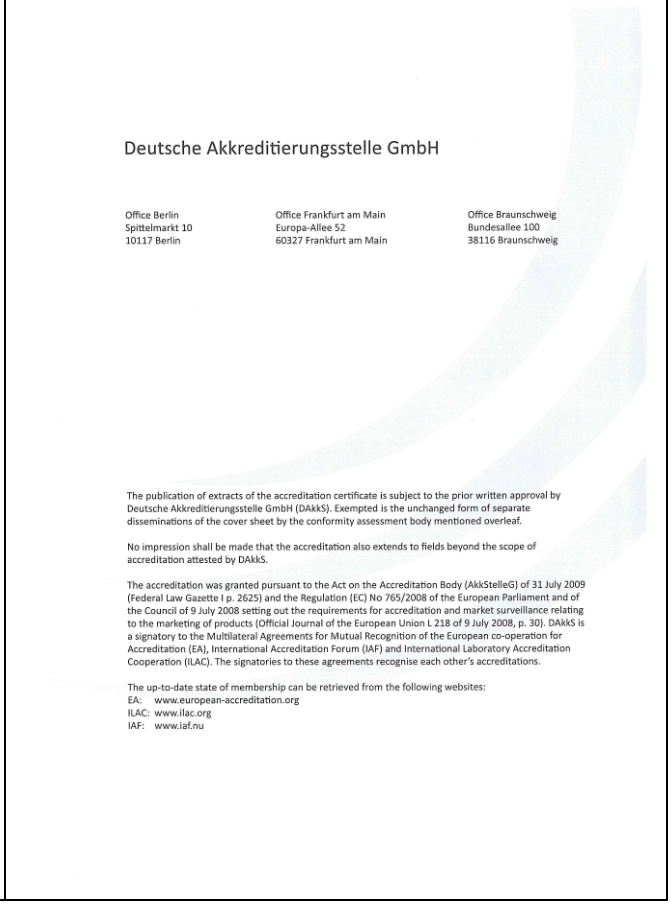
14 Glossary

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

15 Document history

Version	Applied changes	Date of release
-/-	Initial release	2021-021-21
A	HVIN changed	2021-01-21

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

first page	last page
	

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

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

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

first page	last page
	

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-12076-01-05e.pdf

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