

TEST REPORT

Test report no.: 1-4406/17-02-04-B



Deutsche
Akkreditierungsstelle
D-PL-12076-01-01

Testing laboratory

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Accredited Testing Laboratory:

The testing laboratory (area of testing) is accredited according to DIN EN ISO/IEC 17025 (2005) by the Deutsche Akkreditierungsstelle GmbH (DAKKS)

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

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Manufacturer

Scheidt & Bachmann GmbH

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Test standard/s

47 CFR Part 15

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: Mobile Validation Equipment

Model name: FareGo Val OV|41;
FareGo Val SV|51

FCC ID: O5K-NVP

IC: 8312A-NVP

Frequency: DTS band 2400 MHz to 2483.5 MHz

Technology tested: WLAN

Antenna: 1 integrated PCB antenna

Power supply: 36 V DC by external power supply

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:



Marco Bertolino
Lab Manager
Radio Communications & EMC

Test performed:



David Lang
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2 General information

2.1 Notes and disclaimer

The test results of this test report relate exclusively to the test item specified in this test report. CTC advanced GmbH does not assume responsibility for any conclusions and generalizations drawn from the test results with regard to other specimens or samples of the type of the equipment represented by the test item.

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This test report replaces the test report with the number 1-4406/17-02-04-A and dated 2017-11-06

2.2 Application details

Date of receipt of order:	2017-08-17
Date of receipt of test item:	2017-08-15
Start of test:	2017-08-15
End of test:	2017-10-13
Person(s) present during the test:	-/-

2.3 Test laboratories sub-contracted

None

3 Test standard/s and references

Test standard	Date	Description
47 CFR Part 15	-/-	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
DTS: KDB 558074 D01	V04	Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247
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 Test environment

Temperature	:	T _{nom} T _{max} T _{min}	+22 °C during room temperature tests No tests under extreme temperature conditions required. No tests under extreme temperature conditions required.
Relative humidity content	:		46 %
Barometric pressure	:		1021 hpa
Power supply	:	V _{nom} V _{max} V _{min}	36 V DC by external power supply No tests under extreme voltage conditions required. No tests under extreme voltage conditions required.

5 Test item

5.1 General description

Kind of test item	:	Mobile Validation Equipment
Type identification	:	FareGo Val OV 41; FareGo Val SV 51
HMN	:	-/-
PMN	:	PMN 1: FareGo Val OV 41 PMN 2: FareGo Val SV 51
HVIN	:	HVIN 1: OV41 HVIN 2: SV51
FVIN	:	FVIN 1: 07337760 FVIN 2: 07338370
S/N serial number	:	Radiated unit: 0130070174 Conducted unit: 0130069621
HW hardware status	:	00346640
SW software status	:	07337760
Frequency band	:	DTS band 2400 MHz to 2483.5 MHz
Type of radio transmission	:	DSSS, OFDM
Use of frequency spectrum	:	
Type of modulation	:	(D)BPSK, (D)QPSK, 16 – QAM, 64 – QAM
Number of channels	:	11
Antenna	:	1 integrated PCB antenna; 2390 MHz to 2490 MHz: 1.5 dBi - 2.5 dBi as of operational description 00.02.01 issued 2017-07-27.
Power supply	:	36 V DC by external power supply
Temperature range	:	-20°C to +55°C

Note: Since both devices, the OV41 and the SV51 use the identical WLAN radio module and antenna only the OV41 was actually tested. Justification regarding the equality of components can also be found within the photo documentation. See AnnexA and AnnexB as referenced below.

5.2 Additional information

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

Test setup- and EUT-photos are included in test report:

1-4406/17-02-09_AnnexA
1-4406/17-02-09_AnnexB
1-4406/17-02-09_AnnexD

6 Description of the test setup

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

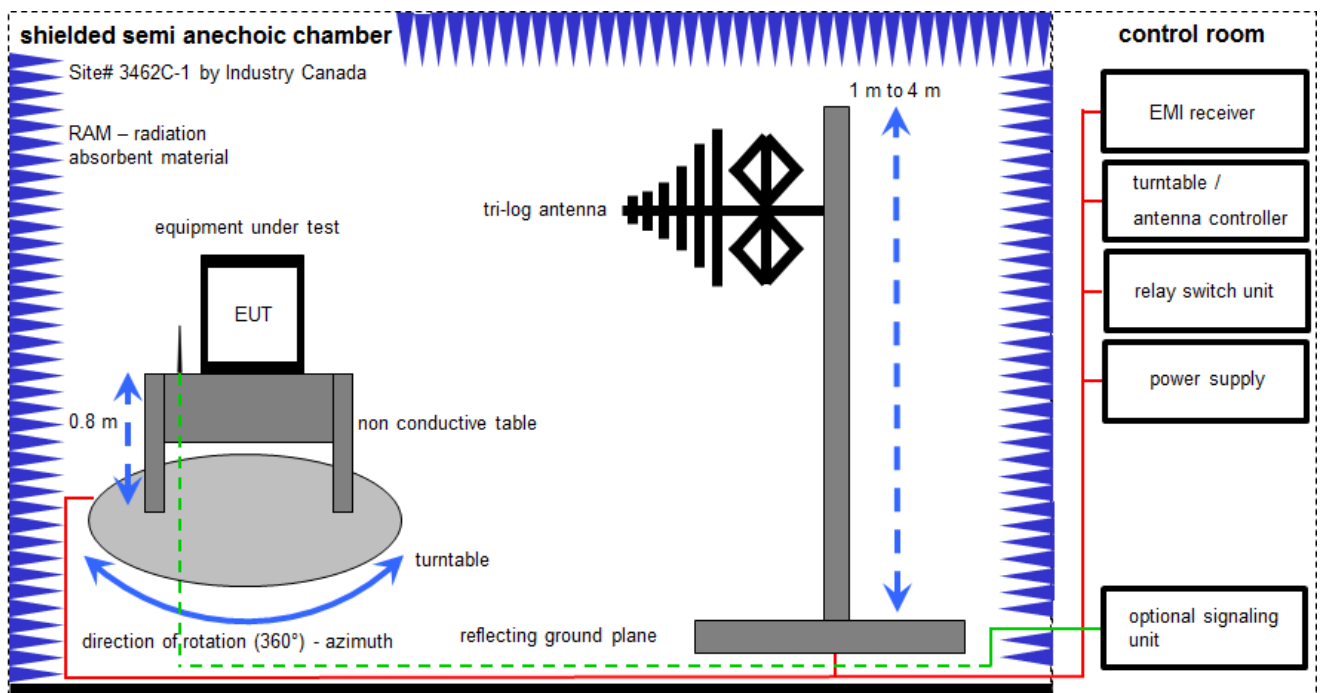
In order to simplify the identification of the equipment used at some special tests, some items of test equipment and ancillaries can be provided with an identifier or number in the equipment list below (Lab/Item).

Agenda: Kind of Calibration

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

6.1 Shielded semi anechoic chamber

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



Measurement distance: tri-log antenna 10 meter

$$FS = UR + CL + AF$$

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

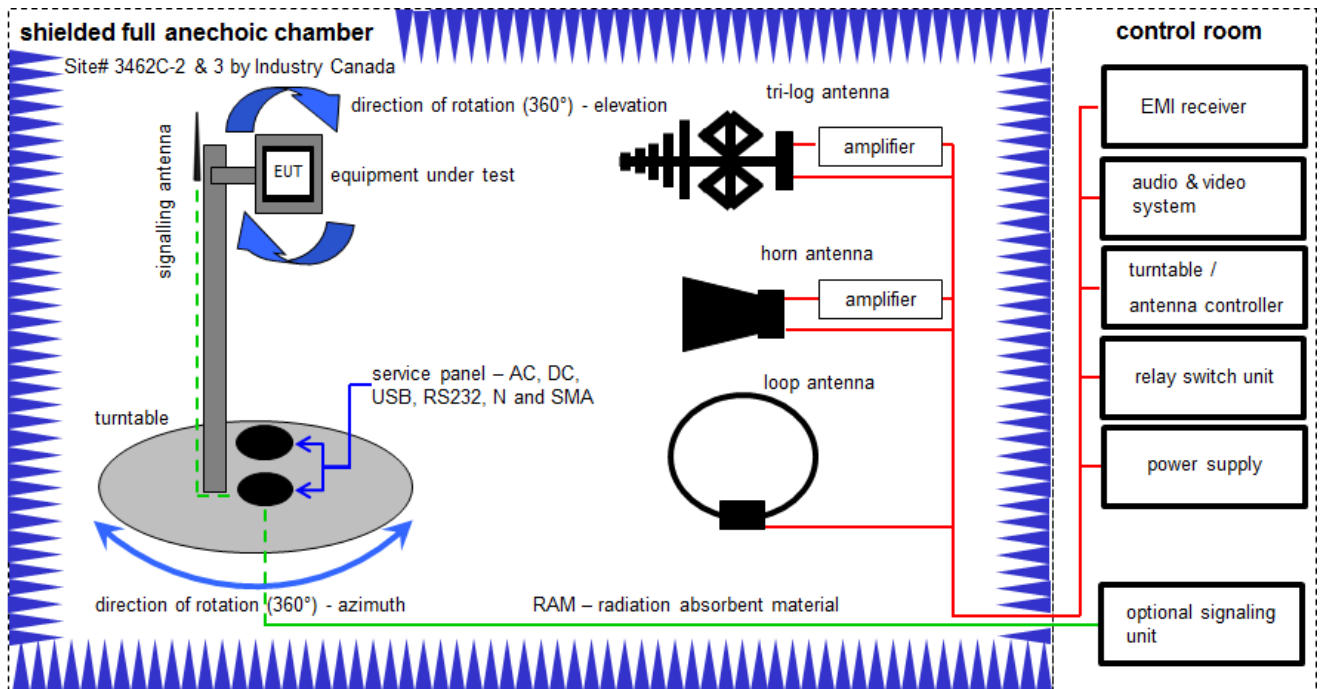
Example calculation:

$$FS [dB\mu V/m] = 12.35 [dB\mu V/m] + 1.90 [dB] + 16.80 [dB/m] = 31.05 [dB\mu V/m] (35.69 \mu V/m)$$

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	DC power supply, 60Vdc, 50A, 1200 W	6032A	HP	2920A04466	300000580	ne	-/-	-/-
3	A	Meßkabine 1	HF-Absorberhalle	MWB AG 300023	-/-	300000551	ne	-/-	-/-
4	A	EMI Test Receiver	ESCI 3	R&S	100083	300003312	k	01.02.2017	31.01.2018
5	A	Antenna Tower	Model 2175	ETS-Lindgren	64762	300003745	izw	-/-	-/-
6	A	Positioning Controller	Model 2090	ETS-Lindgren	64672	300003746	izw	-/-	-/-
7	A	Turntable Interface-Box	Model 105637	ETS-Lindgren	44583	300003747	izw	-/-	-/-
8	A	TRILOG Broadband Test-Antenna 30 MHz - 3 GHz	VULB9163	Schwarzbeck	295	300003787	k	25.04.2016	25.04.2018

6.2 Shielded fully anechoic chamber



Measurement distance: tri-log antenna and 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:

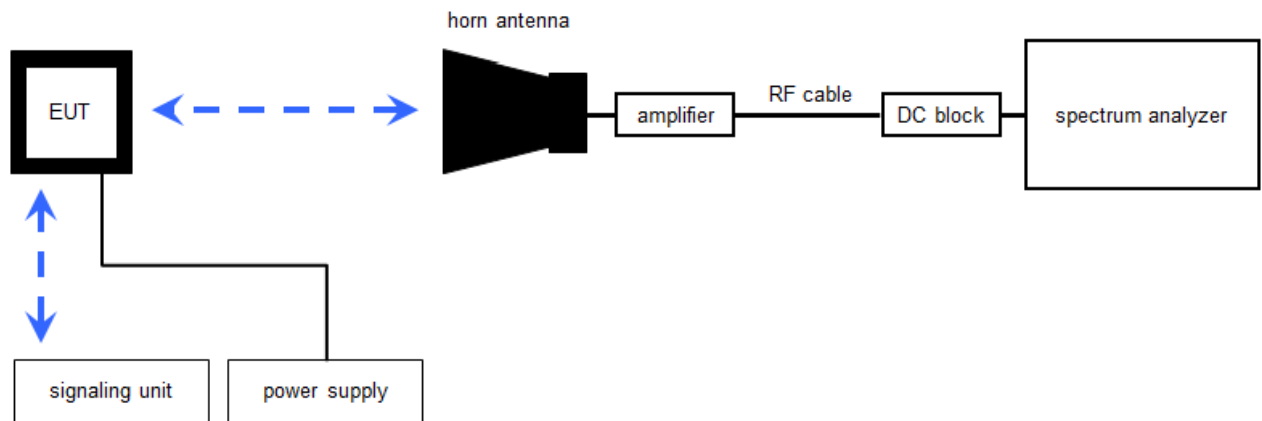
$$FS [dB\mu V/m] = 40.0 [dB\mu V/m] + (-35.8) [dB] + 32.9 [dB/m] = 37.1 [dB\mu V/m] (71.61 \mu V/m)$$

Equipment table:

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	A+B	DC power supply, 60Vdc, 50A, 1200 W	6032A	HP	2818A03450	300001040	Ve	-/-	-/-
2	A+B	Anechoic chamber	FAC 3/5m	MWB / TDK	87400/02	300000996	ev	-/-	-/-
3	B	Double-Ridged Waveguide Horn Antenna 1-18.0GHz	3115	EMCO	9107-3697	300001605	VKII	14.02.2017	13.02.2019
4	A+B	Switch / Control Unit	3488A	HP	*	300000199	ne	-/-	-/-
5	A	Active Loop Antenna 9 kHz to 30 MHz	6502	EMCO	2210	300001015	k	07.07.2017	06.07.2019
6	B	Band Reject filter	WRCG2400/2483-2375/2505-50/10SS	Wainwright	11	300003351	ev	-/-	-/-
7	A+B	EMI Test Receiver 20Hz- 26,5GHz	ESU26	R&S	100037	300003555	k	31.01.2017	30.01.2018
8	B	Highpass Filter	WHKX7.0/18G-8SS	Wainwright	19	300003790	ne	-/-	-/-
9	B	Broadband Amplifier 0.5-18 GHz	CBLU5184540	CERNEX	22049	300004481	ev	-/-	-/-
10	A+B	4U RF Switch Platform	L4491A	Agilent Technologies	MY50000037	300004509	ne	-/-	-/-
11	A+B	NEXIO EMV-Software	BAT EMC V3.16.0.49	EMCO	-/-	300004682	ne	-/-	-/-
12	A+B	PC	ExOne	F+W	-/-	300004703	ne	-/-	-/-

6.3 Radiated measurements > 18 GHz

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:

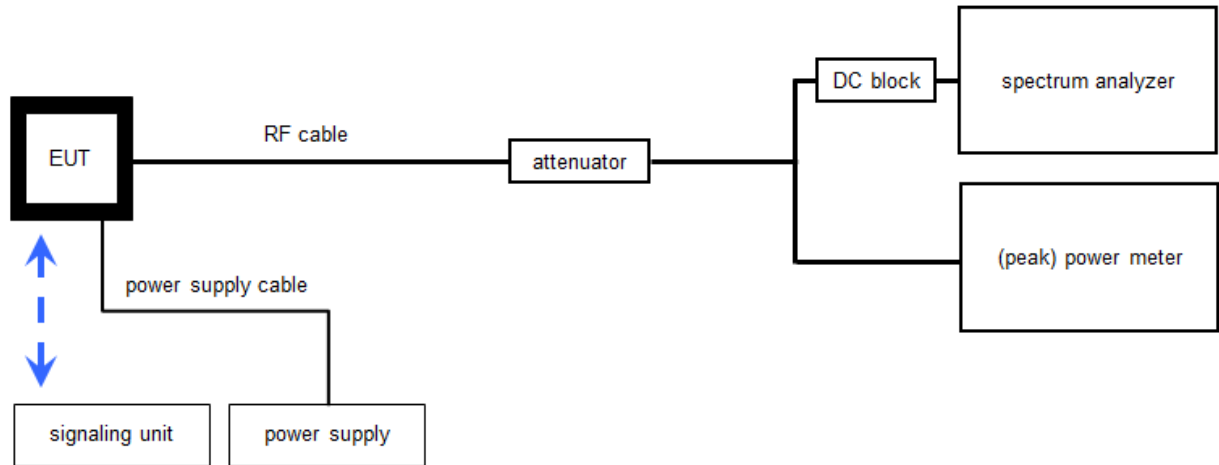
FS [dBμV/m] = 40.0 [dBμV/m] + (-60.1) [dB] + 36.74 [dB/m] = 16.64 [dBμV/m] (6.79 μV/m)

Equipment table:

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	A	Microwave System Amplifier, 0.5-26.5 GHz	83017A	HP	00419	300002268	ev	-/-	-/-
2	A	Horn Antenna 18,0-40,0 GHz	LHAF180	Microw.Devel	39180-103-022	300001748	k	22.05.2015	22.05.2018
3	A	Signal Analyzer 40 GHz	FSV40	R&S	101042	300004517	k	25.01.2017	24.01.2018
4	A	RF-Cable	ST18/SMAM/SMAM/48	Huber & Suhner	Batch no. 600918	400001182	ev	-/-	-/-
5	A	RF-Cable	ST18/SMAM/SMAM/48	Huber & Suhner	Batch no. 127377	400001183	ev	-/-	-/-
6	A	DC-Blocker 0.1-40 GHz	8141A	Inmet	-/-	400001185	ev	-/-	-/-

6.4 Conducted measurements with peak power meter & spectrum analyzer

Conducted measurements normal conditions



$$OP = AV + CA$$

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

Example calculation:

$$OP \text{ [dBm]} = 6.0 \text{ [dBm]} + 11.7 \text{ [dB]} = 17.7 \text{ [dBm]} \text{ (58.88 mW)}$$

Equipment table:

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	A	DC-Blocker 0.1-40 GHz	8141A	Inmet	-/-	400001185	ev	-/-	-/-
2	A	Power Supply + 2nd Power Supply	LA 2x30/5GB2	Zentro	2012	300001275	NK!	12.03.2007	-/-
3	A	PC-WLAN Tester	Intel Core i3 3220/3,3 GHz, Prozessor	-/-	2V2403033A4523	300004589	ne	-/-	-/-
4	A	Teststand	Teststand Custom Sequence Editor	National Instruments GmbH	-/-	300004590	ne	-/-	-/-
5	A	Power Sensor	NRP-Z81	R&S	100010	300003780	k	26.01.2017	25.01.2019
6	A	PowerSplitter/Combiner 150-6000MHz N-Type	ZB3PD-63-N+	Mini-Circuits	-/-	400000451	ev	-/-	-/-
7	A	RF-Cable	ST18/SMAm/SMAm/60	Huber & Suhner	Batch no. 606844	400001181	ev	-/-	-/-
8	A	Coax Attenuator 10 dB 2W 0-40 GHz	MCL BW-K10-2W44+	Mini Circuits	-/-	400001186	ev	-/-	-/-
9	A	Synchron Power Meter	SPM-4	CTC	1	400001294	ev	-/-	-/-

7 Sequence of testing

7.1 Sequence of testing radiated spurious 9 kHz to 30 MHz

Setup

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

Premeasurement*

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

Final measurement

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

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

7.2 Sequence of testing radiated spurious 30 MHz to 1 GHz

Setup

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

Premeasurement

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

Final measurement

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

7.3 Sequence of testing radiated spurious 1 GHz to 18 GHz

Setup

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

Premeasurement

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

Final measurement

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

7.4 Sequence of testing radiated spurious above 18 GHz

Setup

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

Premeasurement

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

Final measurement

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

8 Measurement uncertainty

Measurement uncertainty	
Test case	Uncertainty
Antenna gain	± 3 dB
Power spectral density	± 1.5 dB
DTS bandwidth	± 100 kHz (depends on the used RBW)
Occupied bandwidth	± 100 kHz (depends on the used RBW)
Maximum output power	± 1.5 dB
Detailed spurious emissions @ the band edge - conducted	± 1.5 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
Spurious emissions conducted below 30 MHz (AC conducted)	± 2.6 dB

9 Summary of measurement results

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

TC Identifier	Description	Verdict	Date	Remark
RF-Testing	CFR Part 15 RSS - 247, Issue 2	See table!	2017-12-08	-/-

Test specification clause	Test case	Guideline	Temperature conditions	Power source voltages	Mode	C	NC	NA	NP	Remark
§15.247(b)(4) RSS - 247 / 5.4 (f)(ii)	Antenna gain	-/-	Nominal	Nominal	DSSS	-/-				-/-
	Duty cycle	-/-	Nominal	Nominal	DSSS OFDM	-/-				-/-
§15.247(e) RSS - 247 / 5.2 (b)	Power spectral density	KDB 558074 DTS clause: 10.2	Nominal	Nominal	DSSS OFDM	☒	☐	☐	☐	-/-
§15.247(a)(2) RSS - 247 / 5.2 (a)	DTS bandwidth	KDB 558074 DTS clause: 8.1	Nominal	Nominal	DSSS OFDM	☒	☐	☐	☐	-/-
RSS Gen clause 4.6.1	Occupied bandwidth	-/-	Nominal	Nominal	DSSS OFDM	☒	☐	☐	☐	-/-
§15.247(b)(3) RSS - 247 / 5.4 (d)	Maximum output power	KDB 558074 DTS clause: 9.1.3	Nominal	Nominal	DSSS OFDM	☒	☐	☐	☐	-/-
§15.247(d) RSS - 247 / 5.5	Detailed spurious emissions @ the band edge - conducted	-/-	Nominal	Nominal	DSSS OFDM	☐	☐	☒	☐	-/-
§15.205 RSS - 247 / 5.5 RSS - Gen	Band edge compliance conducted – restricted bands	KDB 558074 DTS clause: 13.3.2 and clause 12.2.2	Nominal	Nominal	DSSS OFDM	☒	☐	☐	☐	-/-
§15.205 RSS - 247 / 5.5 RSS - Gen	Band edge compliance radiated – restricted bands	-/-	Nominal	Nominal	DSSS OFDM	☒	☐	☐	☐	-/-
§15.247(d) RSS - 247 / 5.5	TX spurious emissions conducted	KDB 558074 DTS clause: 11.1 & 11.2 11.3	Nominal	Nominal	DSSS OFDM	☒	☐	☐	☐	-/-
§15.209(a) RSS-Gen	TX spurious emissions radiated below 30 MHz	-/-	Nominal	Nominal	DSSS OFDM	☒	☐	☐	☐	-/-
§15.247(d) RSS - 247 / 5.5 RSS-Gen	TX spurious emissions radiated 30 MHz to 1 GHz	-/-	Nominal	Nominal	DSSS OFDM	☒	☐	☐	☐	-/-
§15.247(d) RSS - 247 / 5.5 RSS-Gen	TX spurious emissions radiated above 1 GHz	-/-	Nominal	Nominal	DSSS OFDM	☒	☐	☐	☐	-/-
§15.109 RSS-Gen	RX spurious emissions radiated 30 MHz to 1 GHz	-/-	Nominal	Nominal	RX / idle	☒	☐	☐	☐	-/-
§15.109 RSS-Gen	RX spurious emissions radiated above 1 GHz	-/-	Nominal	Nominal	RX / idle	☒	☐	☐	☐	-/-
§15.107(a) §15.207	Conducted emissions < 30 MHz	-/-	Nominal	Nominal	DSSS OFDM	☒	☐	☐	☐	-/-

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

10 Additional comments

Reference documents: O5K-NVP_OV41_Customer Questionnaire

Special test descriptions: Power setting versus test mode:

Power Setting	Mode
15	b-mode
14	g-mode
14	nHT20
11	nHT40

Configuration descriptions: None

Test mode:

☐ No test mode available.
Iperf was used to ping another device with the largest support packet size

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

Antennas and transmit operating modes:

☒ Operating mode 1 (single antenna)

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

☐ Operating mode 2 (multiple antennas, no beamforming)

- Equipment operating in this mode contains a smart antenna system using two or more transmit/receive chains simultaneously but without beamforming.

☐ Operating mode 3 (multiple antennas, with beamforming)

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

11 Measurement results

11.1 Antenna gain

A maximum antenna gain of 2.5dBi is stated by the manufacturer (see operational description of FareGo Val OV41)

11.2 Identify worst case data rate

Measurement:

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.

Additional the band edge compliance test will be performed in the lowest and highest modulation scheme.

Measurement parameters:

Measurement parameter	
Detector:	Peak
Sweep time:	Auto
Resolution bandwidth:	3 MHz
Video bandwidth:	3 MHz
Trace mode:	Max hold
Test setup:	See sub clause 6.4 – A
Measurement uncertainty:	-/-

Results:

Modulation	Modulation scheme / bandwidth
DSSS / b – mode	1 Mbit/s
OFDM / g – mode	6 Mbit/s
OFDM / n HT20 – mode	MCS7
OFDM / n HT40 – mode	MCS7

11.3 Maximum output power

Description:

Measurement of the maximum output power conducted and radiated. The measurements are performed using the data rate producing the highest conducted output power.

Measurement:

Measurement parameter	
According to DTS clause: 9.1.3	
Peak power meter	
Test setup:	See sub clause 6.4 – A
Measurement uncertainty:	See sub clause 8

Limits:

FCC	IC
Conducted: 1.0 W – Antenna gain with max. 6 dBi	

Results:

Frequency	Maximum Output Power [dBm]		
	2412 MHz	2437 MHz	2462 MHz
Output power conducted DSSS / b – mode	15.9	17.9	17.8
Output power conducted OFDM / g – mode	22.9	23.4	22.8
Output power conducted OFDM / n HT20 – mode	22.1	22.4	22.3
Frequency	2422 MHz	2437 MHz	2452 MHz
Output power conducted OFDM / n HT40 – mode	21.1	21.1	21.1

11.4 Duty cycle

Measurement parameters:

Measurement parameter	
Detector:	Peak
Sweep time:	Depends on the signal see plot
Resolution bandwidth:	10 MHz
Video bandwidth:	10 MHz
Trace mode:	Max hold
Test setup:	See sub clause 6.4 – A
Measurement uncertainty:	See sub clause 8

Limits:

FCC	IC
-/-	

Results:

T _{nom}	V _{nom}	lowest channel 2412 MHz	middle channel 2437 MHz	highest channel 2462 MHz
DSSS / b – mode		100 % / 0.0 dB	100 % / 0.0 dB	100 % / 0.0 dB
OFDM / g – mode		100 % / 0.0 dB	100 % / 0.0 dB	100 % / 0.0 dB
OFDM / n HT20 – mode		100 % / 0.0 dB	100 % / 0.0 dB	100 % / 0.0 dB
T _{nom}	V _{nom}	lowest channel 2422 MHz	middle channel 2437 MHz	highest channel 2452 MHz
OFDM / n HT40 – mode		100 % / 0.0 dB	100 % / 0.0 dB	100 % / 0.0 dB

11.5 Peak power spectral density

Description:

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

Measurement:

Measurement parameter	
According to DTS clause: 10.2	
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)
Test setup:	See sub clause 6.4 – A
Measurement uncertainty	See sub clause 8

Limits:

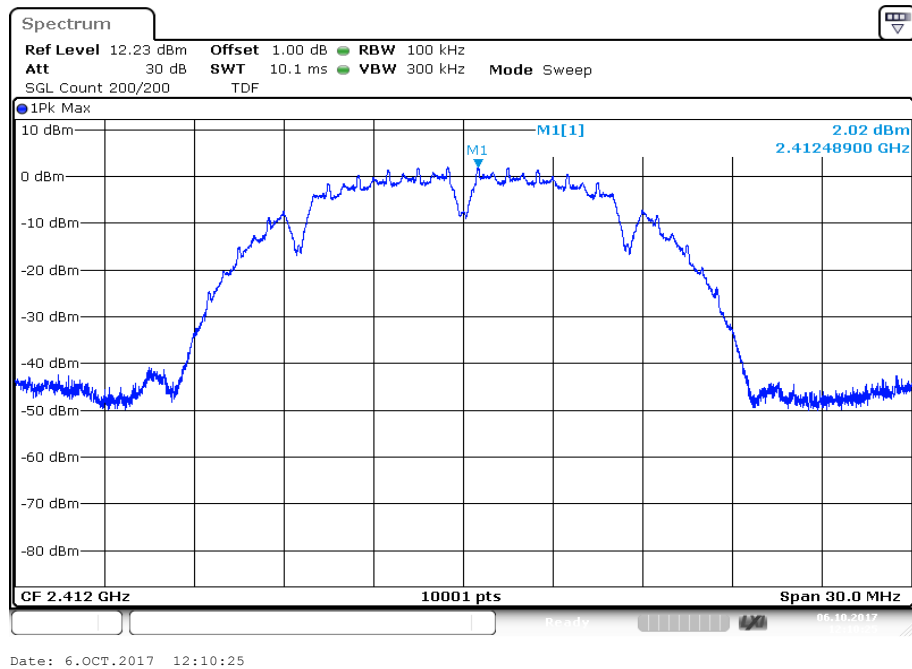
FCC	IC
8 dBm / 3kHz (conducted)	

Results:

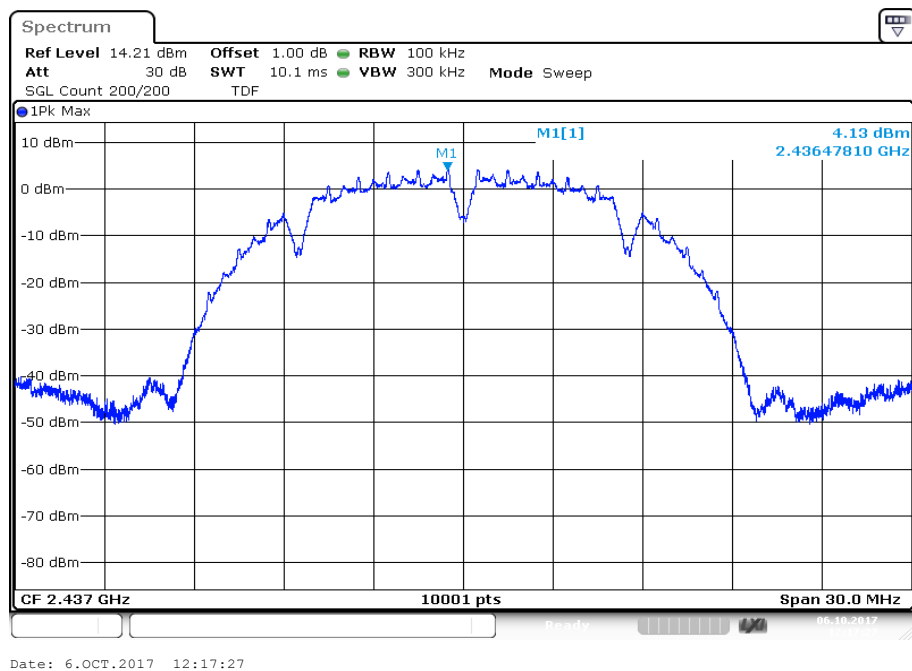
Modulation Frequency	Peak power spectral density [dBm @ 100 kHz]		
	2412 MHz	2437 MHz	2462 MHz
DSSS / b – mode	2.0	4.1	3.9
OFDM / g – mode	-1.1	-0.9	-0.9
OFDM / n HT20 – mode	-0.9	-1.4	-0.4
Frequency	2422 MHz	2437 MHz	2452 MHz
OFDM / n HT40 – mode	-6.3	-6.0	-6.3

Plots: DSSS / b – mode

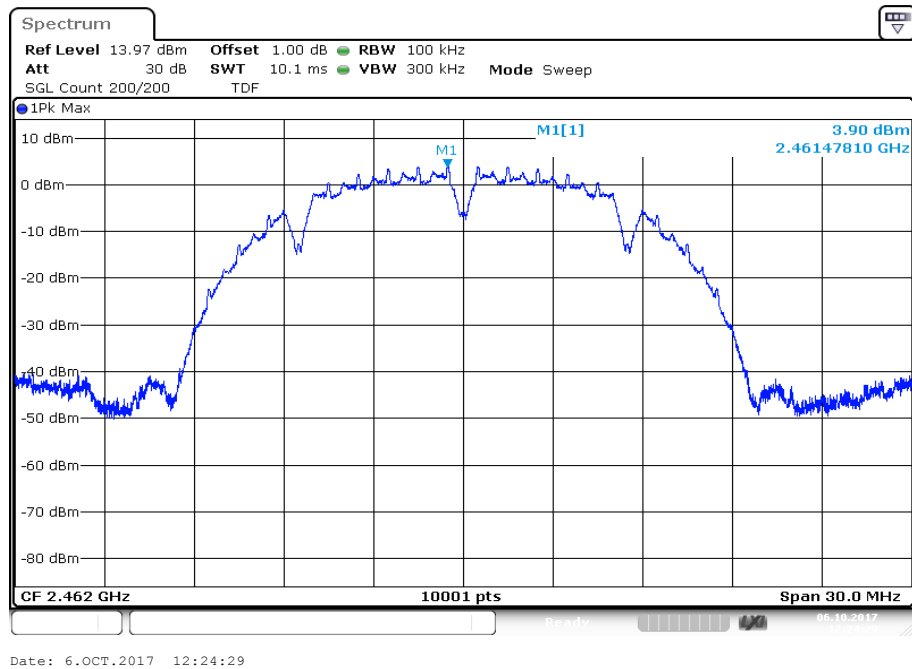
Plot 1: Lowest channel



Plot 2: Middle channel

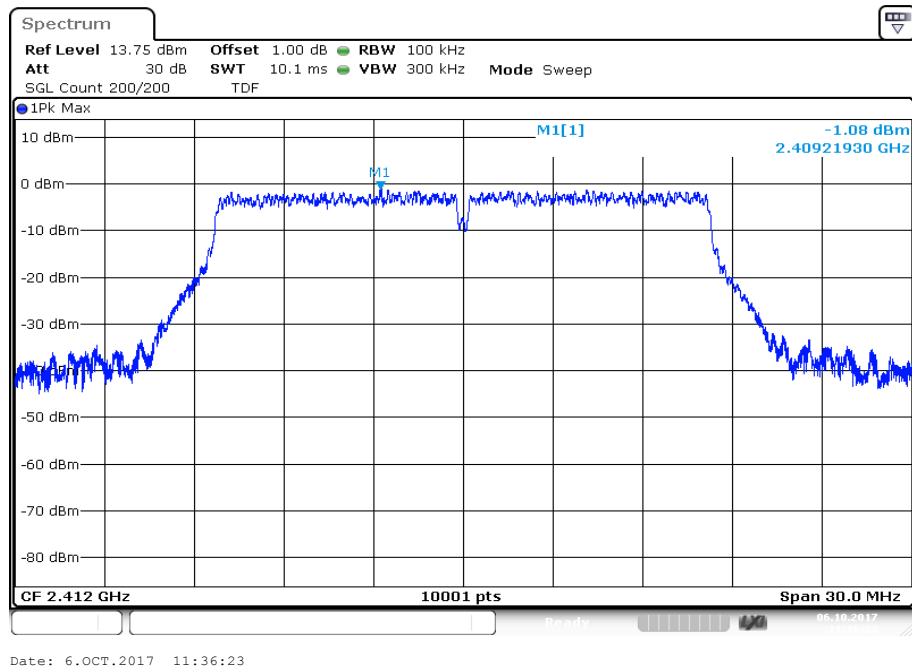


Plot 3: Highest channel

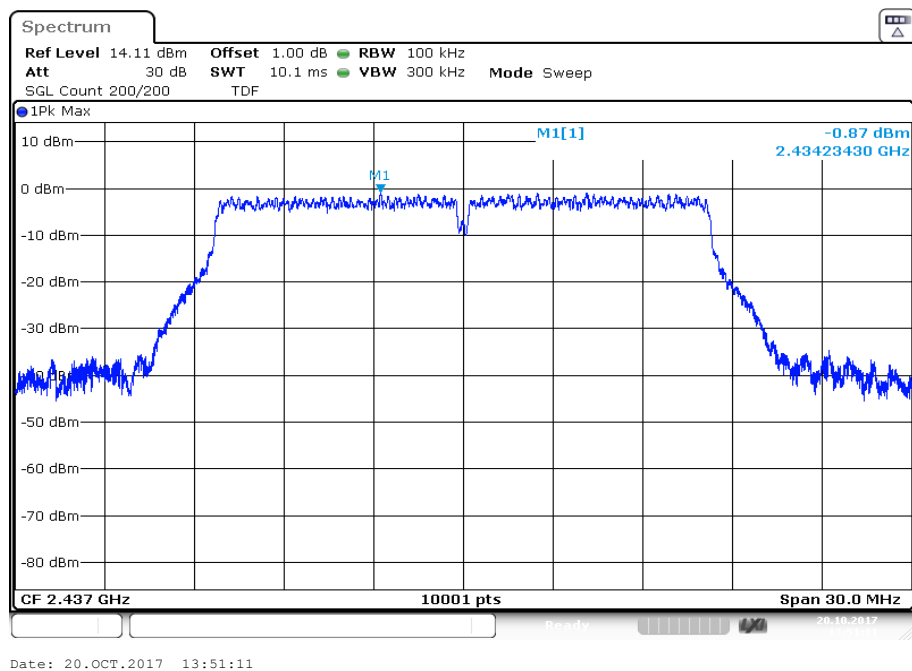


Plots: OFDM / g – mode

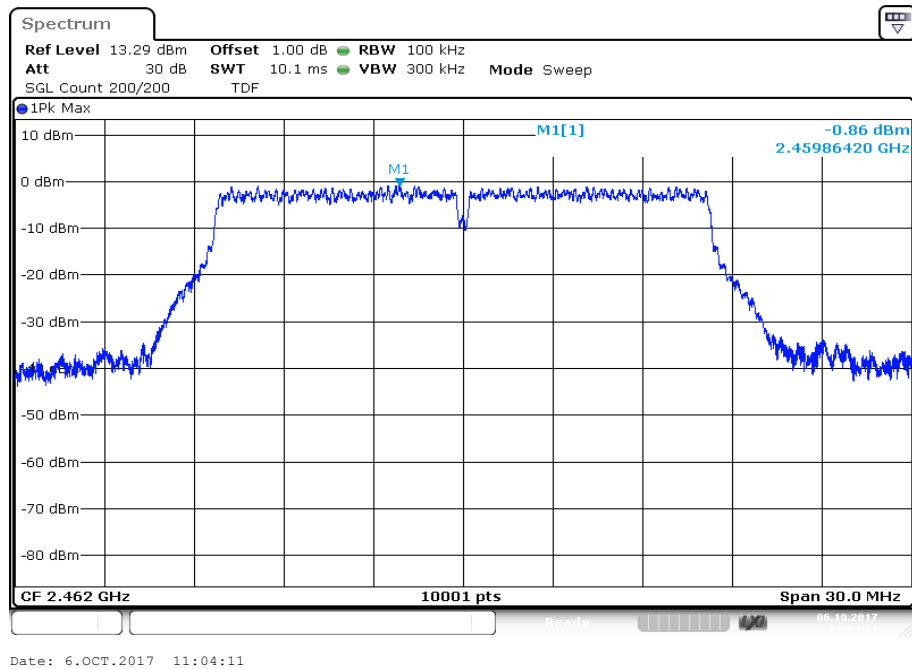
Plot 1: Lowest channel



Plot 2: Middle channel

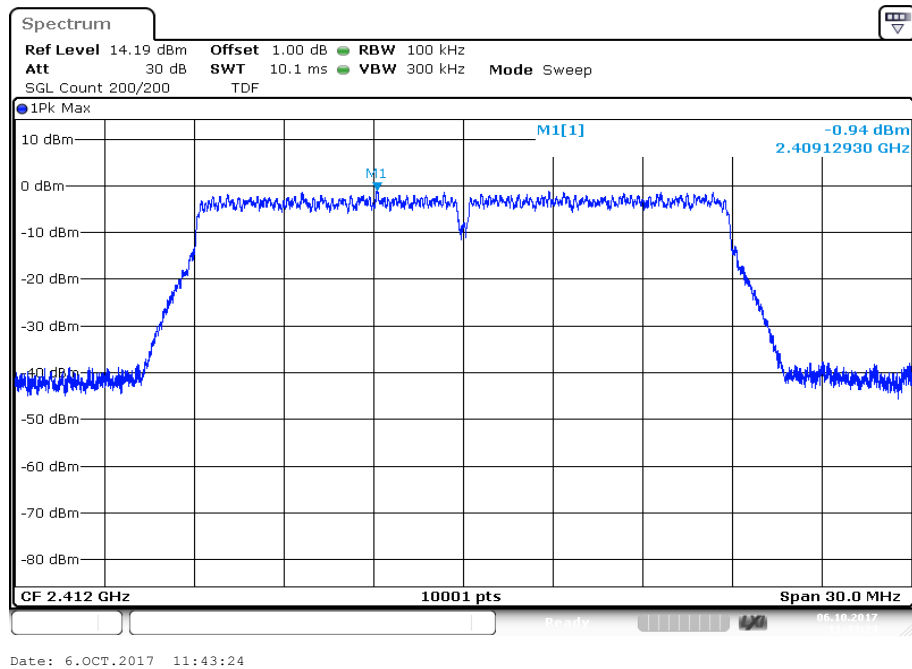


Plot 3: Highest channel

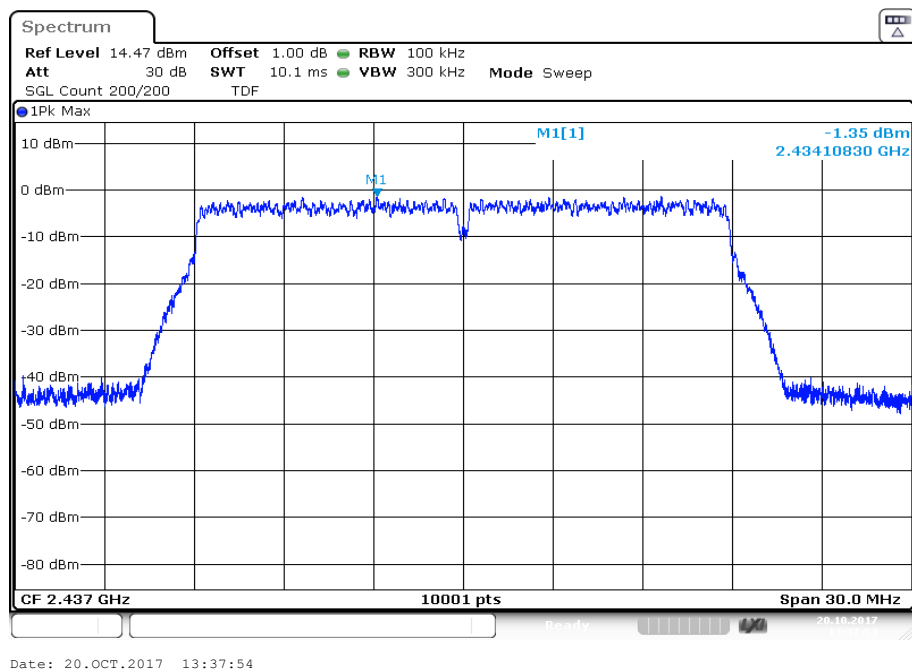


Plots: OFDM / n HT20 – mode

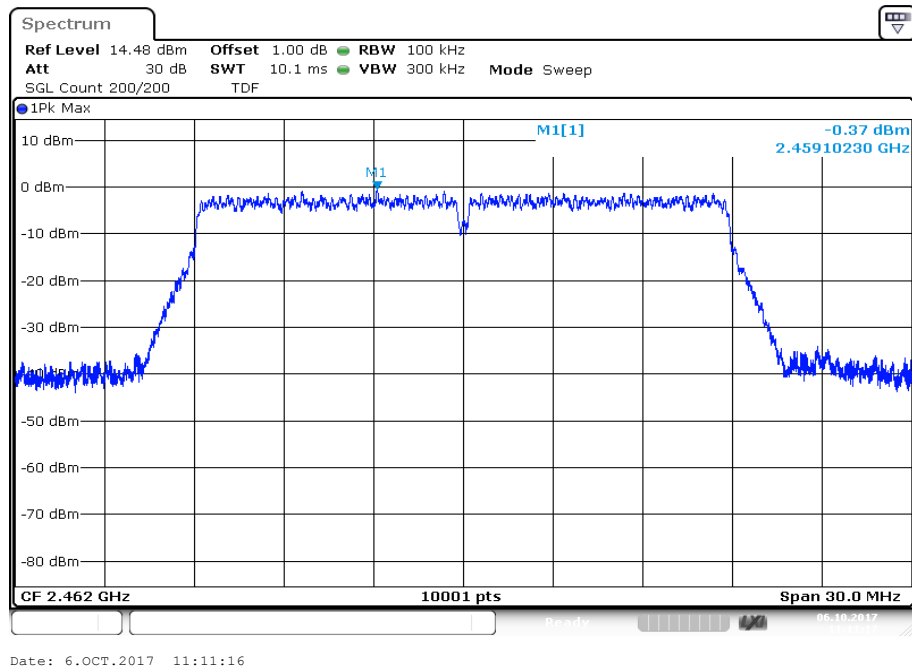
Plot 1: Lowest channel



Plot 2: Middle channel

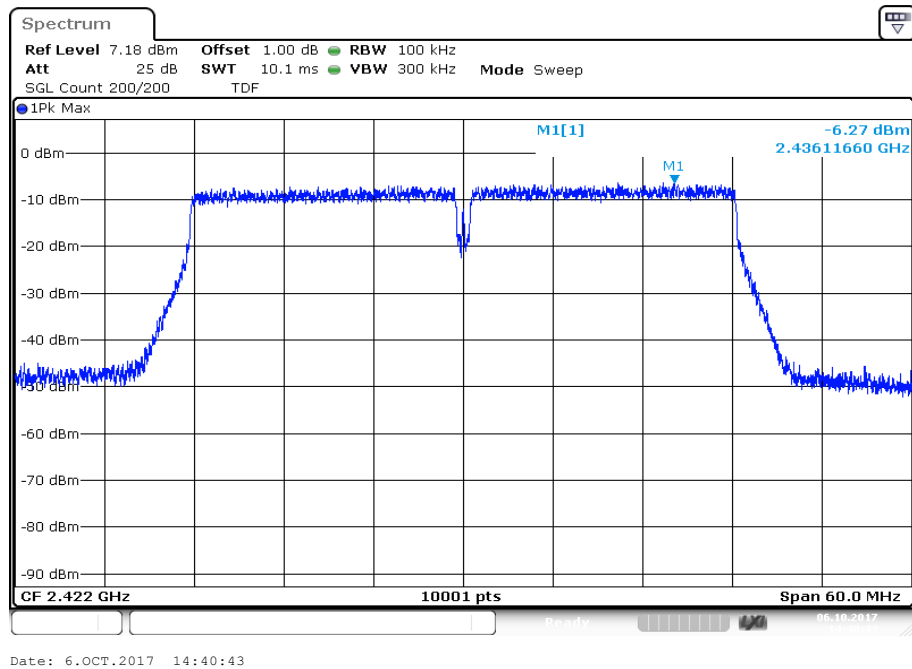


Plot 3: Highest channel

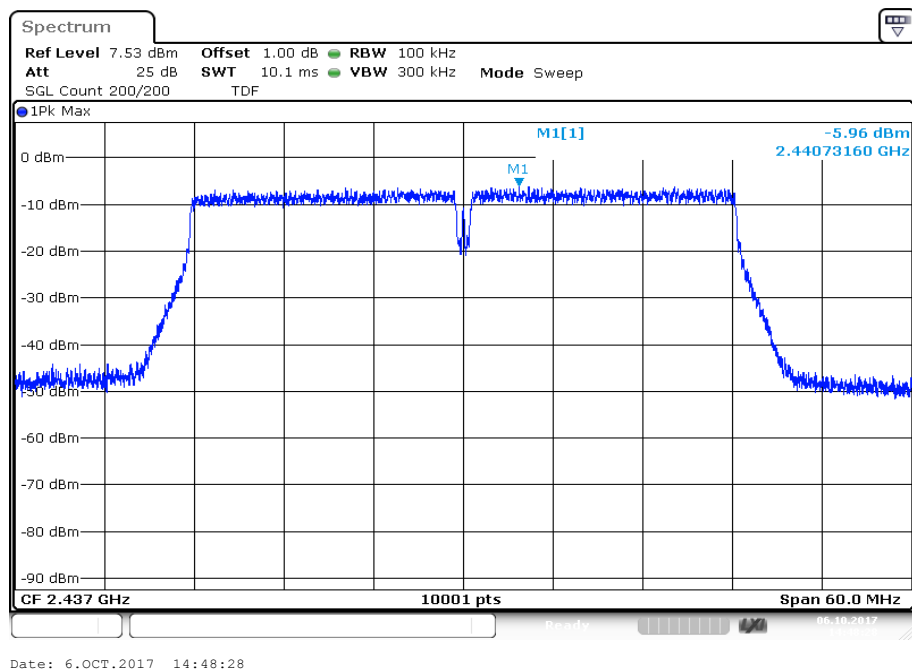


Plots: OFDM / n HT40 – mode

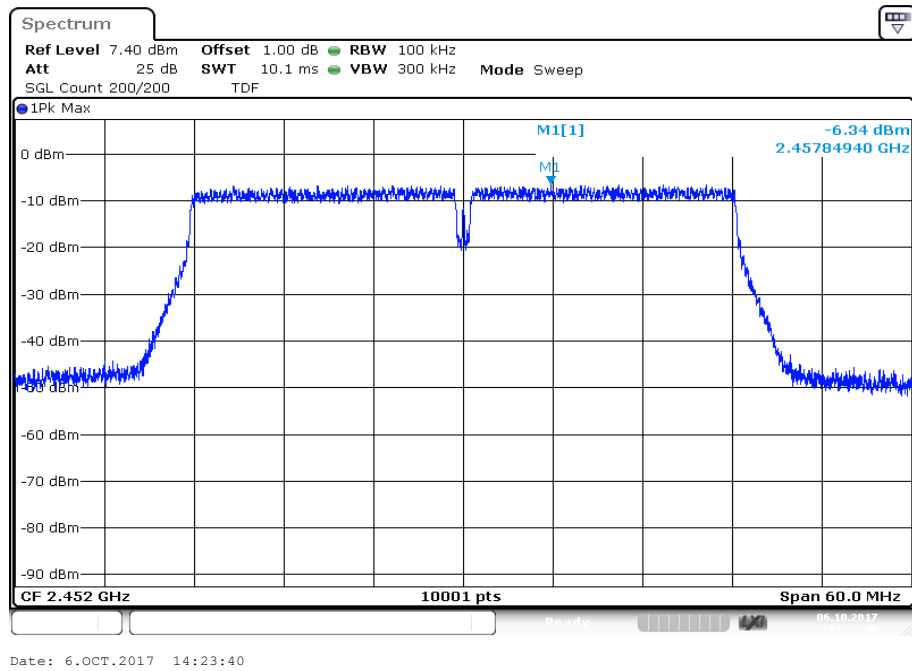
Plot 1: Lowest channel



Plot 2: Middle channel



Plot 3: Highest channel



11.6 6 dB DTS bandwidth

Description:

Measurement of the 6 dB bandwidth of the modulated signal.

Measurement:

Measurement parameter	
According to DTS clause: 8.1	
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
Test setup:	See sub clause 6.4 – A
Measurement uncertainty	See sub clause 8

Limits:

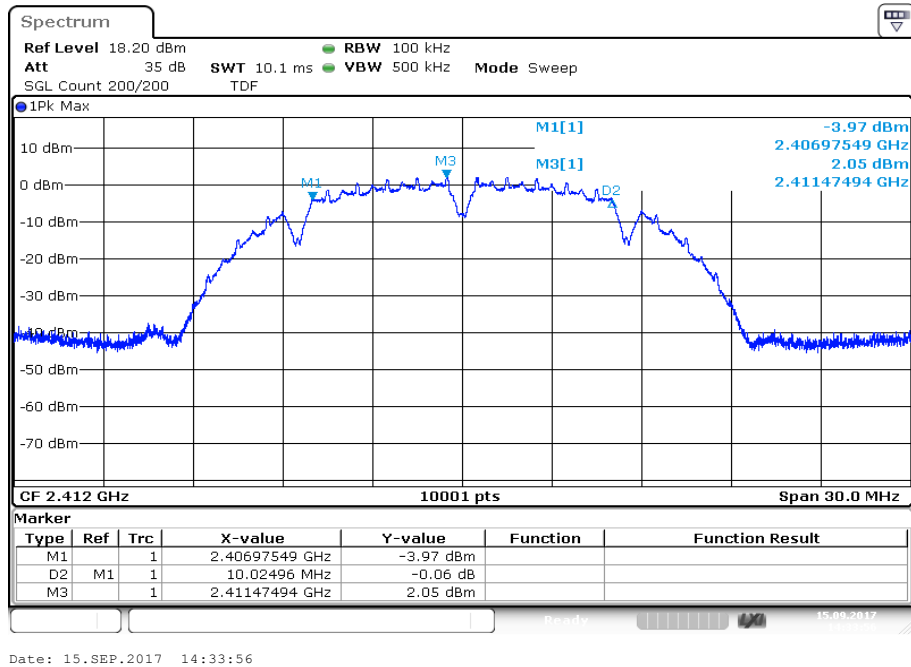
FCC	IC
Systems using digital modulation techniques may operate in the 2400–2483.5 MHz band. The minimum 6 dB bandwidth shall be at least 500 kHz.	

Results:

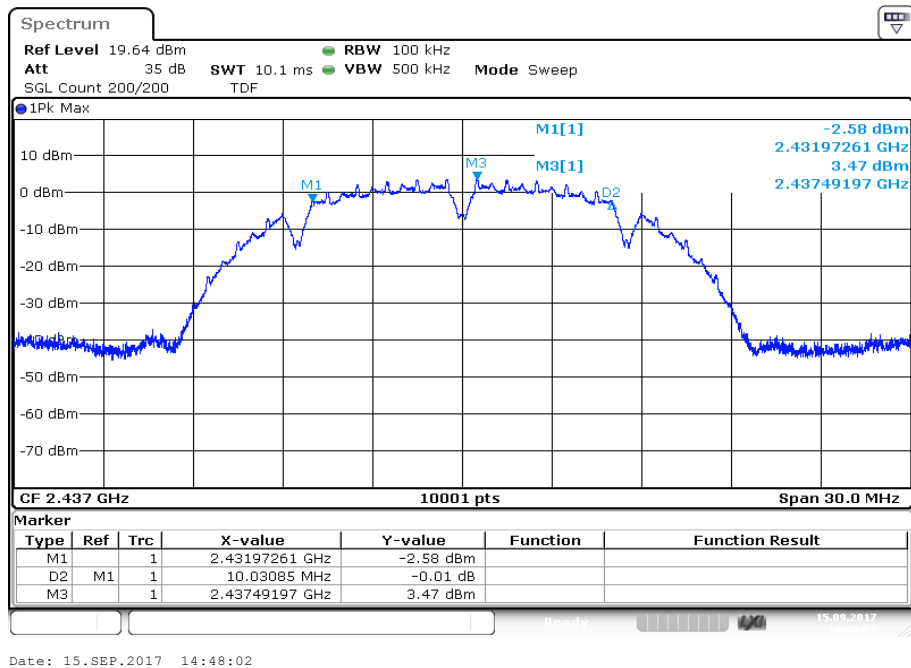
Frequency	6 dB DTS bandwidth [kHz]		
	2412 MHz	2437 MHz	2462 MHz
DSSS / b – mode	10025	10031	10031
OFDM / g – mode	16564	16564	16561
OFDM / n HT20 – mode	17797	17797	17806
Frequency	2422 MHz	2437 MHz	2452 MHz
OFDM / n HT40 – mode	36494	36476	36488

Plots: DSSS / b – mode

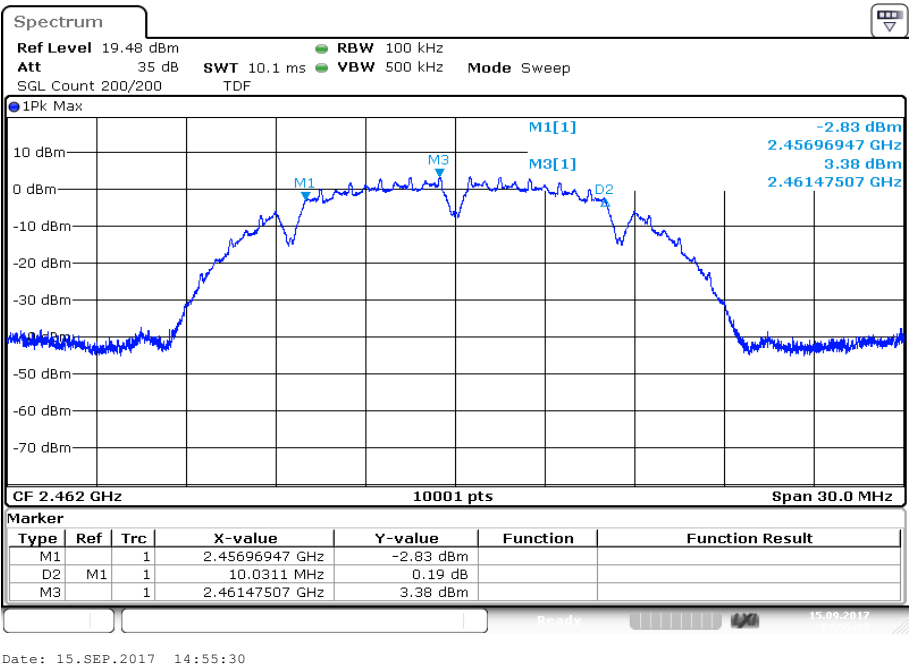
Plot 1: Lowest channel

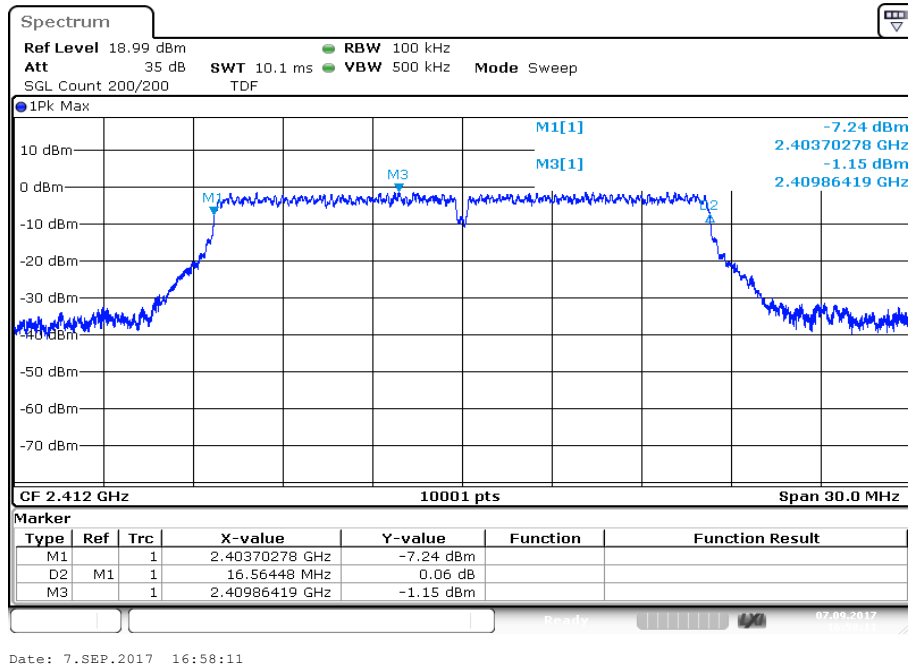
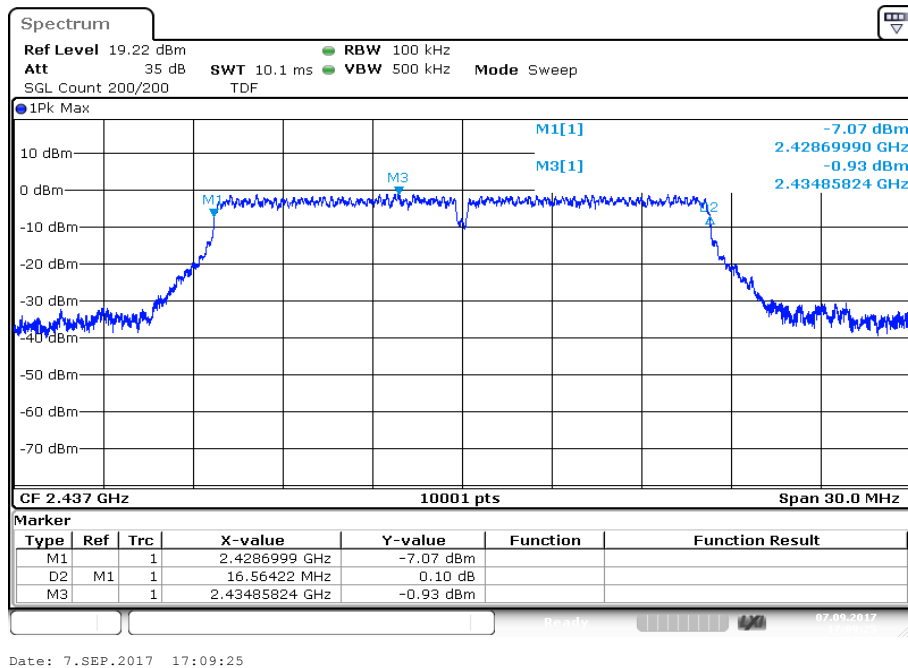


Plot 2: Middle channel

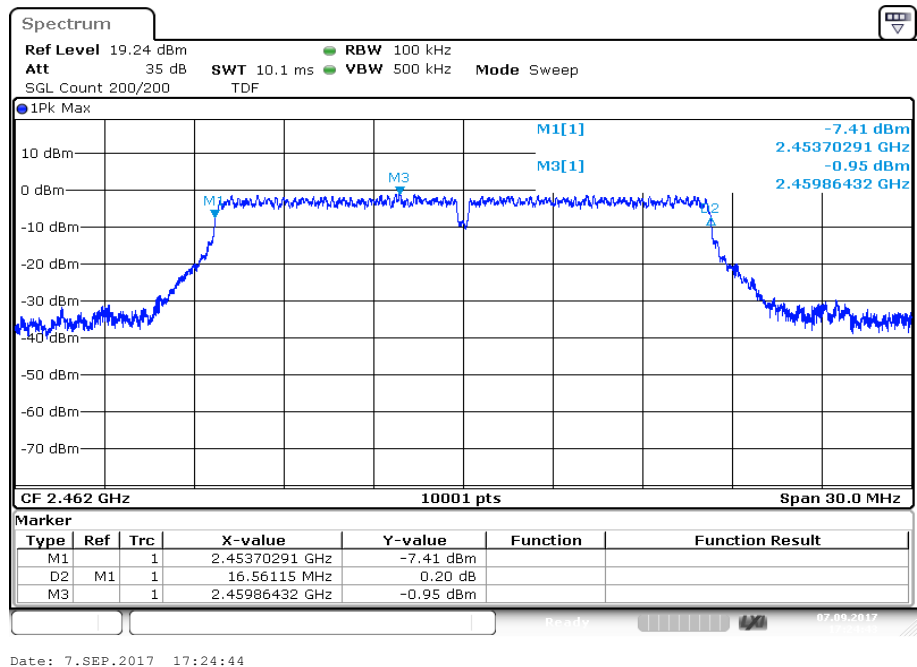


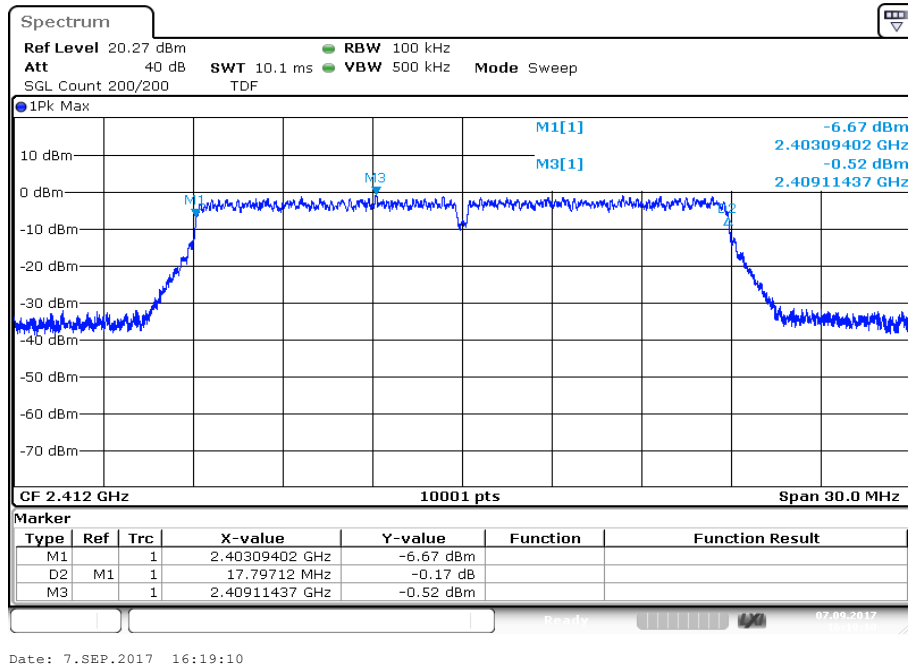
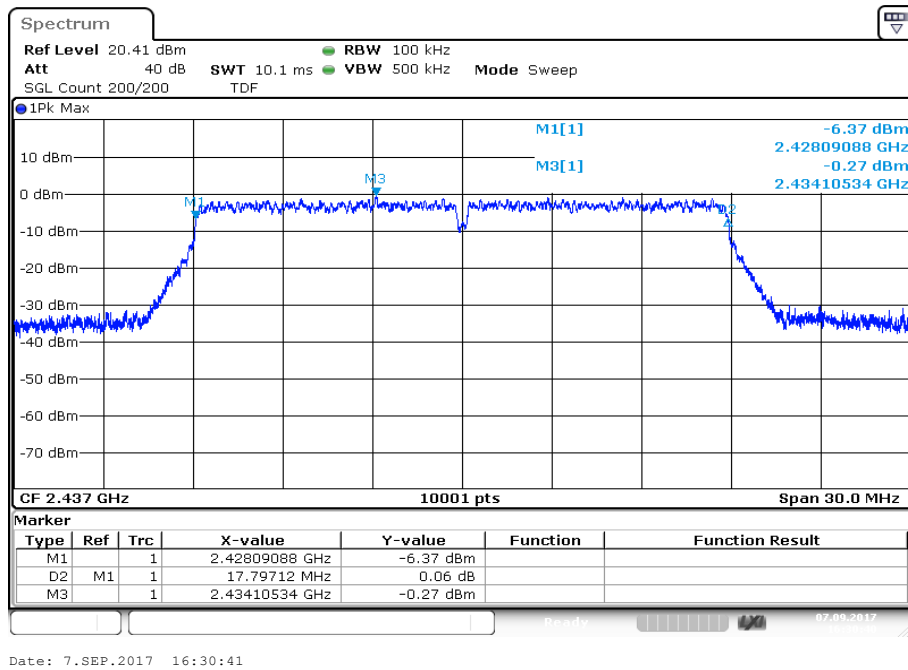
Plot 3: Highest channel



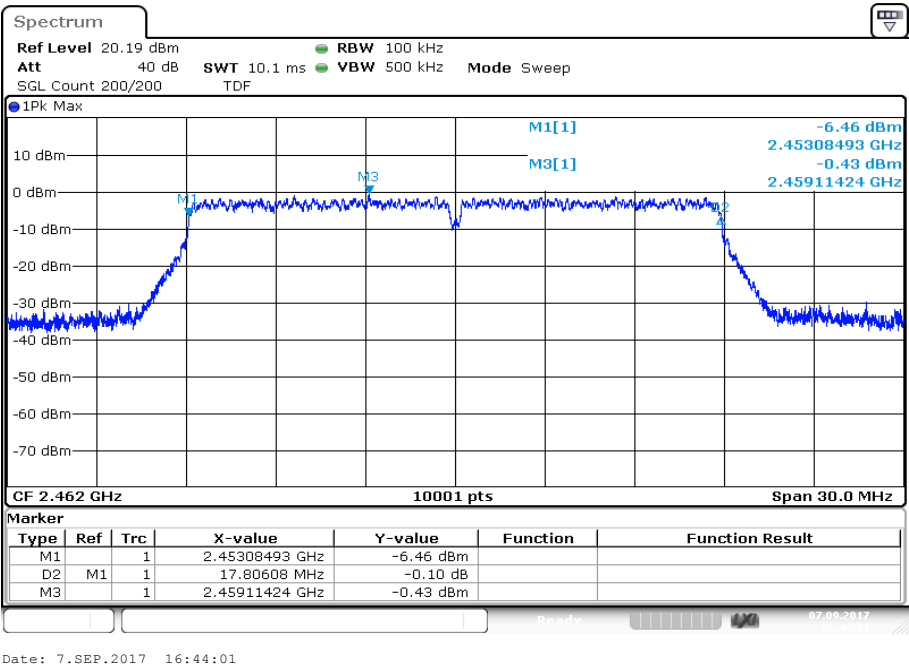
Plots: OFDM / g – mode**Plot 1:** Lowest channel**Plot 2:** Middle channel

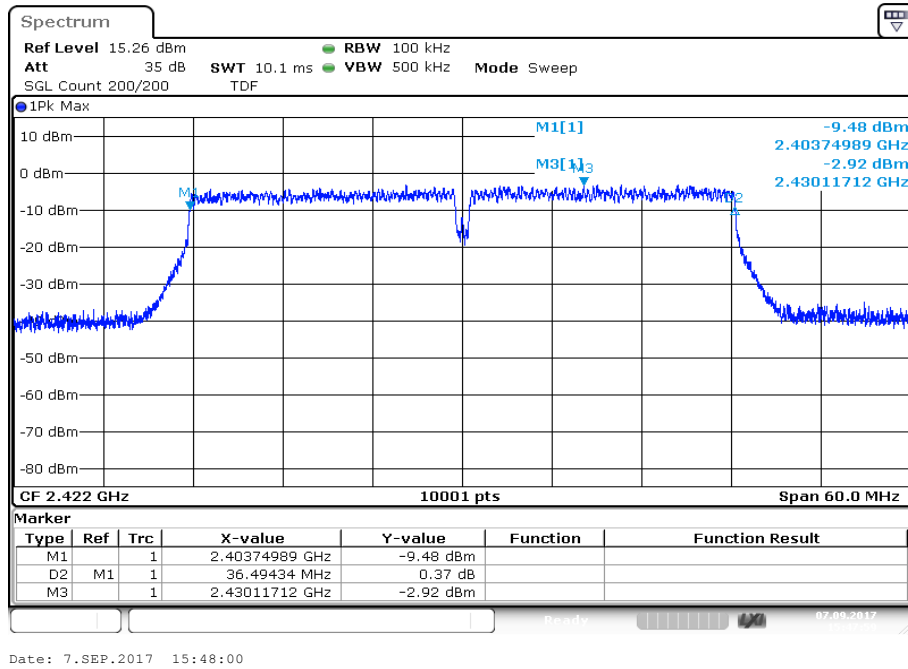
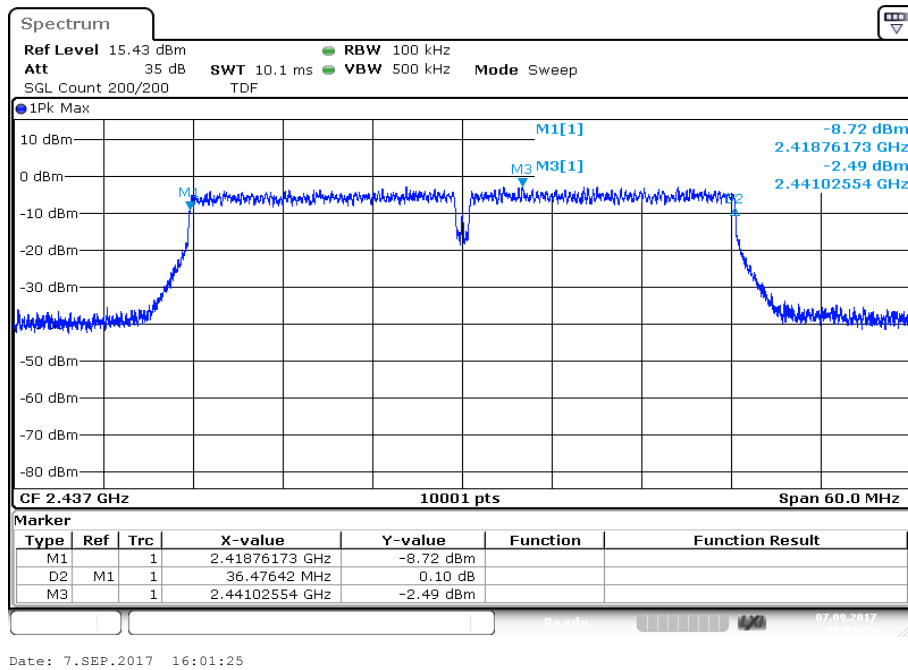
Plot 3: Highest channel



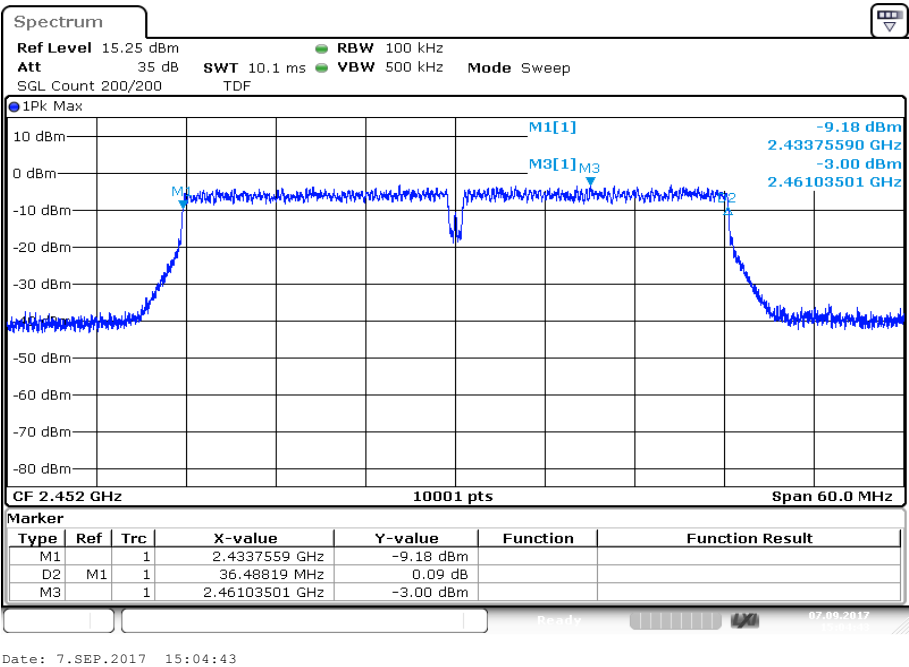
Plots: OFDM / n HT20 – mode**Plot 1:** Lowest channel**Plot 2:** Middle channel

Plot 3: Highest channel



Plots: OFDM / n HT40 – mode**Plot 1:** Lowest channel**Plot 2:** Middle channel

Plot 3: Highest channel



11.7 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
Test setup:	See sub clause 6.4 – A
Measurement uncertainty	See sub clause 8

Usage:

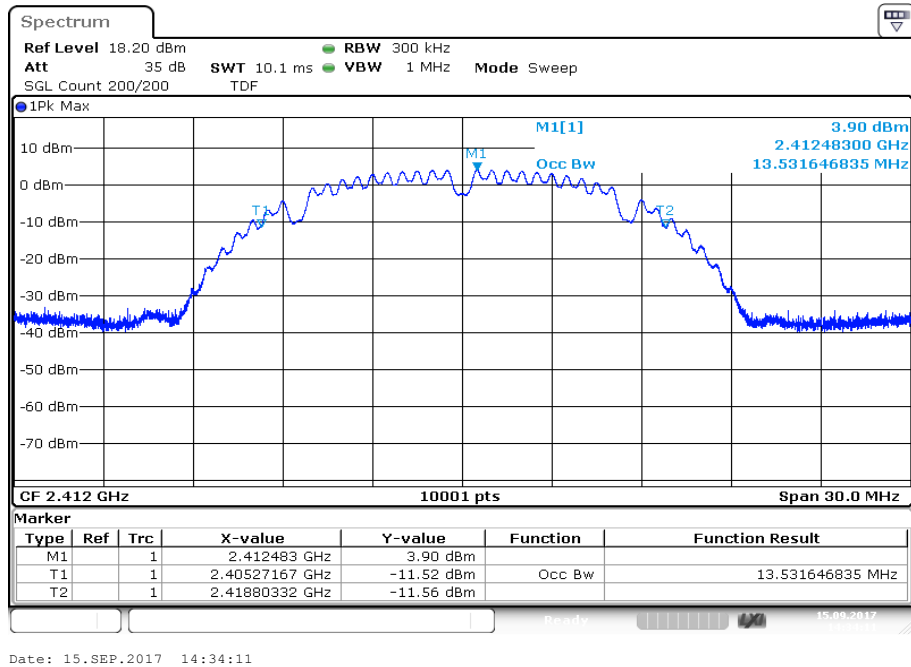
-/-	IC
OBW is necessary for Emission Designator	

Results:

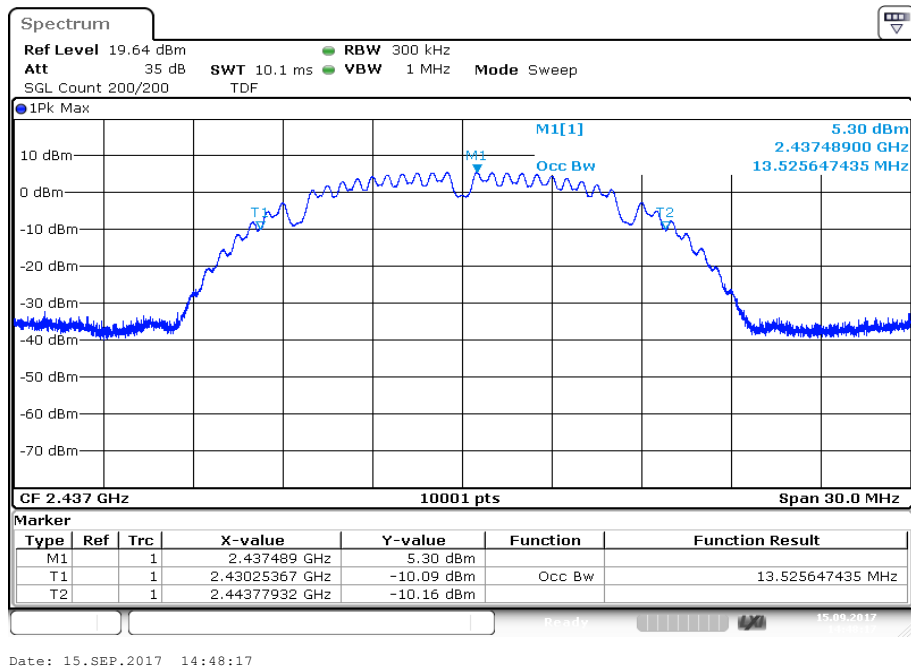
Modulation	99% bandwidth [kHz]		
	2412 MHz	2437 MHz	2462 MHz
Frequency			
DSSS / b – mode	13532	13526	13541
OFDM / g – mode	16747	16753	16750
OFDM / n HT20 – mode	17860	17869	17869
Frequency	2422 MHz	2437 MHz	2452 MHz
OFDM / n HT40 – mode	36728	36734	36704

Plots: DSSS / b – mode

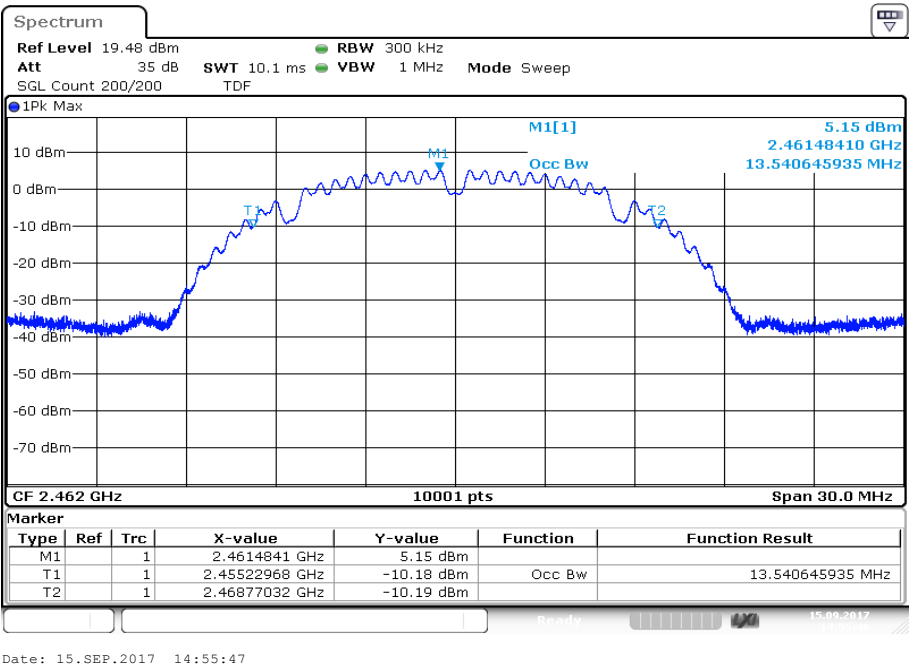
Plot 1: Lowest channel

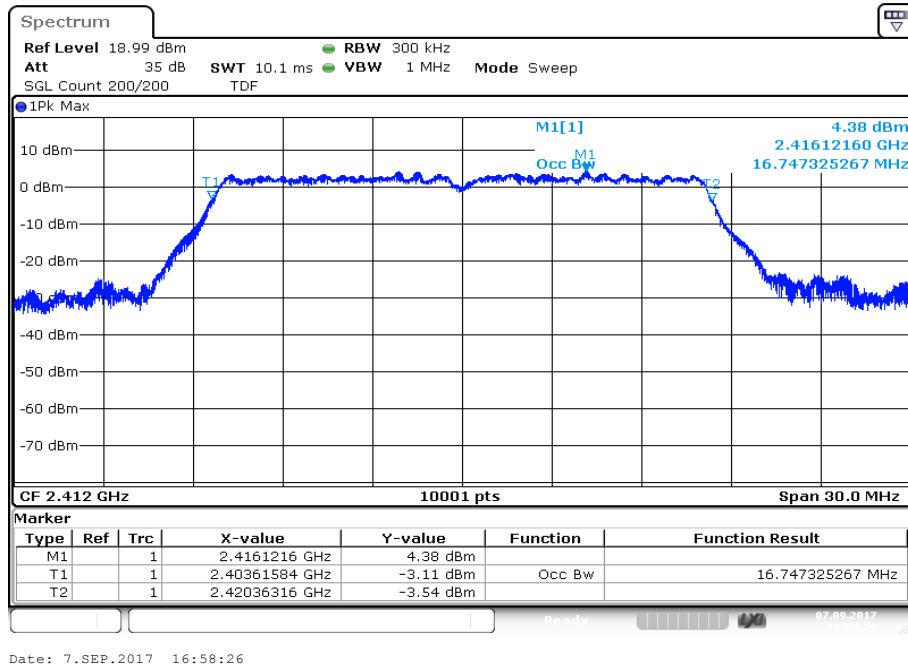
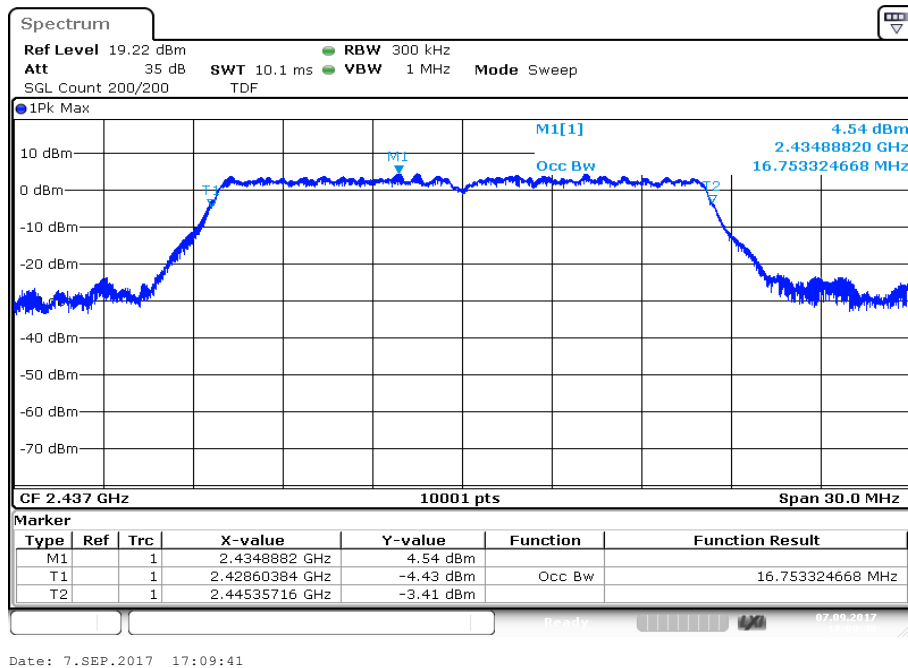


Plot 2: Middle channel

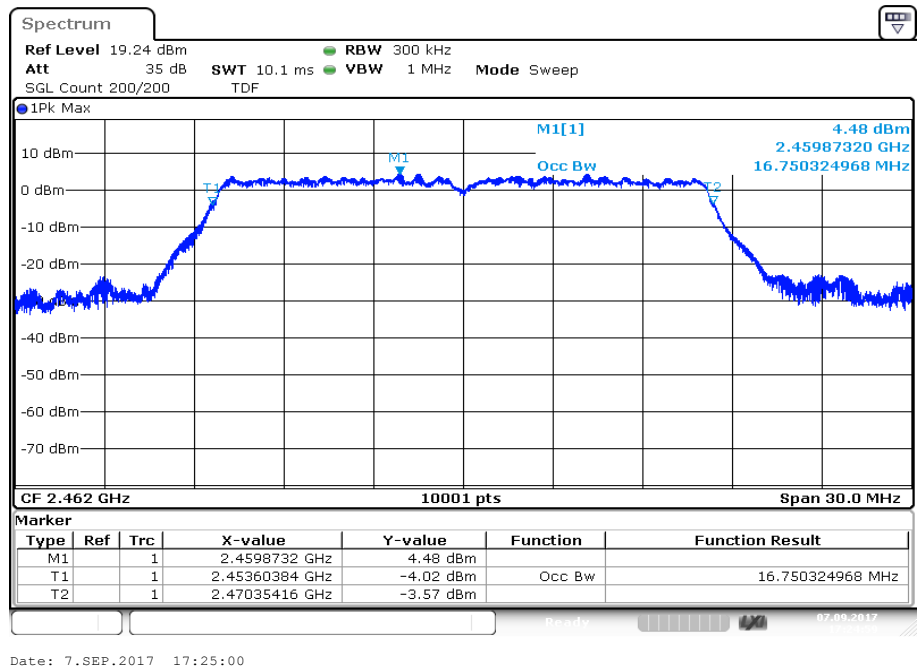


Plot 3: Highest channel



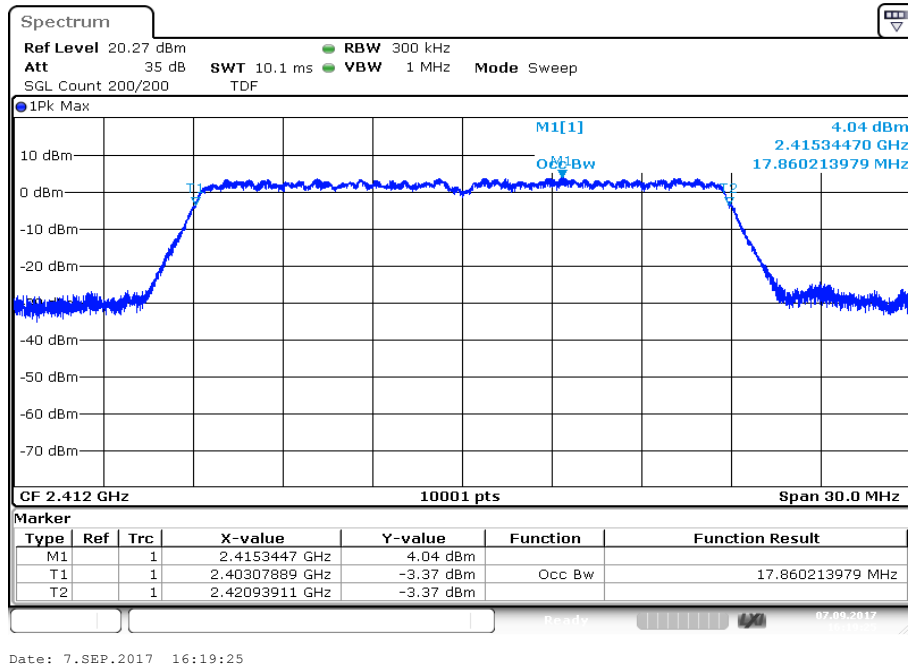
Plots: OFDM / g – mode**Plot 1:** Lowest channel**Plot 2:** Middle channel

Plot 3: Highest channel

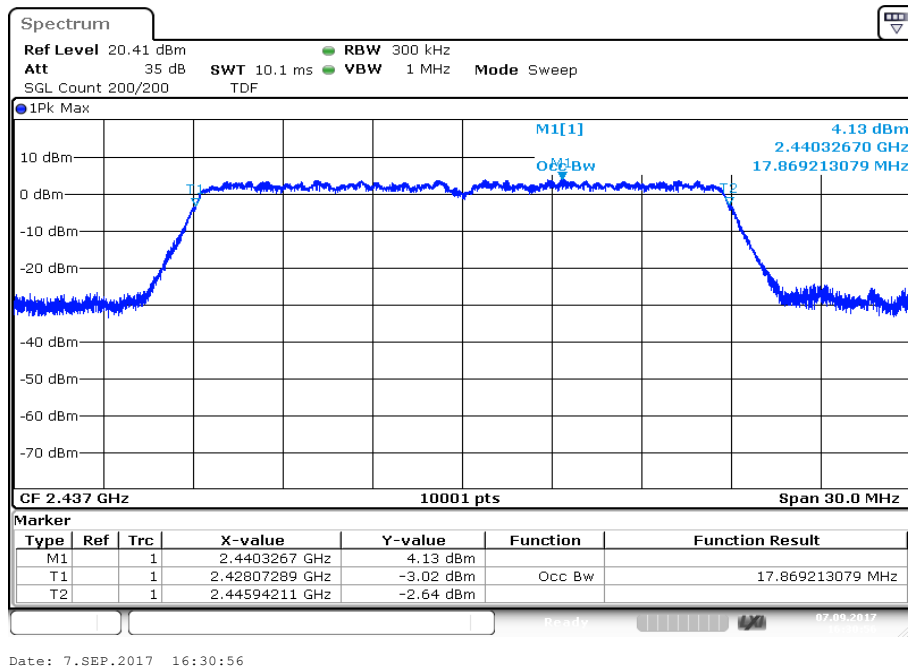


Plots: OFDM / n HT20 – mode

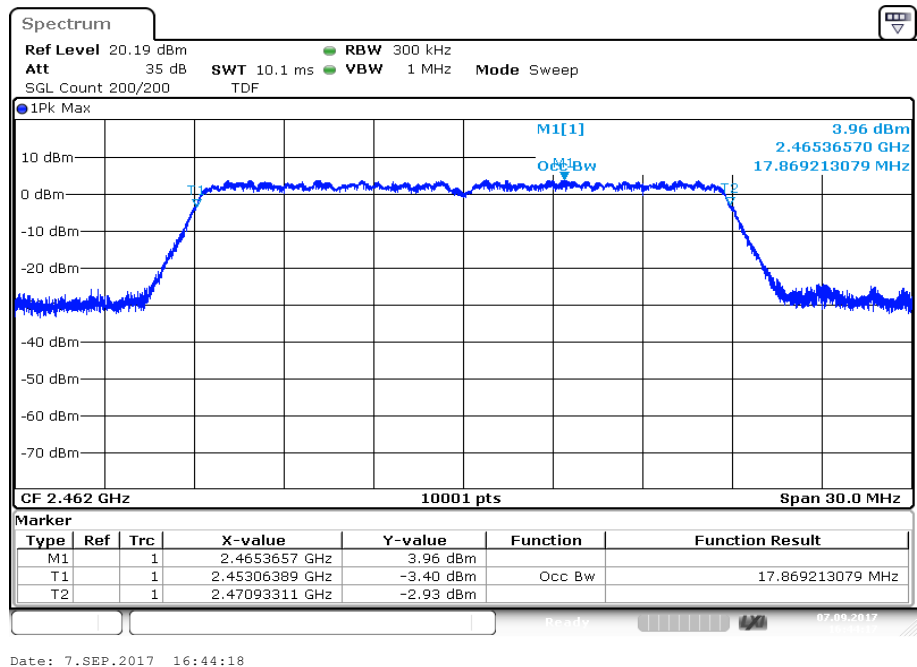
Plot 1: Lowest channel



Plot 2: Middle channel

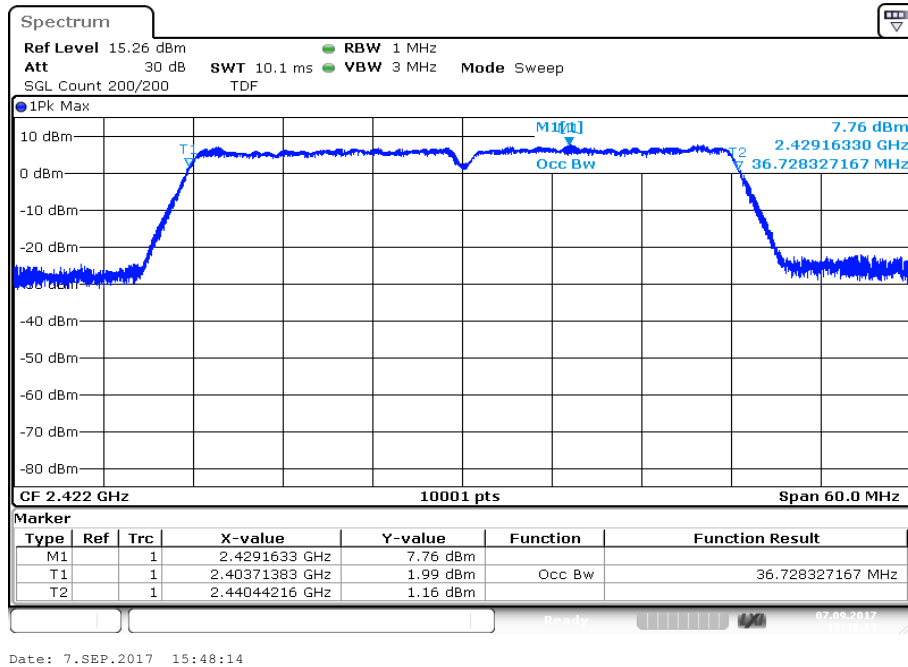


Plot 3: Highest channel

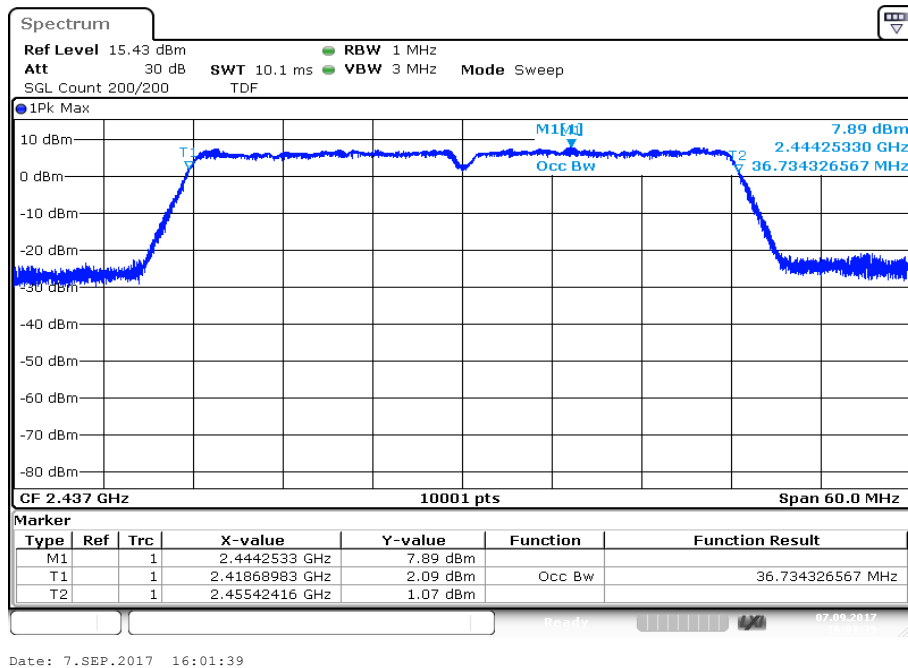


Plots: OFDM / n HT40 – mode

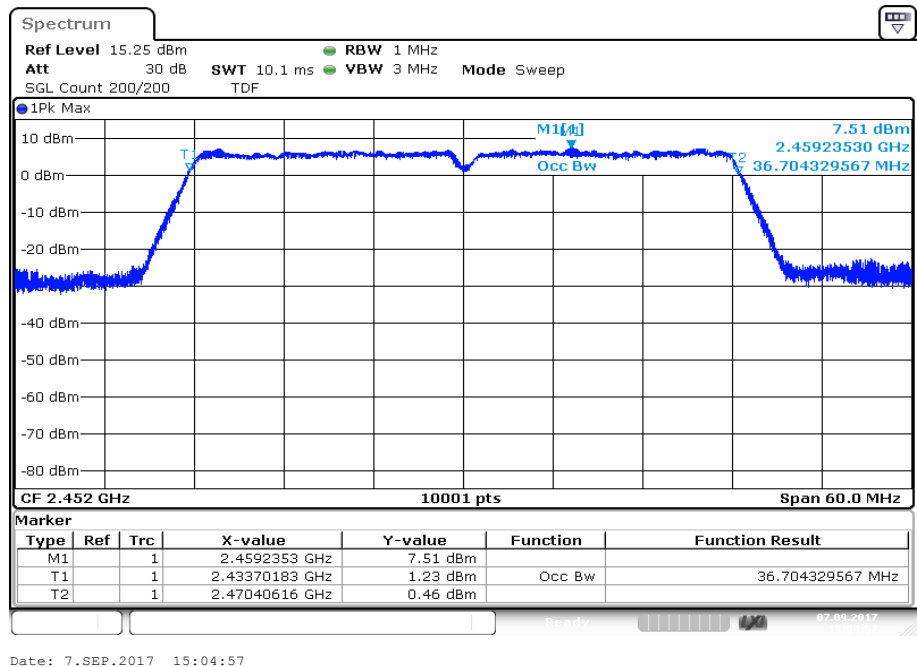
Plot 1: Lowest channel



Plot 2: Middle channel



Plot 3: Highest channel



11.8 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
Test setup:	See sub clause 6.4 – A
Measurement uncertainty	See sub clause 8

Usage:

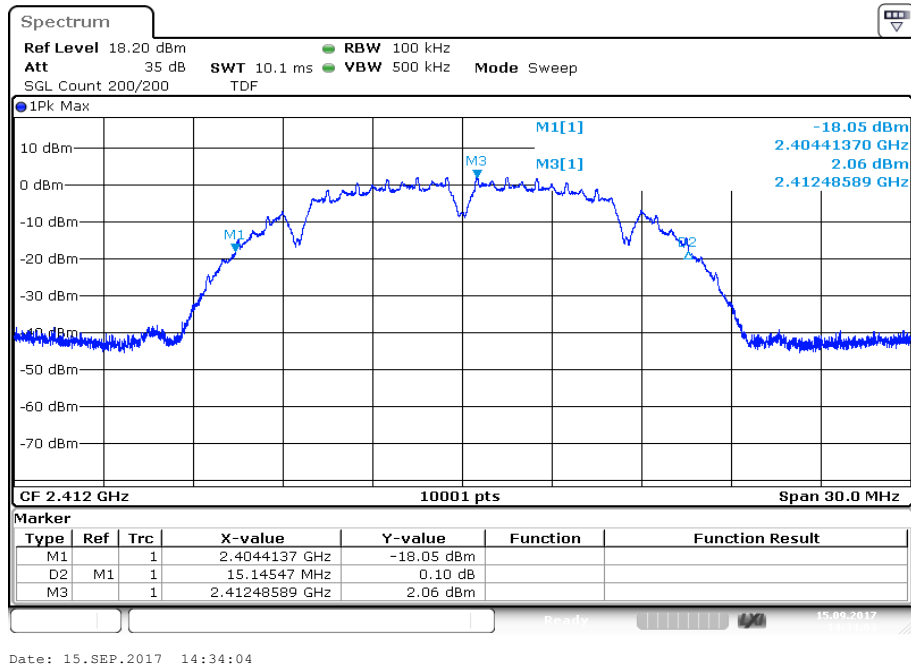
-/-	IC
Within the used band!	

Results:

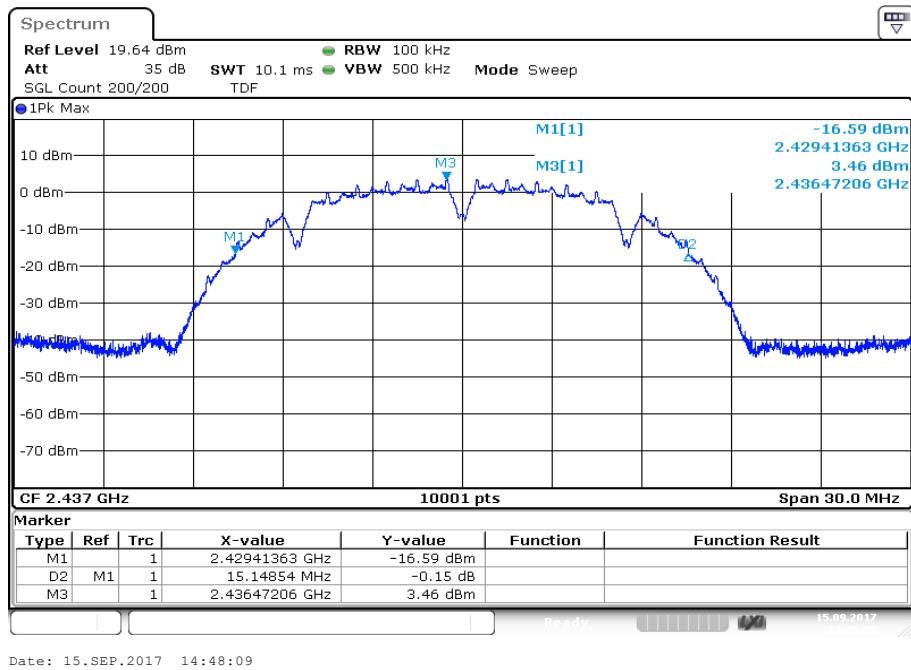
Modulation	20 dB bandwidth [MHz]		
	2412 MHz	2437 MHz	2462 MHz
Frequency			
DSSS / b – mode	15.15	15.15	15.15
OFDM / g – mode	18.25	18.24	18.26
OFDM / n HT20 – mode	19.14	19.15	19.12
Frequency	2422 MHz	2437 MHz	2452 MHz
OFDM / n HT40 – mode	37.99	37.82	37.83

Plots: DSSS / b – mode

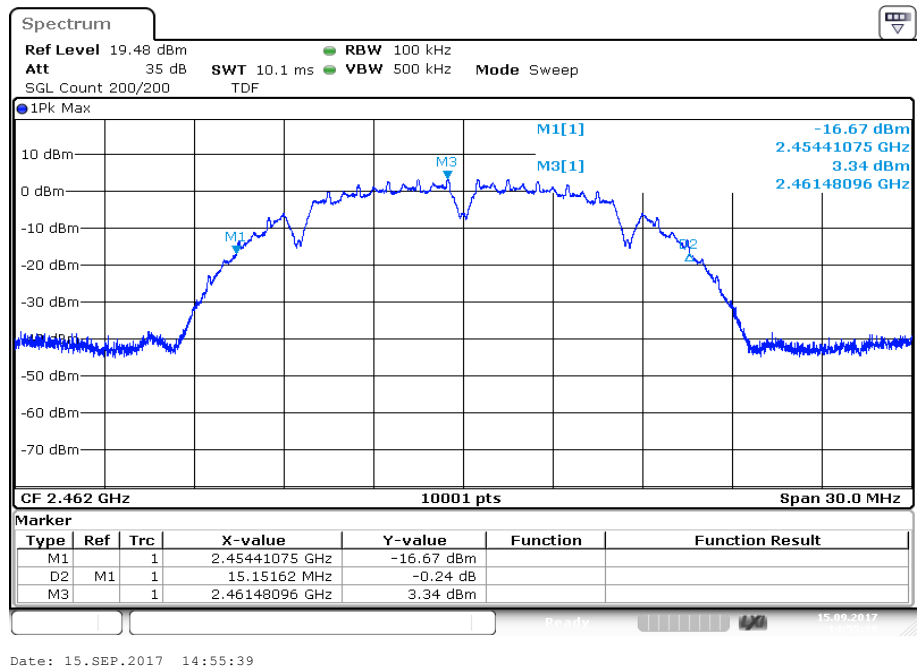
Plot 1: Lowest channel

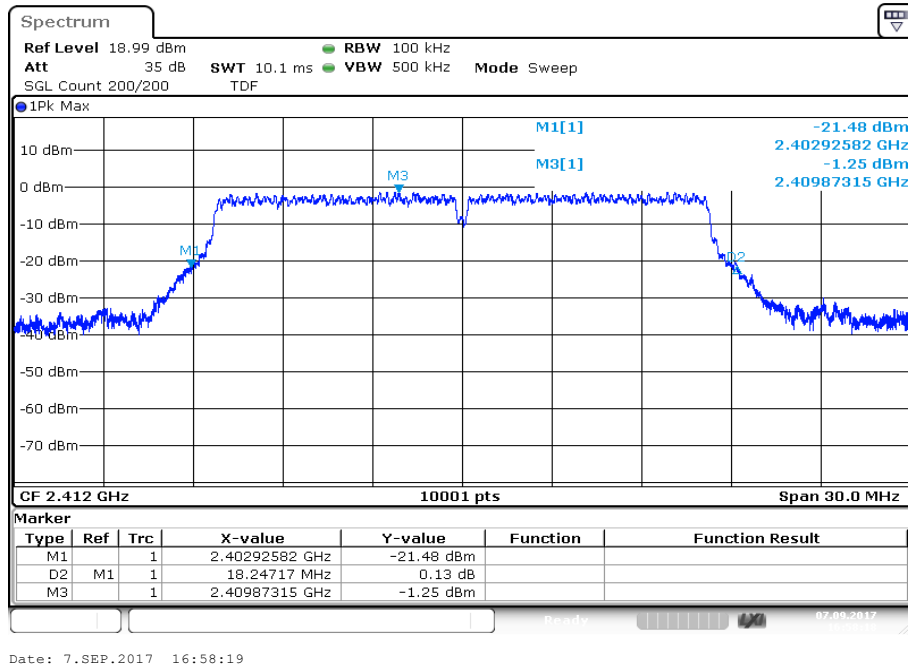
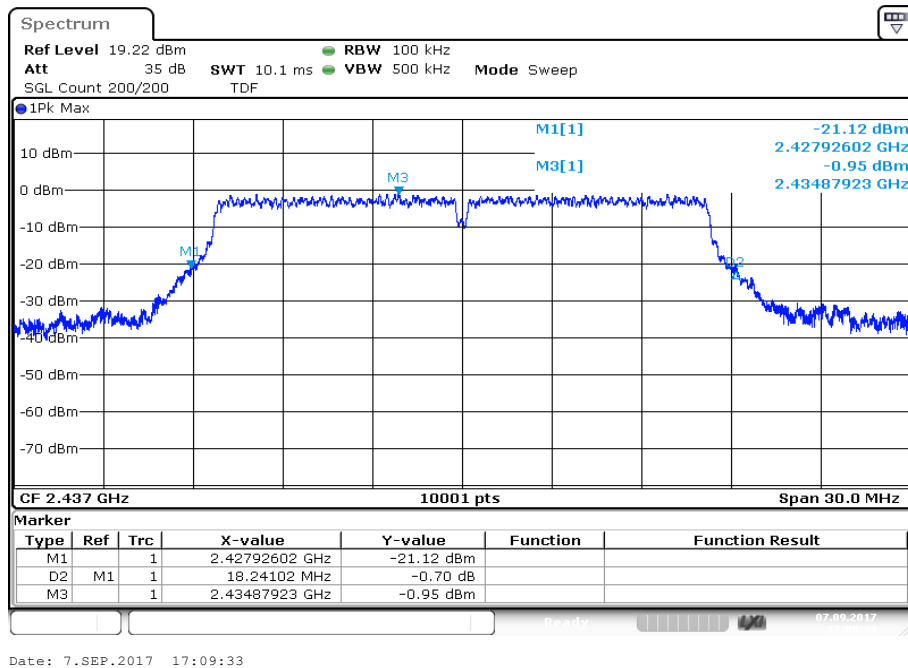


Plot 2: Middle channel

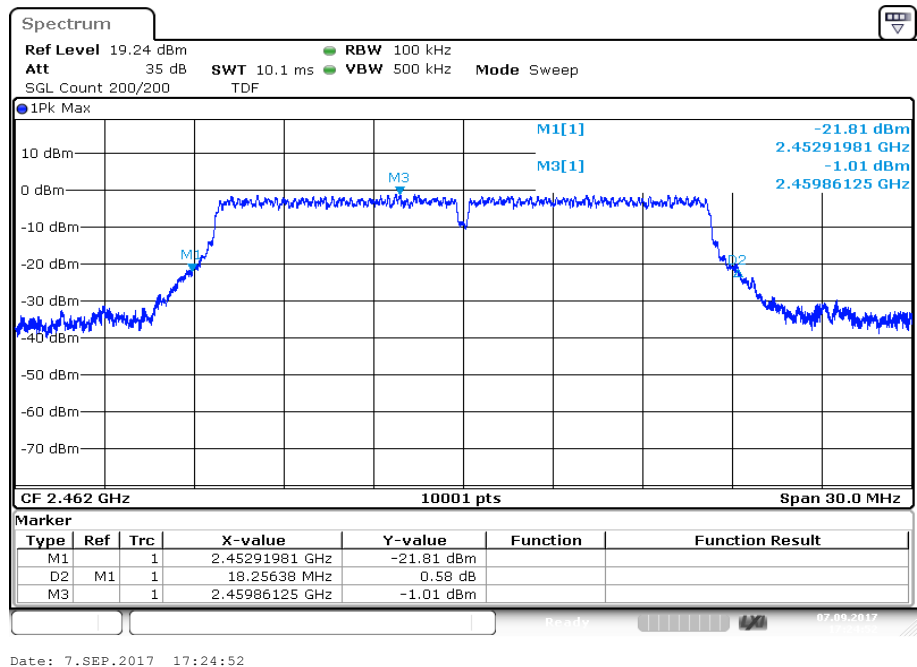


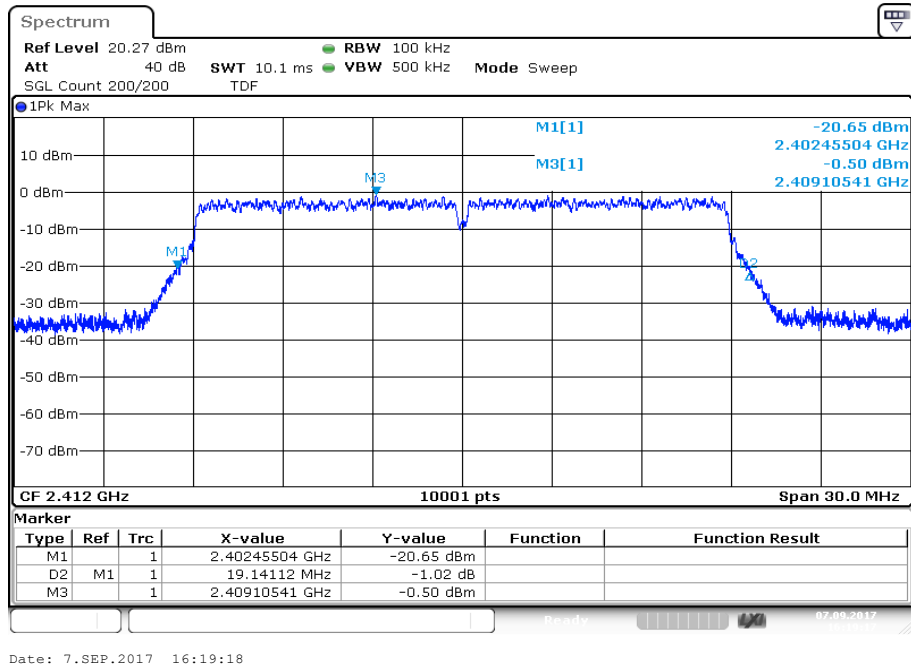
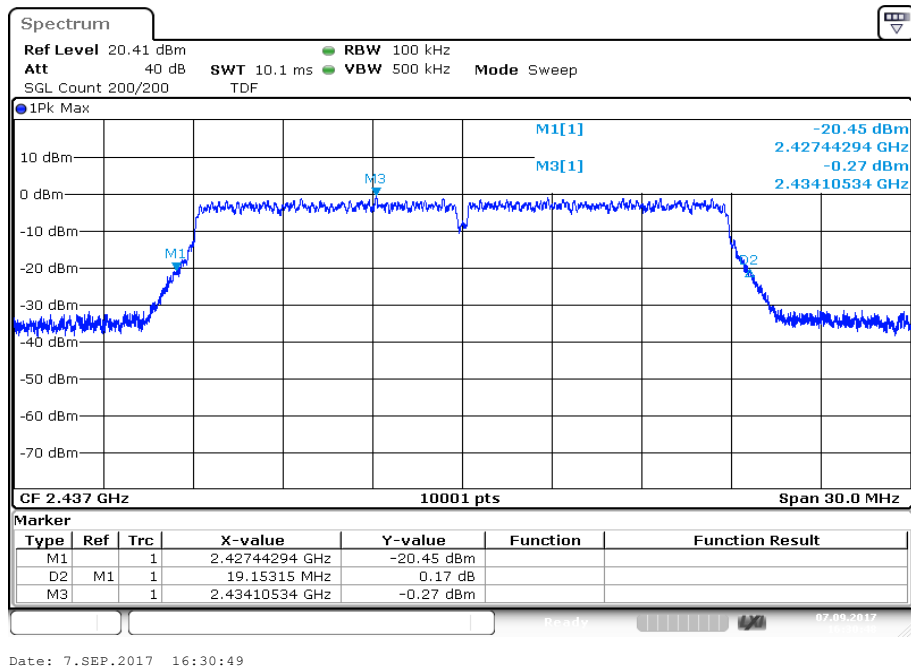
Plot 3: Highest channel



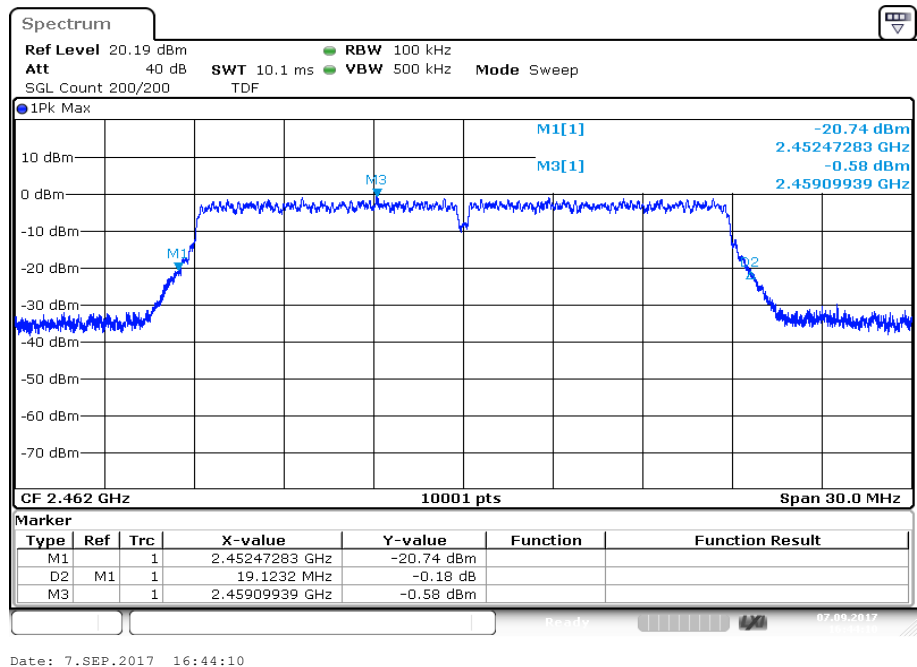
Plots: OFDM / g – mode**Plot 1:** Lowest channel**Plot 2:** Middle channel

Plot 3: Highest channel



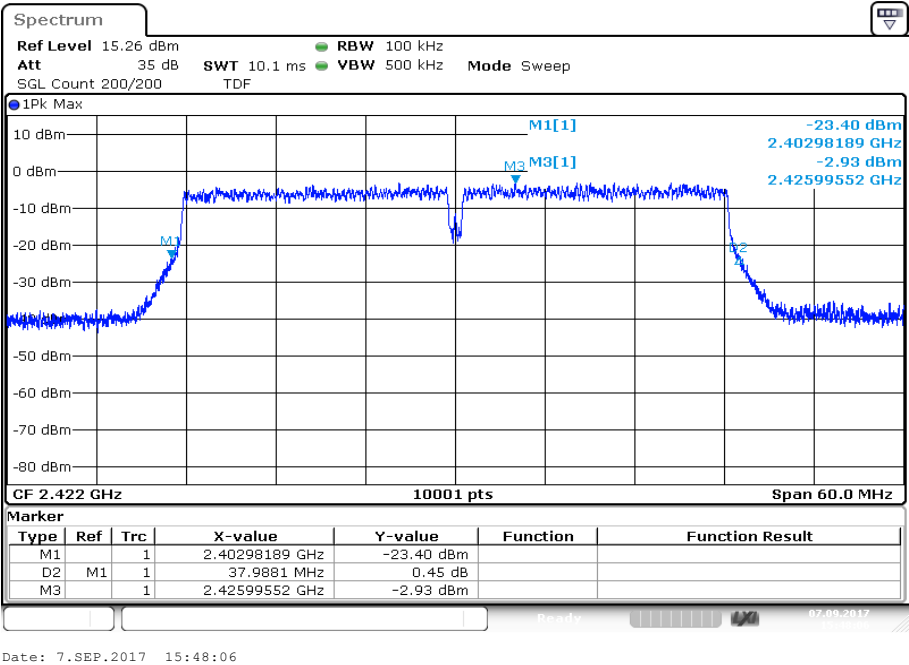
Plots: OFDM / n HT20 – mode**Plot 1:** Lowest channel**Plot 2:** Middle channel

Plot 3: Highest channel

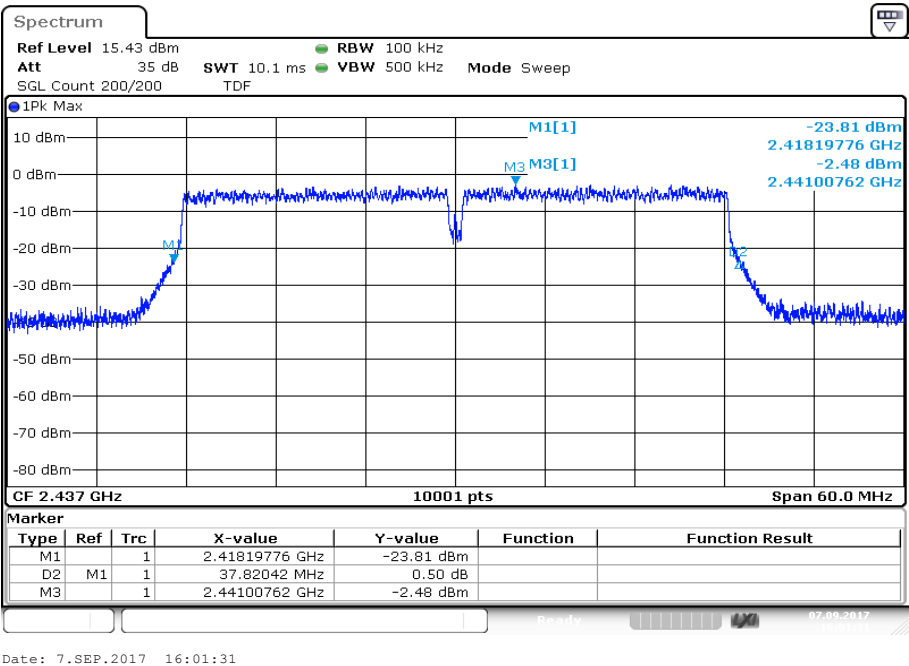


Plots: OFDM / n HT40 – mode

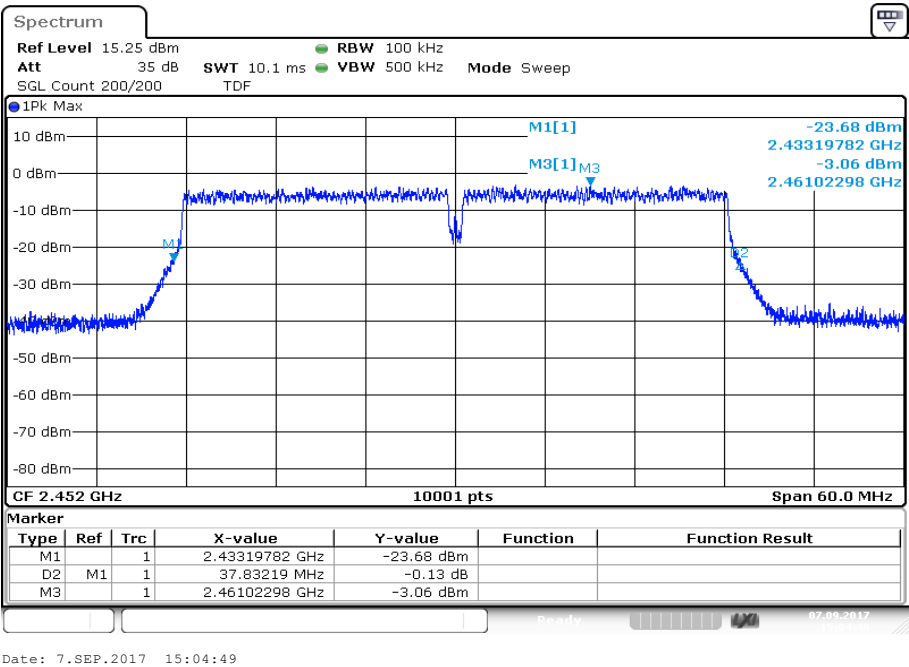
Plot 1: Lowest channel



Plot 2: Middle channel



Plot 3: Highest channel



11.9 Band edge compliance conducted - restricted bands

Description:

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

Measurement:

Measurement parameter for measurements	
According to DTS clause: 13.3.2 and clause 12.2.2	
Detector:	RMS
Sweep time:	Auto
Resolution bandwidth:	100 kHz
Video bandwidth:	300 kHz
Span:	Lower band edge: 2388 MHz to 2390 MHz (2 MHz) Upper band edge: 2483.5 MHz to 2485.5 MHz (2 MHz)
Trace mode:	Trace average with 200 counts
Test setup:	See sub clause 6.4 – A
Measurement uncertainty	See sub clause 8

Limits:

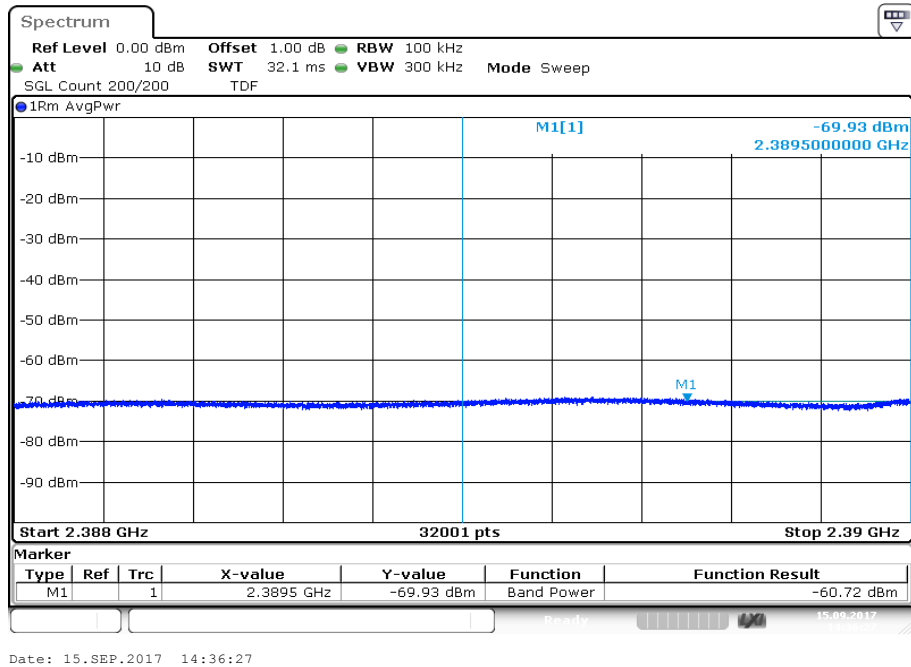
FCC	IC
-41.26 dBm	

Results:

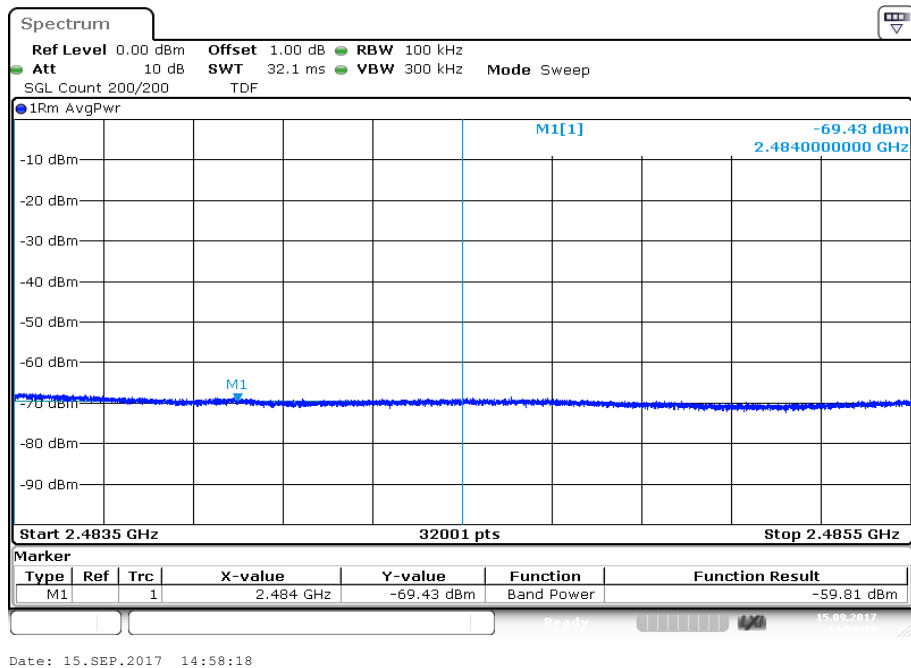
Scenario Modulation	Band edge compliance [dBm] (gain calculation)			
	DSSS / b – mode	OFDM / g – mode	OFDM / n HT20 – mode	OFDM / n HT40 – mode
Max. lower band edge power conducted	-60.7	-48.5	-47.4	-49.0
Antenna gain	2.5			
Max. lower band edge power radiated	-57.7	-46.0	-44.9	-46.5
Max. upper band edge power conducted	-59.8	-47.7	-46.6	-50.9
Antenna gain	2.5			
Max. upper band edge power radiated	-57.3	-45.2	-44.1	-48.5

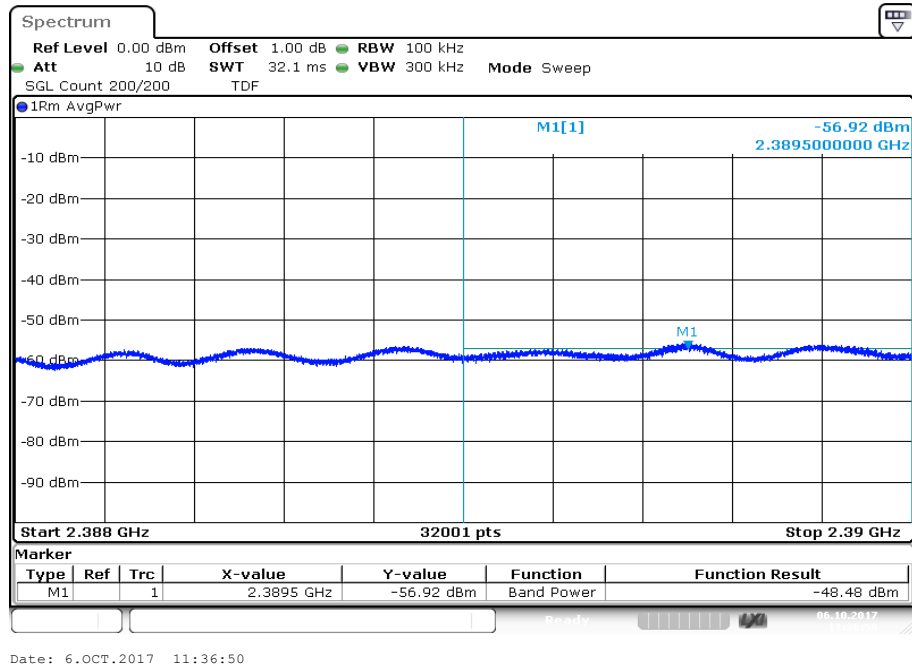
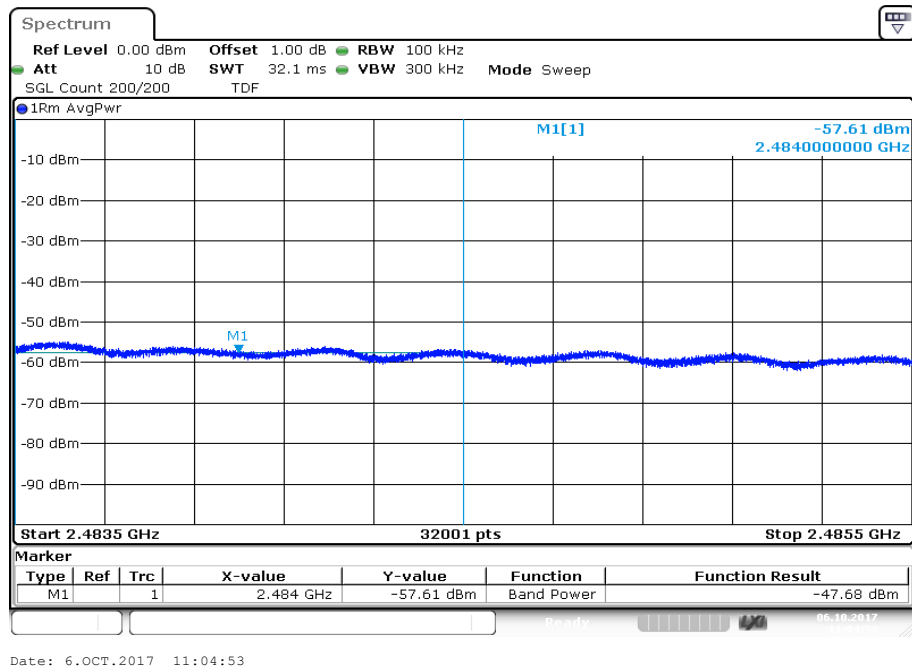
Plots: DSSS / b – mode

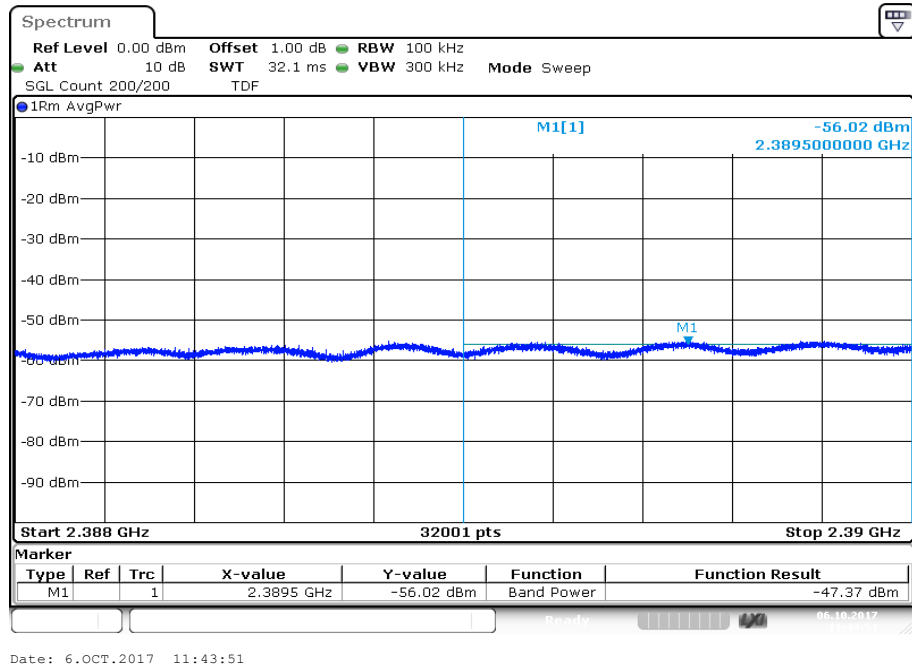
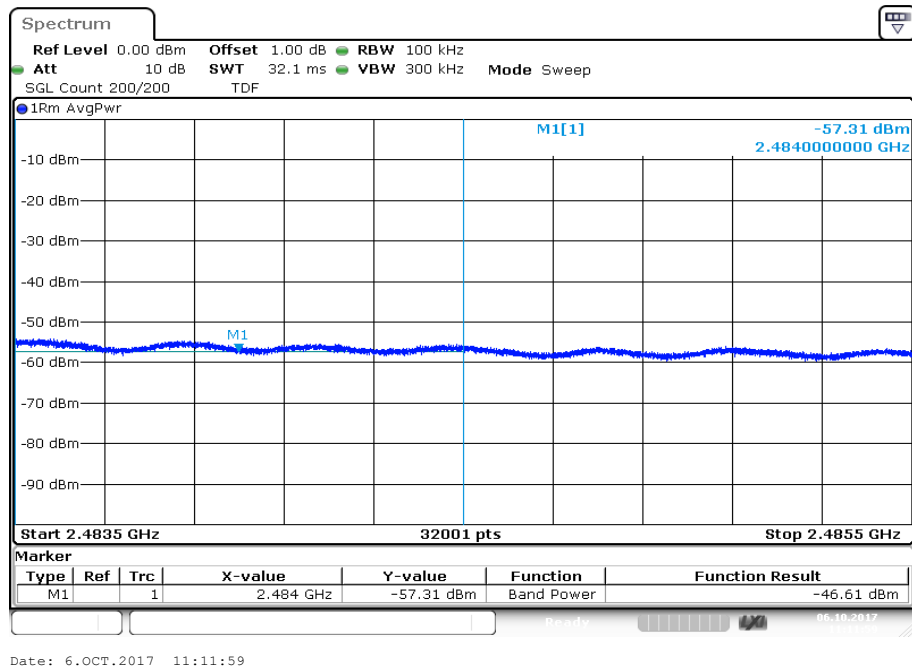
Plot 1: Lower band edge

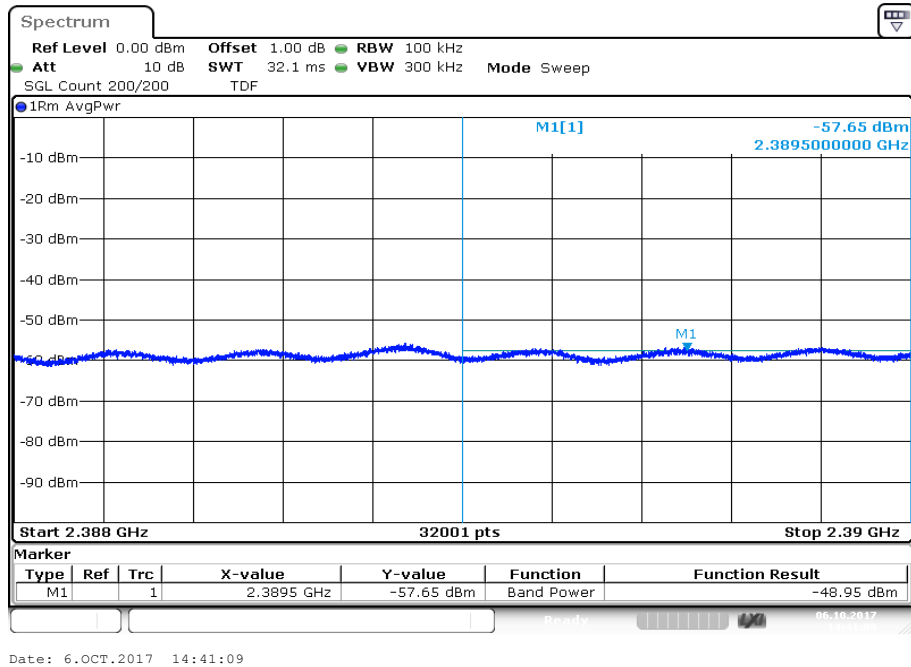
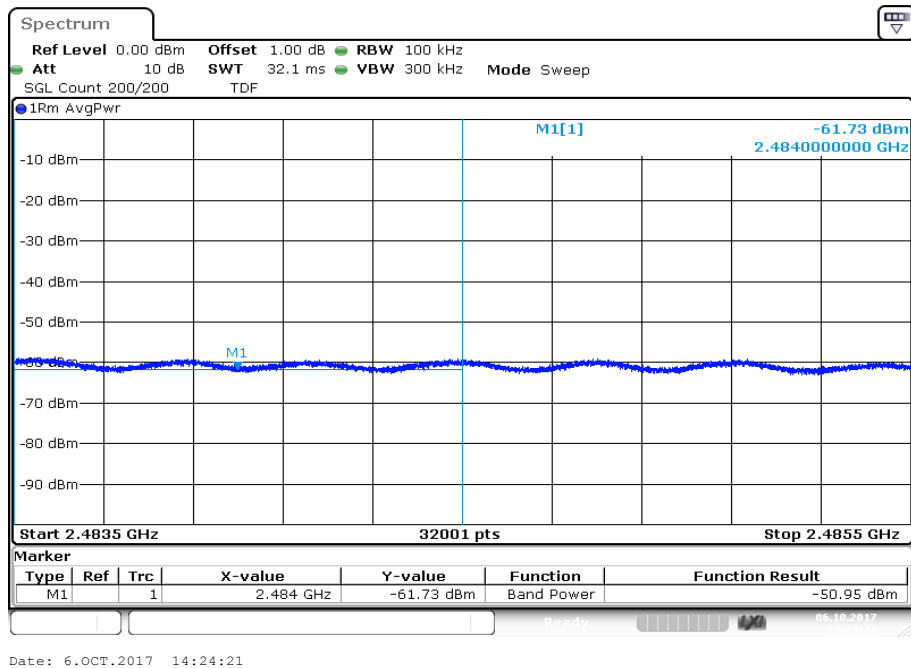


Plot 2: Upper band edge



Plots: OFDM / g – mode**Plot 1:** Lower band edge**Plot 2:** Upper band edge

Plots: OFDM / n HT20 – mode**Plot 1:** Lower band edge**Plot 2:** Upper band edge

Plots: OFDM / n HT40 – mode**Plot 1:** Lower band edge**Plot 2:** Upper band edge

11.10 Spurious emissions conducted

Description:

Measurement of the conducted spurious emissions in transmit mode. The measurement is performed at channel 1, 6 and 11. The measurement is repeated for all modulations.

Measurement:

Measurement parameter	
Detector:	Peak
Sweep time:	Auto
Resolution bandwidth:	100 kHz
Video bandwidth:	500 kHz
Span:	9 kHz to 25 GHz
Trace mode:	Max Hold
Test setup:	See sub clause 6.4 – A
Measurement uncertainty	See sub clause 8

Limits:

FCC	IC
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 30 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required	

Results: DSSS / b – mode

TX Spurious Emissions Conducted					
DSSS / b – mode					
f [MHz]		amplitude of emission [dBm]	limit max. allowed emission power	actual attenuation below frequency of operation [dB]	results
2412		3.36	30 dBm	-/-	Operating frequency
No peaks detected.			-20 dBc (peak) -30 dBc (average)	-/-	compliant
2437		4.30	30 dBm	-/-	Operating frequency
No peaks detected.			-20 dBc (peak) -30 dBc (average)	-/-	compliant
2462		4.42	30 dBm	-/-	Operating frequency
No peaks detected.			-20 dBc (peak) -30 dBc (average)	-/-	compliant

Results: OFDM / g – mode

TX Spurious Emissions Conducted					
OFDM / g – mode					
f [MHz]		amplitude of emission [dBm]	limit max. allowed emission power	actual attenuation below frequency of operation [dB]	results
2412		0.06	30 dBm	-/-	Operating frequency
No peaks detected.			-20 dBc (peak) -30 dBc (average)		compliant
2437		-0.16	30 dBm	-/-	Operating frequency
No peaks detected.			-20 dBc (peak) -30 dBc (average)		compliant
2462		0.23	30 dBm	-/-	Operating frequency
No peaks detected.			-20 dBc (peak) -30 dBc (average)		compliant

Results: OFDM / n HT20 – mode

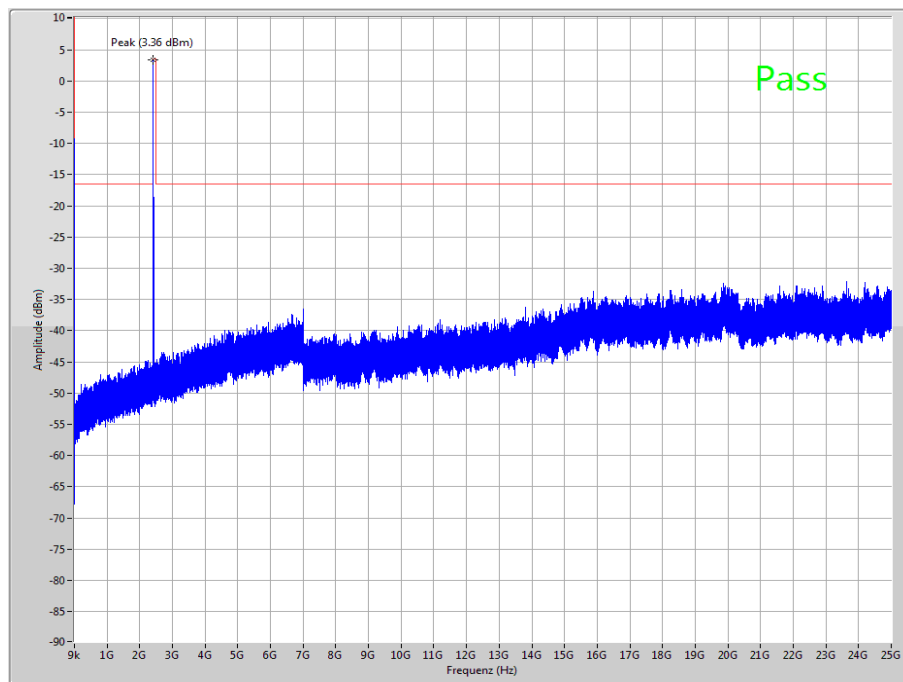
TX Spurious Emissions Conducted					
OFDM / n HT20 – mode					
f [MHz]		amplitude of emission [dBm]	limit max. allowed emission power	actual attenuation below frequency of operation [dB]	results
2412		-0.21	30 dBm	-/-	Operating frequency
No peaks detected.			-20 dBc (peak) -30 dBc (average)		compliant
2437		0.01	30 dBm	-/-	Operating frequency
No peaks detected.			-20 dBc (peak) -30 dBc (average)		compliant
2462		-0.61	30 dBm	-/-	Operating frequency
No peaks detected.			-20 dBc (peak) -30 dBc (average)		compliant

Results: OFDM / n HT40 – mode

TX Spurious Emissions Conducted					
OFDM / n HT40 – mode					
f [MHz]		amplitude of emission [dBm]	limit max. allowed emission power	actual attenuation below frequency of operation [dB]	results
2422		-1.97	30 dBm	-/-	Operating frequency
No peaks detected.			-20 dBc (peak) -30 dBc (average)		compliant
2437		-1.72	30 dBm	-/-	Operating frequency
No peaks detected.			-20 dBc (peak) -30 dBc (average)		compliant
2452		-2.85	30 dBm	-/-	Operating frequency
No peaks detected.			-20 dBc (peak) -30 dBc (average)		compliant

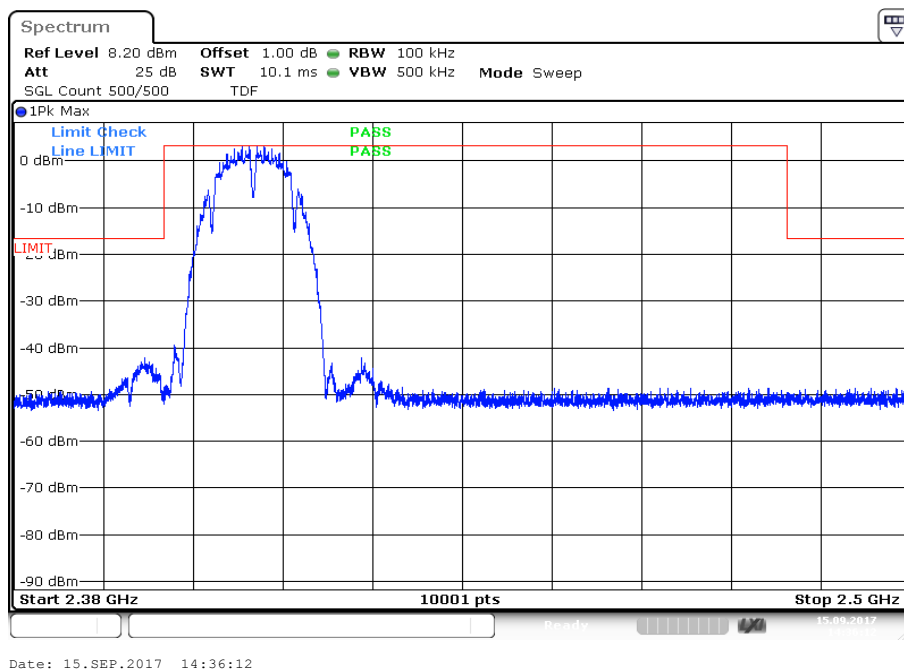
Plots: DSSS / b – mode

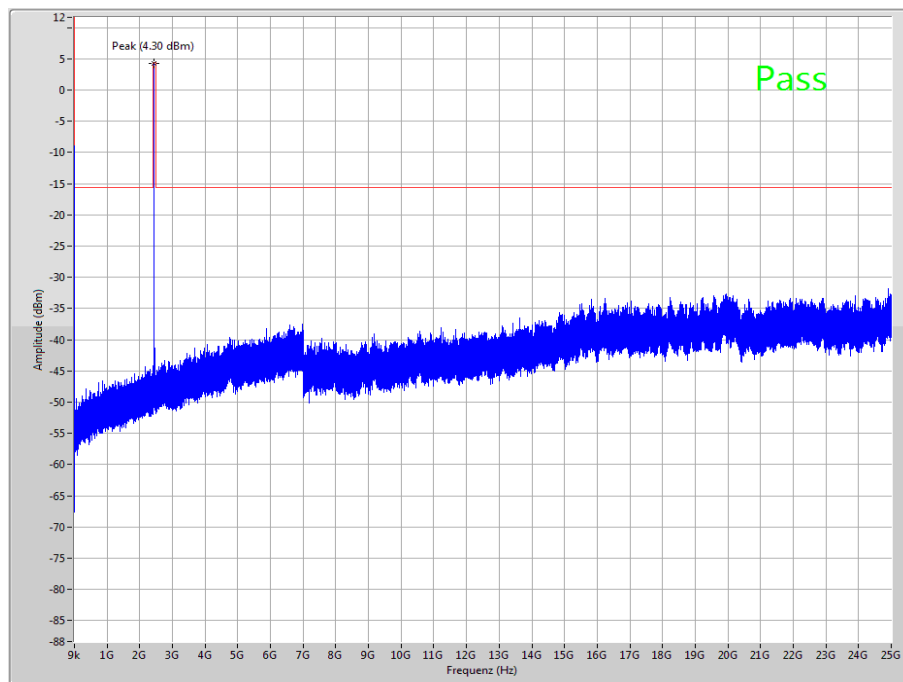
Plot 1: Lowest channel, up to 25 GHz



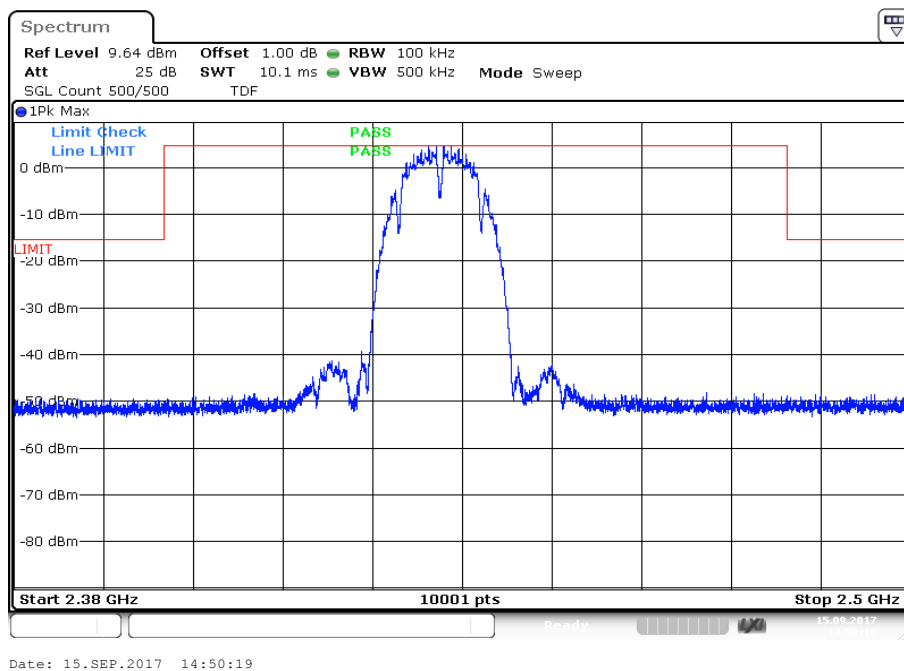
The peak at the beginning of the plot is the LO from the SA.

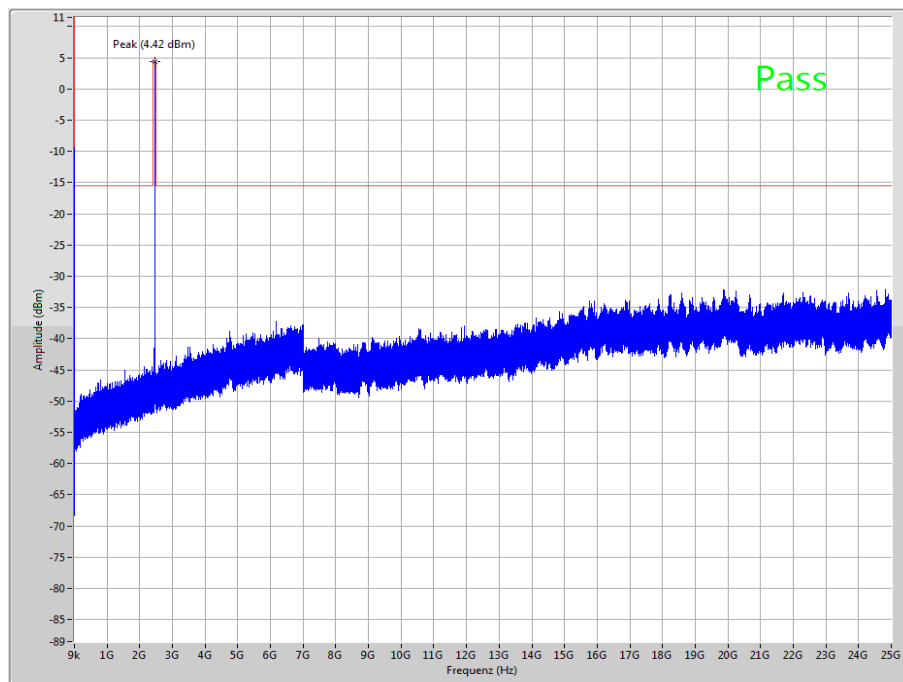
Plot 2: Lowest channel, zoomed carrier



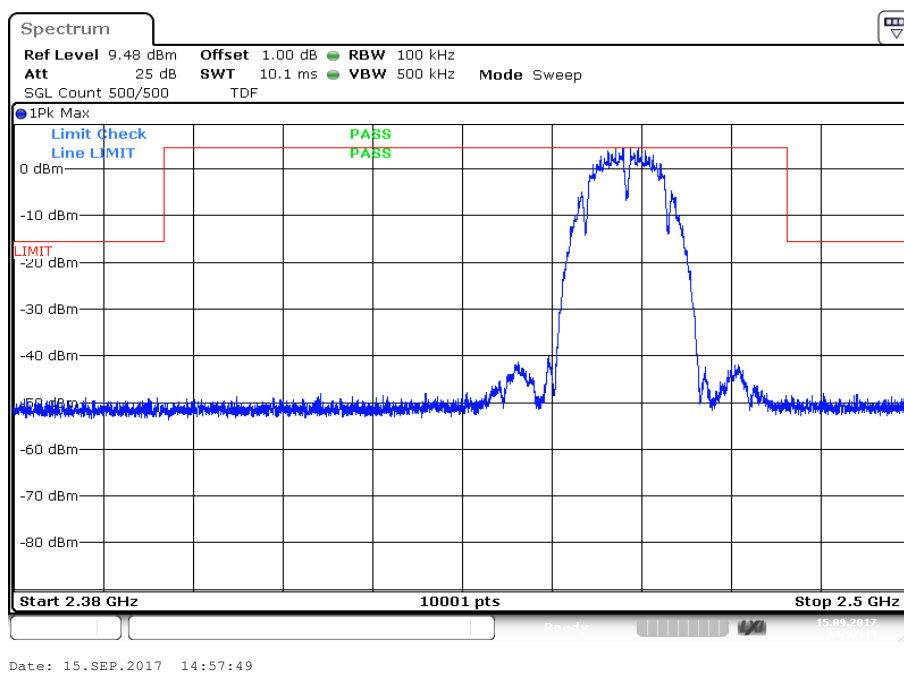
Plot 3: Middle channel, up to 25 GHz

The peak at the beginning of the plot is the LO from the SA.

Plot 4: Middle channel, zoomed carrier

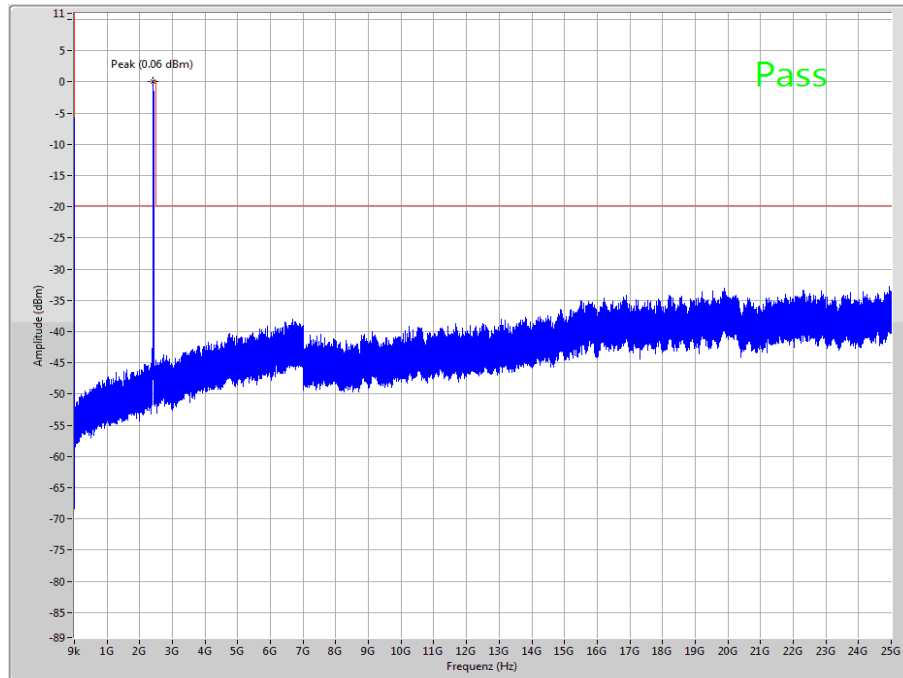
Plot 5: Highest channel, up to 25 GHz

The peak at the beginning of the plot is the LO from the SA.

Plot 6: Highest channel, zoomed carrier

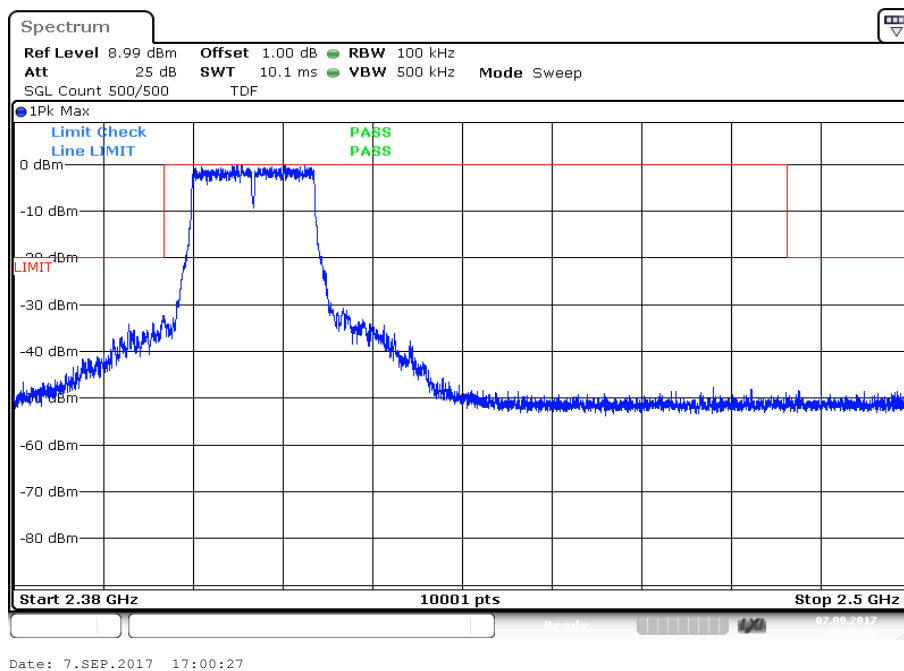
Plots: OFDM / g – mode

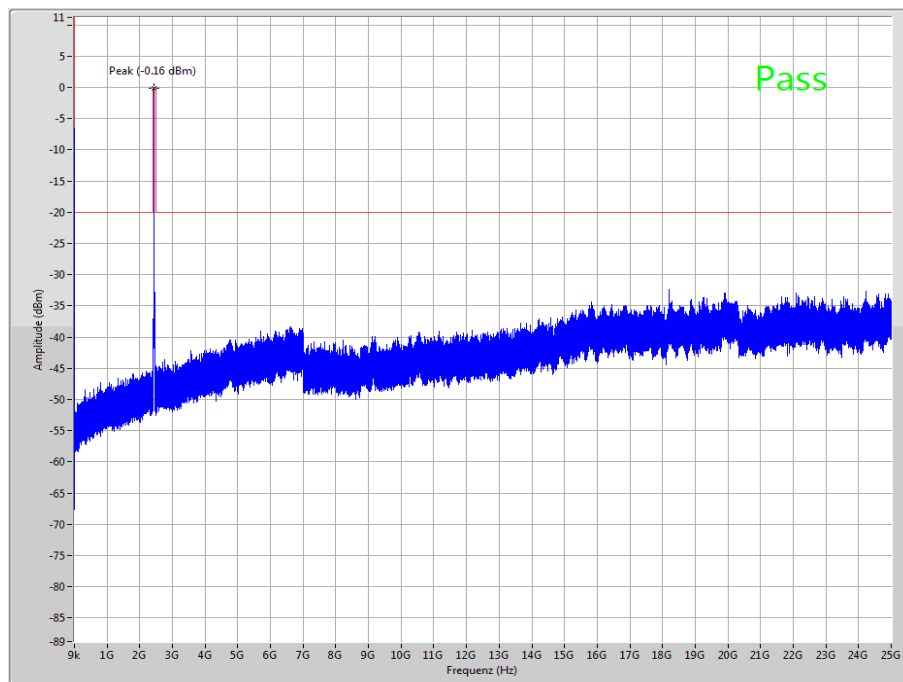
Plot 1: Lowest channel, up to 25 GHz



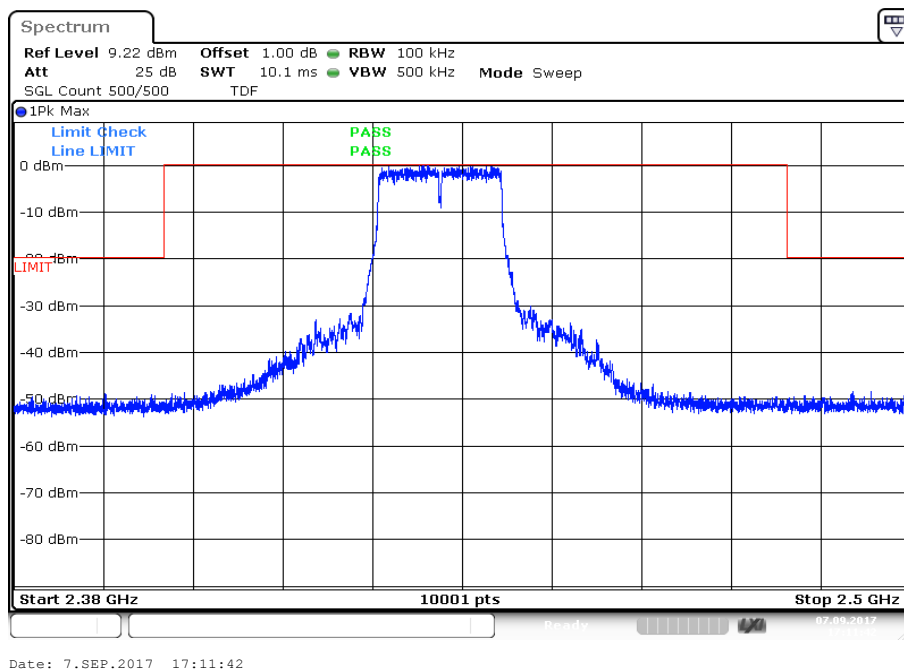
The peak at the beginning of the plot is the LO from the SA.

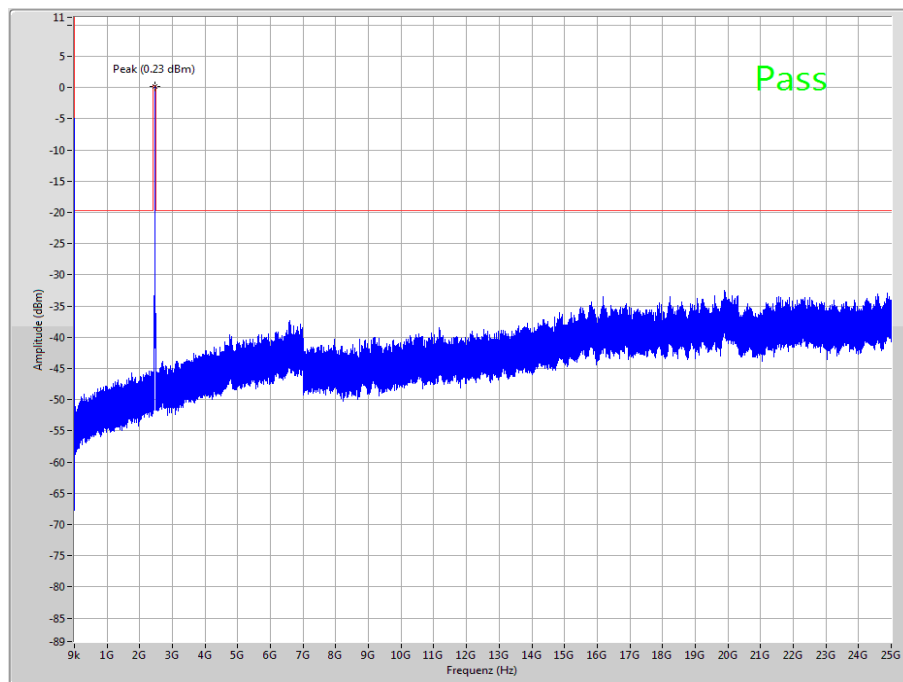
Plot 2: Lowest channel, zoomed carrier



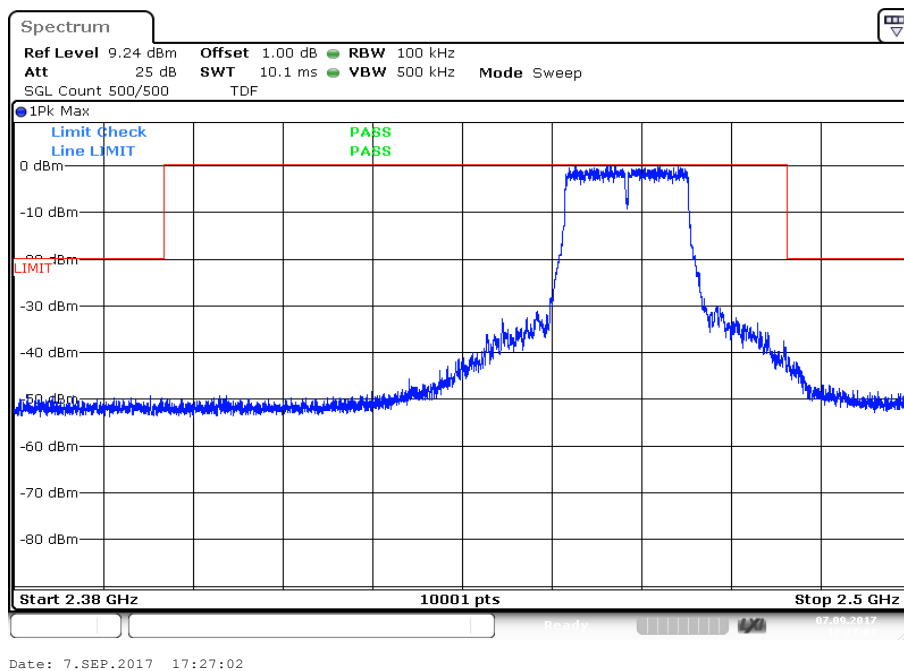
Plot 3: Middle channel, up to 25 GHz

The peak at the beginning of the plot is the LO from the SA.

Plot 4: Middle channel, zoomed carrier

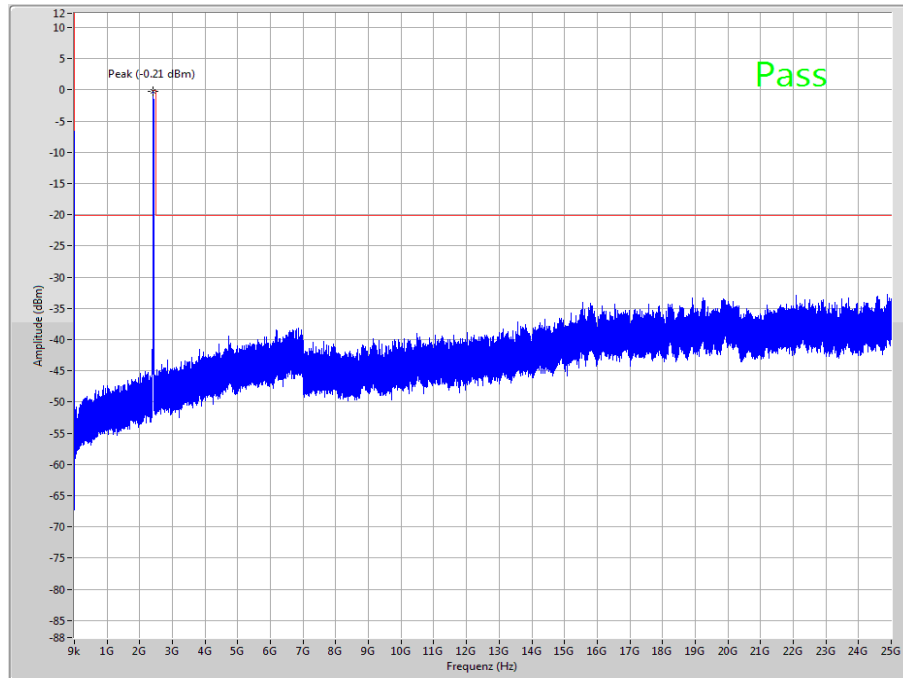
Plot 5: Highest channel, up to 25 GHz

The peak at the beginning of the plot is the LO from the SA.

Plot 6: Highest channel, zoomed carrier

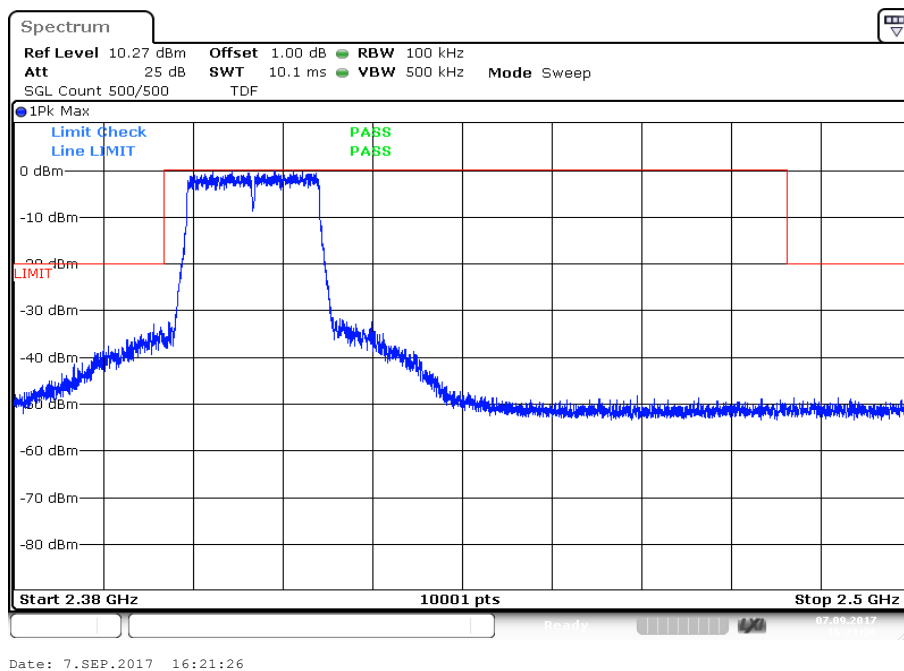
Plots: OFDM / n HT 20 – mode

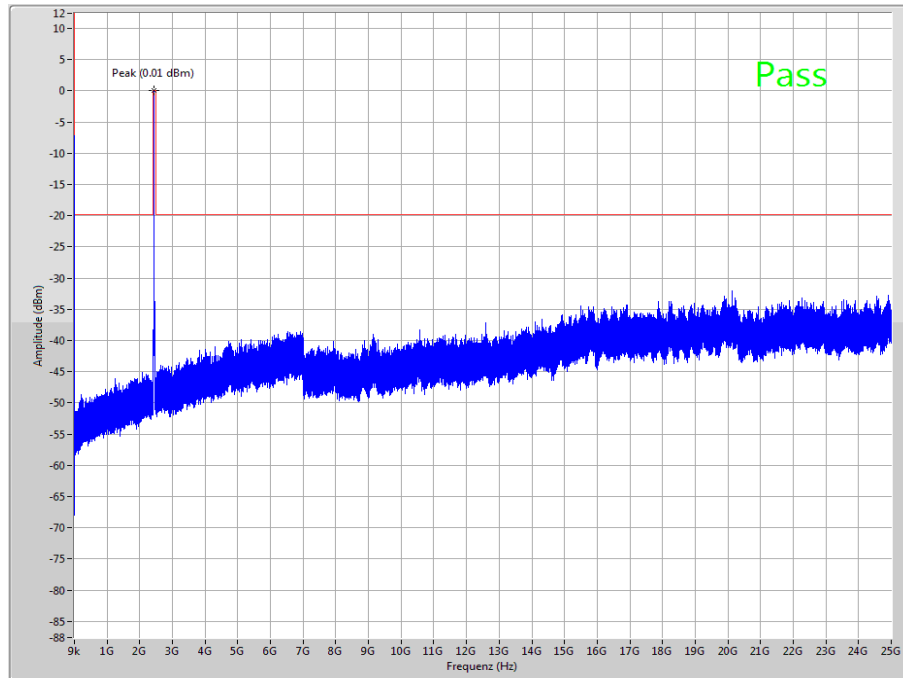
Plot 1: Lowest channel, up to 25 GHz



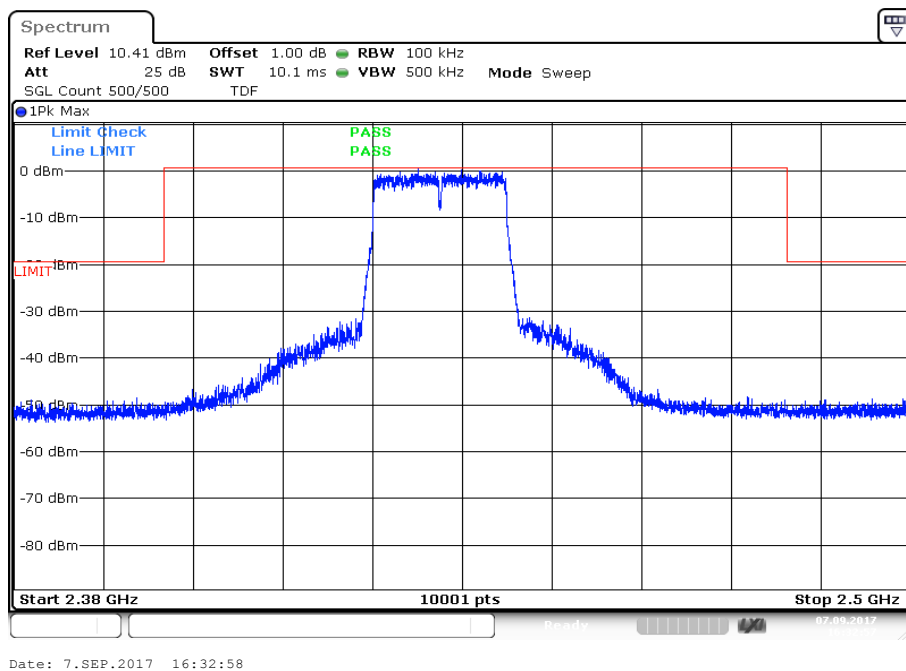
The peak at the beginning of the plot is the LO from the SA.

Plot 2: Lowest channel, zoomed carrier

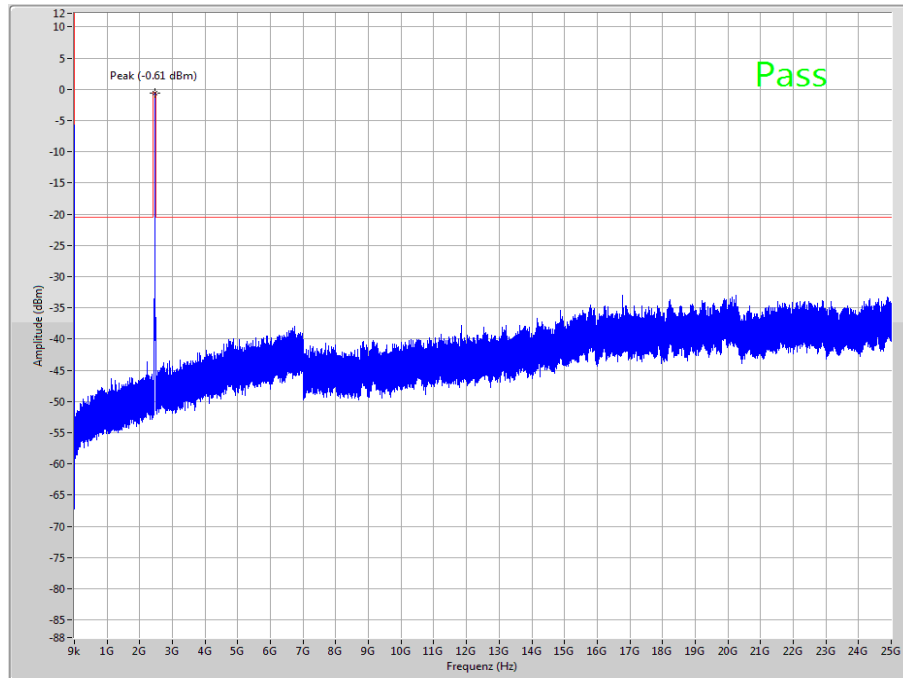


Plot 3: Middle channel, up to 25 GHz

The peak at the beginning of the plot is the LO from the SA.

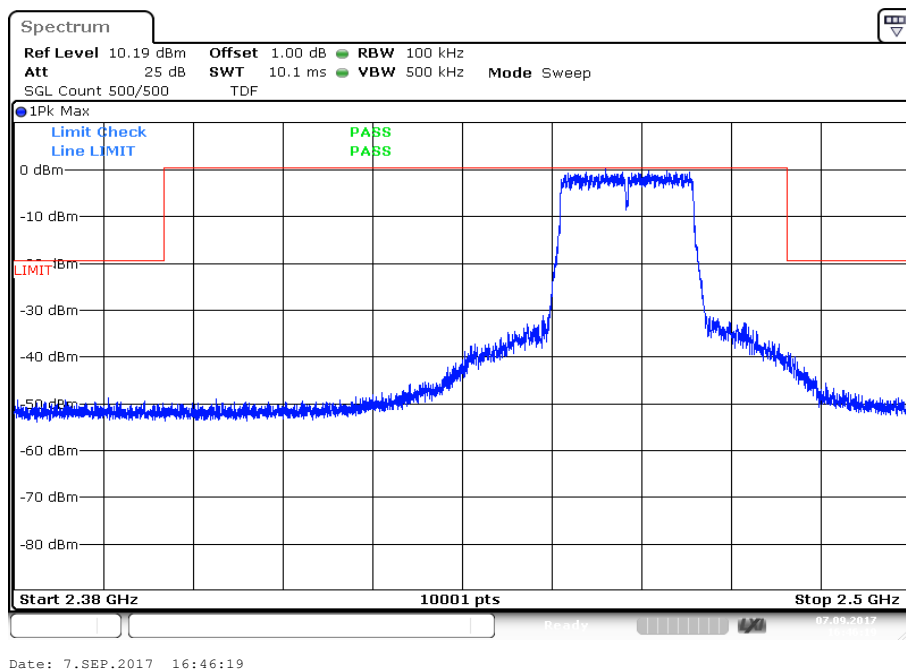
Plot 4: Middle channel, zoomed carrier

Plot 5: Highest channel, up to 25 GHz



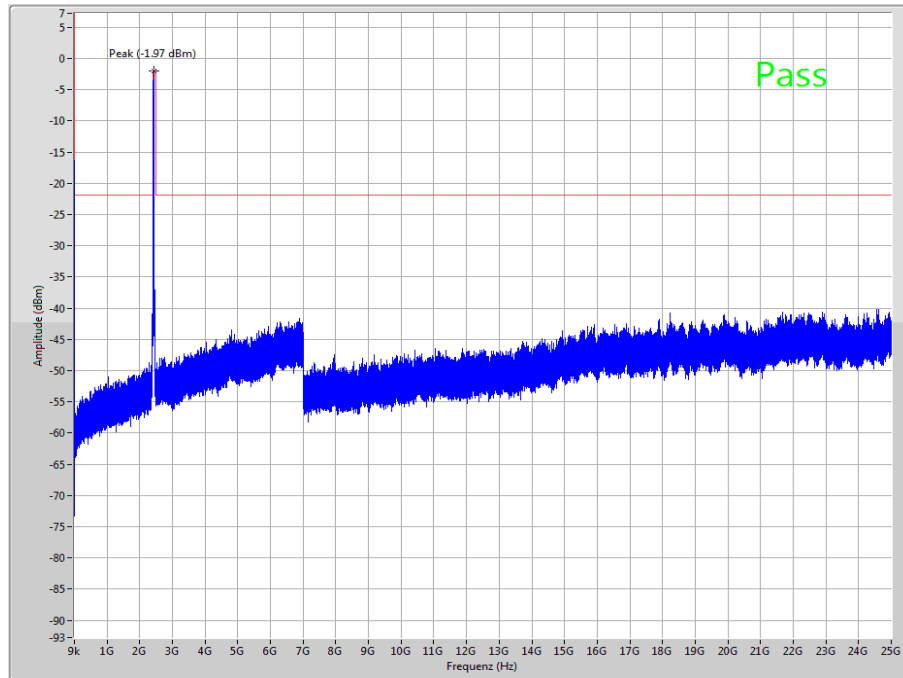
The peak at the beginning of the plot is the LO from the SA.

Plot 6: Highest channel, zoomed carrier



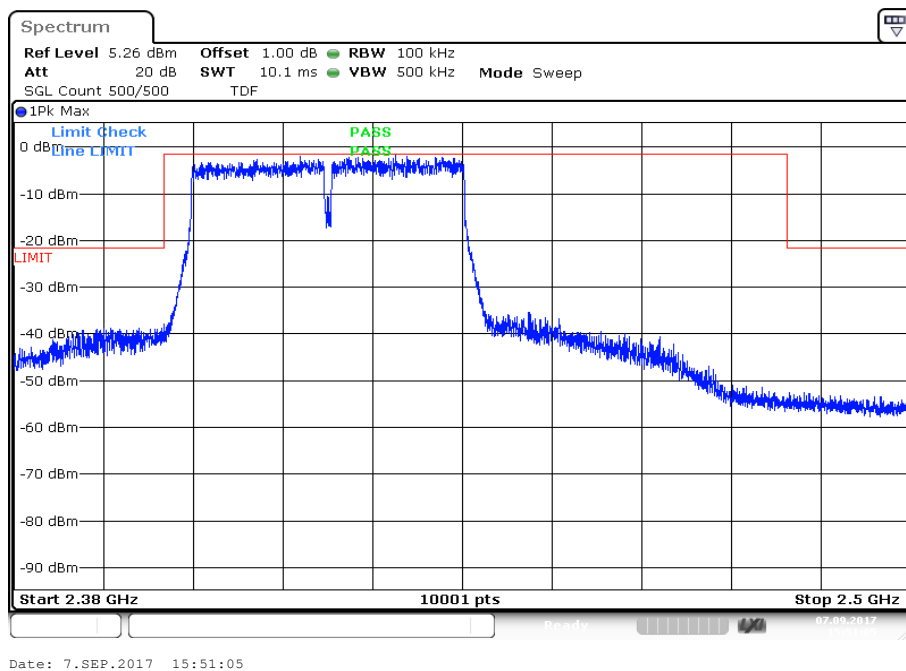
Plots: OFDM / n HT 40 – mode

Plot 1: Lowest channel, up to 25 GHz

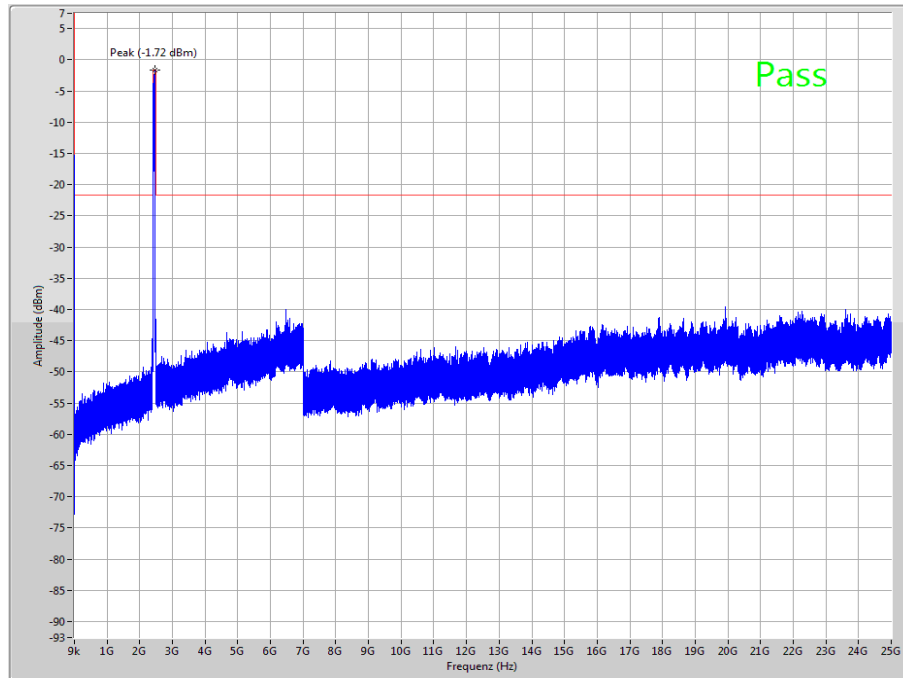


The peak at the beginning of the plot is the LO from the SA.

Plot 2: Lowest channel, zoomed carrier

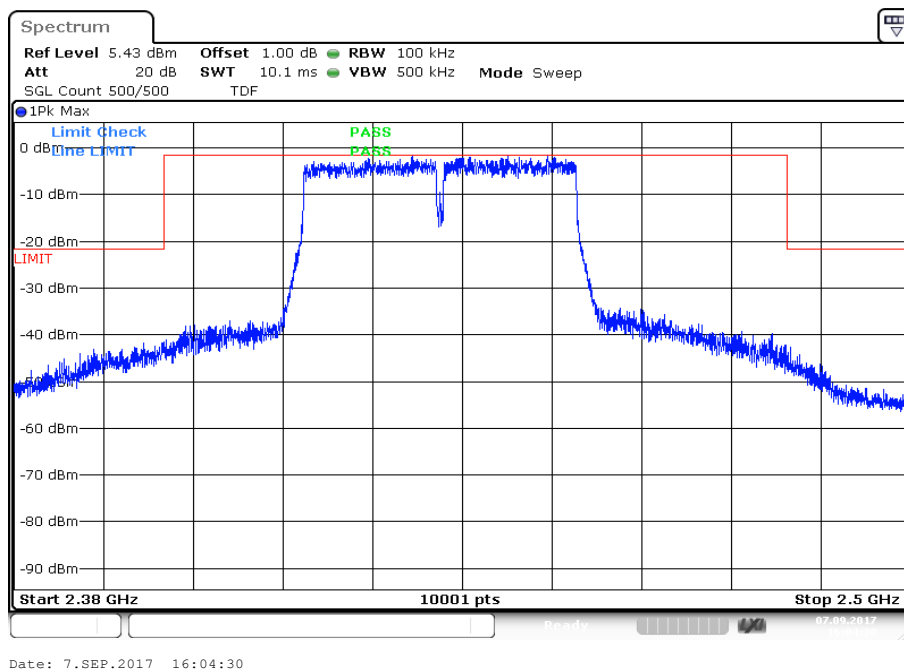


Plot 3: Middle channel, up to 25 GHz

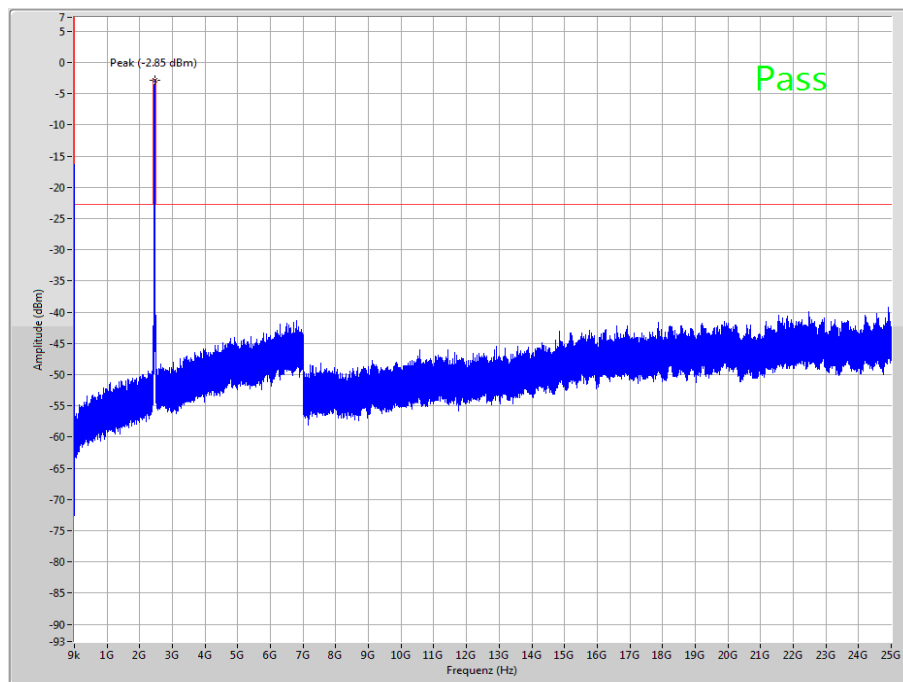


The peak at the beginning of the plot is the LO from the SA.

Plot 4: Middle channel, zoomed carrier

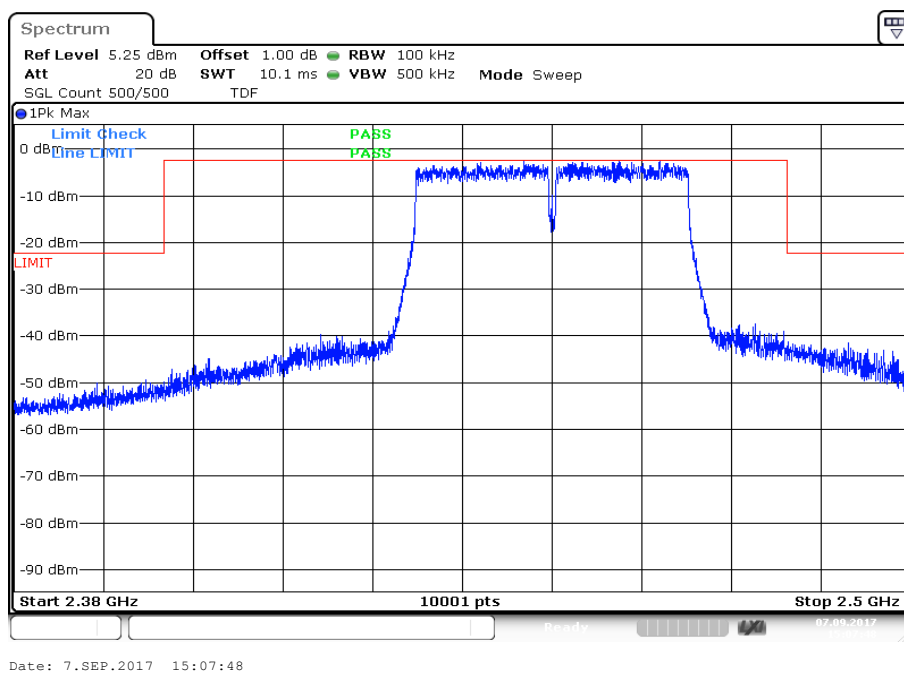


Plot 5: Highest channel, up to 25 GHz



The peak at the beginning of the plot is the LO from the SA.

Plot 6: Highest channel, zoomed carrier



11.11 Spurious emissions radiated below 30 MHz

Description:

Measurement of the radiated spurious emissions in transmit mode below 30 MHz. The EUT is set to channel 6. This measurement is representative for all channels and modes. If peaks are found channel 1 and channel 11 will be measured too. The measurement is performed with the data rate producing the highest output power. 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 sub clause 6.2 - A
Measurement uncertainty	See sub clause 8

Limits:

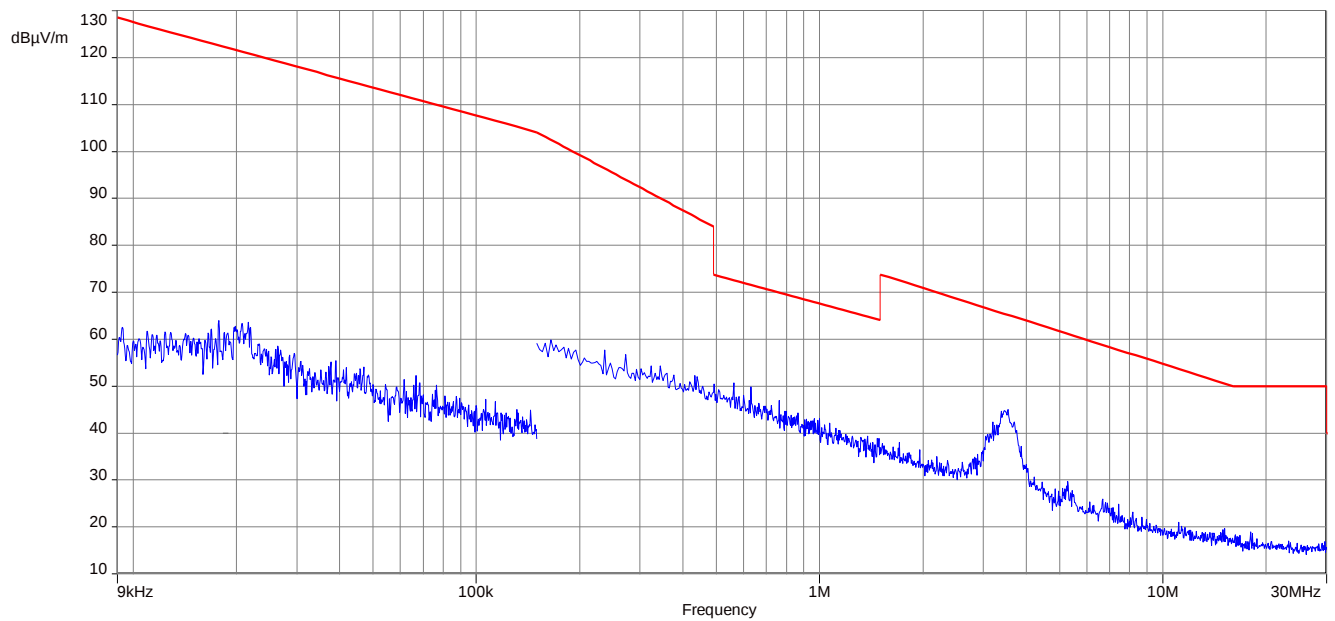
FCC		IC
Frequency (MHz)	Field Strength (dBμV/m)	Measurement distance
0.009 – 0.490	2400/F(kHz)	300
0.490 – 1.705	24000/F(kHz)	30
1.705 – 30.0	30	30

Results:

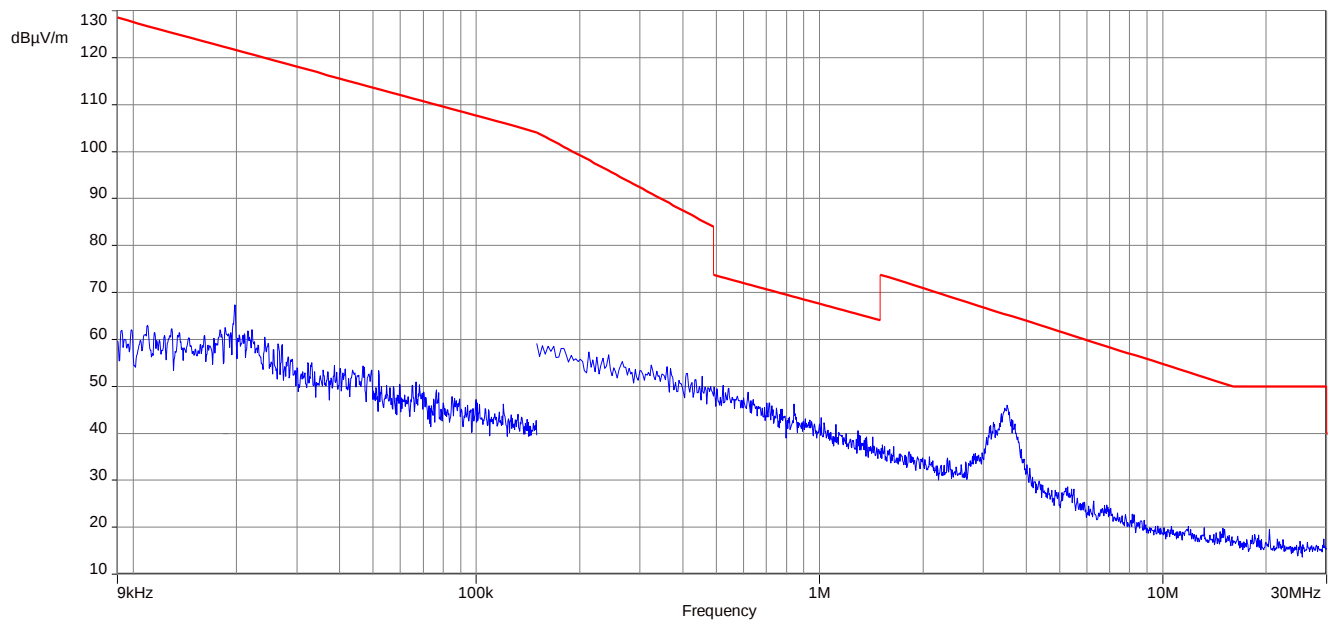
TX Spurious Emissions Radiated < 30 MHz [dBμV/m]		
F [MHz]	Detector	Level [dBμV/m]
All detected peaks are more than 20 dB below the limit.		

Plots: DSSS

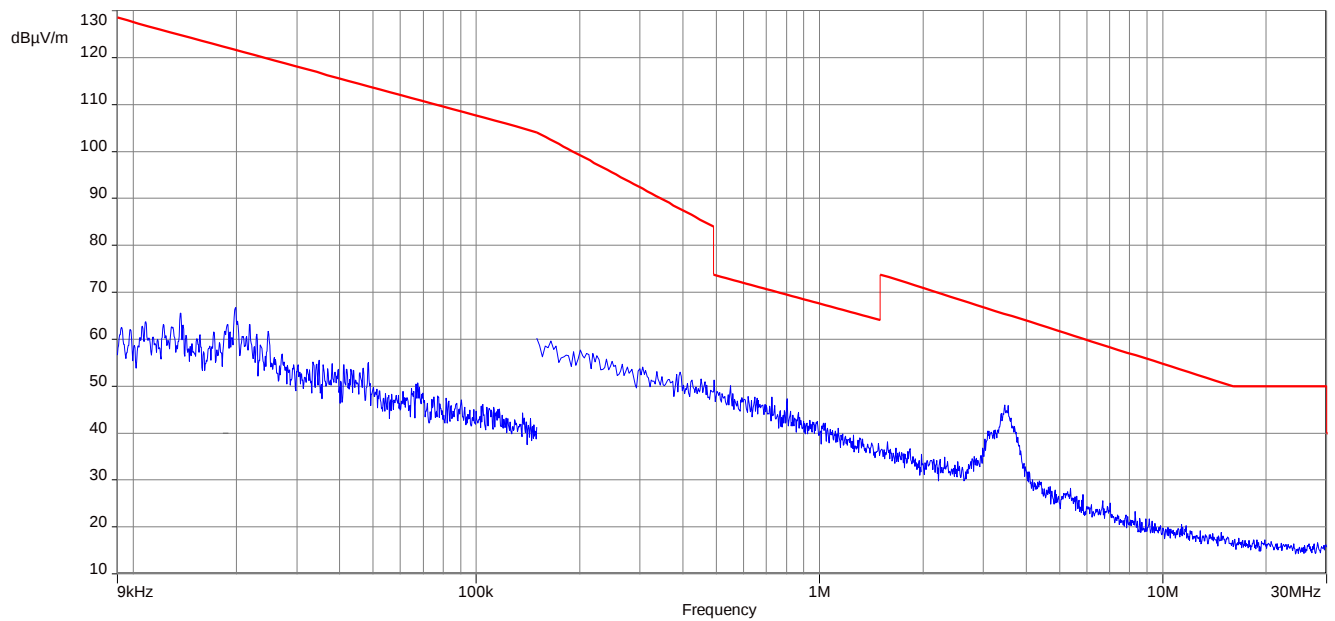
Plot 1: 9 kHz to 30 MHz, low channel



Plot 2: 9 kHz to 30 MHz, mid channel

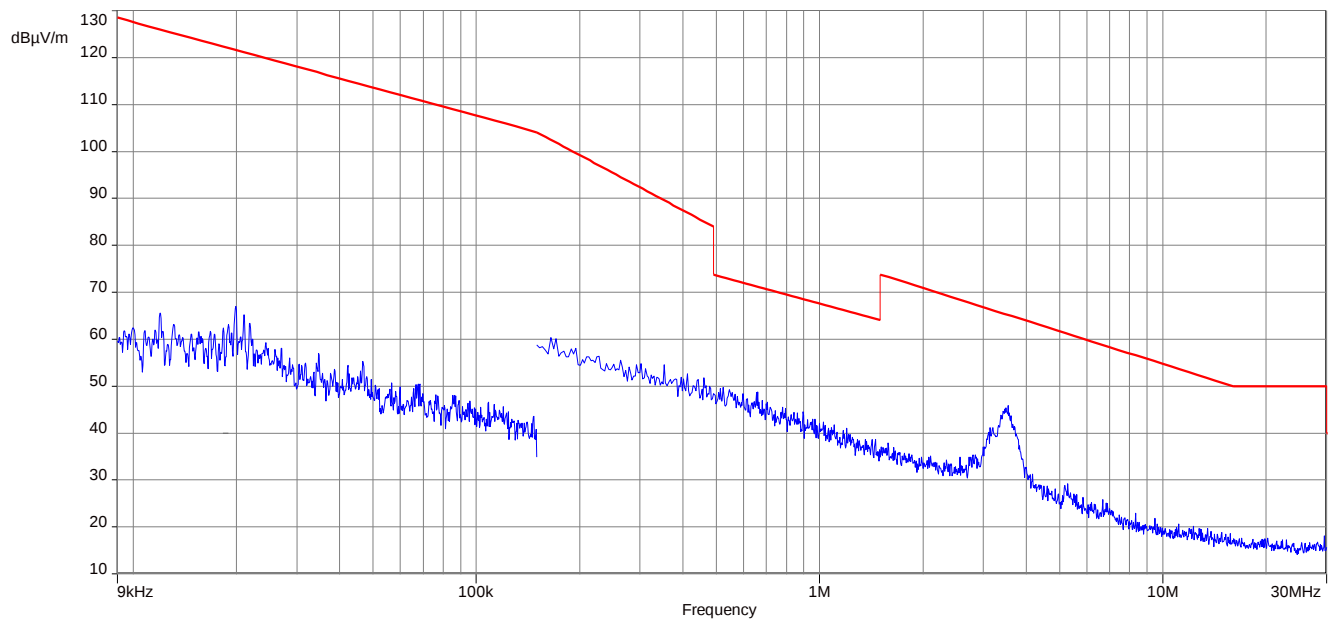


Plot 3: 9 kHz to 30 MHz, high channel

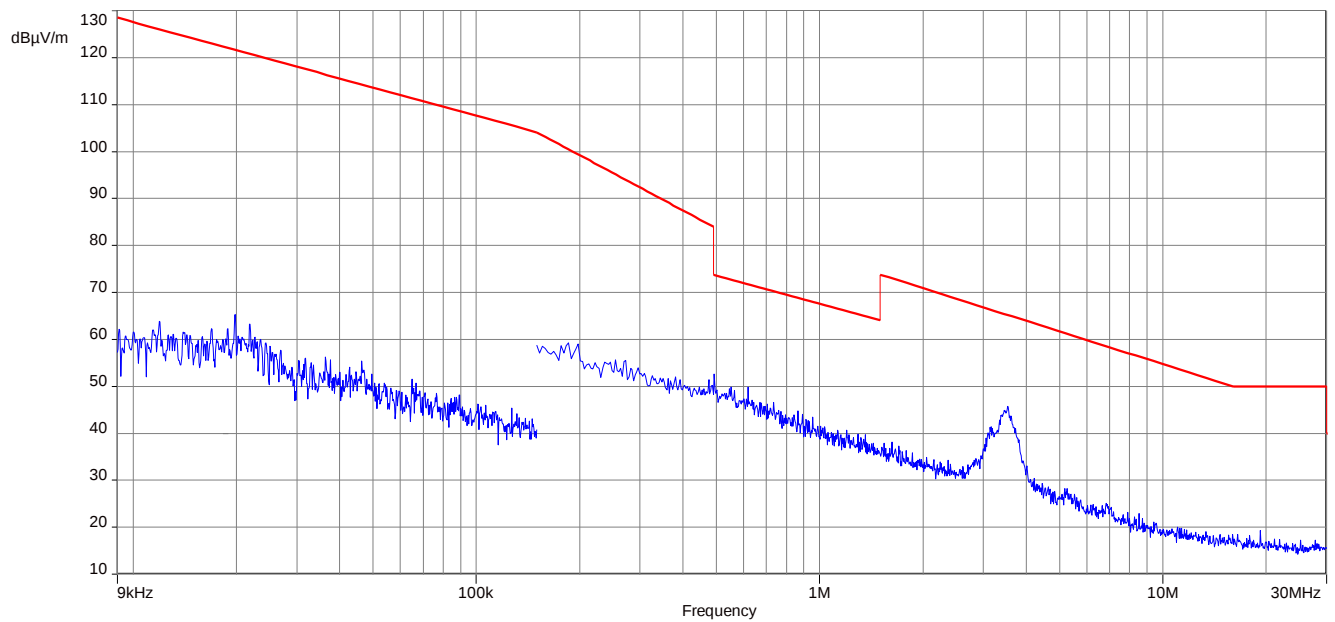


Plots: OFDM (20 MHz bandwidth)

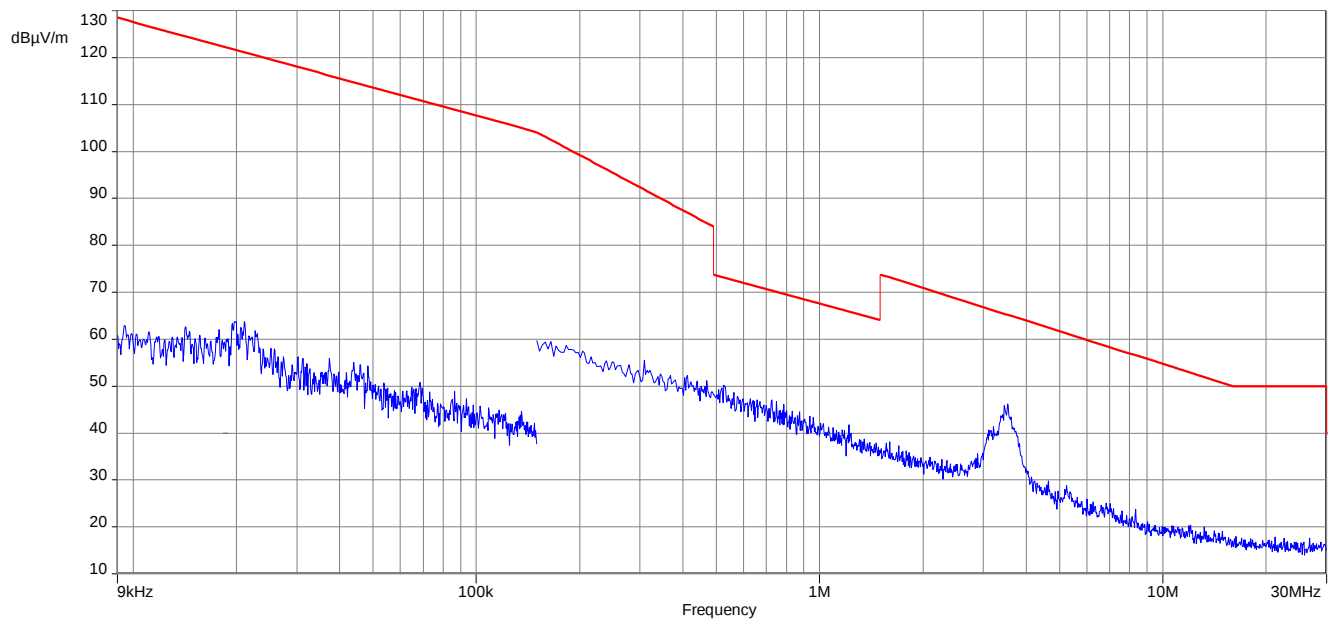
Plot 1: 9 kHz to 30 MHz, low channel



Plot 2: 9 kHz to 30 MHz, mid channel

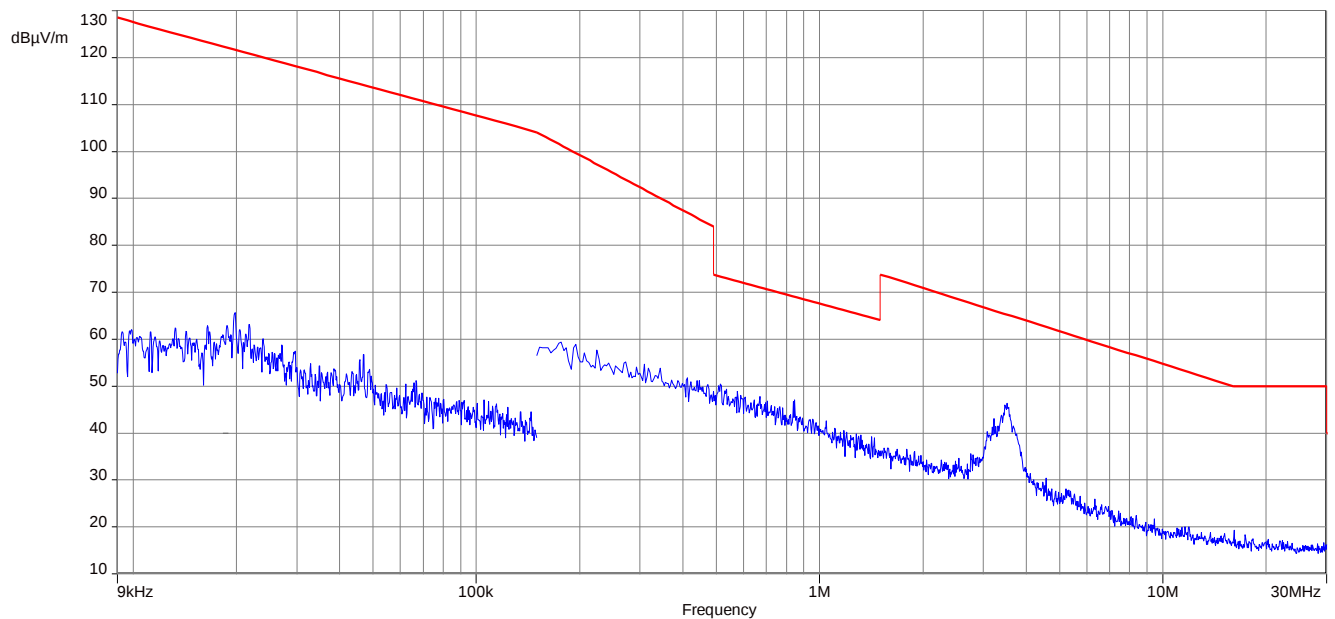


Plot 3: 9 kHz to 30 MHz, high channel

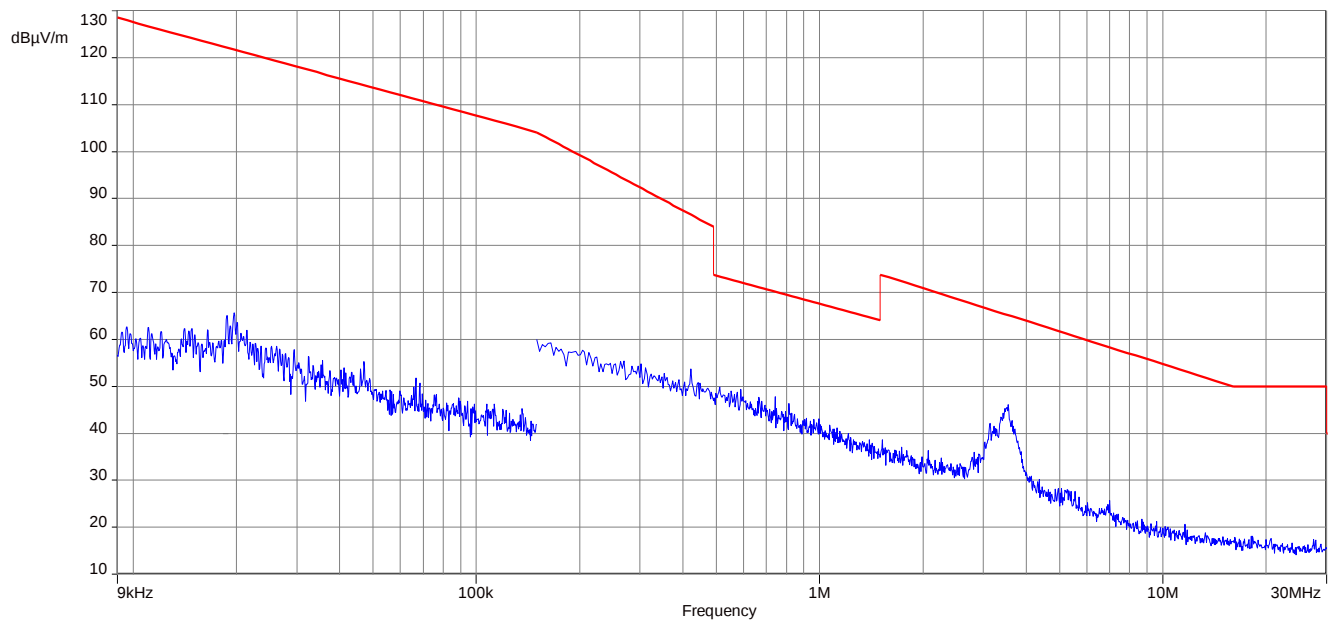


Plots: OFDM (40 MHz bandwidth)

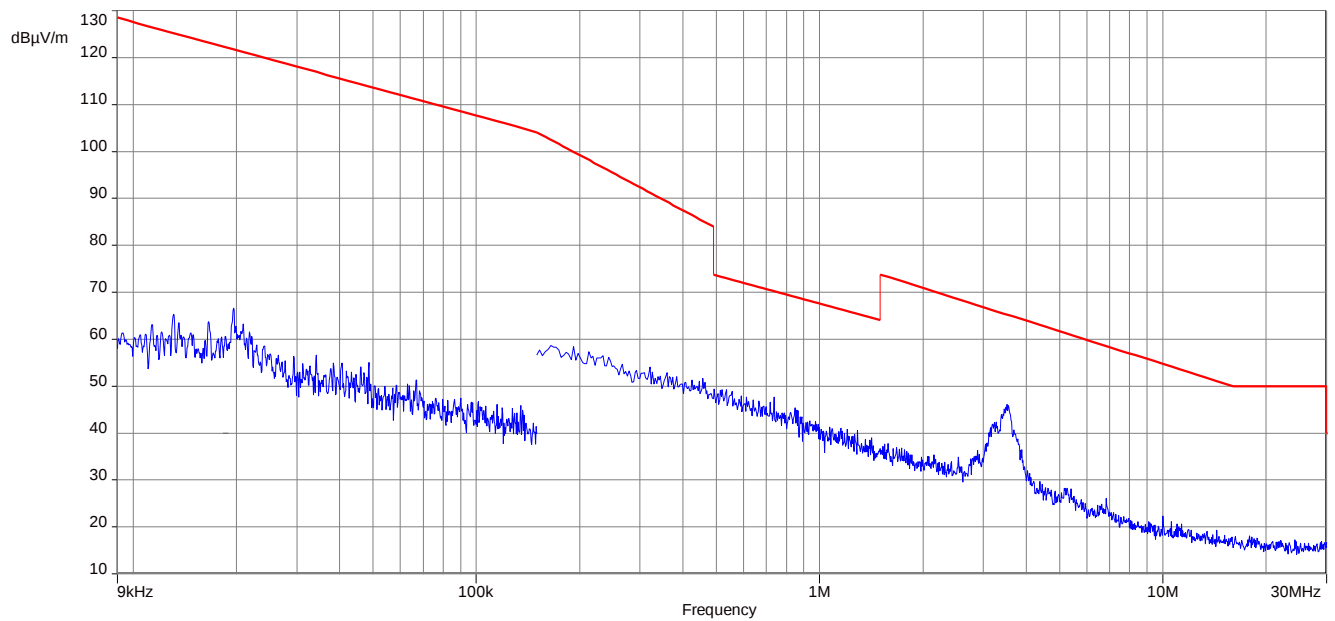
Plot 1: 9 kHz to 30 MHz, low channel



Plot 2: 9 kHz to 30 MHz, mid channel



Plot 3: 9 kHz to 30 MHz, high channel



11.12 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 ☒ RX / Idle – mode
Test setup:	See sub clause 6.1 – A
Measurement uncertainty	See sub clause 8

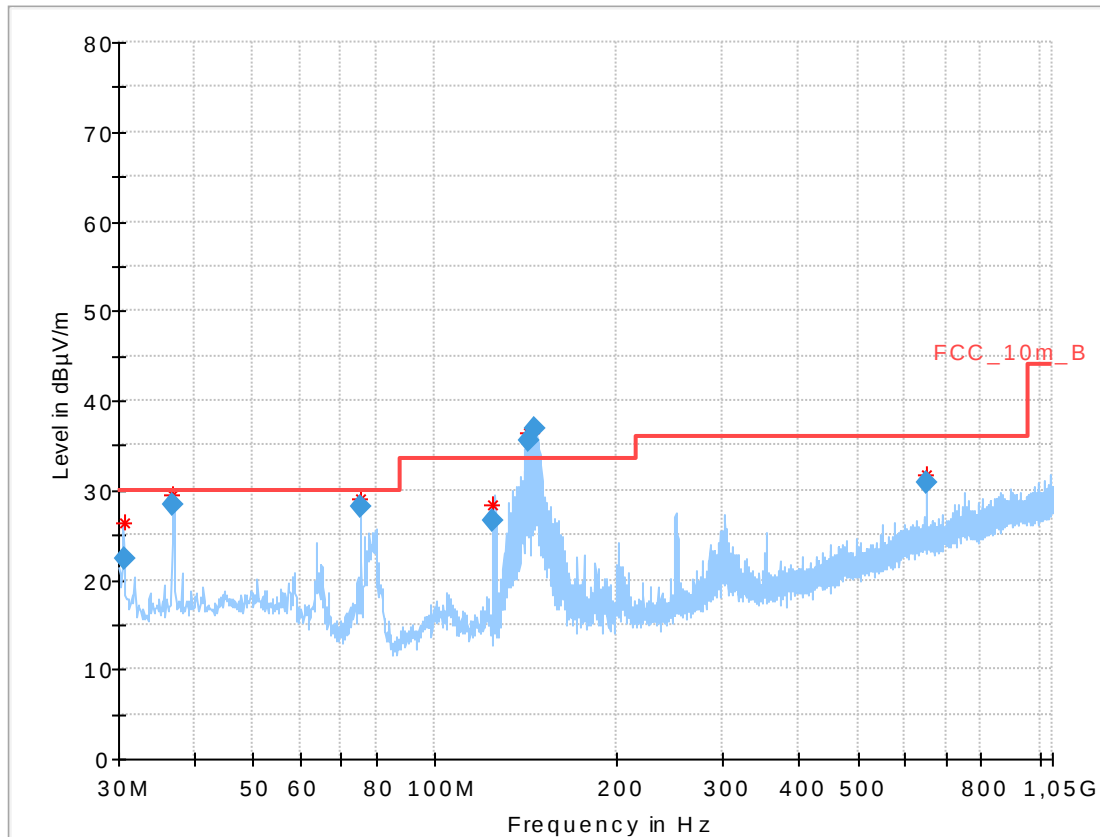
The modulation with the highest output power was used to perform the transmitter spurious emissions. If spurious were detected a re-measurement was performed on the detected frequency with each modulation.

Limits:

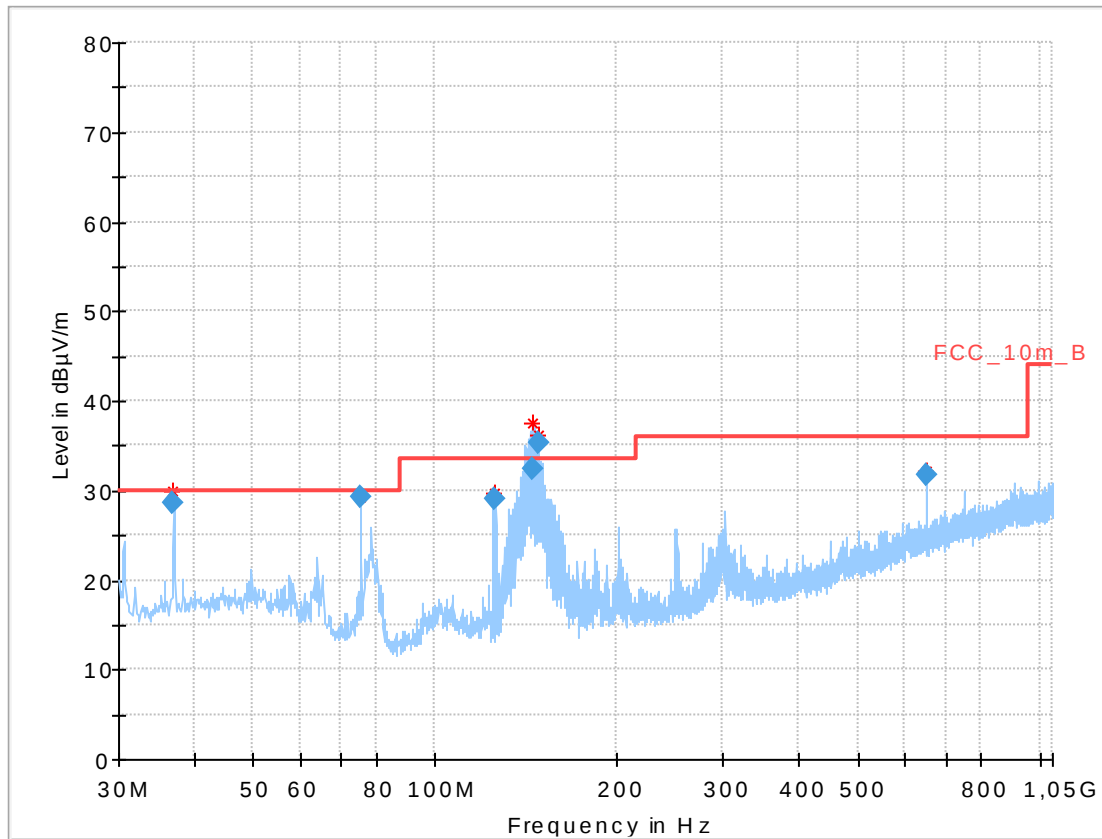
FCC		IC
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains 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
30 - 88	30.0	10
88 – 216	33.5	10
216 – 960	36.0	10

Note: Emissions exceeding the given limit in the sub-range 30 MHz to 1 GHz are not caused by the evaluated radio module. To indicate that these emissions are caused by the peripherals the measurement was also performed with the radio module shut off.

Plot: W-LAN Module shut off.

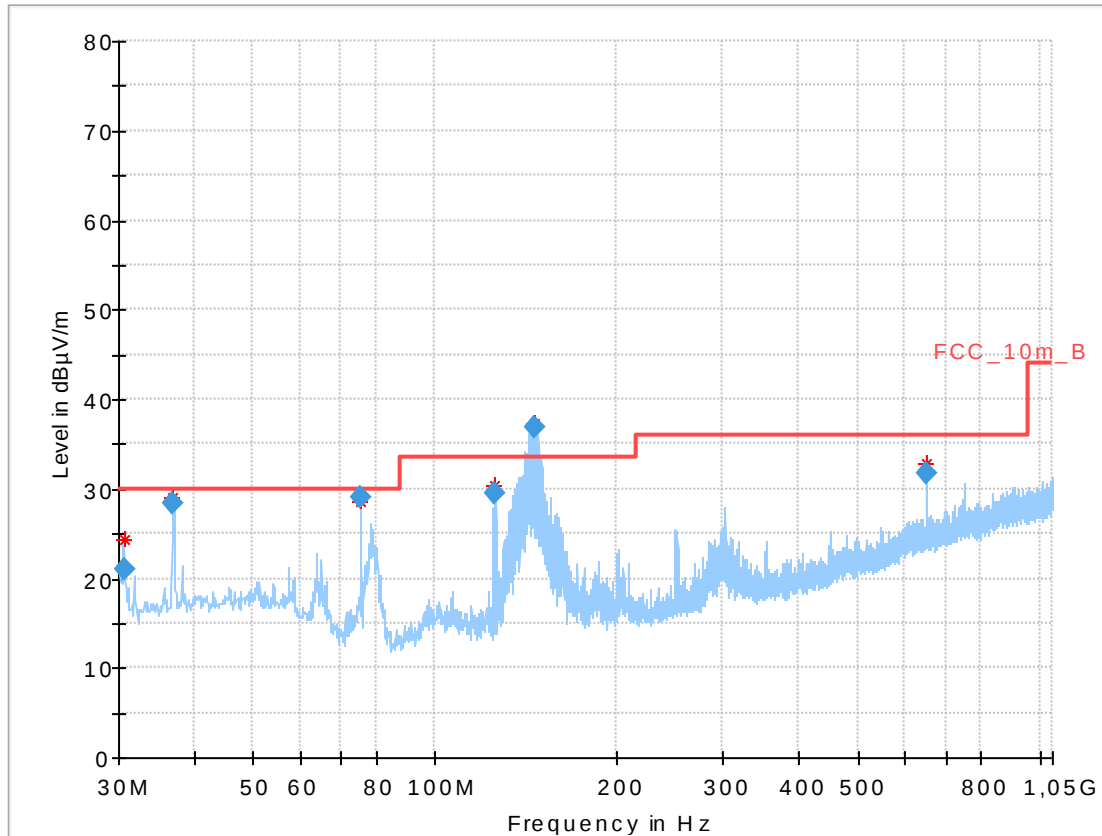


Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
30.584	22.37	30.0	7.63	1000	120	101.0	V	176.0	11.9
36.927	28.34	30.0	1.66	1000	120	98.0	V	290.0	12.9
75.554	28.05	30.0	1.95	1000	120	170.0	V	297.0	8.8
125.006	26.68	33.5	6.82	1000	120	98.0	V	8.0	9.9
143.366	35.53	33.5	-2.03	1000	120	98.0	V	135.0	9.0
145.626	36.92	33.5	-3.42	1000	120	98.0	V	160.0	9.1
649.998	30.75	36.0	5.25	1000	120	98.0	H	10.0	21.1

Plot: DSSS**Plot 1:** 30 MHz to 1 GHz, vertical & horizontal polarization, low channel

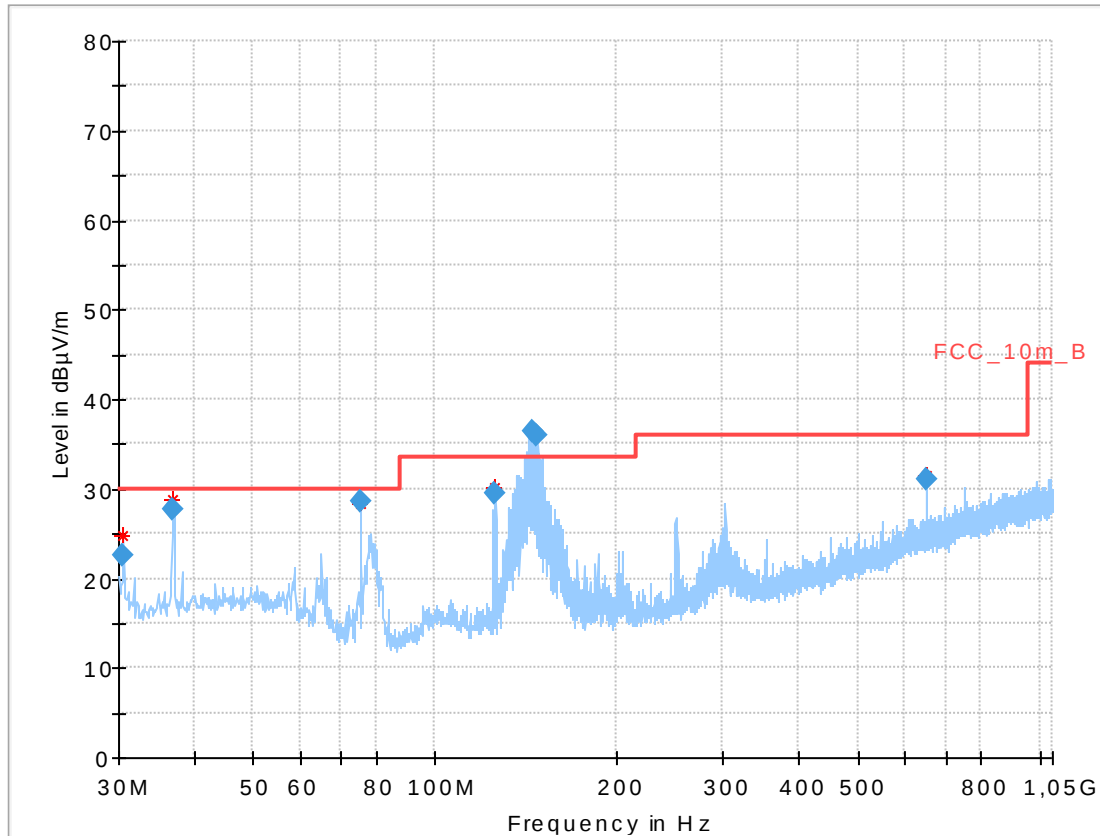
Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
36.958	28.67	30.0	1.33	1000	120	100.0	V	275.0	12.9
75.557	29.31	30.0	0.69	1000	120	170.0	V	1.0	8.8
125.941	29.02	33.5	4.48	1000	120	98.0	V	0.0	9.8
144.663*	32.36	33.5	1.14	1000	120	98.0	V	204.0	9.1
147.917*	35.31	33.5	-1.81	1000	120	98.0	V	197.0	9.2
650.010	31.81	36.0	4.19	1000	120	98.0	H	169.0	21.1

* Frequency is outside the restricted bands and therefore not rated.

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

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
30.603	20.92	30.0	9.08	1000	120	101.0	V	151.0	11.9
36.925	28.30	30.0	1.70	1000	120	98.0	V	235.0	12.9
75.573	29.15	30.0	0.85	1000	120	170.0	V	92.0	8.8
125.938	29.47	33.5	4.03	1000	120	98.0	V	12.0	9.8
145.623*	36.78	33.5	-3.28	1000	120	98.0	V	212.0	9.1
650.006	31.64	36.0	4.36	1000	120	98.0	H	166.0	21.1

* Frequency is outside the restricted bands and therefore not rated.

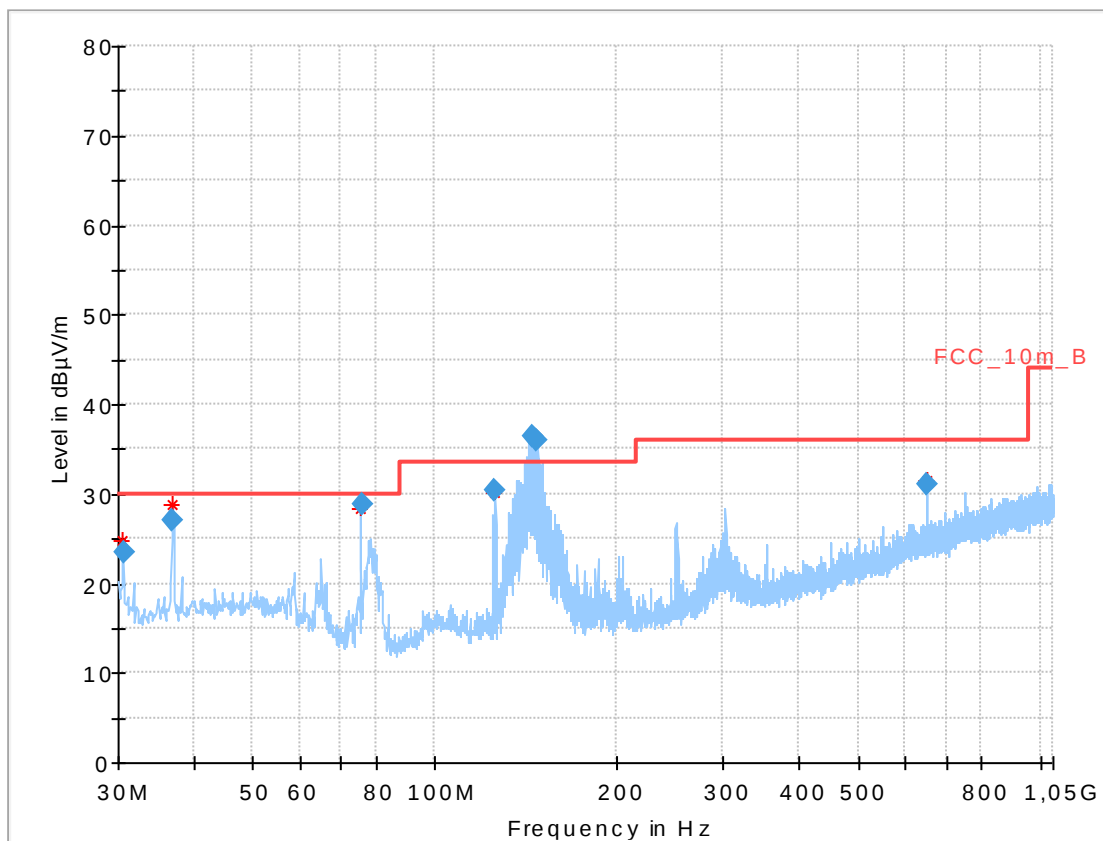
Plot 3: 30 MHz to 1 GHz, vertical & horizontal polarization, high channel

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
30.534	22.46	30.0	7.54	1000	120	101.0	V	213.0	11.9
36.928	27.78	30.0	2.22	1000	120	101.0	V	120.0	12.9
75.566	28.66	30.0	1.34	1000	120	170.0	V	99.0	8.8
125.941	29.40	33.5	4.10	1000	120	101.0	V	-9.0	9.8
143.564*	36.53	33.5	-3.03	1000	120	98.0	V	129.0	9.1
147.843*	35.99	33.5	-2.49	1000	120	98.0	V	164.0	9.2
650.015	31.07	36.0	4.93	1000	120	98.0	H	43.0	21.1

* Frequency is outside the restricted bands and therefore not rated.

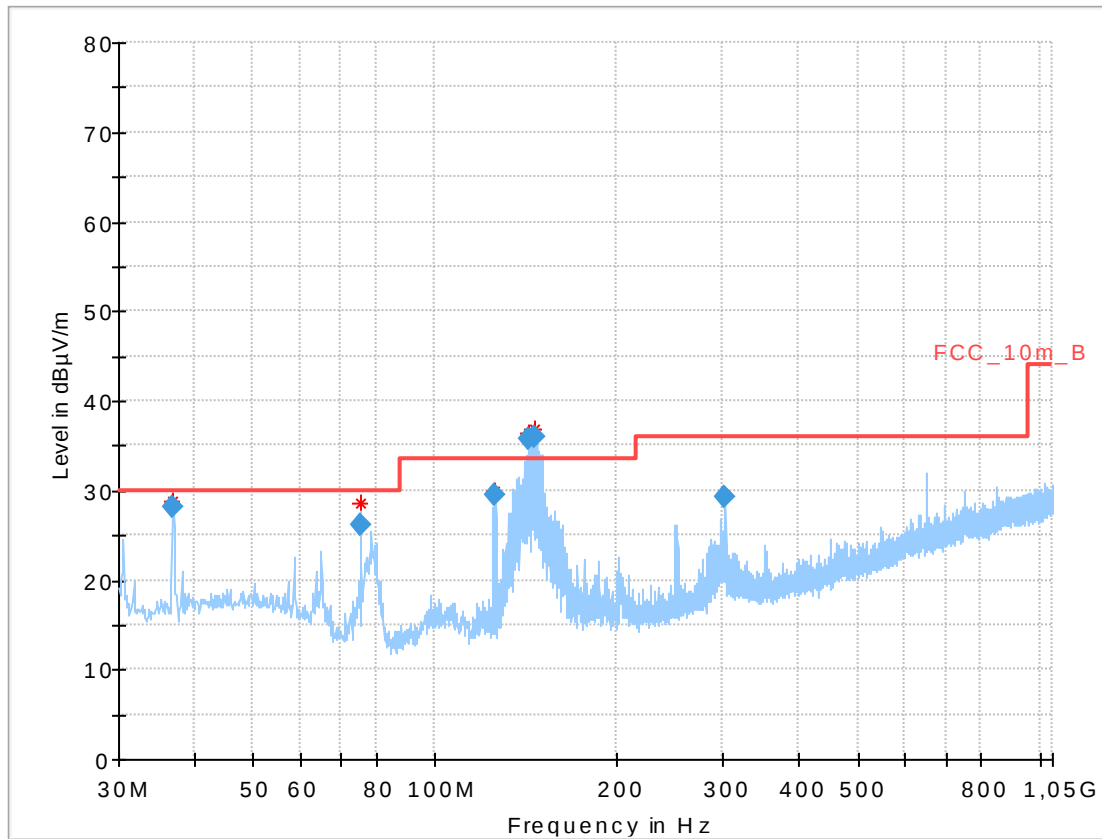
Plot: OFDM (20 MHz bandwidth)

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

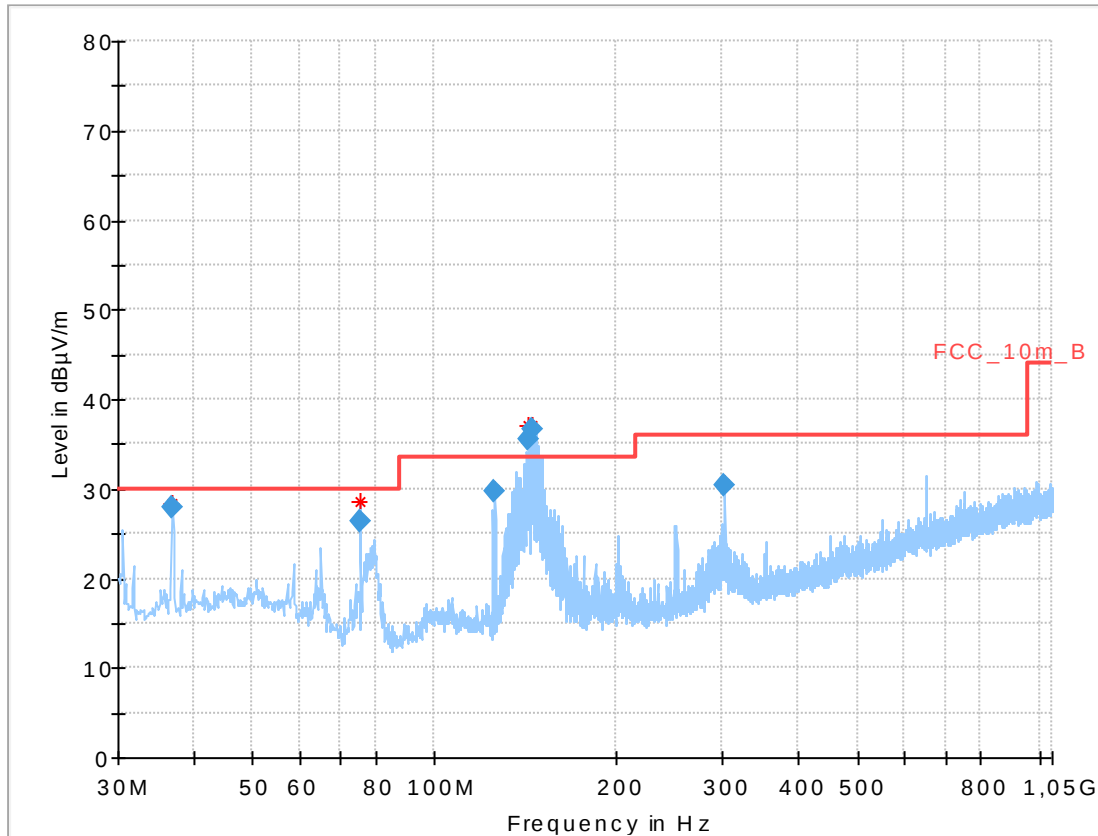


Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
30.641	23.46	30.0	6.54	1000	120	100.0	V	223.0	11.9
36.898	27.02	30.0	2.98	1000	120	101.0	V	130.0	12.9
75.766	28.86	30.0	1.24	1000	120	152.0	V	99.0	8.8
125.921	30.40	33.5	3.10	1000	120	121.0	V	9.0	9.8
145.164*	36.51	33.5	-3.01	1000	120	99.0	V	128.0	9.1
147.803*	36.05	33.5	-2.45	1000	120	102.0	V	144.0	9.2

* Frequency is outside the restricted bands and therefore not rated.

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

* Frequency is outside the restricted bands and therefore not rated.

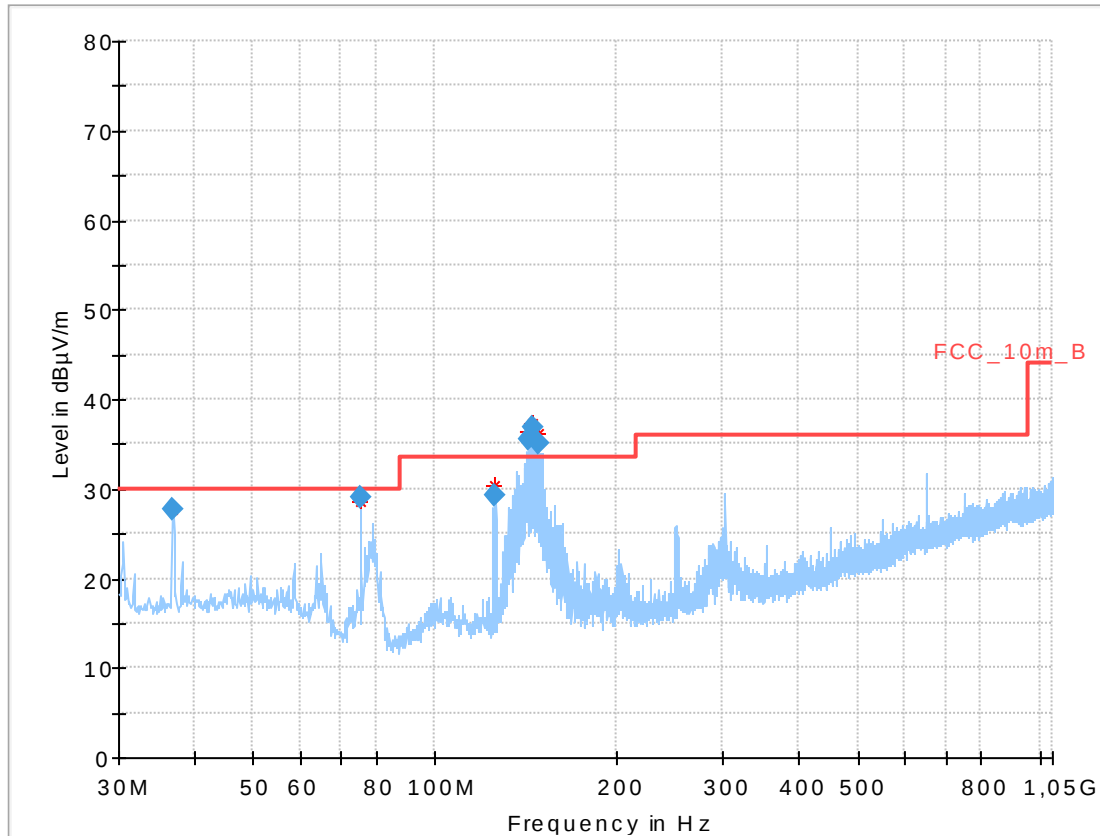
Plot 3: 30 MHz to 1 GHz, vertical & horizontal polarization, high channel

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
36.907	27.88	30.0	2.12	1000	120	100.0	V	121.0	12.9
75.563	26.28	30.0	3.72	1000	120	101.0	V	341.0	8.8
125.946	29.63	33.5	3.87	1000	120	98.0	V	-3.0	9.8
143.365*	35.54	33.5	-2.04	1000	120	100.0	V	123.0	9.0
145.563*	36.71	33.5	-3.21	1000	120	98.0	V	163.0	9.1
302.254	30.30	36.0	5.70	1000	120	170.0	H	295.0	14.5

* Frequency is outside the restricted bands and therefore not rated.

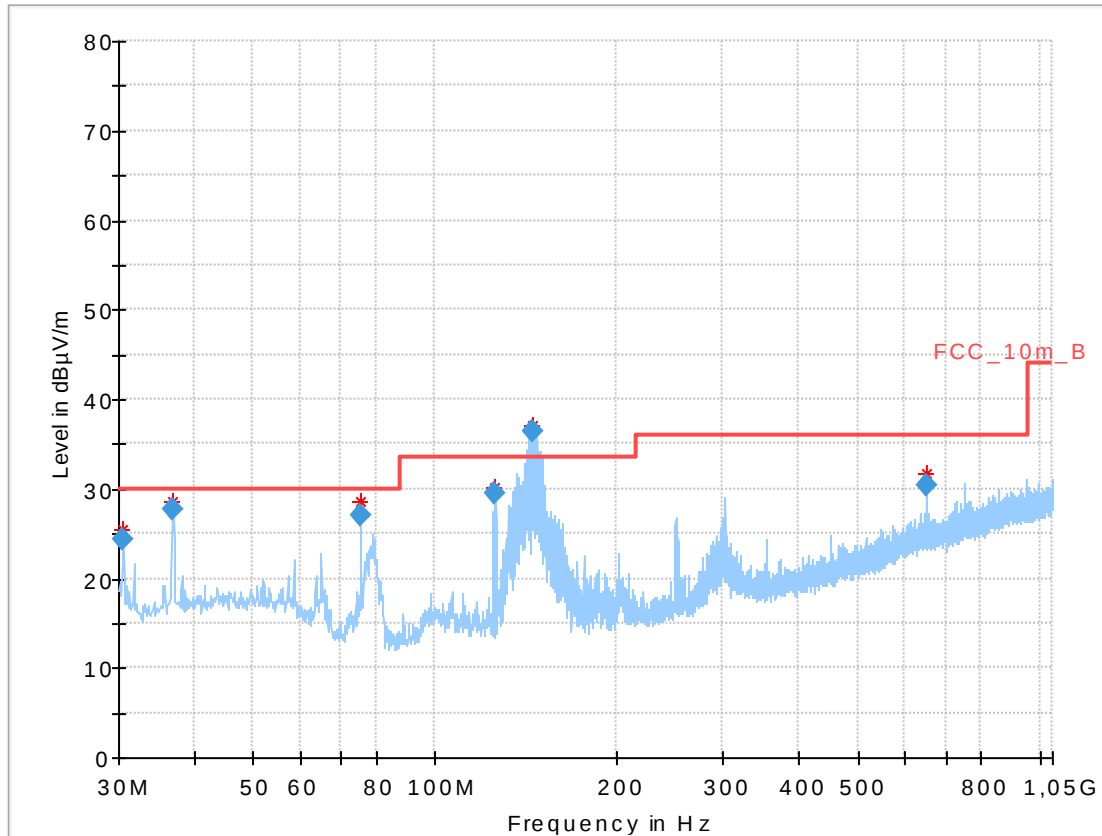
Plot: OFDM (40 MHz bandwidth)

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



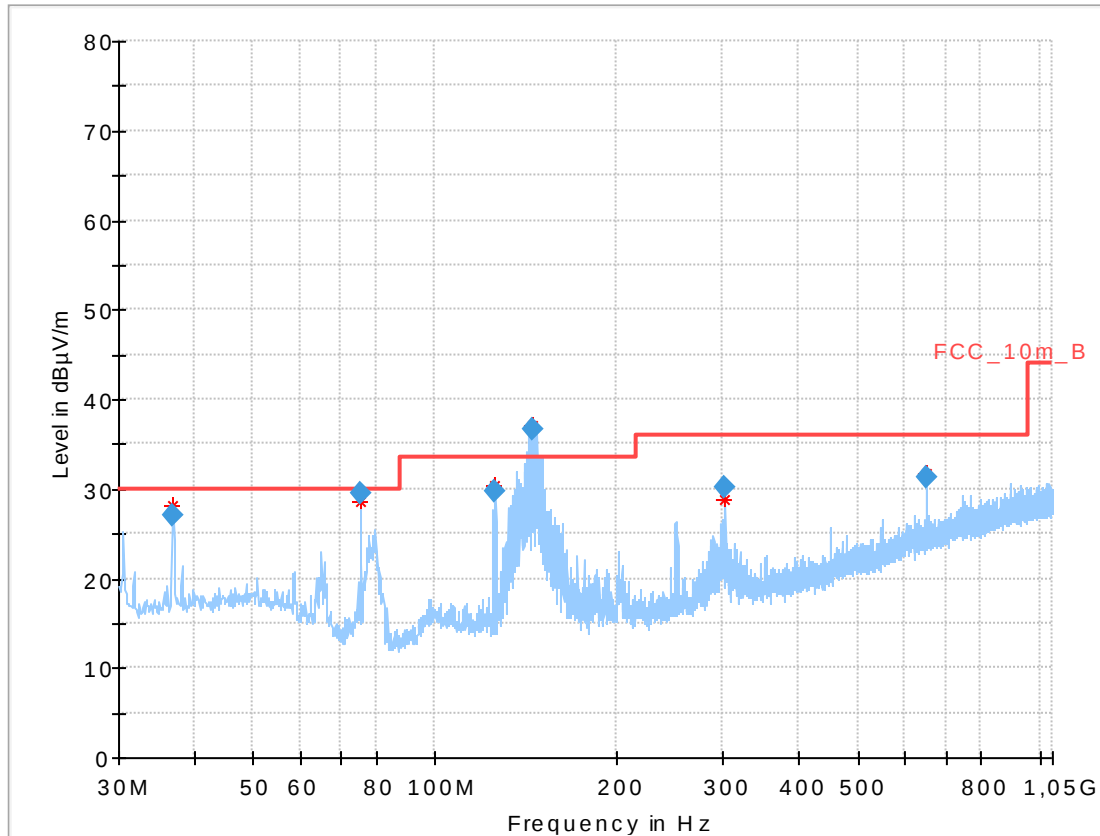
Frequency (MHz)	QuasiPeak (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
36.910	27.81	30.0	2.19	1000	120	101.0	V	111.0	12.9
75.572	29.03	30.0	0.97	1000	120	170.0	V	101.0	8.8
125.931	29.38	33.5	4.12	1000	120	98.0	V	3.0	9.8
143.303*	35.46	33.5	-1.96	1000	120	98.0	V	173.0	9.0
145.565*	36.76	33.5	-3.26	1000	120	100.0	V	160.0	9.1
147.855*	35.14	33.5	-1.64	1000	120	98.0	V	129.0	9.2

* Frequency is outside the restricted bands and therefore not rated.

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

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
30.534	24.35	30.0	5.65	1000	120	100.0	V	353.0	11.9
36.896	27.64	30.0	2.36	1000	120	98.0	V	126.0	12.9
75.556	26.96	30.0	3.04	1000	120	101.0	V	59.0	8.8
125.945	29.53	33.5	3.97	1000	120	98.0	V	-10.0	9.8
145.562*	36.52	33.5	-3.02	1000	120	98.0	V	80.0	9.1
650.016	30.37	36.0	5.63	1000	120	98.0	H	1.0	21.1

* Frequency is outside the restricted bands and therefore not rated.

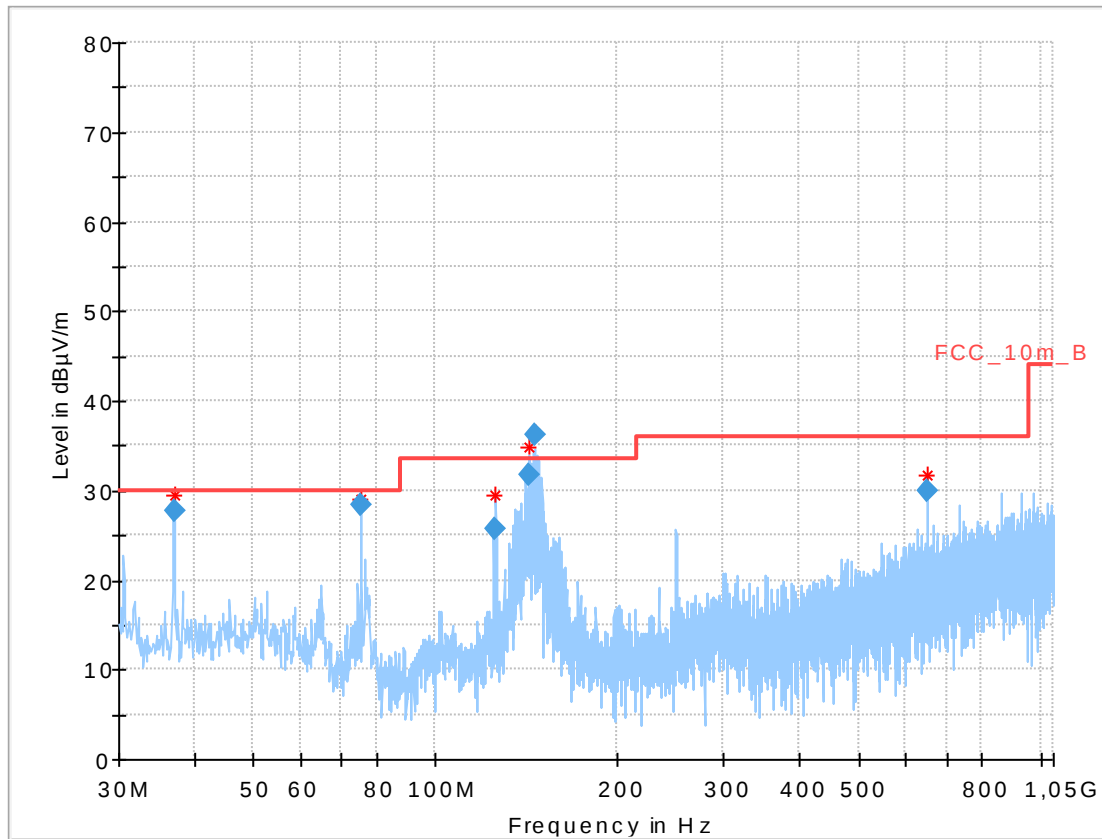
Plot 3: 30 MHz to 1 GHz, vertical & horizontal polarization, high channel

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
36.904	27.10	30.0	2.90	1000	120	98.0	V	217.0	12.9
75.559	29.52	30.0	0.48	1000	120	170.0	V	84.0	8.8
125.945	29.62	33.5	3.88	1000	120	98.0	V	-5.0	9.8
145.548*	36.71	33.5	-3.21	1000	120	98.0	V	157.0	9.1
302.237	30.09	36.0	5.91	1000	120	170.0	H	280.0	14.5
650.013	31.23	36.0	4.77	1000	120	98.0	H	35.0	21.1

* Frequency is outside the restricted bands and therefore not rated.

Plot: RX / Idle mode

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



Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
37.025	27.70	30.0	2.30	1000	120	101.0	V	300.0	12.9
75.573	28.30	30.0	1.70	1000	120	101.0	V	287.0	8.8
125.933	25.81	33.5	7.69	1000	120	98.0	V	350.0	9.8
142.421*	31.74	33.5	1.76	1000	120	98.0	V	34.0	9.0
145.678*	36.16	33.5	-2.66	1000	120	98.0	V	141.0	9.1
649.989	29.98	36.0	6.02	1000	120	98.0	H	0.0	21.1

* Frequency is outside the restricted bands and therefore not rated.

11.13 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 ☒ RX / Idle – mode
Test setup:	See sub clause 6.2 – B See sub clause 6.3 – A
Measurement uncertainty	See sub clause 8

Limits:

FCC		IC
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 30 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).		
Frequency (MHz)	Field Strength (dBμV/m)	Measurement distance
Above 960	54.0	3

Results: DSSS

TX Spurious Emissions Radiated [dBµV/m]								
2412 MHz			2437 MHz			2462 MHz		
F [MHz]	Detector	Level [dBµV/m]	F [MHz]	Detector	Level [dBµV/m]	F [MHz]	Detector	Level [dBµV/m]
All detected peak emissions are below the average limit.			All detected peak emissions are below the average limit.			4933	Peak	54.2
							AVG	44.5

Results: OFDM (20 MHz bandwidth)

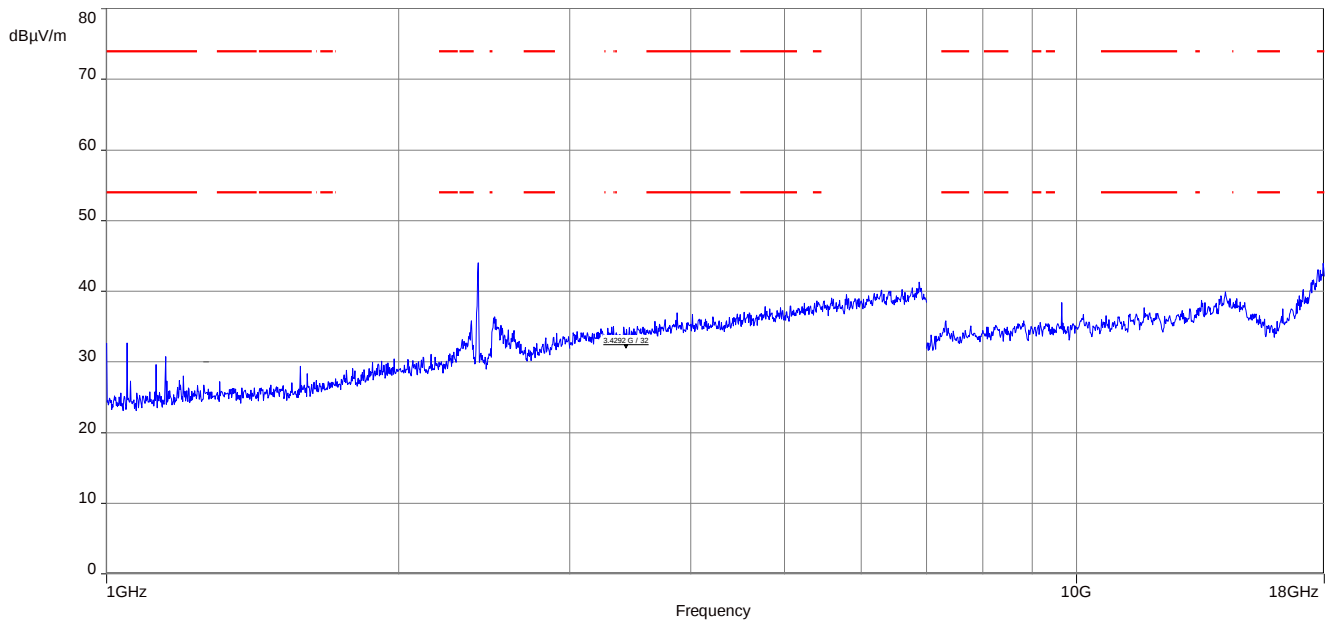
TX Spurious Emissions Radiated [dBµV/m]								
2412 MHz			2437 MHz			2462 MHz		
F [MHz]	Detector	Level [dBµV/m]	F [MHz]	Detector	Level [dBµV/m]	F [MHz]	Detector	Level [dBµV/m]
All detected peak emissions are below the average limit.			All detected peak emissions are below the average limit.			All detected peak emissions are below the average limit.		

Results: OFDM (40 MHz bandwidth)

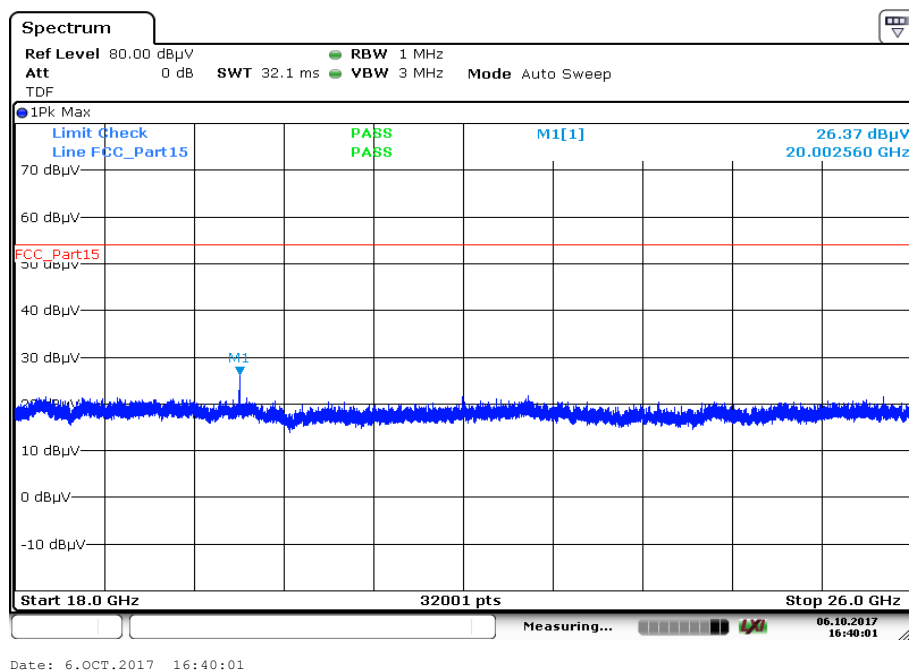
TX Spurious Emissions Radiated [dBµV/m]								
2412 MHz			2437 MHz			2462 MHz		
F [MHz]	Detector	Level [dBµV/m]	F [MHz]	Detector	Level [dBµV/m]	F [MHz]	Detector	Level [dBµV/m]
All detected peak emissions are below the average limit.			All detected peak emissions are below the average limit.			4908	Peak	55.2
							AVG	42.4

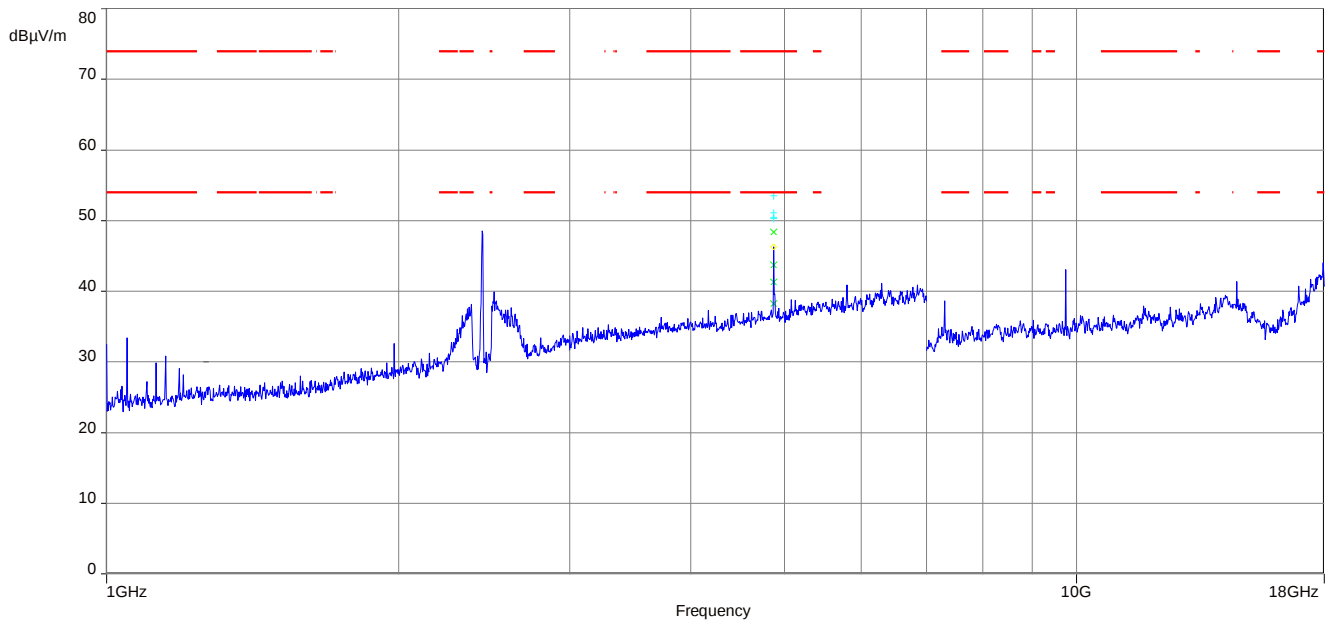
Results: RX / idle – mode

TX Spurious Emissions Radiated [dBµV/m]		
F [MHz]	Detector	Level [dBµV/m]
All detected peak emissions are below the average limit.		
Peak		
AVG		

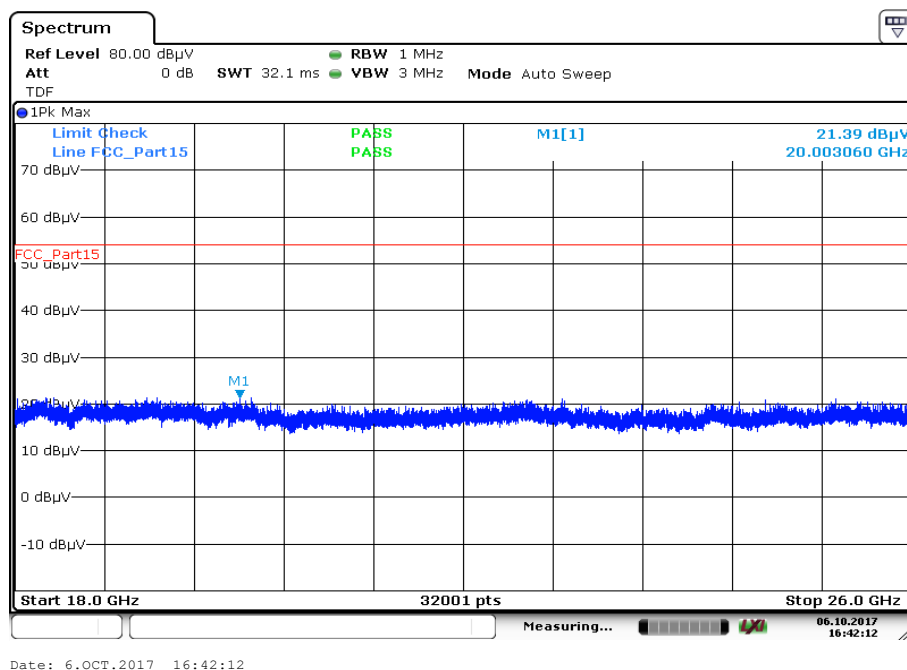
Plots: DSSS**Plot 1:** Lowest channel, 1 GHz to 18 GHz, vertical & horizontal polarization

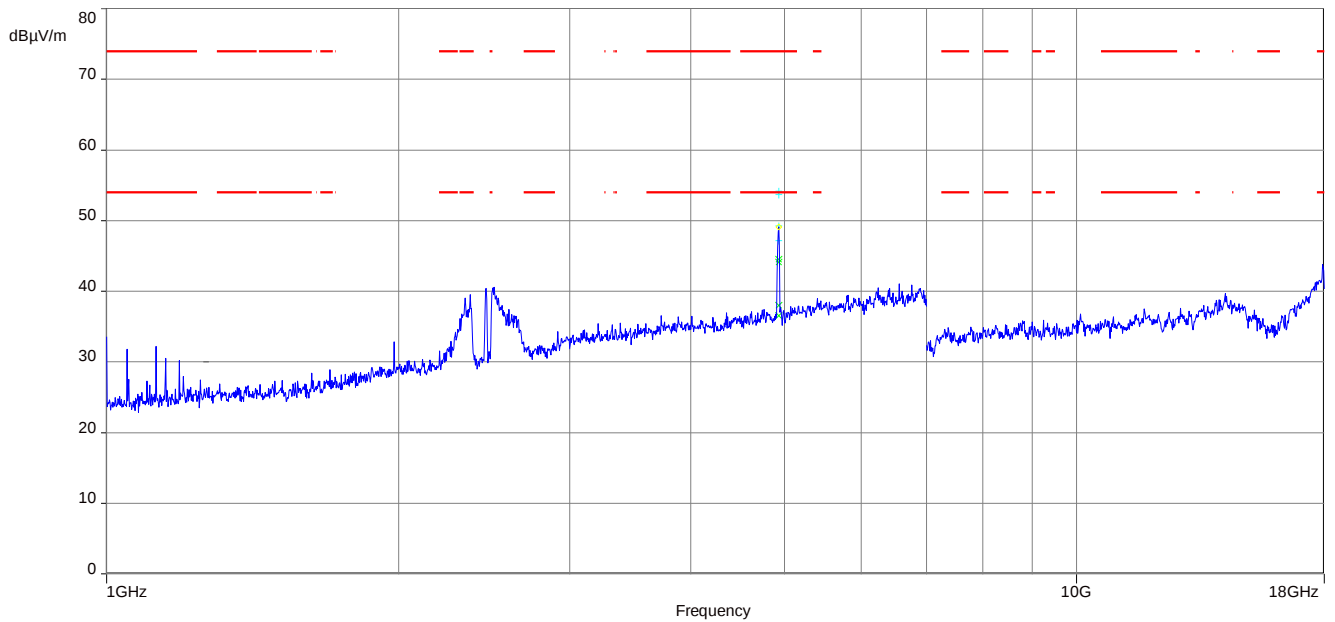
The carrier signal is notched with a 2.4 GHz band rejection filter.

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

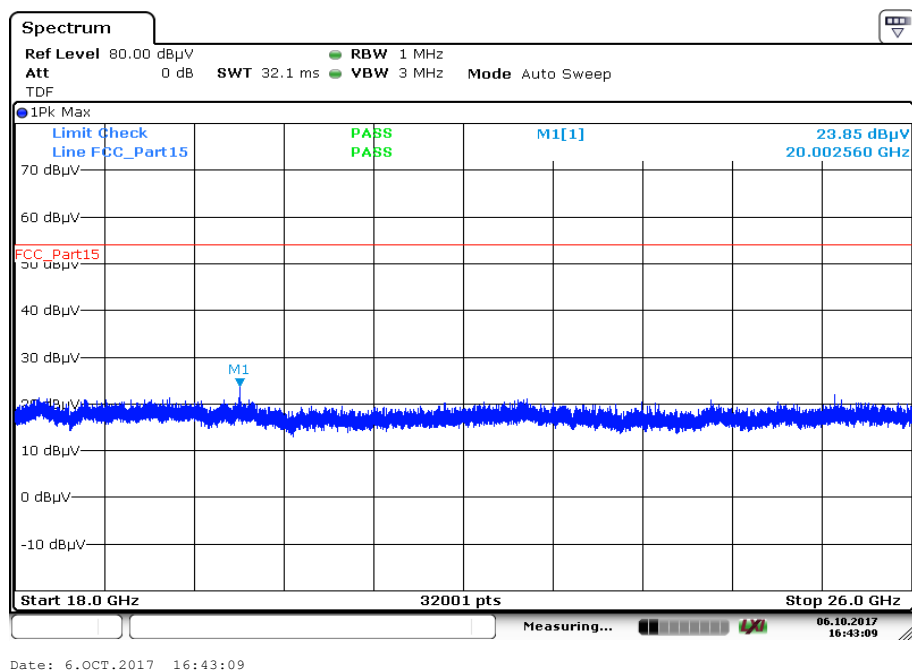
Plot 3: Middle channel, 1 GHz to 18 GHz, vertical & horizontal polarization

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

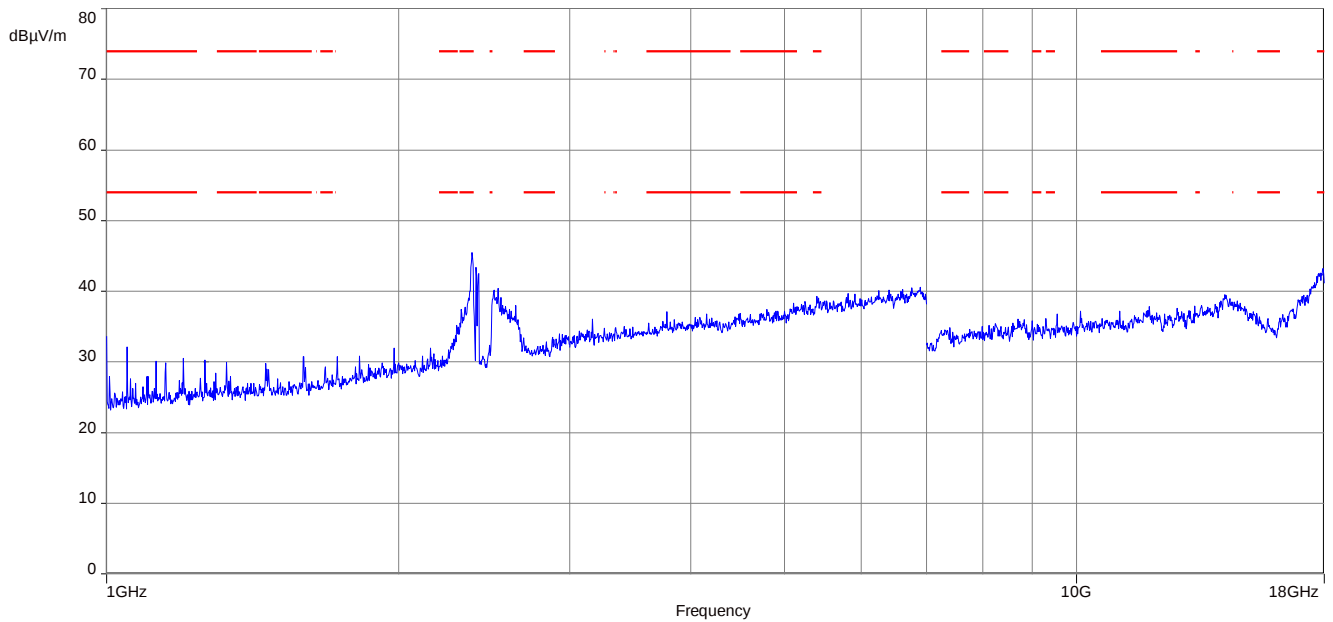
Plot 5: Highest channel, 1 GHz to 18 GHz, vertical & horizontal polarization

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

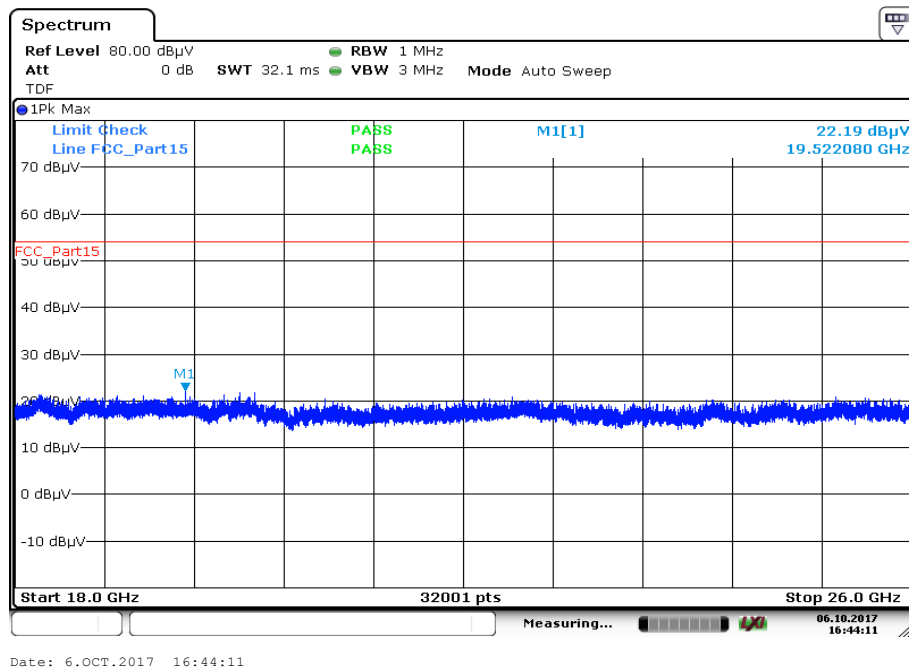
Plots: OFDM (20 MHz bandwidth)

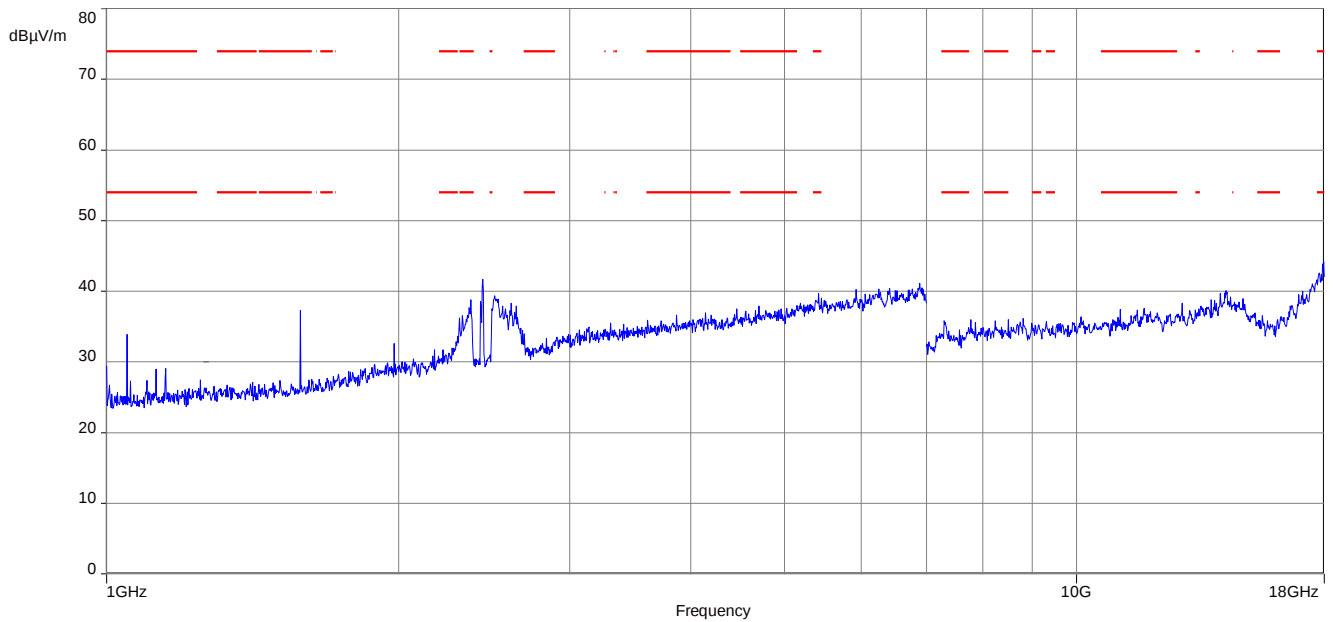
Plot 1: Lowest channel, 1 GHz to 18 GHz, vertical & horizontal polarization



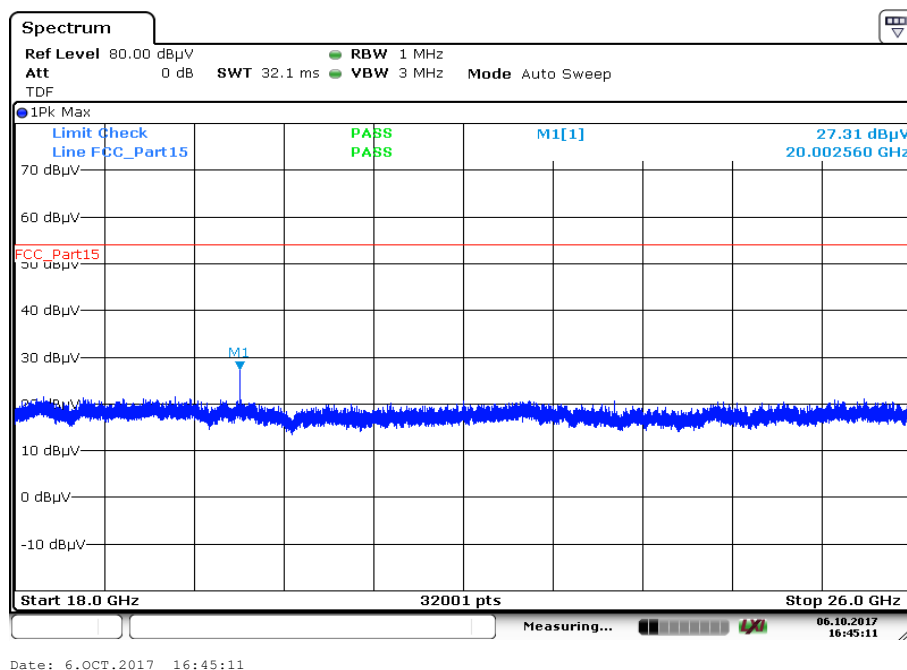
The carrier signal is notched with a 2.4 GHz band rejection filter.

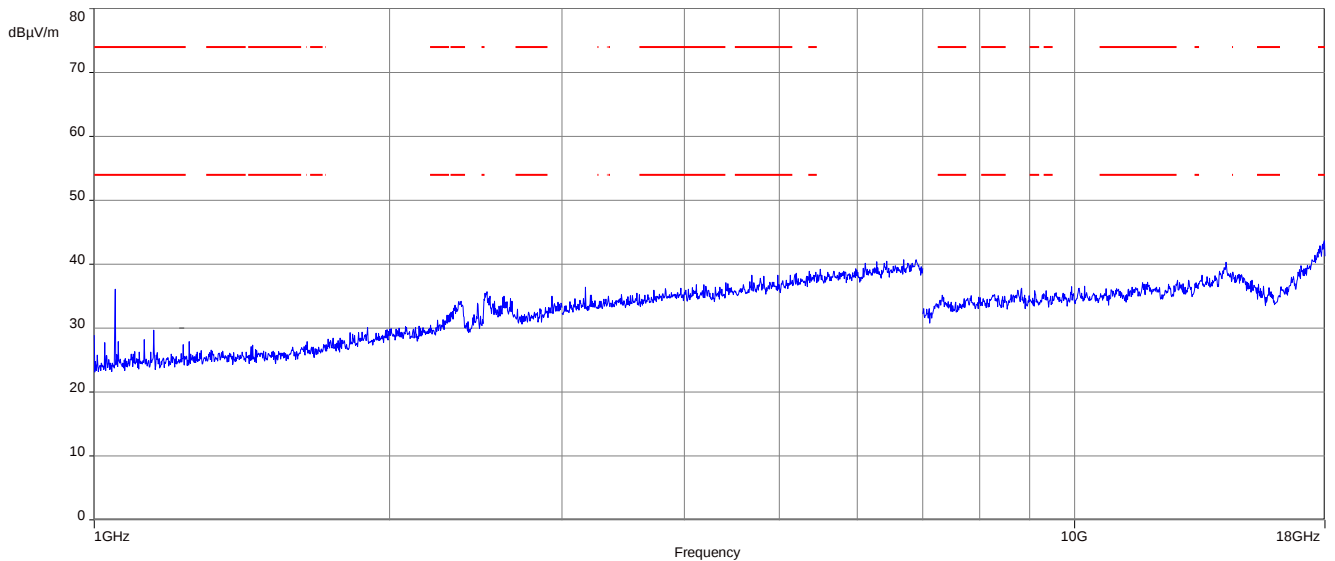
Plot 2: Lowest channel, 18 GHz to 26 GHz, vertical & horizontal polarization



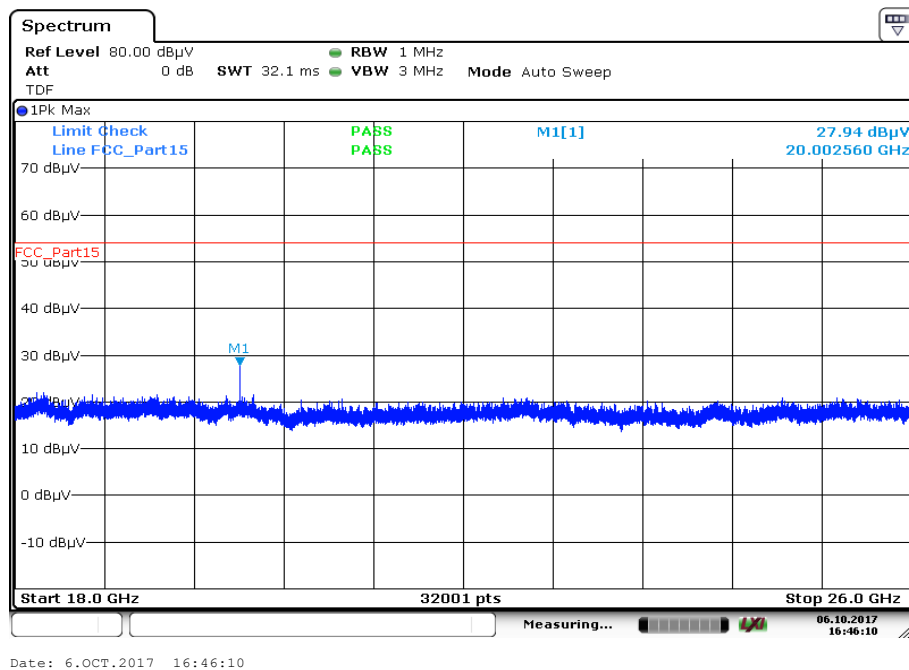
Plot 3: Middle channel, 1 GHz to 18 GHz, vertical & horizontal polarization

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

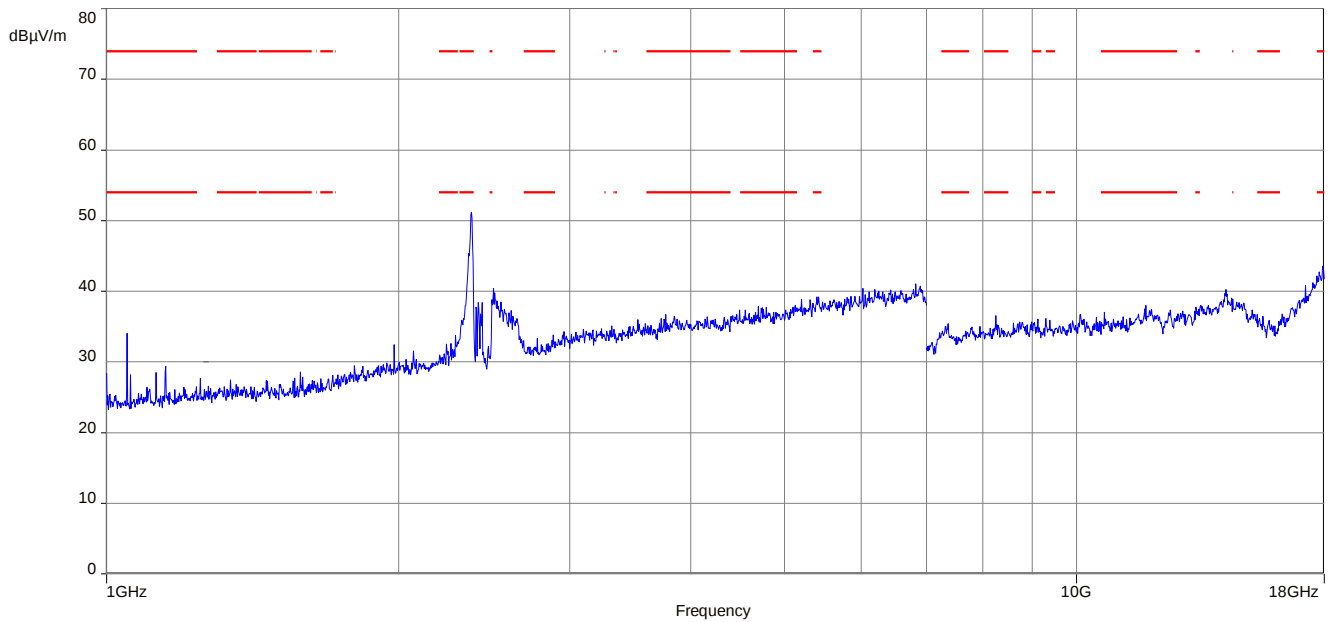
Plot 5: Highest channel, 1 GHz to 18 GHz, vertical & horizontal polarization

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

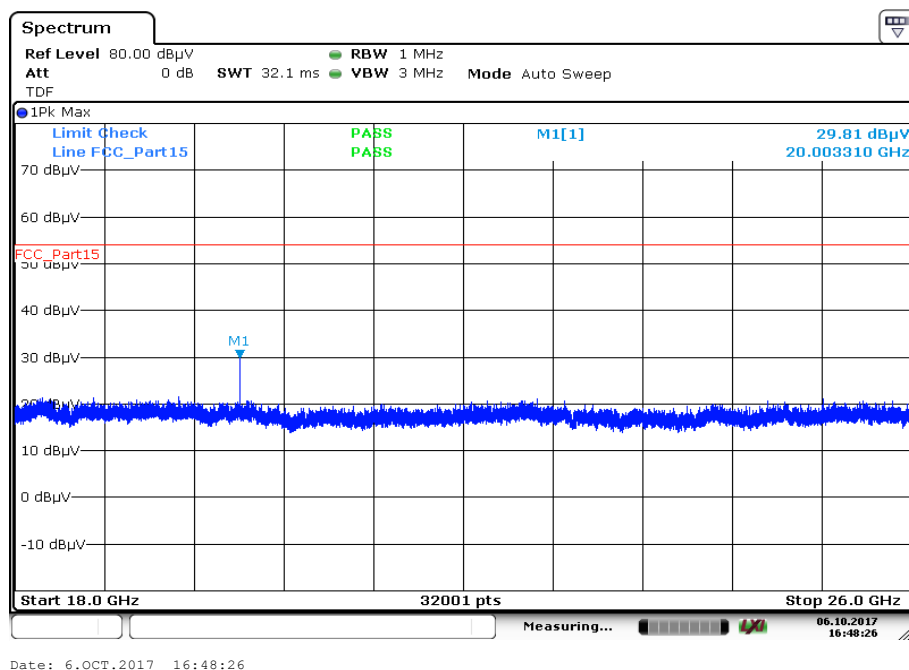
Plots: OFDM (40 MHz bandwidth)

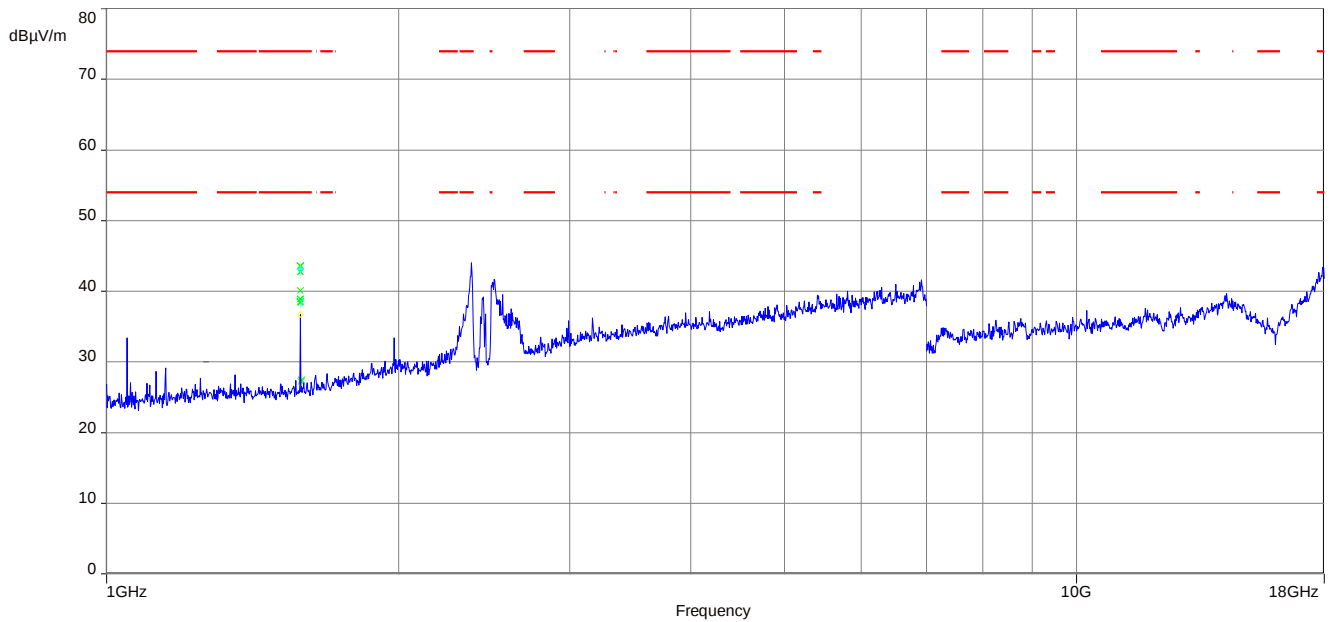
Plot 1: Lowest channel, 1 GHz to 18 GHz, vertical & horizontal polarization



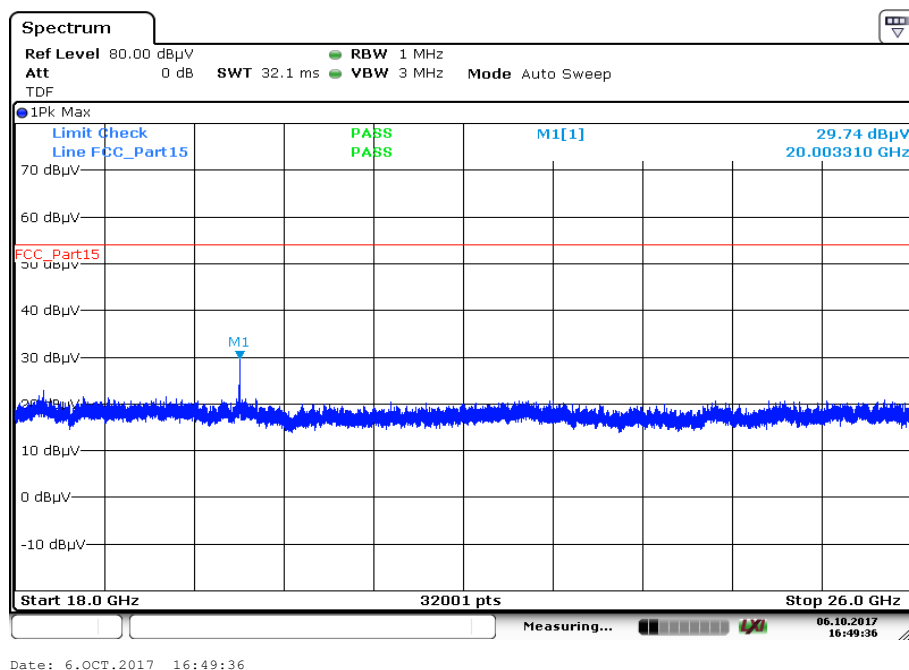
The carrier signal is notched with a 2.4 GHz band rejection filter.

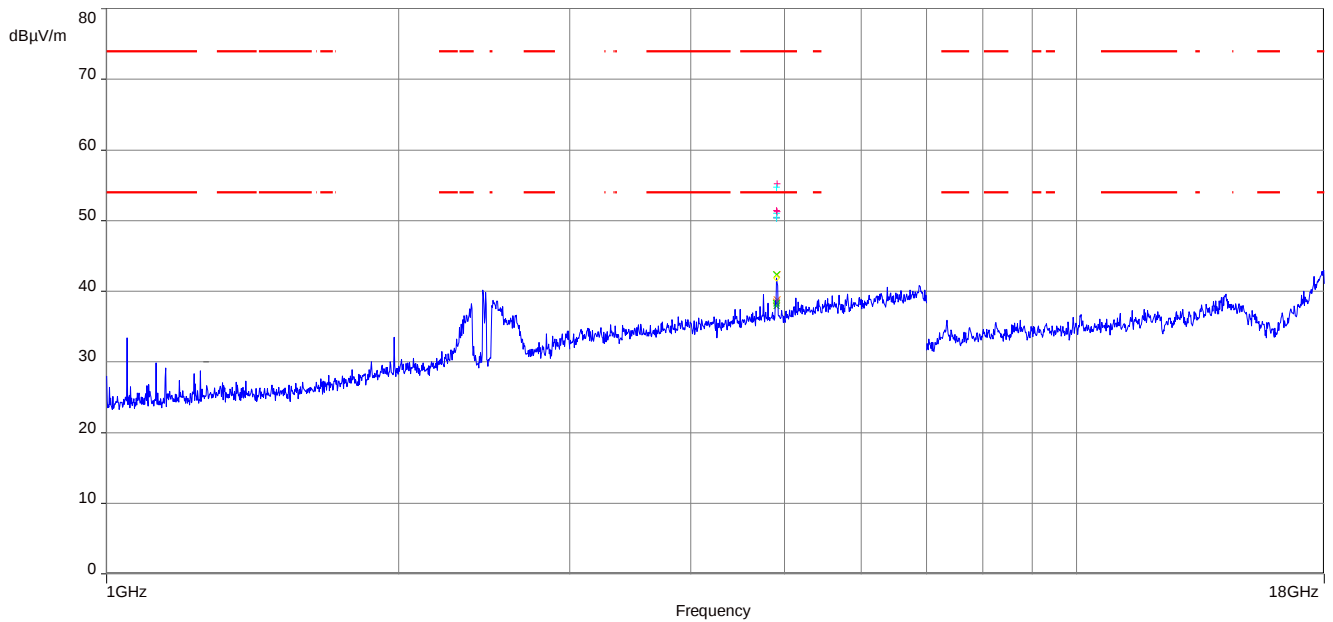
Plot 2: Lowest channel, 18 GHz to 26 GHz, vertical & horizontal polarization



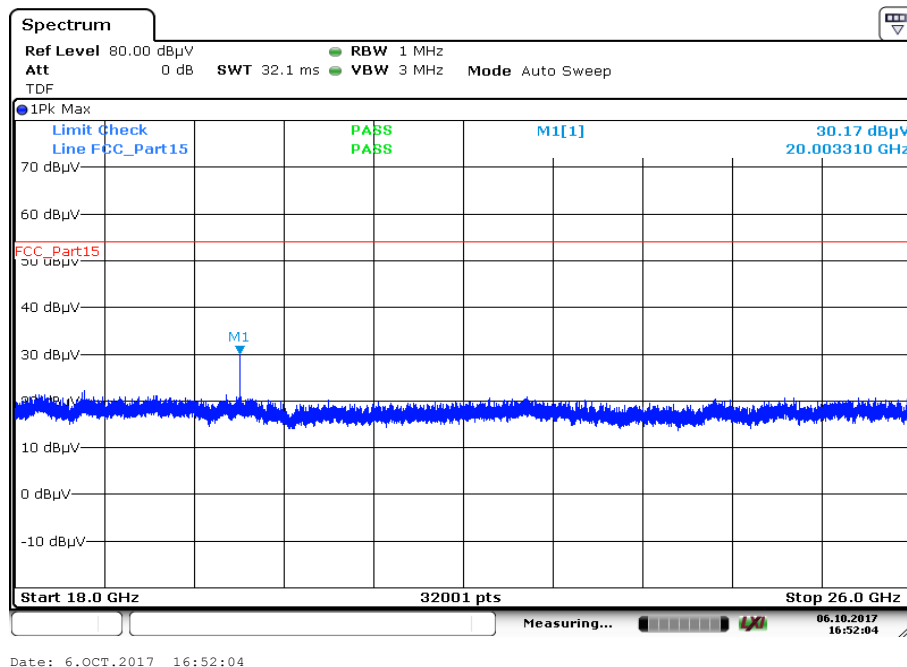
Plot 3: Middle channel, 1 GHz to 18 GHz, vertical & horizontal polarization

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

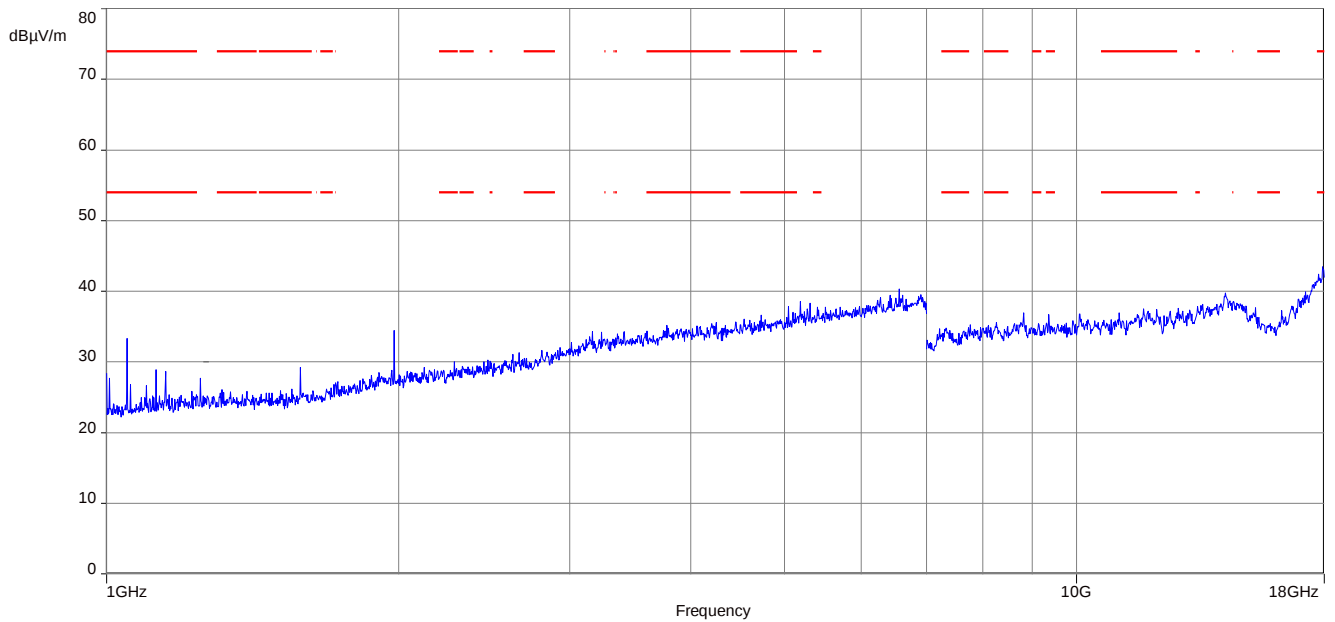
Plot 5: Highest channel, 1 GHz to 18 GHz, vertical & horizontal polarization

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

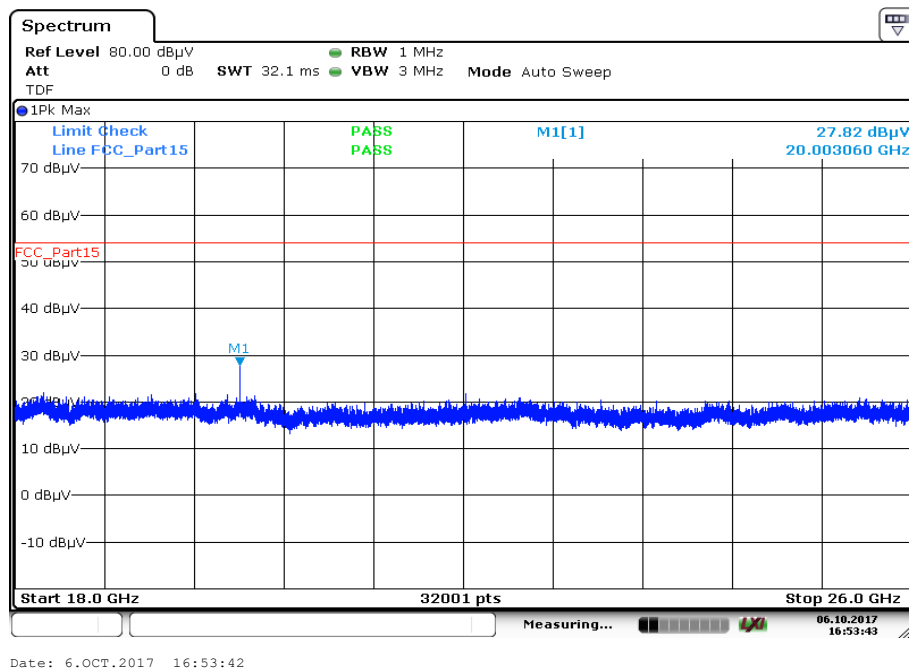
Plot 6: Highest channel, 18 GHz to 26 GHz, vertical & horizontal polarization

Plots: RX / idle mode

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



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



12 Observations

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

Annex A Glossary

EUT	Equipment under test
DUT	Device under test
UUT	Unit under test
EN	European Standard
FCC	Federal Communications Commission
FCC ID	Company Identifier at FCC
IC	Industry Canada
PMN	Product marketing name
HMN	Host marketing name
HVIN	Hardware version identification number
FVIN	Firmware version identification number
EMC	Electromagnetic Compatibility
HW	Hardware
SW	Software
Inv. No.	Inventory number
S/N or SN	Serial number
C	Compliant
NC	Not compliant
NA	Not applicable
NP	Not performed
PP	Positive peak
QP	Quasi peak
AVG	Average
OC	Operating channel
OCW	Operating channel bandwidth
OBW	Occupied bandwidth
OOB	Out of band
CAC	Channel availability check
OP	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

Annex B Document history

Version	Applied changes	Date of release
-/-	Initial release	2017-10-25
A	General information revised FCC ID, PMN, HVIN, FVIN	2017-11-06
B	Editorial changes	2017-12-08

Annex C Accreditation Certificate

first page	last page
 Deutsche Akkreditierungsstelle GmbH Beliehene gemäß § 8 Absatz 1 AkkStelleG i.V.m. § 1 Absatz 1 AkkStelleGBV Unterzeichnerin der Multilateralen Abkommen von EA, ILAC und IAF zur gegenseitigen Anerkennung Akkreditierung  Die Deutsche Akkreditierungsstelle GmbH bestätigt hiermit, dass das Prüflaboratorium CTC advanced GmbH Untertürkheimer Straße 6-10, 66117 Saarbrücken die Kompetenz nach DIN EN ISO/IEC 17025:2005 besitzt, Prüfungen in folgenden Bereichen durchzuführen: Funk Mobilfunk (GSM / DCS) + OTA Elektromagnetische Verträglichkeit (EMV) Produktsicherheit SAR / EMF Umwelt Smart Card Technology Bluetooth® Automotive Wi-Fi Services Kanadische Anforderungen US-Anforderungen Akustik Near Field Communication (NFC) Die Akkreditierungsurkunde gilt nur in Verbindung mit dem Bescheid vom 25.11.2016 mit der Akkreditierungsnummer D-PL-12076-01 und ist gültig bis 17.01.2018. Sie besteht aus diesem Deckblatt, der Rückseite des Deckblatts und der folgenden Anlage mit insgesamt 63 Seiten. Registrierungsnummer der Urkunde: D-PL-12076-01-01 Frankfurt, 25.11.2016  Im Auftrag Dipl.-Ing. Ralf Egner Abteilungsleiter Siehe Hinweise auf der Rückseite	Deutsche Akkreditierungsstelle GmbH Standort Berlin Spittelmarkt 10 10117 Berlin Standort Frankfurt am Main Europa-Allee 52 60327 Frankfurt am Main Standort Braunschweig Bundesallee 100 38116 Braunschweig Die auszugsweise Veröffentlichung der Akkreditierungsurkunde bedarf der vorherigen schriftlichen Zustimmung der Deutsche Akkreditierungsstelle GmbH (DAKKS). Ausgenommen davon ist die separate Weiterverbreitung des Deckblattes durch die umseitig genannte Konformitätsbewertungsstelle in unveränderter Form. Es darf nicht der Anschein erweckt werden, dass sich die Akkreditierung auch auf Bereiche erstreckt, die über den durch die DAKKS bestätigten Akkreditierungsbereich hinausgehen. Die Akkreditierung erfolgte gemäß des Gesetzes über die Akkreditierungsstelle (AkkStelleG) vom 31. Juli 2009 (BGBl. I S. 2625) sowie der Verordnung (EG) Nr. 765/2008 des Europäischen Parlaments und des Rates vom 9. Juli 2008 über die Vorschriften für die Akkreditierung und Marktüberwachung im Zusammenhang mit der Vermarktung von Produkten (Abi. L 218 vom 9. Juli 2008, S. 30). Die DAKKS ist Unterzeichnerin der Multilateralen Abkommen zur gegenseitigen Anerkennung der European co-operation for Accreditation (EA), des International Accreditation Forum (IAF) und der International Laboratory Accreditation Cooperation (ILAC). Die Unterzeichner dieser Abkommen erkennen ihre Akkreditierungen gegenseitig an. Der aktuelle Stand der Mitgliedschaft kann folgenden Webseiten entnommen werden: EA: www.european-accreditation.org ILAC: www.ilac.org IAF: www.iaf.nu

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<http://www.dakks.de/as/ast/d/D-PL-12076-01-02.pdf>