Bundesnetzagentur

BNetzA-CAB-02/21-102

TEST REPORT

Test report no.: 1-5253/17-01-02

DAkkS Deutsche Akkreditierungsstelle D-PL-12076-01-03

Testing laboratory

CTC advanced GmbH
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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-12076-01-03

Applicant

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Manufacturer

Ingenico Group
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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
RSS - Gen Issue 4	Spectrum Management and Telecommunications Radio Standards Specifications - General Requirements and Information for the Certification of Radio Apparatus

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

Test Item

Kind of test item:	**Payment Terminal**
Model name:	**Lane/5000 CL/Eth/WiFi/BT**
FCC ID:	**XKB-L5000CLWIBT**
IC:	**2586D-L5000CLWIBT**
Frequency:	ISM band 2400 MHz to 2483.5 MHz
Technology tested:	WLAN
Antenna:	Integrated PCB antenna
Power supply:	115 V AC & 8 V DC by mains adapter
Temperature range:	0°C to +40°C

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

Test report authorized:

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Mihail Dorongovskij
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1 Table of contents

2 General information

2.1 Notes and disclaimer

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2.2 Application details

Date of receipt of order:	2017-11-13
Date of receipt of test item:	2018-01-22
Start of test:	2018-01-22
End of test:	2018-02-15
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
RSS - Gen Issue 4	November 2014	Spectrum Management and Telecommunications Radio Standards Specifications - General Requirements and Information for the Certification of Radio Apparatus

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	:		40 %
Barometric pressure	:		998 hpa
Power supply	:	V_{nom} V_{max} V_{min}	115 V AC & 8 V DC by mains adapter 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	:	Payment Terminal
Type identification	:	Lane/5000 CL/Eth/WiFi/BT
HMN	:	-/-
PMN	:	Lane/5000
HVIN	:	Lane/5000 CL/Eth/WiFi/BT
FVIN	:	-/-
S/N serial number	:	Radiated unit: 17089991326104459999913 17089991326104459999916 (Only used for receiver spurious emission measurements) Conducted unit: 17089991326104459999920
HW hardware status	:	01
SW software status	:	OS_038105_HTB_0086; RF test mode
Frequency band	:	ISM band 2400 MHz to 2483.5 MHz
Type of radio transmission Use of frequency spectrum	: :	DSSS, OFDM
Type of modulation	:	(D)BPSK, (D)QPSK, 16 – QAM, 64 – QAM
Number of channels	:	11
Antenna	:	Integrated PCB antenna
Power supply	:	115 V AC & 8 V DC by mains adapter
Temperature range	:	0°C to +40°C

5.2 Additional information

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

Test setup- and EUT-photos are included in test report: 1-5253/17-01-01_AnnexA
1-5253/17-01-01_AnnexB
1-5253/17-01-01_AnnexD

6 Description of the test setup

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

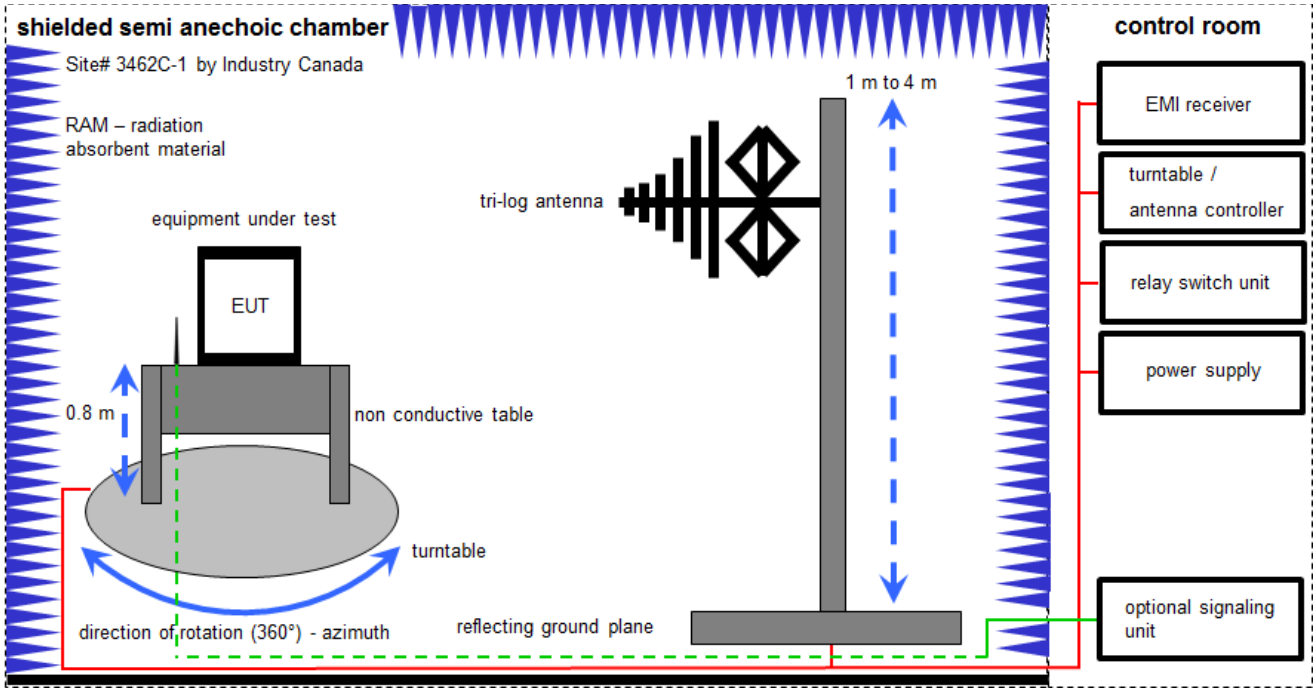
In order to simplify the identification of the equipment used at some special tests, some items of test equipment and ancillaries can be provided with an identifier or number in the equipment list below (Lab/Item).

Agenda: Kind of Calibration

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

6.1 Shielded semi anechoic chamber

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



Measurement distance: tri-log antenna 10 meter

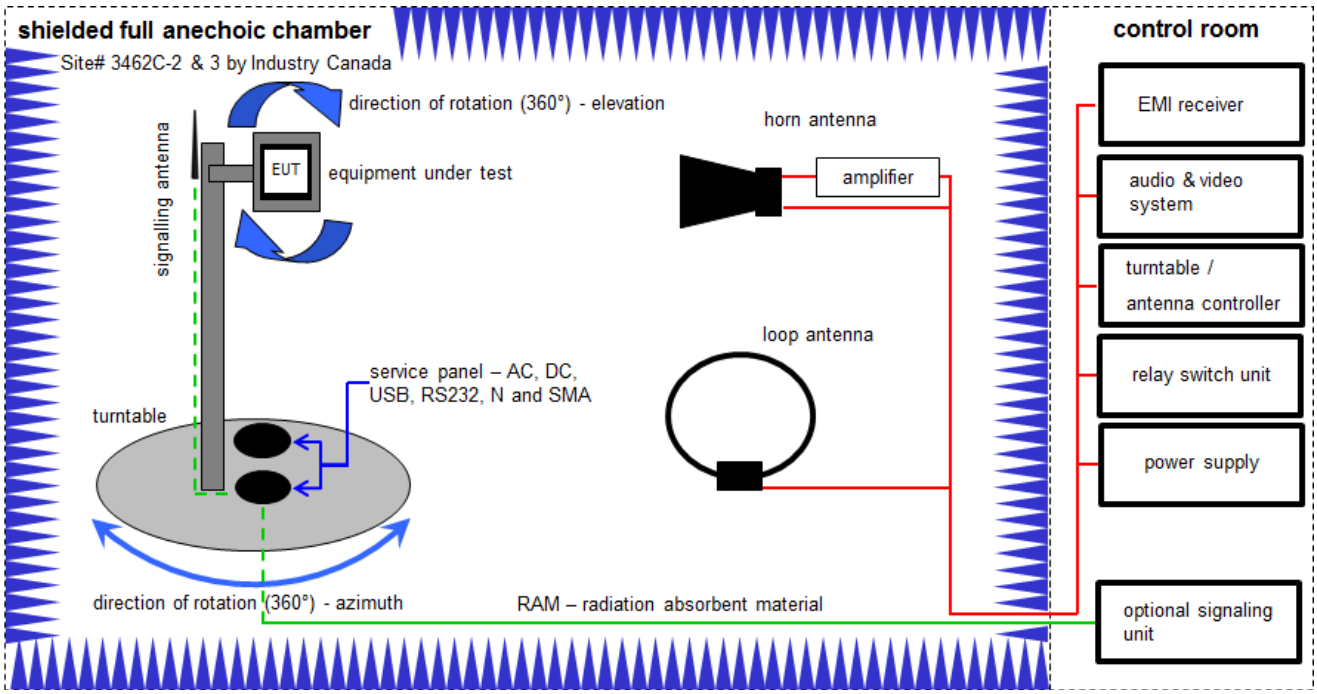
FS = UR + CL + AF
(FS-field strength; UR-voltage at the receiver; CL-loss of the cable; AF-antenna factor)

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	Meßkabine 1	HF-Absorberhalle	MWB AG 300023	-/-	300000551	ne	-/-	-/-
3	A	EMI Test Receiver	ESCI 3	R&S	100083	300003312	k	15.12.2017	14.12.2018
4	A	Analyzer-Reference-System (Harmonics and Flicker)	ARS 16/1	SPS	A3509 07/0 0205	300003314	vIKI!	15.01.2018	14.01.2020
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: horn antenna 3 meter; loop antenna 3 meter

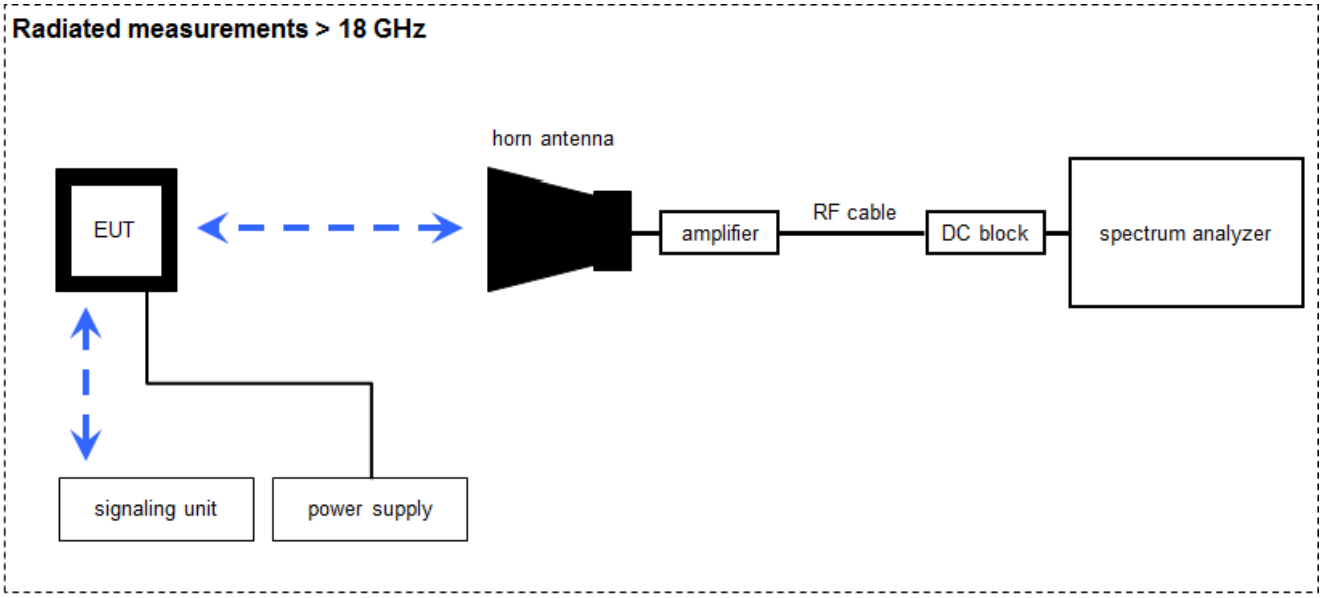
FS = UR + CA + AF
(FS-field strength; UR-voltage at the receiver; CA-loss of the signal path; AF-antenna factor)

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	k	07.07.2017	06.07.2019
2	A, B, C	Anechoic chamber	FAC 3/5m	MWB / TDK	87400/02	300000996	ev	-/-	-/-
3	B, C	Double-Ridged Waveguide Horn Antenna 1-18.0GHz	3115	EMCO	9107-3697	300001605	vIKI!	14.02.2017	13.02.2019
4	A, B, C	Switch / Control Unit	3488A	HP	*	300000199	ne	-/-	-/-
5	C	Band Reject filter	WRCG2400/2483-2375/2505-50/10SS	Wainwright	11	300003351	ev	-/-	-/-
6	B, C	EMI Test Receiver 20Hz- 26,5GHz	ESU26	R&S	100037	300003555	k	20.12.2017	19.12.2018
7	C	Highpass Filter	WHK1.1/15G-10SS	Wainwright	3	300003255	ev	-/-	-/-
8	C	Highpass Filter	WHKX7.0/18G-8SS	Wainwright	19	300003790	ne	-/-	-/-
9	C	Broadband Amplifier 0.5-18 GHz	CBLU5184540	CERNEX	22049	300004481	ev	-/-	-/-
10	A, B, C	4U RF Switch Platform	L4491A	Agilent Technologies	MY50000037	300004509	ne	-/-	-/-
11	A, B, C	NEXIO EMV-Software	BAT EMC V3.16.0.49	EMCO	-/-	300004682	ne	-/-	-/-
12	A, B, C	PC	ExOne	F+W	-/-	300004703	ne	-/-	-/-

6.3 Radiated measurements > 18 GHz



Measurement distance: horn antenna 50 cm

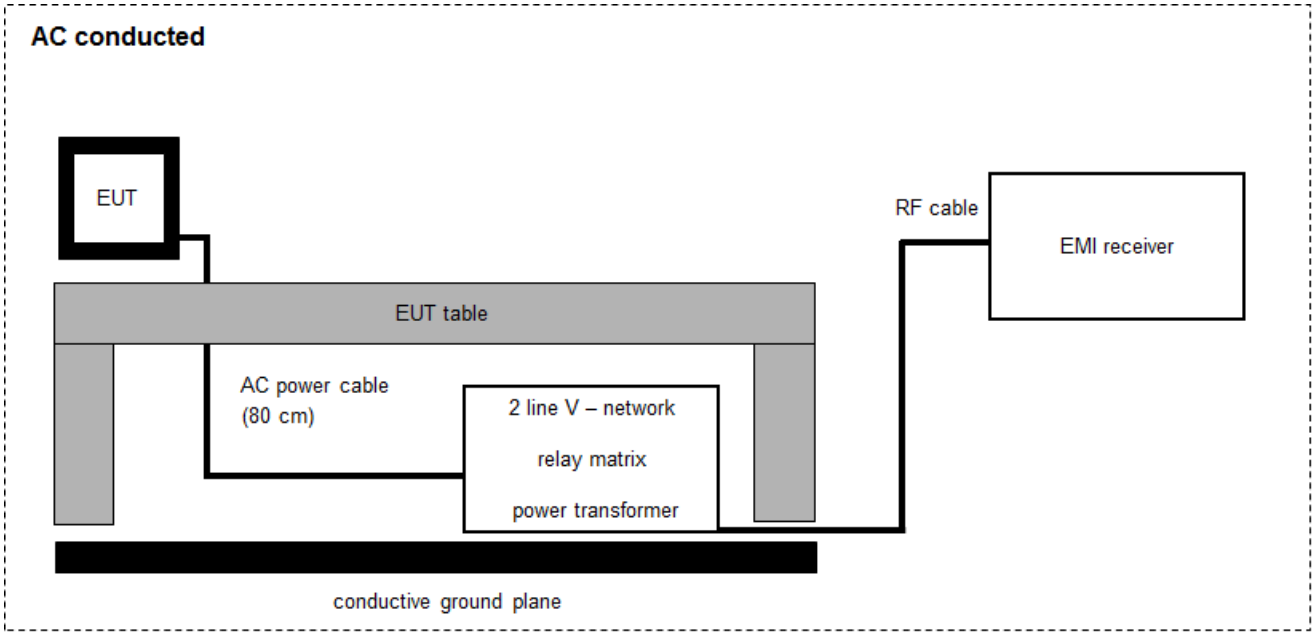
FS = UR + CA + AF
(FS-field strength; UR-voltage at the receiver; CA-loss signal path & distance correction; AF-antenna factor)

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

Equipment table:

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	A	Amplifier 2-40 GHz	JS32-02004000-57-5P	MITEQ	1777200	300004541	ev	-/-	-/-
2	A	RF-Cable	ST18/SMAm/SMAm/48	Huber & Suhner	Batch no. 600918	400001182	ev	-/-	-/-
3	A	RF-Cable	ST18/SMAm/SMAm/48	Huber & Suhner	Batch no. 127377	400001183	ev	-/-	-/-
4	A	DC-Blocker 0.1-40 GHz	8141A	Inmet	-/-	400001185	ev	-/-	-/-
5	A	Std. Gain Horn Antenna 18.0-26.5 GHz	638	Narda	-/-	300000486	k	13.12.2017	12.12.2019
6	A	Signal Analyzer 40 GHz	FSV40	R&S	101042	300004517	k	16.01.2018	15.01.2019

6.4 AC conducted



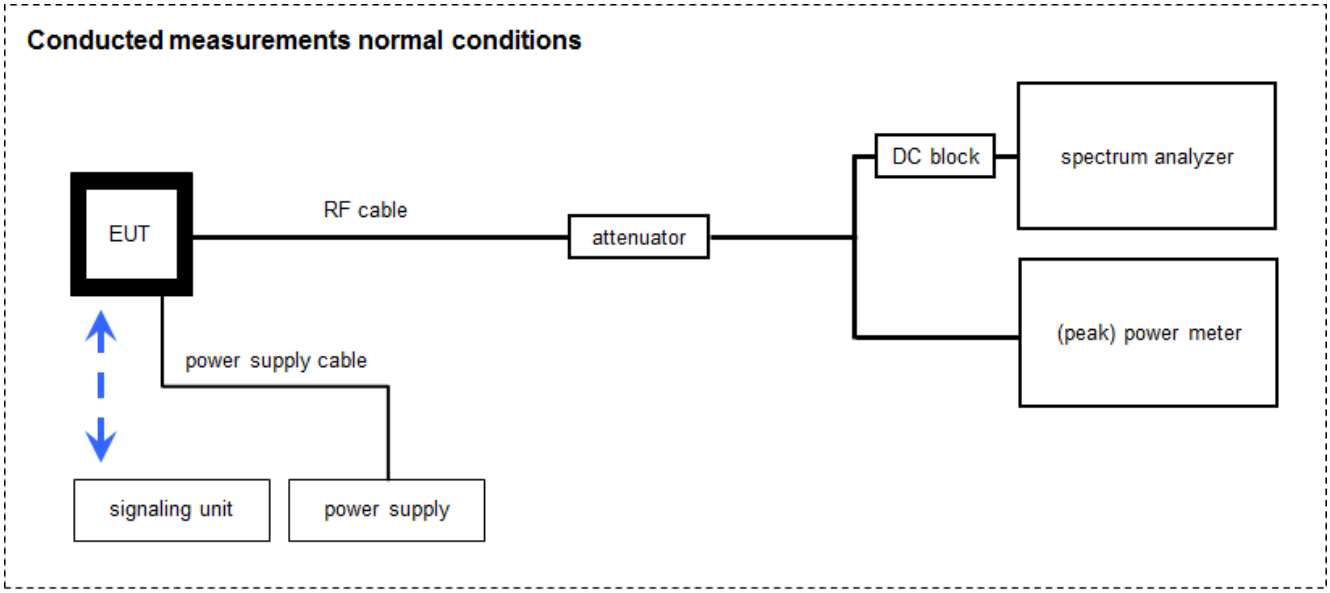
FS = UR + CF + VC
(FS-field strength; UR-voltage at the receiver; CR-loss of the cable and filter; VC-correction factor of the ISN)

Example calculation:
FS [dBµV/m] = 37.62 [dBµV/m] + 9.90 [dB] + 0.23 [dB] = 47.75 [dBµV/m] (244.06 µV/m)

Equipment table:

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	A	Two-line V-Network (LISN) 9 kHz to 30 MHz	ESH3-Z5	R&S	892475/017	300002209	k	13.12.2017	12.12.2019
2	A	RF-Filter-section	85420E	HP	3427A00162	300002214	k	-/-	-/-
3	A	AC-Spannungsquelle variabel	MV2616-V	EM-Test	0397-12	300003259	k	26.01.2018	26.01.2020
4	A	Hochpass 150 kHz	EZ-25	R&S	100010	300003798	ev	-/-	-/-
5	A	EMI Test Receiver	ESCI 3	R&S	100083	300003312	k	01.02.2017	31.01.2018

6.5 Conducted measurements with peak power meter & spectrum analyzer



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	Isolating Transformer	RT5A	Grundig	12780	300001166	ev	-/-	-/-
2	A	Signal Analyzer 40 GHz	FSV40	R&S	101042	300004517	k	16.01.2018	15.01.2019
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	RF-Cable	ST18/SMAm/SMAm/60	Huber & Suhner	Batch no. 606844	400001181	ev	-/-	-/-
7	A	DC-Blocker 0.1-40 GHz	8141A	Inmet	-/-	400001185	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 ± 45° and antenna height between 1 and 4 m.
- The final measurement is done with quasi-peak detector (as described in ANSI C 63.4).
- Final levels, frequency, measuring time, bandwidth, antenna height, antenna polarization, turntable angle, correction factor, margin to the limit and limit are recorded. A plot with the graph of the premeasurement with marked maximum final results and the limit is stored.

7.3 Sequence of testing radiated spurious 1 GHz to 18 GHz

Setup

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

Premeasurement

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

Final measurement

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

7.4 Sequence of testing radiated spurious above 18 GHz

Setup

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

Premeasurement

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

Final measurement

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

8 Measurement uncertainty

Measurement uncertainty	
Test case	**Uncertainty**
Antenna gain	± 3 dB
Power spectral density	± 1.5 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!	2018-02-22	-/-

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	-/-				-/-
§15.35	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: 9.1.2	Nominal	Nominal	DSSS OFDM	☒	☐	☐	☐	-/-
§15.247(d) RSS - 247 / 5.5	Detailed spurious emissions @ the band edge – cond.	-/-	Nominal	Nominal	DSSS OFDM	☒	☐	☐	☐	-/-
§15.205 RSS - 247 / 5.5 RSS - Gen	Band edge compliance cond. & rad.	KDB 558074 DTS clause: 13.3.2 and clause 12.2.2	Nominal	Nominal	DSSS OFDM	☒	☐	☐	☐	-/-
§15.247(d) RSS - 247 / 5.5	TX spurious emissions cond.	KDB 558074 DTS clause: 11.1 & 11.2 11.3	Nominal	Nominal	DSSS OFDM	☒	☐	☐	☐	-/-
§15.209(a) RSS-Gen	TX spurious emissions rad. below 30 MHz	-/-	Nominal	Nominal	DSSS OFDM	☒	☐	☐	☐	-/-
§15.247(d) RSS - 247 / 5.5 RSS-Gen	TX spurious emissions rad. 30 MHz to 1 GHz	-/-	Nominal	Nominal	DSSS OFDM	☒	☐	☐	☐	-/-
§15.247(d) RSS - 247 / 5.5 RSS-Gen	TX spurious emissions rad. above 1 GHz	-/-	Nominal	Nominal	DSSS OFDM	☒	☐	☐	☐	-/-
§15.109 RSS-Gen	RX spurious emissions rad. 30 MHz to 1 GHz	-/-	Nominal	Nominal	RX / idle	☒	☐	☐	☐	-/-
§15.109 RSS-Gen	RX spurious emissions rad. above 1 GHz	-/-	Nominal	Nominal	RX / idle	☒	☐	☐	☐	-/-
§15.107(a) §15.207	Conducted emissions < 30 MHz	-/-	Nominal	Nominal	DSSS OFDM	☒	☐	☐	☐	-/-

Notes:

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

10 Additional comments

Reference documents: Test report no. 1-5253_17-01-06
ICO-OPE-03994 Wifi_labtool_Radio_agreement_procedure.pdf
Customer Questionnaire_Lane5000.docx

Special test descriptions: A new "WlanCalData_ext.conf" file was provided by the customer in order to comply with the band edge requirements.

Configuration descriptions: For all tests the following power settings were used:

Channel	1	2	3	4	5	6	7	8	9	10	11
11b	11	11	11	11	11	11	11	11	11	11	11
11g	8	9	9	10	11	12	11	11	9	9	7
11n-20	8	9	9	10	11	12	11	10	9	9	7
11n-40			7	7	7	7	7	7	7		

Provided channels:

Channels with 20 MHz channel bandwidth:

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

Channels with 40 MHz channel bandwidth:

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

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

11 Additional EUT parameter

Test mode:

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

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

Modulation types:

☒ Wide Band Modulation (None Hopping – e.g. DSSS, OFDM)

☐ Frequency Hopping Spread Spectrum (FHSS)

Antennas and transmit operating modes:

☒ Operating mode 1 (single antenna)

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

☐ Operating mode 2 (multiple antennas, no beamforming)

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

☐ Operating mode 3 (multiple antennas, with beamforming)

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

12 Measurement results

12.1 Antenna gain

Limits:

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

Results: Extracted from Test report no. 1-5253_17-01-06

	lowest channel	middle channel	highest channel
Gain / dBi Calculated	2.8	2.2	1.2

12.2 Identify worst case data rate

Description:

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

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

Measurement:

Measurement parameter	
Detector	Peak
Sweep time	Auto
Resolution bandwidth	3 MHz
Video bandwidth	3 MHz
Trace mode	Max hold
Test setup	See chapter 6.5 A
Measurement uncertainty	-/-

Results:

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

12.3 Maximum output power

Description:

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

Measurement:

Measurement parameter	
According to DTS clause: 9.1.2	
Peak power meter	
Test setup	See chapter 6.5 A
Measurement uncertainty	See chapter 8

Limits:

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

Results:

	Maximum Output Power [dBm]										
Frequency	2412 MHz	2417 MHz	2422 MHz	2427 MHz	2432 MHz	2437 MHz	2442 MHz	2447 MHz	2452 MHz	2457 MHz	2462 MHz
DSSS / b – mode	16.2					16.2					16.6
OFDM / g – mode	18.9	19.6	19.4	19.7	20.0	20.1	19.8	19.9	19.2	19.2	17.8
OFDM / n HT20 – mode	18.5	19.3	19.1	19.6	19.9	20.1	19.8	19.5	19.0	19.0	17.1
OFDM / n HT40 – mode			17.5			17.4			17.2		

12.4 Duty cycle

Description:

Measurement of the timing behavior.

Measurement:

Measurement parameter	
Detector	Peak
Sweep time	Depends on the signal see plot
Resolution bandwidth	10 MHz
Video bandwidth	10 MHz
Trace mode	Max hold
Test setup	See chapter 6.5 A
Measurement uncertainty	See chapter 8

Limits:

FCC	IC
No limitation!	

Results:

T_{nom}	V_{nom}	All channels
DSSS / b – mode		100.0 % / 0.0 dB
OFDM / g – mode		100.0 % / 0.0 dB
OFDM / n HT20 – mode		100.0 % / 0.0 dB
OFDM / n HT40 – mode		100.0 % / 0.0 dB

12.5 Peak power spectral density

Description:

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

Measurement:

Measurement parameter	
According to DTS clause: 10.2	
Detector	Positive Peak
Sweep time	Auto
Resolution bandwidth	100 kHz
Video bandwidth	300 kHz
Span	30 MHz / 60 MHz
Trace mode	Max. hold (allow trace to fully stabilize)
Test setup	See chapter 6.5 A
Measurement uncertainty	See chapter 8

Limits:

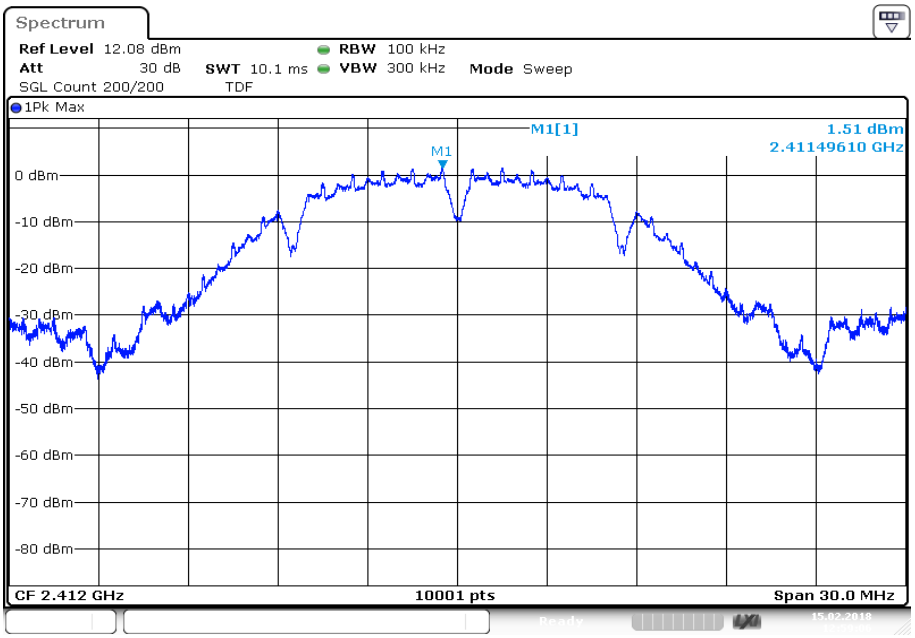
FCC	IC
8 dBm / 3 kHz (conducted)	
8 dBm / 100 kHz (conducted)	

Results:

	Peak power spectral density / dBm @ 100 kHz										
Frequency	2412 MHz	2417 MHz	2422 MHz	2427 MHz	2432 MHz	2437 MHz	2442 MHz	2447 MHz	2452 MHz	2457 MHz	2462 MHz
DSSS / b – mode	1.5					1.3					1.8
OFDM / g – mode	-6.8	-1.9	-4.9	-2.6	-1.8	-0.8	-2.1	-1.6	-4.2	-4.2	-7.6
OFDM / n HT20 – mode	-6.2	-4.4	-4.3	-2.4	-1.7	-0.3	-1.8	-2.1	-3.8	-4.0	-5.0
OFDM / n HT40 – mode			-12.0			-11.7			-8.8		

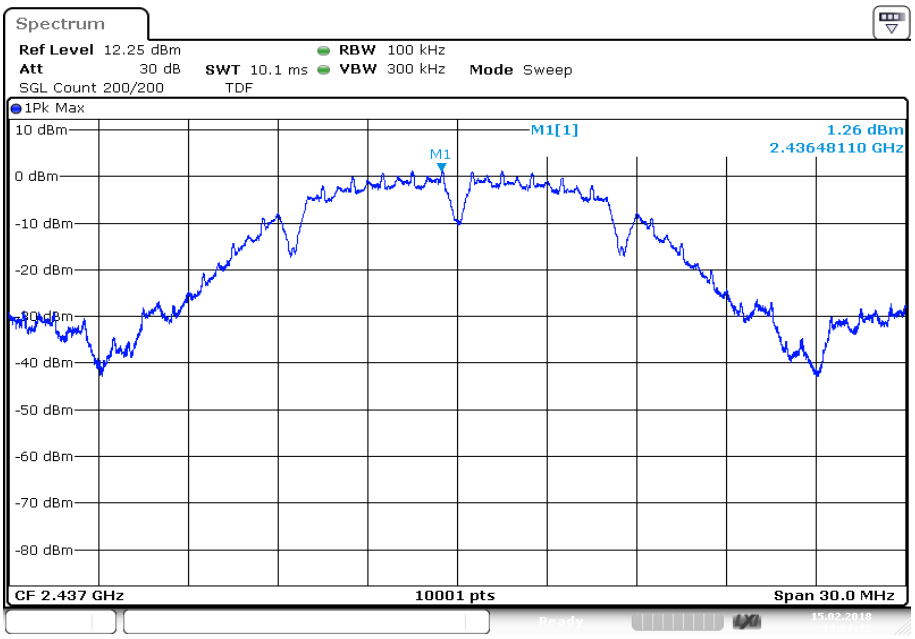
Plots: DSSS / b – mode

Plot 1: Channel 1



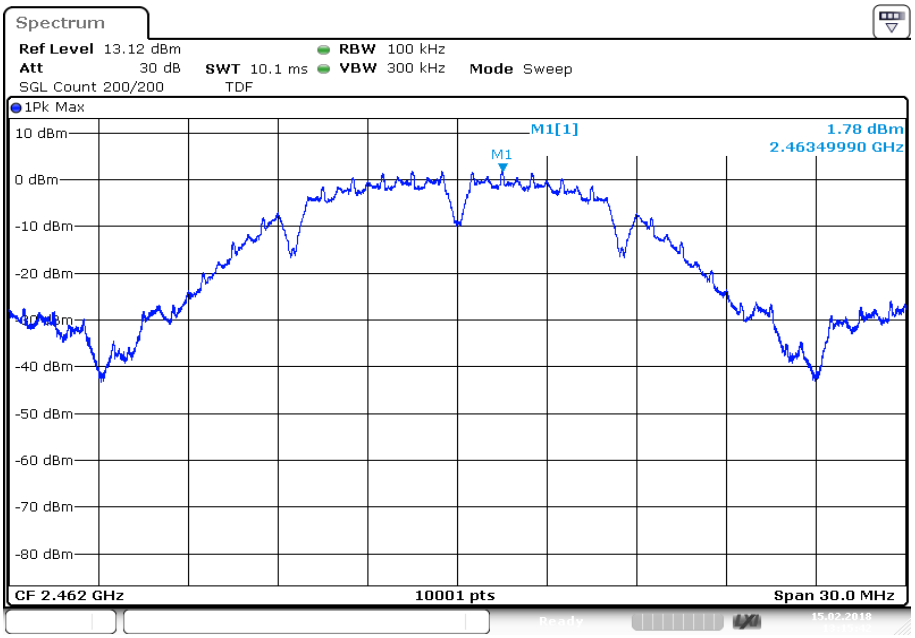
Date: 15.FEB.2018 12:59:06

Plot 2: Channel 6



Date: 15.FEB.2018 13:07:32

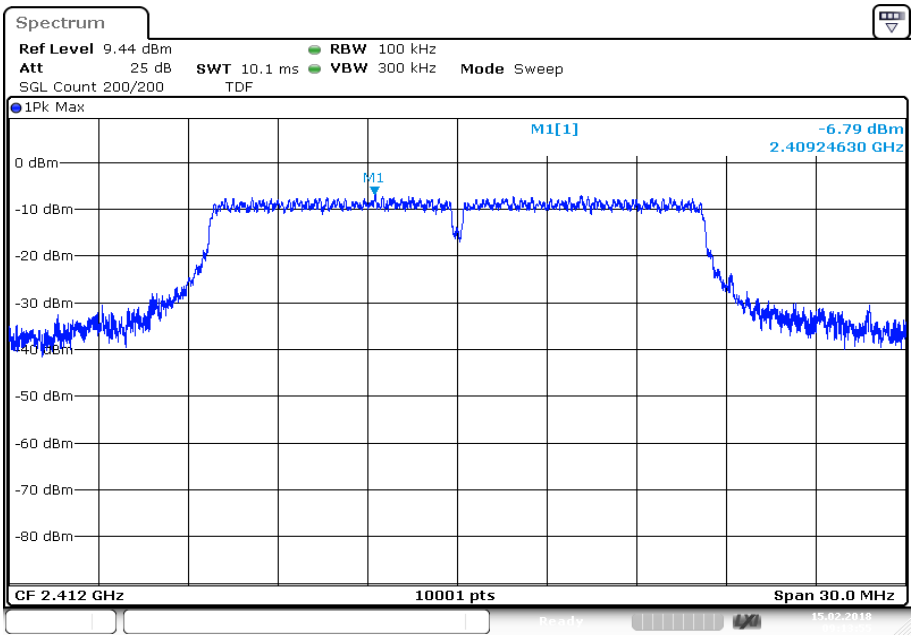
Plot 3: Channel 11



Date: 15.FEB.2018 13:15:42

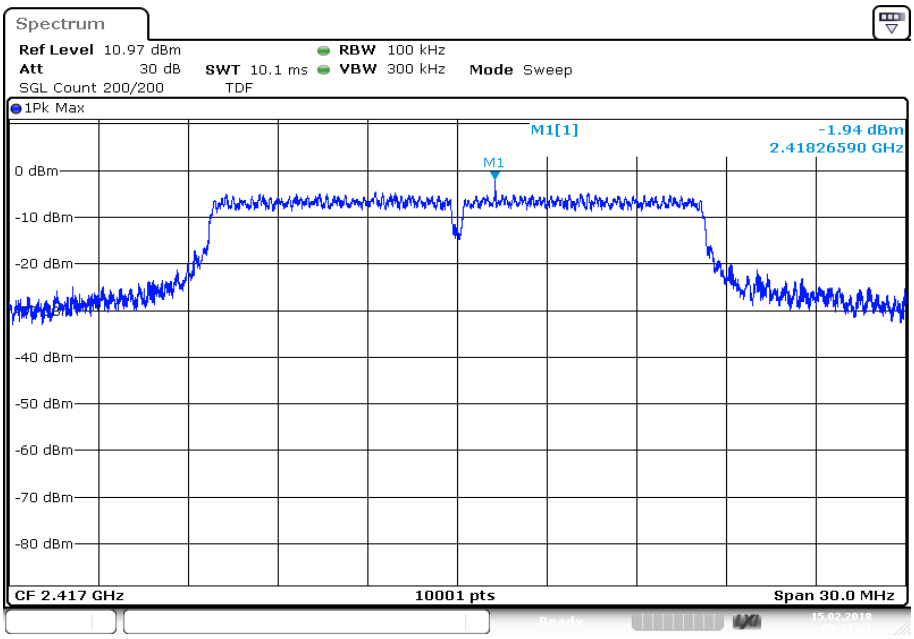
Plots: OFDM / g – mode

Plot 1: Channel 1



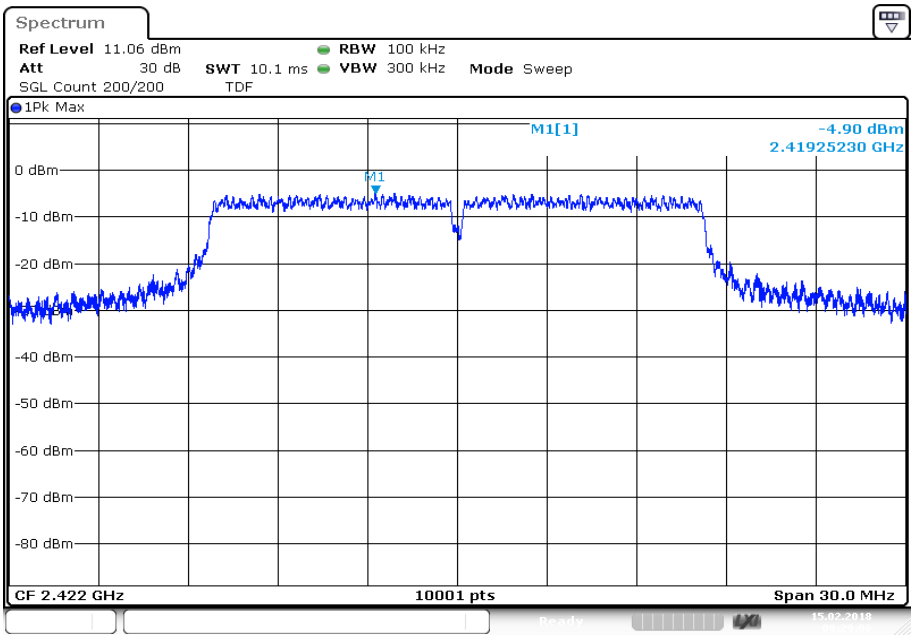
Date: 15.FEB.2018 09:13:55

Plot 2: Channel 2

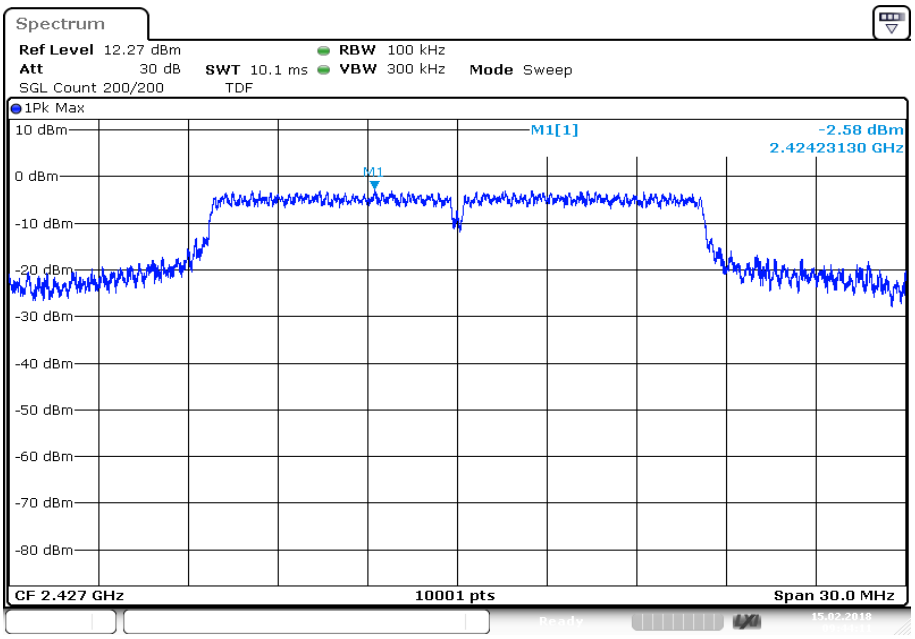


Date: 15.FEB.2018 09:21:31

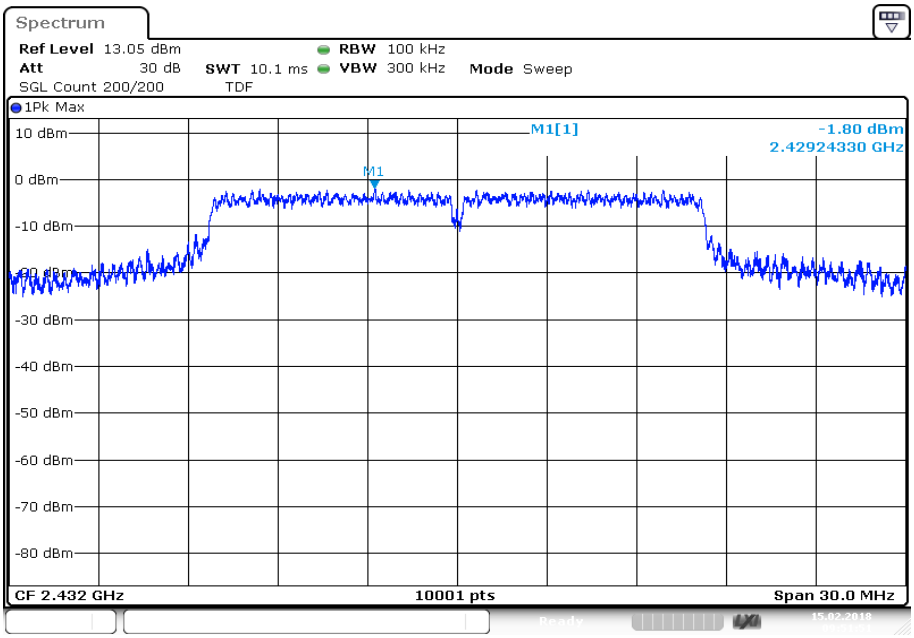
Plot 3: Channel 3



Plot 4: Channel 4

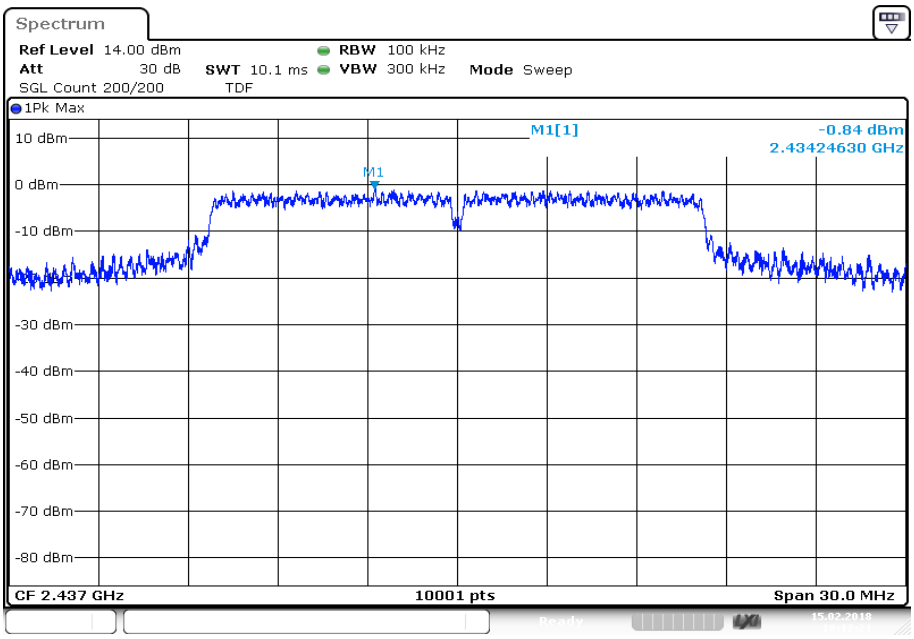


Plot 5: Channel 5



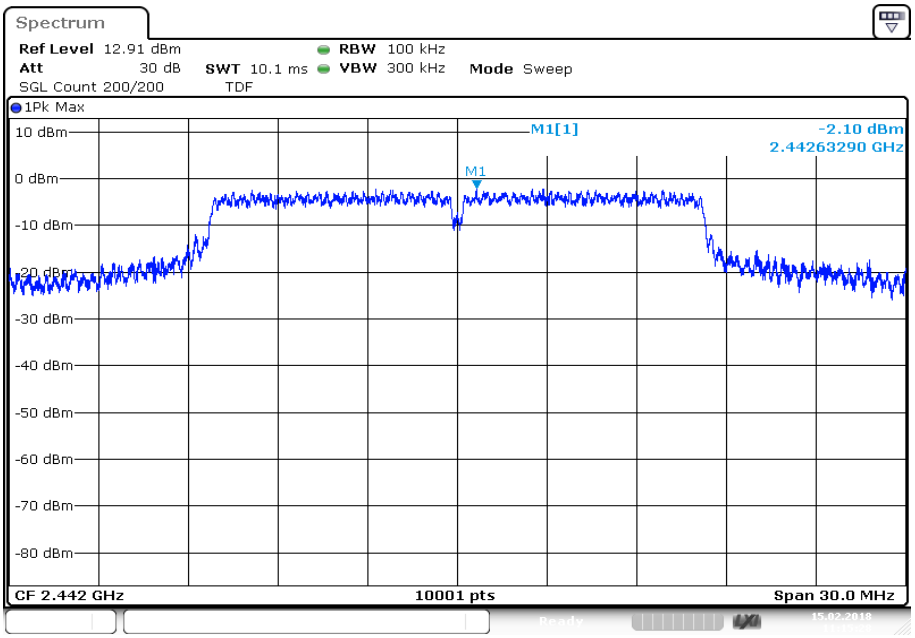
Date: 15.FEB.2018 09:51:51

Plot 6: Channel 6



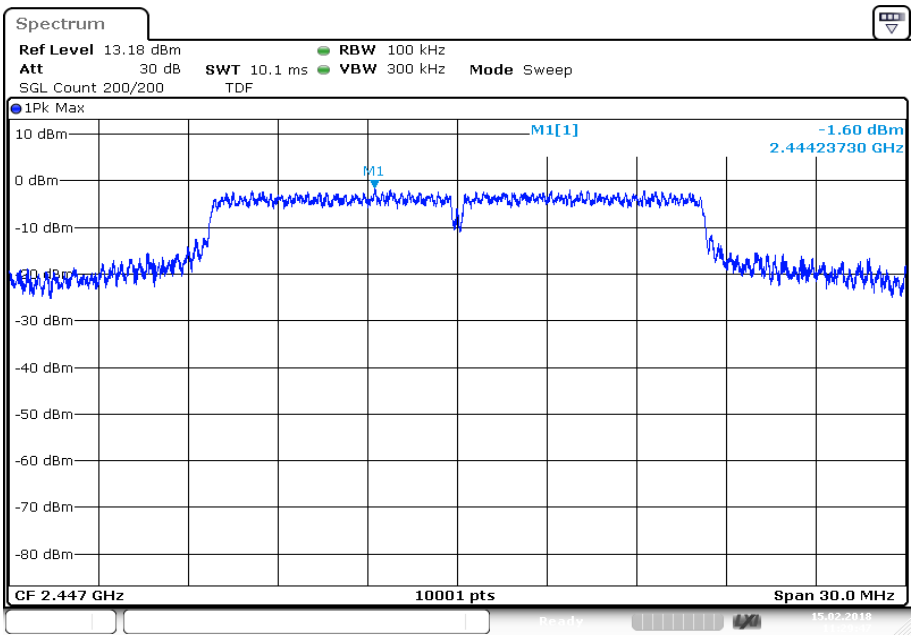
Date: 15.FEB.2018 10:12:21

Plot 7: Channel 7



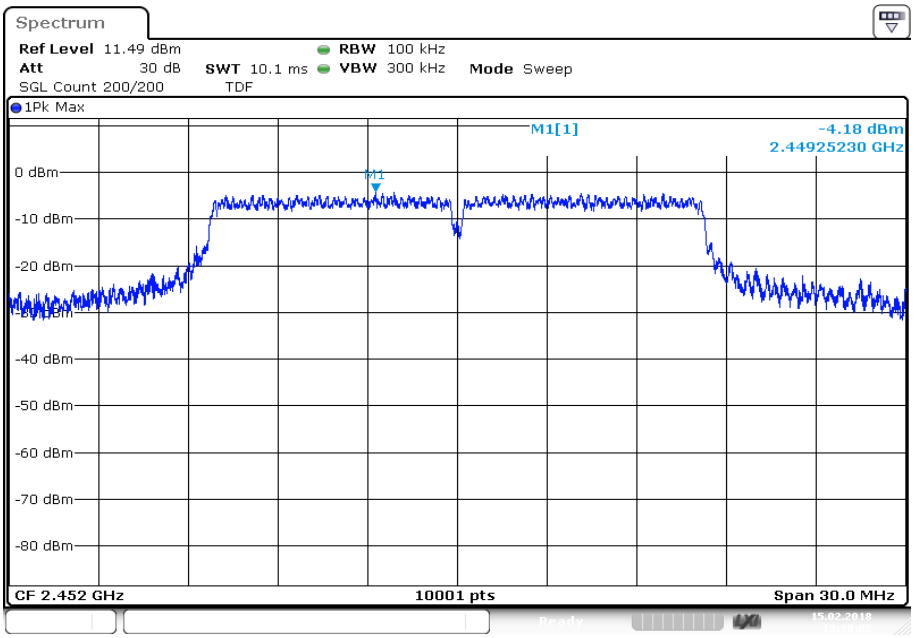
Date: 15.FEB.2018 11:15:28

Plot 8: Channel 8



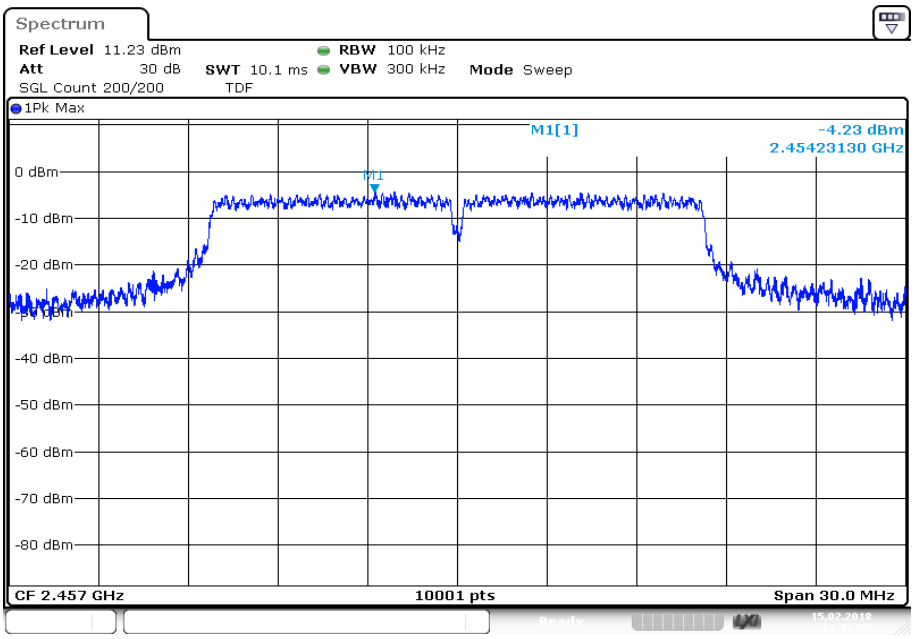
Date: 15.FEB.2018 11:29:47

Plot 9: Channel 9



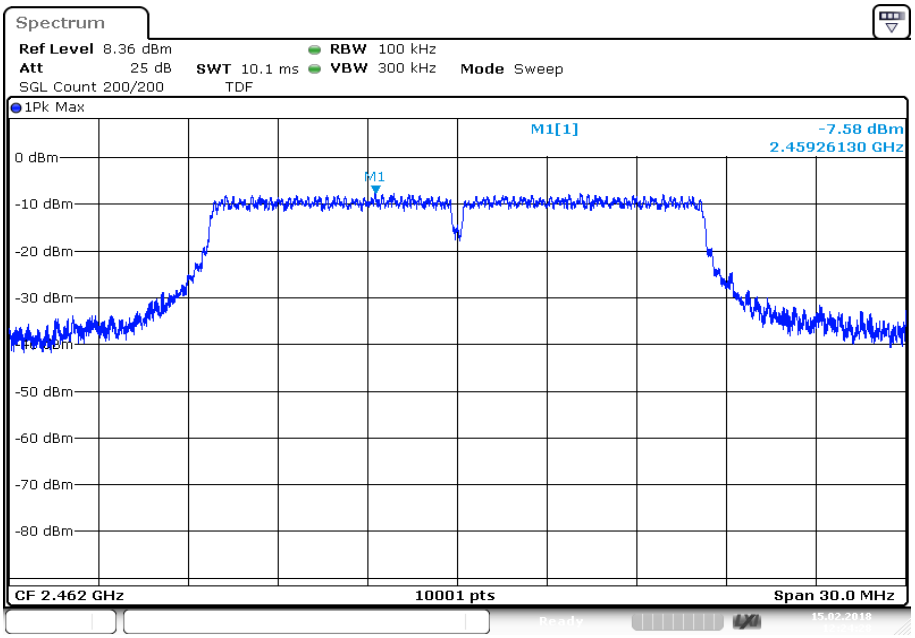
Date: 15.FEB.2018 13:30:02

Plot 10: Channel 10



Date: 15.FEB.2018 11:56:53

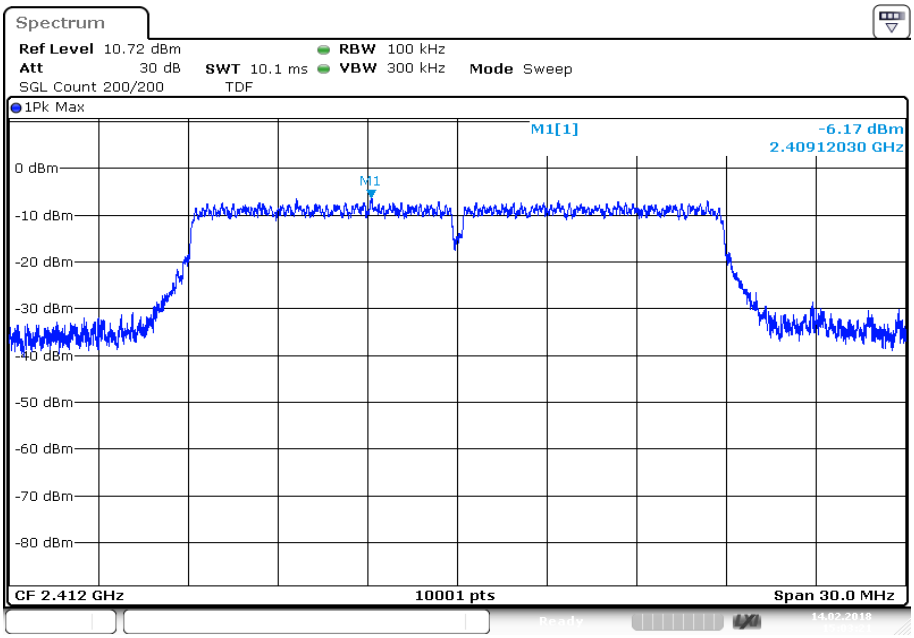
Plot 11: Channel 11



Date: 15.FEB.2018 12:24:28

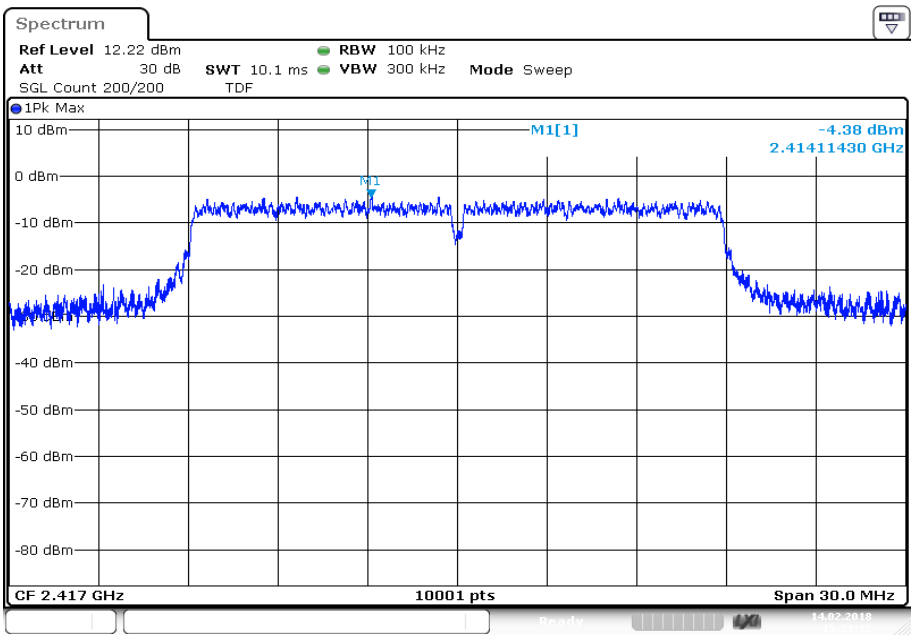
Plots: OFDM / n HT20 – mode

Plot 1: Channel 1



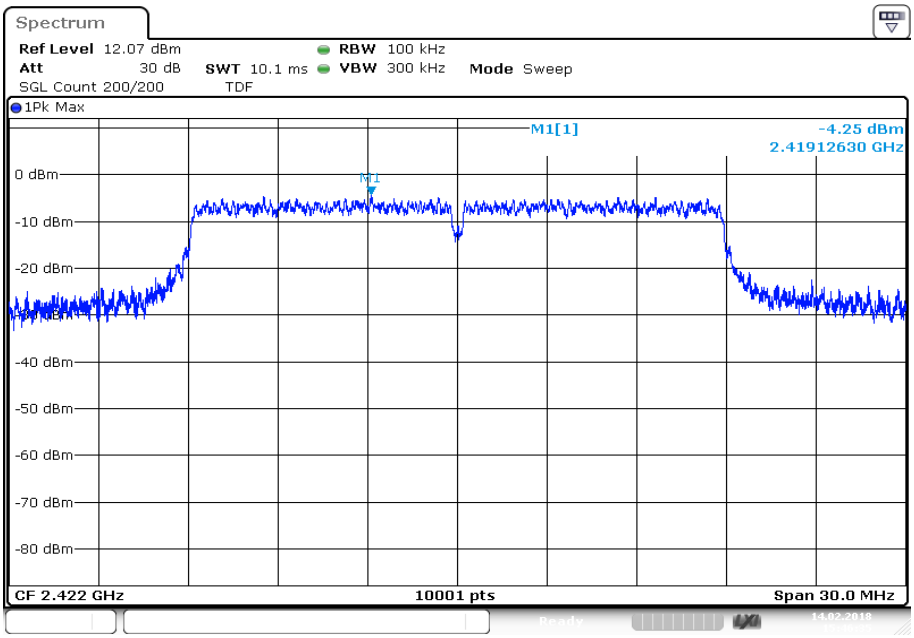
Date: 14.FEB.2018 15:03:21

Plot 2: Channel 2



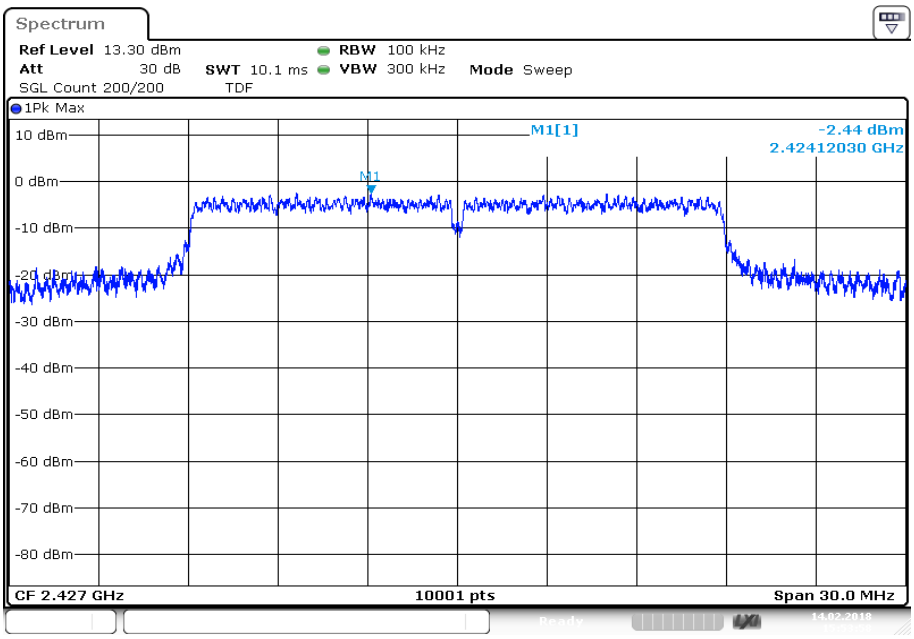
Date: 14.FEB.2018 15:21:13

Plot 3: Channel 3



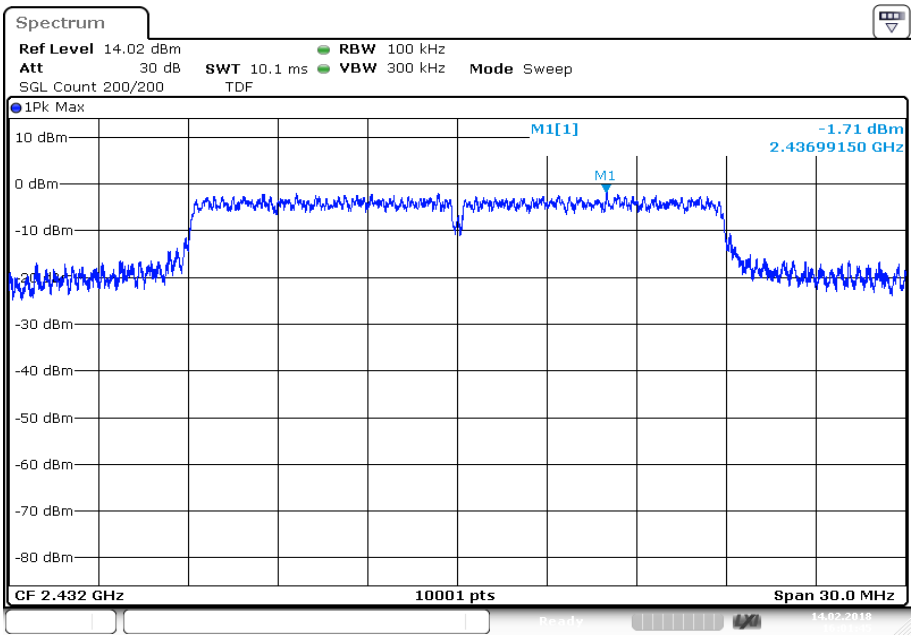
Date: 14.FEB.2018 15:46:36

Plot 4: Channel 4



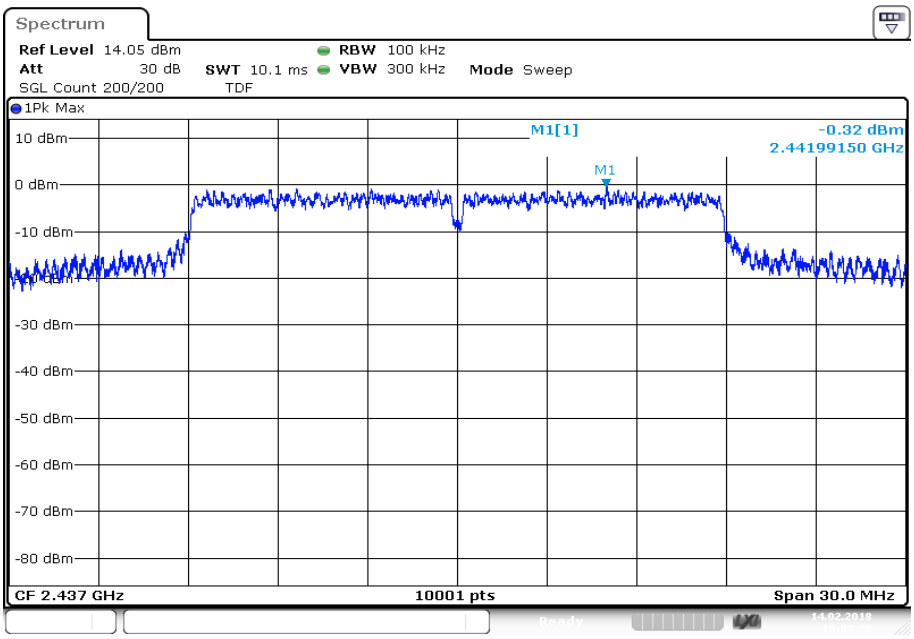
Date: 14.FEB.2018 15:53:58

Plot 5: Channel 5



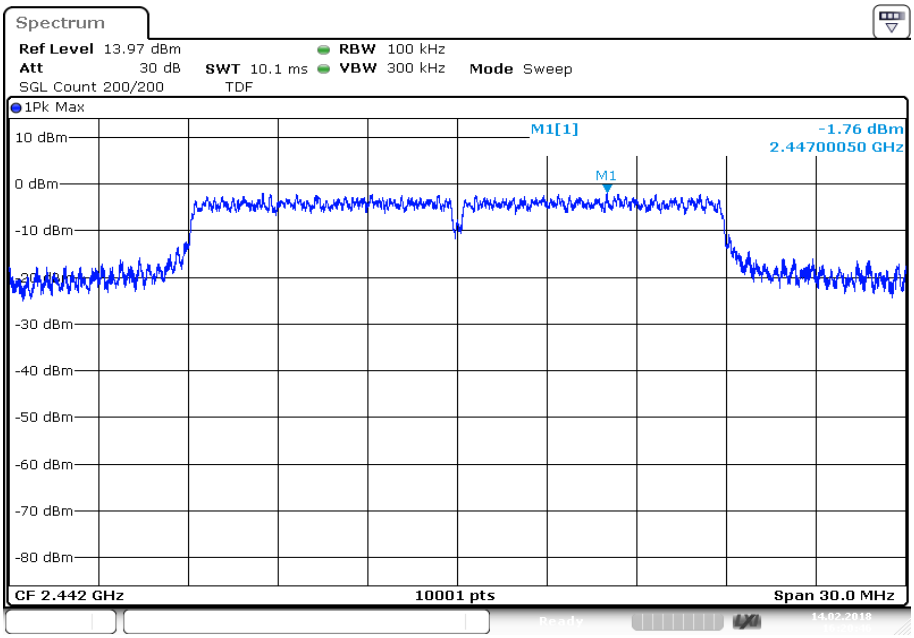
Date: 14.FEB.2018 16:01:45

Plot 6: Channel 6



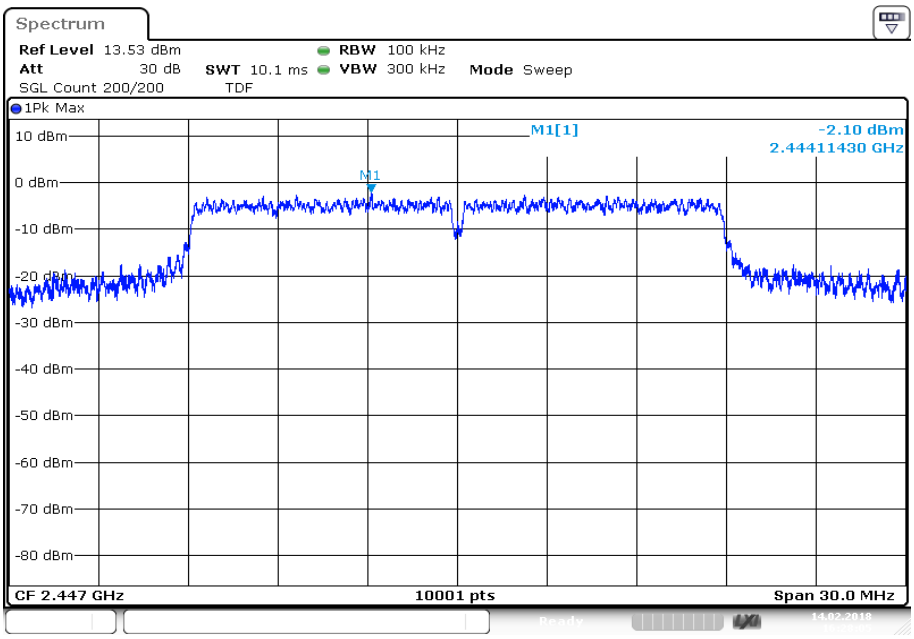
Date: 14.FEB.2018 16:09:09

Plot 7: Channel 7



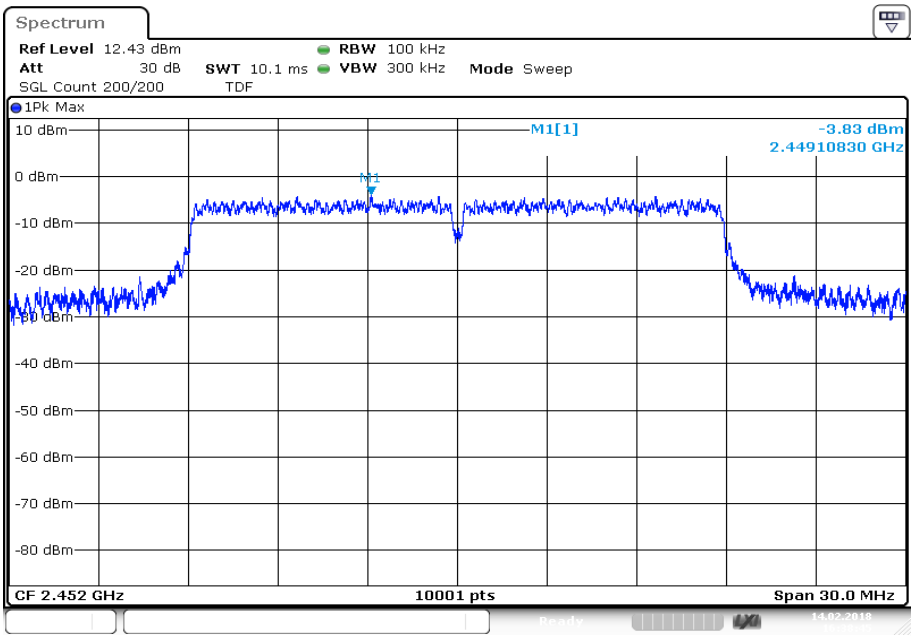
Date: 14.FEB.2018 16:20:46

Plot 8: Channel 8



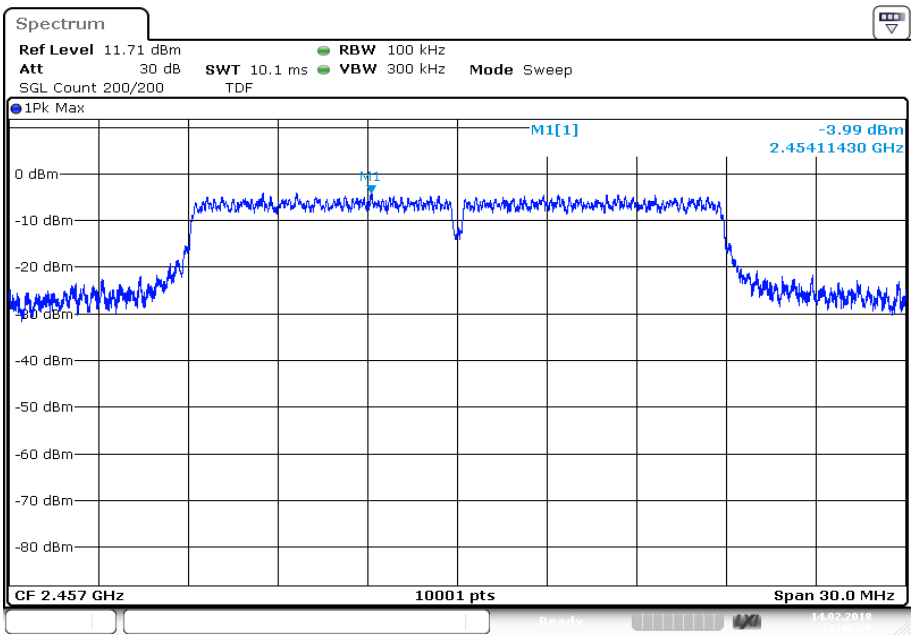
Date: 14.FEB.2018 16:28:05

Plot 9: Channel 9



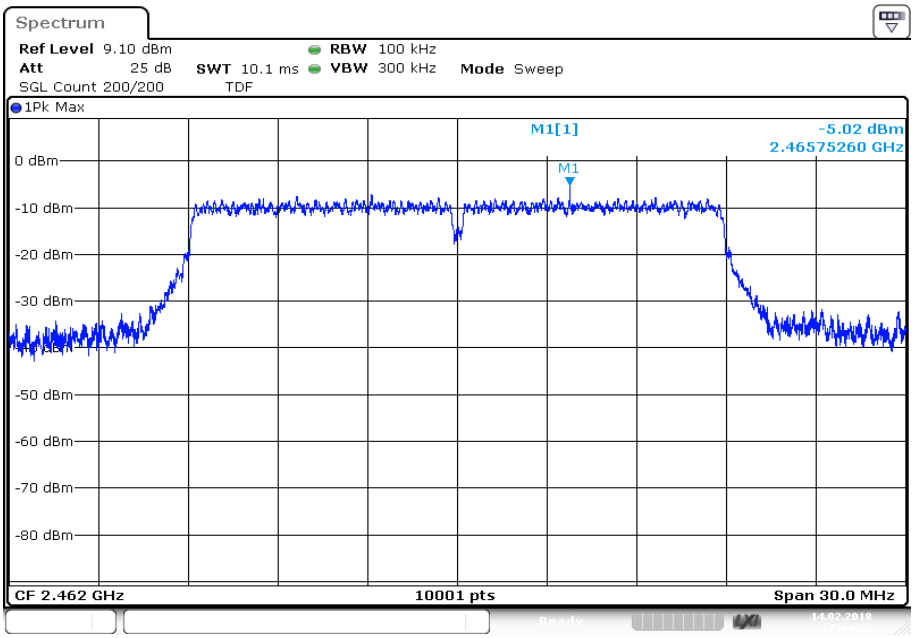
Date: 14.FEB.2018 16:38:45

Plot 10: Channel 10



Date: 14.FEB.2018 16:46:29

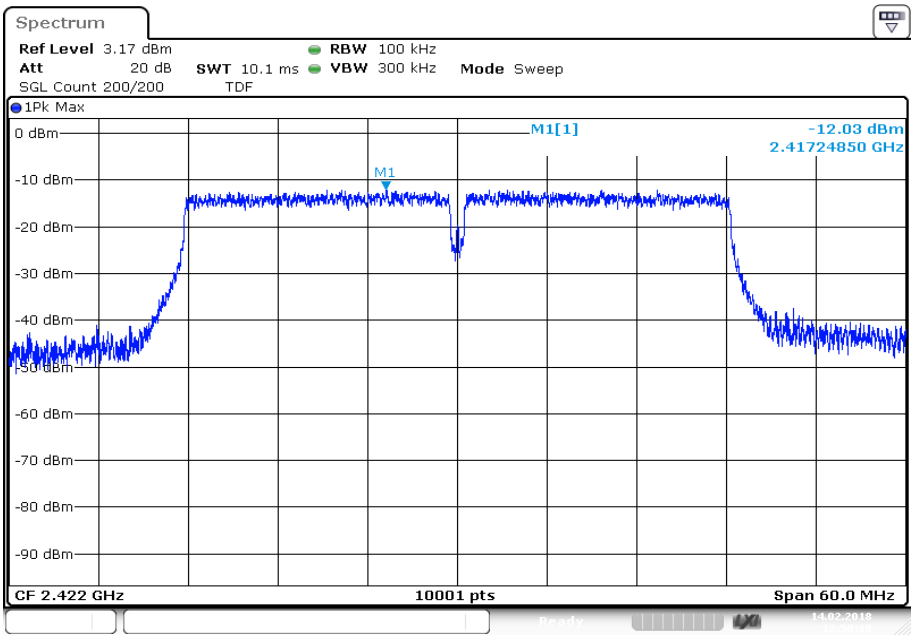
Plot 11: Channel 11



Date: 14.FEB.2018 17:44:24

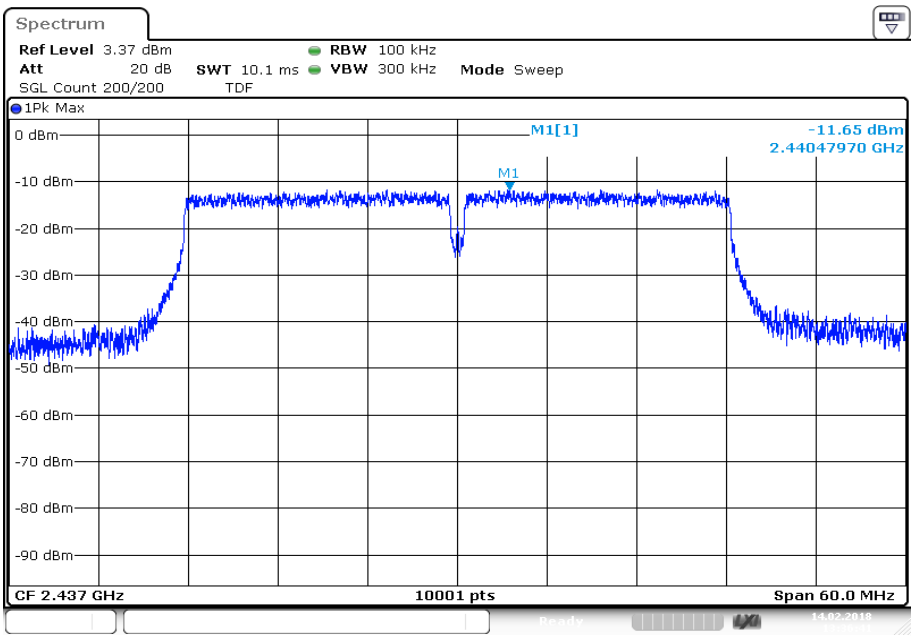
Plots: OFDM / n HT40 – mode

Plot 1: Channel 3



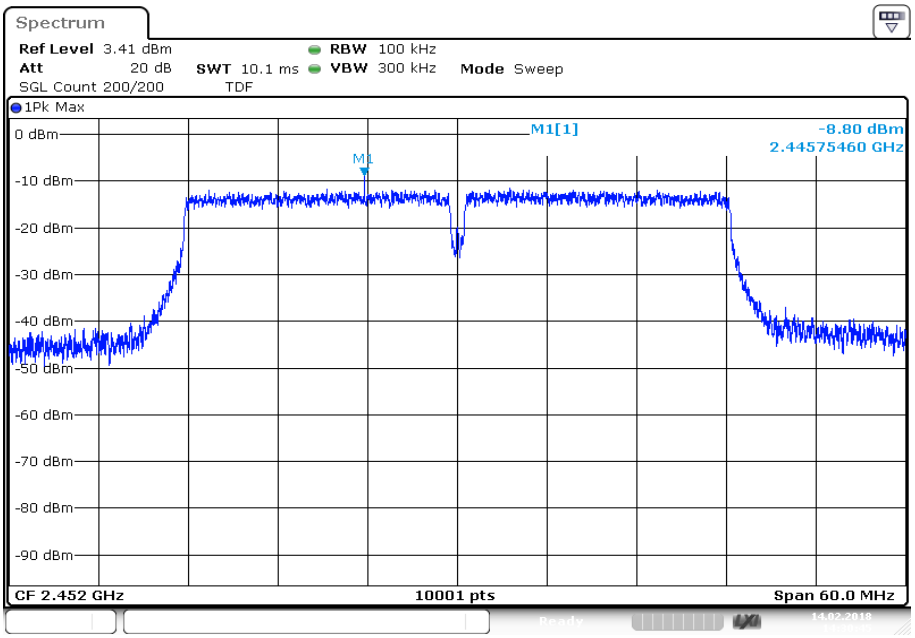
Date: 14.FEB.2018 12:50:10

Plot 2: Channel 6



Date: 14.FEB.2018 13:36:40

Plot 3: Channel 9



Date: 14.FEB.2018 14:30:46

12.6 6 dB DTS bandwidth

Description:

Measurement of the 6 dB bandwidth of the modulated signal.

Measurement:

Measurement parameter	
According to DTS clause: 8.1	
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 chapter 6.5 A
Measurement uncertainty	See chapter 8

Limits:

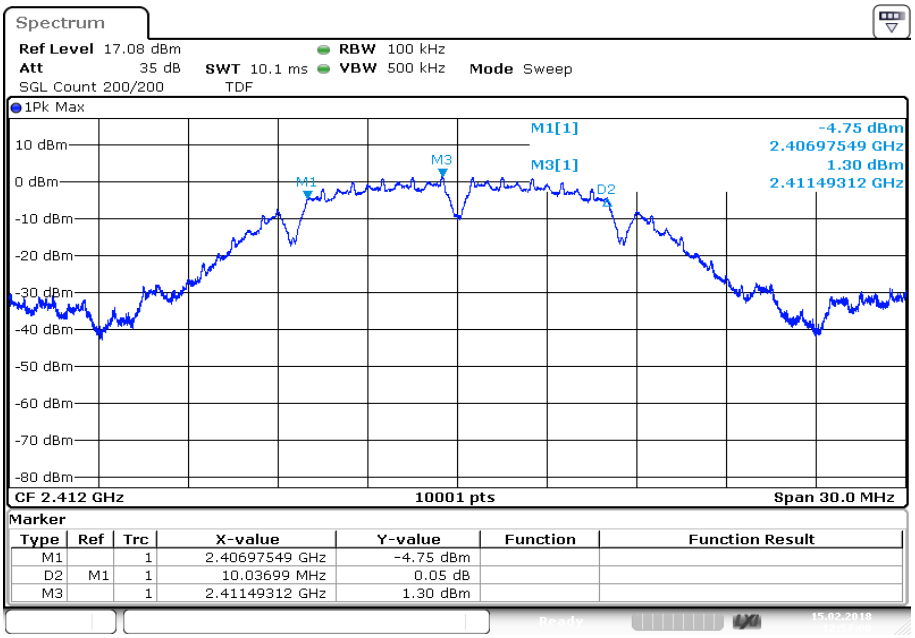
FCC	IC
Systems using digital modulation techniques may operate in the 2400–2483.5 MHz band. The minimum 6 dB bandwidth shall be at least 500 kHz.	

Results:

	6 dB DTS bandwidth / kHz										
Frequency	2412 MHz	2417 MHz	2422 MHz	2427 MHz	2432 MHz	2437 MHz	2442 MHz	2447 MHz	2452 MHz	2457 MHz	2462 MHz
DSSS / b – mode	10037					10037					10043
OFDM / g – mode	16561	16546	16549	16546	16534	16519	16537	16510	16549	16549	16570
OFDM / n HT20 – mode	17620	17779	17794	17653	17806	17815	17833	17782	17806	17794	17806
OFDM / n HT40 – mode			36560			36572			36560		

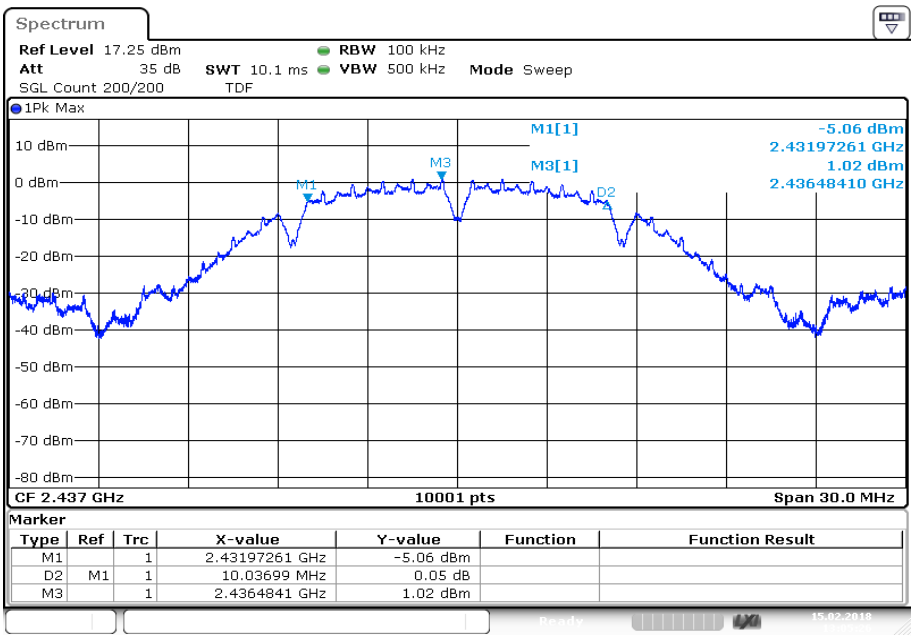
Plots: DSSS / b – mode

Plot 1: Channel 1



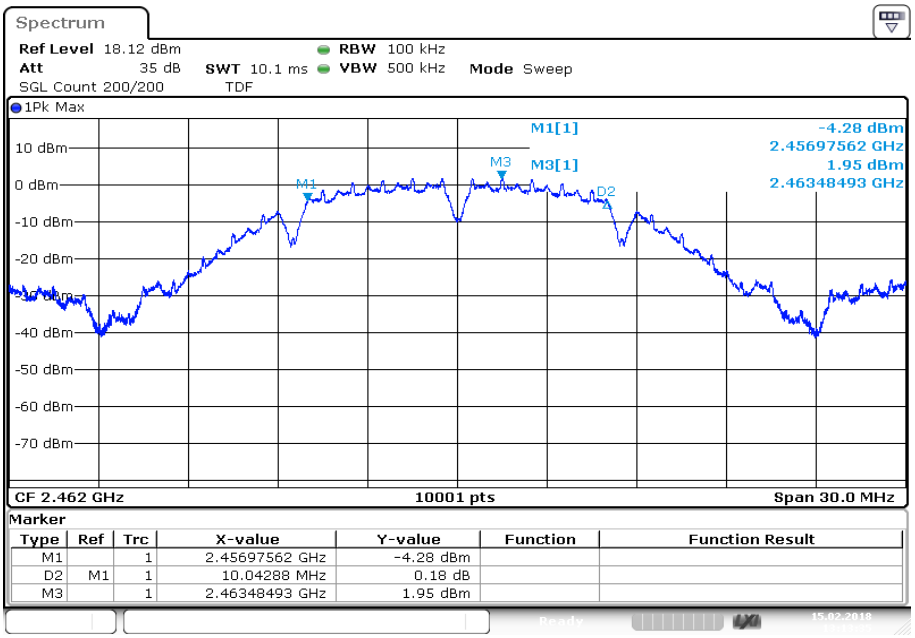
Date: 15.FEB.2018 12:57:01

Plot 2: Channel 6



Date: 15.FEB.2018 13:05:26

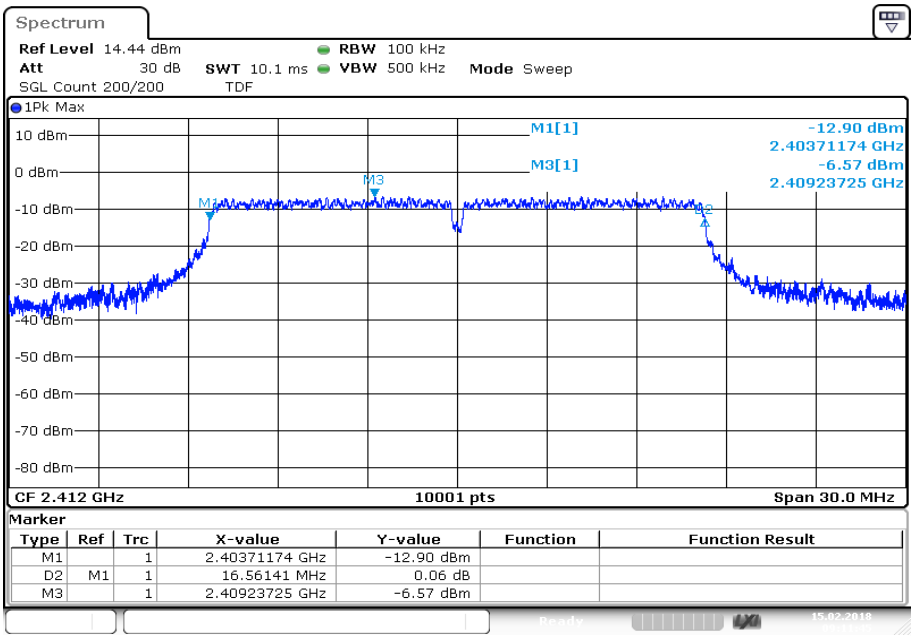
Plot 3: Channel 11



Date: 15.FEB.2018 13:13:35

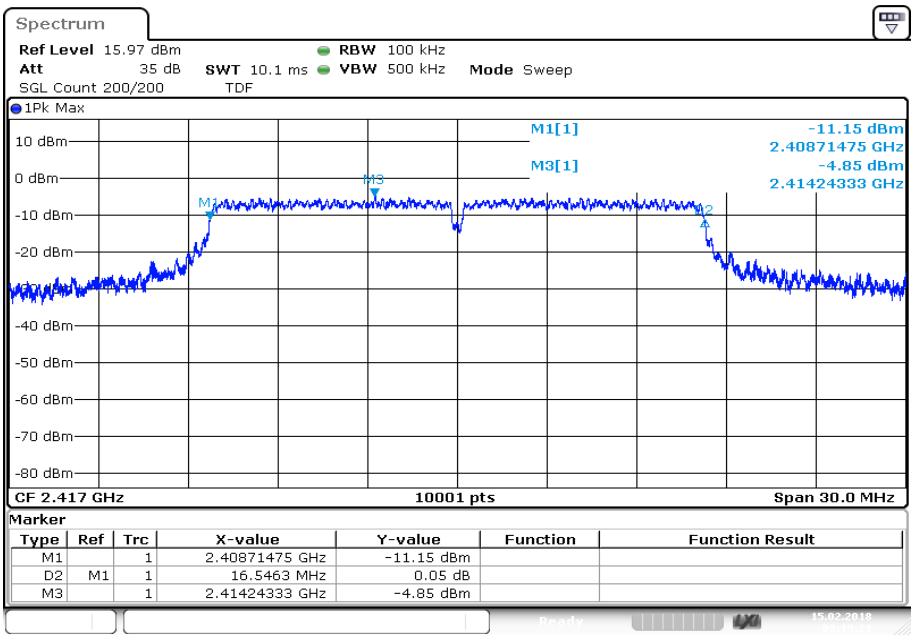
Plots: OFDM / g – mode

Plot 1: Channel 1



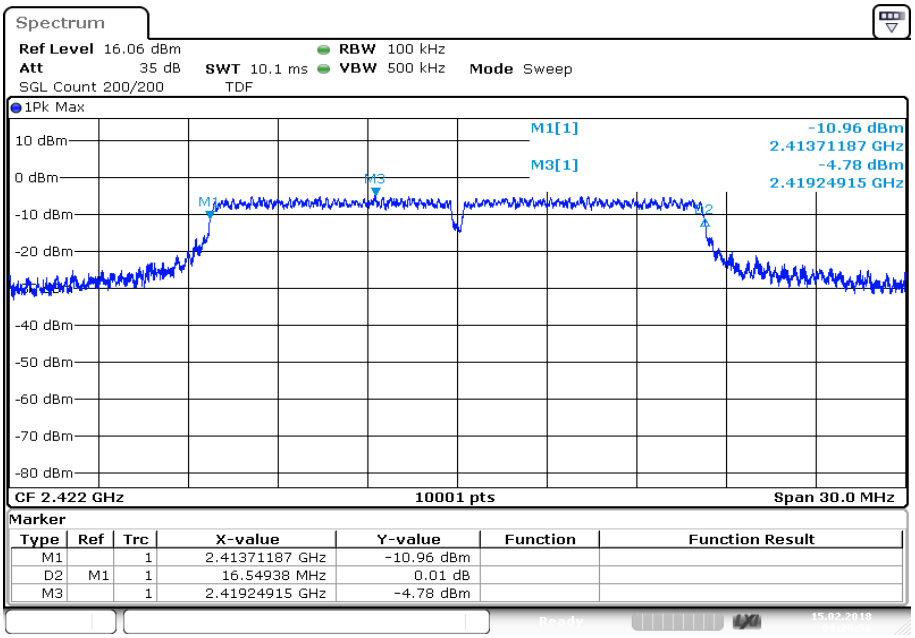
Date: 15.FEB.2018 09:11:45

Plot 2: Channel 2



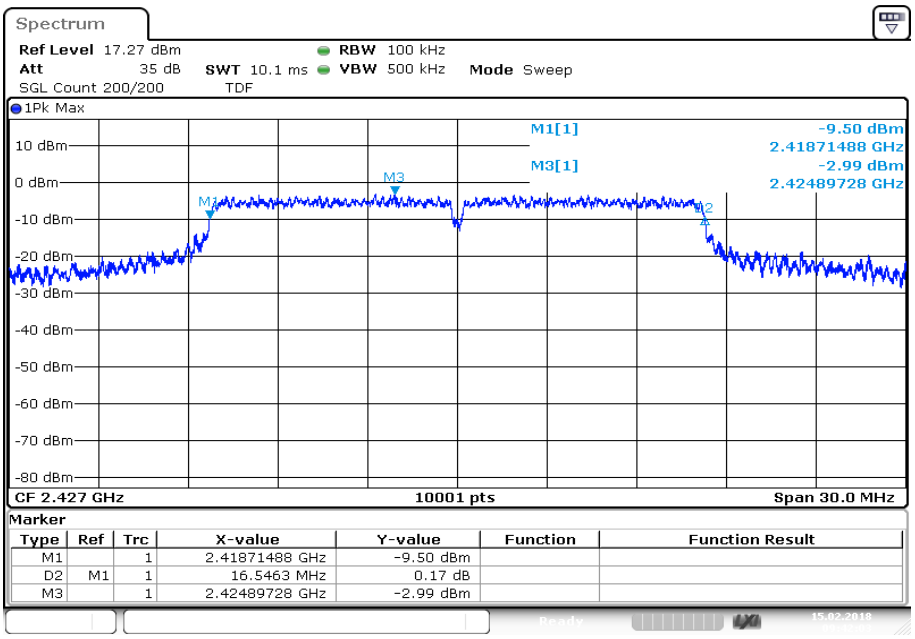
Date: 15.FEB.2018 09:19:21

Plot 3: Channel 3



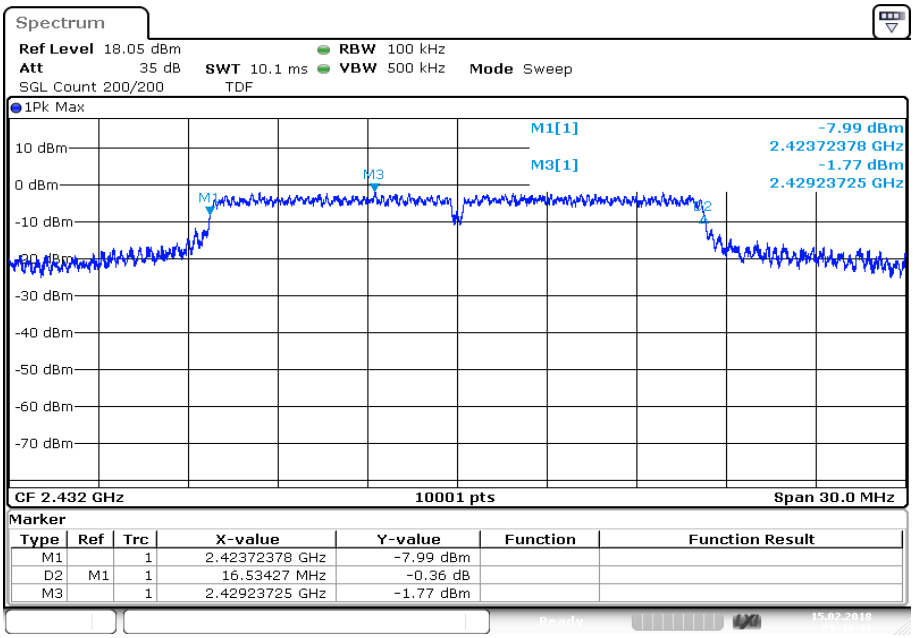
Date: 15.FEB.2018 09:26:56

Plot 4: Channel 4



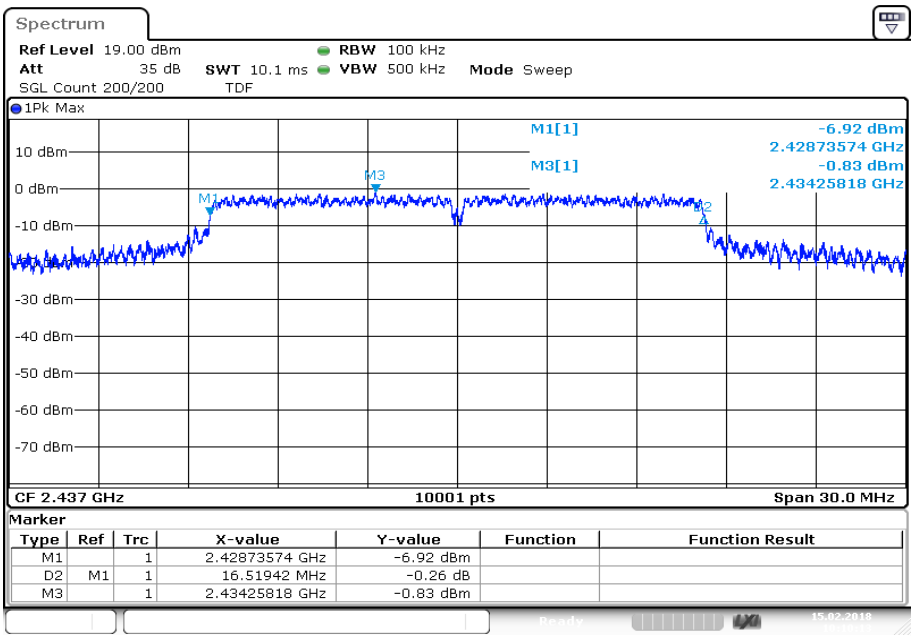
Date: 15.FEB.2018 09:42:03

Plot 5: Channel 5



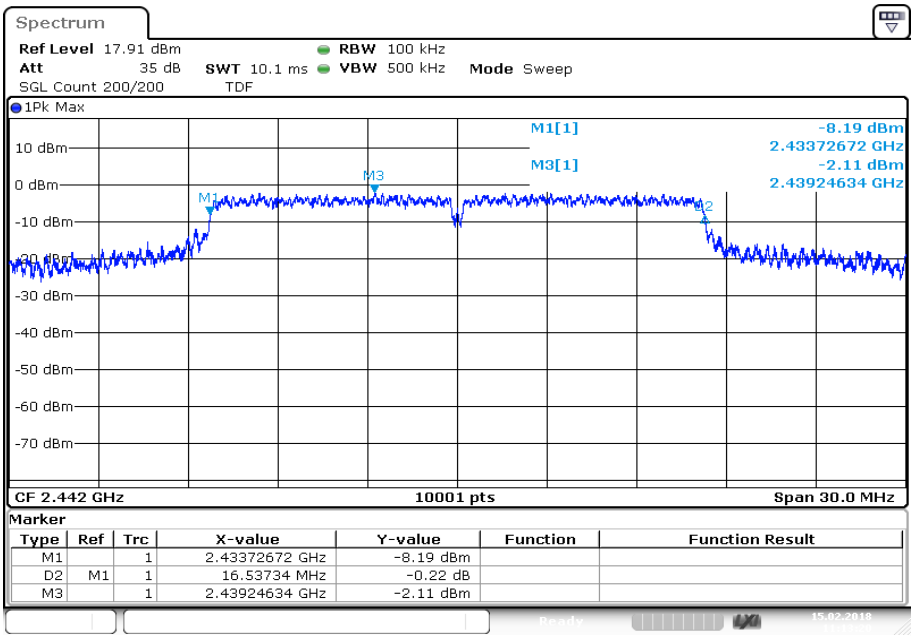
Date: 15.FEB.2018 09:49:43

Plot 6: Channel 6



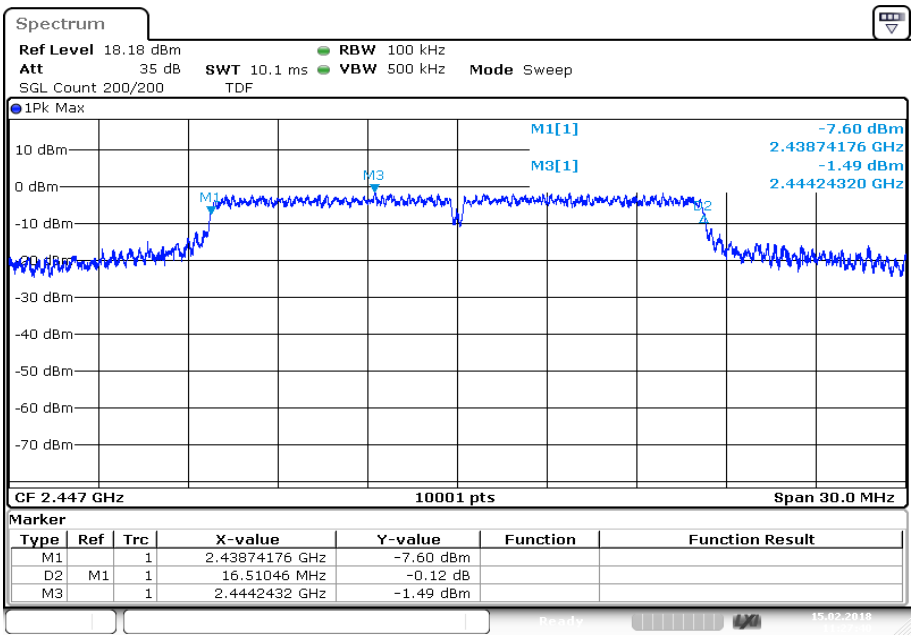
Date: 15.FEB.2018 10:10:13

Plot 7: Channel 7



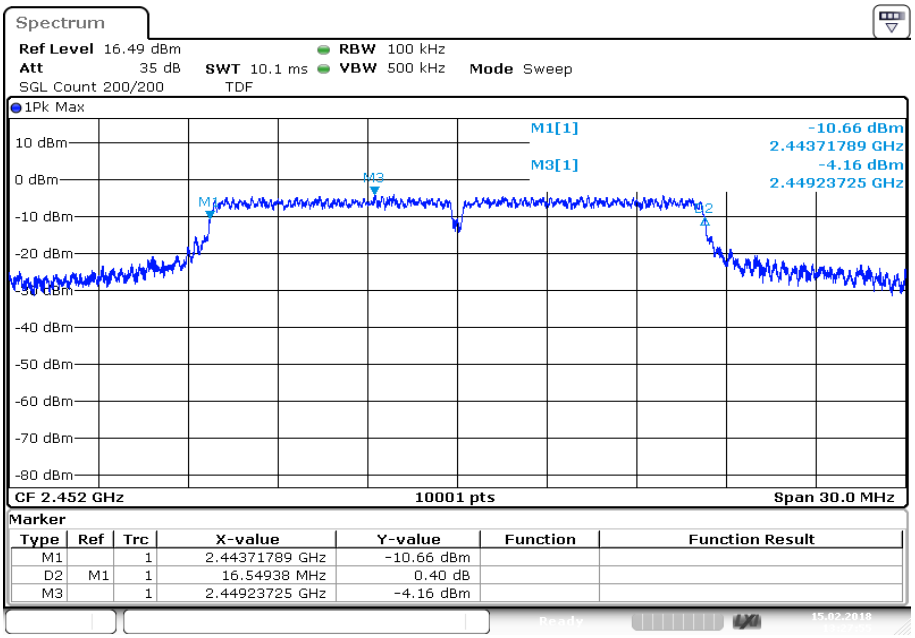
Date: 15.FEB.2018 11:13:20

Plot 8: Channel 8



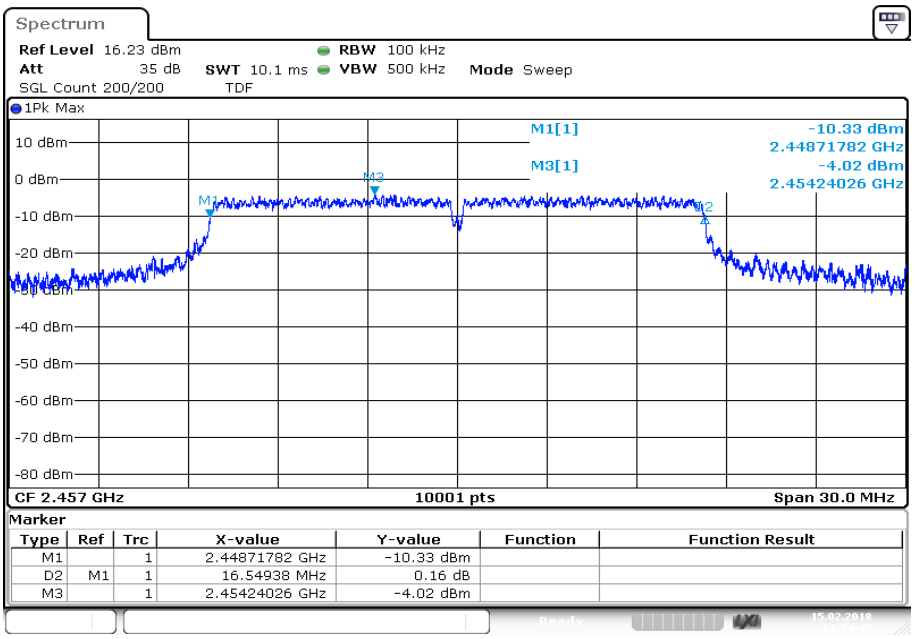
Date: 15.FEB.2018 11:27:40

Plot 9: Channel 9



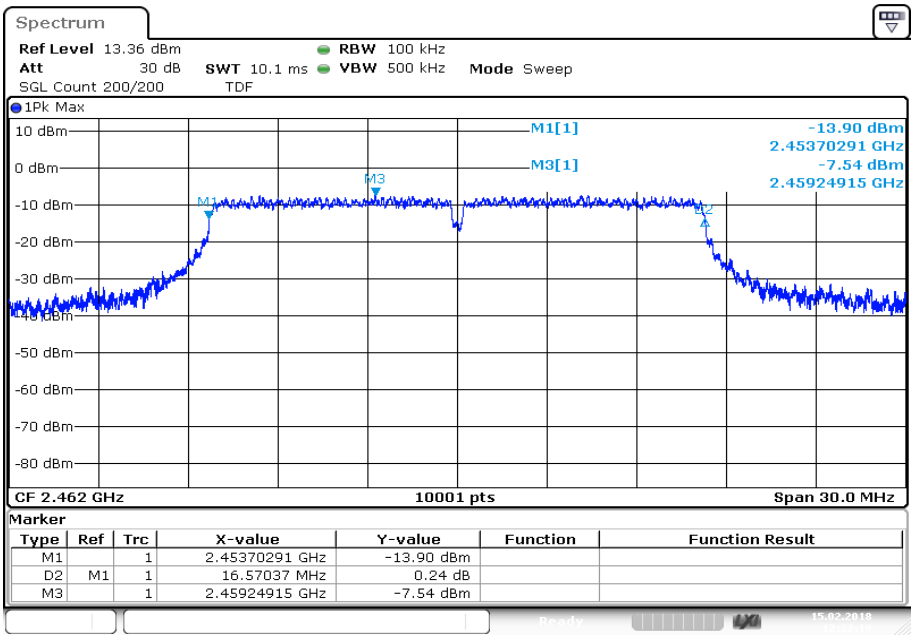
Date: 15.FEB.2018 13:27:56

Plot 10: Channel 10



Date: 15.FEB.2018 11:54:45

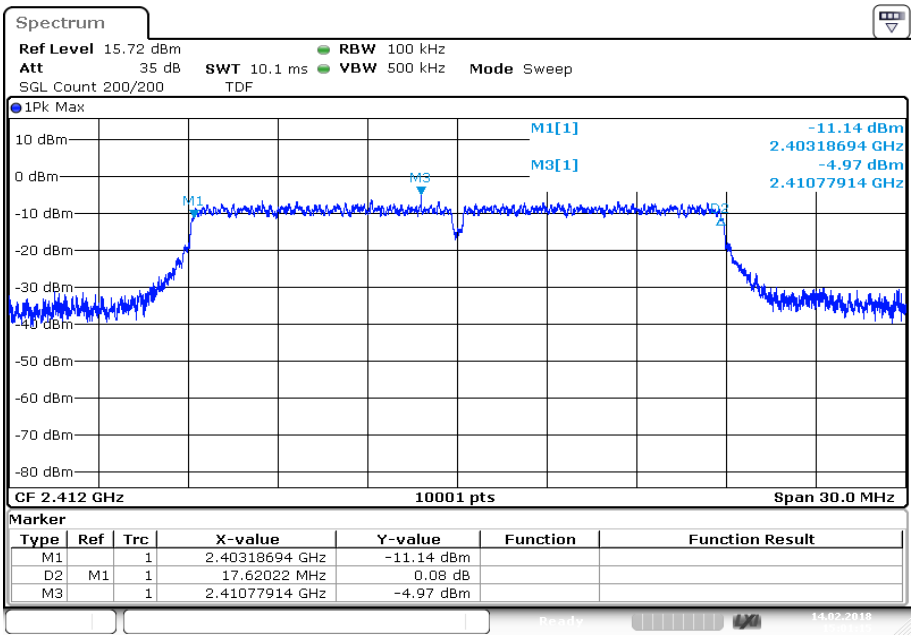
Plot 11: Channel 11



Date: 15.FEB.2018 12:22:19

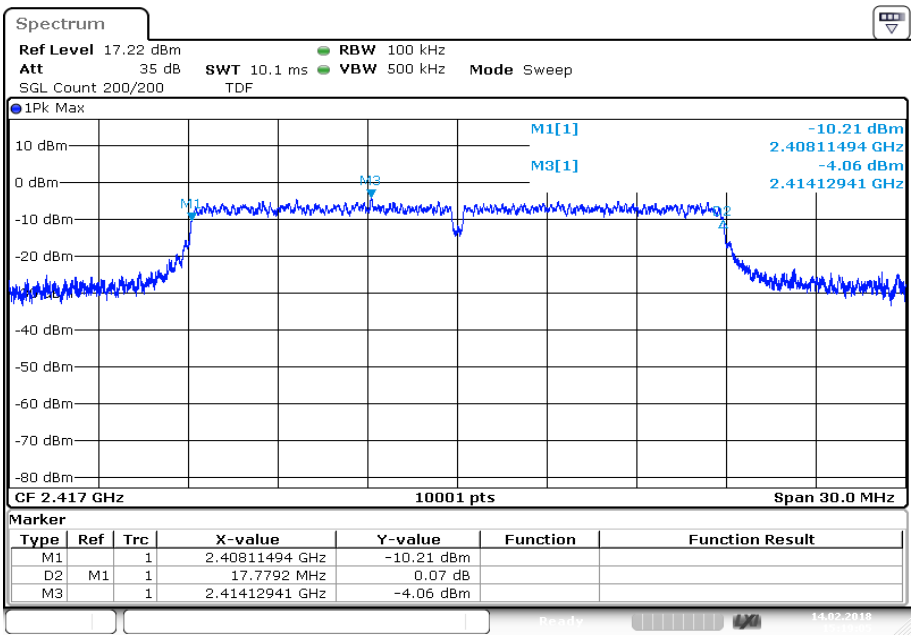
Plots: OFDM / n HT20 – mode

Plot 1: Channel 1



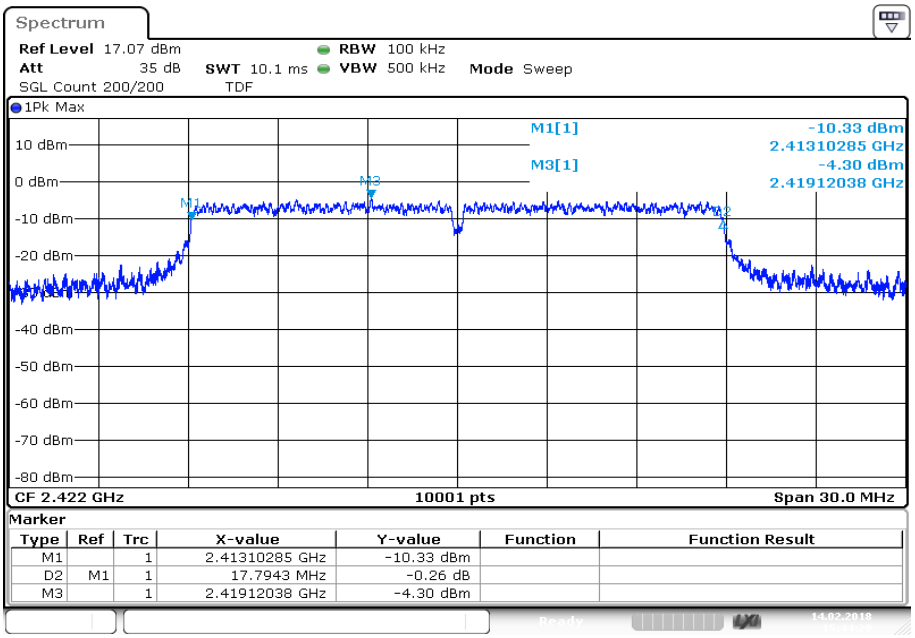
Date: 14.FEB.2018 15:01:16

Plot 2: Channel 2



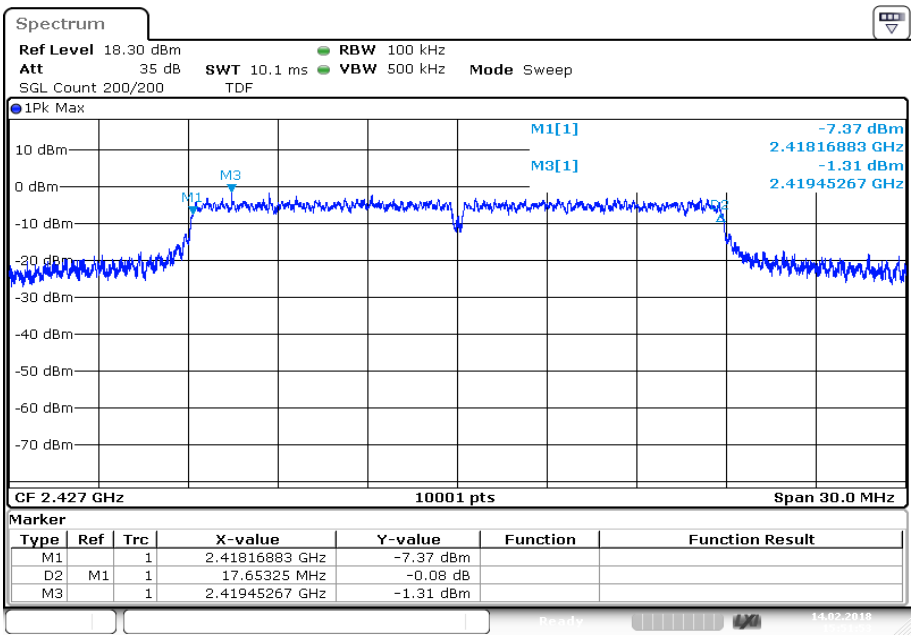
Date: 14.FEB.2018 15:19:06

Plot 3: Channel 3



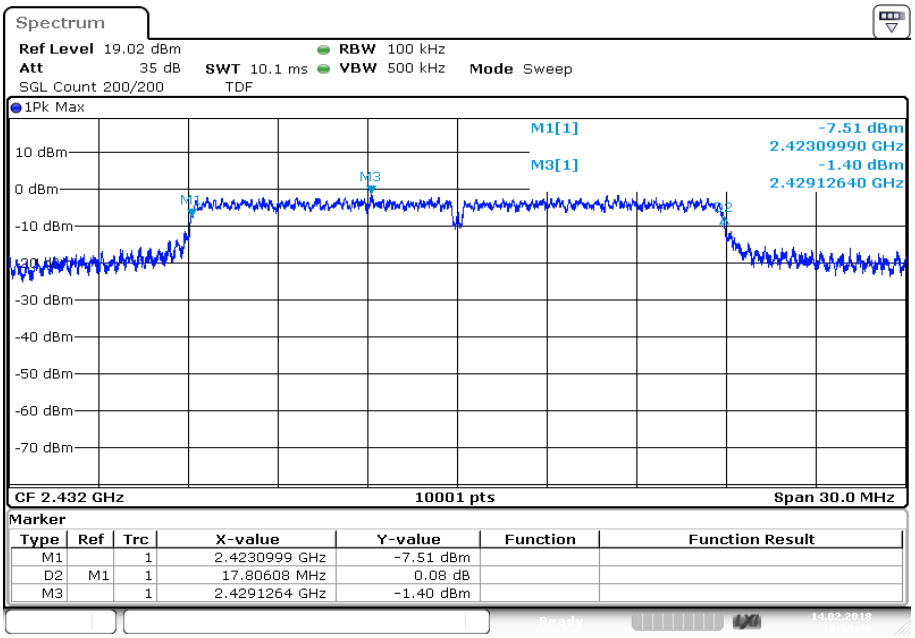
Date: 14.FEB.2018 15:44:30

Plot 4: Channel 4



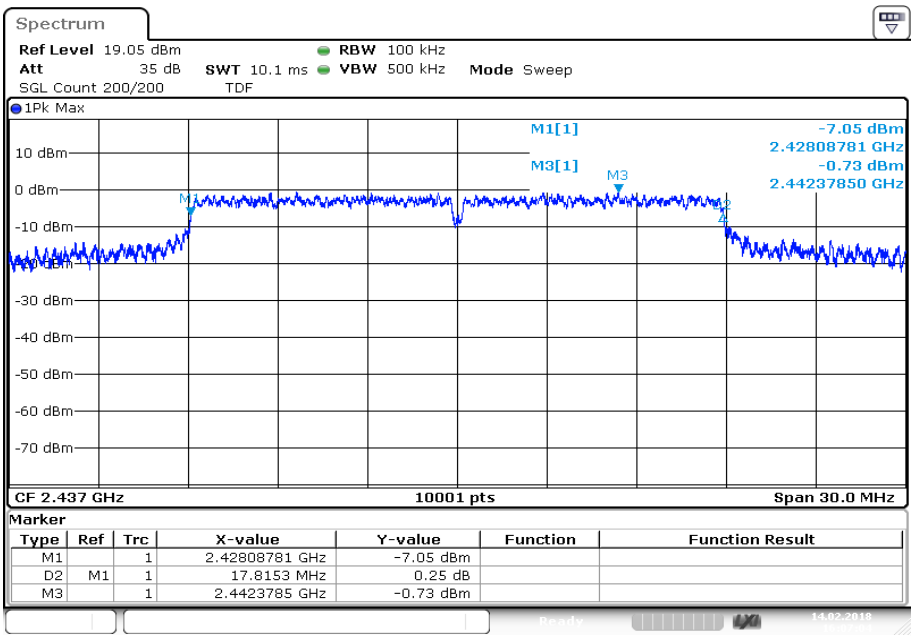
Date: 14.FEB.2018 15:51:52

Plot 5: Channel 5



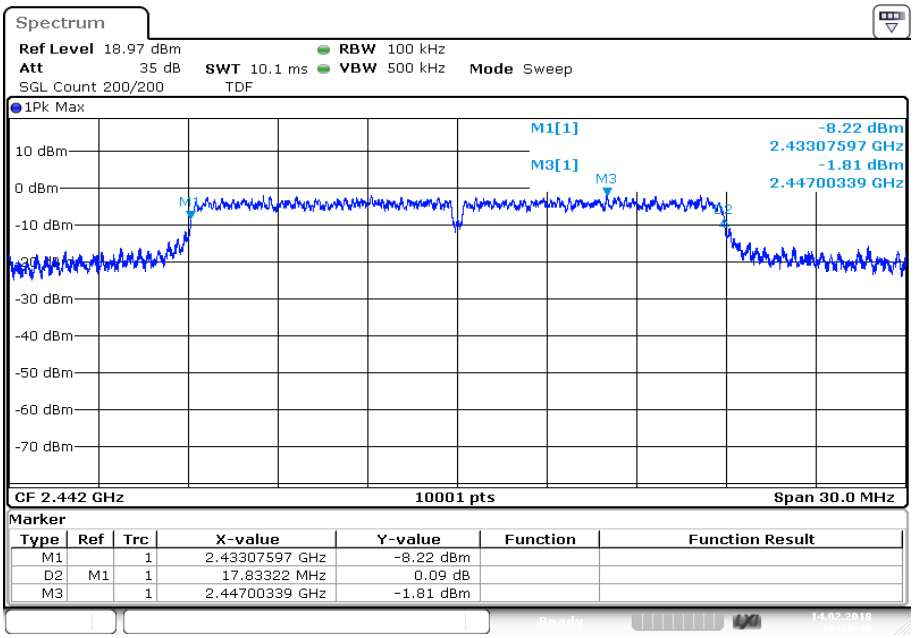
Date: 14.FEB.2018 15:59:40

Plot 6: Channel 6



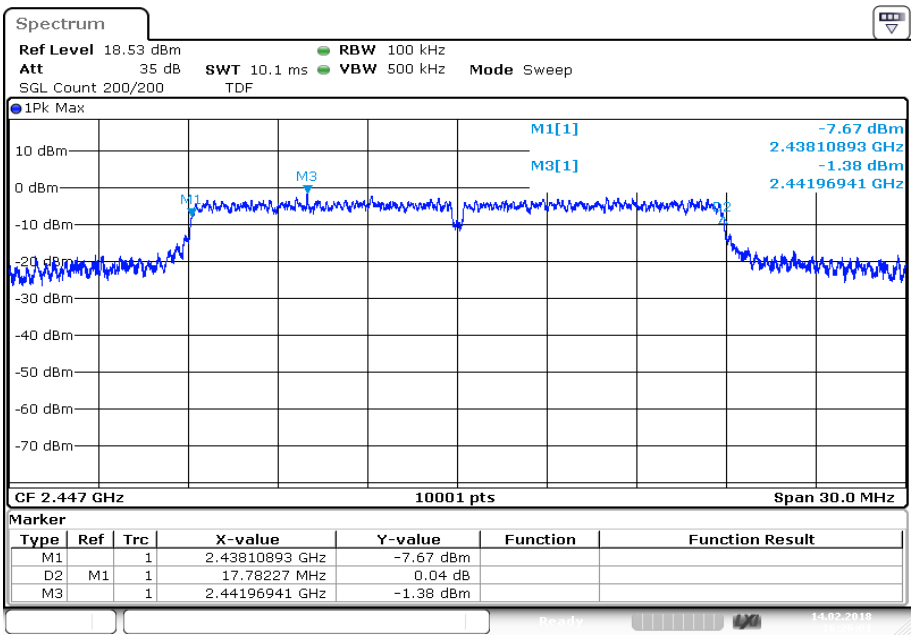
Date: 14.FEB.2018 16:07:04

Plot 7: Channel 7



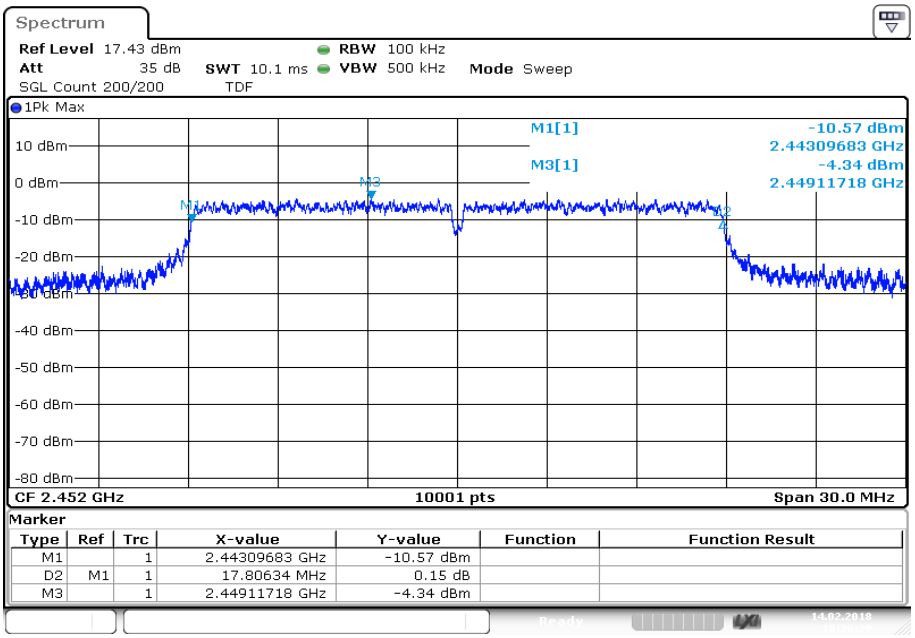
Date: 14.FEB.2018 16:18:39

Plot 8: Channel 8



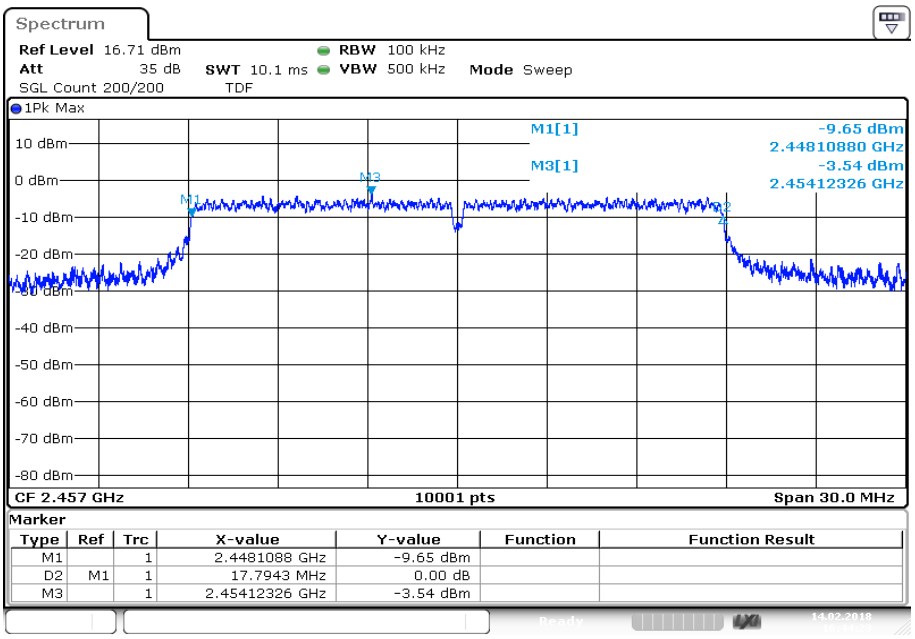
Date: 14.FEB.2018 16:26:01

Plot 9: Channel 9



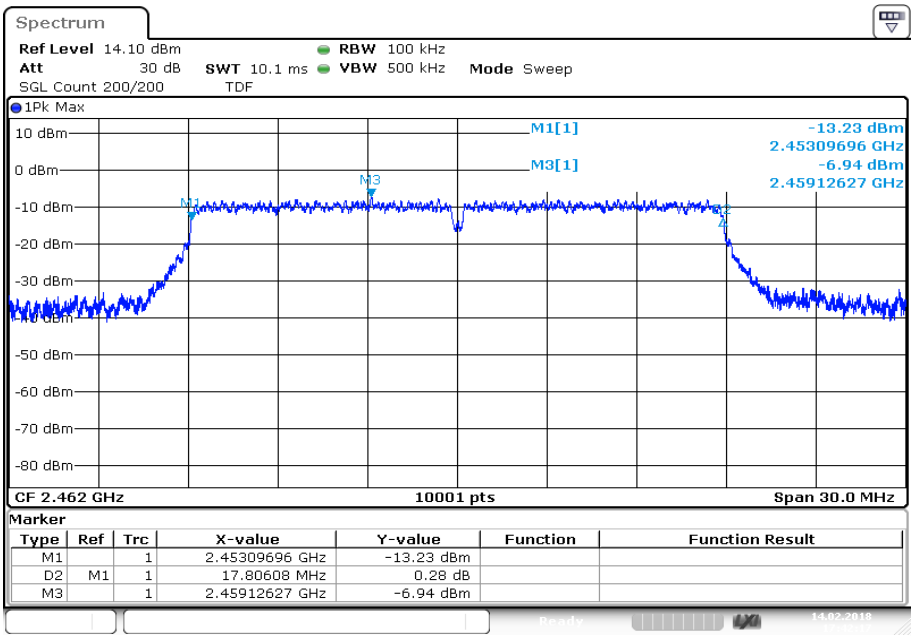
Date: 14.FEB.2018 16:36:39

Plot 10: Channel 10



Date: 14.FEB.2018 16:44:23

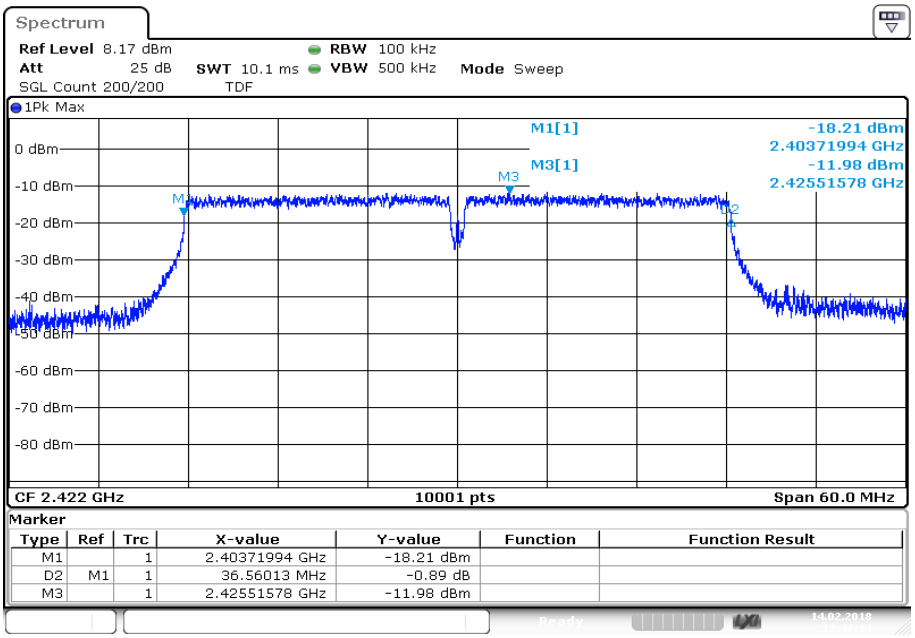
Plot 11: Channel 11



Date: 14.FEB.2018 17:42:17

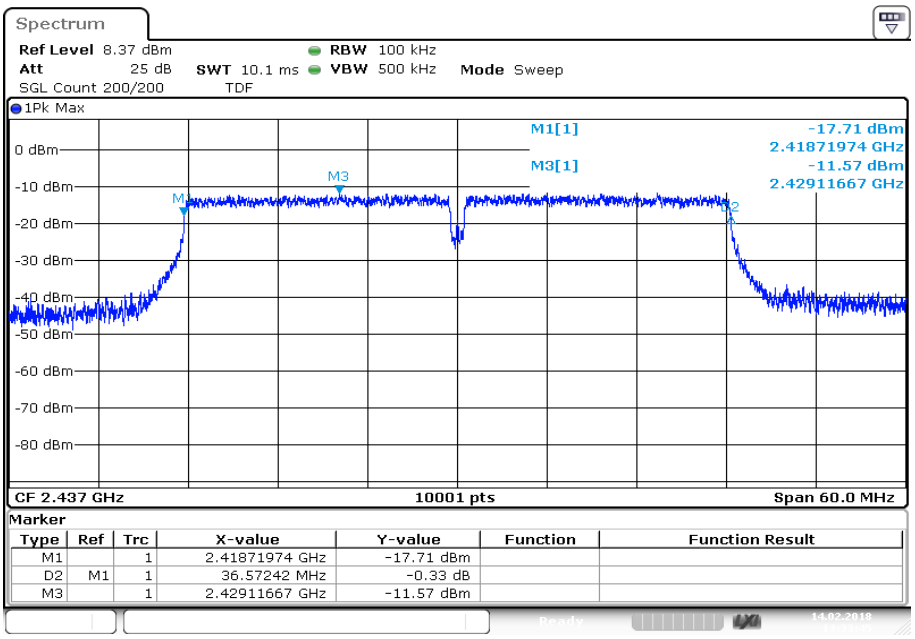
Plots: OFDM / n HT40 – mode

Plot 1: Channel 3



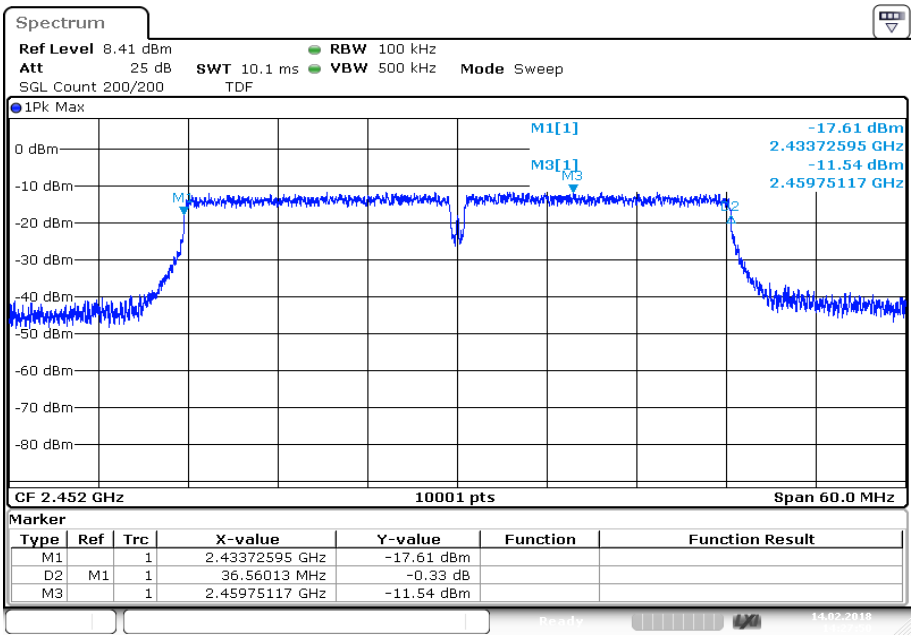
Date: 14.FEB.2018 12:47:14

Plot 2: Channel 6



Date: 14.FEB.2018 13:33:45

Plot 3: Channel 9



Date: 14.FEB.2018 14:27:51

12.7 Occupied bandwidth – 99% emission bandwidth

Description:

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

Measurement:

Measurement parameter	
Detector	Peak
Sweep time	Auto
Resolution bandwidth	300 kHz
Video bandwidth	1 MHz
Span	30 MHz / 50 MHz
Measurement procedure	Measurement of the 99% bandwidth using the integration function of the analyzer
Trace mode	Single count with 200 counts
Test setup	See chapter 6.5 A
Measurement uncertainty	See chapter 8

Usage:

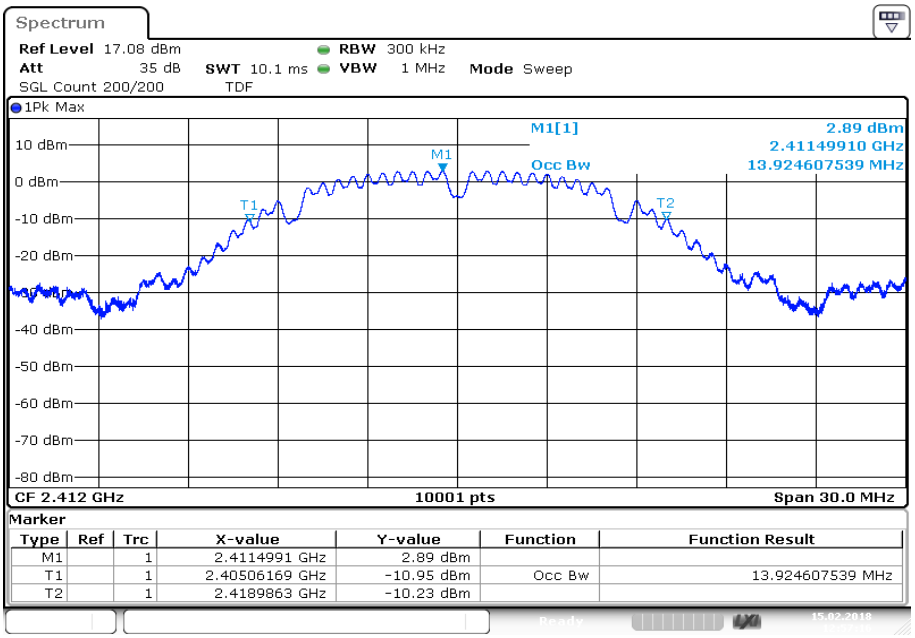
-/-	IC
OBW is necessary for Emission Designator	

Results:

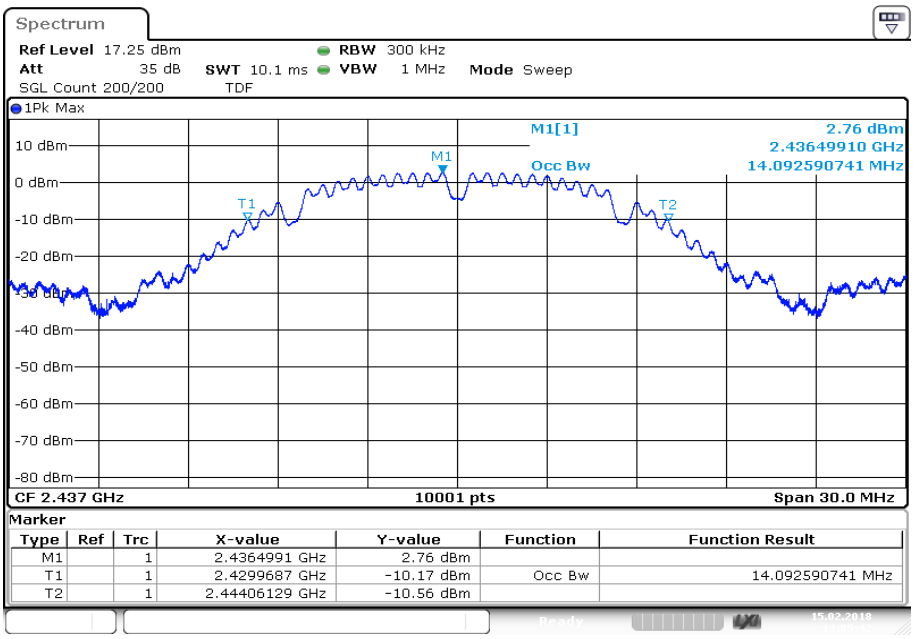
	99% emission bandwidth / kHz										
Frequency	2412 MHz	2417 MHz	2422 MHz	2427 MHz	2432 MHz	2437 MHz	2442 MHz	2447 MHz	2452 MHz	2457 MHz	2462 MHz
DSSS / b – mode	13925					14093					14285
OFDM / g – mode	16969	17443	17653	20188	22747	23881	22231	22618	18148	17914	16891
OFDM / n HT20 – mode	18004	18463	18499	20929	23407	24448	23083	21787	18871	18784	17977
OFDM / n HT40 – mode			36914			36974			36926		

Plots: DSSS / b – mode

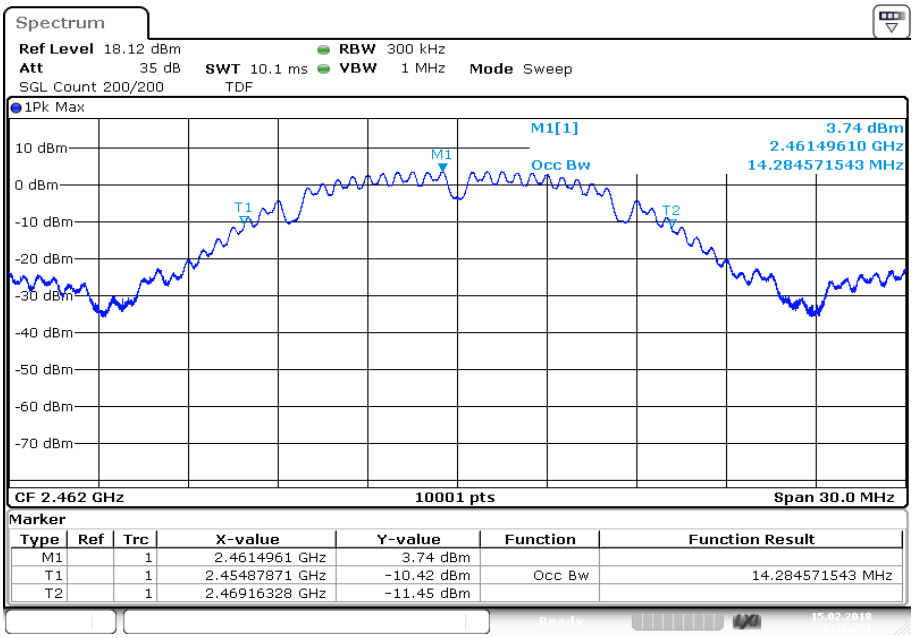
Plot 1: Channel 1



Plot 2: Channel 6



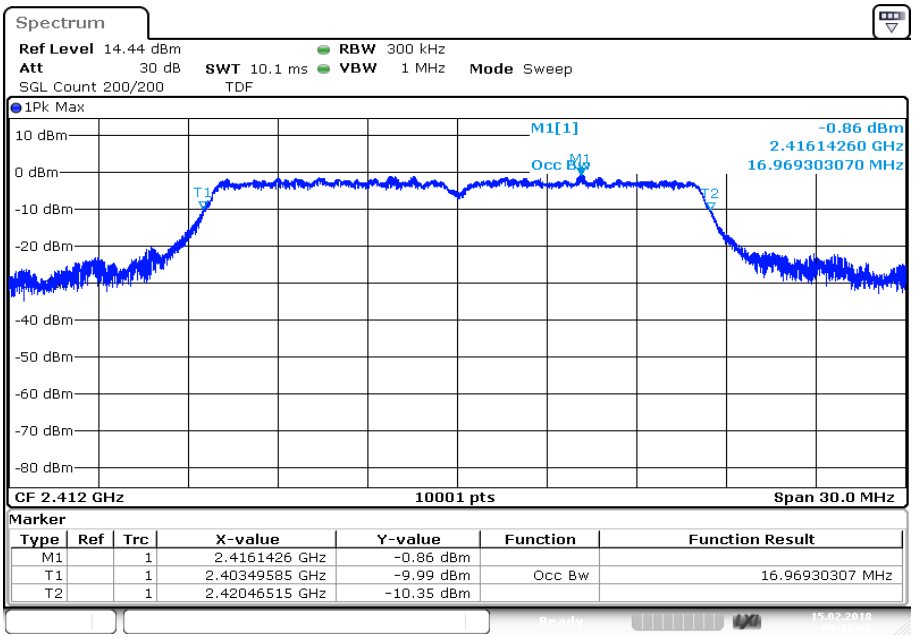
Plot 3: Channel 11



Date: 15.FEB.2018 13:13:52

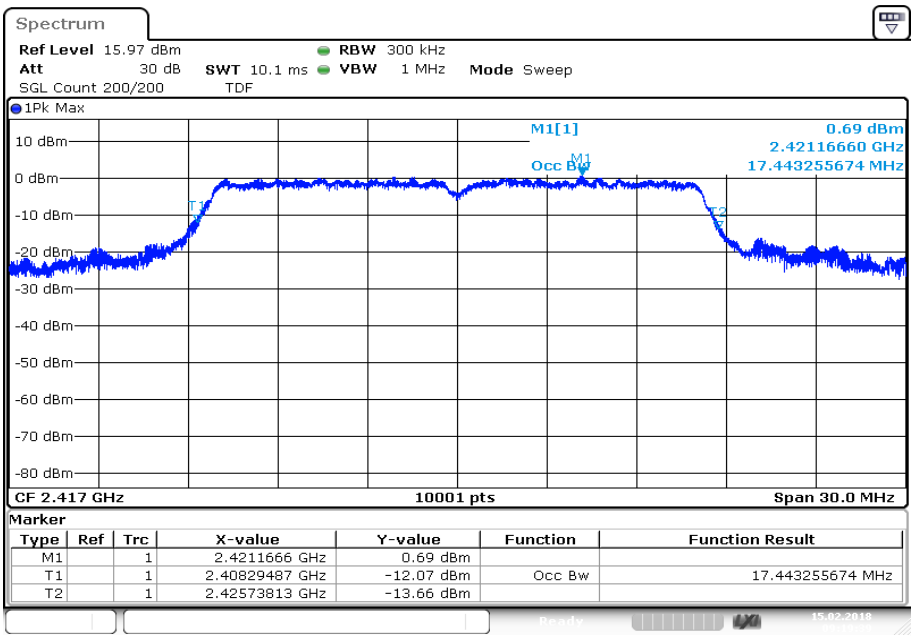
Plots: OFDM / g – mode

Plot 1: Channel 1



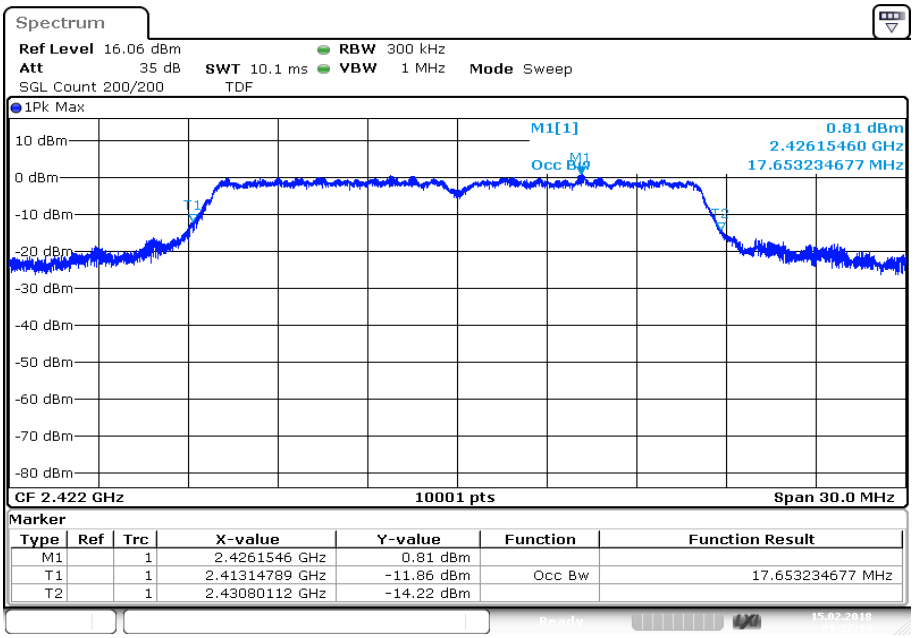
Date: 15.FEB.2018 09:12:02

Plot 2: Channel 2



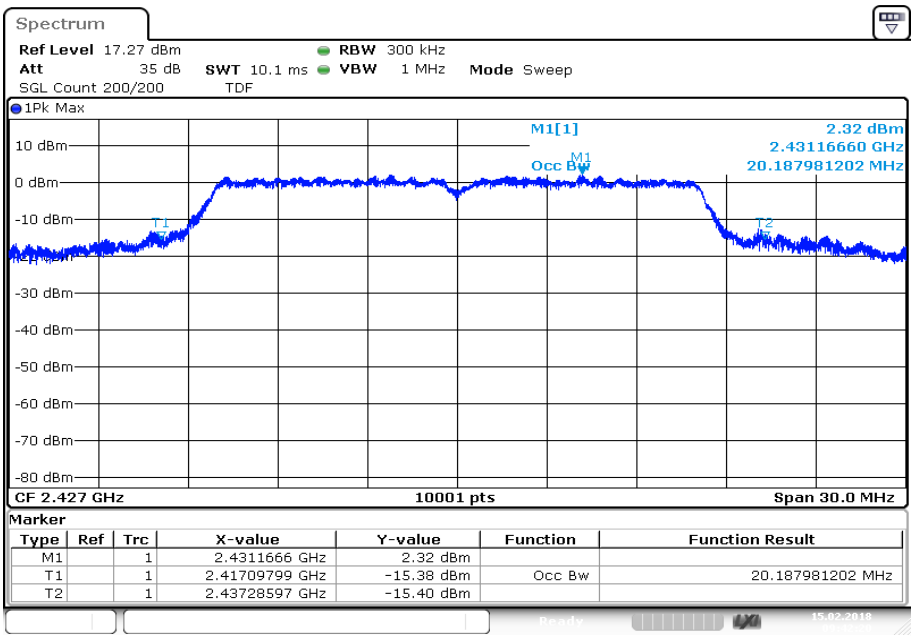
Date: 15.FEB.2018 09:19:39

Plot 3: Channel 3



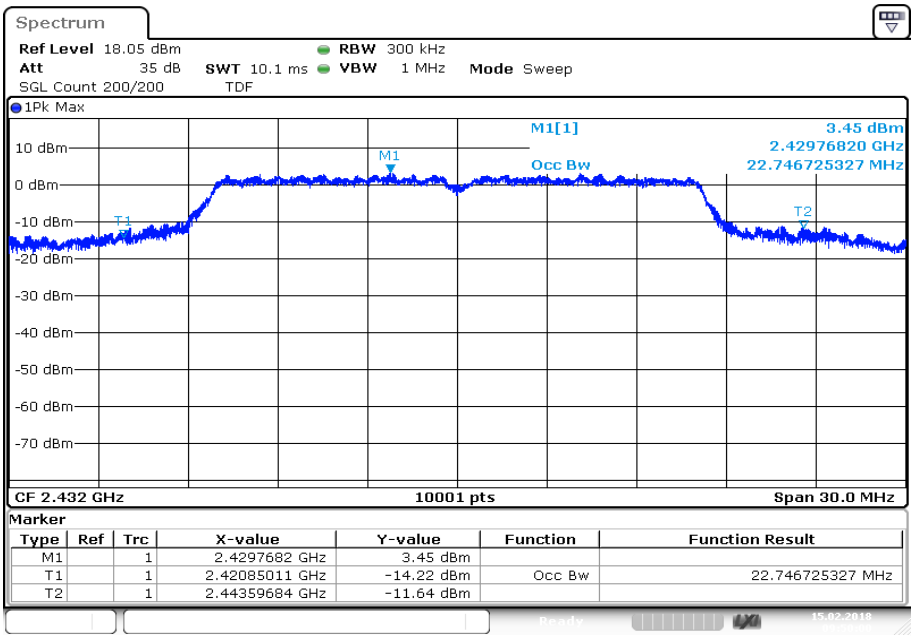
Date: 15.FEB.2018 09:27:14

Plot 4: Channel 4



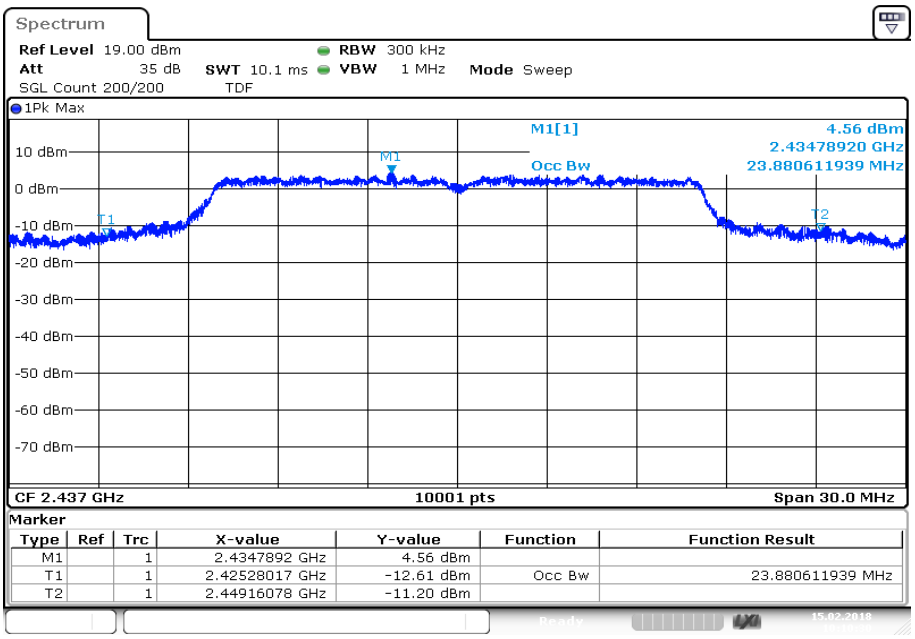
Date: 15.FEB.2018 09:42:20

Plot 5: Channel 5



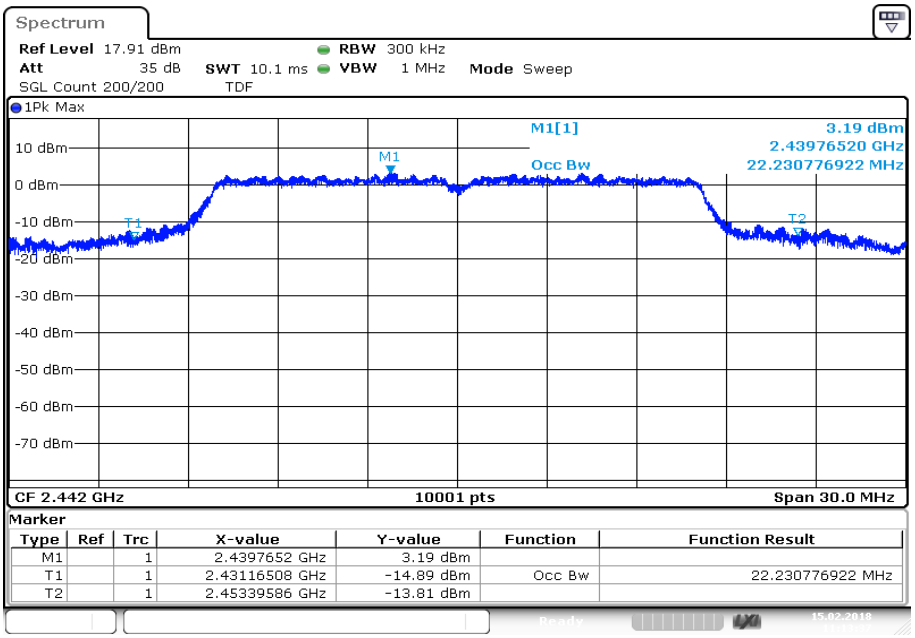
Date: 15.FEB.2018 09:50:00

Plot 6: Channel 6



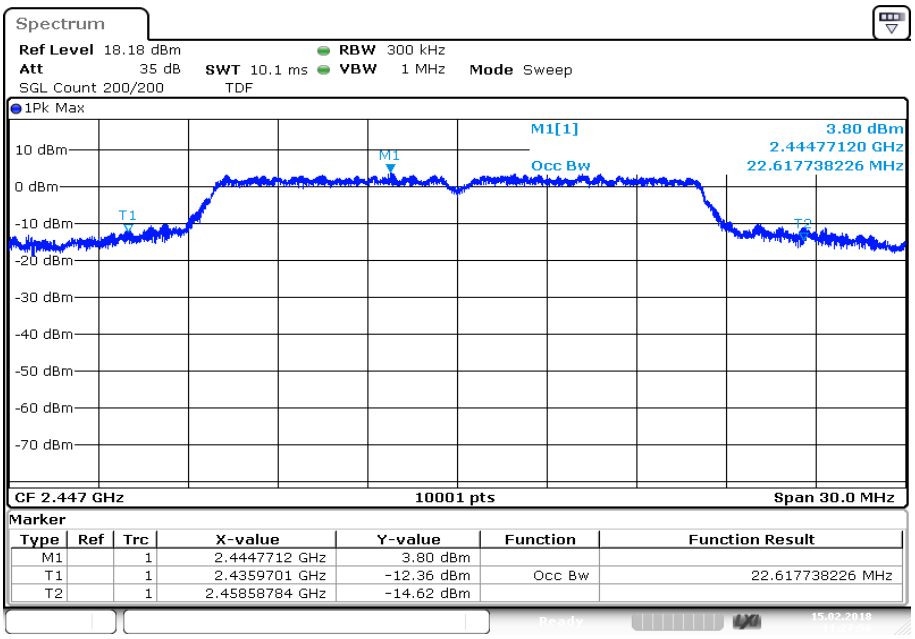
Date: 15.FEB.2018 10:10:30

Plot 7: Channel 7



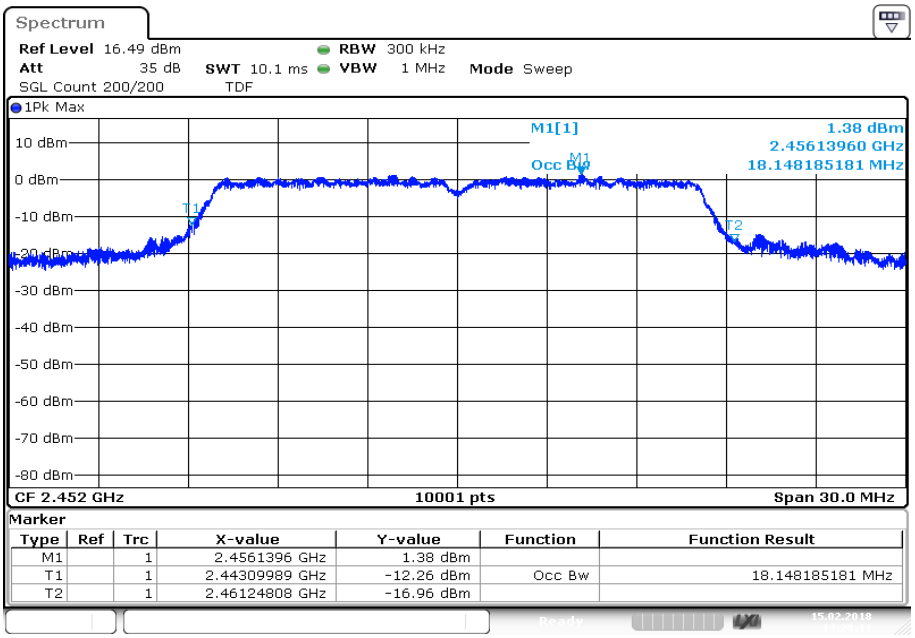
Date: 15.FEB.2018 11:13:37

Plot 8: Channel 8



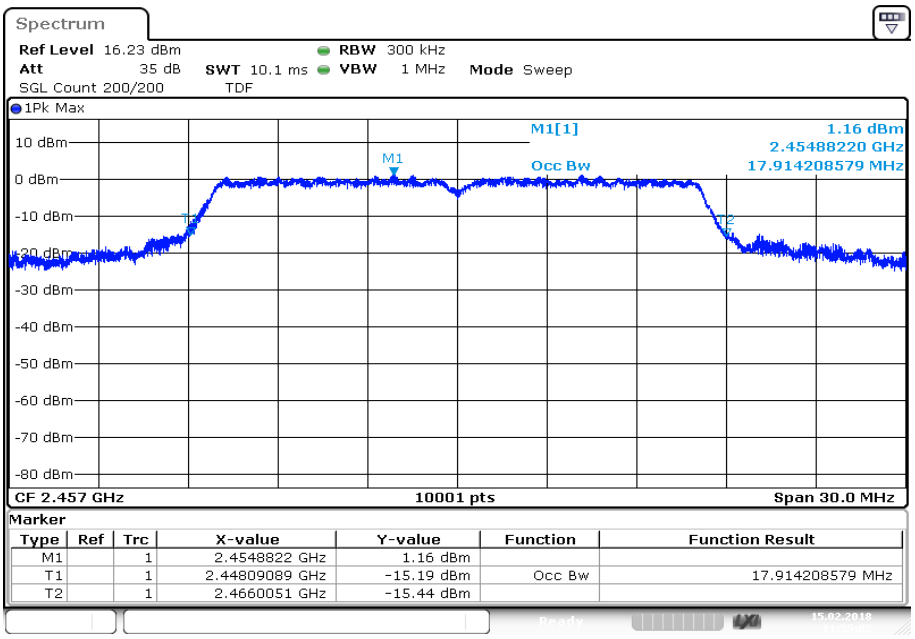
Date: 15.FEB.2018 11:27:56

Plot 9: Channel 9



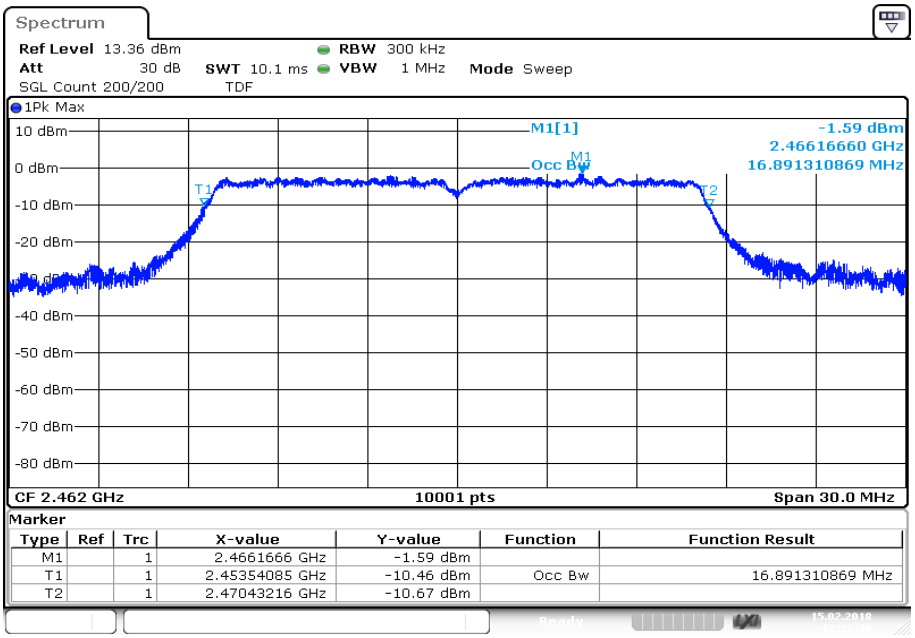
Date: 15.FEB.2018 13:28:12

Plot 10: Channel 10



Date: 15.FEB.2018 11:55:02

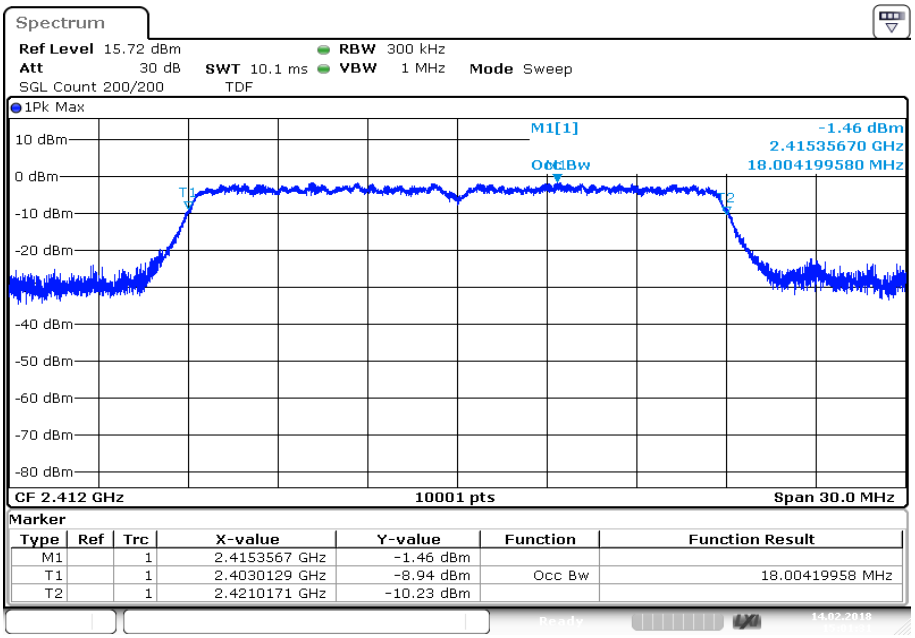
Plot 11: Channel 11



Date: 15.FEB.2018 12:22:36

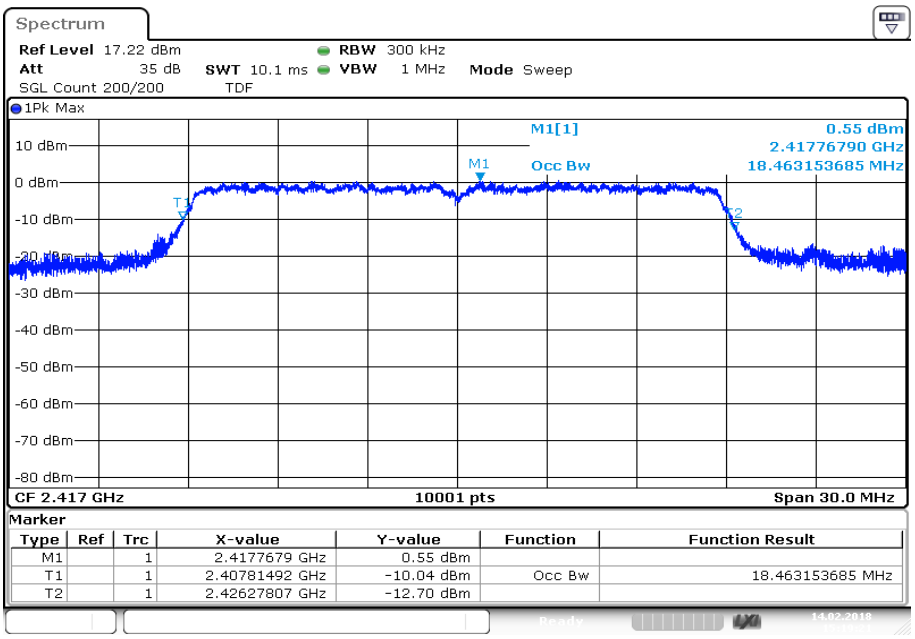
Plots: OFDM / n HT20 – mode

Plot 1: Channel 1



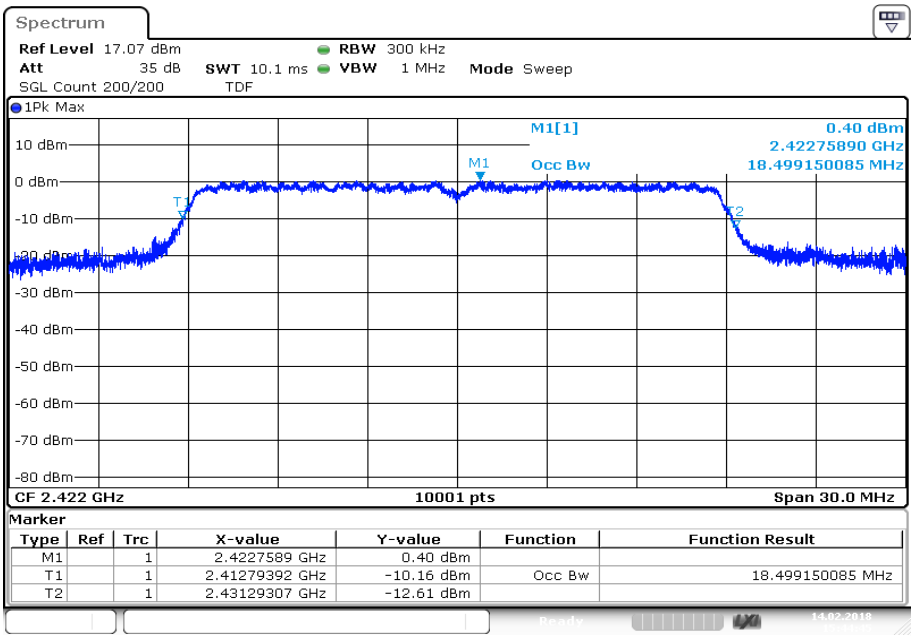
Date: 14.FEB.2018 15:01:31

Plot 2: Channel 2



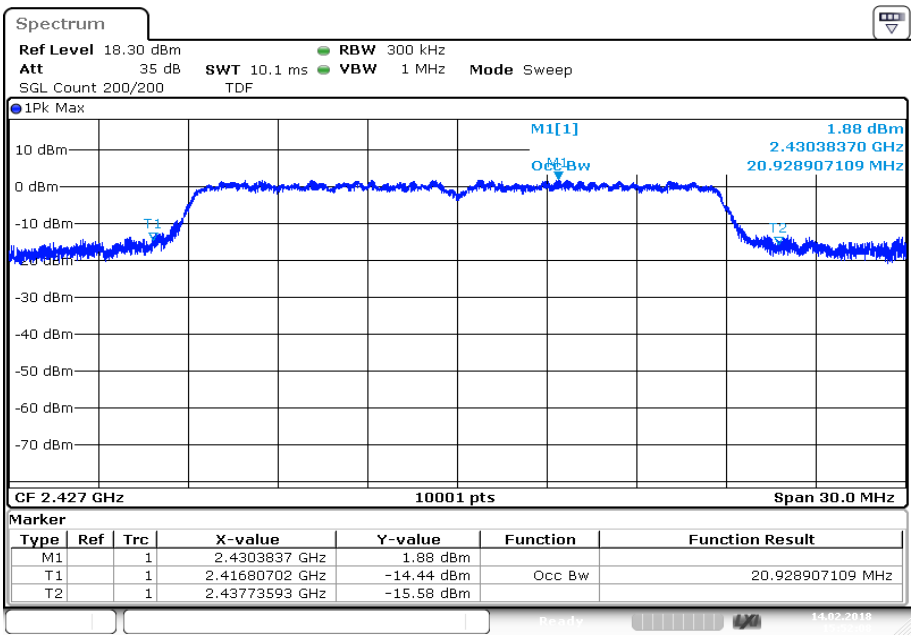
Date: 14.FEB.2018 15:19:22

Plot 3: Channel 3



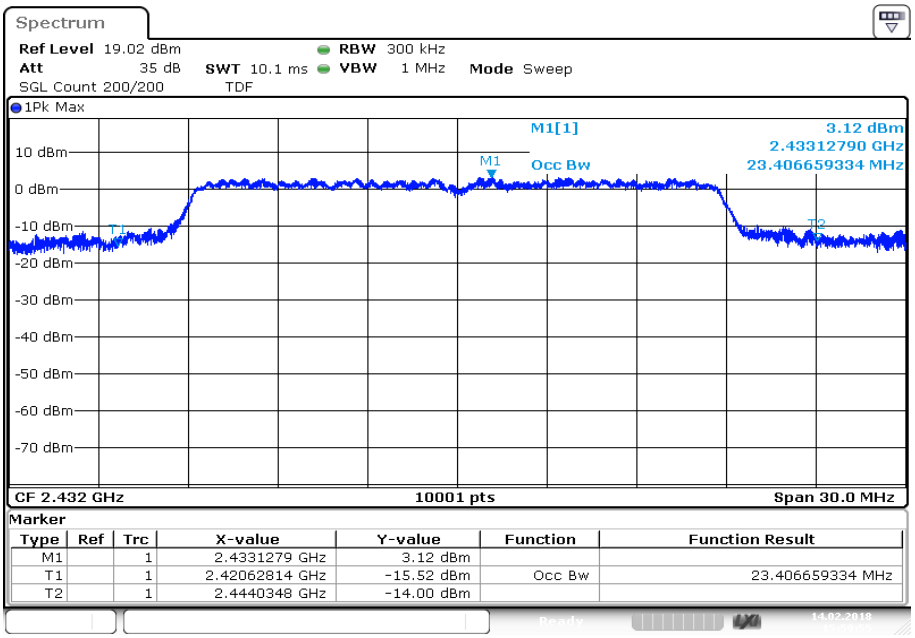
Date: 14.FEB.2018 15:44:46

Plot 4: Channel 4



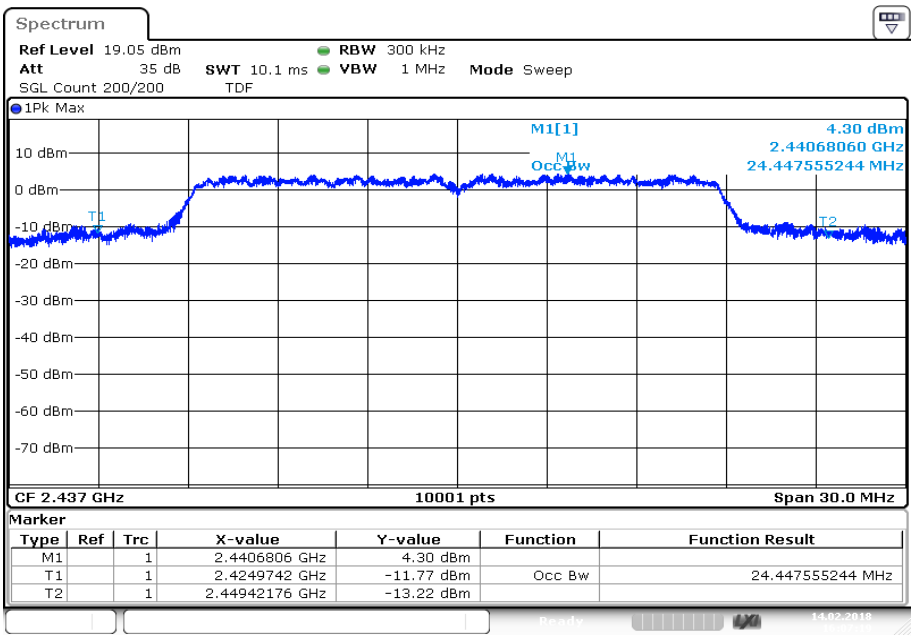
Date: 14.FEB.2018 15:52:08

Plot 5: Channel 5



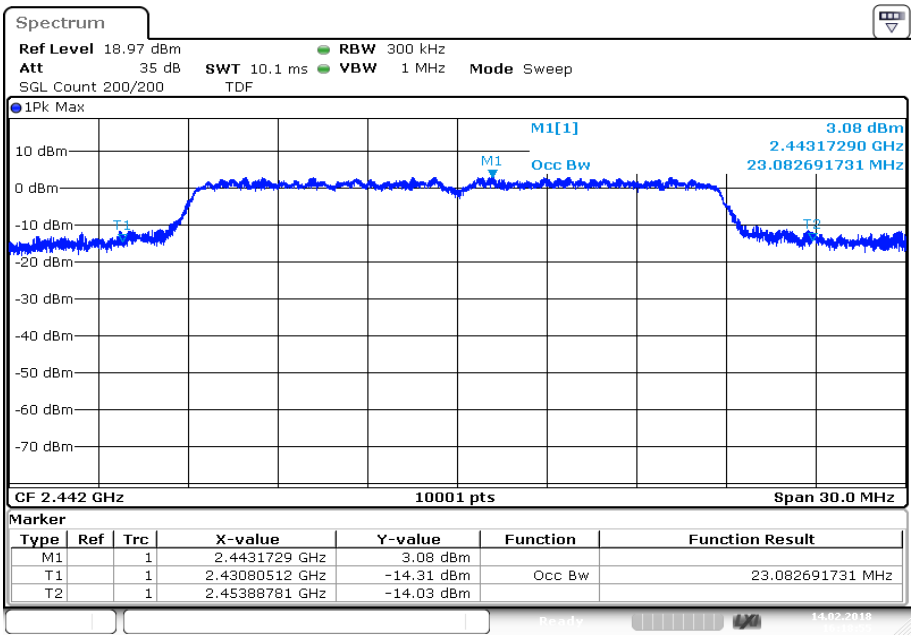
Date: 14.FEB.2018 15:59:55

Plot 6: Channel 6



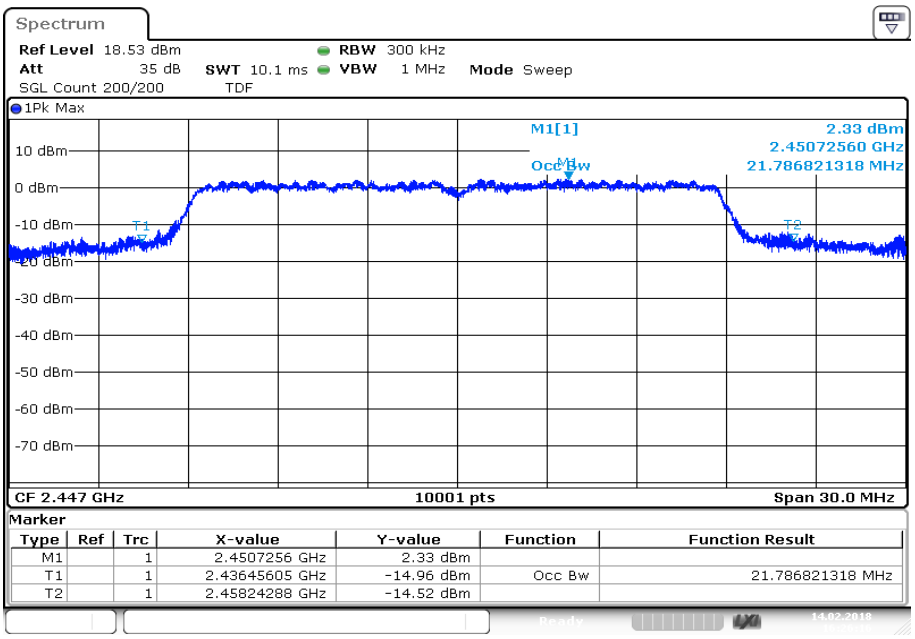
Date: 14.FEB.2018 16:07:19

Plot 7: Channel 7



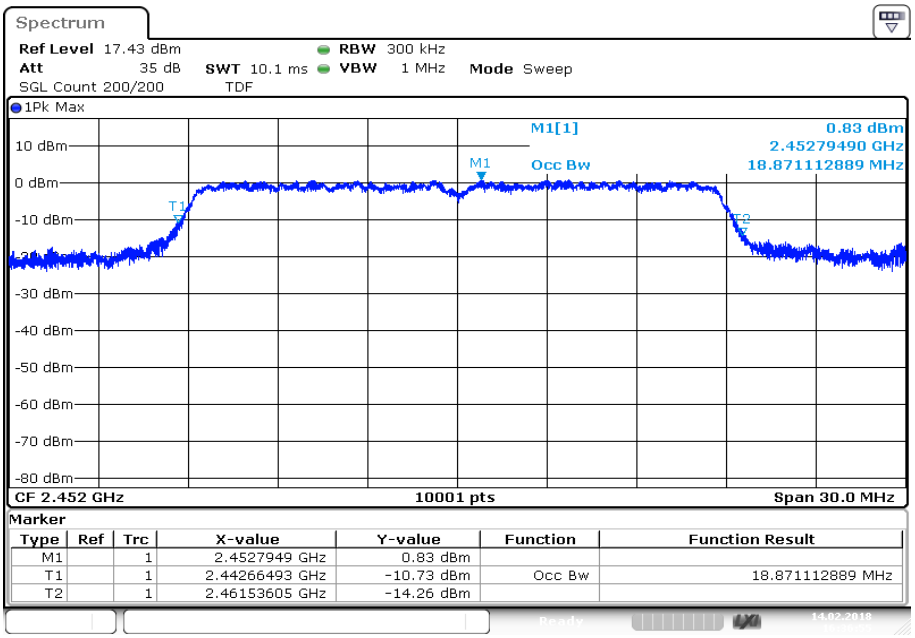
Date: 14.FEB.2018 16:18:55

Plot 8: Channel 8



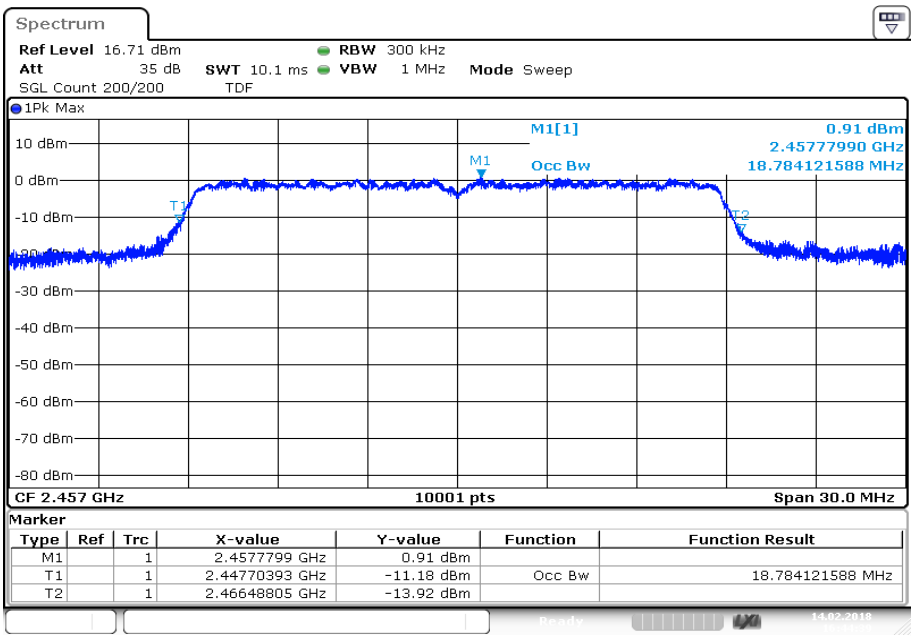
Date: 14.FEB.2018 16:26:16

Plot 9: Channel 9



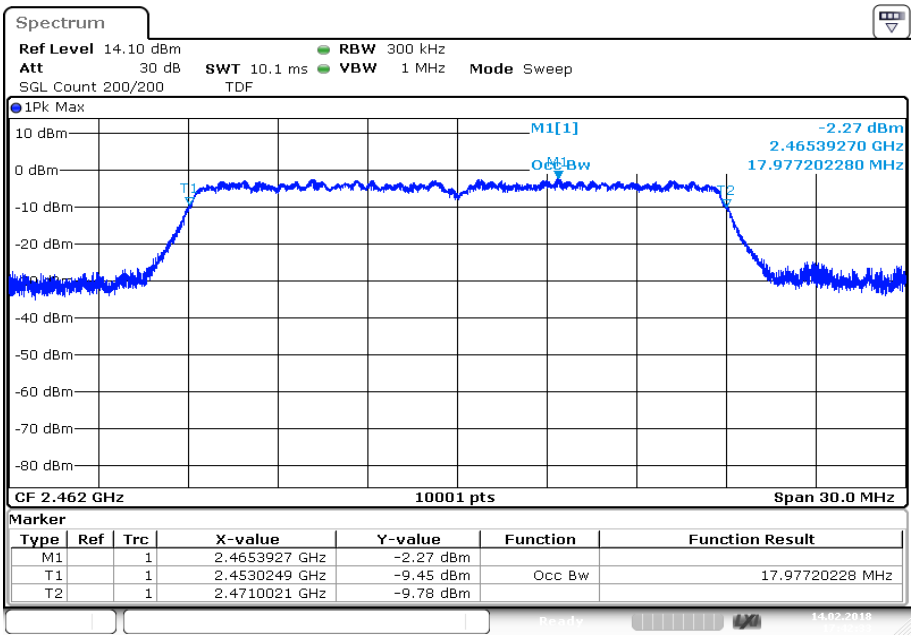
Date: 14.FEB.2018 16:36:55

Plot 10: Channel 10



Date: 14.FEB.2018 16:44:39

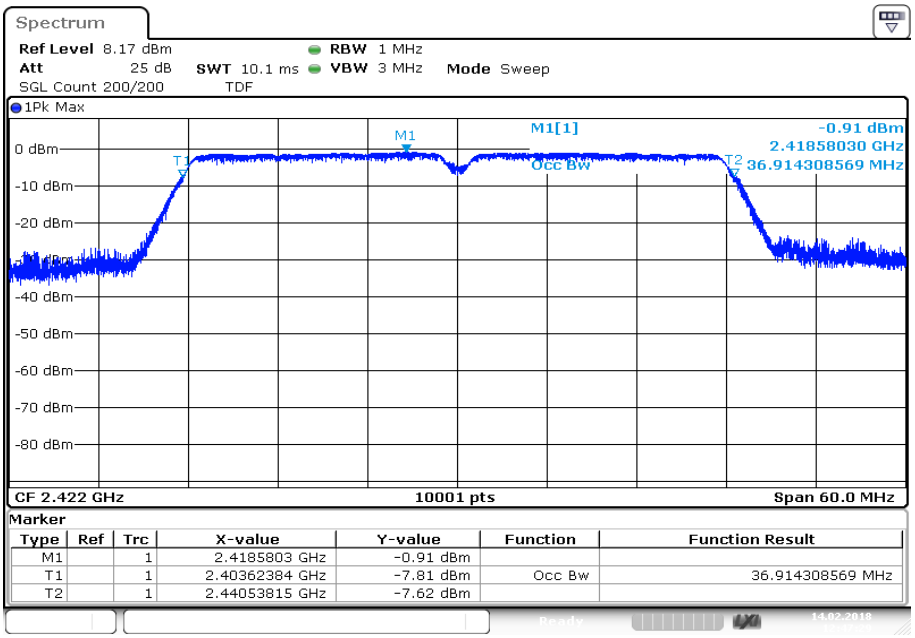
Plot 11: Channel 11



Date: 14.FEB.2018 17:42:33

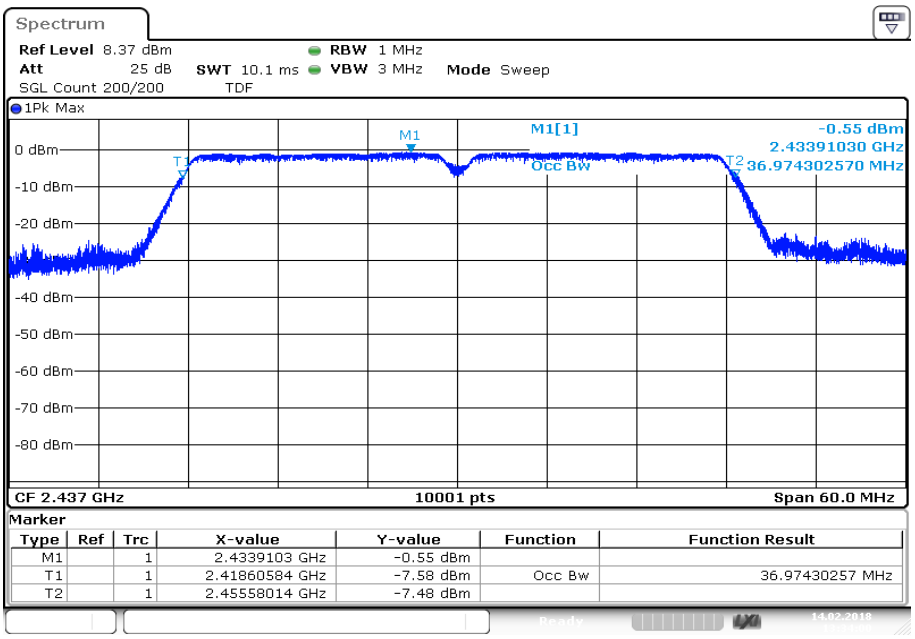
Plots: OFDM / n HT40 – mode

Plot 1: Channel 3



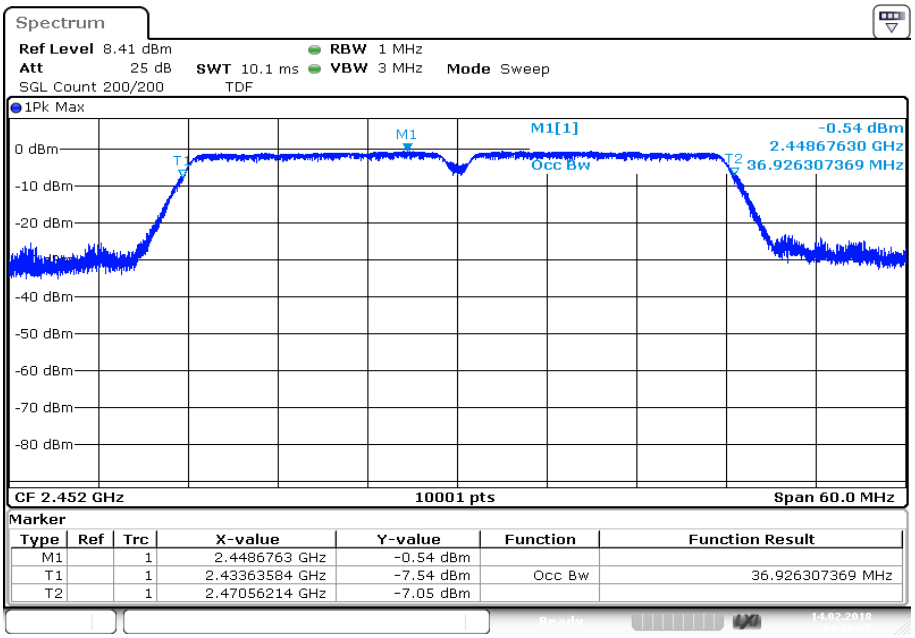
Date: 14.FEB.2018 12:47:28

Plot 2: Channel 6



Date: 14.FEB.2018 13:34:00

Plot 3: Channel 9



Date: 14.FEB.2018 14:28:05

12.8 Occupied bandwidth – 20 dB bandwidth

Description:

Measurement of the 20 dB bandwidth of the modulated carrier.

Measurement:

Measurement parameter	
Detector	Peak
Sweep time	Auto
Resolution bandwidth	100 kHz
Video bandwidth	500 kHz
Span	30 MHz / 50 MHz
Trace mode	Single count with min. 200 counts
Test setup	See chapter 6.5 A
Measurement uncertainty	See chapter 8

Usage:

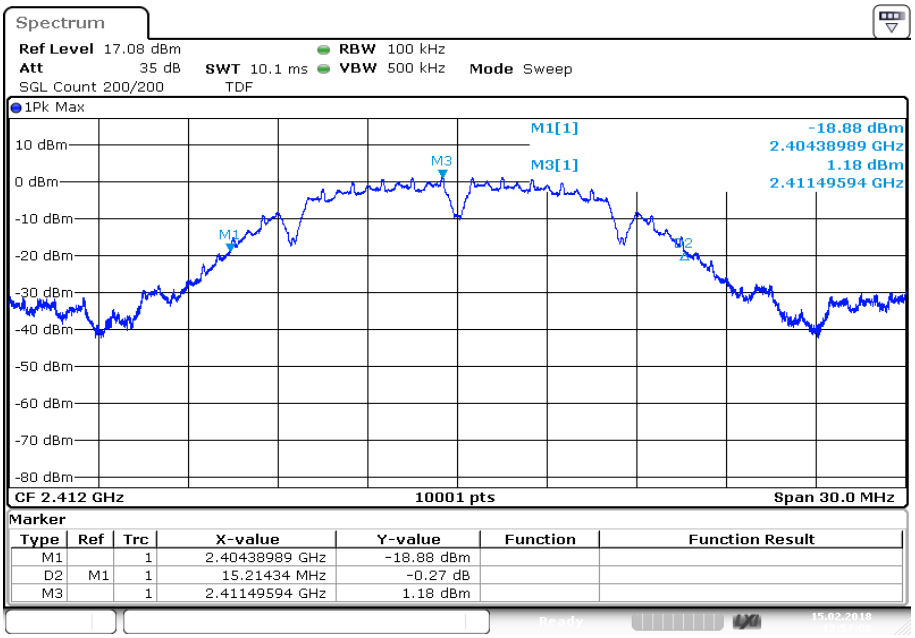
-/-	IC
Within the used band!	

Results:

	20 dB bandwidth / MHz										
Frequency	2412 MHz	2417 MHz	2422 MHz	2427 MHz	2432 MHz	2437 MHz	2442 MHz	2447 MHz	2452 MHz	2457 MHz	2462 MHz
DSSS / b – mode	15.214					16.009					16.105
OFDM / g – mode	18.616	21.859	24.787	29.730	29.991	29.991	29.991	29.991	26.898	25.692	18.280
OFDM / n HT20 – mode	19.321	26.619	19.876	29.991	29.991	29.991	29.991	29.973	28.731	27.576	19.447
OFDM / n HT40 – mode			38.546			38.000			38.396		

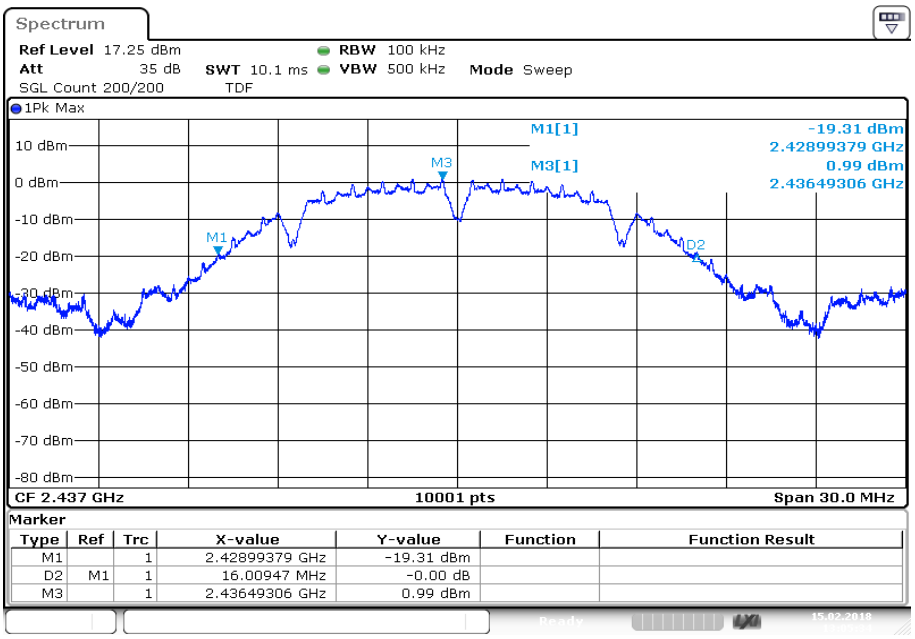
Plots: DSSS / b – mode

Plot 1: Channel 1



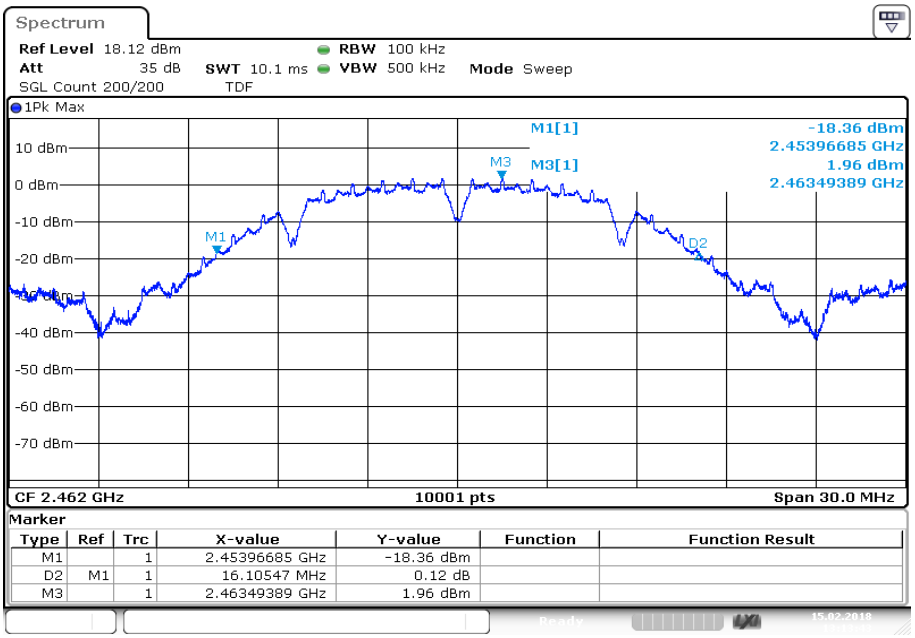
Date: 15.FEB.2018 12:57:09

Plot 2: Channel 6



Date: 15.FEB.2018 13:05:34

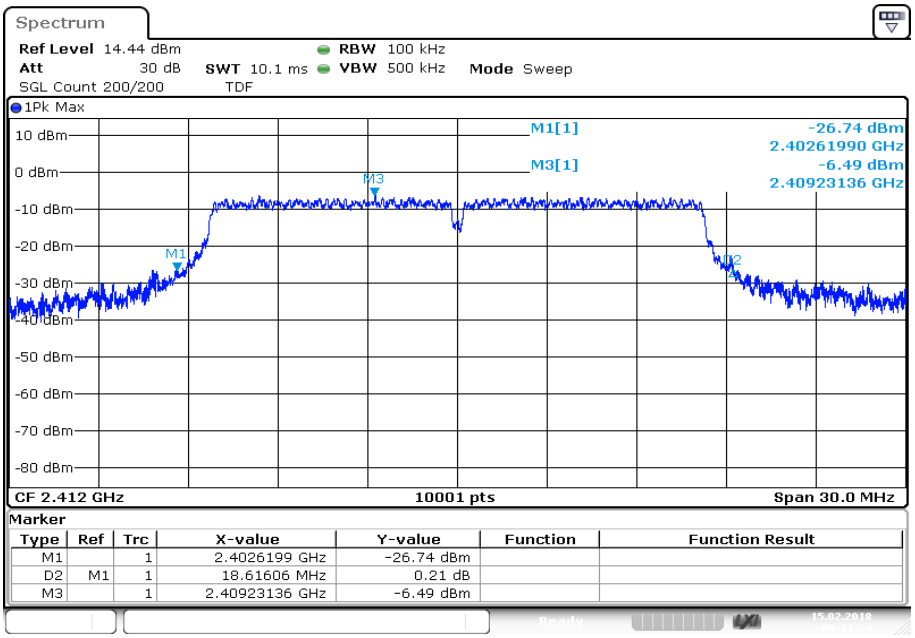
Plot 3: Channel 11



Date: 15.FEB.2018 13:13:44

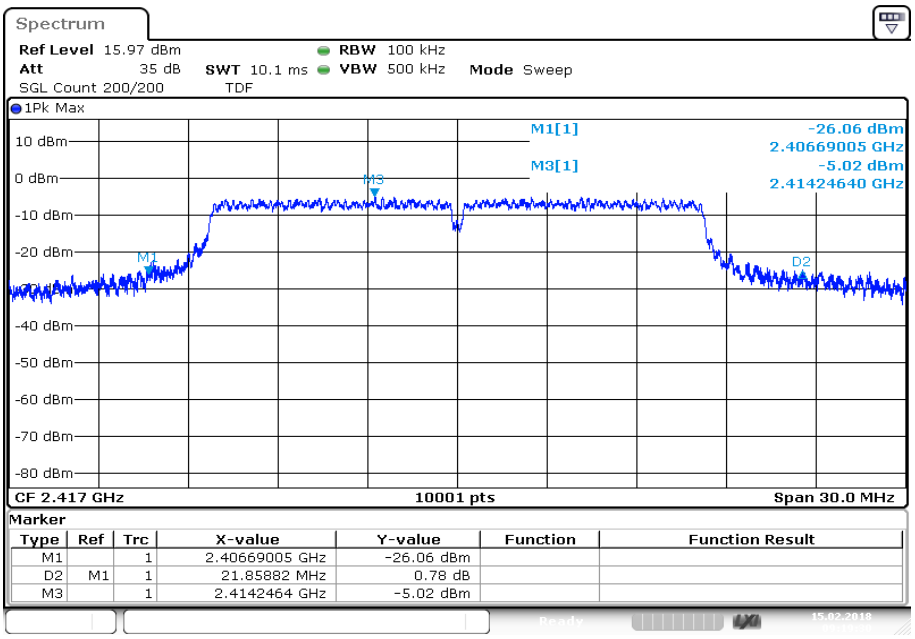
Plots: OFDM / g – mode

Plot 1: Channel 1



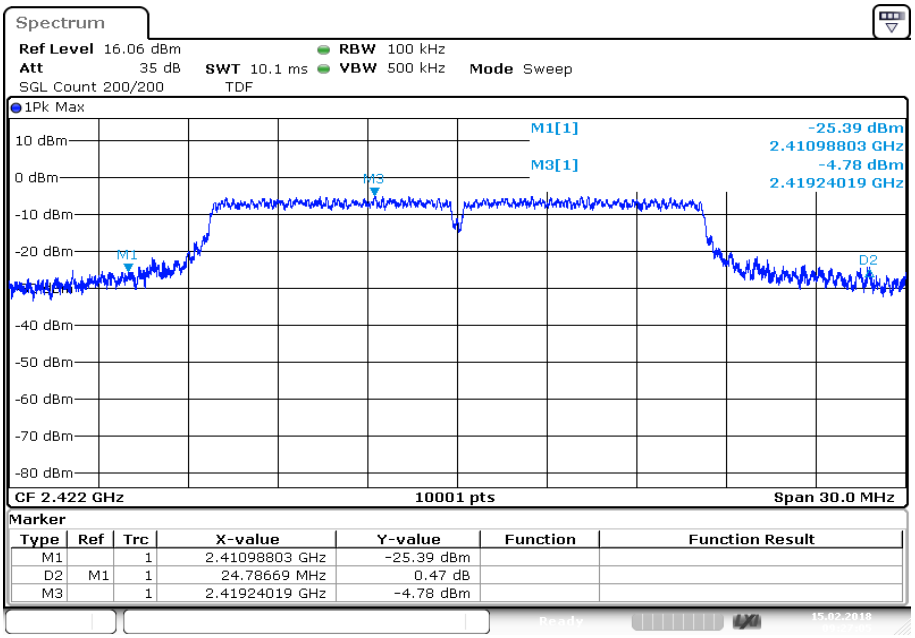
Date: 15.FEB.2018 09:11:54

Plot 2: Channel 2



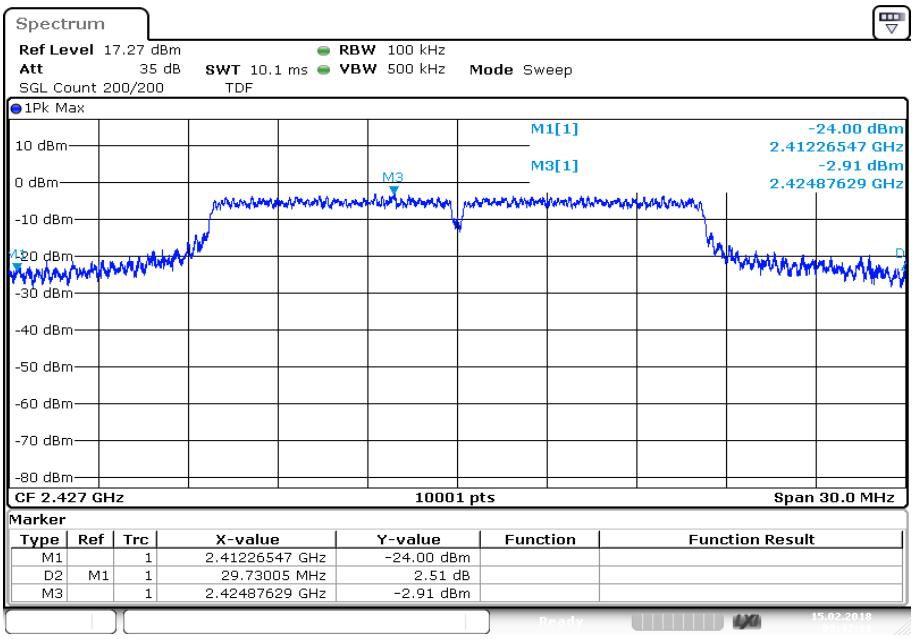
Date: 15.FEB.2018 09:19:30

Plot 3: Channel 3



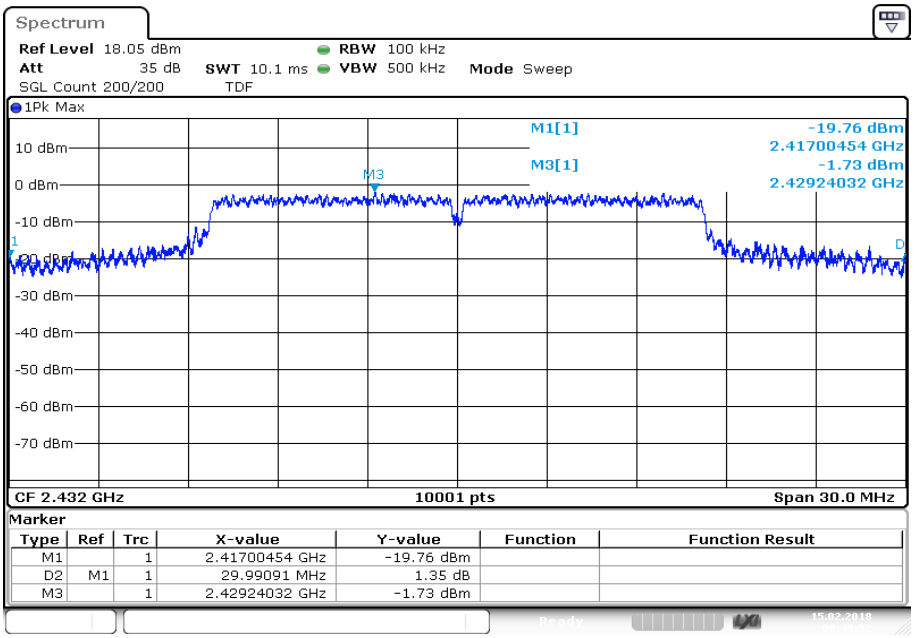
Date: 15.FEB.2018 09:27:05

Plot 4: Channel 4



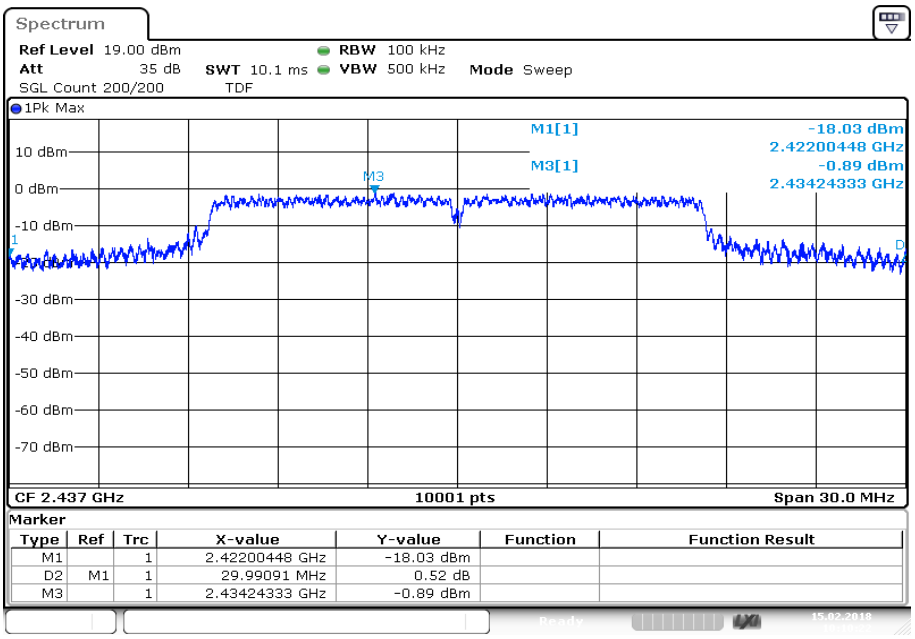
Date: 15.FEB.2018 09:42:11

Plot 5: Channel 5



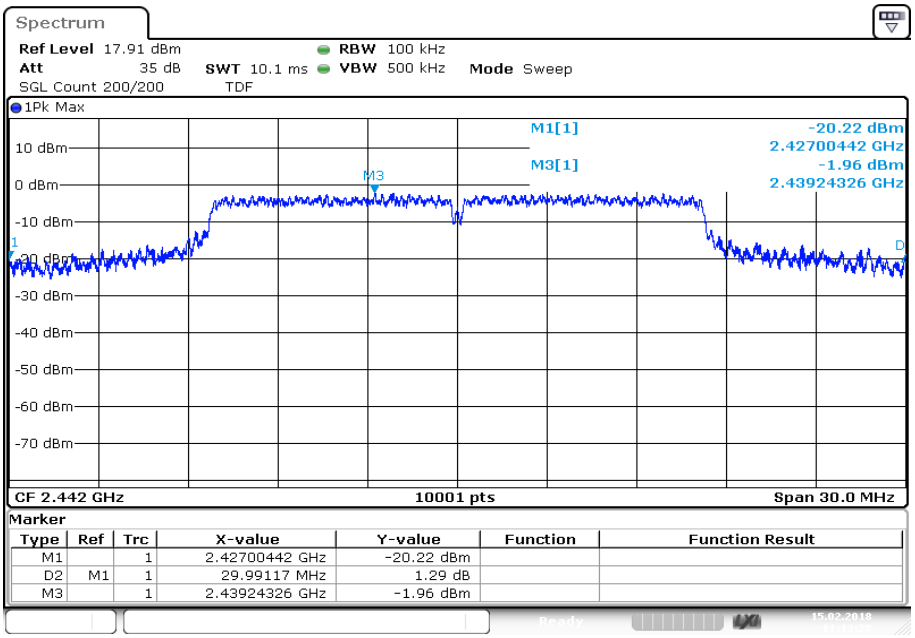
Date: 15.FEB.2018 09:49:52

Plot 6: Channel 6



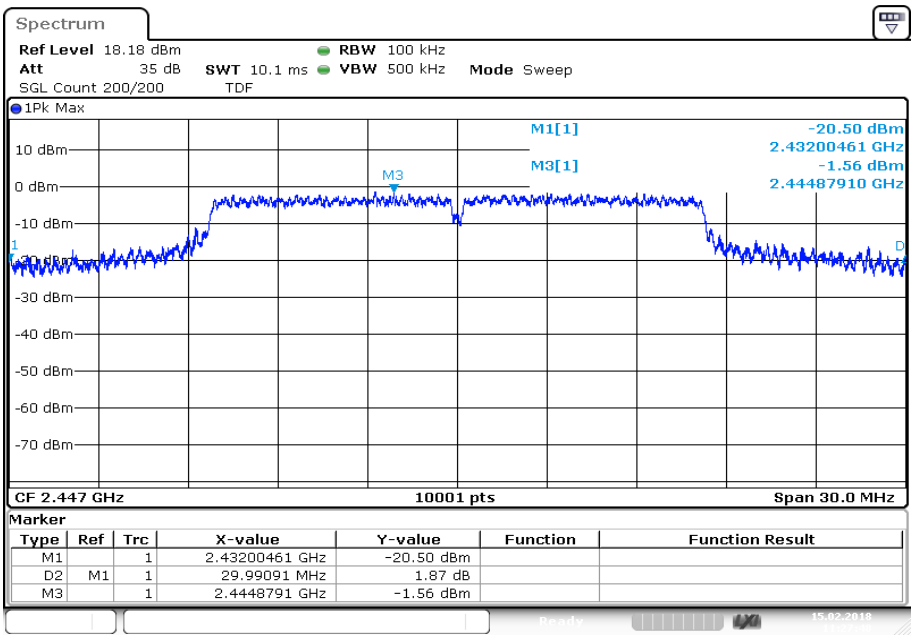
Date: 15.FEB.2018 10:10:22

Plot 7: Channel 7



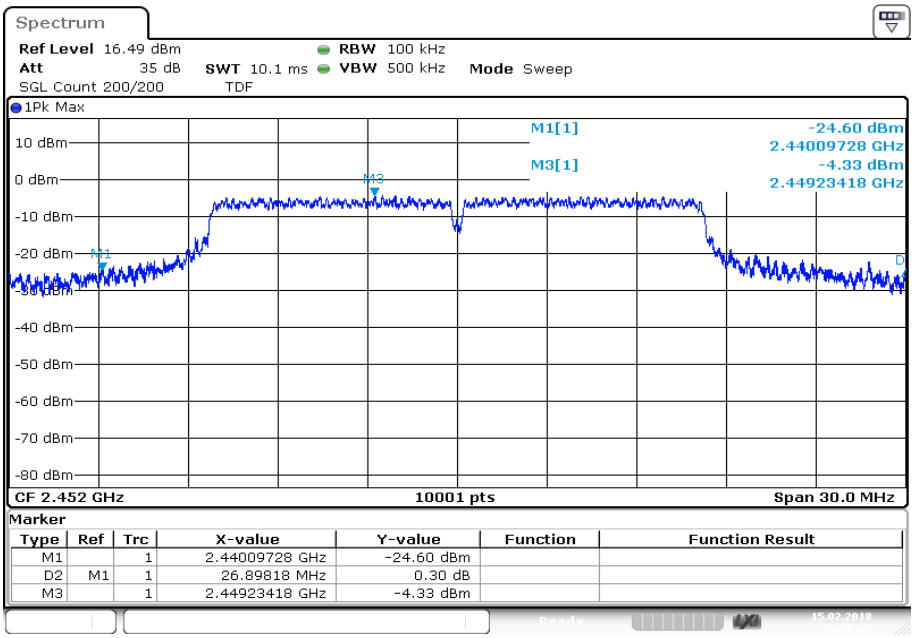
Date: 15.FEB.2018 11:13:28

Plot 8: Channel 8



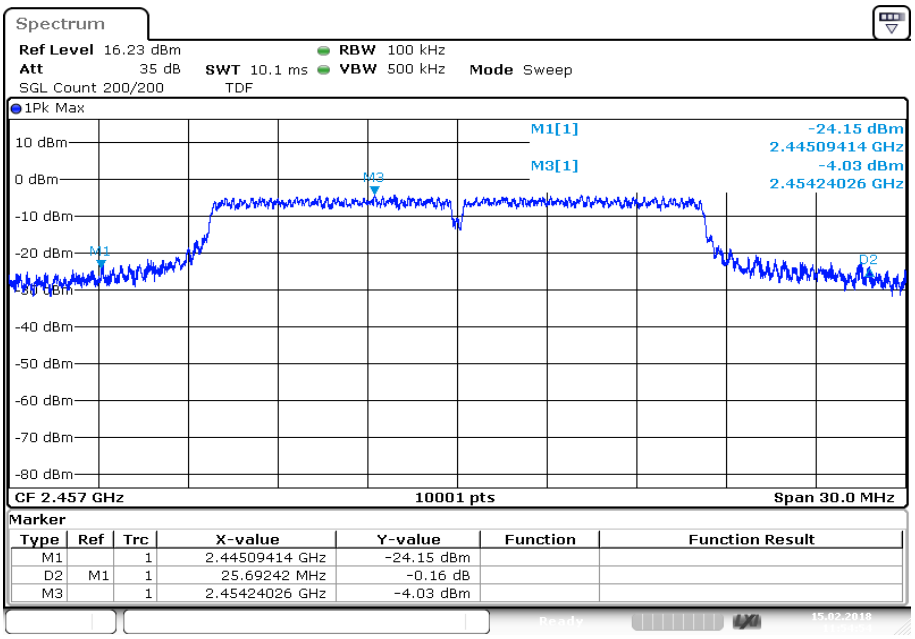
Date: 15.FEB.2018 11:27:48

Plot 9: Channel 9



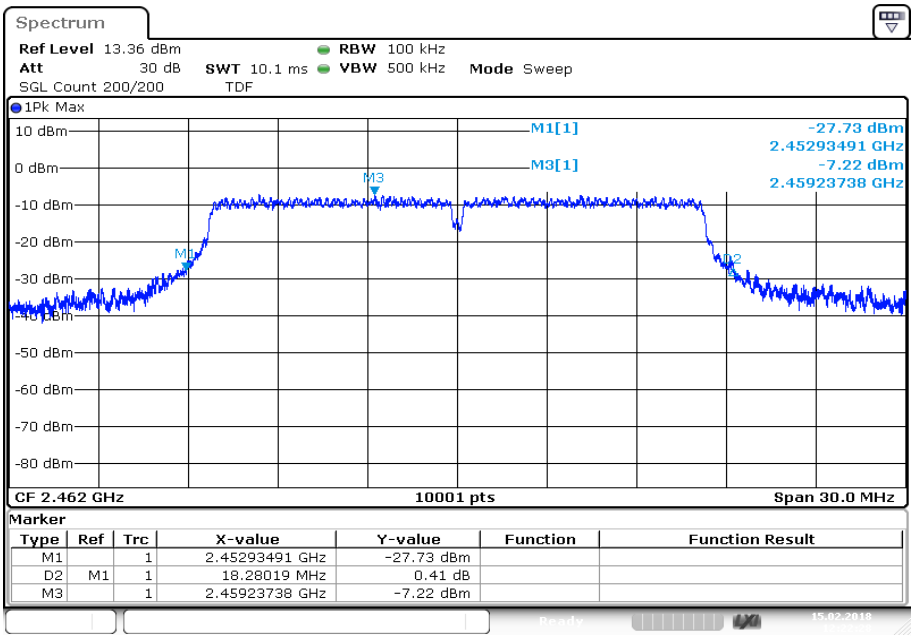
Date: 15.FEB.2018 13:28:04

Plot 10: Channel 10



Date: 15.FEB.2018 11:54:54

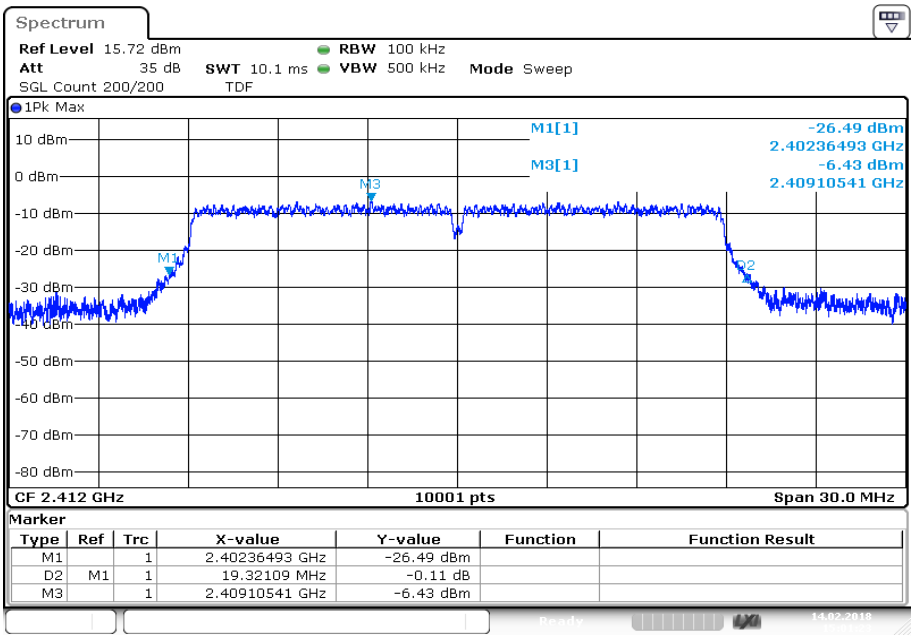
Plot 11: Channel 11



Date: 15.FEB.2018 12:22:28

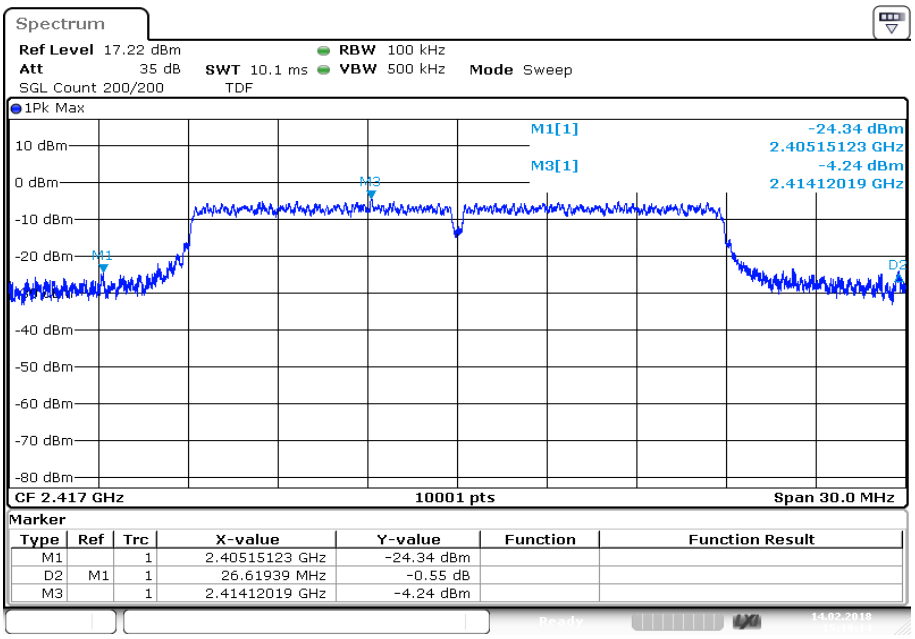
Plots: OFDM / n HT20 – mode

Plot 1: Channel 1



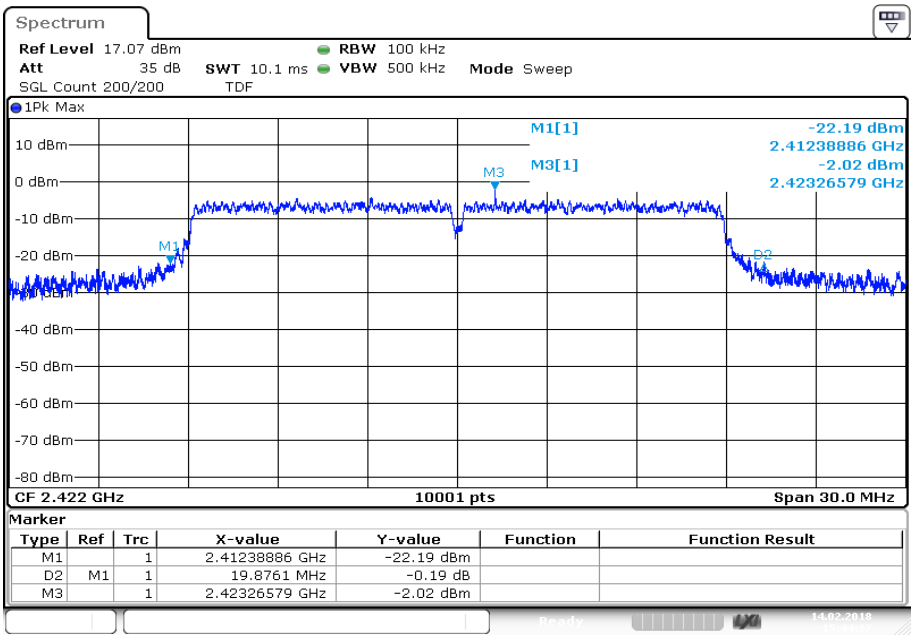
Date: 14.FEB.2018 15:01:23

Plot 2: Channel 2



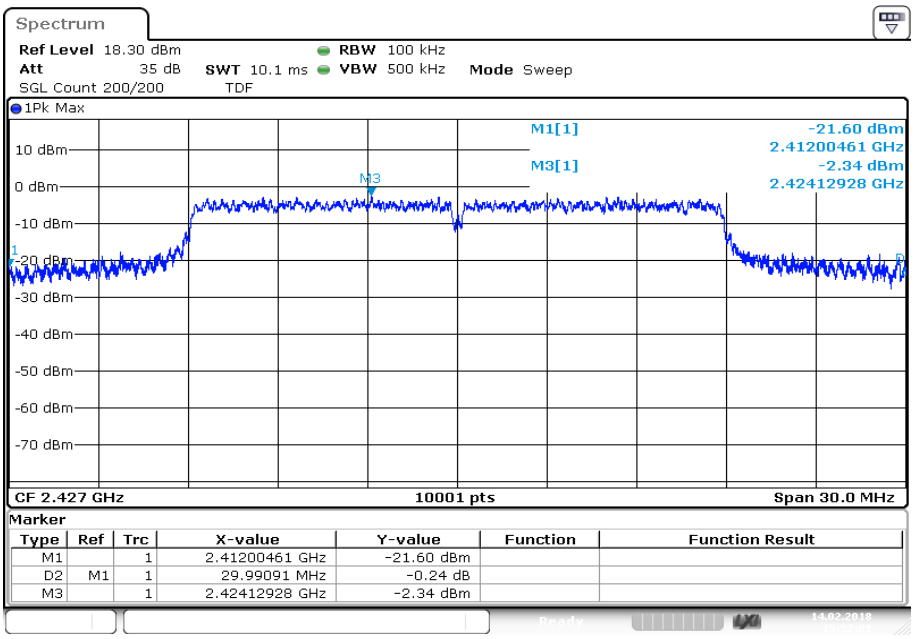
Date: 14.FEB.2018 15:19:14

Plot 3: Channel 3



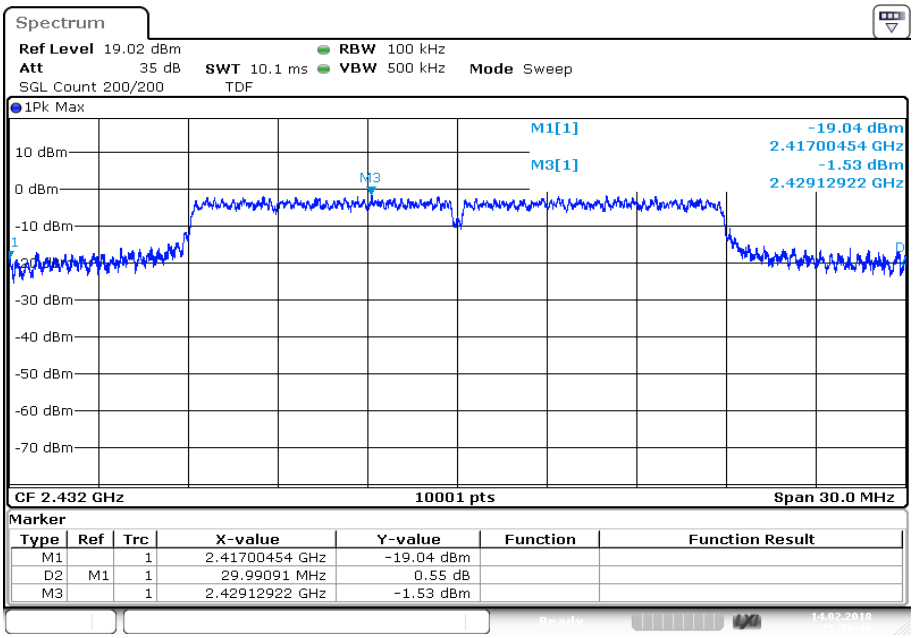
Date: 14.FEB.2018 15:44:38

Plot 4: Channel 4



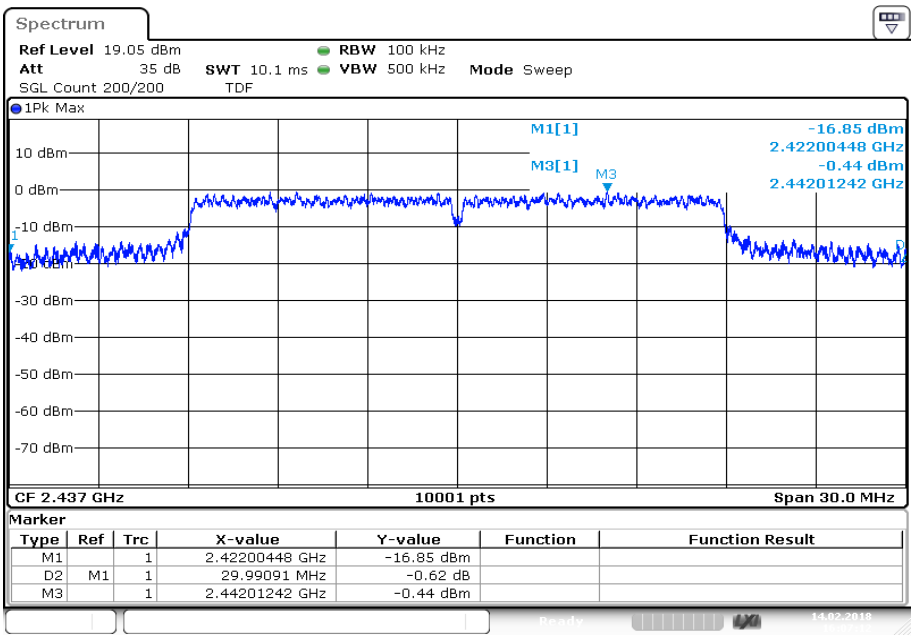
Date: 14.FEB.2018 15:52:00

Plot 5: Channel 5



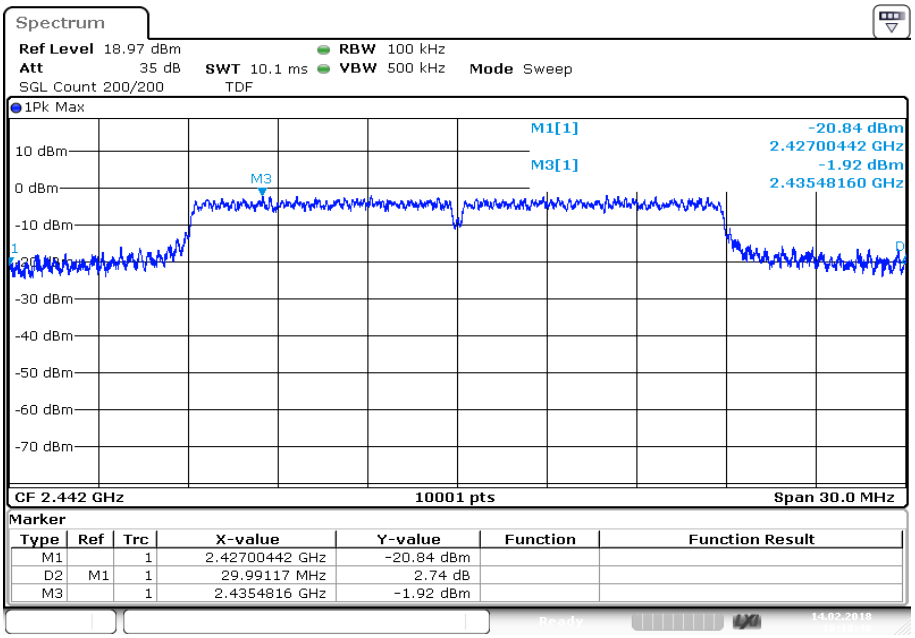
Date: 14.FEB.2018 15:59:48

Plot 6: Channel 6



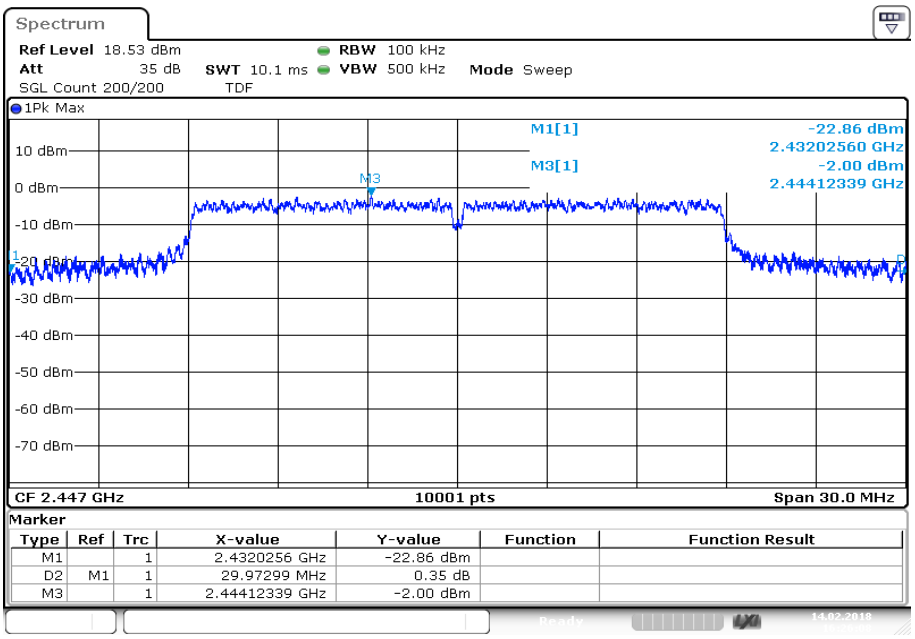
Date: 14.FEB.2018 16:07:12

Plot 7: Channel 7



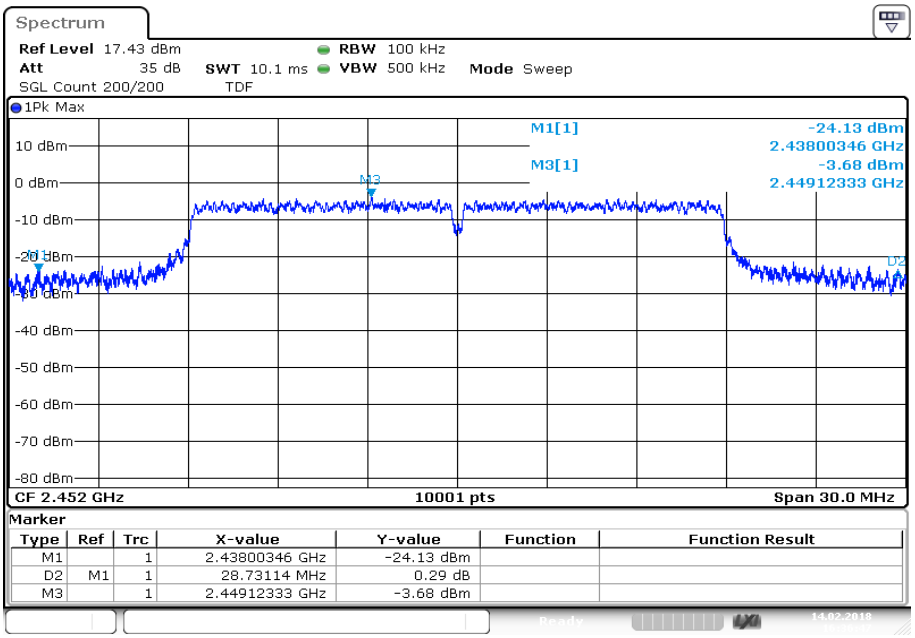
Date: 14.FEB.2018 16:18:48

Plot 8: Channel 8



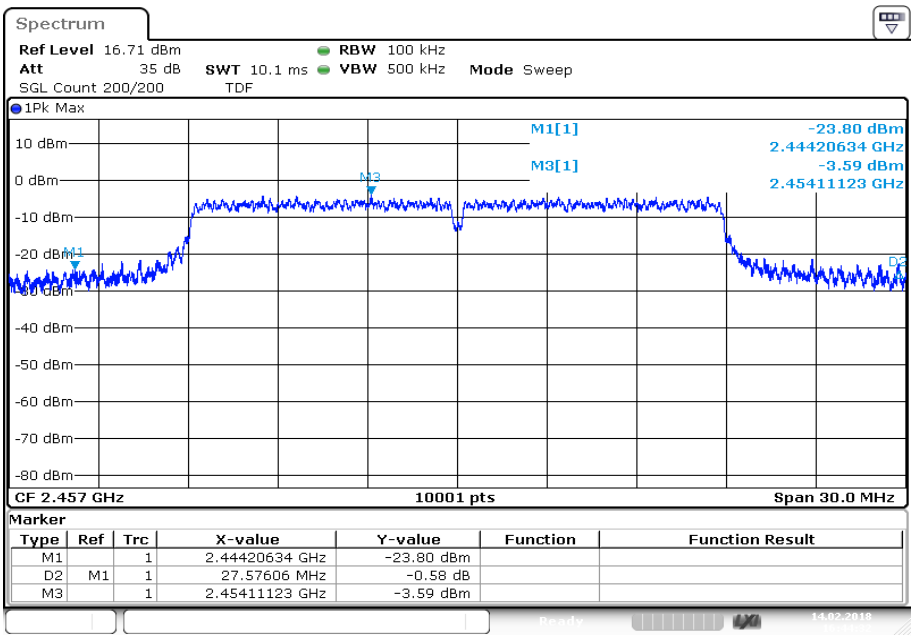
Date: 14.FEB.2018 16:26:08

Plot 9: Channel 9



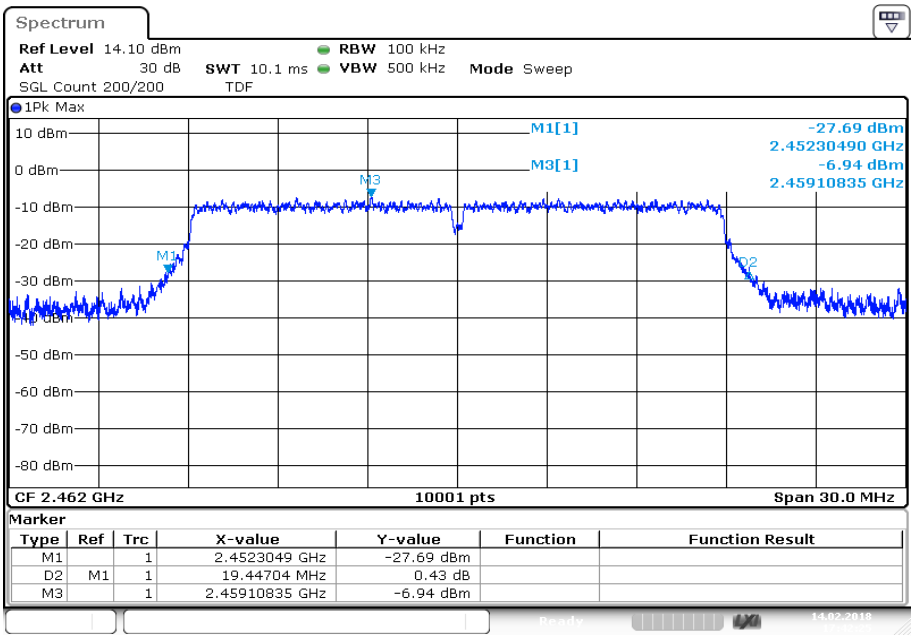
Date: 14.FEB.2018 16:36:48

Plot 10: Channel 10



Date: 14.FEB.2018 16:44:32

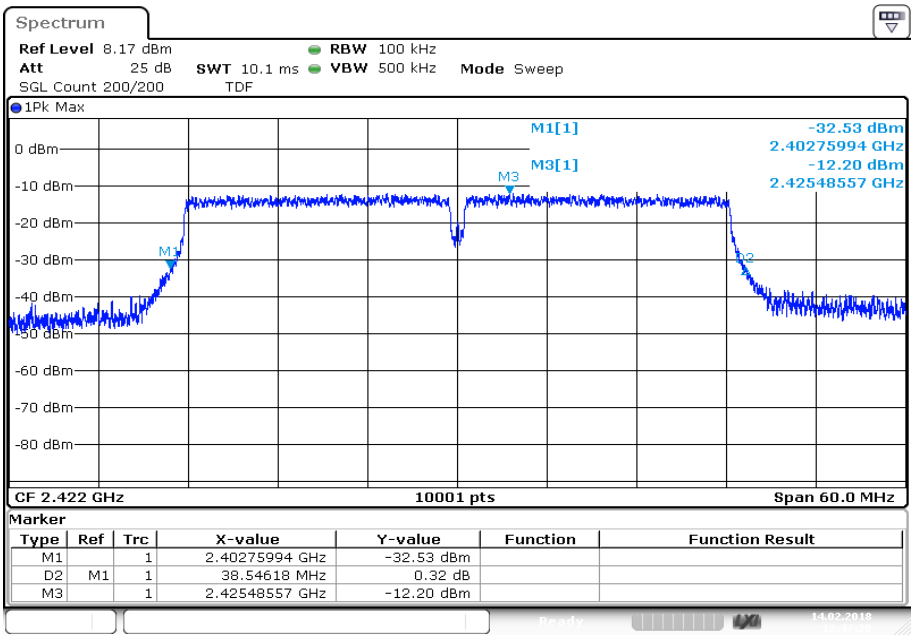
Plot 11: Channel 11



Date: 14.FEB.2018 17:42:26

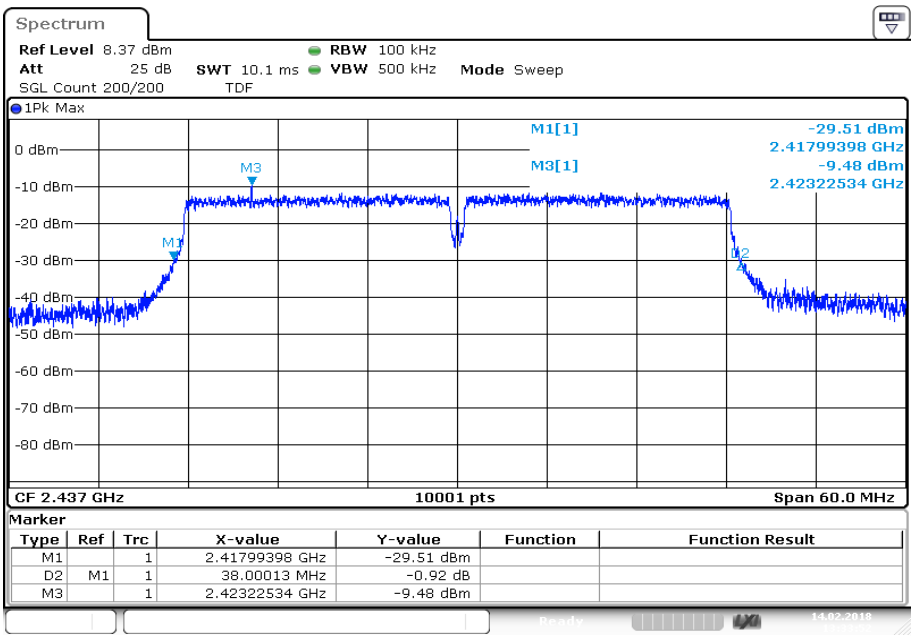
Plots: OFDM / n HT40 – mode

Plot 1: Channel 3



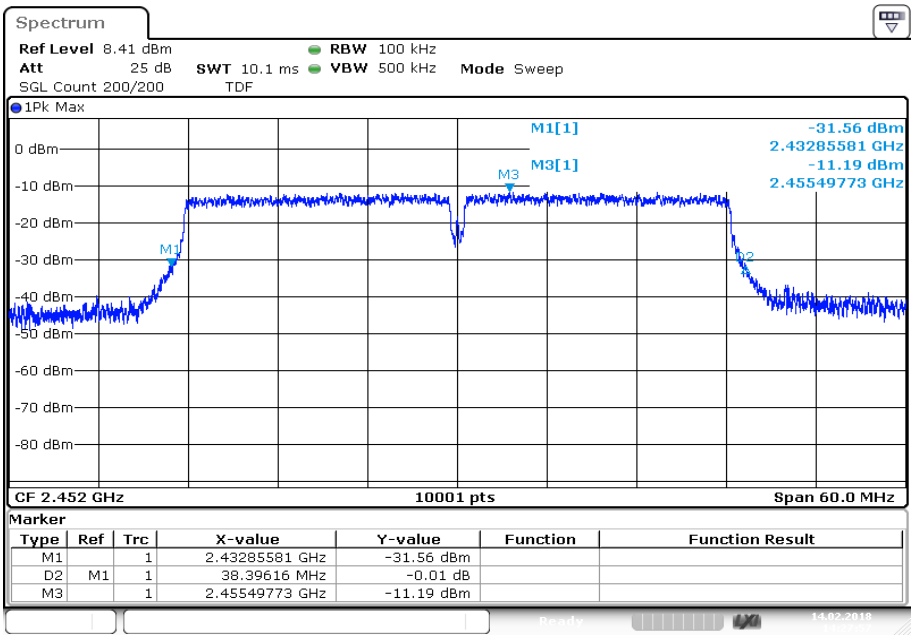
Date: 14.FEB.2018 12:47:20

Plot 2: Channel 6



Date: 14.FEB.2018 13:33:52

Plot 3: Channel 9



Date: 14.FEB.2018 14:27:57