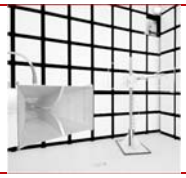
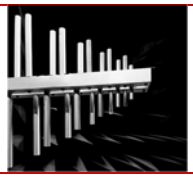
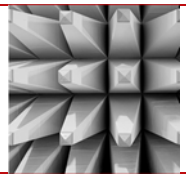

CETECOM™
CETECOM ICT Services
consulting - testing - certification

TEST REPORT

Test report no.: 1-0585/15-01-02

ilac-MRA DAkkS Deutsche Akkreditierungsstelle D-PL-12076-01-00

Testing laboratory

CETECOM ICT Services GmbH
Untertuerkheimer Strasse 6 – 10
66117 Saarbruecken / Germany
Phone: + 49 681 5 98 - 0
Fax: + 49 681 5 98 - 9075
Internet: http://www.cetecom.com
e-mail: ict@cetecom.com

Accredited Testing Laboratory:
The testing laboratory (area of testing) is accredited according to DIN EN ISO/IEC 17025 (2005) by the Deutsche Akkreditierungsstelle GmbH (DAkkS)
The accreditation is valid for the scope of testing procedures as stated in the accreditation certificate with the registration number: D-PL-12076-01-00

Applicant

Neratec Solutions AG
Rosswiesstrasse 29
8608 Bubikon / SWITZERLAND
Phone: +41 55 253 2078
Fax: +41 55 253 20 70
Contact: Michael Aeschbacher
e-mail: michael.aeschbacher@neratec.com
Phone: +41 55 253 20 73

Manufacturer

Neratec Solutions AG
Rosswiesstrasse 29
8608 Bubikon / SWITZERLAND

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 1	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:	**WLAN modem**
Model name:	**DT50RF MK2**
FCC ID:	**2AEJD-103902-DT50RF**
IC:	**9301A-103902DT50**
Frequency:	DTS band 2400 MHz to 2483.5 MHz
Technology tested:	WLAN (DSSS/b-mode; OFDM/g-; n HT20-mode)
Antenna:	External omni-directional dual band dipole antenna – up to 3 x Tekfun F51-N
Power supply:	3.3 V DC by external power supply
Temperature range:	-40°C to +85°C

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

Test report authorized:

cn=Andreas Luckenbill, o=CETECOM ICT Services GmbH, ou=LUC-111202, email=andreas.luckenbill@cetecom.com, c=DE
2016.04.27 07:03:47 +02'00'

Andreas Luckenbill
Lab Manager
Radio Communications & EMC

Test performed:

cn=Marco Bertolino, o=CETECOM ICT Services GmbH, ou=BTL-150828, email=marco.bertolino@cetecom.com, c=DE
2016.04.27 06:51:06 +02'00'

Marco Bertolino
Lab Manager
Radio Communications & EMC

1 Table of contents

2 General information

2.1 Notes and disclaimer

The test results of this test report relate exclusively to the test item specified in this test report. CETECOM ICT Services 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 is electronically signed and valid without handwritten signature. For verification of the electronic signatures, the public keys can be requested at the testing laboratory.

2.2 Application details

Date of receipt of order:	2015-12-02
Date of receipt of test item:	2015-12-07
Start of test:	2015-12-07
End of test:	2016-03-08
Person(s) present during the test:	-/-

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 1	May 2015	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	v03r04	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
KDB 662911 D01	V02r01	Emissions Testing of Transmitters with Multiple Outputs in the Same Band

4 Test environment

Temperature	:	T_{nom} T_{max} T_{min}	+23 °C during room temperature tests No tests under extreme conditions required! No tests under extreme conditions required!
Relative humidity content	:		55 %
Barometric pressure	:		not relevant for this kind of testing
Power supply	:	V_{nom} V_{max} V_{min}	3.3 V DC by external power supply No tests under extreme conditions required! No tests under extreme conditions required!

5 Test item

5.1 General description

Kind of test item	:	WLAN modem
Type identification	:	DT50RF MK2
HMN	:	-/-
PMN	:	DT50RF_MK2
HVIN	:	DT50RF_MK2
FVIN	:	6.6
S/N serial number	:	Conducted unit: 0060010001030016 Radiated unit: 0060010001030021
HW hardware status	:	MK2
SW software status	:	6.6
Frequency band	:	DTS band 2400 MHz to 2483.5 MHz (lowest channel 2412 MHz; highest channel 2462 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 channels supported for 20 MHz
Antenna	:	External omni-directional dual band dipole antenna – up to 3 x Tekfun F51-N
Power supply	:	3.3 V DC by external power supply
Temperature range	:	-40°C to +85°C

5.2 Additional information

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

Test setup- and EUT-photos are included in test report: 1-0585/15-01-01_AnnexA
1-0585/15-01-01_AnnexB
1-0585/15-01-01_AnnexD

6 Test laboratories sub-contracted

None

7 Description of the test setup

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

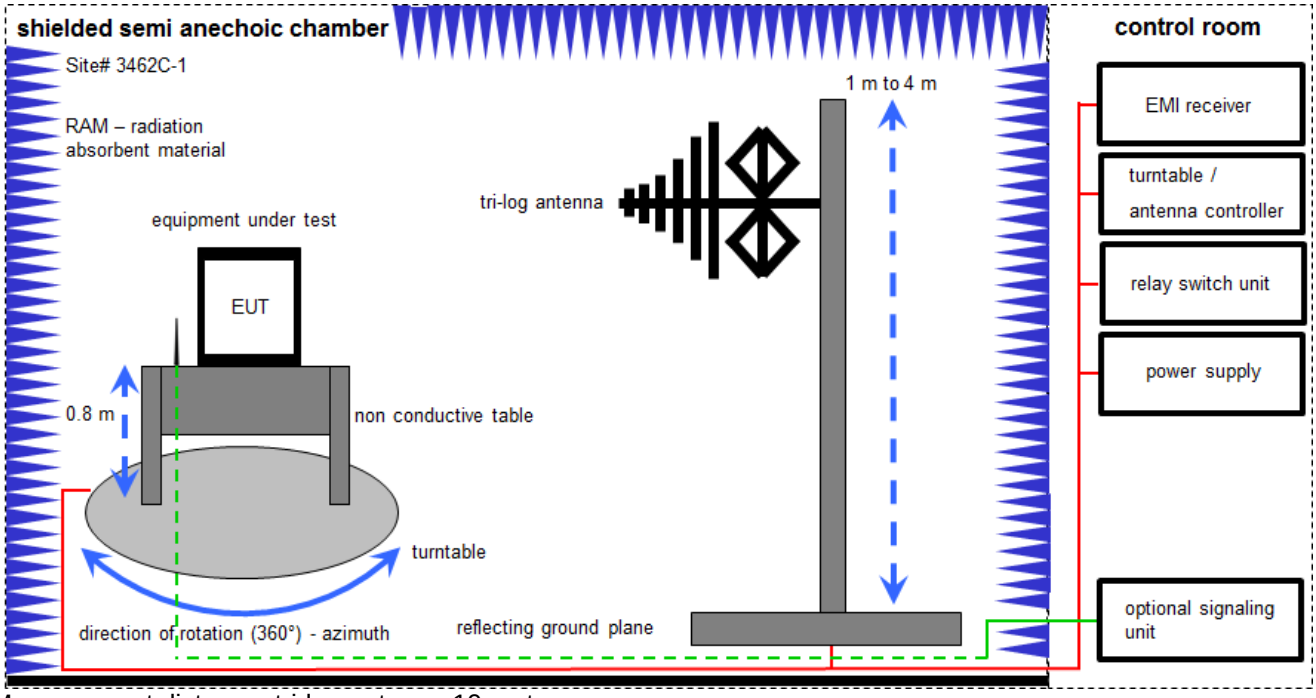
In order to simplify the identification of the equipment used at some special tests, some items of test equipment and ancillaries can be provided with an identifier or number in the equipment list below (Lab/Item).

Agenda: Kind of Calibration

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

7.1 Shielded semi anechoic chamber

The radiated measurements are performed in vertical and horizontal plane in the frequency range from 9 kHz 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 confirmed with 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

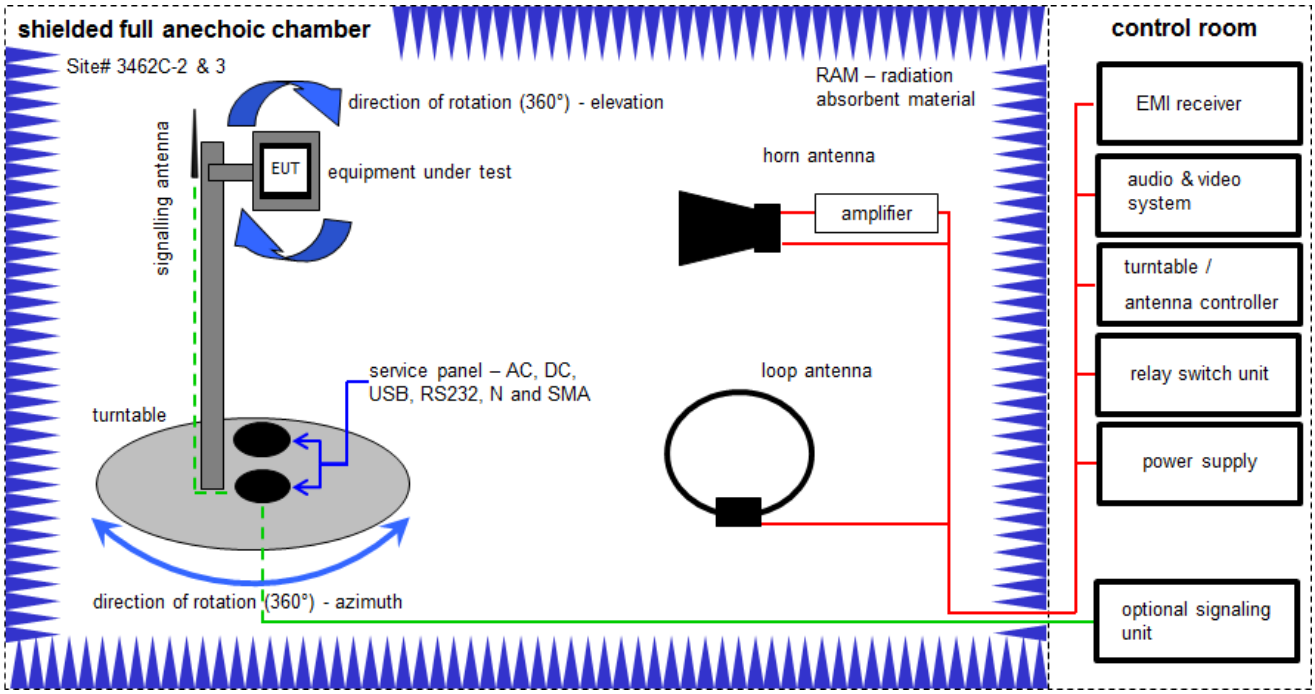
FS = UR + CL + AF
(FS-field strength; UR-voltage at the receiver; CL-loss of the cable; AF-antenna factor)

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 Cetecom	Kind of Calibration	Last Calibration	Next Calibration
1	A	EMI Test Receiver	ESCI 3	R&S	100083	300003312	k	26.01.2016	27.01.2017
2	A	Antenna Tower	Model 2175	ETS-Lindgren	64762	300003745	izw	-/-	-/-
3	A	Positioning Controller	Model 2090	ETS-Lindgren	64672	300003746	izw	-/-	-/-
4	A	Turntable Interface-Box	Model 105637	ETS-Lindgren	44583	300003747	izw	-/-	-/-
5	A	TRILOG Broadband Test-Antenna 30 MHz - 3 GHz	VULB9163	Schwarzbeck	295	300003787	k	22.04.2014	22.04.2016

7.2 Shielded fully anechoic chamber



Measurement distance: tri-log antenna and horn antenna 3 meter / 50 cm (above 12.75 GHz)

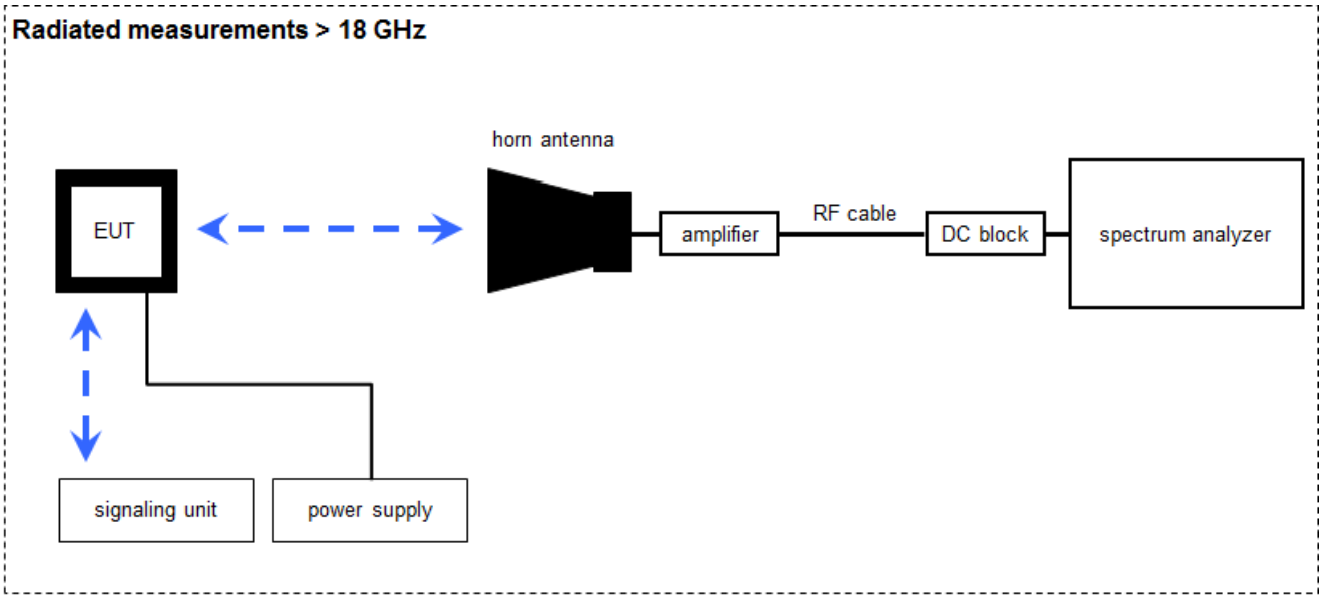
FS = UR + CA + AF
(FS-field strength; UR-voltage at the receiver; CA-loss of the signal path; AF-antenna factor)

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 Cetecom	Kind of Calibration	Last Calibration	Next Calibration
1	A, B, D	DC power supply	6032A	HP	2818A03450	300001040	Ve	20.01.2015	20.01.2018
2	A	Double-Ridged Waveguide Horn Antenna 1-18.0GHz	3115	EMCO	8812-3088	300001032	vIKI!	20.05.2015	20.05.2017
3	A, B, D	Anechoic chamber	FAC 3/5m	MWB / TDK	87400/02	300000996	ev	-/-	-/-
4	A, B, D	Switch / Control Unit	3488A	HP	*	300000199	ne	-/-	-/-
5	A, B	Active Loop Antenna 10 kHz to 30 MHz	6502	EMCO/2	8905-2342	300000256	k	24.06.2015	24.06.2017
6	A	Amplifier	js42-00502650-28-5a	Parzich GMBH	928979	300003143	ne	-/-	-/-
7	A	Band Reject filter	WRCG2400/2483-2375/2505-50/10SS	Wainwright	11	300003351	ev	-/-	-/-
8	A	TRILOG Broadband Test-Antenna 30 MHz - 3 GHz	VULB9163	Schwarzbeck	371	300003854	vIKI!	29.10.2014	29.10.2017
9	A, B, D	4U RF S.P.	L4491A	Agilent Technologies	MY50000037	300004509	ne	-/-	-/-
10	A, B, D	EMI Test Receiver 9kHz-26,5GHz	ESR26	R&S	101376	300005063	k	04.09.2015	04.09.2016
11	C	Signal Analyzer	FSV40	R&S	101042	300004517	k	21.01.2016	21.01.2017
12	C	Amplifier 2-40 GHz	JS32-02004000-57-5P	MITEQ	1777200	300004541	ev	-/-	-/-
13	C	RF-Cable	ST18/SMAm/SMAm/48	Huber & Suhner	Batch no. 600918	400001182	ev	-/-	-/-
14	C	RF-Cable	ST18/SMAm/SMm/48	Huber & Suhner	Batch no. 127377	400001183	ev	-/-	-/-
15	C	DC-Blocker 0.1-40 GHz	8141A	Inmet	Batch no. 606844	400001185	ev	-/-	-/-
16	C	Std. Gain Horn Antenna 12.4 to 18.0 GHz	639	Narda	8402	300000787	k	14.08.2015	14.08.2017

7.3 Radiated measurements > 18 GHz



Measurement distance: horn antenna 50 cm

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

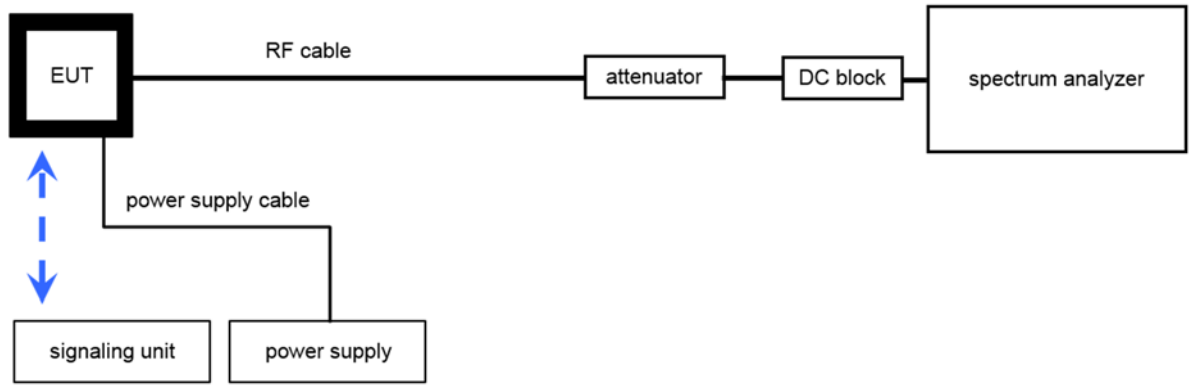
Example calculation:
FS [dBµV/m] = 40.0 [dBµV/m] + (-60.1) [dB] + 36.74 [dB/m] = 16.64 [dBµV/m] (6.79 µV/m)

Equipment table:

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No Cetecom	Kind of Calibration	Last Calibration	Next Calibration
1	A	Signal Analyzer 40 GHz	FSV40	R&S	101042	300004517	k	21.01.2016	21.01.2017
2	A	Amplifier 2-40 GHz	JS32-02004000-57-5P	MITEQ	1777200	300004541	ev	-/-	-/-
3	A	RF-Cable	ST18/SMAm/SMAm/48	Huber & Suhner	Batch no. 600918	400001182	ev	-/-	-/-
4	A	RF-Cable	ST18/SMAm/SMm/48	Huber & Suhner	Batch no. 127377	400001183	ev	-/-	-/-
5	A	DC-Blocker 0.1-40 GHz	8141A	Inmet	Batch no. 606844	400001185	ev	-/-	-/-
6	A	Std. Gain Horn Antenna 18.0 to 26.5 GHz	638	Narda	8402	300000486	k	10.09.2015	10.09.2017

7.4 Conducted measurements

Conducted measurements normal conditions



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

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

Equipment table:

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No Cetecom	Kind of Calibration	Last Calibration	Next Calibration
1	A, B	PC-WLAN Tester	Intel Core i3 3220/3,3 GHz, Prozessor	-/-	2V2403033A4523	300004589	ne	-/-	-/-
2	A, B	Teststand	Teststand Custom Sequence Editor	National Instruments GmbH	2V2403033A4523	300004590	ne	-/-	-/-
3	A, B	RF-Cable	ST18/SMAm/SMAm/60	Huber & Suhner	Batch no. 606844	400001181	ev	-/-	-/-
4	A, B	DC-Blocker 0.1-40 GHz	8141A	Inmet	Batch no. 606844	400001185	ev	-/-	-/-
5	B	Signal Analyzer 40 GHz	FSV40	R&S	101042	300004517	k	21.01.2016	21.01.2017
6	A	NRP Power meter Display and control unit AC sup	NRP	R&S	100212	300003780	vlKI!	25.01.2016	24.01.2017

8 Sequence of testing

8.1 Sequence of testing radiated spurious 9 kHz to 30 MHz

Setup

- The equipment is set up to simulate normal operation mode as described in the user manual or defined by the manufacturer.
- If the EUT is a tabletop system, 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 height is 1.5 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 premeasurement are maximized by the software by rotating the turntable from 0° to 360°. In case of the 2-axis positioner is used the elevation axis is also rotated from 0° to 360°.
- 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.

8.2 Sequence of testing radiated spurious 30 MHz to 1 GHz

Setup

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

Premeasurement

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

Final measurement

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

8.3 Sequence of testing radiated spurious 1 GHz to 18 GHz

Setup

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

Premeasurement

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

Final measurement

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

8.4 Sequence of testing radiated spurious above 18 GHz

Setup

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

Premeasurement

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

Final measurement

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

9 Measurement uncertainty

Measurement uncertainty	
Test case	**Uncertainty**
Antenna gain	± 3 dB
Power spectral density	± 1.5 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

10 Summary of measurement results

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

TC Identifier	Description	Verdict	Date	Remark
RF-Testing	CFR Part 15 RSS - 247, Issue 1	See table!	2016-04-27	-/-

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 (4)	Antenna gain	-/-	Nominal	Nominal	DSSS	-/-				Declared
§15.247(e) RSS - 247 / 5.2 (2)	Power spectral density	KDB 558074 DTS clause: 10.2	Nominal	Nominal	DSSS OFDM	☒	☐	☐	☐	-/-
§15.247(a)(2) RSS - 247 / 5.2 (1)	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 (4)	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 - conducted	-/-	Nominal	Nominal	DSSS OFDM	☒	☐	☐	☐	-/-
§15.205 RSS - 247 / 5.5 RSS - Gen	Band edge compliance conducted and radiated	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 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

* Test cases performed under the project number: 1-0585/15-02

11 Additional comments

Reference documents: Dual_Band_Dipole_Tekfun

Antennas_DT50RF_Module_Certification

Cetecom_Customer_Questionnaire

Offer_request_Cetecom

PowerSettings_Tekfun_2G4

Special test descriptions: EUT supports 3 TX / RX antennas with 3 spatial streams

Configuration descriptions: provided power settings

Mode 2.4 GHz	1	2	3	4	5	6	7	8	9	10	11	12	13
b	10	10	14	14	14	14	14	14	14	10	10	N/A	N/A
g	6	6	12	14	14	14	14	14	10	6	6	N/A	N/A
n20	N/A	10	12	12	12	12	12	12	10	10	N/A	N/A	N/A
n40	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

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.

12 Measurement results

12.1 Antenna gain

Limits:

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

Results:

T_{nom}	V_{nom}	DTS band 2400 MHz to 2483.5 MHz
Gain [dBi] Declared by the manufacturer		4.5

3 ELECTRICAL CHARACTERISTICS

3.1 Frequency Rang:	2.4/5Ghz
3.2 V.S.W.R:	< 2.3
3.3 Impedance:	50 OHM
3.4 Type of Radiation:	Omni-directional
3.5 Electrical Wave:	1/4
3.6 Gain:	**4.5dBi for 2.4GHz** **7dBi for 5GHz**
3.7 Connector:	N Male (BRASS)
3.8 Size:	187x22mm
3.9 Color:	Pure White

12.2 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 7.4 – A
Measurement uncertainty:	-/-

Results:

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

12.3 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: 9.1.2	
peak power meter	
Test setup:	See sub clause 7.4 – A
Measurement uncertainty	See sub clause 9

Limits:

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

Results: antenna port 1

Frequency	Maximum Output Power [dBm]				
	2412 MHz	2422 MHz	2437 MHz	2452 MHz	2462 MHz
Output power conducted DSSS / b – mode	11.94	16.10	16.16	16.13	11.63
Output power conducted OFDM / g – mode	16.27	22.42	25.28	20.51	15.62
Frequency	2417 MHz	2422 MHz	2437 MHz	2447 MHz	2457 MHz
Output power conducted OFDM / n HT20 – mode	20.56	22.52	22.59	22.60	20.20

Results: antenna port 2

Frequency	Maximum Output Power [dBm]				
	2412 MHz	2422 MHz	2437 MHz	2452 MHz	2462 MHz
Output power conducted DSSS / b – mode	12.26	16.44	16.22	16.17	12.04
Output power conducted OFDM / g – mode	16.91	23.00	24.61	20.59	16.96
Frequency	2417 MHz	2422 MHz	2437 MHz	2447 MHz	2457 MHz
Output power conducted OFDM / n HT20 – mode	20.93	23.15	22.94	22.74	20.75

Results: antenna port 3

Frequency	Maximum Output Power [dBm]				
	2412 MHz	2422 MHz	2437 MHz	2452 MHz	2462 MHz
Output power conducted DSSS / b – mode	11.73	16.43	16.17	15.94	12.52
Output power conducted OFDM / g – mode	16.10	22.68	24.58	20.36	16.97
Frequency	2417 MHz	2422 MHz	2437 MHz	2447 MHz	2457 MHz
Output power conducted OFDM / n HT20 – mode	20.80	22.85	22.76	22.62	21.02

Results: antenna port 1 + antenna port 2 (calculated)

	Maximum Output Power [dBm]				
Frequency	2412 MHz	2422 MHz	2437 MHz	2452 MHz	2462 MHz
Output power conducted DSSS / b – mode	15.11	19.28	19.20	19.16	14.85
Output power conducted OFDM / g – mode	19.61	25.73	27.97	23.56	19.35
Frequency	2417 MHz	2422 MHz	2437 MHz	2447 MHz	2457 MHz
Output power conducted OFDM / n HT20 – mode	23.76	25.86	25.78	25.68	23.49

Results: antenna port 1 + antenna port 2 + antenna port 3 (calculated)

	Maximum Output Power [dBm]				
Frequency	2412 MHz	2422 MHz	2437 MHz	2452 MHz	2462 MHz
Output power conducted DSSS / b – mode	16.75	21.10	20.95	20.85	16.85
Output power conducted OFDM / g – mode	21.21	27.48	29.61	25.26	21.33
Frequency	2417 MHz	2422 MHz	2437 MHz	2447 MHz	2457 MHz
Output power conducted OFDM / n HT20 – mode	25.54	27.62	27.54	27.42	25.44

12.4 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 7.4 – B
Measurement uncertainty	See sub clause 9

Limits:

FCC	IC
8 dBm / 3kHz (conducted)	

Note:

All values are re-calculated to 3 kHz with the formula: 10*log(3000/100000) = 15.23 dB

Results: antenna port 1

Frequency	Peak power spectral density [dBm] @ 100 kHz				
	2412 MHz	2422 MHz	2437 MHz	2452 MHz	2462 MHz
DSSS / b – mode	-0.53	3.70	3.57	3.75	-0.72
OFDM / g – mode	-6.83	-0.64	2.05	-2.56	-7.39
Frequency	2417 MHz	2422 MHz	2437 MHz	2447 MHz	2457 MHz
OFDM / n HT20 – mode	-2.66	-0.69	-0.63	-0.60	-3.09

Frequency	Peak power spectral density [dBm] @ 3 kHz				
	2412 MHz	2422 MHz	2437 MHz	2452 MHz	2462 MHz
DSSS / b – mode	-15.76	-11.53	-11.66	-11.48	-15.95
OFDM / g – mode	-22.06	-15.87	-13.18	-17.79	-22.62
Frequency	2417 MHz	2422 MHz	2437 MHz	2447 MHz	2457 MHz
OFDM / n HT20 – mode	-17.89	-15.92	-15.86	-15.83	-18.32

Results: antenna port 2

Frequency	Peak power spectral density [dBm] @ 100 kHz				
	2412 MHz	2422 MHz	2437 MHz	2452 MHz	2462 MHz
DSSS / b – mode	0.03	3.79	4.25	2.83	0.45
OFDM / g – mode	-5.79	-0.25	1.12	-2.48	-6.13
Frequency	2417 MHz	2422 MHz	2437 MHz	2447 MHz	2457 MHz
OFDM / n HT20 – mode	-2.35	-1.33	-0.52	-0.59	-2.62

Frequency	Peak power spectral density [dBm] @ 3 kHz				
	2412 MHz	2422 MHz	2437 MHz	2452 MHz	2462 MHz
DSSS / b – mode	-15.20	-11.44	-10.98	-12.4	-14.78
OFDM / g – mode	-21.02	-15.48	-14.11	-17.71	-21.36
Frequency	2417 MHz	2422 MHz	2437 MHz	2447 MHz	2457 MHz
OFDM / n HT20 – mode	-17.58	-16.56	-15.75	-15.82	-17.85

Results: antenna port 3

Frequency	Peak power spectral density [dBm] @ 100 kHz				
	2412 MHz	2422 MHz	2437 MHz	2452 MHz	2462 MHz
DSSS / b – mode	-0.71	3.64	3.76	3.51	0.08
OFDM / g – mode	-7.03	-0.59	1.34	-2.61	-6.10
Frequency	2417 MHz	2422 MHz	2437 MHz	2447 MHz	2457 MHz
OFDM / n HT20 – mode	-2.51	-0.55	-0.55	-0.69	-2.34

Frequency	Peak power spectral density [dBm] @ 3 kHz				
	2412 MHz	2422 MHz	2437 MHz	2452 MHz	2462 MHz
DSSS / b – mode	-15.94	-11.59	-11.47	-11.72	-15.15
OFDM / g – mode	-22.26	-15.82	-13.89	-17.84	-21.33
Frequency	2417 MHz	2422 MHz	2437 MHz	2447 MHz	2457 MHz
OFDM / n HT20 – mode	-17.74	-15.78	-15.78	-15.92	-17.57

Results: antenna port 1 + antenna port 2 (calculated)

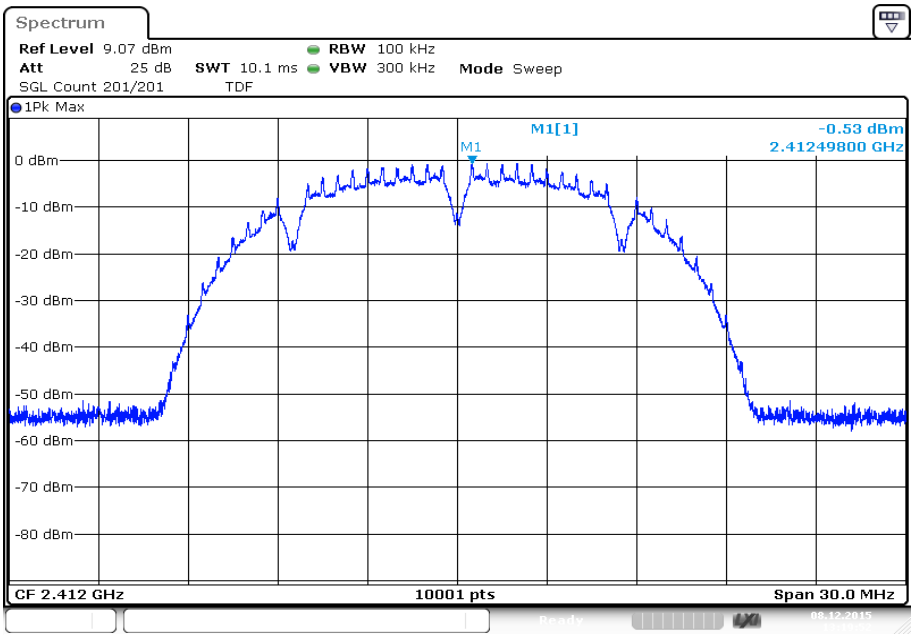
Frequency	Peak power spectral density [dBm] @ 3 kHz				
	2412 MHz	2422 MHz	2437 MHz	2452 MHz	2462 MHz
DSSS / b – mode	-12.46	-8.47	-8.30	-8.91	-12.32
OFDM / g – mode	-18.50	-12.66	-10.61	-14.74	-18.93
Frequency	2417 MHz	2422 MHz	2437 MHz	2447 MHz	2457 MHz
OFDM / n HT20 – mode	-14.72	-13.22	-12.79	-12.81	-15.07

Results: antenna port 1 + antenna port 2 + antenna port 3 (calculated)

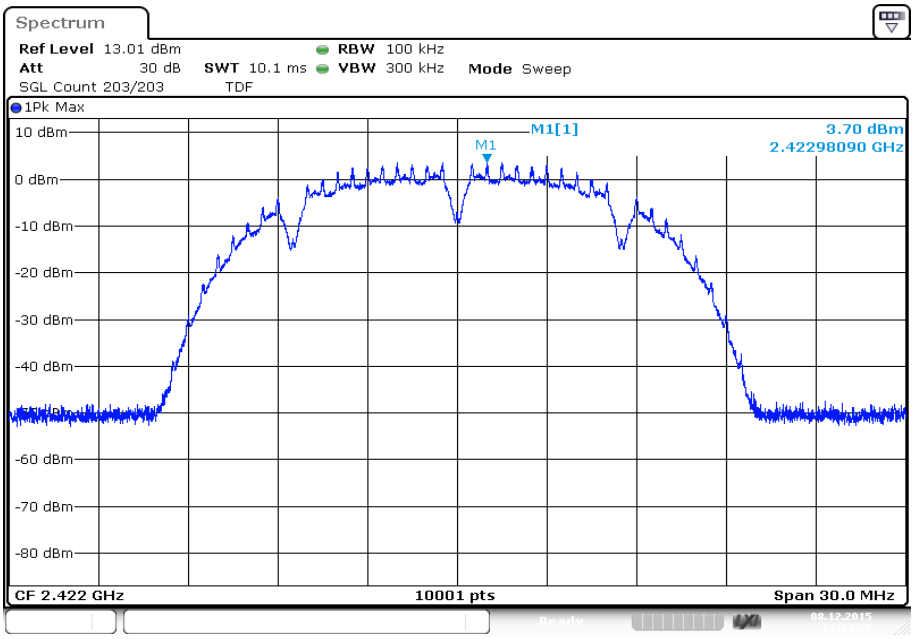
Frequency	Peak power spectral density [dBm] @ 3 kHz				
	2412 MHz	2422 MHz	2437 MHz	2452 MHz	2462 MHz
DSSS / b – mode	-10.85	-6.75	-6.59	-7.08	-10.50
OFDM / g – mode	-16.97	-10.95	-8.94	-13.01	-16.96
Frequency	2417 MHz	2422 MHz	2437 MHz	2447 MHz	2457 MHz
OFDM / n HT20 – mode	-12.96	-11.30	-11.03	-11.09	-13.13

Plots: DSSS / b – mode, antenna port 1

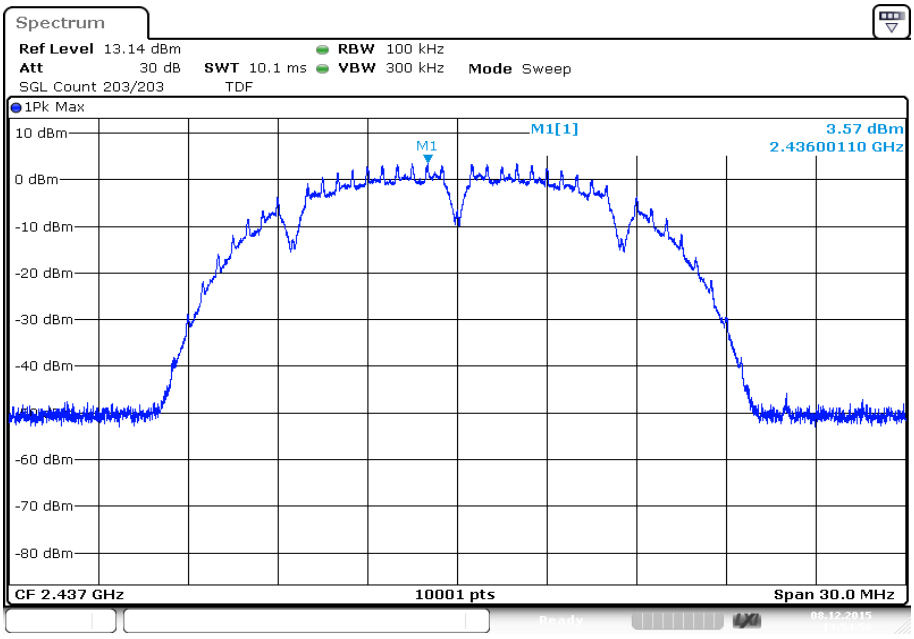
Plot 1: 2412 MHz



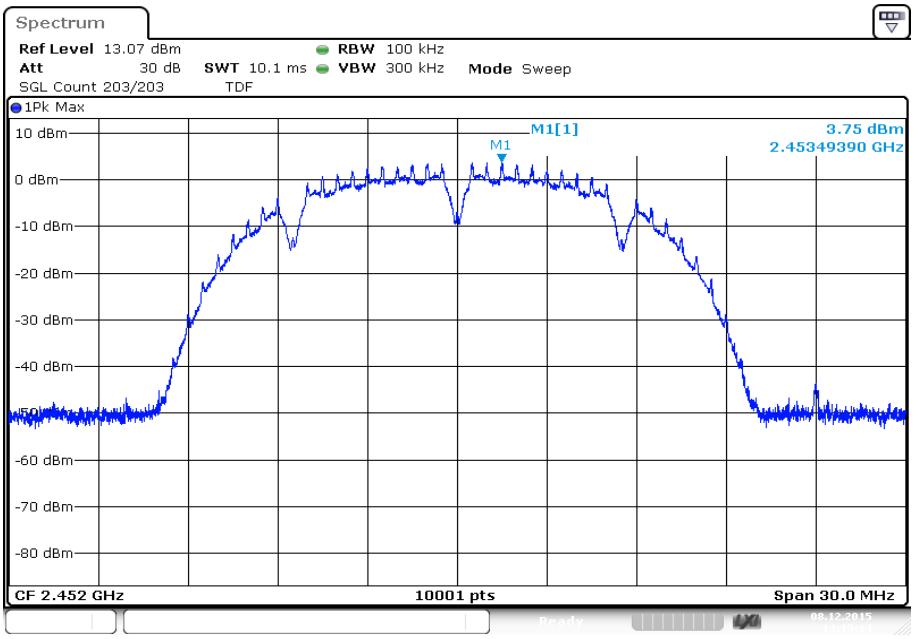
Plot 2: 2422 MHz



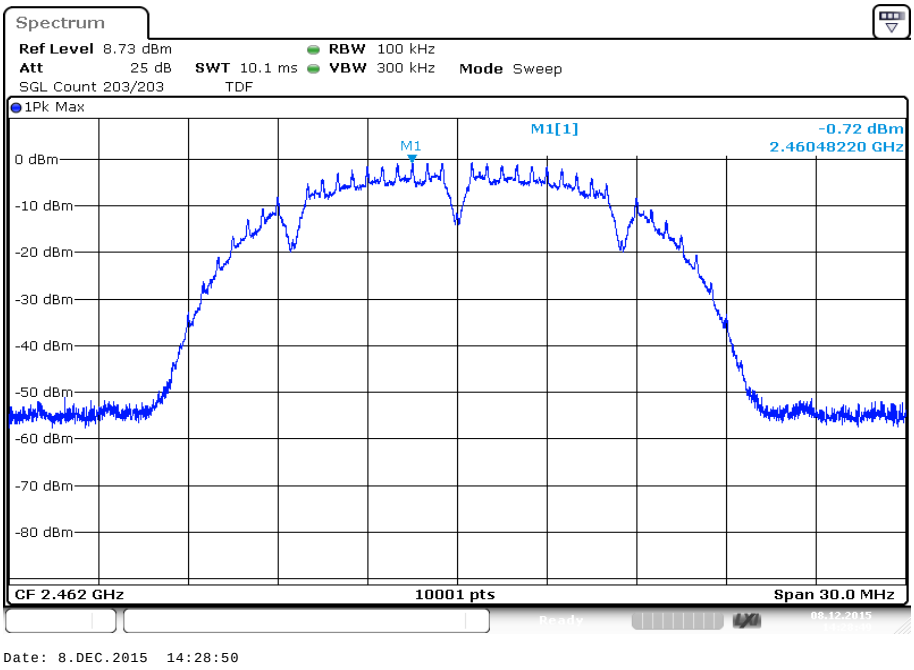
Plot 3: 2437 MHz



Plot 4: 2452 MHz

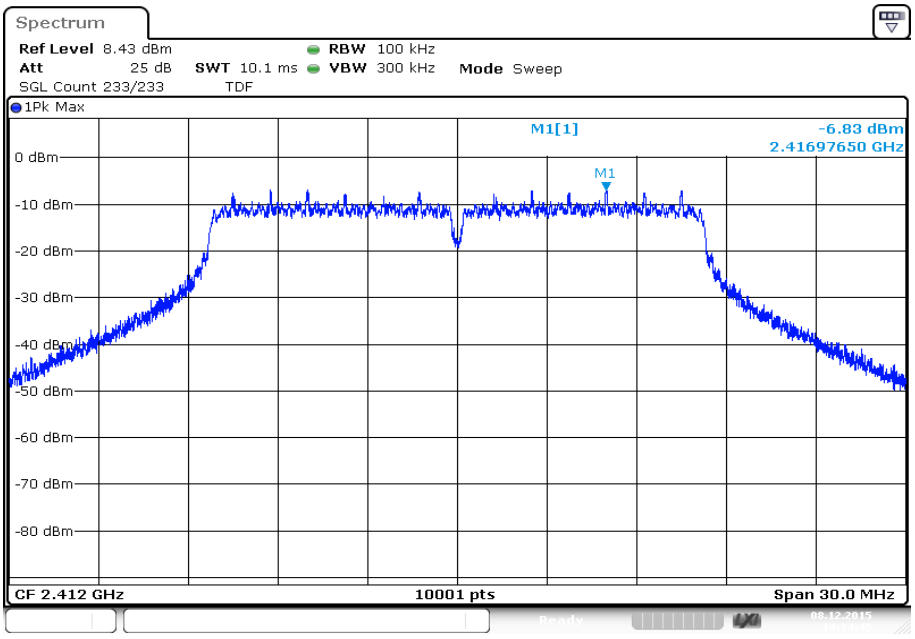


Plot 5: 2462 MHz



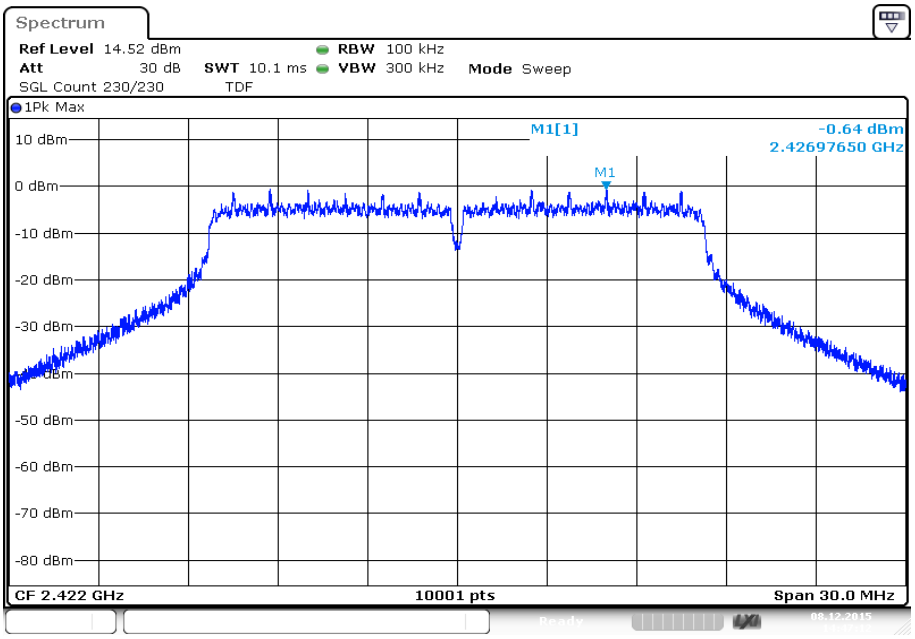
Plots: OFDM / g – mode, antenna port 1

Plot 1: 2412 MHz



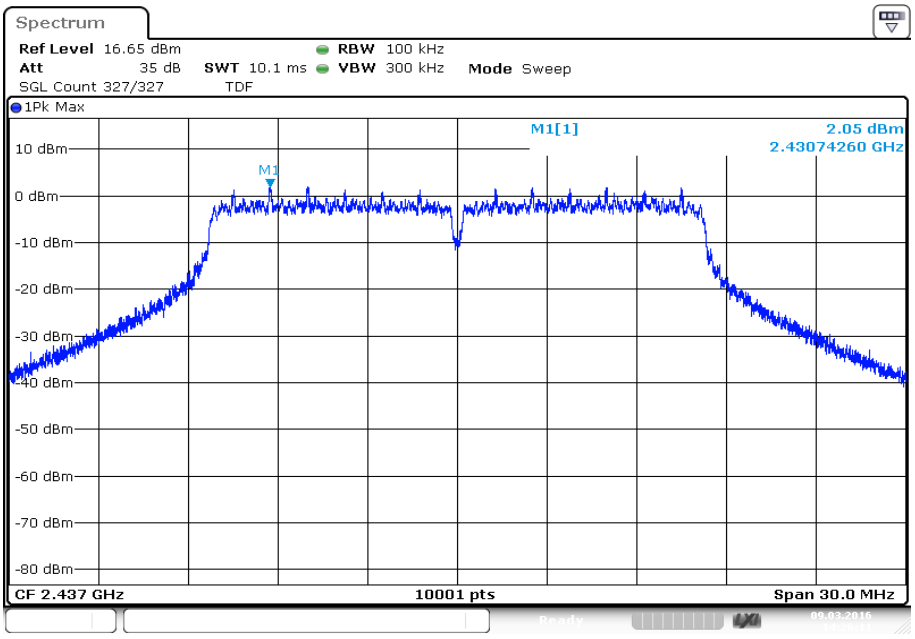
Date: 8.DEC.2015 14:34:45

Plot 2: 2422 MHz

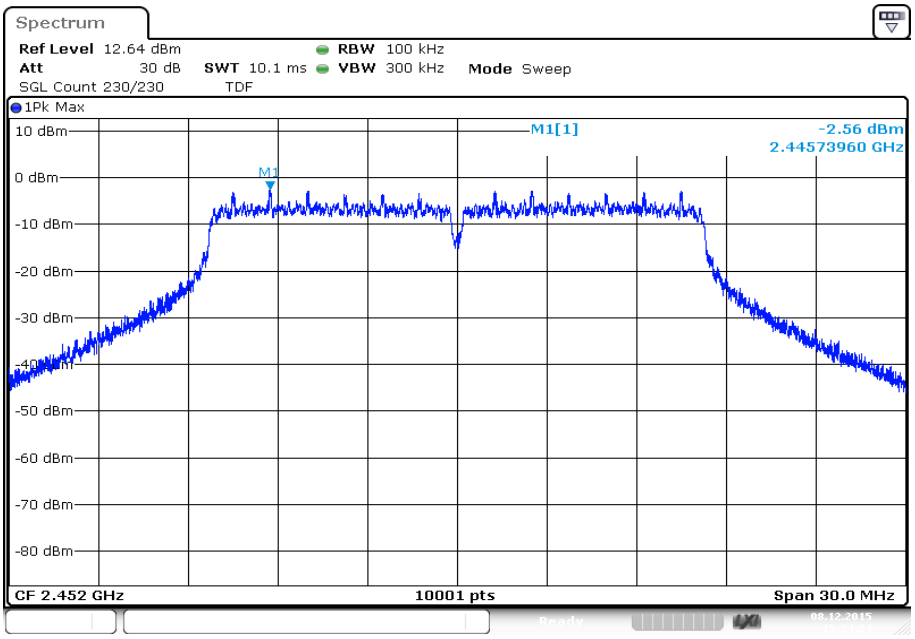


Date: 8.DEC.2015 14:47:13

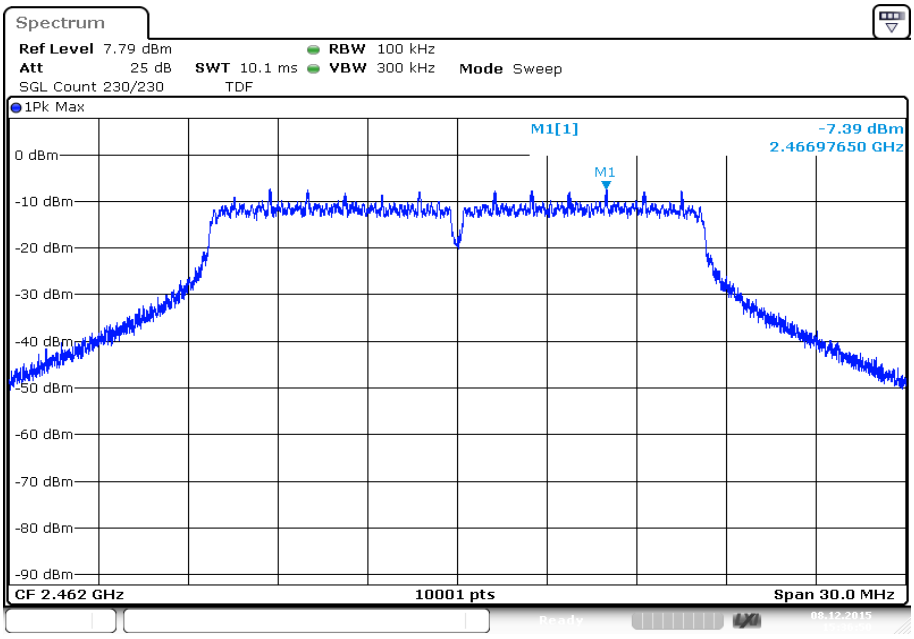
Plot 3: 2437 MHz



Plot 4: 2452 MHz

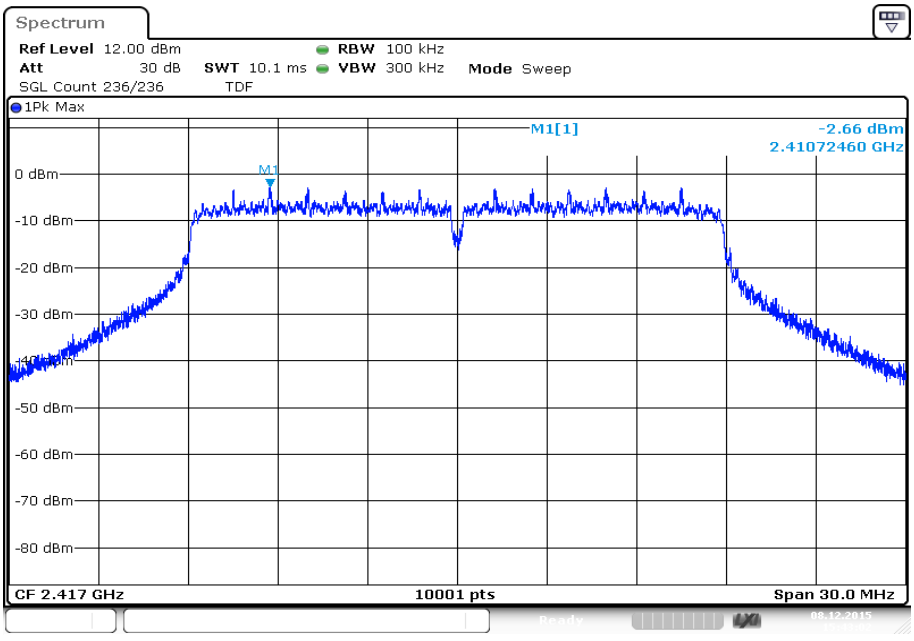


Plot 5: 2462 MHz



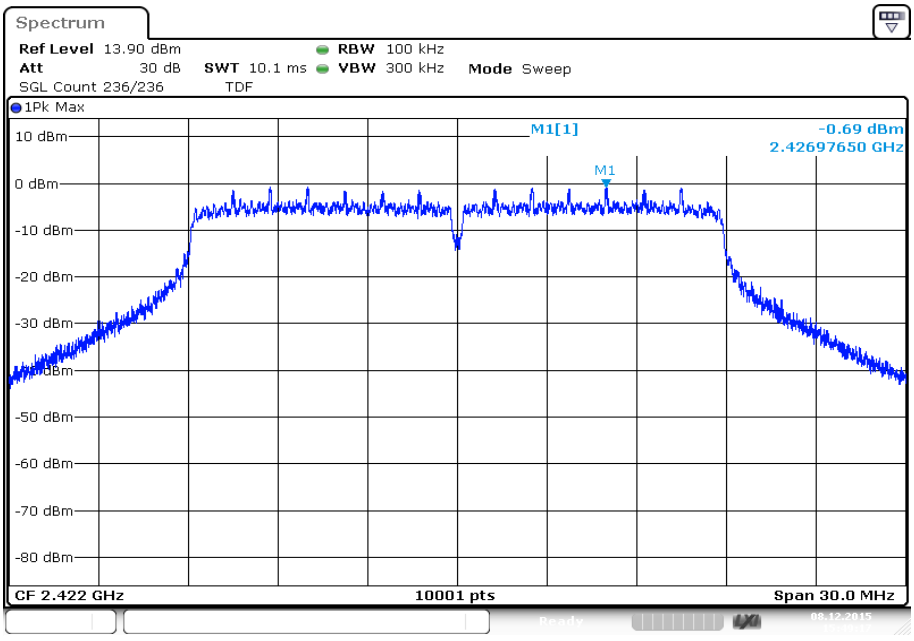
Plots: OFDM / n HT20 – mode, antenna port 1

Plot 1: 2417 MHz



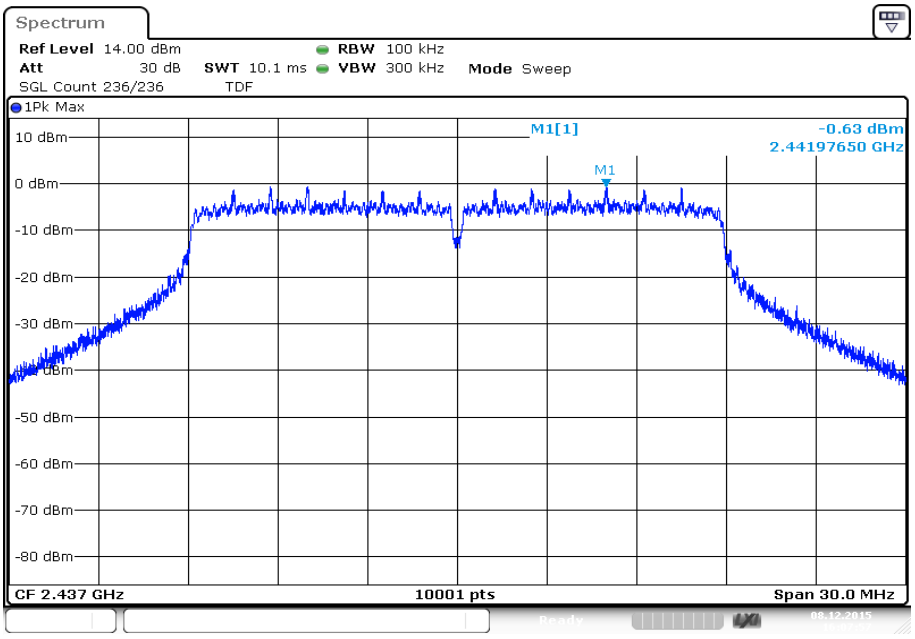
Date: 8.DEC.2015 15:43:03

Plot 2: 2422 MHz



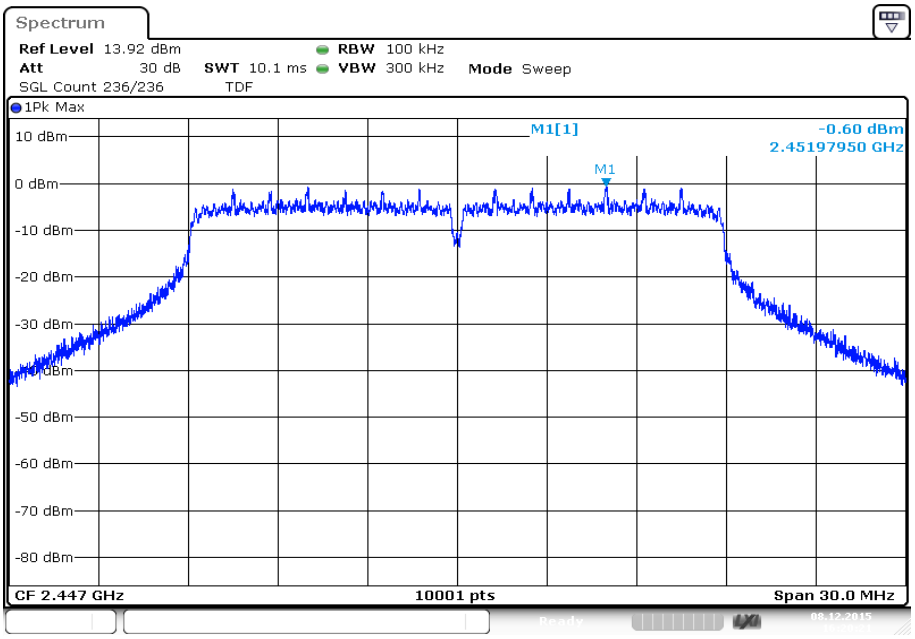
Date: 8.DEC.2015 15:49:18

Plot 3: 2437 MHz



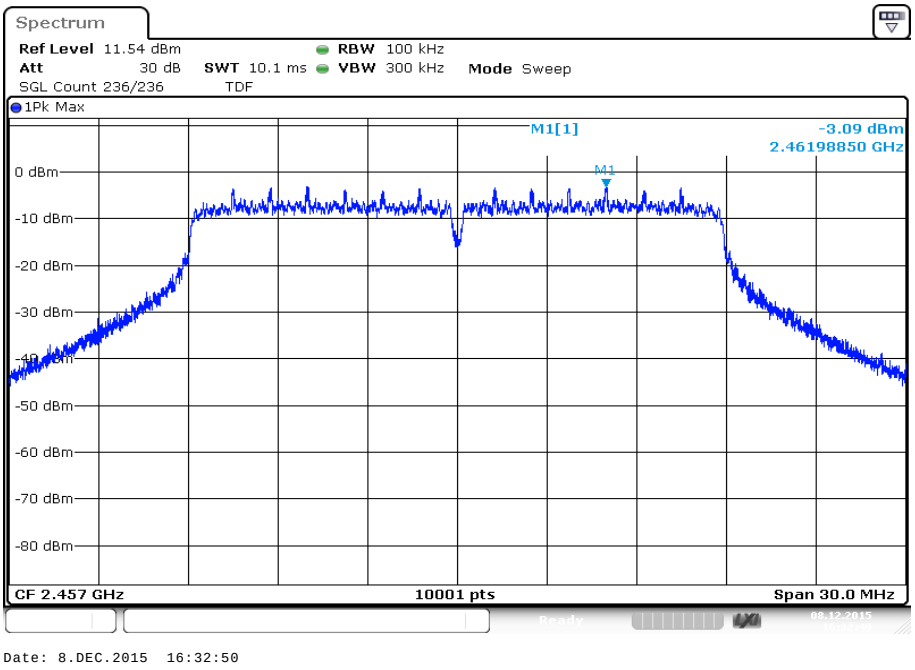
Date: 8.DEC.2015 16:07:58

Plot 4: 2447 MHz



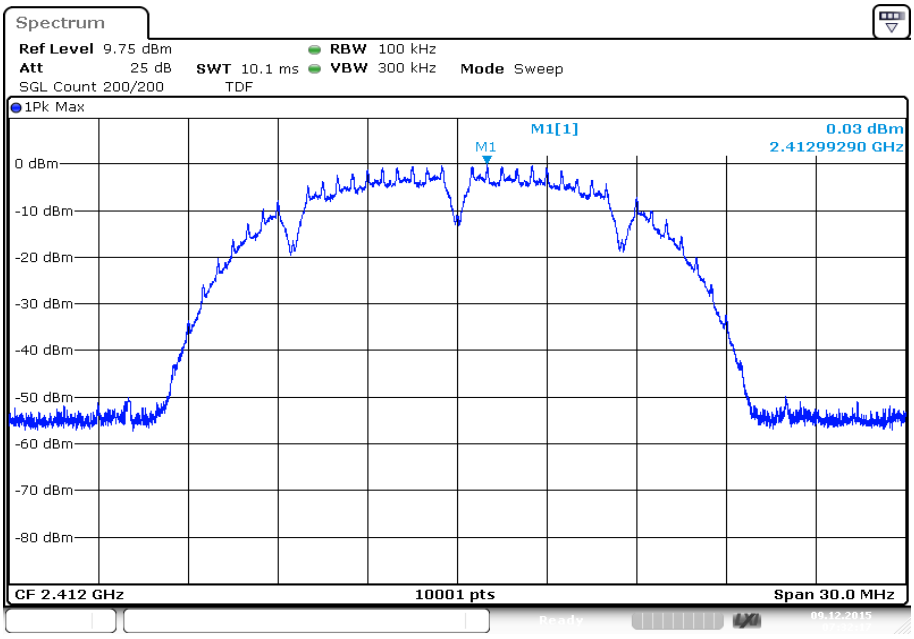
Date: 8.DEC.2015 16:20:21

Plot 5: 2457 MHz

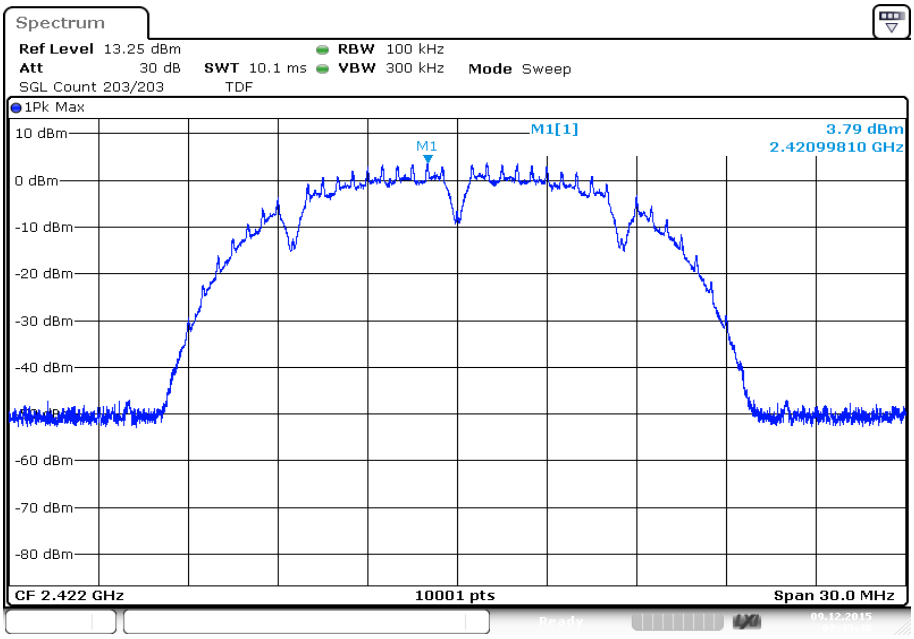


Plots: DSSS / b – mode, antenna port 2

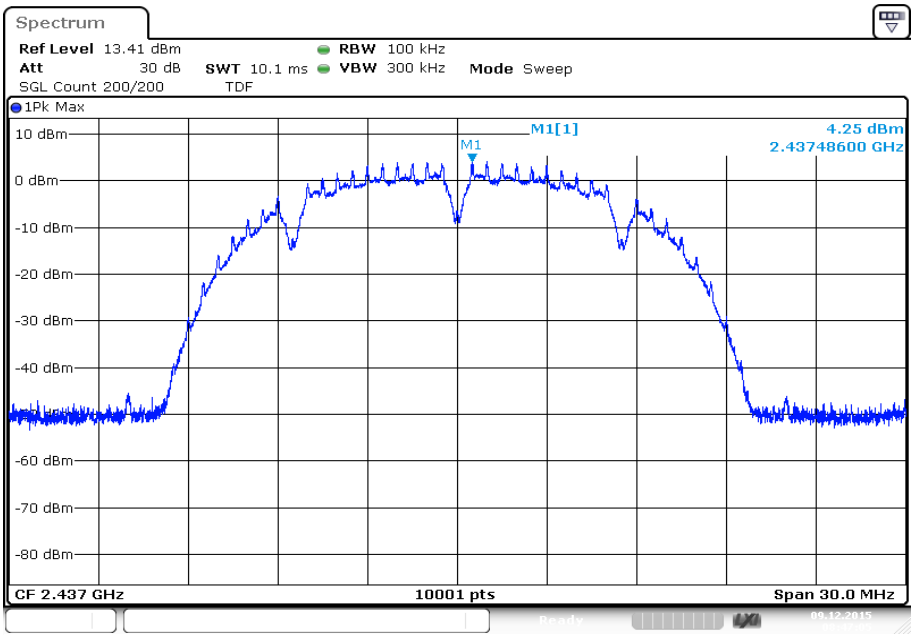
Plot 1: 2412 MHz



Plot 2: 2422 MHz

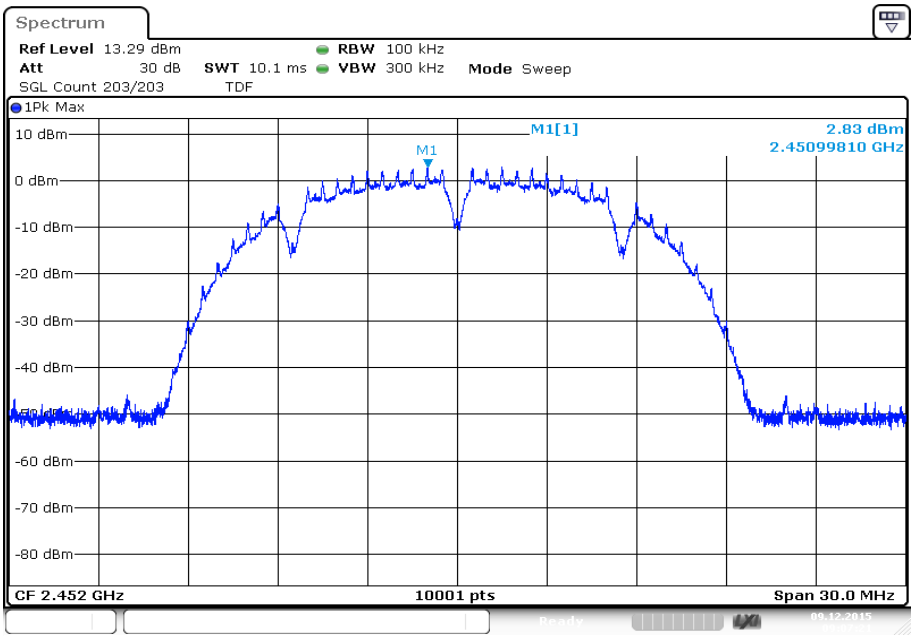


Plot 3: 2437 MHz



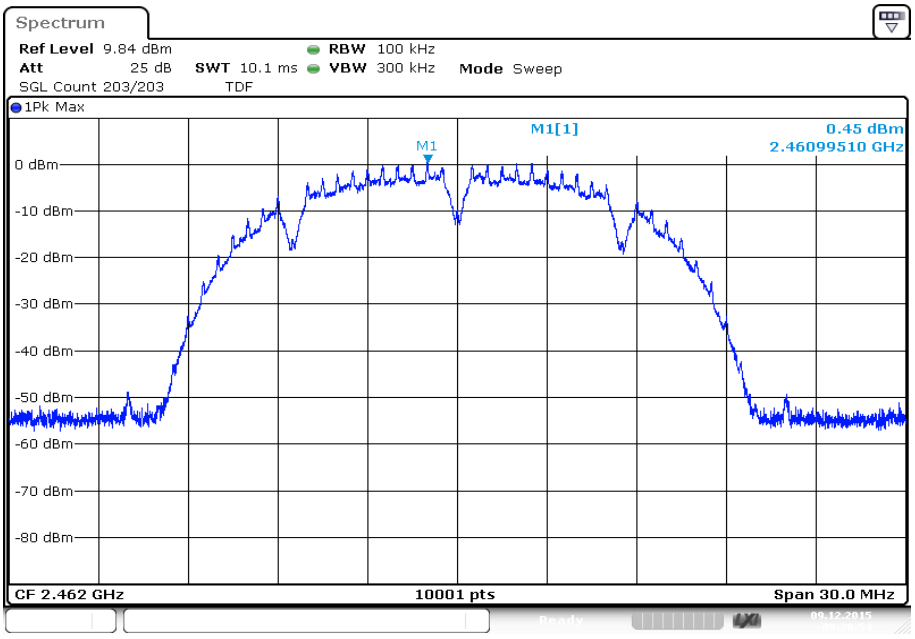
Date: 9.DEC.2015 08:47:06

Plot 4: 2452 MHz



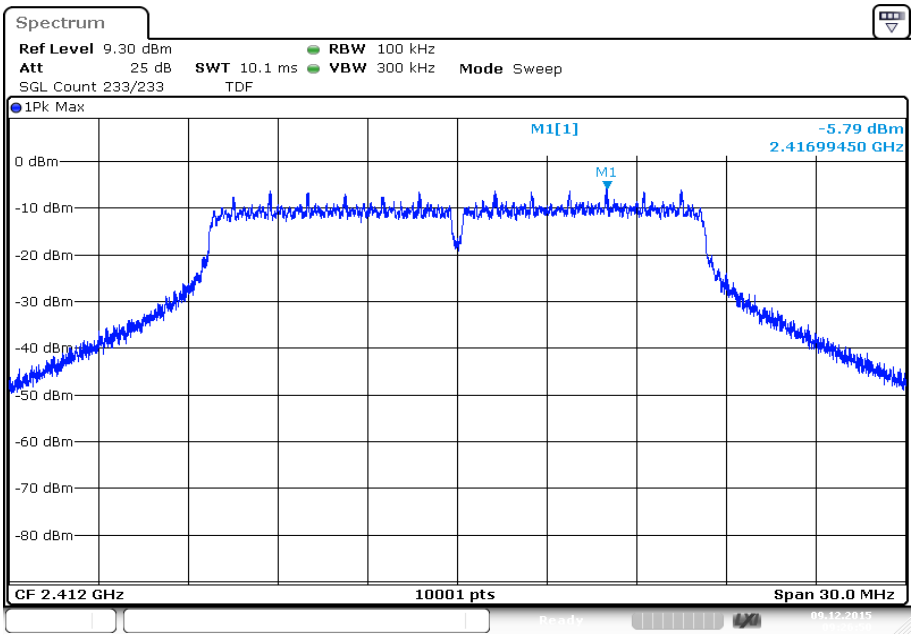
Date: 9.DEC.2015 09:07:22

Plot 5: 2462 MHz



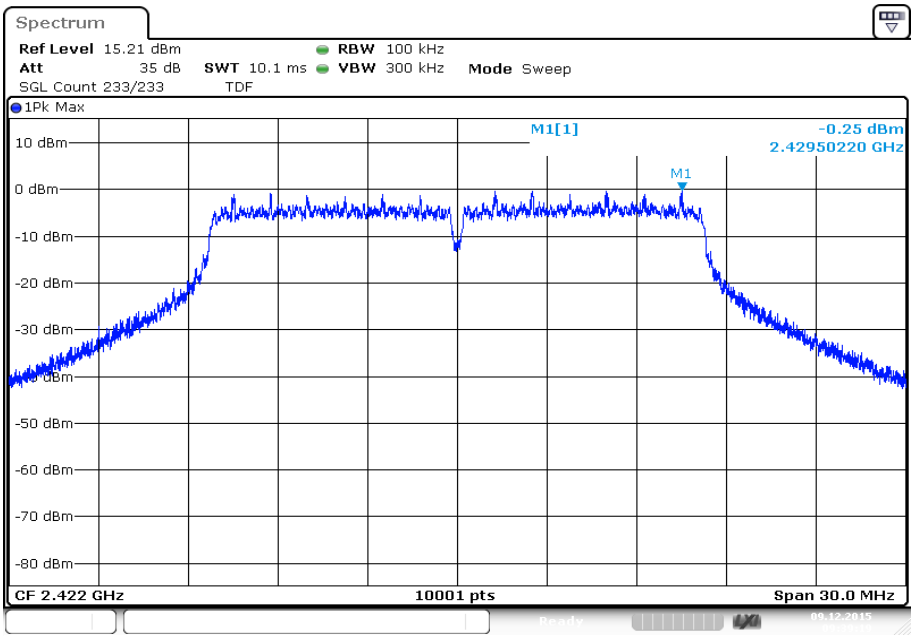
Plots: OFDM / g – mode, antenna port 2

Plot 1: 2412 MHz



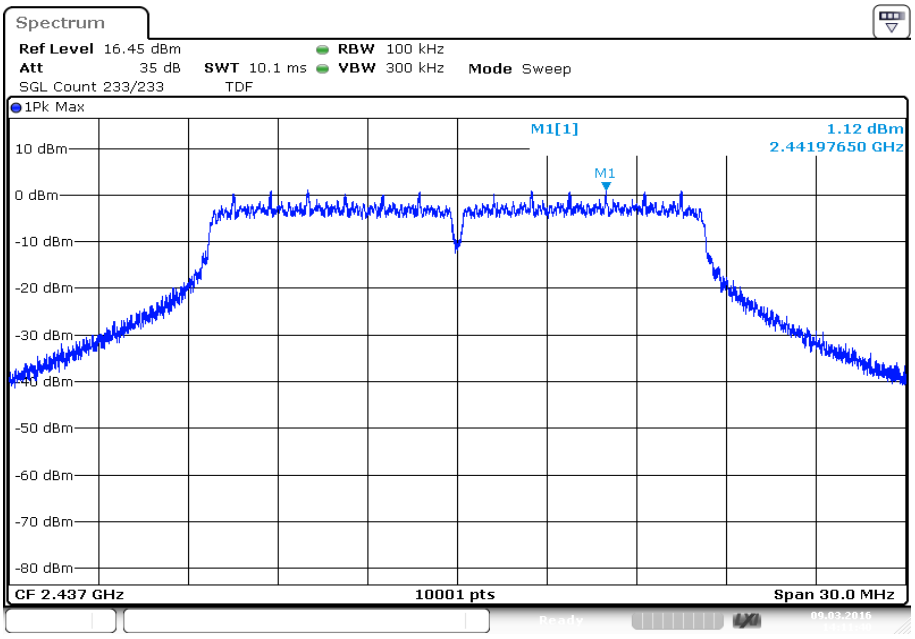
Date: 9.DEC.2015 09:26:51

Plot 2: 2422 MHz



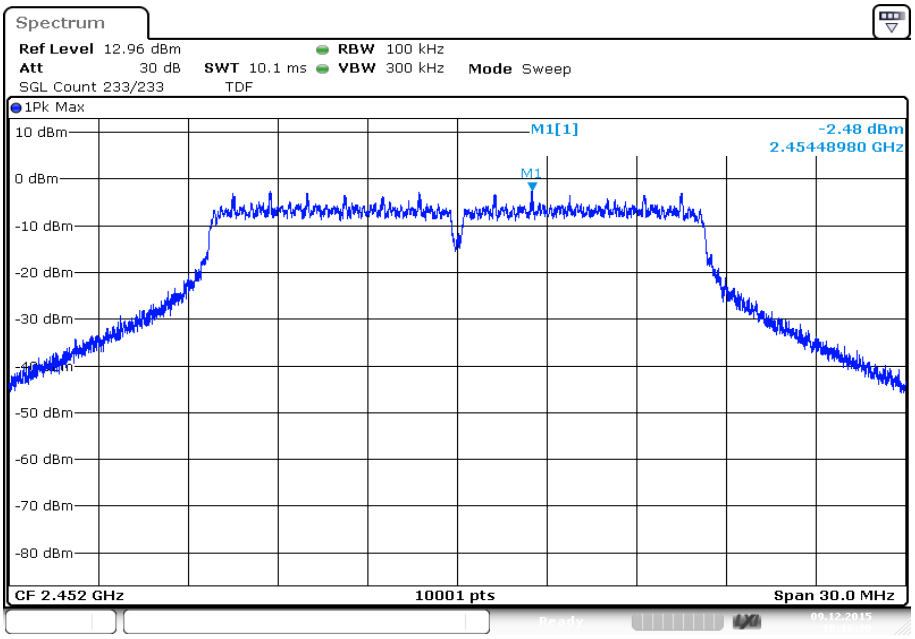
Date: 9.DEC.2015 09:39:19

Plot 3: 2437 MHz



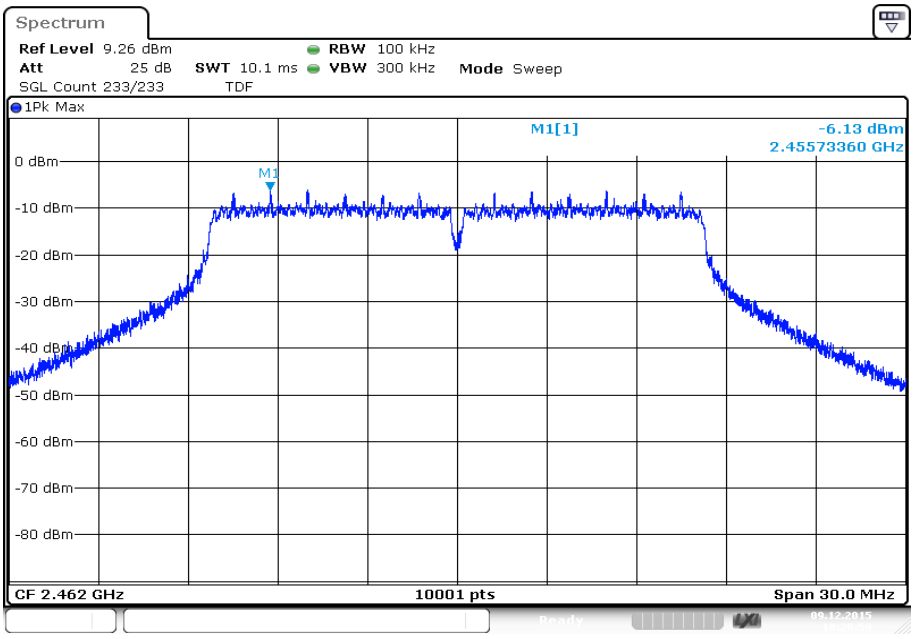
Date: 9.MAR.2016 14:11:40

Plot 4: 2452 MHz



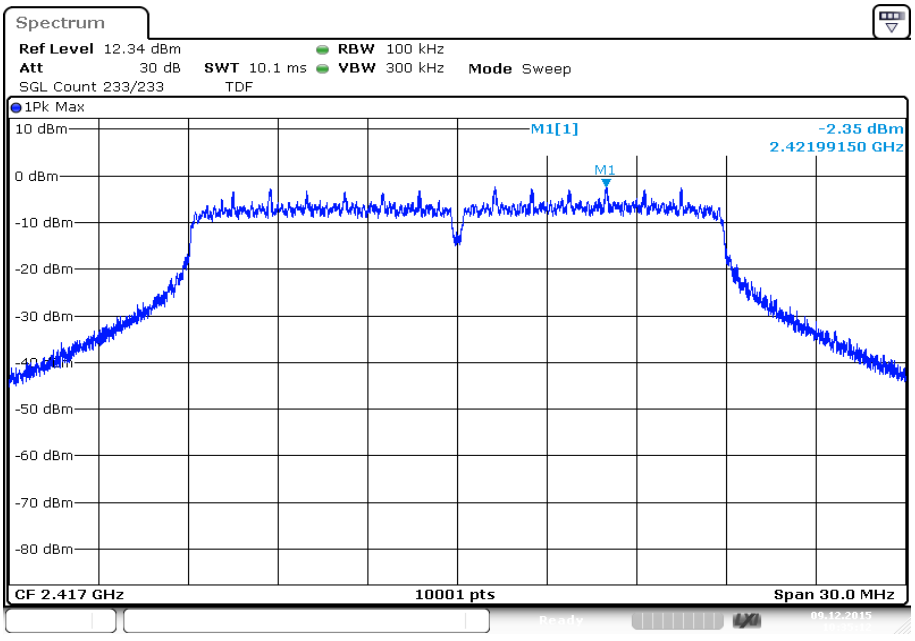
Date: 9.DEC.2015 10:16:31

Plot 5: 2462 MHz

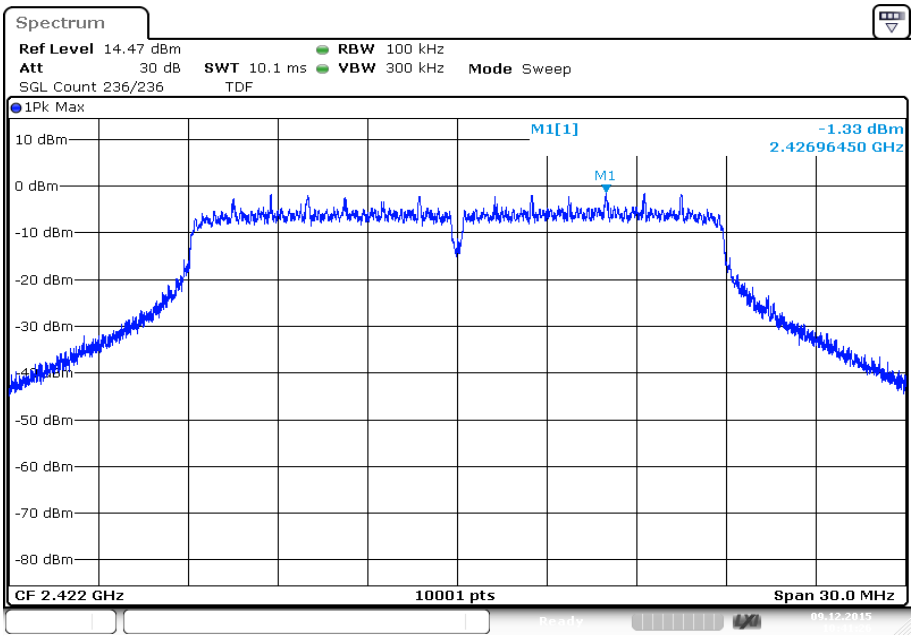


Plots: OFDM / n HT20 – mode, antenna port 2

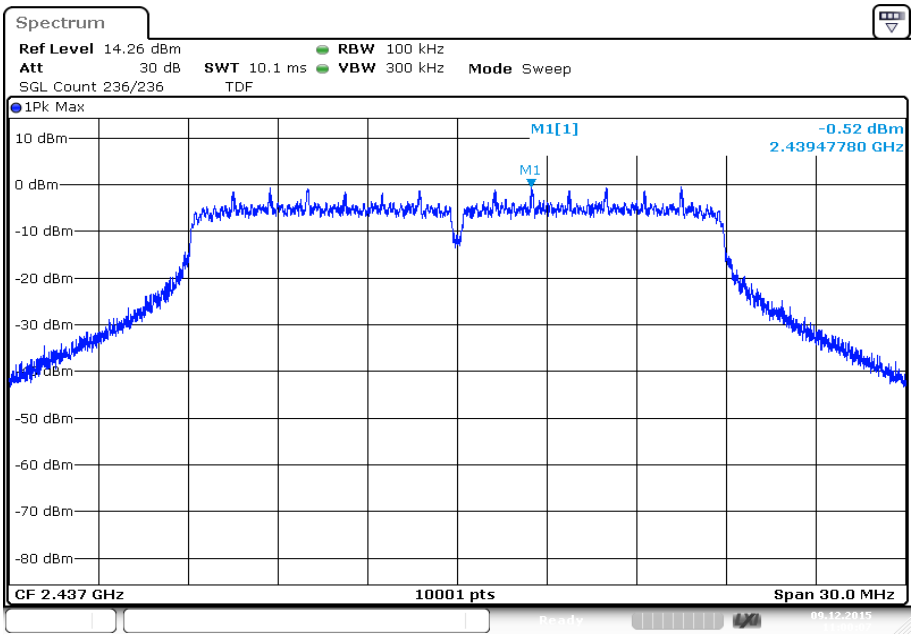
Plot 1: 2417 MHz



Plot 2: 2422 MHz

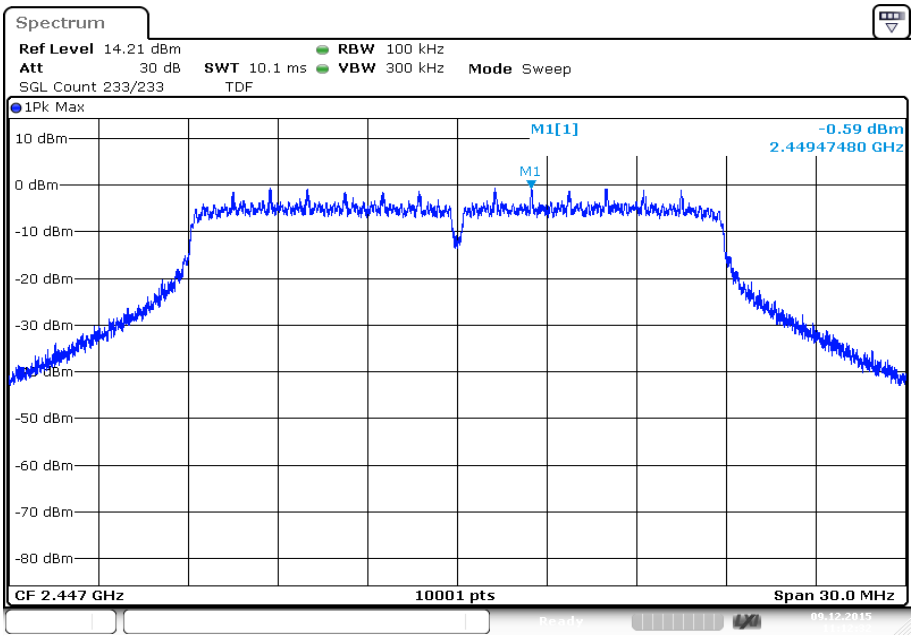


Plot 3: 2437 MHz



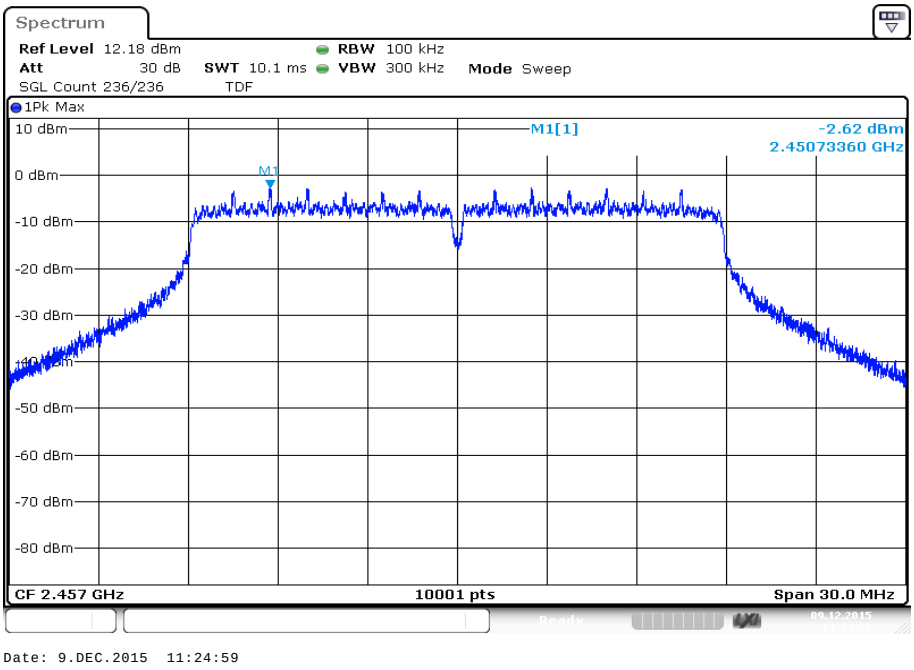
Date: 9.DEC.2015 11:00:08

Plot 4: 2447 MHz



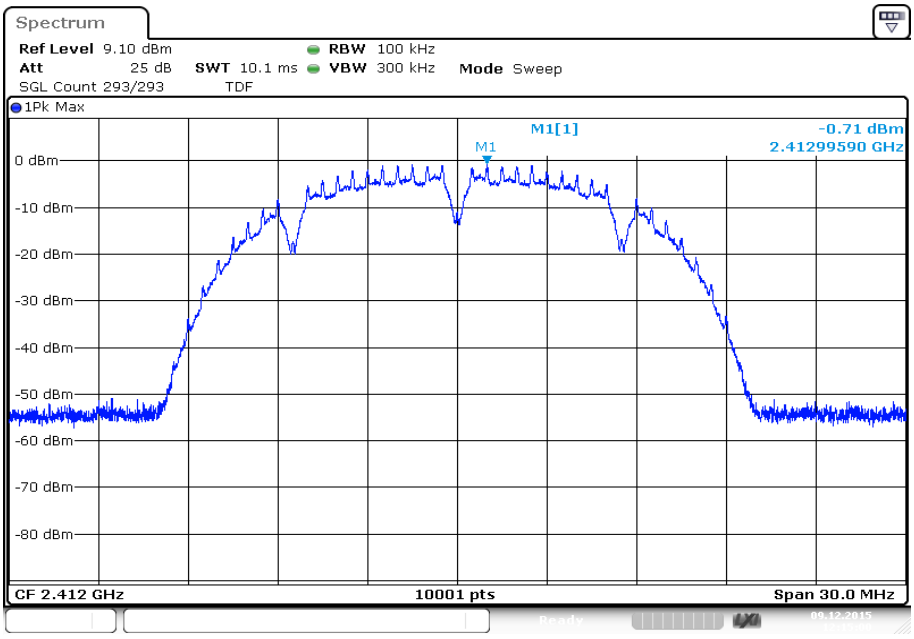
Date: 9.DEC.2015 11:12:32

Plot 5: 2457 MHz

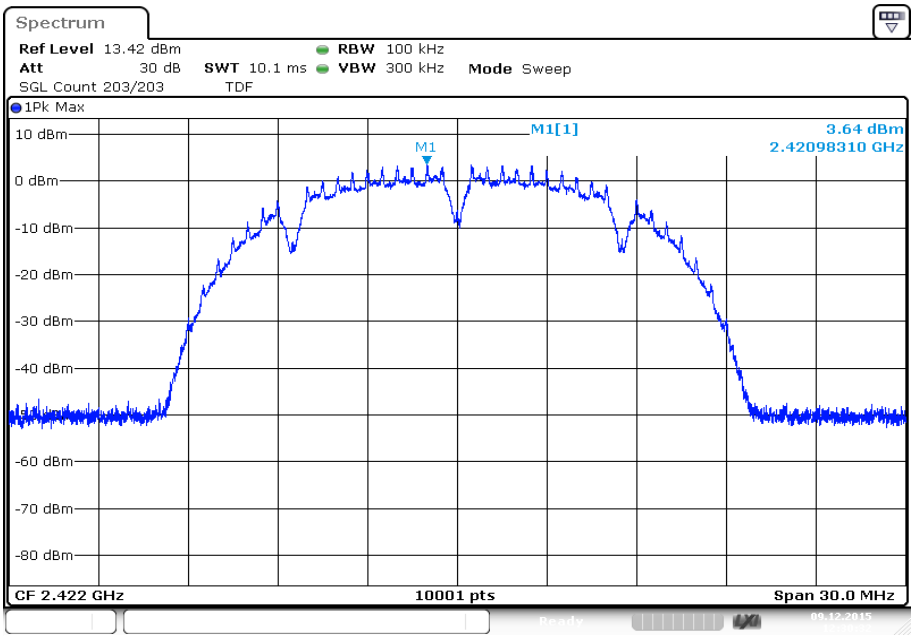


Plots: DSSS / b – mode, antenna port 3

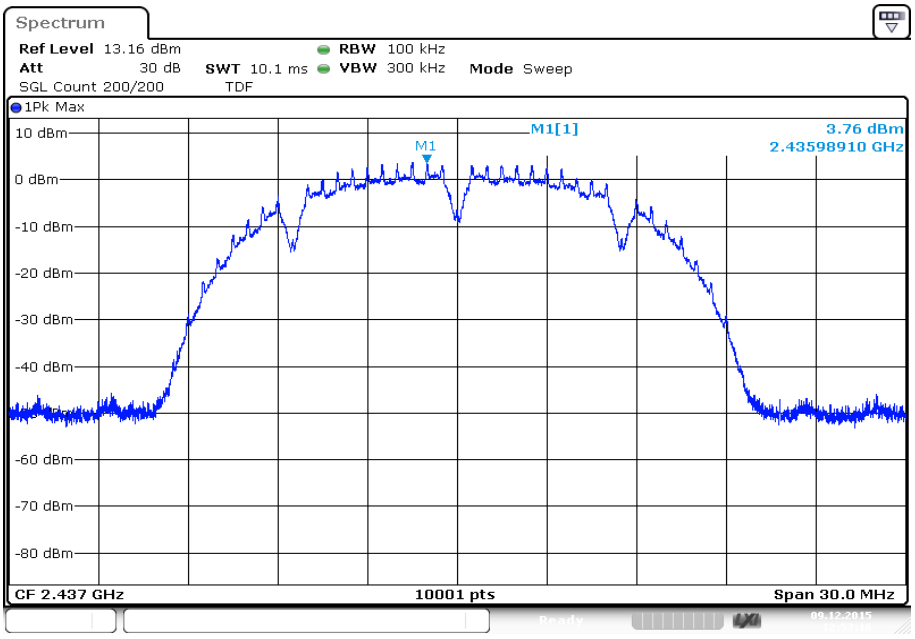
Plot 1: 2412 MHz



Plot 2: 2422 MHz

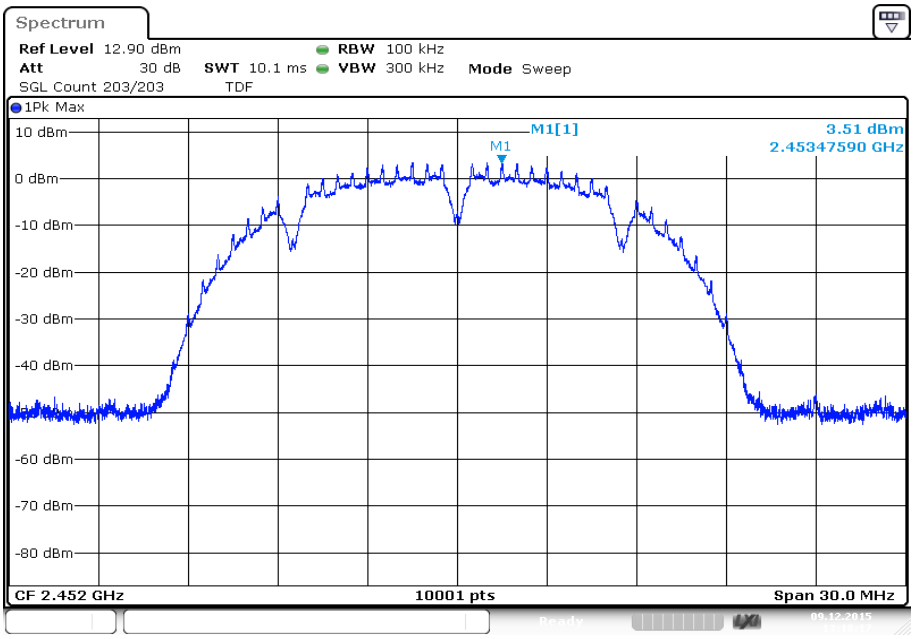


Plot 3: 2437 MHz



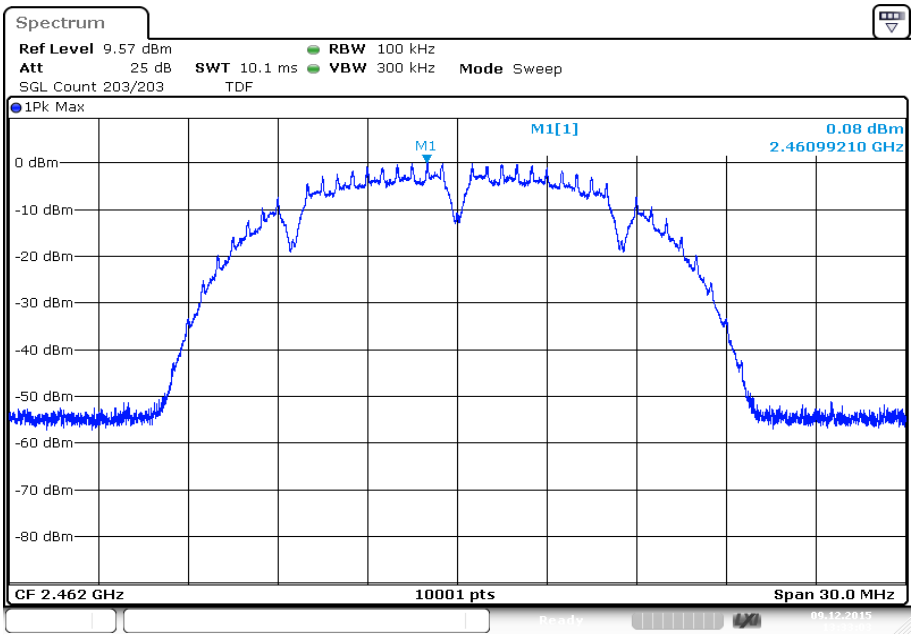
Date: 9.DEC.2015 12:53:16

Plot 4: 2452 MHz



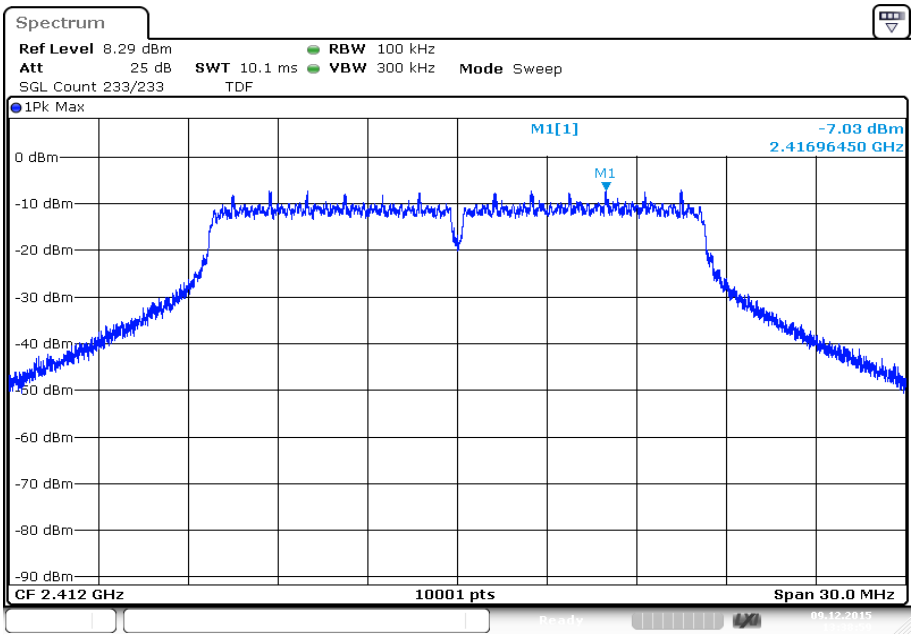
Date: 9.DEC.2015 13:18:17

Plot 5: 2462 MHz

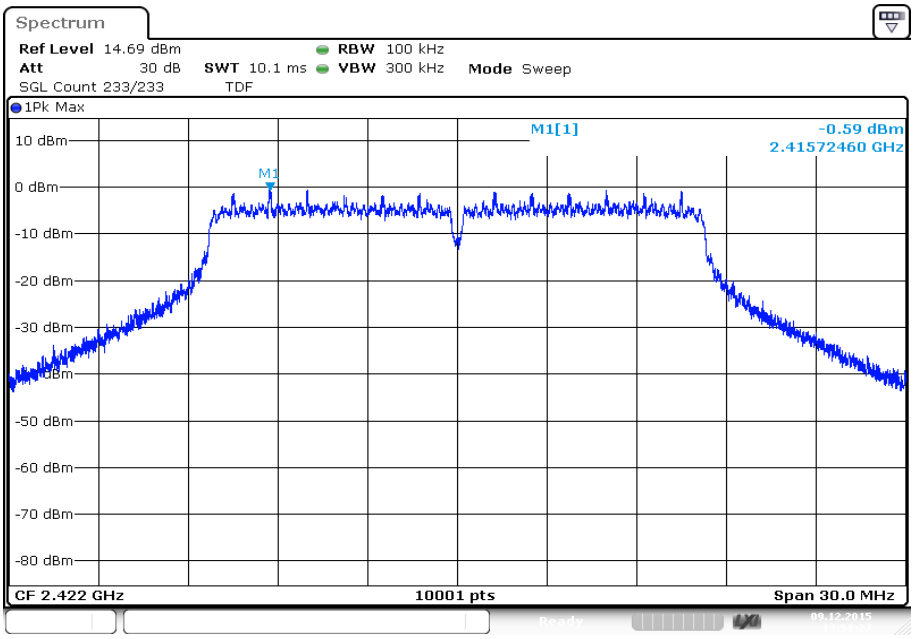


Plots: OFDM / g – mode, antenna port 3

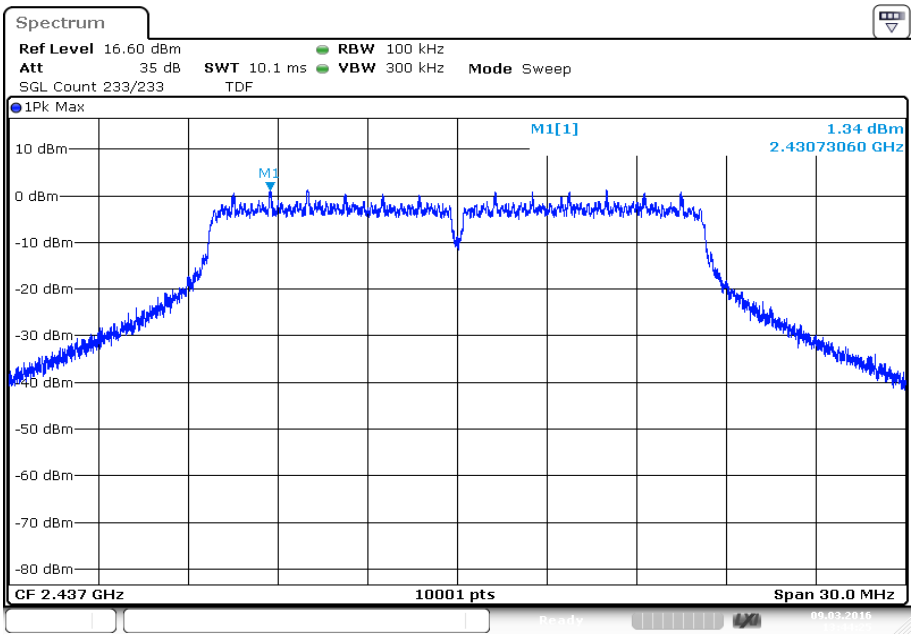
Plot 1: 2412 MHz



Plot 2: 2422 MHz

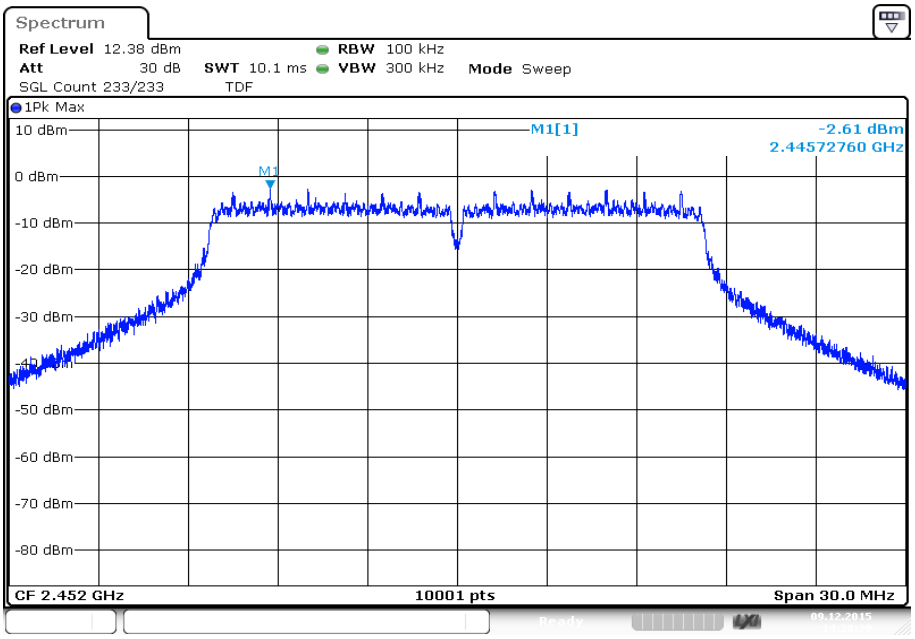


Plot 3: 2437 MHz



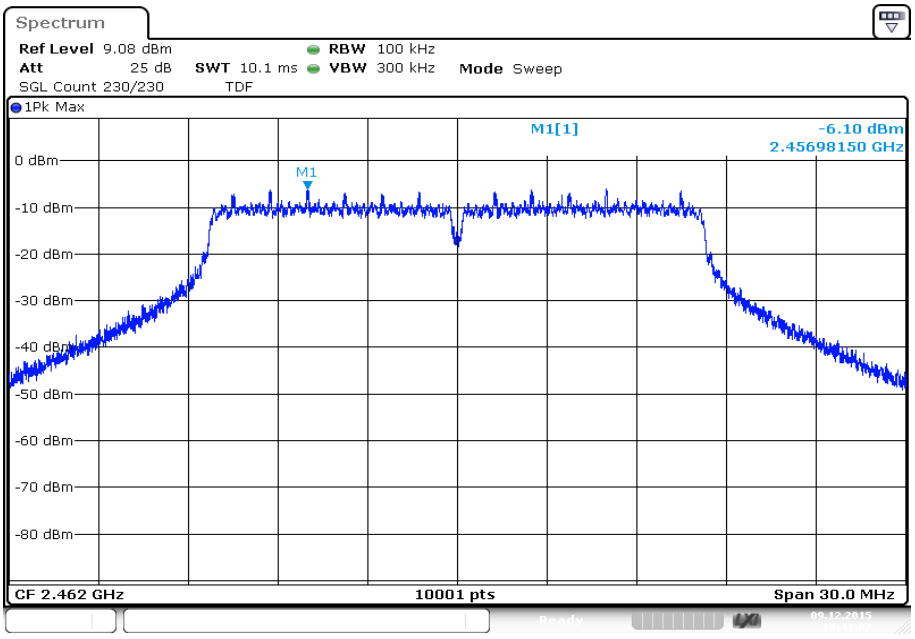
Date: 9.MAR.2016 13:44:26

Plot 4: 2452 MHz



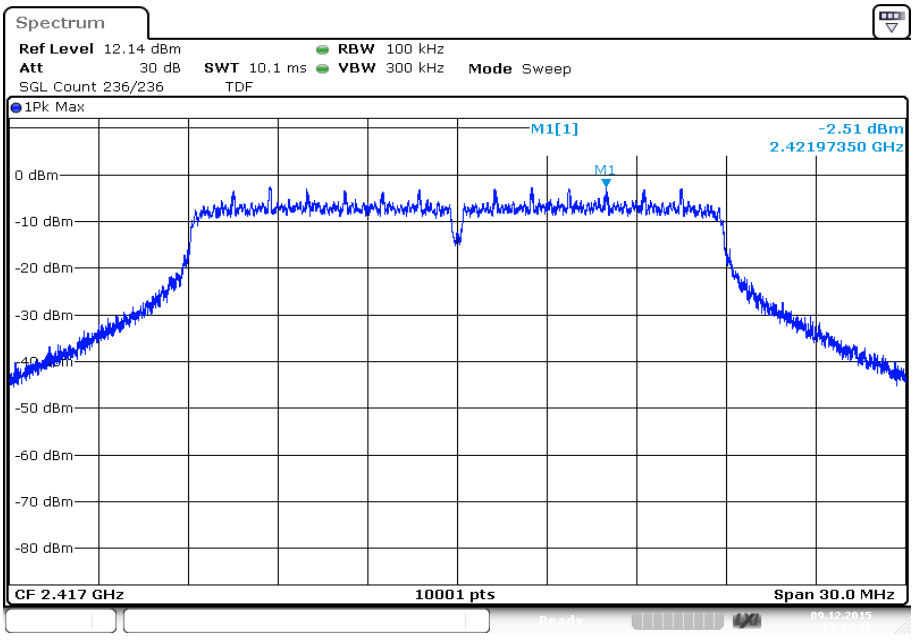
Date: 9.DEC.2015 14:28:39

Plot 5: 2462 MHz



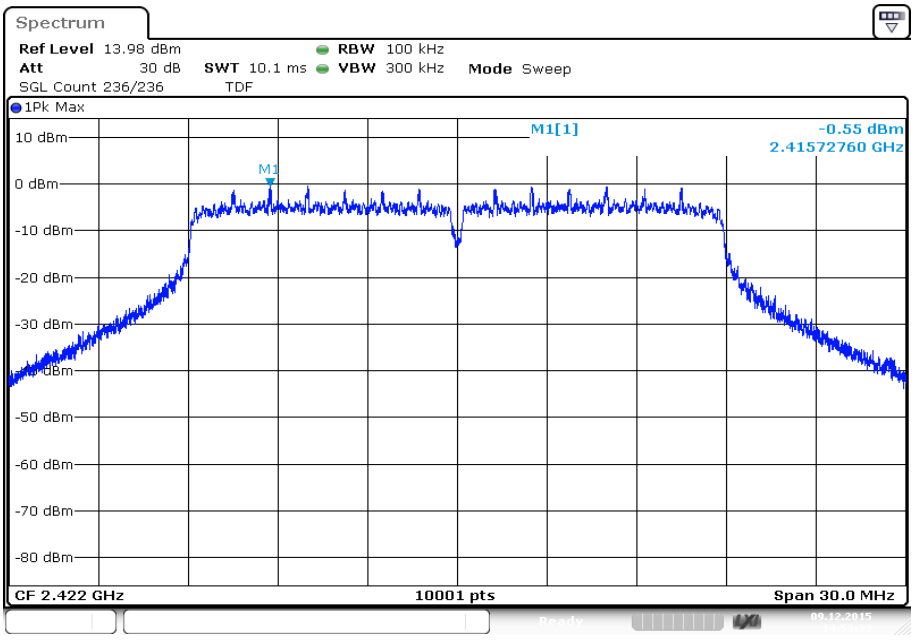
Plots: OFDM / n HT20 – mode, antenna port 3

Plot 1: 2417 MHz



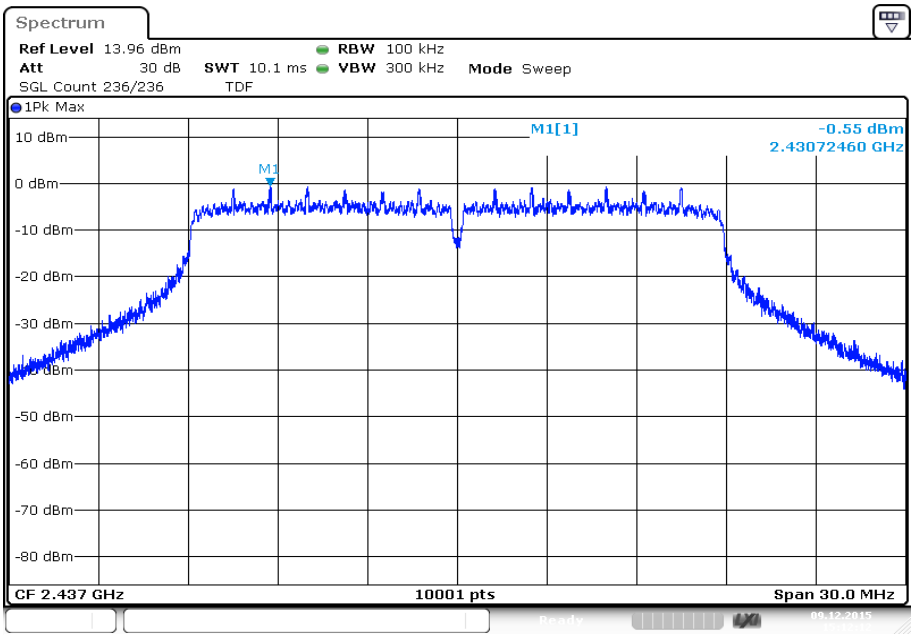
Date: 9.DEC.2015 14:47:20

Plot 2: 2422 MHz



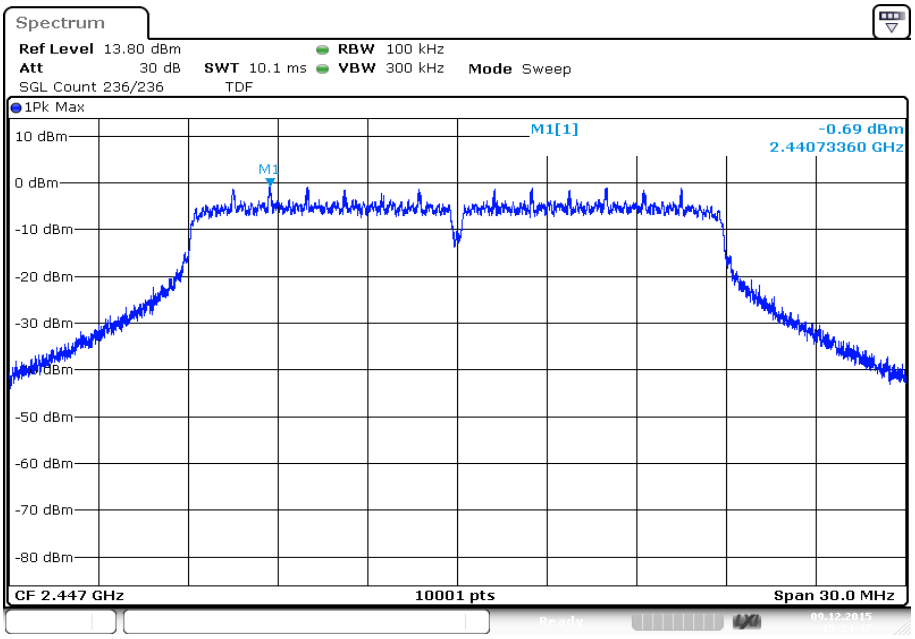
Date: 9.DEC.2015 14:53:34

Plot 3: 2437 MHz



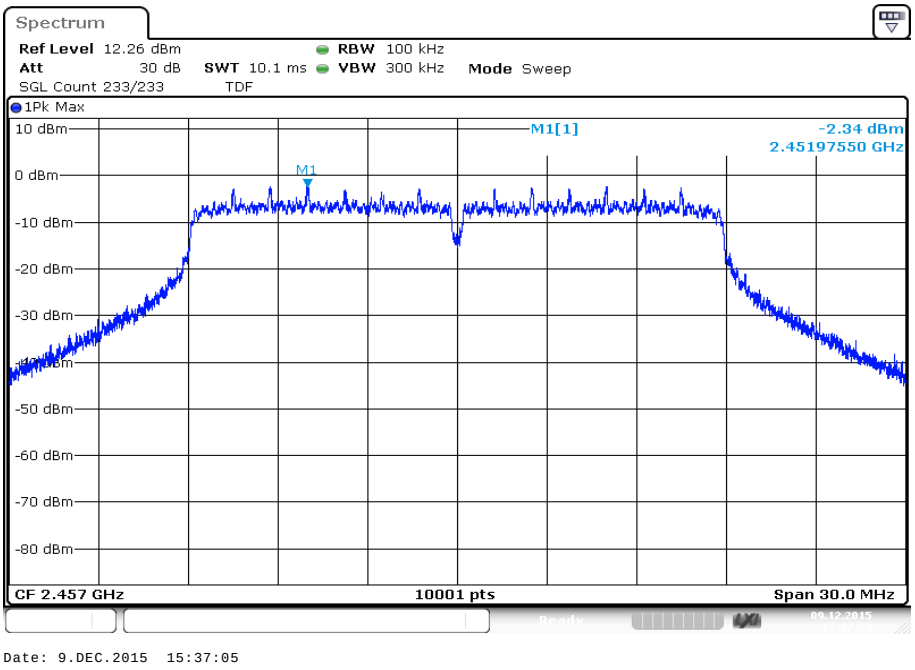
Date: 9.DEC.2015 15:12:12

Plot 4: 2447 MHz



Date: 9.DEC.2015 15:24:38

Plot 5: 2457 MHz



12.5 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
Measurement procedure:	Measurement of the 75% bandwidth using the integration function of the analyzer
Trace mode:	Single count with 200 counts
Test setup:	See sub clause 7.4 – B
Measurement uncertainty	See sub clause 9

Limits:

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

Results: antenna port 1

Frequency	6 dB DTS bandwidth [MHz]				
	2412 MHz	2422 MHz	2437 MHz	2452 MHz	2462 MHz
DSSS / b – mode	10.08	10.07	10.06	10.08	10.07
OFDM / g – mode	16.36	16.35	16.33	16.35	16.35
Frequency	2417 MHz	2422 MHz	2437 MHz	2447 MHz	2457 MHz
OFDM / n HT20 – mode	17.58	17.59	17.59	17.58	17.58

Results: antenna port 2

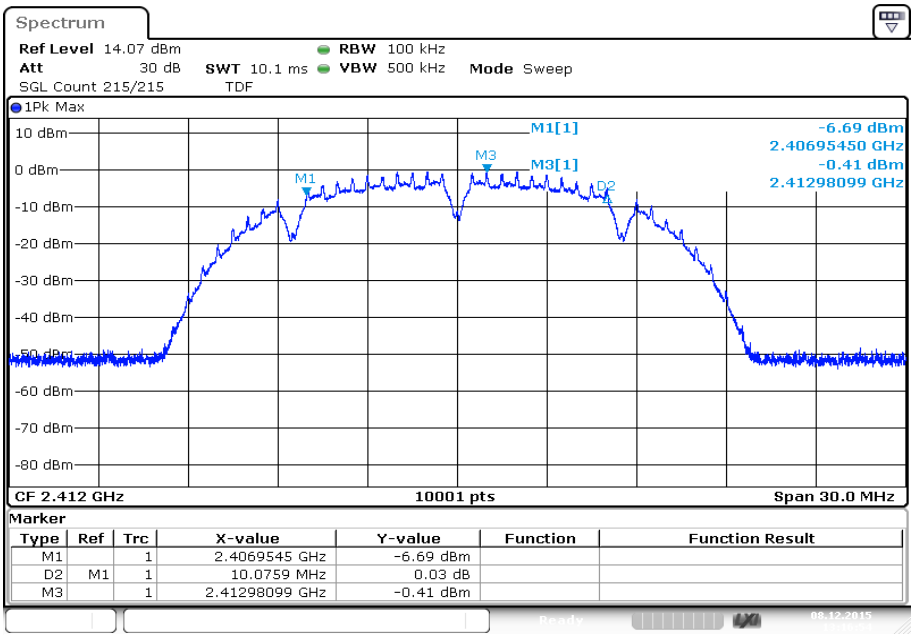
Frequency	6 dB DTS bandwidth [MHz]				
	2412 MHz	2422 MHz	2437 MHz	2452 MHz	2462 MHz
DSSS / b – mode	10.08	10.05	10.05	10.05	10.07
OFDM / g – mode	16.35	16.36	16.35	16.35	16.34
Frequency	2417 MHz	2422 MHz	2437 MHz	2447 MHz	2457 MHz
OFDM / n HT20 – mode	17.58	17.57	17.58	17.58	17.59

Results: antenna port 3

Frequency	6 dB DTS bandwidth [MHz]				
	2412 MHz	2422 MHz	2437 MHz	2452 MHz	2462 MHz
DSSS / b – mode	10.08	10.07	10.06	10.06	10.09
OFDM / g – mode	16.34	16.35	16.35	16.34	16.34
Frequency	2417 MHz	2422 MHz	2437 MHz	2447 MHz	2457 MHz
OFDM / n HT20 – mode	17.57	17.58	17.57	17.58	17.58

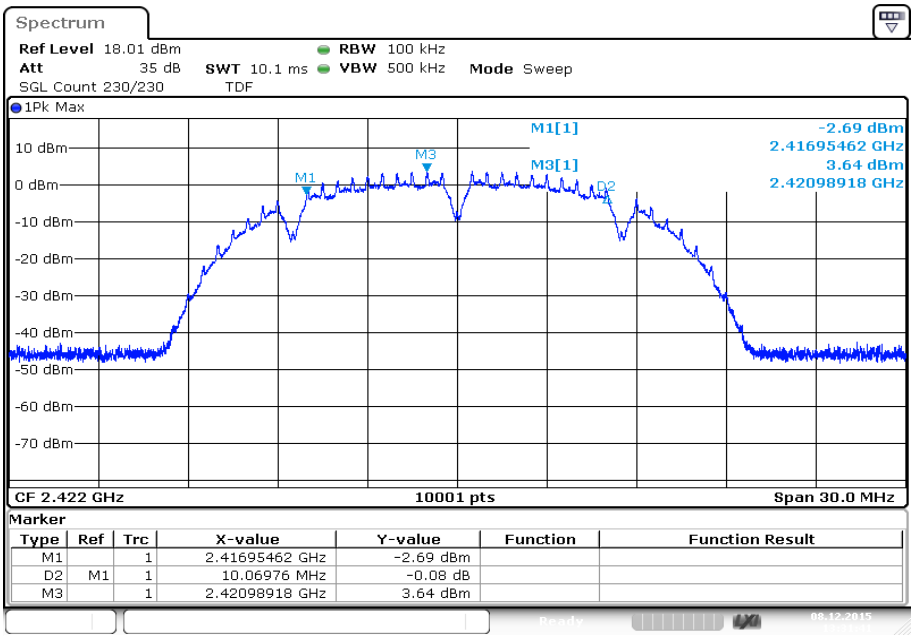
Plots: DSSS / b – mode, antenna port 1

Plot 1: 2412 MHz



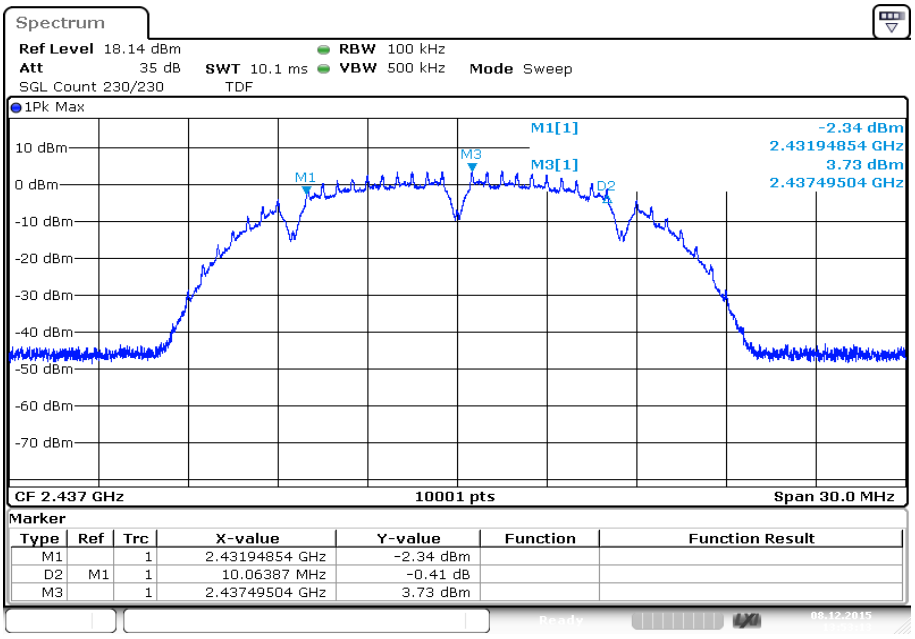
Date: 8.DEC.2015 13:16:55

Plot 2: 2422 MHz



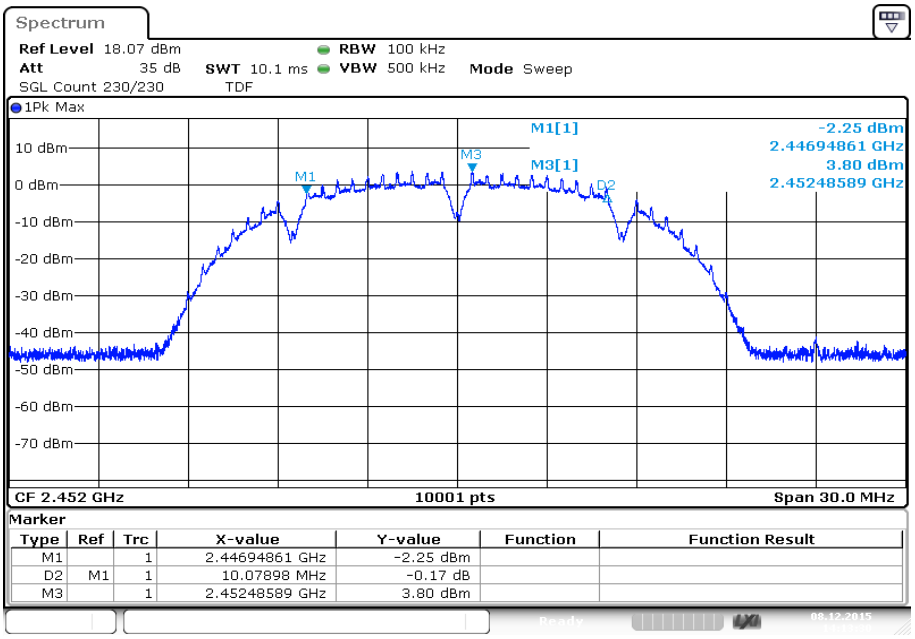
Date: 8.DEC.2015 13:31:41

Plot 3: 2437 MHz



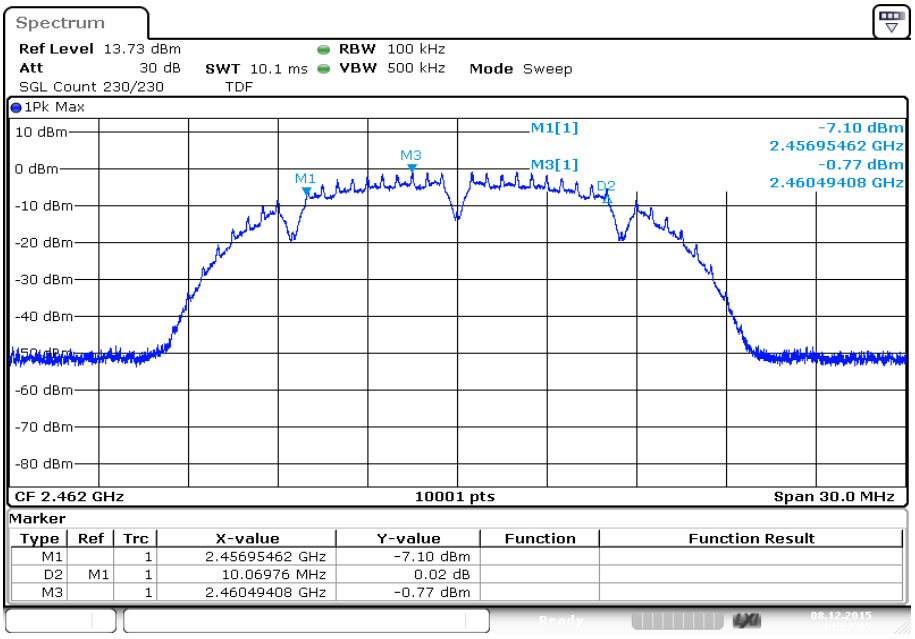
Date: 8.DEC.2015 13:53:13

Plot 4: 2452 MHz



Date: 8.DEC.2015 14:13:31

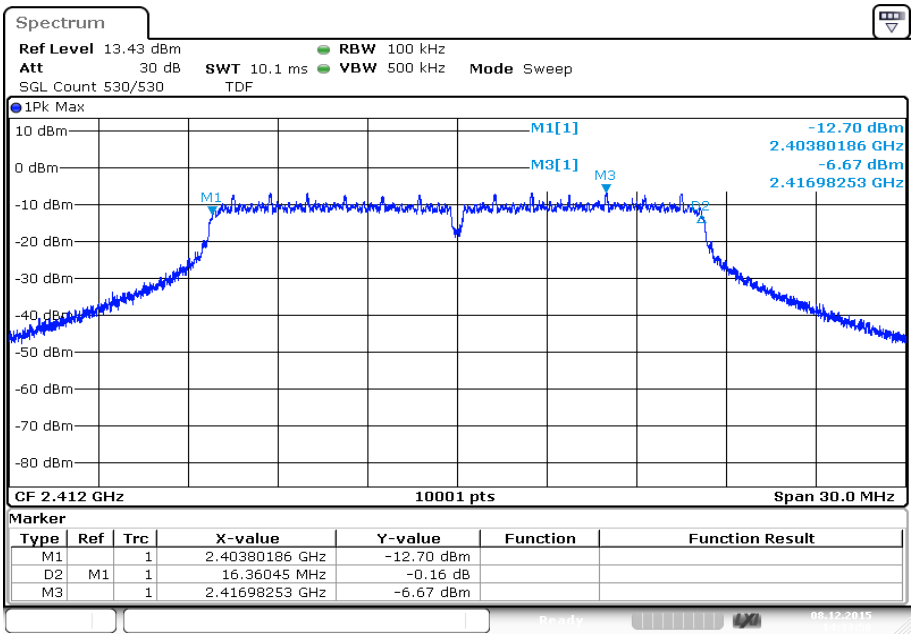
Plot 5: 2462 MHz



Date: 8.DEC.2015 14:27:05

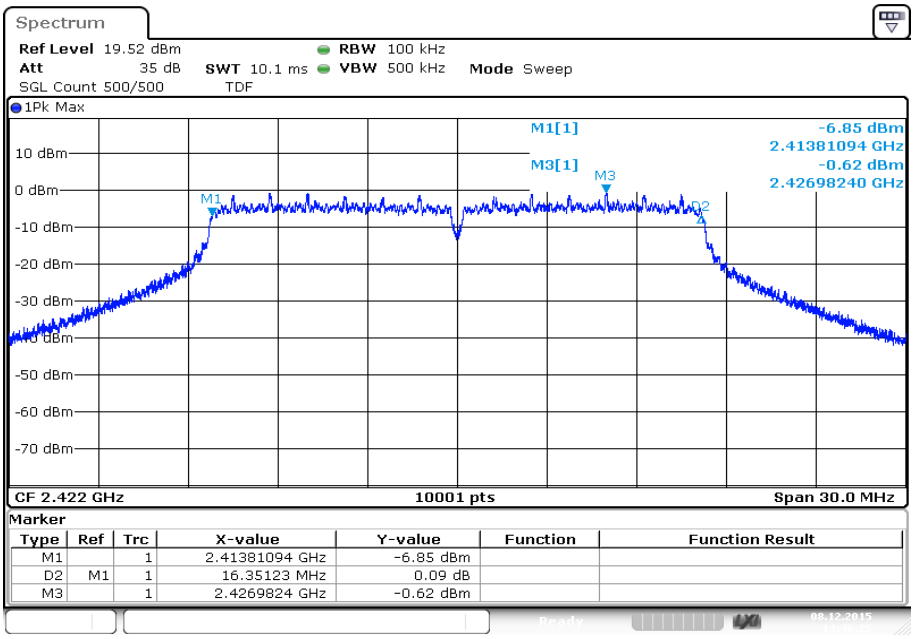
Plots: OFDM / g – mode, antenna port 1

Plot 1: 2412 MHz



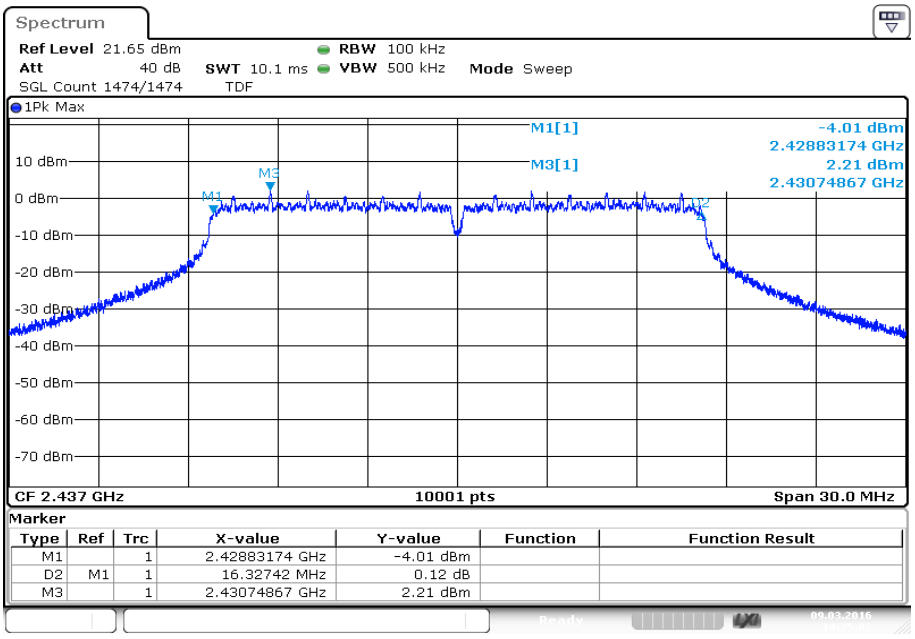
Date: 8.DEC.2015 14:33:59

Plot 2: 2422 MHz



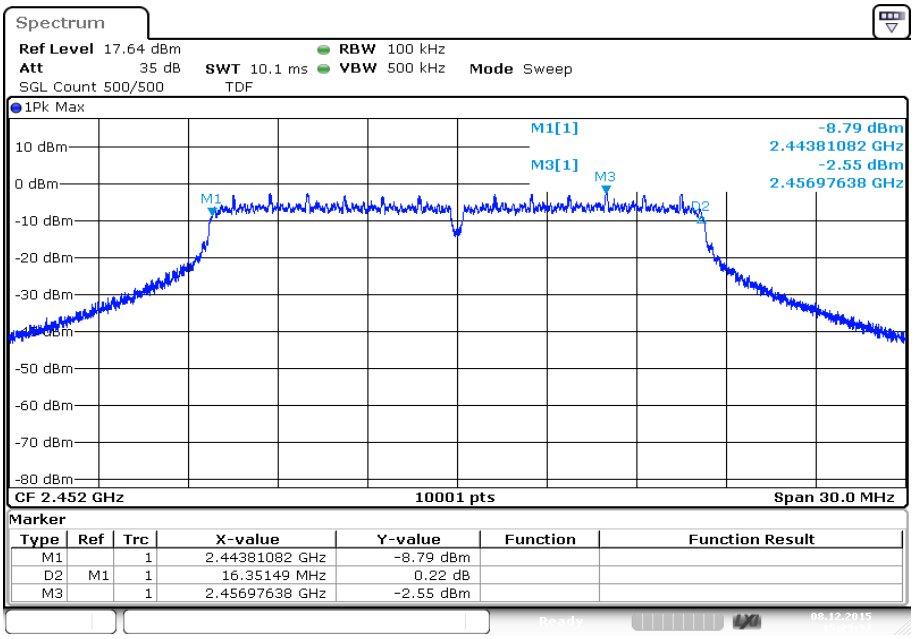
Date: 8.DEC.2015 14:46:26

Plot 3: 2437 MHz



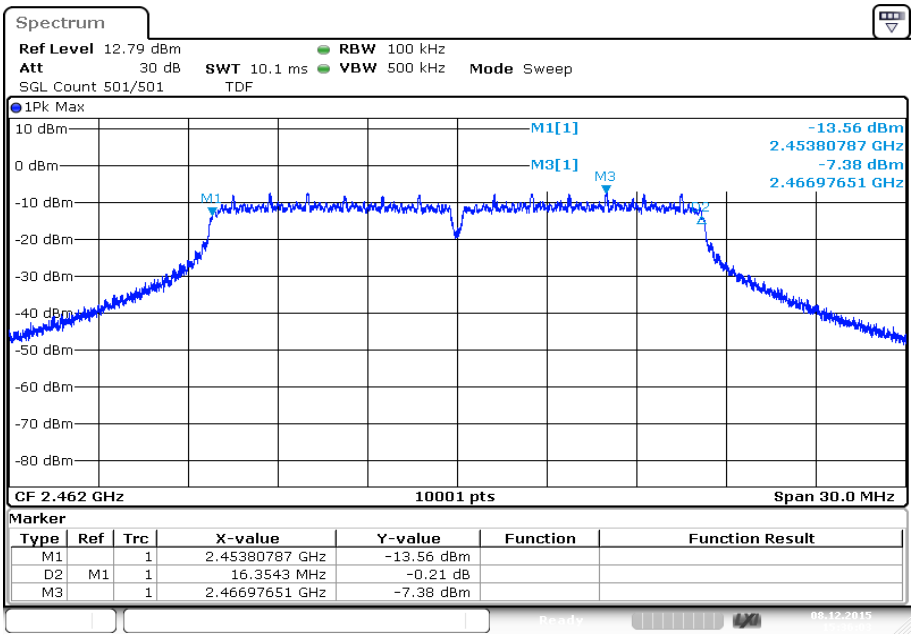
Date: 9.MAR.2016 14:25:03

Plot 4: 2452 MHz



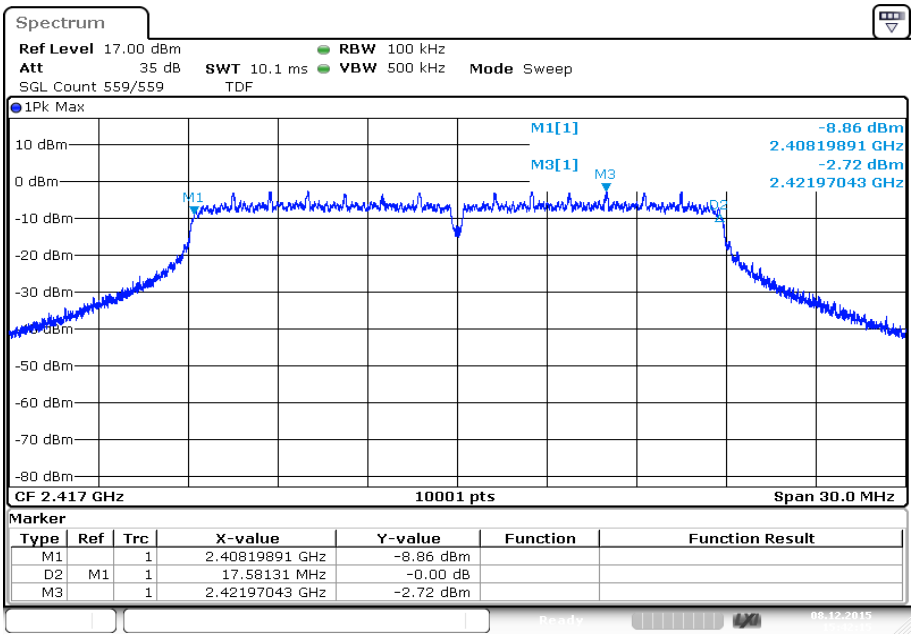
Date: 8.DEC.2015 15:23:38

Plot 5: 2462 MHz



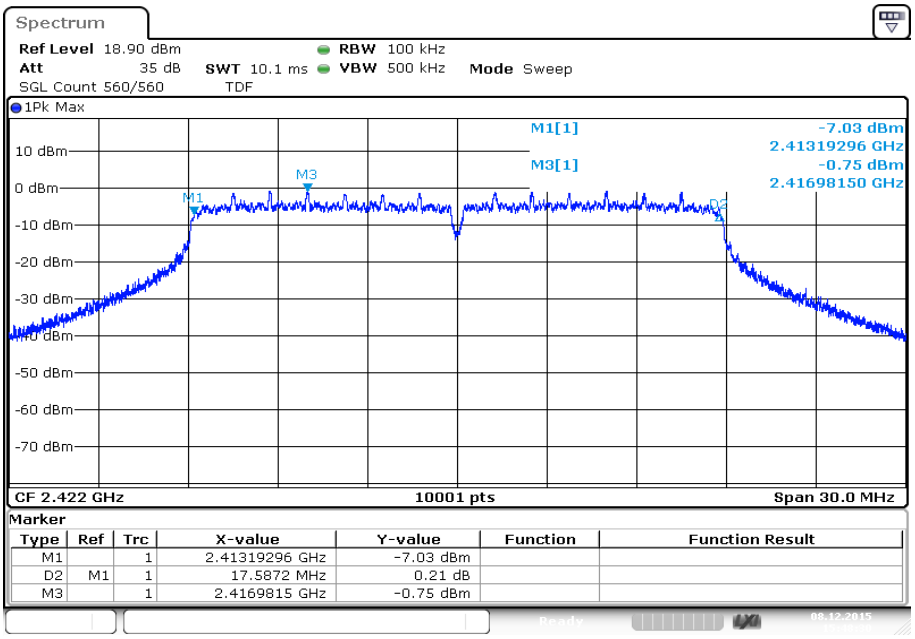
Plots: OFDM / n HT20 – mode, antenna port 1

Plot 1: 2417 MHz



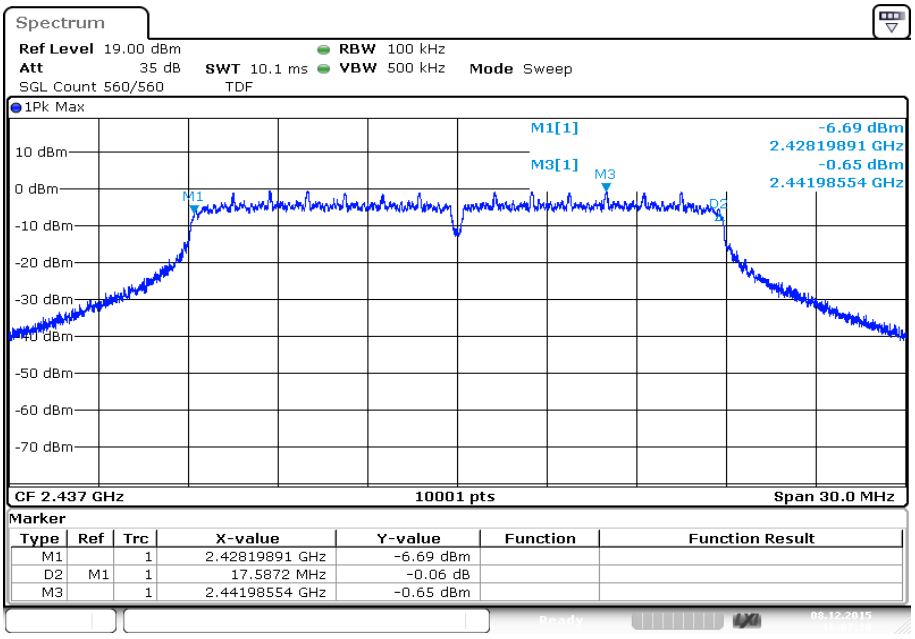
Date: 8.DEC.2015 15:42:16

Plot 2: 2422 MHz



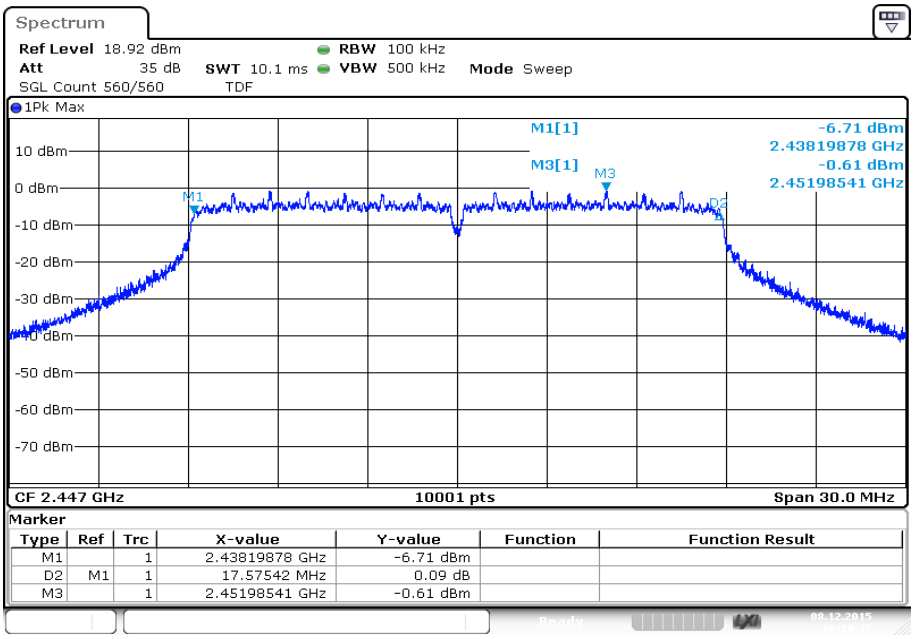
Date: 8.DEC.2015 15:48:31

Plot 3: 2437 MHz



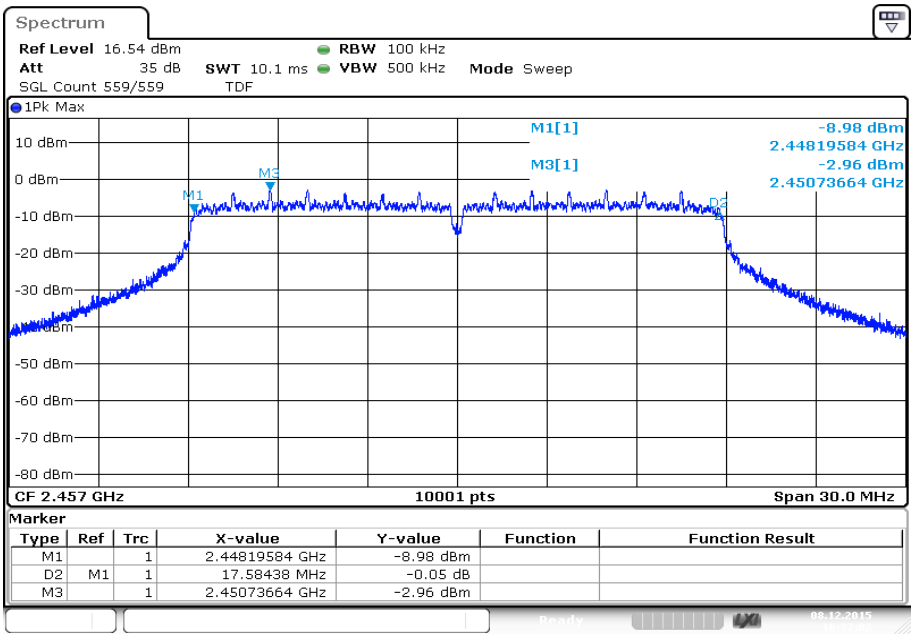
Date: 8.DEC.2015 16:07:11

Plot 4: 2447 MHz



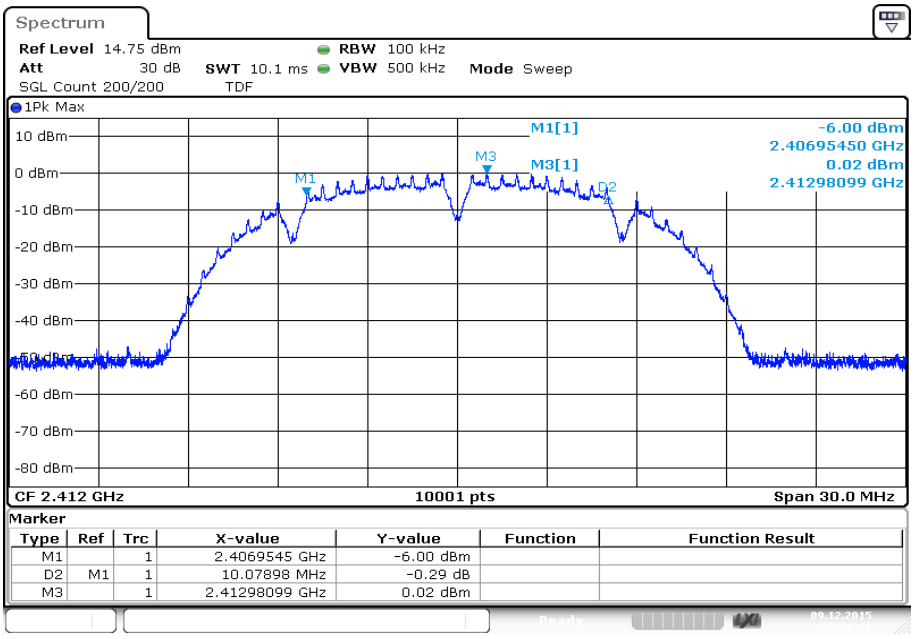
Date: 8.DEC.2015 16:19:35

Plot 5: 2457 MHz



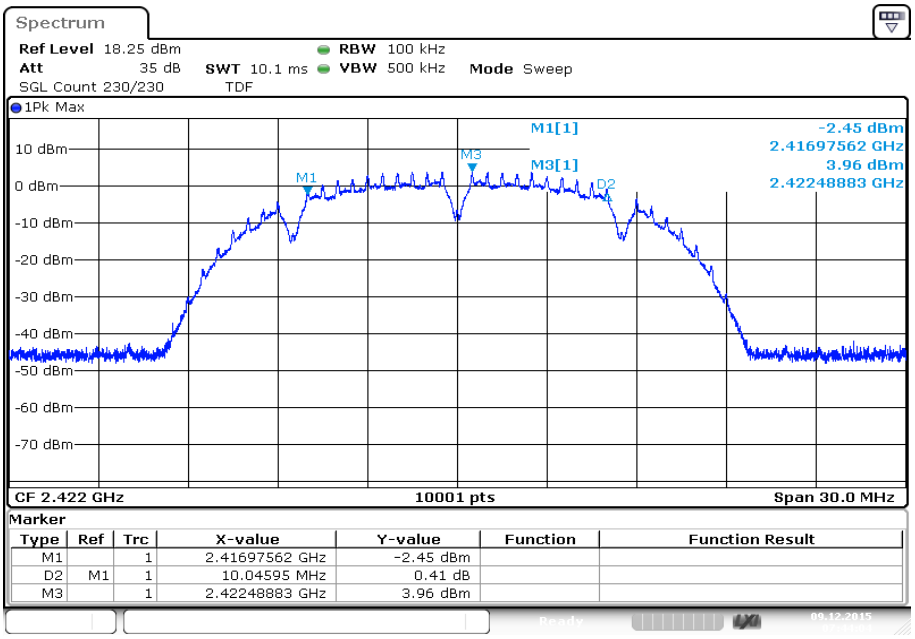
Plots: DSSS / b – mode, antenna port 2

Plot 1: 2412 MHz



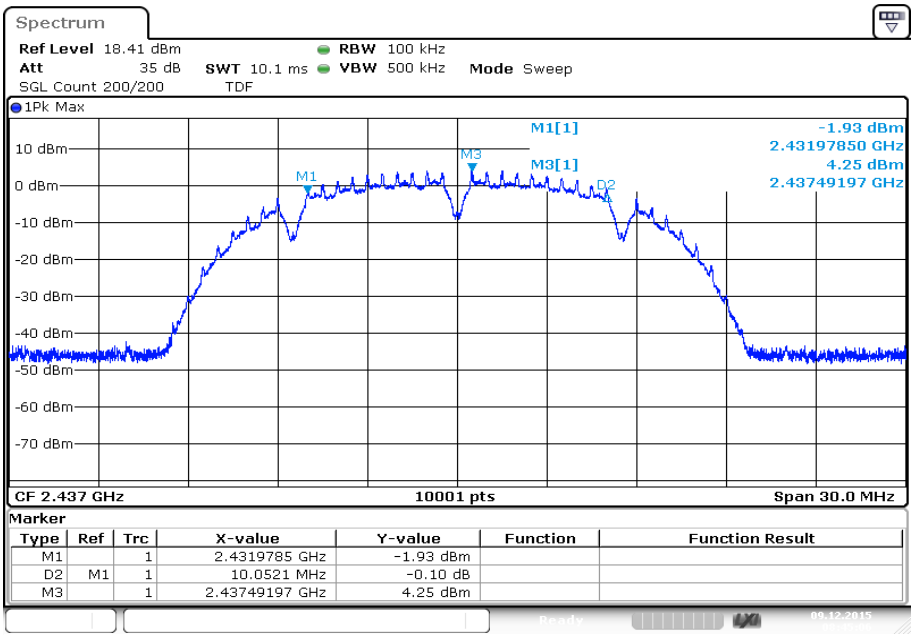
Date: 9.DEC.2015 07:30:19

Plot 2: 2422 MHz



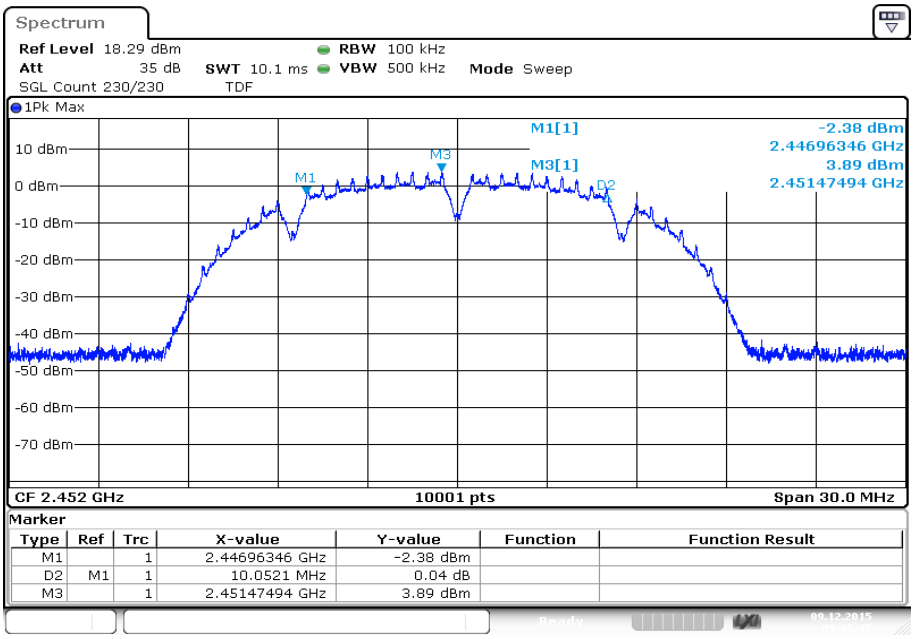
Date: 9.DEC.2015 07:44:05

Plot 3: 2437 MHz



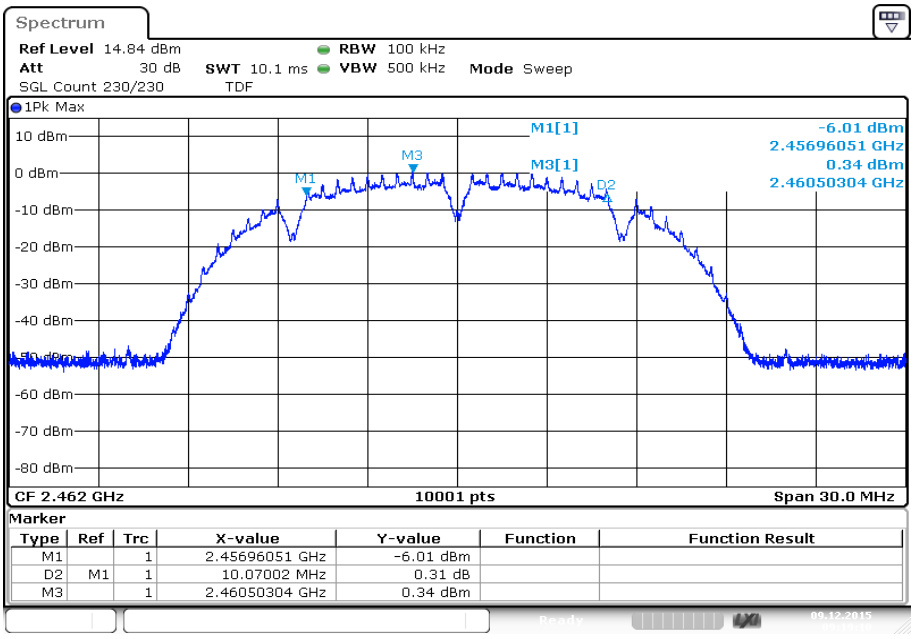
Date: 9.DEC.2015 08:45:07

Plot 4: 2452 MHz



Date: 9.DEC.2015 09:05:38

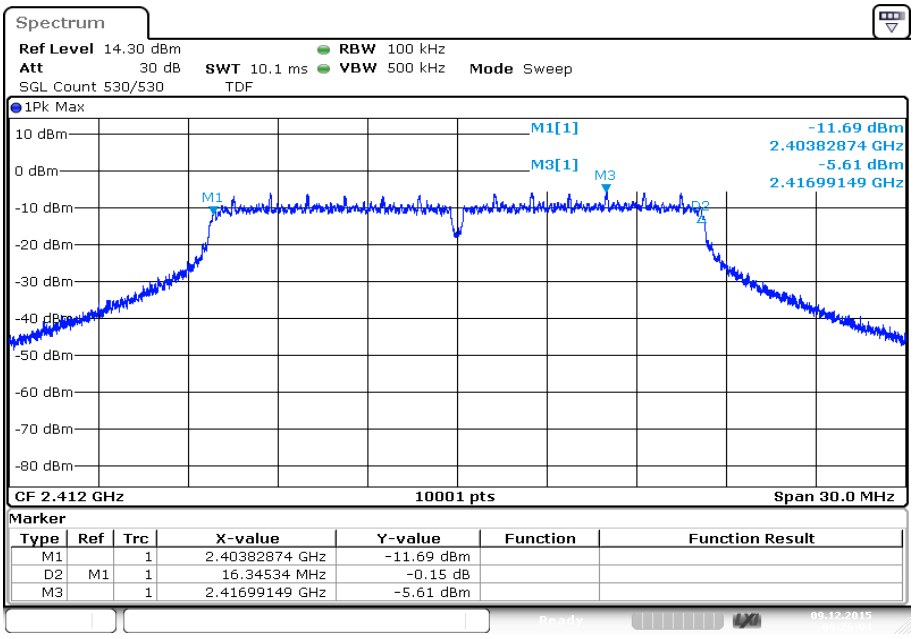
Plot 5: 2462 MHz



Date: 9.DEC.2015 09:19:11

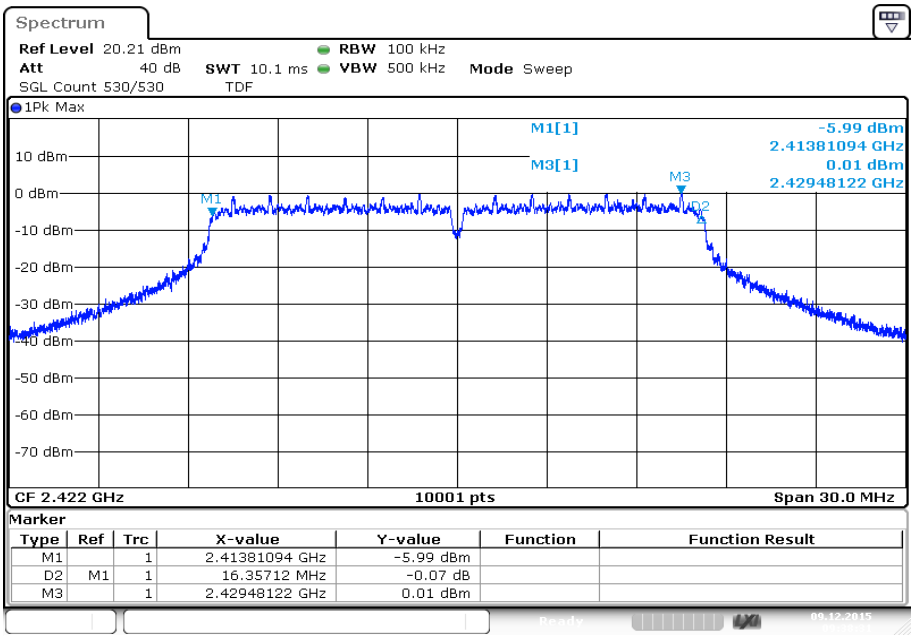
Plots: OFDM / g – mode, antenna port 2

Plot 1: 2412 MHz



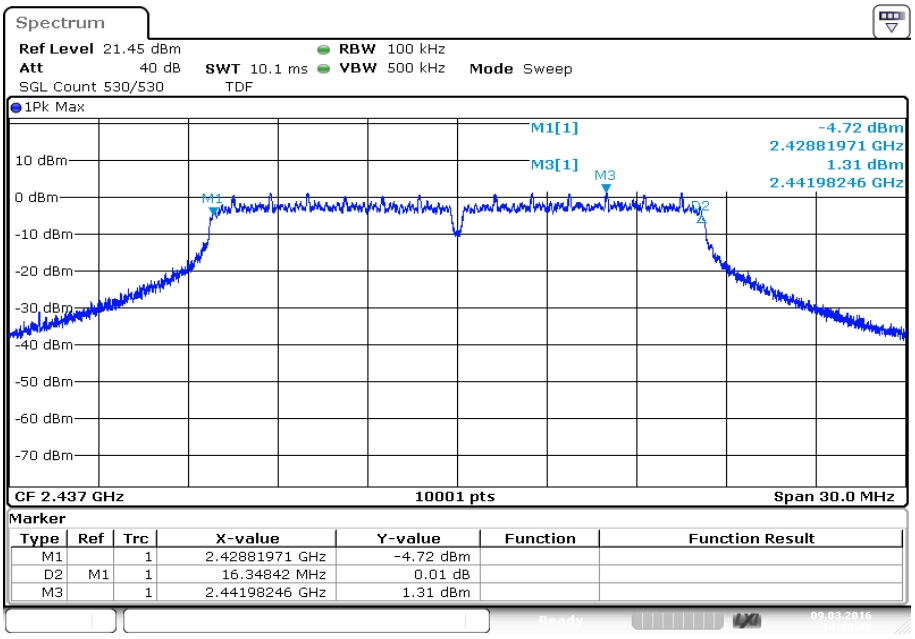
Date: 9.DEC.2015 09:26:04

Plot 2: 2422 MHz

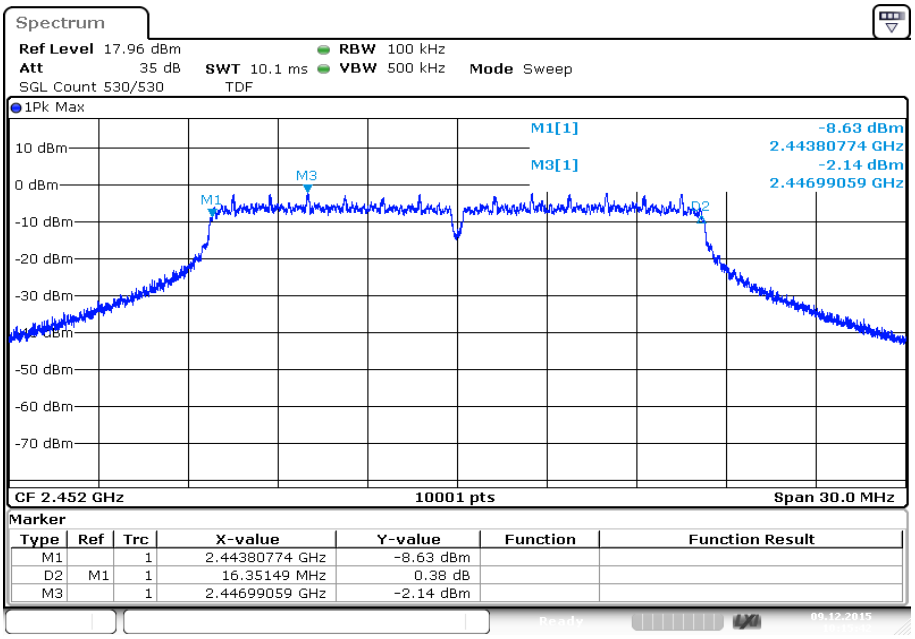


Date: 9.DEC.2015 09:38:32

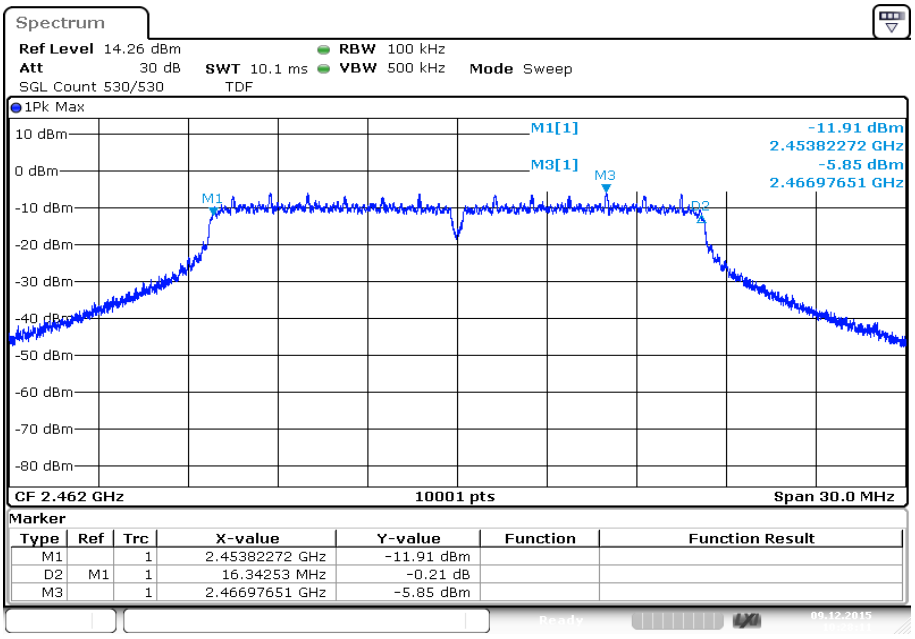
Plot 3: 2437 MHz



Plot 4: 2452 MHz

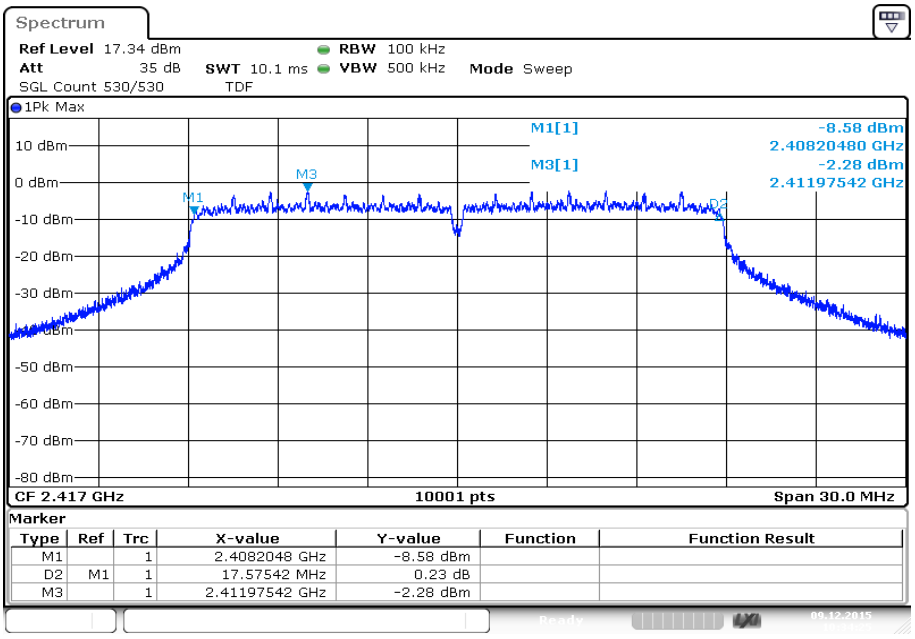


Plot 5: 2462 MHz



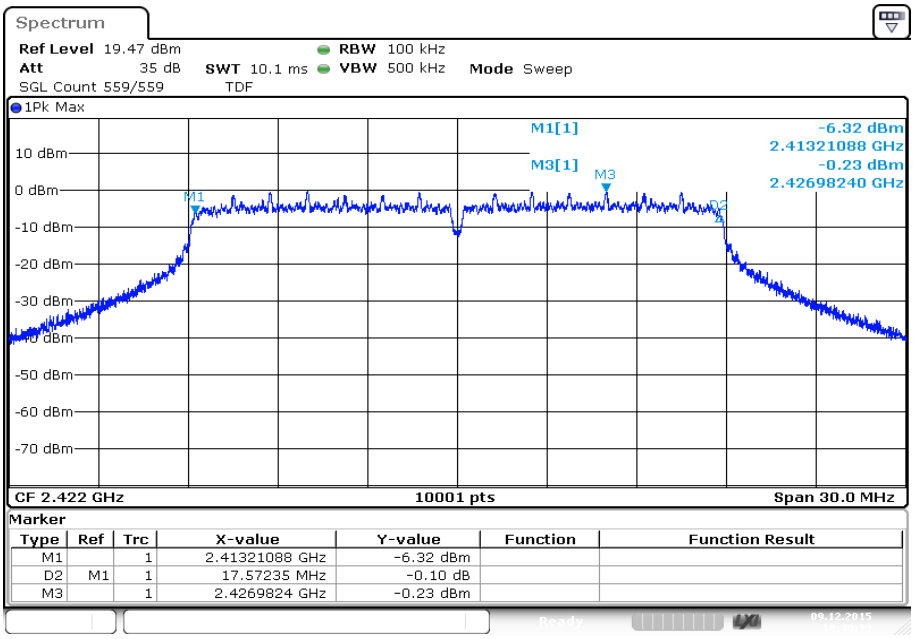
Plots: OFDM / n HT20 – mode, antenna port 2

Plot 1: 2417 MHz



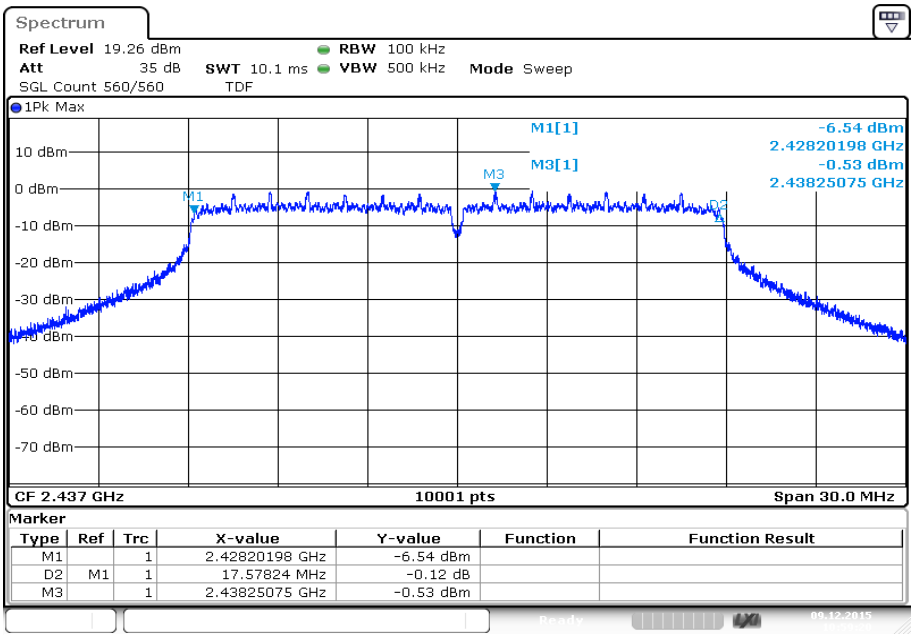
Date: 9.DEC.2015 10:34:26

Plot 2: 2422 MHz



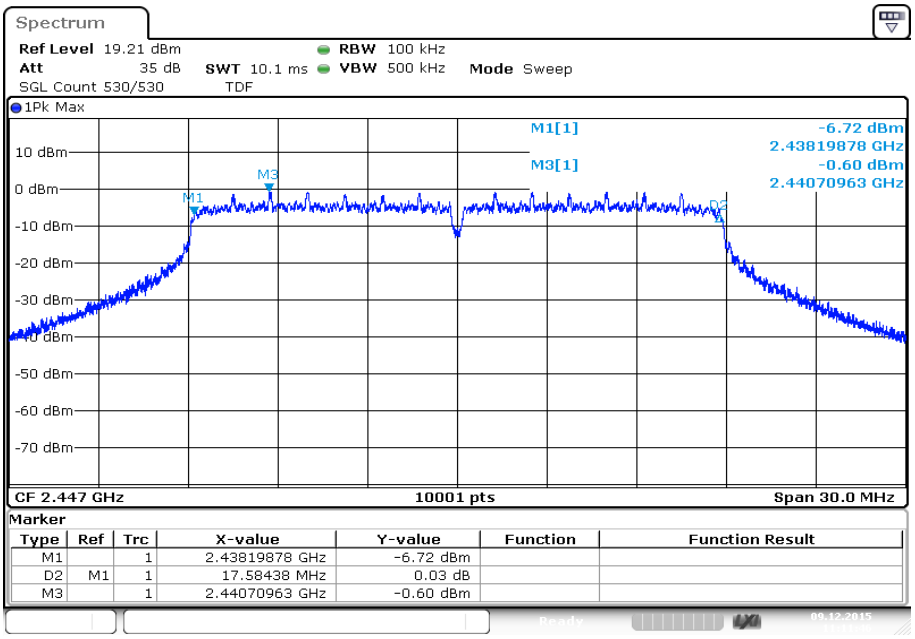
Date: 9.DEC.2015 10:40:40

Plot 3: 2437 MHz



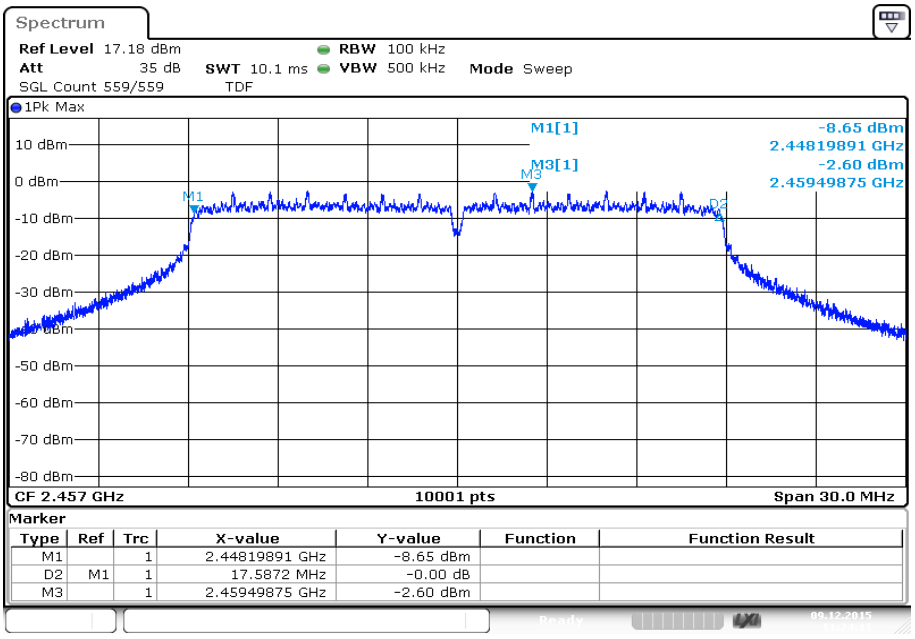
Date: 9.DEC.2015 10:59:21

Plot 4: 2447 MHz



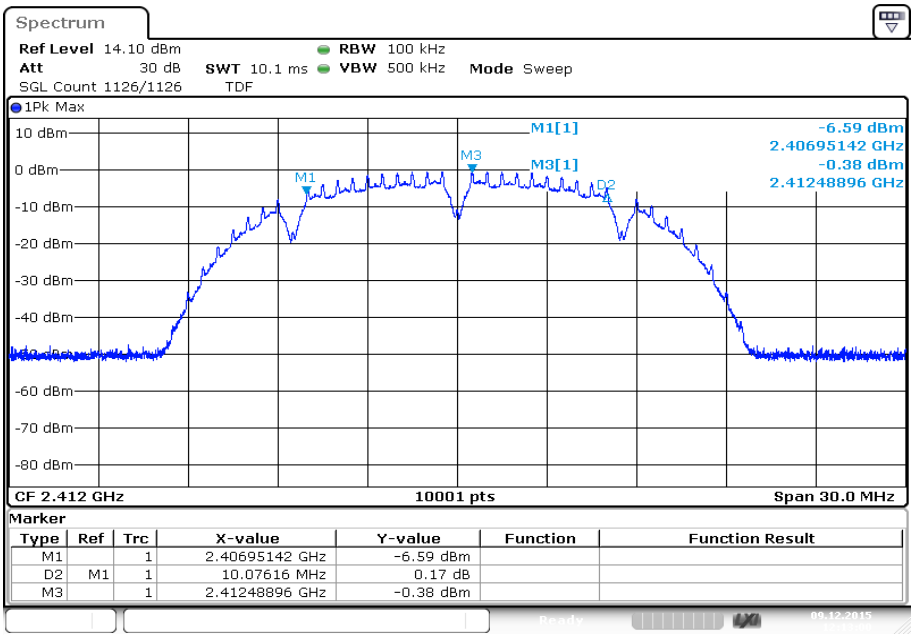
Date: 9.DEC.2015 11:11:47

Plot 5: 2457 MHz



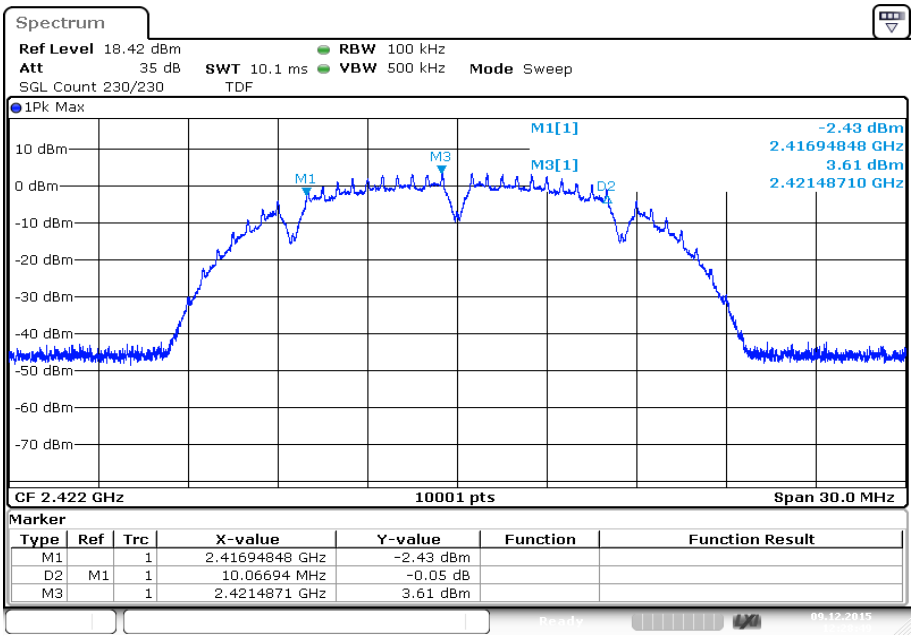
Plots: DSSS / b – mode, antenna port 3

Plot 1: 2412 MHz



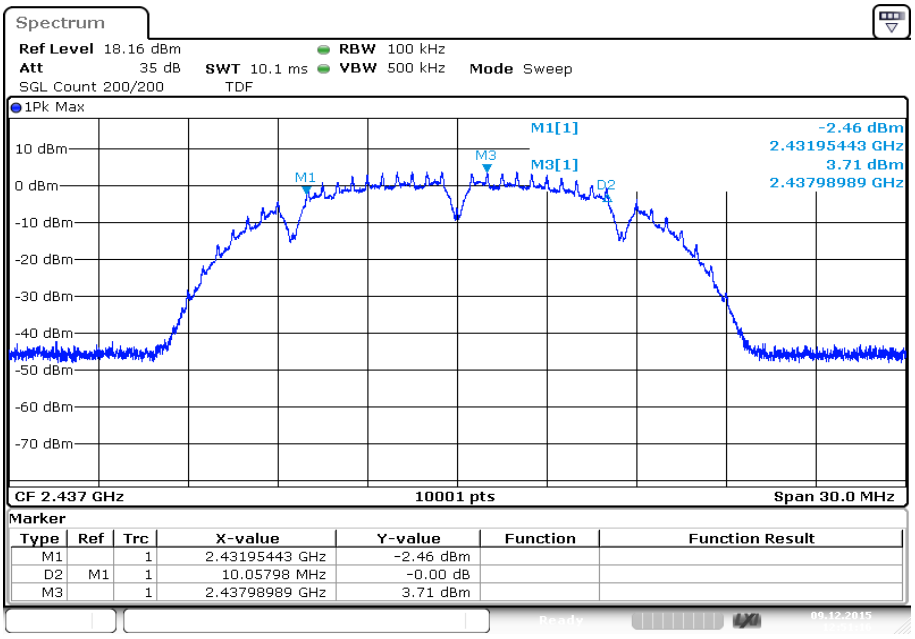
Date: 9.DEC.2015 12:13:01

Plot 2: 2422 MHz



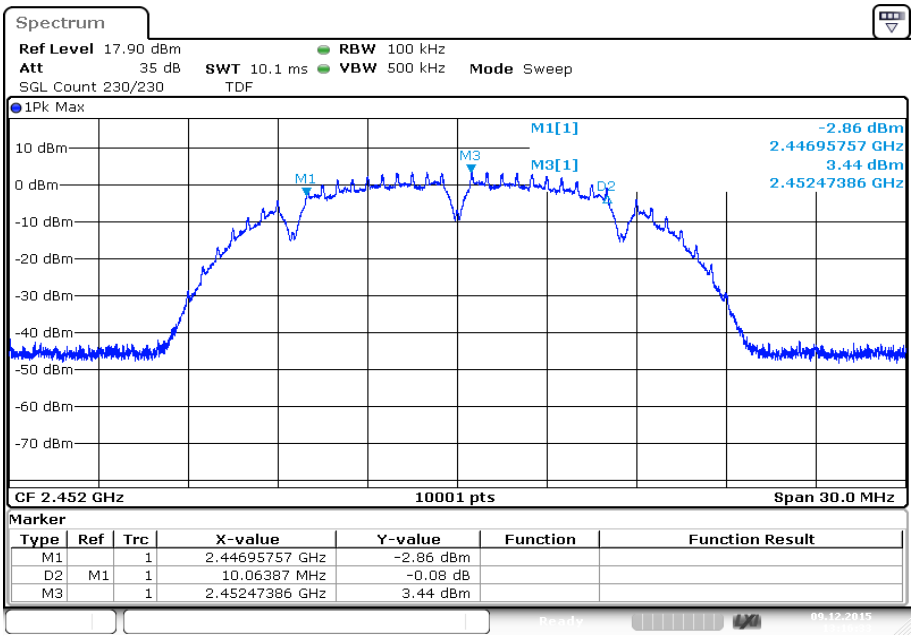
Date: 9.DEC.2015 12:28:49

Plot 3: 2437 MHz



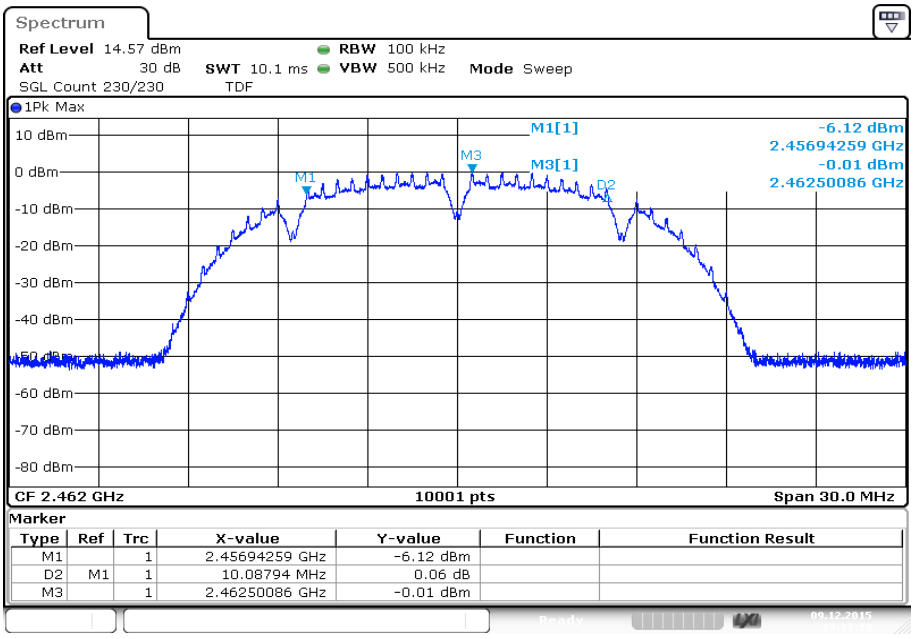
Date: 9.DEC.2015 12:51:17

Plot 4: 2452 MHz



Date: 9.DEC.2015 13:16:34

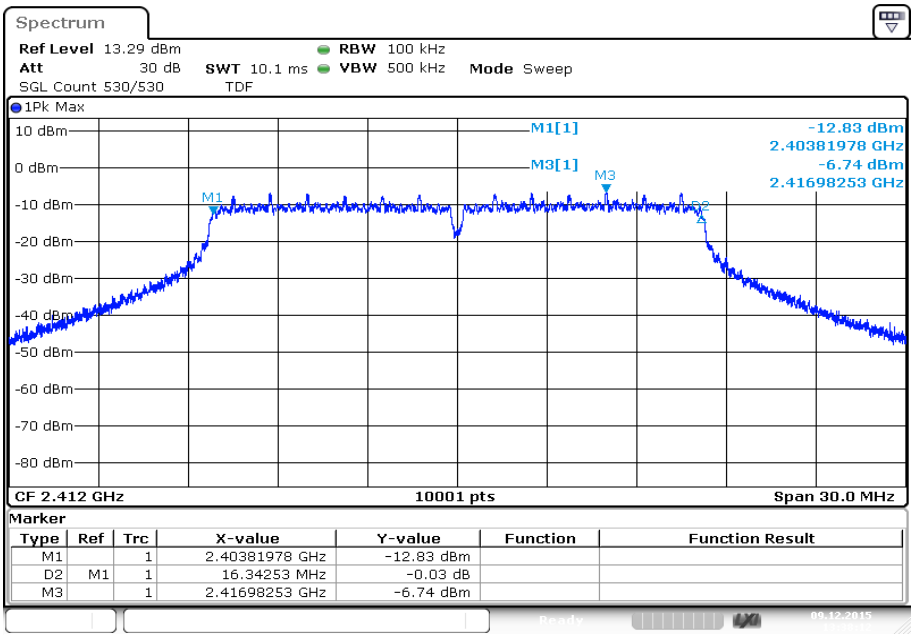
Plot 5: 2462 MHz



Date: 9.DEC.2015 13:31:20

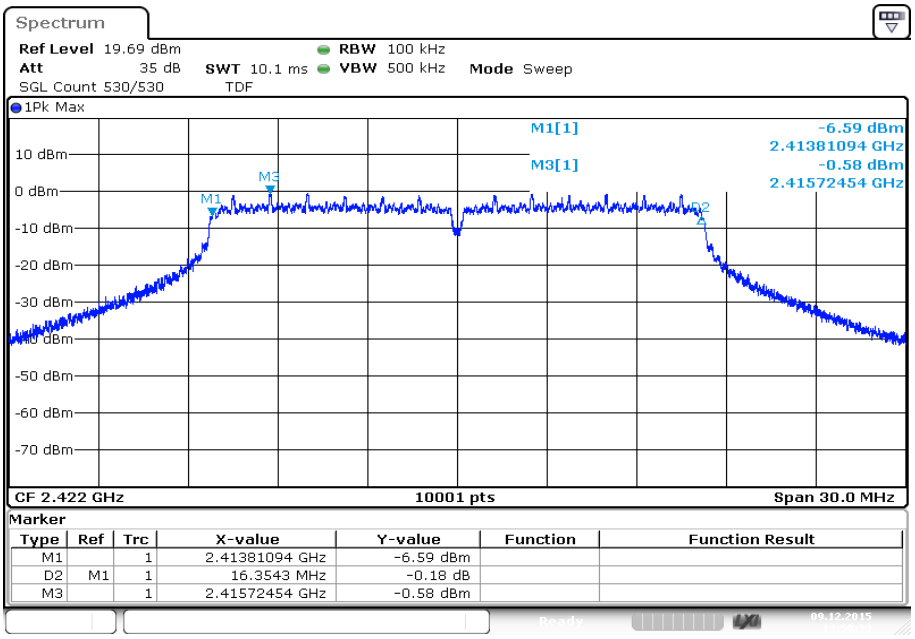
Plots: OFDM / g – mode, antenna port 3

Plot 1: 2412 MHz



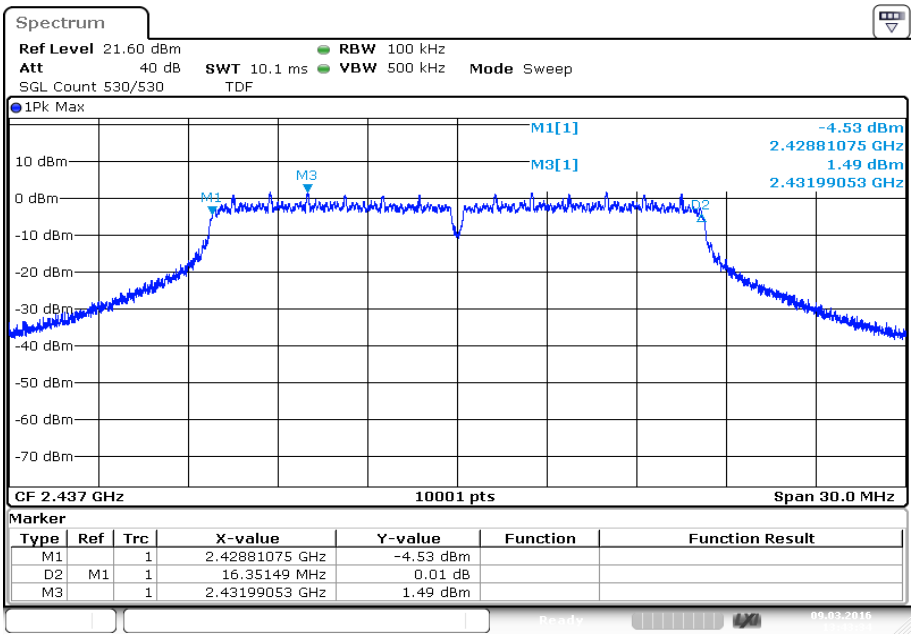
Date: 9.DEC.2015 13:38:13

Plot 2: 2422 MHz

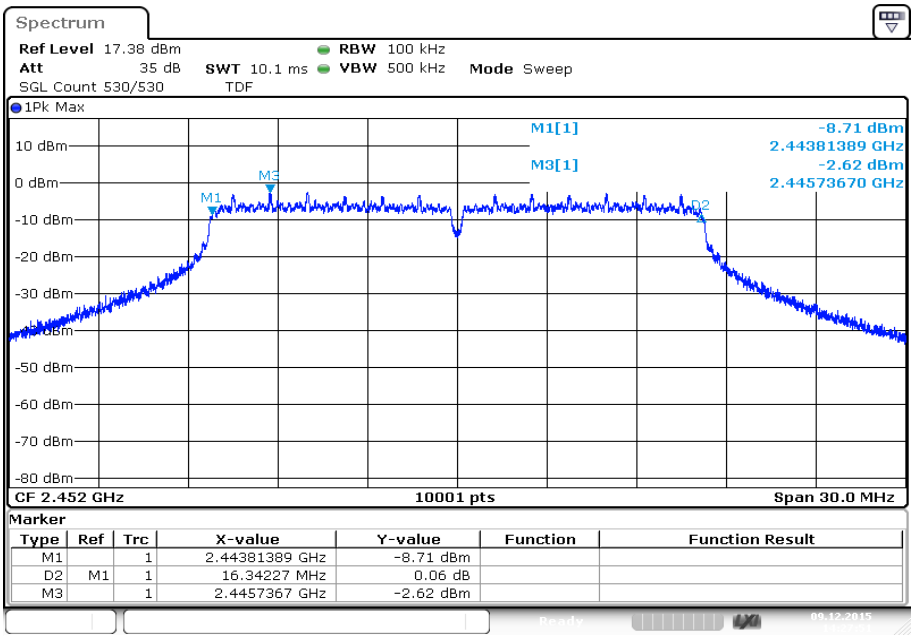


Date: 9.DEC.2015 13:50:40

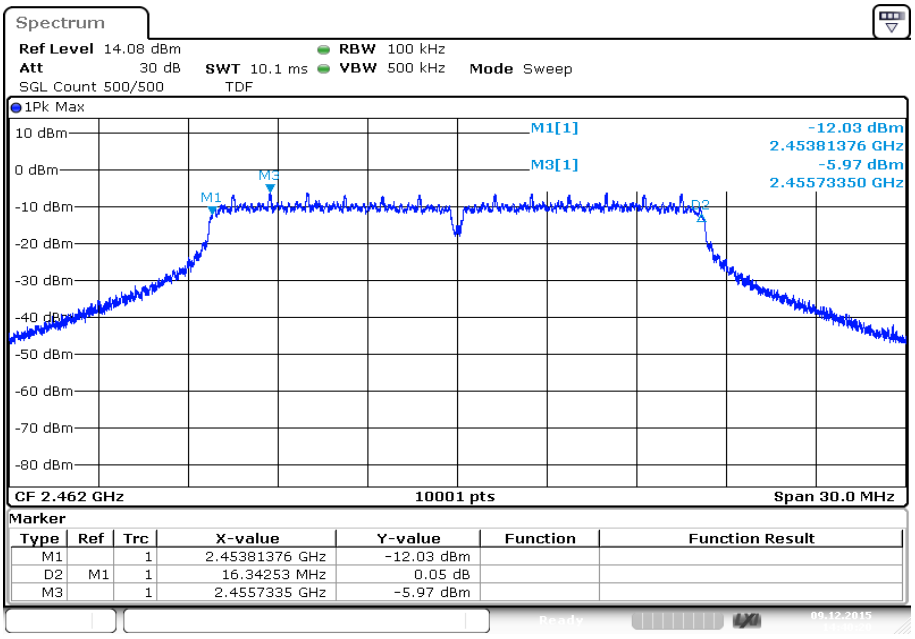
Plot 3: 2437 MHz



Plot 4: 2452 MHz

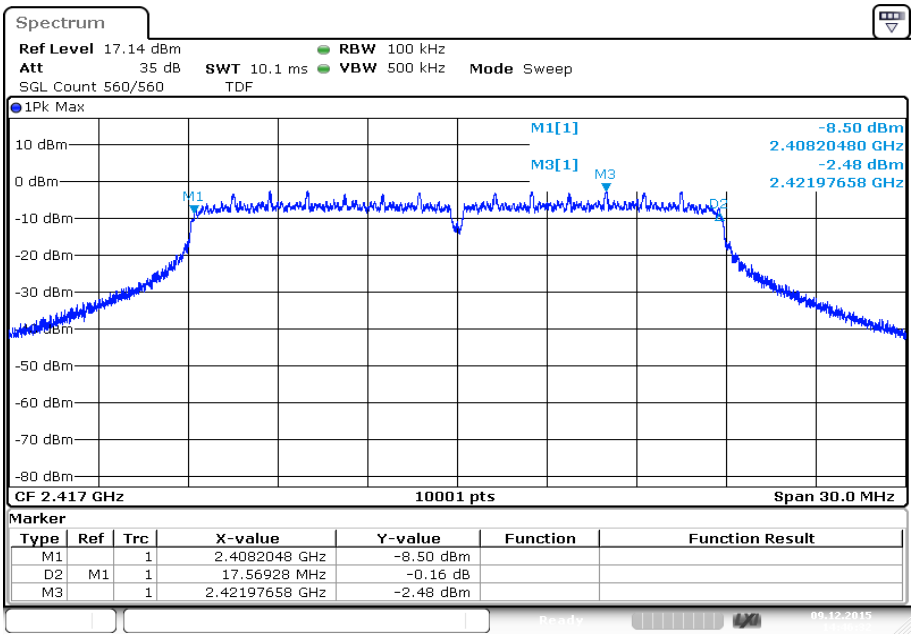


Plot 5: 2462 MHz

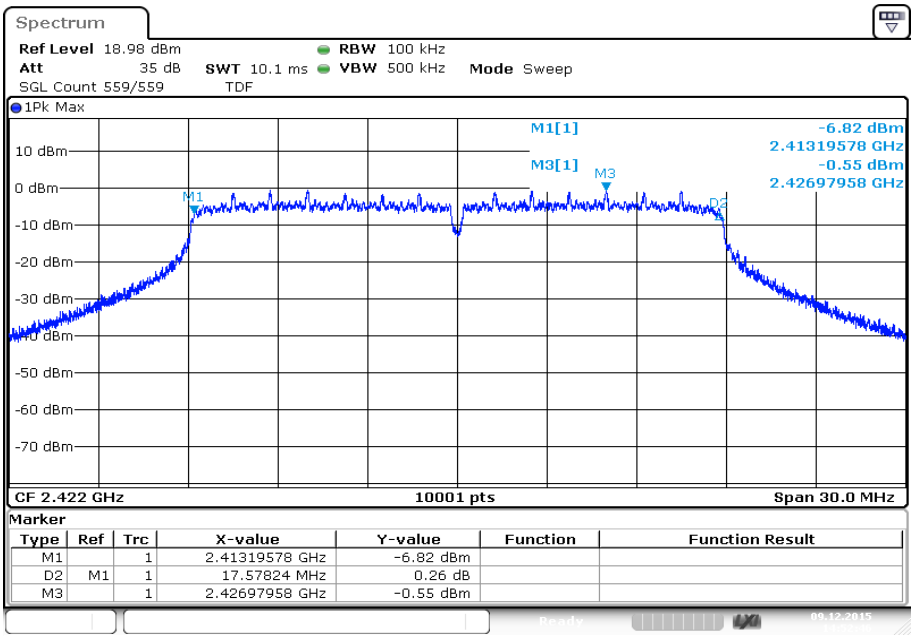


Plots: OFDM / n HT20 – mode, antenna port 3

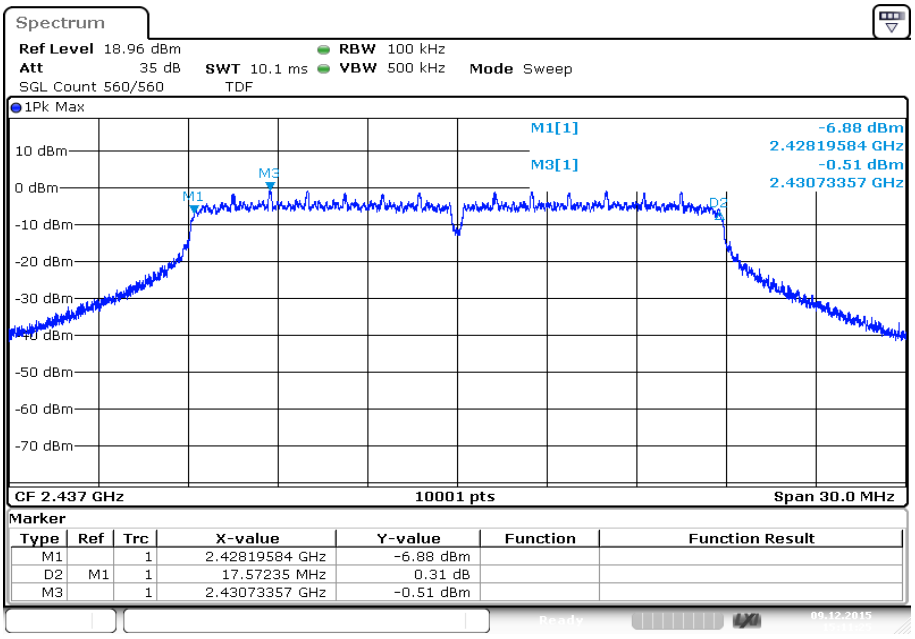
Plot 1: 2417 MHz



Plot 2: 2422 MHz

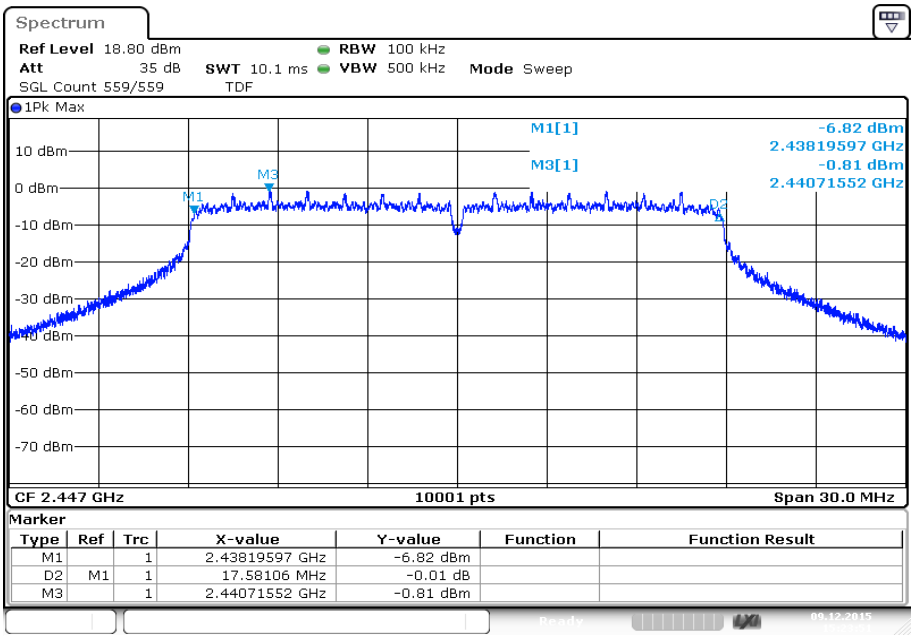


Plot 3: 2437 MHz



Date: 9.DEC.2015 15:11:26

Plot 4: 2447 MHz



Date: 9.DEC.2015 15:23:52

Plot 5: 2457 MHz