
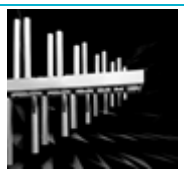


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TEST REPORT

Test report no.: 1-3116/16-01-17-A

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

Testing laboratory

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

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

Applicant

Digi International Inc
11001 Bren Road East
MN 55343 Minnetonka / United States
Phone: +1-952-912-4248
Fax: -/-
Contact: Scott McCall
e-mail: Scott.mccall@digi.com
Phone: +1-952-912-4248

Manufacturer

Digi International Inc
11001 Bren Road East
MN 55343 Minnetonka / United States

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:	**Embedded ARM Module**
Model name:	**ConnectCore 6UL**
FCC ID:	**MCQ-CCIMX6UL**
IC:	**1846A-CCIMX6UL**
Frequency:	DTS band 2400 MHz to 2483.5 MHz
Technology tested:	WLAN IEEE802.11bgn
Antenna:	3 different external antennas
Power supply:	5.0 V DC by C-24000120(RVB) 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=Marco Bertolino, o=CTC advanced GmbH, ou=BTL-161128, email=Marco.Bertolino@ctcadvanced.com, c=DE
2017.05.31 14:42:43 +02'00'

Marco Bertolino
Lab Manager
Radio Communications & EMC

Test performed:

cn=Mihail Dorongovskij, o=CTC advanced GmbH, ou=DOR-281116, email=Mihail.Dorongovskij@ctcadvanced.com, c=DE
2017.05.31 14:36:41 +02'00'

Mihail Dorongovskij
Testing 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. CTC advanced GmbH does not assume responsibility for any conclusions and generalizations drawn from the test results with regard to other specimens or samples of the type of the equipment represented by the test item.
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This test report replaces the test report with the number 1-3116/16-01-17 and dated 2017-04-12

2.2 Application details

Date of receipt of order:	2017-01-16
Date of receipt of test item:	2017-01-16
Start of test:	2017-02-07
End of test:	2017-04-06
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	v03r05	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 conditions required. No tests under extreme conditions required.
Relative humidity content	:		38 %
Barometric pressure	:		1021 hpa
Power supply	:	V_{nom} V_{max} V_{min}	5.0 V DC by C-24000120(RVB) 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	:	Embedded ARM Module
Type identification	:	ConnectCore 6UL
HMN	:	-/-
PMN	:	CC IMX6UL
HVIN	:	55001944-xx
FVIN	:	82004060
S/N serial number	:	Rad. Cond. UL-SBC3-020 Cond. Cond. UL-SBC3-020
HW hardware status	:	55001944-01 rev 1P
SW software status	:	82004060 rev 1P
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
Antenna	:	3 different external antennas
Power supply	:	5.0 V DC by C-24000120(RVB) 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: 1-3116/16-01-01_AnnexA
1-3116/16-01-01_AnnexB
1-3116/16-01-01_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).

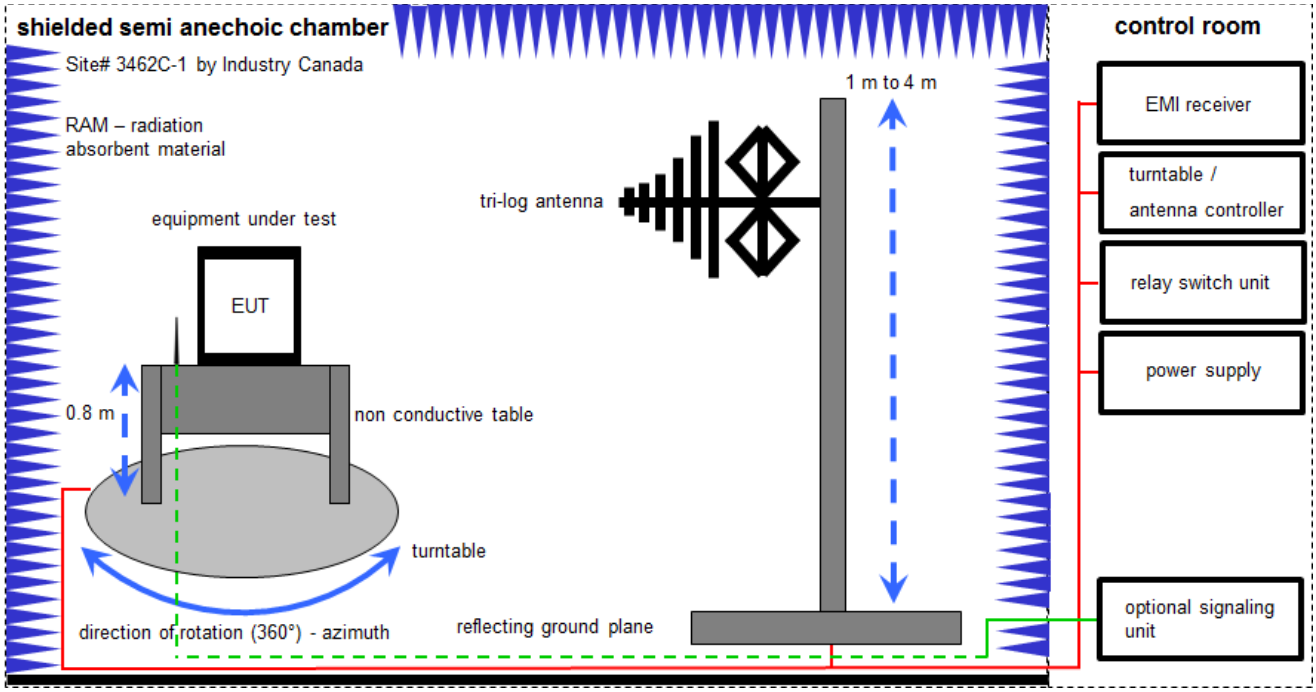
In order to simplify the identification of the equipment used at some special tests, some items of test equipment and ancillaries can be provided with an identifier or number in the equipment list below (Lab/Item).

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 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 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

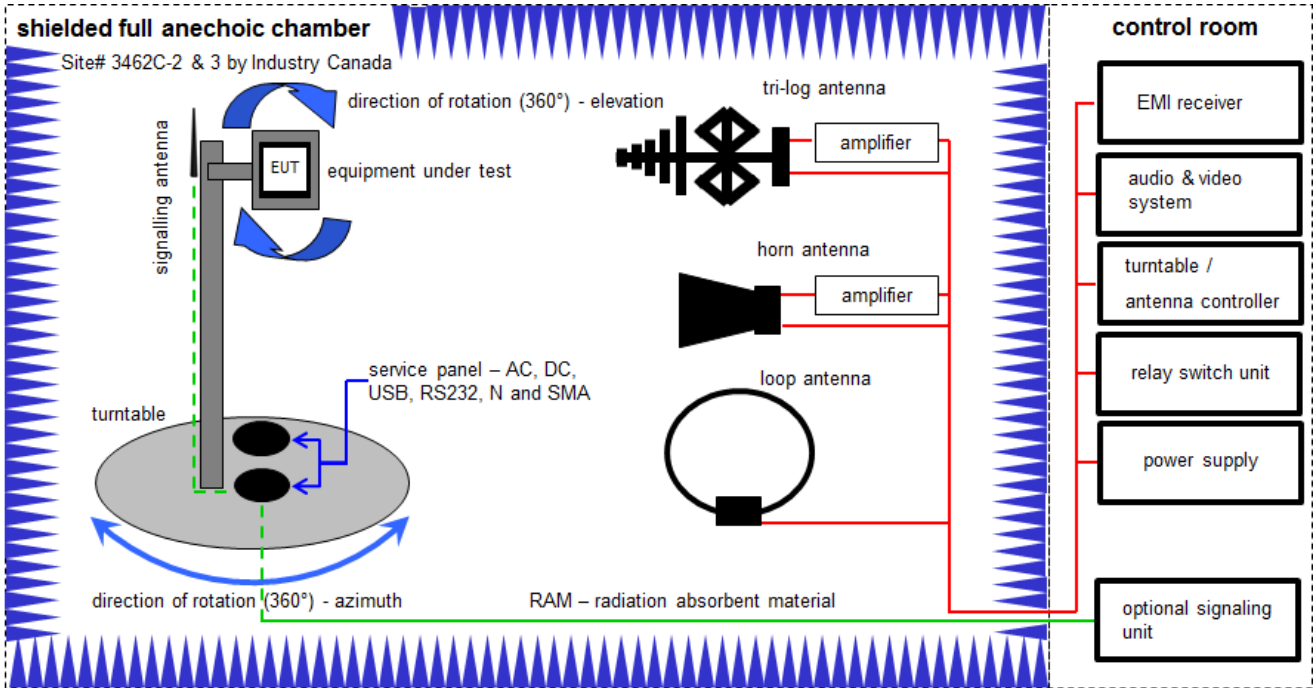
FS = UR + CL + AF
(FS-field strength; UR-voltage at the receiver; CL-loss of the cable; AF-antenna factor)

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	101042	300000551	ne	-/-	-/-
3	A	EMI Test Receiver	ESCI 3	R&S	100083	300003312	k	08.03.2016	08.03.2017
4	A	Analyzer-Reference-System (Harmonics and Flicker)	ARS 16/1	SPS	A3509 07/0 0205	300003314	Ve	02.02.2016	02.02.2018
5	A	Antenna Tower	Model 2175	ETS-Lindgren	64762	300003745	izw	-/-	-/-
6	A	Positioning Controller	Model 2090	ETS-Lindgren	64672	300003746	izw	-/-	-/-
7	A	Turntable Interface-Box	Model 105637	ETS-Lindgren	44583	300003747	izw	-/-	-/-
8	A	TRILOG Broadband Test-Antenna 30 MHz - 3 GHz	VULB9163	Schwarzbeck	295	300003787	k	25.04.2016	25.04.2018

6.2 Shielded fully anechoic chamber



Measurement distance: tri-log antenna and horn antenna 3 meter; loop antenna 3 meter

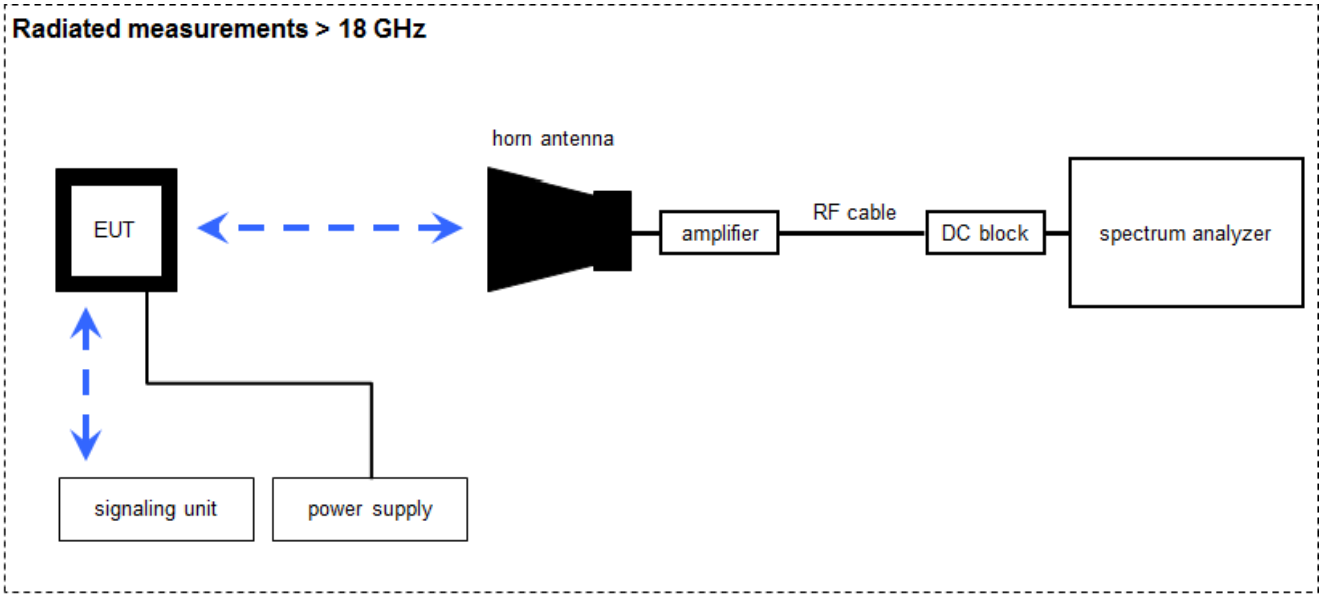
FS = UR + CA + AF
(FS-field strength; UR-voltage at the receiver; CA-loss of the signal path; AF-antenna factor)

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	C	Active Loop Antenna 10 kHz to 30 MHz	6502	EMCO	2210	300001015	k	20.05.2015	20.05.2017
2	A	Double-Ridged Waveguide Horn Antenna 1-18.0GHz	3115	EMCO	9709-5290	300000212	k	13.08.2015	13.08.2017
3	A	Highpass Filter	WHK1.1/15G-10SS	Wainwright	37	400000148	ne	-/-	-/-
4	A	Highpass Filter	WHKX7.0/18G-8SS	Wainwright	18	300003789	ne	-/-	-/-
5	A	Band Reject Filter	WRCG2400/2483-2375/2505-50/10SS	Wainwright	26	300003792	ne	-/-	-/-
6	B	TRILOG Broadband Test-Antenna 30 MHz - 3 GHz	VULB9163	Schwarzbeck	318	300003696	k	22.04.2014	22.04.2017
7	A, B	Broadband Amplifier 0.5-18 GHz	CBLU5184540	CERNEX	22051	300004483	ev	-/-	-/-
8	A, B, C	4U RF Switch Platform	L4491A	Agilent Technologies	MY50000032	300004510	ne	-/-	-/-
9	A, B, C	Messrechner und Monitor	Intel Core i3 3220/3,3 GHz, Prozessor	Huber & Suhner	2V2403033A54 21	300004591	ne	-/-	-/-
10	A, B, C	NEXIO EMV-Software	BAT EMC V3.16.0.49	EMCO	Batch no. 14844	300004682	ne	-/-	-/-
11	A, B, C	Anechoic chamber	ESH3-Z5	TDK	893045/004	300003726	ne	-/-	-/-
12	A, B, C	EMI Test Receiver 9kHz-26,5GHz	ESR26	R&S	101376	300005063	vIKI!	13.09.2016	13.03.2018

6.3 Radiated measurements > 18 GHz



Measurement distance: horn antenna 50 cm

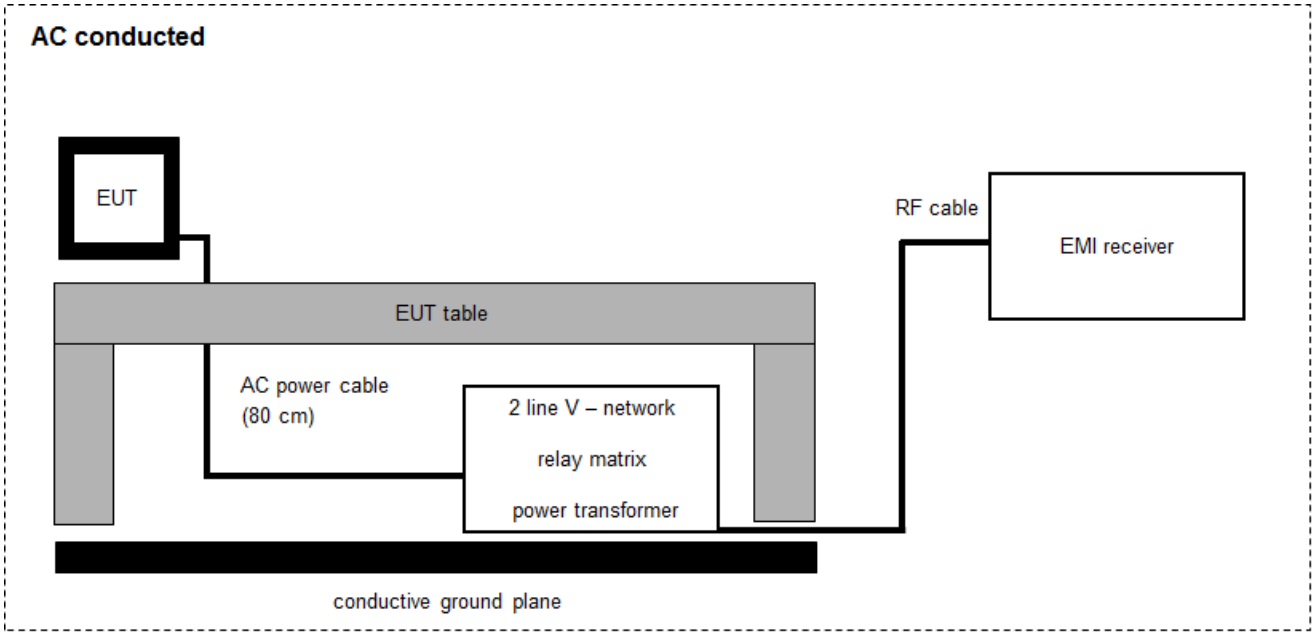
FS = U_R + CA + AF
(FS-field strength; U_R-voltage at the receiver; CA-loss signal path & distance correction; AF-antenna factor)

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.	Kind of Calibration	Last Calibration	Next Calibration
1	A	Std. Gain Horn Antenna 18.0 to 26.5 GHz	638	Narda	-/-	300000486	k	10.09.2015	10.09.2017
2	A	Signal Analyzer 40 GHz	FSV40	R&S	101042	300004517	k	27.01.2017	26.01.2018
3	A	Amplifier 2-40 GHz	JS32-02004000-57-5P	MITEQ	1777200	300004541	ev	-/-	-/-
4	A	RF-Cable	ST18/SMAm/SMAm/48	Huber & Suhner	Batch no. 600918	400001182	ev	-/-	-/-
5	A	RF-Cable	ST18/SMAm/SMAm/48	Huber & Suhner	Batch no. 127377	400001183	ev	-/-	-/-
6	A	DC-Blocker 0.1-40 GHz	8141A	Inmet	-/-	400001185	ev	-/-	-/-

6.4 AC conducted



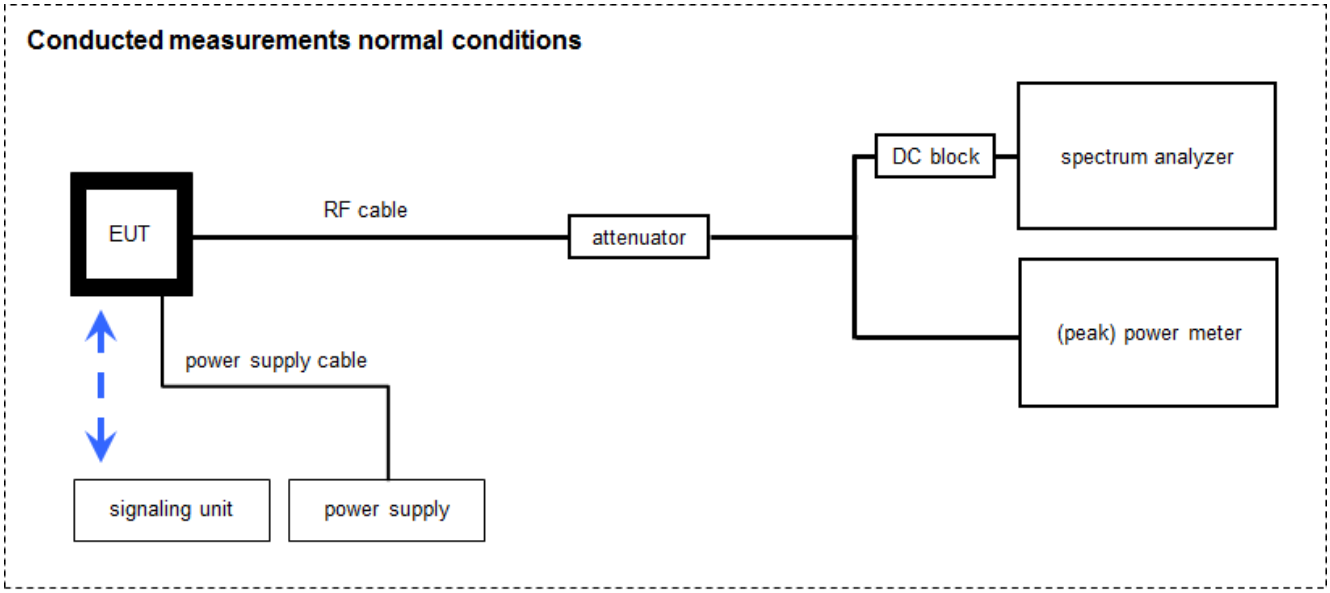
FS = UR + CF + VC
(FS-field strength; UR-voltage at the receiver; CR-loss of the cable and filter; VC-correction factor of the ISN)

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	893045/004	300000584	k	31.01.2017	30.01.2018
2	A	RF-Filter-section	85420E	HP	3427A00162	300002214	k	27.11.2006	-/-
3	A	EM-Injection Clamp	FCC-203i	emv	232	300000626	ev	18.05.2001	-/-
4	A	AC-Spannungsquelle variabel	MV2616-V	EM-Test	0397-12	300003259	k	11.12.2015	11.12.2017
5	A	Hochpass 150 kHz	EZ-25	R&S	100010	300003798	ev	08.04.2008	-/-
6	A	MXE EMI Receiver 20 Hz to 26,5 GHz	N9038A	Agilent Technologies	MY51210197	300004405	k	16.08.2016	16.08.2017

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, B	Switch / Control Unit	3488A	HP	2719A15013	300000151	ne	-/-	-/-
2	A, B	PC-WLAN Tester	Intel Core i3 3220/3,3 GHz, Prozessor	R&S	2V2403033A4523	300004589	ne	-/-	-/-
3	A, B	Teststand	Teststand Custom Sequence Editor	National Instruments GmbH	2V2403033A4523	300004590	ne	-/-	-/-
4	A	Wideband Power Sensor, 50 MHz to 18 GHz	NRP-Z81	R&S	102585	300004863	k	27.01.2017	26.01.2019
5	A, B	PowerSplitter/Combiner 150-6000MHz N-Type	ZB3PD-63-N+	Mini-Circuits	100010	400000451	ev	-/-	-/-
6	A, B	RF-Cable	ST18/SMAm/SMAm/60	Huber & Suhner	Batch no. 606844	400001181	ev	-/-	-/-
7	A, B	Coax Attenuator 10 dB 2W 0-40 GHz	MCL BW-K10-2W44+	Mini Circuits	Batch no. 606844	400001186	ev	-/-	-/-
8	B	DC-Blocker 0.1-40 GHz	8141A	Inmet	Batch no. 127377	400001185	ev	-/-	-/-
9	B	Signal Analyzer 40 GHz	FSV40	R&S	101042	300004517	k	27.01.2017	26.01.2018

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, 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.

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!	2017-05-31	-/-

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	-/-				-/-
RSS – 247 / 6.0	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 - 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 §15.109 RSS - Gen	TX spurious emissions radiated 30 MHz to 1 GHz	-/-	Nominal	Nominal	DSSS OFDM	☒	☐	☐	☐	-/-
§15.247(d) RSS - 247 / 5.5 §15.109 RSS - Gen	TX spurious emissions radiated above 1 GHz	-/-	Nominal	Nominal	DSSS OFDM	☒	☐	☐	☐	-/-
§15.109 RSS-Gen	RX spurious emissions radiated 30 MHz to 1 GHz	-/-	Nominal	Nominal	RX / idle	☒	☐	☐	☐	-/-
§15.109 RSS-Gen	RX spurious emissions radiated above 1 GHz	-/-	Nominal	Nominal	RX / idle	☒	☐	☐	☐	-/-
§15.107(a) §15.207	Conducted emissions < 30 MHz	-/-	Nominal	Nominal	DSSS OFDM	☒	☐	☐	☐	-/-

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

10 Additional comments

Reference documents:

An_PCB_2400-5000_ANTX100P001B24553_v0.pdf
ant-db1-raf-xxx.pdf
Prestta-WLAN-1001932PT_11August2015s.pdf
CC6UL – Antennenstecker.docx

Special test descriptions:

The radiated tests were performed with the ANTX100P001B24553 (PCB) antenna and the ANT-DB1-RAF-xxx (dipole) antenna.
The ANTX100P001B24553 antenna has the highest gain among the two PCB antennas from Chapter 11.1. That way the radiated measurements are covered for both types of antennas.

The EUT has two different ports for external antennas (UFL and MMCX). Simultaneous transmission not possible. The conducted measurements were performed on both ports. The radiated measurements were performed on the UFL port because of the higher output power.

Configuration descriptions:

Used power settings for all measurements:

	Channel 1	Channel 6	Channel 11
b-mode	16	16	16
g-mode	15	15	15
nHT20-mode	14	14	14
	Channel 3	Channel 7	Channel 9
nHT40-mode	10	10	10

Test mode:

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

Antennas and transmit operating modes:

☒ Operating mode 1 (single antenna)

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

☐ Operating mode 2 (multiple antennas, no beamforming)

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

☐ Operating mode 3 (multiple antennas, with beamforming)

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

11 Measurement results

11.1 Antenna gain

Measurement:

The antenna gain of the complete system is calculated by the difference of radiated power in EIRP and the conducted power of the module. For normal WLAN devices, the DSSS mode is used.

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 7.3 – A
Measurement uncertainty:	See sub clause 8

Limits:

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

Results: Declared by applicant according to antenna data sheets

	ISM band 2400 MHz to 2483.5 MHz
ANTX100P001B24553 (PCB)	4.6 dBi
1001932PT (PCB)	2.5 dBi
ANT-DB1-RAF-xxx (Dipole)	2.5 dBi

11.2 Identify worst case data rate

Measurement:

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

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

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

Measurement parameters:

Measurement parameter	
Detector:	Peak
Sweep time:	Auto
Resolution bandwidth:	3 MHz
Video bandwidth:	3 MHz
Trace mode:	Max hold
Test setup:	See sub clause 6.5 – 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
OFDM / n HT40 – mode	MCS0

11.3 Maximum output power

Description:

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

Measurement:

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

Limits:

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

Results: UFL port

Frequency	Maximum Output Power [dBm]		
	2412 MHz	2437 MHz	2462 MHz
Output power conducted DSSS / b – mode	18.0	18.4	18.6
Output power conducted OFDM / g – mode	20.8	20.8	21.3
Output power conducted OFDM / n HT20 – mode	20.3	20.3	20.8
Frequency	2422 MHz	2437 MHz	2452 MHz
Output power conducted OFDM / n HT40 – mode	16.9	17.6	17.7

Results: MMCX port

Frequency	Maximum Output Power [dBm]		
	2412 MHz	2437 MHz	2462 MHz
Output power conducted DSSS / b – mode	17.9	18.3	18.4
Output power conducted OFDM / g – mode	20.8	20.7	21.2
Output power conducted OFDM / n HT20 – mode	20.0	20.1	20.6
Frequency	2422 MHz	2437 MHz	2452 MHz
Output power conducted OFDM / n HT40 – mode	16.8	17.8	17.7

11.4 Duty cycle

Measurement:

Measurement parameters:

Measurement parameter	
Detector:	Peak
Sweep time:	Depends on the signal see plot
Resolution bandwidth:	10 MHz
Video bandwidth:	10 MHz
Trace mode:	Max hold
Test setup:	See sub clause 7.5 - A
Measurement uncertainty:	See sub clause 8

Limits:

FCC	IC
-/-	

Results:

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

11.5 Peak power spectral density

Description:

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

Measurement:

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

Limits:

FCC	IC
8 dBm / 3kHz (conducted)	

Results: UFL port

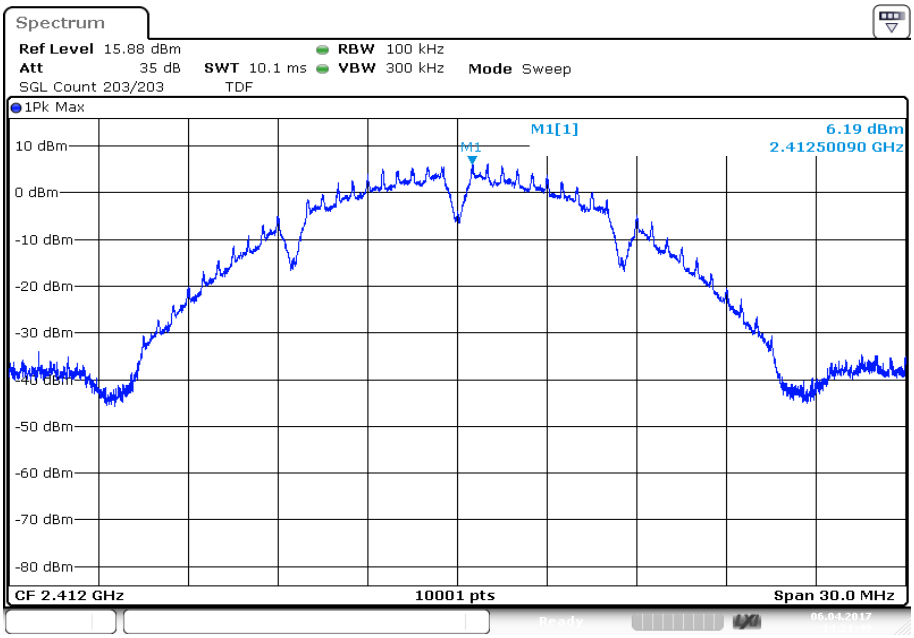
Modulation	Peak power spectral density [dBm]		
Frequency	2412 MHz	2437 MHz	2462 MHz
DSSS / b – mode	6.2	7.0	7.0
OFDM / g – mode	2.7	3.0	3.6
OFDM / n HT20 – mode	1.8	2.2	2.5
Frequency	2422 MHz	2437 MHz	2452 MHz
OFDM / n HT40 – mode	-5.3	-4.0	-4.3

Results: MMCX port

Modulation	Peak power spectral density [dBm]		
Frequency	2412 MHz	2437 MHz	2462 MHz
DSSS / b – mode	6.9	6.8	7.8
OFDM / g – mode	1.9	3.0	3.2
OFDM / n HT20 – mode	1.3	1.9	2.2
Frequency	2422 MHz	2437 MHz	2452 MHz
OFDM / n HT40 – mode	-5.2	-4.4	-4.4

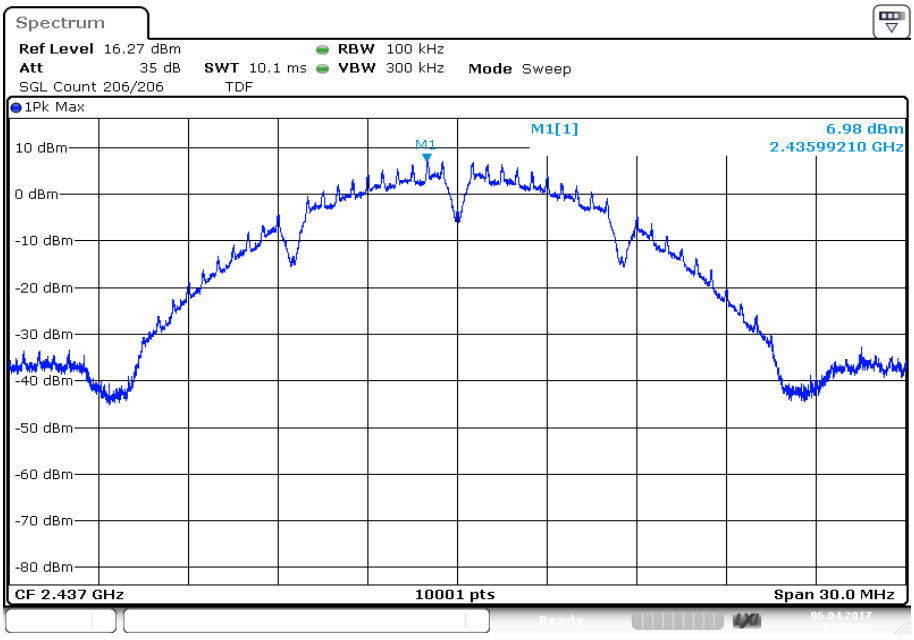
Plots: DSSS / b – mode, UFL port

Plot 1: Lowest channel



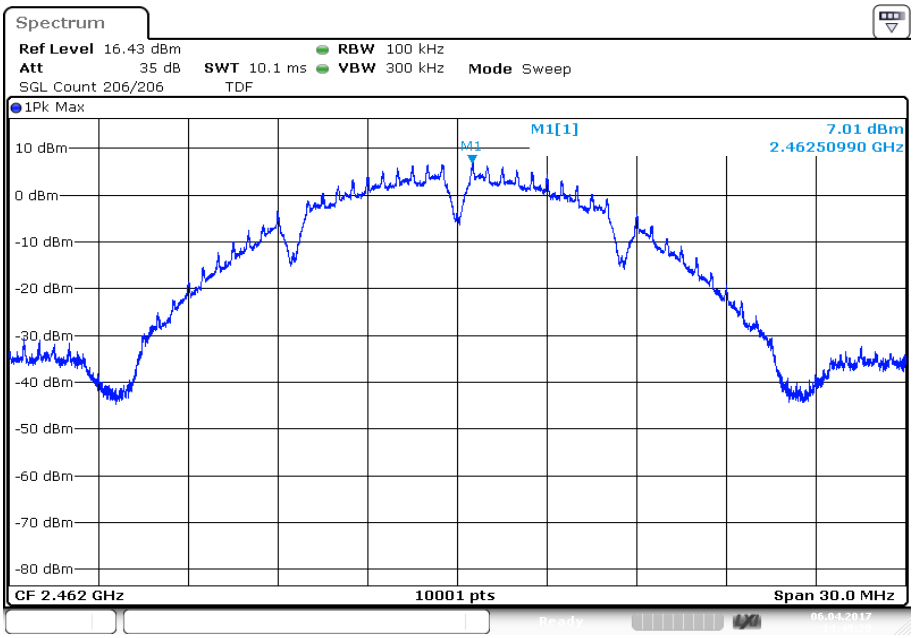
Date: 6.APR.2017 14:21:50

Plot 2: Middle channel



Date: 6.APR.2017 14:39:38

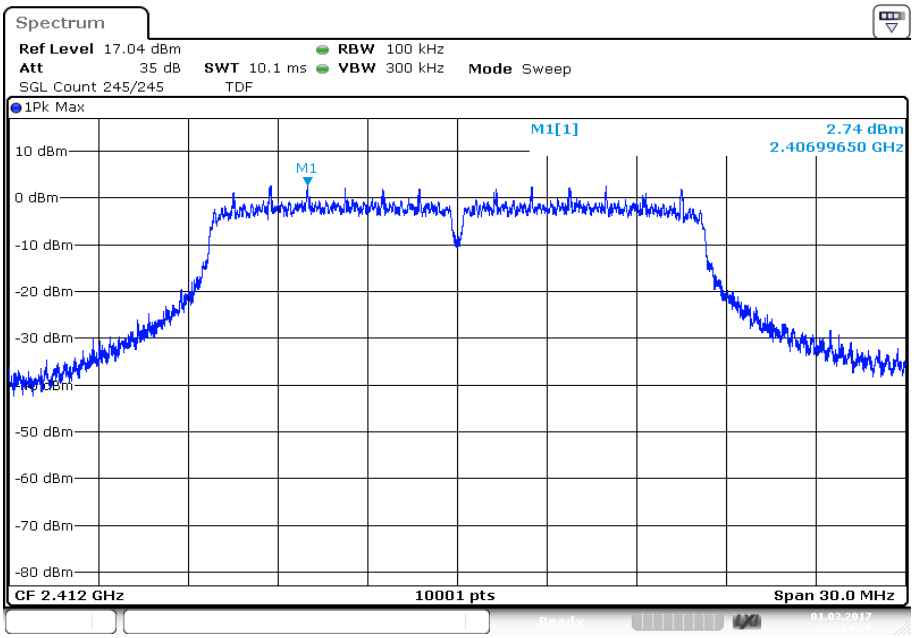
Plot 3: Highest channel



Date: 6.APR.2017 14:49:21

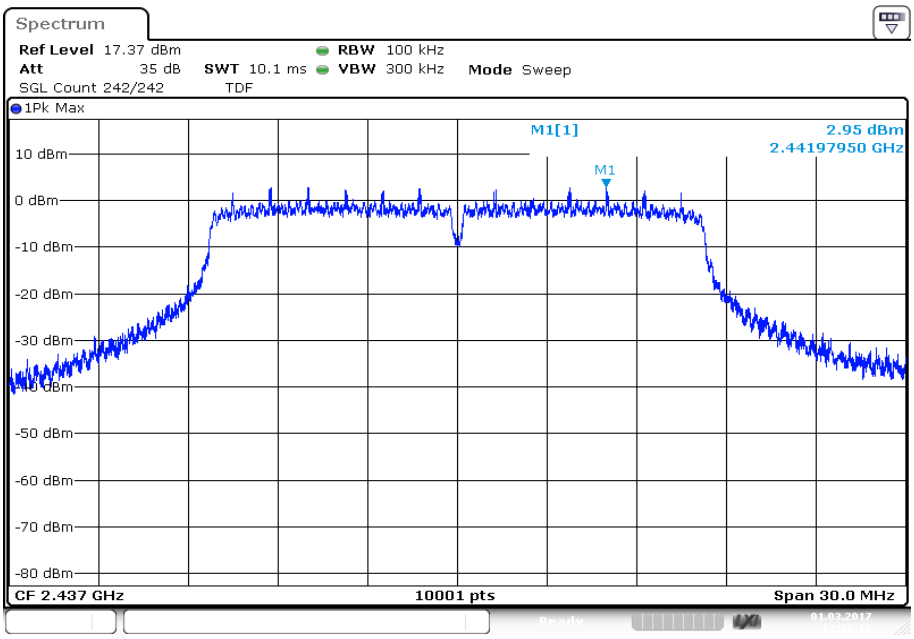
Plots: OFDM / g – mode, UFL port

Plot 1: Lowest channel



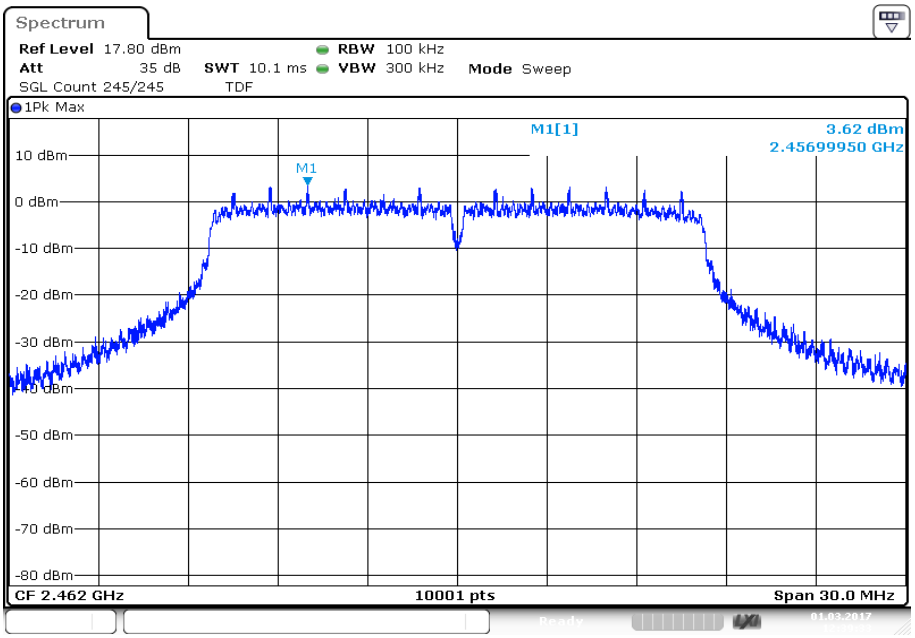
Date: 1.MAR.2017 12:14:40

Plot 2: Middle channel



Date: 1.MAR.2017 12:22:14

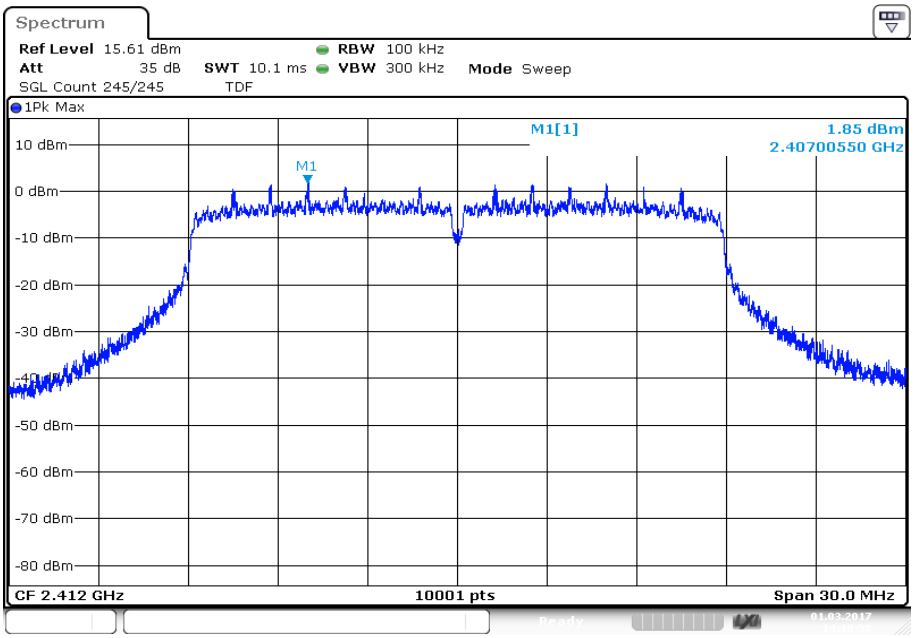
Plot 3: Highest channel



Date: 1.MAR.2017 12:39:33

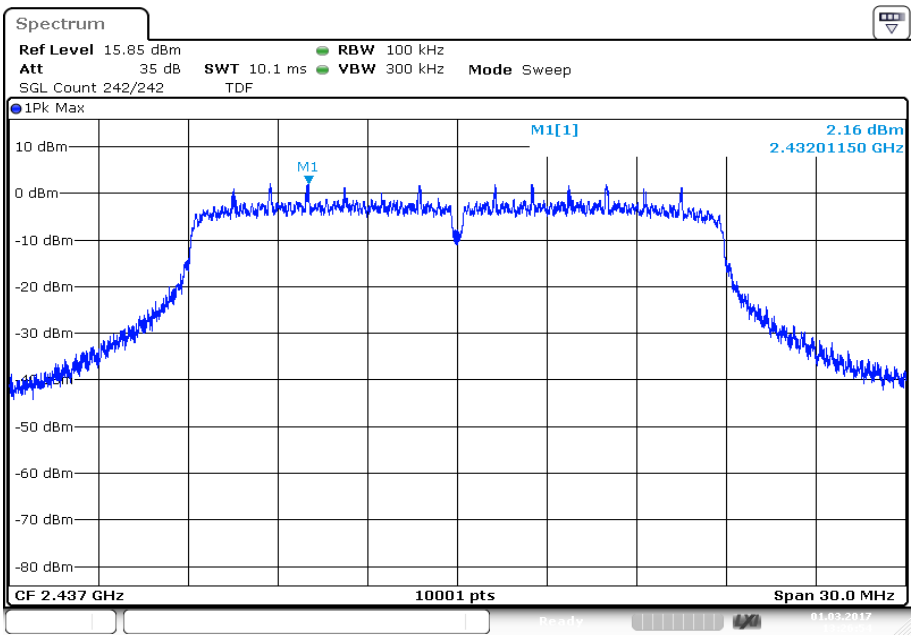
Plots: OFDM / n HT20 – mode, UFL port

Plot 1: Lowest channel



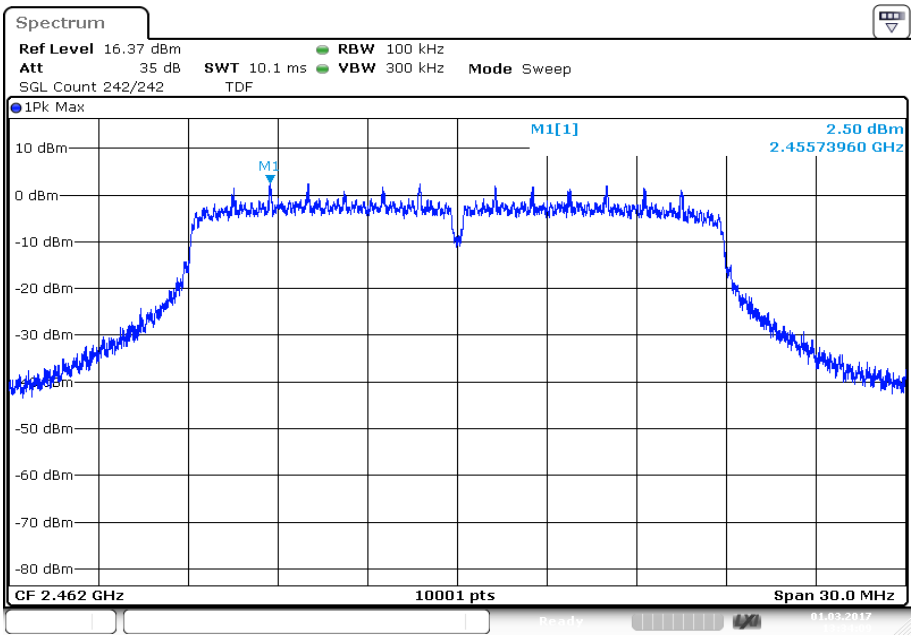
Date: 1.MAR.2017 14:10:59

Plot 2: Middle channel



Date: 1.MAR.2017 13:26:55

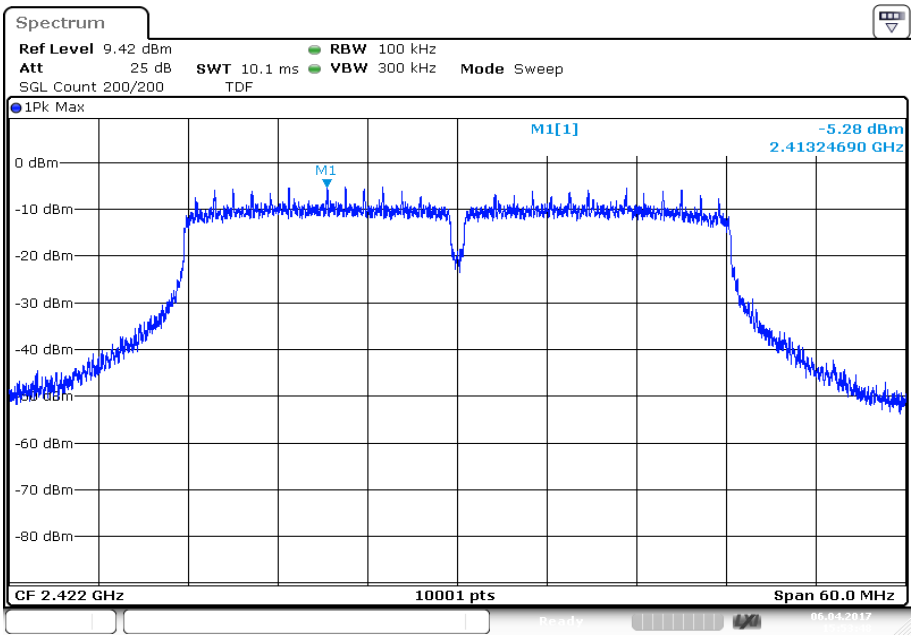
Plot 3: Highest channel



Date: 1.MAR.2017 13:34:10

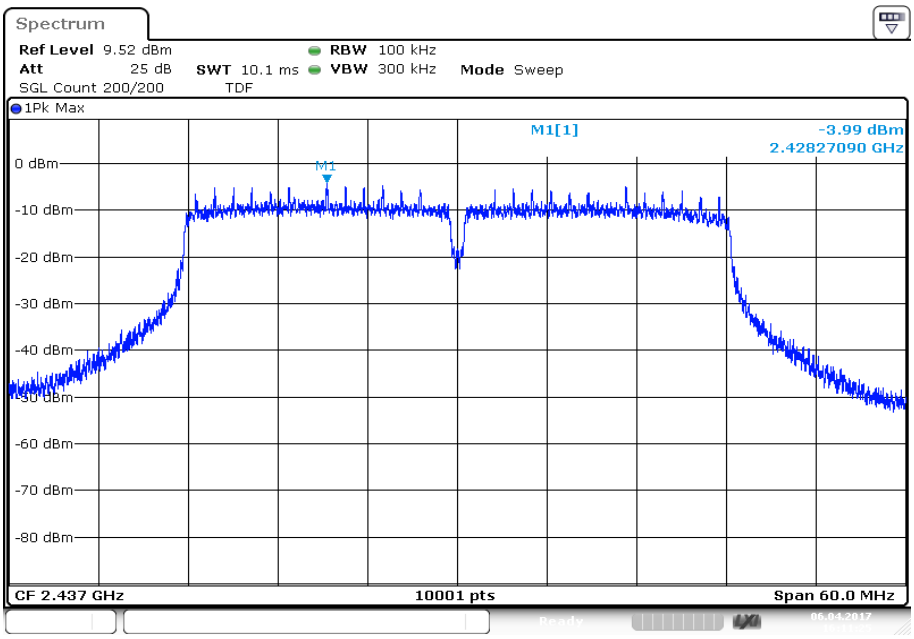
Plots: OFDM / n HT40 – mode, UFL port

Plot 1: Lowest channel



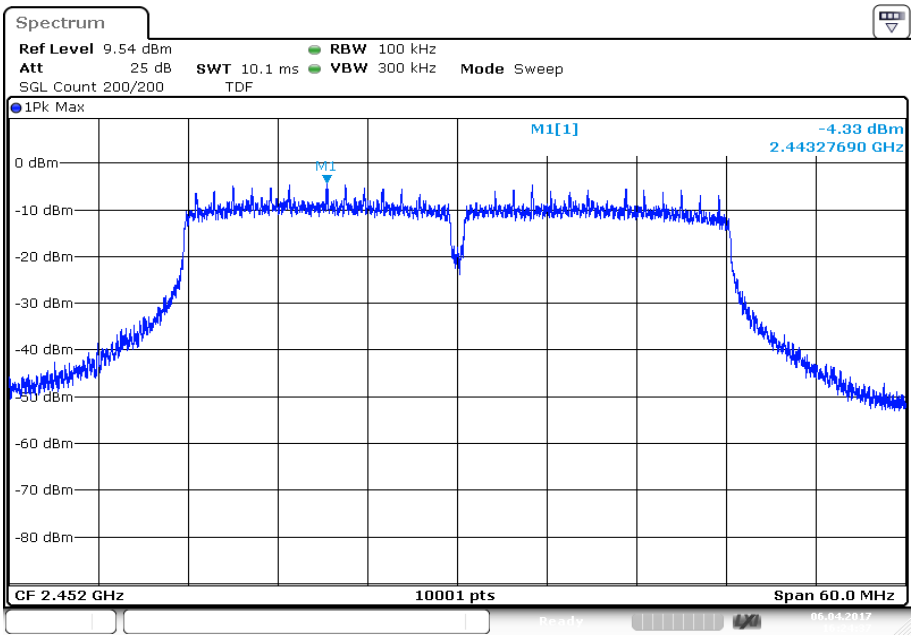
Date: 6.APR.2017 15:53:48

Plot 2: Middle channel



Date: 6.APR.2017 16:11:26

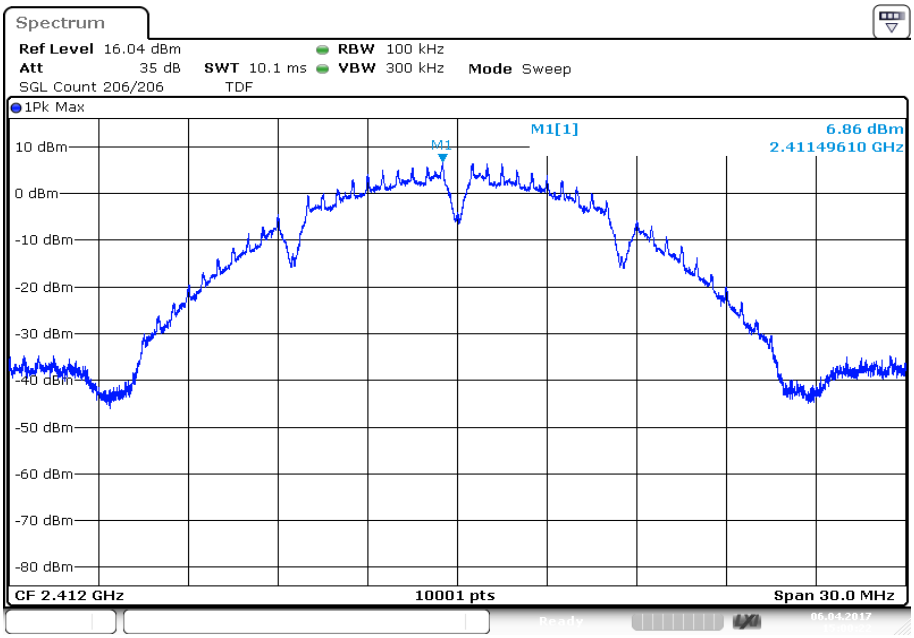
Plot 3: Highest channel



Date: 6.APR.2017 16:24:37

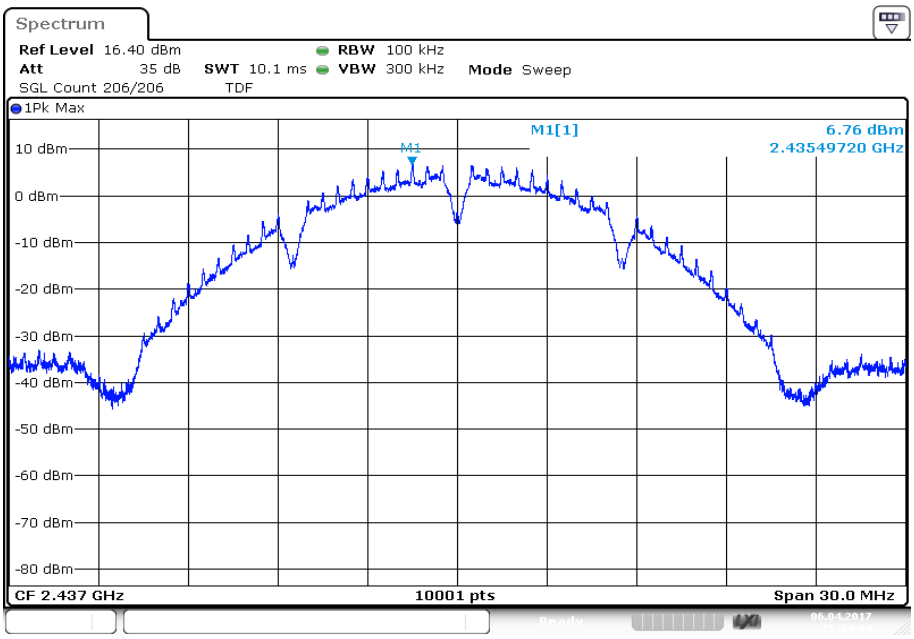
Plots: DSSS / b – mode, MMCX port

Plot 1: Lowest channel



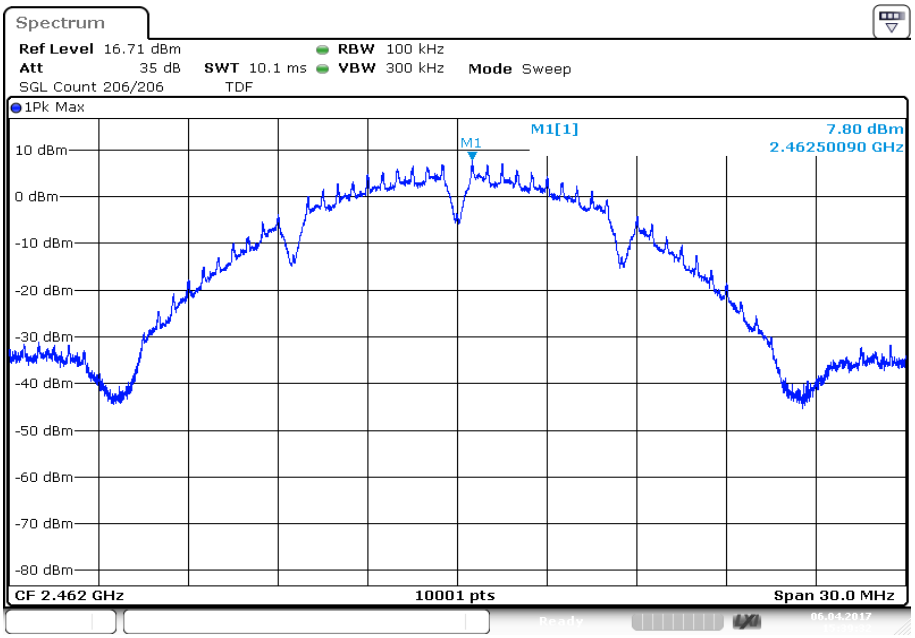
Date: 6.APR.2017 15:00:23

Plot 2: Middle channel



Date: 6.APR.2017 15:14:04

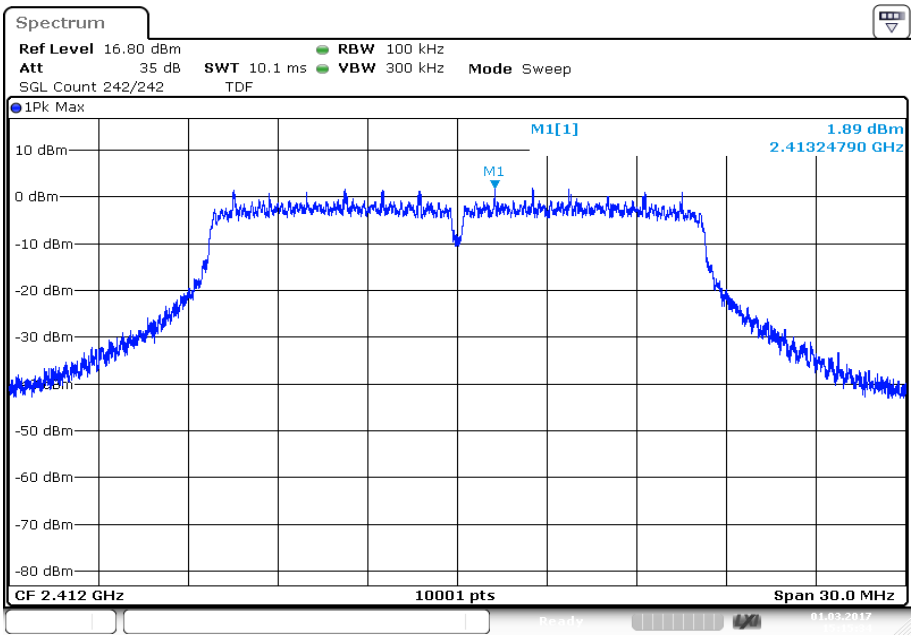
Plot 3: Highest channel



Date: 6.APR.2017 15:39:32

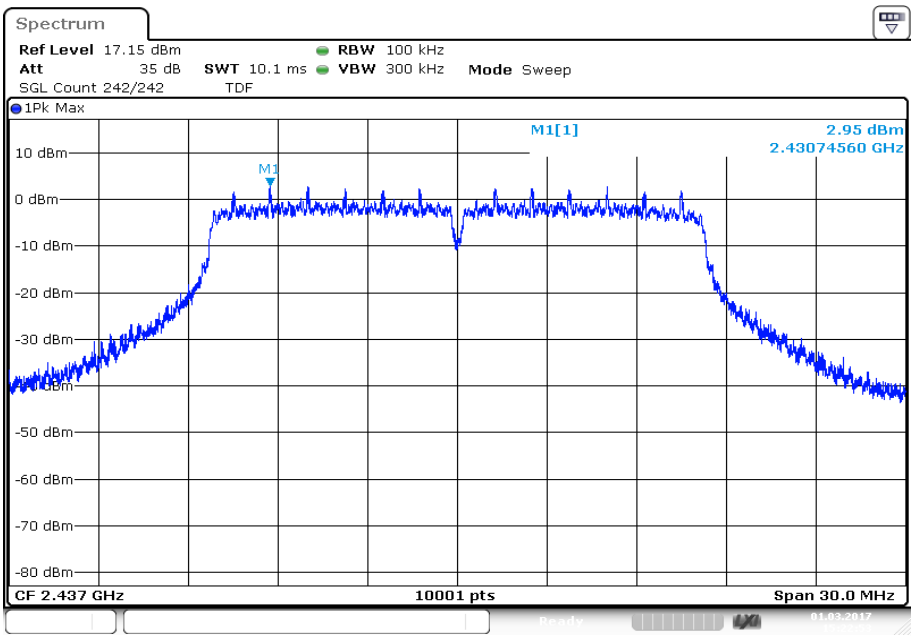
Plots: OFDM / g – mode, MMCX port

Plot 1: Lowest channel



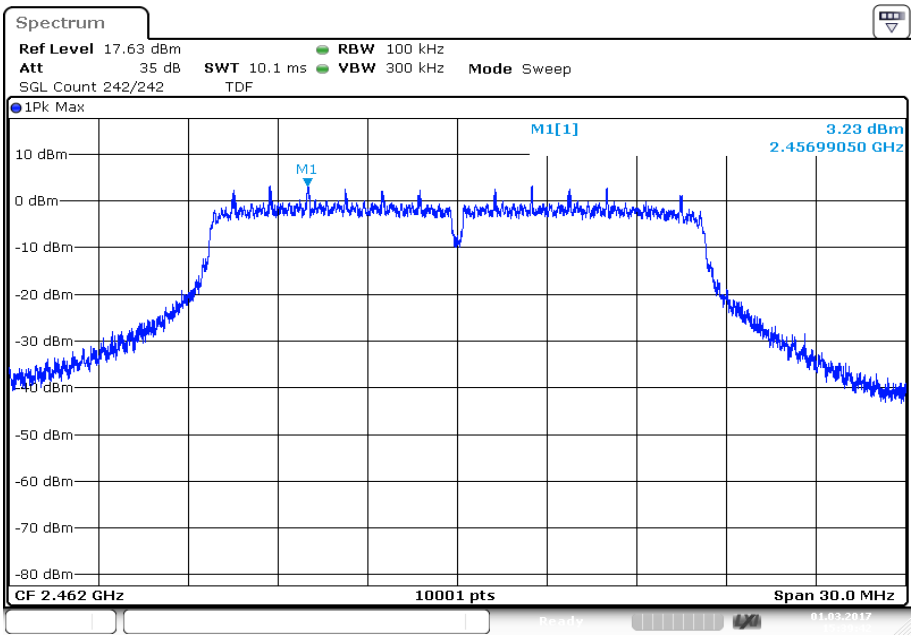
Date: 1.MAR.2017 15:15:35

Plot 2: Middle channel



Date: 1.MAR.2017 15:22:54

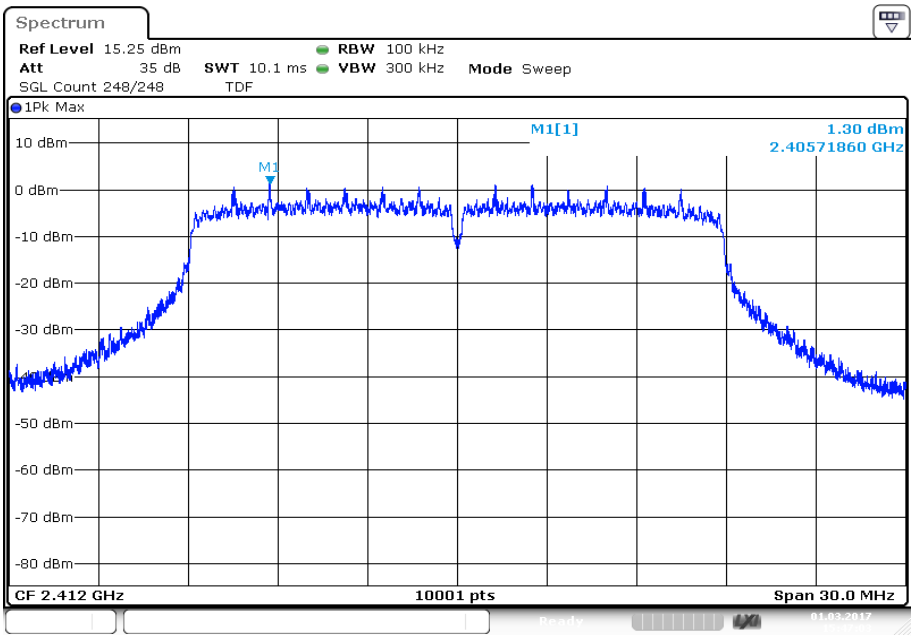
Plot 3: Highest channel



Date: 1.MAR.2017 15:39:43

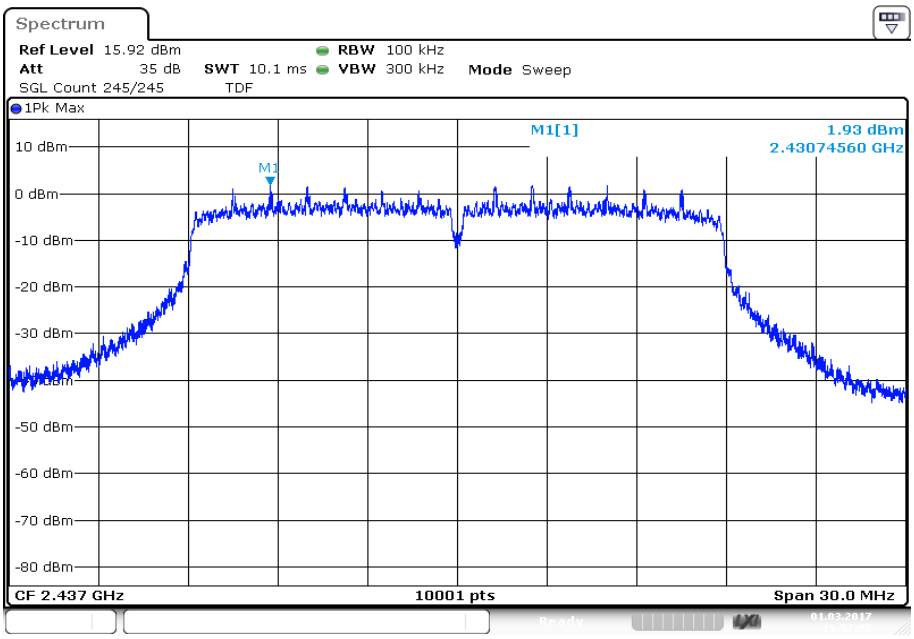
Plots: OFDM / n HT20 – mode, MMCX port

Plot 1: Lowest channel



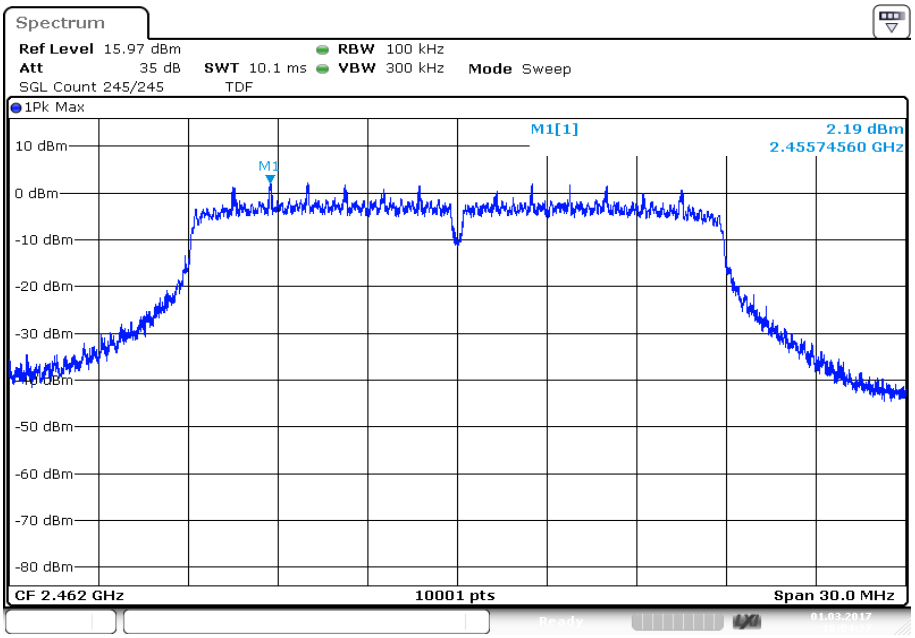
Date: 1.MAR.2017 15:47:04

Plot 2: Middle channel



Date: 1.MAR.2017 15:57:06

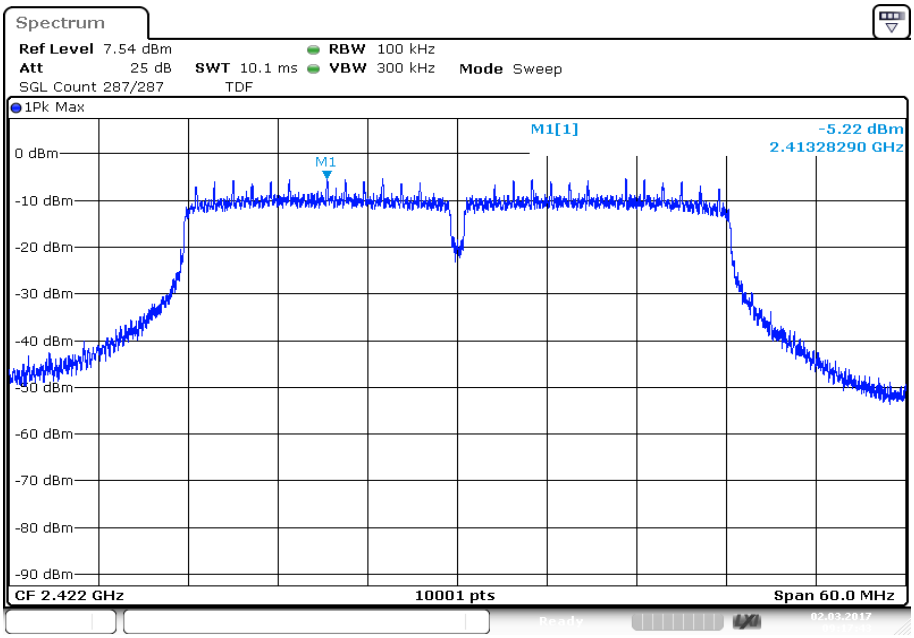
Plot 3: Highest channel



Date: 1.MAR.2017 16:04:38

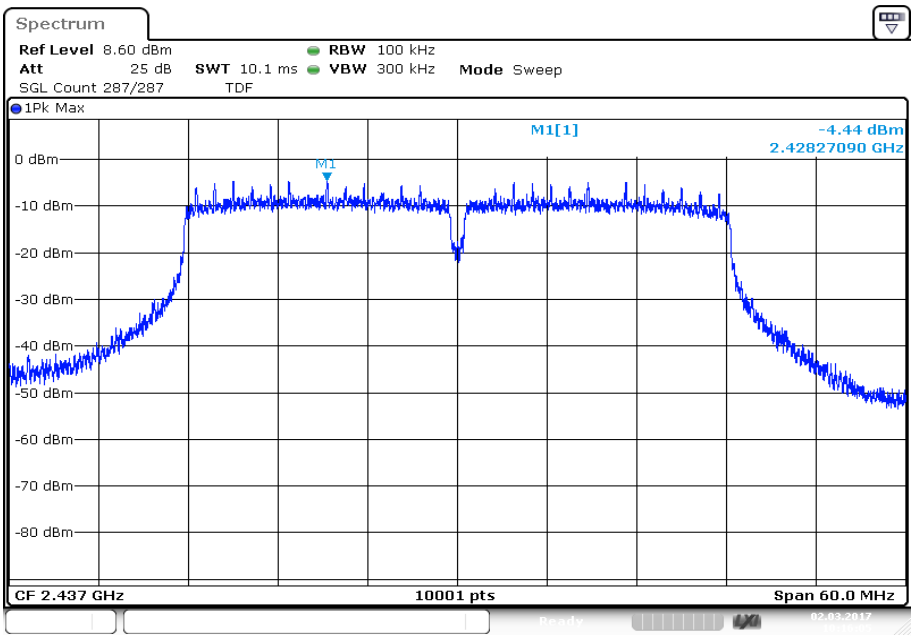
Plots: OFDM / n HT40 – mode, MMCX port

Plot 1: Lowest channel



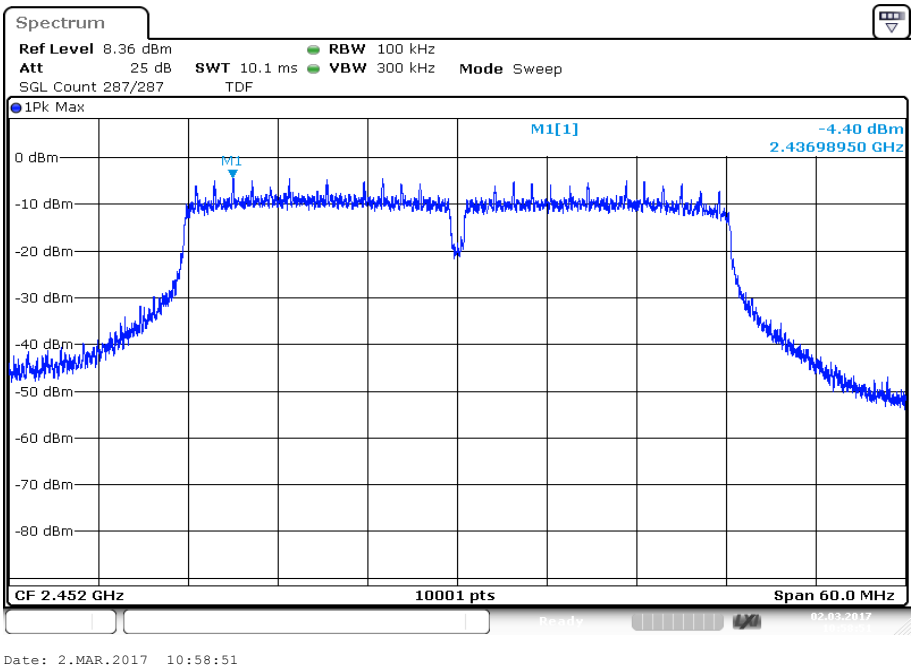
Date: 2.MAR.2017 09:17:43

Plot 2: Middle channel



Date: 2.MAR.2017 10:16:05

Plot 3: Highest channel



11.6 6 dB DTS bandwidth

Description:

Measurement of the 6 dB bandwidth of the modulated signal.

Measurement:

Measurement parameter	
According to DTS clause: 8.1	
Detector:	Peak
Sweep time:	Auto
Resolution bandwidth:	100 kHz
Video bandwidth:	500 kHz
Span:	30 MHz / 50 MHz
Trace mode:	Single count with 200 counts
Test setup:	See sub clause 6.5 – A
Measurement uncertainty	See sub clause 8

Limits:

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

Results: UFL port

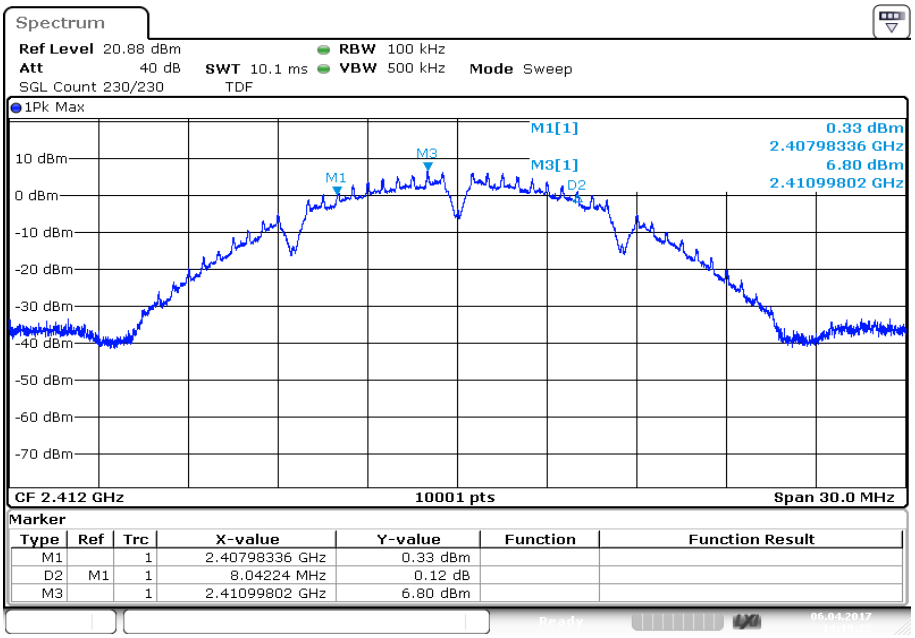
Frequency	6 dB DTS bandwidth [kHz]		
	2412 MHz	2437 MHz	2462 MHz
DSSS / b – mode	8042	8030	8033
OFDM / g – mode	16273	16292	16276
OFDM / n HT20 – mode	17023	16786	16666
Frequency	2422 MHz	2437 MHz	2452 MHz
OFDM / n HT40 – mode	35474	35468	35708

Results: MMCX port

Frequency	6 dB DTS bandwidth [kHz]		
	2412 MHz	2437 MHz	2462 MHz
DSSS / b – mode	8531	8054	8054
OFDM / g – mode	16294	16282	16297
OFDM / n HT20 – mode	16909	17029	16657
Frequency	2422 MHz	2437 MHz	2452 MHz
OFDM / n HT40 – mode	35720	35474	35715

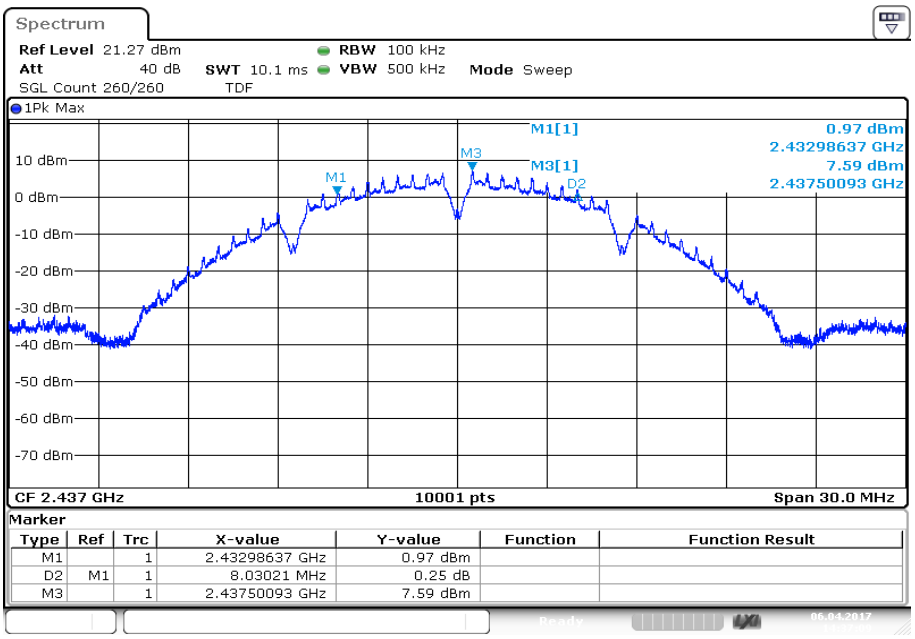
Plots: DSSS / b – mode, UFL port

Plot 1: Lowest channel



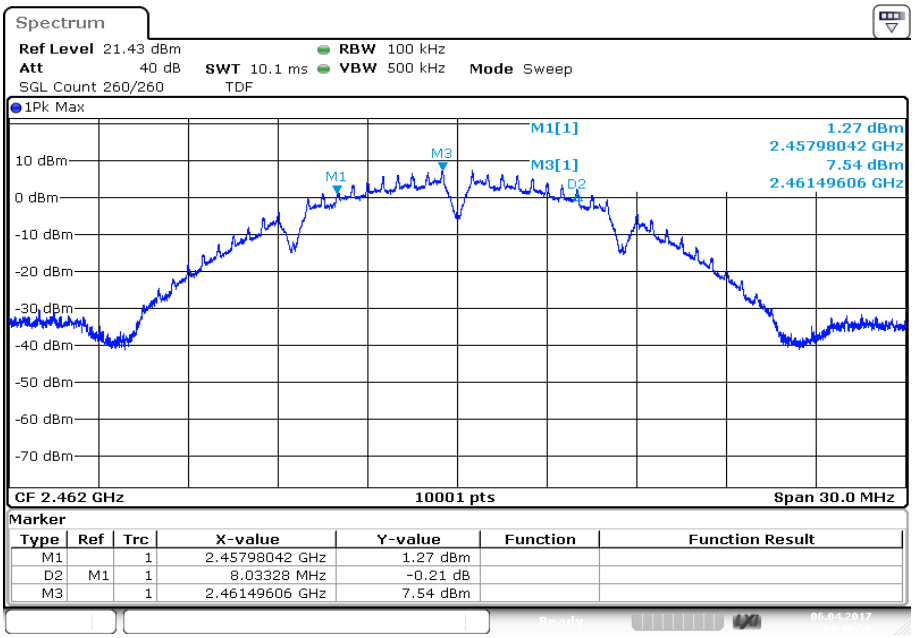
Date: 6.APR.2017 14:19:22

Plot 2: Middle channel



Date: 6.APR.2017 14:37:09

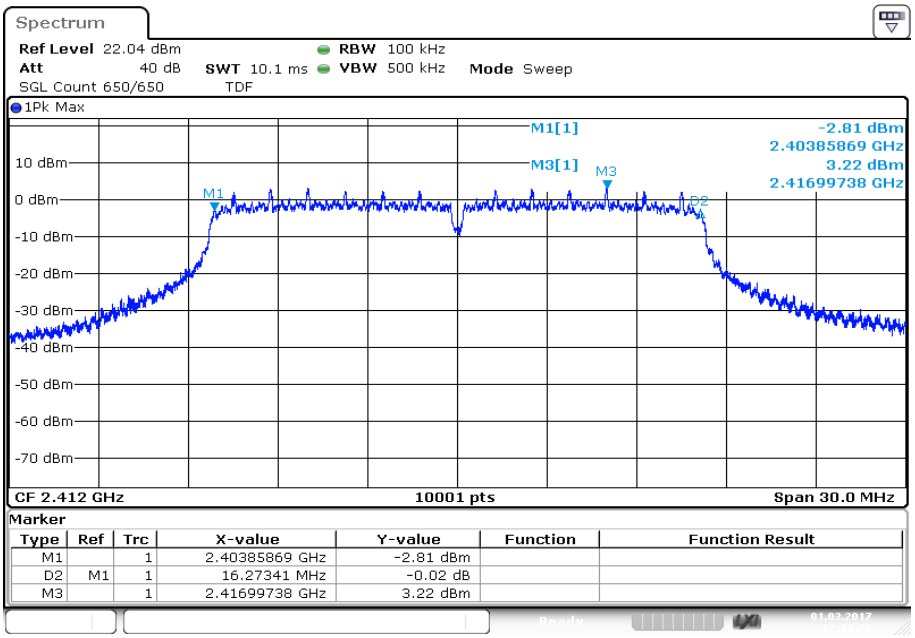
Plot 3: Highest channel



Date: 6.APR.2017 14:46:51

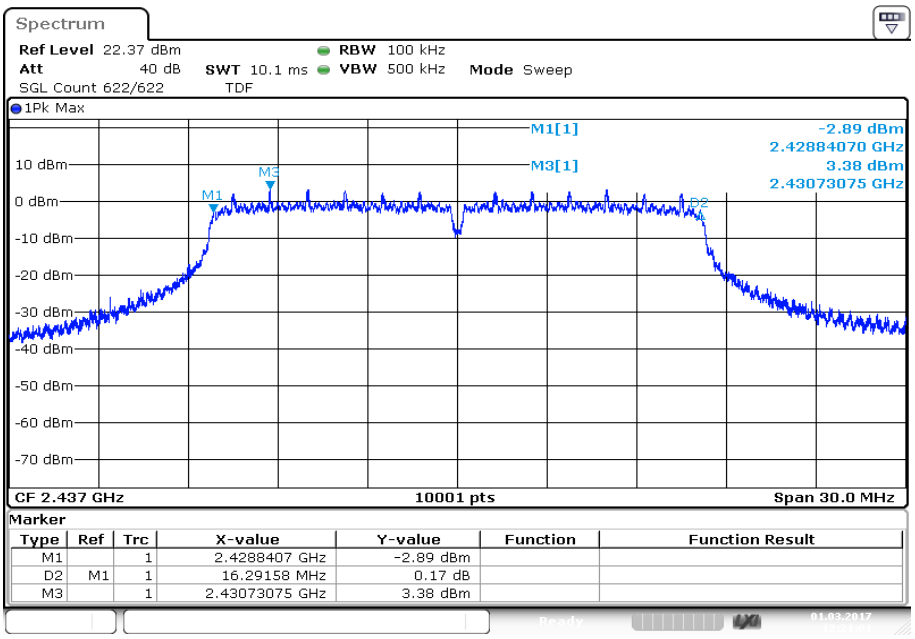
Plots: OFDM / g – mode, UFL port

Plot 1: Lowest channel



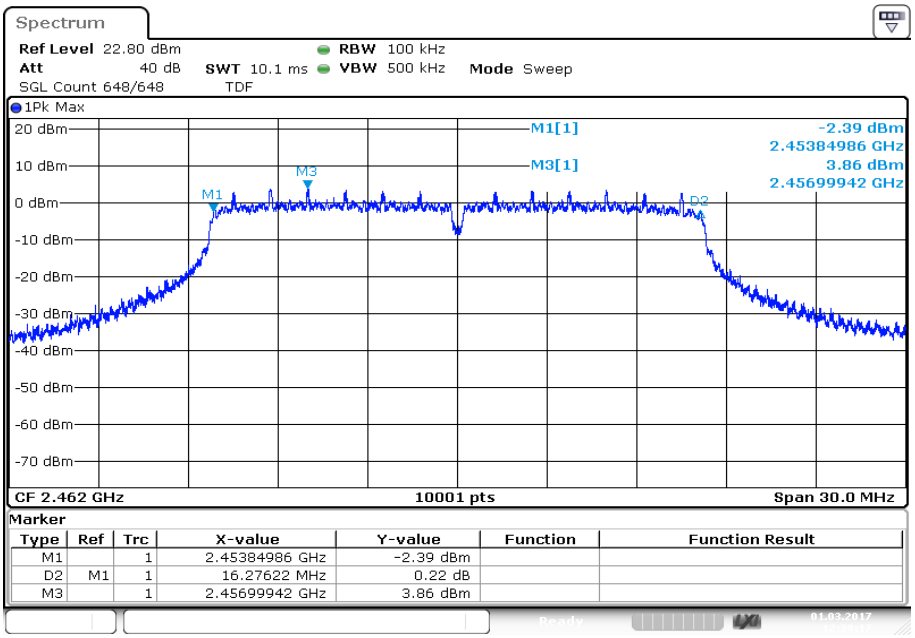
Date: 1.MAR.2017 12:13:29

Plot 2: Middle channel



Date: 1.MAR.2017 12:21:02

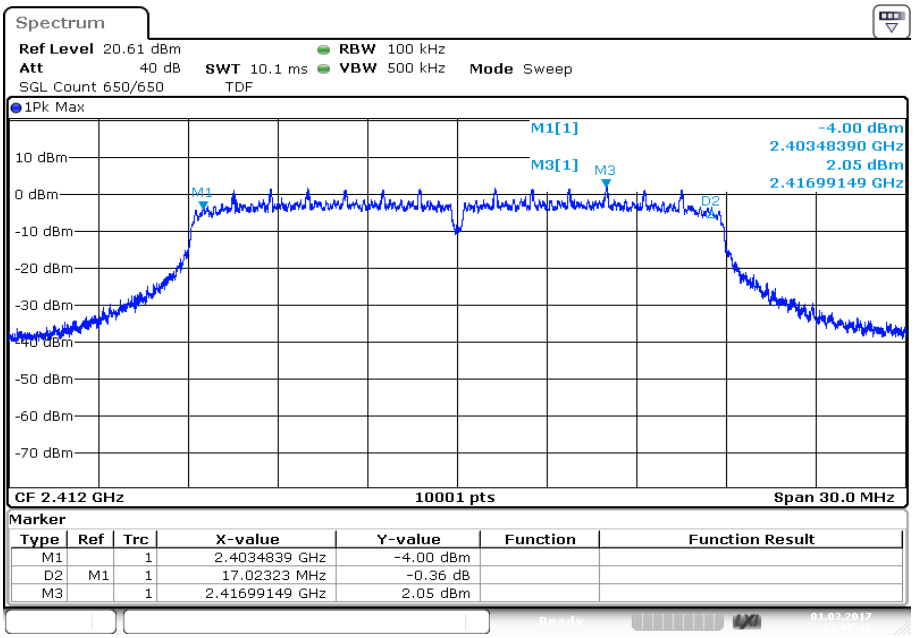
Plot 3: Highest channel



Date: 1.MAR.2017 12:38:18

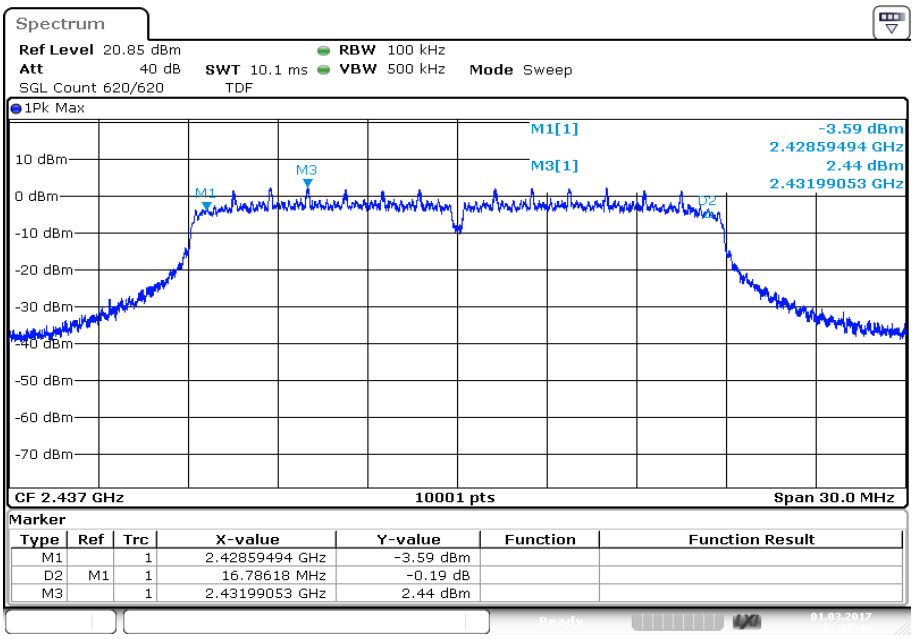
Plots: OFDM / n HT20 – mode, UFL port

Plot 1: Lowest channel



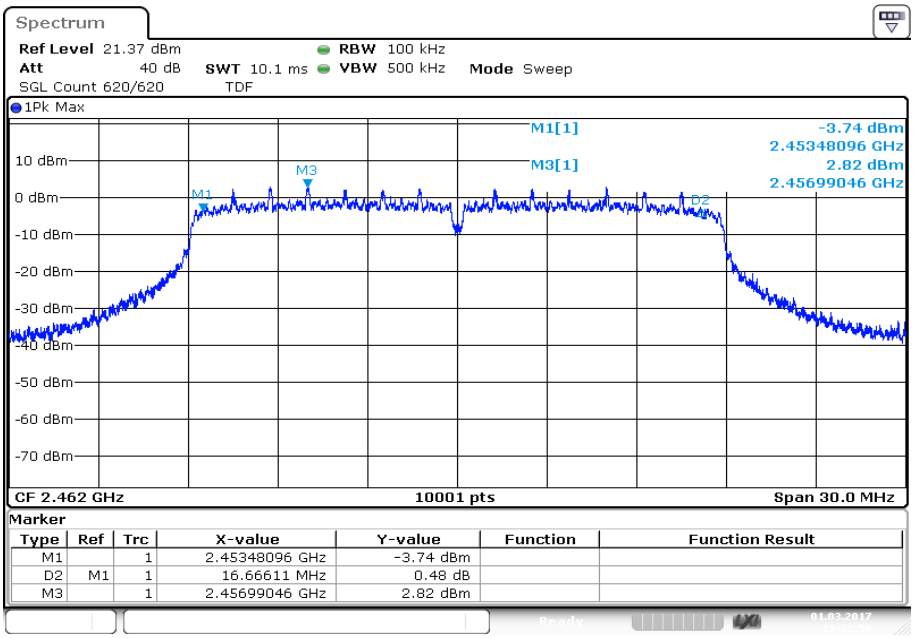
Date: 1.MAR.2017 14:09:49

Plot 2: Middle channel



Date: 1.MAR.2017 13:25:45

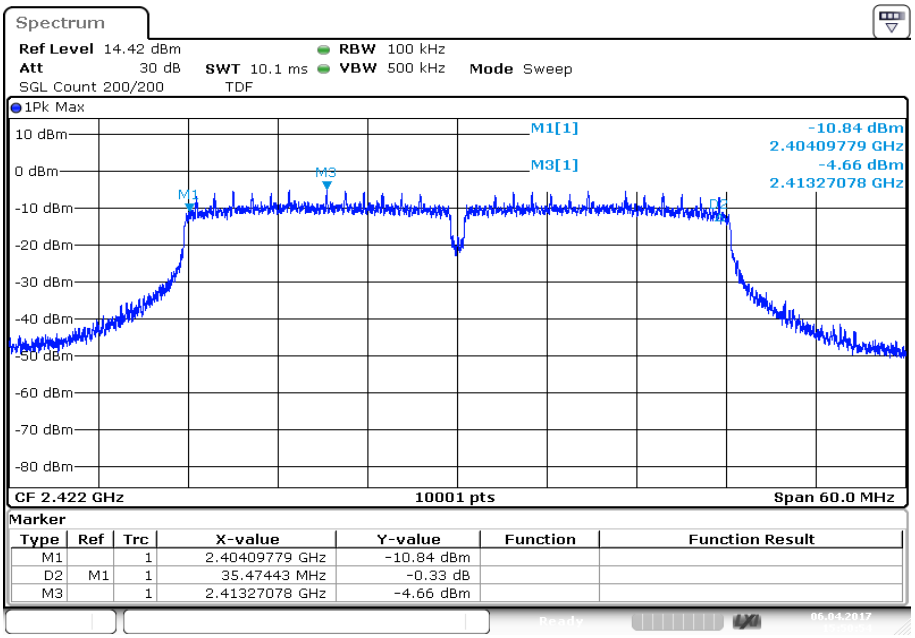
Plot 3: Highest channel



Date: 1.MAR.2017 13:32:57

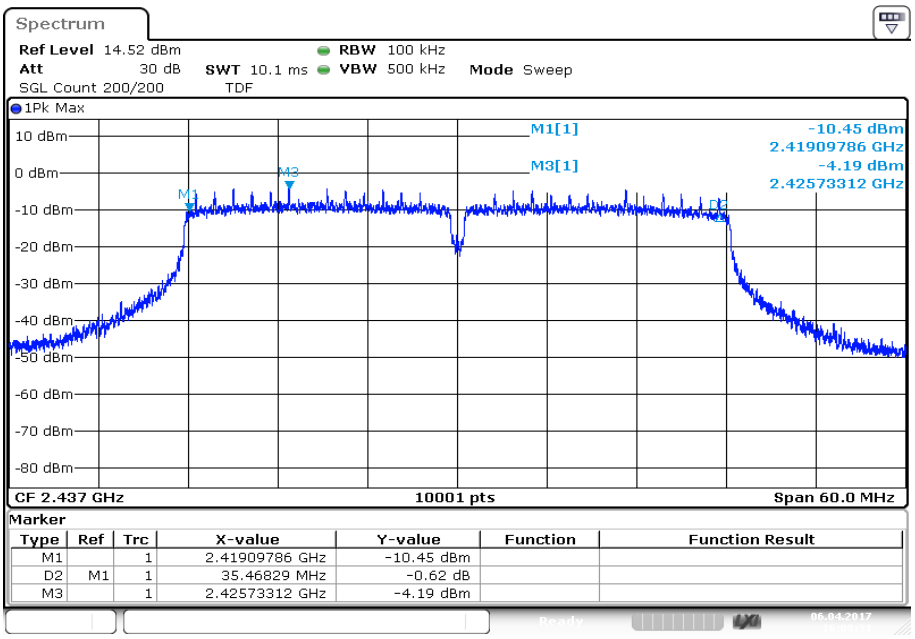
Plots: OFDM / n HT40 – mode, UFL port

Plot 1: Lowest channel



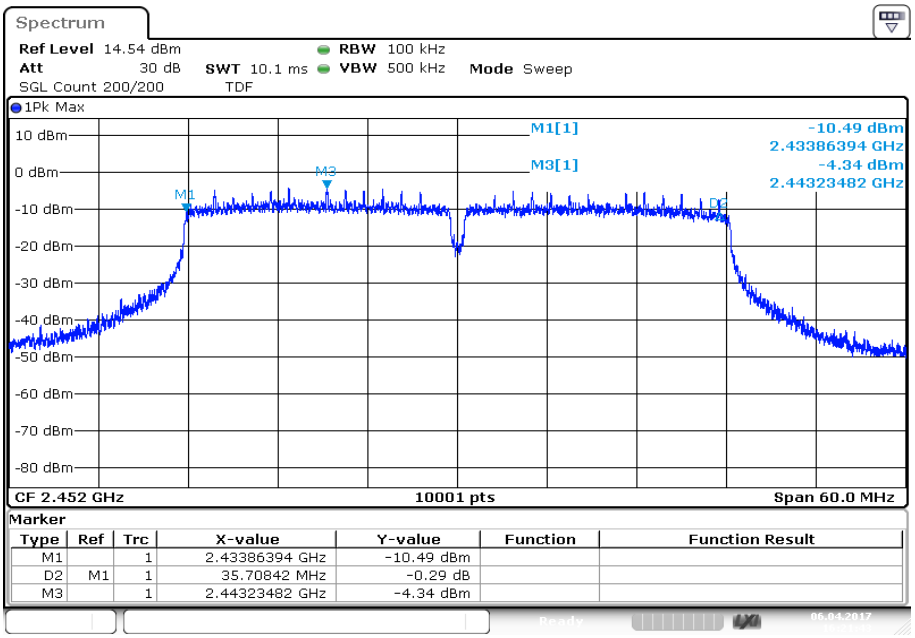
Date: 6.APR.2017 15:50:54

Plot 2: Middle channel



Date: 6.APR.2017 16:08:32

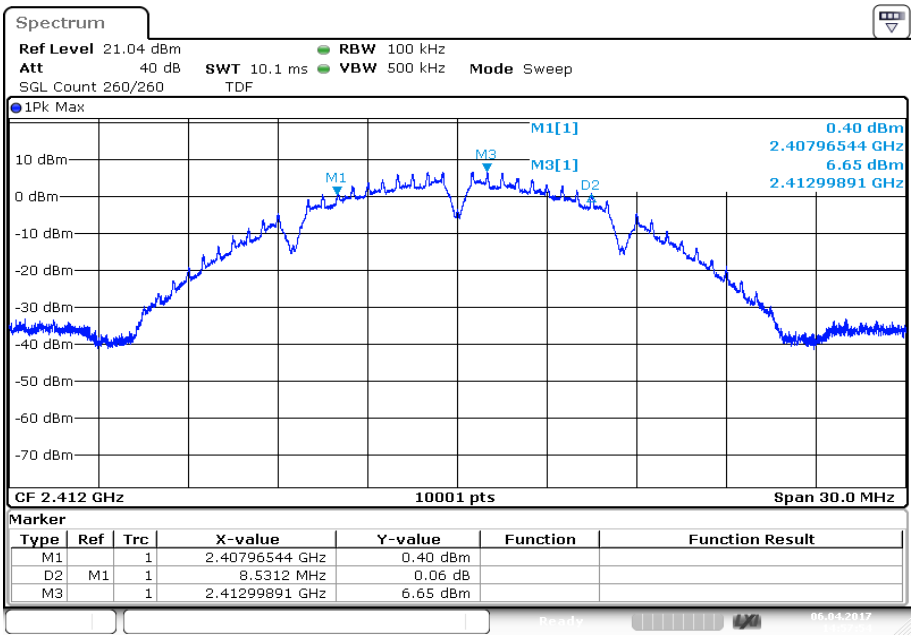
Plot 3: Highest channel



Date: 6.APR.2017 16:21:43

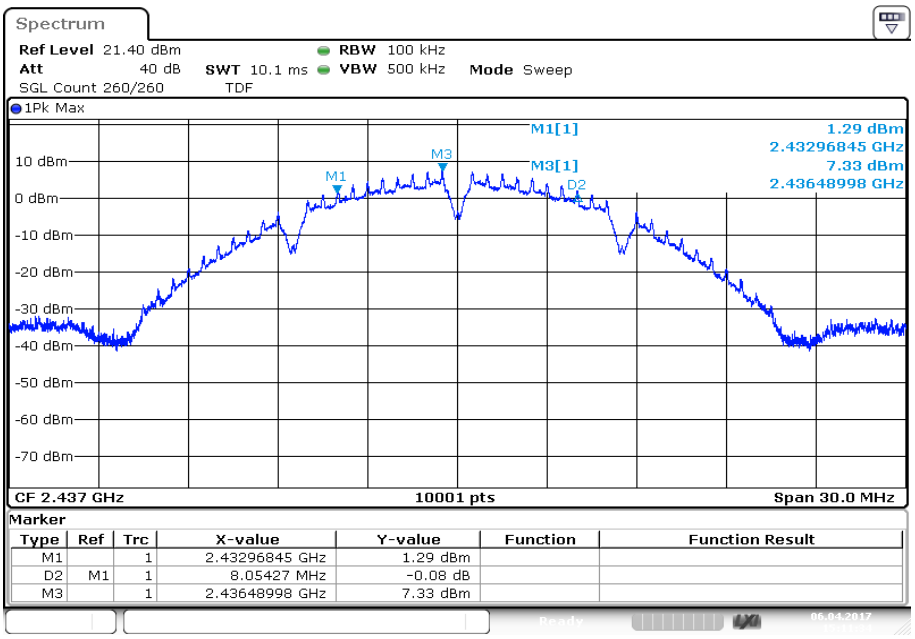
Plots: DSSS / b – mode, MMCX port

Plot 1: Lowest channel



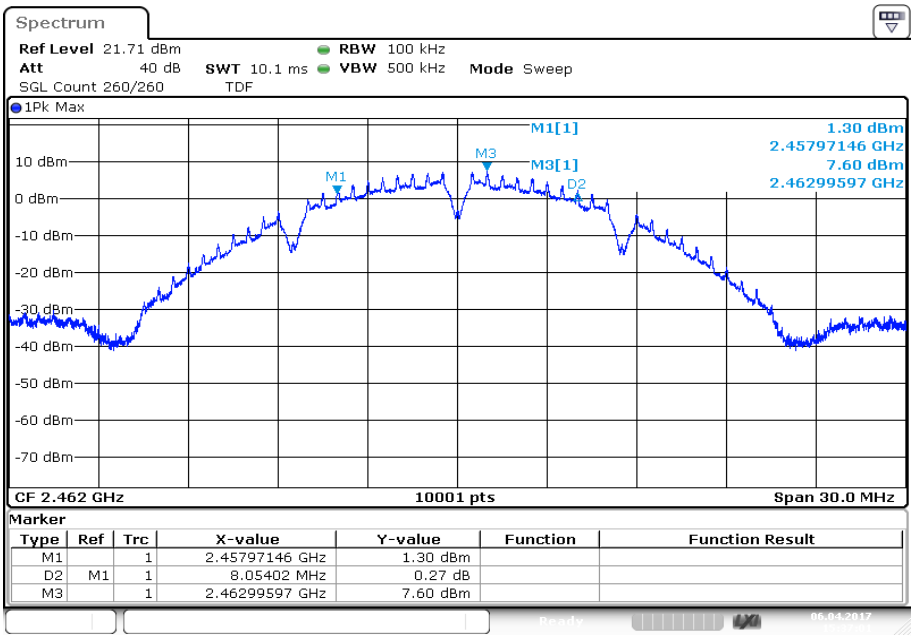
Date: 6.APR.2017 14:57:54

Plot 2: Middle channel



Date: 6.APR.2017 15:11:35

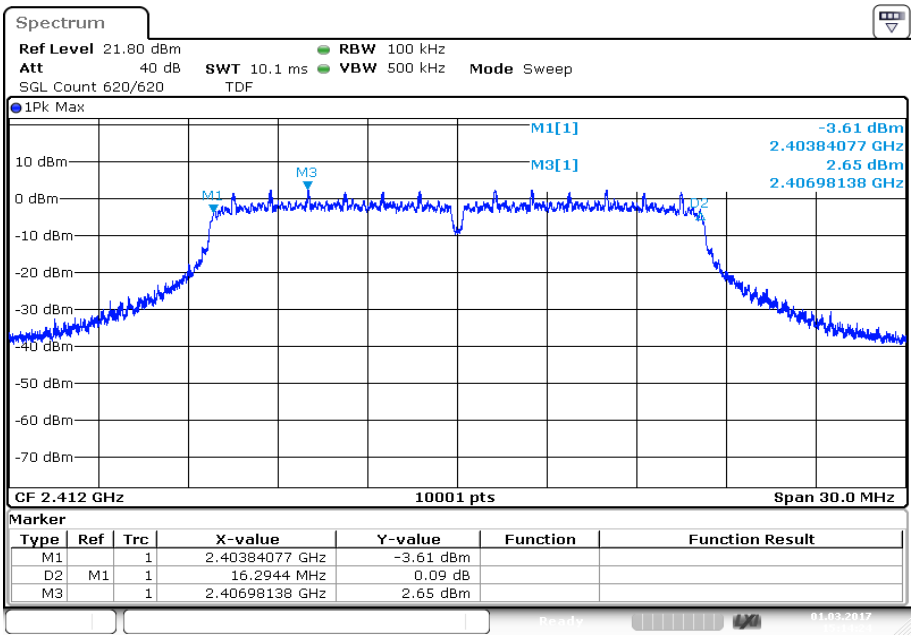
Plot 3: Highest channel



Date: 6.APR.2017 15:37:02

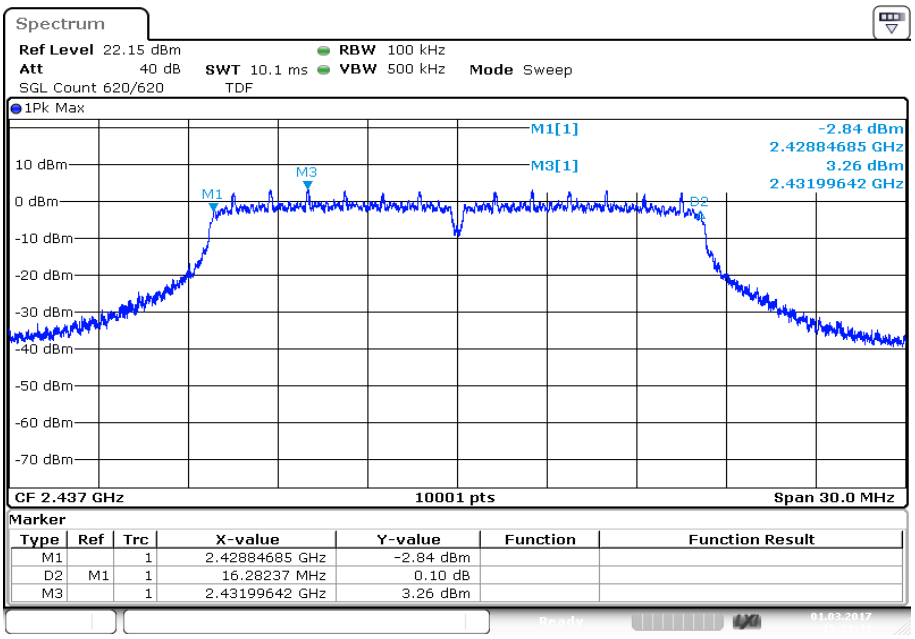
Plots: OFDM / g – mode, MMCX port

Plot 1: Lowest channel



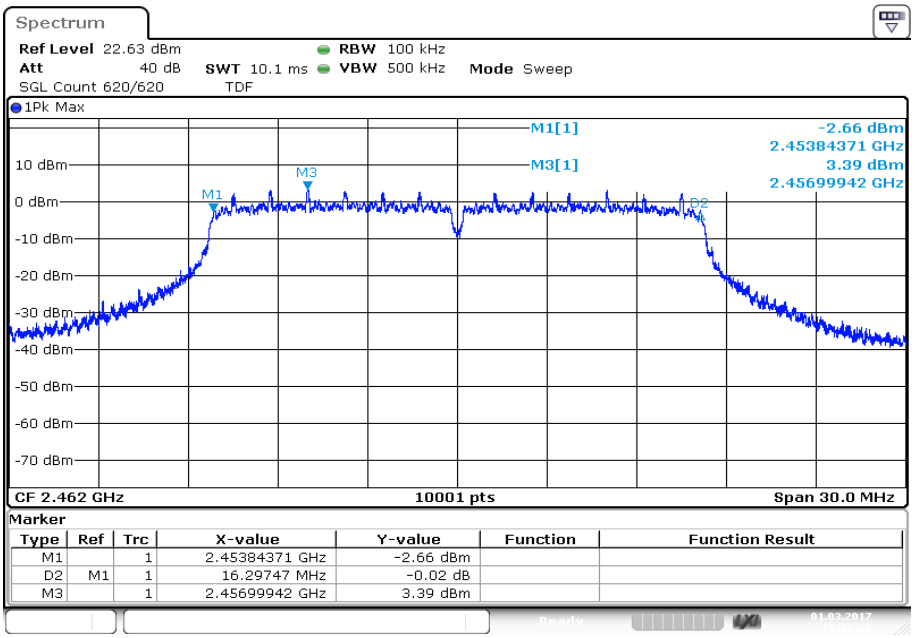
Date: 1.MAR.2017 15:14:25

Plot 2: Middle channel



Date: 1.MAR.2017 15:21:42

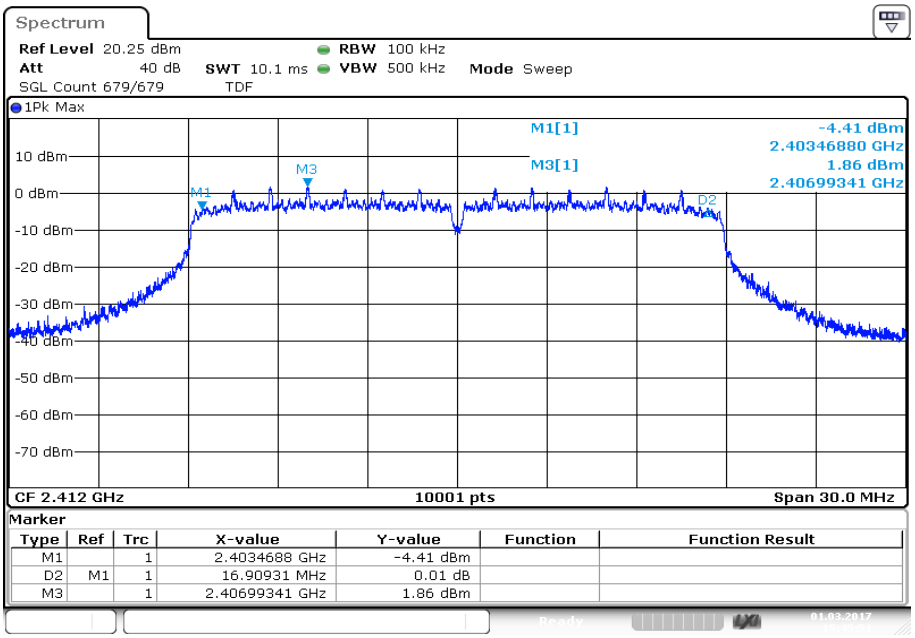
Plot 3: Highest channel



Date: 1.MAR.2017 15:38:28

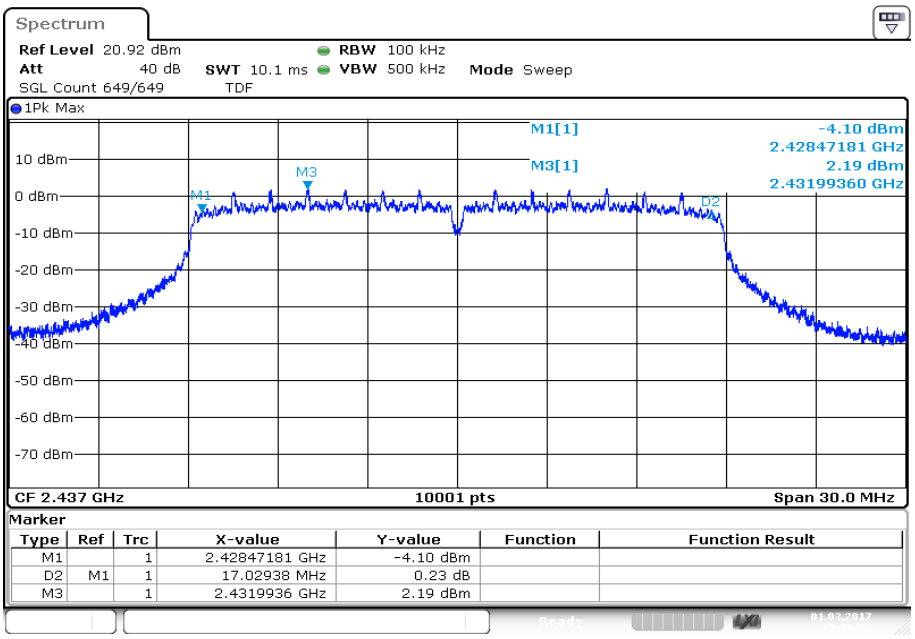
Plots: OFDM / n HT20 – mode, MMCX port

Plot 1: Lowest channel



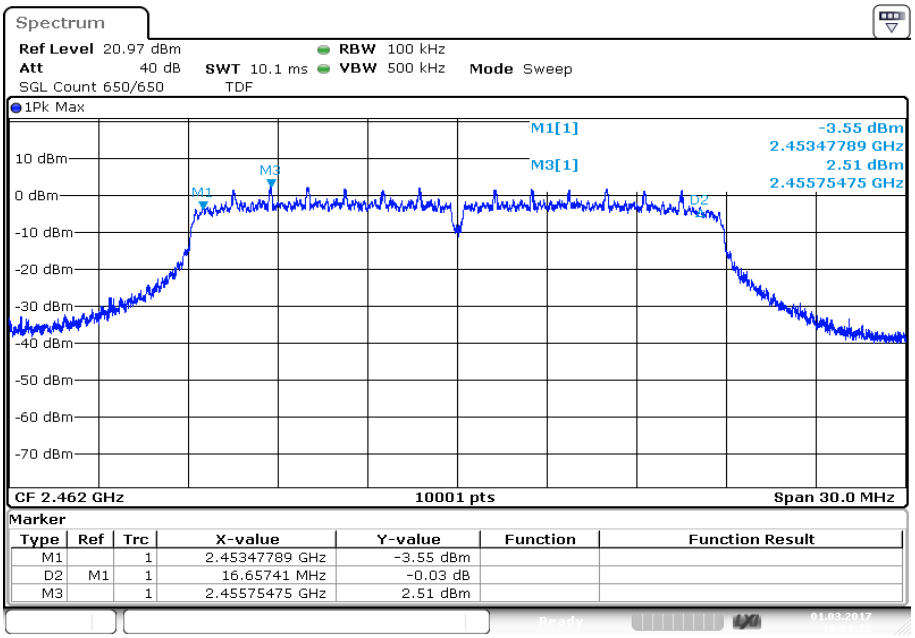
Date: 1.MAR.2017 15:45:52

Plot 2: Middle channel



Date: 1.MAR.2017 15:55:55

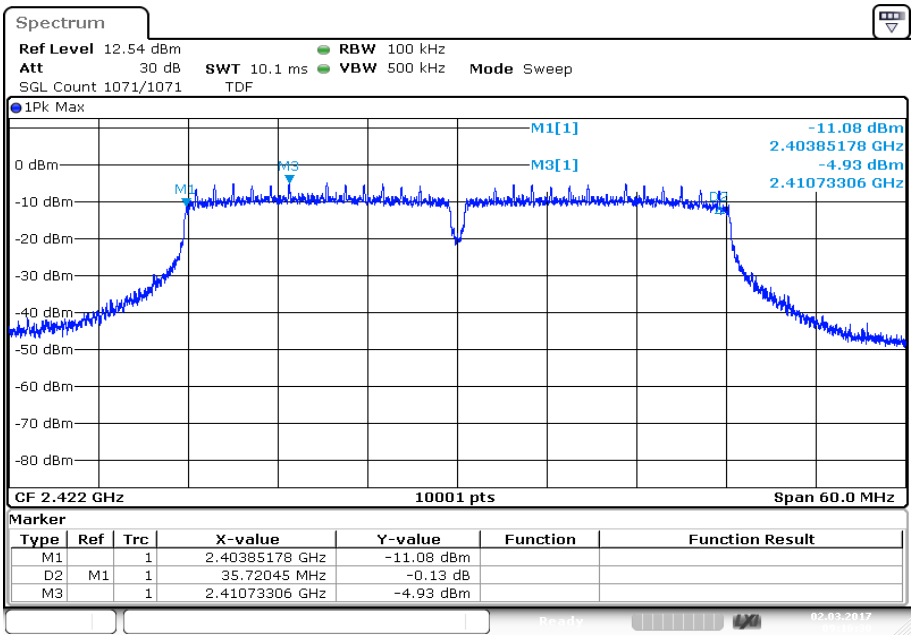
Plot 3: Highest channel



Date: 1.MAR.2017 16:03:23

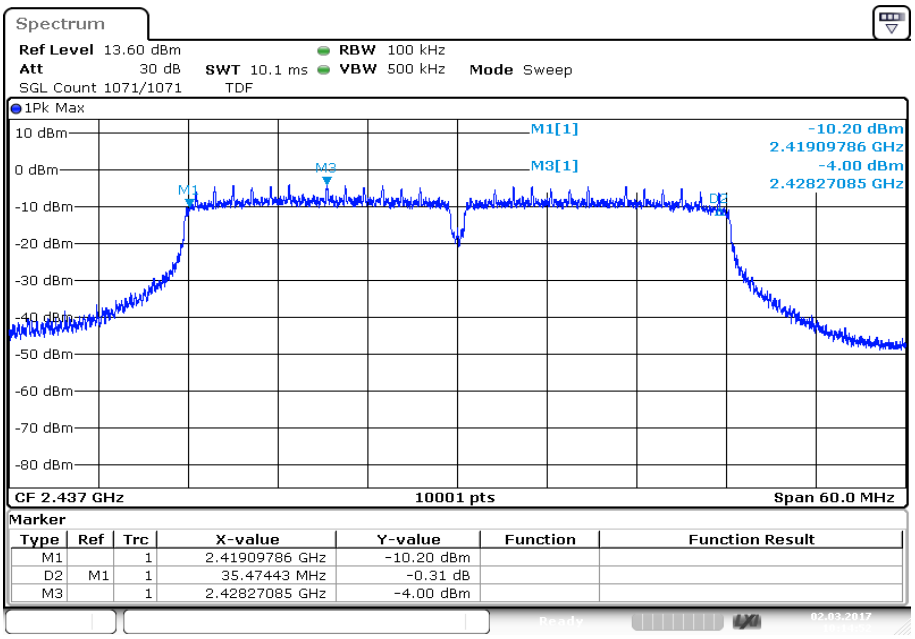
Plots: OFDM / n HT40 – mode, MMCX port

Plot 1: Lowest channel



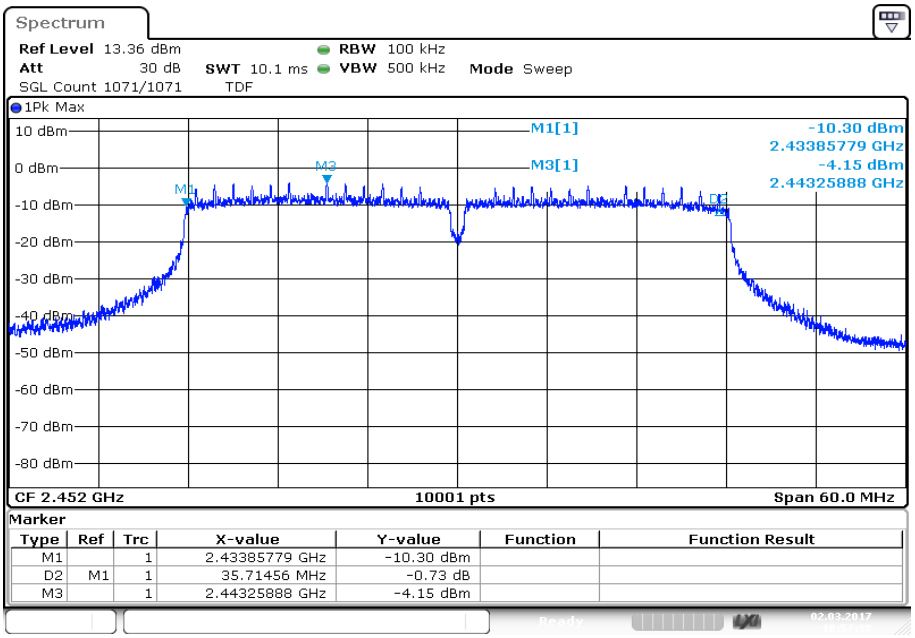
Date: 2.MAR.2017 09:16:30

Plot 2: Middle channel



Date: 2.MAR.2017 10:14:52

Plot 3: Highest channel



Date: 2.MAR.2017 10:57:37

11.7 Occupied bandwidth – 99% emission bandwidth

Description:

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

Measurement:

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

Usage:

-/-	IC
OBW is necessary for Emission Designator	

Results: UFL port

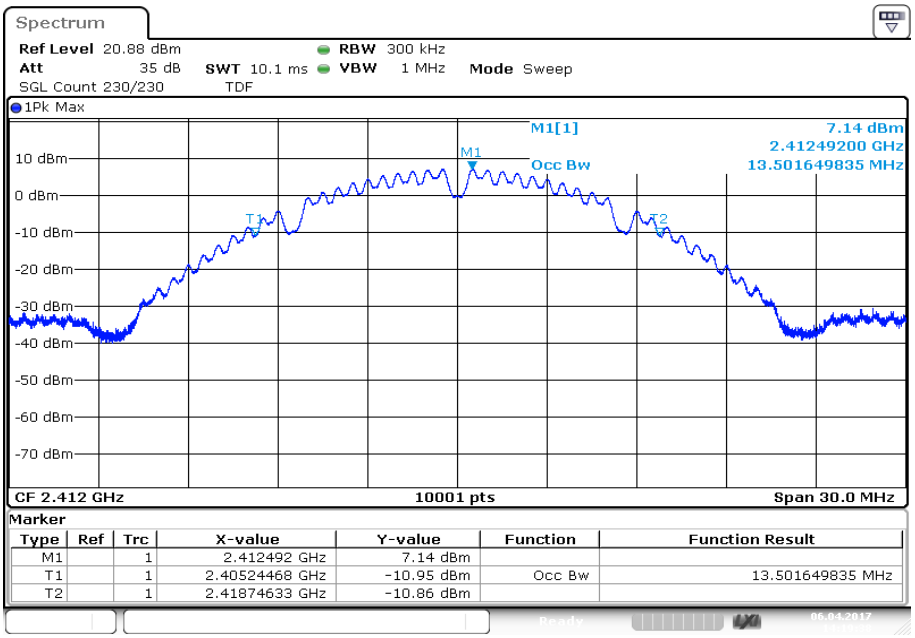
Modulation	99% bandwidth [kHz]		
Frequency	2412 MHz	2437 MHz	2462 MHz
DSSS / b – mode	13502	13760	13865
OFDM / g – mode	16546	16549	16543
OFDM / n HT20 – mode	17626	17635	17632
Frequency	2422 MHz	2437 MHz	2452 MHz
OFDM / n HT40 – mode	36422	36416	36422

Results: MMCX port

Modulation	99% bandwidth [kHz]		
Frequency	2412 MHz	2437 MHz	2462 MHz
DSSS / b – mode	13700	13766	13880
OFDM / g – mode	16534	16513	16540
OFDM / n HT20 – mode	17632	17623	17626
Frequency	2422 MHz	2437 MHz	2452 MHz
OFDM / n HT40 – mode	36554	36524	36530

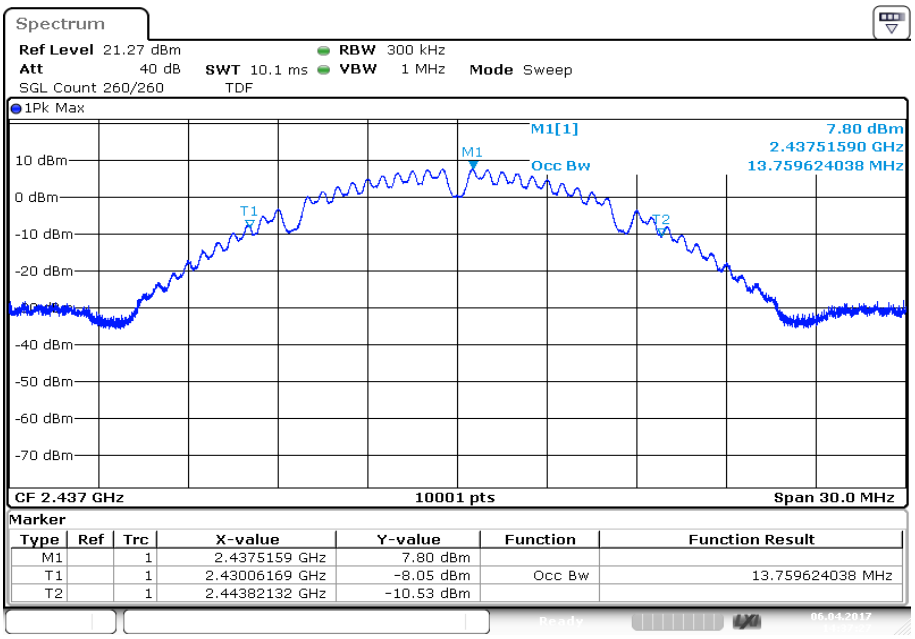
Plots: DSSS / b – mode, UFL port

Plot 1: Lowest channel



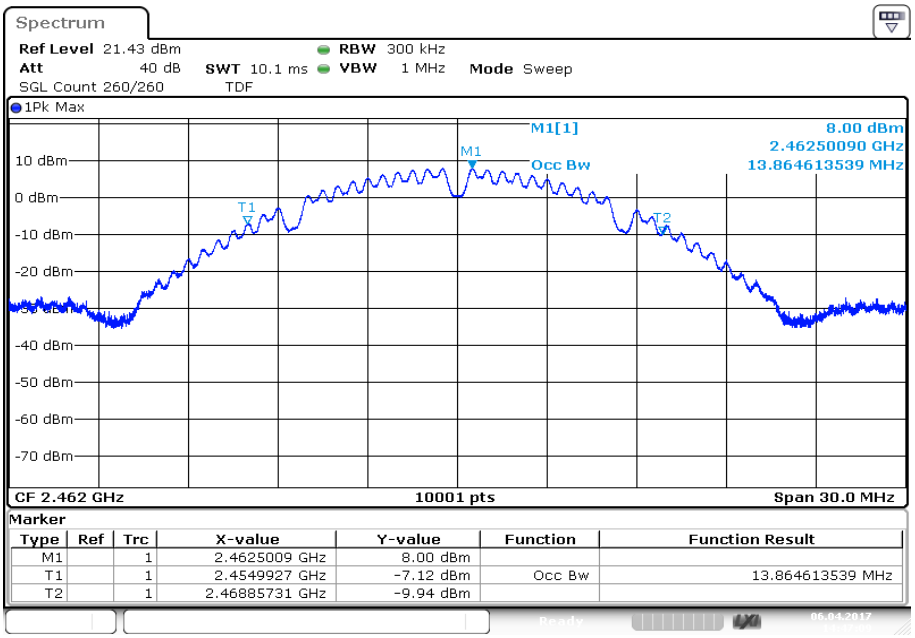
Date: 6.APR.2017 14:19:39

Plot 2: Middle channel



Date: 6.APR.2017 14:37:28

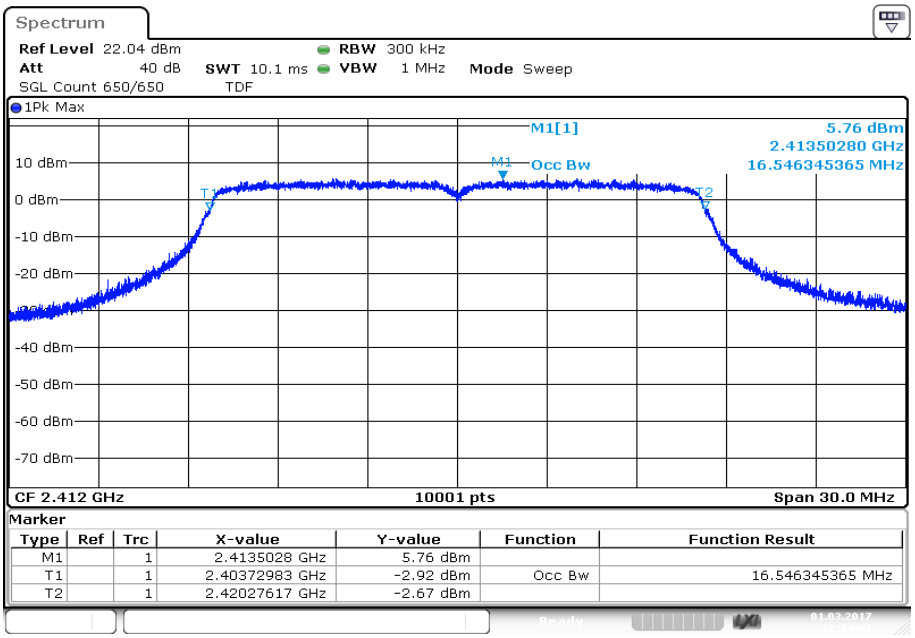
Plot 3: Highest channel



Date: 6.APR.2017 14:47:10

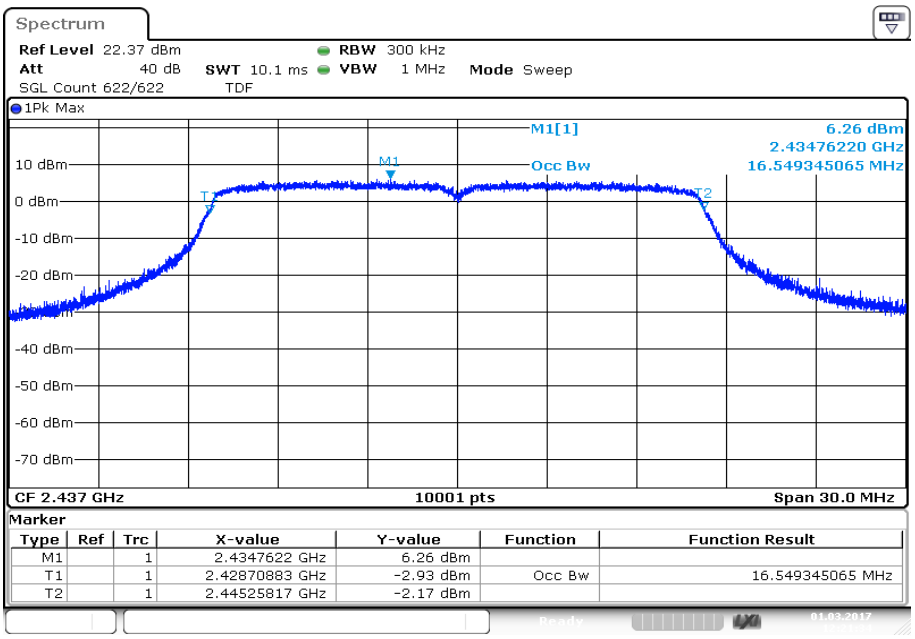
Plots: OFDM / g – mode, UFL port

Plot 1: Lowest channel



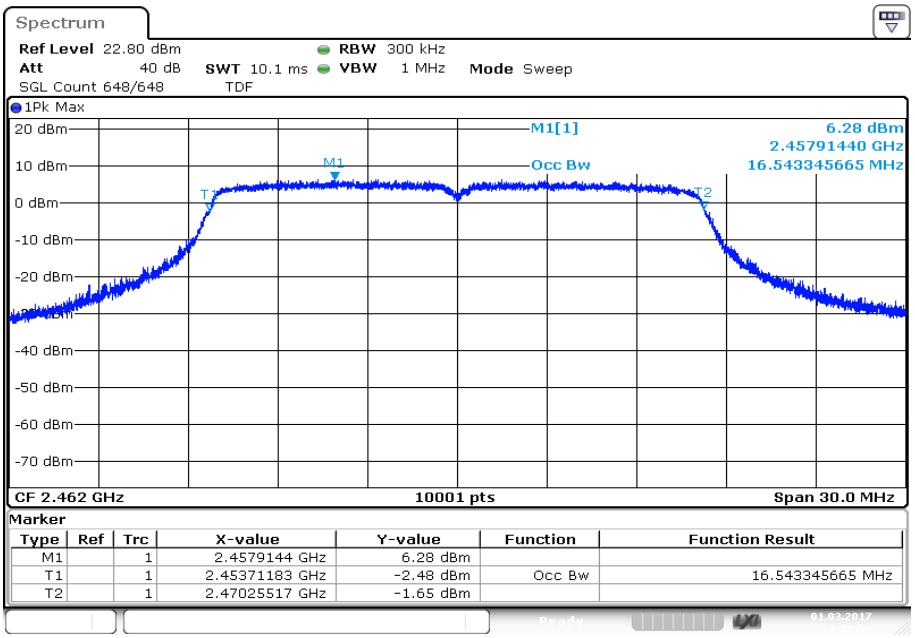
Date: 1.MAR.2017 12:14:02

Plot 2: Middle channel



Date: 1.MAR.2017 12:21:35

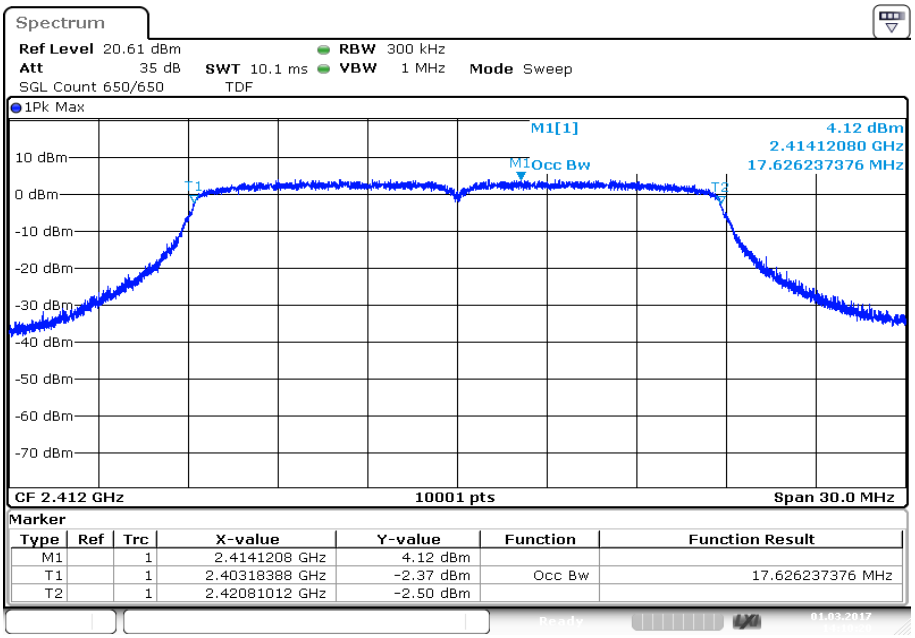
Plot 3: Highest channel



Date: 1.MAR.2017 12:38:54

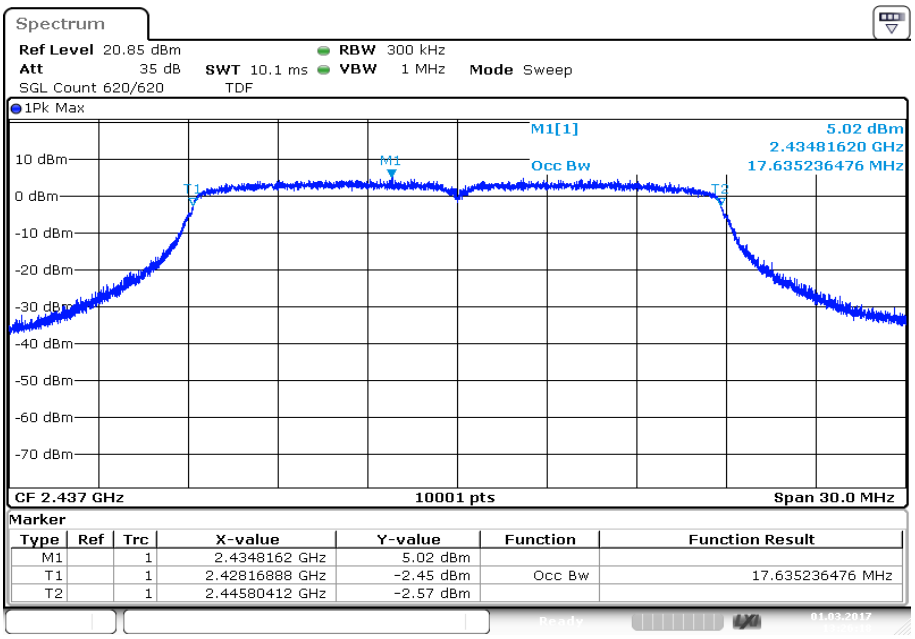
Plots: OFDM / n HT20 – mode, UFL port

Plot 1: Lowest channel



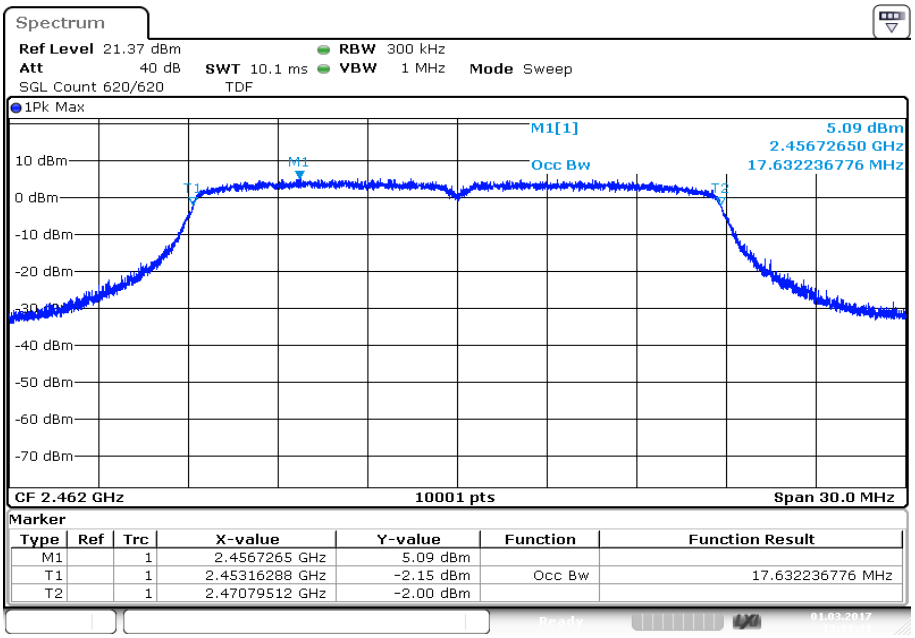
Date: 1.MAR.2017 14:10:21

Plot 2: Middle channel



Date: 1.MAR.2017 13:26:17

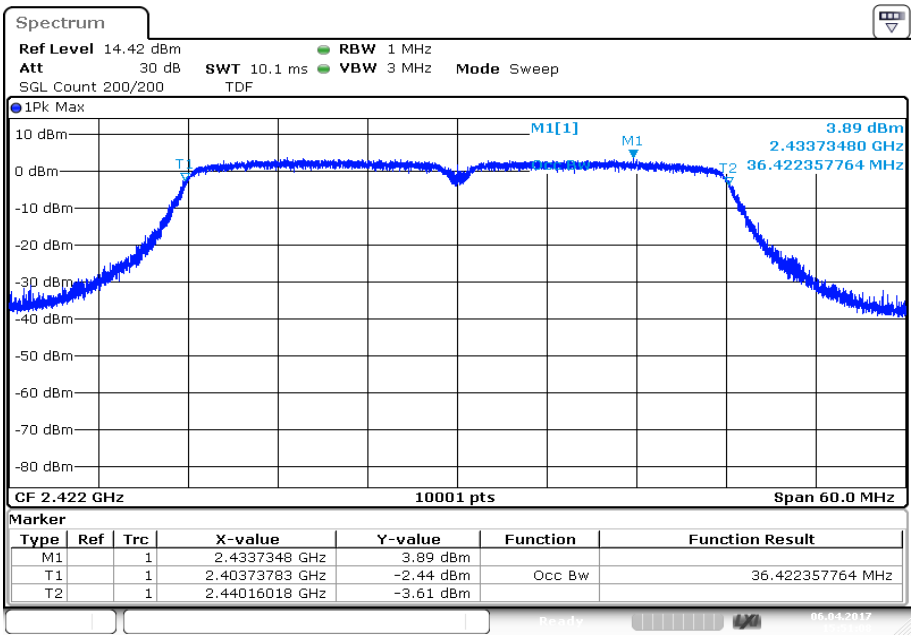
Plot 3: Highest channel



Date: 1.MAR.2017 13:33:32

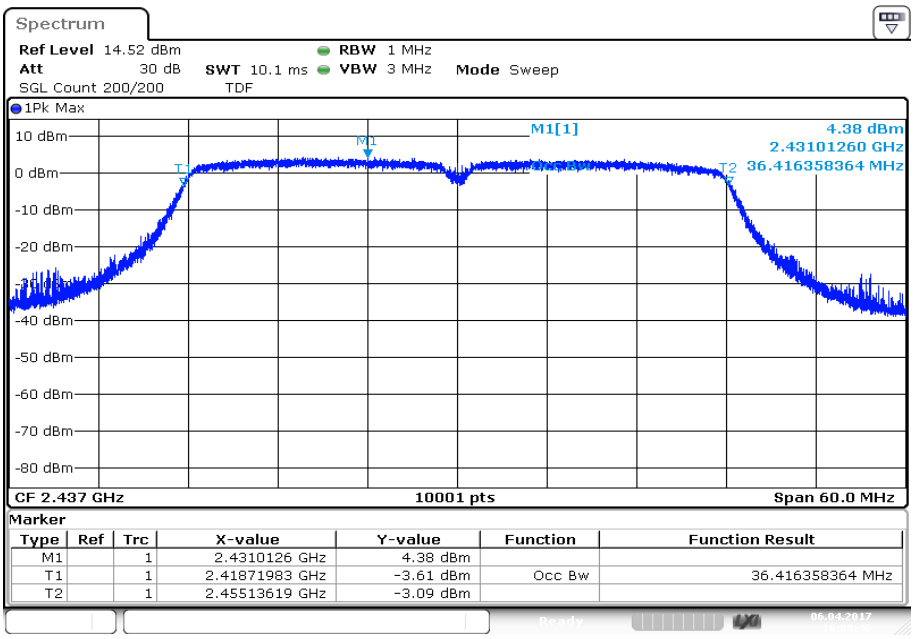
Plots: OFDM / n HT40 – mode, UFL port

Plot 1: Lowest channel



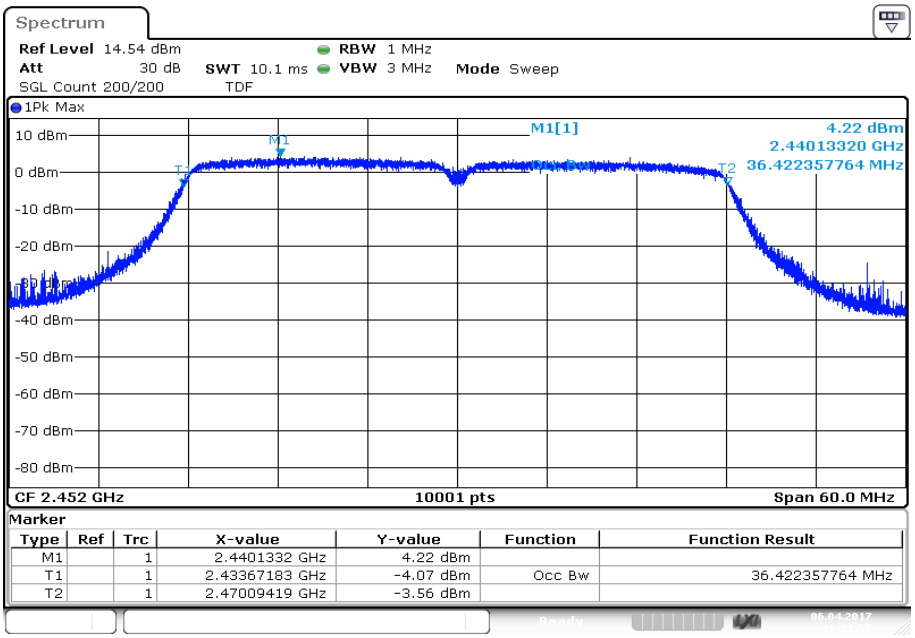
Date: 6.APR.2017 15:51:08

Plot 2: Middle channel



Date: 6.APR.2017 16:08:46

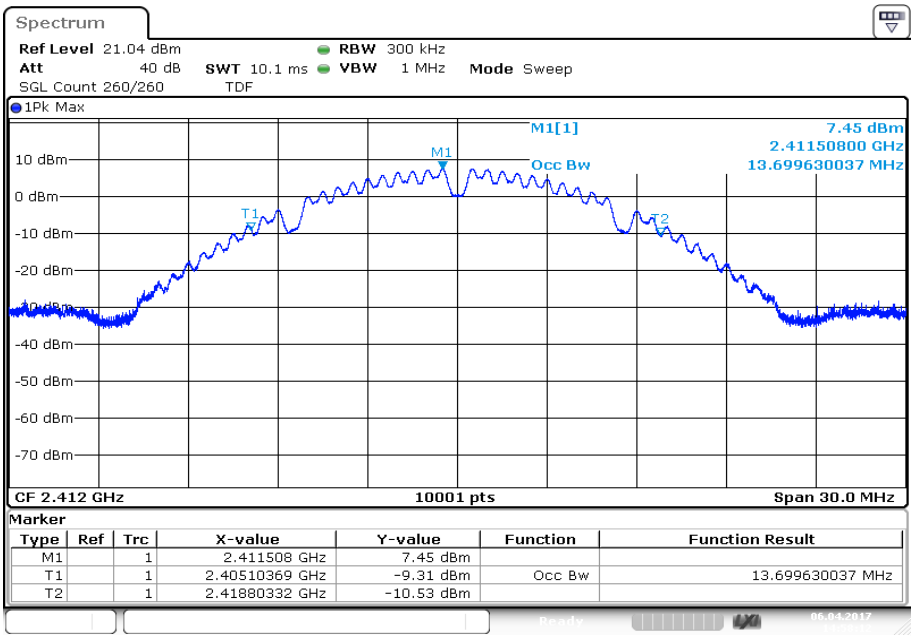
Plot 3: Highest channel



Date: 6.APR.2017 16:21:58

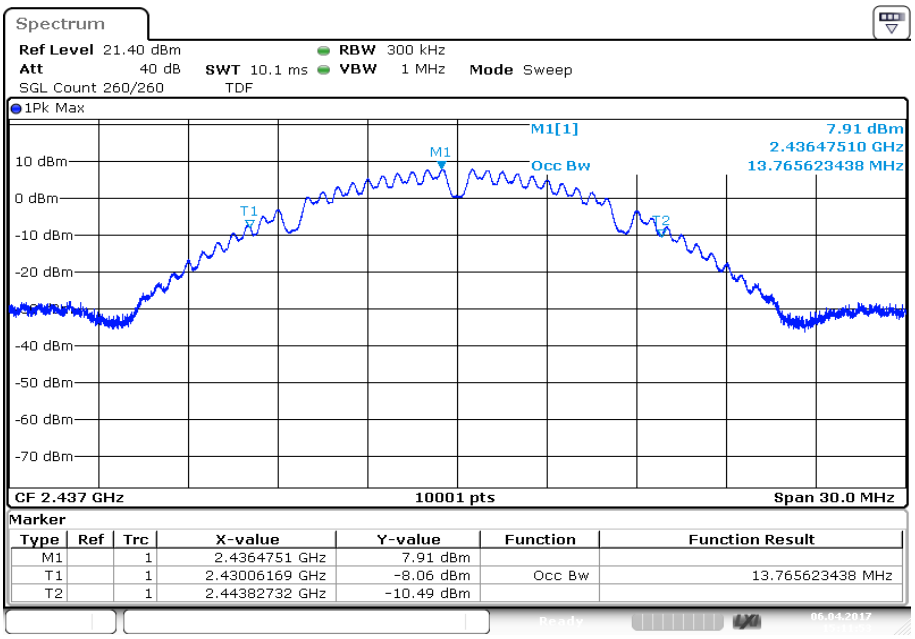
Plots: DSSS / b – mode, MMCX port

Plot 1: Lowest channel



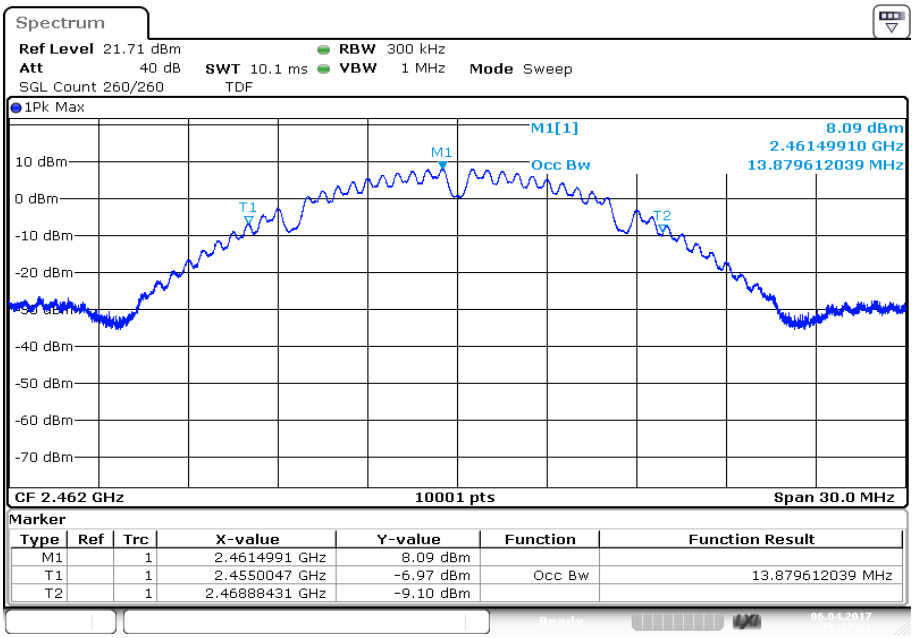
Date: 6.APR.2017 14:58:12

Plot 2: Middle channel



Date: 6.APR.2017 15:11:53

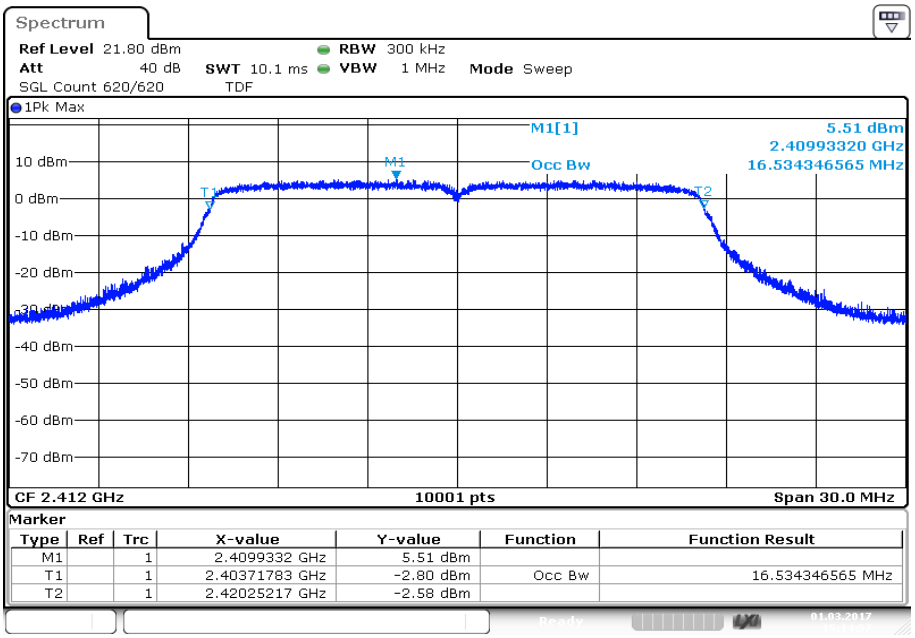
Plot 3: Highest channel



Date: 6.APR.2017 15:37:21

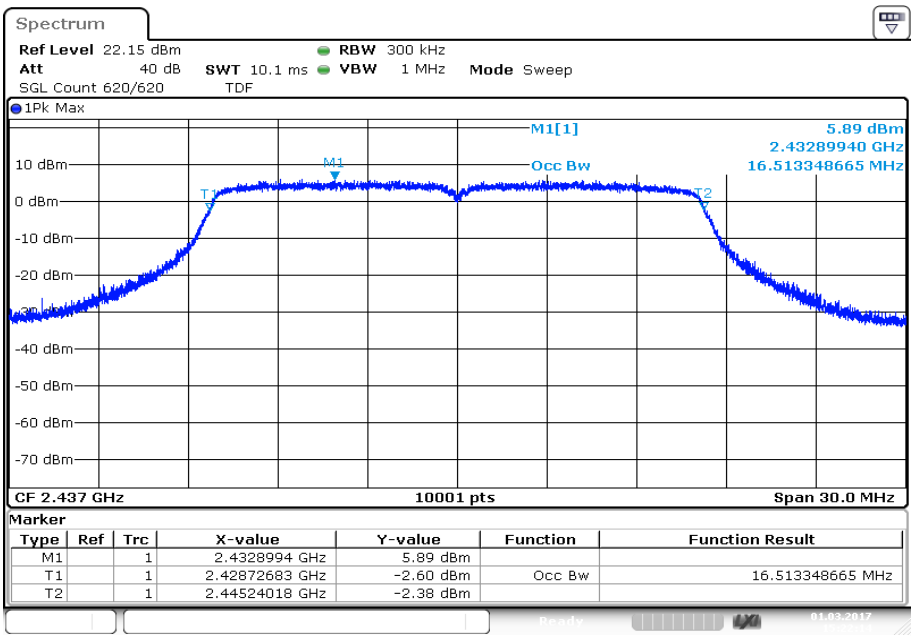
Plots: OFDM / g – mode, MMCX port

Plot 1: Lowest channel



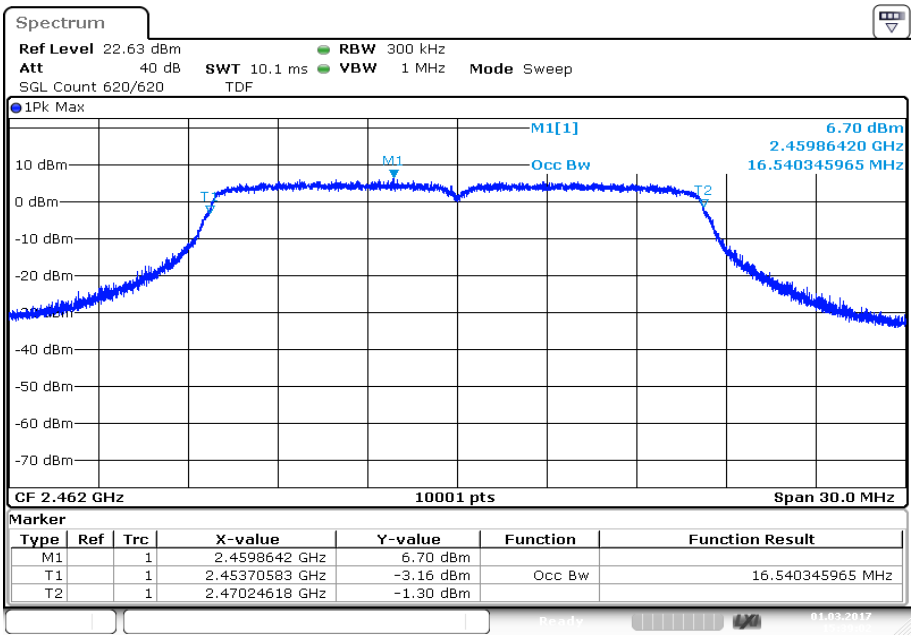
Date: 1.MAR.2017 15:14:56

Plot 2: Middle channel



Date: 1.MAR.2017 15:22:15

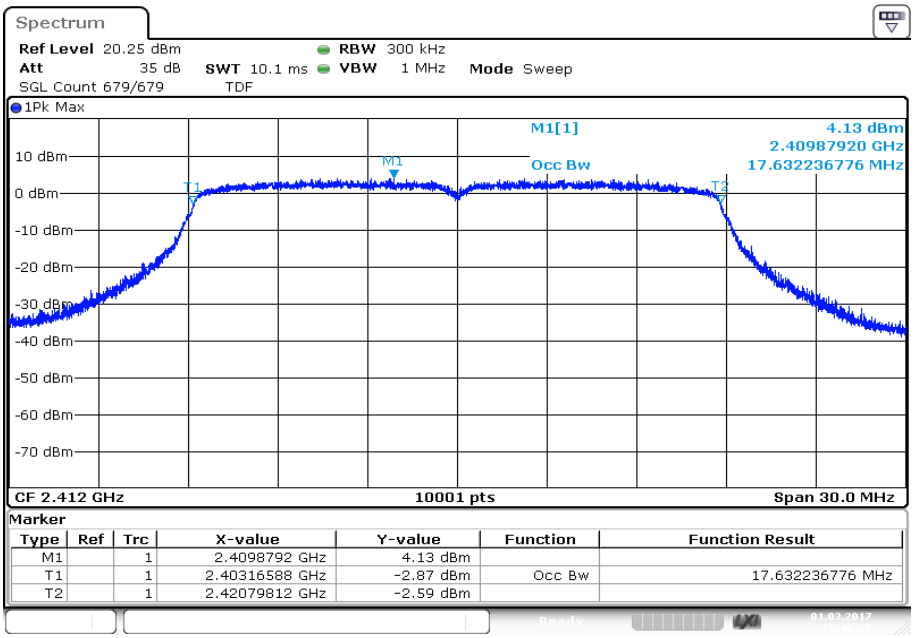
Plot 3: Highest channel



Date: 1.MAR.2017 15:39:03

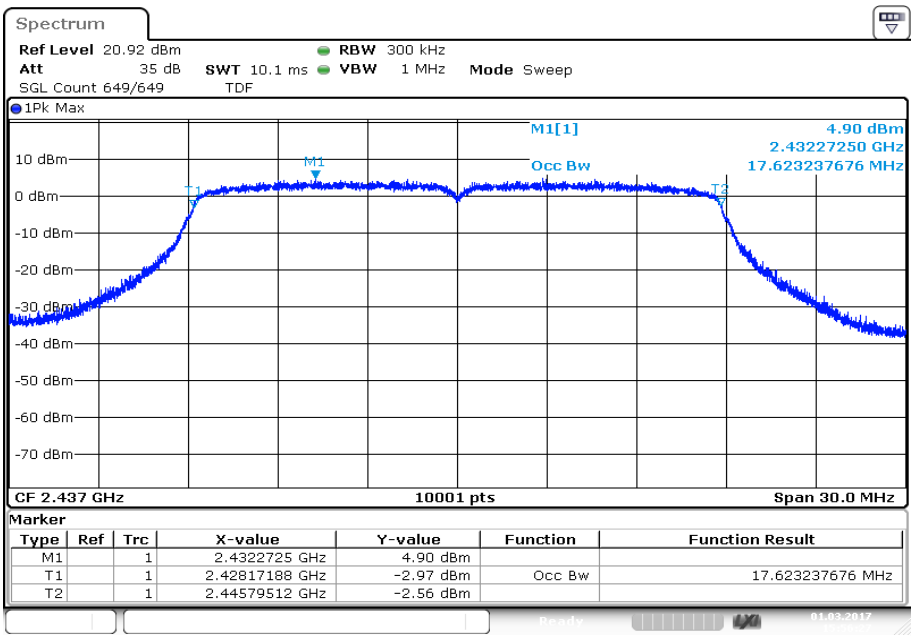
Plots: OFDM / n HT20 – mode, MMCX port

Plot 1: Lowest channel



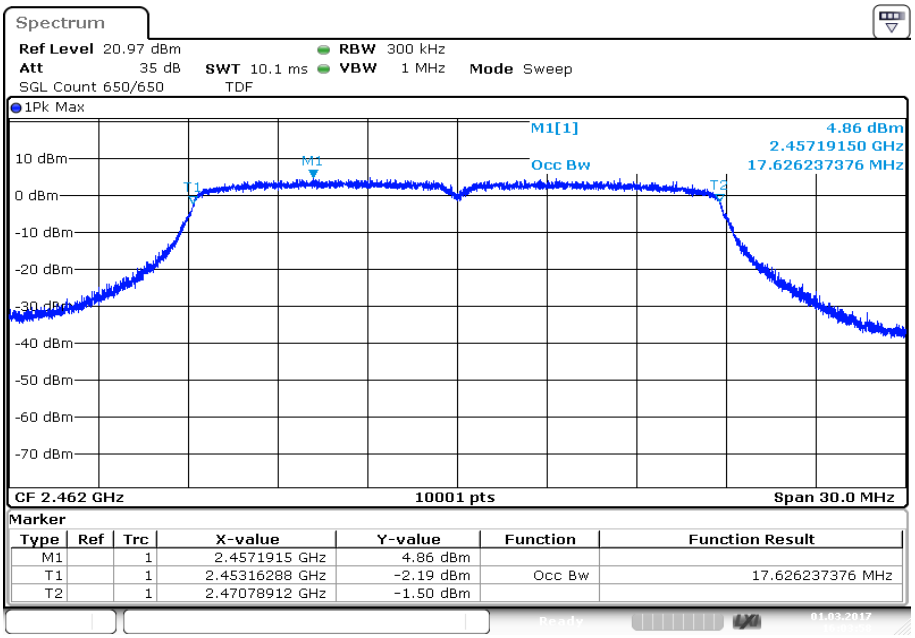
Date: 1.MAR.2017 15:46:26

Plot 2: Middle channel



Date: 1.MAR.2017 15:56:28

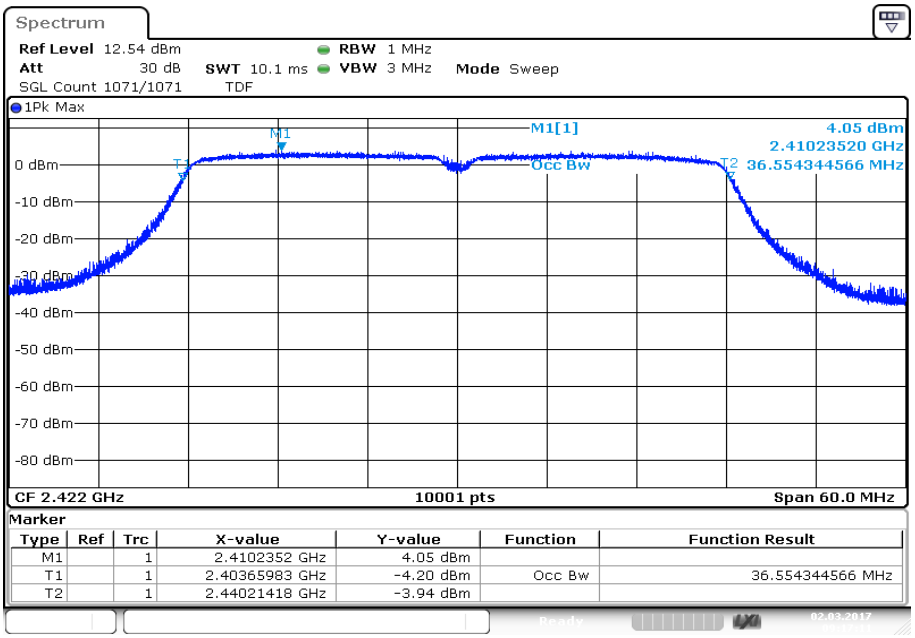
Plot 3: Highest channel



Date: 1.MAR.2017 16:03:59

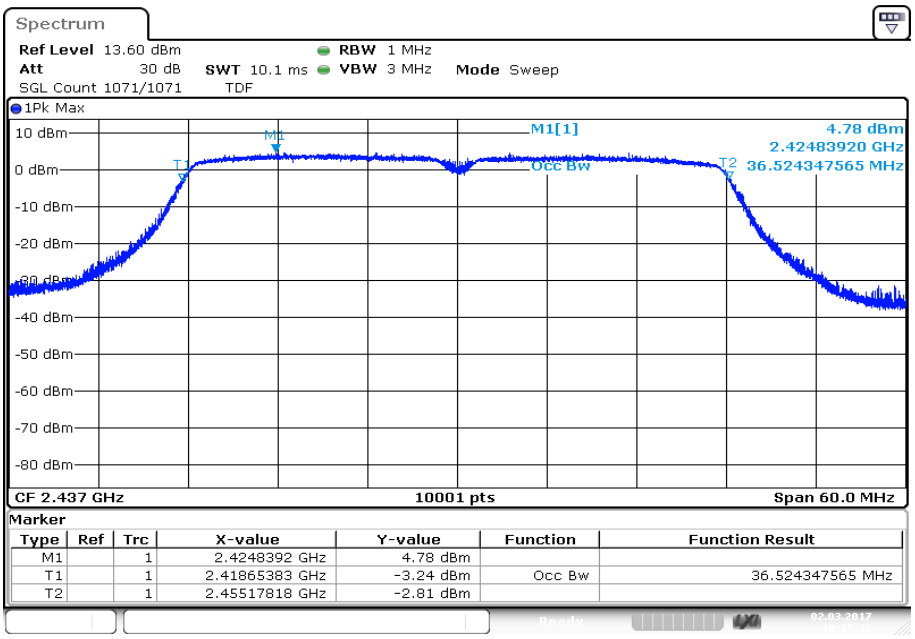
Plots: OFDM / n HT40 – mode, MMCX port

Plot 1: Lowest channel



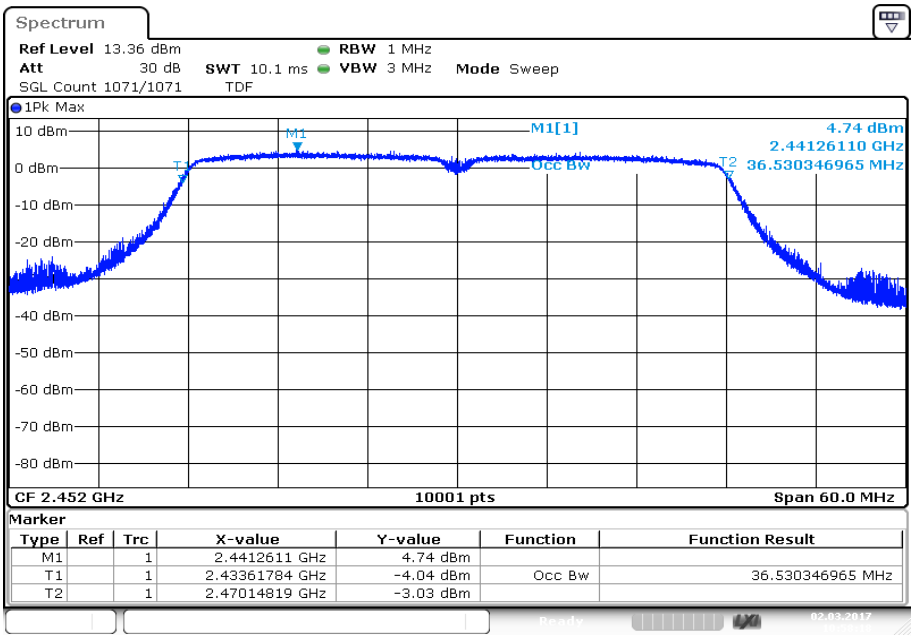
Date: 2.MAR.2017 09:17:11

Plot 2: Middle channel



Date: 2.MAR.2017 10:15:32

Plot 3: Highest channel



Date: 2.MAR.2017 10:58:18