FCC / IC Test Report

FOR:
Virscient Limited

Model Name:
Trimble Comm board Tornado

Product Description:
WIFI/BT Module

FCC ID: YK5-73350047
IC ID: ----------

Applied Rules and Standards:
47 CFR Part 15.247 (DTS)
RSS-247 Issue 1 (DTS) & RSS-Gen Issue 4

REPORT #: EMC_VIRSC-001-17001_15.247_WLAN

DATE: 2019-02-08

A2LA Accredited

IC recognized # 3462B-2

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1 Assessment

The following device was evaluated against the applicable criteria specified in FCC rules Parts 15.247 of Title 47 of the Code of Federal Regulations and the relevant ISED Canada standard RSS-247.

No deviations were ascertained.

Company	Description	Model #
Virscient Limited	WIFI/BT Module	V0009F

Responsible for Testing Laboratory:

Date	Section	Name	Signature
2019-02-08	Compliance	Cindy Li (EMC Lab Manager)	Cindy Li Digitally signed by Cindy Li DN: cn=Cindy Li, o=Cetecom Inc., ou=EMC, email=cindy.li@cetecom.com, c=US Date: 2019.02.08 16:02:50 -08'00'

Responsible for the Report:

Date	Section	Name	Signature
2019-02-08	Compliance	Kevin Wang (Senior EMC Engineer)	kevin.wang@cetecom.com Digitally signed by: kevin.wang@cetecom.com DN: CN = kevin.wang@cetecom.com Date: 2019.02.08 15:42:08 -08'00'

2 Administrative Data

2.1 Identification of the Testing Laboratory Issuing the EMC Test Report

Company Name:	CETECOM Inc.
Department:	Compliance
Street Address:	411 Dixon Landing Road
City/Zip Code	Milpitas, CA 95035
Country	USA
Telephone:	+1 (408) 586 6200
Fax:	+1 (408) 586 6299
EMC Lab Manager:	Cindy Li
Responsible Project Leader:	Rami Saman

2.2 Identification of the Client

Applicant's Name:	Virscient Limited
Street Address:	Ruakura Research Centre, 10 Bisley Road
City/Zip Code:	Hamilton/3214
Country:	New Zealand

2.3 Identification of the Manufacturer

Manufacturer's Name:	Trimble Jena GmbH
Manufacturers Address:	Carl-Zeiss-Promenade 10
City/Zip Code	Jena/07745
Country	Germany

3 Equipment under Test (EUT)

3.1 EUT Specifications

Model No:	Trimble Comm board Tornado
HW Version :	F
SW Version :	v4.5.10.016.DFS
FCC-ID:	YK5-73350047
IC-ID:	--------
HVIN:	--------
PMN:	--------
Product Description:	WIFI/BT Module
Frequency Range / number of channels:	Nominal band: 2400 MHz – 2483.5 MHz; Center to center: 2412 MHz (ch 1) – 2462 MHz (ch 11), 11 channels
Type(s) of Modulation:	BPSK, QPSK, 16-QAM, 64QAM
Modes of Operation:	802.11b/g/n, 20MHz and 40MHz
Antenna Information as declared:	Pulse W3334B0150, 2.4G 4dBi 5G 5.5dBi
Max. Peak Output Power:	Conducted Power 20.98 dBm
Power Supply/ Rated Operating Voltage Range:	USB / Vmin: 4.75 VDC/ Vnom: 5 VDC / Vmax: 5.5 VDC
Operating Temperature Range:	-20 °C to +70 °C
Other Radios included in the device:	Bluetooth BR / EDR WIFI 802.11a/ac
Sample Revision:	☐Prototype Unit; ■Production Unit; ☐Pre-Production

3.2 EUT Sample details

EUT #	Serial Number	HW Version	SW Version	Notes/Comments
1	311	F	V4.5.10.016.DFS	Radiated Emissions
2	351	F	V4.5.10.016.DFS	Conducted RF

3.3 Accessory Equipment (AE) details

AE #	Type	Model	Manufacturer	Serial Number
1	Laptop	Dell	Latitude E6440	00186-242-768-970
2	Laptop	Dell	Latitude E6430s	00186-210-105-587

3.4 Test Sample Configuration

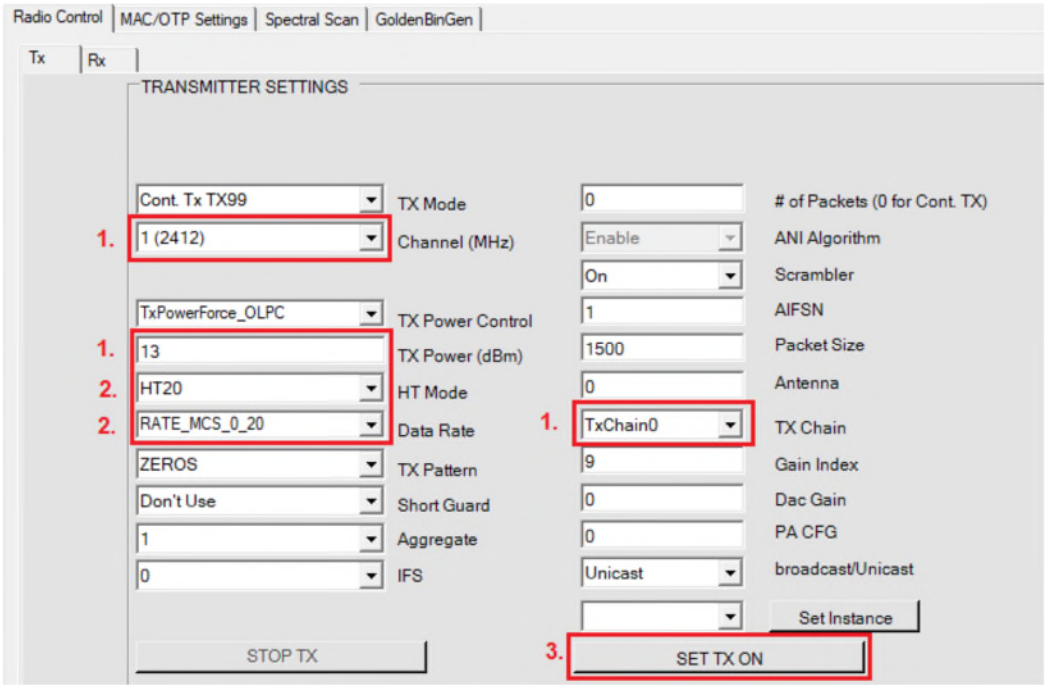
EUT Set-up #	Combination of AE used for test set up	Comments
1	EUT#2 + AE#1 + AE#2	The radio of the EUT was configured to a fixed channel transmission with highest possible duty cycle using software “QRCT” provided by client that is not available to the end user. The measurement equipment was connected to the 50 ohm RF port of the EUT.
2	EUT#1 + AE#1 + AE#2	The radio of the EUT was configured to a fixed channel with highest possible duty cycle using software “QRCT” provided by client that is not available to the end user. The external antenna “Pulse W3334B0150” provided by client was used for radiated testing.

3.5 Justification for Worst Case Mode of Operation

During the testing process, the EUT was tested with transmitter sets on low, mid and high channels with the highest possible duty cycle. For radiated measurements, all data in this report shows the worst case between horizontal and vertical antenna polarizations and for all orientations of the EUT.

The EUT were configured by "QRCT" provided by client (not available to the end user).

QRCT Tool:



The target power indexs in below table were set in QRCT provided by client for all the test items except Band edge

802.11b:

Test Frequency	DSSS 1-2 Mbps	CCK 5.5 – 11 Mbps
2412	19	19
2437	19	19
2472	19	19

802.11g:

Test Frequency (MHz)	6 – 24 Mbps	36 Mbps	48 Mbps	54 Mbps
2412	18	16	14	14
2437	18	16	14	14
2472	18	16	14	14

802.11n HT20 1SS:

Test Frequency	MCS0		MCS1 MCS2		MCS3 MCS4		MCS5		MCS6		MCS7	
Chain	0	1	0	1	0	1	0	1	0	1	0	1
2412	18	18	18	18	12	12	12	12	12	12	12	12
2437	18	18	18	18	13	13	12	12	12	12	12	12
2472	18	18	18	18	13	13	13	13	13	13	13	13

802.11n HT20 2SS:

Test Frequency	MCS8		MCS9 MCS10		MCS11 MCS12		MCS13		MCS14		MCS15	
Chain	0	1	0	1	0	1	0	1	0	1	0	1
2412	18	18	18	18	12	12	12	12	12	12	12	12
2437	18	18	18	18	13	13	12	12	12	12	12	12
2472	18	18	18	18	13	13	13	13	13	13	13	13

802.11n HT40 1SS:

Test Frequency	MCS0		MCS1 MCS2		MCS3 MCS4		MCS5		MCS6		MCS7	
Chain	0	1	0	1	0	1	0	1	0	1	0	1
2422	17	17	17	17	16	16	15	15	15	15	15	15
2437	17	17	17	17	16	16	15	15	15	15	15	15
2472	17	17	17	17	16	16	15	15	15	15	15	15

802.11n HT40 2SS:

Test Frequency	MCS8		MCS9 MCS10		MCS11 MCS12		MCS13		MCS14		MCS15	
Chain	0	1	0	1	0	1	0	1	0	1	0	1
2422	17	17	17	17	16	16	15	15	15	15	15	15
2437	17	17	17	17	16	16	15	15	15	15	15	15
2472	17	17	17	17	16	16	15	15	15	15	15	15

The target power index in below tables were set in QRCT provided by client for the compliance test of Band edge

802.11b:

Test Frequency	DSSS 1-2 Mbps	CCK 5.5 – 11 Mbps
2412	9	9
2437	9	9
2462	9	9

802.11g:

Test Frequency (MHz)	6 – 24 Mbps	36 Mbps	48 Mbps	54 Mbps
2412	6	6	6	6
2437	14	14	14	14
2462	6	6	6	6

802.11n HT20 1SS:

Test Frequency	MCS0 MCS2				MCS1 MCS4				MCS3			
Chain	0	1	0	1	0	1	0	1	0	1	0	1
2412	6	12	6	12	6	12	6	12	6	12	6	12
2437	14	14	14	14	13	13	12	12	12	12	12	12
2462	6	12	6	12	6	12	6	12	6	12	6	12

802.11n HT20 2SS:

Test Frequency	MCS8 MCS10				MCS9 MCS12				MCS11			
Chain	0	1	0	1	0	1	0	1	0	1	0	1
2412	6	12	6	12	6	12	6	12	6	12	6	12
2437	14	14	14	14	13	13	12	12	12	12	12	12
2462	6	12	6	12	6	12	6	12	6	12	6	12

802.11n HT40 1SS:

Test Frequency	MCS0 MCS2				MCS1 MCS4				MCS3			
Chain	0	1	0	1	0	1	0	1	0	1	0	1
2422	4	10	4	10	4	10	4	10	4	10	4	10
2437	6	7	6	7	6	7	6	7	6	7	6	7
2462	5	7	5	7	5	7	5	7	5	7	5	7

802.11n HT40 2SS:

Test Frequency	MCS8 MCS10				MCS9 MCS12				MCS11			
Chain	0	1	0	1	0	1	0	1	0	1	0	1
2422	4	10	4	10	4	10	4	10	4	10	4	10
2437	6	7	6	7	6	7	6	7	6	7	6	7
2462	5	7	5	7	5	7	5	7	5	7	5	7

4 Subject of Investigation

The objective of the measurements done by CETECOM Inc. was to assess the performance of the EUT according to the relevant requirements specified in FCC rules Part 15.247 of Title 47 of the Code of Federal Regulations and Radio Standard Specification RSS-247 of ISED Canada.

Testing procedures are based on 558074 D01 DTS Meas Guidance v04 – "GUIDANCE FOR PERFORMING COMPLIANCE MEASUREMENTS ON DIGITAL TRANSMISSION SYSTEMS (DTS) OPERATING UNDER SECTION 15.247" - April 5, 2017, by the Federal Communications Commission, Office of Engineering and Technology, Laboratory Division.

The power level setting has been reduced as described in Section3 in order to comply with the limit of Band edge. This power level will be used for the final product

5 Measurement Results Summary

Test Specification	Test Case	Temperature and Voltage Conditions	Mode	Pass	NA	NP	Result
§15.247(a)(1) RSS-247 5.2(1)	Emission Bandwidth	Nominal	802.11 b/g/n	■	☐	☐	Complies
§15.247(e) RSS-247 5.2(2)	Power Spectral Density	Nominal	802.11 b/g/n	■	☐	☐	Complies
§15.247(b)(1) RSS-247 5.4(4)	Maximum Conducted Output Power and EIRP	Nominal	802.11 b/g/n	■	☐	☐	Complies
§15.247(d) RSS-247 5.5	Band edge compliance Unrestricted Band Edges	Nominal	802.11 b/g/n	■	☐	☐	Complies
§15.247; 15.209; 15.205 RSS-Gen 8.9; 8.10	Band edge compliance Restricted Band Edges	Nominal	802.11 b/g/n	■	☐	☐	Complies
§15.247(d); §15.209 RSS-Gen 6.13	TX Spurious emissions-Radiated	Nominal	802.11n_ HT20 MIMO	■	☐	☐	Complies
§15.207(a) RSS Gen 8.8	AC Conducted Emissions	Nominal	N/A	☐	■	☐	N/A[2]

Note1: NA= Not Applicable; NP= Not Performed.
Note2: EUT is powered by USB

6 Measurement Uncertainty

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus, with 95% confidence interval (in dB delta to result), based on a coverage factor k=1.

Radiated measurement

9 kHz to 30 MHz	±2.5 dB (Magnetic Loop Antenna)
30 MHz to 1000 MHz	±2.0 dB (Biconilog Antenna)
1 GHz to 40 GHz	±2.3 dB (Horn Antenna)

Conducted measurement

150 kHz to 30 MHz	±0.7 dB (LISN)
RF conducted measurement	±0.5 dB

According to TR 102 273 a multiplicative propagation of error is assumed for RF measurement systems. For this reason the RMS method is applied to dB values and not to linear values as appropriate for additive propagation of error. Also used: http://physics.nist.gov/cuu/Uncertainty/typeb.html. The above calculated uncertainties apply to direct application of the Substitution method. The Substitution method is always used when the EUT comes closer than 3 dB to the limit.

6.1 Environmental Conditions during Testing:

The following environmental conditions were maintained during the course of testing:

- Ambient Temperature: 20-25° C
- Relative humidity: 40-60%

6.2 Dates of Testing:

07/10/2018 - 10/12/2018

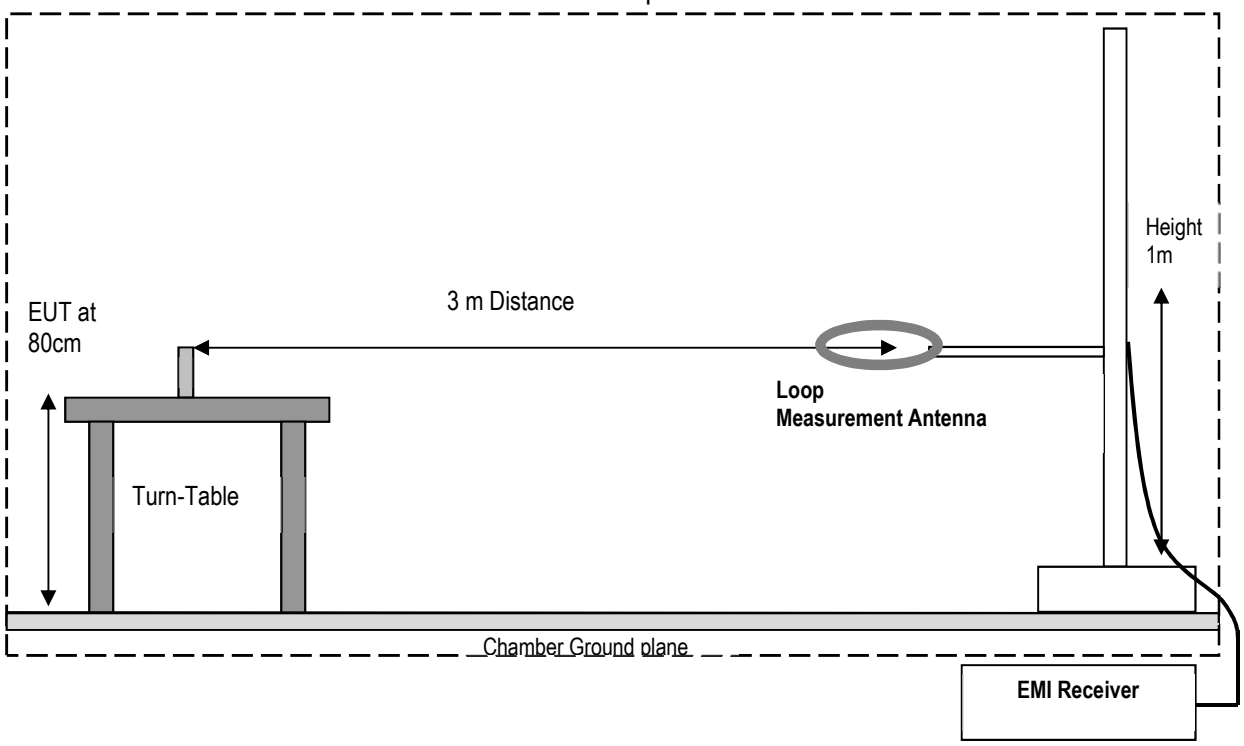
7 Measurement Procedures

7.1 Radiated Measurement

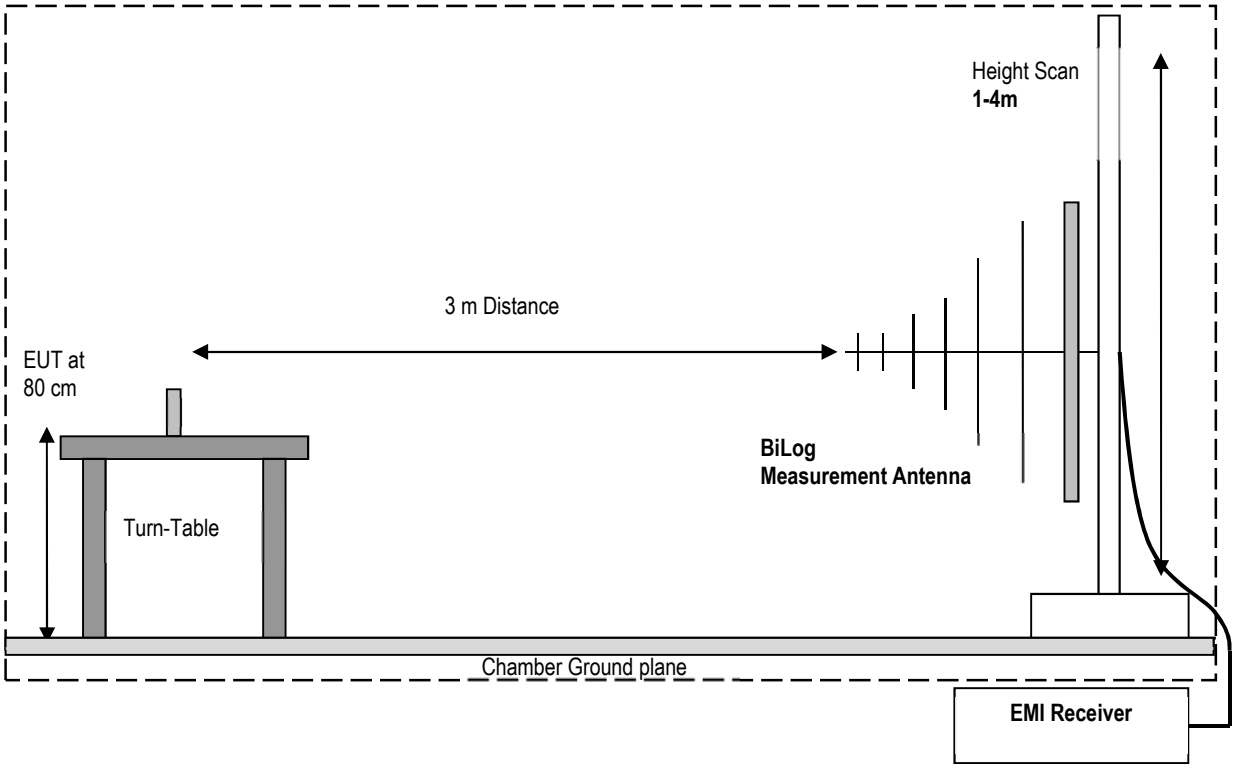
The radiated measurement is performed according to ANSI C63.10 (2013)

- The exploratory measurement is accomplished by running a matrix of 16 sweeps over the required frequency range with R&S Test-SW EMC32 for 4 positions of the turntable, two orthogonal positions of the EUT and both antenna polarizations. This procedure exceeds the requirement of the above standards to cover the 3 orthogonal axis of the EUT. A max peak detector is utilized during the exploratory measurement. The Test-SW creates an overall maximum trace for all 12 sweeps and saves the settings for each point of this trace. The maximum trace is part of the test report.
- The 10 highest emissions are selected with an automatic algorithm of EMC32 searching for peaks in the noise floor and ensuring that broadband signals are not selected multiple times.
- The maxima are then put through the final measurement and again maximized in a 90deg range of the turntable, fine search in frequency domain and height scan between 1m and 4m.
- The above procedure is repeated for all possible ways of power supply to EUT and for all supported modulations.
- In case there are no emissions above noise floor level only the maximum trace is reported as described above.
- The results are split up into up to 4 frequency ranges due to antenna bandwidth restrictions. A magnetic loop is used from 9 kHz to 30 MHz, a Biconilog antenna is used from 30 MHz to 1 GHz, and two different horn antennas are used to cover frequencies up to 40 GHz.

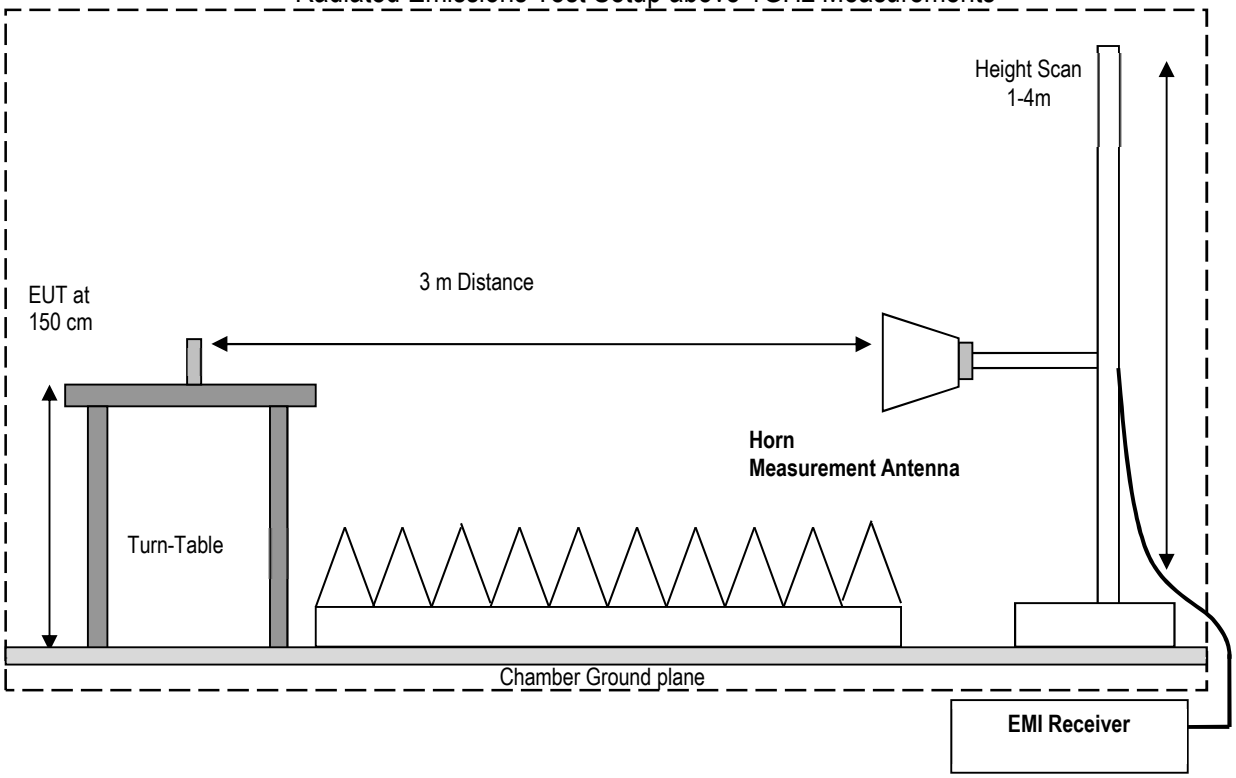
Radiated Emissions Test Setup below 30MHz Measurements



Radiated Emissions Test Setup 30MHz-1GHz Measurements



Radiated Emissions Test Setup above 1GHz Measurements



7.1.1 Sample Calculations for Field Strength Measurements

Field Strength is calculated from the Spectrum Analyzer/ Receiver readings, taking into account the following parameters:

1. Measured reading in dBµV
2. Cable Loss between the receiving antenna and SA in dB and
3. Antenna Factor in dB/m

All radiated measurement plots in this report are taken from a test SW that calculates the Field Strength based on the following equation:

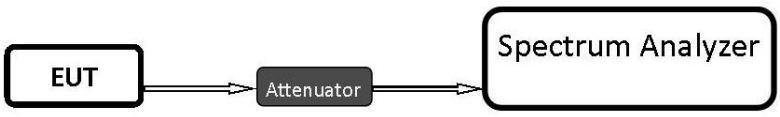
FS (dBµV/m) = Measured Value on SA (dBµV)- Cable Loss (dB)+ Antenna Factor (dB/m)

Example:

Frequency (MHz)	Measured SA (dBµV)	Cable Loss (dB)	Antenna Factor Correction (dB)	Field Strength Result (dBµV/m)
1000	80.5	3.5	14	98.0

7.2 RF Conducted Measurement Procedure

Testing procedures are based on 558074 D01 DTS Meas Guidance v04 – "GUIDANCE FOR PERFORMING COMPLIANCE MEASUREMENTS ON DIGITAL TRANSMISSION SYSTEMS (DTS) OPERATING UNDER SECTION 15.247" - April 5, 2017, by the Federal Communications Commission, Office of Engineering and Technology, Laboratory Division.



- Connect the equipment as shown in the above diagram.
- Adjust the settings of the SA (Rohde-Schwarz Spectrum Analyzer) to connect the EUT at the required mode of test.
- Measurements are to be performed with the EUT set to the low, middle and high channels and for worst case modulation schemes.
- Calculate the conducted power by taking into account attenuation of the cable and the attenuator

8 Test Result Data

8.1 Duty cycle

8.1.1 Measurement according to FCC 558074 D01 DTS Meas Guidance v04

Spectrum Analyzer settings:

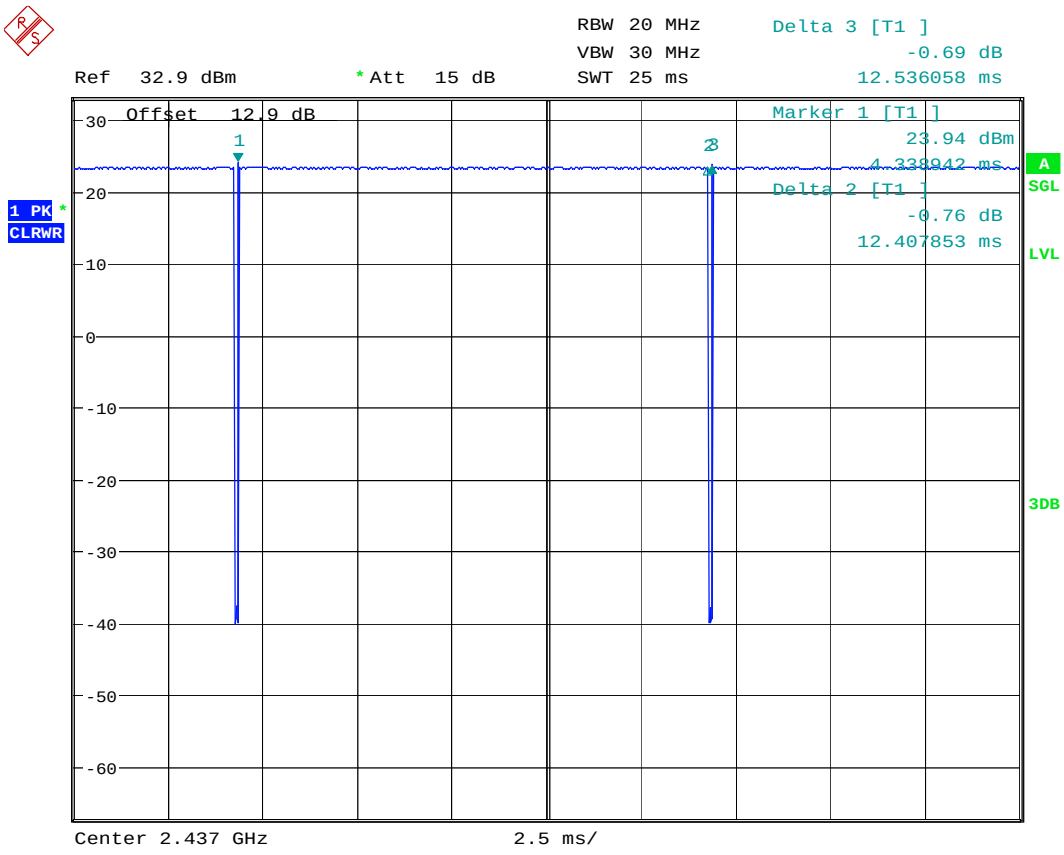
- Set the center frequency and of the instrument to the center frequency of the transmission
- Zero span
- Set RBW >=OBW if possible; otherwise, set RBW to the largest available value
- Detector = Peak or average

8.1.2 Measurement result

Plot #	Mode	Data Rate	Duty Cycle	Duty Cycle Correction Factor (dB)
1	802.11b	1Mpbs	99.00%	0.04
2	802.11b	11Mbps	94.20%	0.26
3	802.11g	6Mbps	95.40%	0.20
4	802.11g	54Mbps	73.40%	1.34
5	802.11n_HT20	MCS0	95.00%	0.22
6	802.11n_HT40	MCS0	91.50%	0.39

Plot #1

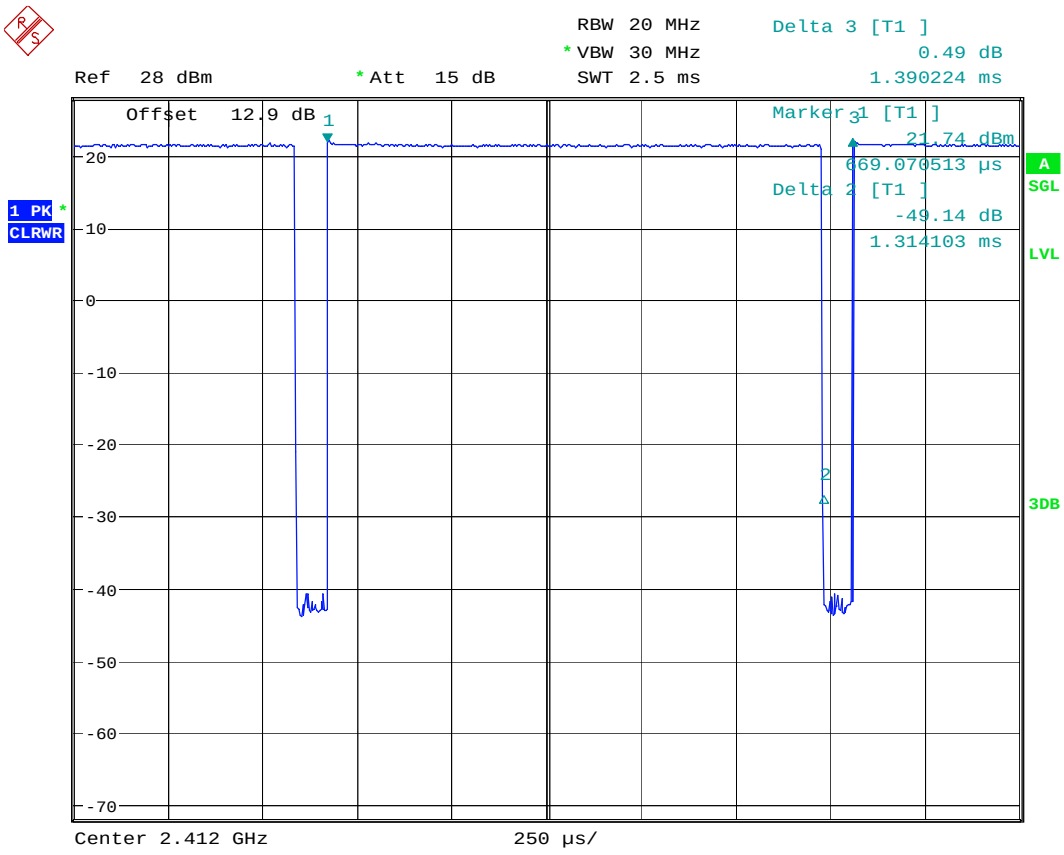
Mid channel / 2437 MHz | **Modulation/Packet Type: 802.11b 1 Mbps**



Date: 5.JUL.2018 09:50:59

Plot #2

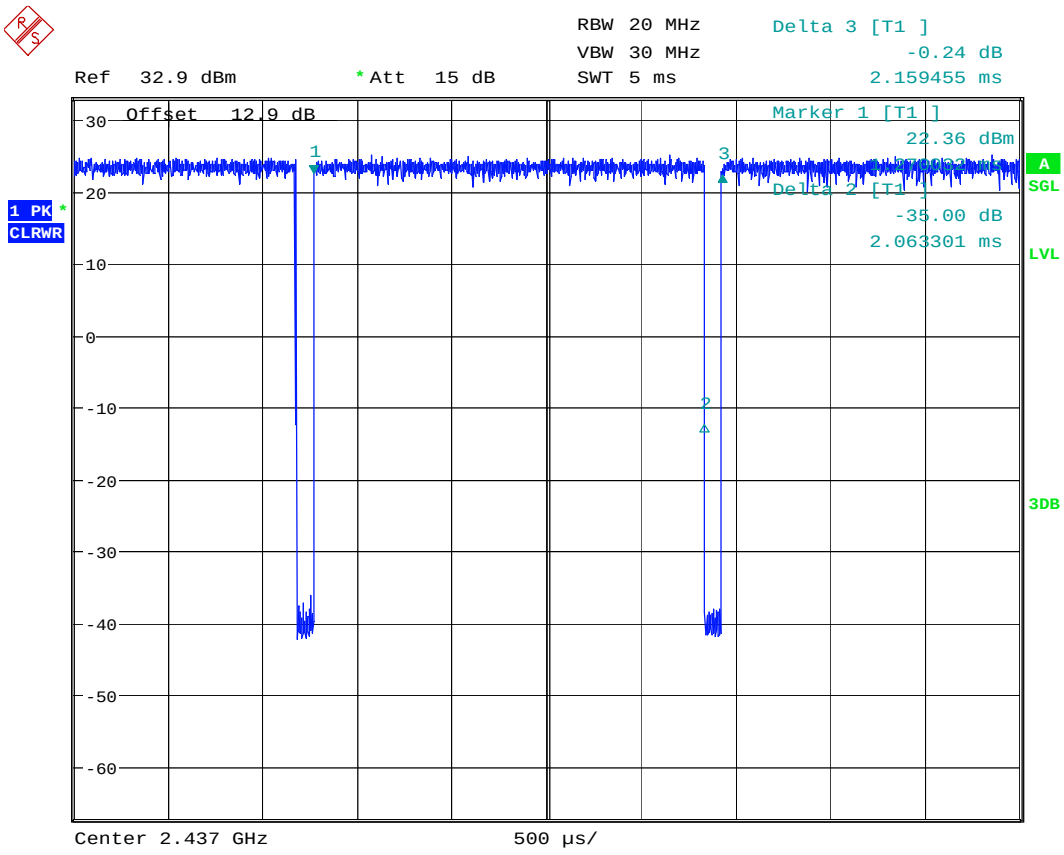
Mid channel / 2437 MHz | **Modulation/Packet Type: 802.11b 11 Mbps**



Date: 6.JUL.2018 13:03:26

Plot #3

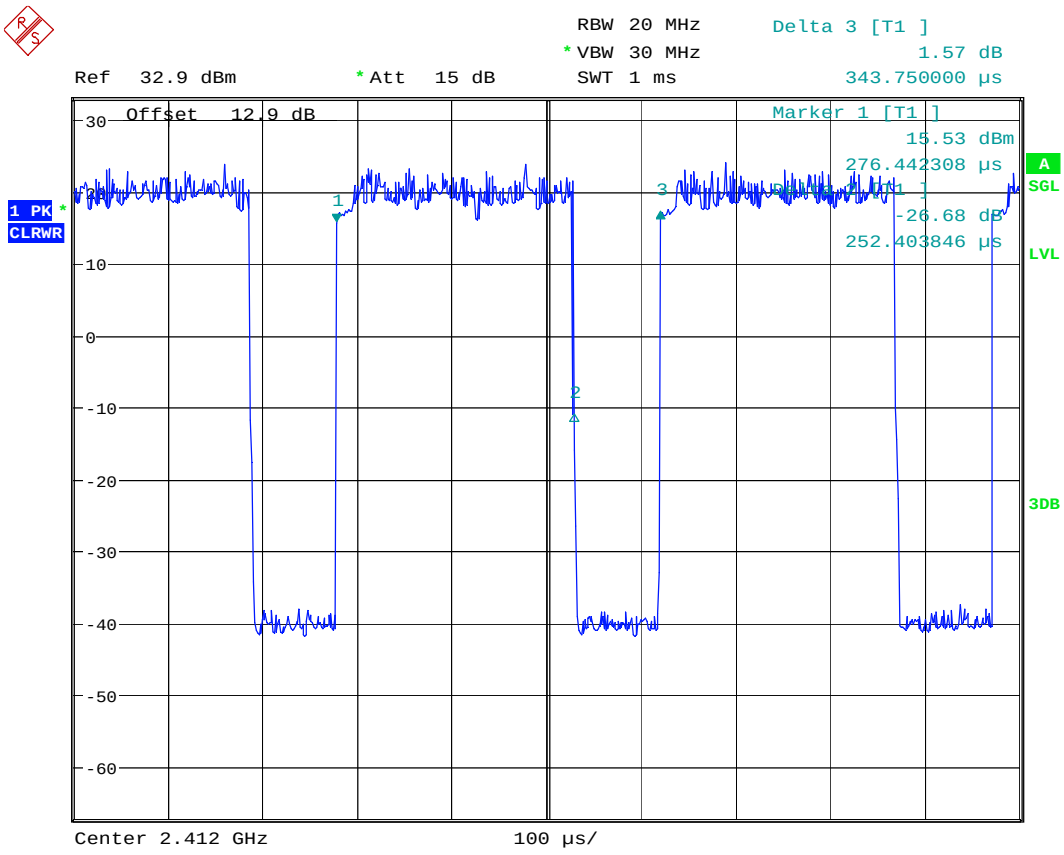
Mid channel / 2437 MHz | **Modulation/Packet Type: 802.11g 6 Mbps**



Date: 5.JUL.2018 09:54:13

Plot #4

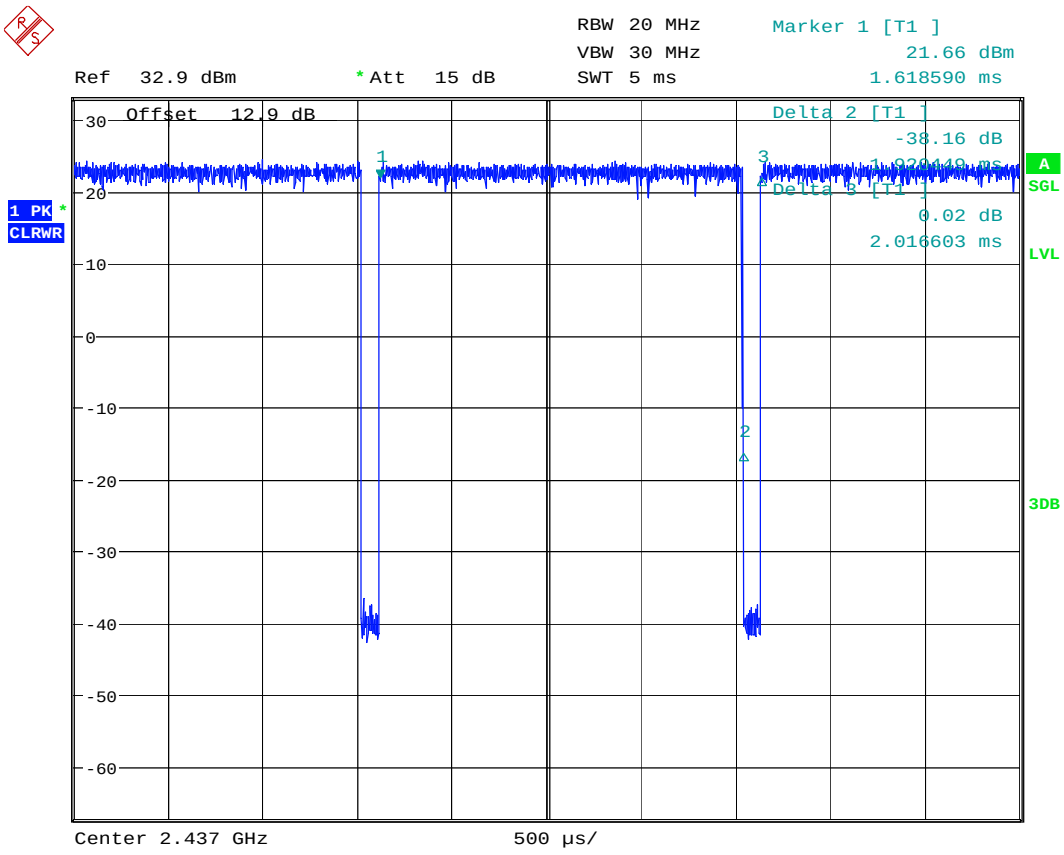
Mid channel / 2437 MHz | **Modulation/Packet Type: 802.11g 54 Mbps**



Date: 6.JUL.2018 13:08:32

Plot #5

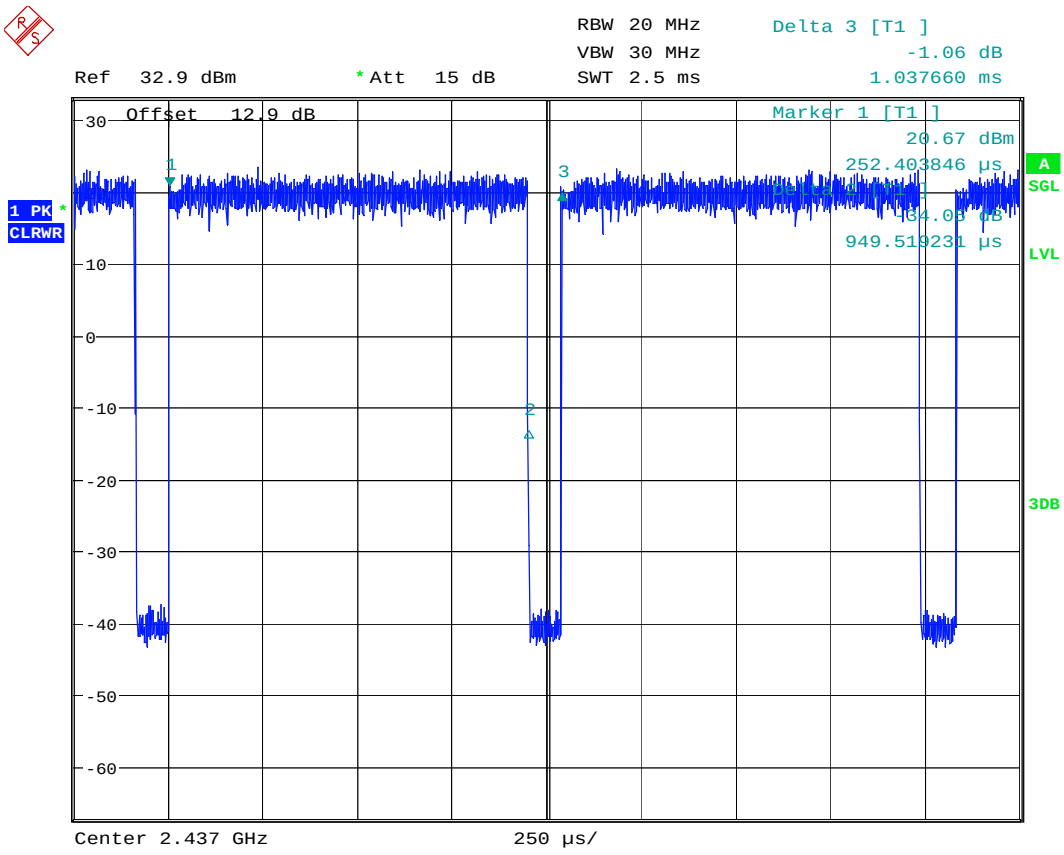
Mid channel / 2437 MHz | **Modulation/Packet Type: 802.11n_HT20 MCS0**



Date: 5.JUL.2018 09:43:07

Plot #6

Mid channel / 2437 MHz | **Modulation/Packet Type: 802.11n_HT40 MCS0**



8.2 Maximum Conducted Output Power

8.2.1 Measurement according to FCC 558074 D01 DTS Meas Guidance v04

Spectrum Analyzer settings:

- Measure the duty cycle, x, of the transmitter output signal.
- Set span to at least 1.5 □ OBW.
- Set RBW = 1 % to 5 % of the OBW, not to exceed 1 MHz.
- Set VBW ≥ 3 □ RBW.
- Number of points in sweep ≥ 2 □ span / RBW. (This gives bin-to-bin spacing ≤ RBW/2, so that narrowband signals are not lost between frequency bins.)
- Sweep time = auto.
- Detector = RMS (i.e., power averaging), if available. Otherwise, use sample detector mode.
- Allow the sweep to "free run". RBW ≥ DTS bandwidth
- Trace average at least 100 traces in power averaging (i.e., RMS) mode; however, the number of traces to be averaged shall be increased above 100 as needed such that the average accurately represents the true average over the on and off periods of the transmitter.
- Compute power by integrating the spectrum across the OBW of the signal using the instrument's band power measurement function with band limits set equal to the OBW band edges. If the instrument does not have a band power function, sum the spectrum levels (in power units) at intervals equal to the RBW extending across the entire OBW of the spectrum.
- Add 10 log (1/x), where x is the duty cycle, to the measured power in order to compute the average power during the actual transmission times (because the measurement represents an average over both the on- and off-times of the transmission). For example, add 10 log (1/0.25) = 6 dB if the duty cycle is 25 %.

8.2.2 Limits:

Maximum Peak Output Power:

- FCC §15.247 (b)(1): 1 W
- IC RSS-247: 1 W

8.2.3 Test conditions and setup:

Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input	Single Antenna Gain
22° C	1	802.11b/g/n	USB 5 VDC	4dBi

8.2.4 Measurement result:

Attenuation of cable and attenuator (already taken into account): 12.9 dB

Mode	Tx Chain	Date Rate	Channel	Measured conducted powered(dBm)	Corrected by DCCF(dBm)	EIRP (dBm)	Limit (dBm)	Result
802.11b	0	1Mbps	1	18.52	18.56	22.56	30 / 36 (EIRP)	Pass
			6	20.2	20.24	24.24	30 / 36 (EIRP)	Pass
			11	20.67	20.71	24.71	30 / 36 (EIRP)	Pass
		11Mbps	1	18.53	18.79	22.79	30 / 36 (EIRP)	Pass
			6	20.24	20.5	24.5	30 / 36 (EIRP)	Pass
			11	20.72	20.98	24.98	30 / 36 (EIRP)	Pass
	1	1Mbps	1	16.22	16.26	20.26	30 / 36 (EIRP)	Pass
			6	16.5	16.54	20.54	30 / 36 (EIRP)	Pass
			11	16.92	16.96	20.96	30 / 36 (EIRP)	Pass
		11Mbps	1	15.84	16.1	20.1	30 / 36 (EIRP)	Pass
			6	16.36	16.62	20.62	30 / 36 (EIRP)	Pass
			11	16.78	17.04	21.04	30 / 36 (EIRP)	Pass
802.11g	0	6Mbps	1	18.23	18.43	22.43	30 / 36 (EIRP)	Pass
			6	18.89	19.09	23.09	30 / 36 (EIRP)	Pass
			11	19.14	19.34	23.34	30 / 36 (EIRP)	Pass
		54Mbps	1	12.62	13.96	17.96	30 / 36 (EIRP)	Pass
			6	13.46	14.8	18.8	30 / 36 (EIRP)	Pass
			11	13.37	14.71	18.71	30 / 36 (EIRP)	Pass

Mode	Tx Chain	Date Rate	Channel	Measured conducted powered(dBm)	Corrected by DCCF(dBm)	Summed power MIMO(dBm)	EIRP (dBm)	Limit (dBm)	Result
802.11n_HT20 MIMO	0	MCS0	1	17.77	17.99	19.46	26.47	28.99 / 36 (EIRP)	Pass
			6	18.02	18.24	19.70	26.71	28.99 / 36 (EIRP)	Pass
			11	18.51	18.73	20.19	27.20	28.99 / 36 (EIRP)	Pass
		MCS8	1	17.29	17.51	19.07	26.08	28.99 / 36 (EIRP)	Pass
			6	17.94	18.16	19.58	26.59	28.99 / 36 (EIRP)	Pass
			11	18.37	18.59	20.03	27.04	28.99 / 36 (EIRP)	Pass
	1	MCS0	1	13.81	14.03	-	-	28.99 / 36 (EIRP)	-
			6	14.04	14.26	-	-	28.99 / 36 (EIRP)	-
			11	14.52	14.74	-	-	28.99 / 36 (EIRP)	-
		MCS8	1	13.64	13.86	-	-	28.99 / 36 (EIRP)	-
			6	13.82	14.04	-	-	28.99 / 36 (EIRP)	-
			11	14.33	14.55	-	-	28.99 / 36 (EIRP)	-
802.11n_HT40 MIMO	0	MCS0	3	16.84	17.23	18.63	25.64	28.99 / 36 (EIRP)	Pass
			6	17.14	17.53	18.89	25.90	28.99 / 36 (EIRP)	Pass
			9	17.27	17.66	19.01	26.02	28.99 / 36 (EIRP)	Pass
		MCS8	3	16.82	17.21	18.59	25.60	28.99 / 36 (EIRP)	Pass
			6	17.04	17.43	18.79	25.80	28.99 / 36 (EIRP)	Pass
			9	17.11	17.5	18.85	25.86	28.99 / 36 (EIRP)	Pass
	1	MCS0	3	12.64	13.03	-	-	28.99 / 36 (EIRP)	-
			6	12.79	13.18	-	-	28.99 / 36 (EIRP)	-
			9	12.88	13.27	-	-	28.99 / 36 (EIRP)	-
		MCS8	3	12.54	12.93	-	-	28.99 / 36 (EIRP)	-
			6	12.71	13.1	-	-	28.99 / 36 (EIRP)	-
			9	12.73	13.12	-	-	28.99 / 36 (EIRP)	-

EIRP= Conducted output power + Antenna gain
Directional antenna gain of MIMO = Gain of antenna element + 10log(Nant)
Limit of MIMO: 30dBm – (7.01 -6 dBi) = 28.99 dBm

Maximum peak conducted output power was measured on the worst case of above result,

Mode	Tx Chain	Date Rate	Channel	Measured peak conducted powered(dBm)	Summed power MIMO(dBm)	EIRP (dBm)	Limit (dBm)	Result
802.11n _HT20 MIMO	0	MCS0	1	25.34	27.00	34.01	28.99 / 36 (EIRP)	Pass
			6	26.15	27.73	34.74	28.99 / 36 (EIRP)	Pass
			11	26.71	28.13	35.14	28.99 / 36 (EIRP)	Pass
	1		1	22.02	-	-	28.99 / 36 (EIRP)	-
			6	22.58	-	-	28.99 / 36 (EIRP)	-
			11	22.58	-	-	28.99 / 36 (EIRP)	-

8.3 Power Spectral Density

8.3.1 Measurement according to FCC 558074 D01 DTS Meas Guidance v04

Spectrum Analyzer settings for Peak PSD method:

- Set analyzer center frequency to DTS channel center frequency
- Set the span to 1.5 x DTS bandwidth
- Set RBW to: 3 kHz ≤ RBW ≤ 100 kHz
- Set the VBW ≥ 3 x RBW
- Detector = Peak
- Sweep time = Auto couple
- Trace mode = Max hold
- Allow trace to fully stabilize
- Use the peak marker function to determine the maximum amplitude level within the RBW
- If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat

8.3.2 Limits:

FCC§15.247(e) & RSS-247 5.2(2)

- For digitally modulated systems, the peak power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

8.3.3 Test conditions and setup:

Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input	Single Antenna Gain
23° C	1	802.11b/g/n	USB 5 VDC	4dBi

8.3.4 Measurement result:

Attenuation of cable and attenuator (already taken into account): 12.9 dB

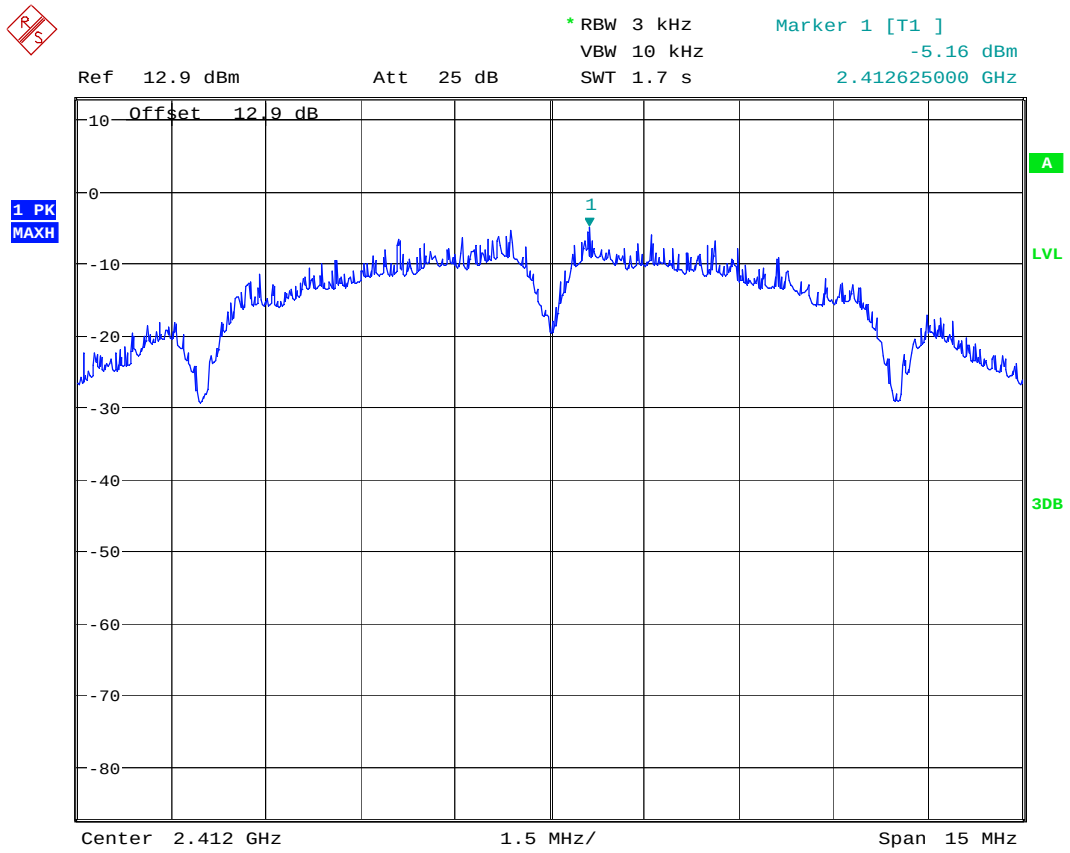
Plot #	Mode	Data Rate	Tx chain	channel	Maximum Power Spectral Density (dBm/3 kHz)	PSD Adjusted for Antenna Gain (dBm/3 kHz)	Limit (dBm / 3 kHz)	Result
1	802.11b	1Mpbs	0	1	-5.16	-1.16	8	Pass
2				6	-3.58	0.42	8	Pass
3				11	-3.98	0.02	8	Pass
4	802.11g	6Mpbs	0	1	-7.84	-3.84	8	Pass
5				6	-8.2	-4.2	8	Pass
6				11	-7.33	-3.33	8	Pass
7	802.11n_HT20	MCS0	0	1	-5.66	-1.66	6.99	Pass
8				6	-4.78	-0.78	6.99	Pass
9				11	-5.11	-1.11	6.99	Pass
10	802.11n_HT20	MCS0	0	3	-9.31	-5.31	6.99	Pass
11				6	-8.62	-4.62	6.99	Pass
12				9	-8.74	-4.74	6.99	Pass

For MIMO, offset is set to cable loss + 10log(Nant) = 15.9dB
Limit for MIMO: 8dBm – (7.01 -6dBi) = 6.99dBm

8.3.5 Measurement Plots:

Plot #1

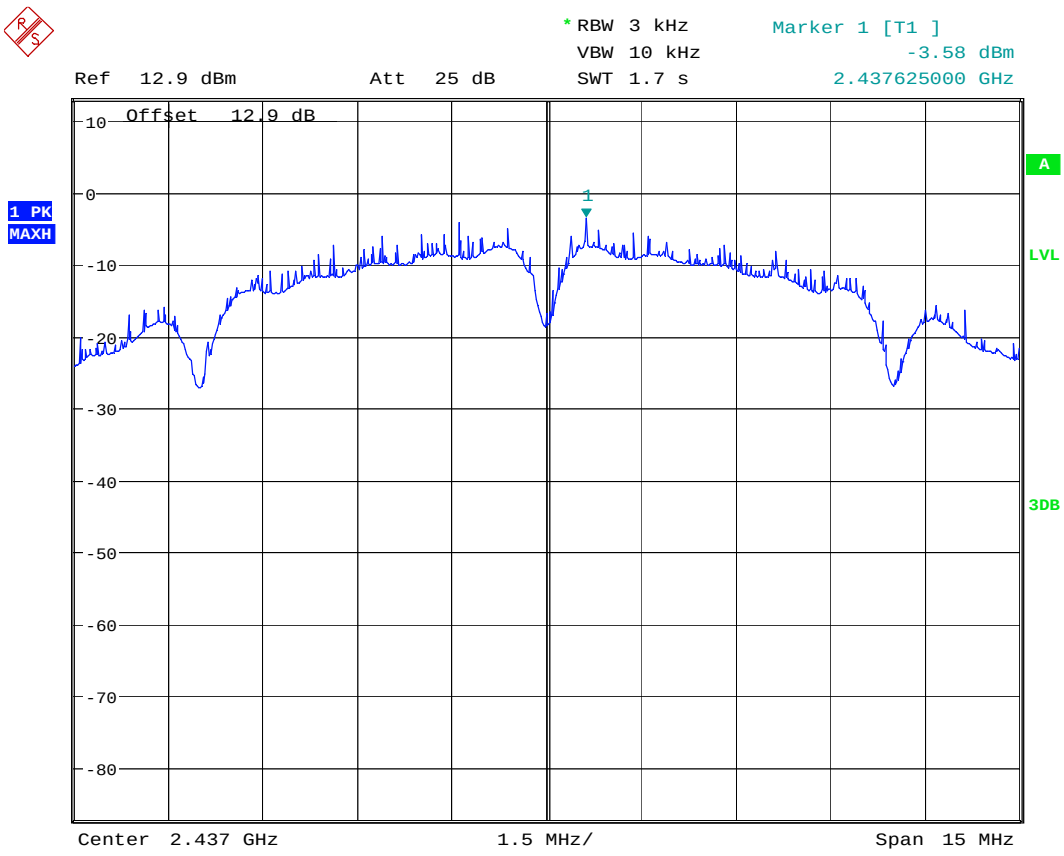
Low channel	Modulation/Packet Type: 802.11b 1Mbps



Date: 6.JUL.2018 15:29:55

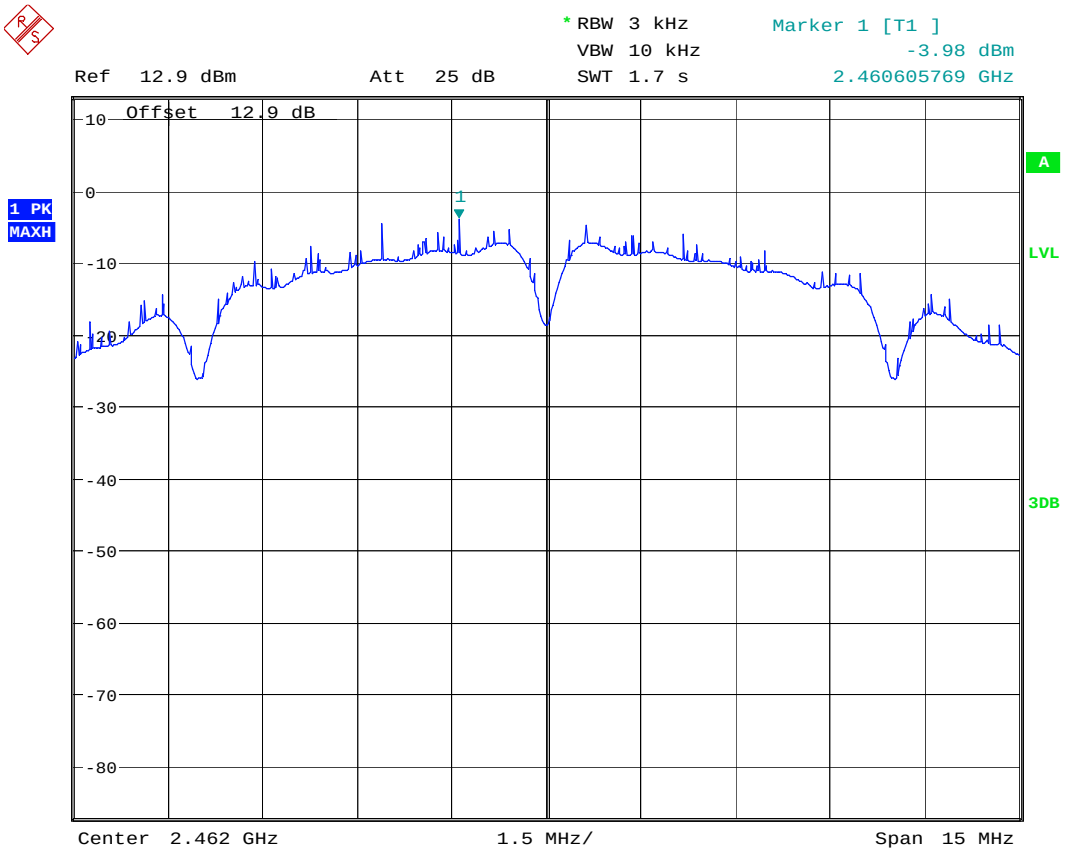
Plot #2

Mid channel	Modulation/Packet Type: 802.11b 1Mbps



Plot #3

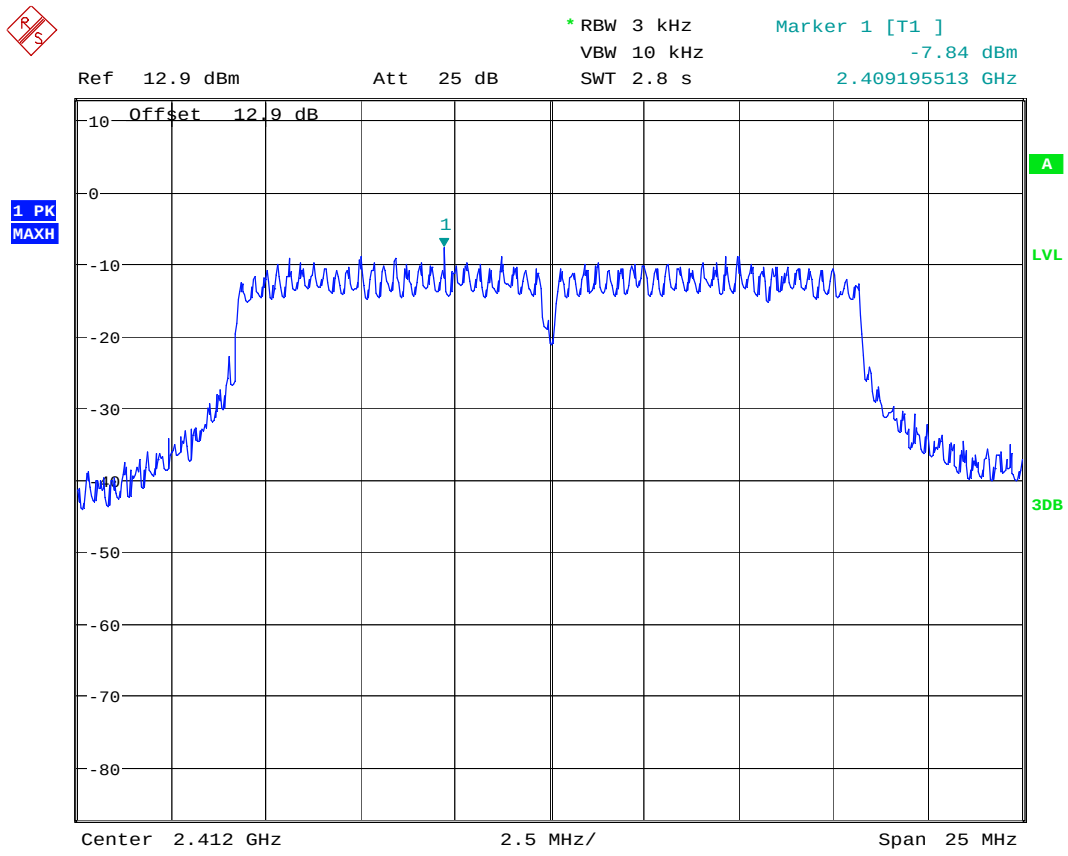
High channel	Modulation/Packet Type: 802.11b 1Mbps



Date: 6.JUL.2018 15:32:08

Plot #4

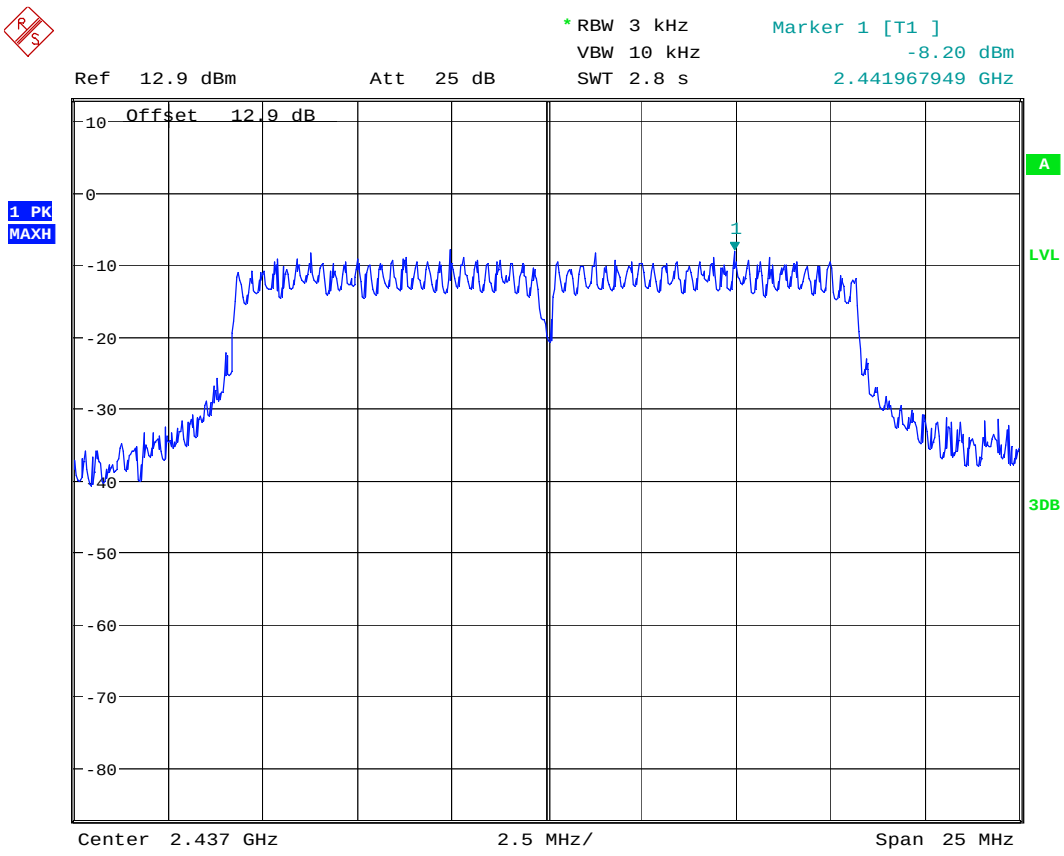
Low channel	Modulation/Packet Type: 802.11g 6Mbps



Date: 6.JUL.2018 15:44:06

Plot #5

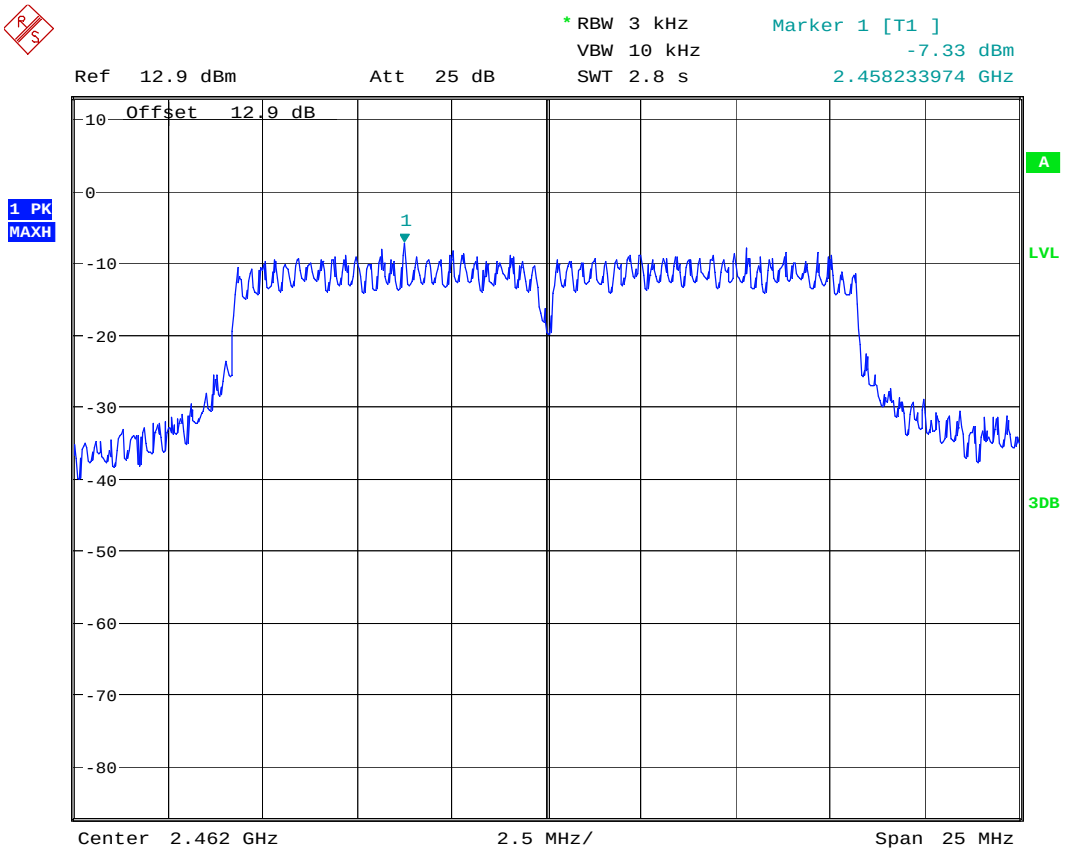
Mid channel	Modulation/Packet Type: 802.11g 6Mbps



Date: 6.JUL.2018 15:45:19

Plot #6

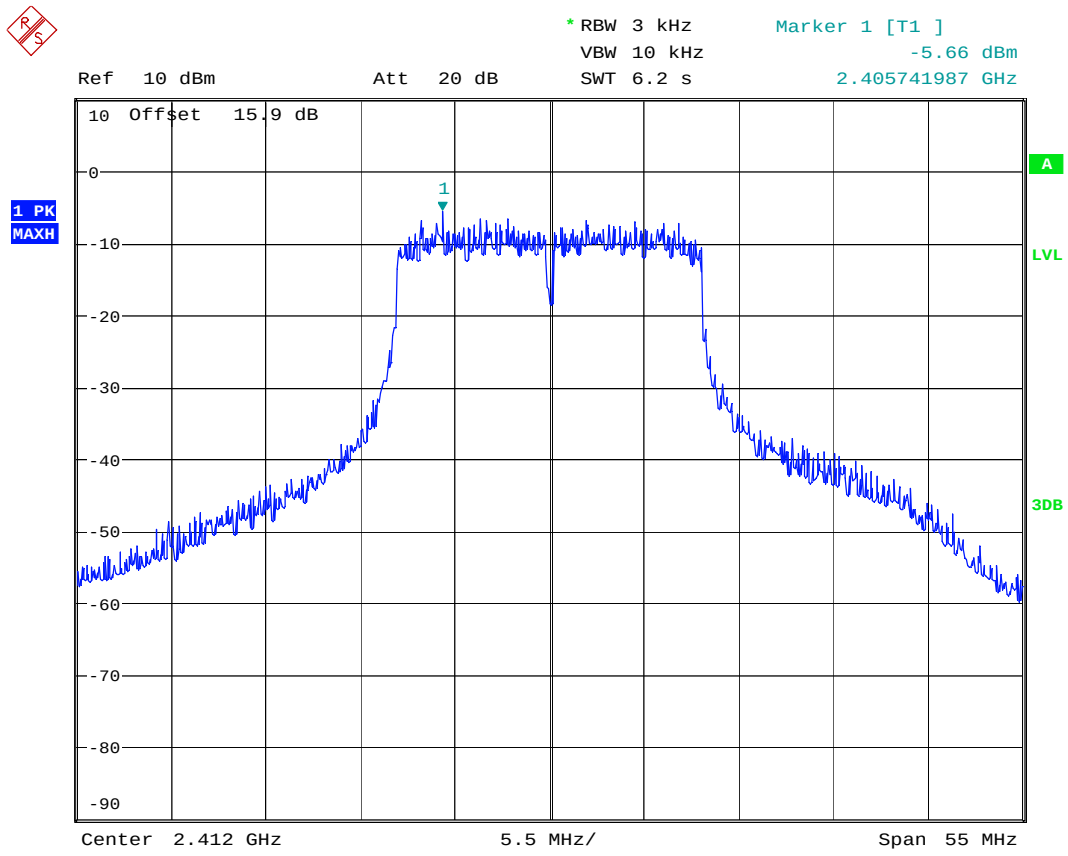
High channel	Modulation/Packet Type: 802.11g 6Mbps



Date: 6.JUL.2018 15:46:45

Plot #7

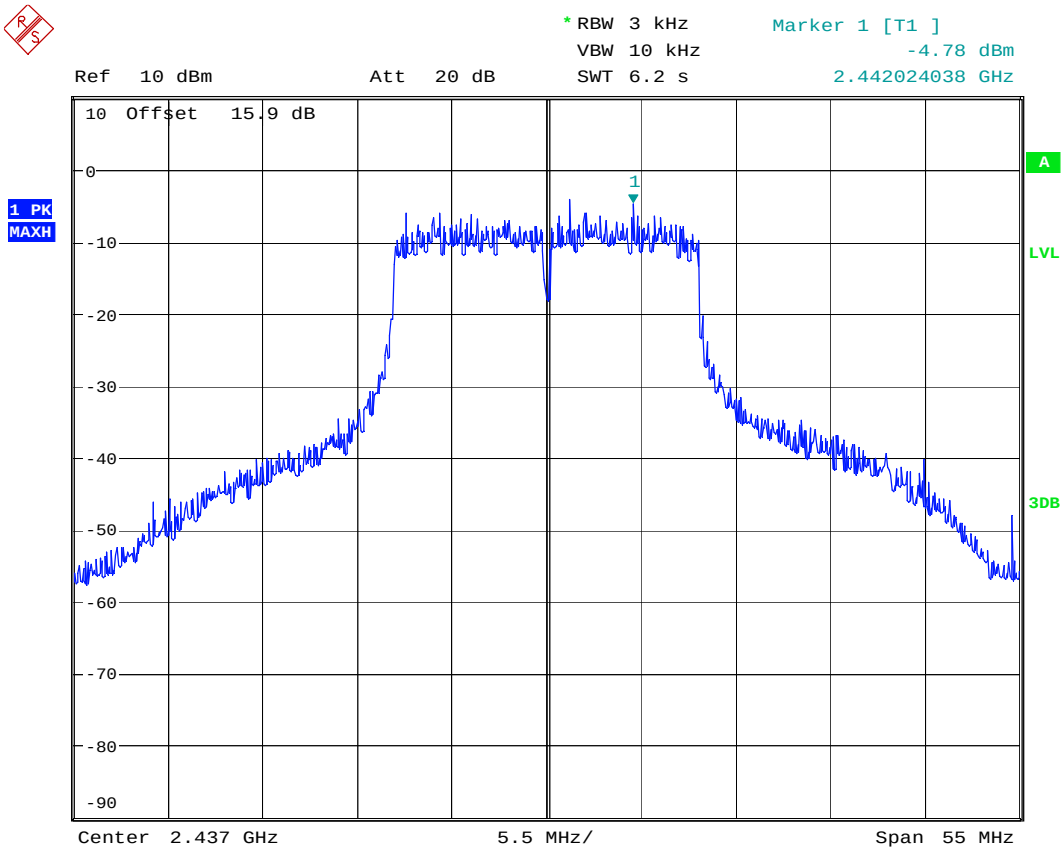
Low channel	Modulation/Packet Type: 802.11n_HT20 MCS0



Date: 6.JUL.2018 15:50:11

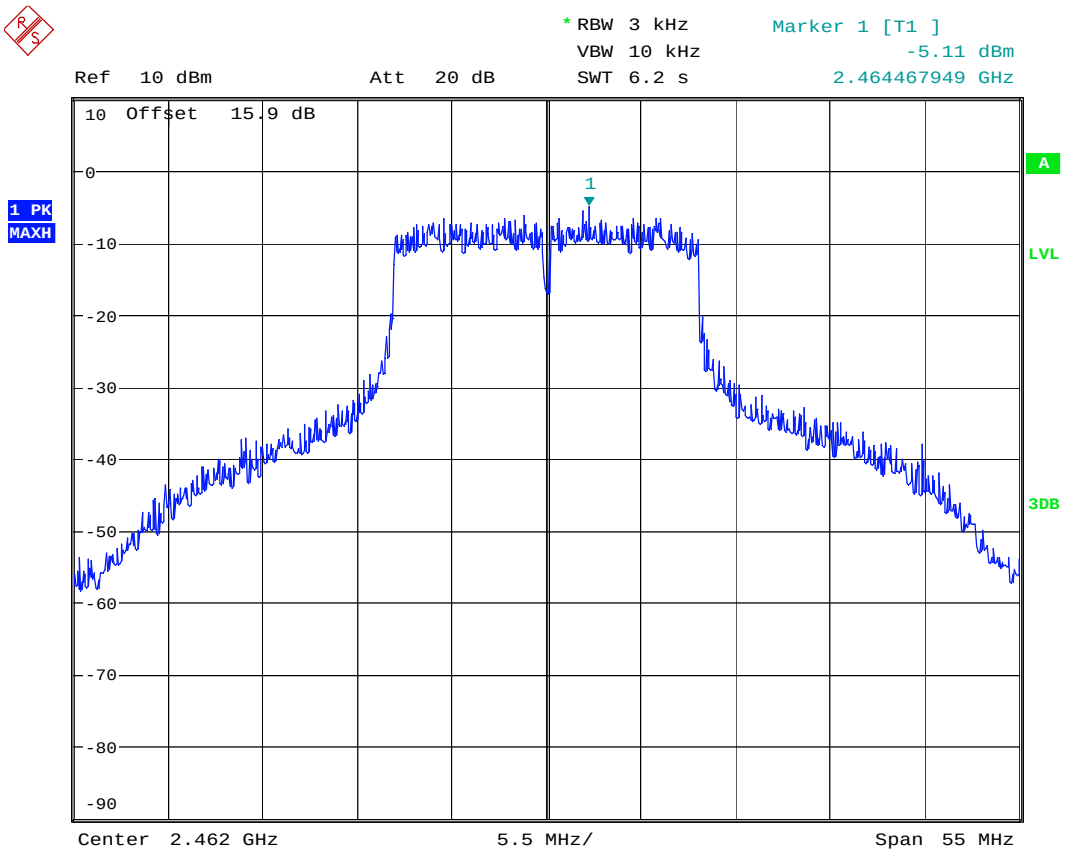
Plot #8

Mid channel	Modulation/Packet Type: 802.11n_HT20 MCS0



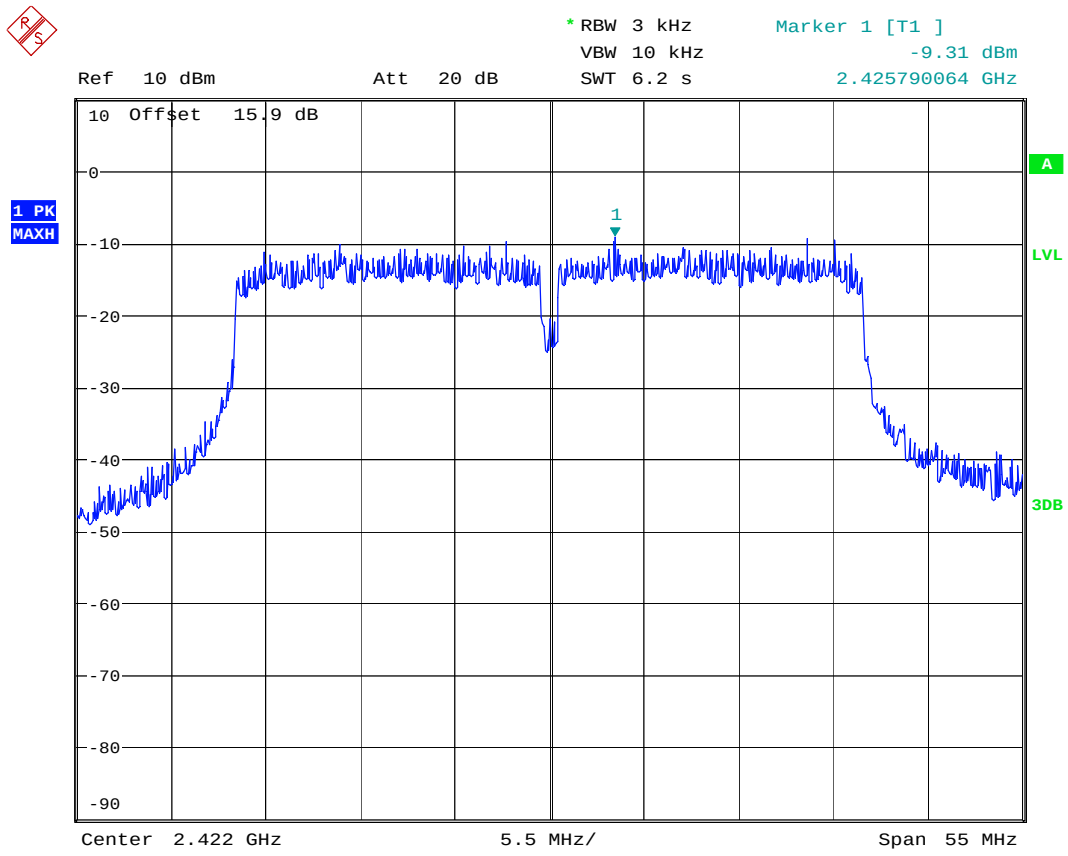
Plot #9

High channel	Modulation/Packet Type: 802.11n_HT20 MCS0



Plot #10

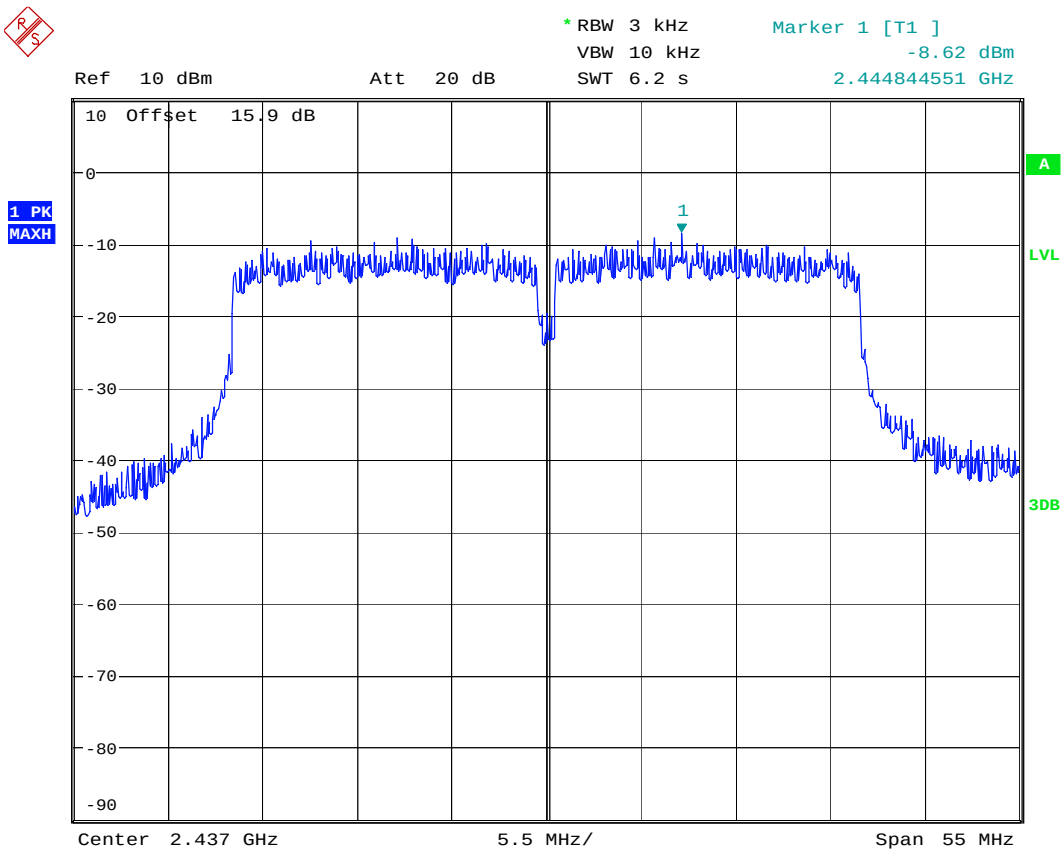
Low channel	Modulation/Packet Type: 802.11n_HT40 MCS0



Date: 6.JUL.2018 17:20:49

Plot #11

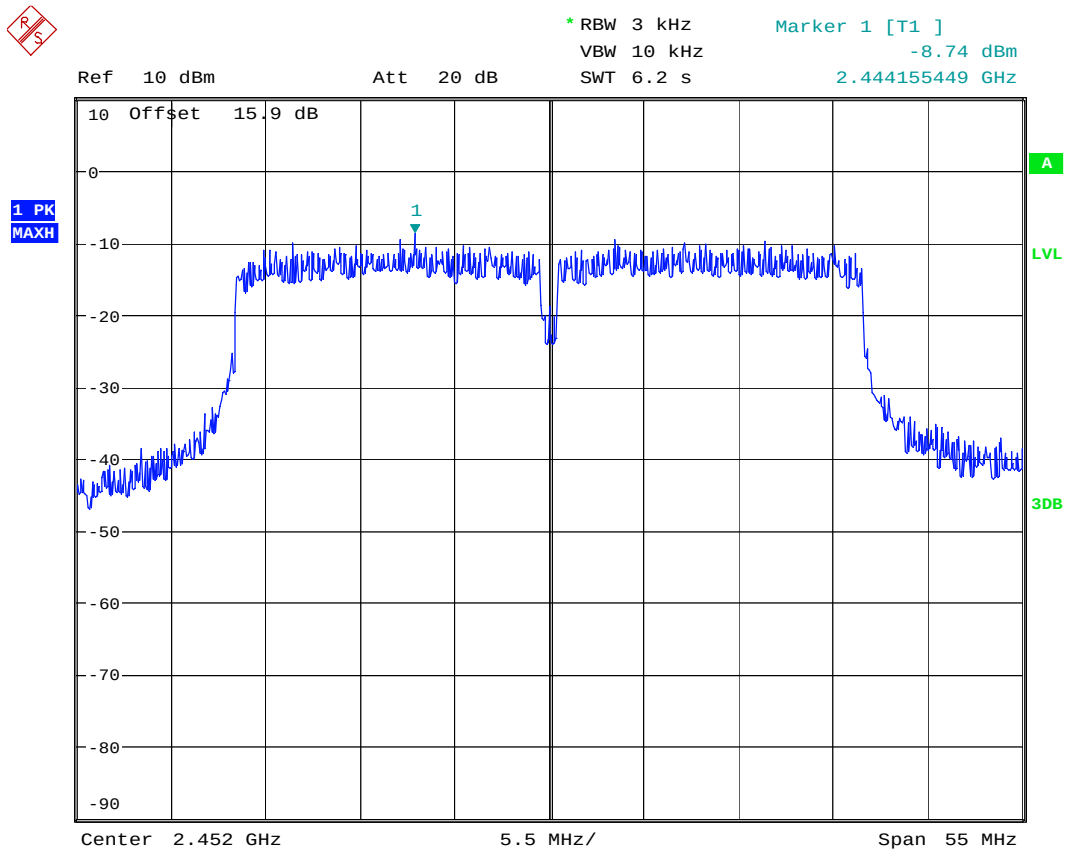
Mid channel	Modulation/Packet Type: 802.11n_HT40 MCS0



Date: 6.JUL.2018 17:19:25

Plot #12

High channel	Modulation/Packet Type: 802.11n_HT40 MCS0



Date: 6.JUL.2018 17:22:32

8.4 Band Edge Compliance

8.4.1 Measurement according to FCC 558074 D01 DTS Meas Guidance v04

Spectrum Analyzer settings for band edge:

- Set the center frequency and span to encompass frequency range to be measured
- RBW = 100 kHz
- VBW ≥ 3 x RBW
- Sweep Time: Auto couple
- Detector = Peak
- Trace = Max hold
- Allow trace to fully stabilize
- Use the peak marker function to determine the maximum amplitude level
- Set the marker on the emission at the band edge, or on the highest modulation product outside of the band, if this level is greater than that at the band edge

8.4.2 Limits non restricted band:

FCC§15.247 (d)

- In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

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- In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30dB instead of 20dB.

Spectrum Analyzer settings for restricted band:

- Peak measurements are made using a peak detector and RBW=1 MHz

8.4.3 Limits restricted band §15.247/15.209/15.205 and RSS-Gen 8.9/8.10

- *PEAK LIMIT= 74 dBµV/m @3m =-21.23 dBm
- *AVG LIMIT= 54 dBµV/m @3m =-41.23 dBm
- Start frequency & stop frequency according to frequency range specified in the restricted band table in FCC section 15.205 & RSS-Gen 8.10
- Measurements with a peak detector were used to show compliance to average limits, thus showing compliance to both peak and average limits.

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

(b)

MHz	MHz	MHz	GHz
0.090-0.110	16.42-16.423	399.9-410	4.5-5.15
[1]0.495-0.505	16.69475-16.69525	608-614	5.35-5.46
2.1735-2.1905	16.80425-16.80475	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.215-6.218	74.8-75.2	1660-1710	10.6-12.7
6.26775-6.26825	108-121.94	1718.8-1722.2	13.25-13.4
6.31175-6.31225	123-138	2200-2300	14.47-14.5
8.291-8.294	149.9-150.05	2310-2390	15.35-16.2
8.362-8.366	156.52475-156.52525	2483.5-2500	17.7-21.4
8.37625-8.38675	156.7-156.9	2690-2900	22.01-23.12
8.41425-8.41475	162.0125-167.17	3260-3267	23.6-24.0
12.29-12.293	167.72-173.2	3332-3339	31.2-31.8
12.51975-12.52025	240-285	3345.8-3358	36.43-36.5
12.57675-12.57725	322-335.4	3600-4400	Above 38.6
13.36-13.41			

8.4.4 Test conditions and setup:

Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input	Single Antenna Gain
22° C	1	802.11b/g/n	USB 5 VDC	4dBi

8.4.5 Measurement result:

Plot #	Tx Chain	EUT operating mode	Band Edge	Frequency (MHz)	Band Edge Delta (dBc)	Limit (dBc)	Result
1	0	802.11b	Lower, Non-restricted	2396.9	-51.64	20	Pass
2	0	802.11g	Lower, Non-restricted	2399.9	-36.5	20	Pass
3	0	802.11n_HT20	Lower, Non-restricted	2399.8	-36.66	20	Pass
4	0	802.11n_HT40	Lower, Non-restricted	2399.8	-32.68	20	Pass
5	1	802.11b	Lower, Non-restricted	2397.9	-55.05	20	Pass
6	1	802.11g	Lower, Non-restricted	2399.88	-36.43	20	Pass
7	1	802.11n_HT20	Lower, Non-restricted	2399.87	-36.55	20	Pass
8	1	802.11n_HT40	Lower, Non-restricted	2399.2	-32.08	20	Pass

Plot #	Tx Chain	EUT operating mode	Band Edge	Frequency (MHz)	Measured Peak Value (dBm)	Corrected by duty cycle	Corrected by Antenna Gain (dBm)	Limit (dBm)	Result
9	0	802.11b	Lower Restricted peak	2389.7	-42.24	NA	-38.24	-21.23 Peak	Pass
10	0	802.11b	Lower Restricted Average	2382.3	-53.59	-53.55	-49.55	-41.23 AVG	Pass
11	0	802.11g	Lower Restricted peak	2389.2	-41.12	NA	-37.12	-21.23 Peak	Pass
12	0	802.11g	Lower Restricted Average	2389.9	-52.2	-52	-48	-41.23 AVG	Pass
13	0	802.11n_HT20	Lower Restricted peak	2388.8	-38.75	NA	-31.74	-21.23 Peak	Pass
14	0	802.11n_HT20	Lower Restricted Average	2390	-51.56	-51.34	-44.33	-41.23 AVG	Pass
15	0	802.11n_HT40	Lower Restricted peak	2387.8	-31.69	NA	-24.68	-21.23 Peak	Pass
16	0	802.11n_HT40	Lower Restricted Average	2389.2	-50.76	-50.37	-43.36	-41.23 AVG	Pass
17	0	802.11b	Upper Restricted peak	2484.1	-40.77	NA	-36.77	-21.23 Peak	Pass
18	0	802.11b	Upper Restricted Average	2483.9	-52.61	-52.57	-48.57	-41.23 AVG	Pass
19	0	802.11g	Upper Restricted peak	2483.58	-39.68	NA	-35.68	-21.23 Peak	Pass
20	0	802.11g	Upper Restricted Average	2483.6	-52.33	-52.13	-48.13	-41.23 AVG	Pass
21	0	802.11n_HT20	Upper Restricted peak	2484.1	-39.61	NA	-32.6	-21.23 Peak	Pass
22	0	802.11n_HT20	Upper Restricted Average	2483.5	-51.34	-51.12	-44.11	-41.23 AVG	Pass
23	0	802.11n_HT40	Upper Restricted peak	2485.6	-30.25	NA	-23.24	-21.23 Peak	Pass
24	0	802.11n_HT40	Upper Restricted Average	2483.9	-50.34	-49.95	-42.94	-41.23 AVG	Pass
25	1	802.11b	Lower Restricted peak	2388.59	-45.48	NA	-41.48	-21.23 Peak	Pass
26	1	802.11b	Lower Restricted Average	2363.8	-56.84	-56.8	-52.8	-41.23 AVG	Pass
27	1	802.11g	Lower Restricted peak	2372.7	-45.04	NA	-41.04	-21.23 Peak	Pass
28	1	802.11g	Lower Restricted Average	2390	-57.02	-56.82	-52.82	-41.23 AVG	Pass
29	1	802.11n_HT20	Lower Restricted peak	2390	-39.08	NA	-32.07	-21.23 Peak	Pass
30	1	802.11n_HT20	Lower Restricted Average	2390	-51.52	-51.3	-44.29	-41.23 AVG	Pass
31	1	802.11n_HT40	Lower Restricted peak	2388.97	-33.1	NA	-26.09	-21.23 Peak	Pass
32	1	802.11n_HT40	Lower Restricted Average	2389.2	-51.11	-50.72	-43.71	-41.23 AVG	Pass
33	1	802.11b	Upper Restricted peak	2498.7	-44.48	NA	-40.48	-21.23 Peak	Pass

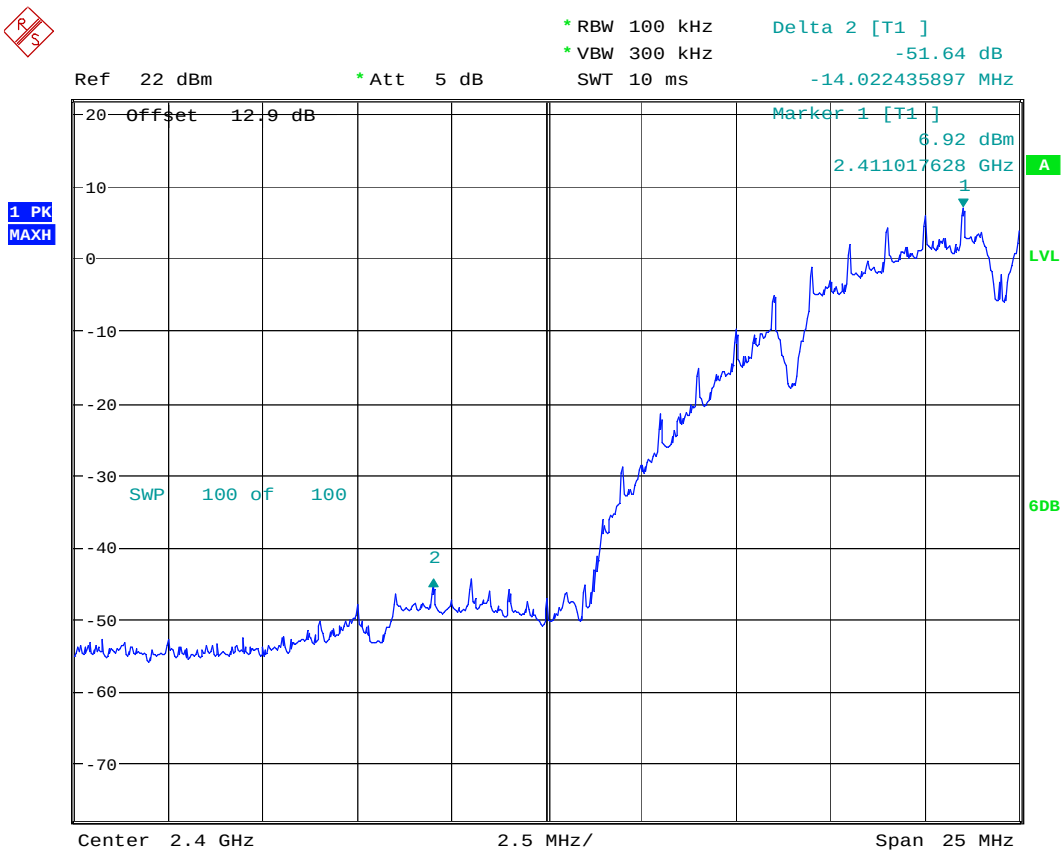
34	1	802.11b	Upper Restricted Average	2490.1	-56.09	-56.05	-52.05	-41.23 AVG	Pass
35	1	802.11g	Upper Restricted peak	2484	-43.94	NA	-39.94	-21.23 Peak	Pass
36	1	802.11g	Upper Restricted Average	2484.2	-56.26	-56.06	-52.06	-41.23 AVG	Pass
37	1	802.11n_HT20	Upper Restricted peak	2487	-41.98	NA	-34.97	-21.23 Peak	Pass
38	1	802.11n_HT20	Upper Restricted Average	2484.3	-53.75	-53.53	-46.52	-41.23 AVG	Pass
39	1	802.11n_HT40	Upper Restricted peak	2484.6	-35.42	NA	-28.41	-21.23 Peak	Pass
40	1	802.11n_HT40	Upper Restricted Average	2500	-54.52	-54.13	-47.12	-41.23 AVG	Pass

The Reduced power level described in Section3 is used for this test
The value of above table shows worst case of each mode.
Directional antenna gain of MIMO is 7.01

8.4.6 Measurement Plots:

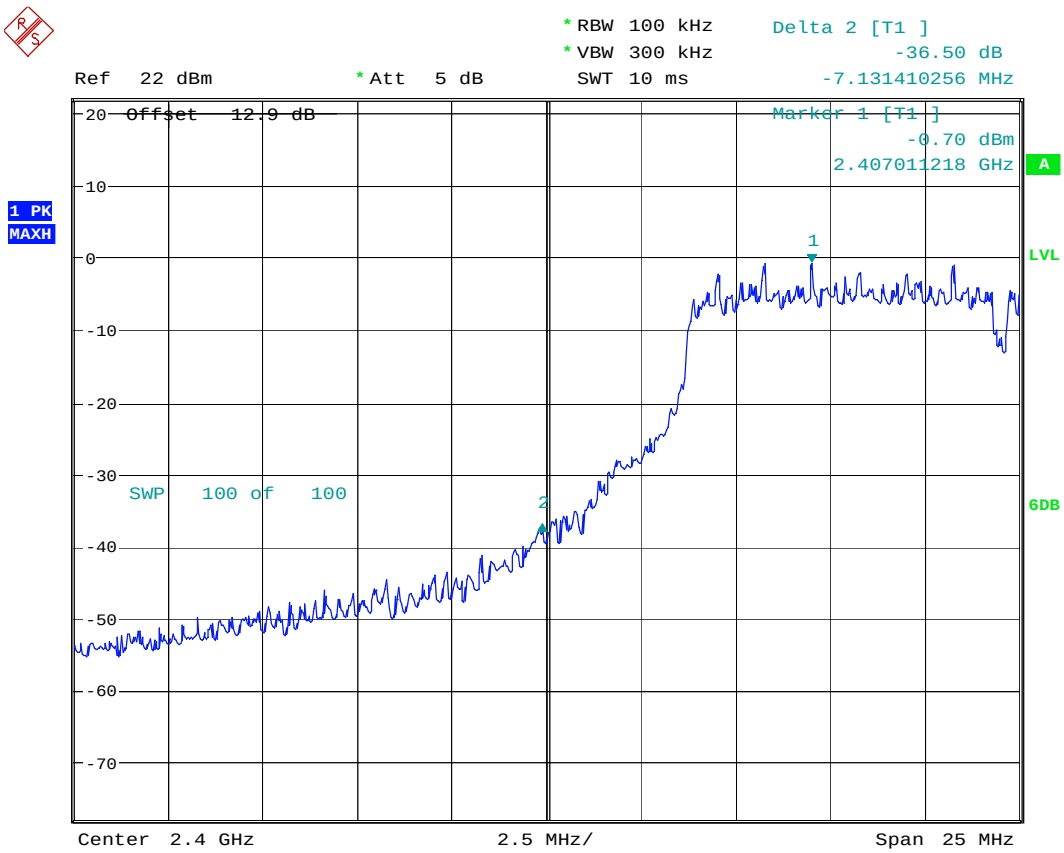
Plot #1

Tx chain 0 Low channel / 2412 MHz	Modulation/Packet Type: 802.11b 1Mbps



Plot #2

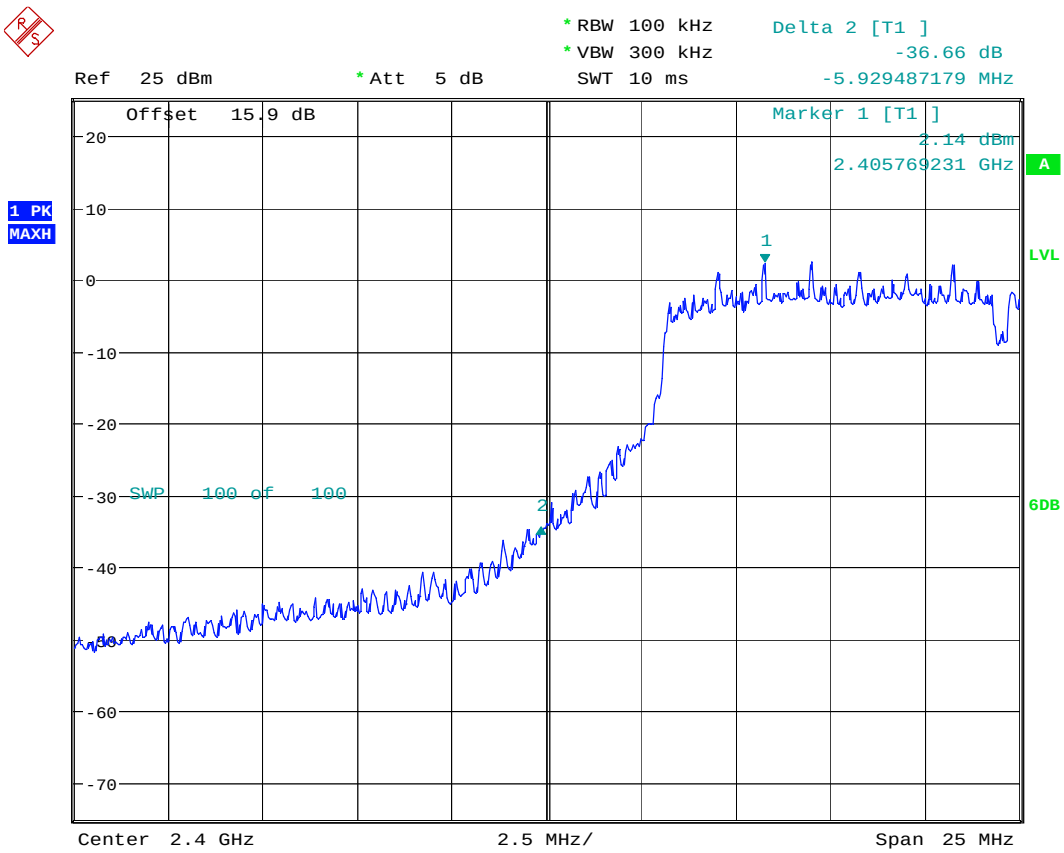
Tx chain 0 Low channel / 2412 MHz | **Modulation/Packet Type: 802.11g 6Mpbs**



Date: 12.SEP.2018 13:30:56

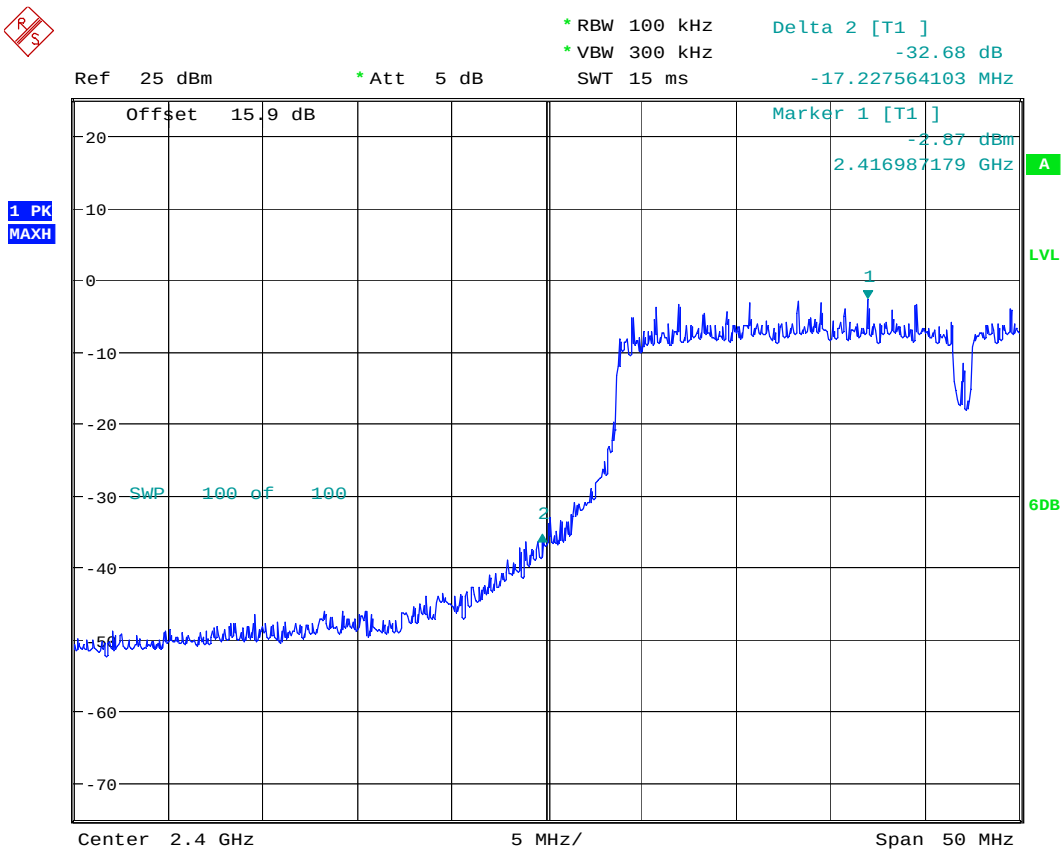
Plot #3

Tx chain 0 Low channel / 2412 MHz | **Modulation/Packet Type: 802.11n_HT20 MCS0**



Plot #4

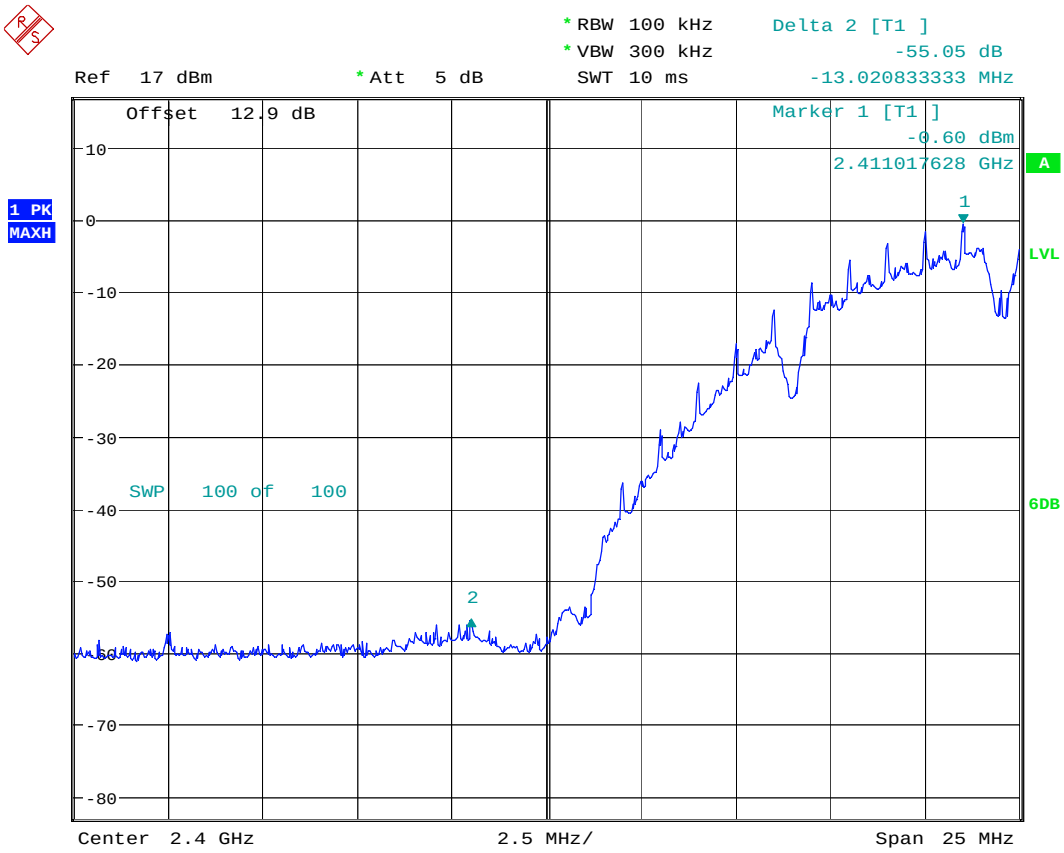
Tx chain 0 Low channel / 2422 MHz | **Modulation/Packet Type: 802.11n_HT40 MCS0**



Date: 12.SEP.2018 13:26:32

Plot #5

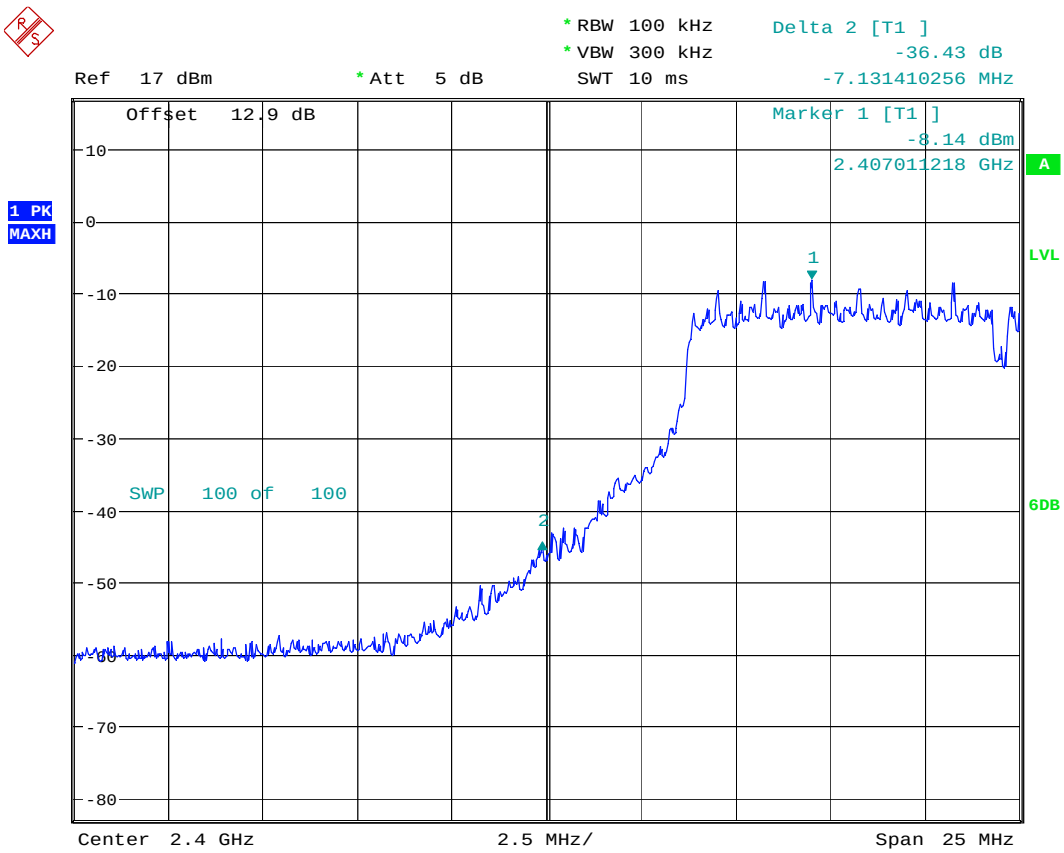
Tx chain 1 Low channel / 2412 MHz	Modulation/Packet Type: 802.11b 1Mbps



Date: 12.SEP.2018 13:33:36

Plot #6

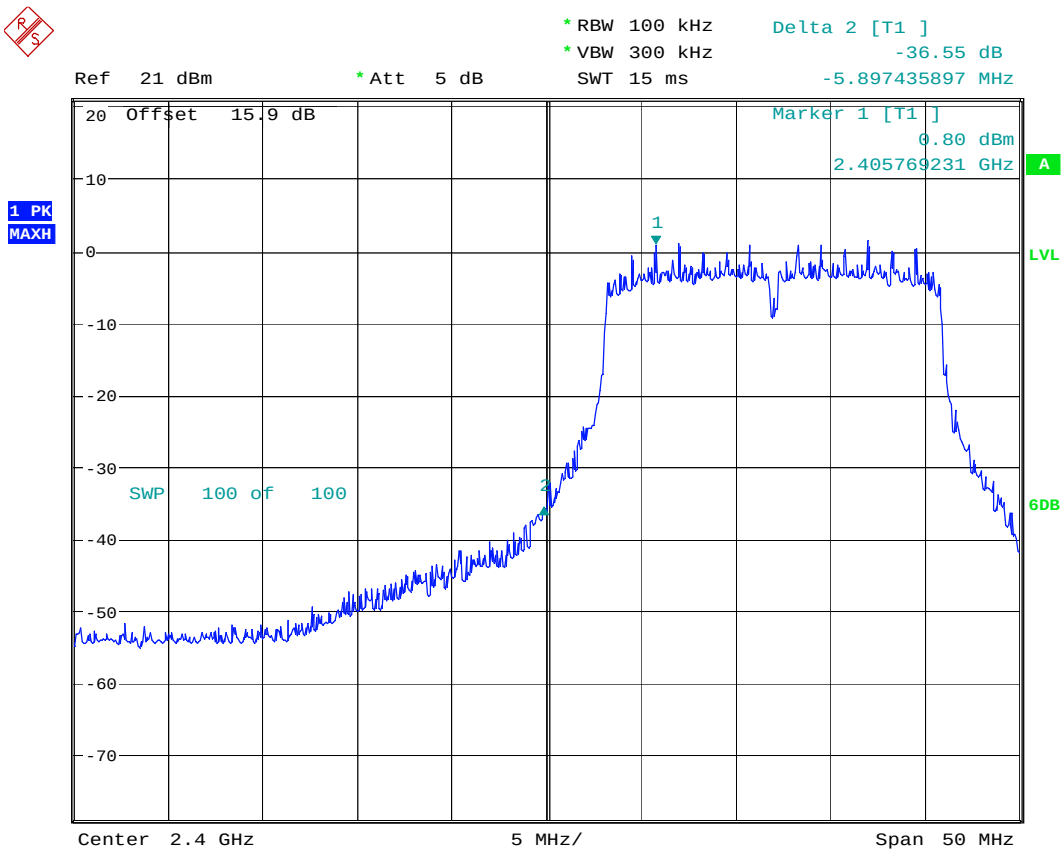
Tx chain 1 Low channel / 2412 MHz | **Modulation/Packet Type: 802.11g 6Mpbs**



Date: 12.SEP.2018 13:34:49

Plot #7

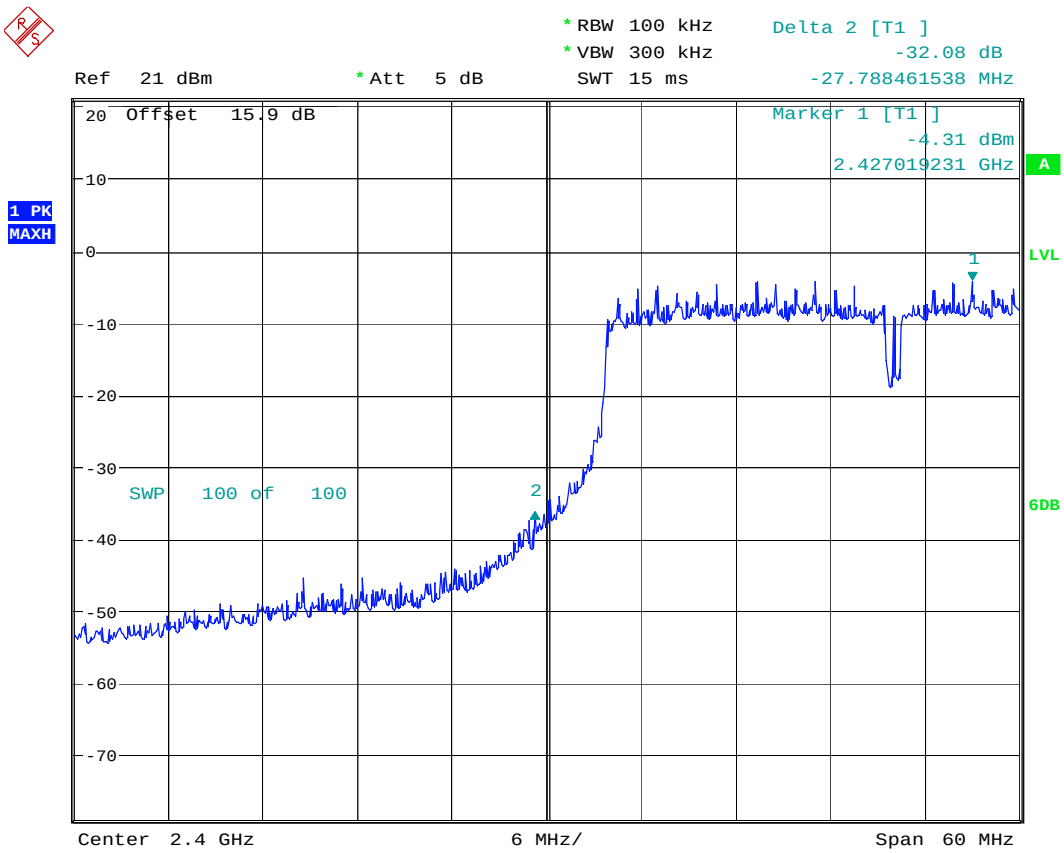
Tx chain 1 Low channel / 2412 MHz | **Modulation/Packet Type: 802.11n_HT20 MCS0**



Date: 12.SEP.2018 13:09:02

Plot #8

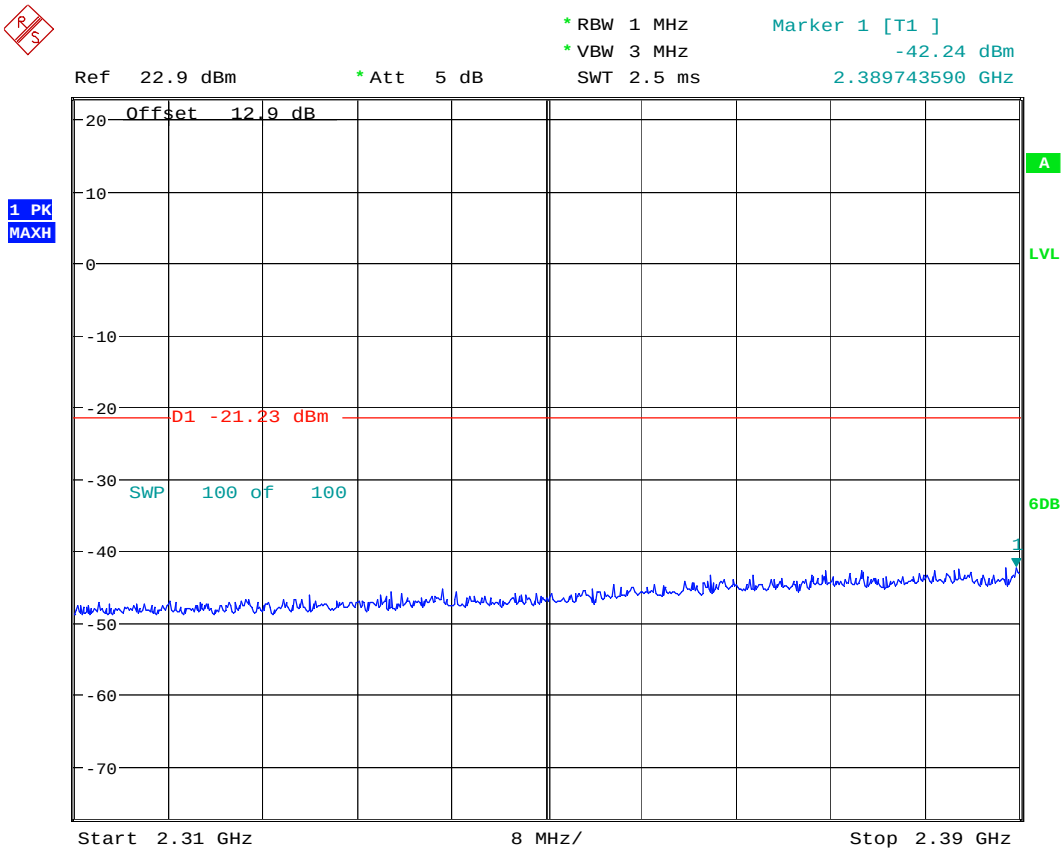
Tx chain 1 Low channel / 2422 MHz | **Modulation/Packet Type: 802.11n_HT40 MCS0**



Date: 12.SEP.2018 13:06:10

Plot #9

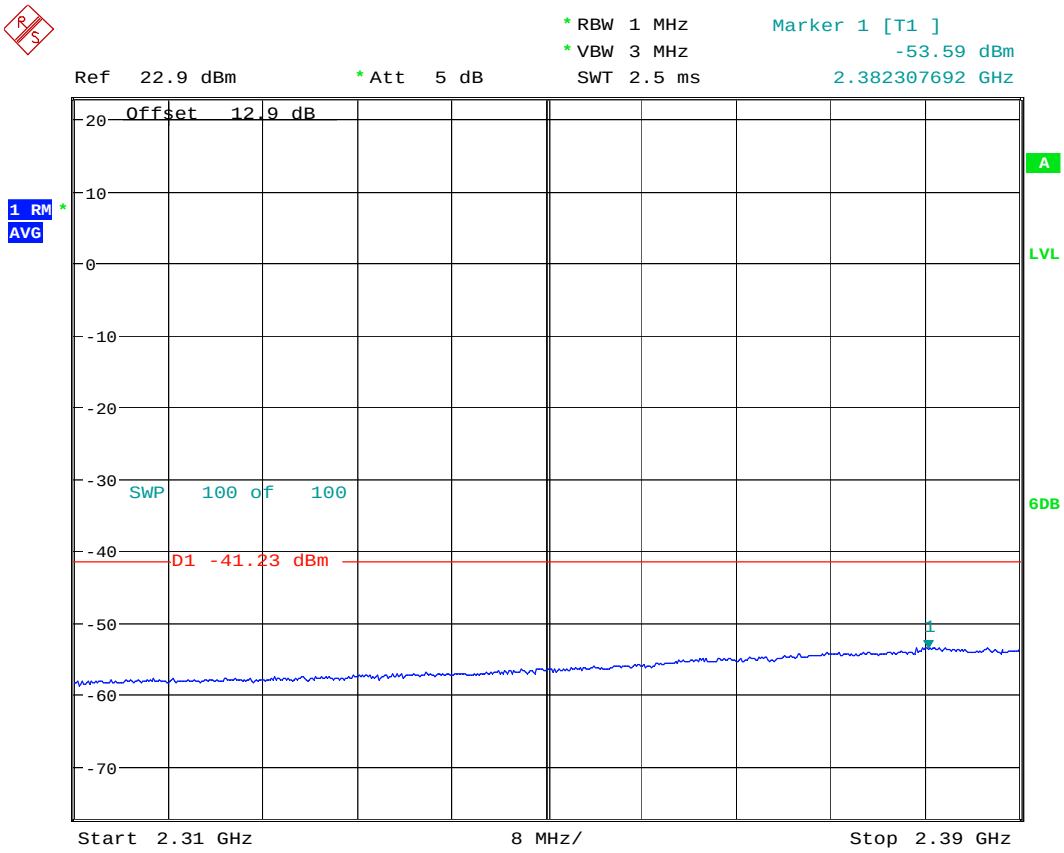
Tx chain 0 Low channel / 2412 MHz | **Modulation/Packet Type: 802.11b 1Mbps Peak**



Date: 12.SEP.2018 11:36:42

Plot #10

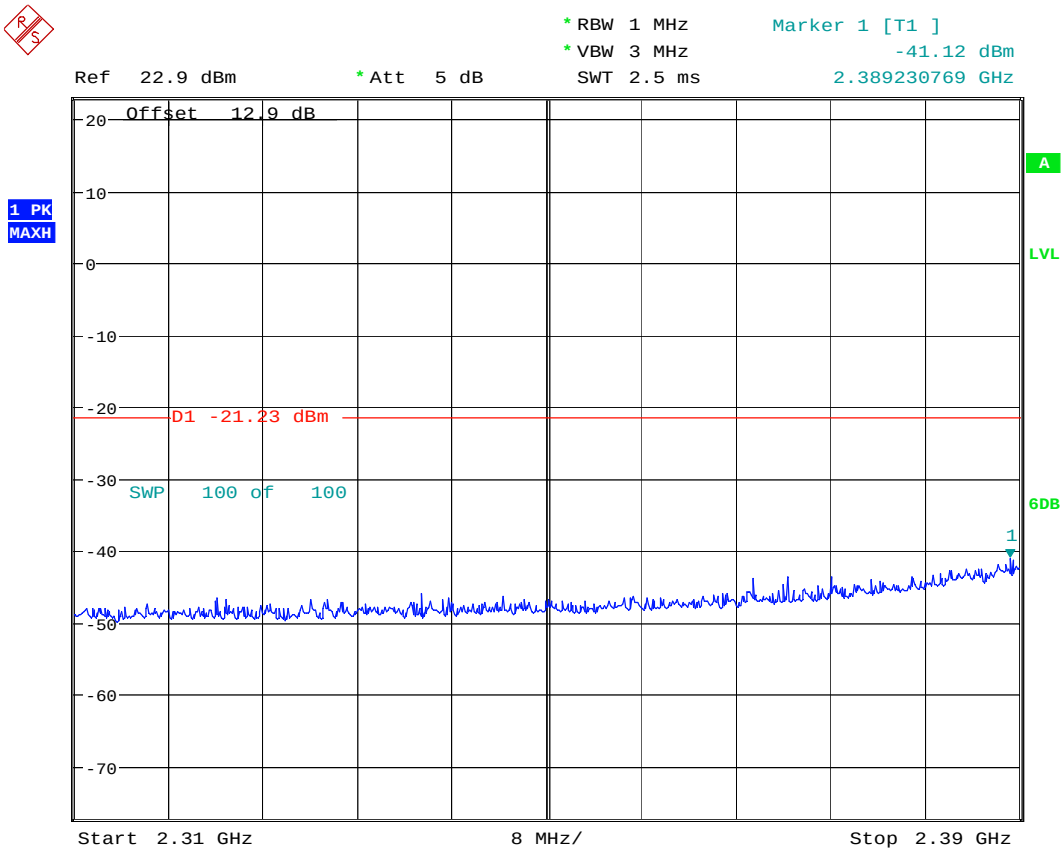
Tx chain 0 Low channel / 2412 MHz | **Modulation/Packet Type: 802.11b 1Mbps Avg**



Date: 12.SEP.2018 11:38:04

Plot #11

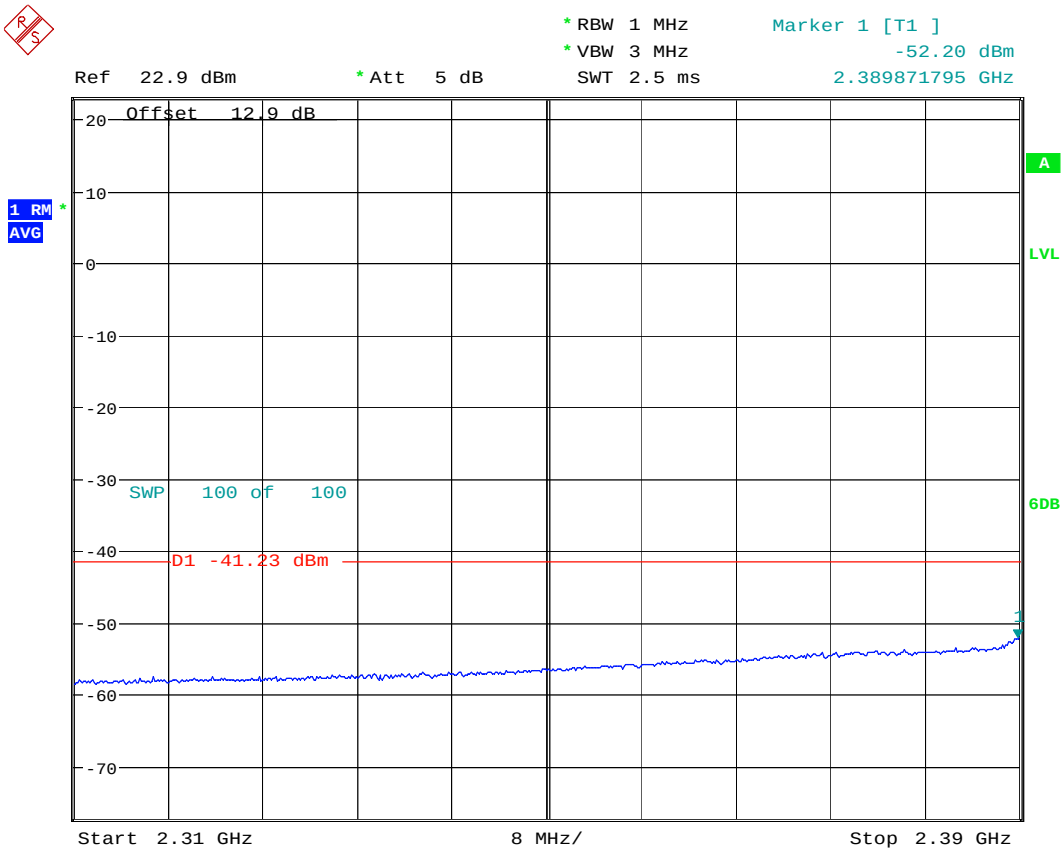
Tx chain 0 Low channel / 2412 MHz | **Modulation/Packet Type: 802.11g 6Mbps Peak**



Date: 12.SEP.2018 11:41:50

Plot #12

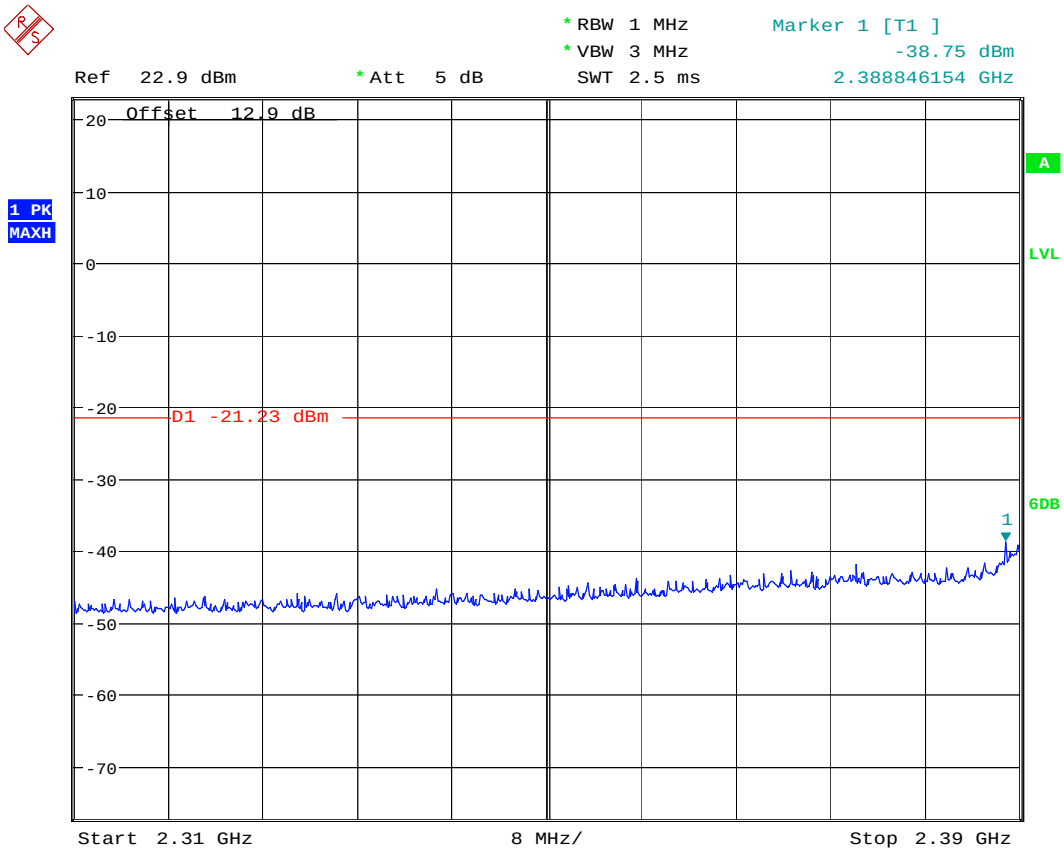
Tx chain 0 Low channel / 2412 MHz | **Modulation/Packet Type: 802.11g 6Mbps Avg**



Date: 12.SEP.2018 11:39:44

Plot #13

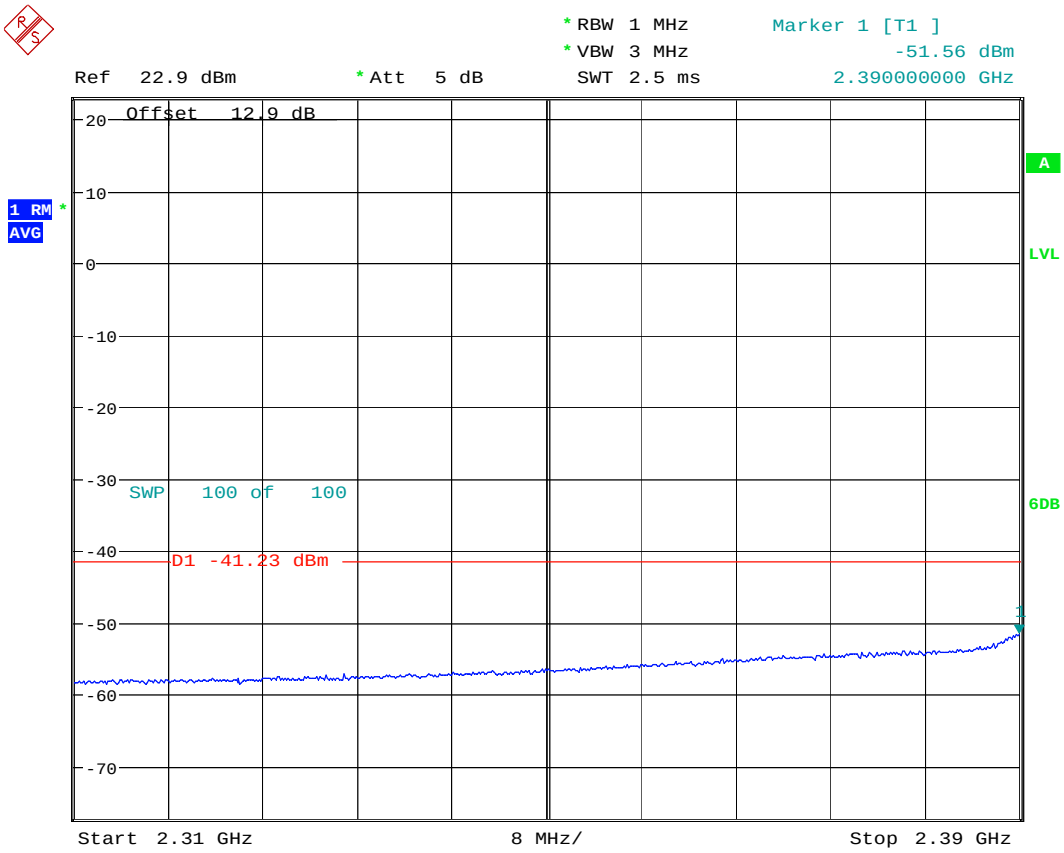
Tx chain 0 Low channel / 2412 MHz | **Modulation/Packet Type: 802.11n_HT20 MCS0 Peak**



Date: 12.SEP.2018 10:46:39

Plot #14

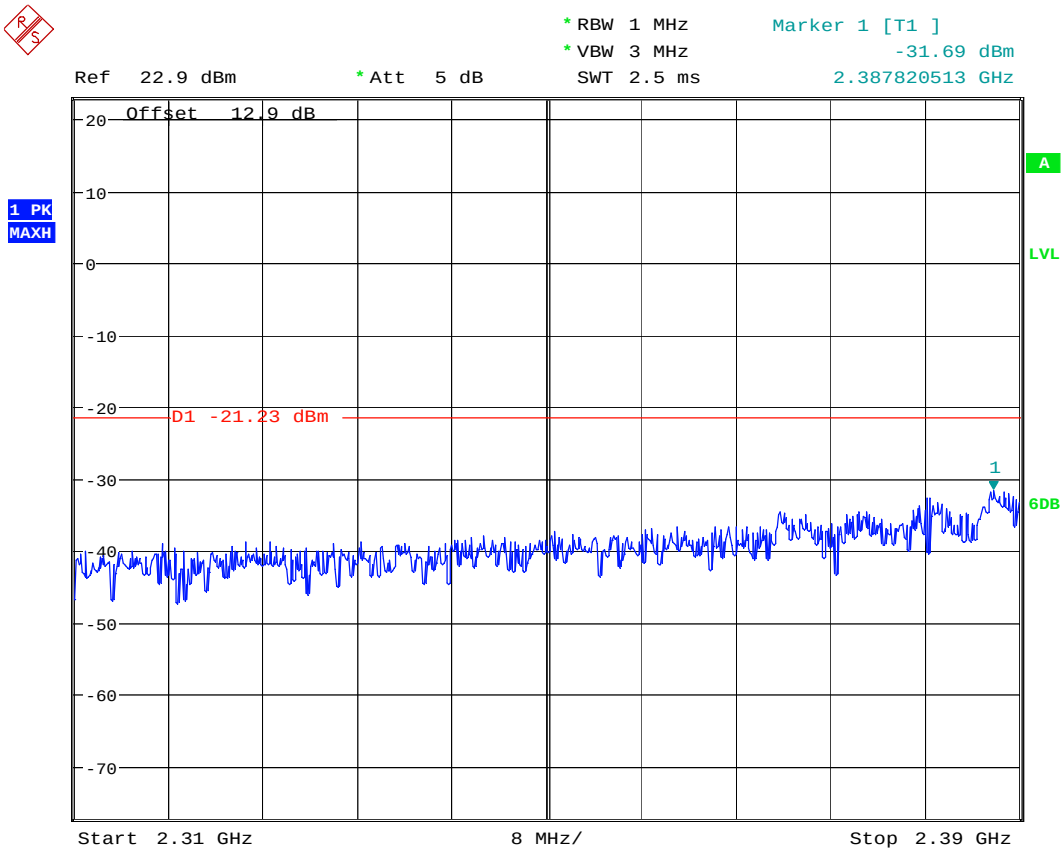
Tx chain 0 Low channel / 2412 MHz | **Modulation/Packet Type: 802.11n_HT20 MCS0 Avg**



Date: 12.SEP.2018 10:47:32

Plot #15

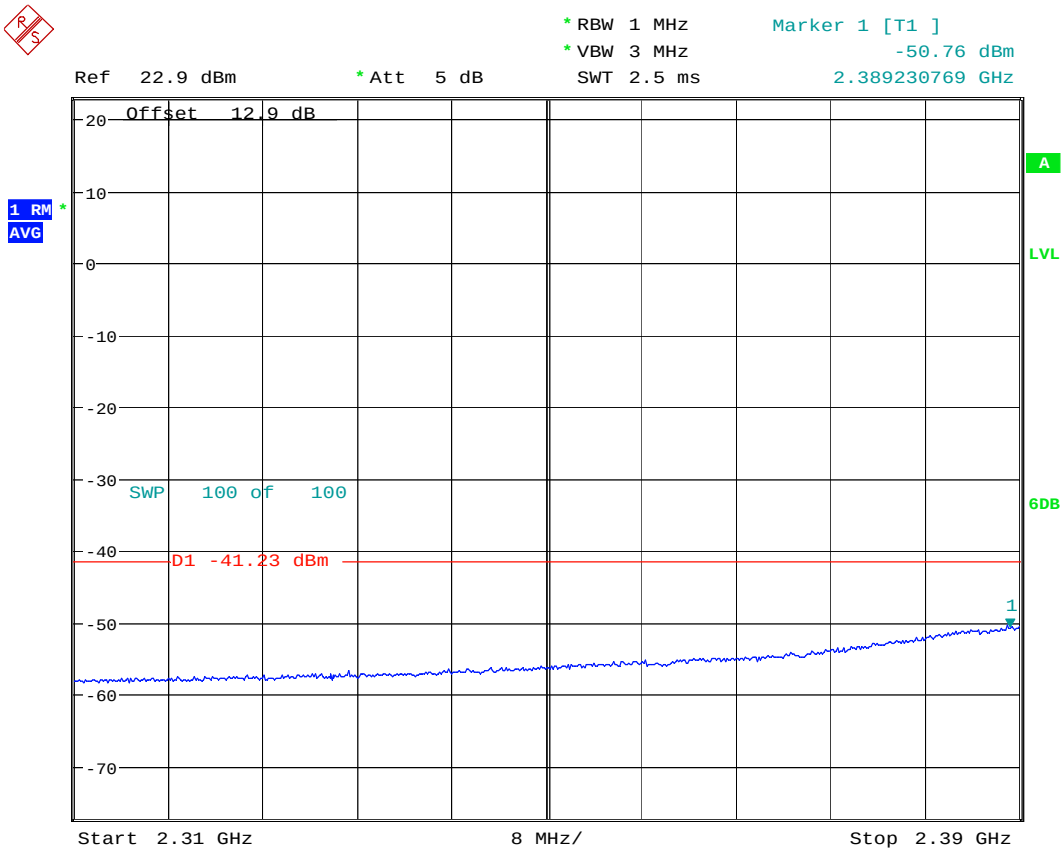
Tx chain 0 Low channel / 2422 MHz | **Modulation/Packet Type: 802.11n_HT40 MCS0 Peak**



Date: 12.SEP.2018 10:26:16

Plot #16

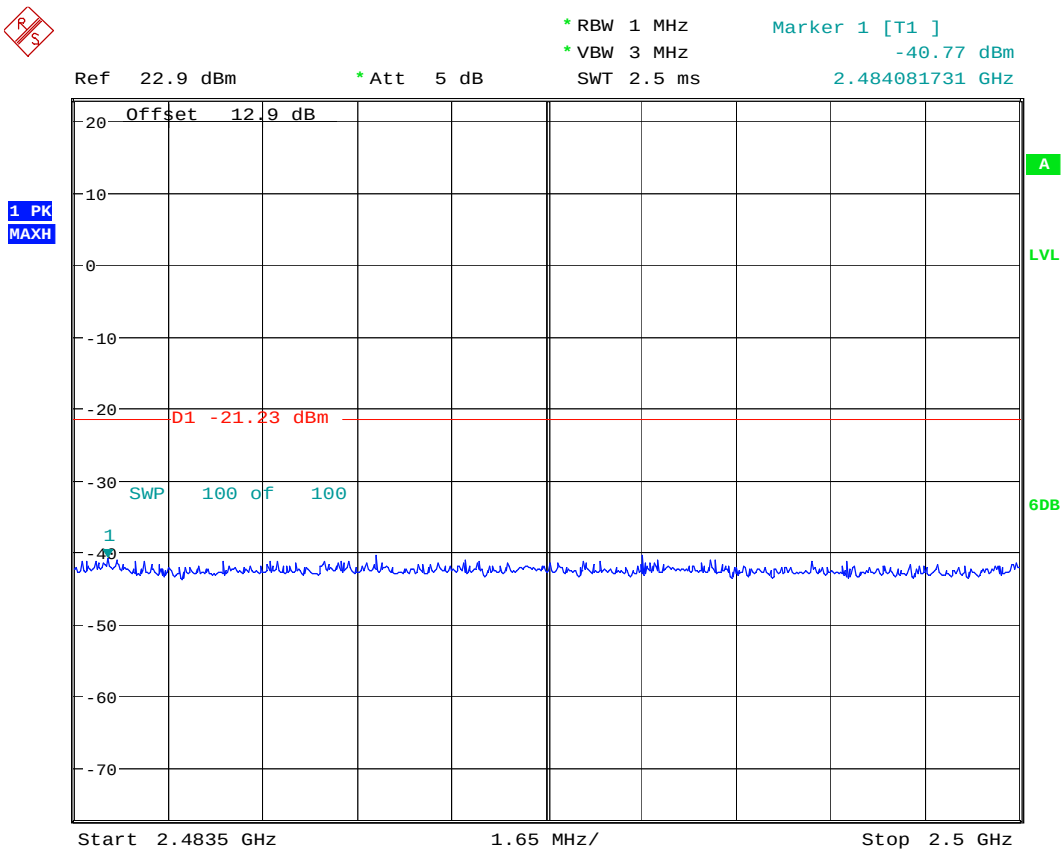
Tx chain 0 Low channel / 2422 MHz | **Modulation/Packet Type: 802.11n_HT40 MCS0 Avg**



Date: 12.SEP.2018 10:22:33

Plot #17

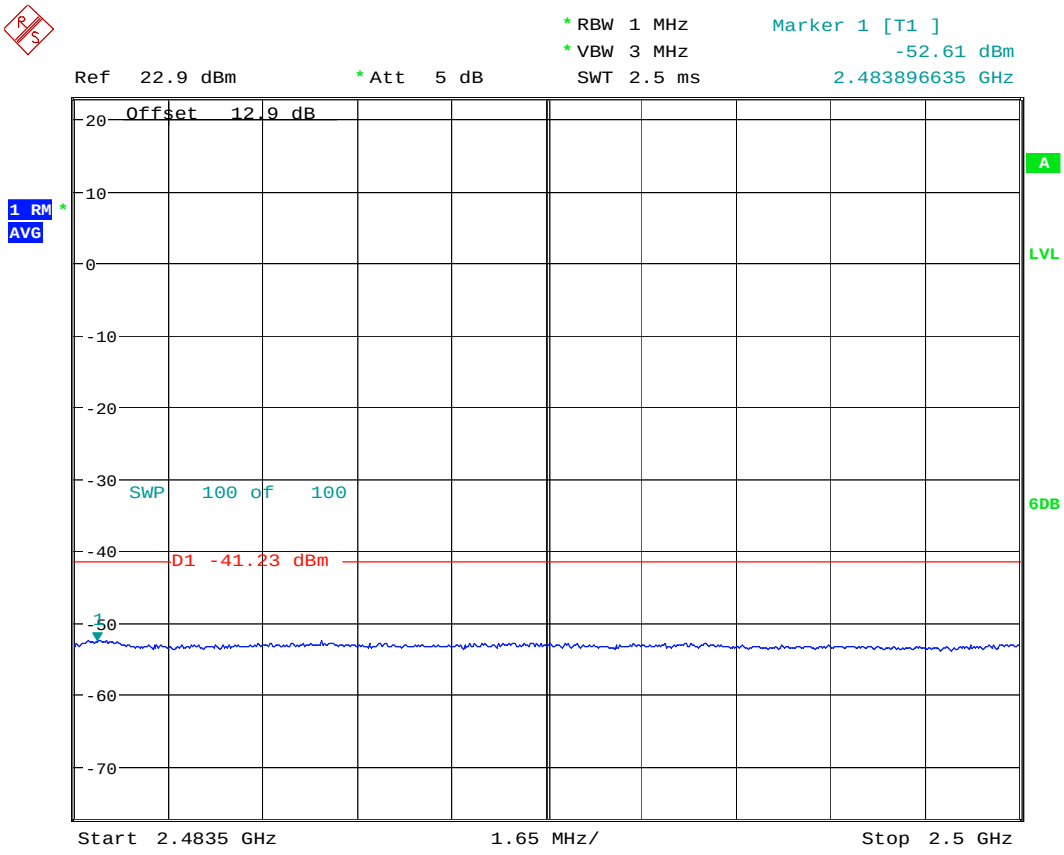
Tx chain 0 High channel/ 2462 MHz | **Modulation/Packet Type: 802.11b 1Mbps Peak**



Date: 12.SEP.2018 11:52:48

Plot #18

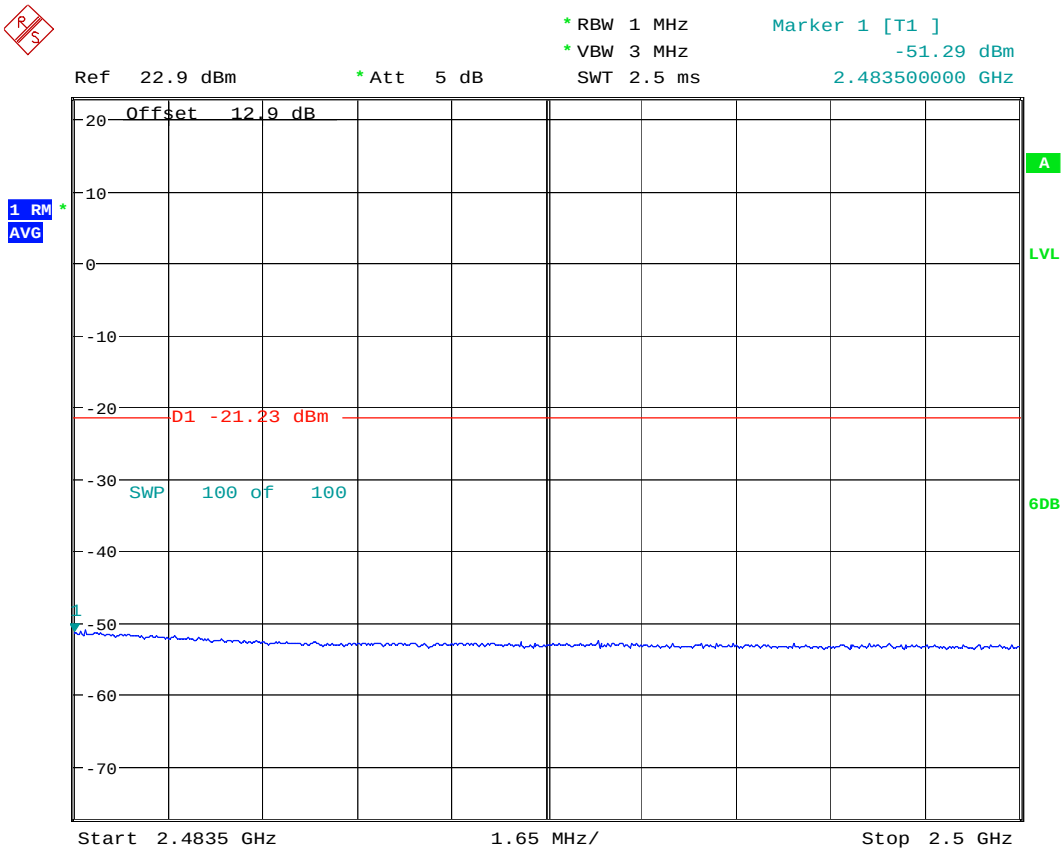
Tx chain 0 High channel/ 2462 MHz | **Modulation/Packet Type: 802.11b 1Mbps Avg**



Date: 12.SEP.2018 11:55:17

Plot #19

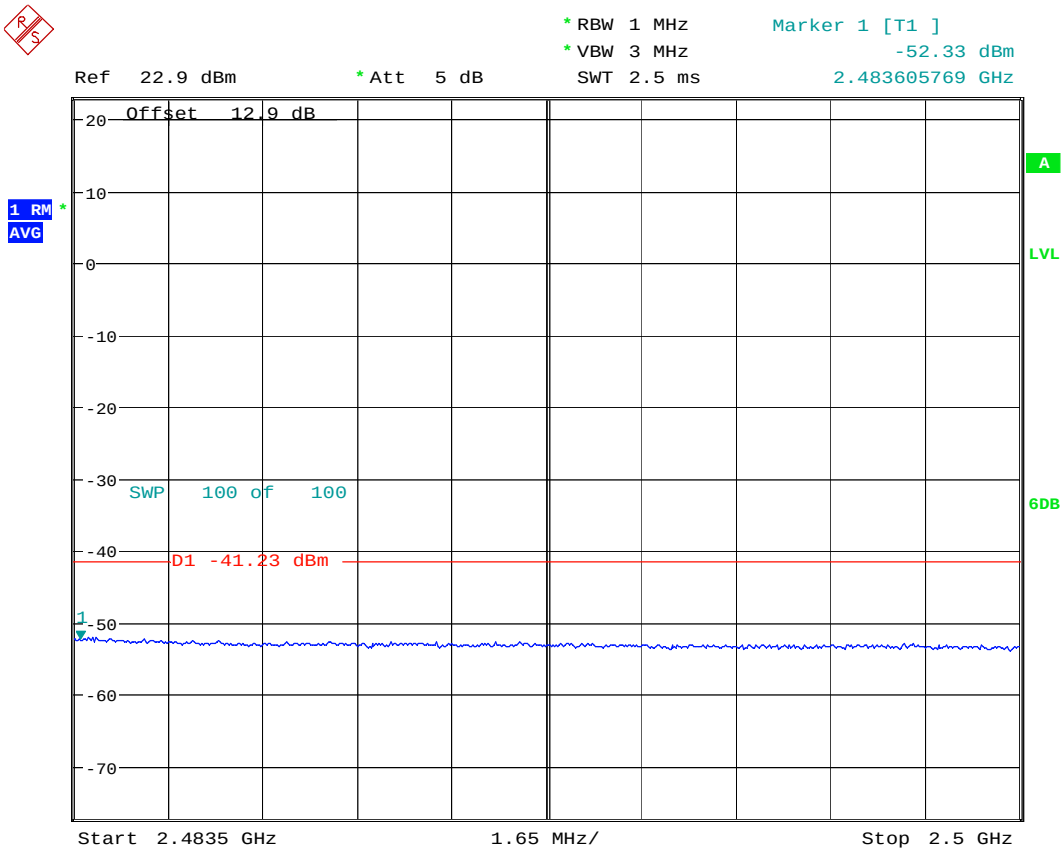
Tx chain 0 High channel/ 2462 MHz | **Modulation/Packet Type: 802.11g 6Mbps Peak**



Date: 12.SEP.2018 12:02:34

Plot #20

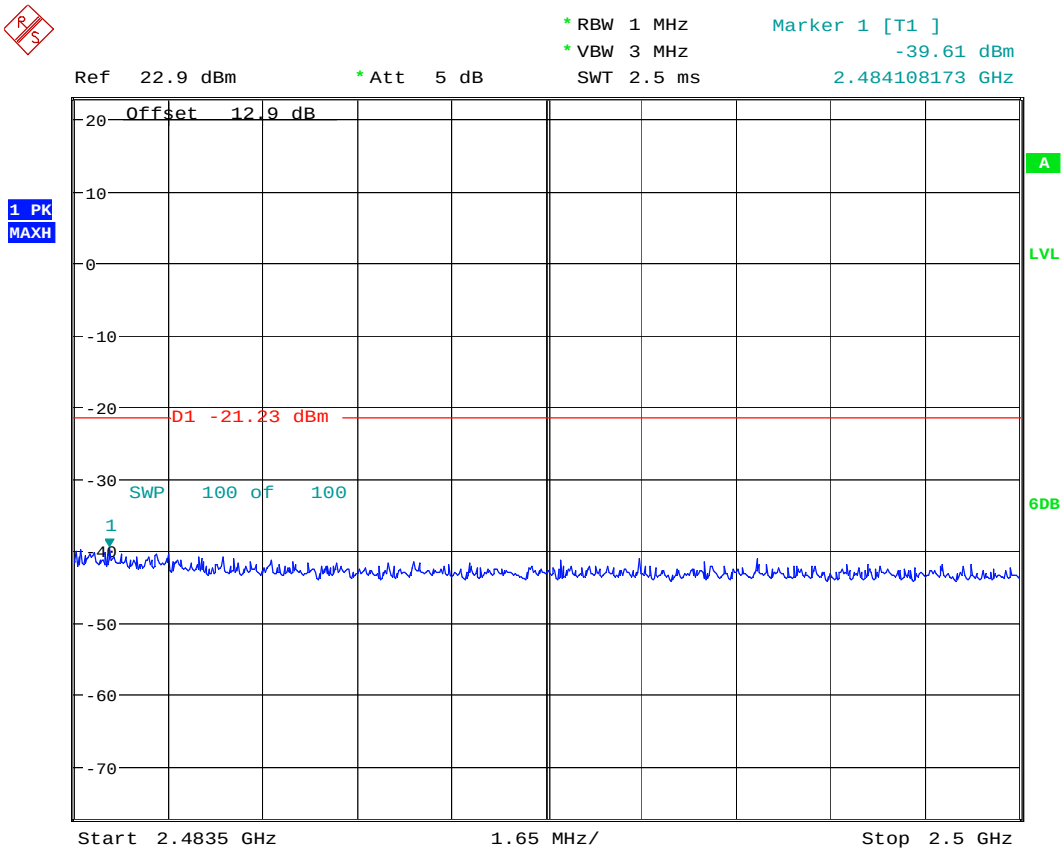
Tx chain 0 High channel/ 2462 MHz | **Modulation/Packet Type: 802.11b 6Mbps Avg**



Date: 12.SEP.2018 11:58:10

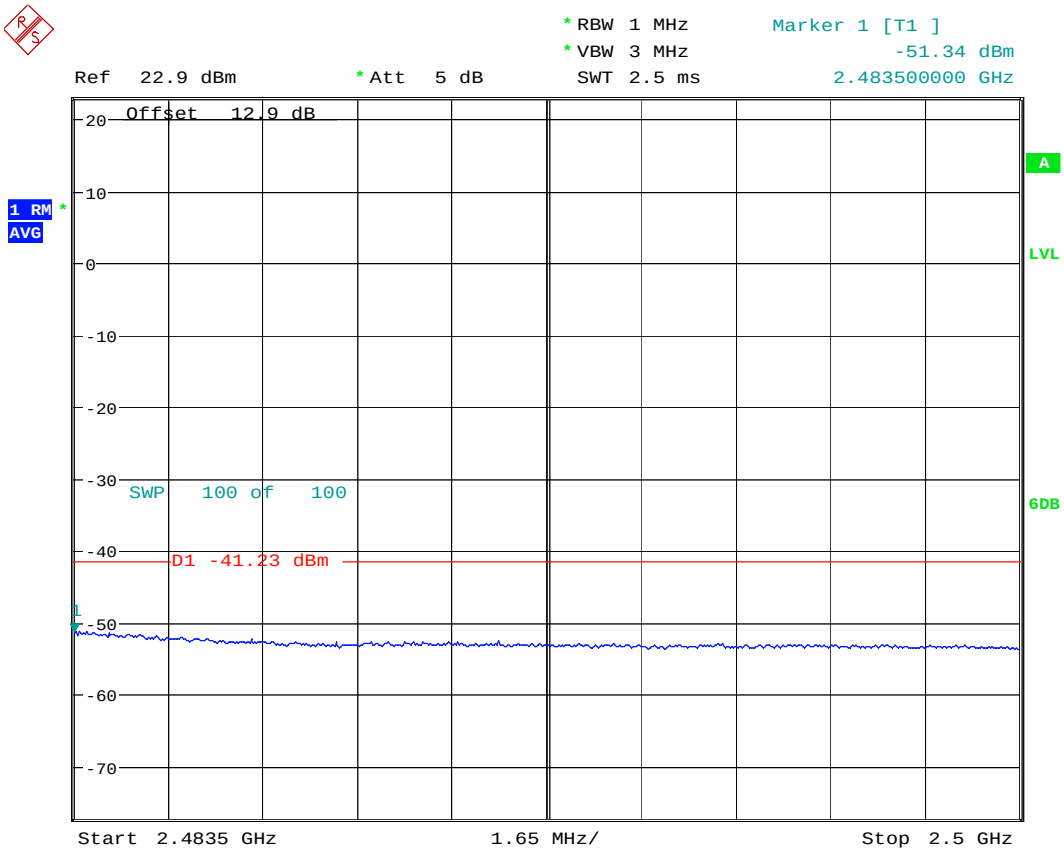
Plot #21

Tx chain 0 High channel/ 2462 MHz | **Modulation/Packet Type: 802.11n_HT20 MCS0 Peak**



Plot #22

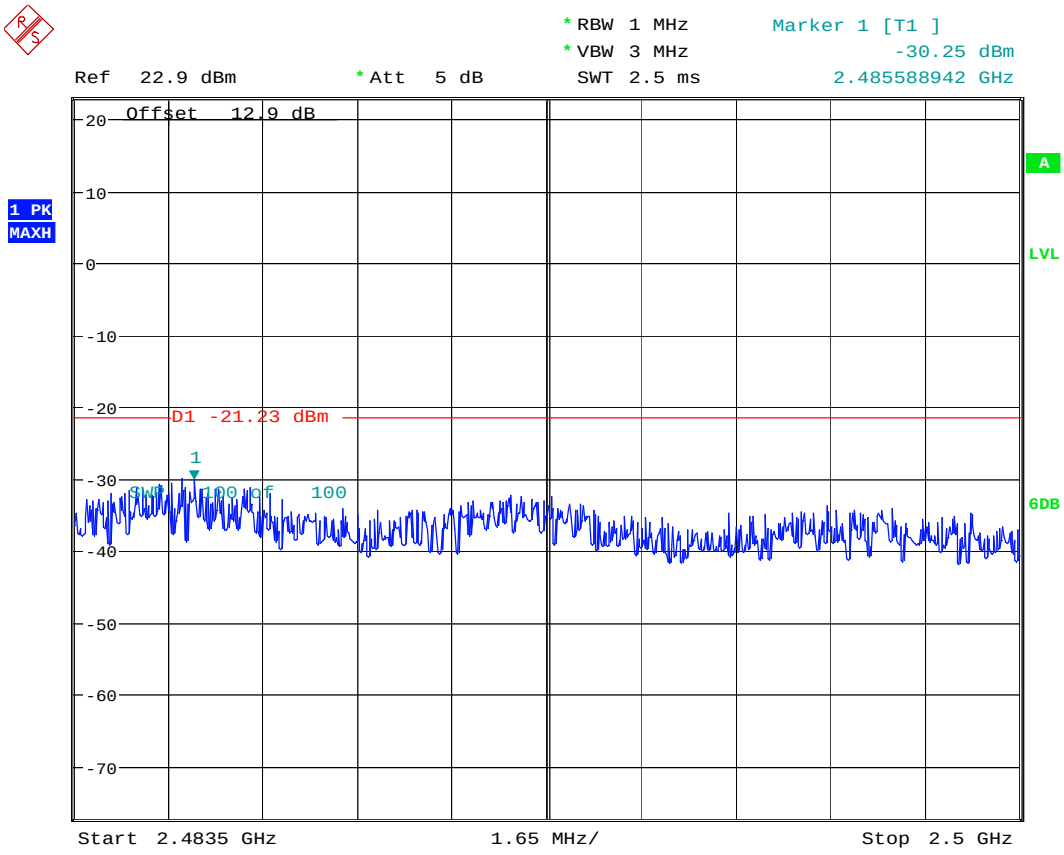
Tx chain 0 High channel/ 2462 MHz | **Modulation/Packet Type: 802.11n_HT20 MCS0 Avg**



Date: 12.SEP.2018 12:03:08

Plot #23

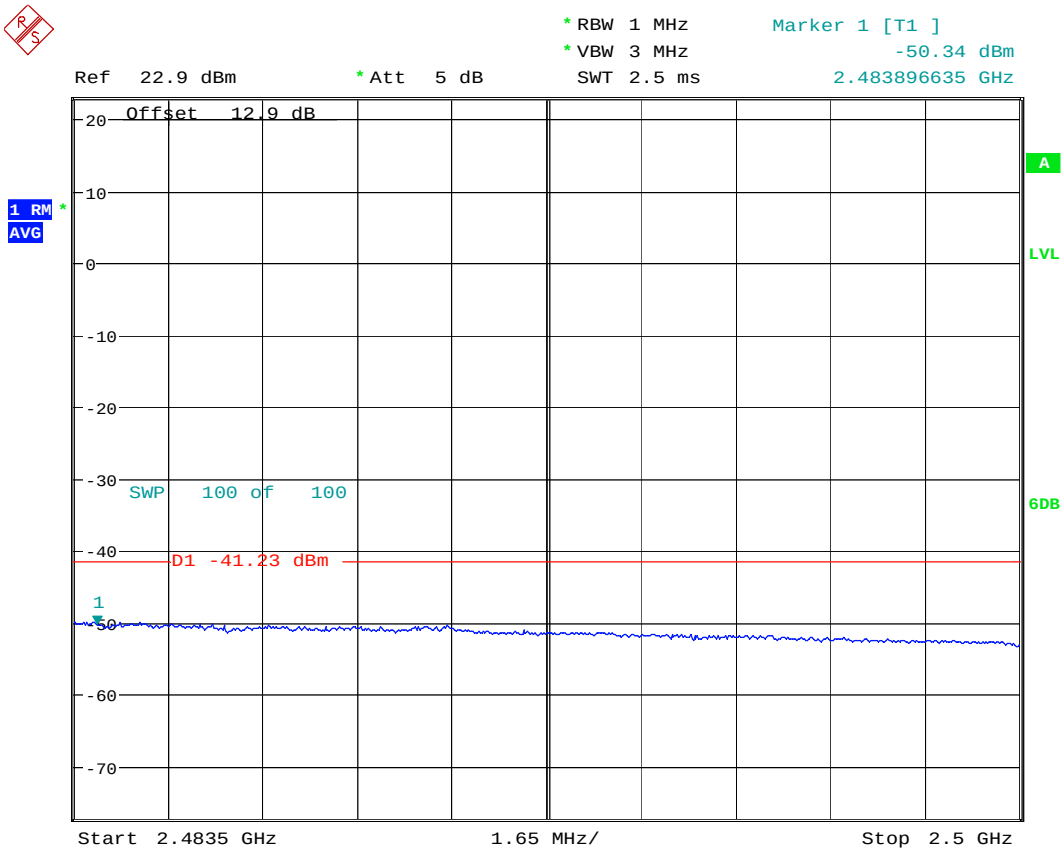
Tx chain 0 High channel/ 2452 MHz | **Modulation/Packet Type: 802.11n_HT40 MCS0 Peak**



Date: 12.SEP.2018 12:08:00

Plot #24

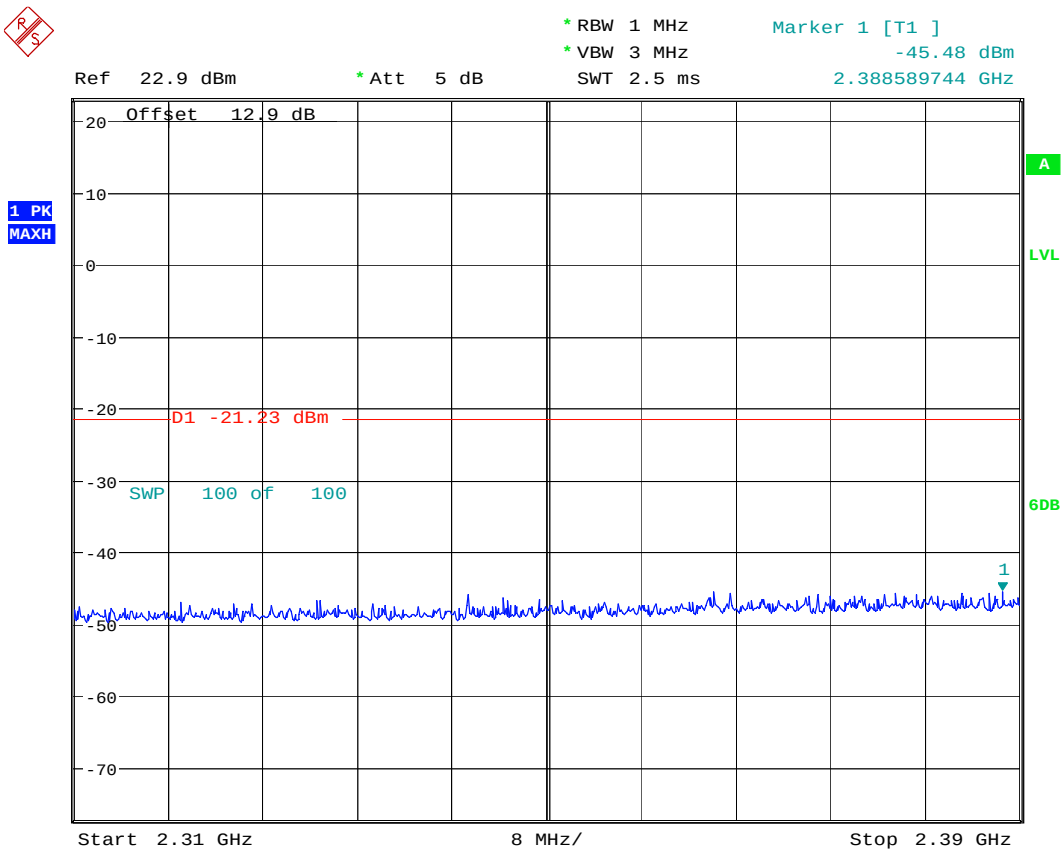
Tx chain 0 High channel/ 2452 MHz | **Modulation/Packet Type: 802.11n_HT40 MCS0 Avg**



Date: 12.SEP.2018 12:10:05

Plot #25

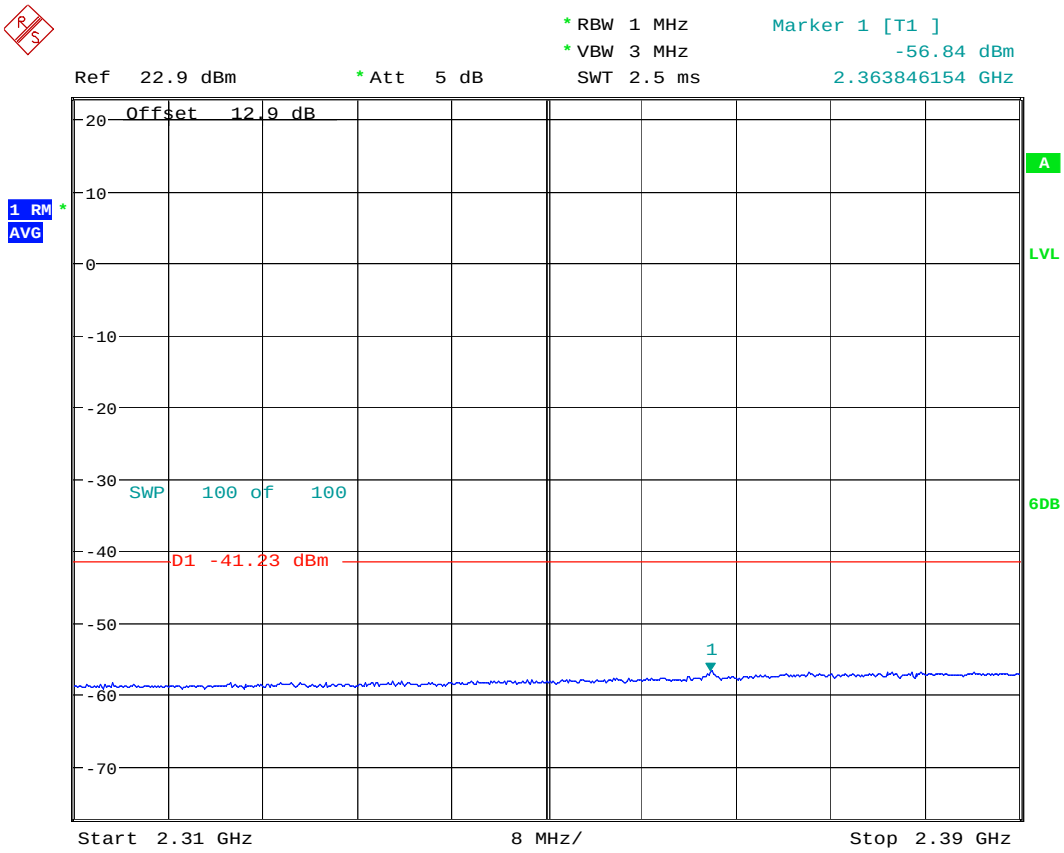
Tx chain 1 Low channel / 2412 MHz | **Modulation/Packet Type: 802.11b 1Mbps Peak**



Date: 12.SEP.2018 10:58:25

Plot #26

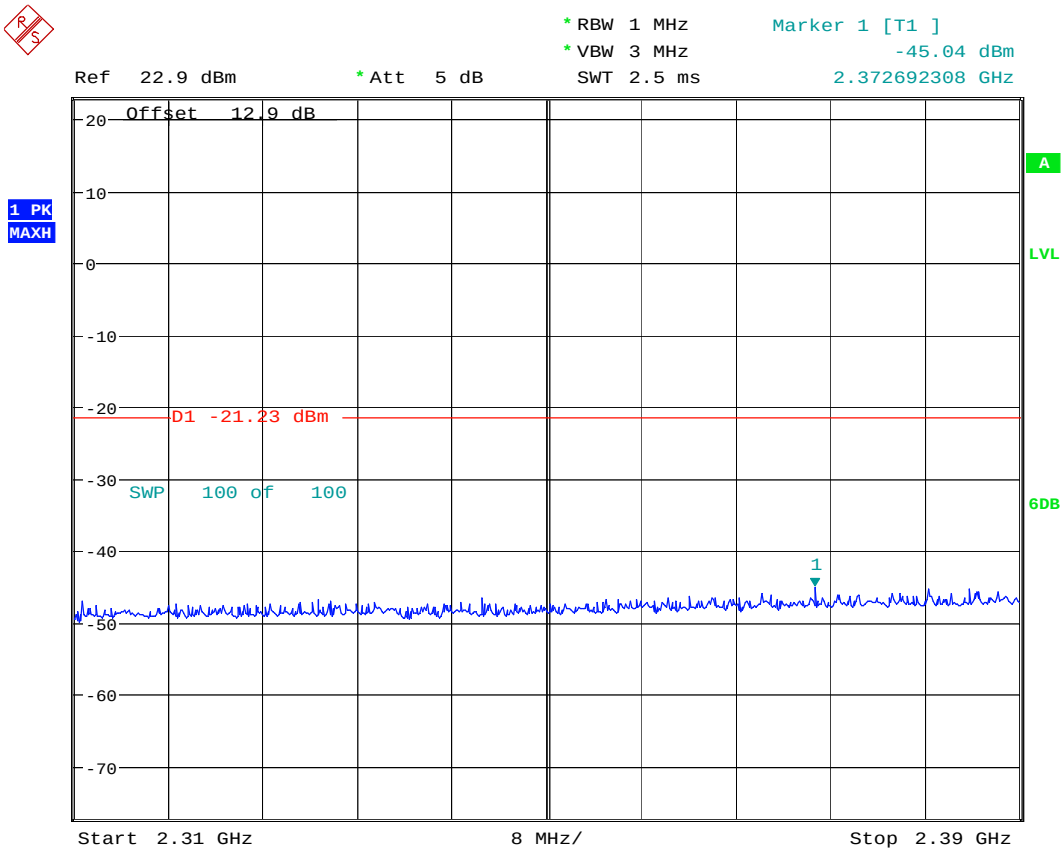
Tx chain 1 Low channel / 2412 MHz | **Modulation/Packet Type: 802.11b 1Mbps Avg**



Date: 12.SEP.2018 10:59:20

Plot #27

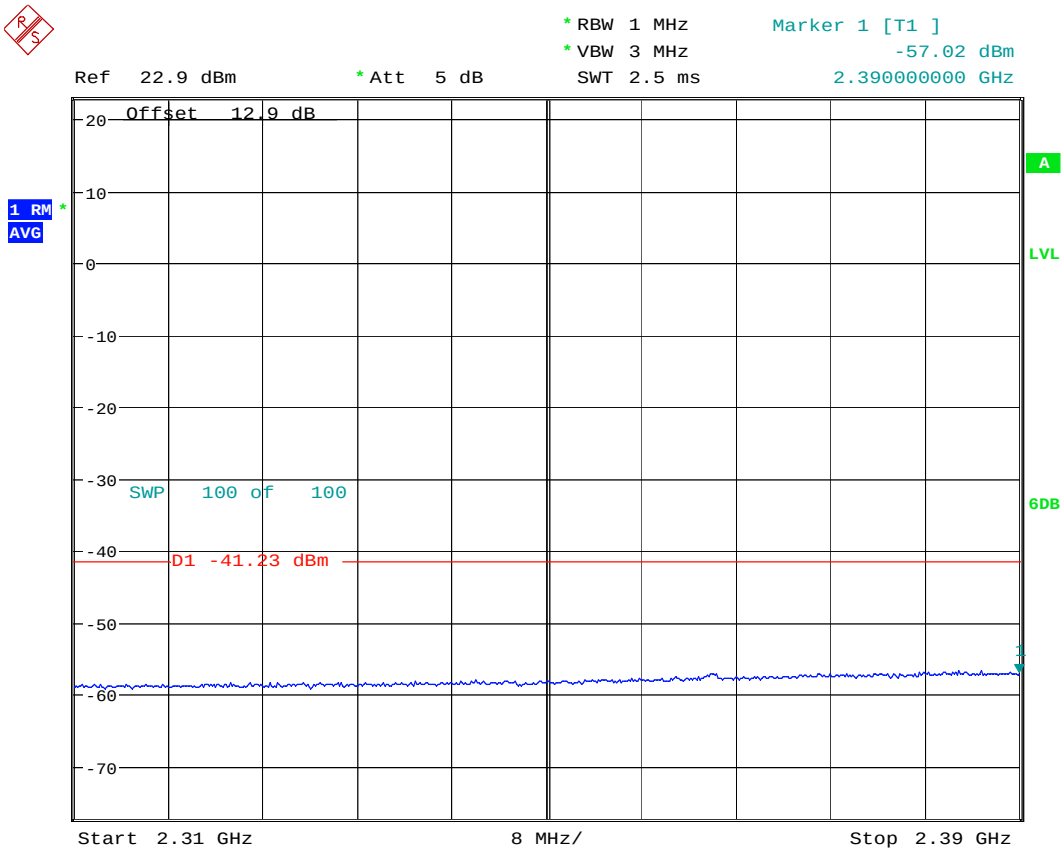
Tx chain 1 Low channel / 2412 MHz | **Modulation/Packet Type: 802.11g 6Mbps Peak**



Date: 12.SEP.2018 11:04:06

Plot #28

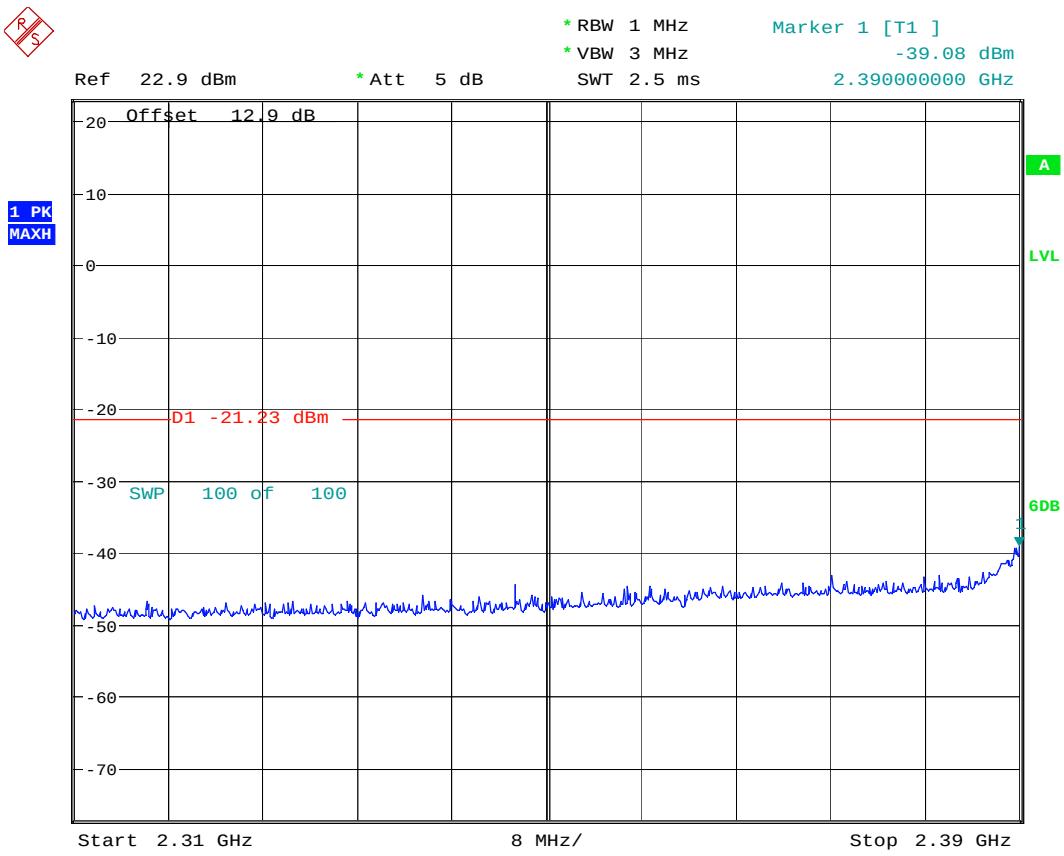
Tx chain 1 Low channel / 2412 MHz | **Modulation/Packet Type: 802.11b 6Mbps Avg**



Date: 12.SEP.2018 11:02:34

Plot #29

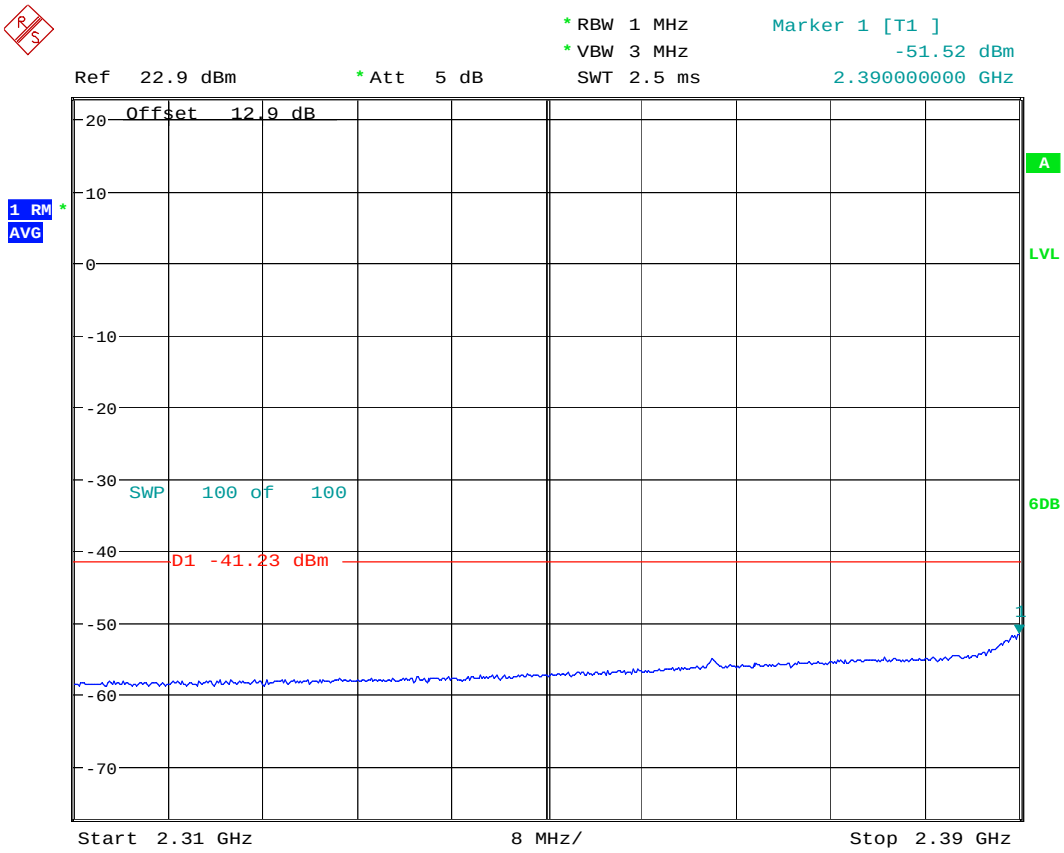
Tx chain 1 Low channel / 2412 MHz | **Modulation/Packet Type: 802.11n_HT20 MCS0 Peak**



Date: 12.SEP.2018 10:53:31

Plot #30

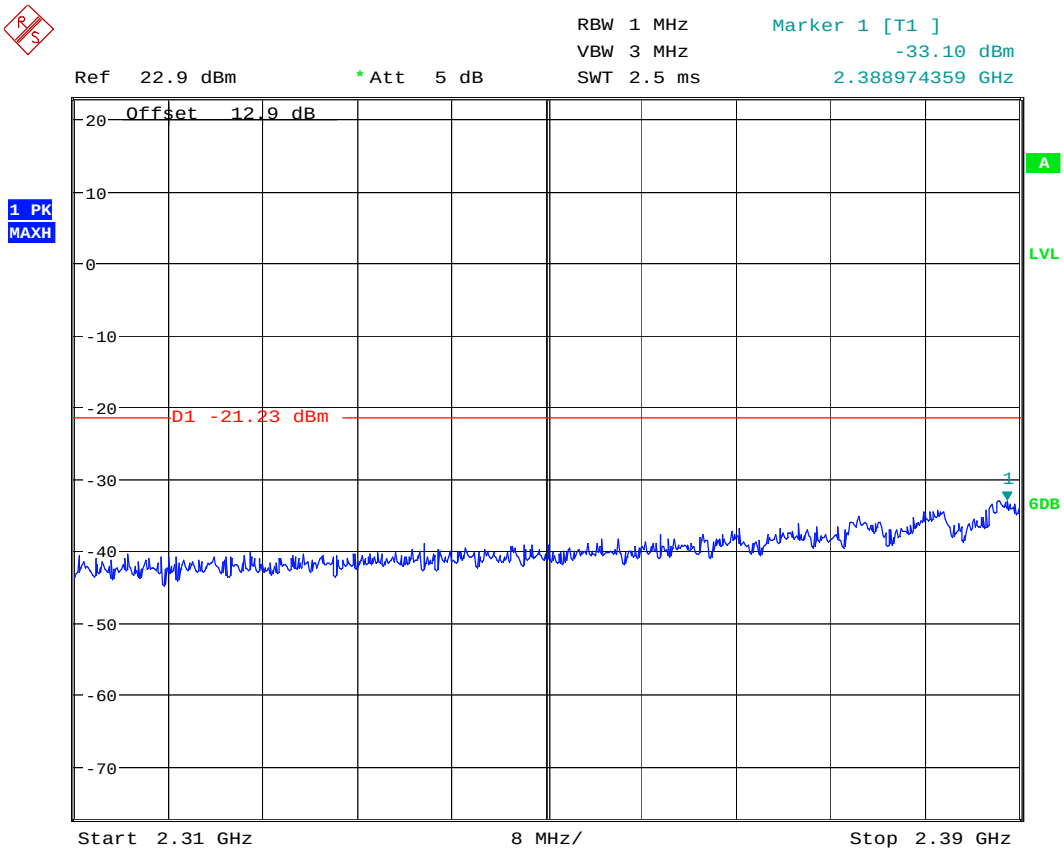
Tx chain 1 Low channel / 2412 MHz | **Modulation/Packet Type: 802.11n_HT20 MCS0 Avg**



Date: 12.SEP.2018 10:52:09

Plot #31

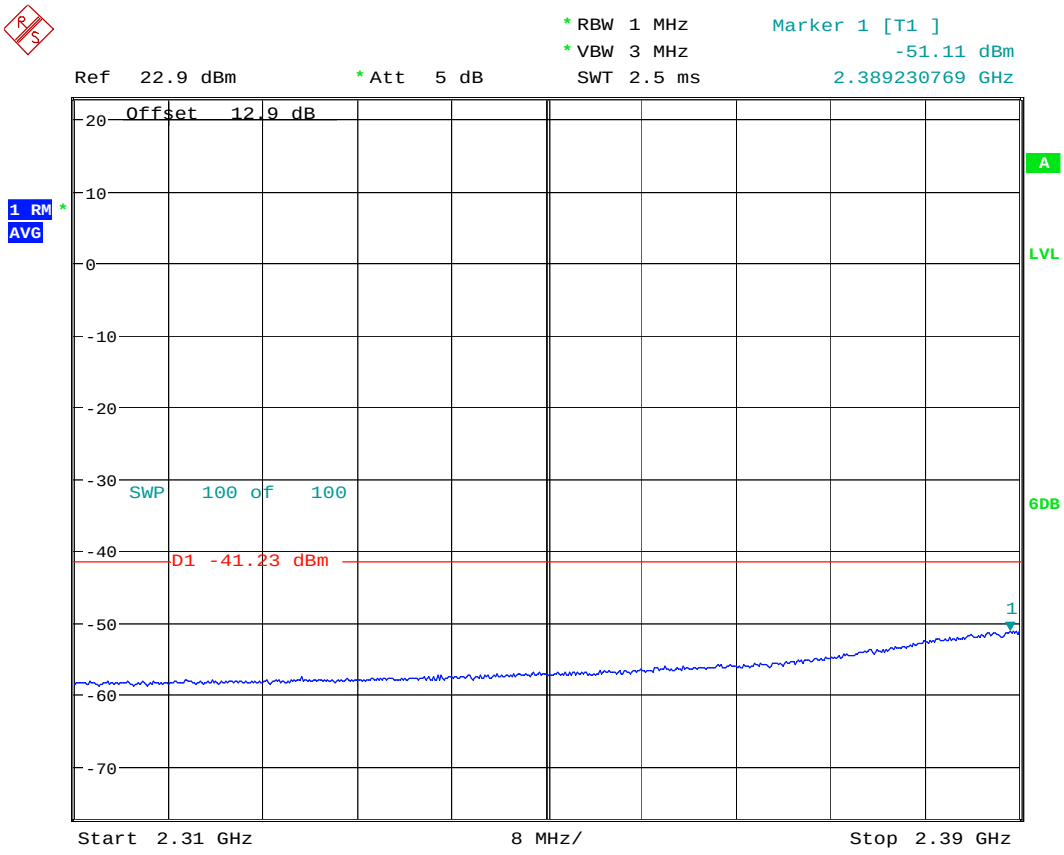
Tx chain 1 Low channel / 2422 MHz | **Modulation/Packet Type: 802.11n_HT40 MCS0 Peak**



Date: 12.SEP.2018 10:13:17

Plot #32

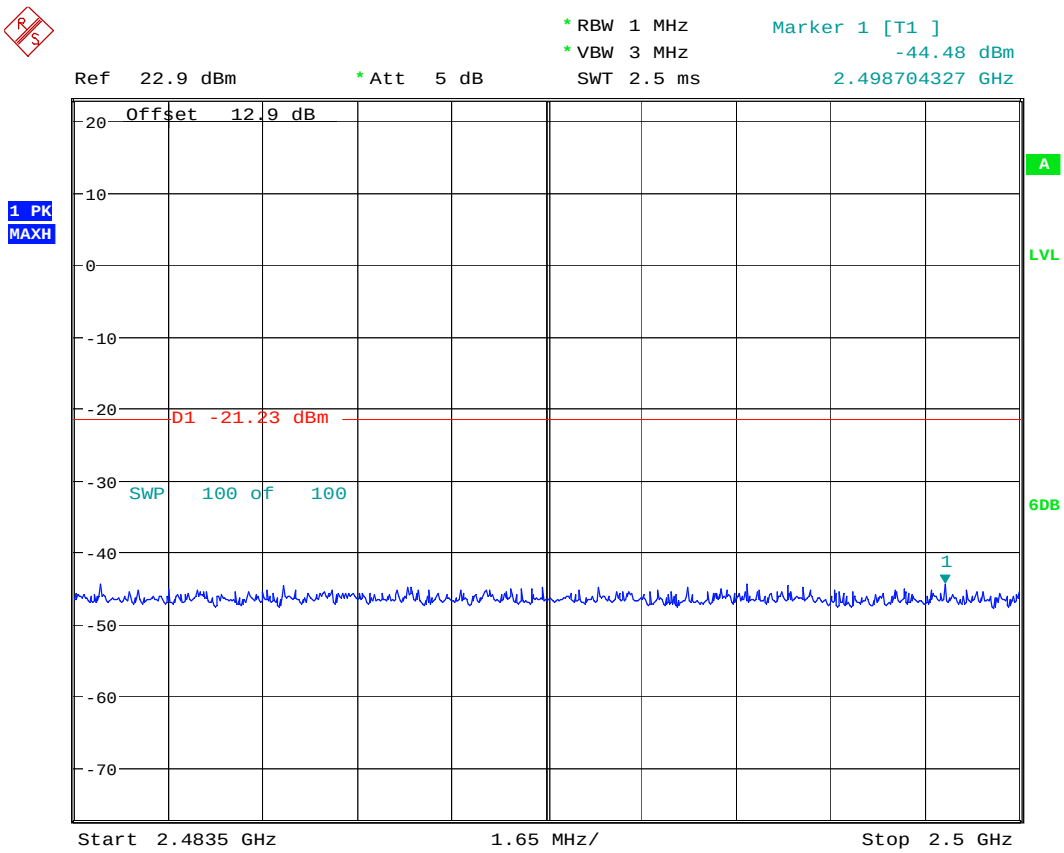
Tx chain 1 Low channel / 2422 MHz | **Modulation/Packet Type: 802.11n_HT40 MCS0 Avg**



Date: 12.SEP.2018 10:20:39

Plot #33

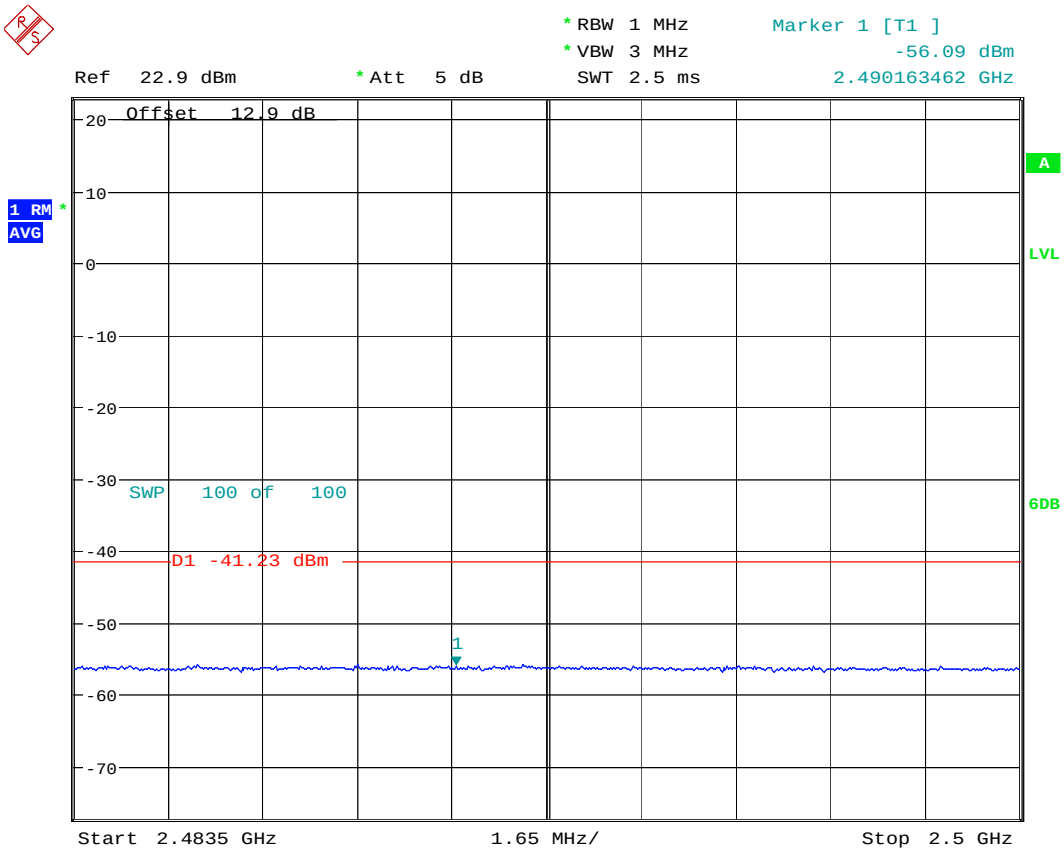
Tx chain 1 High channel/ 2462 MHz | **Modulation/Packet Type: 802.11b 1Mbps Peak**



Date: 12.SEP.2018 12:28:43

Plot #34

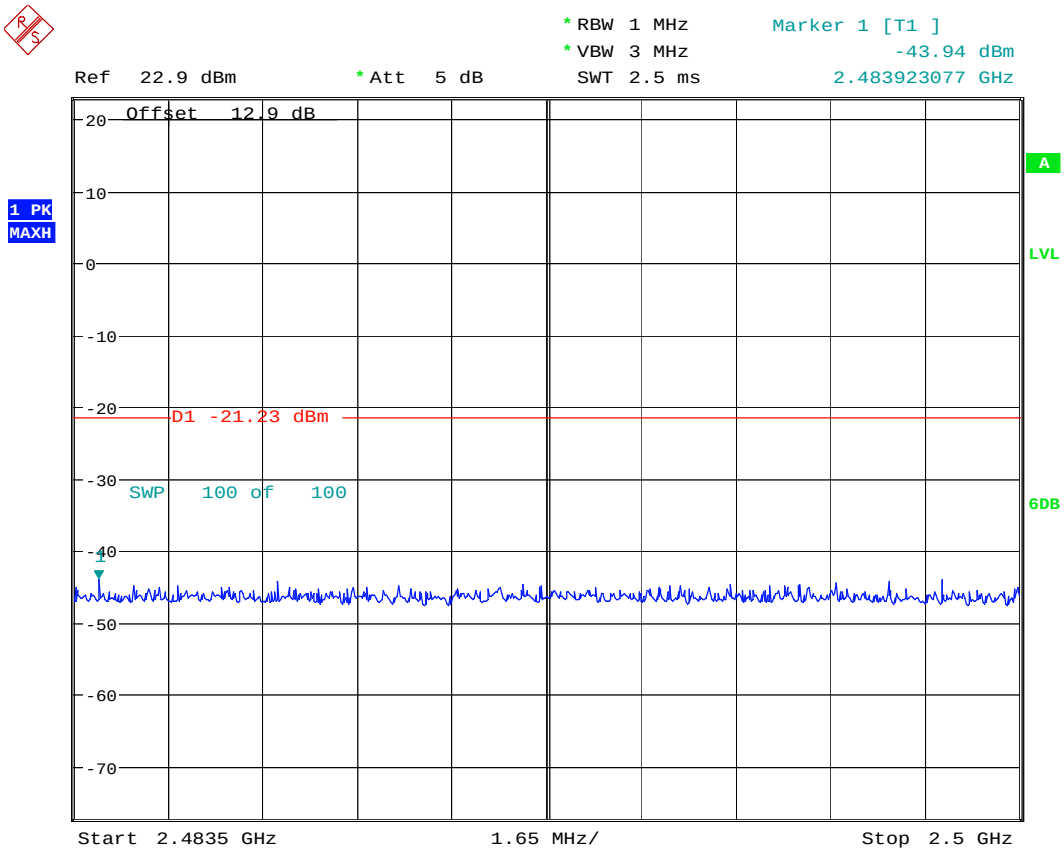
Tx chain 1 High channel/ 2462 MHz | **Modulation/Packet Type: 802.11b 1Mbps Avg**



Date: 12.SEP.2018 12:27:24

Plot #35

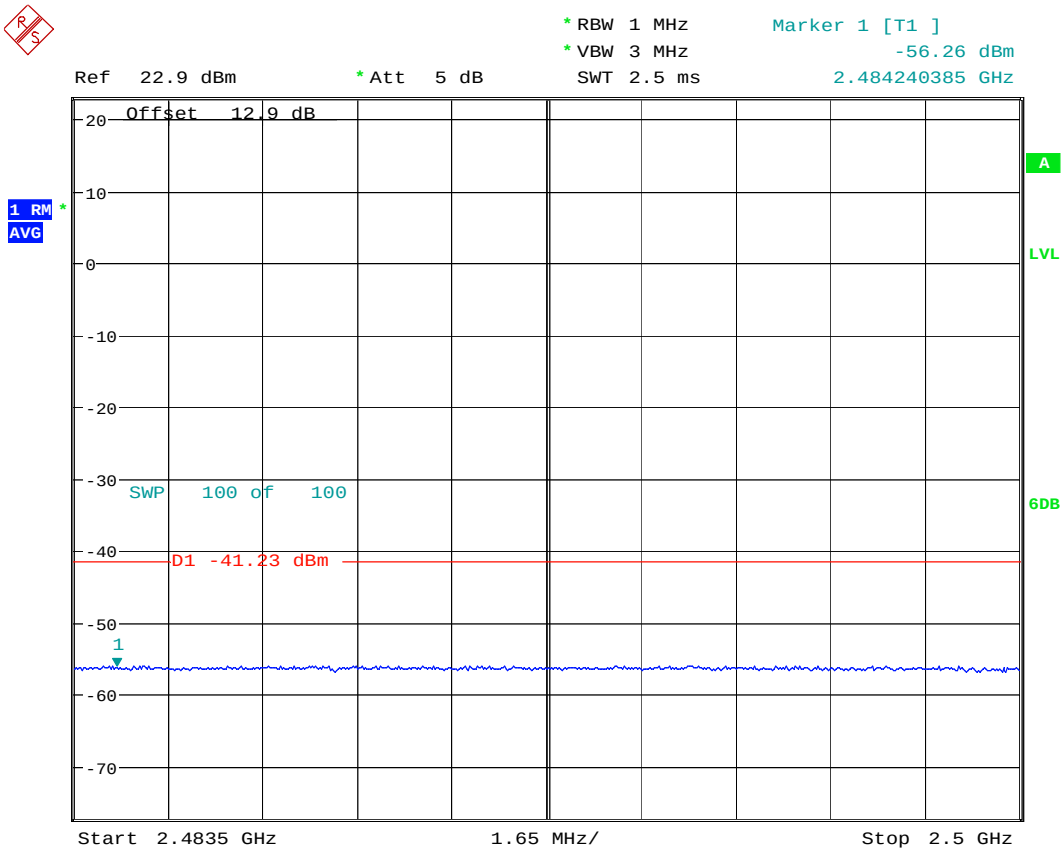
Tx chain 1 High channel/ 2462 MHz | **Modulation/Packet Type: 802.11g 6Mbps Peak**



Date: 12.SEP.2018 12:31:53

Plot #36

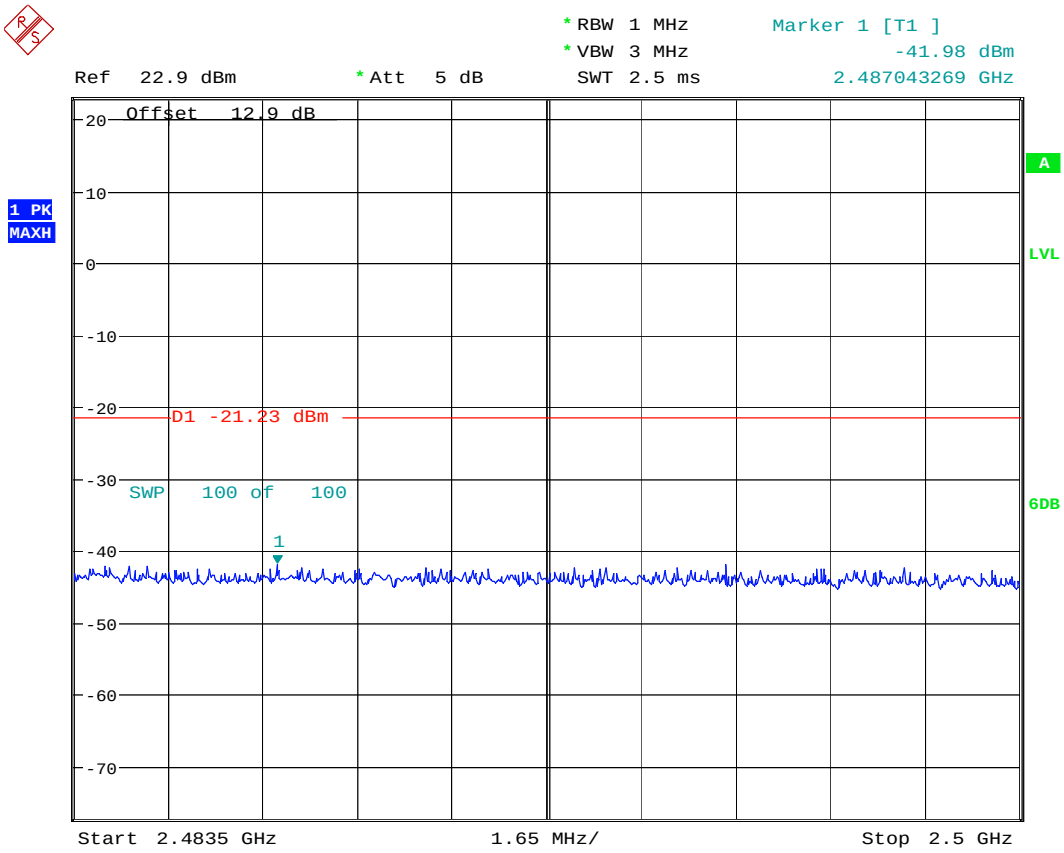
Tx chain 1 High channel/ 2462 MHz | **Modulation/Packet Type: 802.11b 6Mbps Avg**



Date: 12.SEP.2018 12:36:25

Plot #37

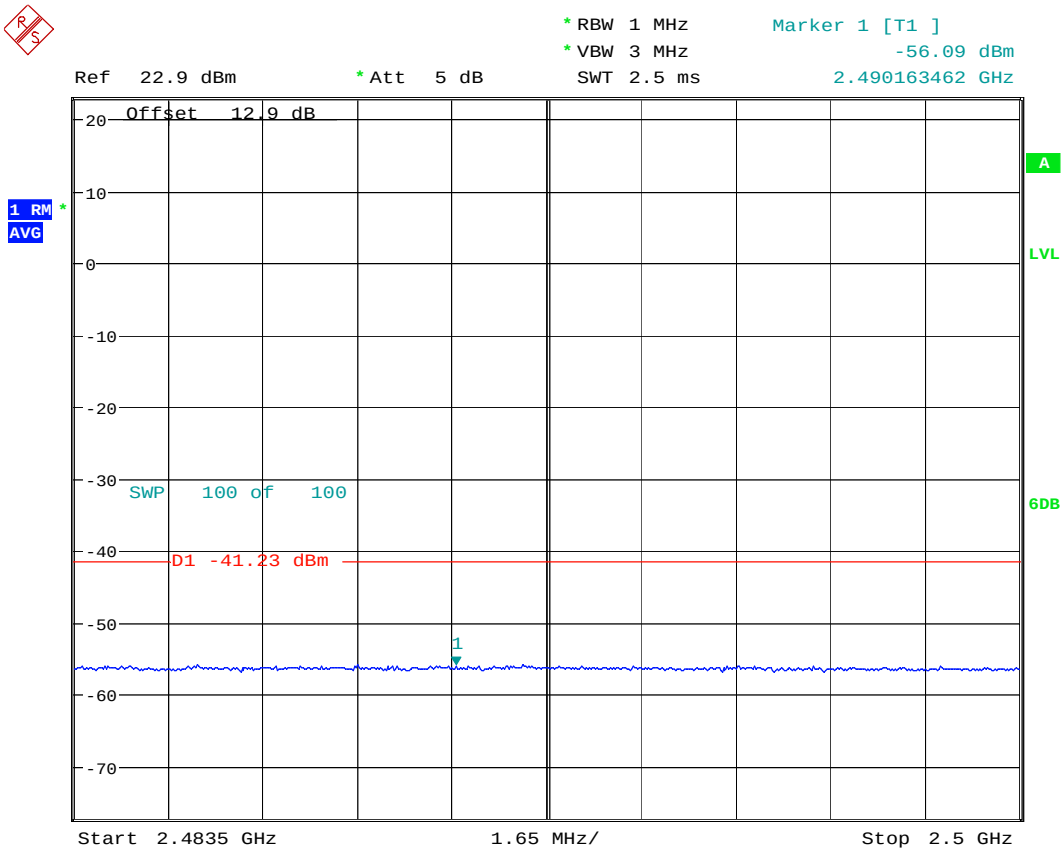
Tx chain 1 High channel/ 2462 MHz | **Modulation/Packet Type: 802.11n_HT20 MCS0 Peak**



Date: 12.SEP.2018 12:21:46

Plot #38

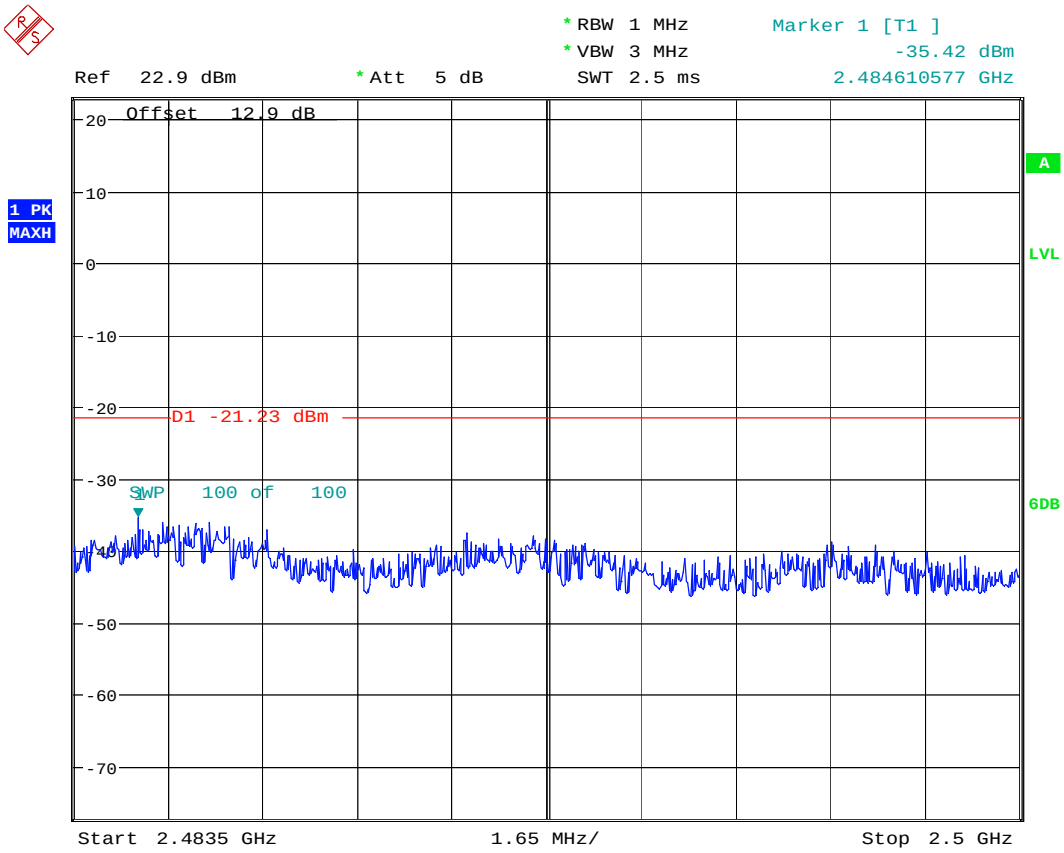
Tx chain 1 High channel/ 2462 MHz | **Modulation/Packet Type: 802.11n_HT20 MCS0 Avg**



Date: 12.SEP.2018 12:27:24

Plot #39

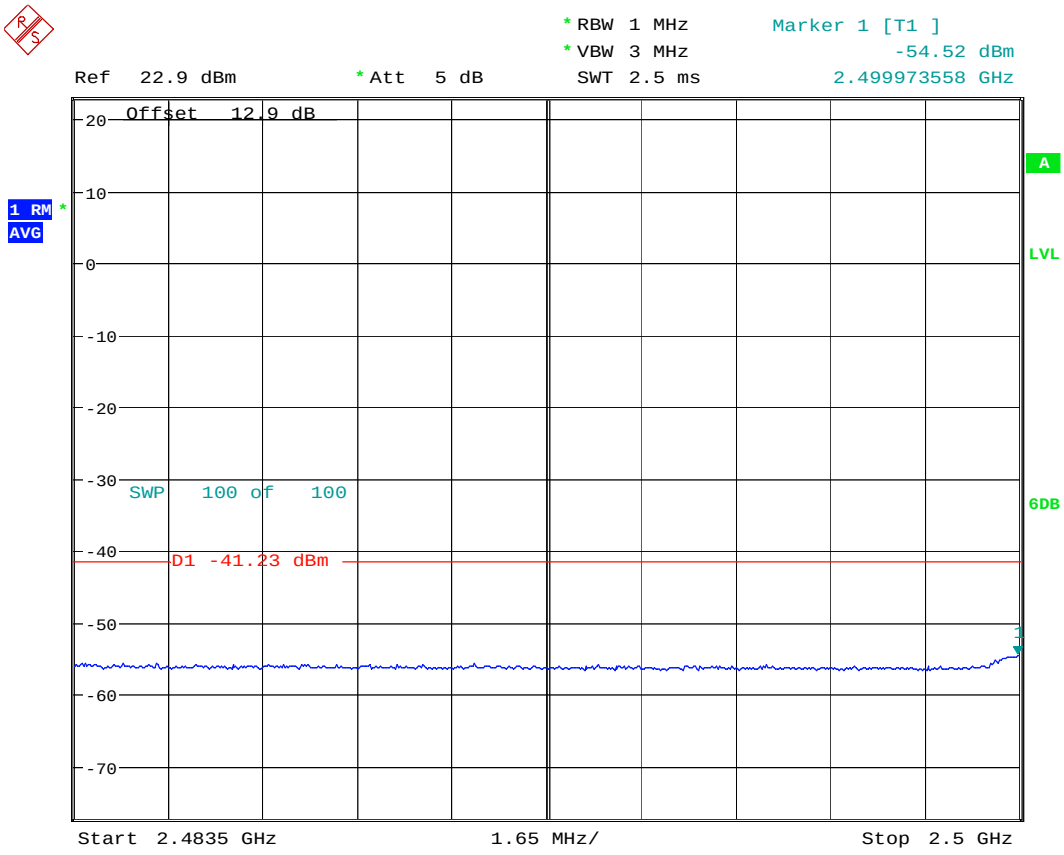
Tx chain 1 High channel/ 2452 MHz | **Modulation/Packet Type: 802.11n_HT40 MCS0 Peak**



Date: 12.SEP.2018 12:18:51

Plot #40

Tx chain1 High channel/ 2452 MHz | **Modulation/Packet Type: 802.11n_HT40 MCS0 Avg**



Date: 12.SEP.2018 12:16:28

8.5 Emission Bandwidth 6 dB and 99% Occupied Bandwidth

8.5.1 Measurement according to FCC 558074 D01 DTS Meas Guidance v04

Spectrum Analyzer settings:

- Set RBW = 100 kHz
- Set the video bandwidth (VBW) ≥ 3 x RBW
- Detector = Peak
- Trace mode = Max hold
- Sweep = Auto couple
- Allow the trace to stabilize
- Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

8.5.2 Limits:

FCC §15.247(a)(1) and RSS-247 5.2(1)

- Systems using digital modulation techniques may operate in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

8.5.3 Test conditions and setup:

Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input
22° C	1	802.11 b/g/n	USB 5VDC

8.5.4 Measurement result:

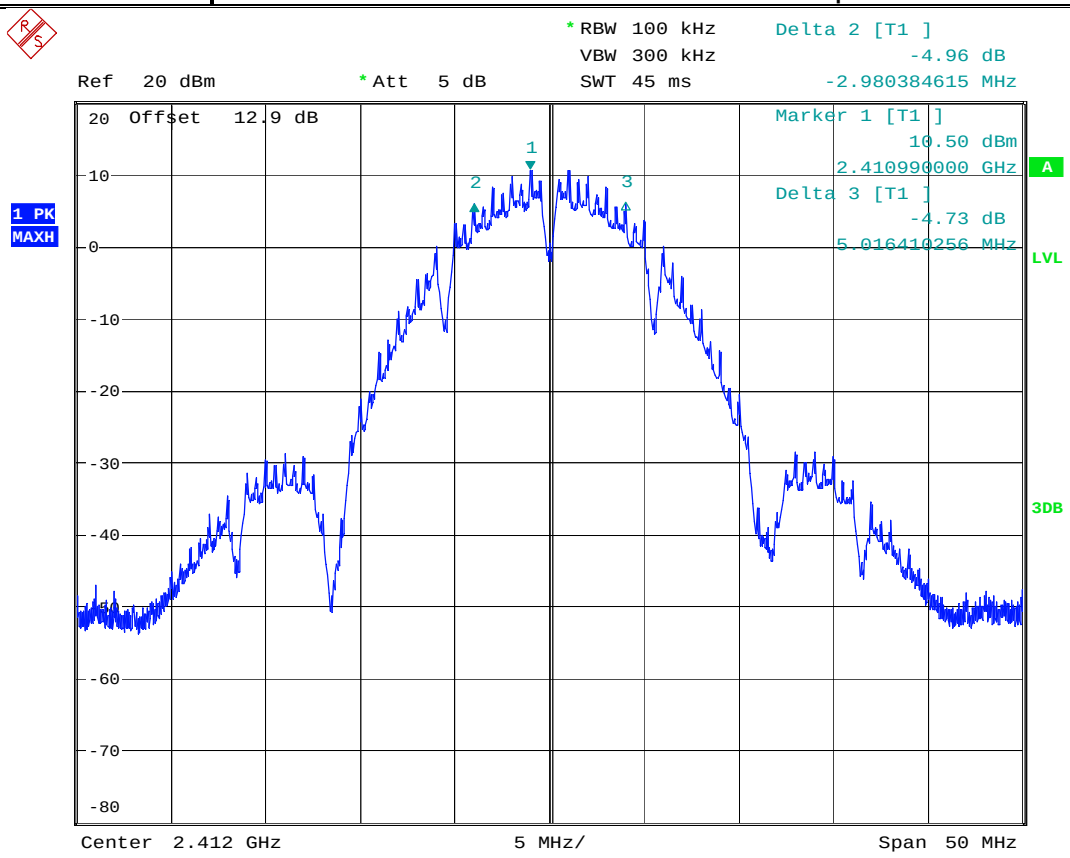
Plot #	Mode	Channel	6 dB Emissions Bandwidth (MHz)	Limit (MHz)	Result
1	802.11b	1	8	> 0.5	Pass
2	802.11b	6	8.01	> 0.5	Pass
3	802.11b	11	7.98	> 0.5	Pass
4	802.11g	1	15.7	> 0.5	Pass
5	802.11g	6	15.71	> 0.5	Pass
6	802.11g	11	15.78	> 0.5	Pass
7	802.11n_HT20	1	15.95	> 0.5	Pass
8	802.11n_HT20	6	15.86	> 0.5	Pass
9	802.11n_HT20	11	16.31	> 0.5	Pass
10	802.11n_HT40	3	35.65	> 0.5	Pass
11	802.11n_HT40	6	35.34	> 0.5	Pass
12	802.11n_HT40	9	35.52	> 0.5	Pass

Plot #	Mode	Channel	99% Occupied Bandwidth (MHz)	Limit (MHz)	Result
13	802.11b	1	13.78	> 0.5	Pass
14	802.11b	6	14.42	> 0.5	Pass
15	802.11b	11	14.9	> 0.5	Pass
16	802.11g	1	16.75	> 0.5	Pass
17	802.11g	6	16.9	> 0.5	Pass
18	802.11g	11	17.07	> 0.5	Pass
19	802.11n_HT20	1	17.79	> 0.5	Pass
20	802.11n_HT20	6	17.95	> 0.5	Pass
21	802.11n_HT20	11	17.95	> 0.5	Pass
22	802.11n_HT40	3	36.22	> 0.5	Pass
23	802.11n_HT40	6	36.22	> 0.5	Pass
24	802.11n_HT40	9	36.22	> 0.5	Pass

8.5.5 Measurement Plots:

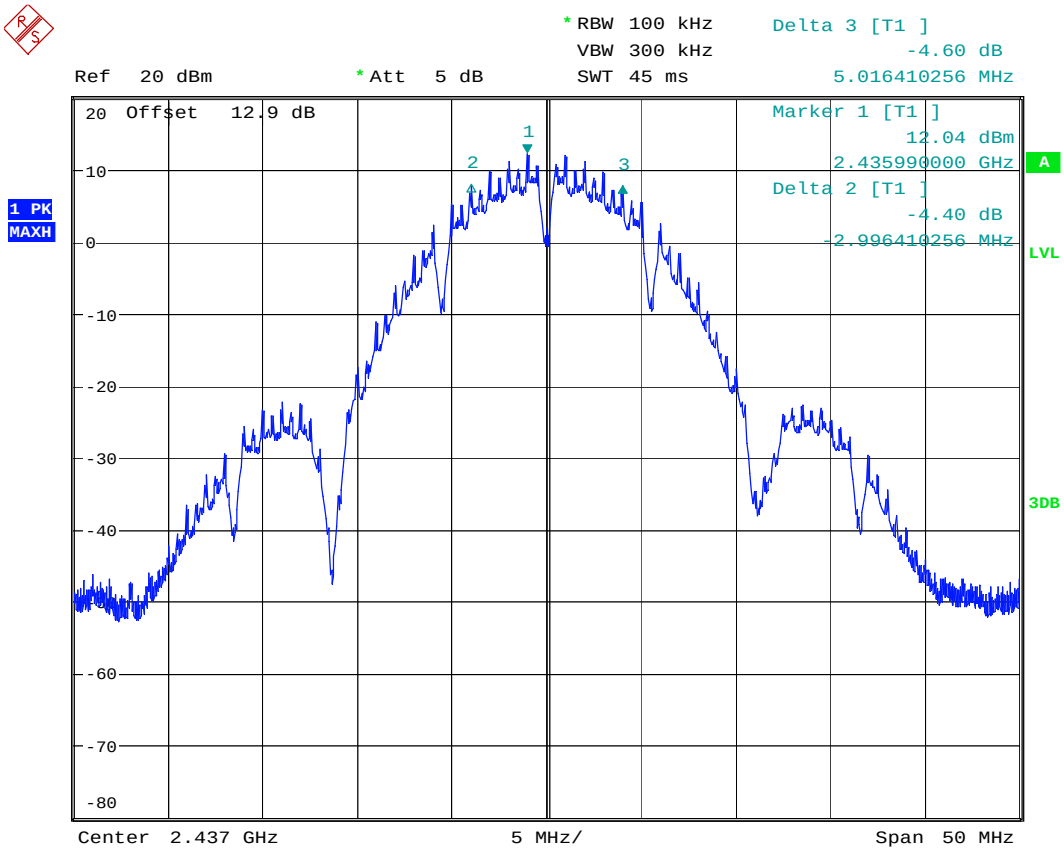
Plot #1

Low channel	Mode: 802.11b 1Mbps



Plot #2

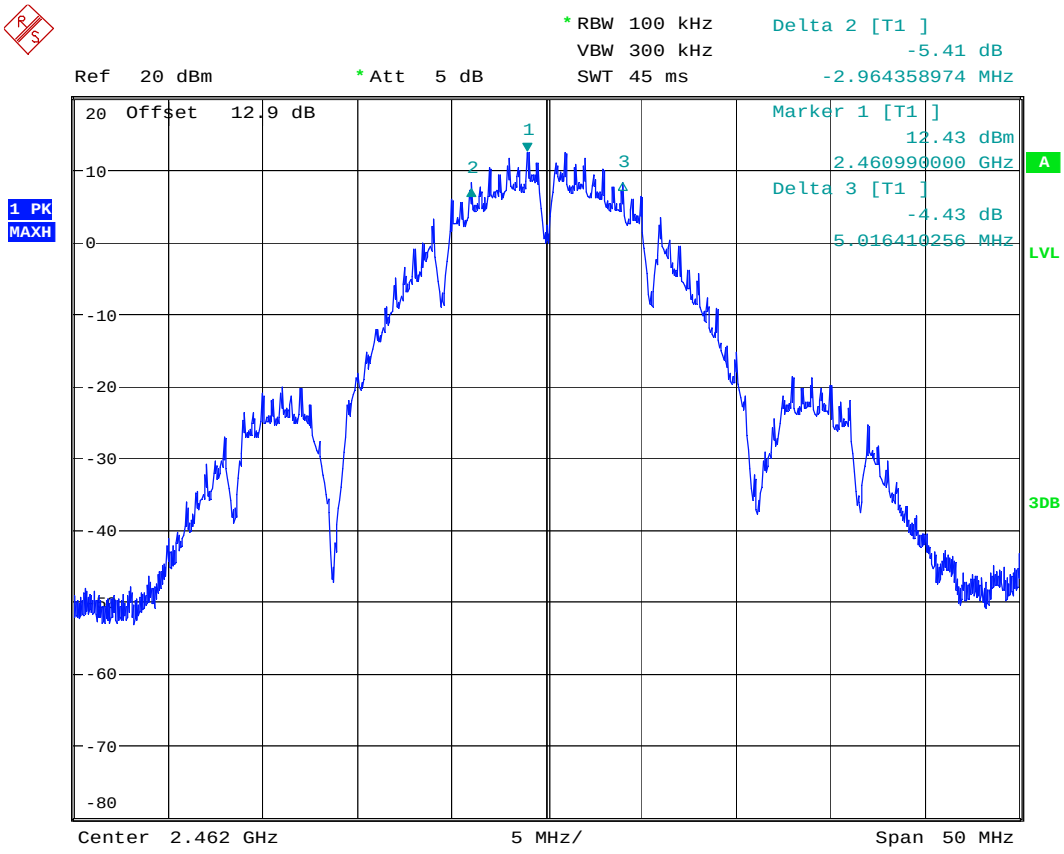
Mid channel | **Mode: 802.11b 1Mbps**



Date: 5.JUL.2018 15:31:54

Plot #3

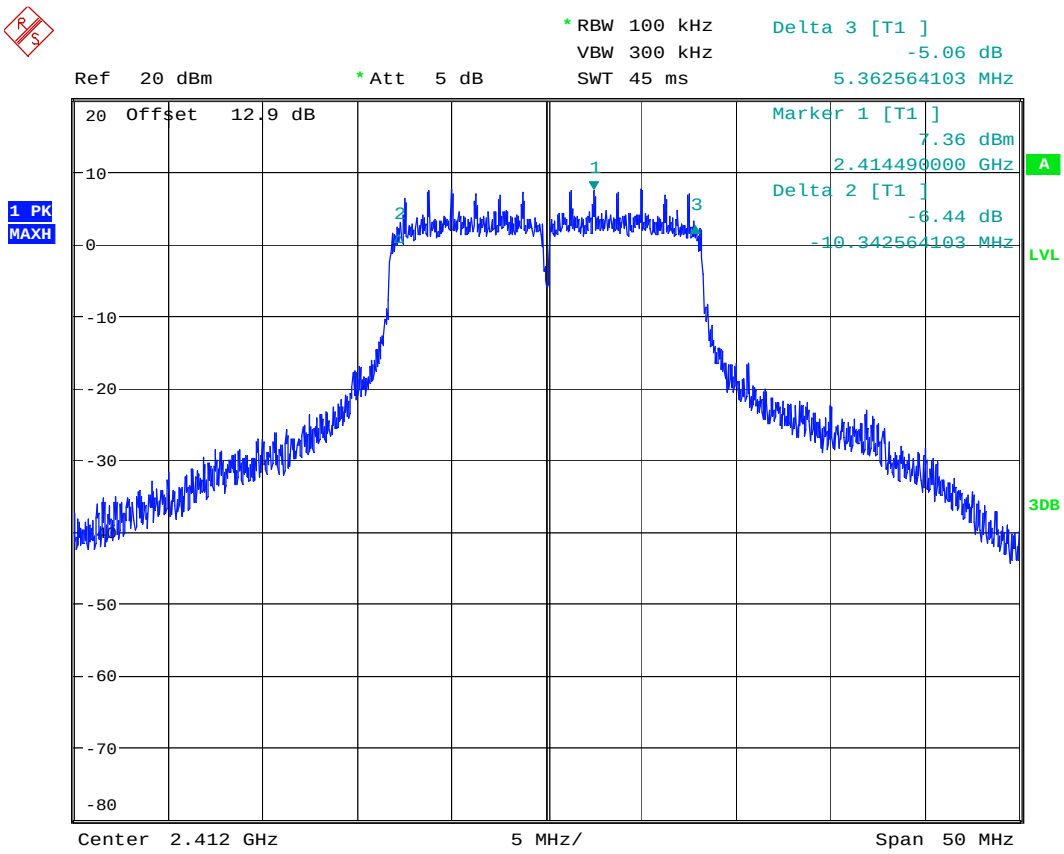
High channel | **Mode: 802.11b 1Mbps**



Date: 5.JUL.2018 15:34:17

Plot #4

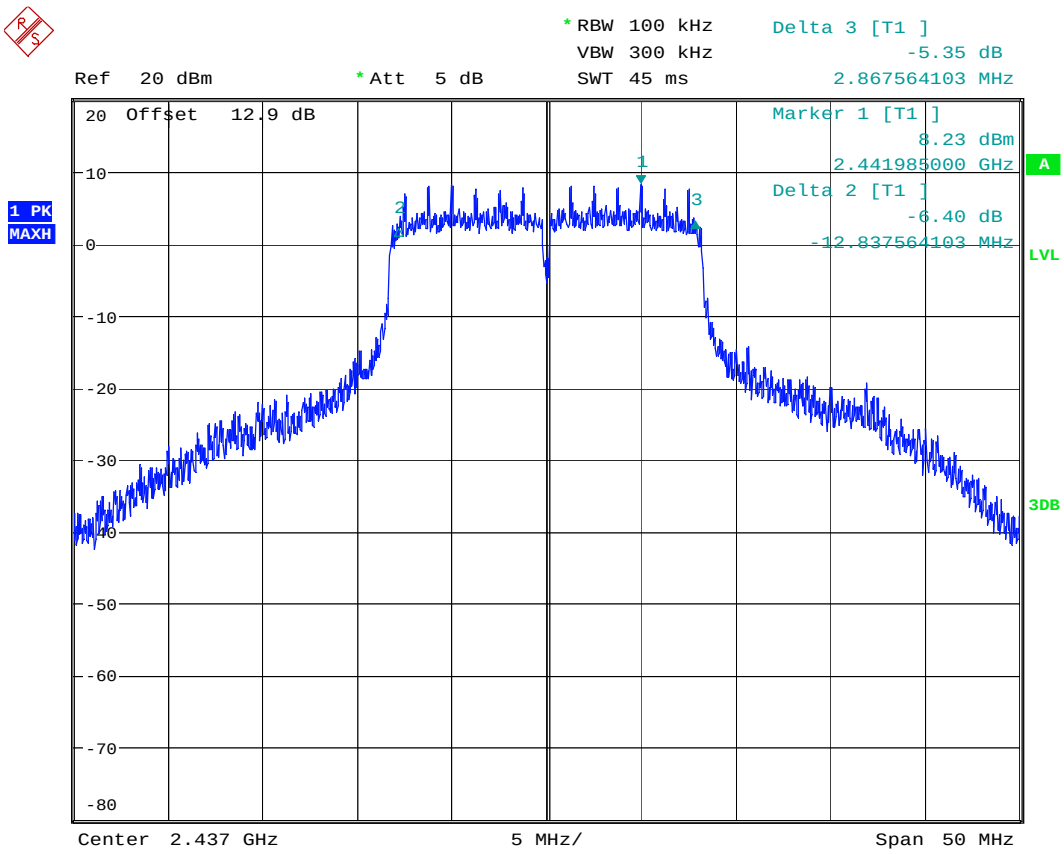
Low channel	Mode: 802.11g 6Mbps



Date: 5.JUL.2018 15:37:23

Plot #5

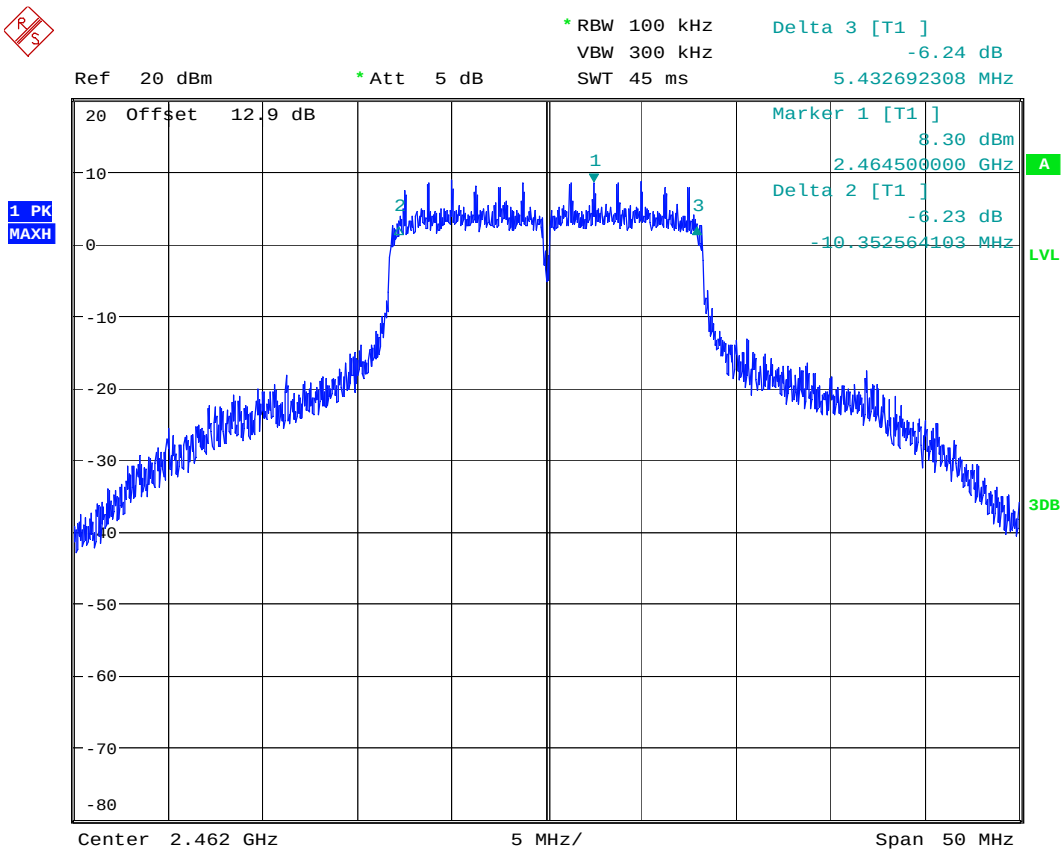
Mid channel	Mode: 802.11g 6Mbps



Date: 5.JUL.2018 15:40:20

Plot #6

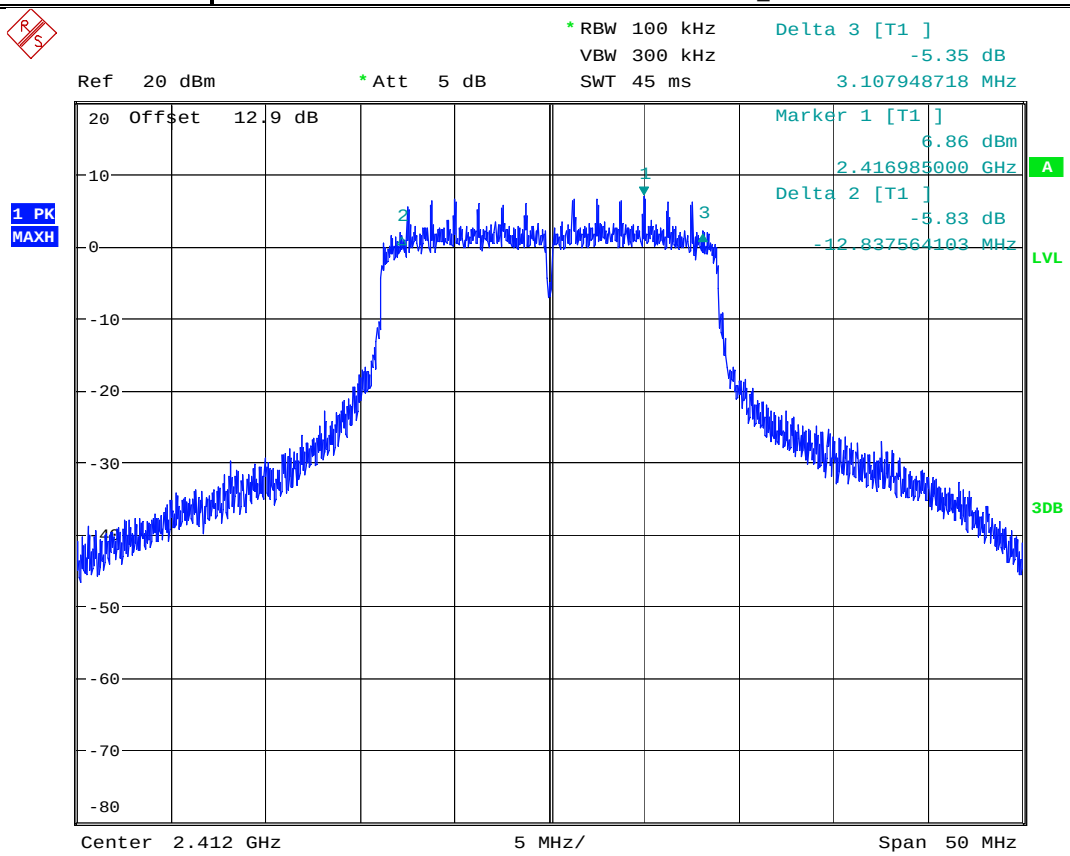
High channel	Mode: 802.11g 6Mbps



Date: 5.JUL.2018 15:42:26

Plot #7

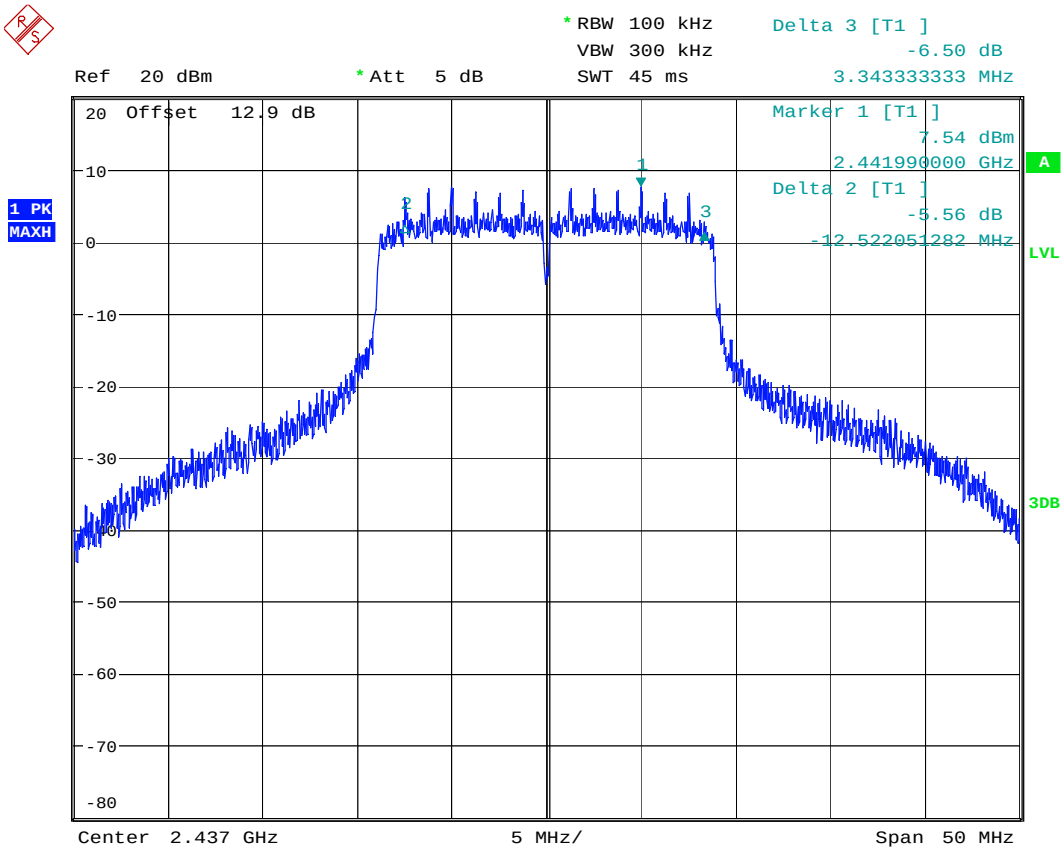
Low channel | **Mode: 802.11n_HT20 MCS0**



Date: 5.JUL.2018 15:00:35

Plot #8

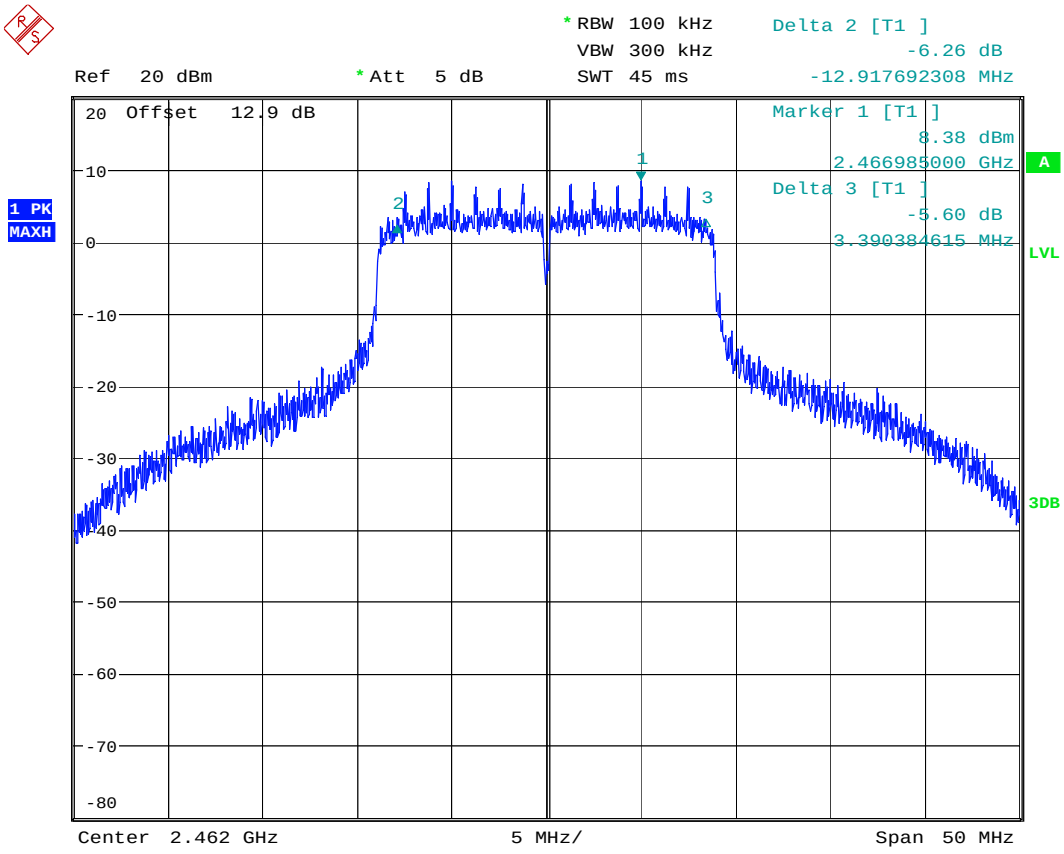
Mid channel | **Mode: 802.11n_HT20 MCS0**



Date: 5.JUL.2018 14:58:22

Plot #9

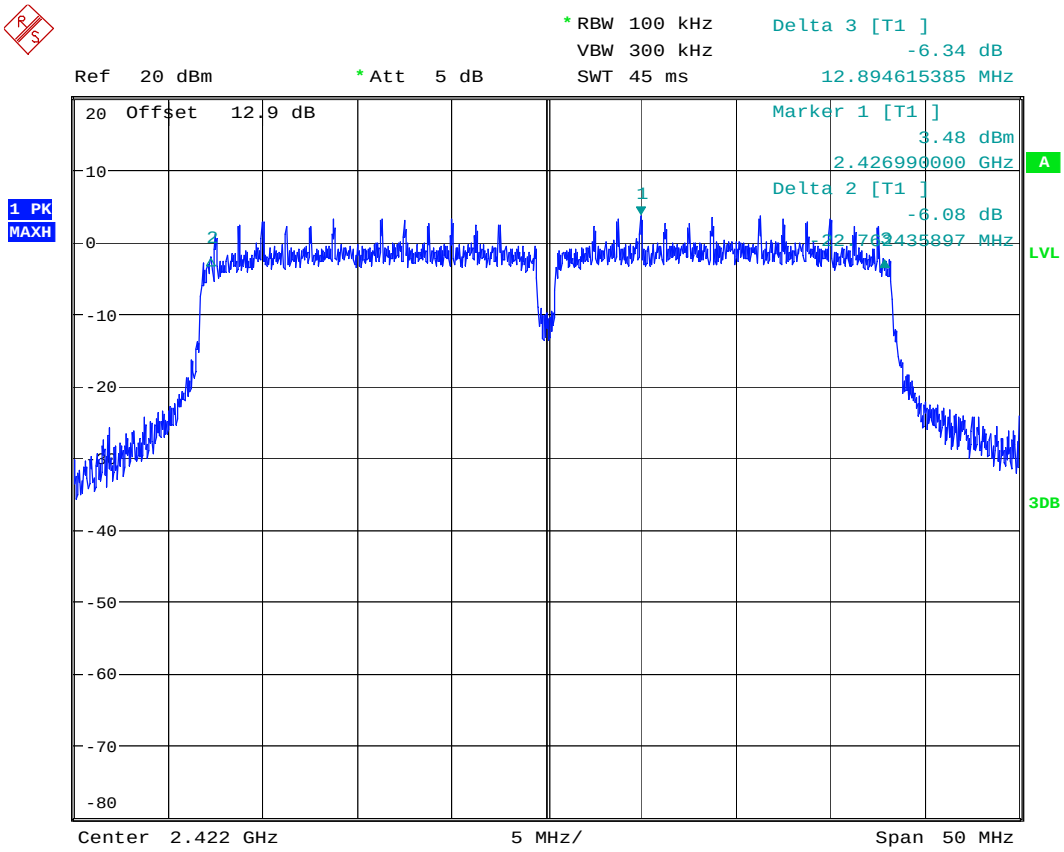
High channel | **Mode: 802.11n_HT20 MCS0**



Date: 5.JUL.2018 14:55:36

Plot #10

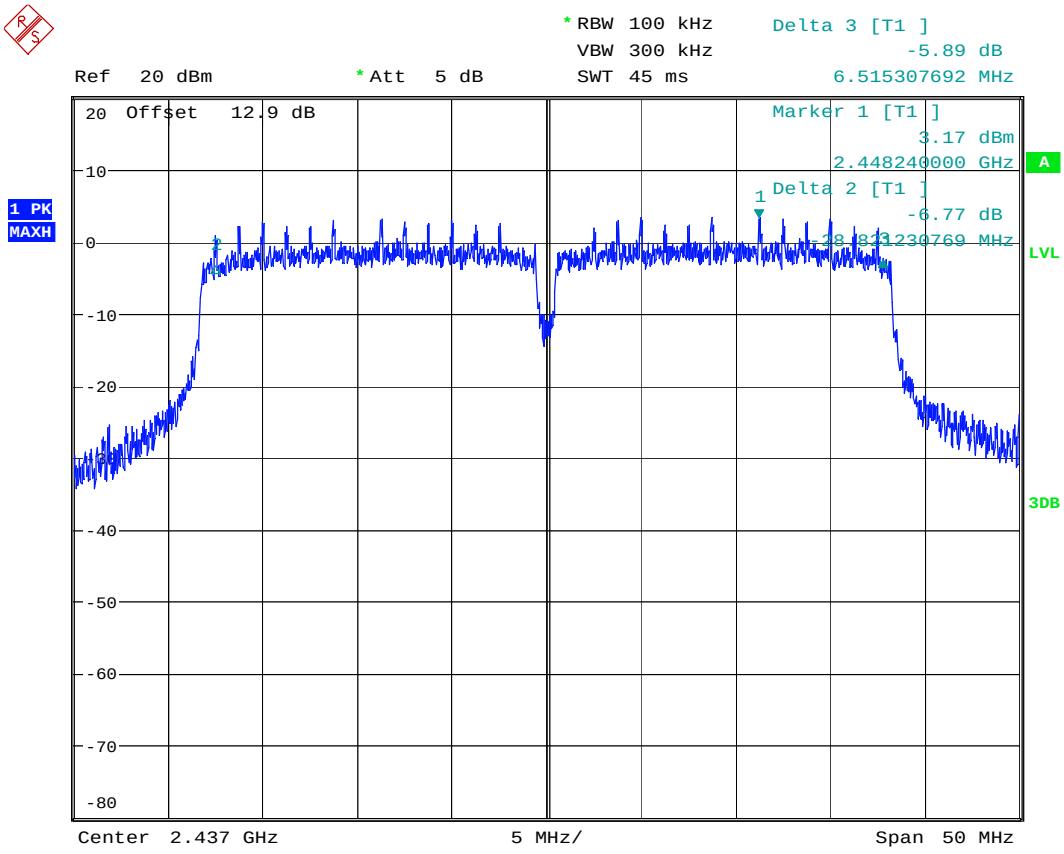
Low channel	Mode: 802.11n_HT40 MCS0



Date: 5.JUL.2018 15:16:05

Plot #11

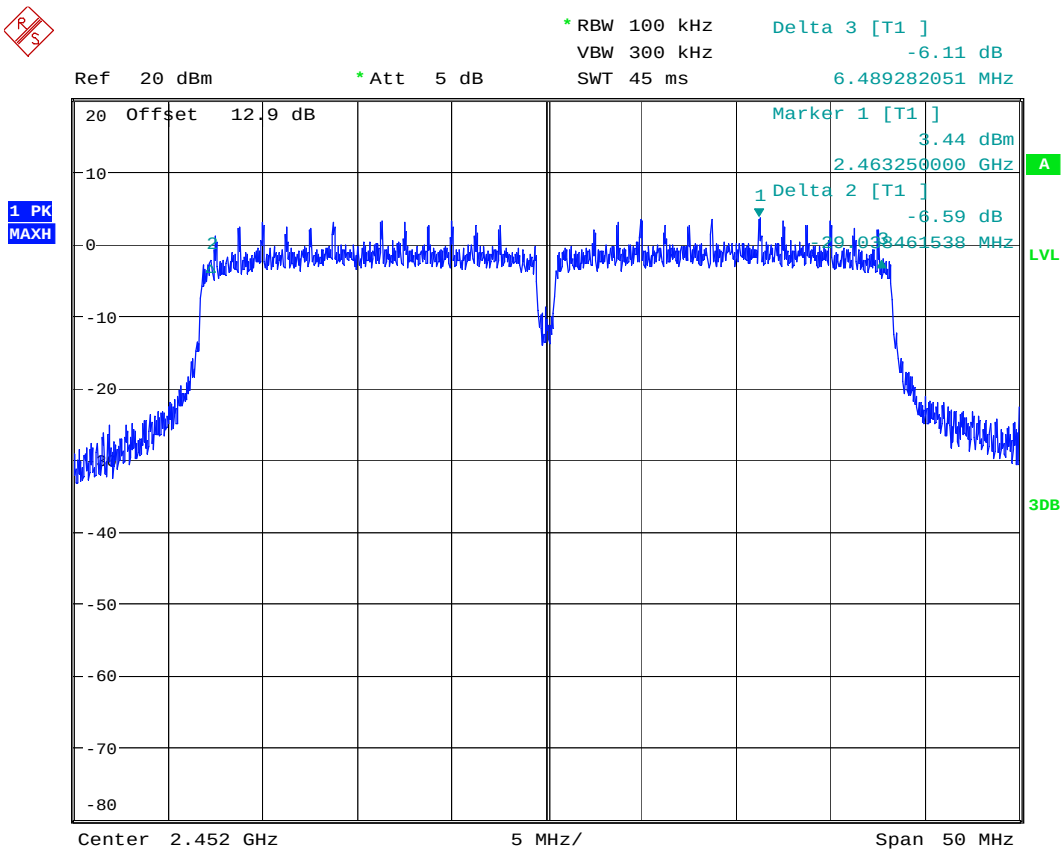
Mid channel	Mode: 802.11n_HT40 MCS0



Date: 5.JUL.2018 15:18:48

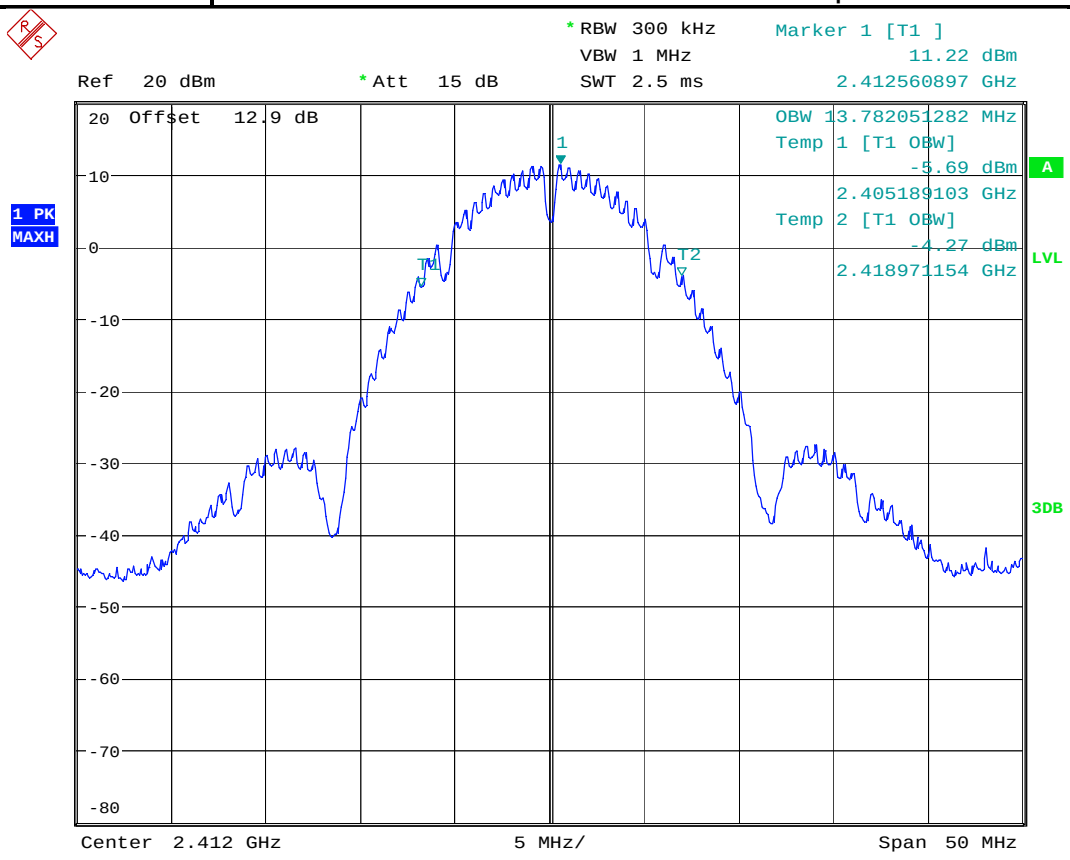
Plot #12

High channel	Mode: 802.11n_HT40 MCS0



Plot #13

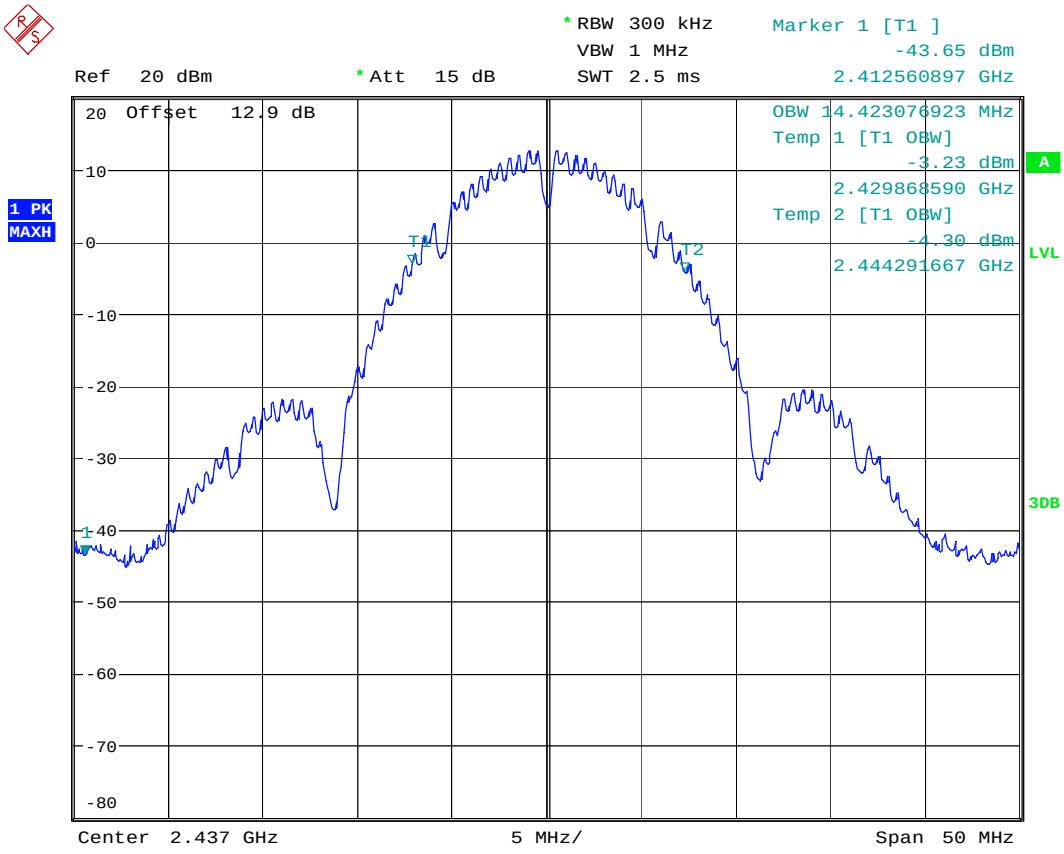
Low channel | **Mode: 802.11b 1Mbps**



Date: 5.JUL.2018 12:36:10

Plot #14

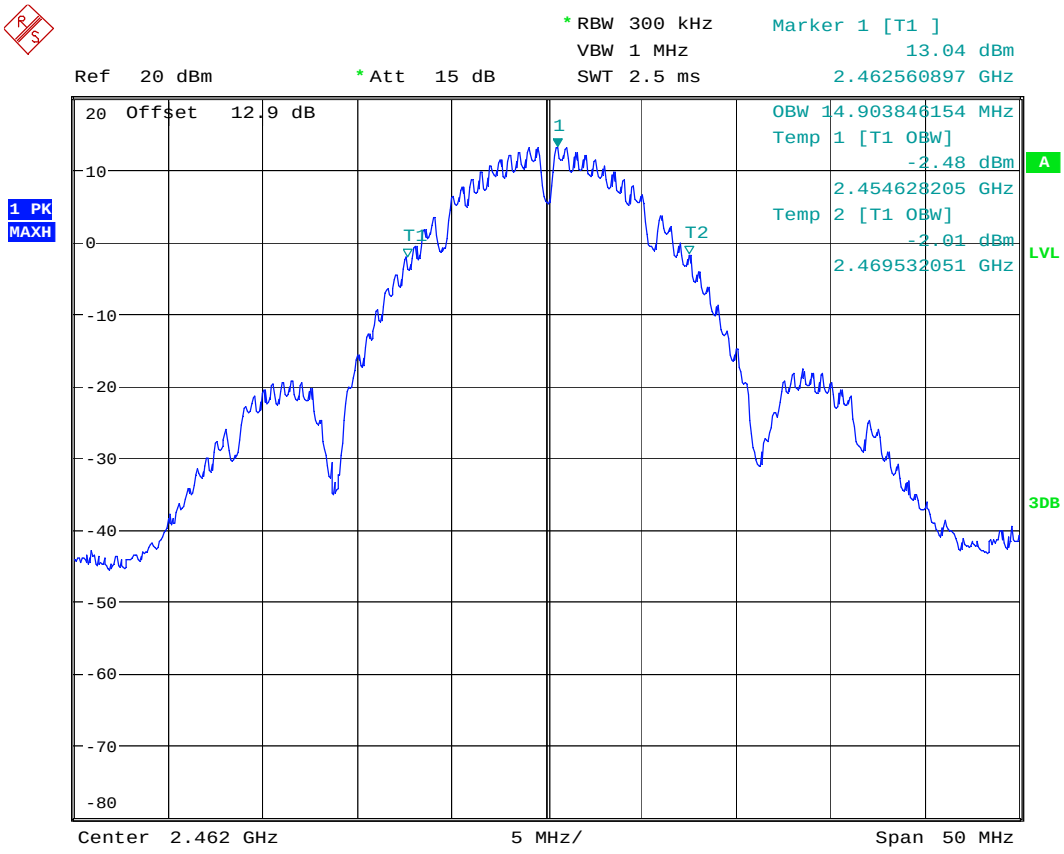
Mid channel | **Mode: 802.11b 1Mbps**



Date: 5.JUL.2018 12:37:51

Plot #15

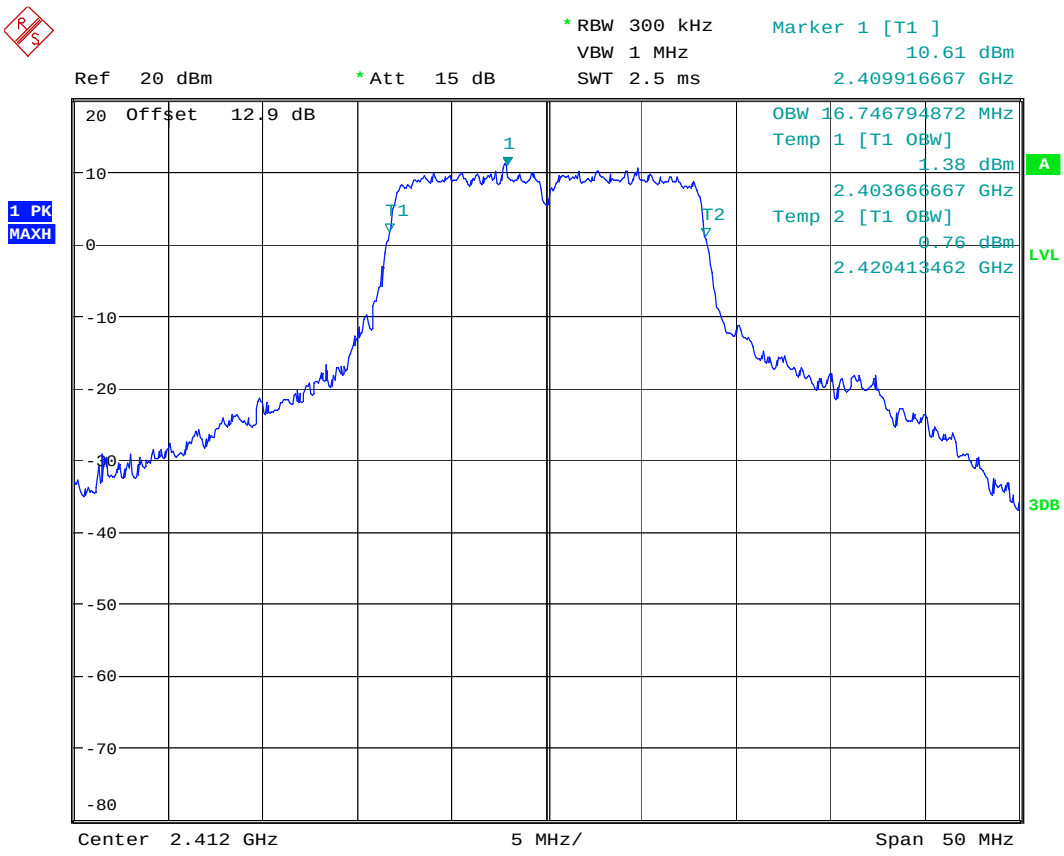
High channel | **Mode: 802.11b 1Mbps**



Date: 5.JUL.2018 12:51:56

Plot #16

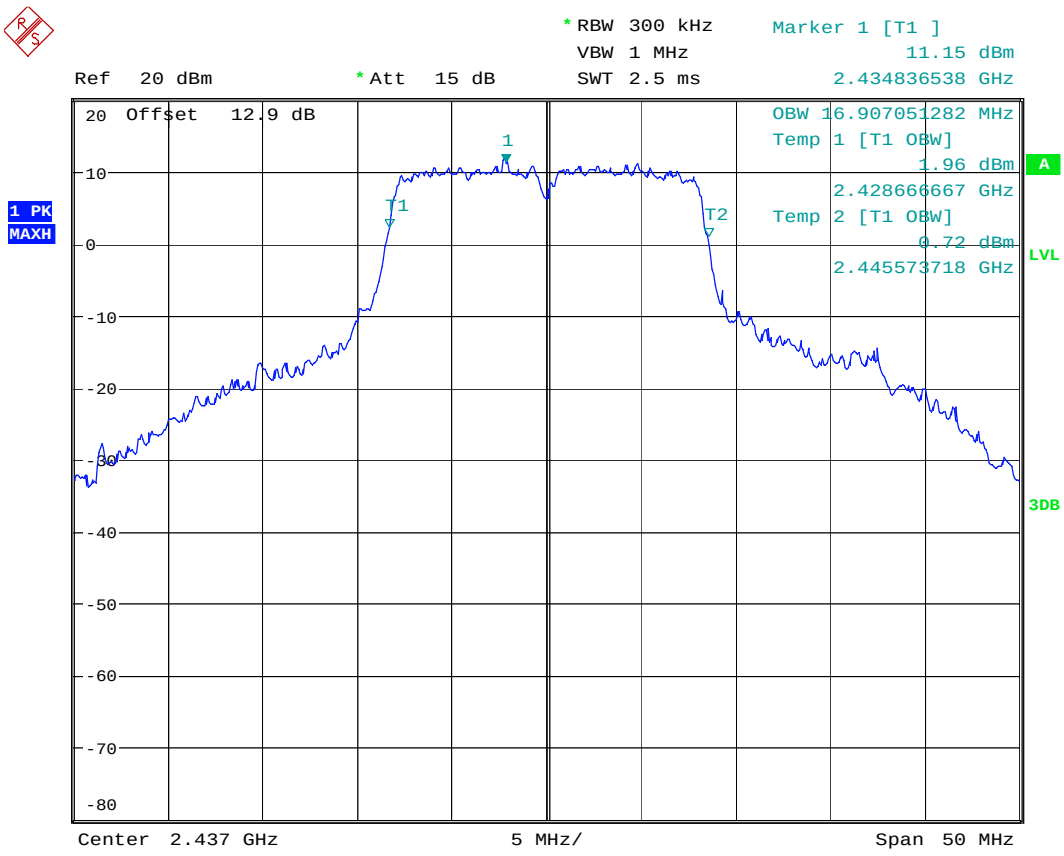
Low channel	Mode: 802.11g 6Mbps



Date: 5.JUL.2018 13:23:18

Plot #17

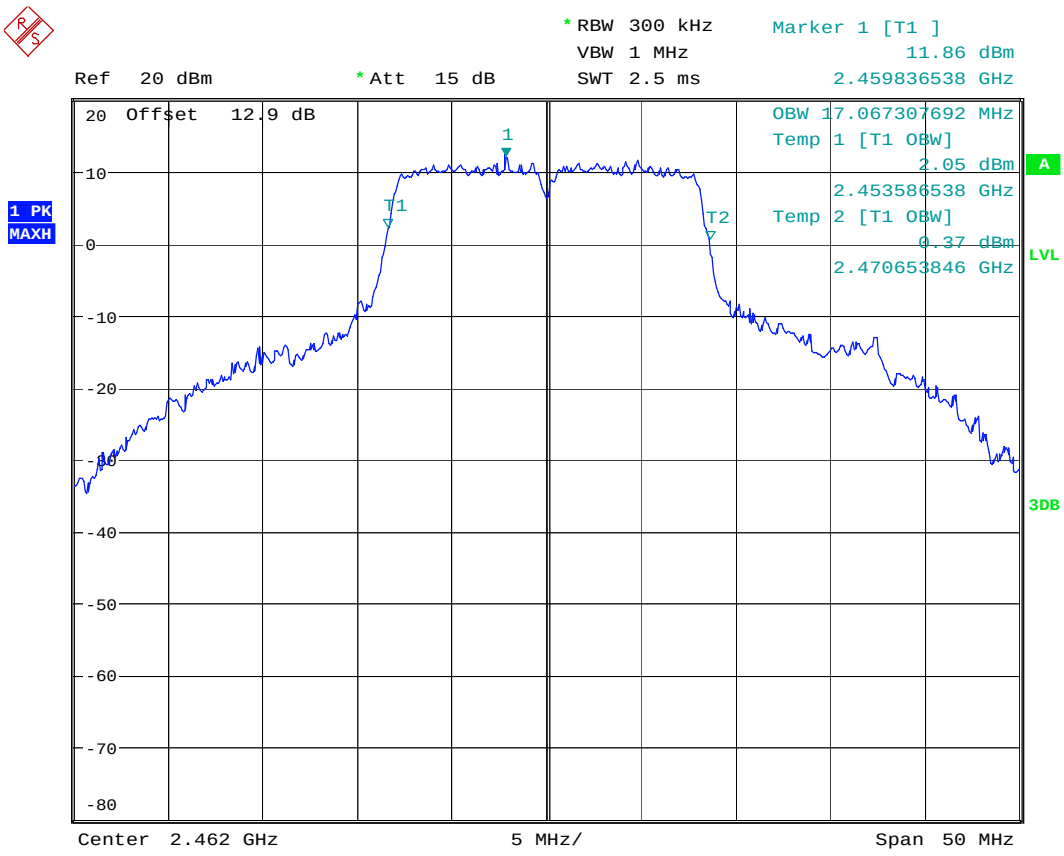
Mid channel	Mode: 802.11g 6Mbps



Date: 5.JUL.2018 12:57:18

Plot #18

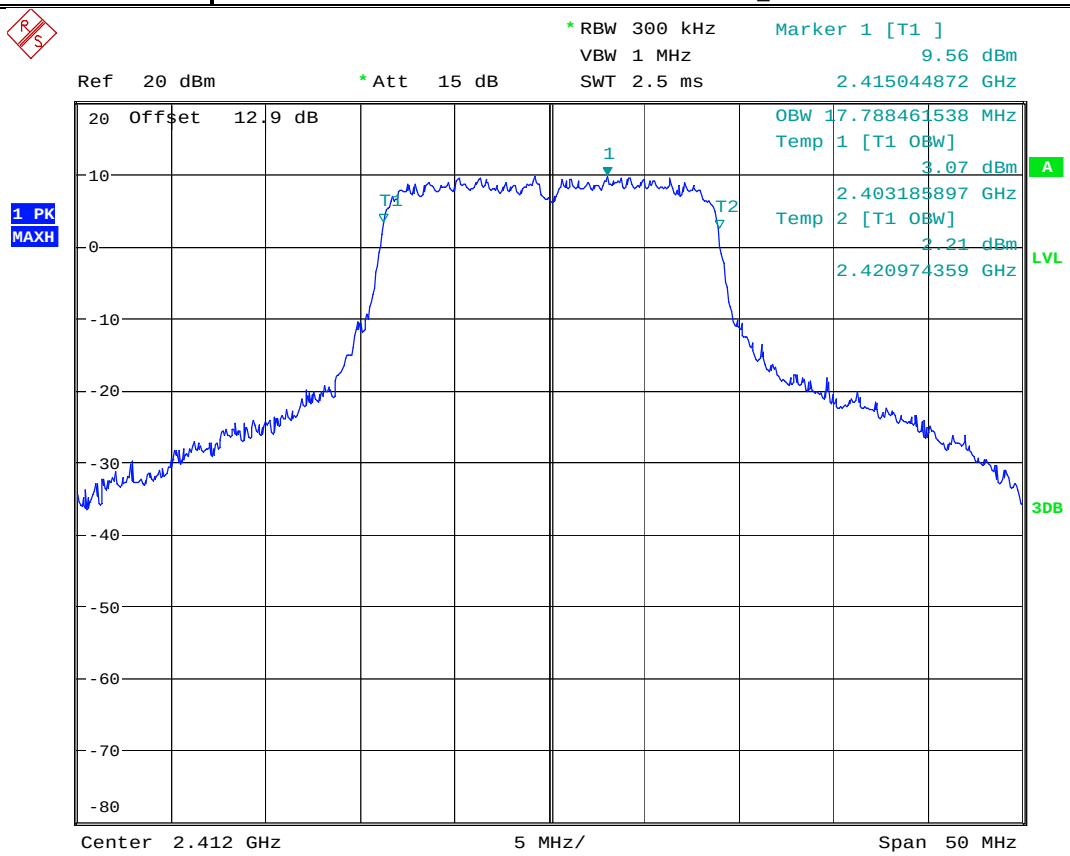
High channel	Mode: 802.11g 6Mbps



Date: 5.JUL.2018 12:58:35

Plot #19

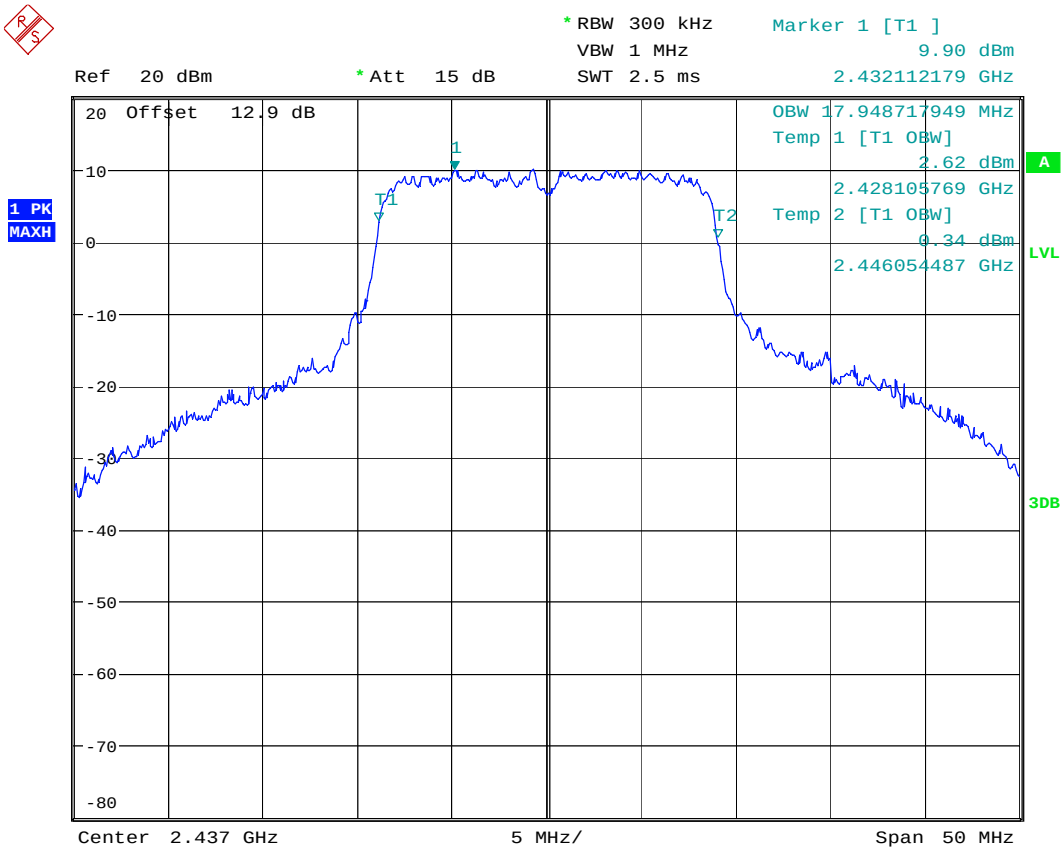
Low channel | **Mode: 802.11n_HT20 MCS0**



Date: 5.JUL.2018 13:04:13

Plot #20

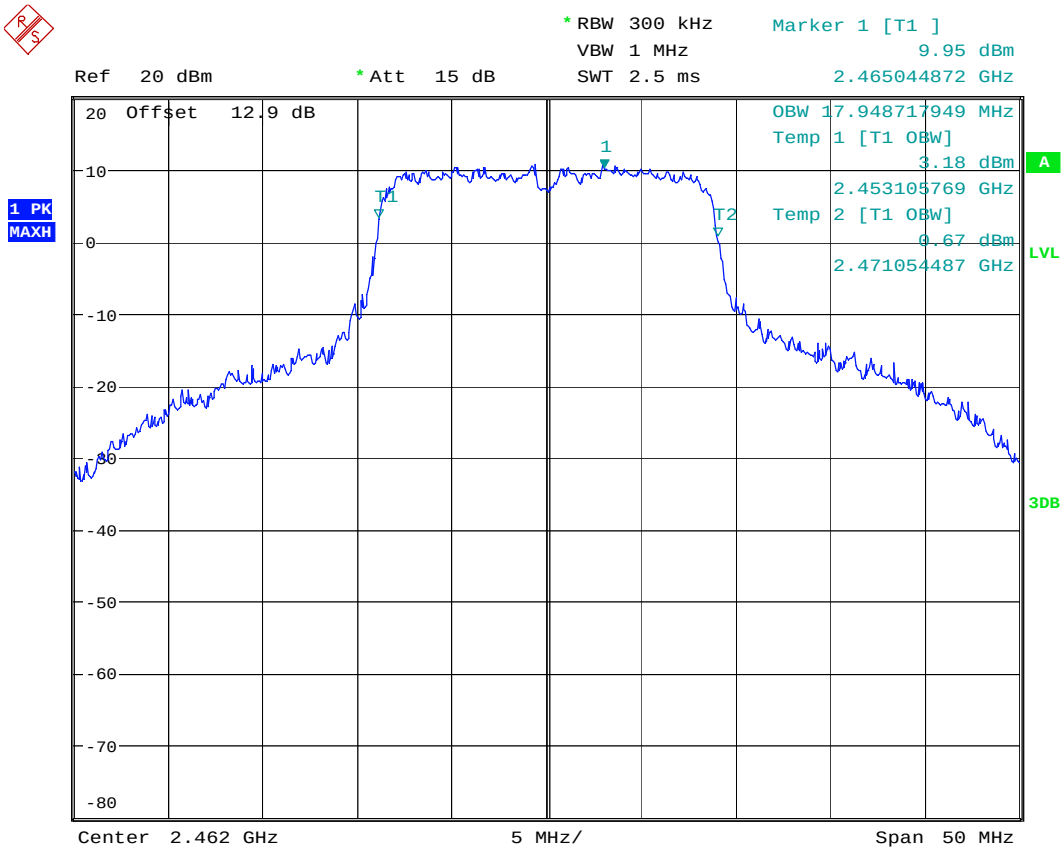
Mid channel | **Mode: 802.11n_HT20 MCS0**



Date: 5.JUL.2018 13:21:40

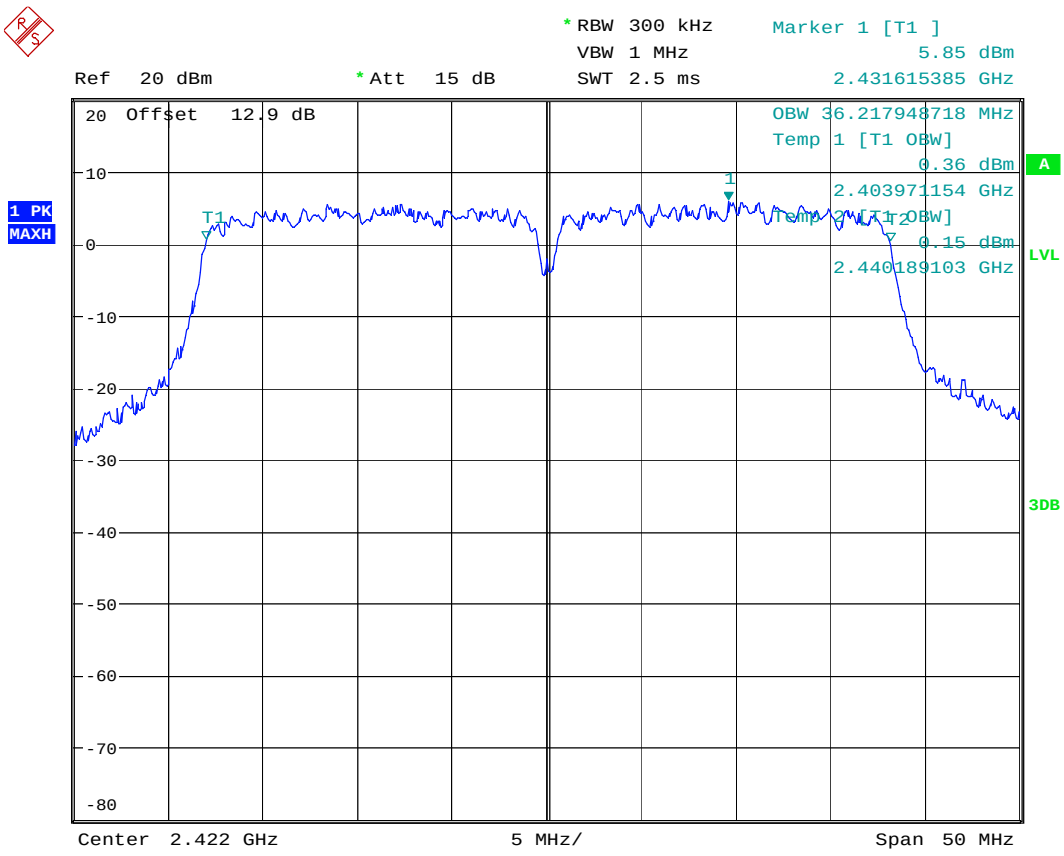
Plot #21

High channel | **Mode: 802.11n_HT20 MCS0**



Plot #22

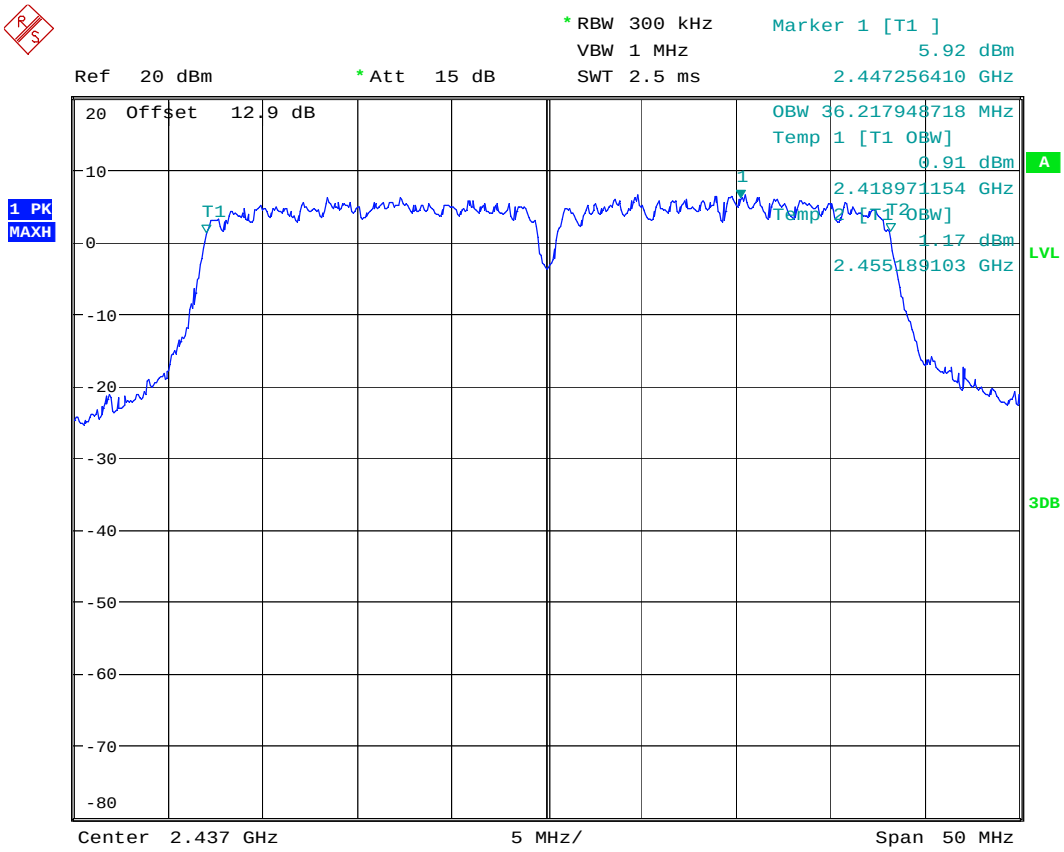
Low channel	Mode: 802.11n_HT40 MCS0



Date: 5.JUL.2018 13:20:01

Plot #23

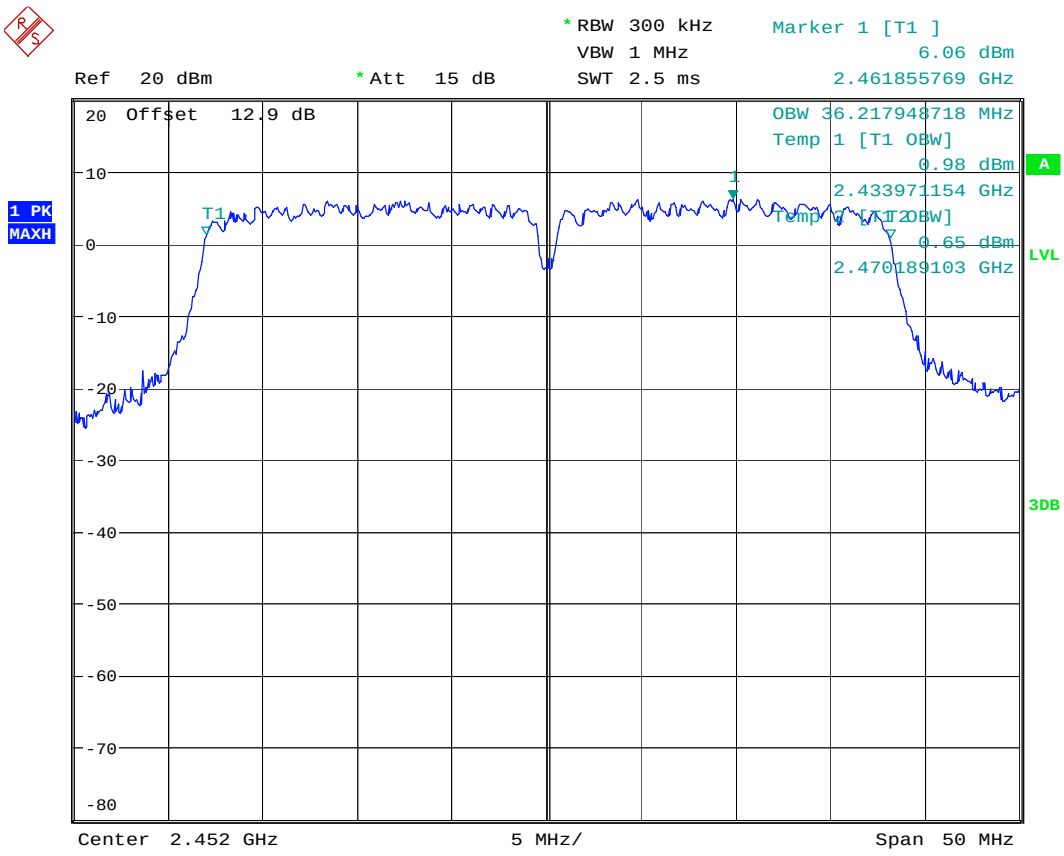
Mid channel	Mode: 802.11n_HT40 MCS0



Date: 5.JUL.2018 13:13:01

Plot #24

High channel	Mode: 802.11n_HT40 MCS0



Date: 5.JUL.2018 13:19:03

8.6 Radiated Transmitter Spurious Emissions and Restricted Bands

8.6.1 Measurement according to ANSI C63.10 (2013)

Spectrum Analyzer Settings:

- Frequency = 9 KHz – 30 MHz
- RBW = 9 KHz
- Detector: Peak

- Frequency = 30 MHz – 1 GHz
- Detector = Peak / Quasi-Peak
- RBW= 120 KHz (<1GHz)

- Frequency > 1 GHz
- Detector = Peak / Average
- RBW = 1 MHz

- Radiated spurious emissions shall be measured for the transmit frequencies, transmit power, and data rate for the lowest, middle and highest channel in each frequency band of operation and for the highest gain antenna for each antenna type, and using the appropriate parameters and test requirements.
- The highest (or worst-case) data rate shall be recorded for each measurement.
- For testing at distance other than the specified in the standard, the limit conversion is calculated by using 40 dB/decade extrapolation factor as follow: Conversion factor (CF) = 40 log (D/d) = 40 log (300m / 3m) = 80dB

8.6.2 Limits:

FCC §15.247

- In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

FCC §15.209 & RSS-Gen 8.9

- Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency of emission (MHz)	Field strength (µV/m)	Measurement Distance (m)	Field strength @ 3m (dBµV/m)
0.009–0.490	2400/F(kHz) / ---------	300	-
0.490–1.705	24000/F(kHz) / --------	30	-
1.705–30.0	30 / (29.5)	30	-
30–88	100	3	40 dBµV/m
88–216	150	3	43.5 dBµV/m
216–960	200	3	46 dBµV/m
Above 960	500	3	54 dBµV/m

FCC §15.205 & RSS-Gen 8.10

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

MHz	MHz	MHz	GHz
0.090-0.110	16.42-16.423	399.9-410	4.5-5.15
[1]0.495-0.505	16.69475-16.69525	608-614	5.35-5.46
2.1735-2.1905	16.80425-16.80475	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.215-6.218	74.8-75.2	1660-1710	10.6-12.7
6.26775-6.26825	108-121.94	1718.8-1722.2	13.25-13.4
6.31175-6.31225	123-138	2200-2300	14.47-14.5
8.291-8.294	149.9-150.05	2310-2390	15.35-16.2
8.362-8.366	156.52475-156.52525	2483.5-2500	17.7-21.4
8.37625-8.38675	156.7-156.9	2690-2900	22.01-23.12
8.41425-8.41475	162.0125-167.17	3260-3267	23.6-24.0
12.29-12.293	167.72-173.2	3332-3339	31.2-31.8
12.51975-12.52025	240-285	3345.8-3358	36.43-36.5
12.57675-12.57725	322-335.4	3600-4400	Above 38.6
13.36-13.41			

- Radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).
  *PEAK LIMIT= 74 dBµV/m
  *AVG. LIMIT= 54 dBµV/m

8.6.3 Test conditions and setup:

Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input
23° C	2	802.11n_HT20 MIMO	USB 5VDC

8.6.4 Measurement result:

Plot #	Channel #	Scan Frequency	Limit	Result
1-3	Low	30 MHz – 18 GHz	See section 8.6.2	Pass
4-8	Mid	9 kHz – 26 GHz	See section 8.6.2	Pass
9-11	High	30 MHz – 18 GHz	See section 8.6.2	Pass

8.6.5 Measurement Plots:

Plot #1 Radiated Emissions: 30 MHz – 1GHz

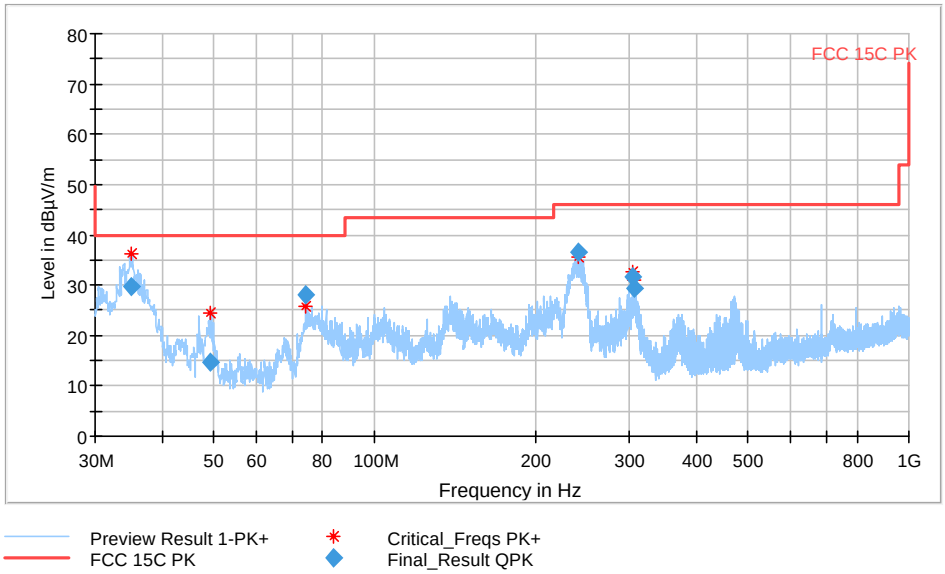
Modulation: 802.11n_HT20 MIMO	Channel: Low	95% Duty Cycle

Final_Result

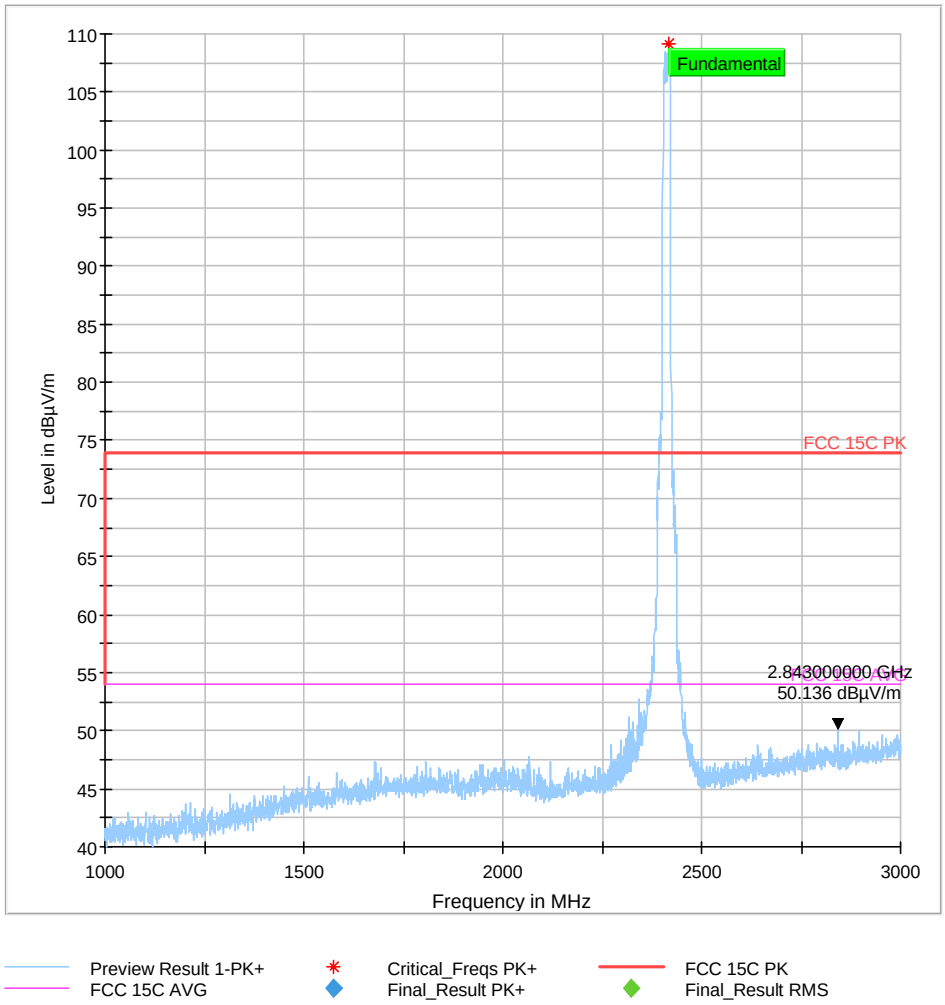
Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
35.173610	29.82	40.00	10.18	500.0	100.000	141.0	V	7.0	-12.7
49.406925	14.75	40.00	25.25	500.0	100.000	100.0	V	295.0	-18.5
74.234620	28.16	40.00	11.84	500.0	100.000	252.0	V	40.0	-25.1
241.260870	36.65	46.00	9.35	500.0	100.000	130.0	H	134.0	-18.6
303.917360	31.63	46.00	14.37	500.0	100.000	100.0	H	254.0	-17.3
306.208480	29.35	46.00	16.65	500.0	100.000	108.0	H	78.0	-17.3

(continuation of the "Final_Result" table from column 16 ...)

Frequency (MHz)	Comment
35.173610	11:12:32 AM - 7/10/2018
49.406925	11:15:29 AM - 7/10/2018
74.234620	11:18:04 AM - 7/10/2018
241.260870	11:07:01 AM - 7/10/2018
303.917360	11:09:42 AM - 7/10/2018
306.208480	11:04:31 AM - 7/10/2018



Plot #2 Radiated Emissions: 1-3 GHz		
Modulation: 802.11n_HT20 MIMO	**Channel: Low**	**95% Duty Cycle**



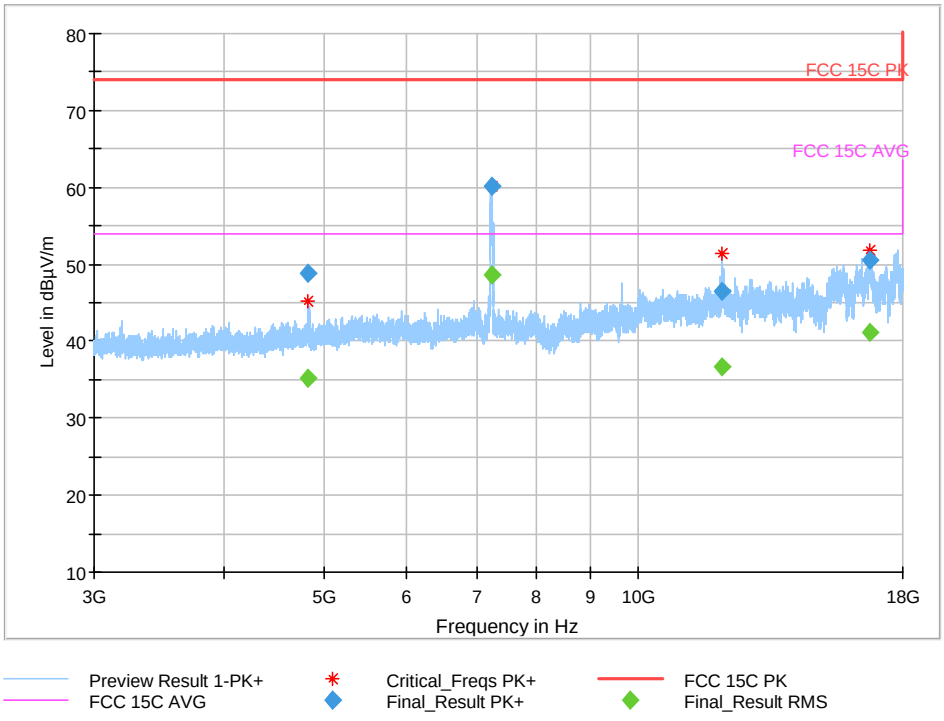
Plot #3 Radiated Emissions: 3-18 GHz		
Modulation: 802.11n_HT20 MIMO	**Channel: Low**	**95% Duty Cycle**

Final_Result

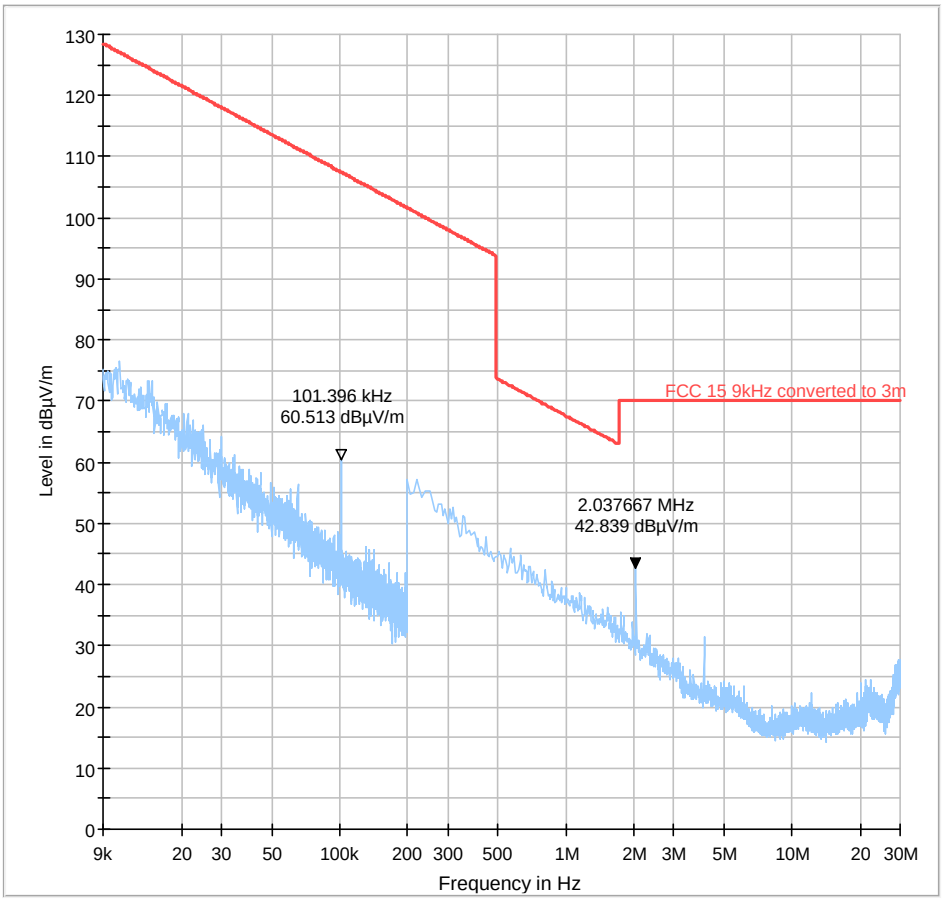
Frequency (MHz)	MaxPeak (dBµV/m)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
4822.084033	---	35.13	53.98	18.85	200.0	1000.000	165.0	V	338.0
4822.084033	48.80	---	73.99	25.19	200.0	1000.000	165.0	V	338.0
7229.438367	60.21	---	73.99	13.78	200.0	1000.000	163.0	V	34.0
7229.438367	---	48.63	53.98	5.35	200.0	1000.000	163.0	V	34.0
12056.136233	---	36.69	53.98	17.29	10.0	1000.000	300.0	V	331.0
12056.136233	46.40	---	73.98	27.58	10.0	1000.000	300.0	V	331.0
16764.621467	50.45	---	73.98	23.53	10.0	1000.000	164.0	V	-127.0
16764.621467	---	41.08	53.98	12.90	10.0	1000.000	164.0	V	-127.0

(continuation of the "Final_Result" table from column 15 ...)

Frequency (MHz)	Corr. (dB)	Comment
4822.084033	-33.5	1:55:40 PM - 7/11/2018
4822.084033	-33.5	1:55:39 PM - 7/11/2018
7229.438367	-29.7	1:45:33 PM - 7/11/2018
7229.438367	-29.7	1:45:33 PM - 7/11/2018
12056.136233	-22.4	1:52:36 PM - 7/11/2018
12056.136233	-22.4	1:52:36 PM - 7/11/2018
16764.621467	-14.8	1:49:11 PM - 7/11/2018
16764.621467	-14.8	1:49:12 PM - 7/11/2018



Plot #2 Radiated Emissions: 9 KHz – 30 MHz		
Modulation: 802.11n_HT20 MIMO	**Channel: Mid**	**95% Duty Cycle**



Plot #5 Radiated Emissions: 30 MHz – 1GHz

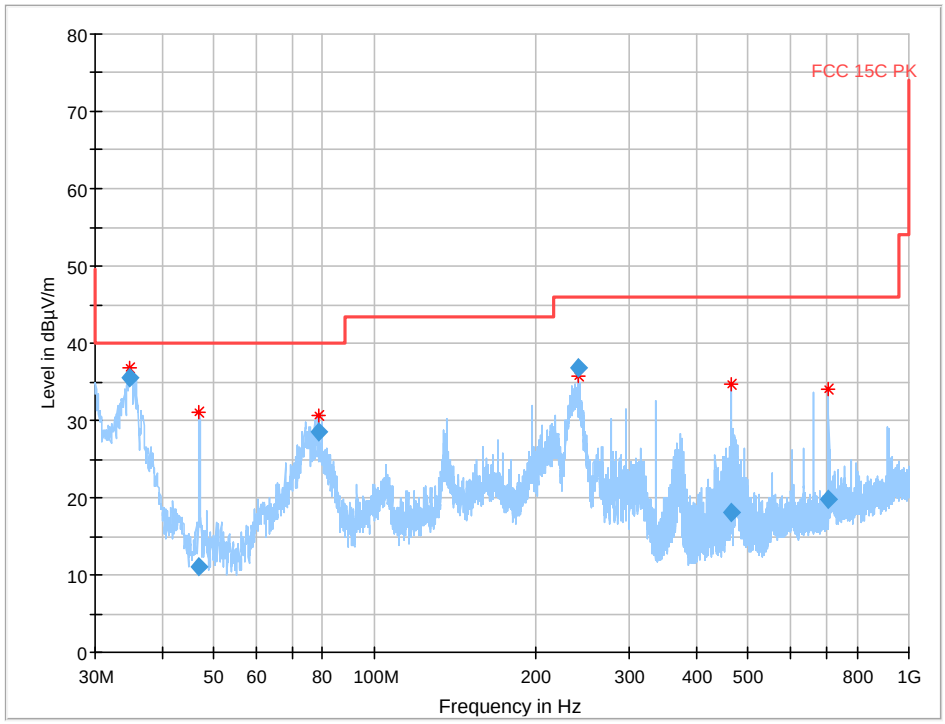
Modulation: 802.11n_HT20 MIMO	Channel: Mid	95% Duty Cycle

Final_Result

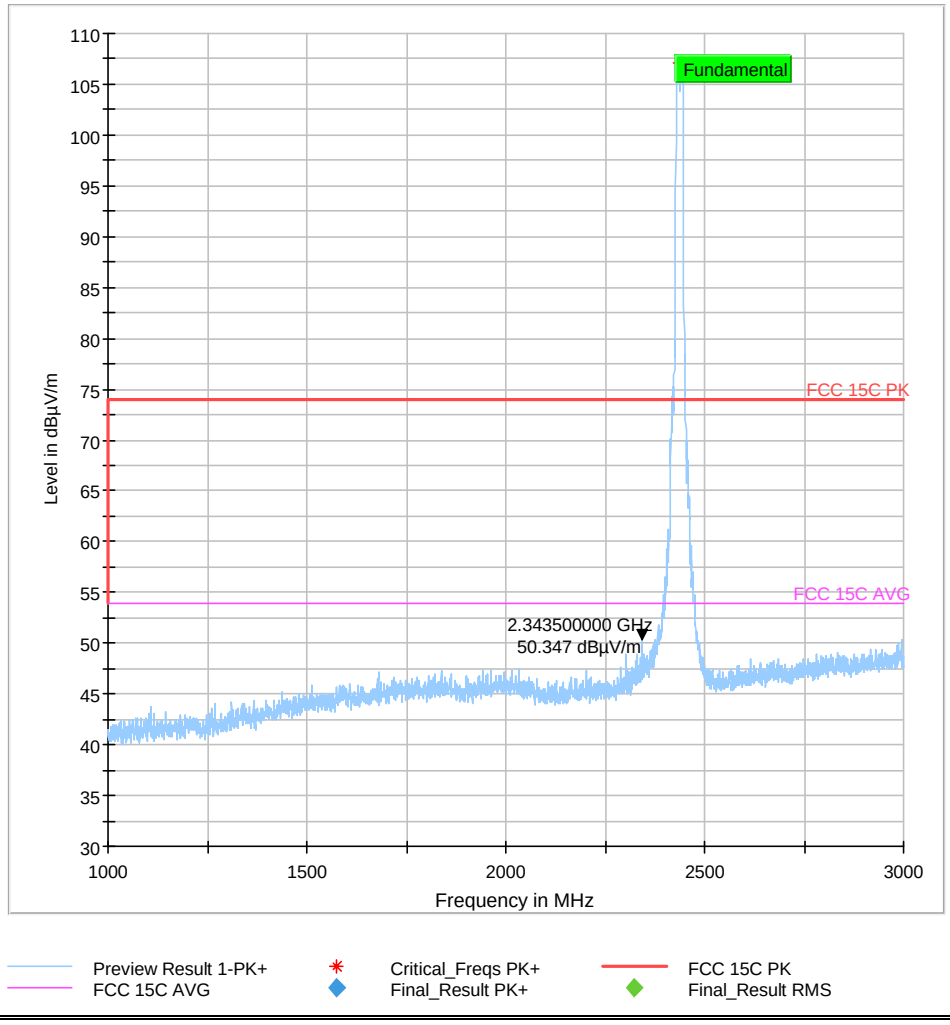
Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
34.746460	35.59	40.00	4.41	500.0	100.000	100.0	V	221.0	-12.4
46.993065	11.11	40.00	28.89	500.0	100.000	300.0	H	78.0	-16.3
78.675755	28.51	40.00	11.49	500.0	100.000	153.0	V	23.0	-24.5
240.381735	36.73	46.00	9.27	500.0	100.000	141.0	H	100.0	-18.6
465.919915	18.14	46.00	27.86	500.0	100.000	284.0	H	220.0	-13.3
709.008890	19.76	46.00	26.24	500.0	100.000	132.0	H	116.0	-8.6

(continuation of the "Final_Result" table from column 16 ...)

Frequency (MHz)	Comment
34.746460	10:37:02 AM - 7/10/2018
46.993065	10:39:32 AM - 7/10/2018
78.675755	10:42:50 AM - 7/10/2018
240.381735	10:45:36 AM - 7/10/2018
465.919915	10:48:01 AM - 7/10/2018
709.008890	10:50:47 AM - 7/10/2018



Plot #6 Radiated Emissions: 1-3 GHz		
Modulation: 802.11n_HT20 MIMO	**Channel: Mid**	**95% Duty Cycle**



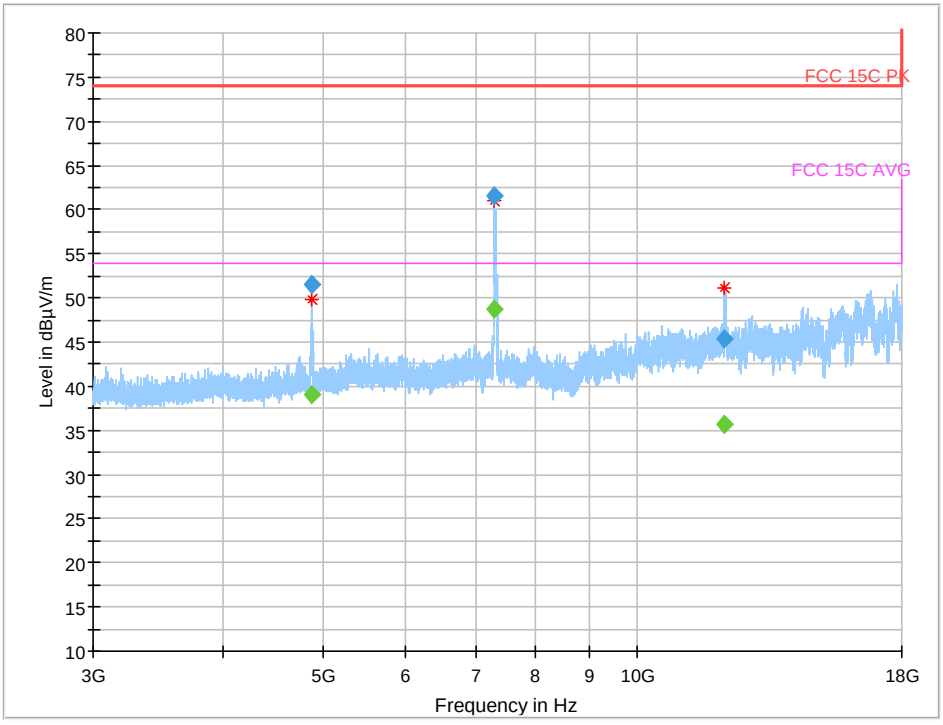
Plot #7 Radiated Emissions: 3-18 GHz		
Modulation: 802.11n_HT20 MIMO	**Channel: Mid**	**95% Duty Cycle**

Final_Result

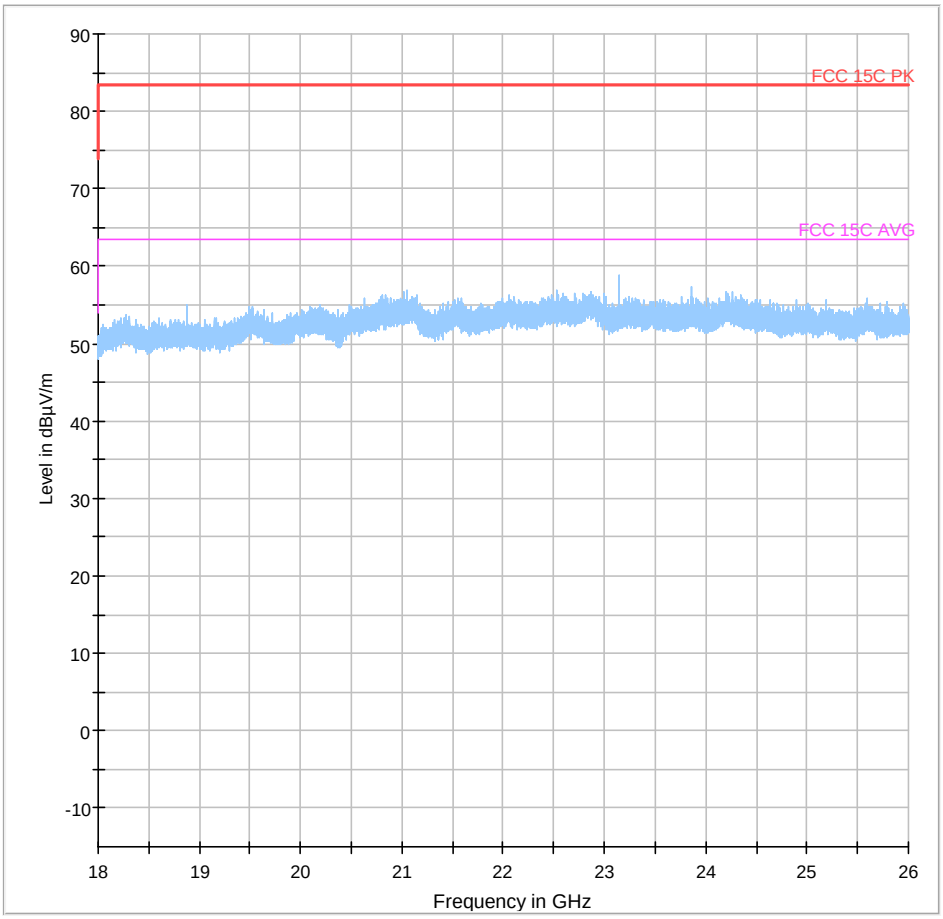
Frequency (MHz)	MaxPeak (dBµV/m)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
4873.585867	---	39.08	53.98	14.90	200.0	1000.000	148.0	V	325.0
4873.585867	51.53	---	73.99	22.46	200.0	1000.000	148.0	V	325.0
7301.169700	61.66	---	73.99	12.33	200.0	1000.000	133.0	V	40.0
7301.169700	---	48.74	53.98	5.24	200.0	1000.000	133.0	V	40.0
12163.956900	45.32	---	73.98	28.67	10.0	1000.000	175.0	V	168.0
12163.956900	---	35.78	53.98	18.20	10.0	1000.000	175.0	V	168.0

(continuation of the "Final_Result" table from column 15 ...)

Frequency (MHz)	Corr. (dB)	Comment
4873.585867	-33.4	2:15:57 PM - 7/11/2018
4873.585867	-33.4	2:15:56 PM - 7/11/2018
7301.169700	-29.9	2:09:11 PM - 7/11/2018
7301.169700	-29.9	2:09:11 PM - 7/11/2018
12163.956900	-22.3	2:12:41 PM - 7/11/2018
12163.956900	-22.3	2:12:41 PM - 7/11/2018



Plot #8 Radiated Emissions: 18-26 GHz		
Modulation: 802.11n_HT20 MIMO	**Channel: Mid**	**95% Duty Cycle**



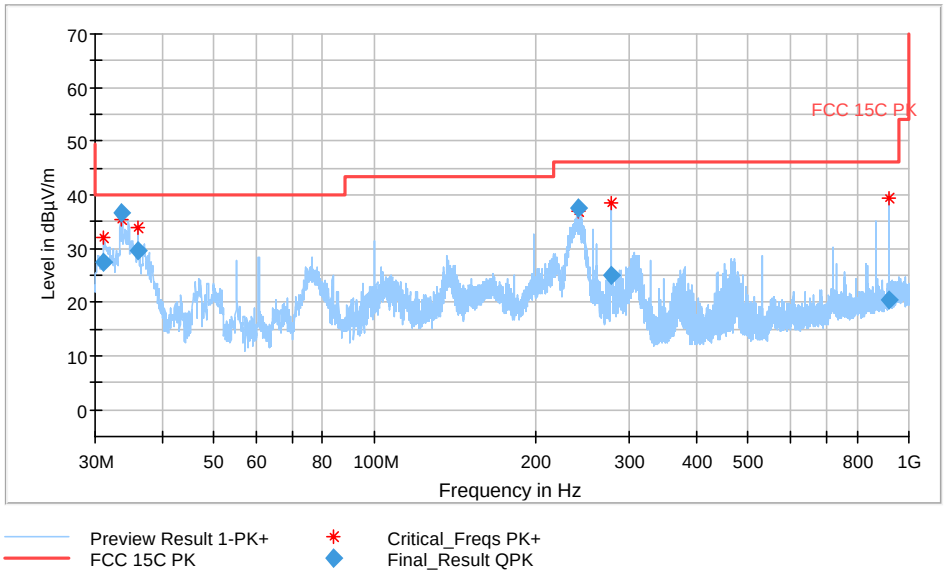
Plot #9 Radiated Emissions: 30 MHz – 1GHz		
Modulation: 802.11n_HT20 MIMO	**Channel: High**	**95% Duty Cycle**

Final_Result

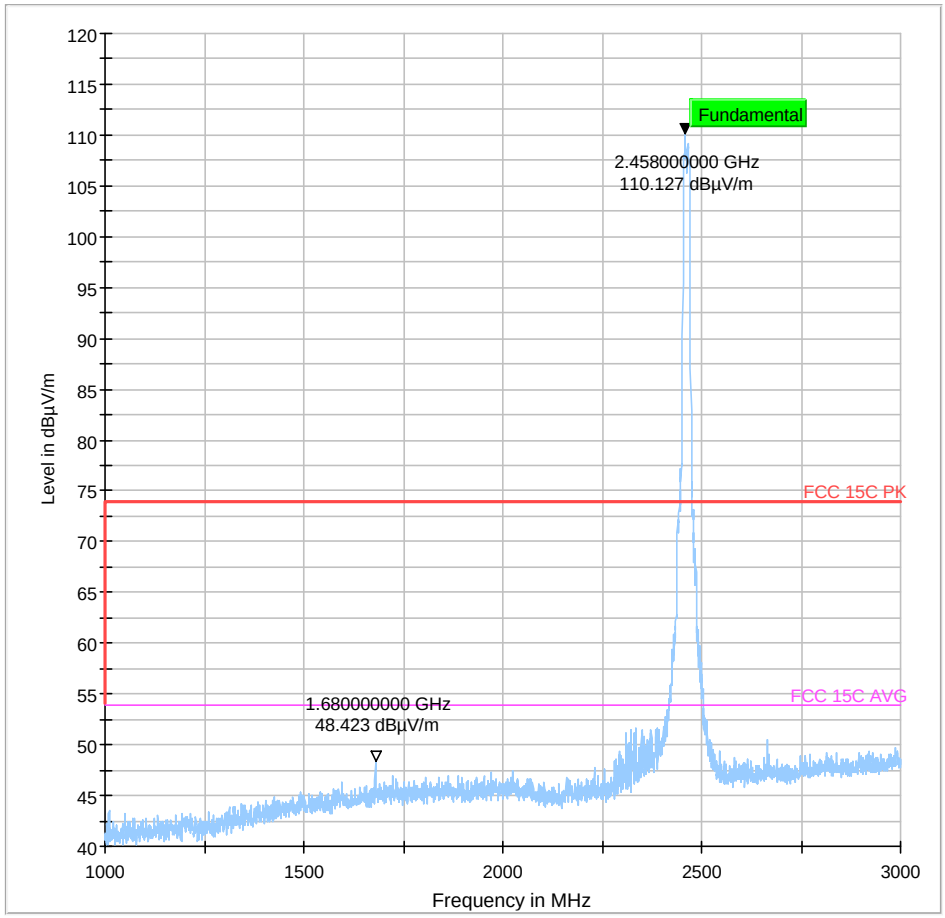
Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
31.102385	27.59	40.00	12.41	500.0	100.000	100.0	V	80.0	-10.9
33.516115	36.62	40.00	3.38	500.0	100.000	206.0	V	22.0	-11.7
36.073415	29.71	40.00	10.29	500.0	100.000	108.0	V	356.0	-13.0
240.131305	37.51	46.00	8.49	500.0	100.000	132.0	V	343.0	-19.0
278.059230	25.10	46.00	20.90	500.0	100.000	175.0	V	158.0	-17.9
918.436350	20.48	46.00	25.52	500.0	100.000	198.0	V	123.0	-6.0

(continuation of the "Final_Result" table from column 16 ...)

Frequency (MHz)	Comment
31.102385	11:28:50 AM - 7/10/2018
33.516115	11:36:48 AM - 7/10/2018
36.073415	11:39:39 AM - 7/10/2018
240.131305	11:42:00 AM - 7/10/2018
278.059230	11:33:47 AM - 7/10/2018
918.436350	11:31:15 AM - 7/10/2018



Plot #10 Radiated Emissions: 1-3 GHz		
Modulation: 802.11n_HT20 MIMO	**Channel: High**	**95% Duty Cycle**



Plot #11 Radiated Emissions: 3-18 GHz

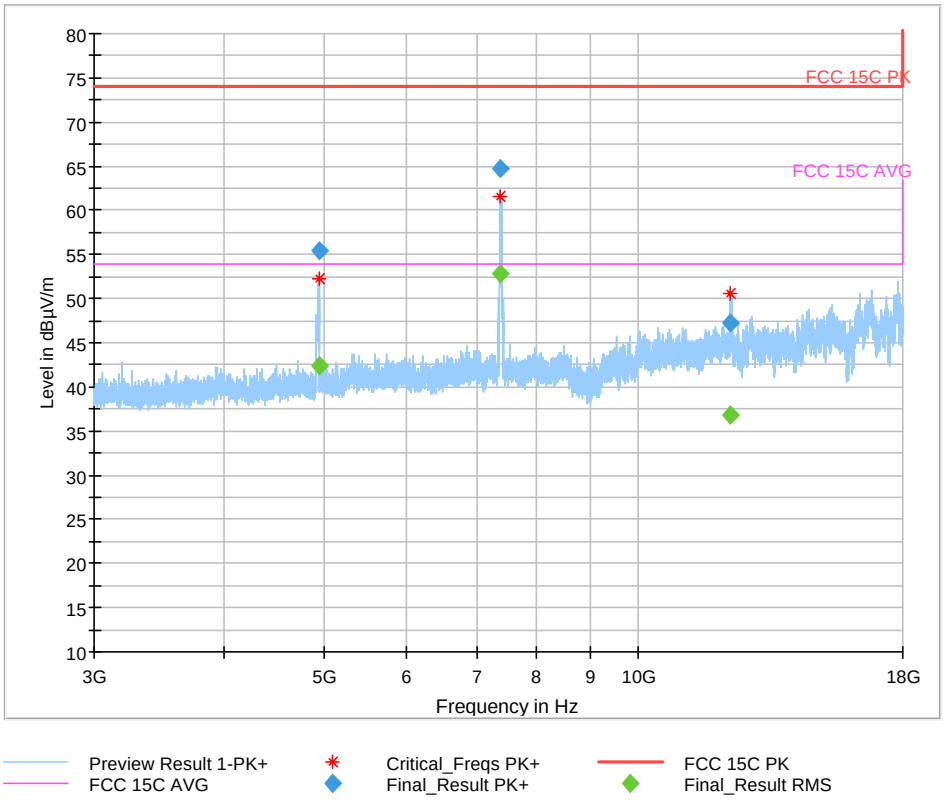
Modulation: 802.11n_HT20 MIMO	Channel: High	95% Duty Cycle

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	RMS (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
4933.084200	55.36	---	73.99	18.63	200.0	1000.000	172.0	H	329.0
4933.084200	---	42.36	53.98	11.62	200.0	1000.000	172.0	H	329.0
7384.014800	---	52.86	53.98	1.12	200.0	1000.000	204.0	H	171.0
7384.014800	64.72	---	73.99	9.26	200.0	1000.000	204.0	H	171.0
12298.523967	47.23	---	73.98	26.75	10.0	1000.000	260.0	V	158.0
12298.523967	---	36.89	53.98	17.09	10.0	1000.000	260.0	V	158.0

(continuation of the "Final_Result" table from column 15 ...)

Frequency (MHz)	Corr. (dB)	Comment
4933.084200	-33.2	2:35:10 PM - 7/11/2018
4933.084200	-33.2	2:35:11 PM - 7/11/2018
7384.014800	-29.7	2:31:54 PM - 7/11/2018
7384.014800	-29.7	2:31:54 PM - 7/11/2018
12298.523967	-22.1	2:28:14 PM - 7/11/2018
12298.523967	-22.1	2:28:14 PM - 7/11/2018



9 Test setup photos

Setup photos are included in supporting file name: “EMC_VIRSC-001-17001_15.247_Setup_Photos.pdf”

10 Test Equipment and Ancillaries Used For Testing

Equipment Type	Manufacturer	Model	Serial #	Calibration Cycle	Last Calibration Date
Biconlog Antenna	EMCO	3142E	166067	3 years	6/28/2017
Loop Antenna	ETS Lindgren	6507	161344	3 years	10/26/2017
Horn Antenna	EMCO	3115	35111	3 years	11/17/2015
Horn Antenna	ETS Lindgren	3117 PA	169547	3 years	8/8/2017
Compact Digital Barometer	Control Company	35519-055	91119547	2 Years	6/20/2017
Spectrum Analyzer	R&S	FSU26	200065	3 years	7/3/2017
Spectrum Analyzer	R&S	FSV40	101022	3 years	7/5/2017
Thermometer Humidity	Dickson	TM320	5280063	1 Year	11/2/2017

Note: Equipment used meets the measurement uncertainty requirements as required per applicable standards for 95% confidence levels. Calibration due dates, unless defined specifically, falls on the last day of the month. Items indicated “N/A” for cal status either do not specifically require calibration or is internally characterized before use.

11 Revision History

Date	Report Name	Changes to report	Report prepared by
2019-02-05	EMC_VIRSC-001-17001_15.247_WLAN	Initial version	Kevin Wang