FCC Test Report

FOR:

Pearl Automation Inc.

Model Name: / Model Number:

RearVision Camera Frame / P110

Product Description:

RearVision consists of 2 main components. The “Car Adapter”, which is an accessory that connects to the vehicle’s OBD-II diagnostic port, and the “Camera Frame” which is an accessory that is mounted at the license plate of the vehicle. The “Car Adapter” will relay information from the “Camera Frame” and vehicle environmental and state information over Bluetooth/WiFi, and that information will be relayed to the phone over Bluetooth/WiFi and displayed to the driver via the phone app.

FCC ID: 2AG6M-P110

47 CFR Part 15.247 (DTS)

TEST REPORT #: EMC-PEARL-004-16001-15.247-P110-DTS-WLAN

DATE: 2016-9-29

FCC Recognized

A2LA Accredited

***CETECOM* Inc.**

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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

No deviations were ascertained during the course of testing performed.

Company	Description	Model #
Pearl Automation Inc.	RearVision Camera Frame	P110

Responsible for Testing Laboratory:

Date	Section	Name	Signature
Sept 29, 2016	Compliance	Franz Engert (Compliance Manager)	Digitally signed by Franz Engert DN: cn=Franz Engert, c=US, o=CETECOM, ou=Complience, email=franz.engert@cetecom.com

Responsible for the Report:

Date	Section	Name	Signature
Sept 29, 2016	Compliance	James Donnellan (EMC Engineer)	James Donnellan Digitally signed by James Donnellan DN: cn=James Donnellan, c=US, o=Cetecom Inc., ou=Compliance, email=james.donnellan@cetecom.com Date: 2016.09.29 20:01:51 -07'00'

The test results of this test report relate exclusively to the test item specified in Section3.
CETECOM Inc. USA 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. The test report may only be reproduced or published in full. Reproduction or publication of extracts from the report requires the prior written approval of CETECOM Inc. USA.

2 Administrative Data

2.1 Identification of the Testing Laboratory Issuing the Test Report

Company Name:	CETECOM Inc.
Department:	Compliance
Address:	411 Dixon Landing Road Milpitas, CA 95035 U.S.A.
Telephone:	+1 (408) 586 6200
Fax:	+1 (408) 586 6299
Manager Compliance Services:	Franz Engert
Project Engineer:	Ruther Navarro

2.2 Identification of the Client

Applicant's Name:	Pearl Automation Inc.
Street Address:	100 Enterprise Way, Suite A101
City/Zip Code	Scotts Valley, CA 95066
Country	USA
Contact Person:	Hagan O'Connor / Erturk Kocalar
Phone No.	+1 408 655-3319 (Hagan) / +1 408 410-0144 (Erturk)
e-mail:	hagan@pearlauto.com / erturk@pearlauto.com.

2.3 Identification of the Manufacturer

Manufacturer's Name:	Dongguan Primax Electronic & Telecommunications Products Co., Ltd
Manufacturers Address:	Liu Wu District, Shek Kit Town,
City/Zip Code	DongGuan City, Guang Dong,
Country	China

3 Equipment under Test (EUT)

3.1 Specification of the Equipment under Test

Model #:	P110
HW Version :	DVT1B
SW Version :	001.668
FCC-ID :	2AG6M-P110
Product Description:	RearVision Camera Frame
Regulatory Band:	Nominal band: 2400 – 2483.5 MHz
Channels Used:	2412 MHz (Ch. 1) – 2462 (Ch.11), 11 channels
Type(s) of Modulation:	802.11b/g/n with CCK, DQPSK, DBPSK + DSSS QBSK, BPSK, 16 QAM, 64 QAM + OFDM
Modes of Operation:	Communicates with and transmits video traffic to the RearVision Car Adapter module
Antenna Type:	1 Custom internal PCB Trace Antenna. For RF conducted measurements, a temporary connection was made from measurement equipment to the 50Ohm UFL port of the EUT.
Max. Declared Antenna Gain:	Documented max antenna gain: 2.4GHz = 5 dBi
Max. Conducted Output Power + Antenna Gain	24.12 dBm EIRP (19.12 dBm plus 5 dbi Antenna gain)
Power Supply:	Internal Li-ion Rechargeable Battery (Solar)
Rated Operating Voltage Range:	Vmin: 2.8 V DC - Vmax: 4.2V DC USB 4.4 VDC - 5.25 VDC
Operating Temperature Range:	Tlow: -20° - Tmax: 45° C
Other Radios included in the Device:	5G WLAN BT 4.0
Sample Revision:	■Prototype; ☐Production; ☐Pre-Production

3.2 EUT Sample details

EUT #	Serial Number	HW Version	SW Version	Notes/Comments
1	A2A6170576	DVT1B	001.668	Radiated Sample
2	A2A61008K4	DVT1B	001.668	Conducted Sample

3.3 Ancillary Equipment (AE) details

AE #	Type	Model	Manufacturer	Serial Number	Notes
1	12W USB Power Adapter	A143	Apple	-	Used to charge internal battery when needed
2	MacBook Air	A1465	Apple	C2QQ606&G4FY	Used to setup channel modes prior to test.
3	Lamp	-	-	-	To stimulate solar charging

3.4 EUT Sample Configuration

EUT Set-Up #	Combination of AE used for test set up	Comments
1	EUT#1	The radio of the EUT was stimulated directly in a test mode not accessible by the end user. The internal antenna was connected.
2	EUT#2	The radio of the EUT was stimulated directly in a test mode not accessible by the end user. The measurement equipment was connected to the 50Ohm UFL port of the EUT.
3	EUT#1 + AE #1	The radio of the EUT was stimulated directly in a test mode not accessible by the end user. The internal antenna was connected.
4	EUT#1 + AE #3	The radio of the EUT was stimulated directly in a test mode not accessible by the end user. The internal antenna was connected.

3.5 Test modes of operation:

The below listed worst case test modes of operation have been established from the output power measurement and evaluation of long term test data available to the lab for the different data rates and modulations which are supported by the equipment.

Modes of Operation		Data rate (Mbps)	Modulation Scheme
2.4 GHz	**802.11b**	1.0	DSSS
	802.11g	6.0	BPSK
	802.11n (20 MHz)	6.5	BPSK

The device was configured with a manufacturer provided test SW, capable of setting the unit in different supported modulation schemes with data rates specified and user selected channels of operation.

The Device was set to continuous framed Tx (burst) mode per test SW and could thus be operated with > 98% duty cycle during testing of 80211b.

The EUT was tested on low, mid and high channels (2.4GHz) in 802.11b, 802.11g, and 802.11n (HT20) modes (n-mode is used with 20 MHz channel bandwidth (HT20) only).

4 Subject Of Investigation

The objective of the measurements applied by Cetecom Inc. was to establish compliance of the EUT as described under Ch. 3 of this Test Report, with the applicable criteria specified in FCC rules Part 15.247 of Title 47 of the Code of Federal Regulations.

This test report is to support a request for new equipment authorization under the FCC ID **2AG6M-P110**

All testing was performed on the product referred to in Section 3 as EUT.

Testing procedures are based on ANSI C63.10:2013 for DTS devices and FCC KDB 558074 D01 v03r05, “GUIDANCE FOR PERFORMING COMPLIANCE MEASUREMENTS ON DIGITAL TRANSMISSION SYSTEMS (DTS) OPERATING UNDER §15.247” and

5 Summary of Measurement Results

Test Specification	Test Case	Temperature and Voltage Conditions	Mode	Pass	Fail	NA	NP	Result
§15.247(e)	Power Spectral Density	Nominal	802.11b 802.11g 802.11n	■	□	□	□	Complies
§15.247(a)(1)	Emission Bandwidth	Nominal	802.11b 802.11g 802.11n	■	□	□	□	Complies
§15.247(b)(3)	Maximum Peak Conducted Output Power	Nominal	802.11b 802.11g 802.11n	■	□	□	□	Complies
§15.247(d)	Band edge compliance	Nominal	802.11b 802.11g 802.11n	■	□	□	□	Complies
§15.247(d)	TX Spurious emissions-Conducted	Nominal	802.11b 802.11g 802.11n	□	□	□	■	See Note 1
§15.247(d) **§15.209(a)**	TX Spurious emissions-Radiated	Nominal	802.11b 802.11n	■	□	□	□	Complies
§15.207(a)	AC Conducted Emissions <30MHz	Nominal	802.11b 802.11g 802.11n	□	□	■	□	-

NA= Not Applicable; NP= Not Performed.

Note 1: Conducted spurious emissions test against non-restricted band limits is NOT PERFORMED since radiated spurious emissions against more stringent restricted band limits over the complete measurement range (9kHz to 26GHz) has passed.

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.

	Uncertainty in dB radiated <30MHz	Uncertainty in dB radiated 30MHz - 1GHz	Uncertainty in dB radiated > 1GHz	Uncertainty in dB Conducted measurement
standard deviation k=1	2.48	1.94	2.16	0.64
95% confidence interval in dB	4.86	3.79	4.24	1.25
95% confidence interval in dB in delta to Result (rounded up to next decimal point)	+/- 2.5 dB	+/- 2.0 dB	+/- 2.3dB	+/- 0.7dB

7 Environmental Conditions During Testing:

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

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

8 Dates of Testing:

April 22, 2016 – June 21, 2016, Sep 28, 2016

9 Measurement Procedures

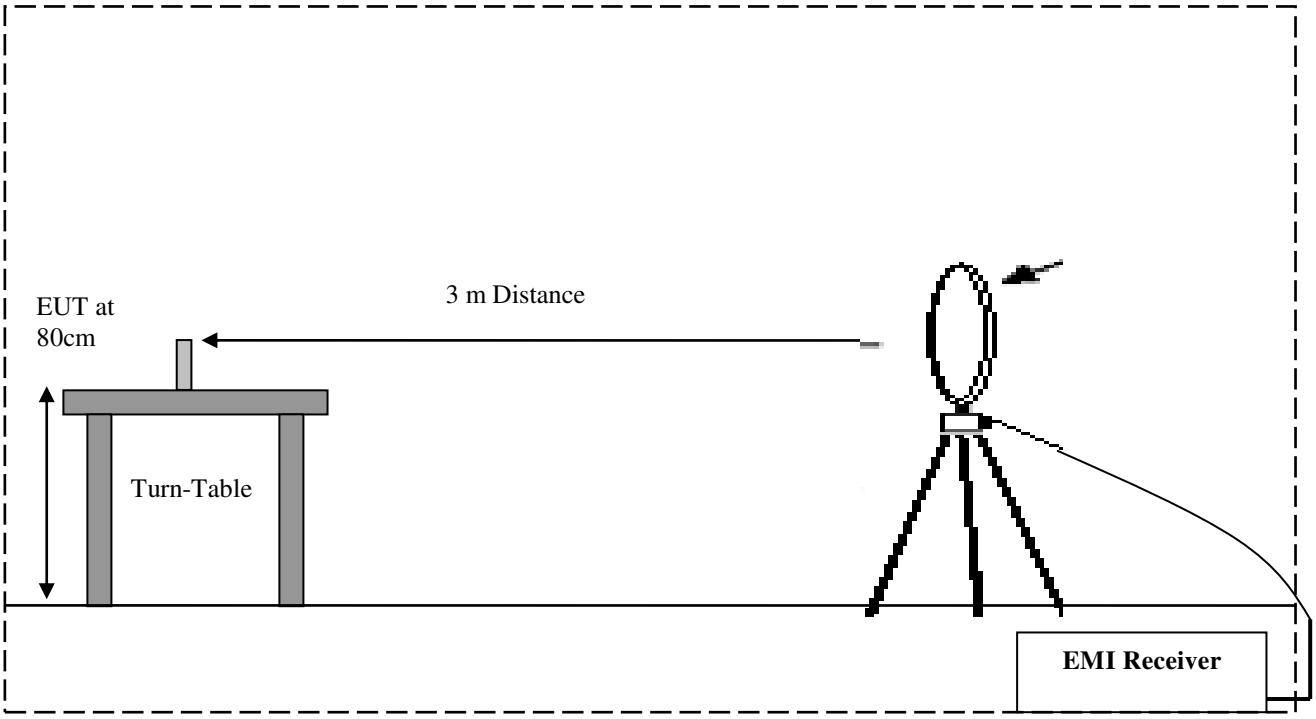
9.1 Radiated Measurement

The radiated measurement is performed according to:

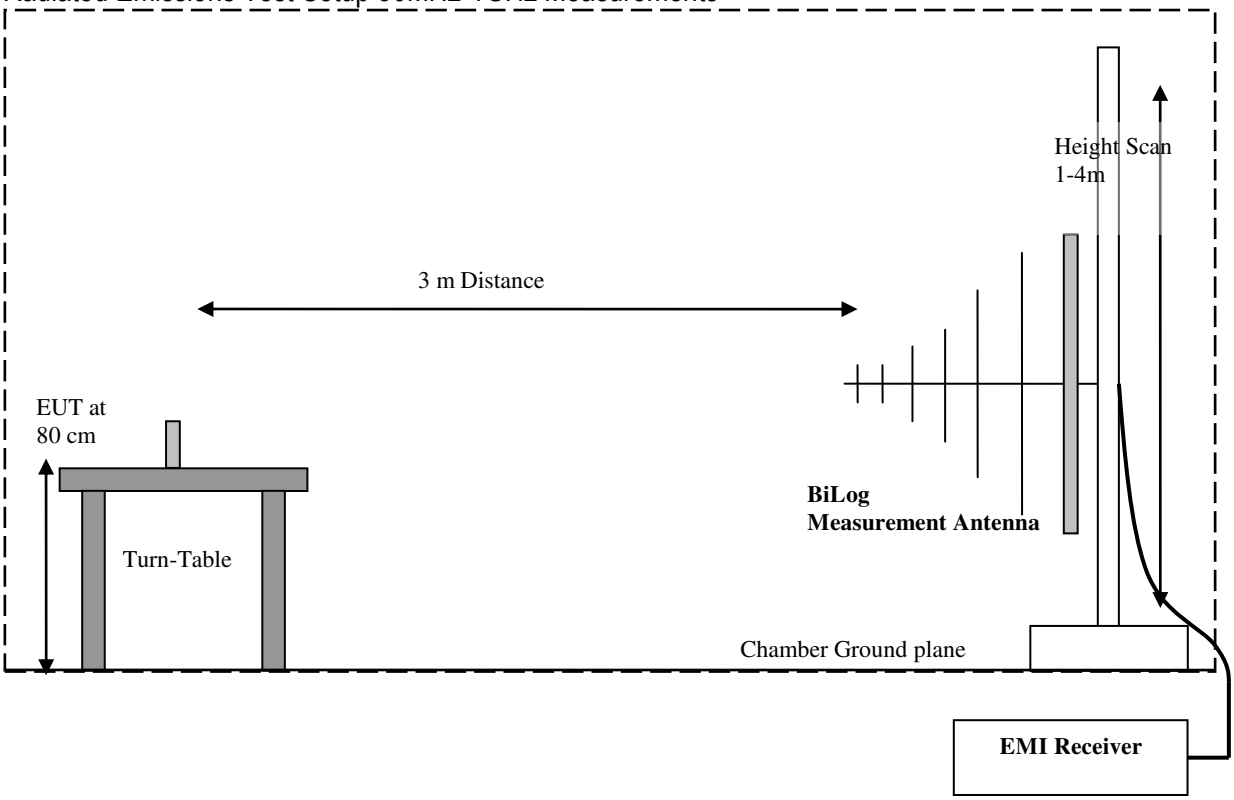
ANSI C63.10 (2013)

- The exploratory measurement is accomplished by running sweeps at 1 and 4m antenna heights over the required frequency range with R&S Test-SW EMC32 for both antenna polarizations. During each frequency scan the turntable rotates by no more than10deg.
- 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 again maximized through a fine search in frequency domain, maximized in the 360deg range of the turntable, and maximized over antenna height between 1m and 4m and for positioning of the EUT.
- The above procedure is repeated for transmission low mid and high channel.
- 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.

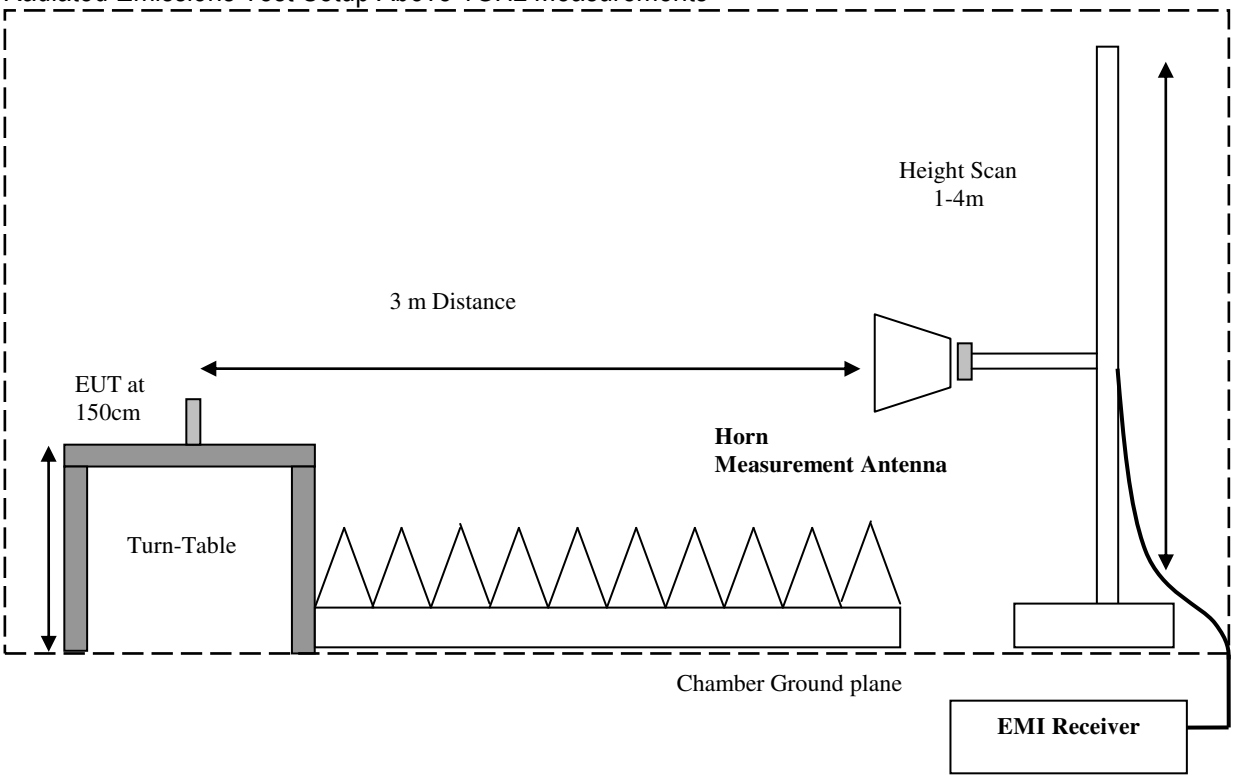
Radiated Emissions Test Setup Below 30MHz Measurements



Radiated Emissions Test Setup 30MHz-1GHz Measurements



Radiated Emissions Test Setup Above 1GHz Measurements



9.2 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:

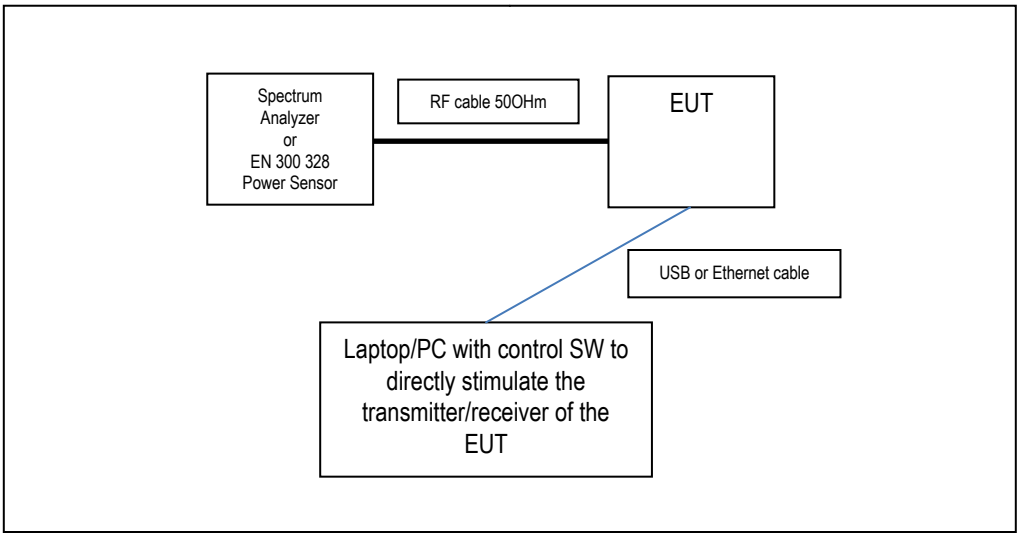
Frequency (MHz)	Measured SA (dBµV)	Cable Loss (dB)	Antenna Factor Correction (dB)	Field Strength Result (dBµV/m)
1000	80.5	3.5	14	98.0

9.3 Power Line Conducted Measurement Procedure

AC Power Line conducted emissions measurements performed according to: ANSI C63.4 (2014)

9.4 RF Conducted Measurement Procedure

9.4.1 Conducted Measurement Setup without companion device



10 Measurements and Results

10.1 Maximum Conducted (Average) Output Power and EIRP

10.1.1 **Limits:**

Maximum Peak Output Power:

FCC §15.247 (b)(3): 1W

10.1.2 **Test Procedure**

Duty cycle measurement according to FCC KDB 558074 D01 v03r05 section 6.0.
Power measurement according to FCC KDB 558074 D01 v03r05 section 9.2.2.4.
§15.247 permits the maximum (average) conducted output power to be measured. Using Method AVGSA-2 (Trace Averaging across on and off times of the EUT transmission followed by duty cycle correction.)

Spectrum Analyzer settings:
Maximum Average Output Power
Span ≥ 1.5 times the OBW.
RBW = 1-5 % of the OBW not to exceed 1 MHz
VBW ≥ 3xRBW
Sweep = auto
Detector function = RMS
Trace = Average of 100 traces
Use integrated band power method. Set channel bandwidth ≥ OBW bandwidth of the emission being measured.
OBW values are given in section 7.2

10.1.3 **Test Conditions:**

Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input
22° C	2	Tx	Battery, 3.8V DC

10.1.4 Test Result: 2.4 GHz Band

Measured Average Conducted Output Power (dBm)			
Mode	**Frequency (MHz)**		
	2412 Channel 1	**2437 Channel 6**	**2462 Channel 11**
802.11b	15.21	19.12	15.33
802.11g	11.97	14.50	12.13
802.11n /MCS0 (20 MHz)	11.78	13.54	11.93

In addition the Duty cycle for the corresponding modes was as follows based on measurements of the mid channel.

Duty Cycle Measured		
802.11b Channel 6	**802.11g Channel 6**	**802.11n Channel 6**
99	97	97

Accounting for Duty Cycle Adjustment for g and n mode

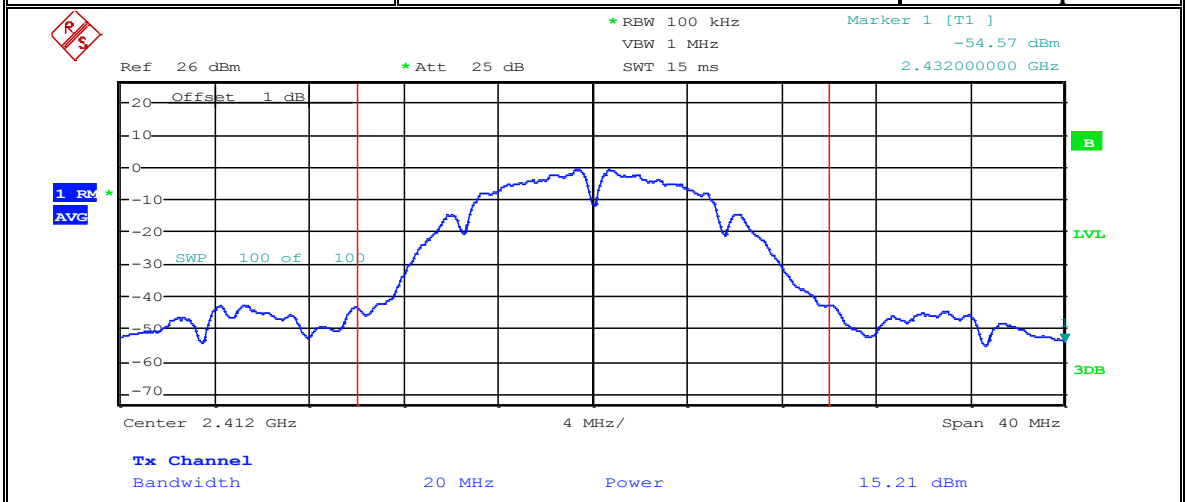
Duty Cycle Adjusted Average Conducted Output Power (dBm)			
Mode	**Frequency (MHz)**		
	2412 Channel 1	**2437 Channel 6**	**2462 Channel 11**
802.11b	15.21	19.12	15.33
802.11g	12.1	14.63	12.26
802.11n /MCS0 (20 MHz)	11.91	13.67	12.06

10.1.5 Test Verdict:
Passed

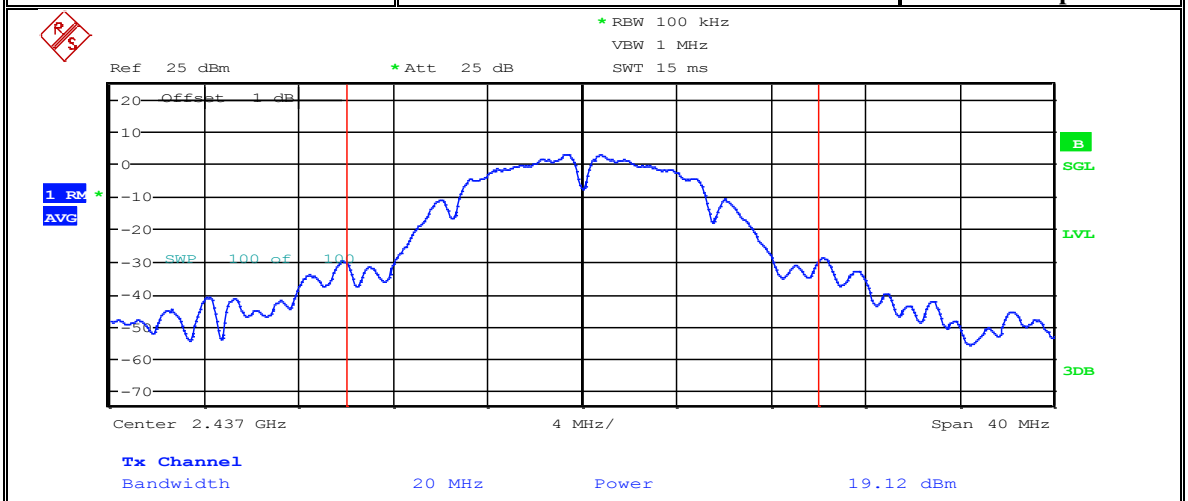
10.1.6 Test Data/plots: 2.4 GHz Band
See plots below.

Maximum Conducted Power

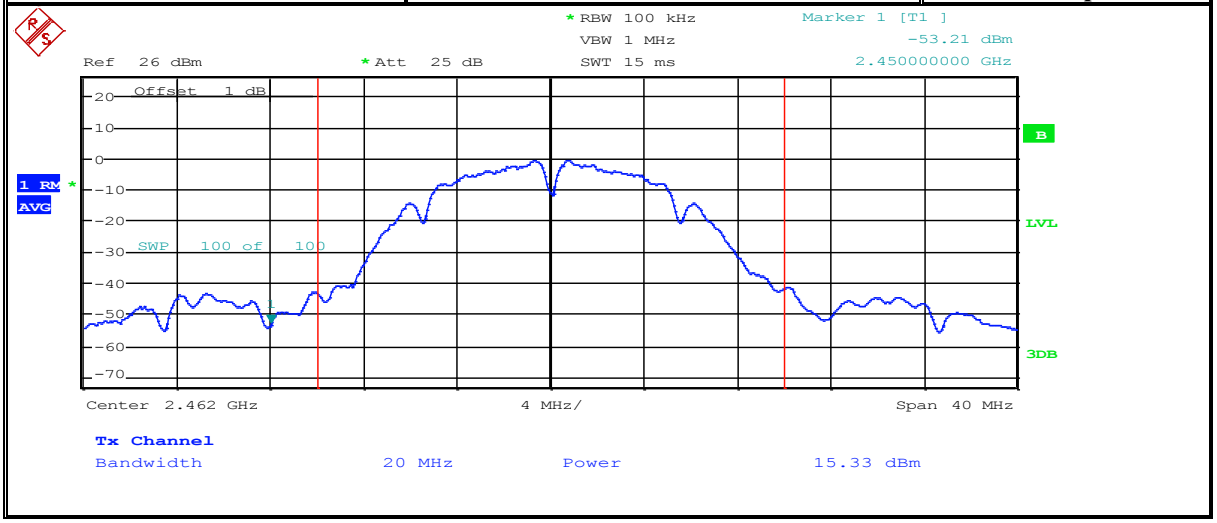
Ch.1 / 2412 MHz	802.11b	1 Mbps



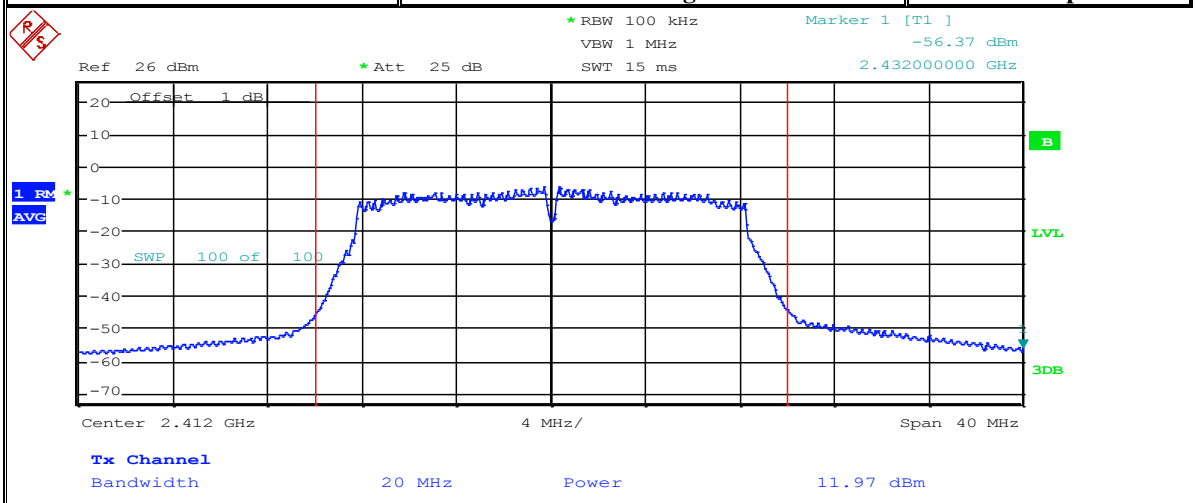
Ch.6 / 2437 MHz	802.11b	1 Mbps



Ch.11 / 2462 MHz	802.11b	1 Mbps

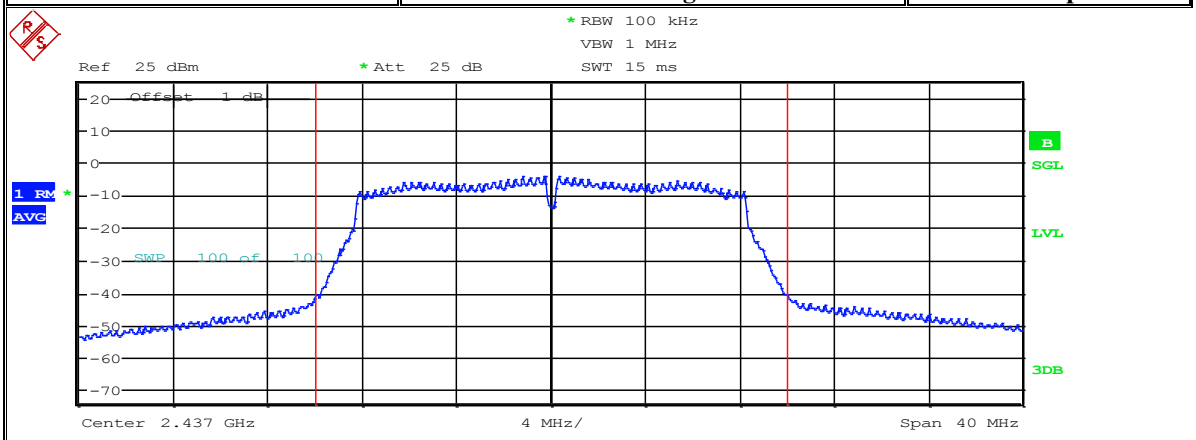


Ch.1 / 2412 MHz	802.11g	6 Mbps



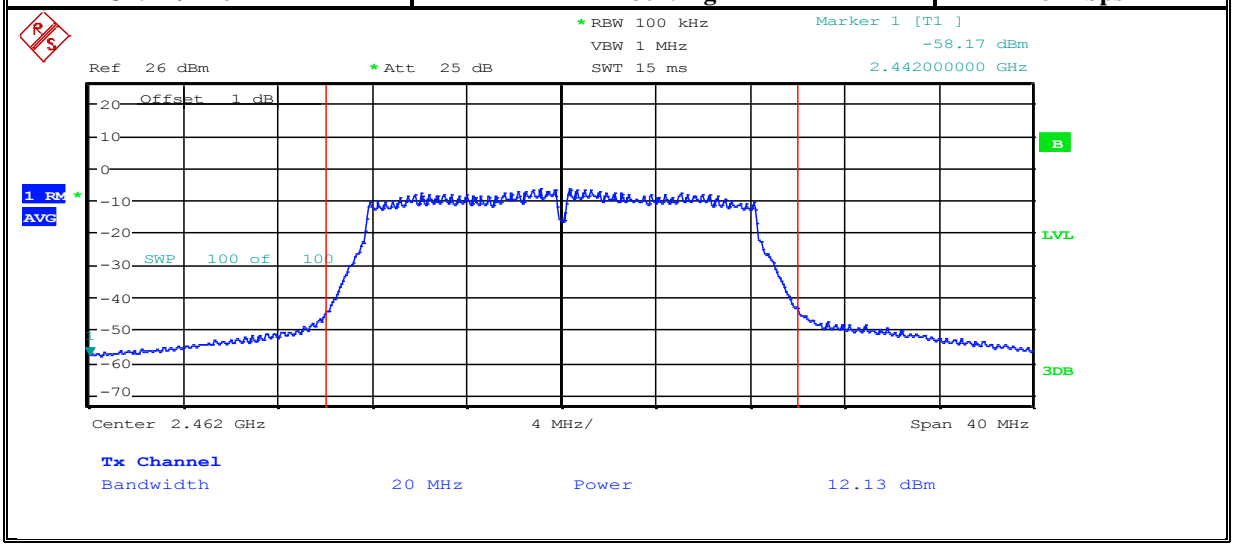
Tx Channel
Bandwidth 20 MHz Power 11.97 dBm

Ch.6 / 2437 MHz	802.11g	6 Mbps

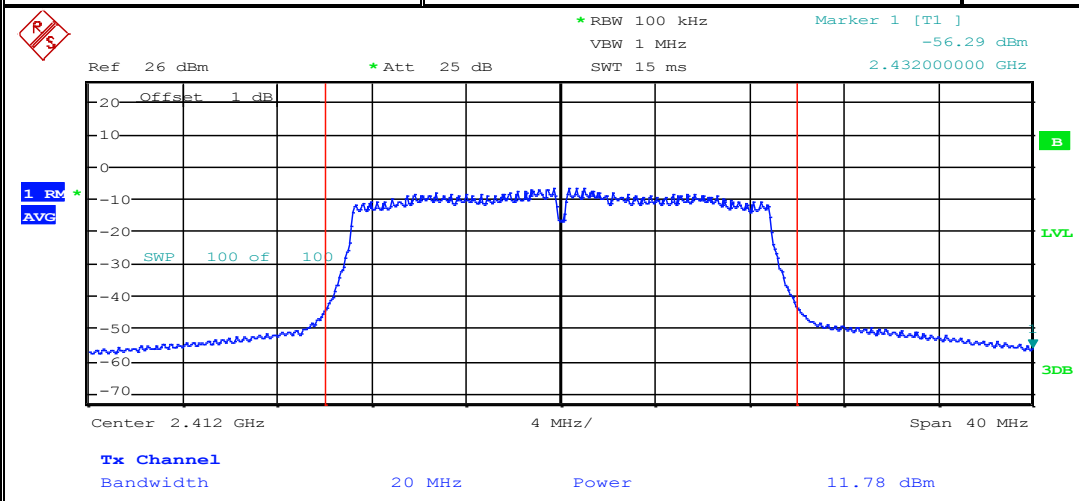


Tx Channel
Bandwidth 20 MHz Power 14.50 dBm

Ch.11 / 2462 MHz	802.11g	6 Mbps

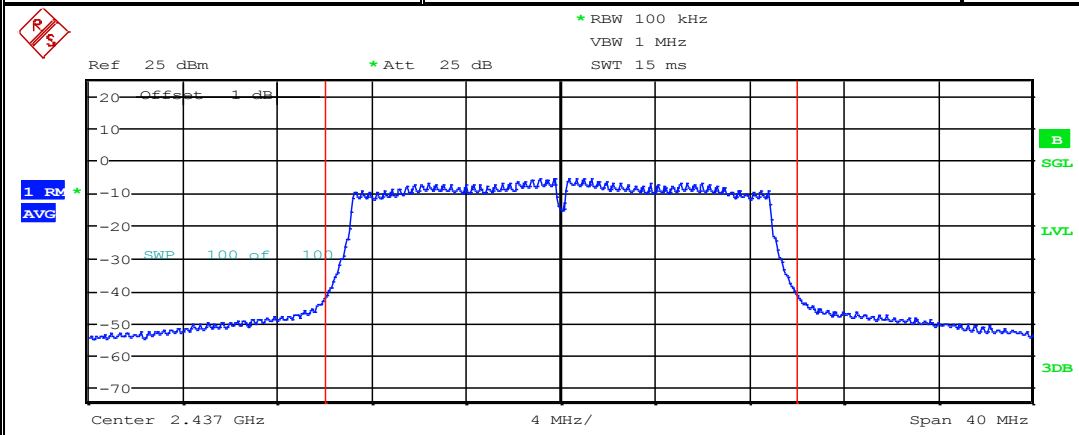


Ch.1 / 2412 MHz	802.11n	6.5 Mbps



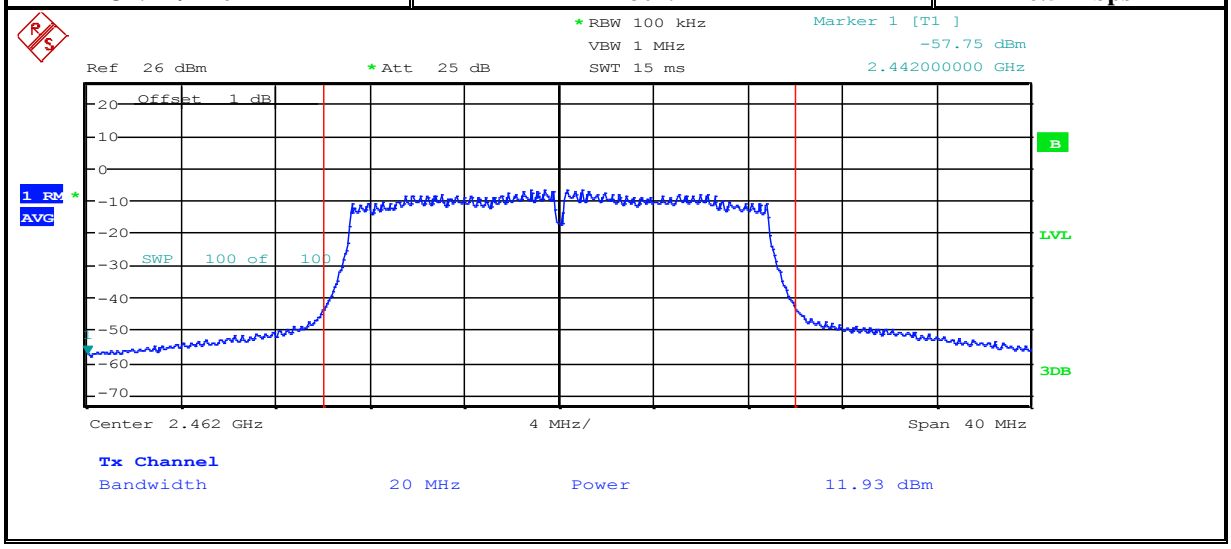
Tx Channel
Bandwidth 20 MHz Power 11.78 dBm

Ch.6 / 2437 MHz	802.11n	6.5 Mbps



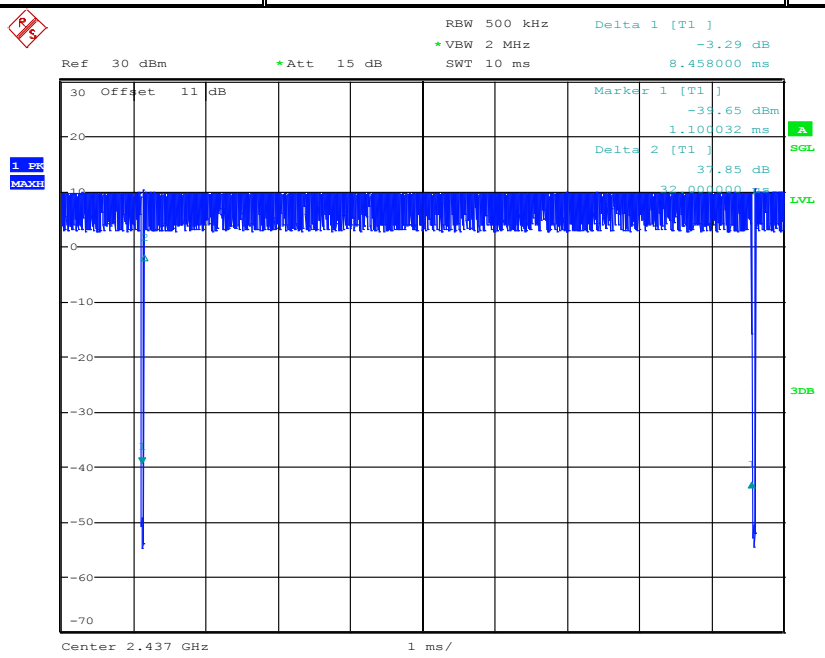
Tx Channel
Bandwidth 20 MHz Power 13.54 dBm

Ch.11 / 2462 MHz	802.11n	6.5 Mbps

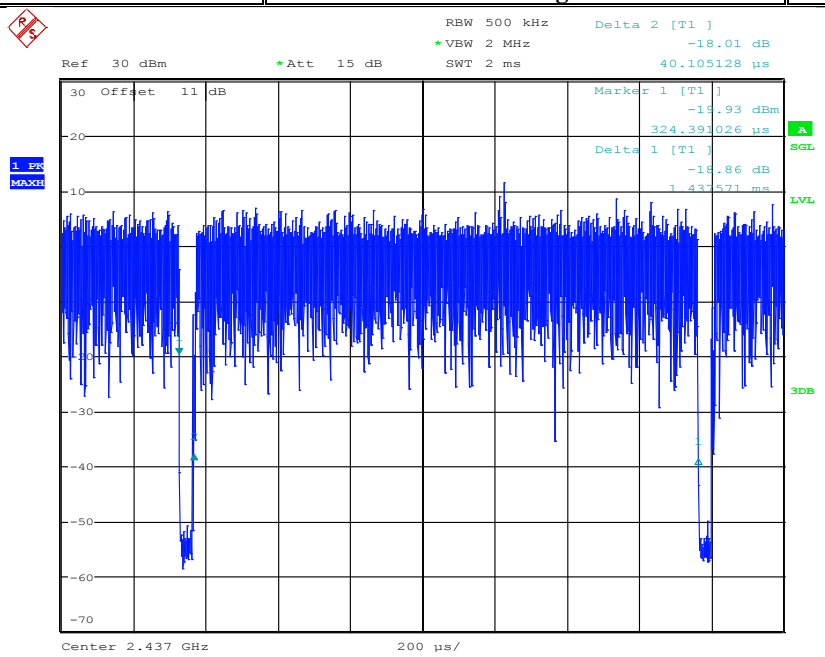


Duty Cycle Plots

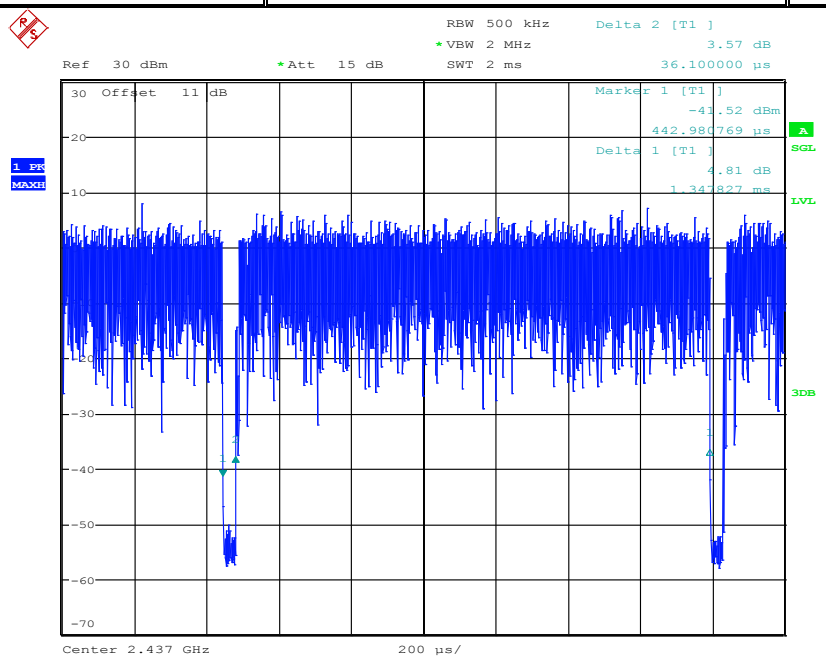
Ch.6 2437 MHz	802.11b	1 Mbps



Ch.6 / 2437 MHz	802.11g	6.0 Mbps



Ch.6 / 2437MHz	802.11n	6.5 Mbps



1) T refers to the minimum transmission duration over which the transmitter is ON and is transmitting at its maximum power control level for the tested mode of operation

Mode	T = Min duration Tx is On.
80211.b	8.42 ms
80211.g	1.40 ms
80211.n	1.31 ms

10.2 Occupied Bandwidth (6 dB & 99%)

10.2.1 Limits:

§15.247 (a)(2)
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.

10.2.2 Test Conditions:

Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input
21.5° C	2	Tx	Battery

10.2.3 Measurement procedure:

For 6dB according to C63-10-2013 section 6.9.2 Occupied bandwidth Relative Measurement procedure.
For 99% according to C63-10-2013 section 6.9.3 power bandwidth (99%) measurement procedure in conjunction with the 99% power bandwidth function of the Spectrum Analyzer.

Spectrum Analyzer settings:
Span= 2 to 5 x the occupied BW
RBW= 1% to 5 % of the occupied BW, unless otherwise specified
VBW≥ 3xRBW, Detector: Peak- Max hold;
Sweep Time: Auto
Allow the trace to stabilize

10.2.4 Test Result: 2.4 GHz Band

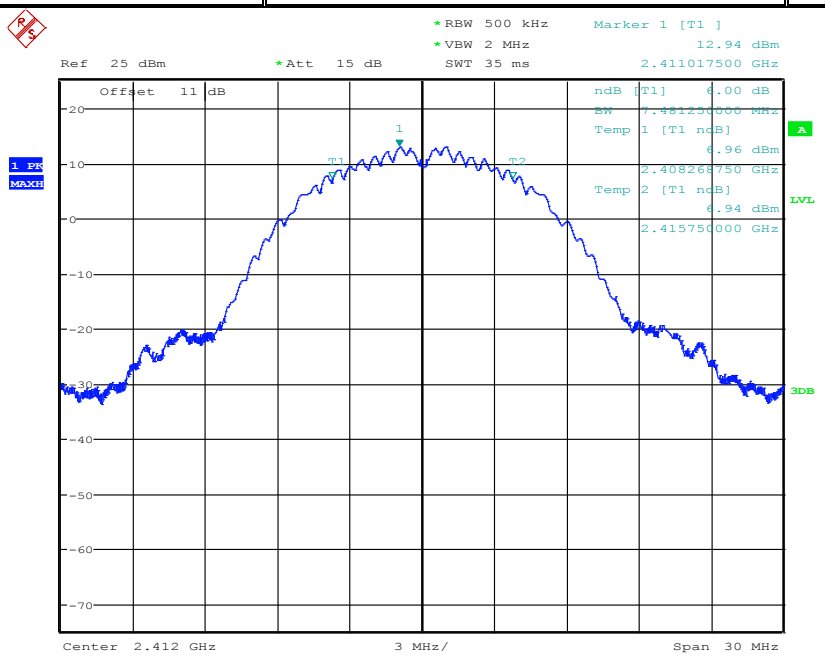
Occupied Bandwidth (MHz)						
Mode	**Frequency (MHz)**					
	2412 Channel 1		**2437 Channel 6**		**2462 Channel 11**	
	6dB	**99%**	**6dB**	**99%**	**6dB**	**99%**
802.11b	7.48	12.15	7.40	12.08	8.30	12.19
802.11g	14.39	16.86	15.02	16.88	14.01	16.84
802.11n (20MHz)	15.01	17.68	14.06	17.70	15.93	17.70

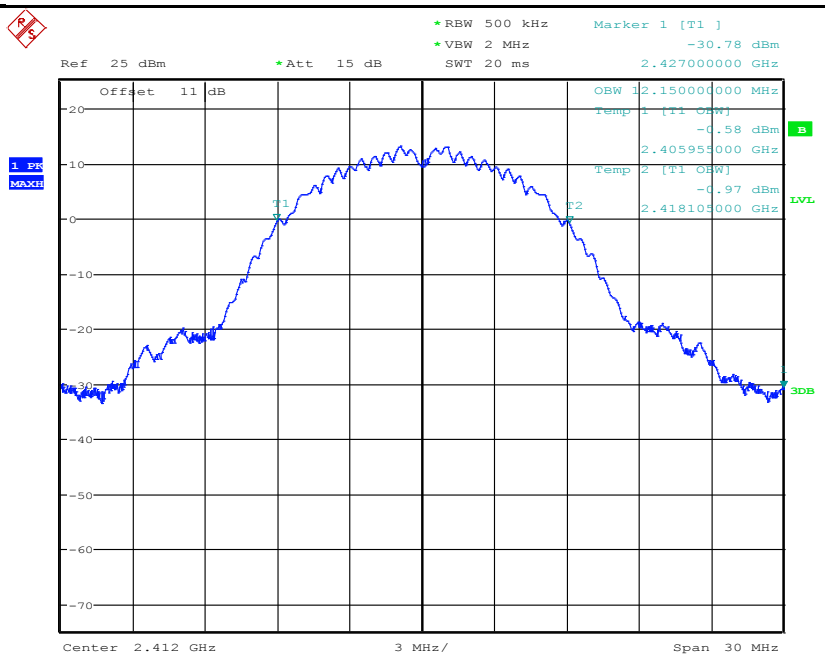
10.2.5 Measurement Result

Pass.

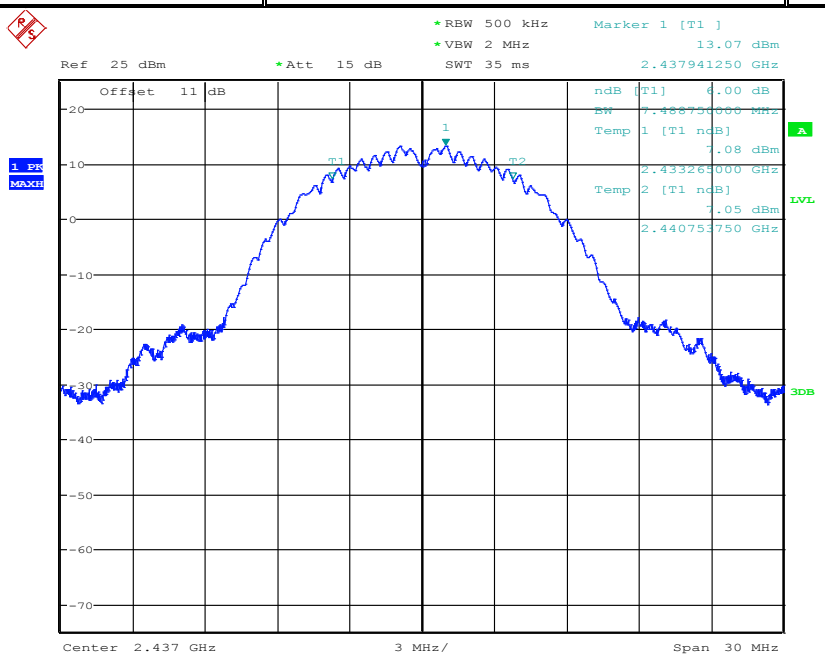
10.2.6 Test Data/plots: 2.4 GHz Band

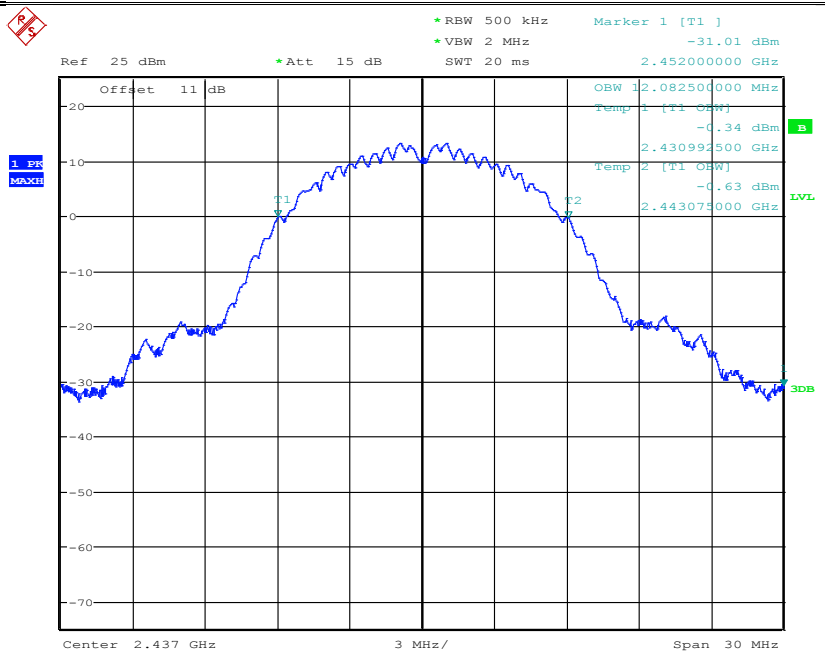
Ch.1 / 2412 MHz	802.11b 6dB and 99% OBW	1 Mbps



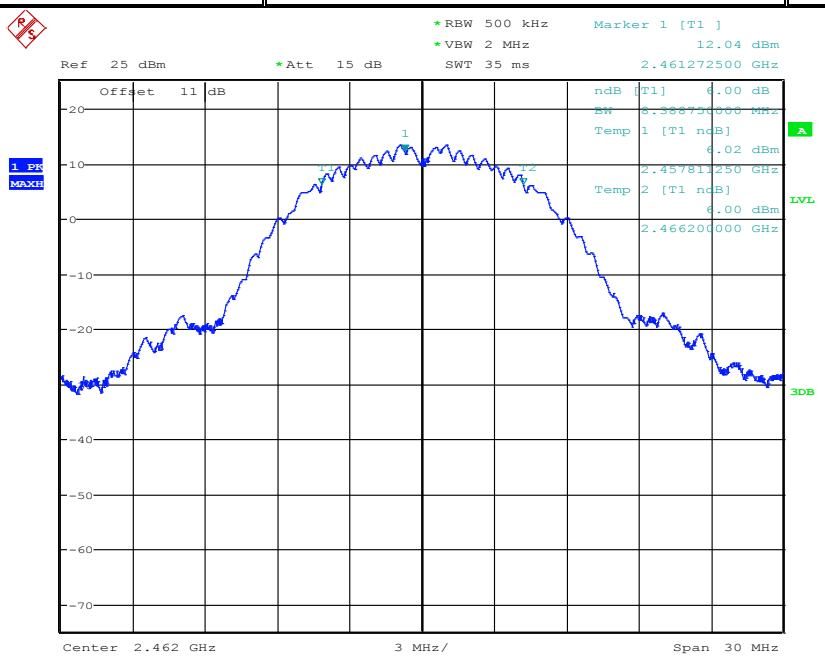


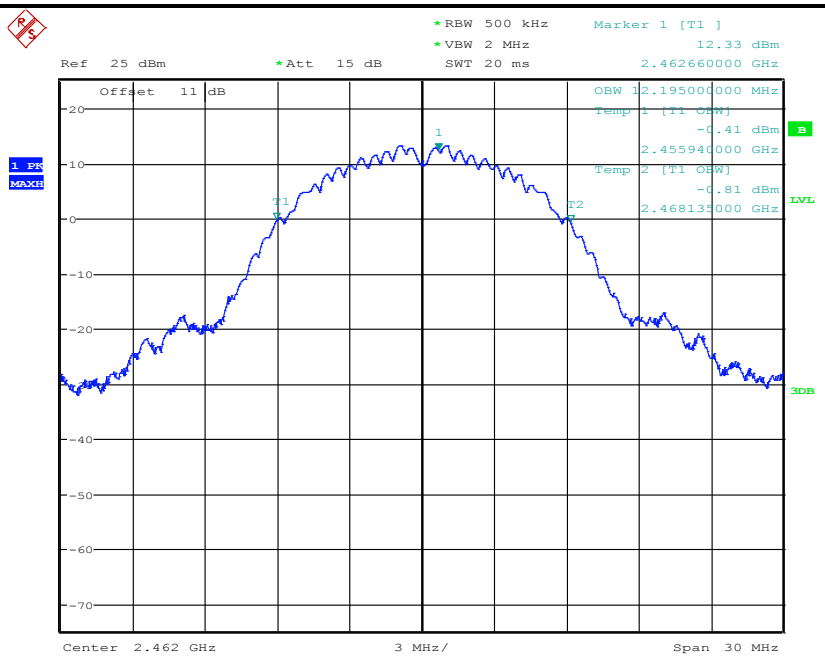
Ch.6 / 2437 MHz	802.11b 6dB and 99% OBW	1 Mbps



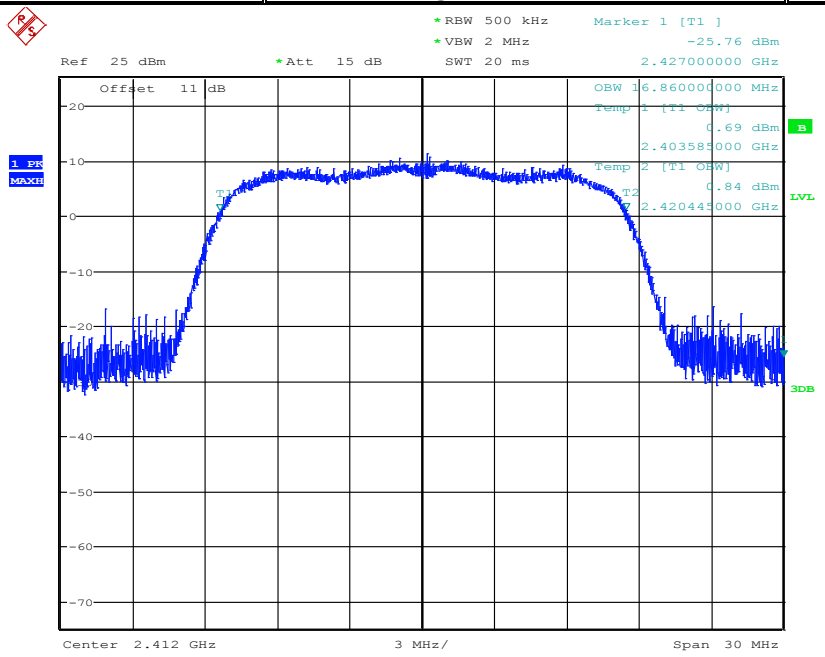


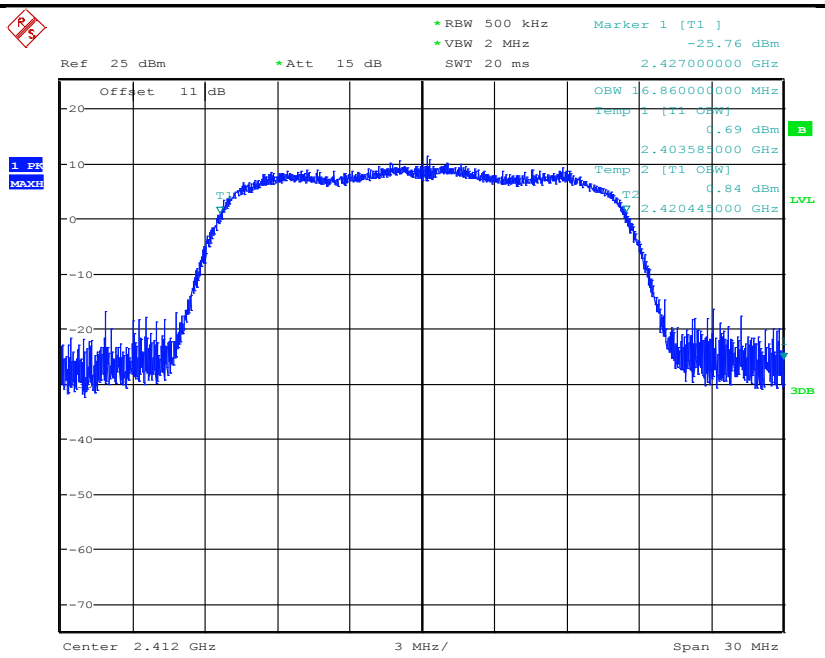
Ch.11 / 2462 MHz	802.11b 6dB and 99% OBW	1 Mbps



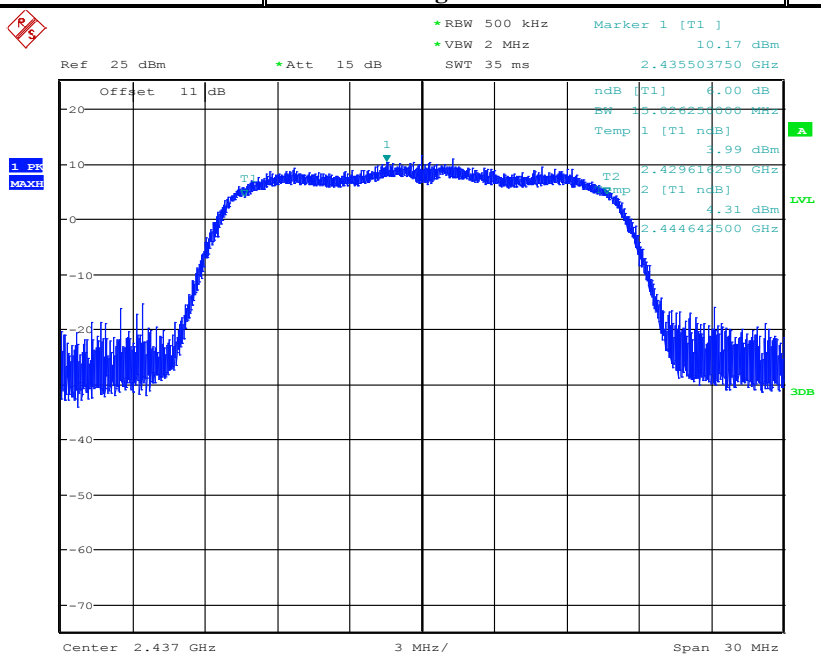


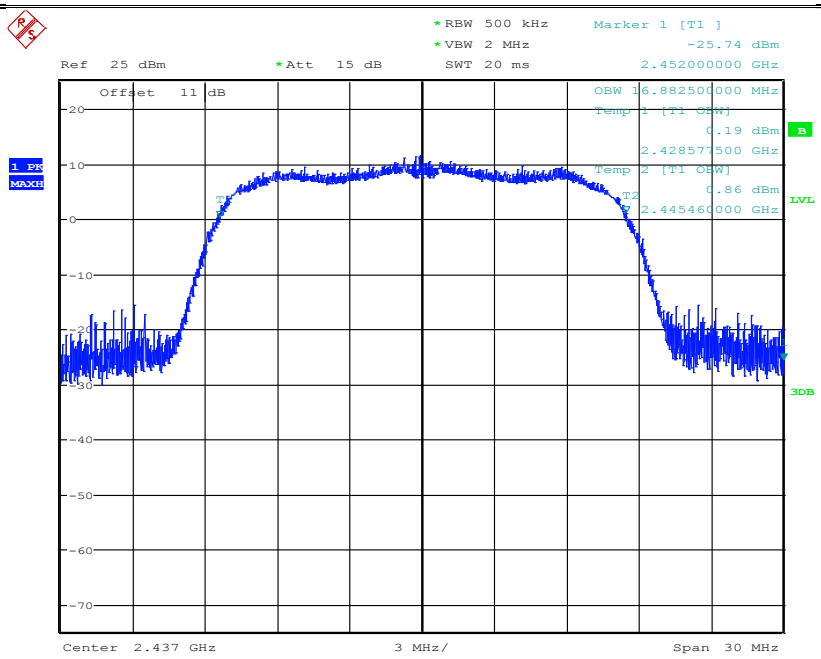
Ch.1 / 2412 MHz	802.11g 6dB and 99% OBW	6 Mbps



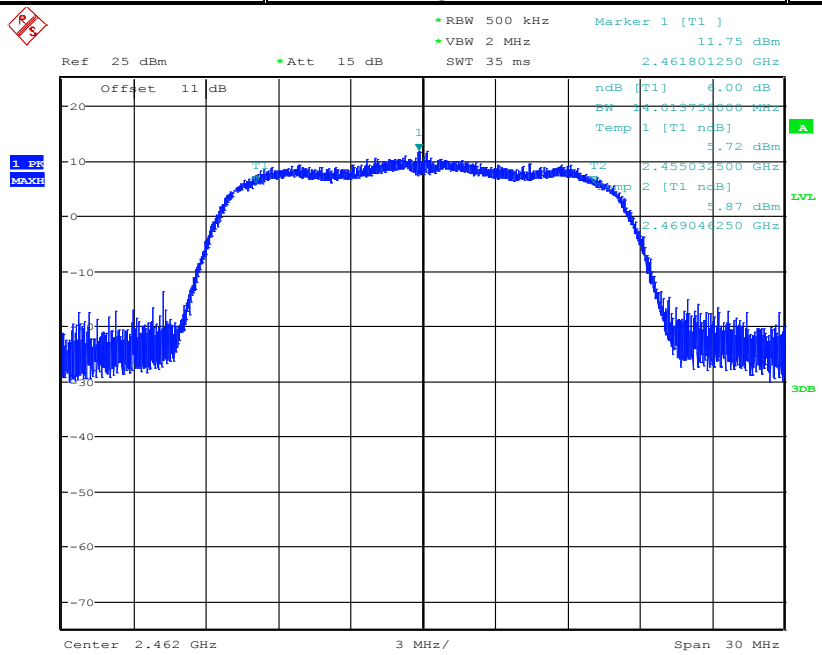


Ch.6 / 2437 MHz	802.11g 6dB and 99% OBW	6 Mbps

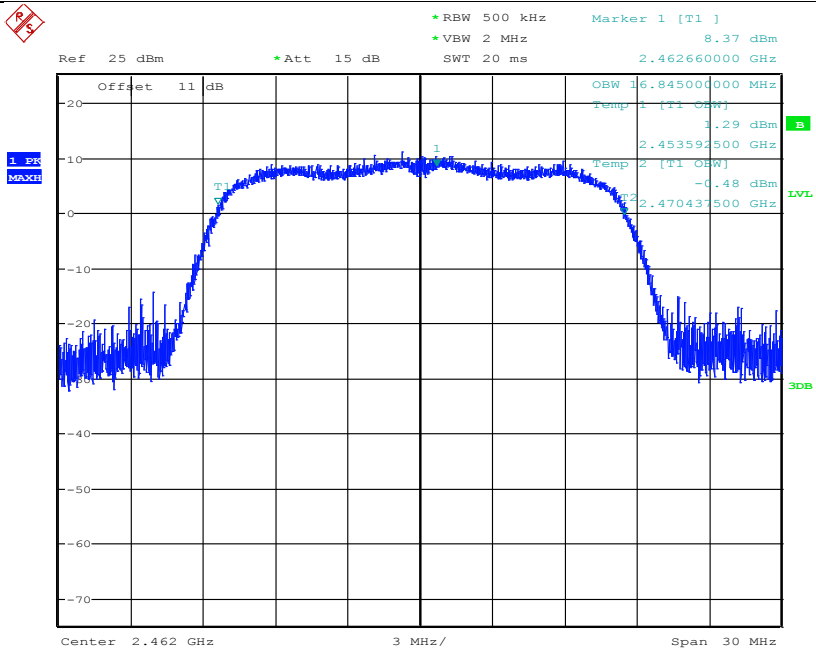




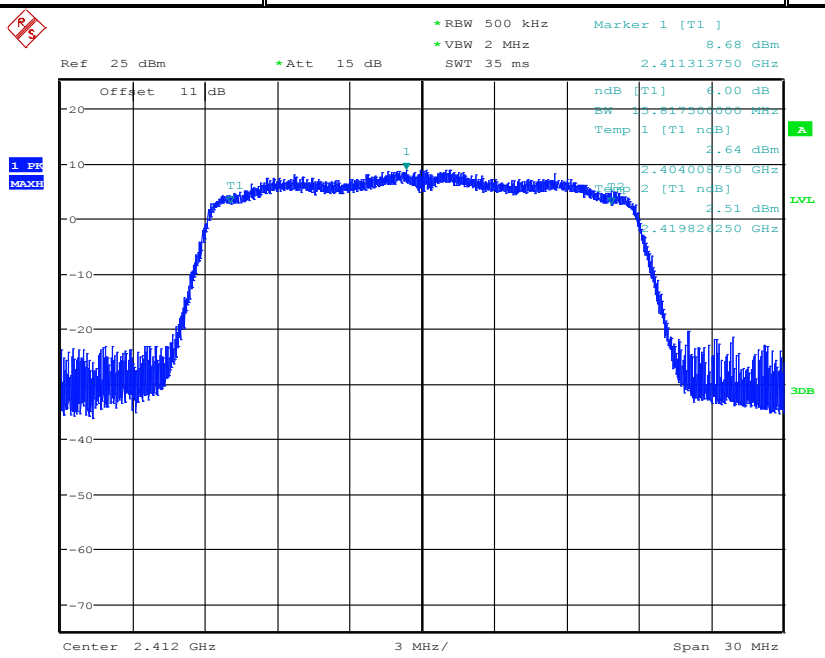
Ch.11 / 2462 MHz	802.11g 6dB and 99% OBW	6 Mbps

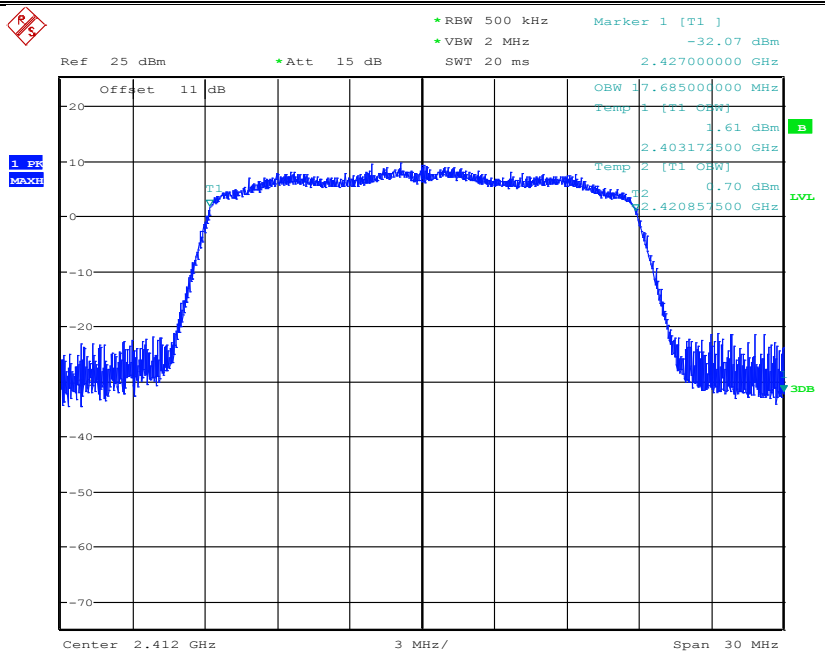


Date: 19.MAY.2016 16:51:49

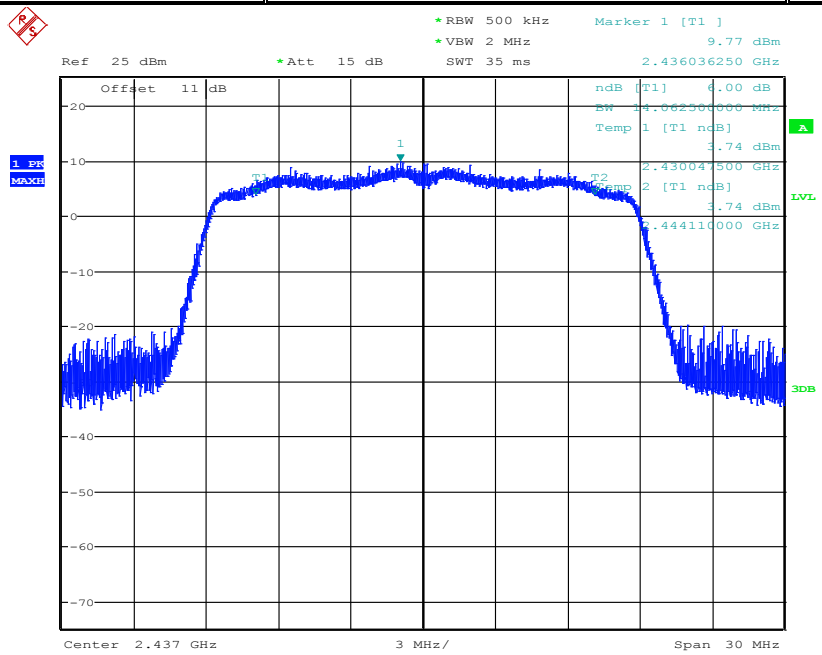


Ch.1 / 2412 MHz	802.11n 6dB and 99% OBW	6.5 Mbps

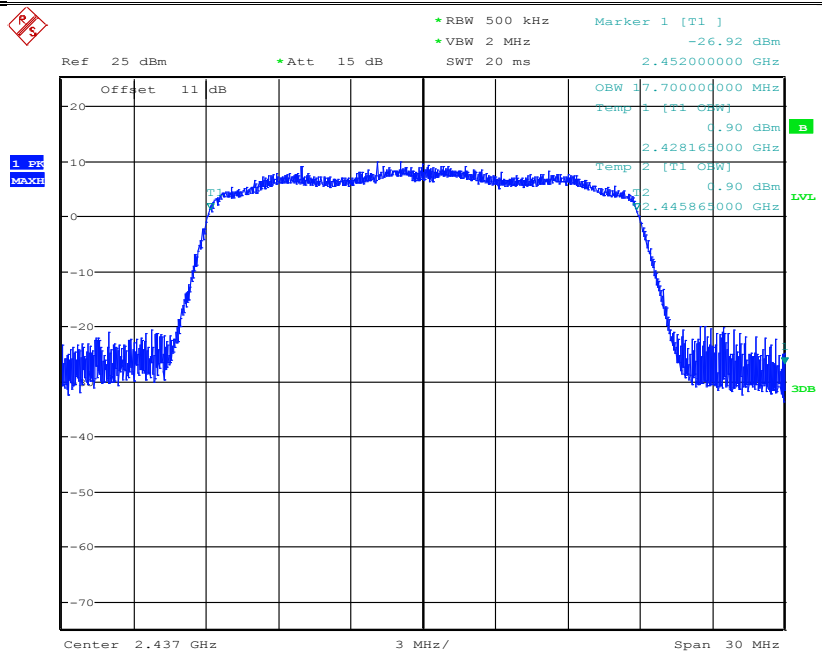




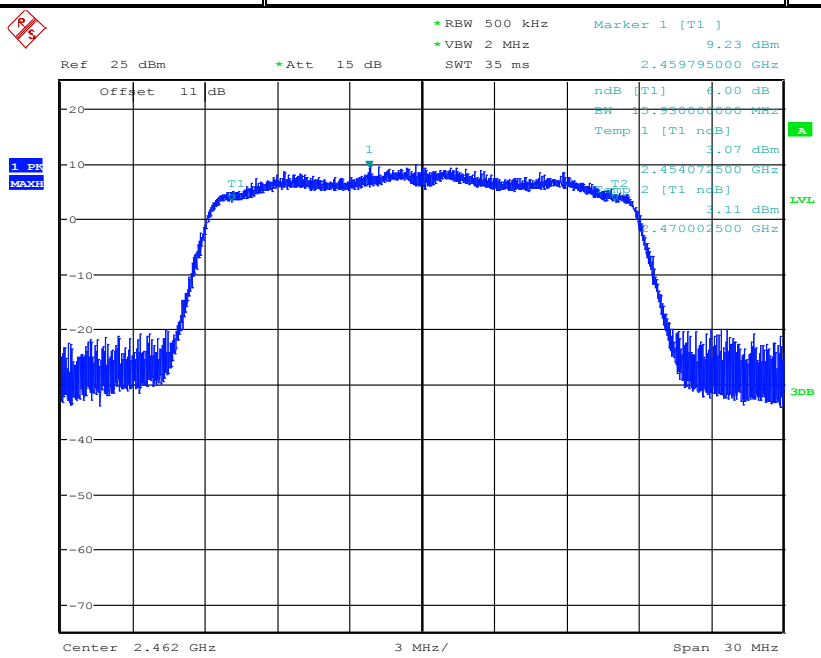
Ch.6 / 2437 MHz	802.11n 6dB and 99% OBW	6.5 Mbps

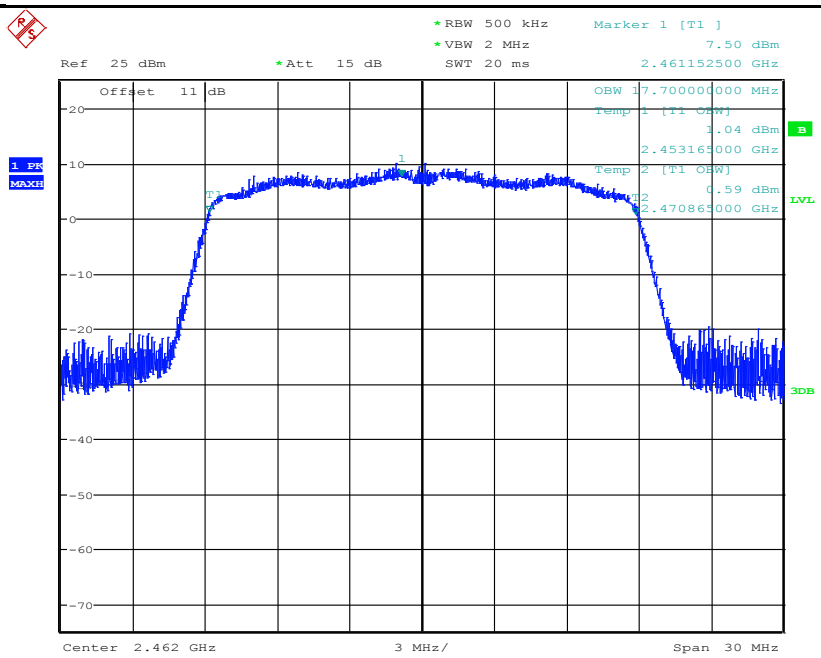


Date: 19.MAY.2016 16:58:54



Ch.11 / 2462 MHz	802.11n 6dB and 99% OBW	6.5 Mbps





10.3 Band Edge Compliance – at restricted and non-restricted band edges

10.3.1 Limits:

§15.209/15.205/15.247 (d)

Only spurious emissions are permitted in any of the frequency bands listed below:

*PEAK LIMIT= 74dBµV/m @3m =-21.23dBm

*AVG. LIMIT= 54dBµV/m @3m =-41.23dBm

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	([2])
13.36 - 13.41			

Limits non restricted band §15.247

FCC15.247 (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)).

10.3.2 Test Conditions:

Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input
22.4° C	2	Tx	Battery, 3.8V DC

10.3.3 Measurement Procedure:

These measurements are performed according to FCC KDB 558074 D01 v03r05 DTS Measurement Guidance.

Per 11.1(b) As maximum conducted (average) output power was used to demonstrate compliance as described in 9.2, then the measured power in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 30 dB relative to the maximum in-band peak PSD level in 100 kHz (i.e. -30 dBc).

Measurement method to establish reference
a) Set instrument center frequency to DTS channel center frequency.
b) Set the span to ≥ 1.5 times the DTS bandwidth.
c) Set the RBW = 100 kHz.
d) Set the VBW ≥ 3 x RBW.
e) Detector = peak.
f) Sweep time = auto couple.
g) Trace mode = max hold.
h) Allow trace to fully stabilize.
i) Use the peak marker function to determine the maximum PSD level.

The Lower band edge emissions measured using average power measurements are shown to be -30dBc relative to the reference signal level, and per the KDB, If the peak-detected amplitude can be shown to comply with the average limit, then it is not necessary to perform a separate average measurement.

Since high band edge (2483.5MHz) falls next to the restricted band (2483.5-2500MHz), it is measured as a restricted band. Measurements made according to KDB 558074 D01 v03r05 Section 12.2.5.2 Trace averaging across on and off times of the EUT transmissions followed by duty cycle correction.

Note: The power level documented in the operational description are used for band edge test.

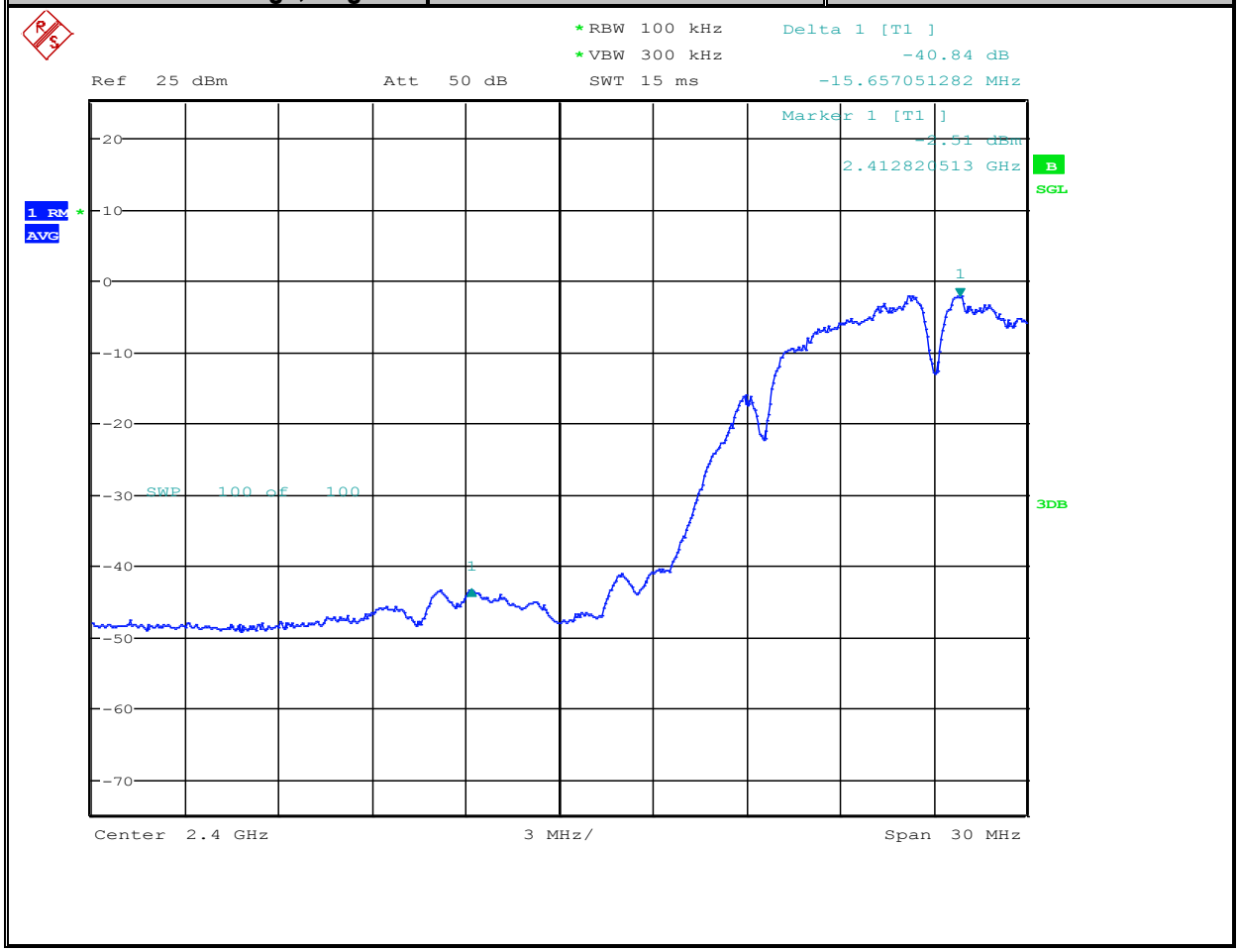
10.3.4 Measurement Result:

Plot #	EUT operating mode	Band Edge	Band Edge Delta (dBc)	Limit (dBc) in case average output power measured	Result
1	802.11b	Lower, non-restricted	-40.84	-30	Pass
2	802.11g	Lower, non-restricted	-44.24	-30	Pass
3	802.11n	Lower, non-restricted	-44.58	-30	Pass

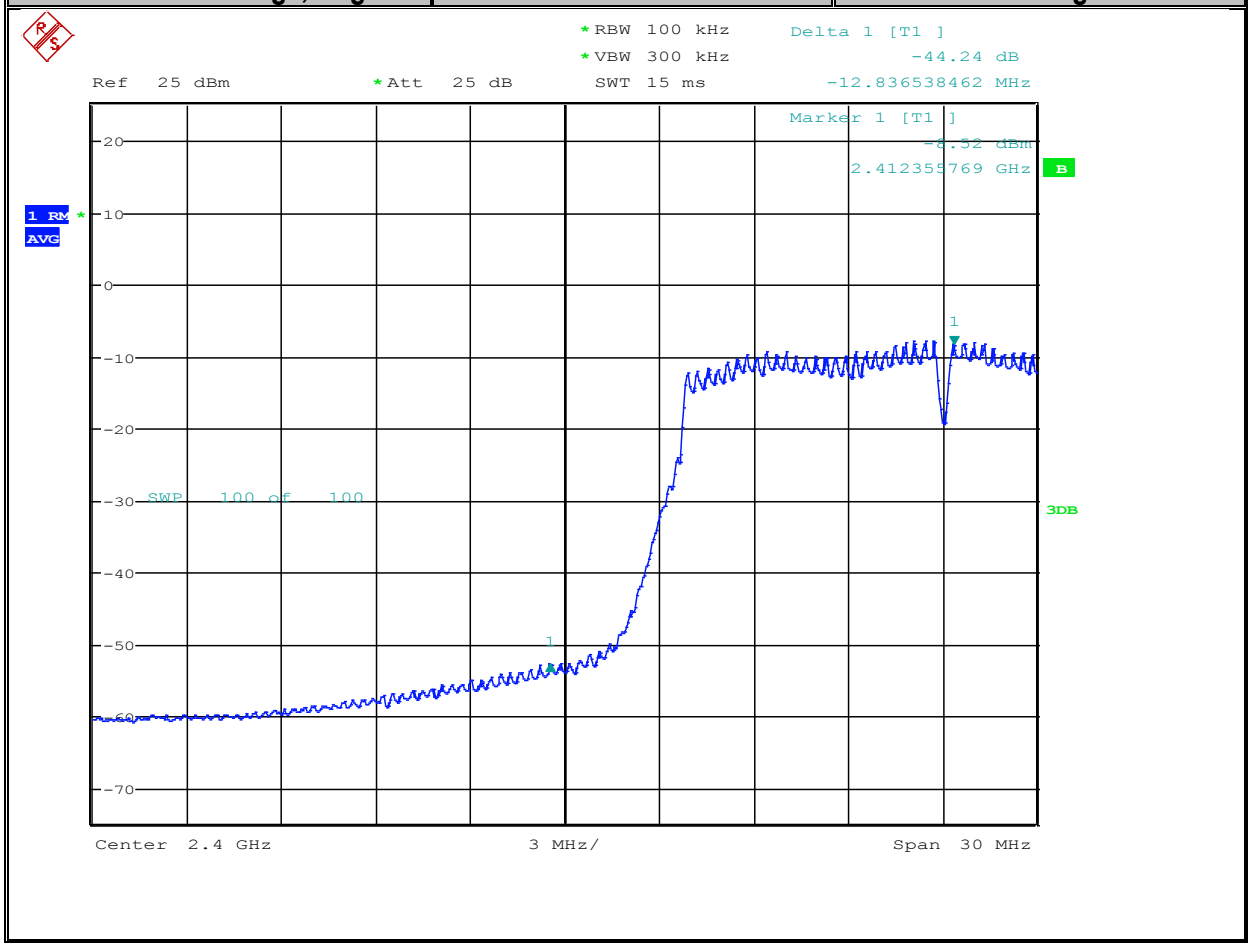
Plot #	EUT operating mode	Band Edge	Measured value	Corrected by Duty Cycle Correction Factor (dBm)	Corrected by Antenna Gain (dBi)	Limit (dBm)	Result
4	802.11b	Upper restricted average	-49.18	-49.18	-44.18	-41.23 avg	Pass
5	802.11g	Upper restricted peak	-50.77	-50.64	-45.64	-41.23 avg	Pass
6	802.11n	Upper restricted average	-48.3	-48.17	-43.17	-41.23 avg	Pass
7	802.11b	Upper restricted average	-37.29	-37.29	-32.29	-21.23 Pk	Pass
8	802.11g	Upper restricted peak	-27.64	-27.51	-22.51	-21.23 Pk	Pass
9	802.11n	Upper restricted average	-26.68	-26.55	-21.55	-21.23 Pk	Pass

10.3.5 Test Data/plots: 2.4 GHz Band

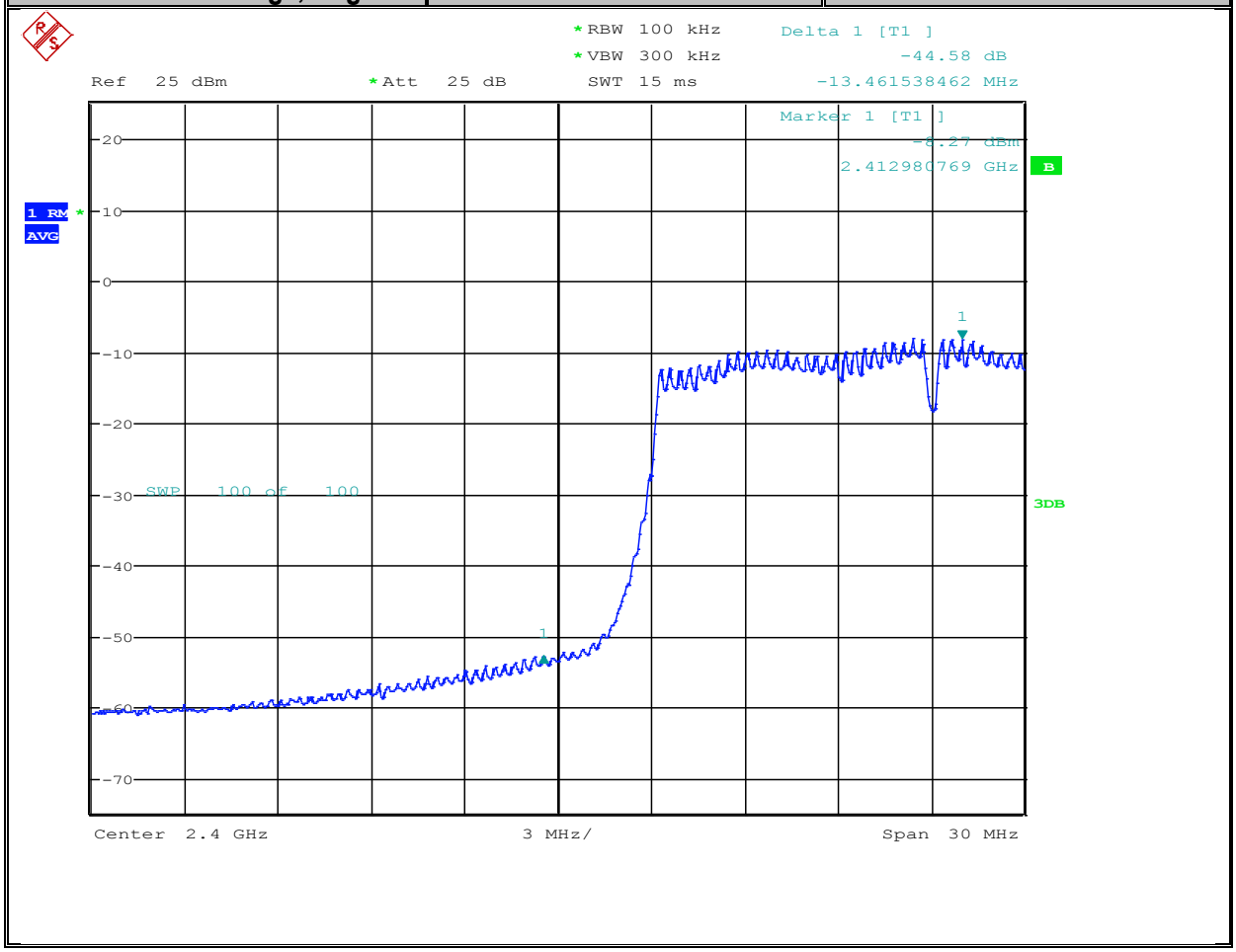
Plot #1		
Lower Band Edge, Avg	Ch. 1 / 2412MHz	802.11b



Plot #1		
Lower Band Edge, Avg	Ch. 1 / 2412MHz	802.11g

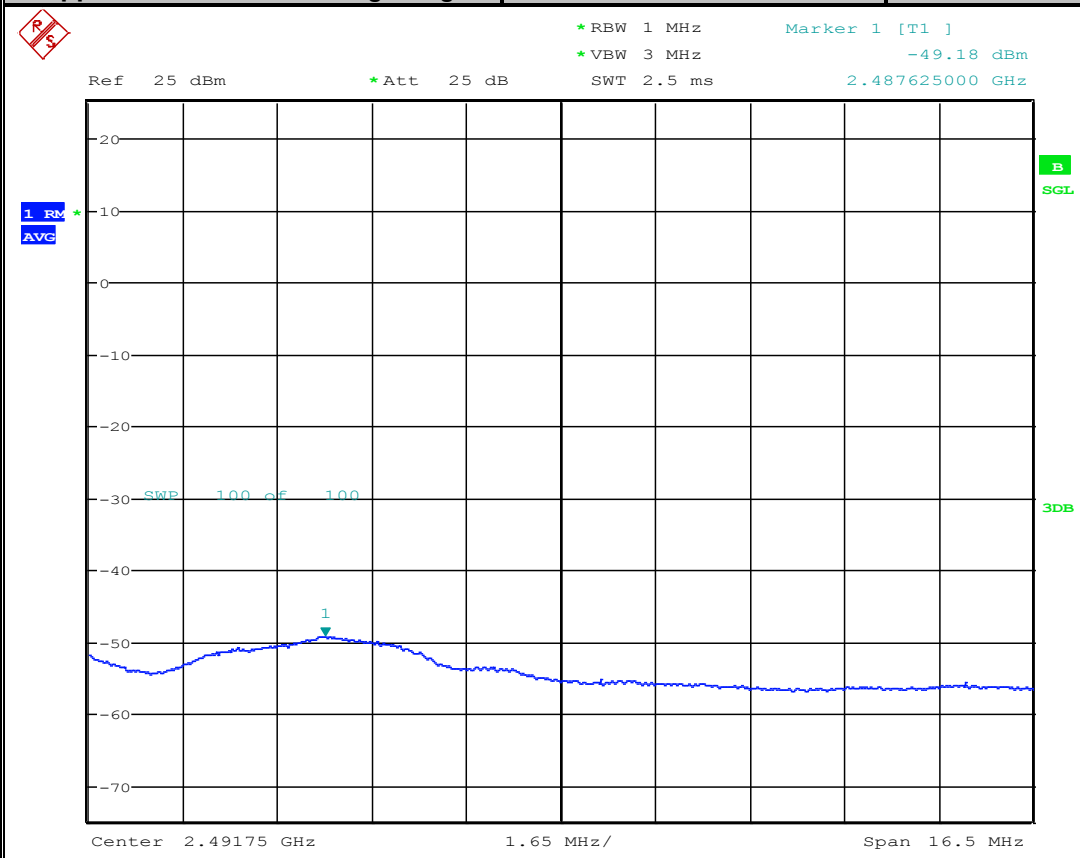


Plot #3		
Lower Band Edge, Avg	Ch. 1 / 2412MHz	802.11n

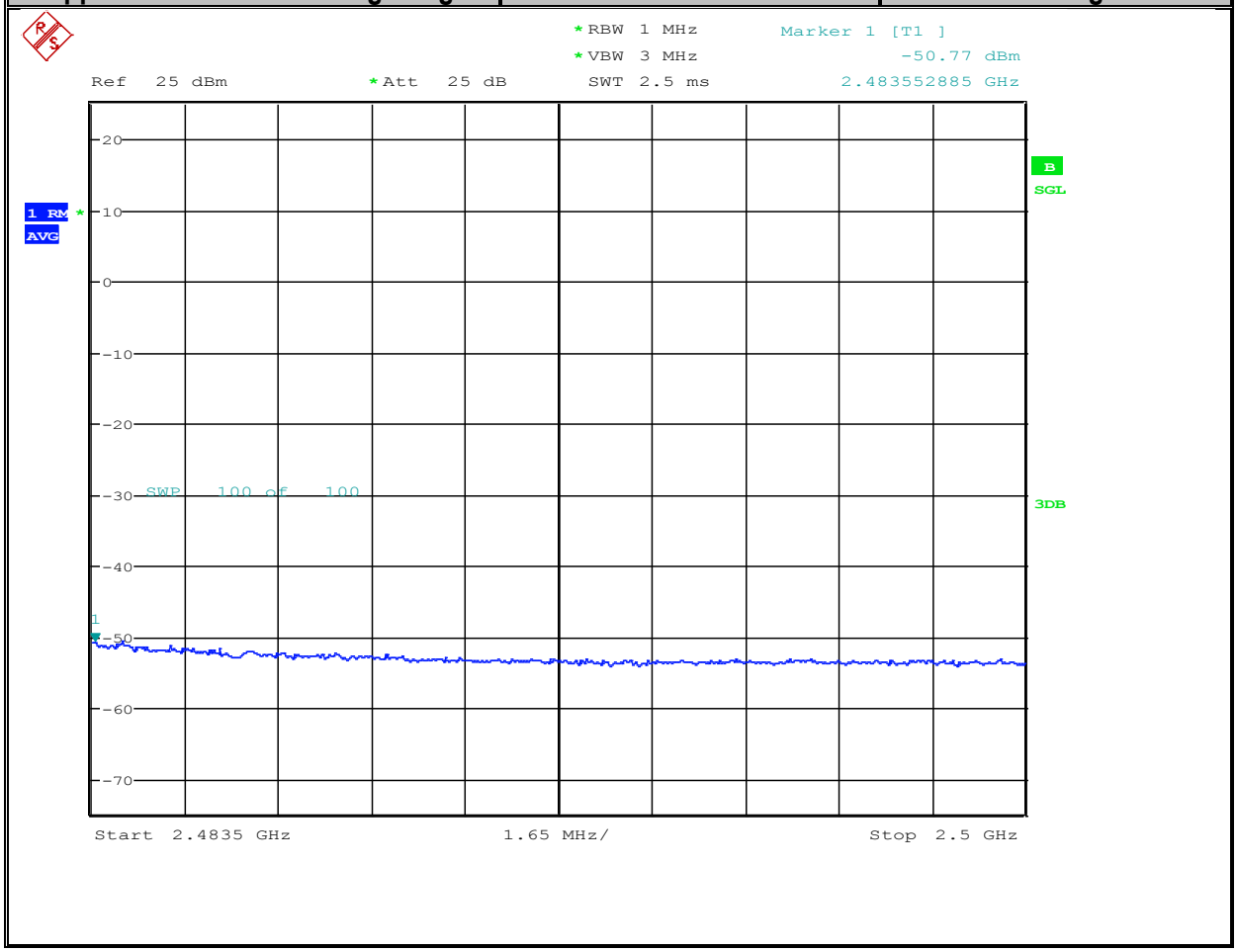


10.3.6 Restricted Band Plots

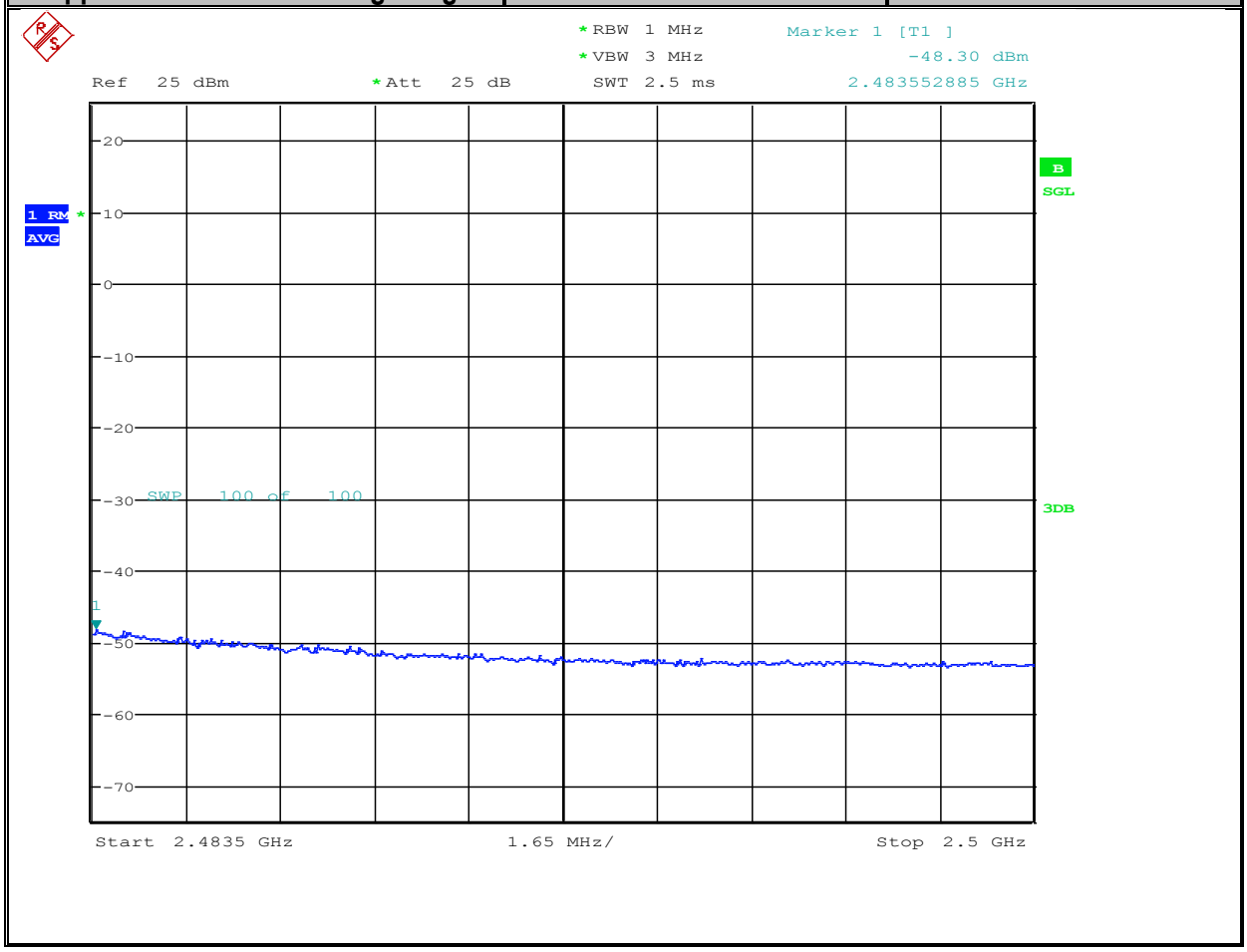
Plot #4		
Upper Restricted Band Edge Avg.	Ch. 11 / 2462MHz	802.11b



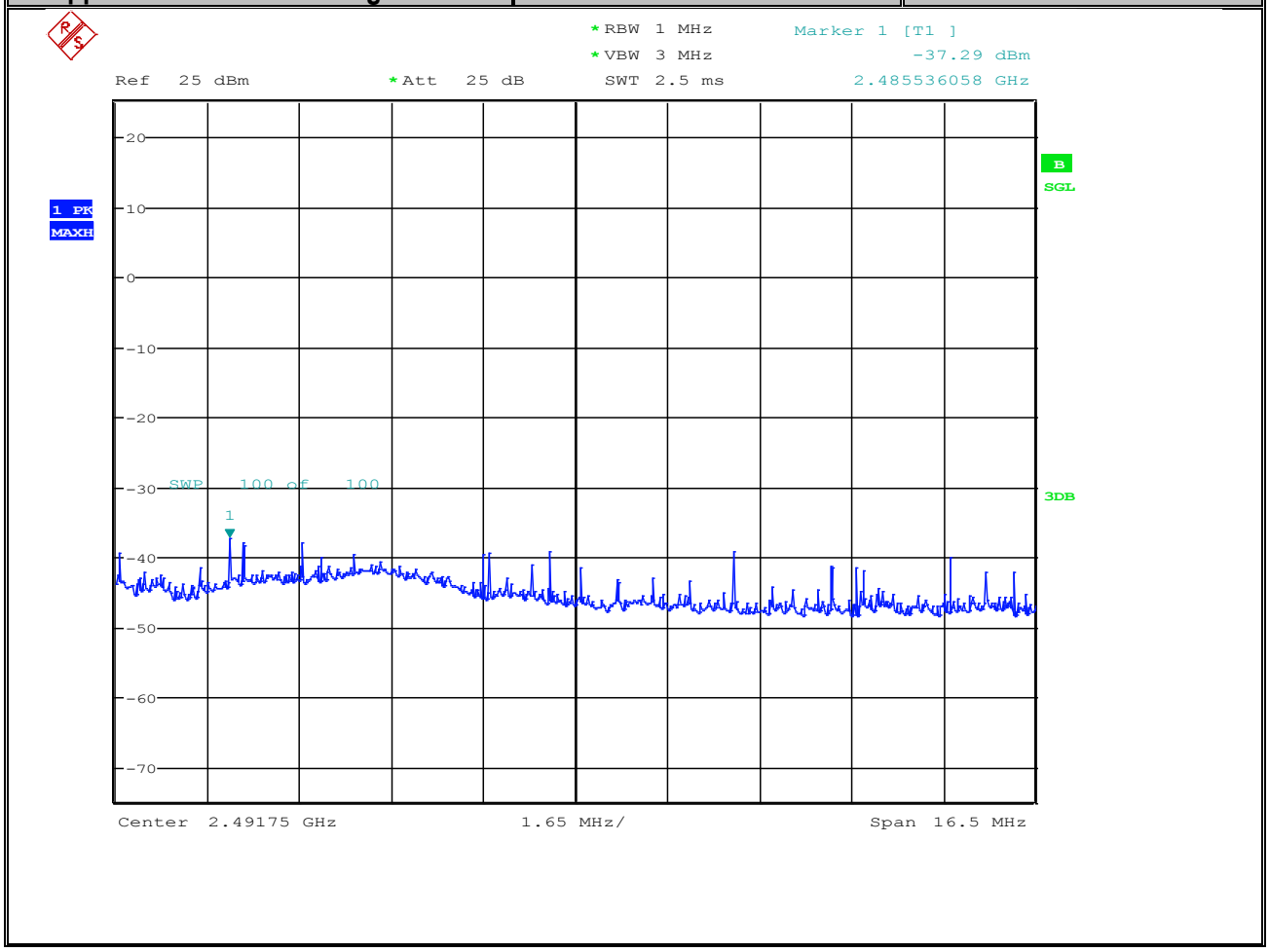
Plot #5		
Upper Restricted Band Edge Avg.	Ch. 11 / 2462MHz	802.11g



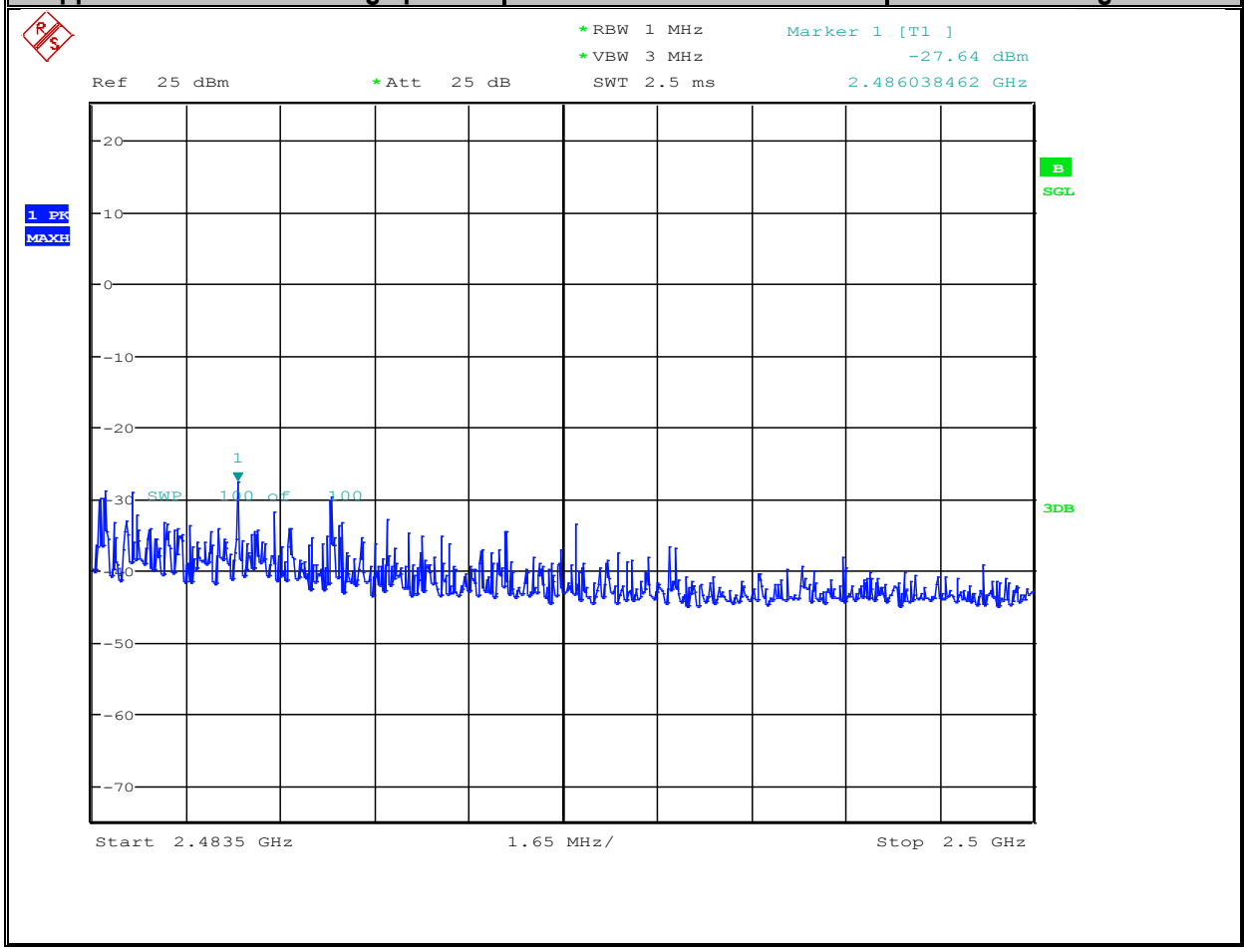
Plot #6		
Upper Restricted Band Edge Avg.	Ch. 11 / 2462MHz	802.11n



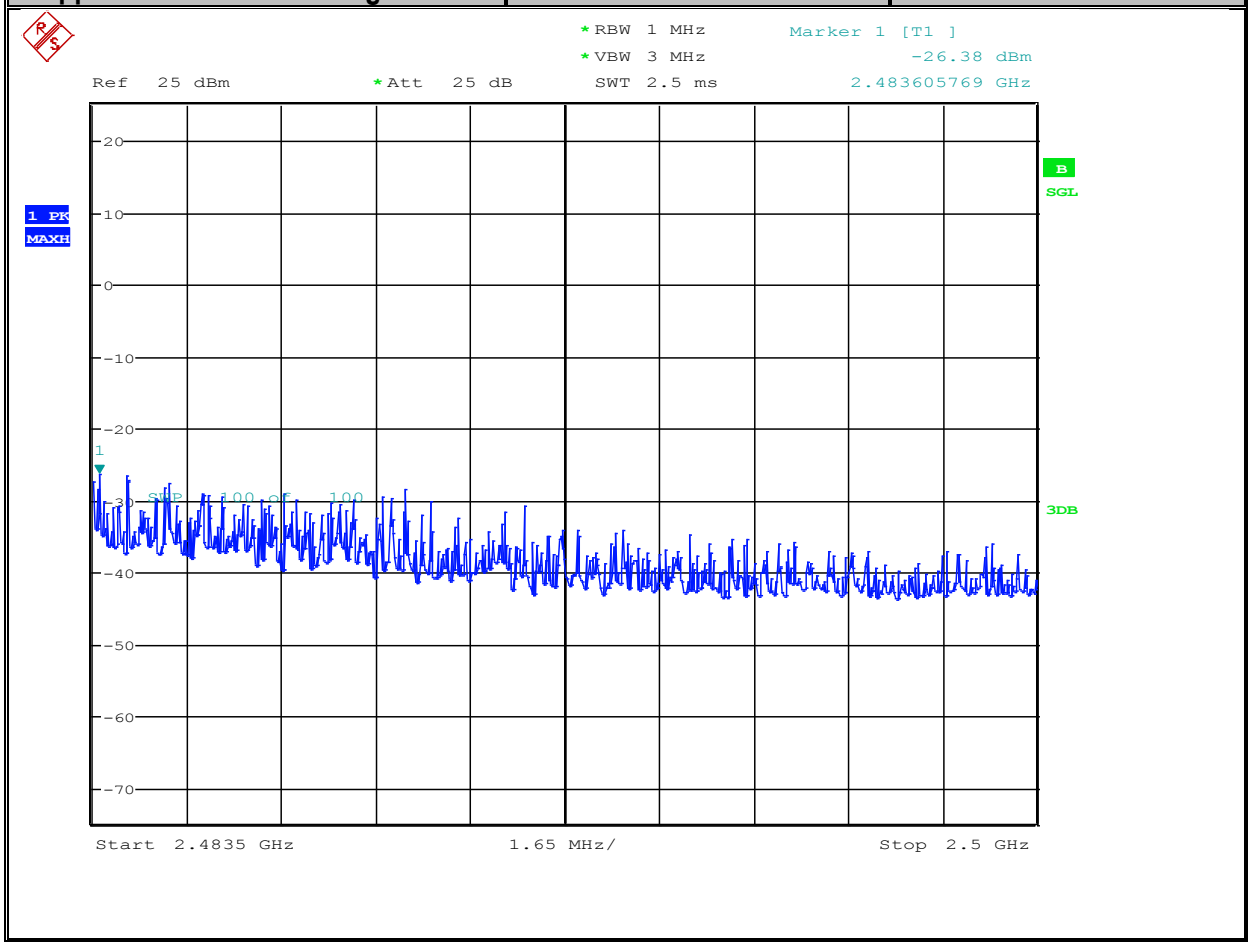
Plot #7		
Upper Restricted Band Edge Peak.	Ch. 11 / 2462MHz	802.11b



Plot #8		
Upper Restricted Band Edge peak.	Ch. 11 / 2462MHz	802.11g



Plot #8		
Upper Restricted Band Edge Peak.	Ch. 11 / 2462MHz	802.11n



10.4 Power Spectral Density

10.4.1 Selection of applicable test method

The DTS rules specify a conducted PSD limit within the DTS bandwidth during any time interval of continuous transmission.6 Such specifications require that the same method as used to determine the conducted output power shall also be used to determine the power spectral density

Hence method selected was per KDB 558074 v03r05 Section10.5. Method AVGPSD-2 (trace averaging across on and off times of the EUT transmissions, followed by duty cycle correction

10.4.2 Limits:

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

10.4.3 Test Conditions:

Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input
24 ° C	2	Tx	Battery, 3.8V DC

10.4.4 Measurement procedure:

Measurement according to FCC KDB 558074 D01 DTS v03r05 section 10.2

1. Set analyzer center frequency to DTS channel center frequency.
2. Set the span to at least1.5 x the OBW
3. Set the RBW 3 kHz ≤ RBW ≤ 100 kHz. =3 kHz,
4. VBW ≥ 3 x RBW and sweep time = auto.
5. Detector = power averaging (RMS) or sample detector (when RMS not available).
6. Employ trace averaging (RMS) mode over a minimum of 100 traces.
7. Use the peak marker function to determine the maximum amplitude level
8. Duty Cycle Correction
9. Compare with limits

10.4.5 Test Data: 2.4 GHz Band

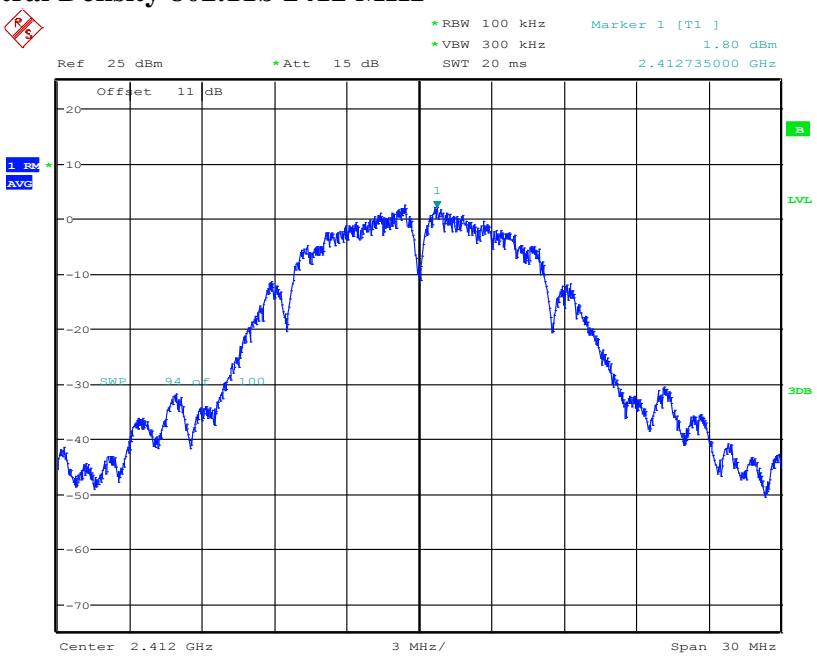
Conducted Power Spectral Density (dBm)			
Mode	**Frequency (MHz)**		
	2412 Channel 1	**2437 Channel 6**	**2462 Channel 11**
802.11b	1.80	2.26	2.11
802.11g	-4.87	-5.04	-4.82
802.11n	-6.05	-6.69	-5.74

DC Correction Power Spectral Density (dBm)				
Mode	**Frequency (MHz)**			
	2412 Channel 1	**2437 Channel 6**	**2462 Channel 11**	**Limit**
802.11b	1.80	2.26	2.11	8 dBm
802.11g	-4.74	-4.91	-4.69	8 dBm
802.11n	-5.92	-6.56	-5.61	8 dBm

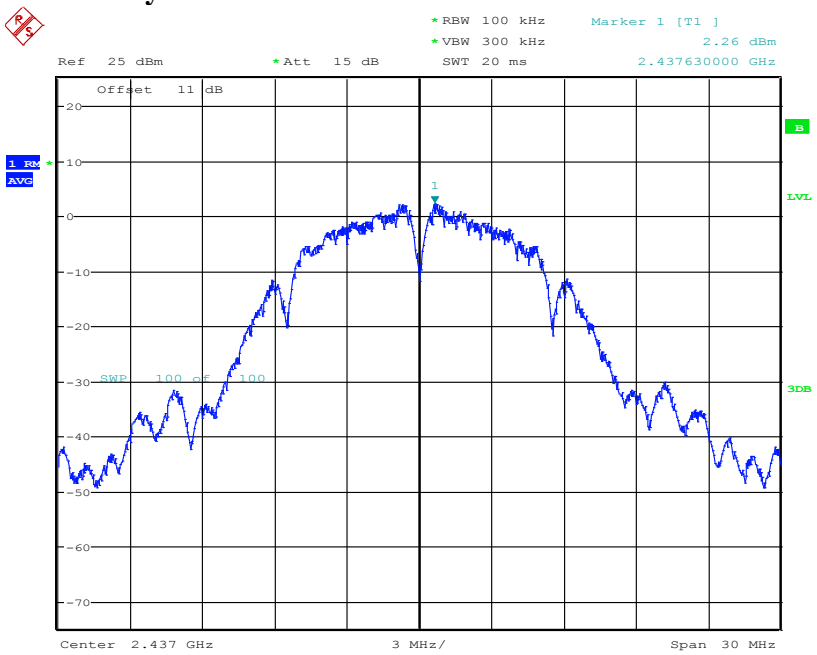
10.4.6 Measurement Result
Pass.

10.4.7 Measurement Plots: 2.4 GHz Band

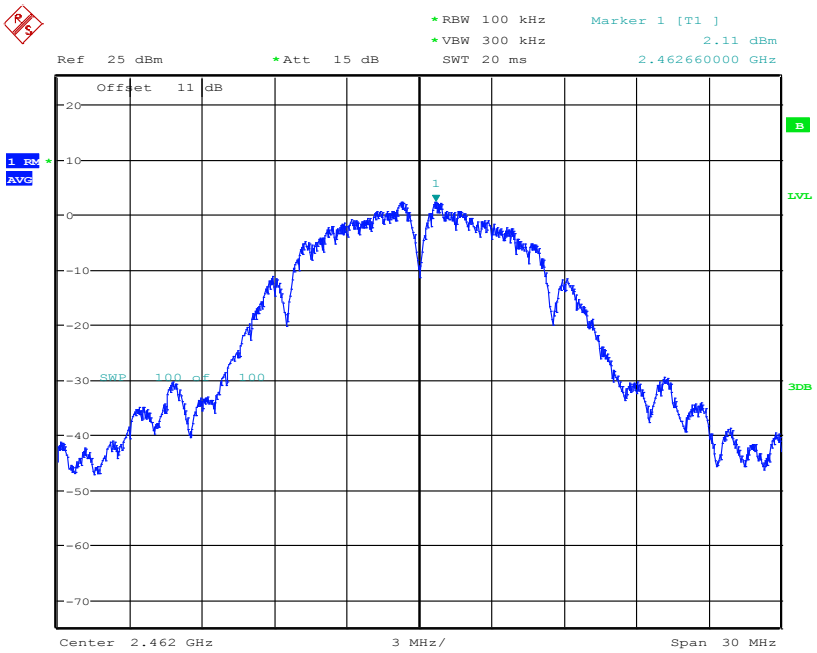
Power Spectral Density 802.11b 2412 MHz



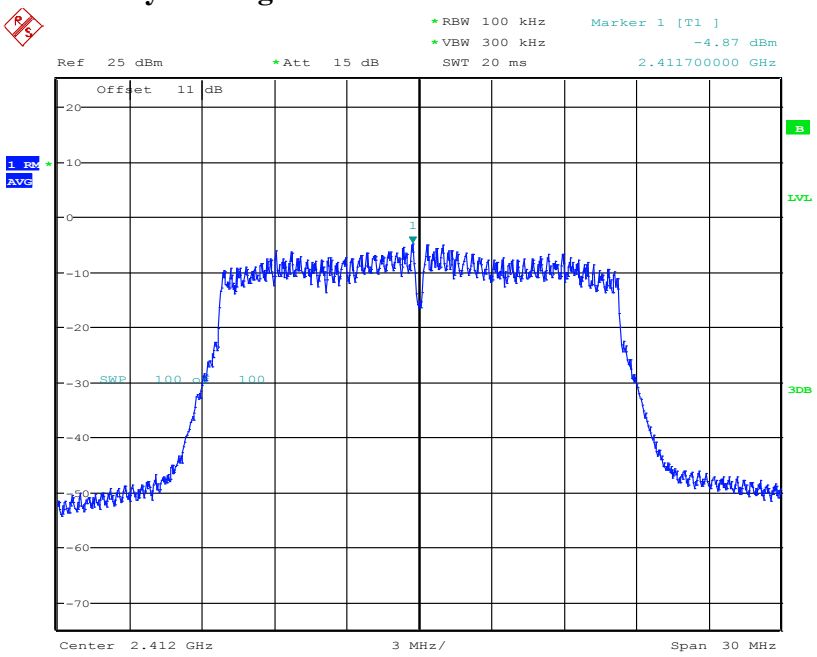
Power Spectral Density 802.11b 2437 MHz



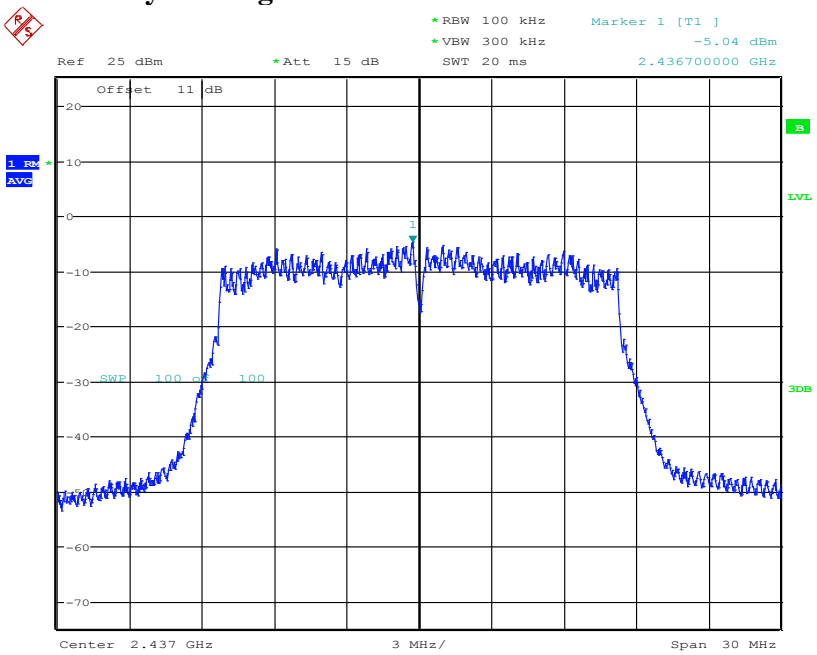
Power Spectral Density 802.11b 2462 MHz



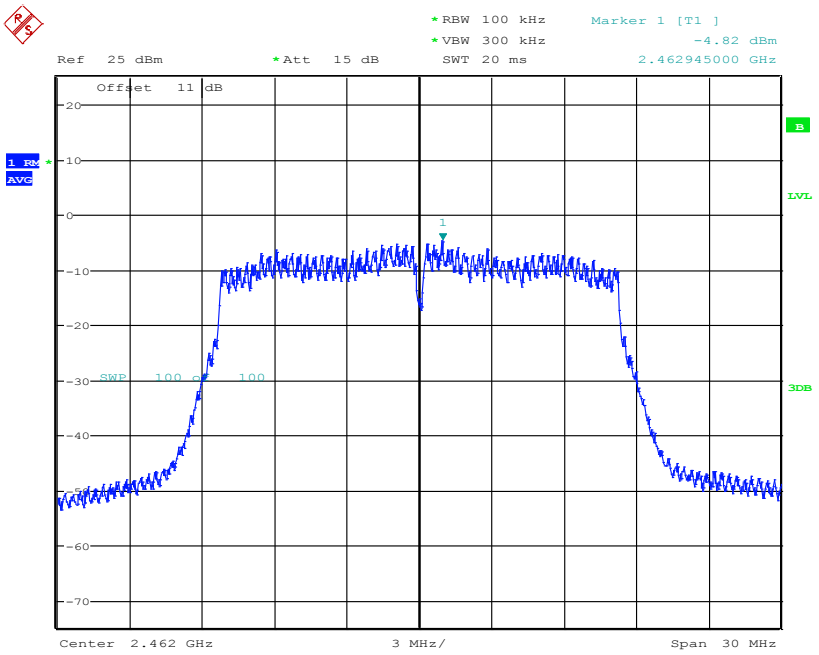
Power Spectral Density 802.11g 2412 MHz



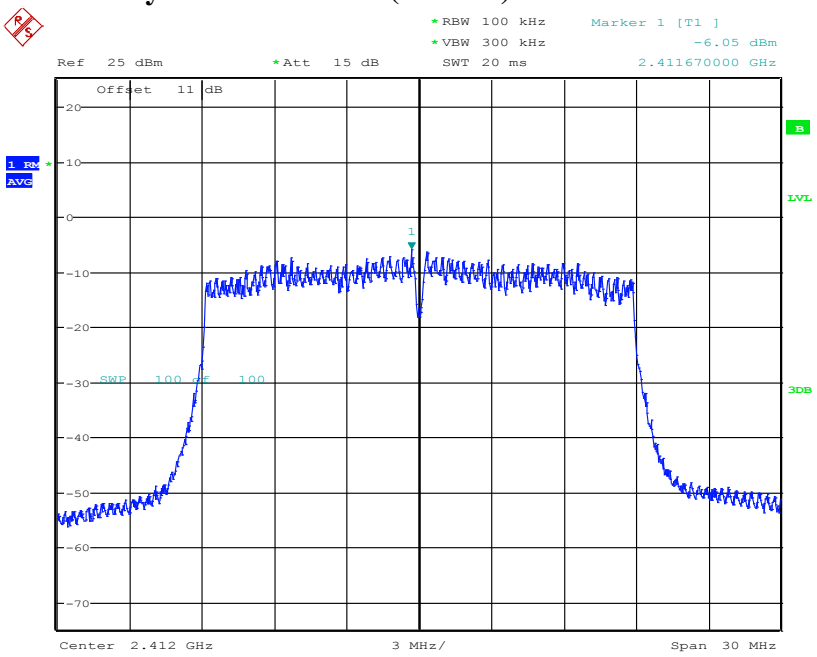
Power Spectral Density 802.11g 2437 MHz



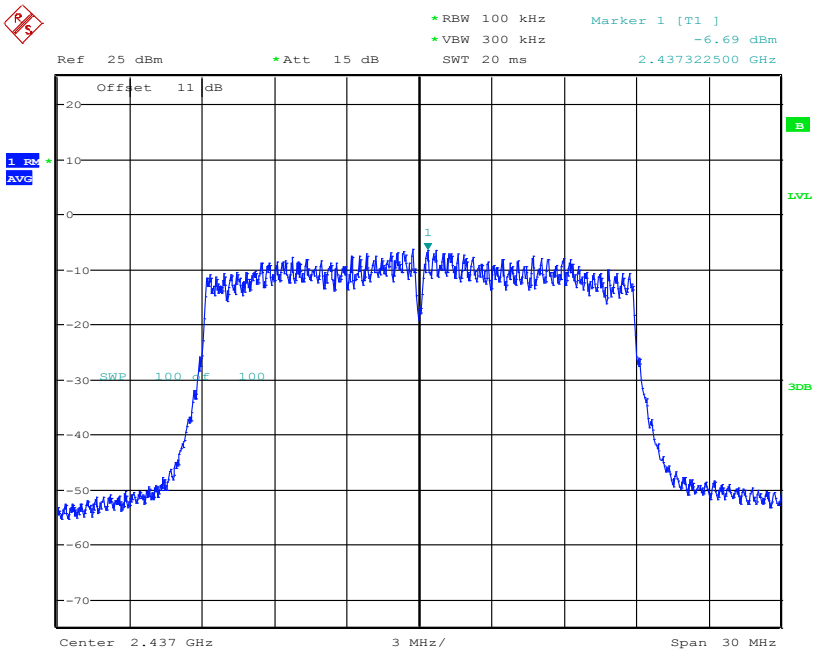
Power Spectral Density 802.11g 2462 MHz



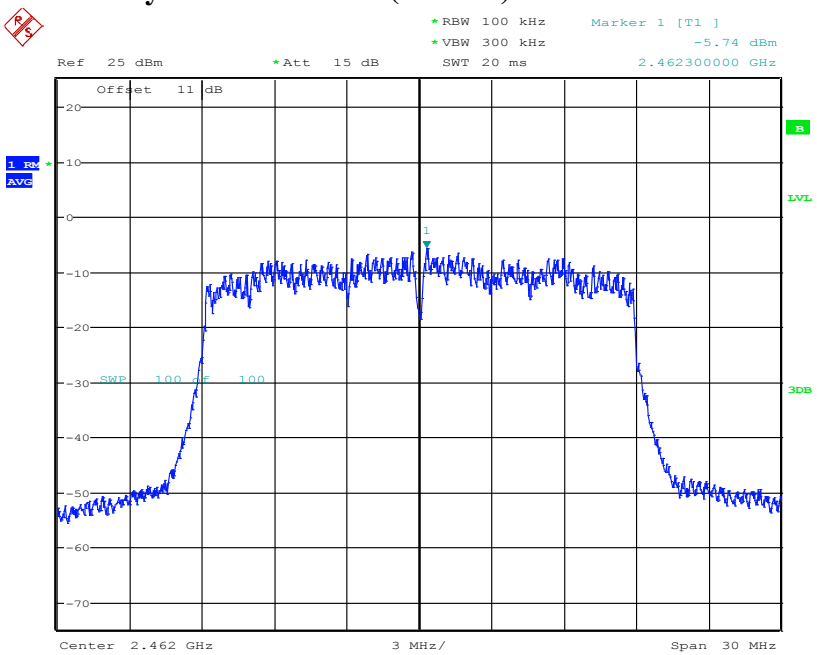
Power Spectral Density 802.11n -MCS0 (20MHz) 2412 MHz



Power Spectral Density 802.11n -MCS0 (20MHz) 2437 MHz



Power Spectral Density 802.11n -MCS0 (20MHz) 2462 MHz



10.5 Radiated Transmitter Spurious Emissions:

10.5.1 **Measurement according to ANSI C63.10 (2013)**

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= 1MHz

Plots reported here represent the worst case emissions for horizontal and vertical antenna polarizations and orientations of the EUT. Unless mentioned otherwise, the emissions outside the limit lines in the plots are from the transmit signal.

10.5.2 Limits:

§15.247/15.205/15.209
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	([2])
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= 74dBµV/m and
*AVG. LIMIT= 54dBµV/m

Table 1:

Frequency of emission (MHz)	Field strength (µV/m)
30–88	100 (40dBµV/m)
88–216	150 (43.5 dBµV/m)
216–960	200 (46 dBµV/m)
Above 960	500 (54 dBµV/m, average) (Peak limit: 74 dBµV/m,)

Table 2:

Frequency of emission (MHz)	Field strength (µV/m)	Measurement Distance (m)
0.009–0.490	2400/F(kHz)	300
0.490–1.705	24000/F(kHz)	30
1.705–30.0	30	30

10.5.3 Test Conditions:

Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input
22.5° C	1,3,4	Tx	Battery, Charger, Solar

10.5.4 Measurement procedure:
Measurement according to ANSI C63.10:2013 (also refer to section 6.1 in this test report)

10.5.5 Test Result:

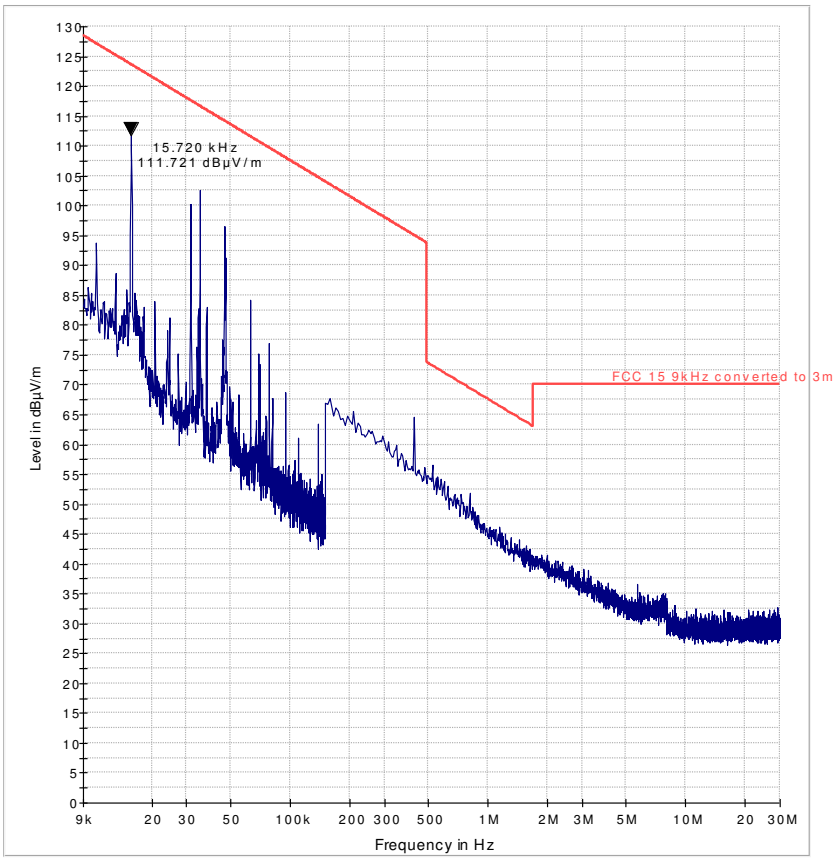
Unless mentioned otherwise, the emissions outside the limit lines in the plots are from the transmit signal.

Plots reported here represent the worst case emissions for horizontal and vertical antenna polarizations and orientations of the EUT.

10.5.6 Measurement Result
Pass.

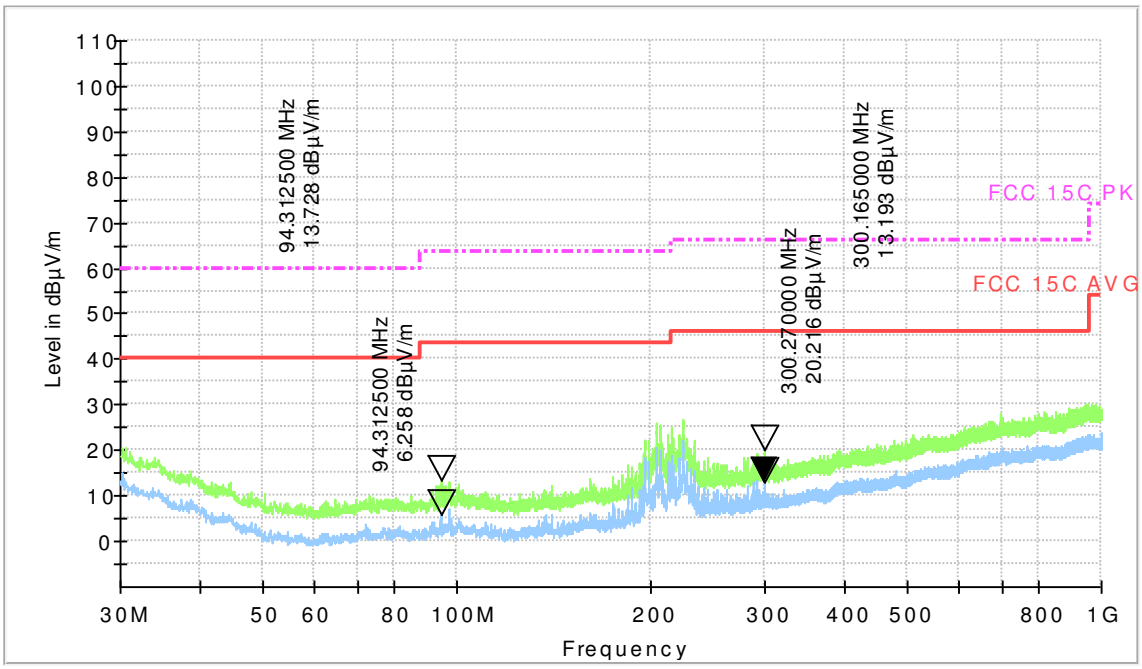
10.5.7 Test data/ plots: 2.4 GHz Band

Transmitter Radiated Spurious Emission: Ch Mid- 9kHz – 30MHz- 802.11b-mode



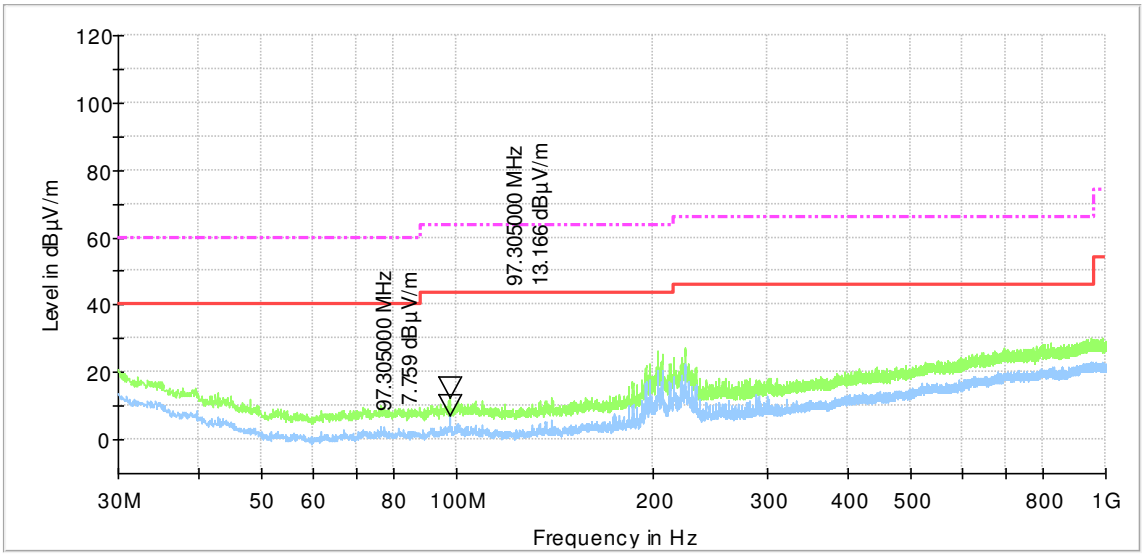
FCC 15 9kHz converted to 3m — Preview Result 1-PK+

Transmitter Radiated Spurious Emission: Ch Low- 30 MHz – 1GHz- 802.11b-mode



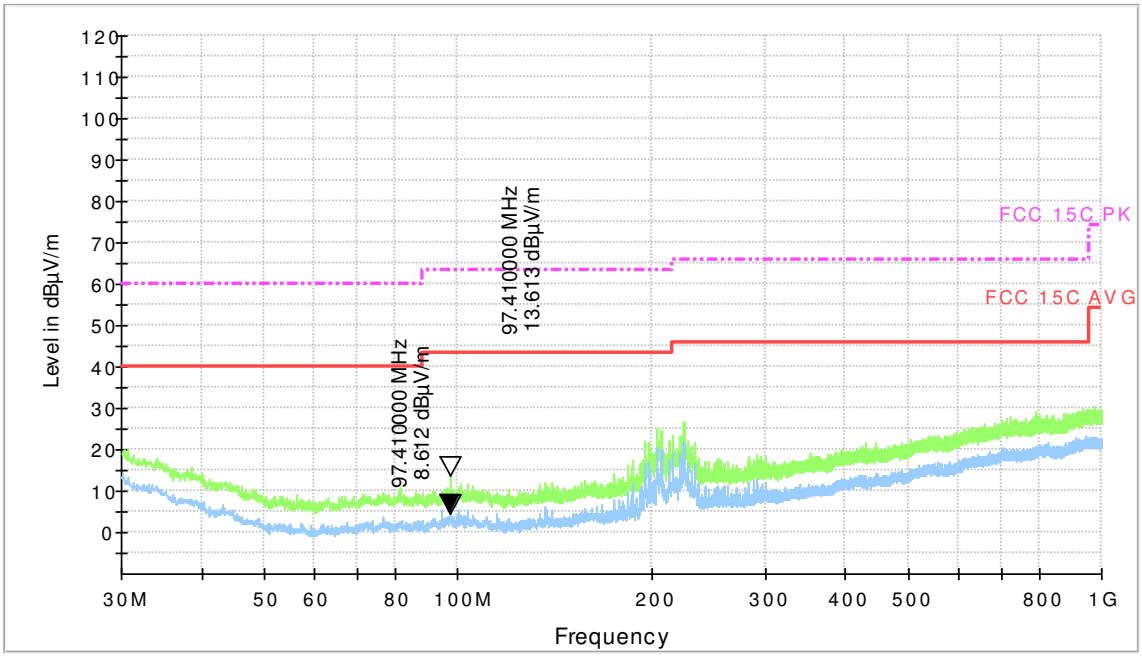
Preview Result 2-PK+ [Preview Result 2.Result:2] Preview Result 1-RMS [Preview Result
FCC 15C AVG [..\]

Transmitter Radiated Spurious Emission: Ch Mid- 30 MHz – 1GHz- 802.11b-mode

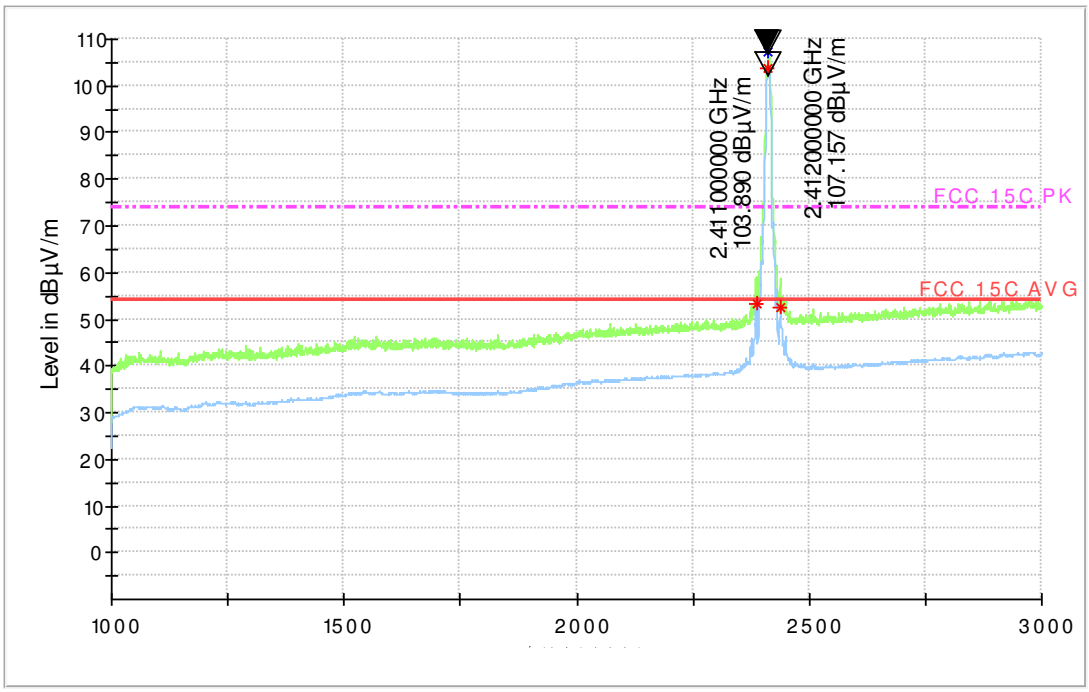


Preview Result 2-PK+ Preview Result 1-RMS FCC 15C AVG
FCC 15C PK RMS-RMS MaxPeak-PK+

Transmitter Radiated Spurious Emission: Ch High- 30 MHz – 1GHz- 802.11b-mode

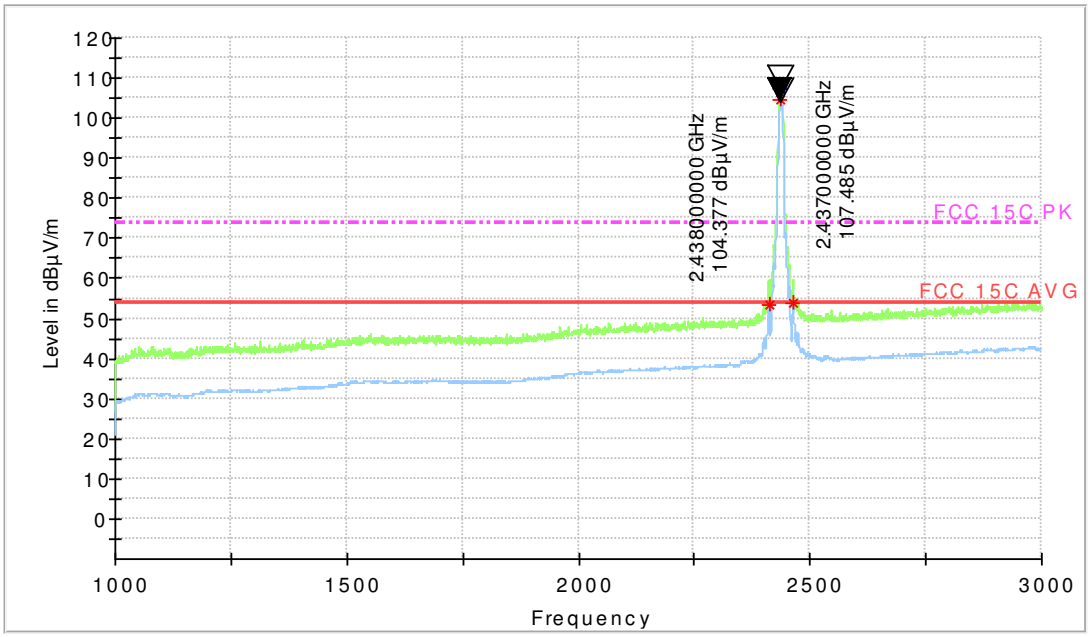


Transmitter Radiated Spurious Emission: Ch Low- 1GHz – 3GHz- 802.11b-mode



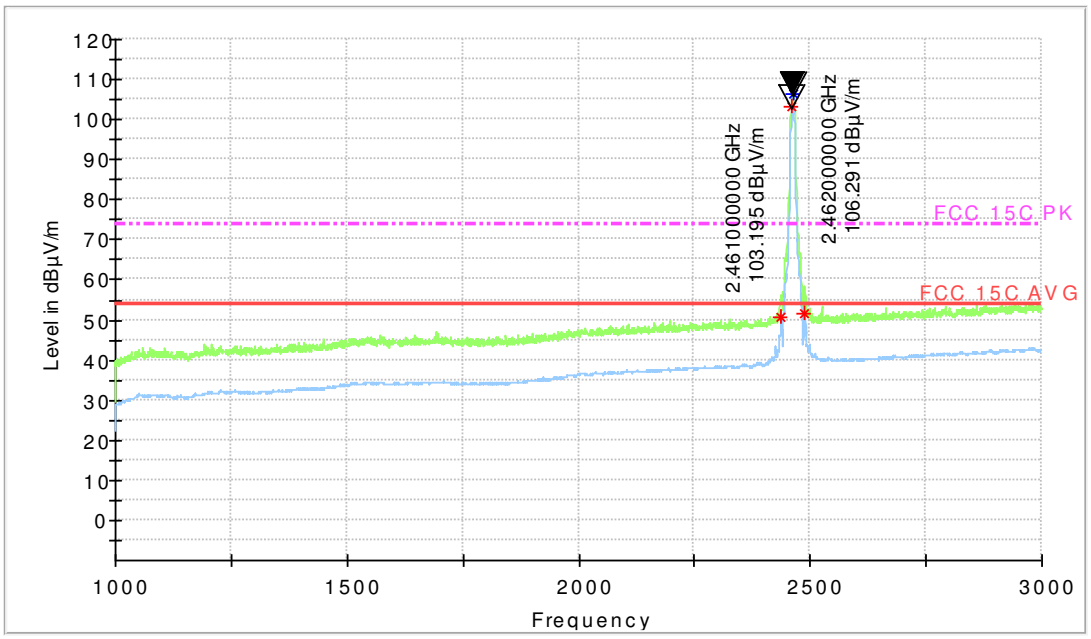
Note: The signal above limit is the Transmit channel.

Transmitter Radiated Spurious Emission: Ch Mid- 1GHz – 3GHz- 802.11b-mode

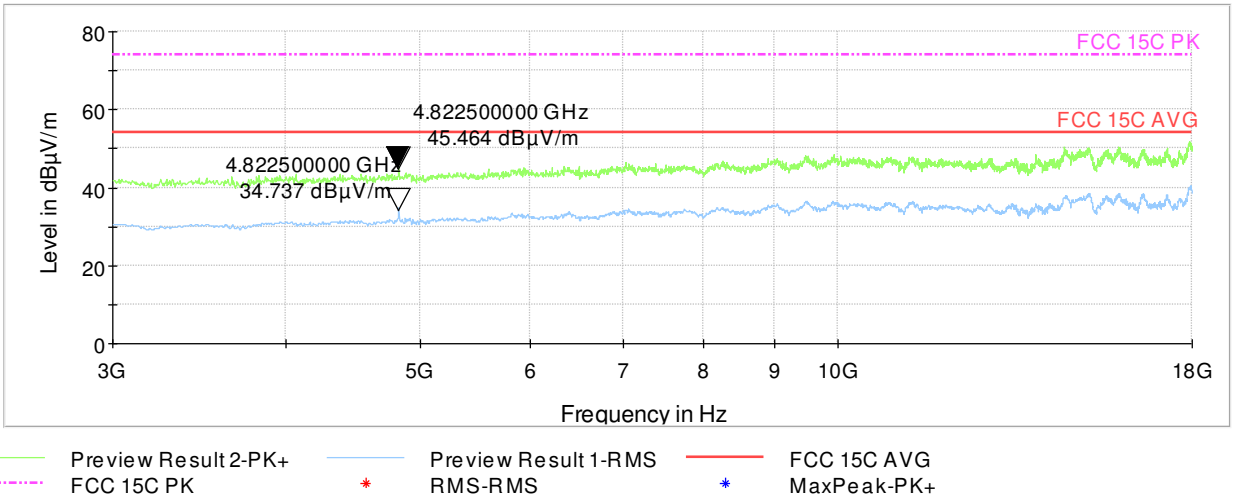


Note: The signal above limit is the Transmit channel.

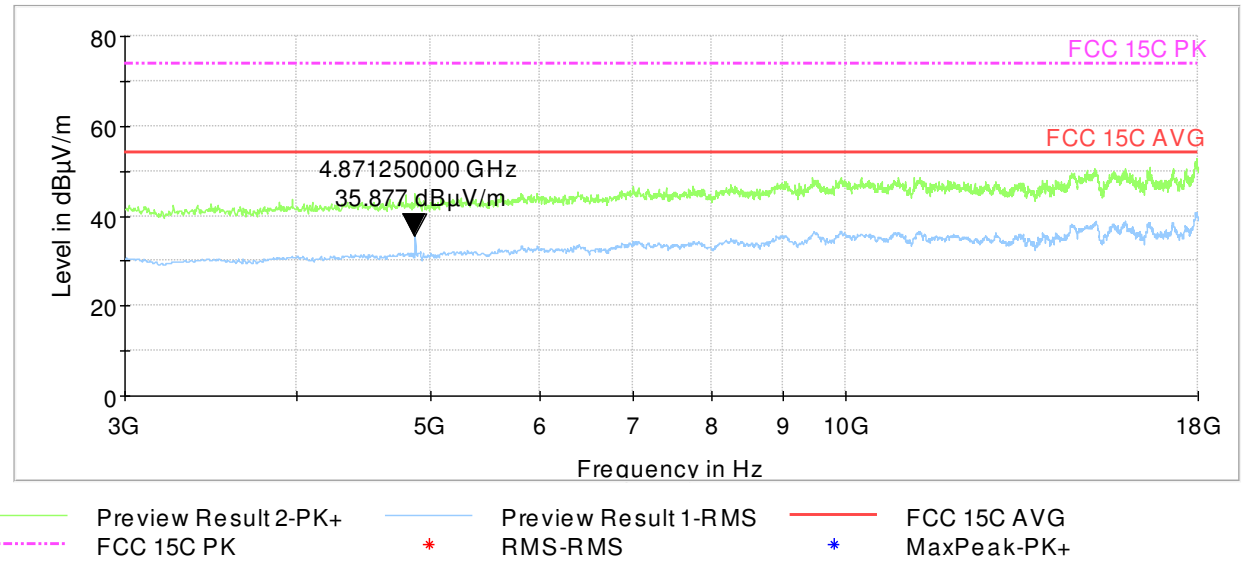
Transmitter Radiated Spurious Emission: Ch High- 1GHz – 3GHz- 802.11b-mode



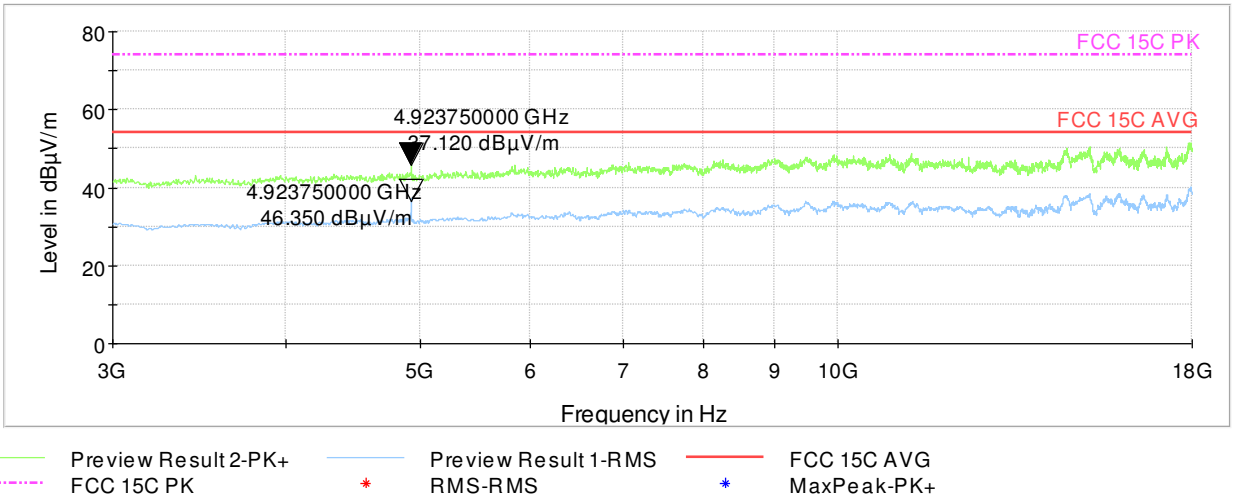
Transmitter Radiated Spurious Emission: Ch Low- 3 GHz – 18 GHz- 802.11b-mode



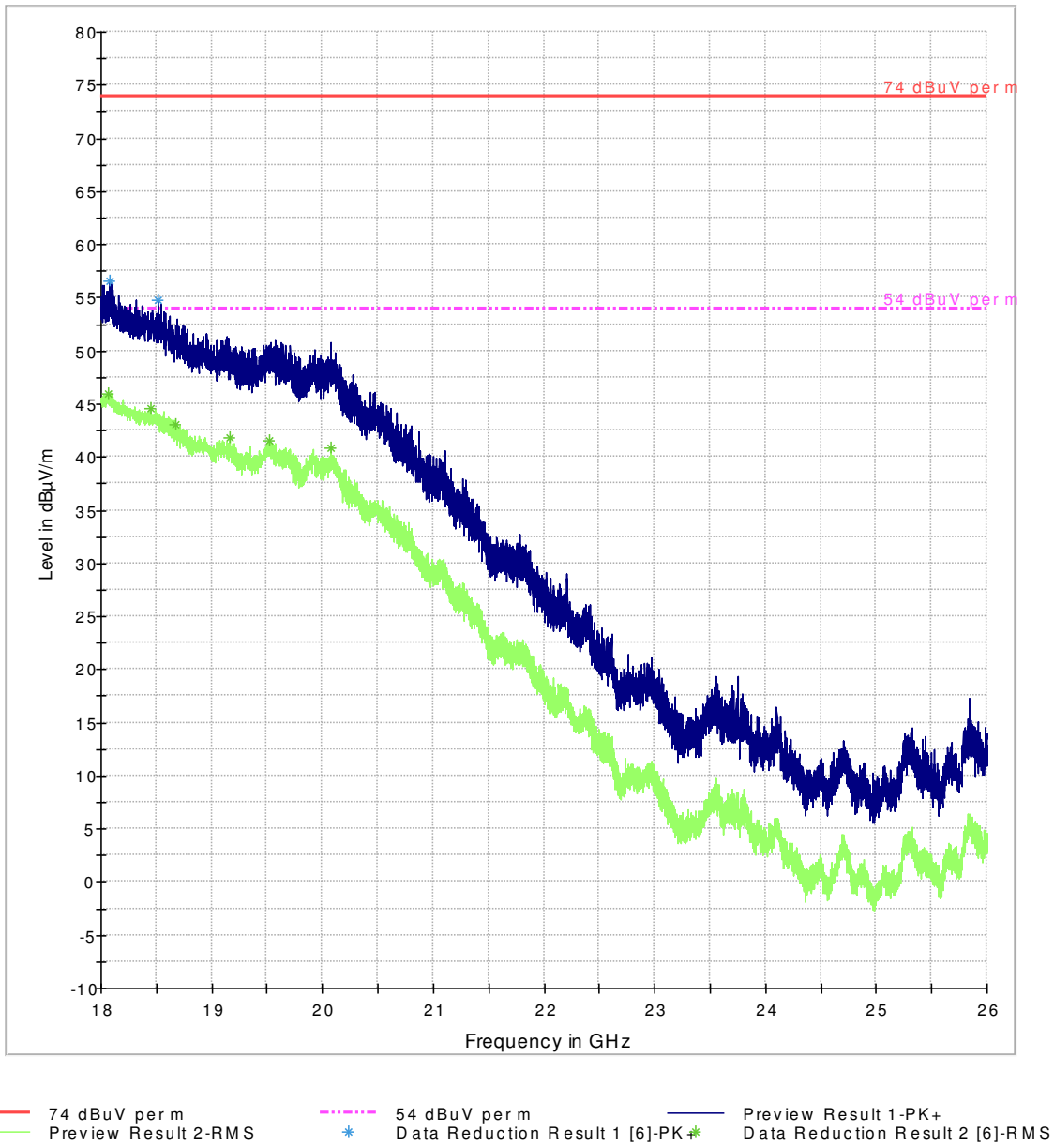
Transmitter Radiated Spurious Emission: Ch Mid- 3 GHz – 18 GHz- 802.11b-mode



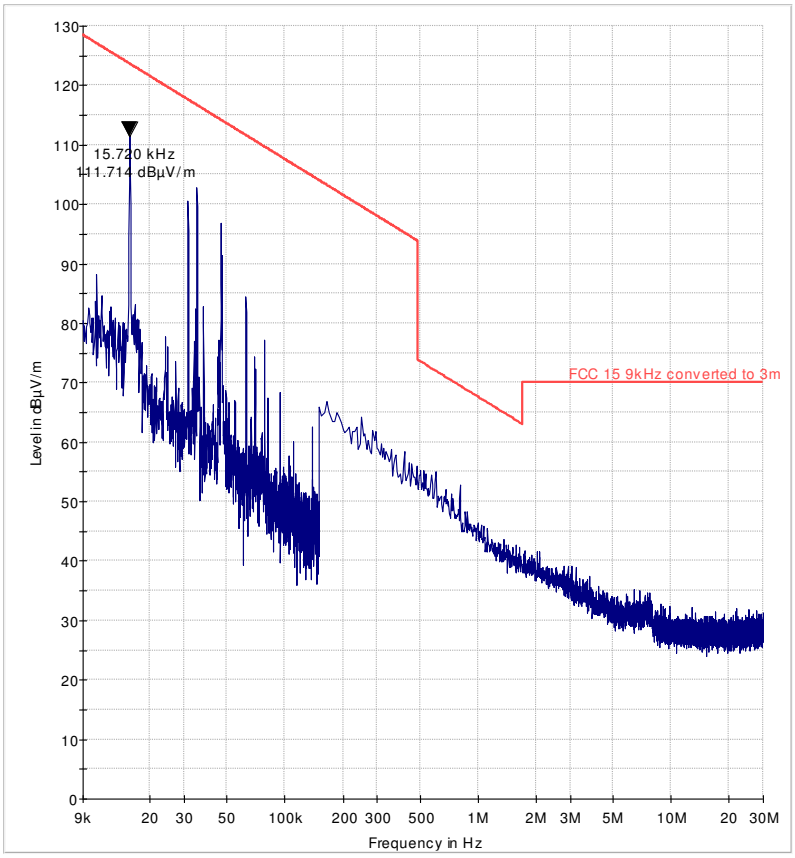
Transmitter Radiated Spurious Emission: Ch High- 3 GHz – 18 GHz- 802.11b-mode



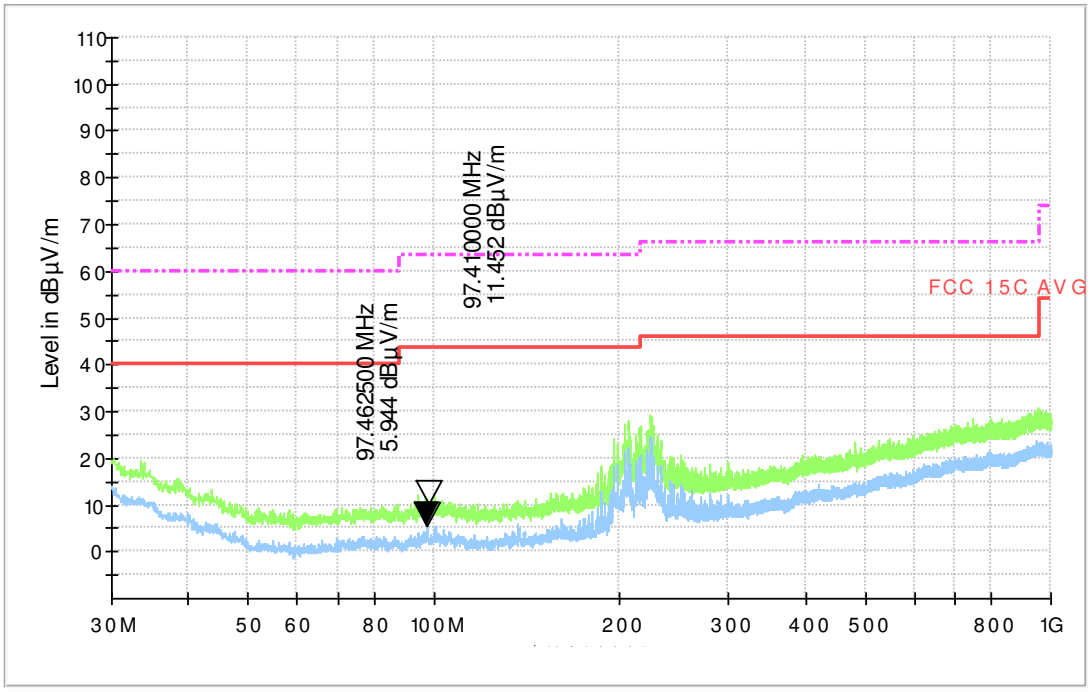
Transmitter Radiated Spurious Emission: Ch Mid 18GHz- 26 GHz - 802.11b-mode



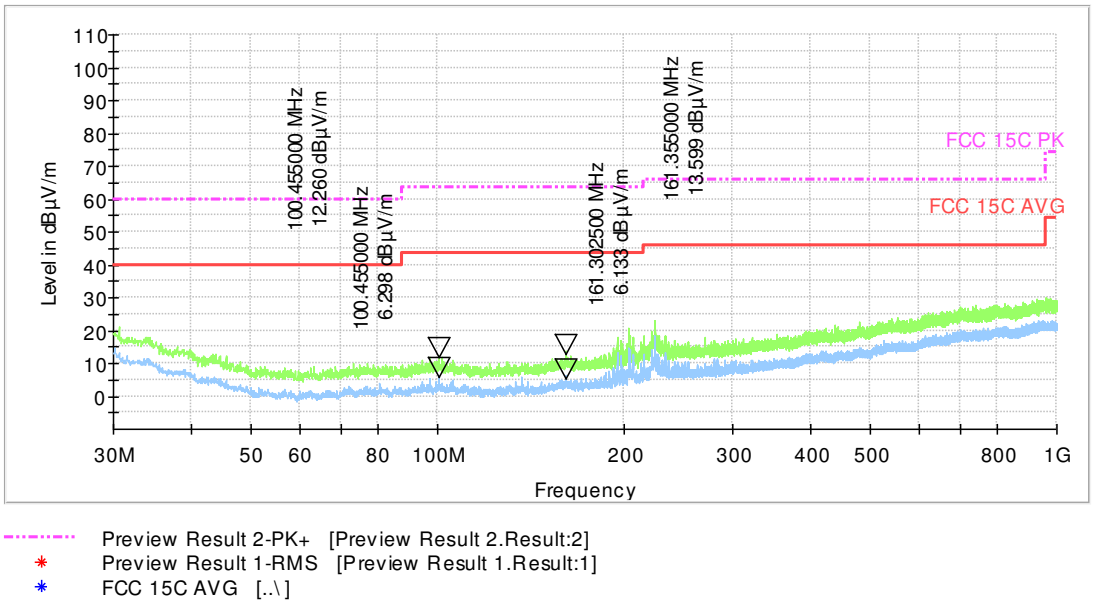
Transmitter Radiated Spurious Emission: Ch Mid- 9kHz – 30MHz- 802.11n-mode



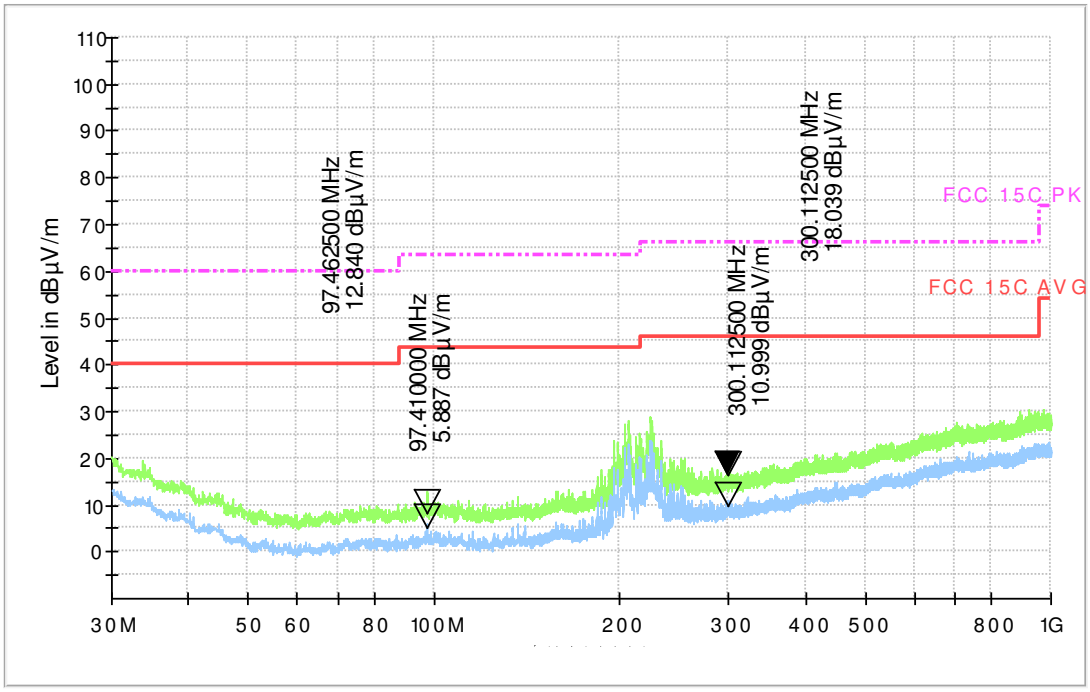
Transmitter Radiated Spurious Emission: Ch Low- 30 MHz – 1GHz - 802.11n-mode



Transmitter Radiated Spurious Emission: Ch Mid- 30 MHz – 1GHz - 802.11n-mode

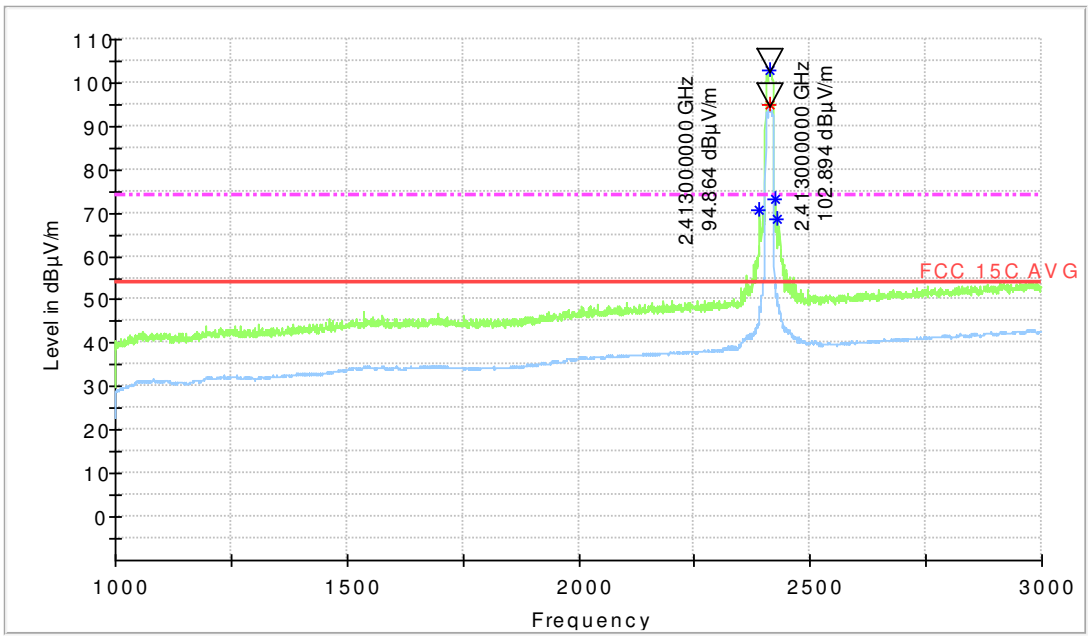


Transmitter Radiated Spurious Emission: Ch High- 30 MHz – 1GHz - 802.11n-mode



Note: The signal above limit is the Transmit channel.

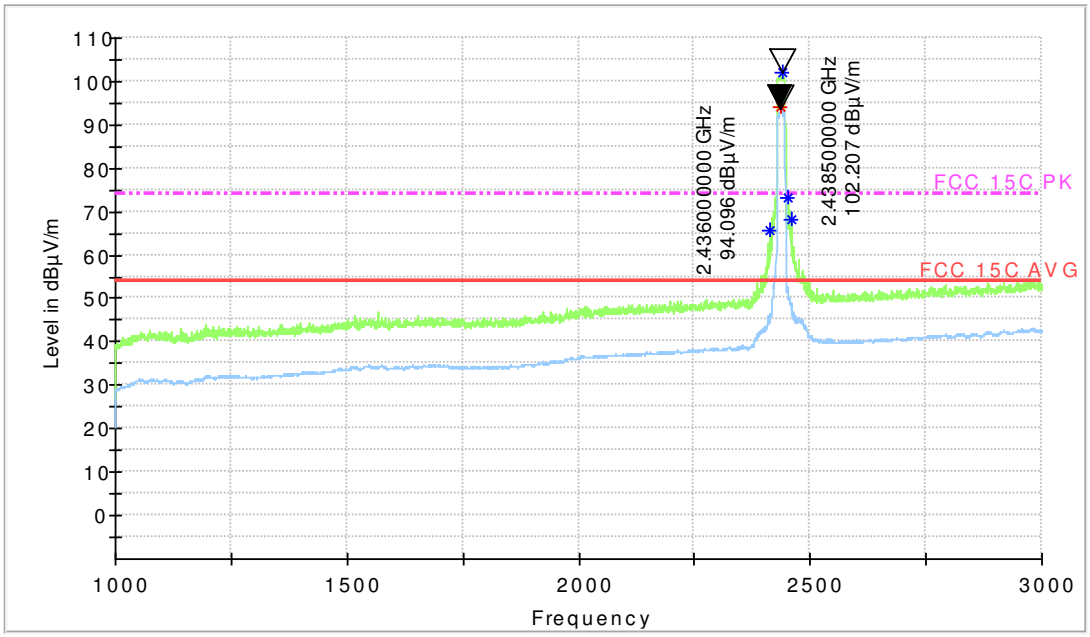
Transmitter Radiated Spurious Emission: Ch Low- 1GHz – 3GHz- 802.11n-mode



Preview Result 2-PK+ [Preview Result 2.Result:2] Preview Result 1-RMS [Preview Result
FCC 15C AVG [..\]

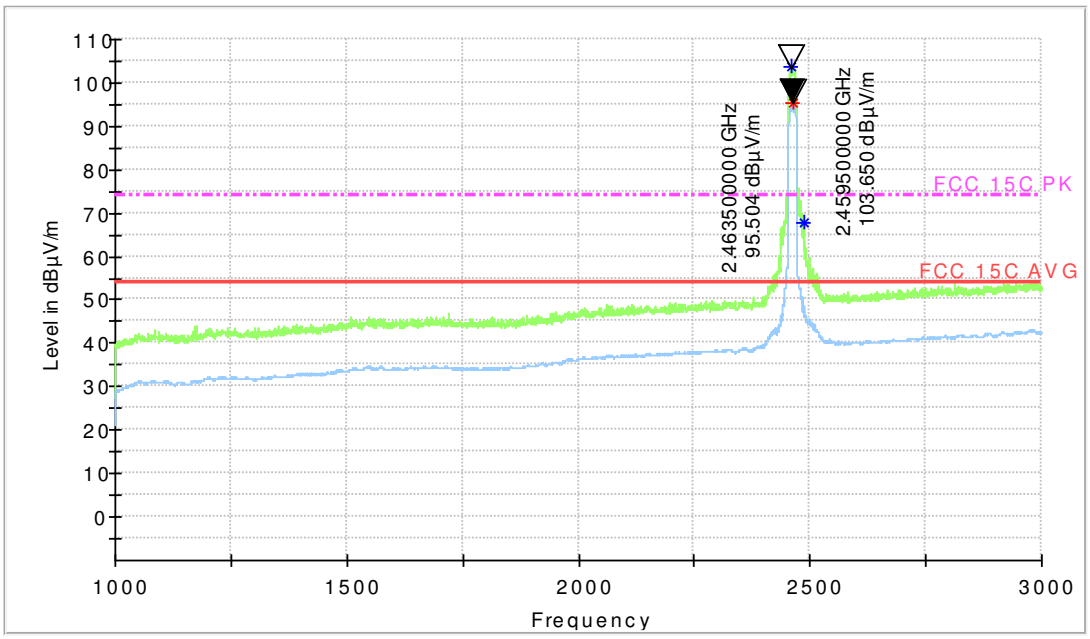
Note: The signal above limit is the Transmit channel.

Transmitter Radiated Spurious Emission: Ch Mid- 1GHz – 3GHz- 802.11n-mode



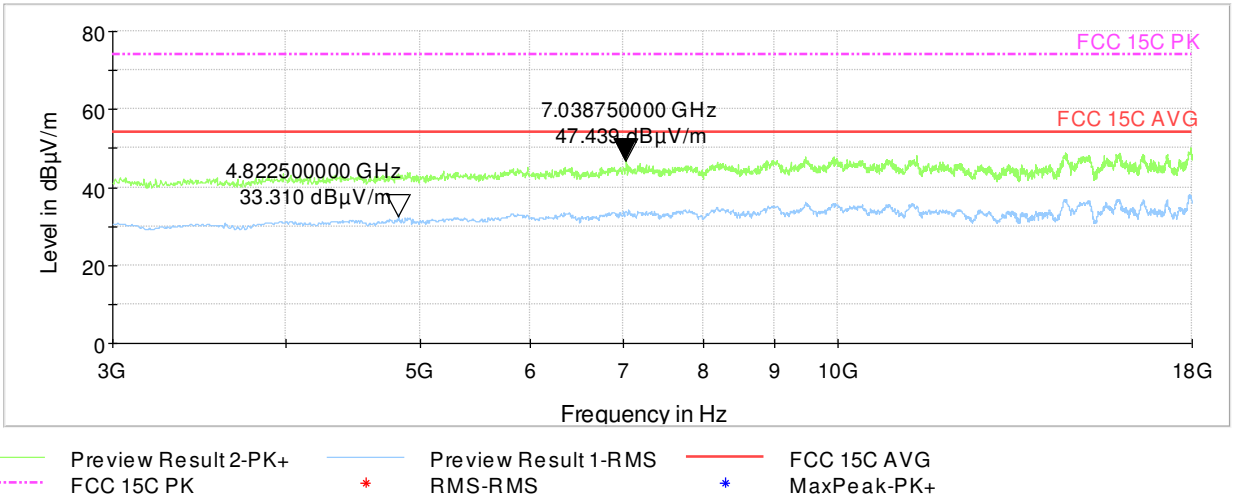
Note: The signal above limit is the Transmit channel.

Transmitter Radiated Spurious Emission: Ch High- 1GHz – 3GHz- 802.11n-mode

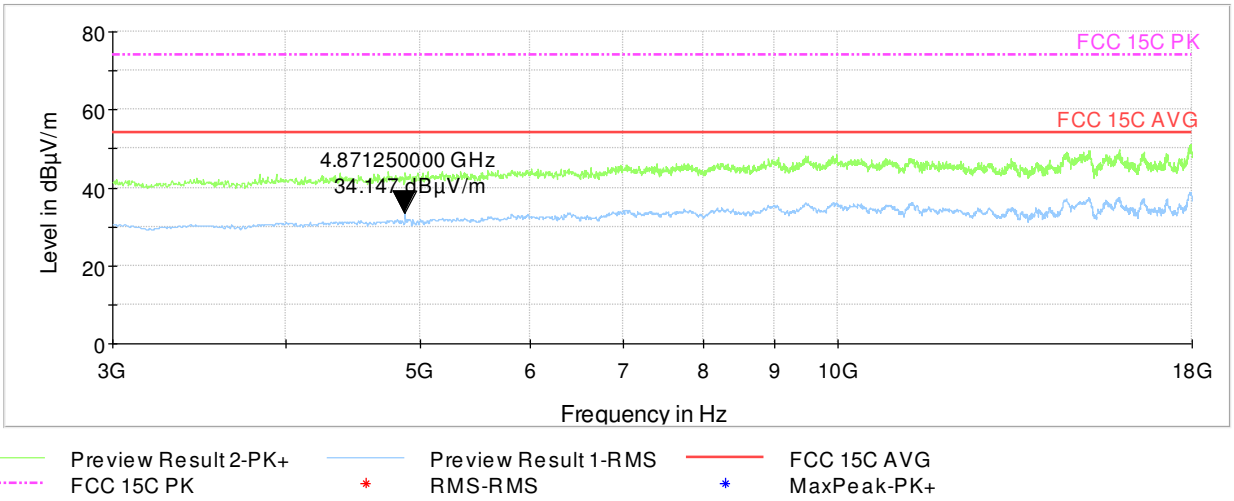


Note: The signal above limit is the Transmit channel.

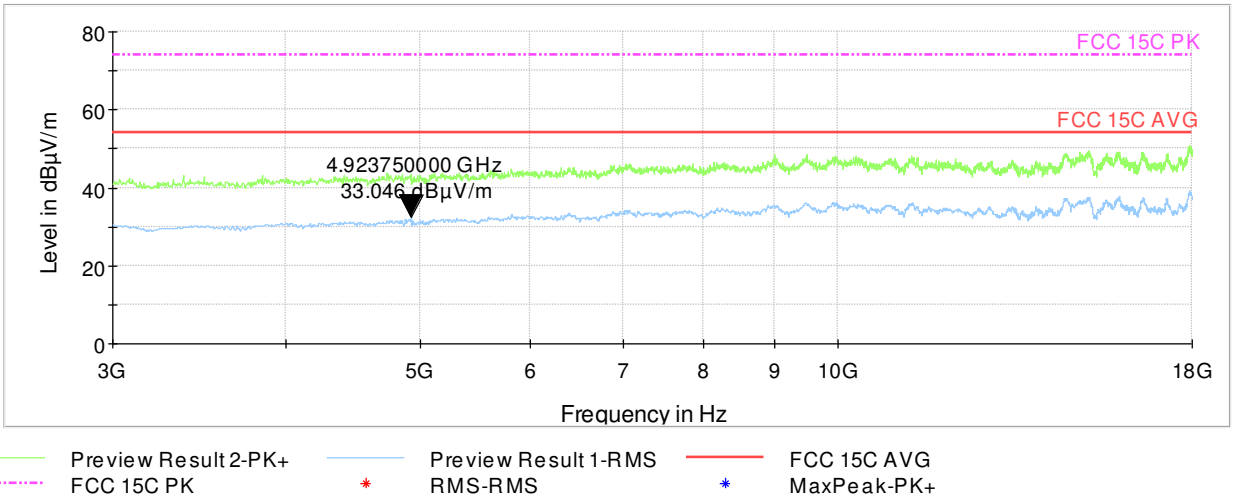
Transmitter Radiated Spurious Emission: Ch Low- 3 GHz – 18 GHz- 802.11n-mode



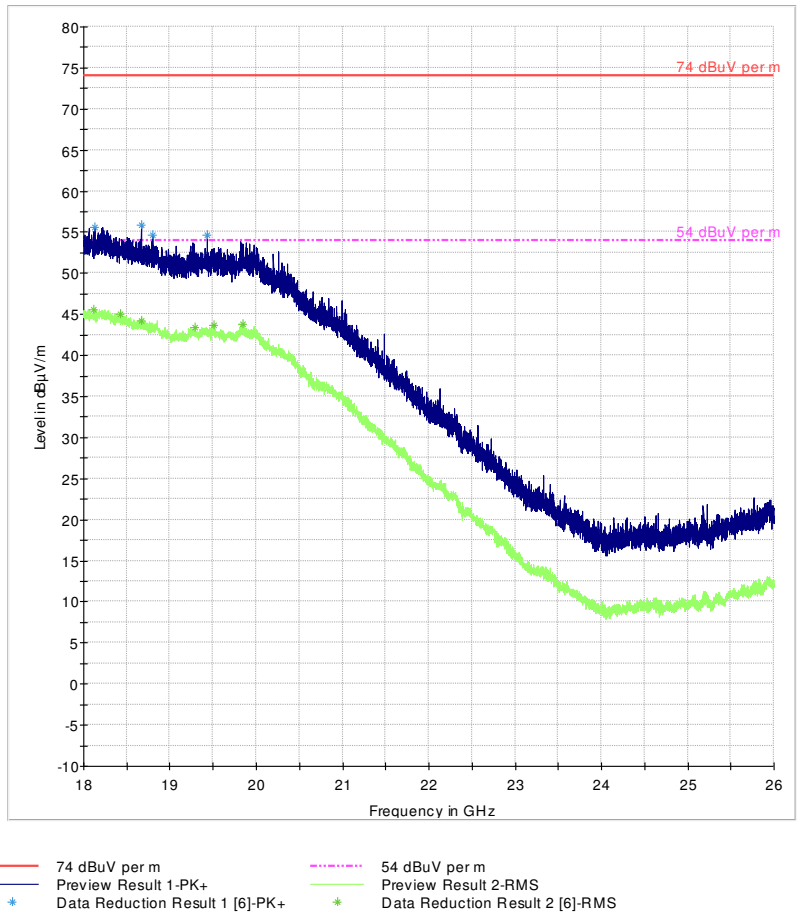
Transmitter Radiated Spurious Emission: Ch Mid- 3 GHz – 18 GHz- 802.11n-mode



Transmitter Radiated Spurious Emission: Ch High- 3 GHz – 18 GHz- 802.11n-mode



Transmitter Radiated Spurious Emission: Ch Mid 18GHz- 26 GHz - 802.11n-mode



11 EUT and Setup Pictures

Please refer to EMC-PEARL-004-16001-P110 -TestSetupPhotos.pdf

12 Test Equipment and Ancillaries used for tests.

Item Name	Equipment Type	Manufacturer	Model	Serial #	Calibration Cycle	Last Calibration Date
Turn table	Turn table	EMCO	2075	N/A	N/A	N/A
MAPS Position Controller	Controller	ETS Lindgren	2092	0004-1510	N/A	N/A
Antenna Mast	Antenna Mast	EMCO	2075	N/A	N/A	N/A
High Pass Filter	Filter	5HC2700	Trilithic Inc.	9926013	Part of system calibration	
High Pass Filter	Filter	4HC1600	Trilithic Inc.	9922307	Part of system calibration	
6GHz High Pass Filter	Filter	HPM50106	Microtronics	001	Part of system calibration	
Pre-Amplifier	Amplifier	JS4-00102600	Miteq	00616	Part of system calibration	
Relay Switch Unit	Relay Switch Unit	Rohde&Schwarz	RSU	338964/001	N/A	N/A
Spectrum Analyzer	Analyzer	Rohde&Schwarz	FSU	200302	3 Years	Jun 2013
Antenna Biconilog 3142E	Biconlog Antenna	EMCO	3142E	166067	3 years	6/14/2014
Antenna Loop 6512	Loop Antenna	ETS Lindgren	6512	49838	3 years	3/13/2014
Antenna Horn 3115 SN 35111	Horn Antenna	EMCO	3115	35111	3 years	7/24/2015
Spectrum Analyzer FSU26	Spectrum Analyzer	R&S	FSU26	200065	3 years	7/4/2015
Antenna Horn 3116	Horn Antenna	ETS Lindgren	3116	70497	3 years	7/22/2015
Digital Barometer	Compact Digital Barometer	Control Company	35519-055	91119547	2 Years	4/7/2015
ESU 40	Receiver	R&S	ESU 40	100251	2 years	6/29/2015
Thermometer Humidity TM320	Thermometer Humidity	Dickson	TM320	5283196	1 Year	10/27/2015

Calibration details valid at the time of testing.
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.

13 Revision History

Date	Report Name	Changes to report	Report prepared by
2016-09-29	EMC-PEARL-004-16001-15.247-P110-DTS-WLAN	Initial version	James Donnellan