TEST REPORT

Report Number: 102241369MPK-011
Project Number: G102241369
January 25, 2016

Testing performed on the
WiFi/BT Module Card
Model: 576253
FCC ID: 2AHLA-576253
IC: 4811A-576253
to

FCC Part 15 Subpart C (15.247)
Industry Canada RSS-247, Issue 1

For

Bosch Automotive Service Solutions LLC

Test Performed by:	Test Authorized by:
Intertek	Bosch Automotive Service Solutions LLC
1365 Adams Court	655 Eisenhower Dr.
Menlo Park, CA 94025 USA	Owatonna, MN 55060, USA

Prepared by: _____ **Date:** January 25, 2016
Anderson Soungpanya

Reviewed by: _____ **Date:** January 25, 2016
Krishna K Vemuri

Report No. 102241369MPK-011

Equipment Under Test:	WiFi/BT Module Card
Trade Name:	WiFi/BT Module Card
Model Number:	576253
Serial Number:	MPK1511100953-001
Applicant:	Bosch Automotive Service Solutions LLC
Contact:	Eric Vande Zande
Address:	Bosch Automotive Service Solutions LLC 655 Eisenhower Dr. Owatonna, MN 55060
Country	USA
Tel. Number:	(507) 455-4437
Email:	eric.vandezande@us.bosch.com
Applicable Regulation:	FCC Part 15 Subpart C (15.247) Industry Canada RSS-247 Issue 1
Date of Test:	November 03 to December 16, 2015

We attest to the accuracy of this report:

Anderson Soungpanya	Krishna K Vemuri
Project Engineer	EMC Senior Staff Engineer

TABLE OF CONTENTS

1.0 Summary of Tests

Test	Reference FCC	Reference Industry Canada	Result
RF Output Power	15.247(b)(3)	RSS-247, 5.4	Complies
6 dB Bandwidth	15.247(a)(2)	RSS-247, 5.2	Complies
Power Density	15.247(e)	RSS-247, 5.2	Complies
Out of Band Antenna Conducted Emission	15.247(d)	RSS-247, 5.5	Complies
Transmitter Radiated Emissions	15.247(d), 15.209, 15.205	RSS-247, 5.5	Complies
AC Line Conducted Emission	15.207	RSS-GEN	Complies
Antenna Requirement	15.203	RSS-GEN	Complies (Unique Connector & Internal Antenna)
RF Exposure	15.247(i), 2.1093(d)	RSS-102	Complies

EUT receive date: October 19, 2015
EUT receive condition: The pre-production version of the EUT was received in good condition with no apparent damage. As declared by the Applicant, it is identical to the production units.
Test start date: November 03, 2015
Test completion date: December 16, 2015
The test results in this report pertain only to the item tested.

2.0 General Information

2.1 Product Description

The Mid Range Scan Tool (MRST) is to be used in an automotive service shop environment in global markets. The MRST is usable as a standalone instrument by connecting to the vehicle diagnostic connector. Vehicle diagnostic connectivity is also added for certain Multi-Media equipped vehicles via USB, Bluetooth, and audio cable.

This test report covers only the WiFi radio. A separate test report covers the Bluetooth radio.

Information about the WiFI radio is presented below:

The EUT supports a wide range of data rates in the 2.4GHz band:

IEEE 802.11b
IEEE 802.11g
IEEE 802.11n

Applicant	Bosch Automotive Service Solutions LLC
Model Number	576253
FCC Identifier	2AHLA-576253
IC Identifier	4811A-576253
Modulation Technique	DSSS (BPSK, QPSK, CCK), OFDM (BPSK, QPSK, 16QAM, 64QAM)
Rated RF Output	802.11b: 16.41 dBm 802.11g: 16.66 dBm 802.11n : 16.56 dBm
Frequency Range	2412 – 2462 MHz, 802.11b/g/n 20MHz
Type of modulation	BPSK, QPSK, 16QAM, 64QAM
Number of Channel(s)	11 for 802.11b/g/n, 20MHz channels
Antenna(s) & Gain	YAGEO - ANTX150P111B24553; Internal Antenna, 3.2 dBi peak gain Taoglas Antenna Solution - FXP.840.07.0055B; Internal Antenna, 2.0 dBi peak gain
Applicant Name & Address	Bosch Automotive Service Solutions LLC 655 Eisenhower Dr. Owatonna, MN 55060 USA

2.2 Related Submittal(s) Grants

None.

2.3 Test Methodology

Antenna conducted measurements were performed according to the FCC documents “Guidance for Performing Compliance Measurement on Digital Transmission Systems (DTS) Operating under §15.247” (KDB 558074), and RSS-247, RSS-GEN, and

Radiated emissions and AC mains conducted emissions measurements were performed according to the procedures in ANSI C63.10. Radiated tests were performed at an antenna to EUT distance of 3 meters, unless stated otherwise in the "Data Sheet" of this report.

2.4 Test Facility

The test site used to collect the radiated data is site 1 (10-m semi-anechoic chamber). This test facility and site measurement data have been fully placed on file with the FCC, IC and A2LA accredited.

2.5 Measurement Uncertainty

Compliance with the limits was based on the results of the measurements and doesn’t take into account the measurement uncertainty.

Estimated Measurement Uncertainty

Measurement	Expanded Uncertainty (k=2)		
	0.15 MHz – 1 GHz	1 GHz – 6 GHz	> 6 GHz
RF Power and Power Density – antenna conducted	1.1 dB	1.5 dB	–
Unwanted emissions - antenna conducted	1.2 dB	1.7 dB	2.0 dB
Bandwidth – antenna conducted	50 Hz	100 Hz	–
Radiated emissions	4.2 dB	5.4 dB	
AC mains conducted emissions	2.4 dB	-	-

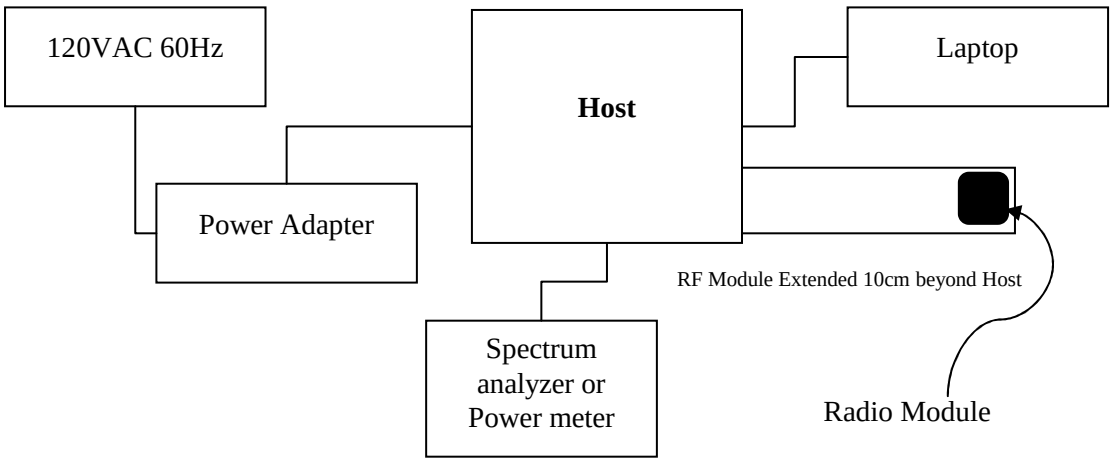
3.0 System Test Configuration

3.1 Support Equipment and description

Description	Manufacturer	Model No./ Part No.
Power Adapter	I.T.E Power Supply	PW172KB1500B02
Laptop	Acer	Aspire E1-571-6811

3.2 Block Diagram of Test Setup

Antenna was removed and co-axial connector with a cable was installed for Conducted Measurements.
50Ohm Load was used for Radiated Measurements.



S = Shielded	**F** = With Ferrite
U = Unshielded	**M** = Meter

3.3 Justification

Preliminary testing was performed for all modulation/data rate modes. The worse-case data rate with highest power and widest spectrum were selected for final measurements:

CCK 1 Mbps – for 802.11b
OFDM 6 Mbps – for 802.11g
OFDM MCS0 – for 802.11n

Unless otherwise stated in this report, measurements made for Power Density, Bandwidth, Conducted Spurious, Radiated Spurious (Cabinet Radiation) were made with the worst case power setting (mid channel power).

3.4 Mode of Operation During Test

During transmitter testing, the transmitter was setup to transmit continuously using the RF power setting below. Their corresponding output power in dBm can be found in section 4.2 of this report.

Frequency (MHz)	Channel	802.11b	802.11g	802.11n
2412	1	18	15	15
2417	2	-	17	17
2437	6	20	20	20
2457	10	-	17	17
2462	11	18	15	14

3.5 Modifications Required for Compliance

Intertek installed no modifications during compliance testing in order to bring the product into compliance.

3.6 Additions, Deviations and Exclusions from Standards

No additions, deviations or exclusions from the standard were made.

4.0 Measurement Results

4.1 6dB DTS Bandwidth, 6dB RSS Bandwidth and 99% Occupied Bandwidth
FCC Rule 15.247(a)(2)

4.1.1 Requirement

The minimum 6-dB bandwidth shall be at least 500 kHz

4.1.2 Procedure

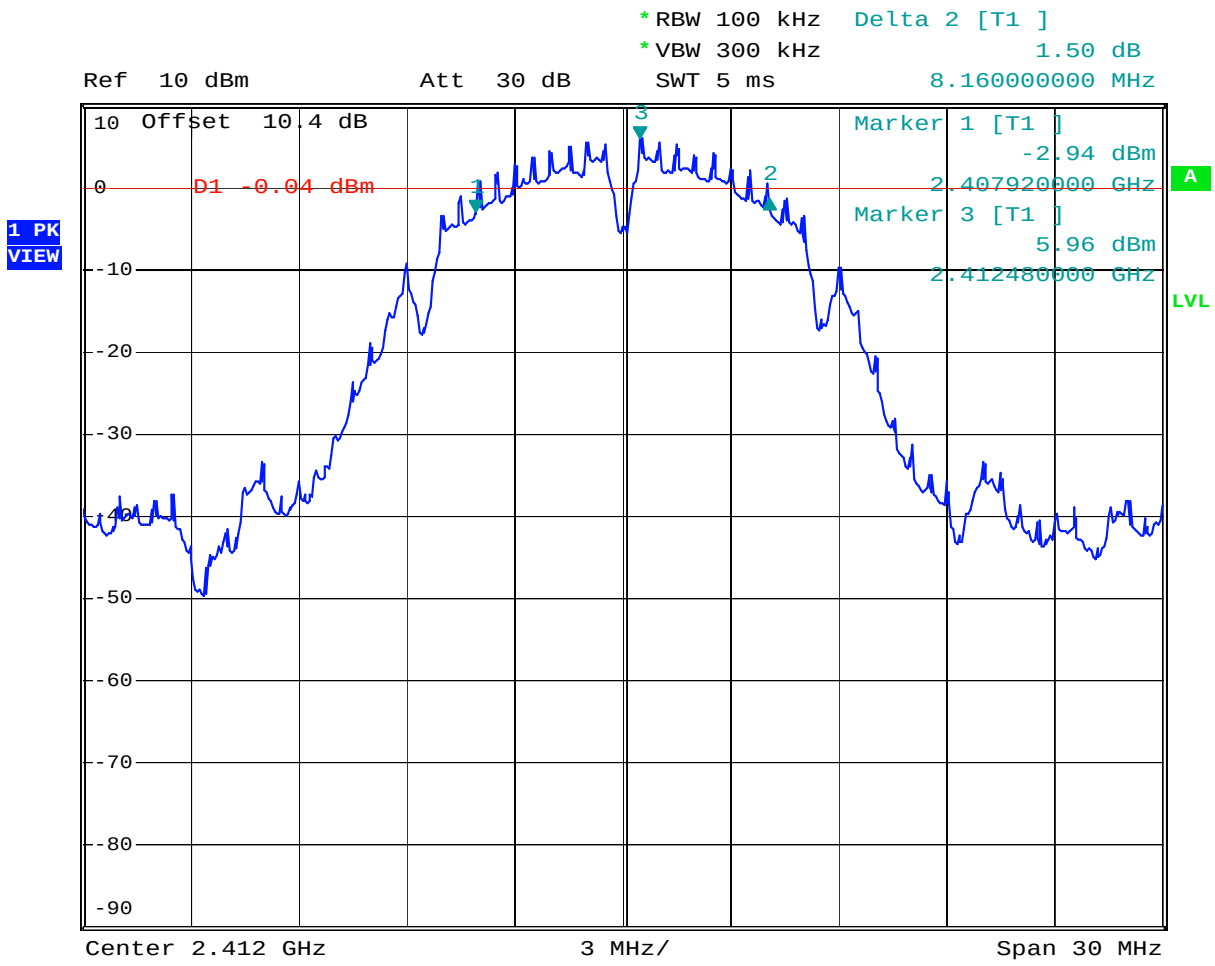
The Procedure described in the FCC Publication 558074 was used.
The antenna port of the EUT was connected to the input of a spectrum analyzer (SA). For each RF output channel investigated, the spectrum analyzer center frequency was set to the channel carrier. A PEAK output reading was taken, a DISPLAY line was drawn 6 dB lower than PEAK level. The 6-dB bandwidth was determined from where the channel output spectrum intersected the display line.

The occupied bandwidth was measured using the built-in spectrum analyzer function for 99% power bandwidth measurement.

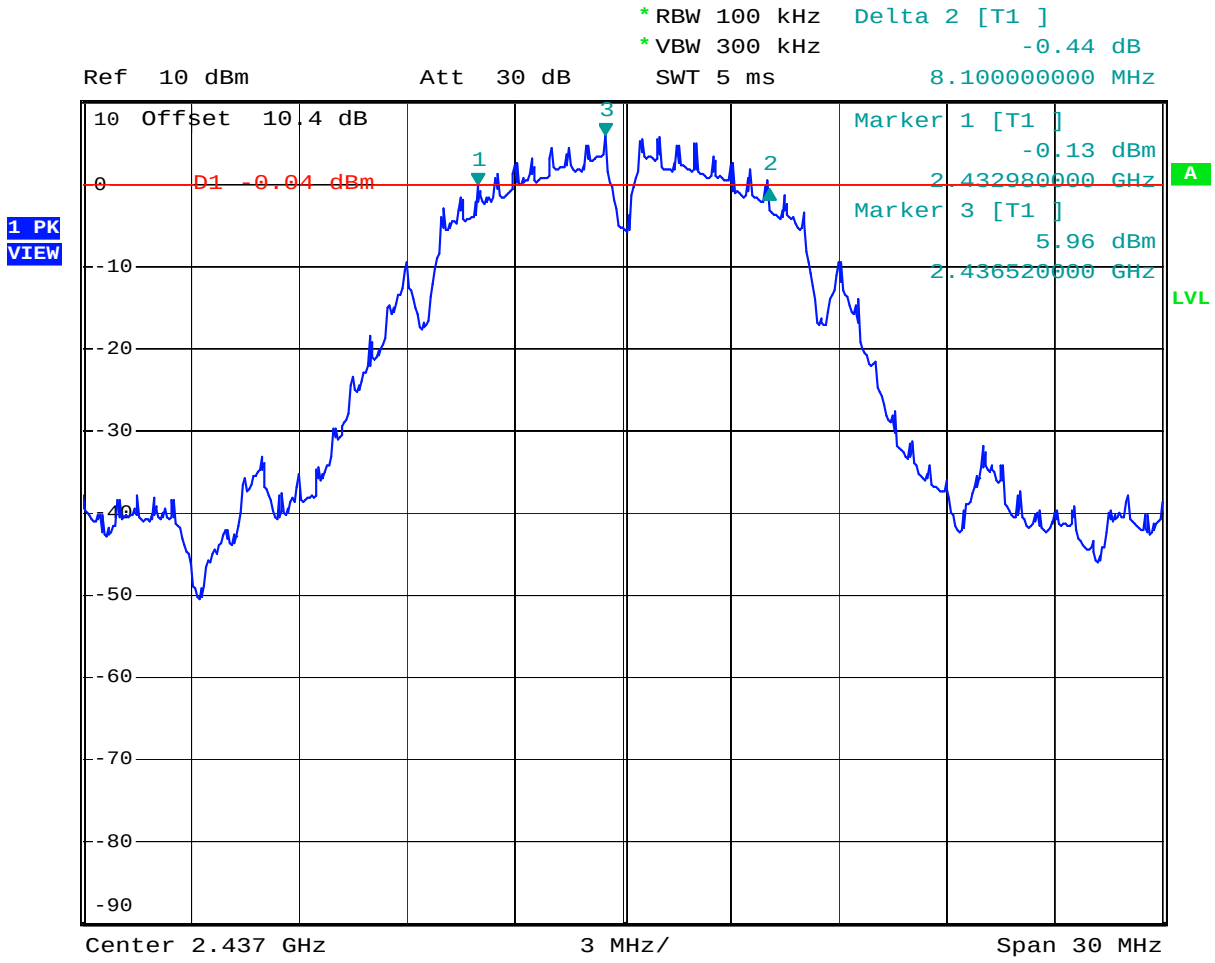
4.1.3 Test Result

Frequency MHz	Ch.	Frequency MHz	6 dB FCC Bandwidth, MHz	Plot #	99% Bandwidth, MHz	Plot #	6 dB RSS Bandwidth, MHz	Plot #
802.11b	1	2412	8.160	1.1	10.665	1.10	8.036	1.10
	6	2437	8.100	1.2	11.171	1.11	8.160	1.11
	11	2462	8.100	1.3	11.093	1.12	8.160	1.12
802.11g	1	2412	16.430	1.4	17.516	1.13	16.560	1.13
	6	2437	16.440	1.5	17.599	1.14	16.706	1.14
	11	2462	16.520	1.6	17.561	1.15	16.650	1.15
802.11n 20MHz	1	2412	17.760	1.7	18.420	1.16	17.820	1.16
	6	2437	17.780	1.8	18.484	1.17	17.700	1.17
	11	2462	17.710	1.9	18.484	1.18	17.696	1.18

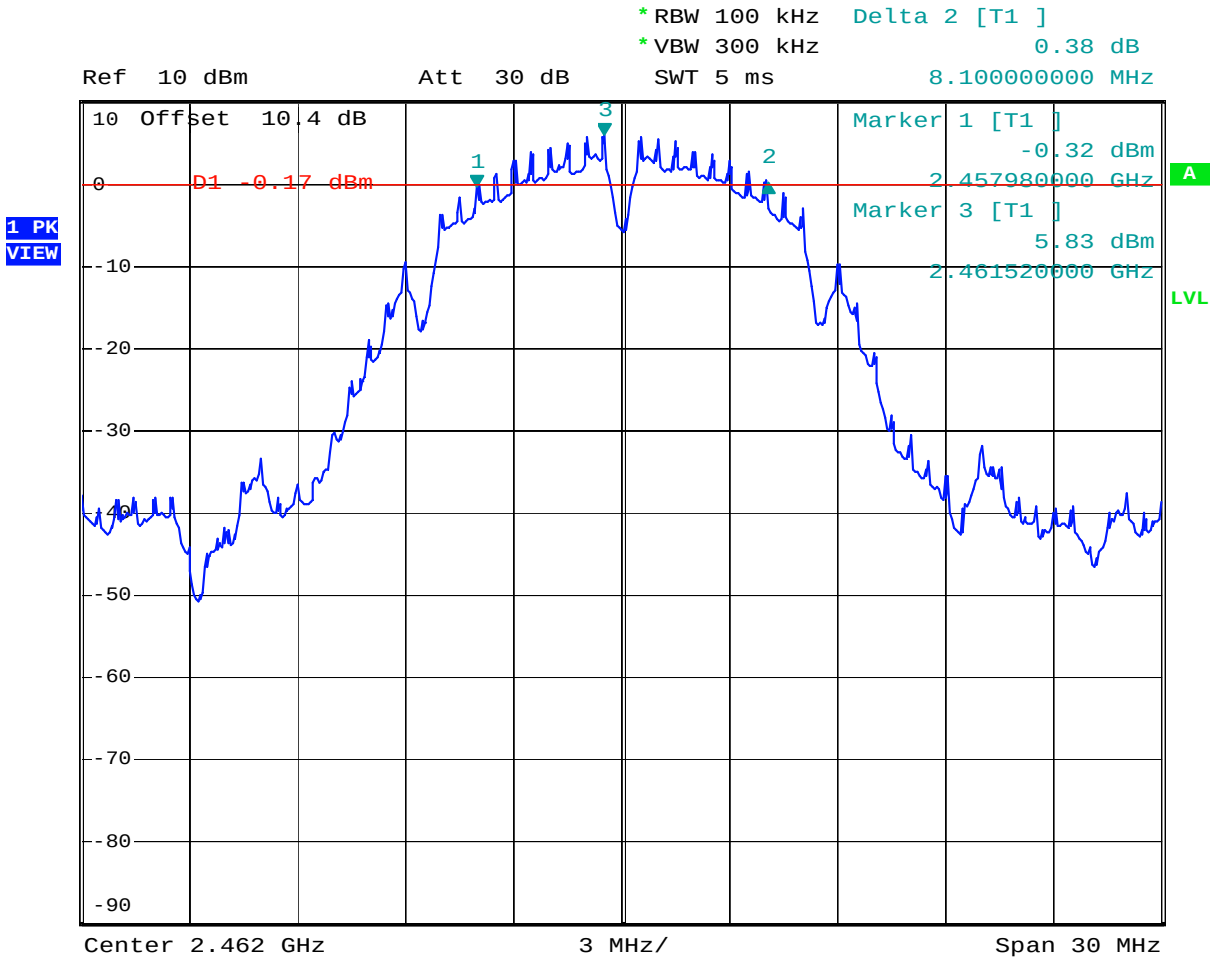
Plot 1.1 – 6dB Bandwidth (FCC)



Plot 1.2 – 6dB Bandwidth (FCC)

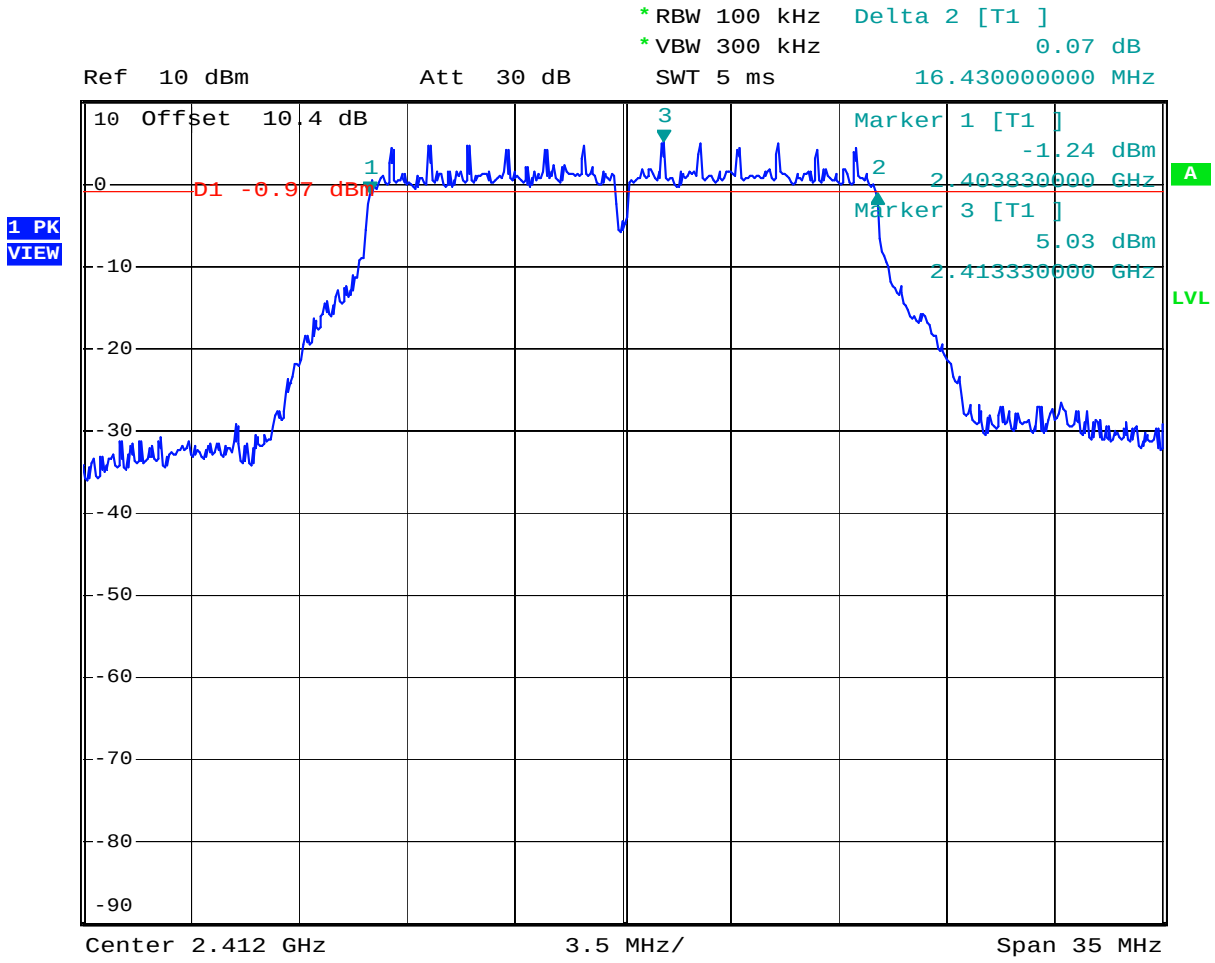


Plot 1 3 – 6dB Bandwidth (FCC)

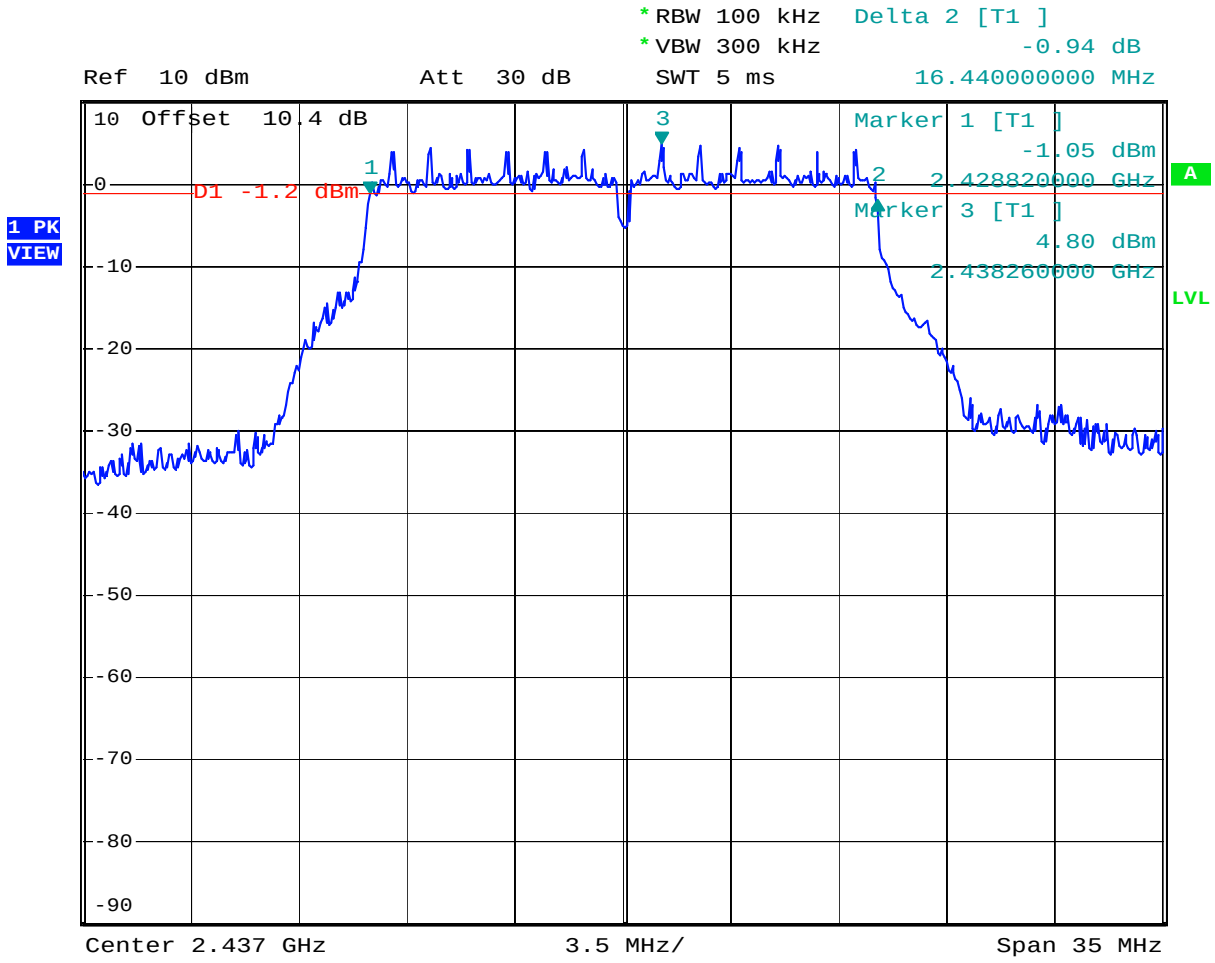


Date: 3.NOV.2015 11:29:25

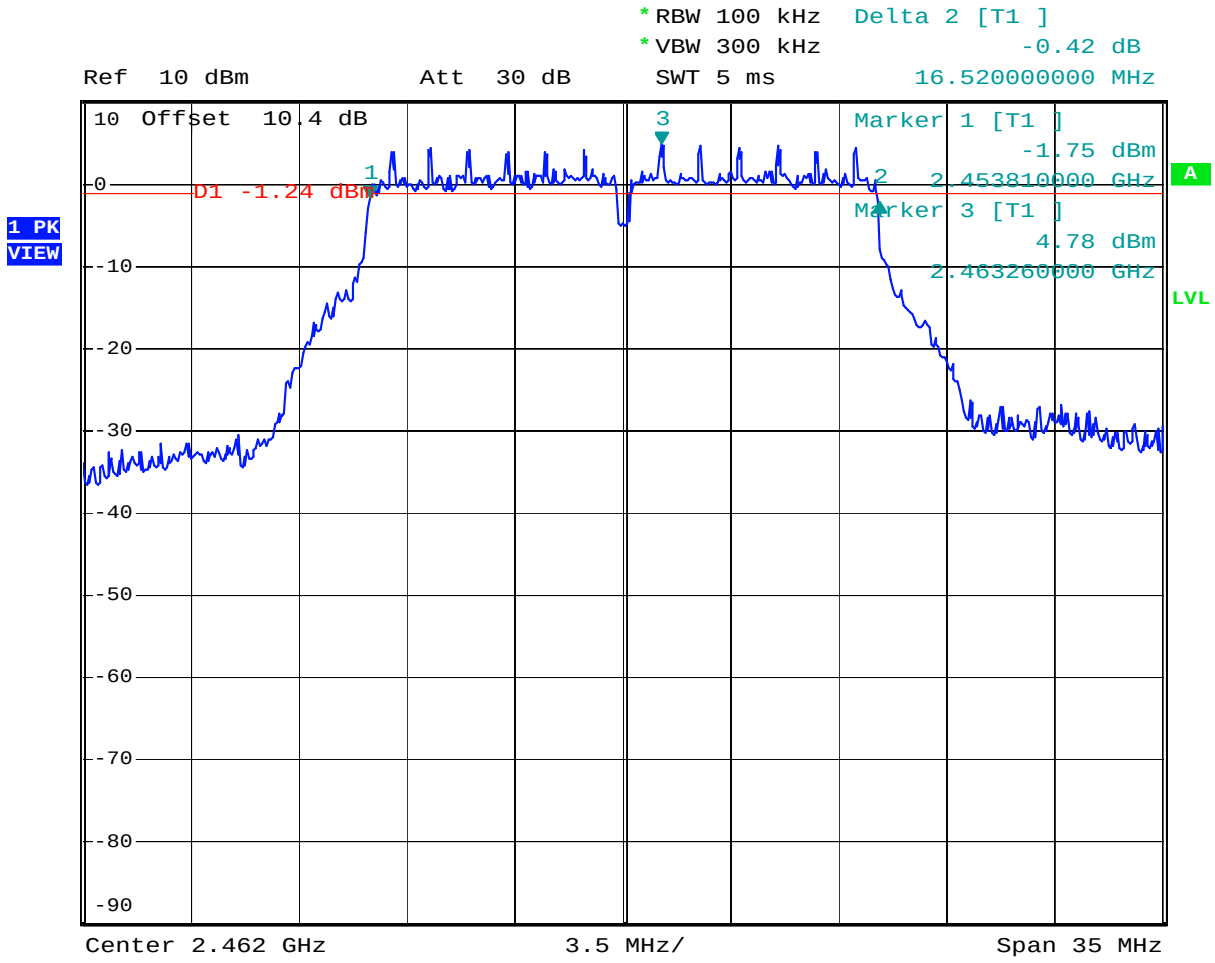
Plot 1.4 – 6dB Bandwidth (FCC)



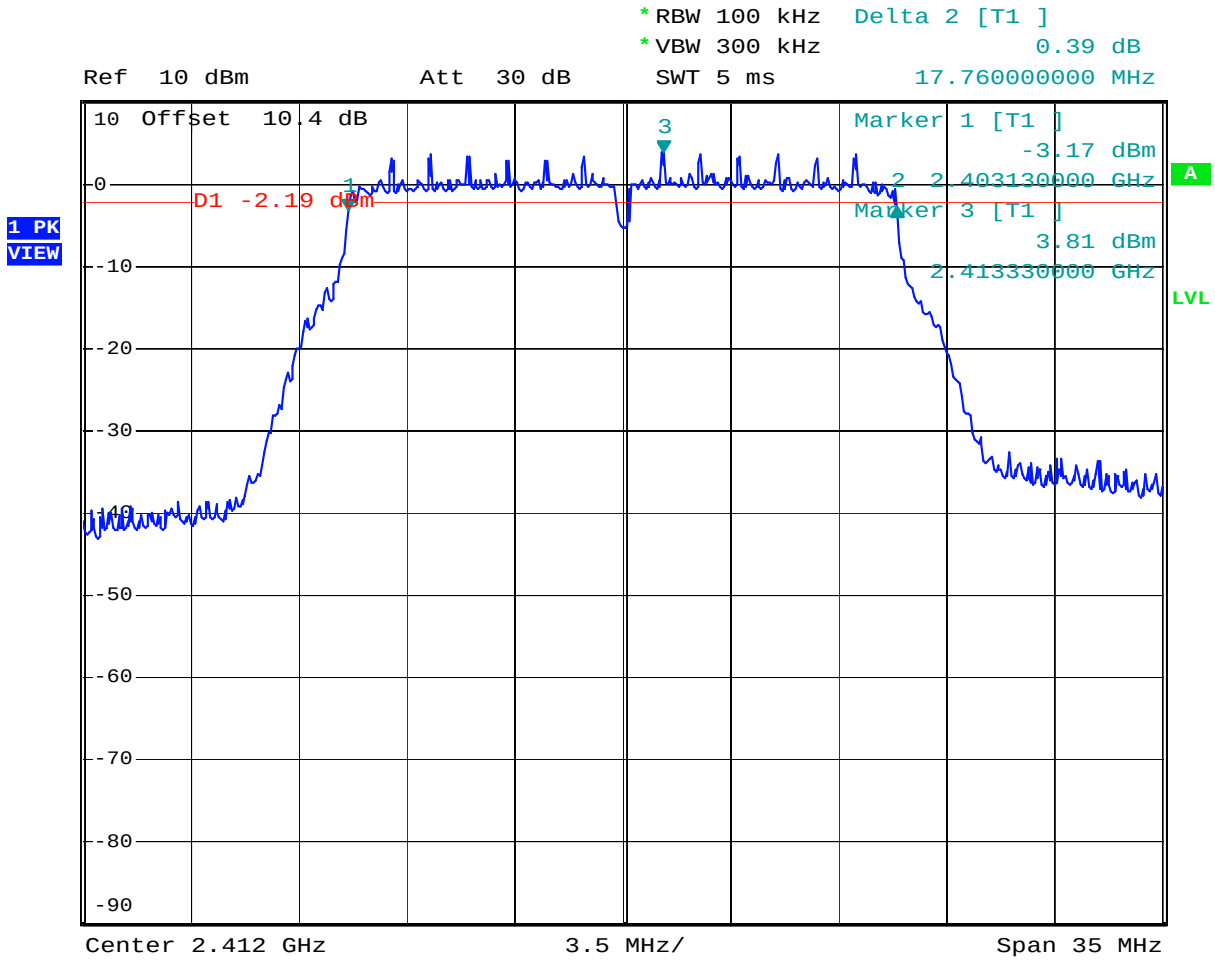
Plot 1.5 – 6dB Bandwidth (FCC)



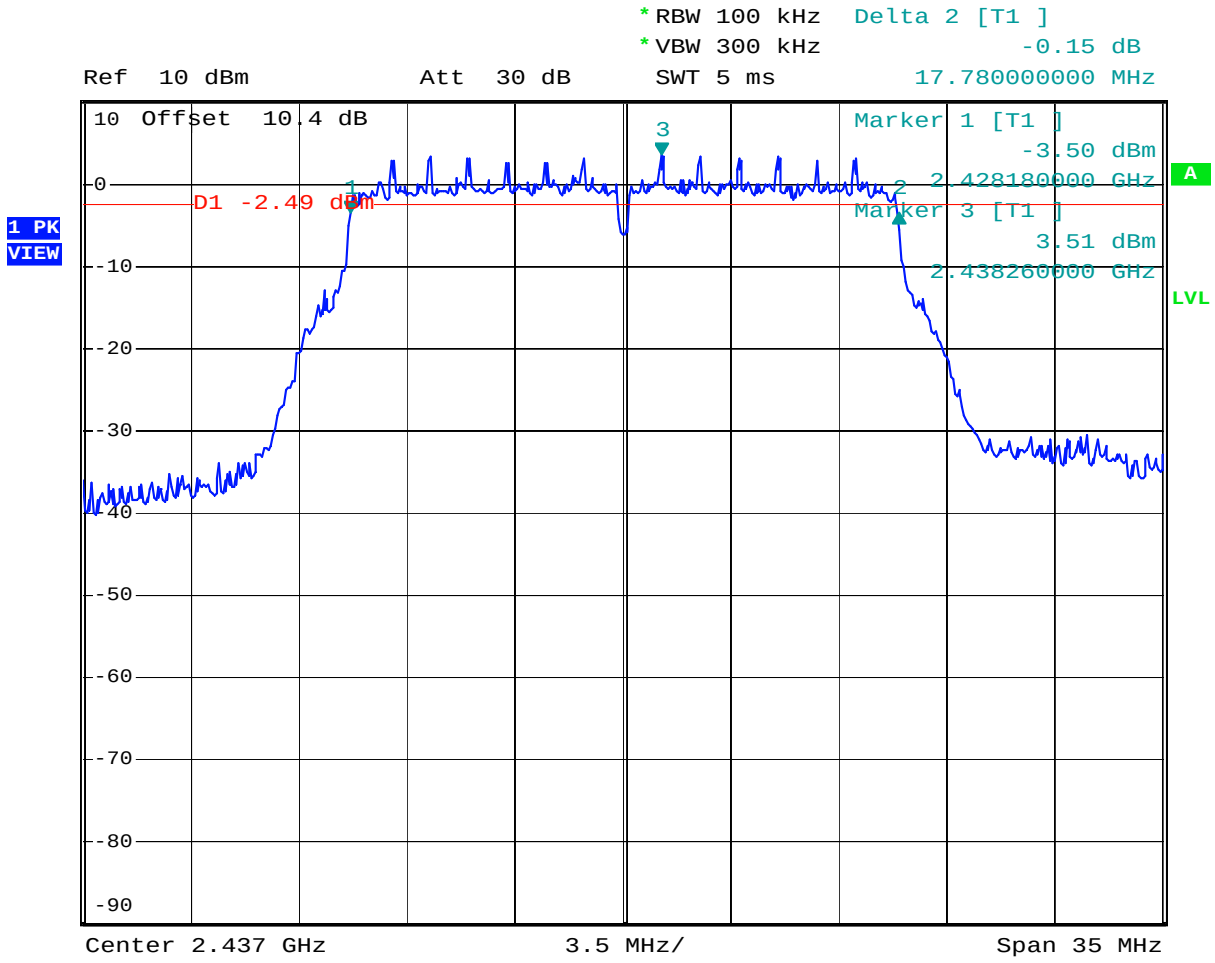
Plot 1.6 – 6dB Bandwidth (FCC)



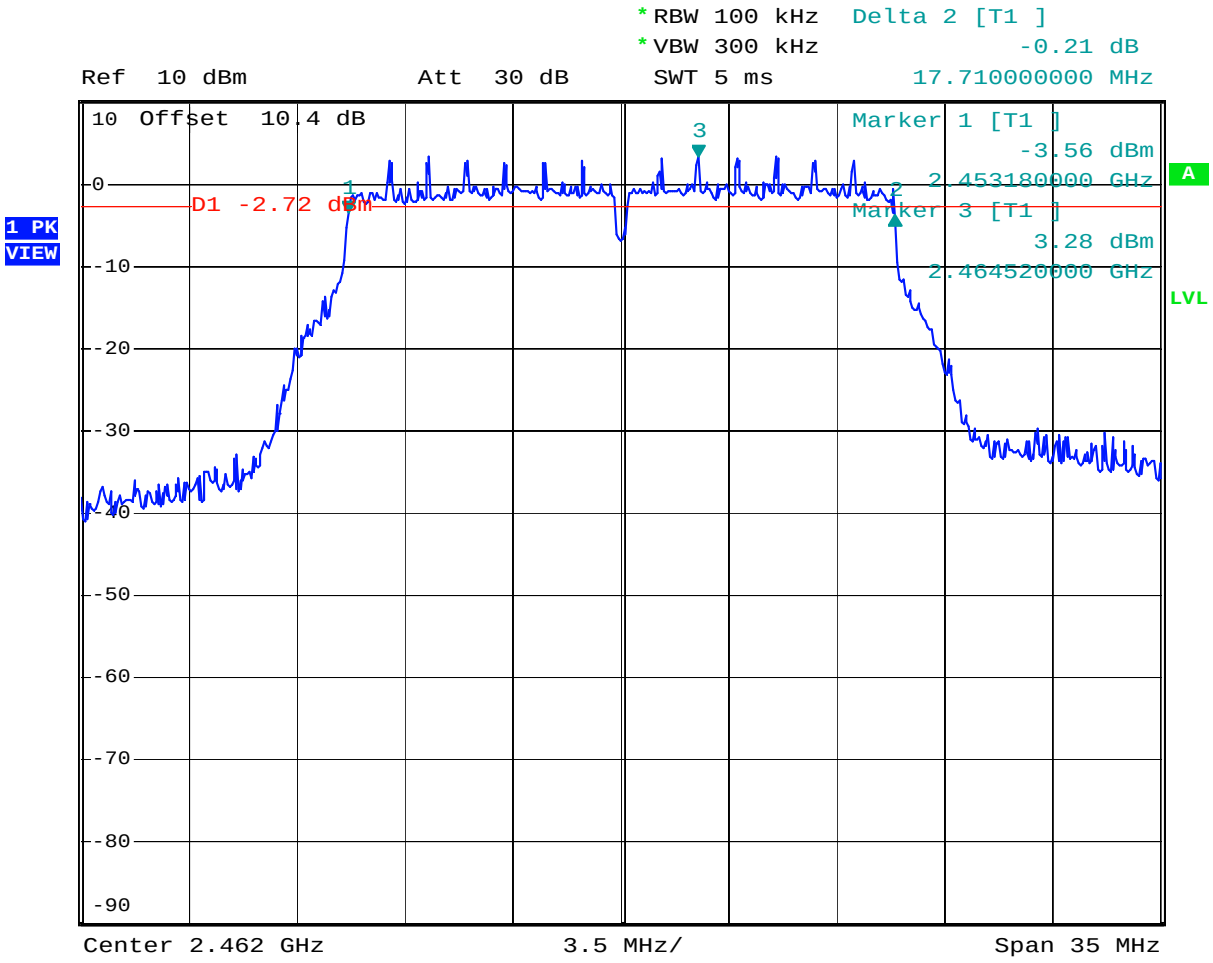
Plot 1.7 – 6dB Bandwidth (FCC)



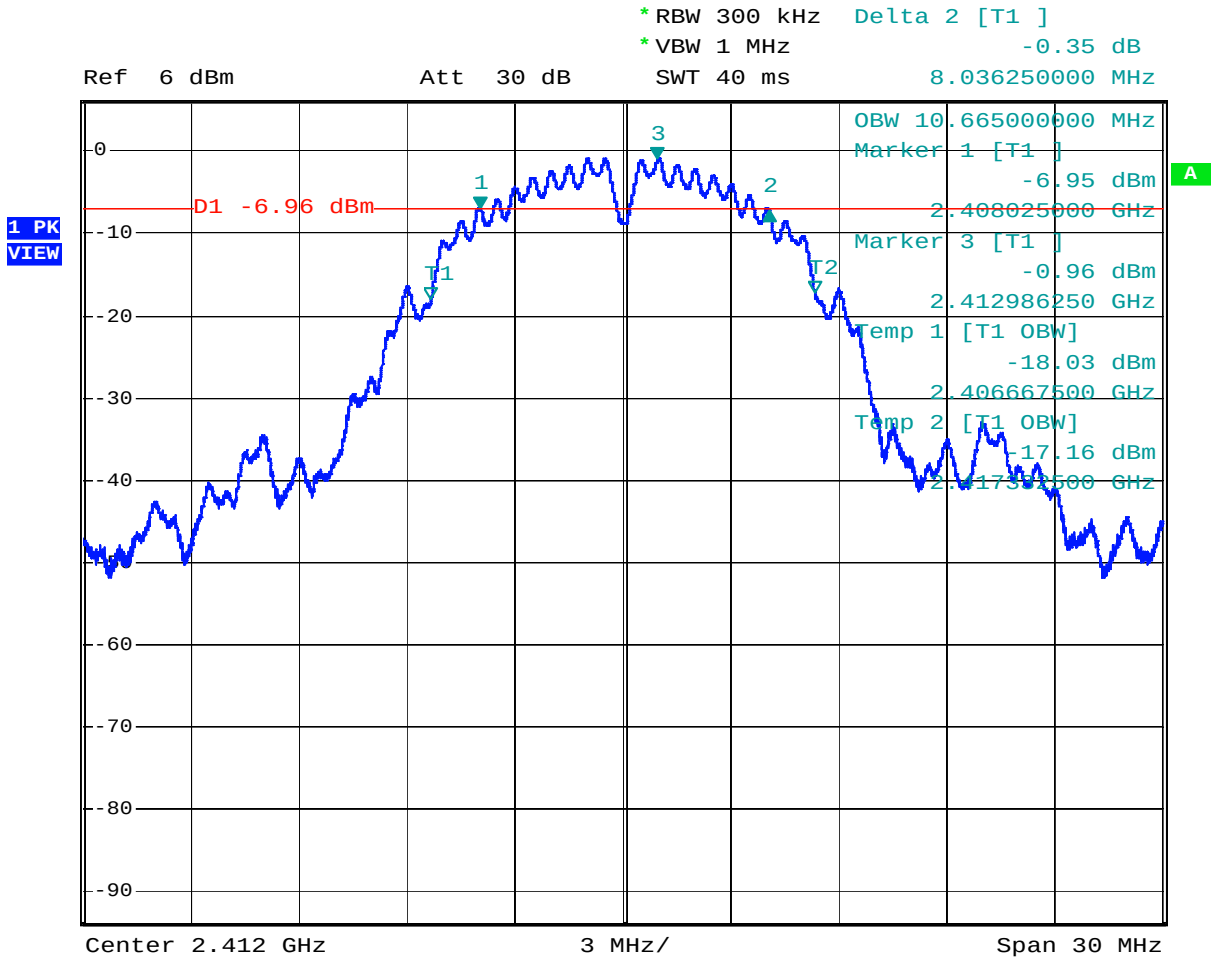
Plot 1.8 – 6dB Bandwidth (FCC)



Plot 1.9 – 6dB Bandwidth (FCC)

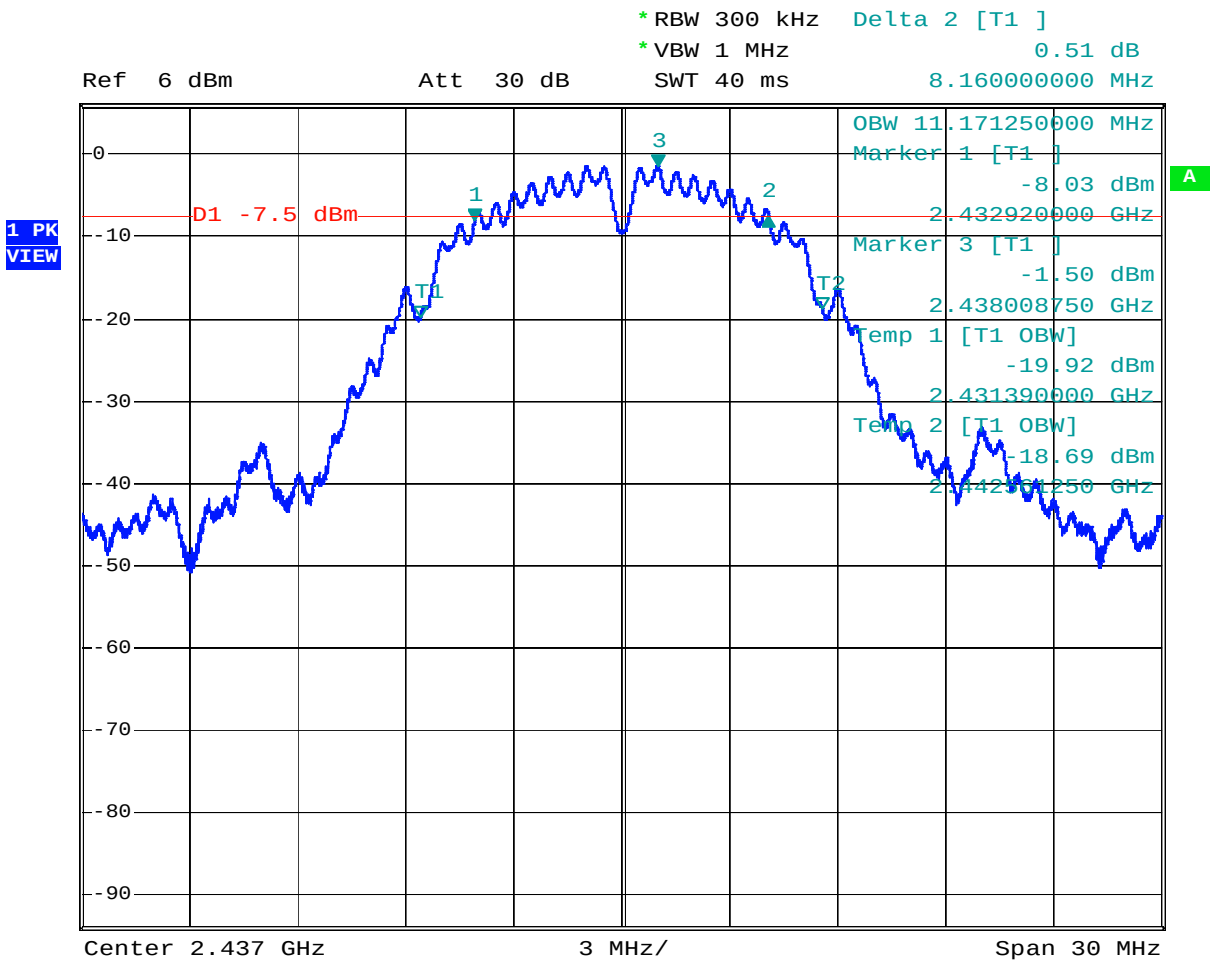


Plot 1.10 – 99% Bandwidth



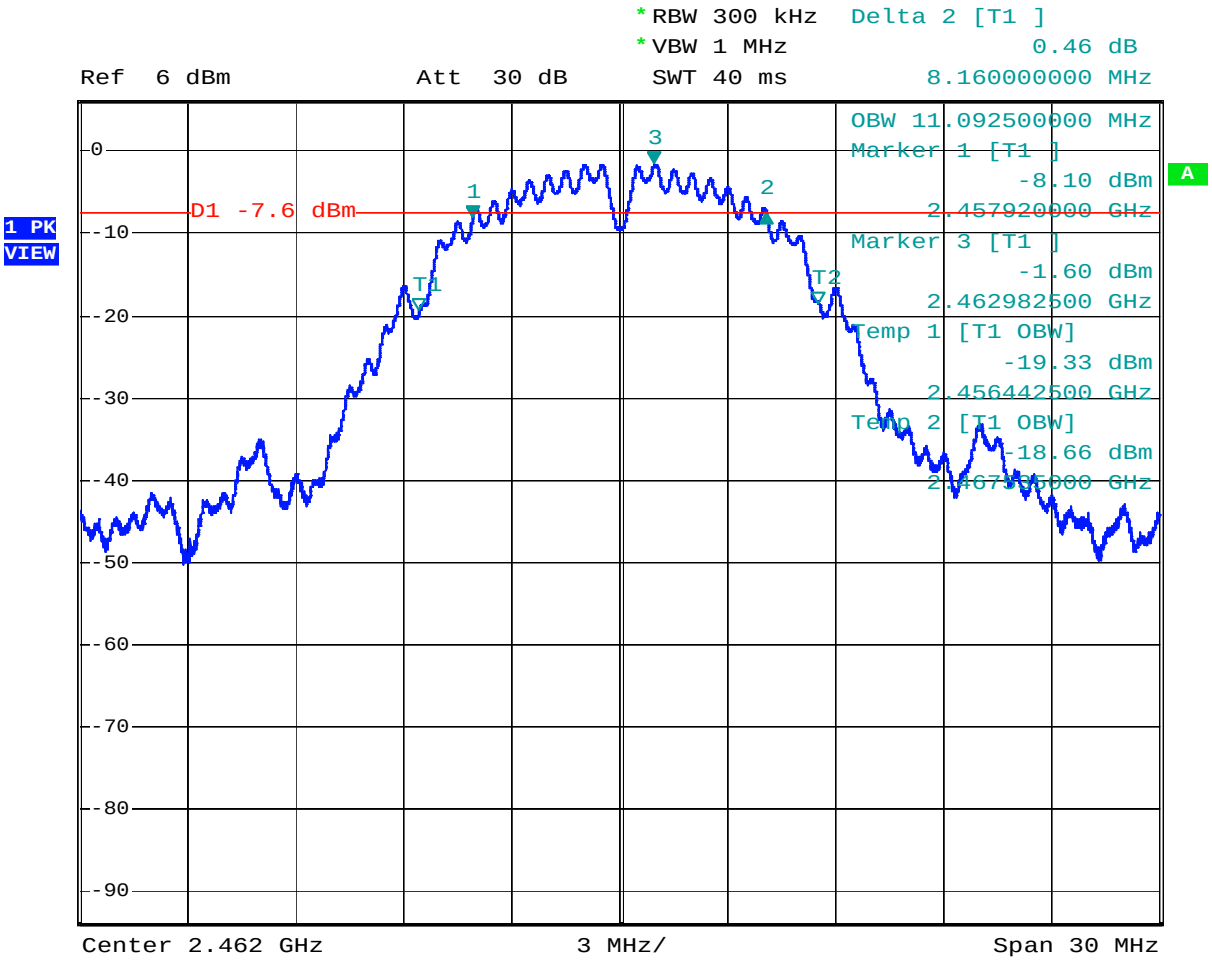
Date: 5.NOV.2015 11:10:04

Plot 1.11 – 99% Bandwidth



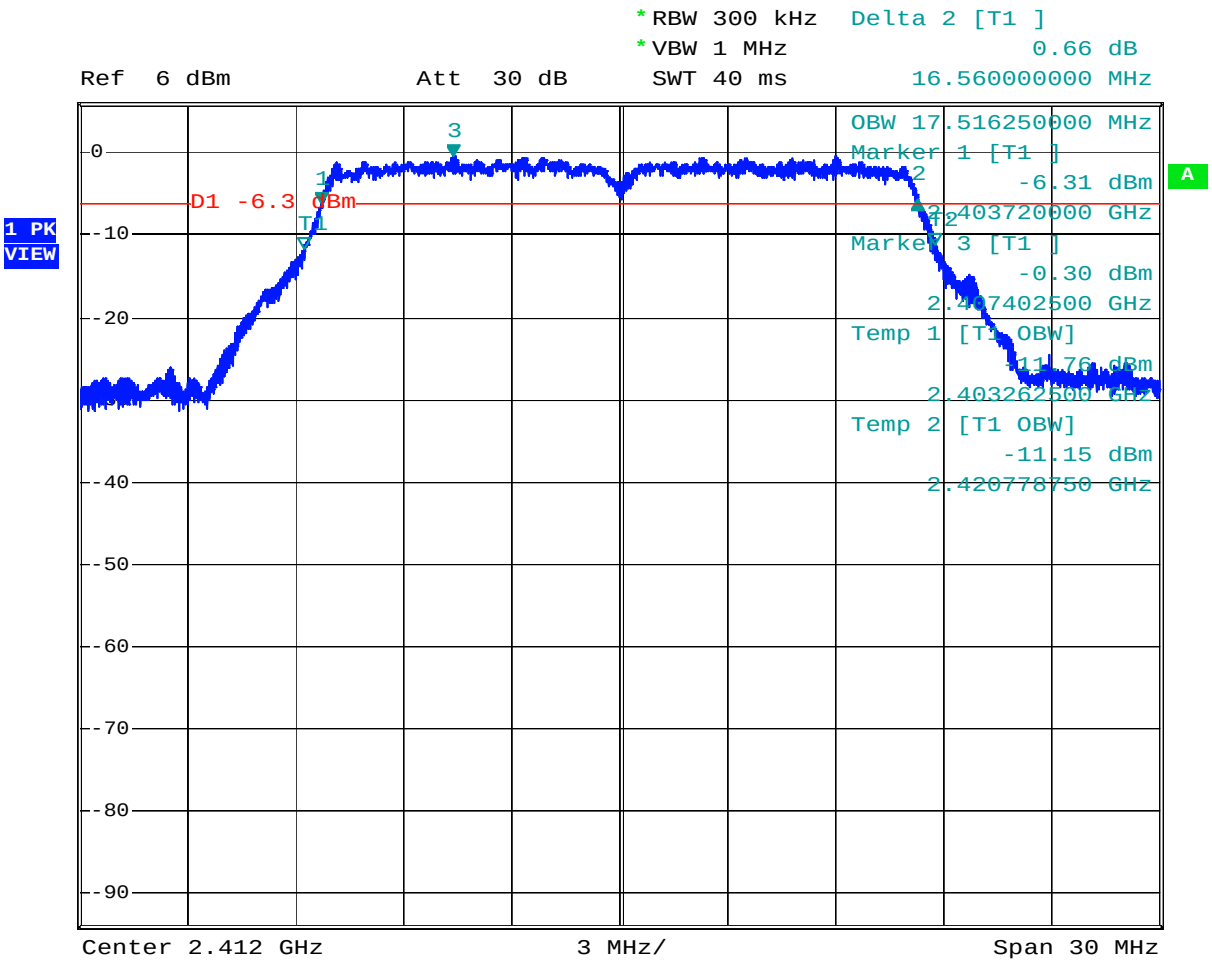
Date: 5.NOV.2015 11:11:48

Plot 1.12 – 99% Bandwidth



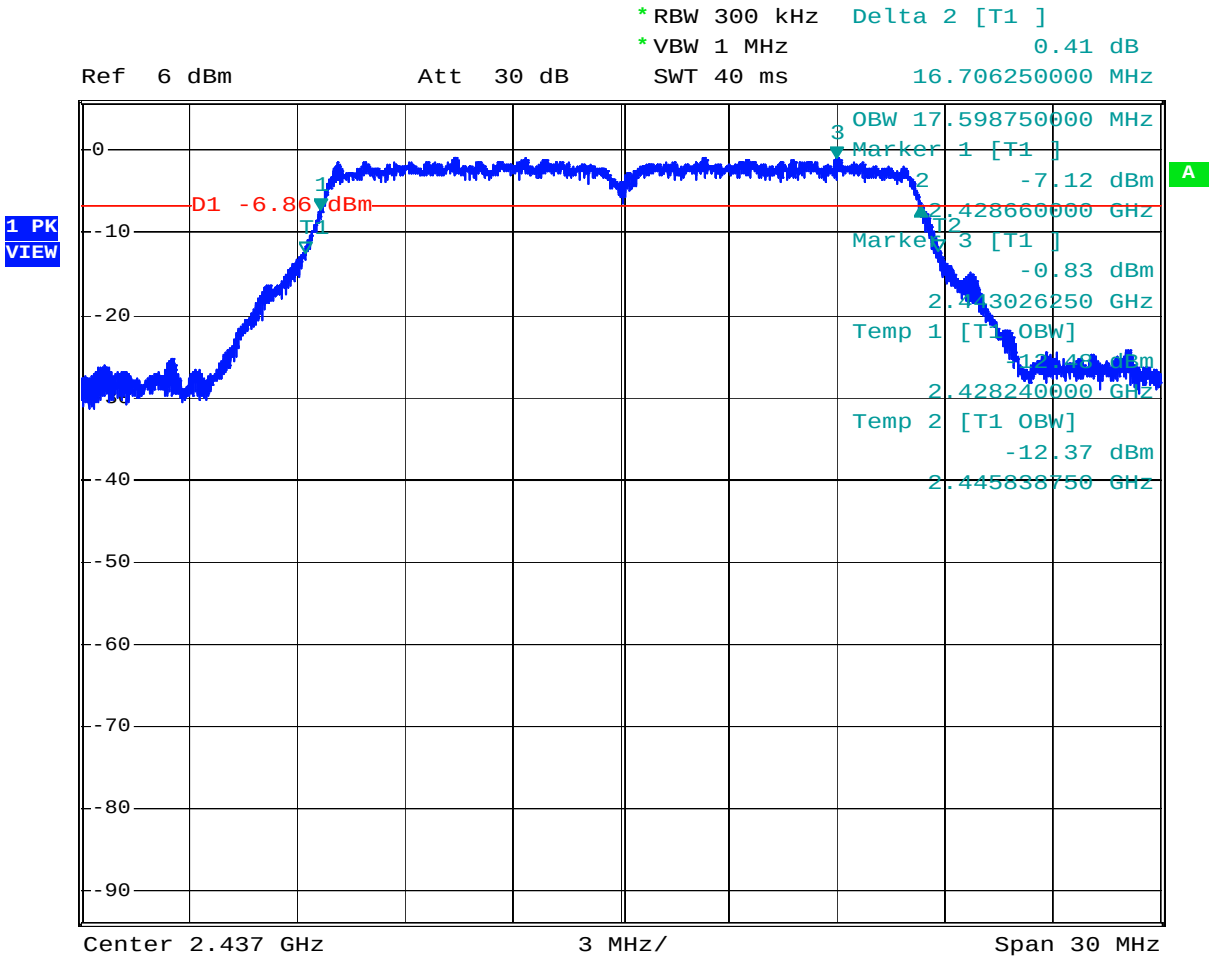
Date: 5.NOV.2015 11:13:42

Plot 1.13 – 99% Bandwidth



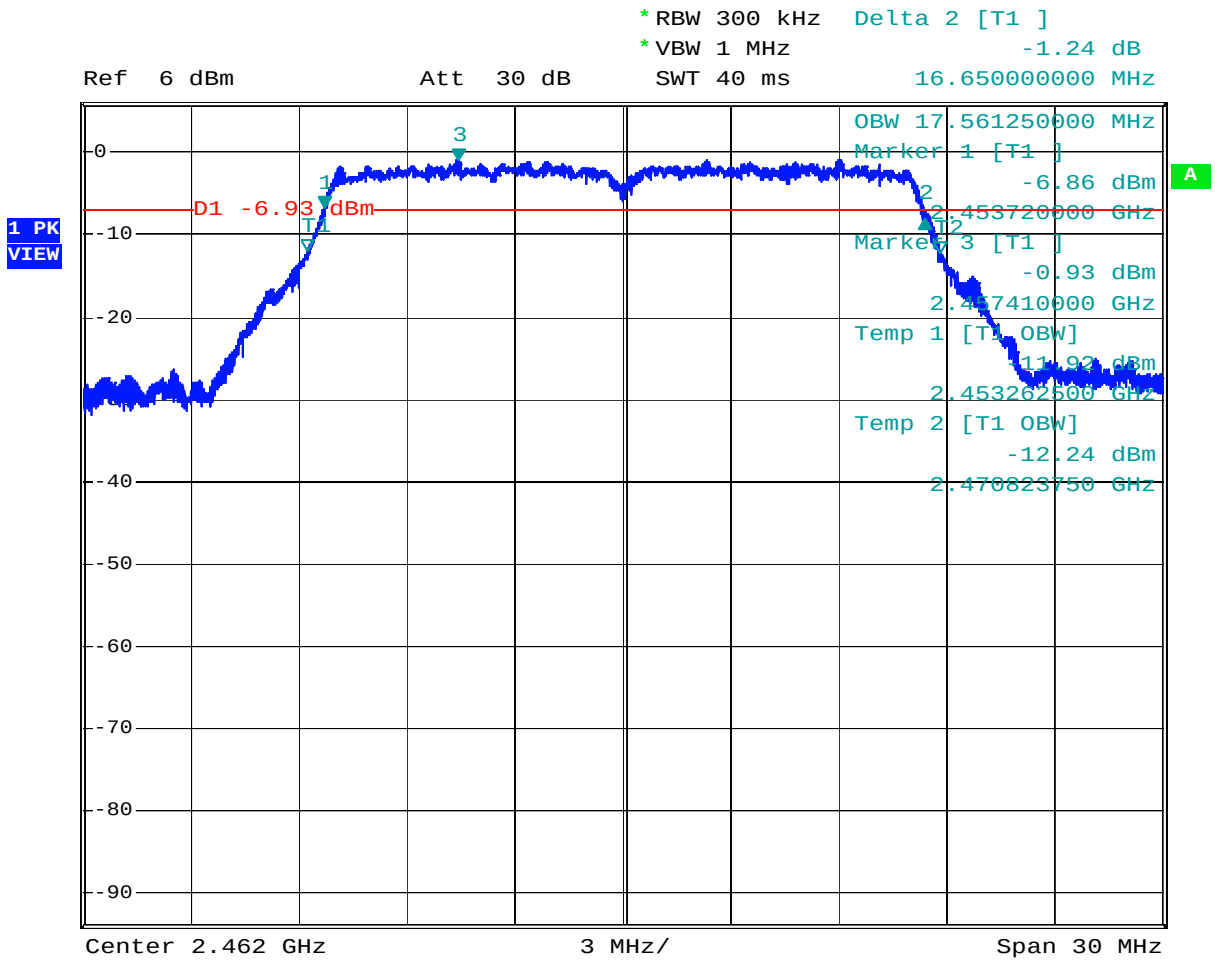
Date: 5.NOV.2015 11:19:53

Plot 1.14 – 99% Bandwidth



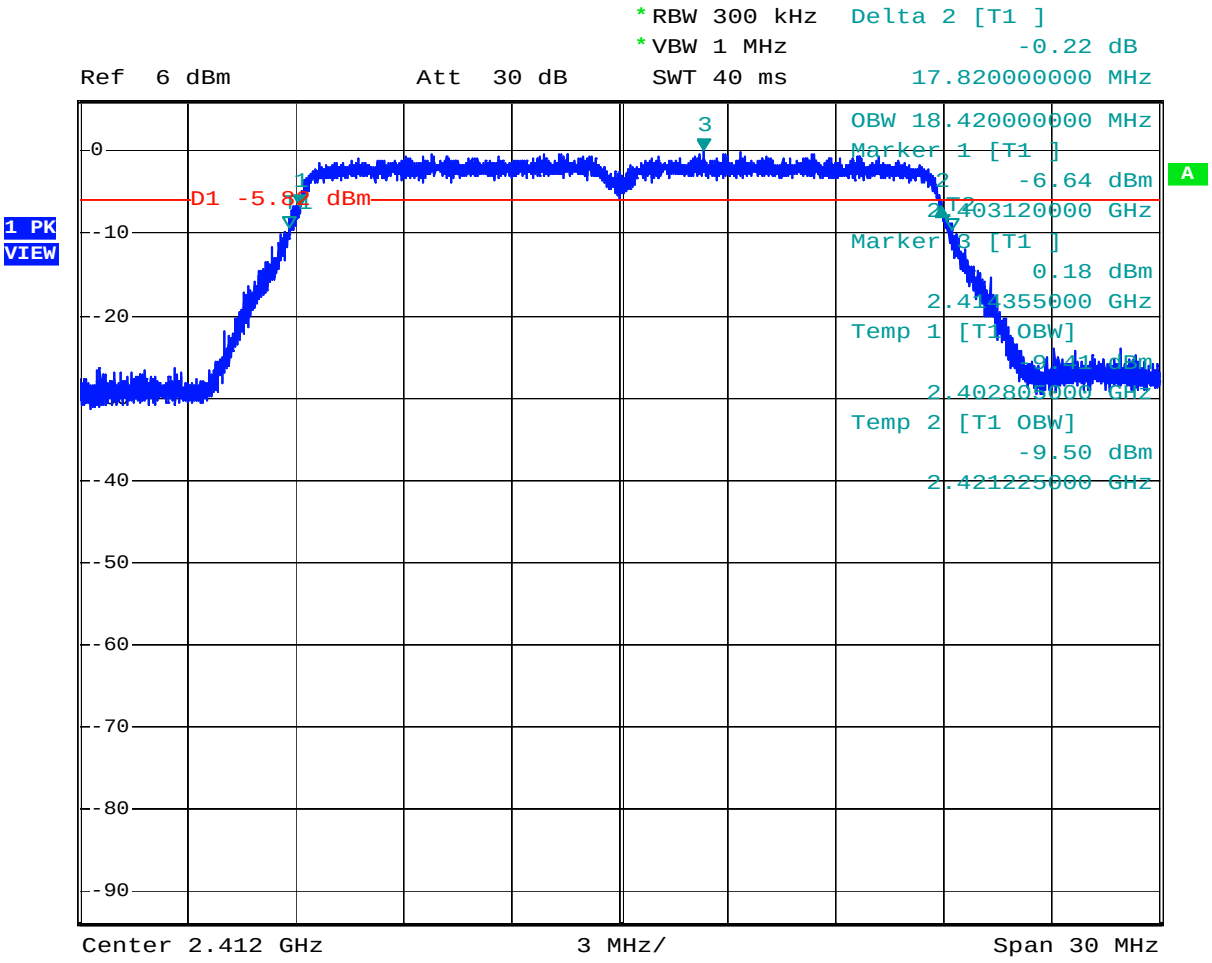
Date: 5.NOV.2015 11:17:51

Plot 1.15 – 99% Bandwidth



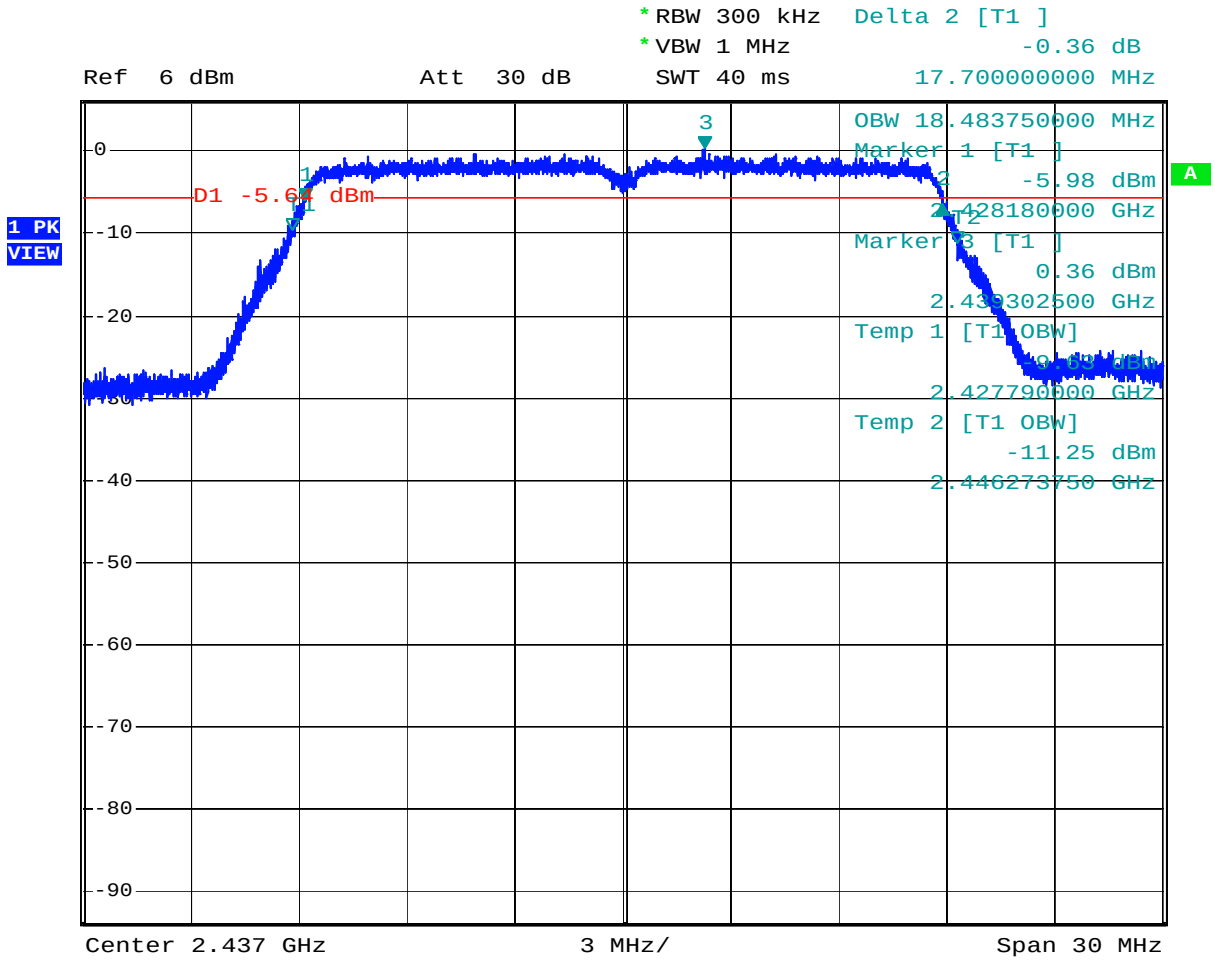
Date: 5.NOV.2015 11:15:58

Plot 1.16 – 99% Bandwidth



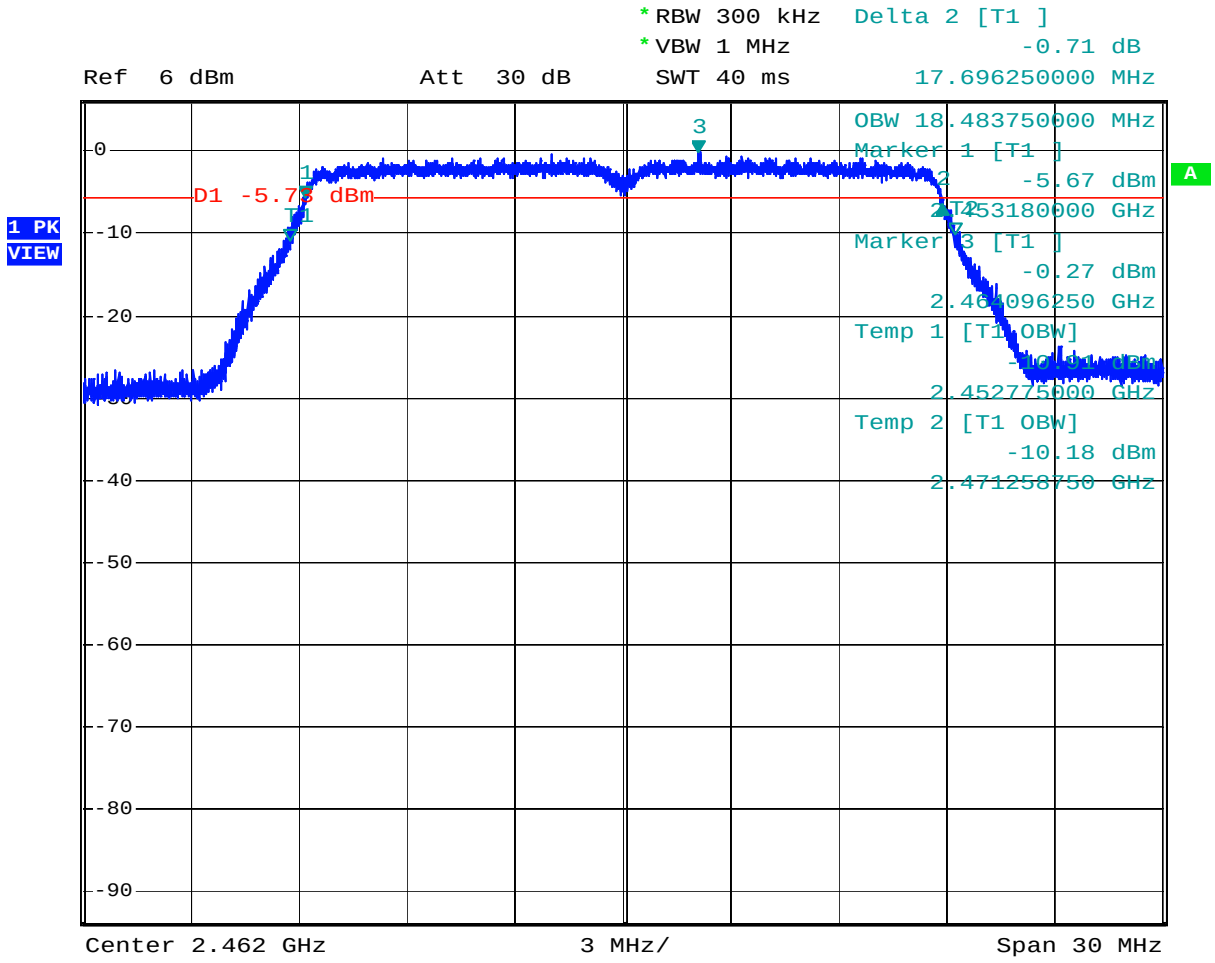
Date: 5.NOV.2015 11:21:54

Plot 1.17 – 99% Bandwidth



Date: 5.NOV.2015 11:26:36

Plot 1.18 – 99% Bandwidth



Date: 5.NOV.2015 11:34:27

4.2 Maximum Conducted Output Power at Antenna Terminals
FCC Rule 15.247(b)(3)

4.2.1 Requirement

For antennas with gains of 6 dBi or less, maximum allowed transmitter output is 1 watt (+30 dBm).
For antennas with gains greater than 6 dBi, transmitter output level must be decreased appropriately, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

4.2.2 Procedure

The antenna port of the EUT was connected to the input of a spectrum analyzer/power meter to measure the Maximum Conducted Transmitter Output Power.

The procedure described in FCC Publication 558074 D01 DTS Meas Guidance v03r03 June 09, 2015 was used. Specifically, section 9.2.2.3 Method AVGSA-1.

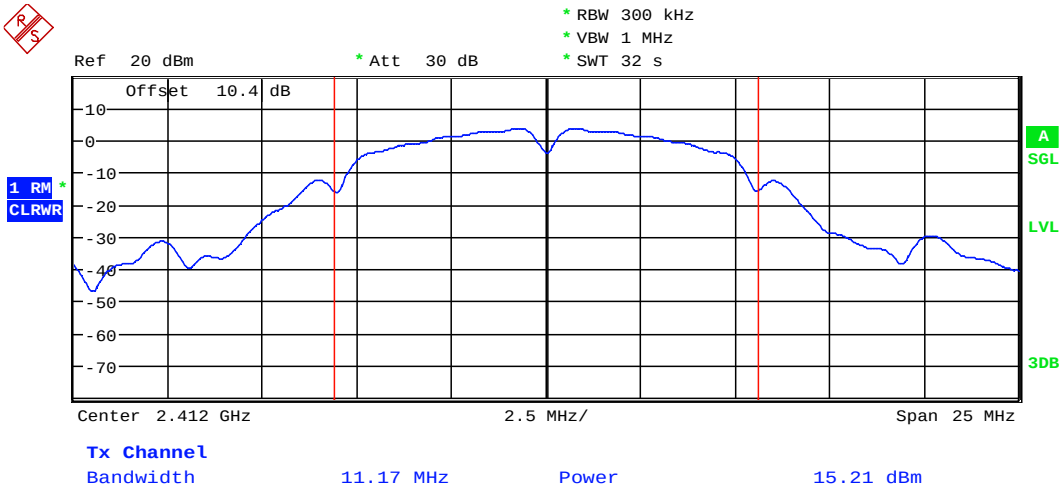
1. Set the RBW = 1-5% of the OBW, not to exceed 1MHz.
2. Set the VBW ≥ 3 x RBW
3. Set the span ≥ 1.5 x *OBW*.
4. Detector = RMS.
5. The EUT shall be operated at ≥ 98 % duty cycle or sweep triggering/signal gating shall be employed such that the sweep time is less than or equal to the transmission duration T.
6. Perform a single sweep
7. Number of points in sweep ≥ 2 x span/RBW.
8. Use the instrument's band/channel power measurement function with the band limits set equal to the OBW band edges If the instrument does not have a band power function, sum the spectrum levels at intervals equal to the RBW extending across the entire OBW of the spectrum.

4.2.3 Test Result

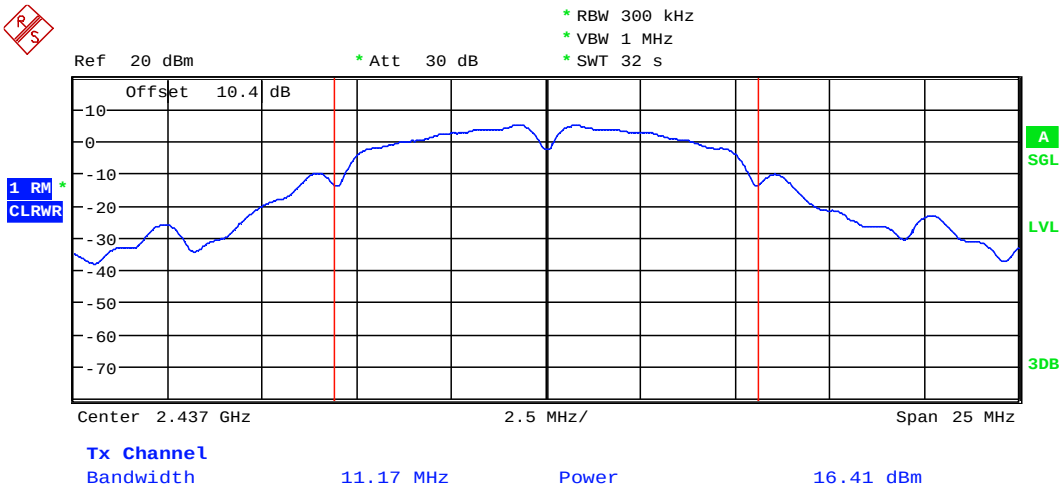
Refer to the following plots for the test result:

Standard	Data Rate	Channel	Frequency MHz	Conducted Average Power dBm	Conducted Average Power mW	Plot #
802.11b	1 Mbps	1	2412	15.21	33.189	2.1
		6	2437	16.41	43.752	2.2
		11	2462	14.80	30.200	2.3
802.11g	6 Mbps	1	2412	12.03	15.959	2.4
		2	2417	14.13	25.882	2.5
		6	2437	16.66	46.345	2.6
		10	2457	13.81	24.044	2.7
		11	2462	11.67	14.689	2.8
802.11n	6.5 Mbps	1	2412	12.00	15.849	2.9
		2	2417	14.03	25.293	2.10
		6	2437	16.56	45.290	2.11
		10	2457	13.76	23.768	2.12
		11	2462	10.62	11.535	2.13

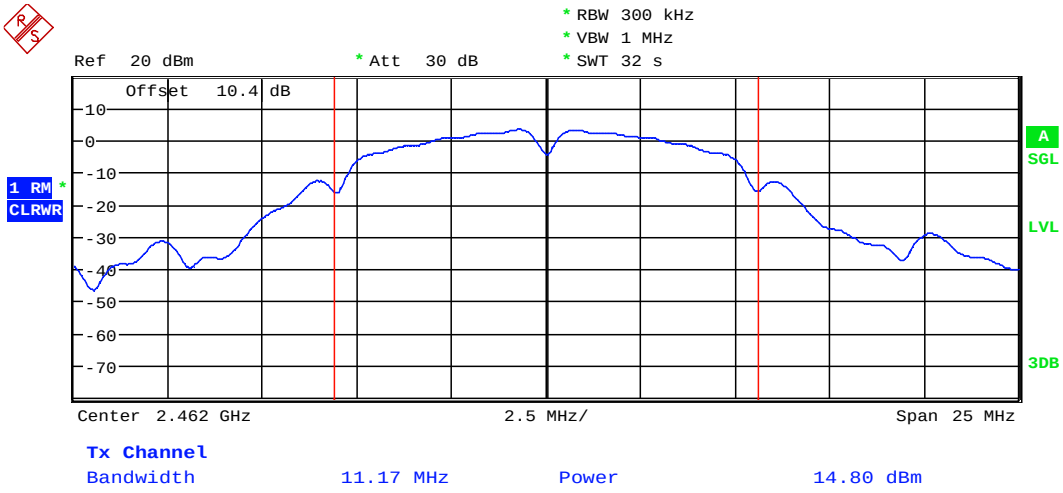
Plot 2. 1



Plot 2. 2



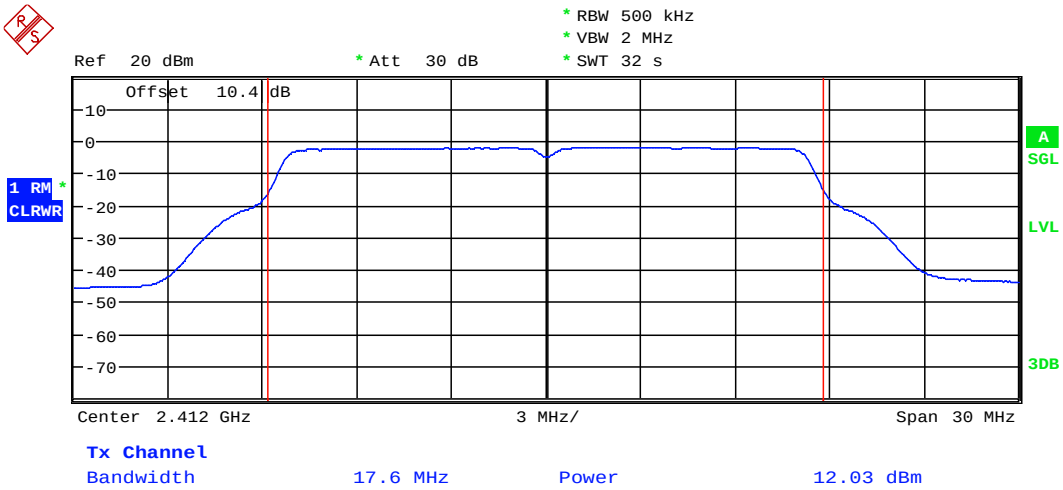
Plot 2. 3



Tx Channel

Bandwidth	11.17 MHz	Power	14.80 dBm

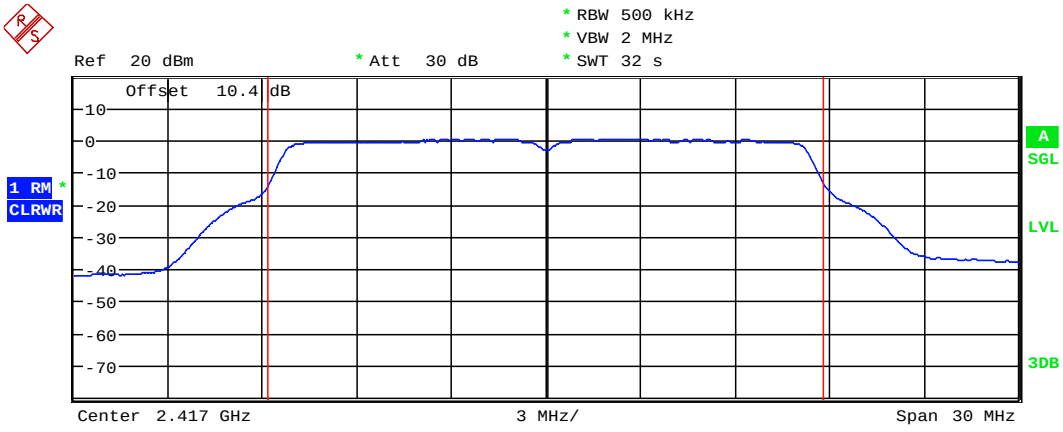
Plot 2. 4



Tx Channel

Bandwidth	17.6 MHz	Power	12.03 dBm

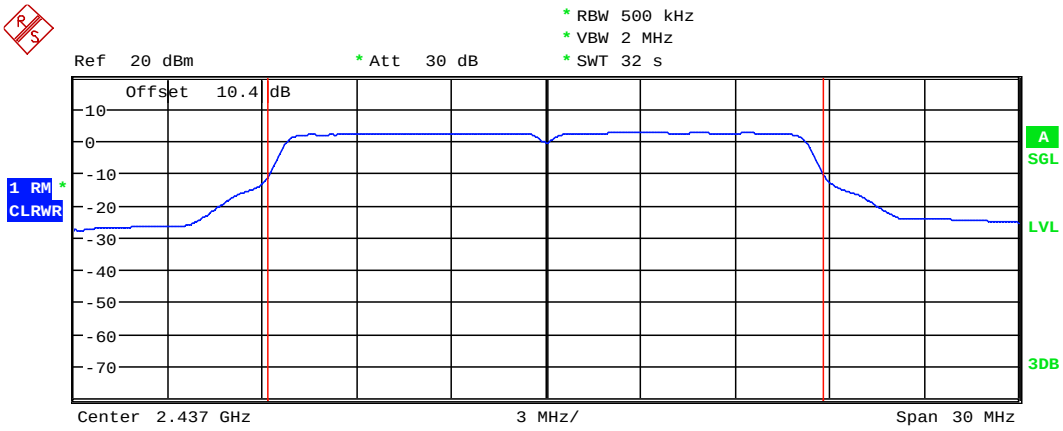
Plot 2. 5



Tx Channel

Bandwidth	17.6 MHz	Power	14.13 dBm

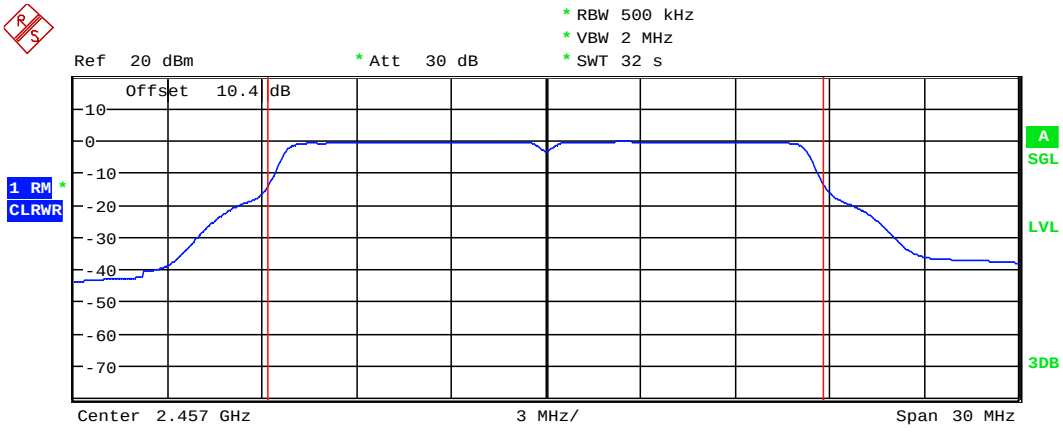
Plot 2. 6



Tx Channel

Bandwidth	17.6 MHz	Power	16.66 dBm

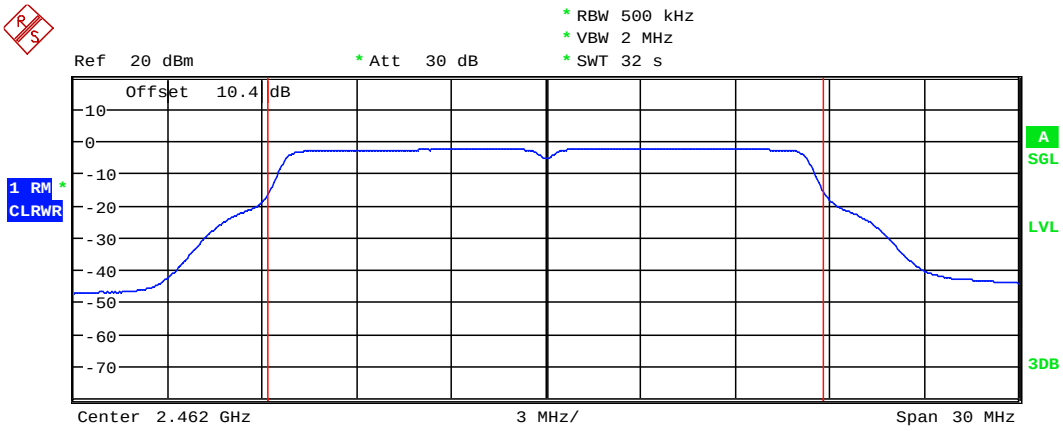
Plot 2. 7



Tx Channel

Bandwidth	17.6 MHz	Power	13.81 dBm

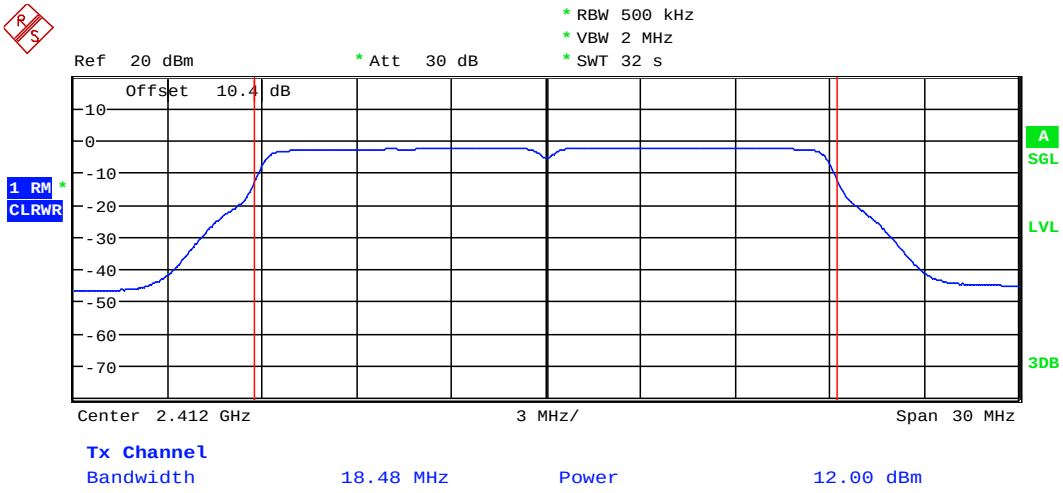
Plot 2. 8



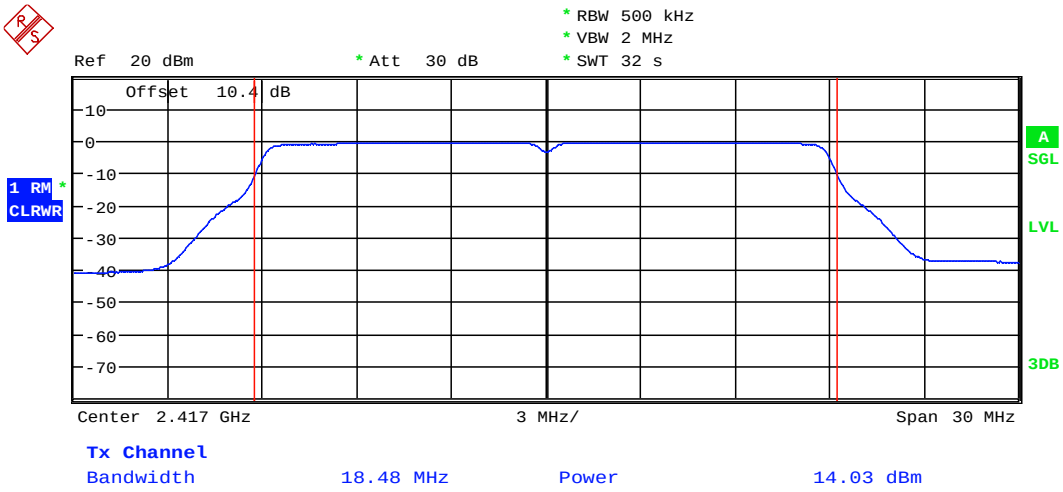
Tx Channel

Bandwidth	17.6 MHz	Power	11.67 dBm

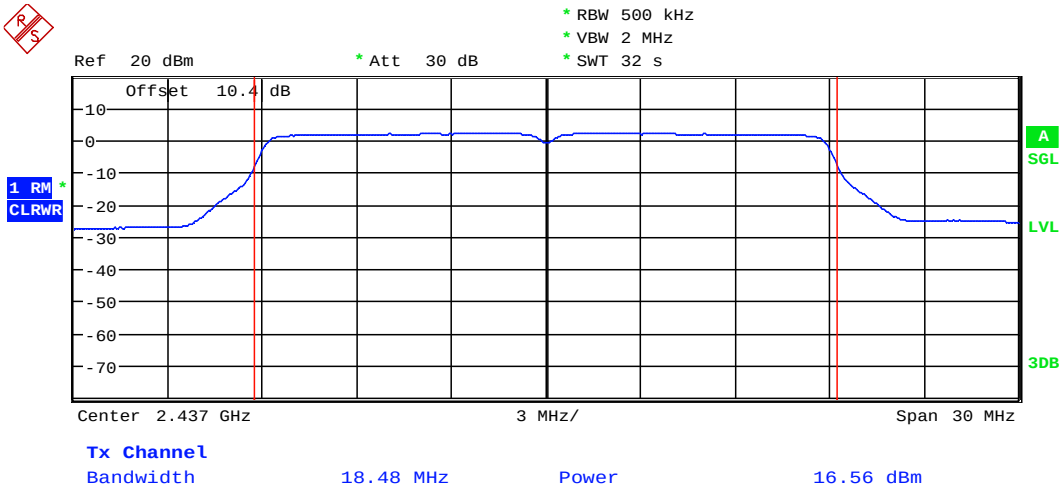
Plot 2. 9



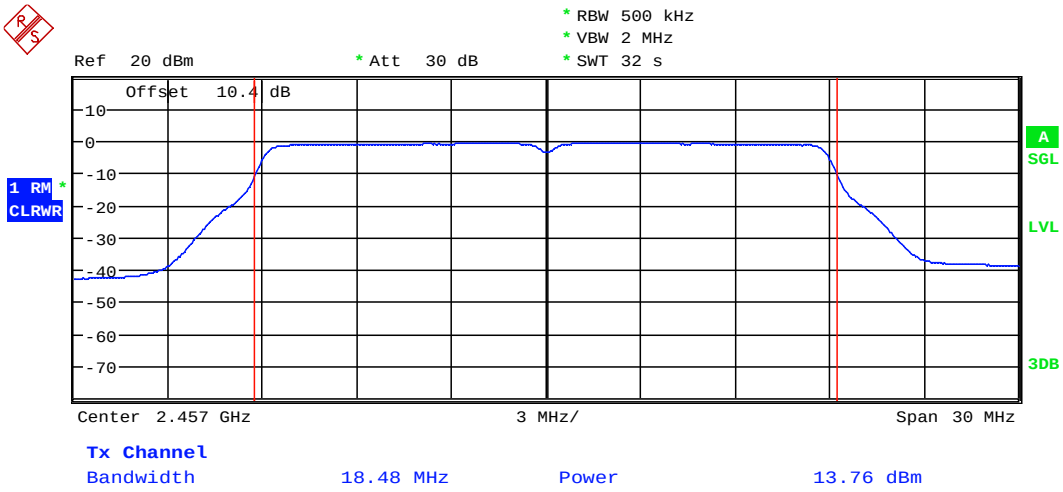
Plot 2. 10



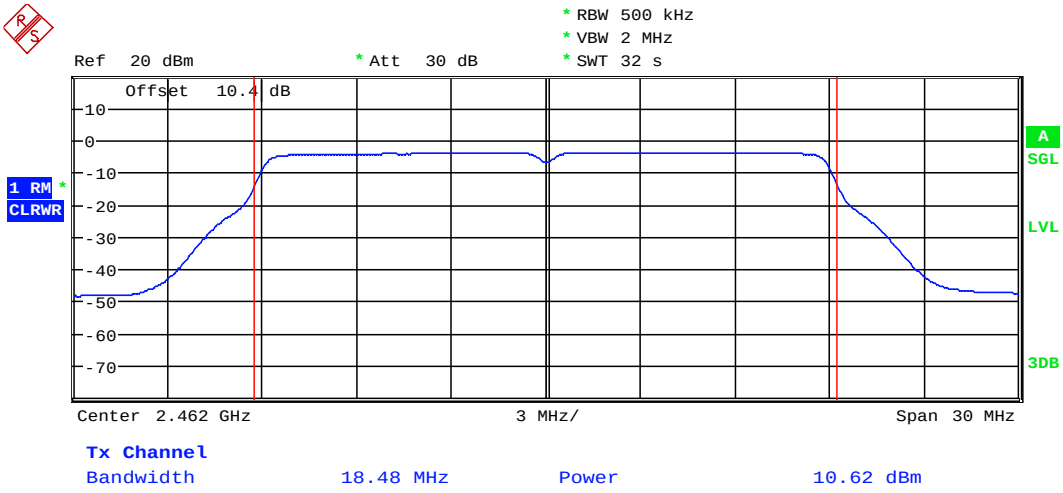
Plot 2. 11



Plot 2. 12



Plot 2. 13


* RBW 500 kHz
* VBW 2 MHz
Ref 20 dBm
* Att 30 dB
* SWT 32 s
Offset 10.4 dB
10
0
-10
-20
-30
-40
-50
-60
-70
1 RM *
CLRWR
A
SGL
LVL
3DB
Center 2.462 GHz
3 MHz/
Span 30 MHz
Tx Channel
Bandwidth 18.48 MHz
Power 10.62 dBm

4.3 Power Spectral Density
FCC 15.247 (e)

4.3.1 Requirement

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

4.3.2 Procedure

The antenna port of the EUT was connected to the input of a spectrum analyzer to measure the Transmitter Power Density (PSD).

The procedure described in FCC Publication 558074 D01 DTS Meas Guidance v03r03 June 09 2015, specifically section 10.2 Method PKPSD (peak PSD).

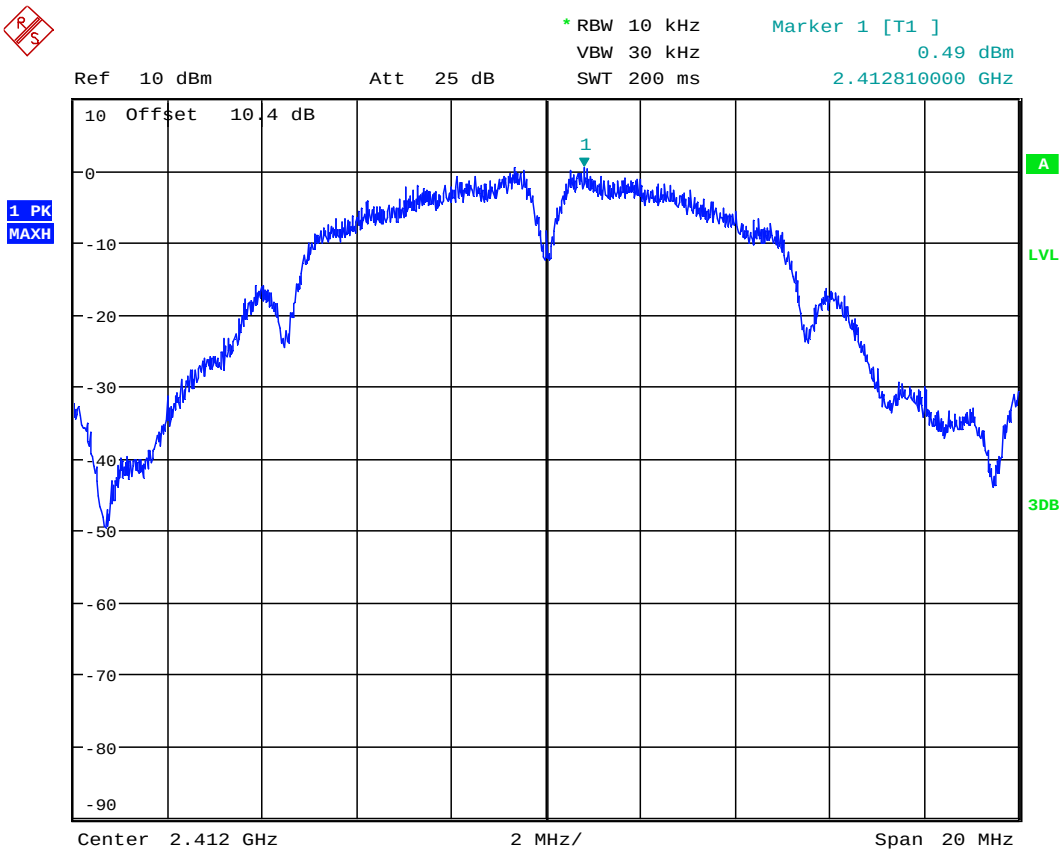
1. Set analyzer center frequency to DTS channel center frequency.
2. Set the span to 1.5 times the *DTS bandwidth*.
3. Set the RBW to: 3 kHz ≤ RBW ≤ 100 kHz.
4. Set the VBW ≥ 3 x RBW.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Use the peak marker function to determine the maximum amplitude level within the RBW.
10. If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

4.3.3 Test Result

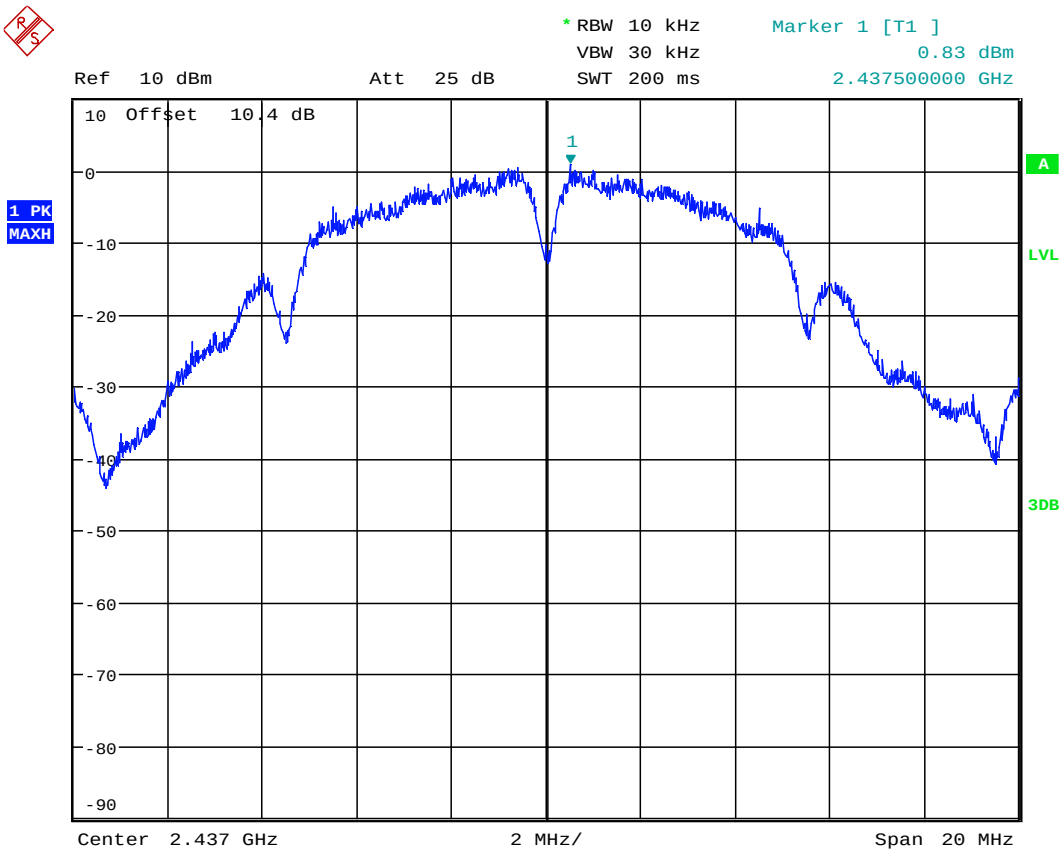
Refer to the following plots for the test result:

Standard	Channel	Frequency MHz	PSD (Peak) dBm	Margin to 8dBm Limit dB	Plot #
802.11b	1	2412	0.49	-7.51	3.1
	6	2437	0.83	-7.17	3.2
	11	2462	0.42	-7.58	3.3
802.11g	1	2412	-2.68	-10.68	3.4
	6	2437	-2.89	-10.89	3.5
	11	2462	-3.36	-11.36	3.6
802.11n	1	2412	-1.56	-9.56	3.7
	6	2437	-1.93	-9.93	3.7
	11	2462	-2.74	-10.74	3.9

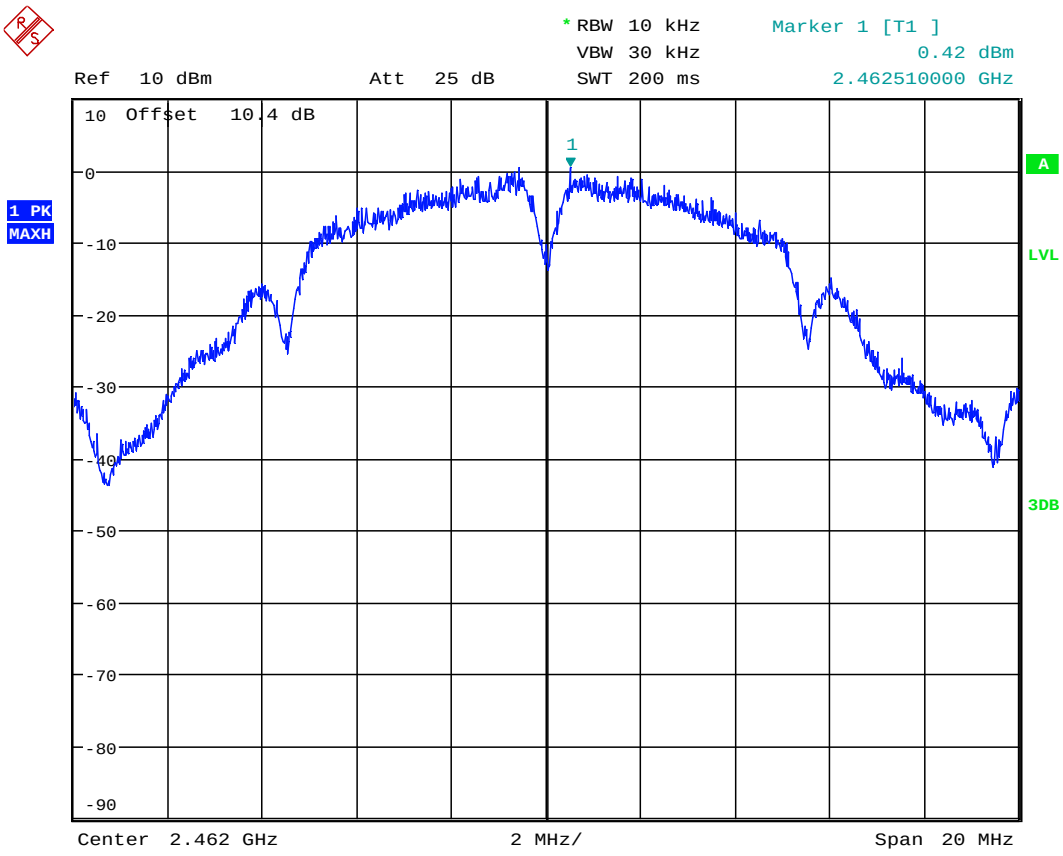
Plot 3. 1


*RBW 10 kHz
VBW 30 kHz
SWT 200 ms
Marker 1 [T1]
0.49 dBm
2.412810000 GHz
Ref 10 dBm
Att 25 dB
10 Offset 10.4 dB
1 PK
MAXH
A
LVL
3DB
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
Center 2.412 GHz
2 MHz/
Span 20 MHz
Date: 5.NOV.2015 12:09:26

Plot 3. 2

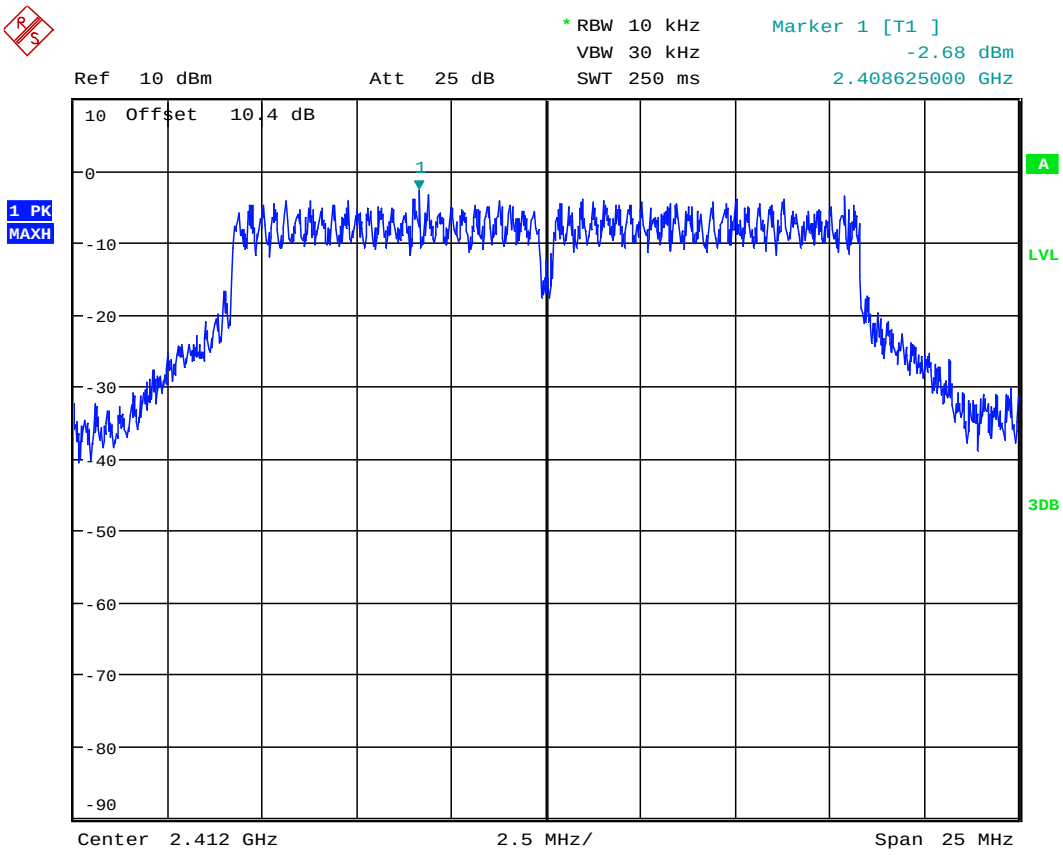

*RBW 10 kHz
VBW 30 kHz
SWT 200 ms
Marker 1 [T1]
0.83 dBm
2.437500000 GHz
Ref 10 dBm
Att 25 dB
10 Offset 10.4 dB
1 PK
MAXH
A
LVL
3DB
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
Center 2.437 GHz
2 MHz/
Span 20 MHz
Date: 5.NOV.2015 12:12:00

Plot 3. 3

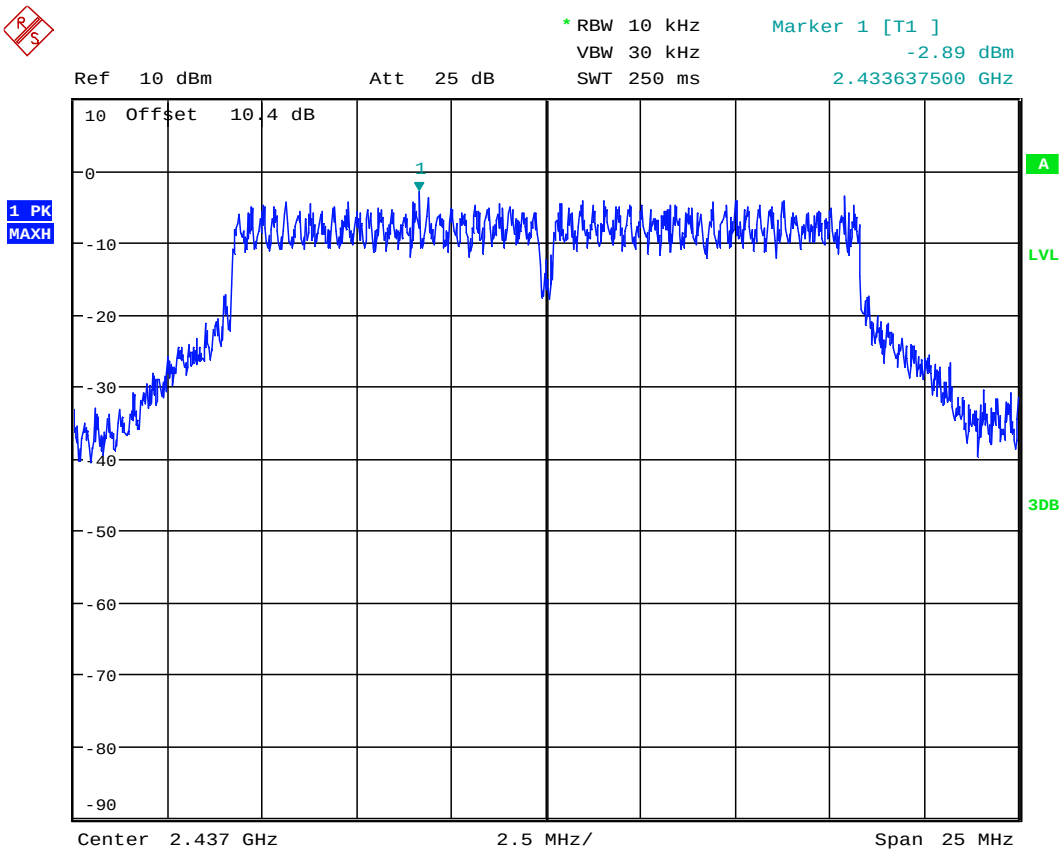


Date: 5.NOV.2015 12:13:28

Plot 3. 4

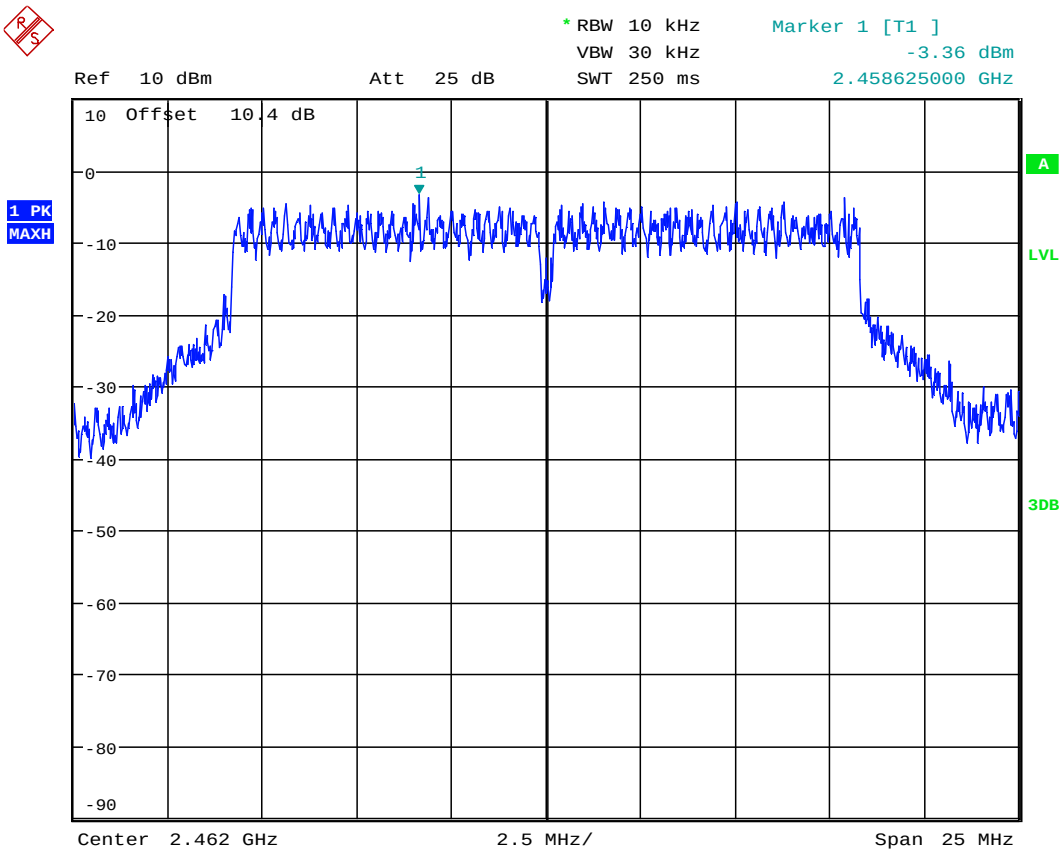

*RBW 10 kHz
VBW 30 kHz
SWT 250 ms
Marker 1 [T1]
-2.68 dBm
2.408625000 GHz
Ref 10 dBm
Att 25 dB
10 Offset 10.4 dB
1 PK
MAXH
A
LVL
3DB
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
Center 2.412 GHz
2.5 MHz/
Span 25 MHz
Date: 5.NOV.2015 12:19:47

Plot 3. 5

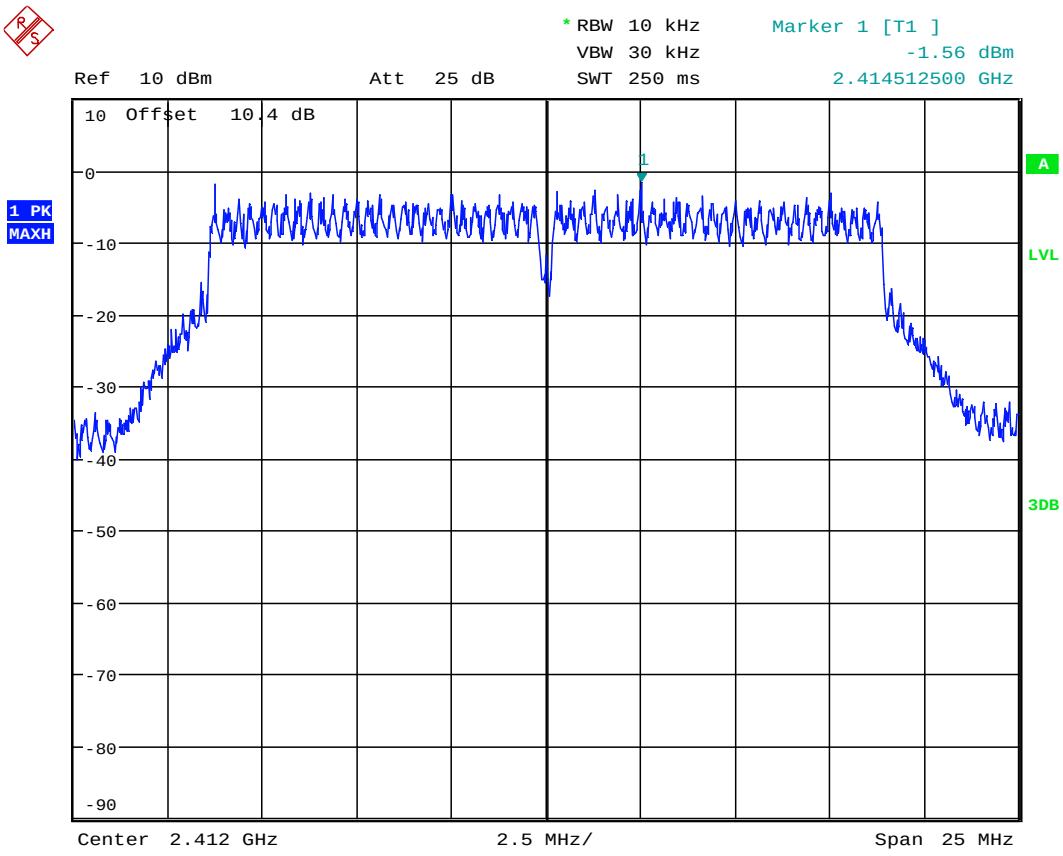


Date: 5.NOV.2015 12:17:41

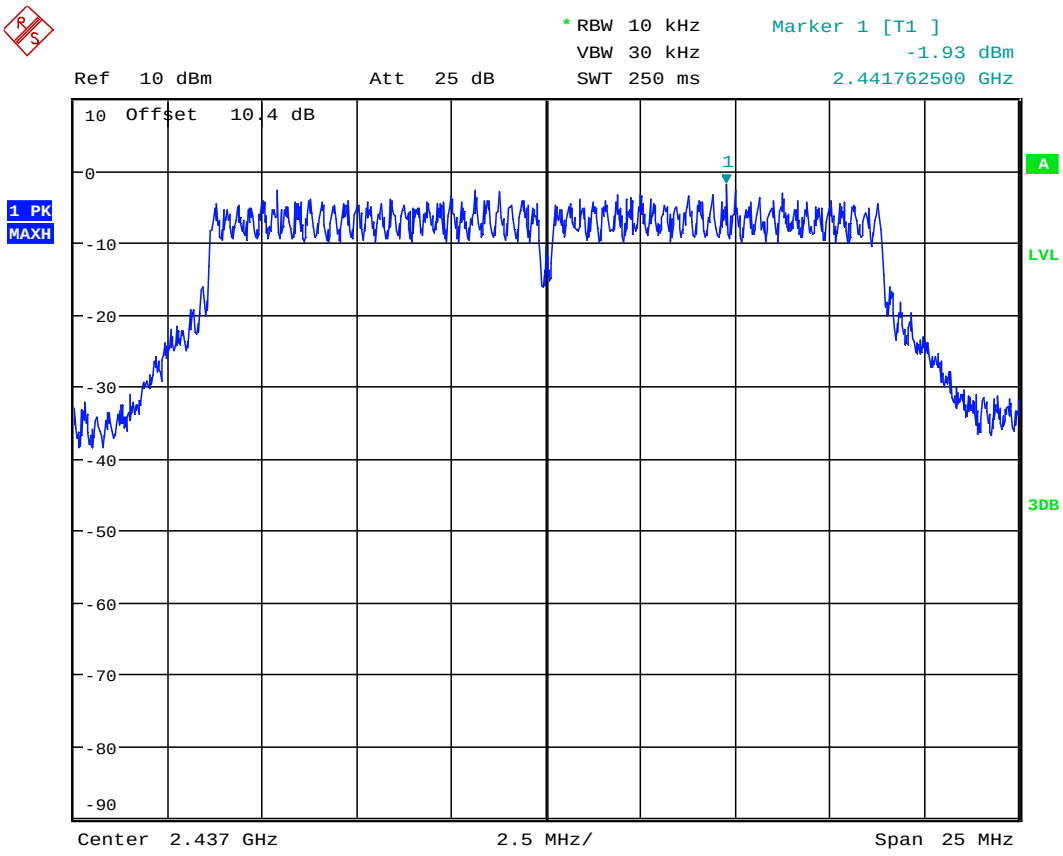
Plot 3. 6


*RBW 10 kHz
VBW 30 kHz
SWT 250 ms
Marker 1 [T1]
-3.36 dBm
2.458625000 GHz
Ref 10 dBm
Att 25 dB
10 Offset 10.4 dB
1 PK
MAXH
A
LVL
3DB
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
Center 2.462 GHz
2.5 MHz/
Span 25 MHz
Date: 5.NOV.2015 12:15:45

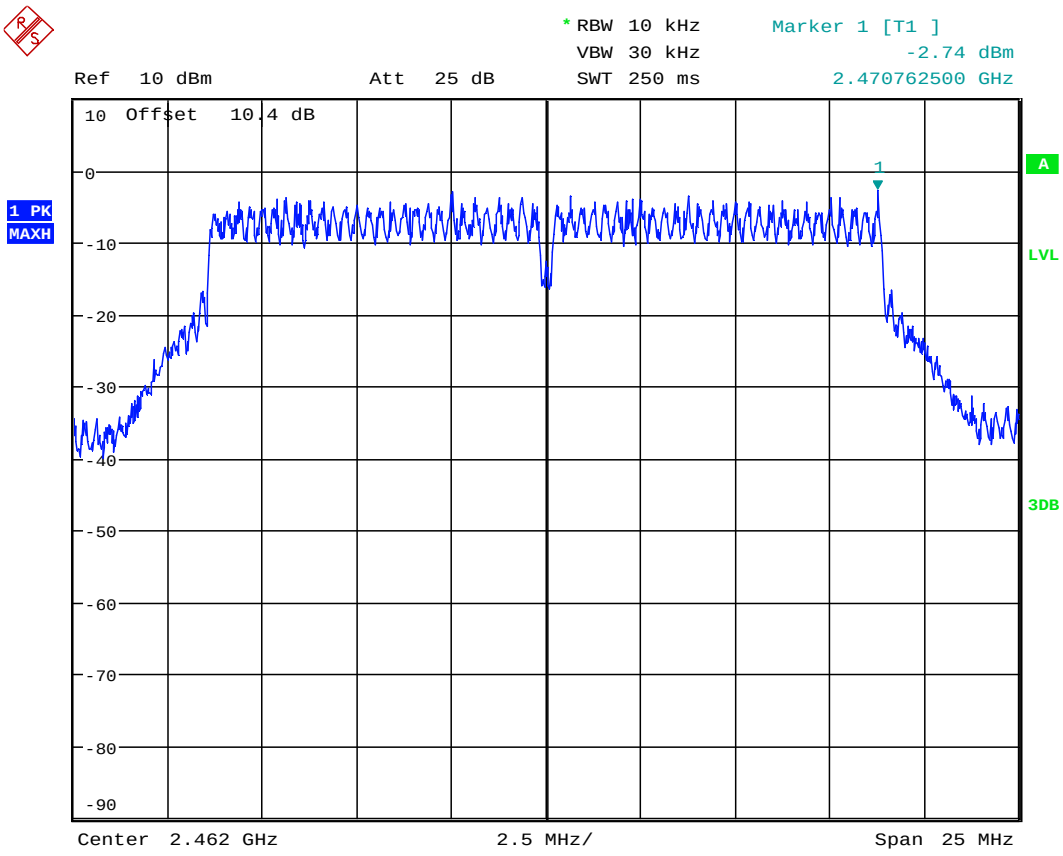
Plot 3. 7


*RBW 10 kHz
VBW 30 kHz
SWT 250 ms
Marker 1 [T1]
-1.56 dBm
2.414512500 GHz
Ref 10 dBm
Att 25 dB
10 Offset 10.4 dB
1 PK
MAXH
A
LVL
3DB
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
Center 2.412 GHz
2.5 MHz/
Span 25 MHz
Date: 5.NOV.2015 12:21:05

Plot 3. 8


*RBW 10 kHz
VBW 30 kHz
SWT 250 ms
Marker 1 [T1]
-1.93 dBm
2.441762500 GHz
Ref 10 dBm
Att 25 dB
10 Offset 10.4 dB
1 PK
MAXH
A
LVL
3DB
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
Center 2.437 GHz
2.5 MHz/
Span 25 MHz
Date: 5.NOV.2015 12:22:45

Plot 3. 9



Date: 5.NOV.2015 12:24:43

4.4 Out-of-Band Conducted Emissions
FCC 15.247(d)

4.4.1 Requirement

In any 100 kHz bandwidths outside the EUT pass-band, the RF power shall be at least 20dB (peak) or 30 dB (average) below that of the maximum in-band 100 kHz emissions.

4.4.2 Procedure

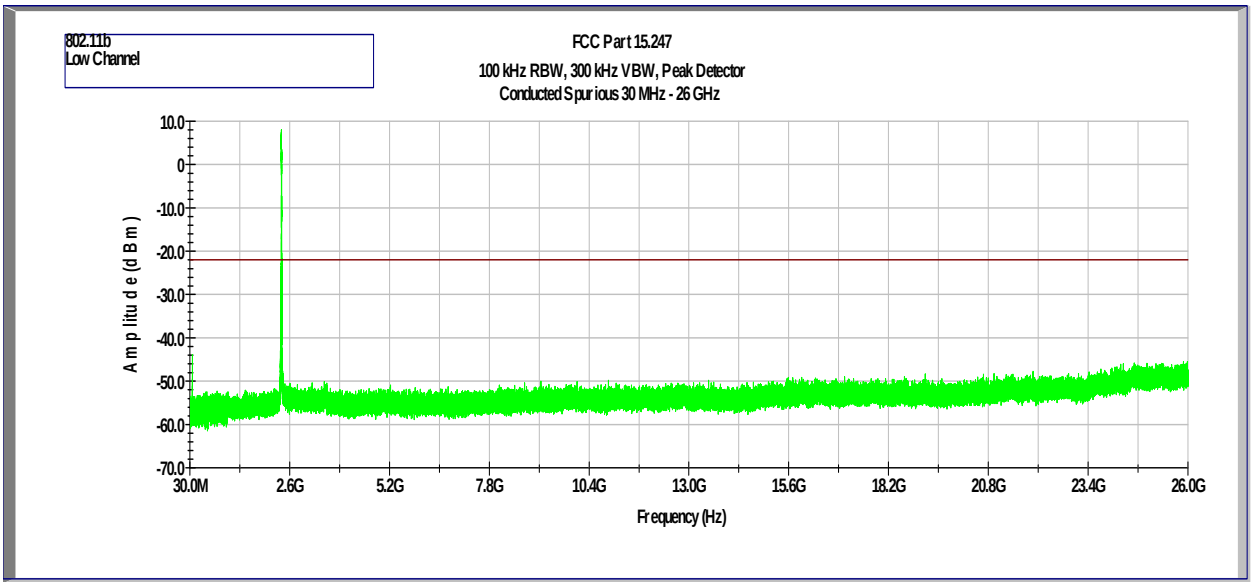
A spectrum analyzer was connected to the antenna port of the transmitter. Analyzer Resolution Bandwidth was set to 100 kHz. For each channel investigated, the in-band and out-of-band emission measurements were performed. The out-of-band emissions were measured from 30 MHz to 25 GHz.

4.4.3 Test Result

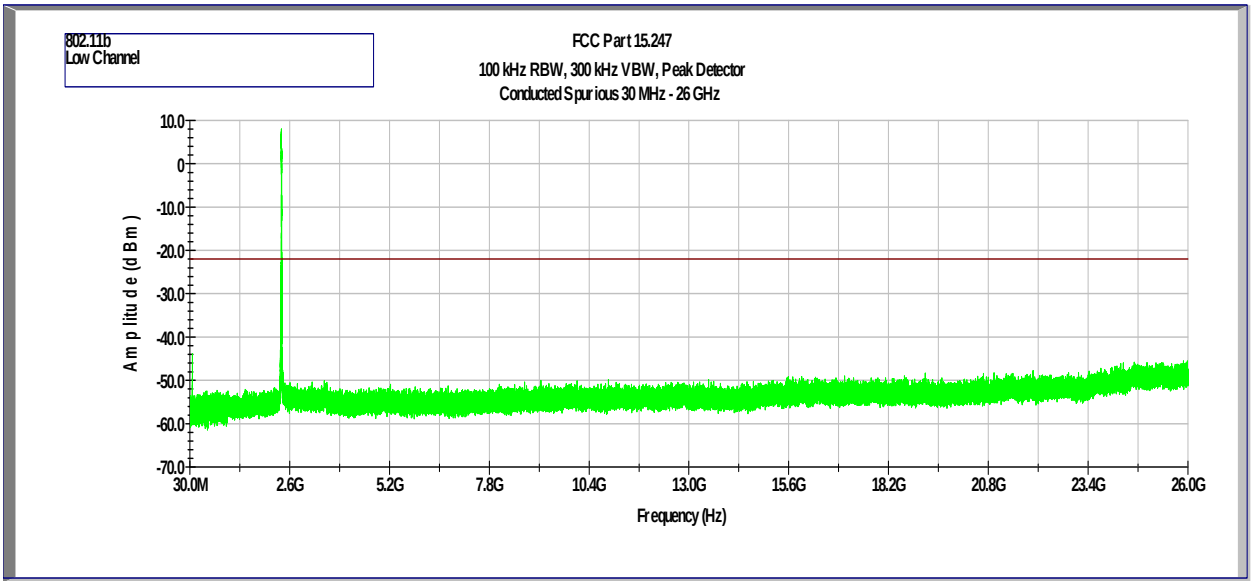
Refer to the following plots 4.1 – 4.9 for unwanted conducted emissions. The plot shows -30dB attenuation limit line.

Results	**Complies**

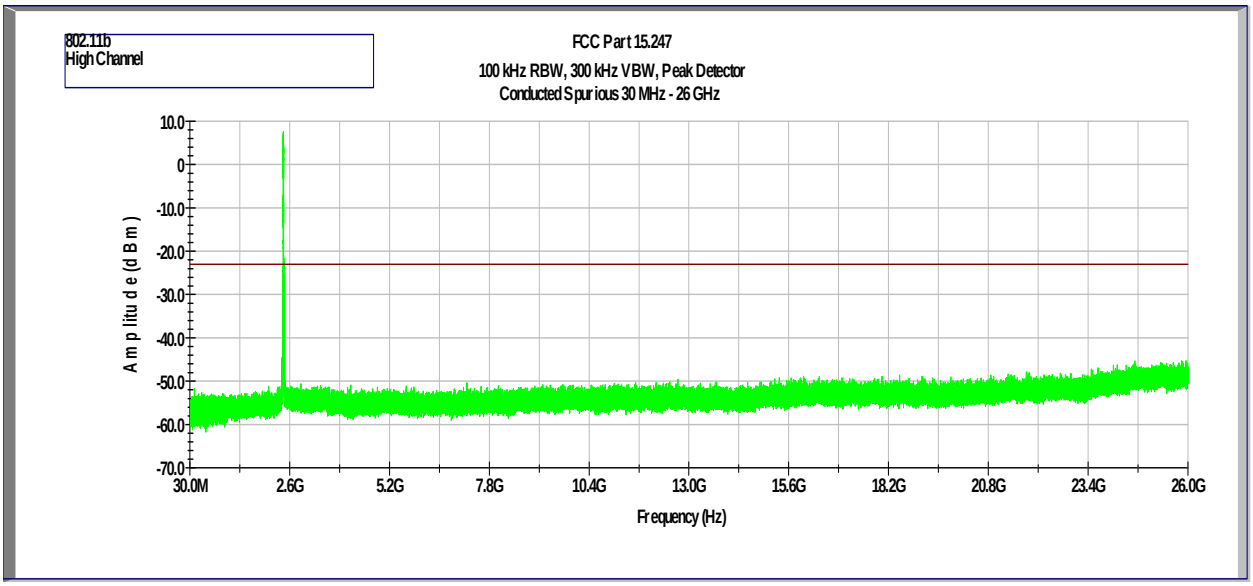
Plot 4.1
Tx @ 2412MHz 802.11b



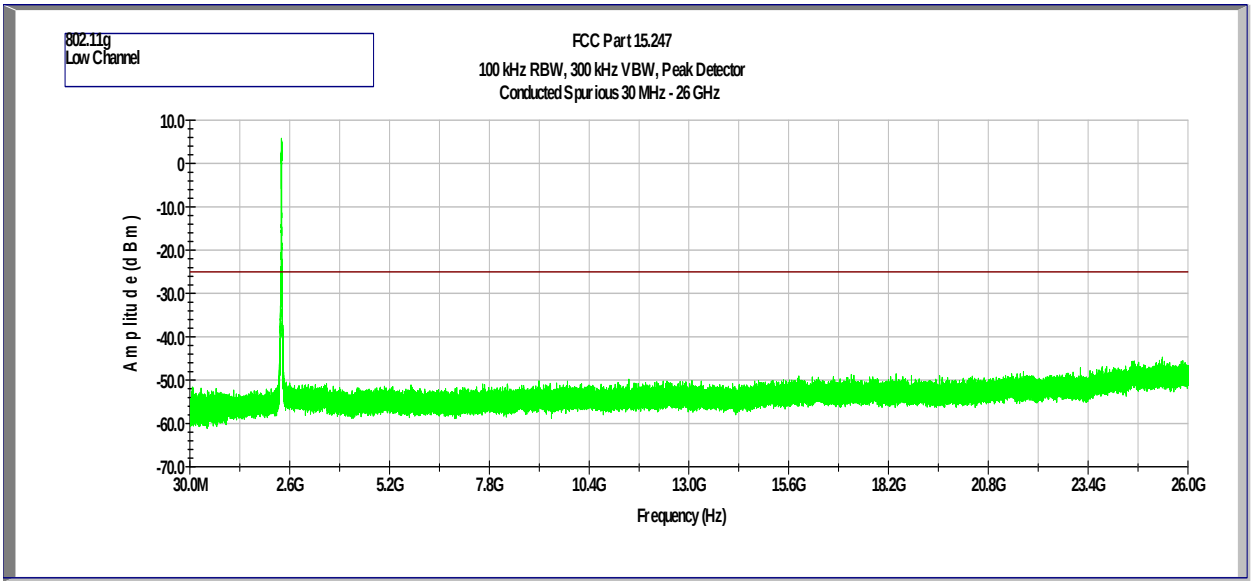
Plot 4.2
Tx @ 2437MHz 802.11b



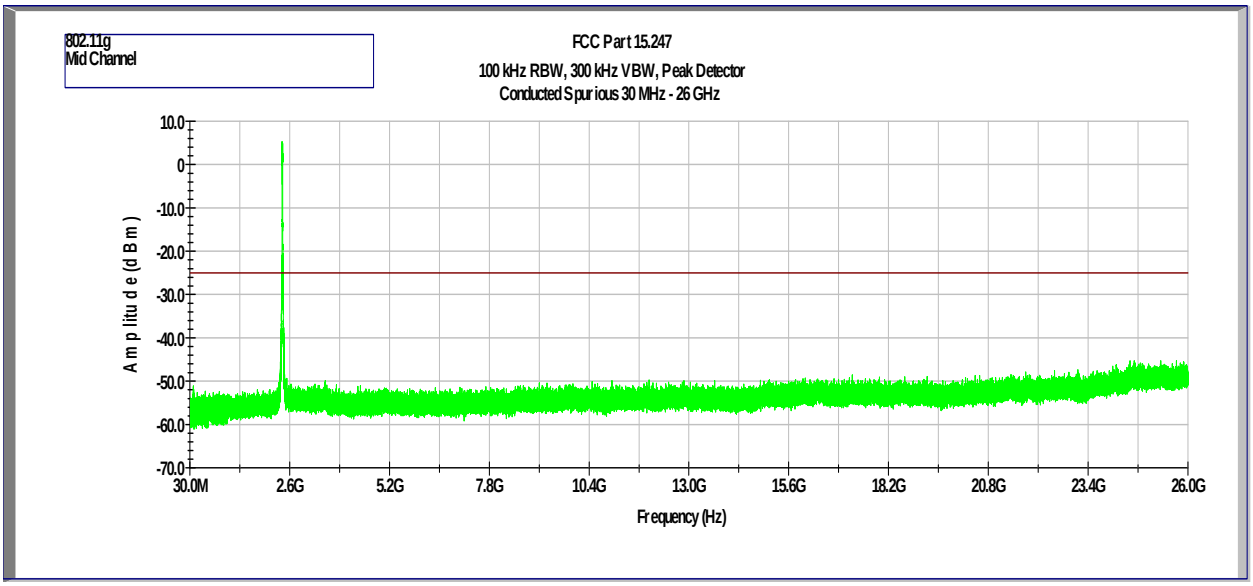
Plot 4.3
Tx @ 2462MHz 802.11b



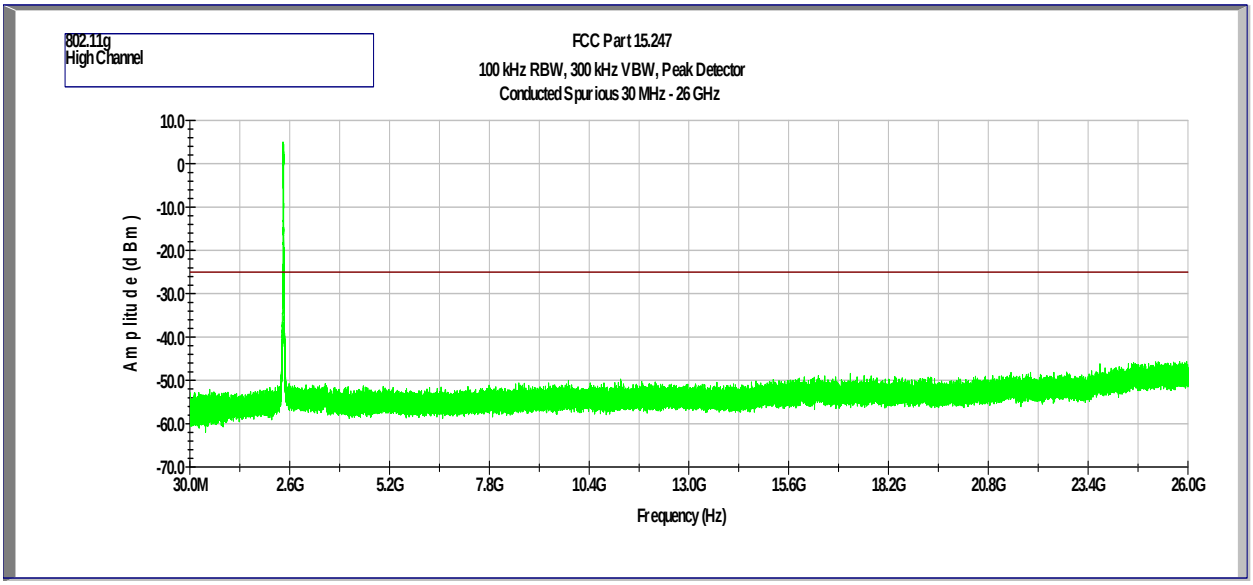
Plot 4.4
Tx @ 2412MHz 802.11g



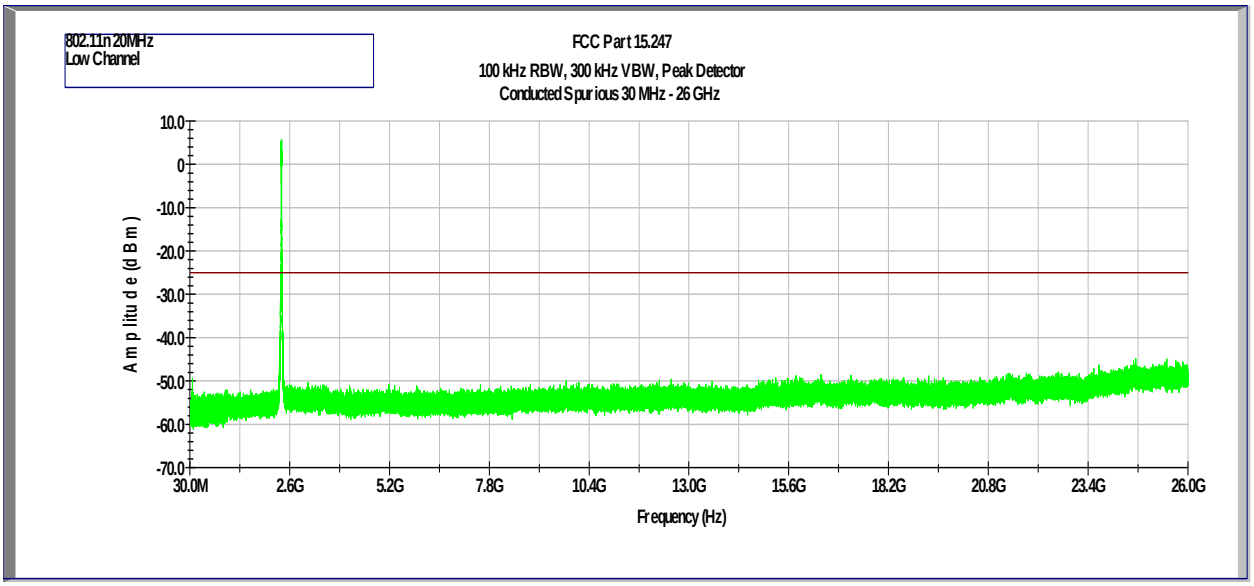
Plot 4.5
Tx @ 2437MHz 802.11g



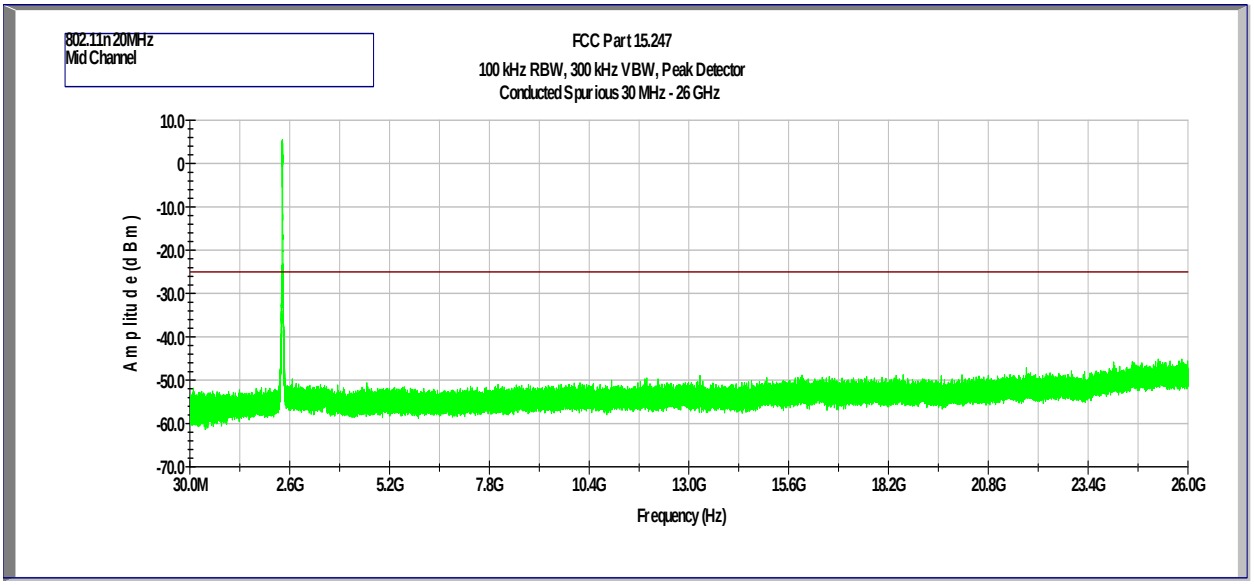
Plot 4.6
Tx @ 2462MHz 802.11g



Plot 4.7
Tx @ 2412MHz 802.11n, 20MHz

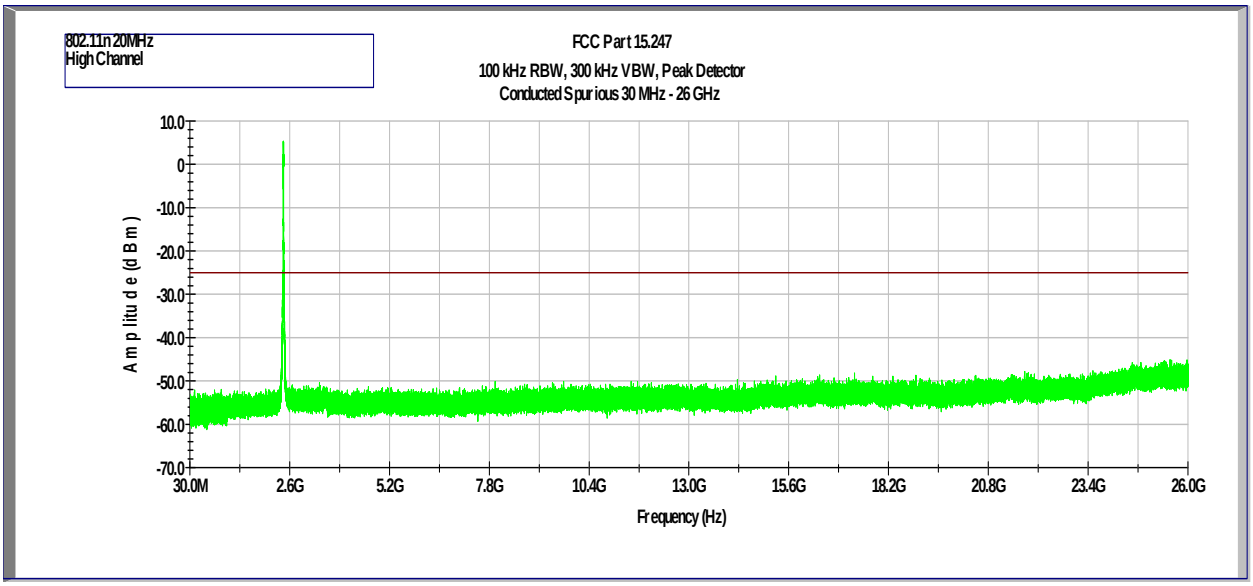


Plot 4.8
Tx @ 2437MHz 802.11n, 20MHz



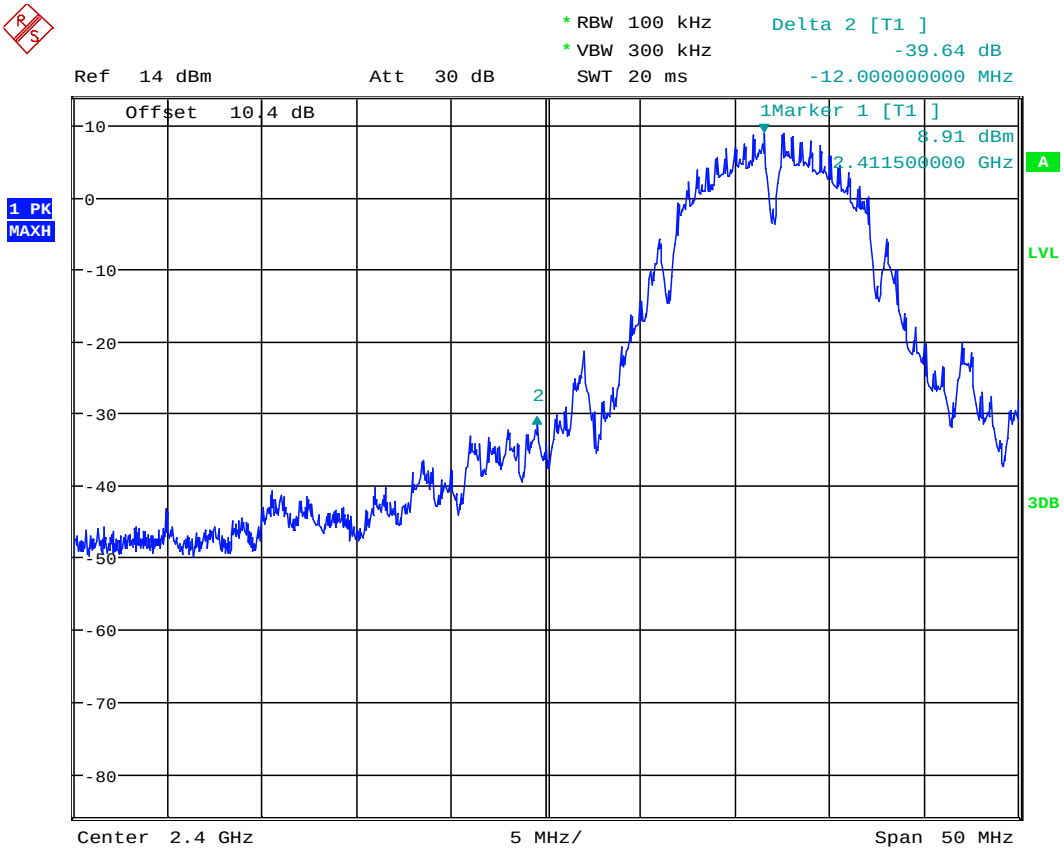
Plot 4.9

Tx @ 2462MHz 802.11n, 20MHz



Plot 4.10

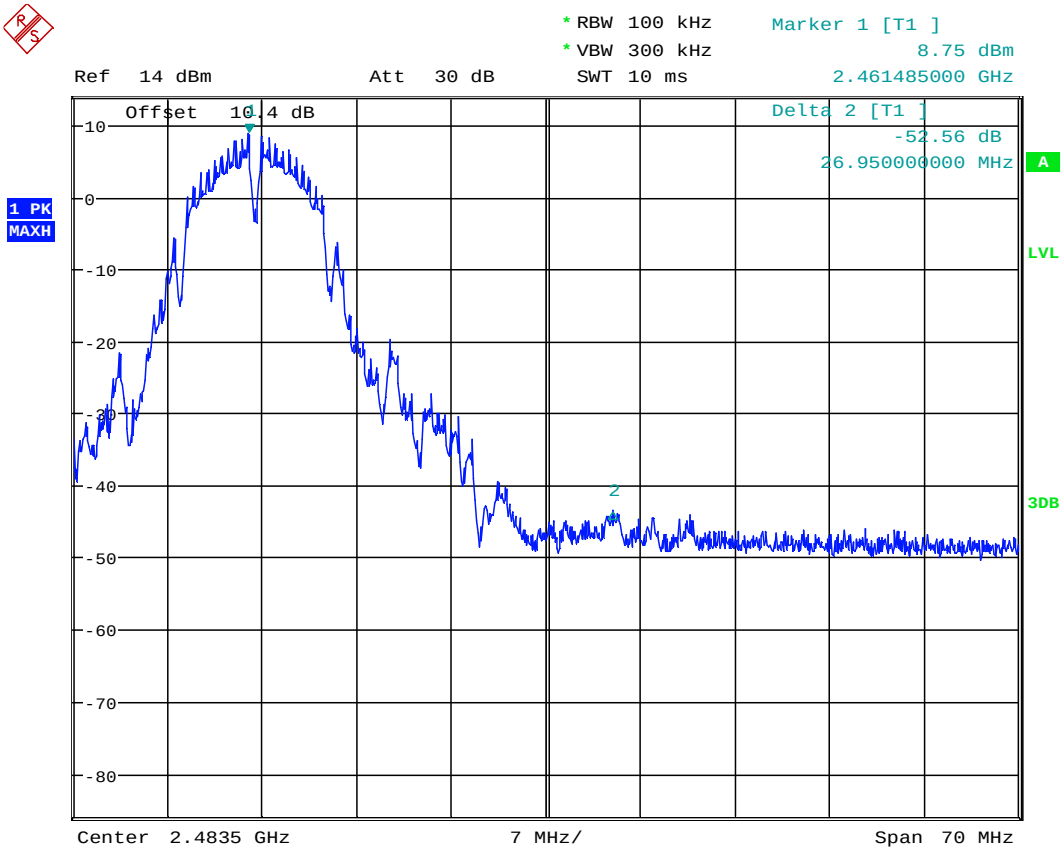
Conducted Band Edge, Tx @ 2412MHz 802.11b



Date: 6.NOV.2015 07:34:57

Plot 4.11

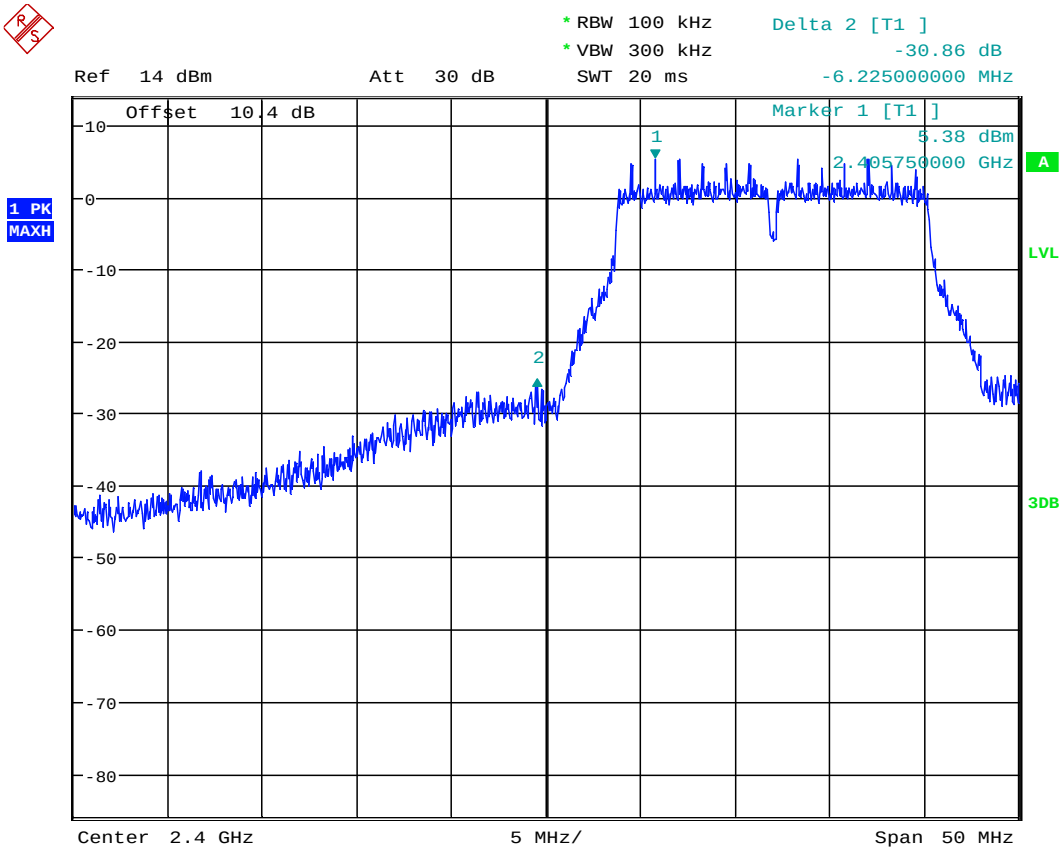
Conducted Band Edge, Tx @ 2462MHz 802.11b



Date: 6.NOV.2015 07:39:28

Plot 4.12

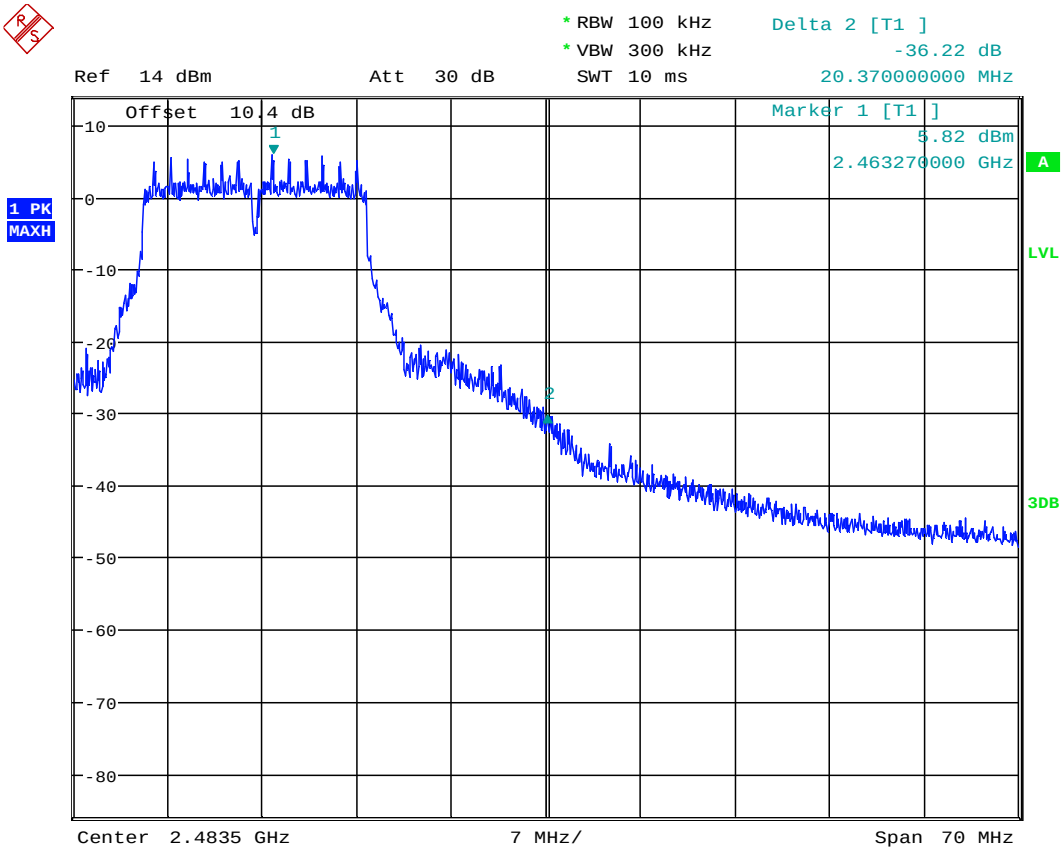
Conducted Band Edge, Tx @ 2412MHz 802.11g (Power 10.45dBm)



Date: 6.NOV.2015 07:33:49

Plot 4.13

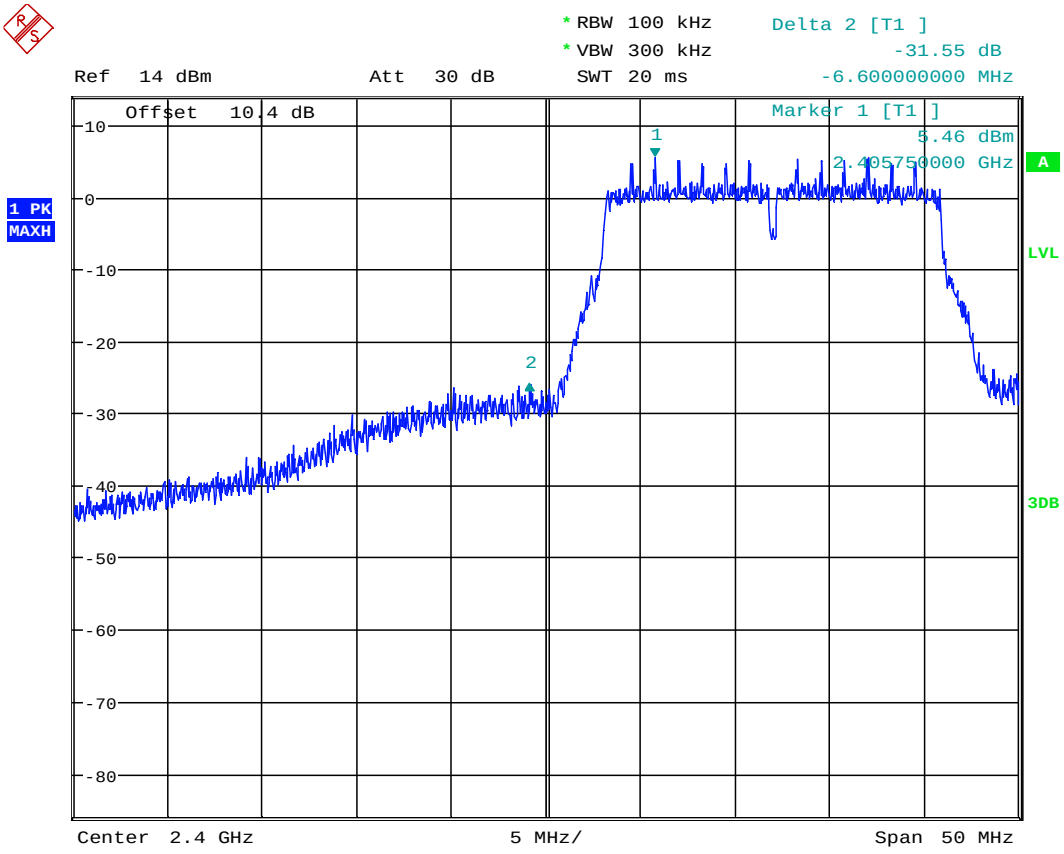
Conducted Band Edge, Tx @ 2462MHz 802.11g



Date: 6.NOV.2015 07:38:42

Plot 4.14

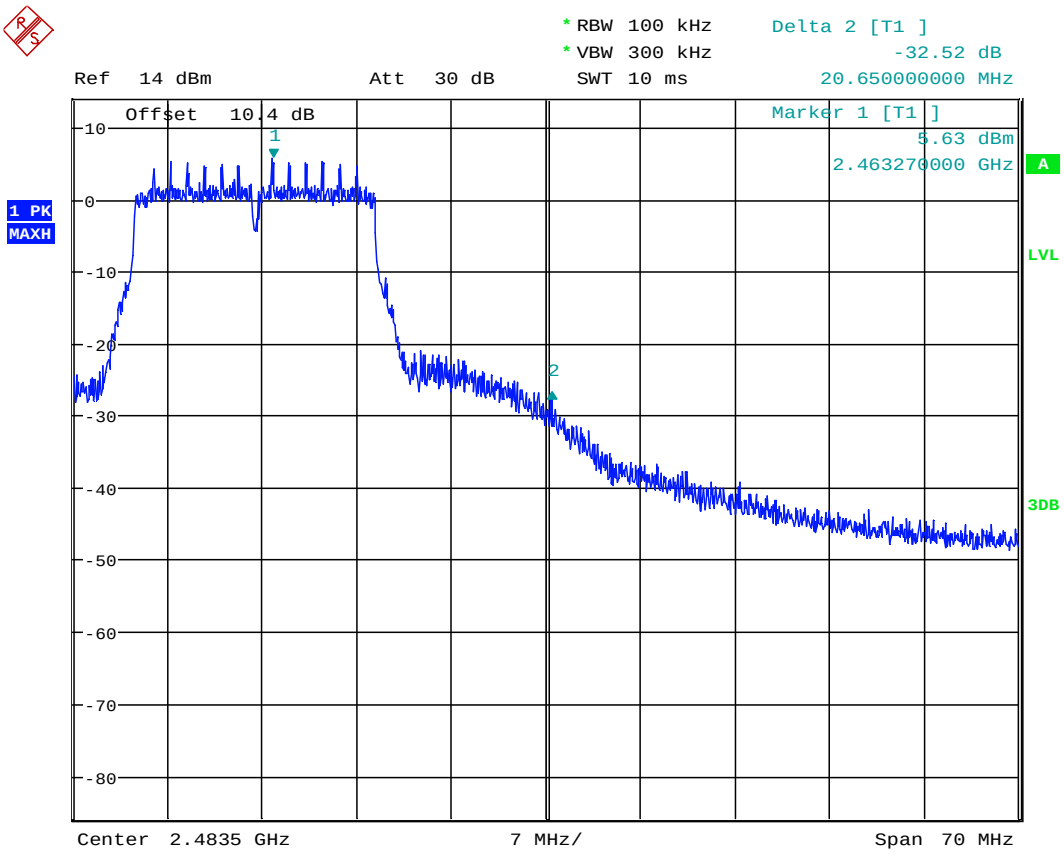
Conducted Band Edge, Tx @ 2412MHz 802.11n



Date: 6.NOV.2015 07:31:17

Plot 4.15

Conducted Band Edge, Tx @ 2462MHz 802.11n



Date: 6.NOV.2015 07:37:21