FCC/IC Test Report

FOR:

Model Name: A1427
Apple TV
FCC ID: BCGA1427
IC ID: 579C-A1427

47 CFR Part 15.407

IC RSS-210 Issue 8

TEST REPORT #: EMC_ APPLE_089_11001_UNII_Rev1
DATE: 2012-02-10

ACCREDITED
TESTING LABORATORY
Certificate #2135.01

Bluetooth Qualification Test Facility (BQTF)

CTIA Authorized Test Lab
LAB CODE 20020328-00

FCC listed: A2LA Accredited

IC recognized # 3462B-1

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1 Assessment

The following is in compliance with the applicable criteria specified in FCC rules Parts 15.407 of Title 47 of the Code of Federal Regulations and Industry Canada Standards RSS 210 Issue 8.

Company	Description	Model #
Apple Inc.	The device is a digital media receiver designed to play internet content onto a TV through an HDMI port. It incorporates WiFi and Bluetooth radios	A1427

Responsible for Testing Laboratory:

Date	Section	Name	Signature
2012-02-10	Compliance	Sajay Jose (Test Lab Manager)	Sajay Jose 2012.02.10 11:33:49 -08'00'

Responsible for the Report:

Date	Section	Name	Signature
2012-02-10	Compliance	Calvin Lee (EMC Engineer)	Calvin Lee Digitally signed by Calvin Lee DN: cn=Calvin Lee, c=US, o=CETECOM Inc, ou=Compliance, email=calvin.lee@cetecomusa.com Date: 2012.02.10 11:35:15 -08'00'

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 the 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
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Test Lab Director:	Heiko Strehlow
Responsible Project Leader:	Sajay Jose

2.2 Identification of the Client

Applicant's Name:	Apple Inc.
Street Address:	1 Infinite Loop
City/Zip Code	Cupertino, CA 95014
Country	USA
Contact Person:	Marc Douat
Phone No.	
e-mail:	mdouat@apple.com

2.3 Identification of the Manufacturer

Manufacturer's Name:	Same as above.
Manufacturers Address:	
City/Zip Code	
Country	

3 Equipment under Test (EUT)

3.1 Specification of the Equipment under Test

Marketing Name / Model No:	Apple TV/A1427
HW / SW Revision :	EVT/9B123
FCC-ID / IC-ID:	BCGA1427 / 579C-A1427
Product Description:	The device is a digital media receiver designed to play internet content onto a TV through an HDMI port. It incorporates WiFi and Bluetooth radios.
Frequency Bands supported:	BT2.1+ EDR: ISM Band 2400-2483.5 MHz BT 4.0: ISM Band 2400-2483.5 MHz WLAN 802.11 a/b/g/n: 5150 MHz-5350 MHz and 5470 MHz-5725 MHz
Type(s) of Modulation:	Bluetooth: GFSK, π/4 DQPSK, 8DPSK; WLAN: CCK, OFDM
Power Supply:	100-240V/50-60Hz
Prototype / Production unit:	Prototype
EUT Specifications for mode of test: WLAN 802.11 a/b/g/n	
Frequency Range:	WLAN: 5180-5250MHz, 5250 – 5350 MHz, 5470 – 5725 MHz
Type(s) of Modulation:	BPSK, OFDM
Modes of Operation:	WLAN - development firmware used to force transmitter and achieve >98% duty cycle

<table>
<tr>
<td>Antenna Type/Gain:</td>
<td>Integrated Antenna: PIFA
Antenna Gain: (the values below represent the max. antenna gain in the given bands and have been provided by the applicant)
<table>
<tr><th colspan="3">Max Gains (dBi)</th></tr>
<tr><th>Band</th><th>Ant1
PIFA</th><th>Ant0
PIFA</th></tr>
<tr><td>2400-2483.5</td><td>3.7</td><td>-</td></tr>
<tr><td>5150-5250</td><td>4.5</td><td>2.4</td></tr>
<tr><td>5250-5350</td><td>4.1</td><td>-</td></tr>
<tr><td>5470-5725</td><td>4.5</td><td>-</td></tr>
<tr><td>5745-5850</td><td>4.6</td><td>-</td></tr>
</table>
Note: Antenna 0 will only be used at one frequency, 5200MHz.</td>
</tr>
</table>

3.2 Identification of the Equipment Under Test (EUT)

EUT #	Serial Number	Sample	HW/SW Version
1	PT662763	Conducted	EVT/9B123
2	PT677761	Radiated	EVT/9B123

3.3 Identification of Accessory equipment

AE #	Type	Manufacturer	Model	Serial Number
1	MacBook Pro	Apple	A1150	YD6124XQUJ1
2	AC Power Cord	Apple	N/A	N/A

3.4 Test modes of operation:

During the tests, the different modes of operation, modulation schemes and channels were selected using an external software.

Settings:

In the 5150-5250 MHz band

Mode	Data Rate
802.11a	6M
802.11n	6.5M

In the 5250-5350 MHz and 5470-5725 MHz bands,

Mode	Data Rate
802.11a	6M
802.11n	6.5M

Note: In all tests in this report each mode was tested at the data rate mentioned in the table.
The reason 6Mbps and 6.5 Mbps are used are they are the lowest available data rates in the 802.11a and 802.11n modes respectively and they have the maximum available duty cycle as a result. Since the duty cycle is the highest in these data rates, the transmitter is on for a greater duration and hence this is the worst case to test with.
When operating in the 802.11n mode, the device only supports 20MHz bandwidth and whenever 802.11n appears in this report it refers to 802.11n with 20MHz bandwidth (802.11n HT20).

4 Subject Of Investigation

The objective of the measurements done by Cetecom Inc. was to measure the performance of the EUT as specified by requirements listed in FCC rules Part 15.407 of Title 47 of the Code of Federal Regulations and Industry Canada rules RSS-210 Issue 8.

This test report is to support a request for new equipment authorization under the FCC ID BCG1427 and IC ID 579C-A1427.

Radiated measurements were performed on the product referred to in Section 3 as EUT, conducted measurements were performed on the radio installed on a test fixture. This test report contains full radiated and conducted testing results as per FCC15.407.

Low, mid and high channels and all modes were tested. All data in this report shows the worst case between horizontal and vertical polarization measurements.

All radiated testing for this report was performed on EUT 1 mentioned in Section 3. All conducted testing was performed on EUT 2 mentioned in Section 3.

This device contains two integral PIFA antennas. Ant. 1 is the primary antenna, and used for Bluetooth, and all WiFi channels, except channel 40. Ant. 0 is the secondary antenna and used for WiFi channel 40.

5 Summary of Measurement Results

Test Specification	Test Case	Temperature and Voltage Conditions	Mode	Pass	Fail	NA	NP	Result
§15.407 (a)(1) RSS210 A9.2	Power Spectral Density	Nominal	802.11a 802.11n	■	☐	☐	☐	Complies
N/A	Spectrum Bandwidth	Nominal	802.11a 802.11n	■	☐	☐	☐	Complies
§15.407 (a)(1) RSS210 A9.2	Maximum Output Power	Nominal	802.11a 802.11n	■	☐	☐	☐	Complies
§15.407 (a)(6)	Peak Excursion	Nominal	802.11a 802.11n	■	☐	☐	☐	Complies
§15.407 (b)(1)(2)(3) RSS210 A9.3	TX Spurious emissions-Conducted	Nominal	802.11a 802.11n	■	☐	☐	☐	Complies
§15.407 (b)(1)(2)(3) RSS210 A9.3	TX Spurious emissions-Radiated	Nominal	802.11a 802.11n	■	☐	☐	☐	Complies
§15.209(a) RSS Gen	TX Spurious Emissions Radiated<30MHz	Nominal	802.11a 802.11n	■	☐	☐	☐	Complies
§15.207(a)	Conducted Emissions <30MHz	Nominal	802.11a 802.11n	■	☐	☐	☐	Complies
15.407 (h) RSS-210 A9.4	DFS	Nominal	802.11a 802.11n	■	☐	☐	☐	Complies[1]

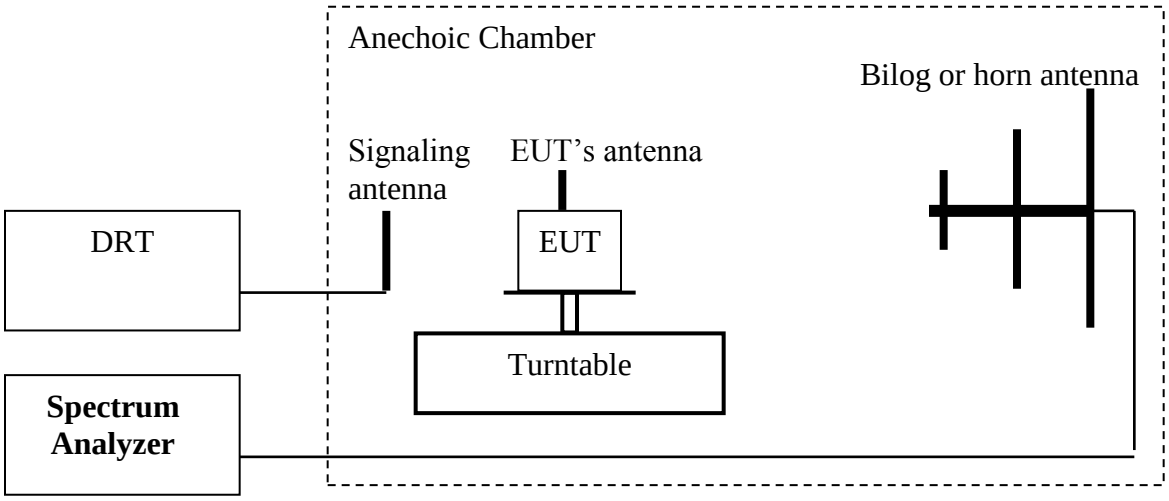
Note: NA= Not Applicable; NP= Not Performed.

1. Separate DFS Report available.

6 Measurements

6.1 Radiated Measurement Procedure

Ref: TIA-603C 2004 -2.2.17.2 Effective Radiated Power (ERP) or Effective Isotropic Radiated Power (EIRP)



1. Connect the equipment as shown in the above diagram with the EUT's antenna in a vertical orientation.
2. Adjust the settings of the Digital RadioCommunication Tester (DRT) to set the EUT to its maximum power at the required channel.
3. Set the spectrum analyzer to the channel frequency. Set the analyzer to measure peak hold with the required settings.
4. Rotate the EUT 360°. Record the peak level in dBm (**LVL**).
5. Replace the EUT with a vertically polarized half wave dipole or known gain antenna. The center of the antenna should be at the same location as the center of the EUT's antenna.
6. Connect the antenna to a signal generator with known output power and record the path loss in dB (**LOSS)**. **LOSS** = Generator Output Power (dBm) – Analyzer reading (dBm).
7. Determine the ERP using the following equation:
   ERP (dBm) = **LVL** (dBm) + **LOSS** (dB)
8. Determine the EIRP using the following equation:
   EIRP (dBm) = **ERP** (dBm) + 2.14 (dB)
9. Measurements are to be performed with the EUT set to the low, middle and high channels.

Spectrum analyzer settings: RBW=VBW=10MHz

Note: Measurement uncertainty for all radiated measurements=+/- 3dB

ANSI C63.4-2003 Section 8.3.1.1: Exploratory radiated emission measurements

Exploratory radiated measurements shall be performed at the measurement distance or at a closer distance than that specified for compliance to determine the emission characteristics of the EUT. At near distances, for EUTs of comparably small size, it is relatively easy to determine the spectrum signature of the EUT and, if applicable, the EUT configuration that produces the maximum level of emissions. A shielded room may be used for exploratory testing, but may have anomalies that can lead to significant errors in amplitude measurements.

Broadband antennas and a spectrum analyzer or a radio-noise meter with a panoramic display are often useful in this type of testing. It is recommended that either a headset or loudspeaker be connected as an aid in detecting ambient signals and finding frequencies of significant emission from the EUT when the exploratory and final testing is performed in an OATS with strong ambient signals. Caution should be taken if either antenna height between 1 and 4 meters or EUT azimuth is not fully explored. Not fully exploring these parameters during exploratory testing may require complete testing at the OATS or semi-anechoic chamber when the final full spectrum testing is conducted.

The EUT should be set up in its typical configuration and arrangement, and operated in its various modes. For tabletop systems, cables or wires should be manipulated within the range of likely arrangements. For floor-standing equipment, the cables or wires should be located in the same manner as the user would install them and no further manipulation is made. For combination EUTs, the tabletop and floor-standing portions of the EUT shall follow the procedures for their respective setups and cable manipulation. If the manner of cable installation is not known, or if it changes with each installation, cables or wires for floor-standing equipment shall be manipulated to the extent possible to produce the maximum level of emissions.

For each mode of operation required to be tested, the frequency spectrum shall be monitored. Variations in antenna height between 1 and 4 m, antenna polarization, EUT azimuth, and cable or wire placement (each variable within bounds specified elsewhere) shall be explored to produce the emission that has the highest amplitude relative to the limit. A step-by-step technique for determining this emission can be found in Annex C.

When measuring emissions above 1 GHz, the frequencies of maximum emission shall be determined by manually positioning the antenna close to the EUT and by moving the antenna over all sides of the EUT while observing a spectral display. It will be advantageous to have prior knowledge of the frequencies of emissions above 1 GHz. If the EUT is a device with dimensions approximately equal to that of the measurement antenna beamwidth, the measurement antenna shall be aligned with the EUT.

ANSI C63.4-2003 Section 8.3.1.2: Final radiated emission measurements

Based on the measurement results in 8.3.1.1, the one EUT, cable and wire arrangement, and mode of operation that produces the emission that has the highest amplitude relative to the limit is selected for the final measurement. The final measurement is then performed on a site meeting the requirements of 5.3, 5.4, or 5.5 as appropriate without variation of the EUT arrangement or EUT mode of operation. If the EUT is relocated from an exploratory test site to a final test site, the highest emission shall be remaximized at the final test location before final radiated emissions measurements are performed. However, antenna height and polarity and EUT azimuth are to be varied. In addition, the full frequency spectrum (for the range to be checked for meeting compliance) shall be investigated.

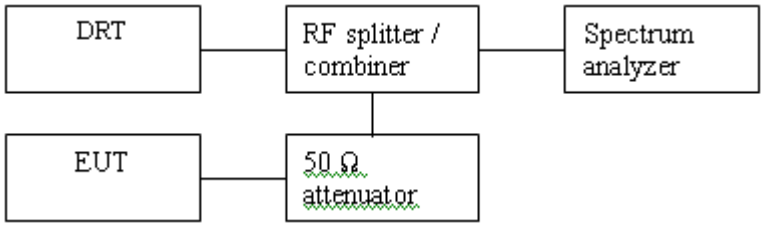
This investigation is performed with the EUT rotated 360°, the antenna height scanned between 1 m and 4 m, and the antenna rotated to repeat the measurements for both the horizontal and vertical antenna polarizations. During the full frequency spectrum investigation, particular focus should be made on those frequencies found in exploratory testing that were used to find the final test configuration, mode of operation, and arrangement (associated with achieving the least margin with respect to the limit). This full spectrum test constitutes the compliance measurement.

For measurements above 1 GHz, use the cable, EUT arrangement, and mode of operation determined in the exploratory testing to produce the emission that has the highest amplitude relative to the limit. Place the measurement antenna away from each area of the EUT determined to be a source of emissions at the specified measurement distance, while keeping the antenna in the “cone of radiation” from that area and pointed at the area both in azimuth and elevation, with polarization oriented for maximum response. The antenna may have to be higher or lower than the EUT, depending on the EUT’s size and mounting height, but the antenna should be restricted to a range of heights of from 1 m to 4 m above the ground or reference ground plane. If the transmission line for the measurement antenna restricts its range of height and polarization, the steps needed to ensure the correct measurement of the maximum emissions, shall be described in detail in the report of measurements. Data collected shall satisfy the report requirements of Clause 10.

NOTES

1— Where limits are specified by agencies for both average and peak (or quasi-peak) detection, if the peak (or quasi-peak) measured value complies with the average limit, it is unnecessary to perform an average measurement.
2—Use of waveguide and flexible waveguide may be necessary at frequencies above 10 GHz to achieve usable signal-to noise ratios at required measurement distances. If so, it may be necessary to restrict the height search of the antenna, and special care should be taken to ensure that maximum emissions are correctly measured.
3—All presently known devices causing emissions above 10 GHz are physically small compared with the beam-widths of typical horn antennas used for EMC measurements. For such EUTs and frequencies, it may be preferable to vary the height and polarization of the EUT instead of the receiving antenna to maximize the measured emissions.

6.2 Conducted Measurement Procedure



1. Connect the equipment as shown in the above diagram.
2. Adjust the settings of the Digital Radio Communication Tester (DRT) to set the EUT to its maximum power at the required channel.
3. Measurements are to be performed with the EUT set to the low, middle and high channels.

Note: Measurement uncertainty for all conducted measurements=+/- 0.5dB

6.3 Sample Calculations for Radiated Measurements

6.3.1 Field Strength Measurements:

Field Strength measurements are directly taken from the Spectrum Analyzer/ Receiver, taking into account the cable loss between the Receiving Antenna and the Spectrum Analyzer/ Receiver. Antenna Factor is accounted for by the test SW.

FS (dBµV/m)= Measured Value on SA (dBµV)+ Cable Loss (dB)
Eg:

Frequency (MHz)	Measured SA (dBµV)	Cable Loss (dB)	Field Strength Result (dBµV/m)
1000	95.5	3.5	99.0

6.3.2 Power Measurements using Substitution Procedure:

The measurement on the Spectrum Analyzer is used as a basis for the Substitution procedure.
The EUT is replaced with a Signal Generator and an antenna. The setting on the Signal Generator is varied until the Spectrum Analyzer displays the original reading. EIRP is calculated as-

EIRP (dBm)= Signal Generator setting (dBm)- Cable Loss (dB)+ Antenna Gain (dBi)
Eg:

Frequency (MHz)	Measured SA (dBµV)	Signal Generator setting (dBm)	Antenna Gain (dBi)	Dipole Gain (dBd)	Cable Loss (dB)	EIRP (dBm)
1000	95.5	24.5	6.5	0	3.5	27.5

6.4 Maximum Peak Output Power

6.4.1 Limits: §15.407

Conducted output power shall not reduce the lesser of the following

FCC:
Sub-band 1: 5150-5250MHz: 15.407(a)(1): 50mW(17dBm) or 4dBm + 10log(B),
Sub-band 2: 5250-5350MHz: 15.407(a)(2): 250mW(24dBm) or 11dBm + 10log(B)
Sub-band 3: 5470-5725MHz: 15.407(a)(2): 250mW(24dBm) or 11dBm + 10log(B)
B is the 26–dB emission bandwidth in MHz.
EIRP limit = Conducted Limit + 6dB

IC: (EIRP)
Sub-band 1: 5150-5250MHz: RSS-210 A9.2: 200mW(23dBm) or 10 + 10log(B),
Sub-band 2: 5250-5350MHz: RSS-210 A9.2:1W(30dBm) or 17 + 10log(B)
Sub-band 3: 5470-5725MHz: RSS-210 A9.2: 4W(30dBm) or 23dBm + 10log(B)

6.4.2 Test Conditions:

Tnom: 21°C; Vnom: 120V

6.4.3 Test Procedure used:

General U-NII Test Procedures from FCC Publication #789033 on Oct 25, 2011.

Measurement using a spectrum analyzer (SA)
Method SA-1 Alternative (RMS detection with slow sweep and EUT transmitting continuously at full power):
(i) Set span to encompass the entire emission bandwidth (EBW) of the signal.
(ii) Set RBW = 1 MHz.
(iii) Set VBW ≥ 3 MHz.
(iv) Number of points in sweep ≥ 2 Span / RBW. (This ensures that bin-to-bin spacing is ≤ RBW/2, so that narrowband signals are not lost between frequency bins.)
(v) Manually set sweep time ≥ 10 * (number of points in sweep) * (symbol period of the transmitted signal).
(vi) Set detector = RMS.
(vii) The EUT must be operated at 100 percent duty cycle.
(viii) Perform a single sweep.
(ix) Compute power by integrating the spectrum across the 26 dB EBW of the signal using the spectrum analyzer's band power measurement function with band limits set equal to the EBW band edges. If the spectrum analyzer does not have a band power function, sum the spectrum levels (in power units) at 1 MHz intervals extending across the 26 dB EBW of the spectrum.

Sweep time determined as > 10* (625)* 1.32 ms

6.4.4 Test Result:

		Measured Conducted Peak Power (dBm)			Calculated EIRP (dBm)		
Frequency (MHz)	**Channel**	**a**	**n HT20**	**Limit**	**a**	**n HT20**	**Limit**
5180	**36**	13.76	13.51	17	18.26	18.01	23
5200	**40**	13.57	13.42	17	15.97	15.82	23
5240	**48**	13.33	13.12	17	17.83	17.62	23
5260	**52**	18.80	18.70	24	23.3	23.2	30
5300	**60**	18.79	18.69	24	23.29	23.19	30
5320	**64**	18.04	17.93	24	22.54	22.43	30
5500	**100**	18.46	18.27	24	22.96	22.77	30
5580	**116**	18.77	18.61	24	23.27	23.11	30
5700	**140**	18.41	18.33	24	22.91	22.83	30

Note: Plots are available under Sec 5.7.4

6.4.5 Test Verdict:

Pass

6.5 Restricted Band Edge Compliance

6.5.1 Limits: §15.205

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	([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)).

6.5.2 Measurement Procedure:

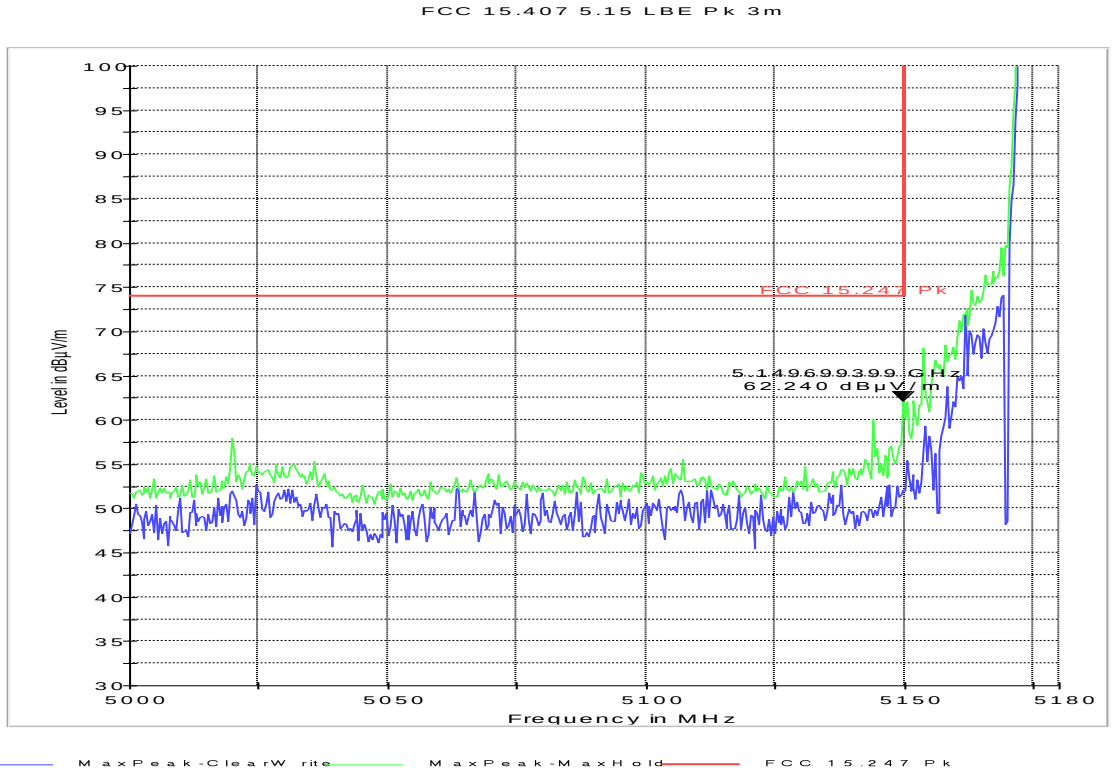
Peak measurements are made using a peak detector and RBW=1MHz.
Average measurements performed using a peak detector and according to video averaging procedure with RBW=1MHz and VBW=10Hz.
*PEAK LIMIT= 74dBµV/m
*AVG. LIMIT= 54dBµV/m
Measurement Uncertainty: ±3.0dB

6.5.3 Test Verdict:

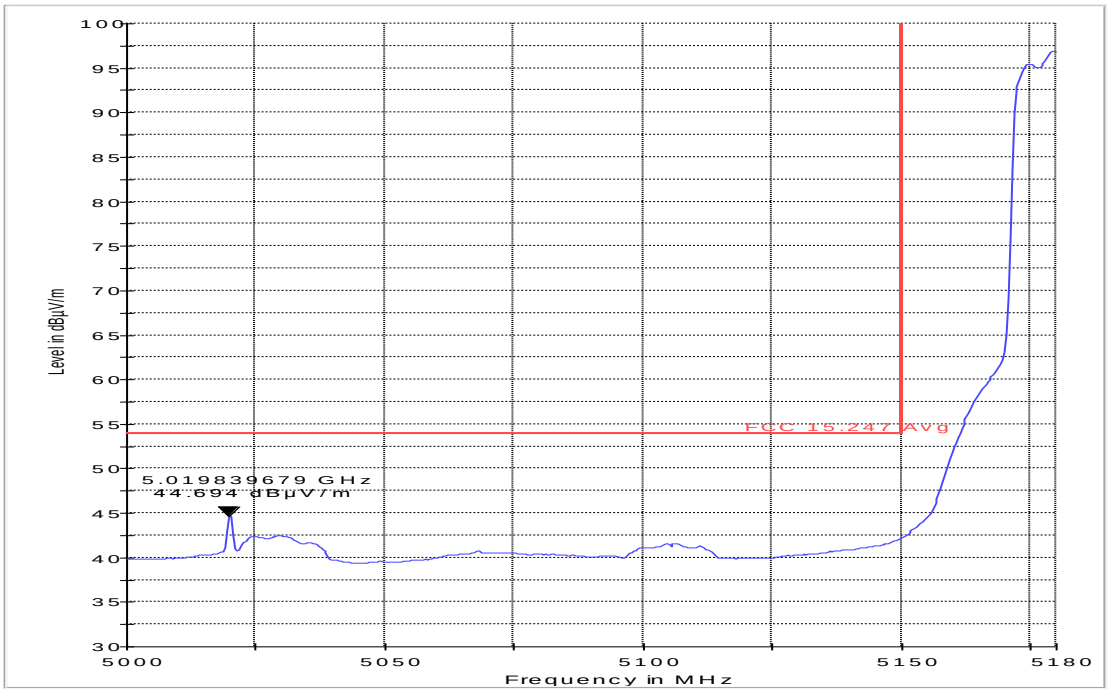
Pass

6.5.4 Test Data/plots:

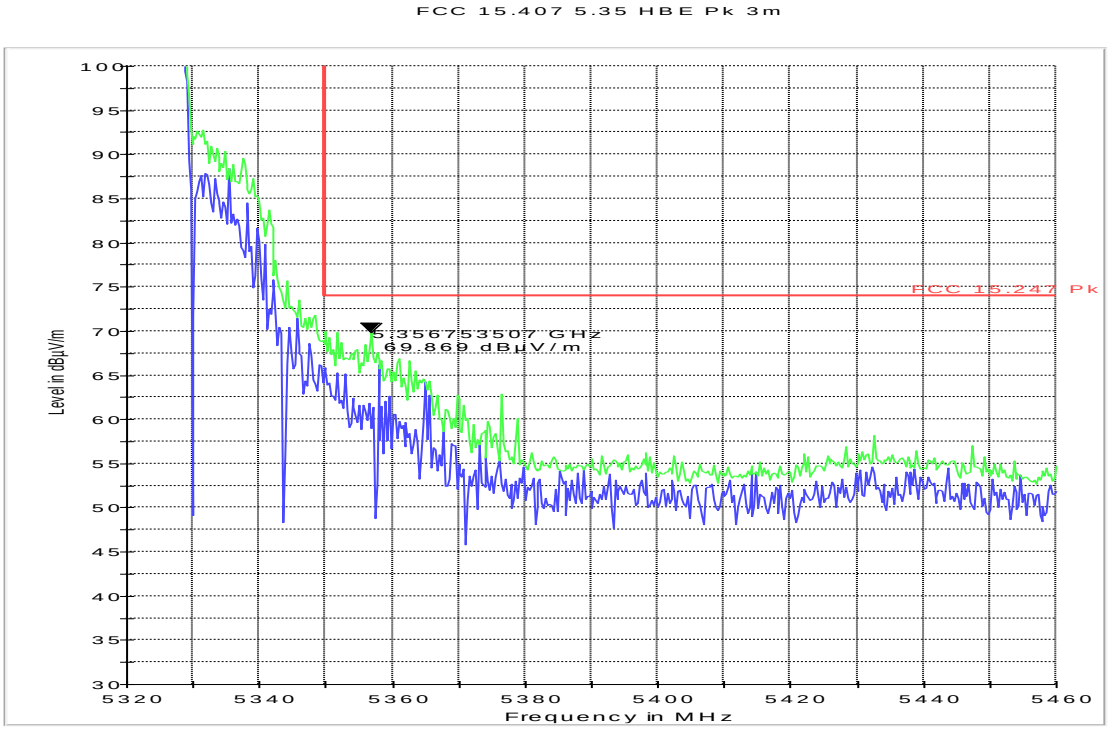
802.11a Channel 36 Low Band Edge Peak measurement



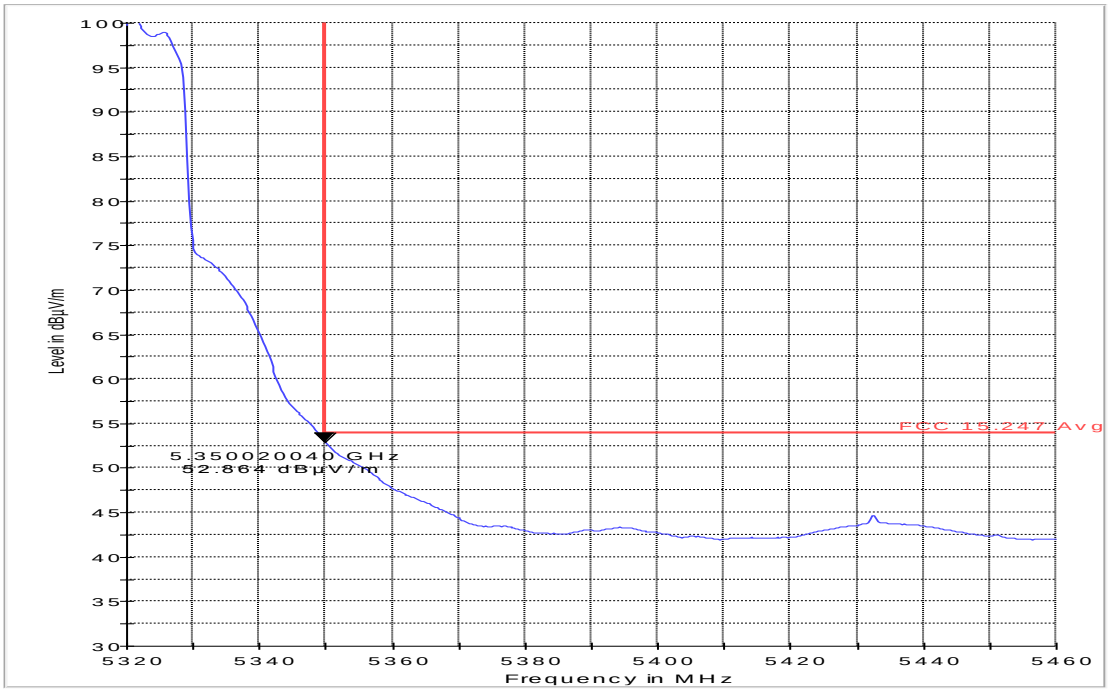
802.11a Channel 36 Low Band Edge Average measurement



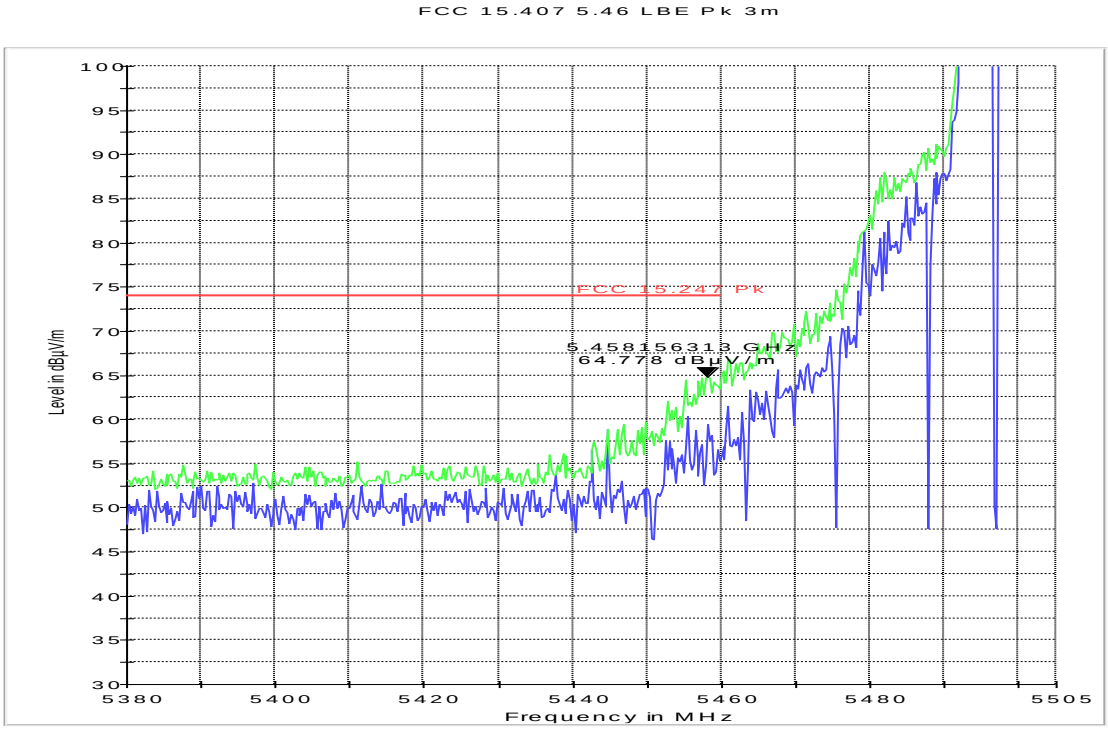
802.11a Channel 64 High Band Edge Peak measurement



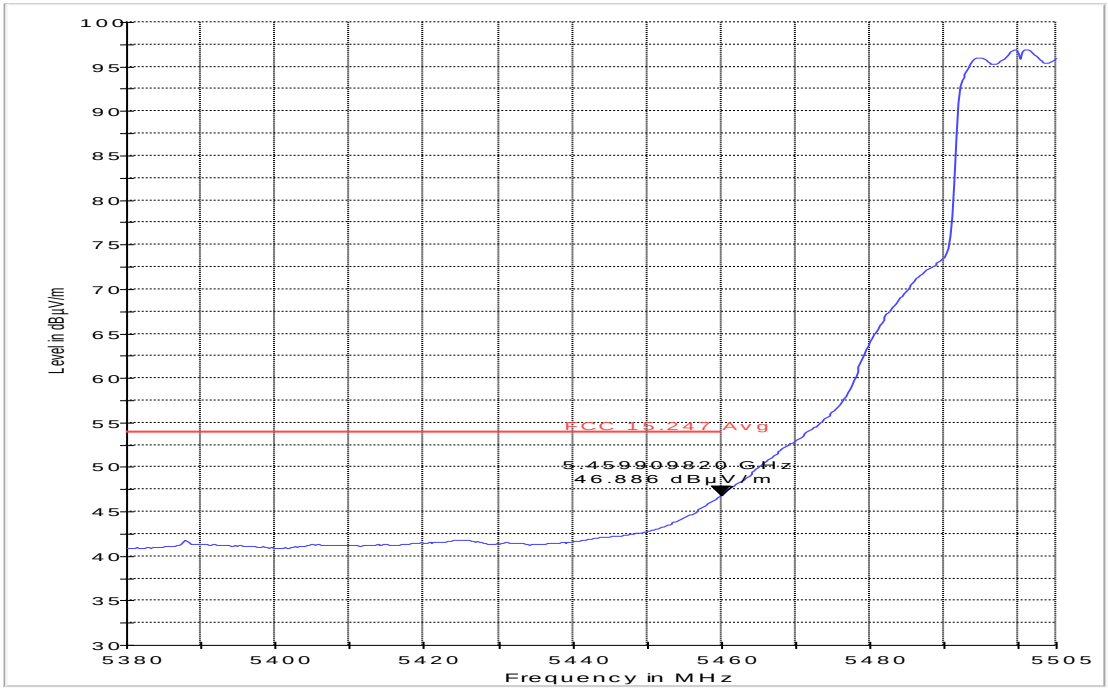
802.11a Channel 64 High Band Edge Average measurement



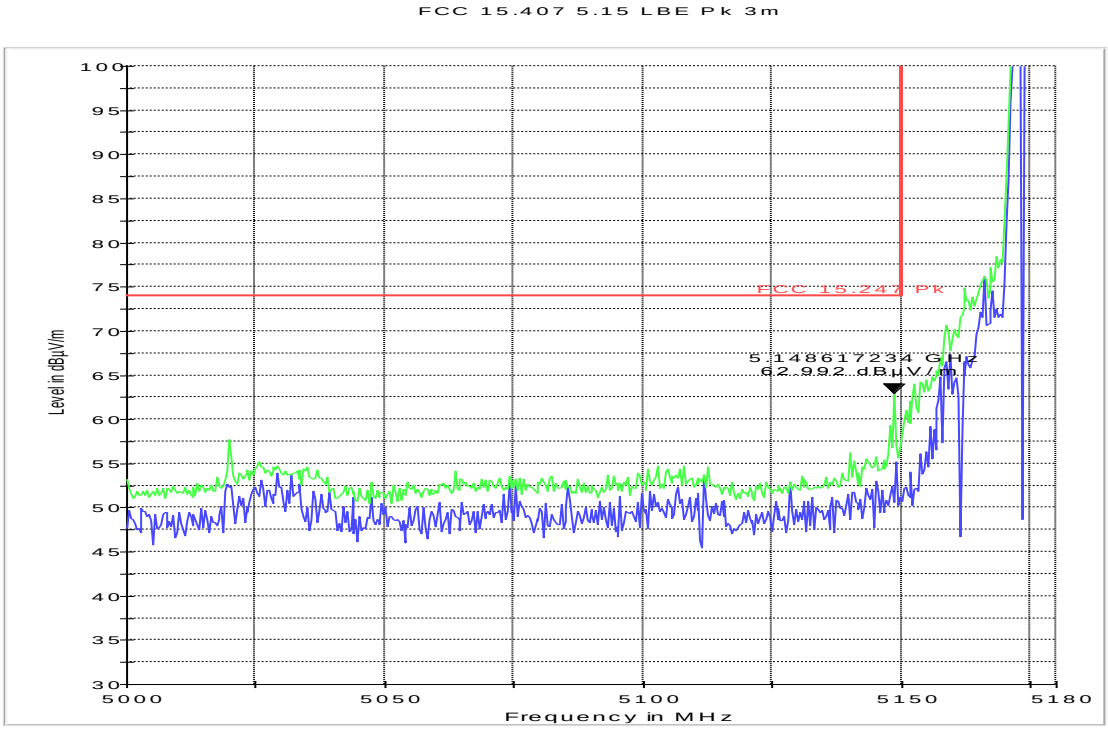
802.11a Channel 100 Low Band Edge Peak measurement



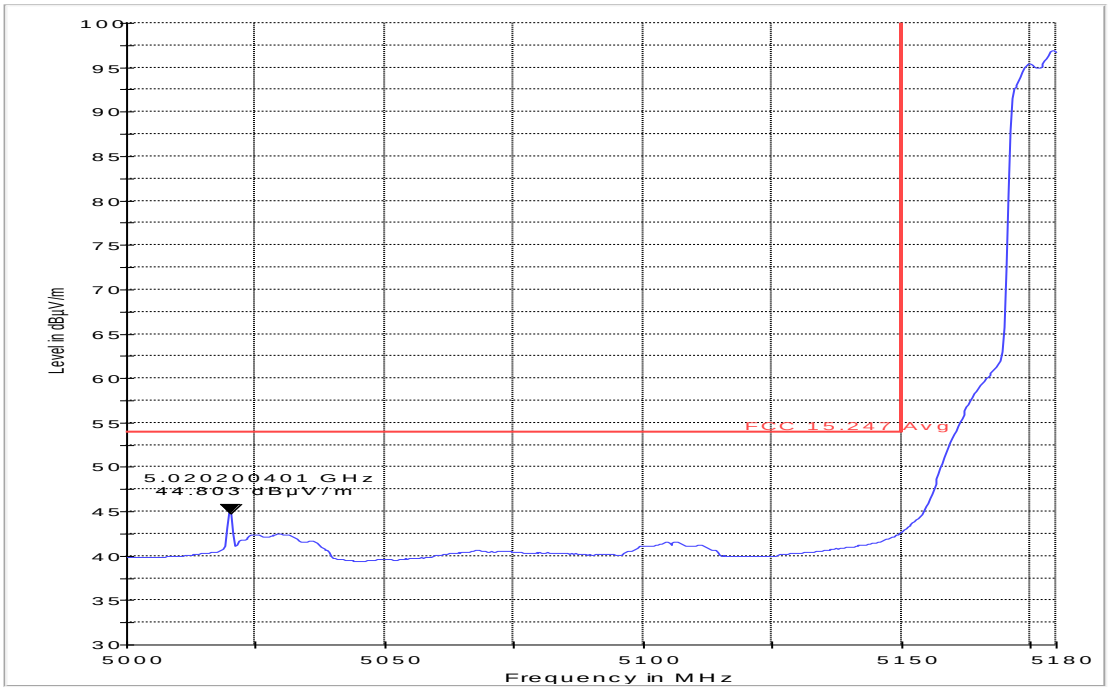
802.11a Channel 100 Low Band Edge Average measurement



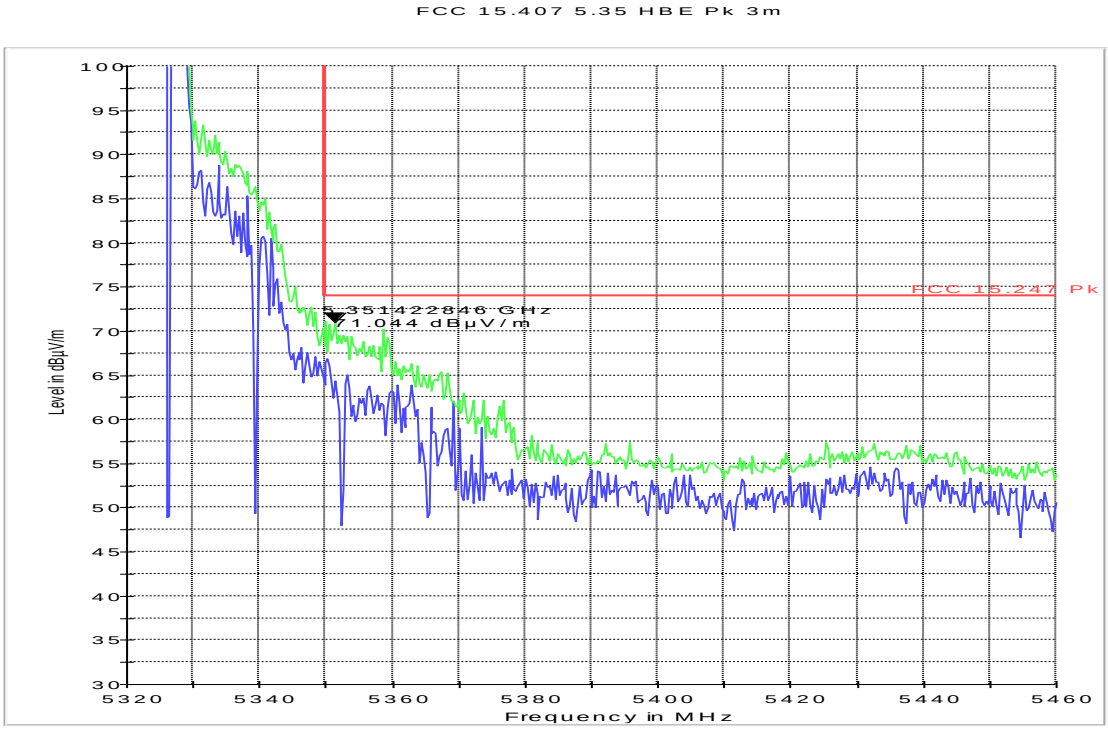
802.11n Channel 36 Low Band Edge Peak measurement



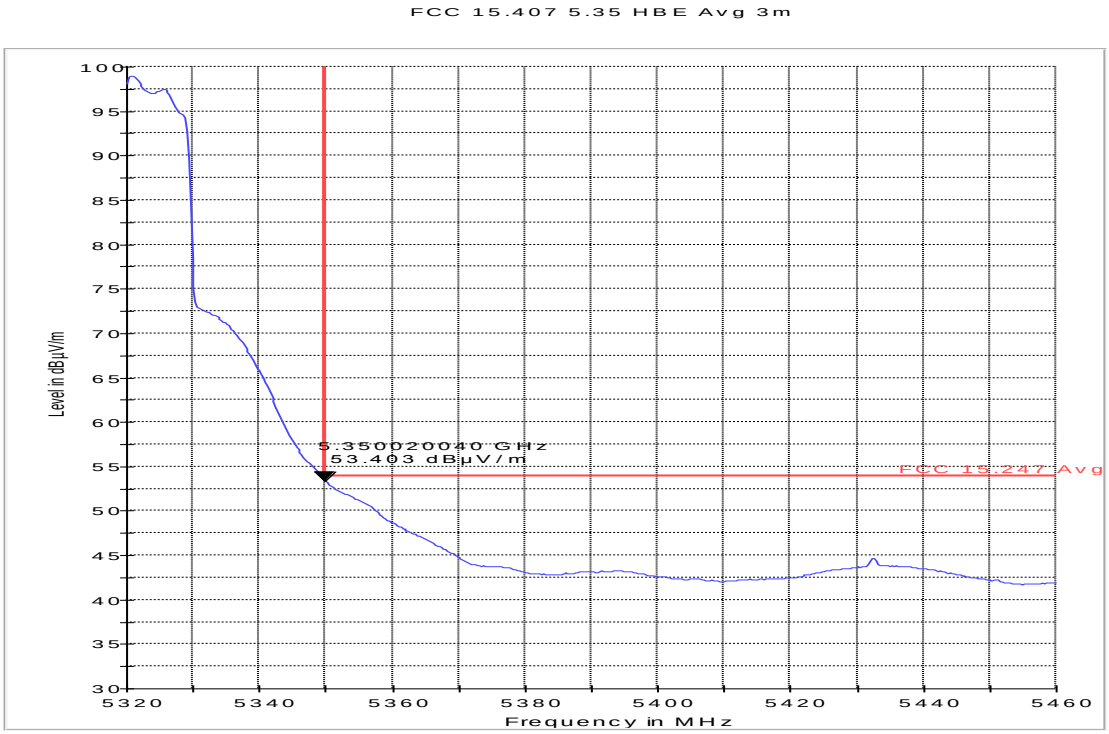
802.11n Channel 36 Low Band Edge Average measurement



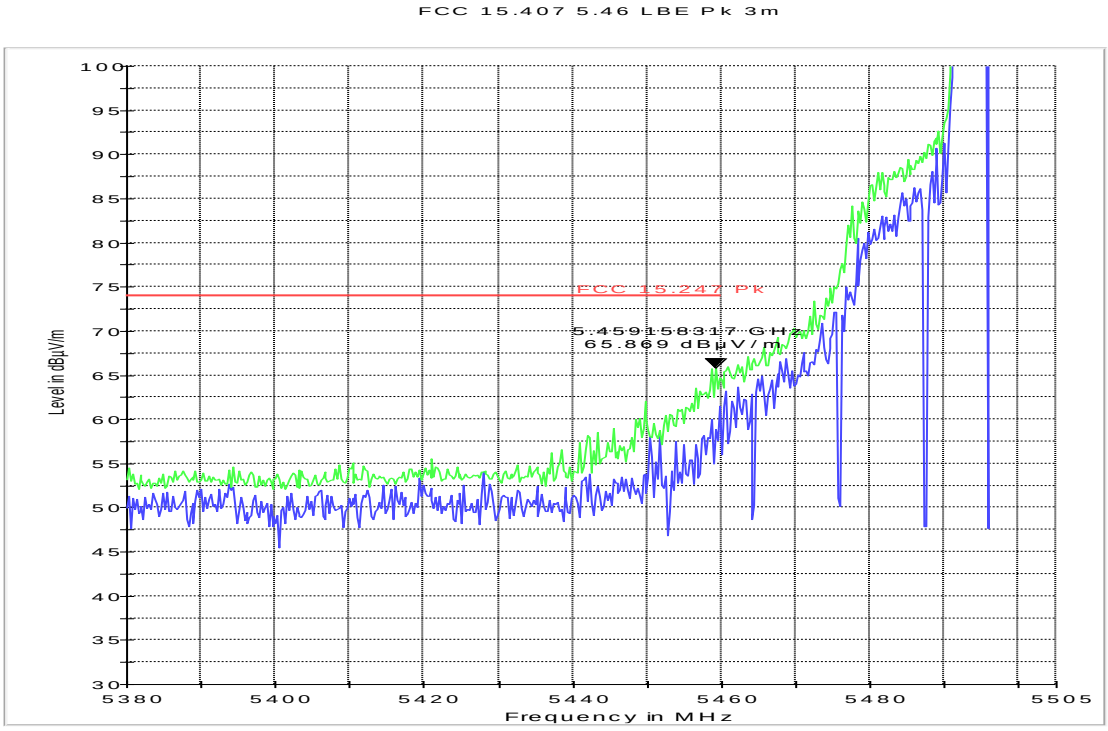
802.11n Channel 64 High Band Edge Peak measurement



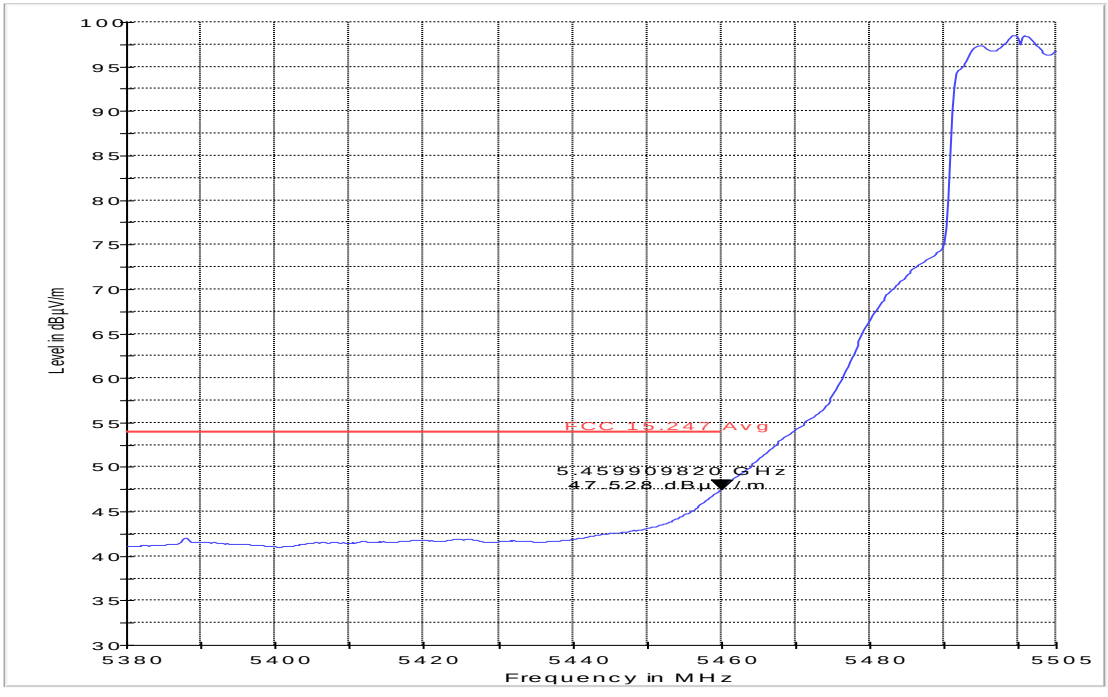
802.11n Channel 64 High Band Edge Average measurement



802.11n Channel 100 Low Band Edge Peak measurement



802.11n Channel 100 Low Band Edge Average measurement



6.6 Occupied Bandwidth

6.6.1 Limits:

None

6.6.2 Test Result:

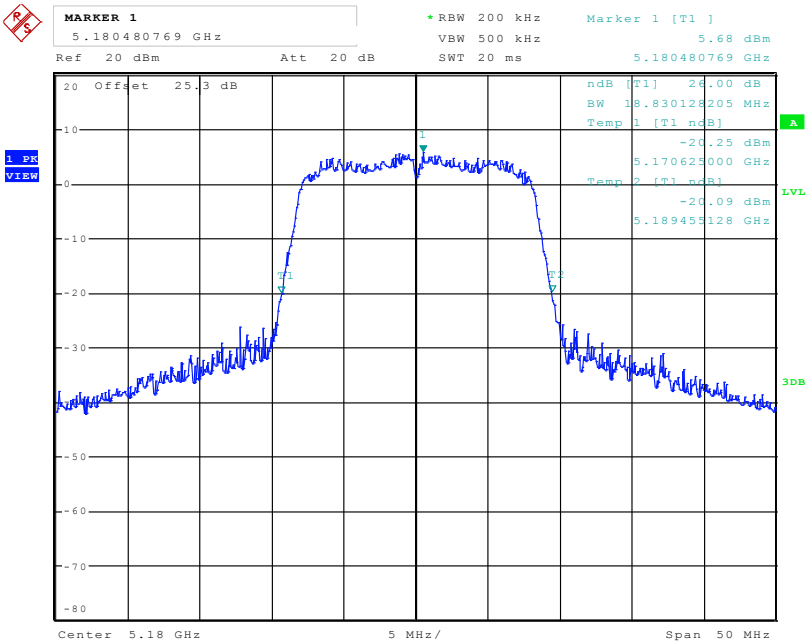
Occupied Bandwidth (MHz)					
Frequency (MHz)	Channel	a		n	
		26 dB	99%	26 dB	99%
5180	36	18.83	16.43	19.31	17.55
5200	40	18.83	16.43	19.23	17.55
5240	48	18.99	16.43	19.31	17.55
5260	52	37.74	17.55	41.51	18.11
5300	60	38.94	17.55	41.27	18.11
5320	64	36.06	16.99	40.79	17.87
5500	100	38.54	17.23	40.87	17.95
5580	116	38.06	17.23	41.59	17.95
5700	140	37.10	17.15	40.63	17.95
Measurement Uncertainty: ±0.01 MHz					

6.6.3 Test Verdict:

Pass

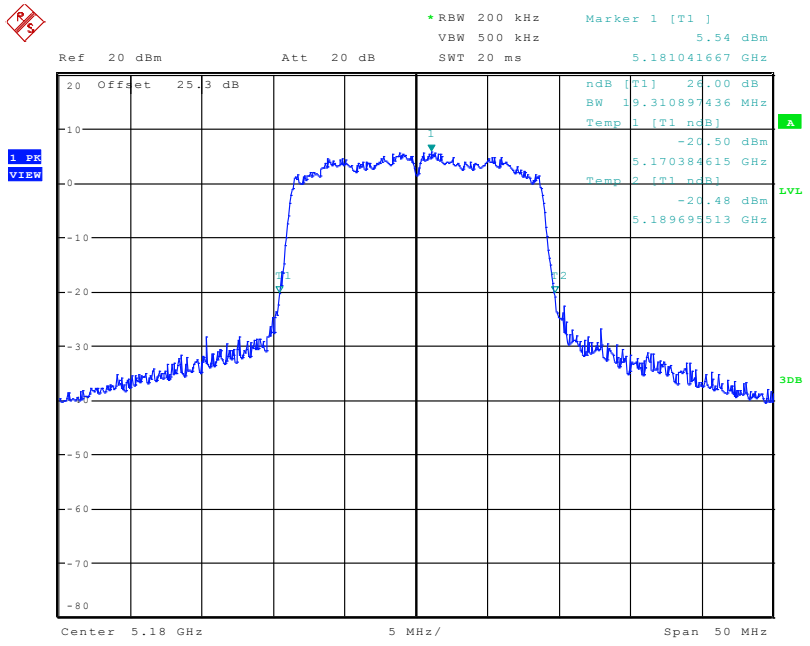
6.6.4 Plots

802.11a Channel 36 26dB BW



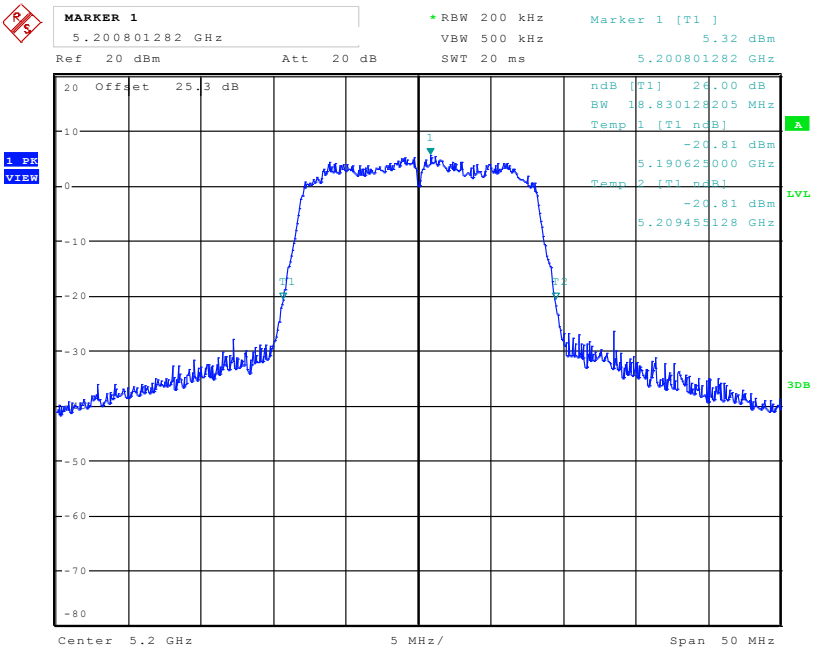
Date: 23.NOV.2011 16:11:25

802.11n Channel 36 26dB BW



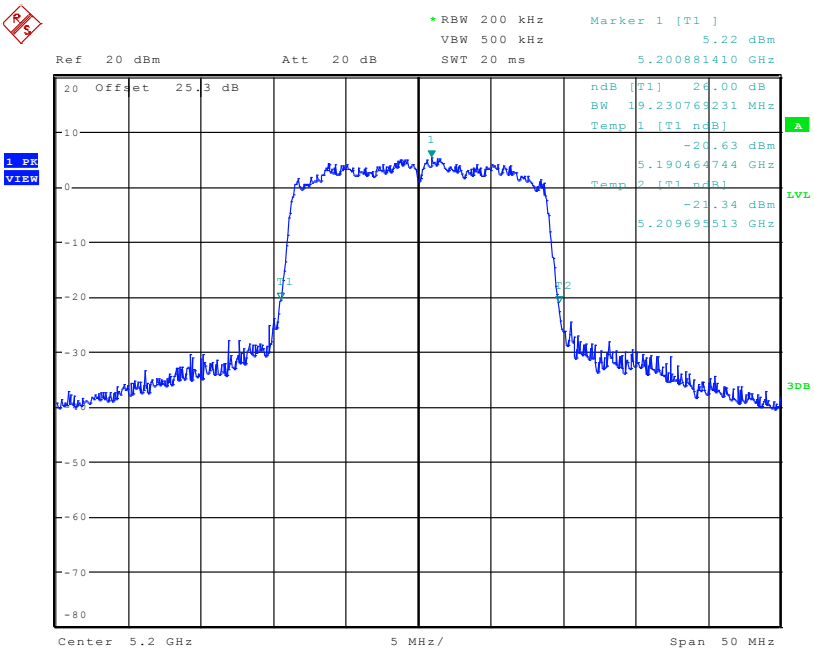
Date: 23.NOV.2011 16:15:36

802.11a Channel 40 26dB BW



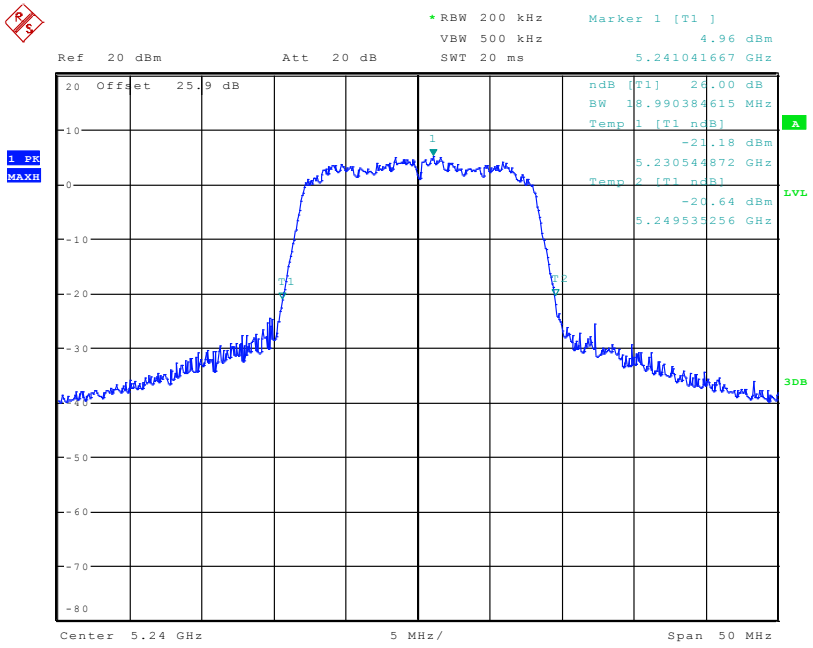
Date: 23.NOV.2011 15:55:45

802.11n Channel 40 26dB BW



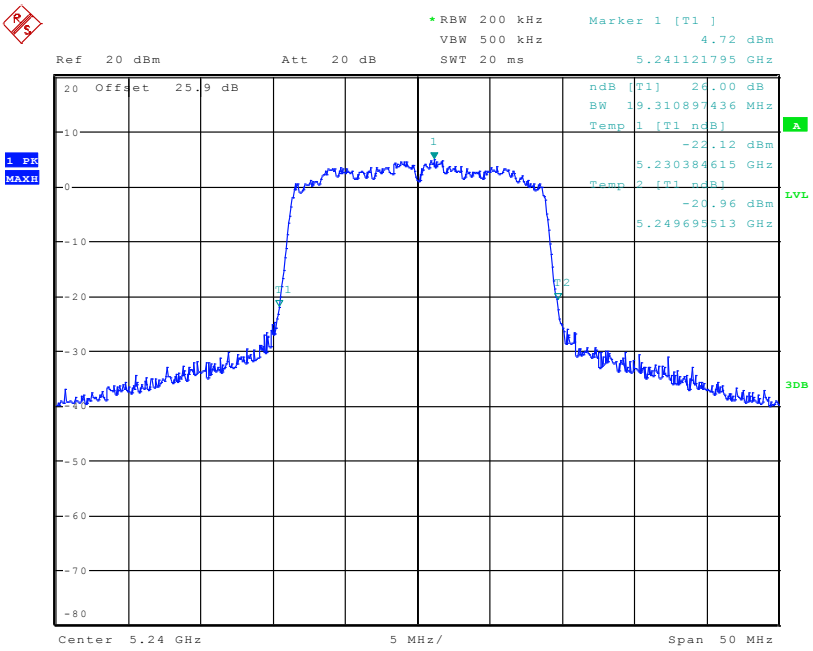
Date: 23.NOV.2011 15:56:31

802.11a Channel 48 26dB BW



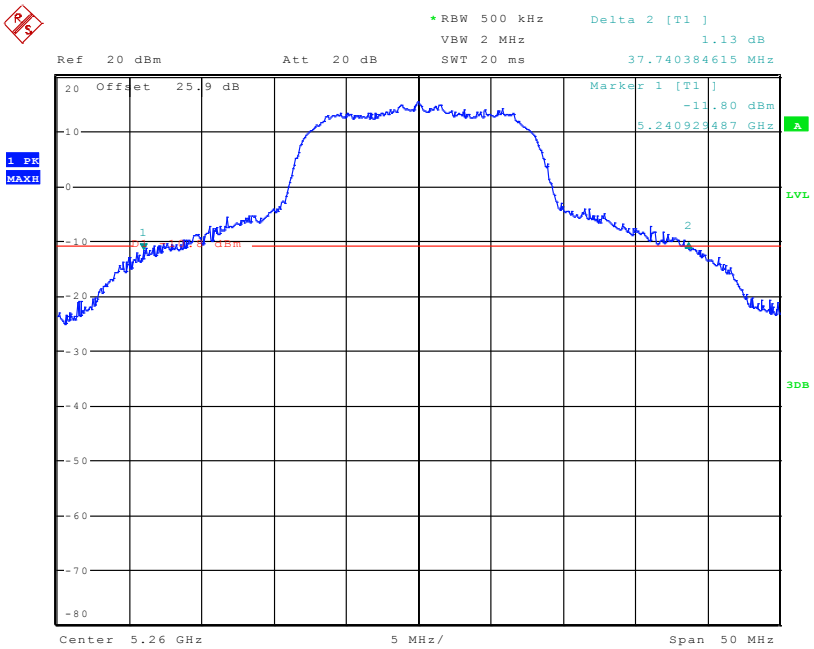
Date: 7.DEC.2011 11:34:27

802.11n Channel 48 26dB BW



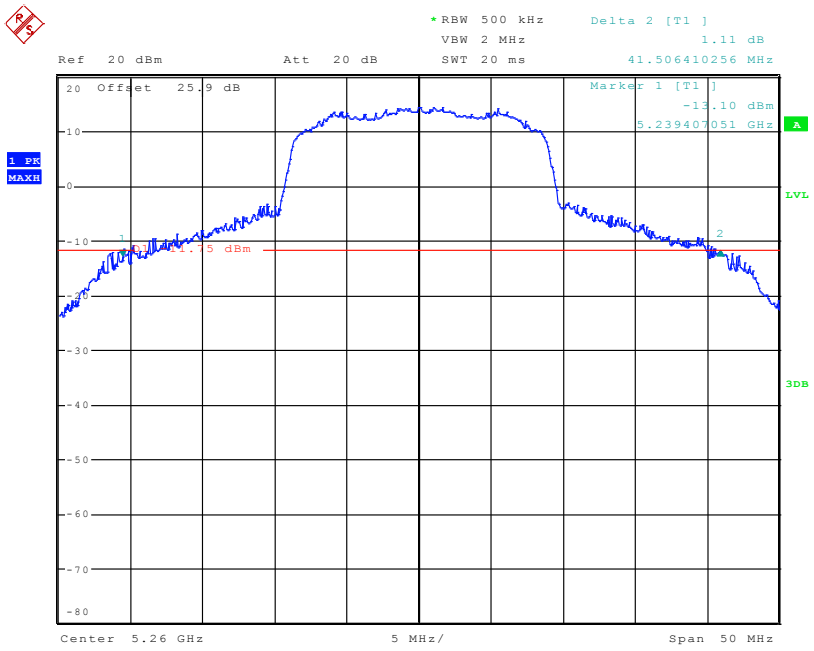
Date: 7.DEC.2011 11:28:36

802.11a Channel 52 26dB BW



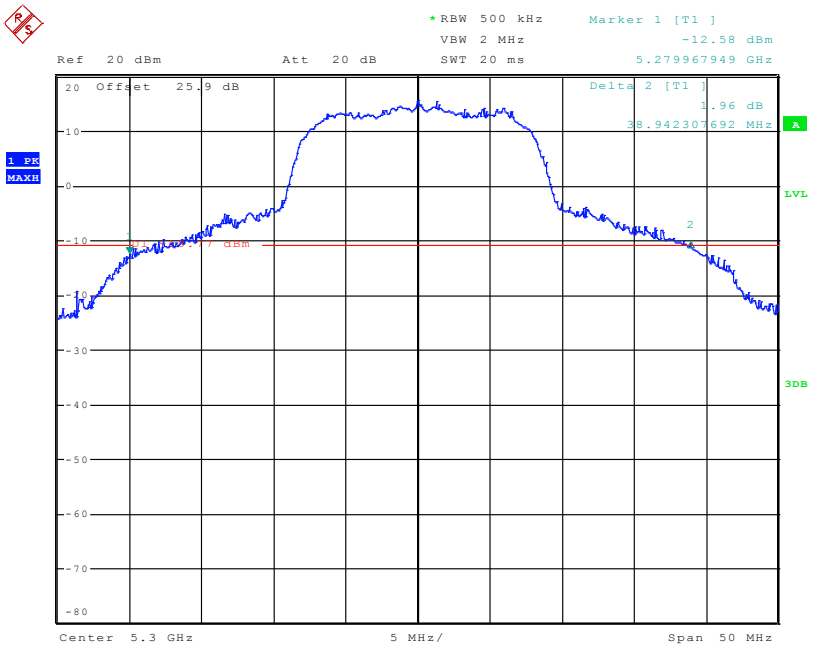
Date: 7.DEC.2011 11:06:52

802.11n Channel 52 26dB BW



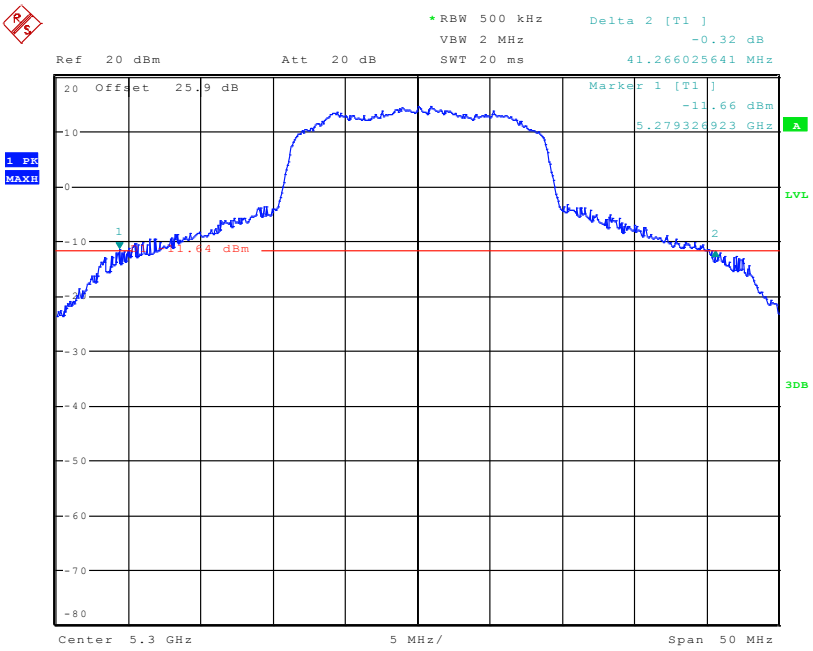
Date: 7.DEC.2011 11:31:25

802.11a Channel 60 26dB BW



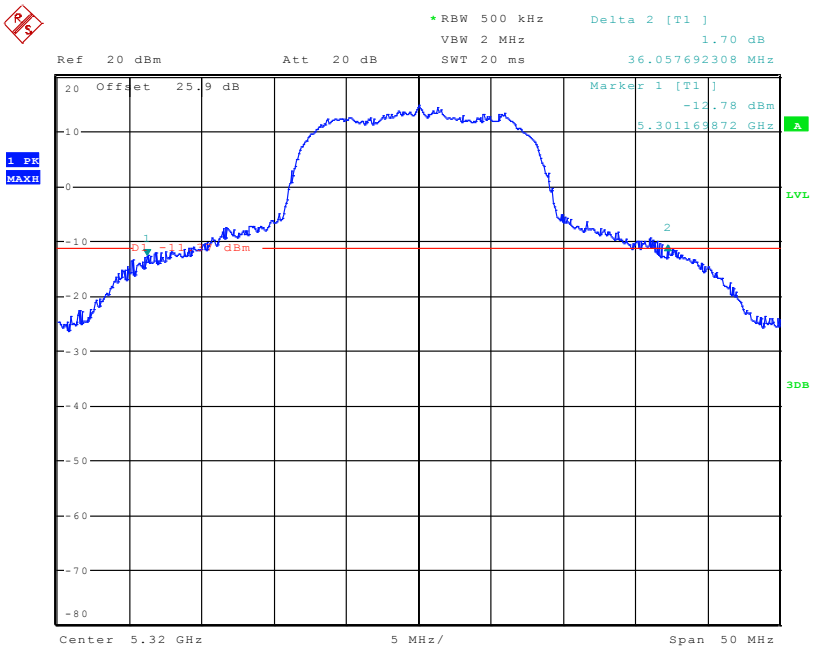
Date: 7.DEC.2011 11:09:35

802.11n Channel 60 26dB BW



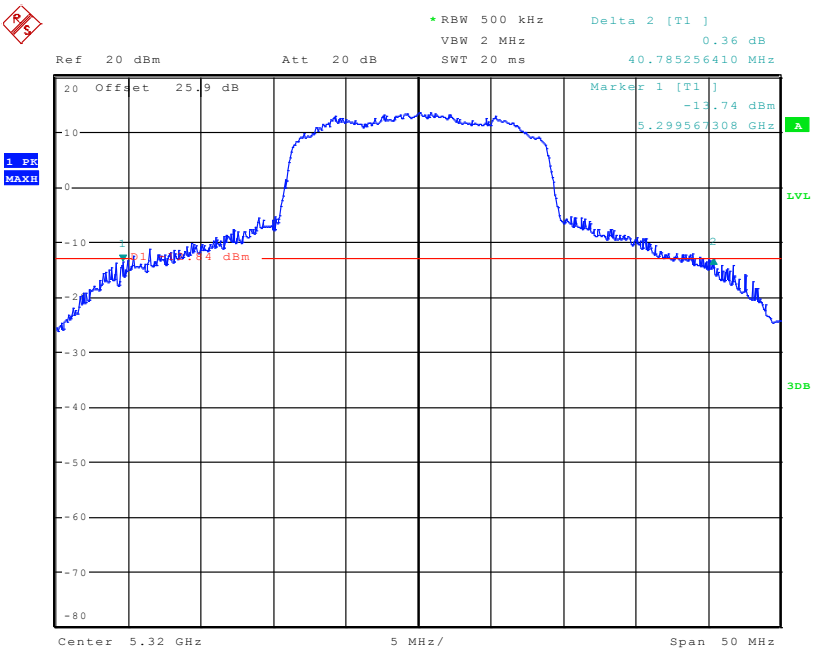
Date: 7.DEC.2011 11:41:59

802.11a Channel 64 26dB BW



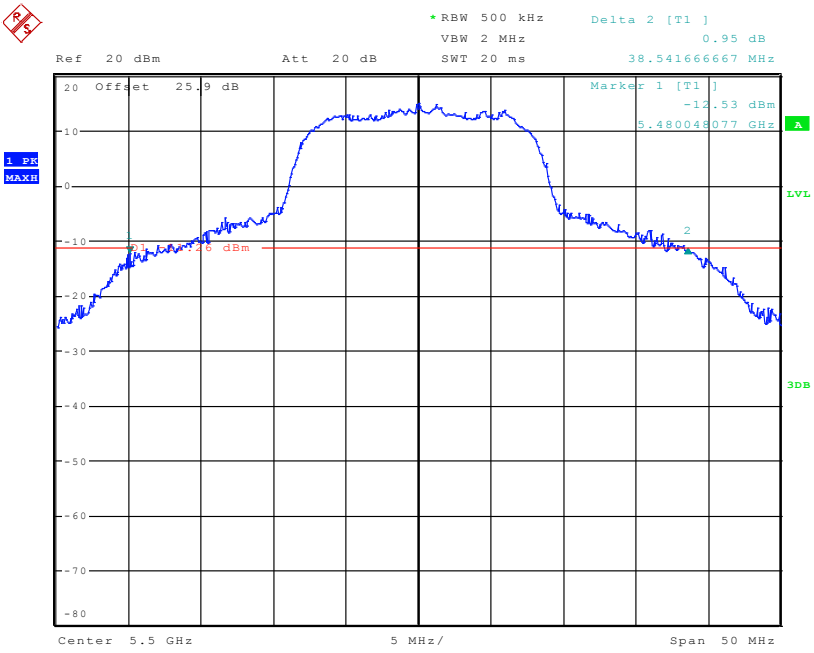
Date: 7.DEC.2011 11:15:38

802.11n Channel 64 26dB BW



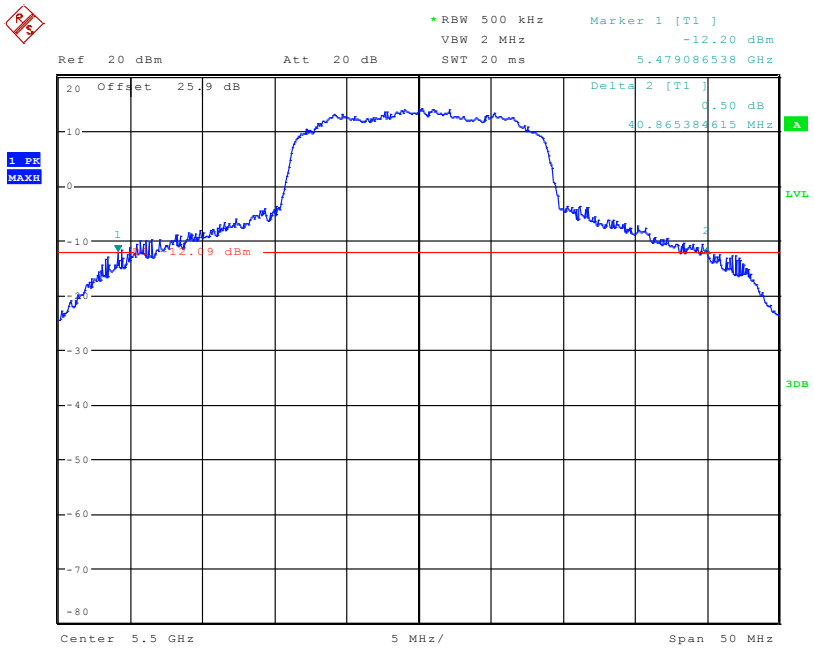
Date: 7.DEC.2011 11:43:57

802.11a Channel 100 26dB BW



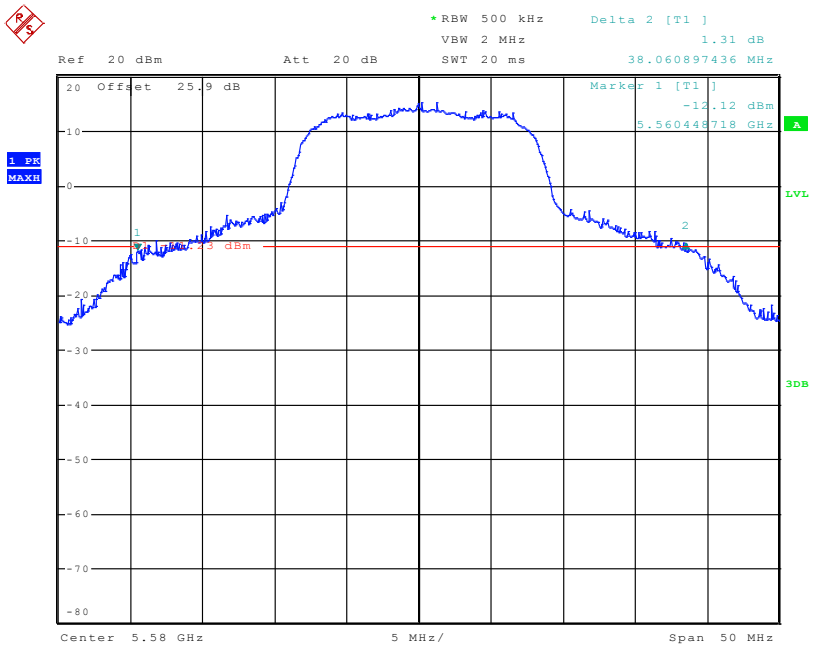
Date: 7.DEC.2011 11:17:27

802.11n Channel 100 26dB BW



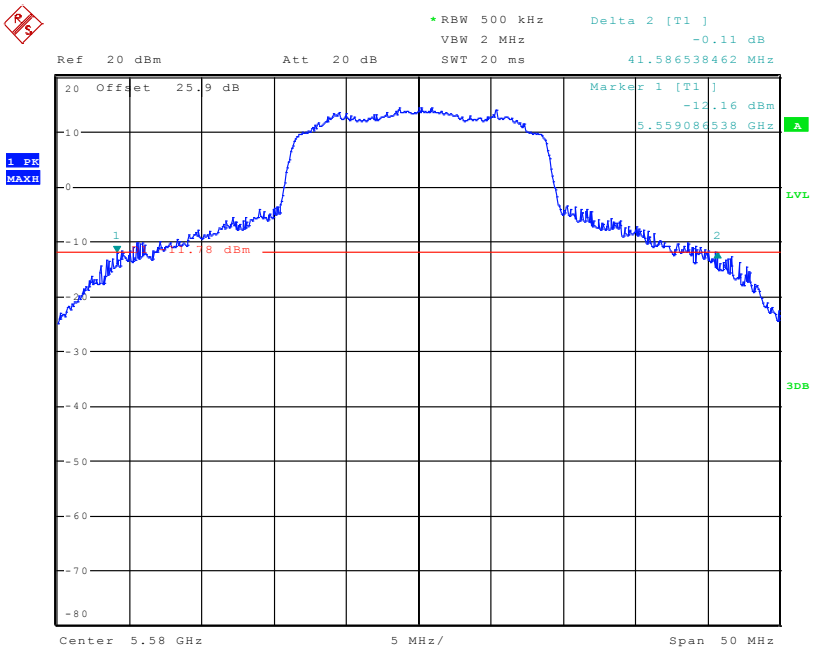
Date: 7.DEC.2011 11:48:54

802.11a Channel 116 26dB BW



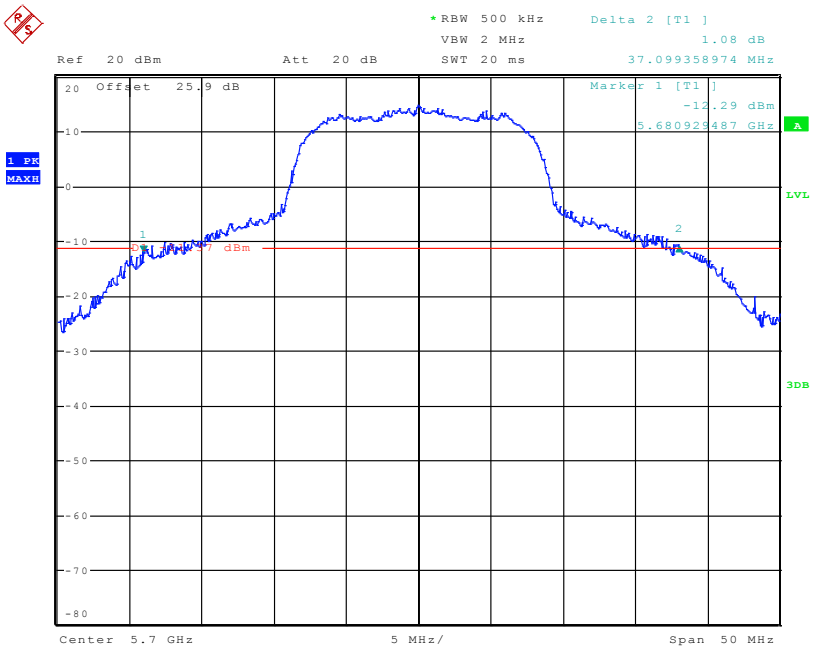
Date: 7.DEC.2011 11:21:54

802.11n Channel 116 26dB BW



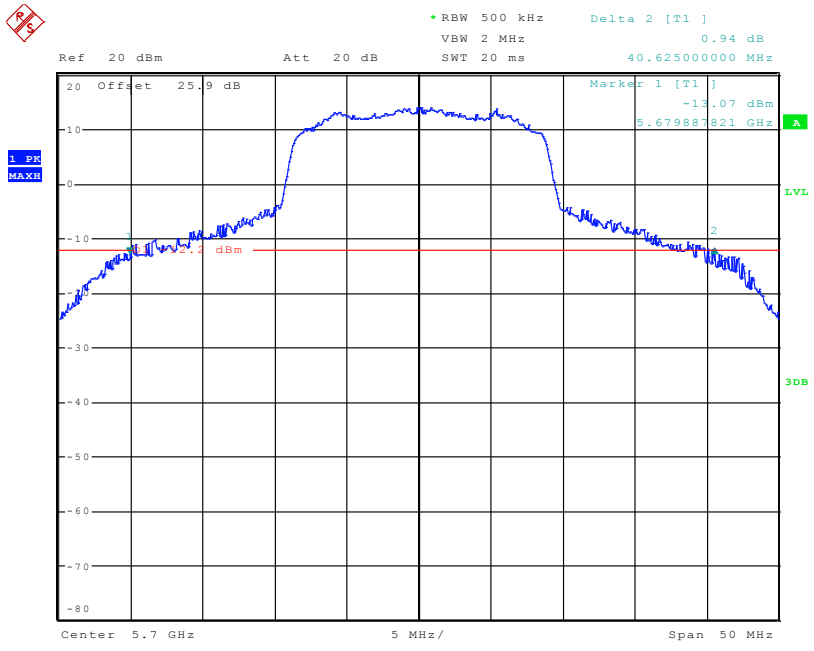
Date: 7.DEC.2011 11:52:46

802.11a Channel 140 26dB BW



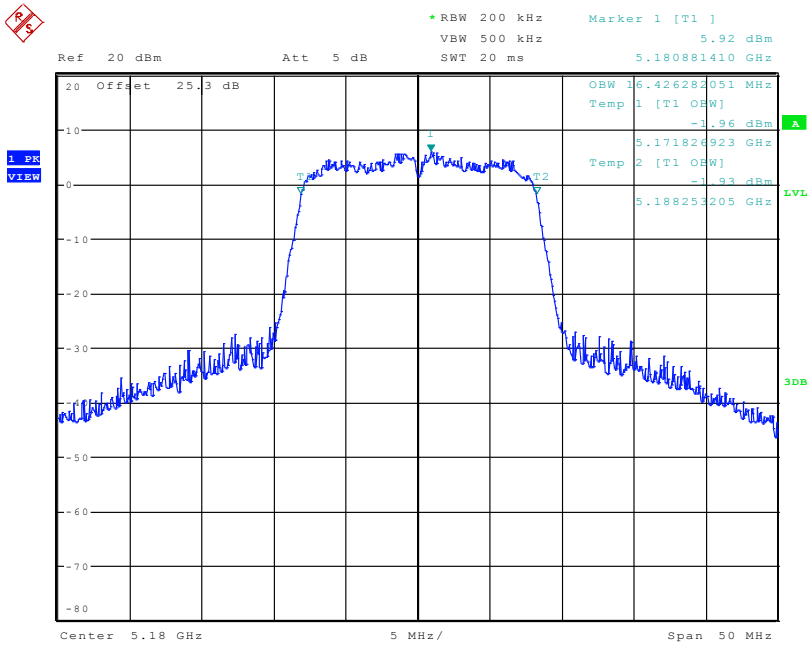
Date: 7.DEC.2011 11:23:32

802.11n Channel 140 26dB BW



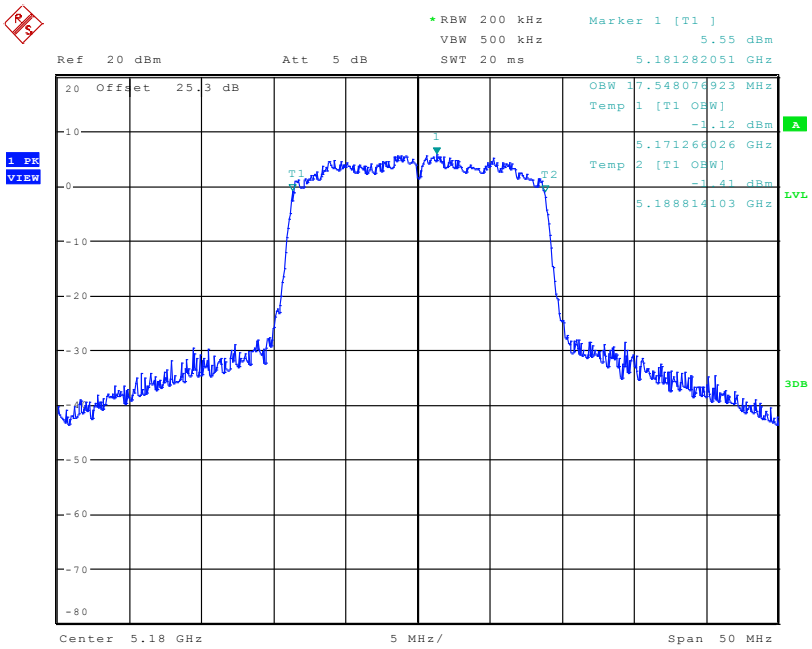
Date: 7.DEC.2011 11:57:27

802.11a Channel 36 99% BW



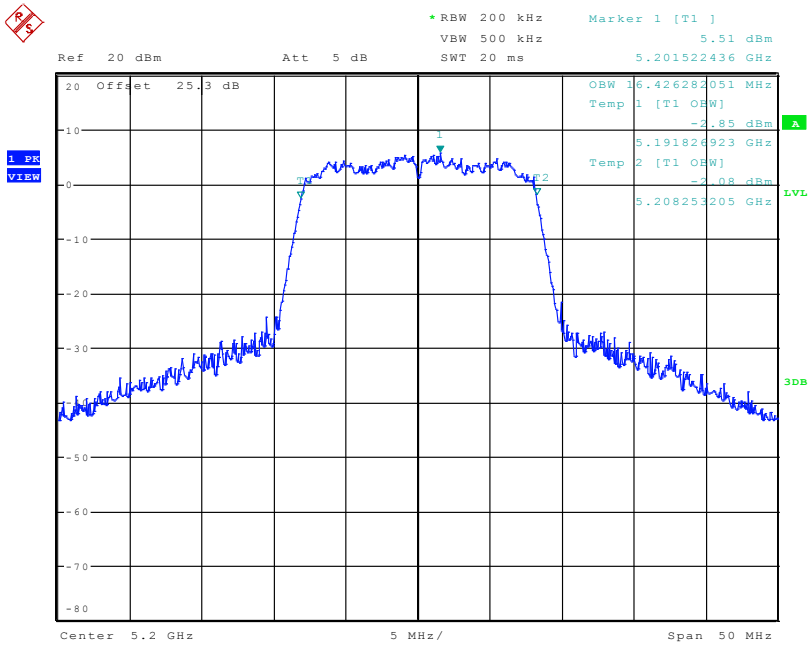
Date: 23.NOV.2011 16:12:12

802.11n Channel 36 99% BW



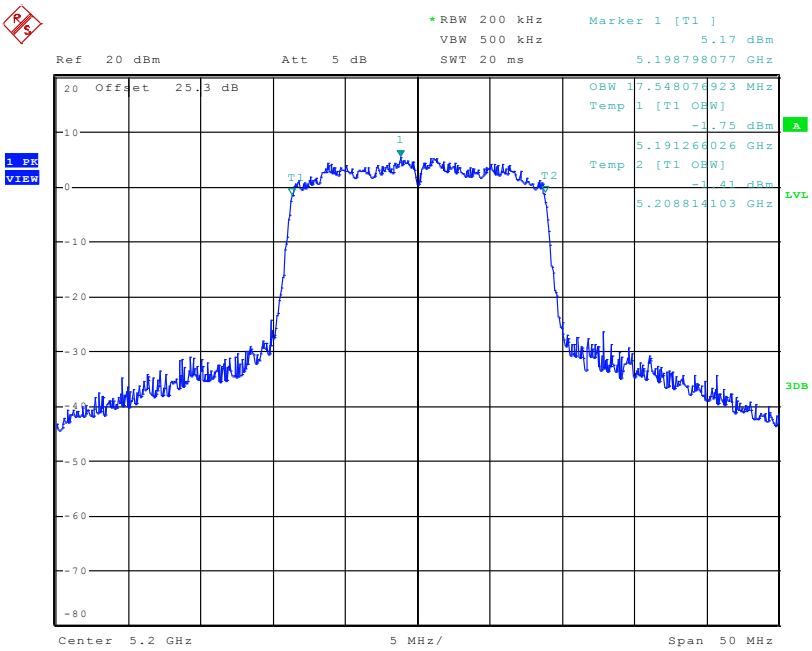
Date: 23.NOV.2011 16:13:58

802.11a Channel 40 99% BW



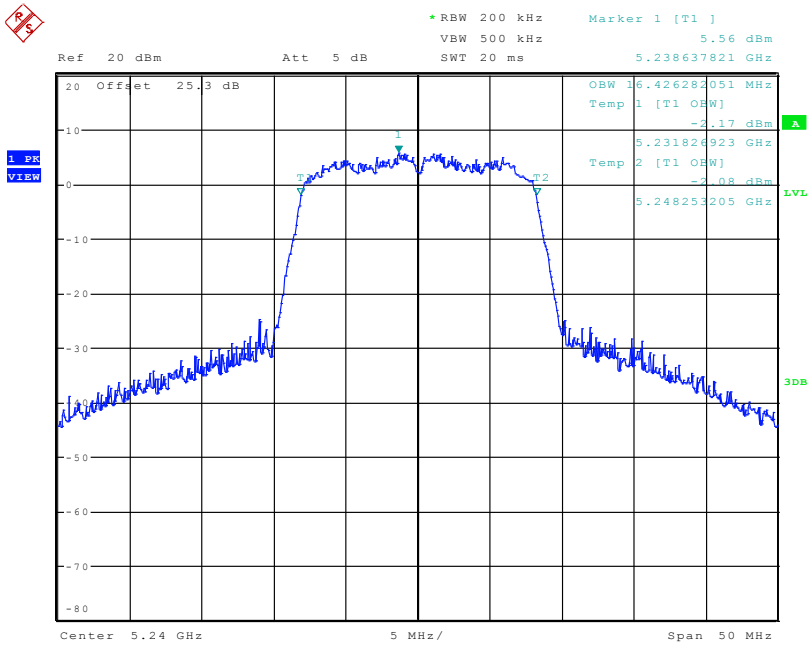
Date: 23.NOV.2011 15:55:03

802.11n Channel 40 99% BW



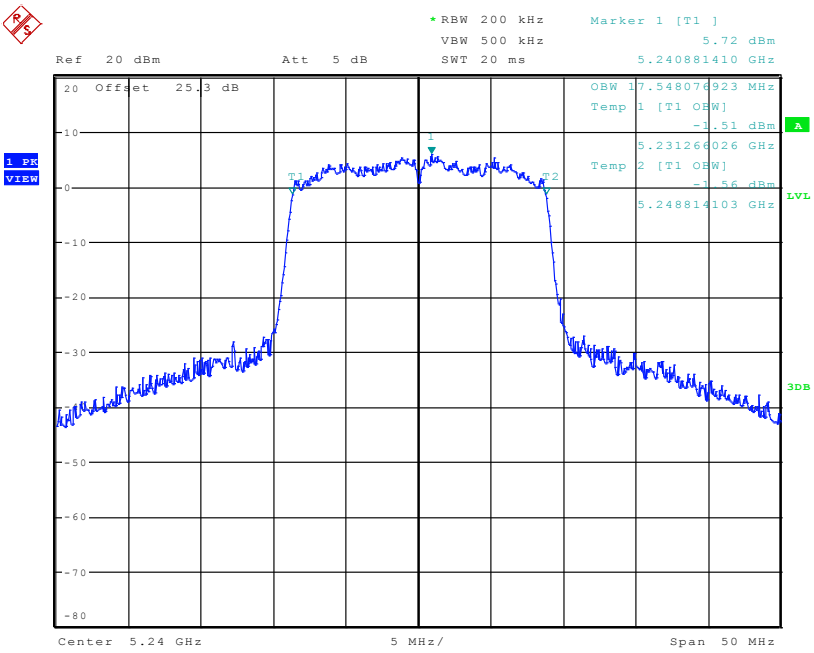
Date: 23.NOV.2011 15:57:14

802.11a Channel 48 99% BW



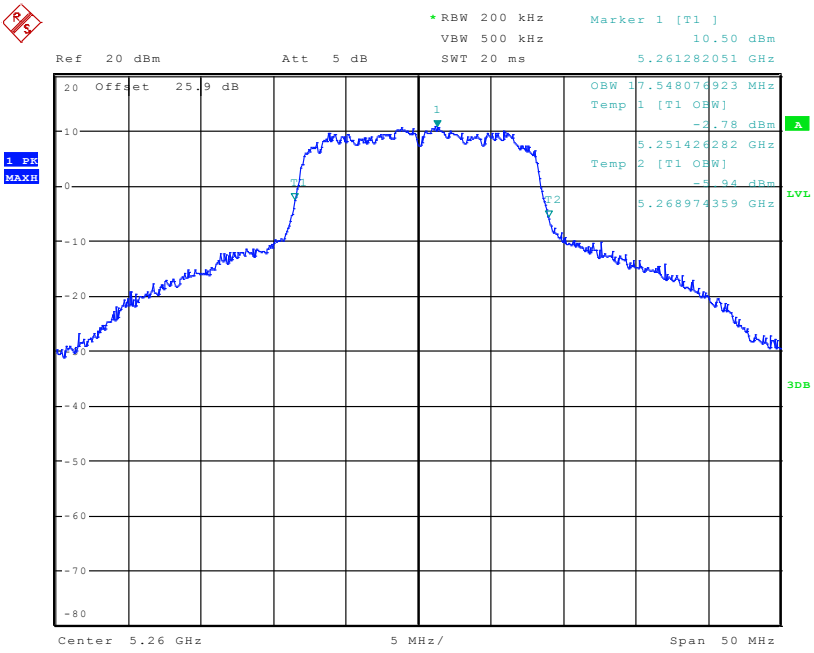
Date: 23.NOV.2011 16:27:25

802.11n Channel 48 99% BW



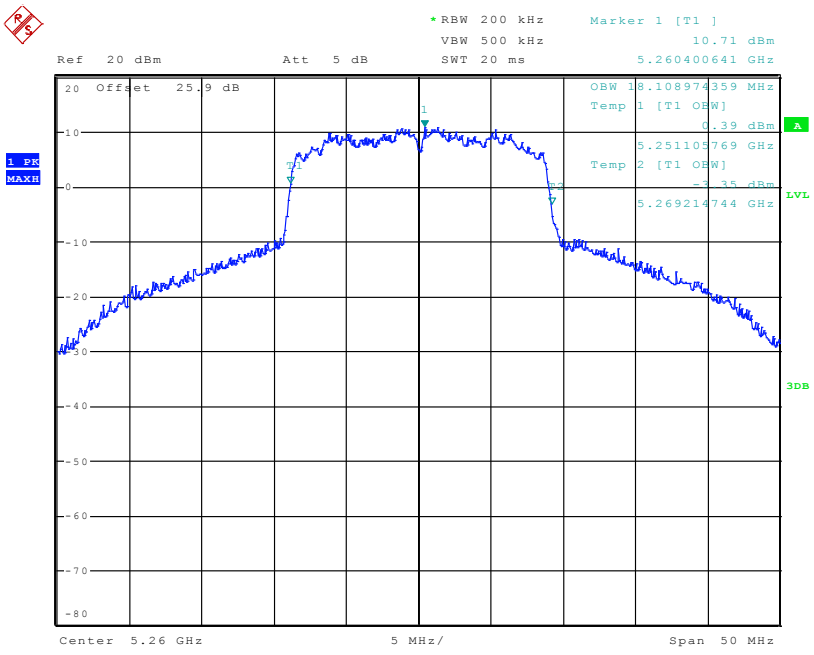
Date: 23.NOV.2011 16:28:37

802.11a Channel 52 99% BW



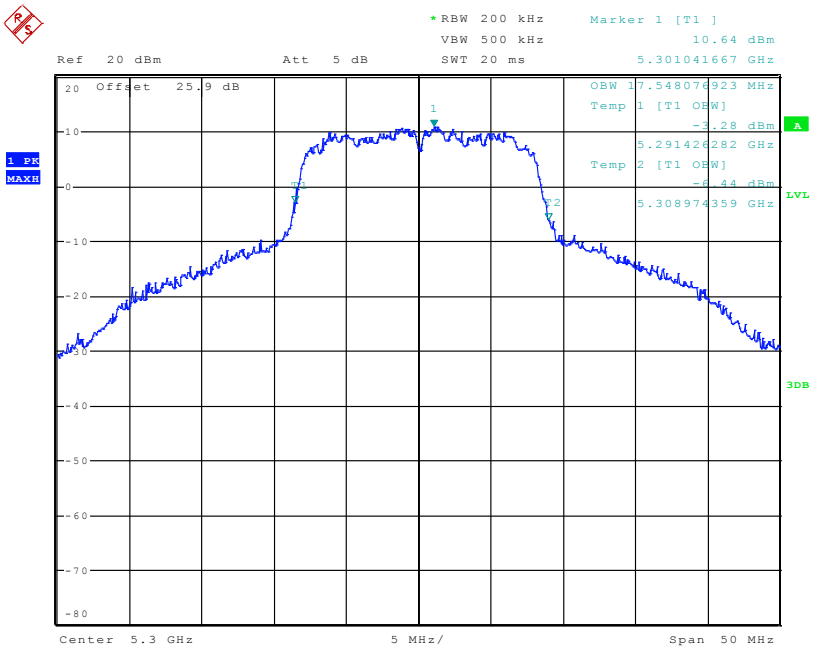
Date: 7.DEC.2011 11:04:59

802.11n Channel 52 99% BW



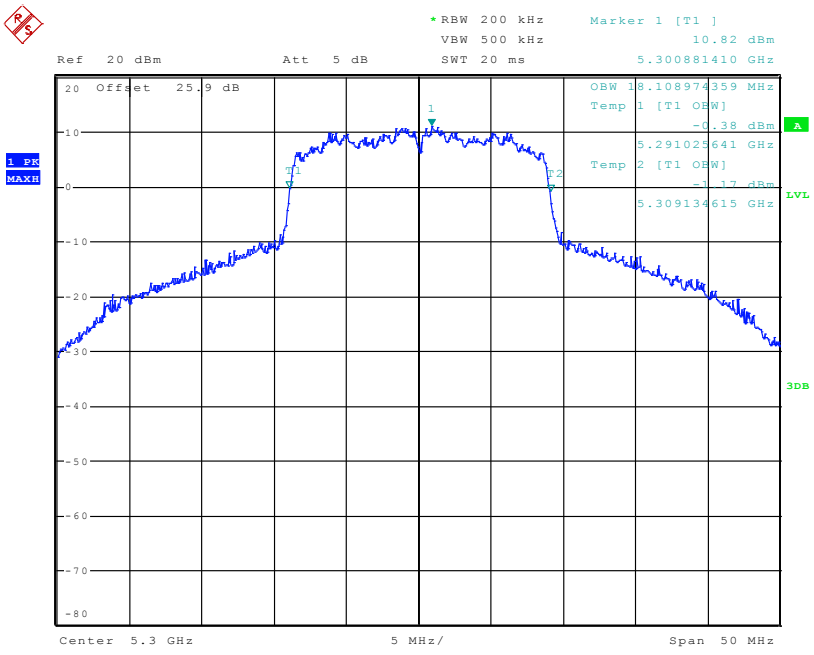
Date: 7.DEC.2011 11:37:56

802.11a Channel 60 99% BW



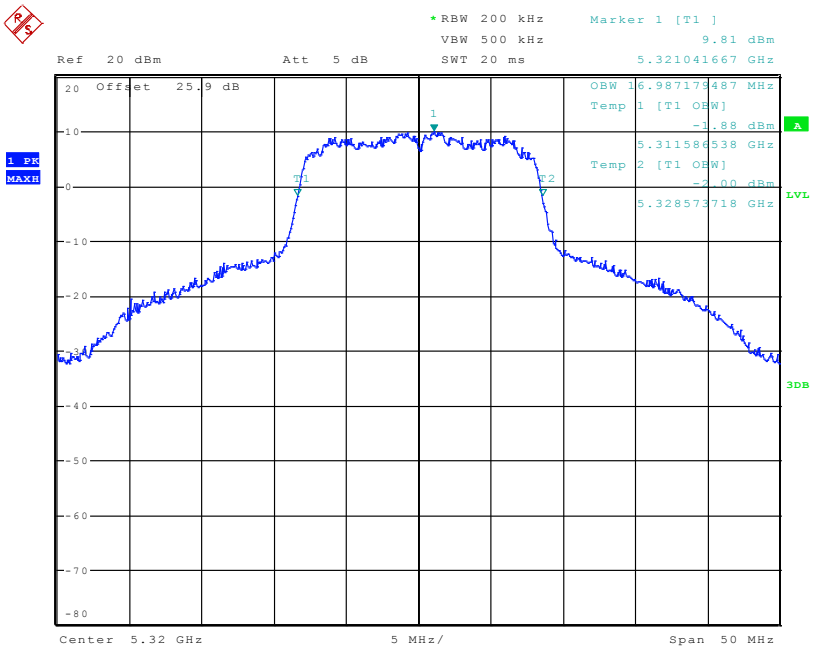
Date: 7.DEC.2011 11:11:40

802.11n Channel 60 99% BW



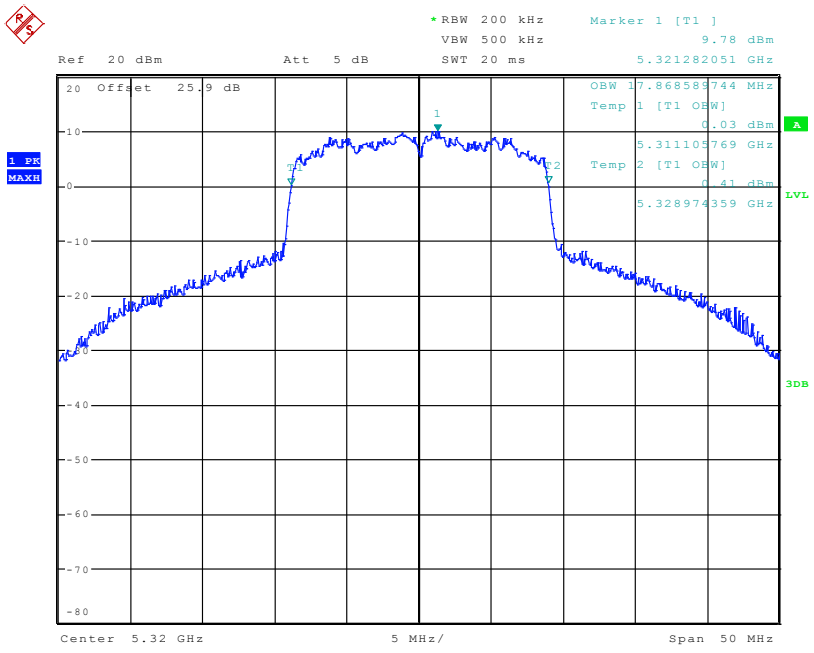
Date: 7.DEC.2011 11:39:24

802.11a Channel 64 99% BW



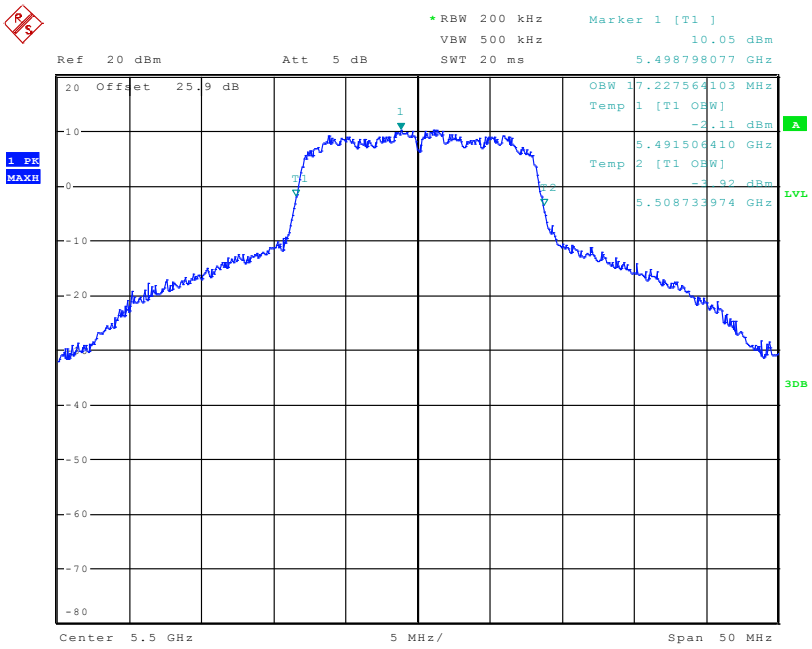
Date: 7.DEC.2011 11:13:41

802.11n Channel 64 99% BW



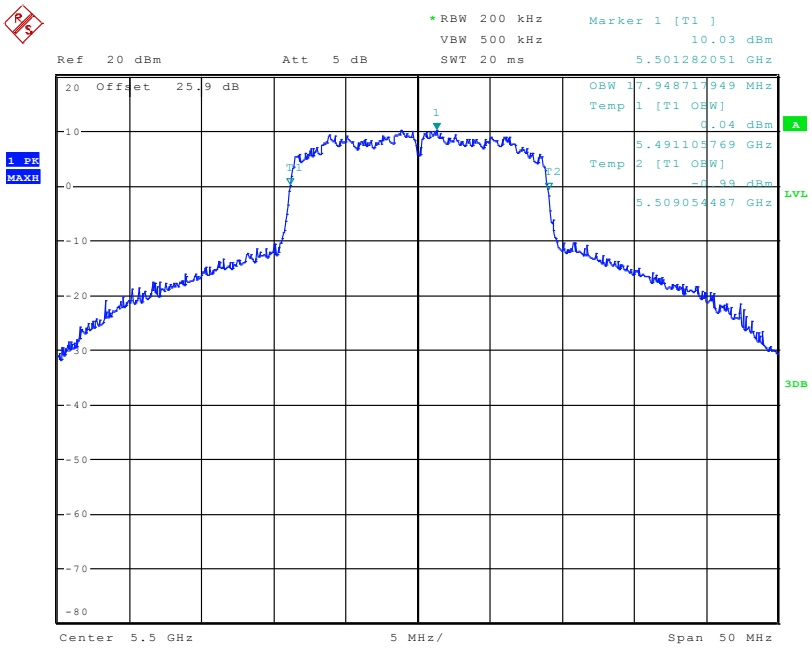
Date: 7.DEC.2011 11:45:12

802.11a Channel 100 99% BW



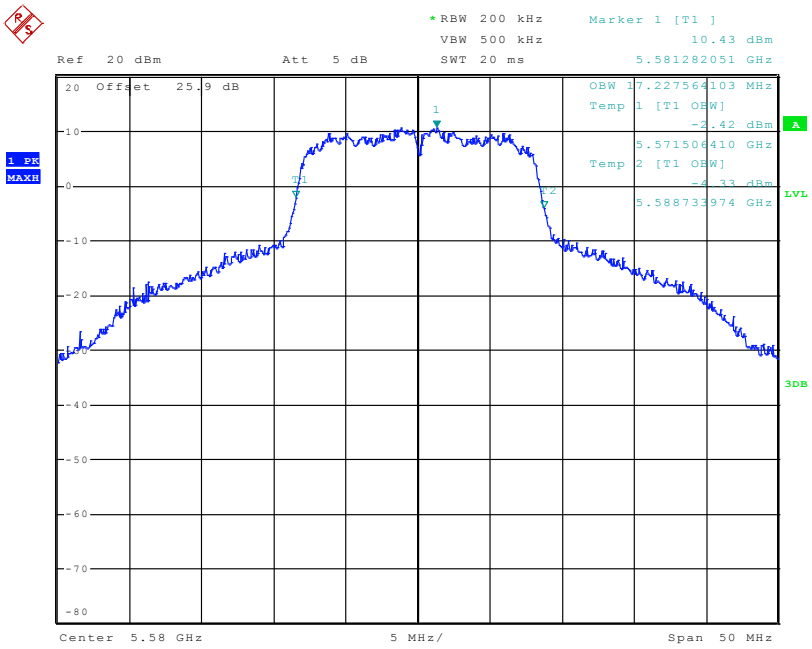
Date: 7.DEC.2011 11:19:08

802.11n Channel 100 99% BW



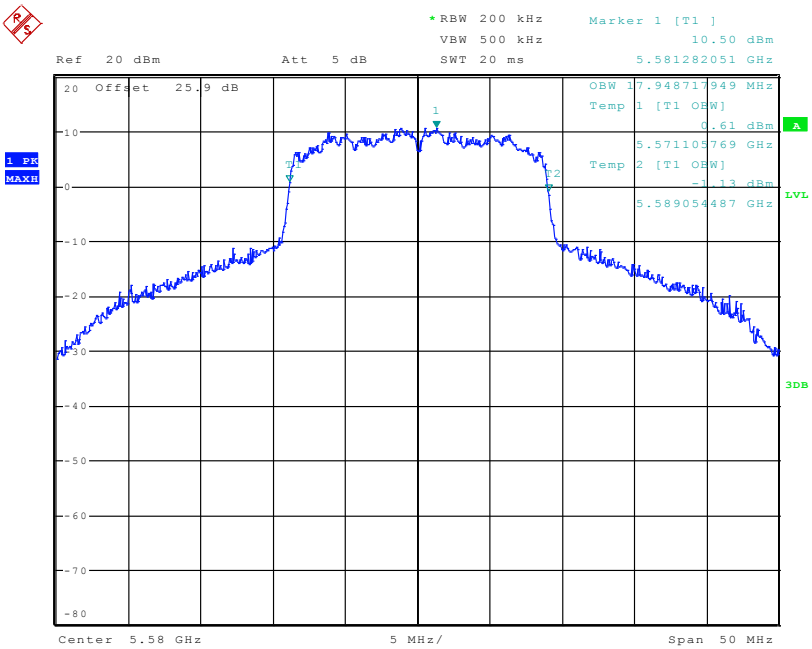
Date: 7.DEC.2011 11:46:58

802.11a Channel 116 99% BW



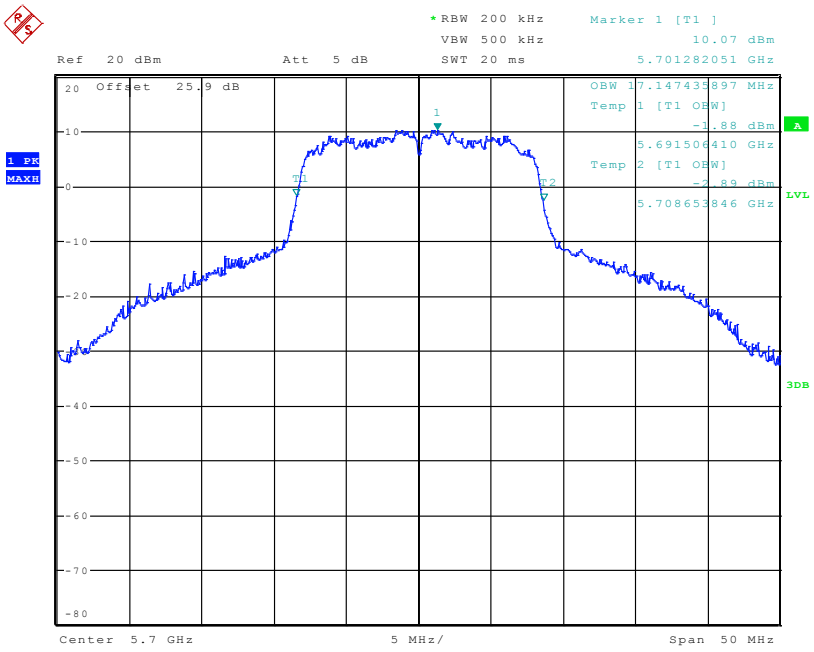
Date: 7.DEC.2011 11:20:31

802.11n Channel 116 99% BW



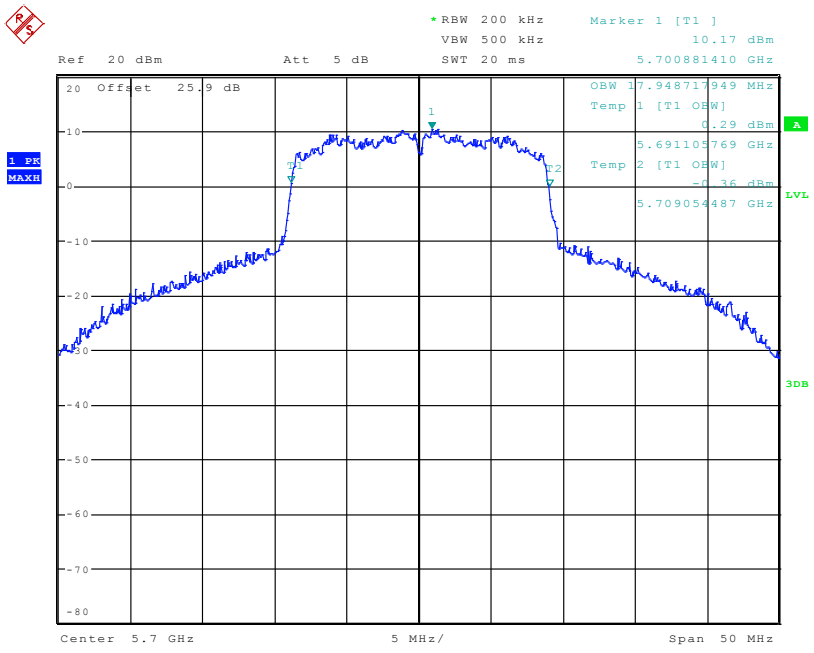
Date: 7.DEC.2011 11:54:06

802.11a Channel 140 99% BW



Date: 7.DEC.2011 11:24:54

802.11n Channel 140 99% BW



Date: 7.DEC.2011 11:55:24

6.7 Peak Power Spectral Density

6.7.1 Limits:

FCC:
Sub-band 1: 5150-5250MHz 15.407(a) (1): 4dBm in any 1–MHz band
Sub-band 2: 5250-5350MHz 15.407(a) (2): 11dBm in any 1–MHz band
Sub-band 3: 5470-5725MHz 15.407(a) (2): 11dBm in any 1–MHz band

IC:
Sub-band 1: 5150-5250MHz RSS-210 A 9.2: 10 dBm in any 1–MHz band- EIRP
Sub-band 2: 5250-5350MHz RSS-210 A 9.2: 11dBm in any 1–MHz band
Sub-band 3: 5470-5725MHz RSS-210 A 9.2: 11dBm in any 1–MHz band

6.7.2 Test Procedure Used:

General U-NII Test Procedures from FCC Publication #789033 on Oct 25, 2011.

Peak Power Spectral Density Measurement:

Method SA-1 Alternative (RMS detection with slow sweep and EUT transmitting continuously at full power):
(i) Set span to encompass the entire emission bandwidth (EBW) of the signal.
(ii) Set RBW = 1 MHz.
(iii) Set VBW ≥ 3 MHz.
(iv) Number of points in sweep ≥ 2 Span / RBW. (This ensures that bin-to-bin spacing is ≤ RBW/2, so that narrowband signals are not lost between frequency bins.)
(v) Manually set sweep time ≥ 10 * (number of points in sweep) * (symbol period of the transmitted signal).
(vi) Set detector = RMS.
(vii) The EUT must be operated at 100 percent duty cycle.
(viii) Perform a single sweep.
(ix) Compute power by integrating the spectrum across the 26 dB EBW of the signal using the spectrum analyzer's band power measurement function with band limits set equal to the EBW band edges. If the spectrum analyzer does not have a band power function, sum the spectrum levels (in power units) at 1 MHz intervals extending across the 26 dB EBW of the spectrum.

Sweep time determined as > 10* (625)* 1.32 ms

2) Use the peak search function on the spectrum analyzer to find the peak of the spectrum.
   a) If Method SA-1 or SA-3 (or the corresponding alternative) was used, the peak of the spectrum is the PPSD.

6.7.3 Test Result:

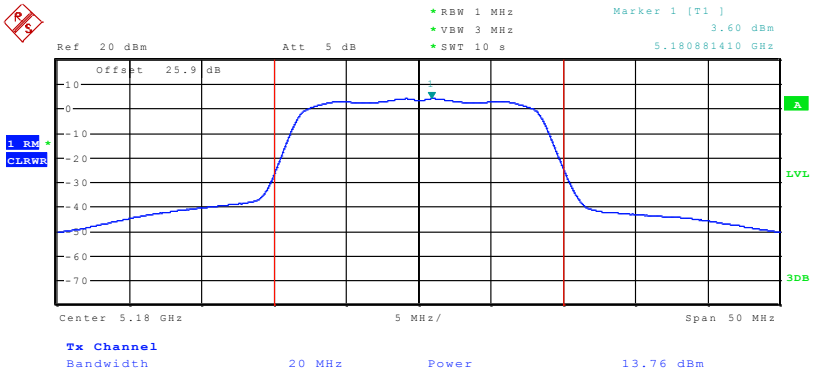
Peak Power Spectral Density (dBm)							
Frequency (MHz)	**Channel**	**Conducted**		**EIRP**		**Limits (conducted)**	
		a	**n HT20**	**a**	**n HT20**	**FCC (dBm)**	**IC (dBm)**
5180	**36**	3.60	3.18	8.1	7.68	4	10- EIRP
5200	**40**	3.40	3.07	5.8	5.47	4	10- EIRP
5240	**48**	3.14	2.74	7.64	7.24	4	10- EIRP
5260	**52**	8.60	8.34	13.1	12.84	11	11
5300	**60**	8.61	8.32	13.11	12.82	11	11
5320	**64**	7.85	7.56	12.35	12.06	11	11
5500	**100**	8.29	7.88	12.79	12.38	11	11
5580	**116**	8.55	8.26	13.05	12.76	11	11
5700	**140**	8.24	7.99	12.74	12.49	11	11

6.7.4 Test Verdict:

Pass

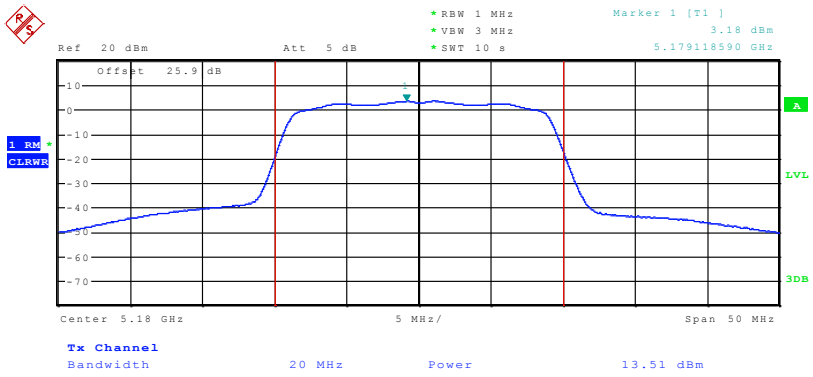
6.7.5 Plots

802.11a Ch36



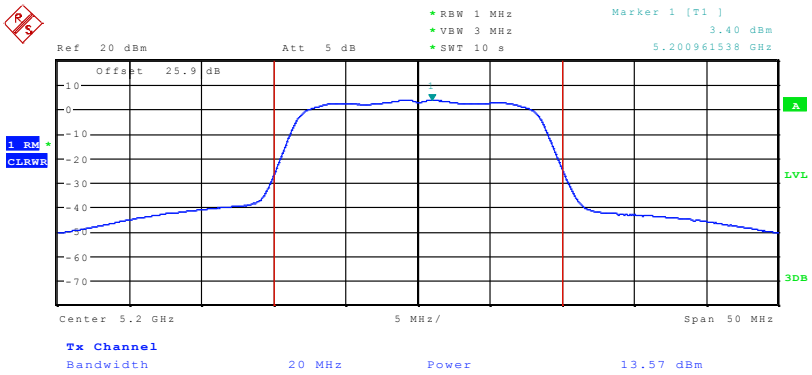
Date: 7.DEC.2011 13:22:03

802.11n Ch36



Date: 7.DEC.2011 13:35:24

802.11a Ch40



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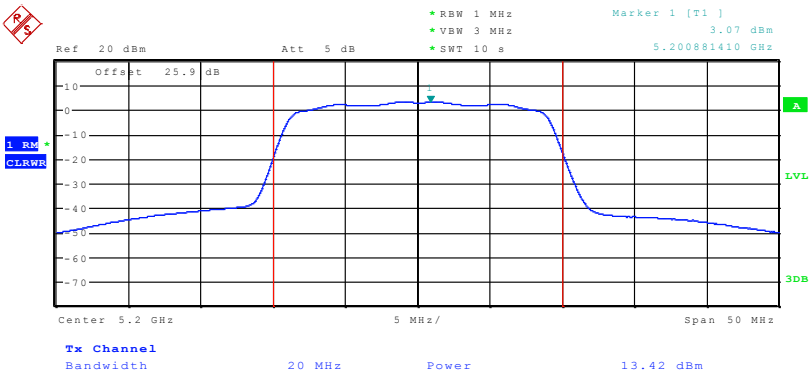
802.11n Ch40



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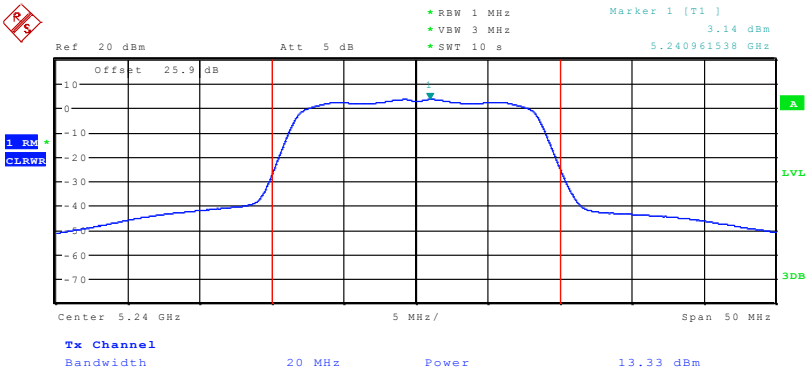
802.11a Ch48



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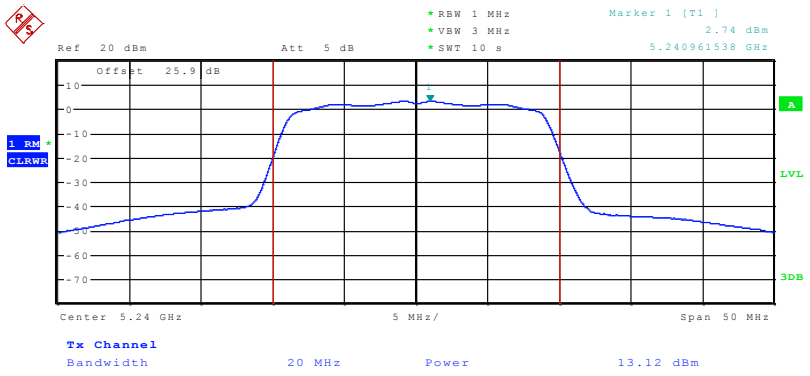
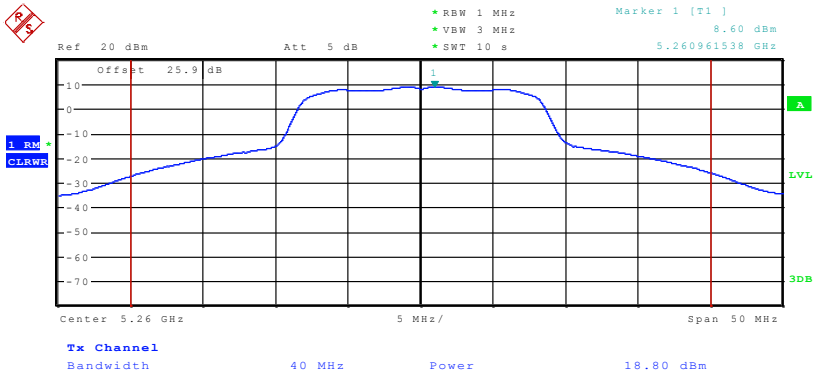
802.11n Ch48



Date: 7.DEC.2011 13:37:23

802.11a Ch52



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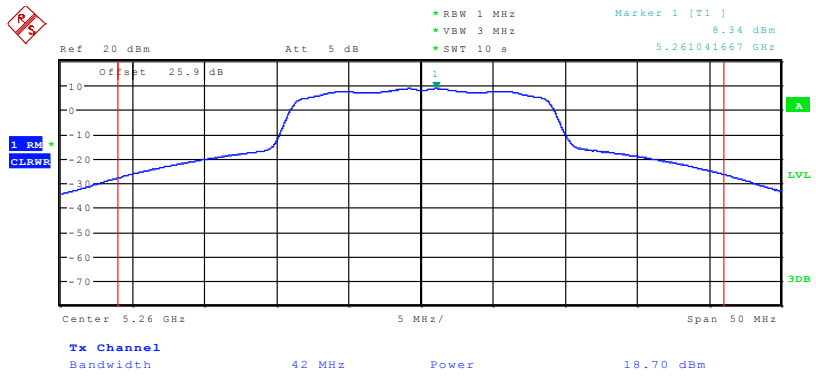
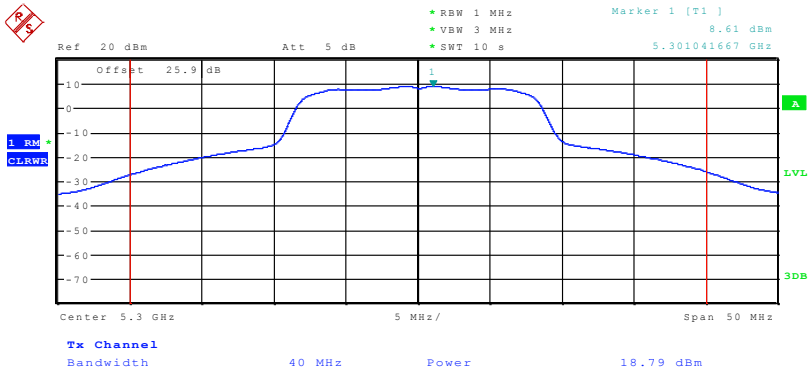
802.11n Ch52



Date: 7.DEC.2011 14:08:56

802.11a Ch60



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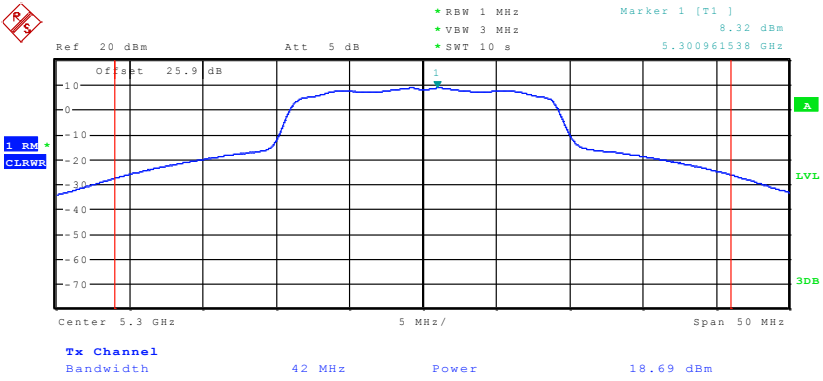
802.11n Ch60



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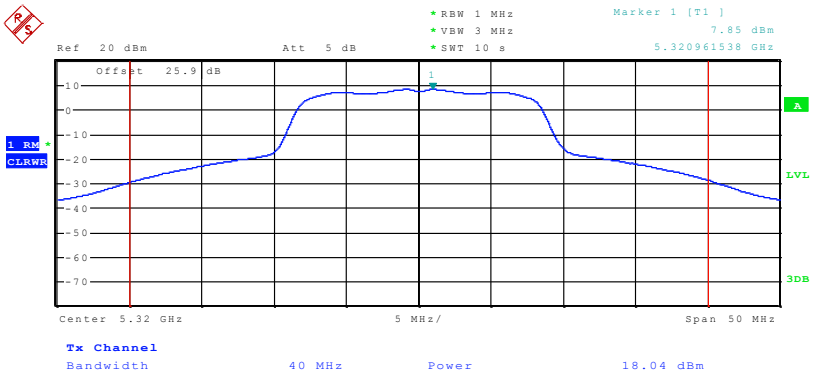
802.11a Ch64



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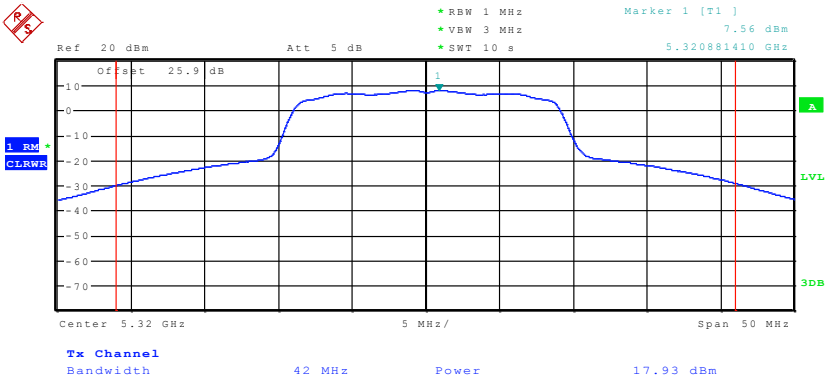

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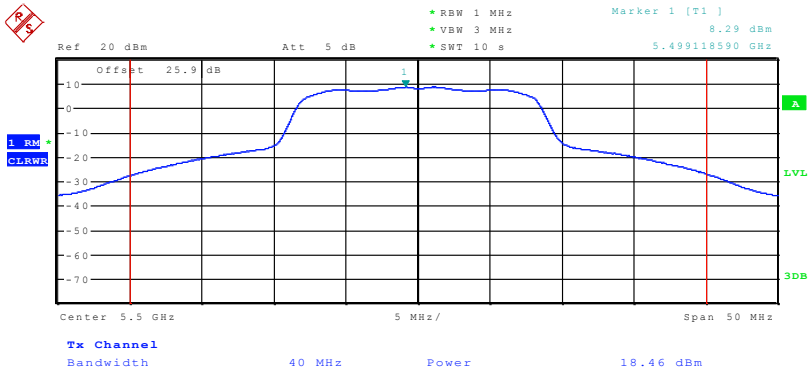
802.11a Ch100



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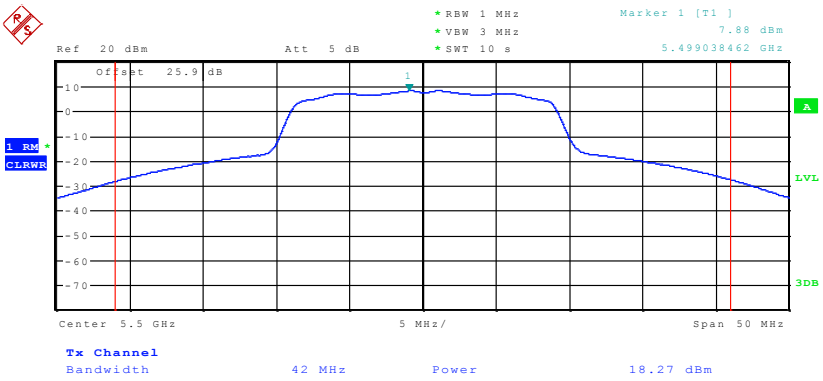

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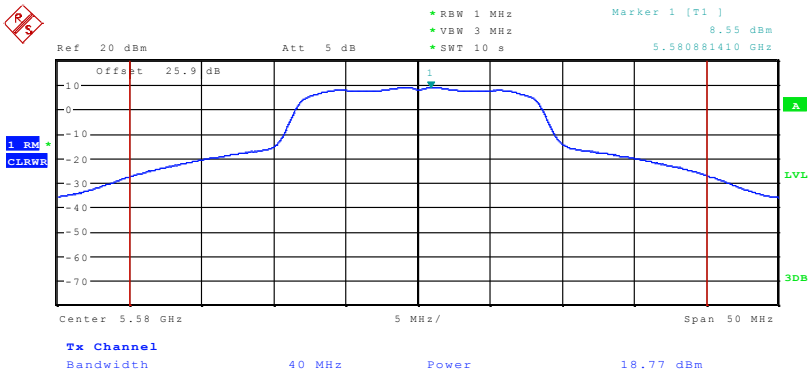
802.11a Ch116



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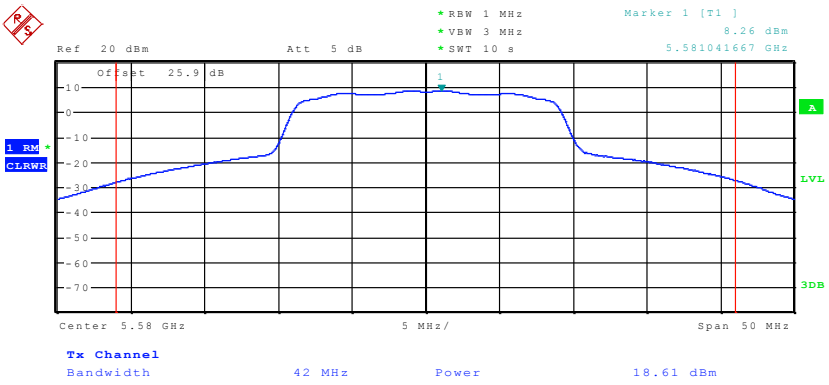

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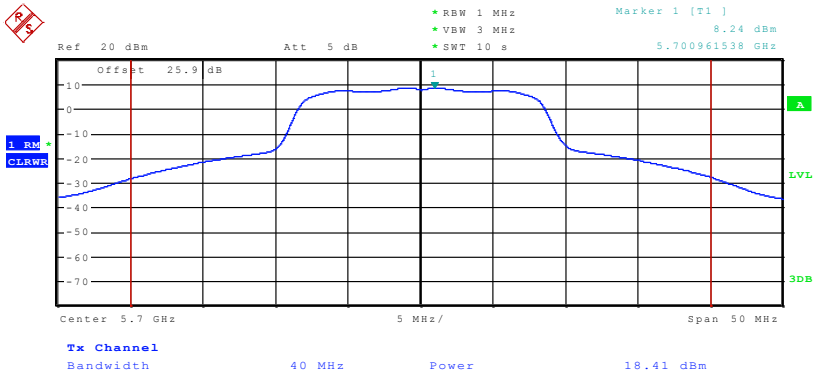
802.11a Ch140



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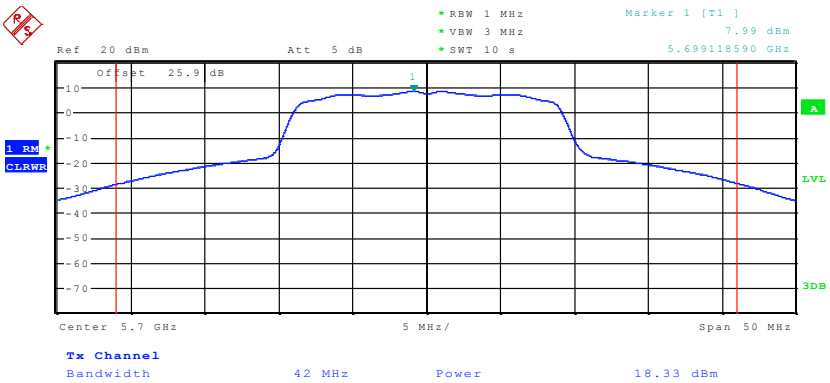
802.11n Ch140



Date: 7.DEC.2011 14:13:01

6.8 Peak Excursion

6.8.1 Limit

FCC15.407 (A)(6): The ratio of the peak excursion of the modulation envelope (measured using a peak hold function) to the maximum conducted output power (measured as specified above) shall not exceed 13 dB across any 1 MHz bandwidth or the emission bandwidth whichever is less.

6.8.2 Test Procedure Used:

The peak-max-hold spectrum is measured with a spectrum analyzer in FCC public knowledge 789033.

Peak excursion measurement

1) Compliance with the peak excursion requirement of 15.407(a)(6) shall be demonstrated by computing the ratio of the maximum of the peak-max-hold spectrum to the maximum of the average spectrum for continuous transmission. (Earlier procedures that required computing the ratio of the two spectra at each frequency can lead to unintended failures at band edges and will no longer be required.)
2) Set the spectrum analyzer span to view the entire emission bandwidth.
3) Find the maximum of the peak-max-hold spectrum.
   a) Set RBW = 1 MHz.
   b) VBW ≤ 3 MHz.
   c) Detector = peak.
   d) Trace mode = max-hold.
   e) Allow the sweeps to continue until the trace stabilizes.
   f) Use the peak search function to find the peak of the spectrum.
4) Use the procedure found under E) to measure the PPSD.
5) Compute the ratio of the maximum of the peak-max-hold spectrum to the PPSD.

Peak Excursion = peak-max-hold spectrum – PPSD

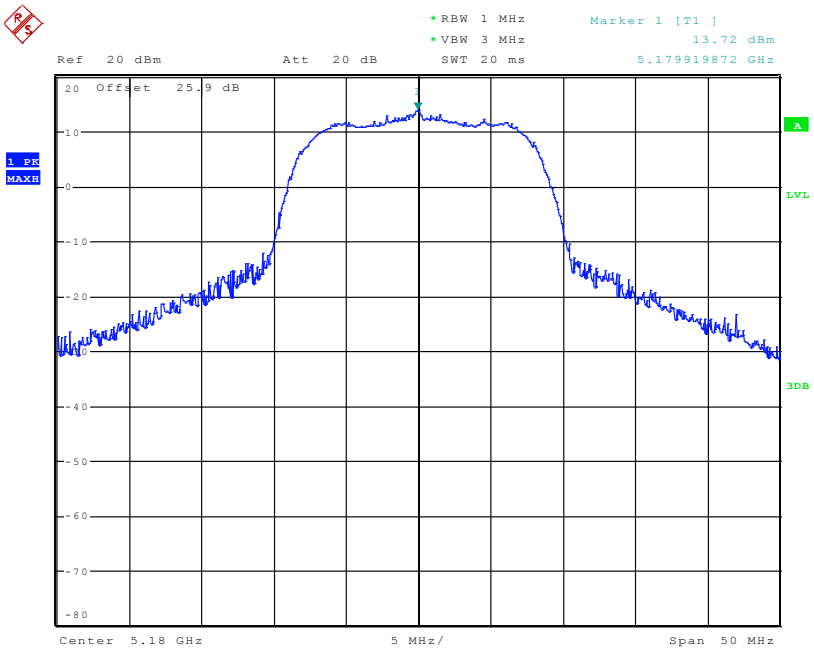
6.8.3 Test Result:

Peak Excursion (dB)			
Frequency (MHz)	**Channel**	**a**	**n**
5180	**36**	10.12	10.46
5200	**40**	10.57	10.29
5240	**48**	10.27	10.58
5260	**52**	10.35	9.74
5300	**60**	10.32	9.71
5320	**64**	10.42	12.57
5500	**100**	10.06	9.59
5580	**116**	10.33	10.13
5700	**140**	10.31	9.47

6.8.4 Test Verdict:

Pass

802.11a Ch36



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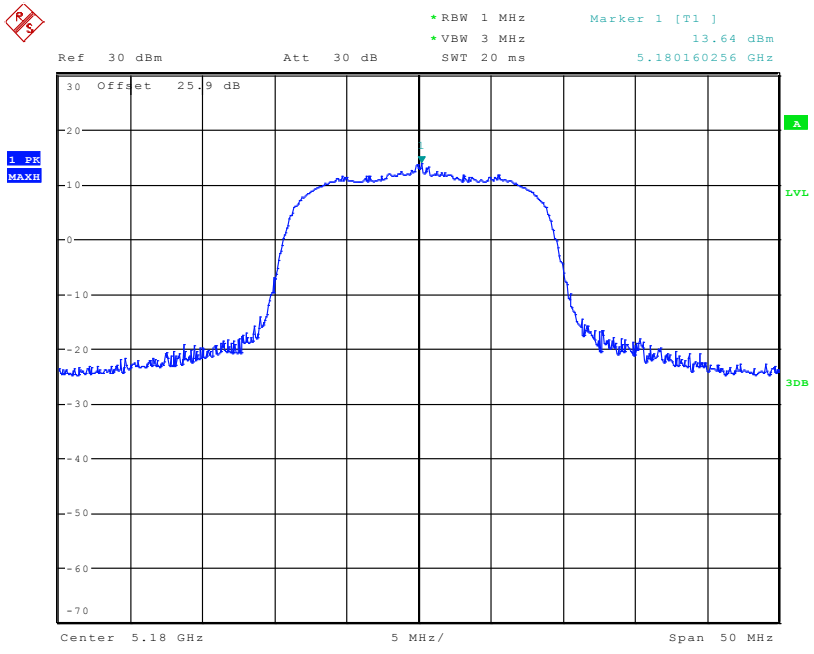
802.11n Ch36



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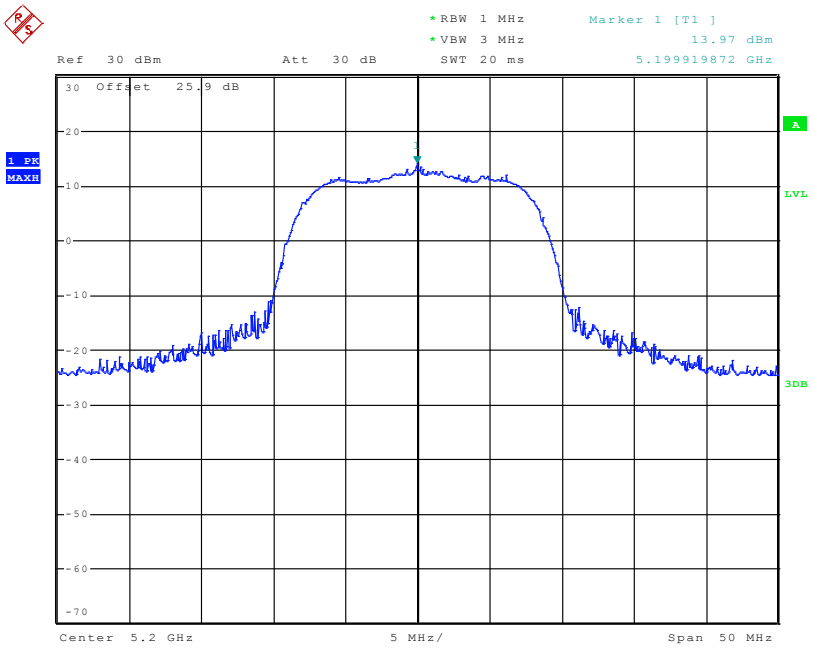
802.11a Ch40



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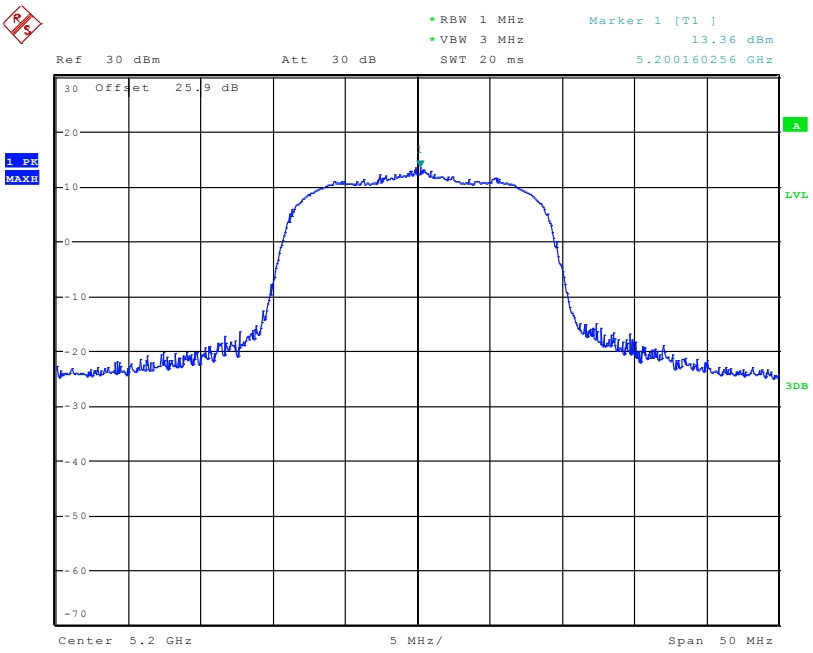

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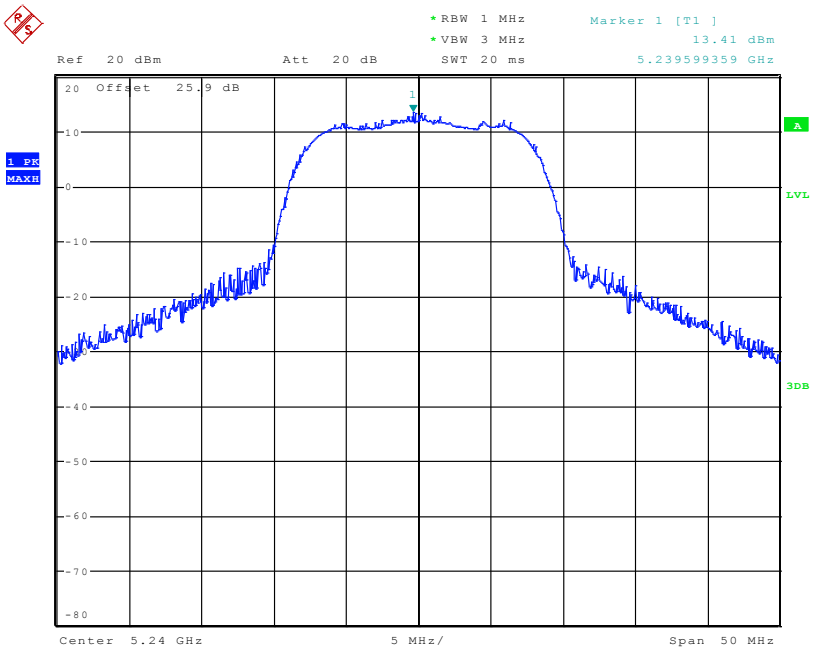

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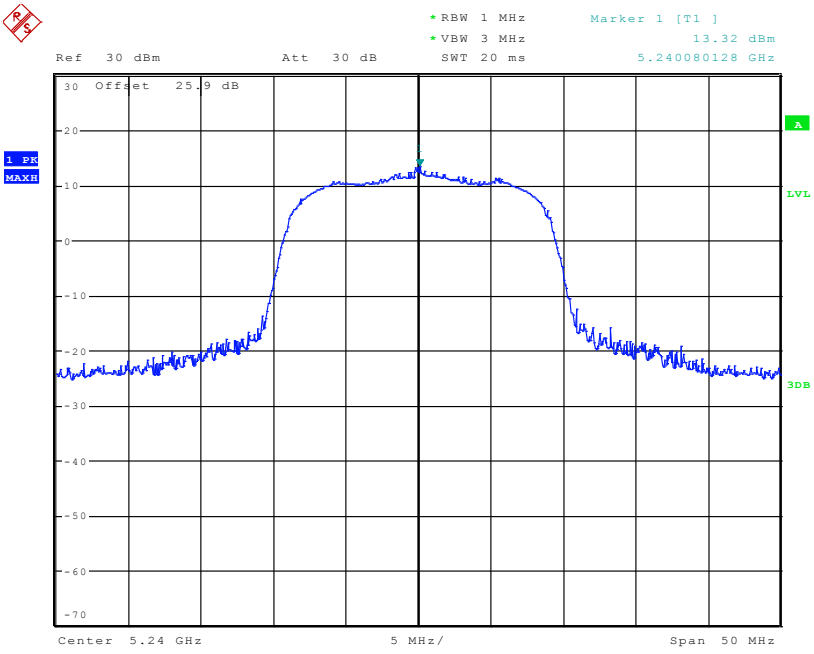

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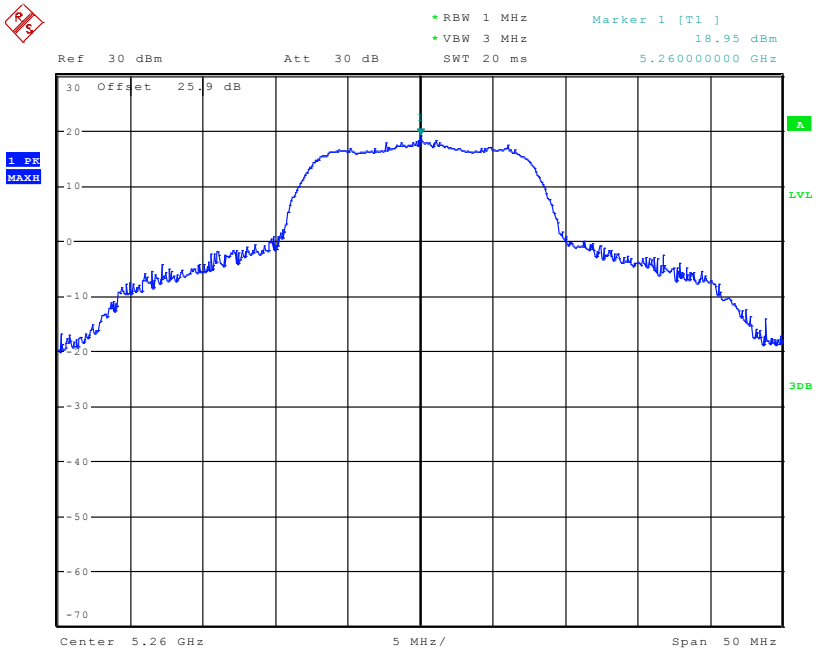

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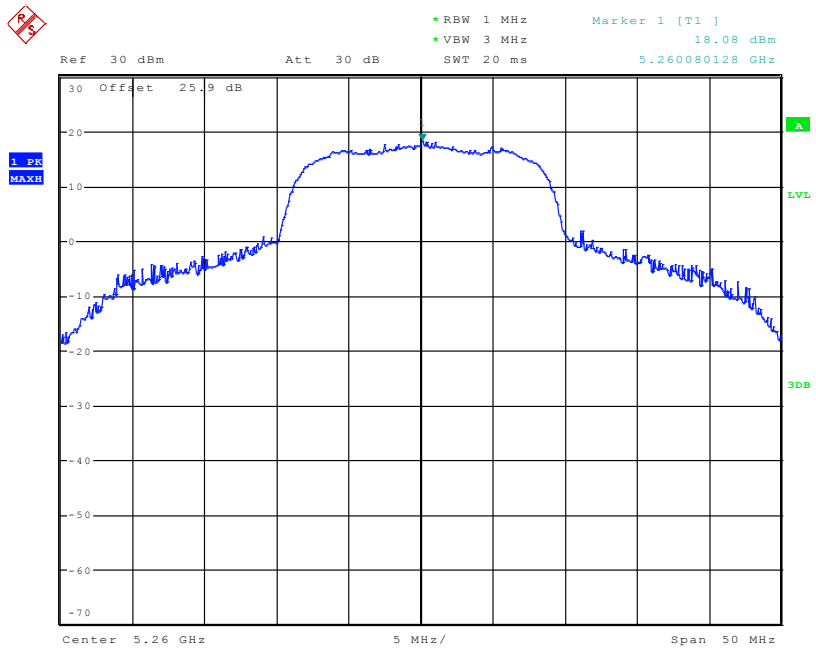
802.11n Ch52



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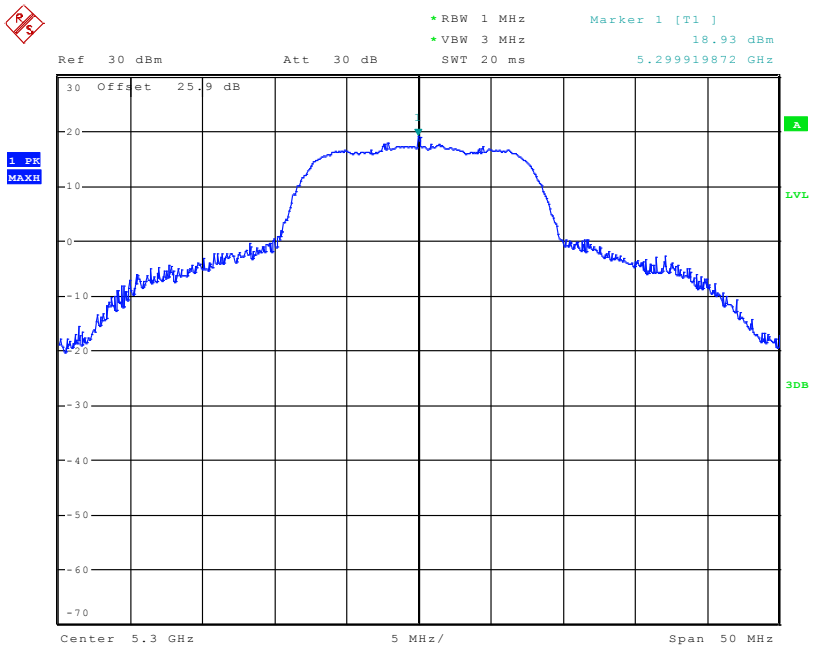
802.11a Ch60



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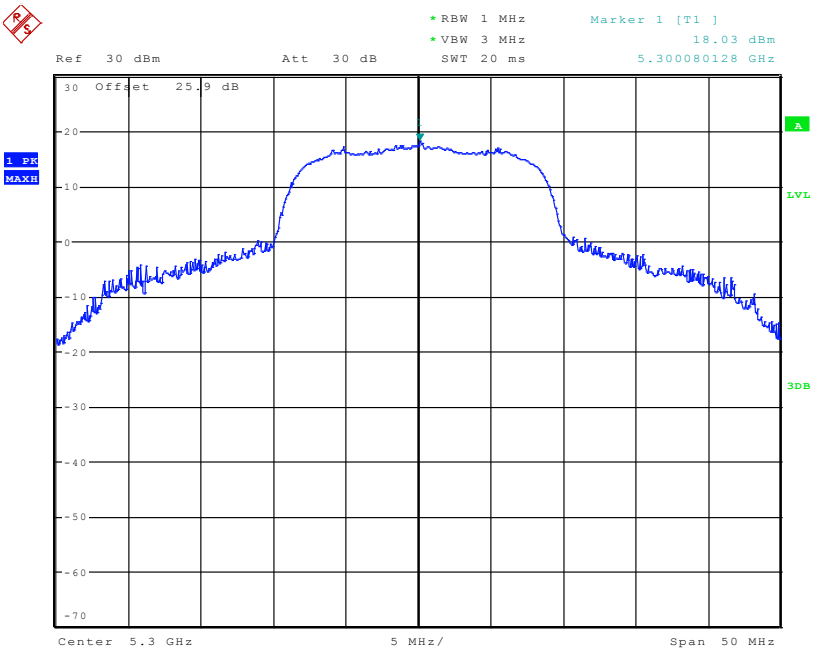

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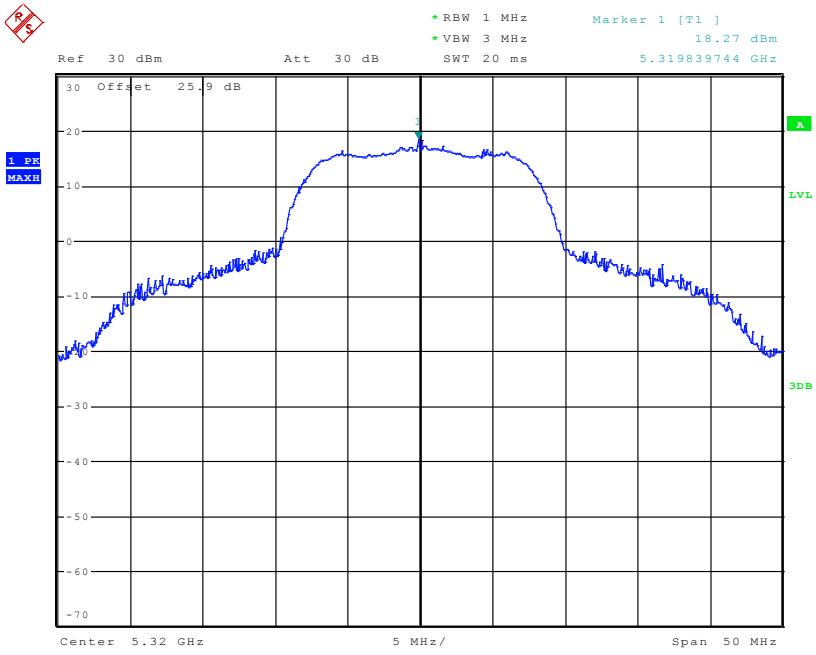

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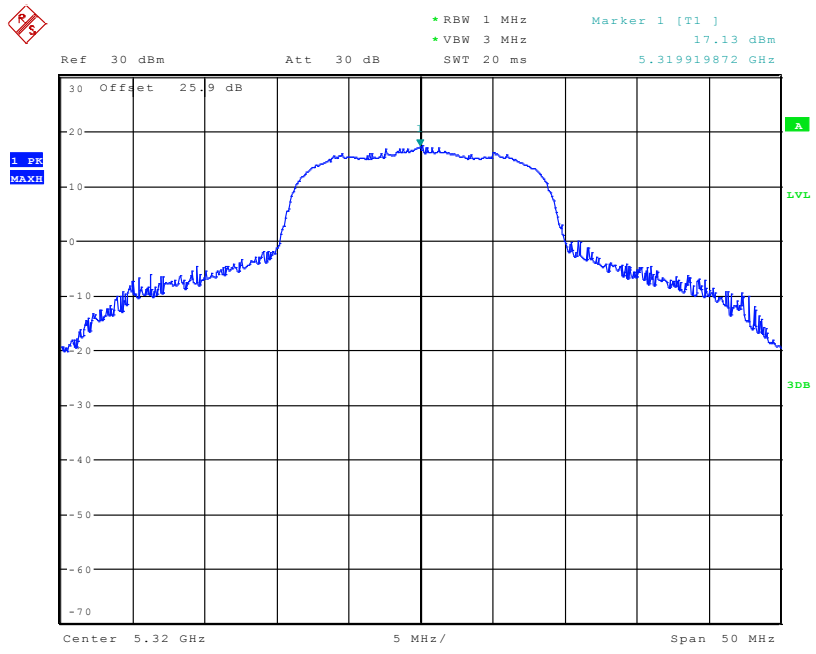

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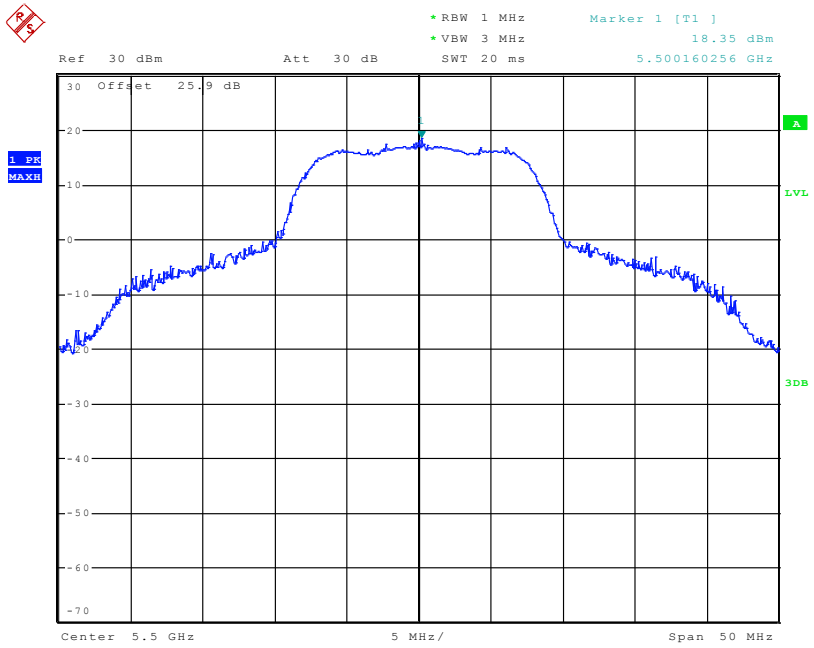

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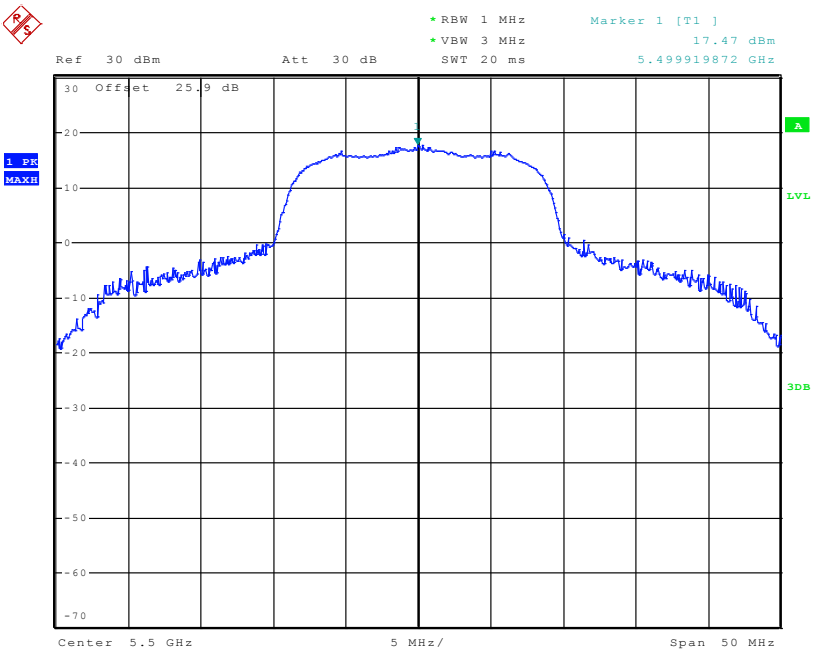

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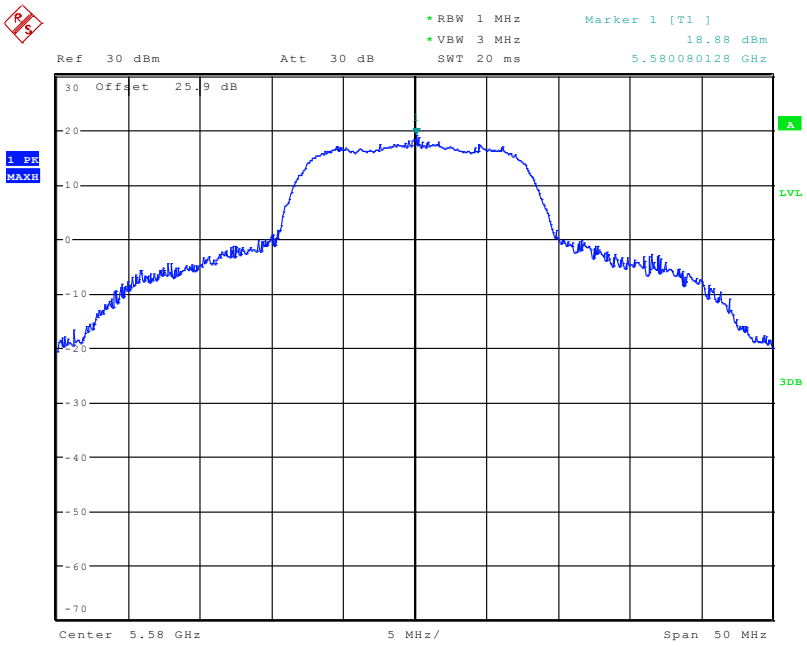
802.11a Ch116



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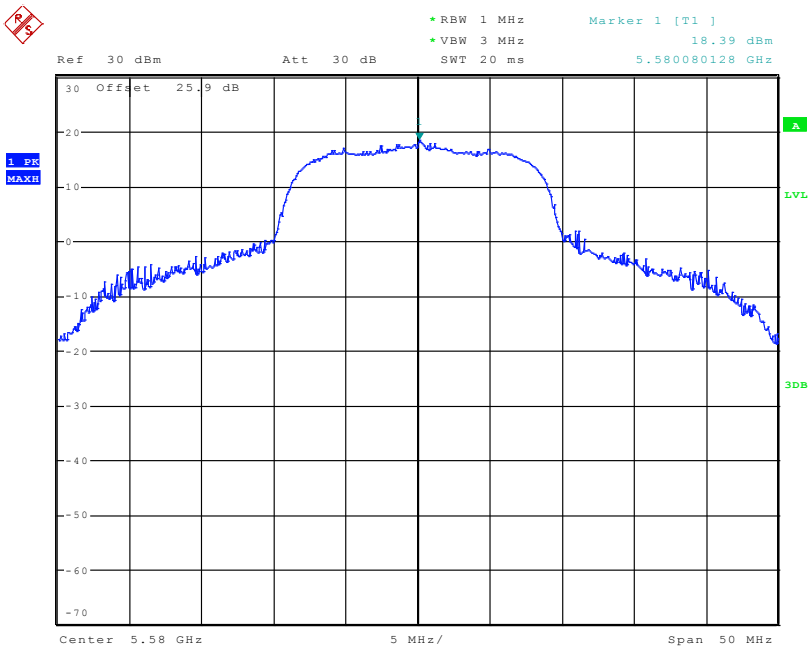
802.11n Ch120



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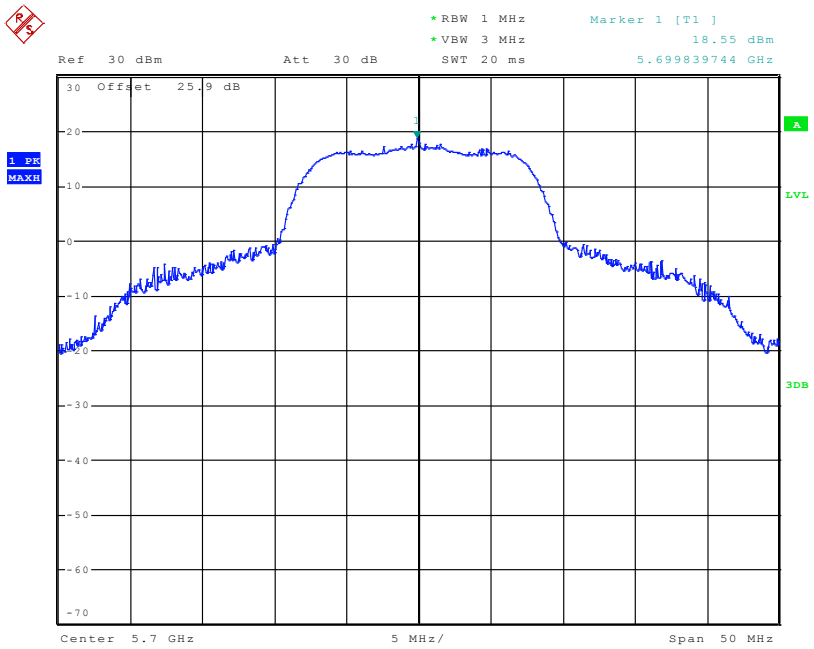
802.11a Ch140



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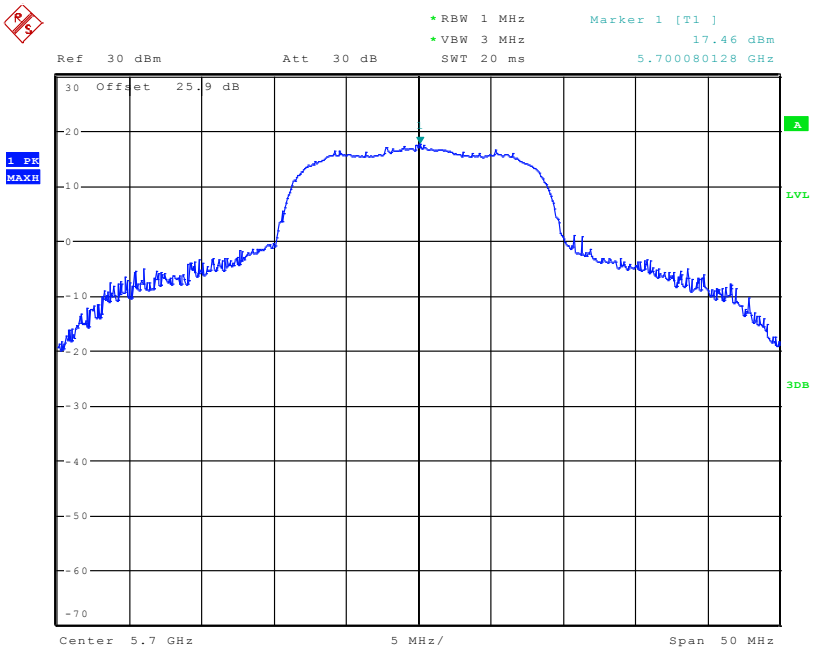


Date: 7.DEC.2011 14:37:23

6.9 Transmitter Spurious Emissions- Radiated

6.9.1 Limits: §15.407

(b) Undesirable emission limits: Except as shown in paragraph (b)(6) of this section, the peak emissions outside of the frequency bands of operation shall be attenuated in accordance with the following limits:

(1) For transmitters operating in the 5.15–5.25 GHz band: all emissions outside of the 5.15–5.35 GHz band shall not exceed an EIRP of –27 dBm/MHz.

(2) For transmitters operating in the 5.25–5.35 GHz band: all emissions outside of the 5.15–5.35 GHz band shall not exceed an EIRP of –27 dBm/MHz. Devices operating in the 5.25–5.35 GHz band that generate emissions in the 5.15–5.25 GHz band must meet all applicable technical requirements for operation in the 5.15–5.25 GHz band (including indoor use) or alternatively meet an out-of-band emission EIRP limit of –27 dBm/MHz in the 5.15–5.25 GHz band.

(3) For transmitters operating in the 5.47–5.725 GHz band: all emissions outside of the 5.47–5.725 GHz band shall not exceed an EIRP of −27 dBm/MHz.

(4) For transmitters operating in the 5.725–5.825 GHz band: all emissions within the frequency range from the band edge to 10 MHz above or below the band edge shall not exceed an EIRP of –17 dBm/MHz; for frequencies 10 MHz or greater above or below the band edge, emissions shall not exceed an EIRP of –27 dBm/MHz.

(6) Unwanted emissions below 1 GHz must comply with the general field strength limits set forth in §15.209.

6.9.2 Limits: §15.209

(For measurement distance of 3m)

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)

NOTE: The radiated emissions were done with different settings, using the relevant pre-amplifiers for the relevant frequency ranges. This is the reason that the graphs show different noise levels.

2. All measurements are done in Peak mode using an Average limit, unless specified within the plots.

6.9.3 Limits: §15.209

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

Note: Measurements done with antenna factors scaled to 3m measurement distance.

6.9.4 Test Result:

No significant emissions measurable. Plots reported here represent the worse case emissions, and both Horizontal and Vertical polarizations. 802.11a represents worst case.

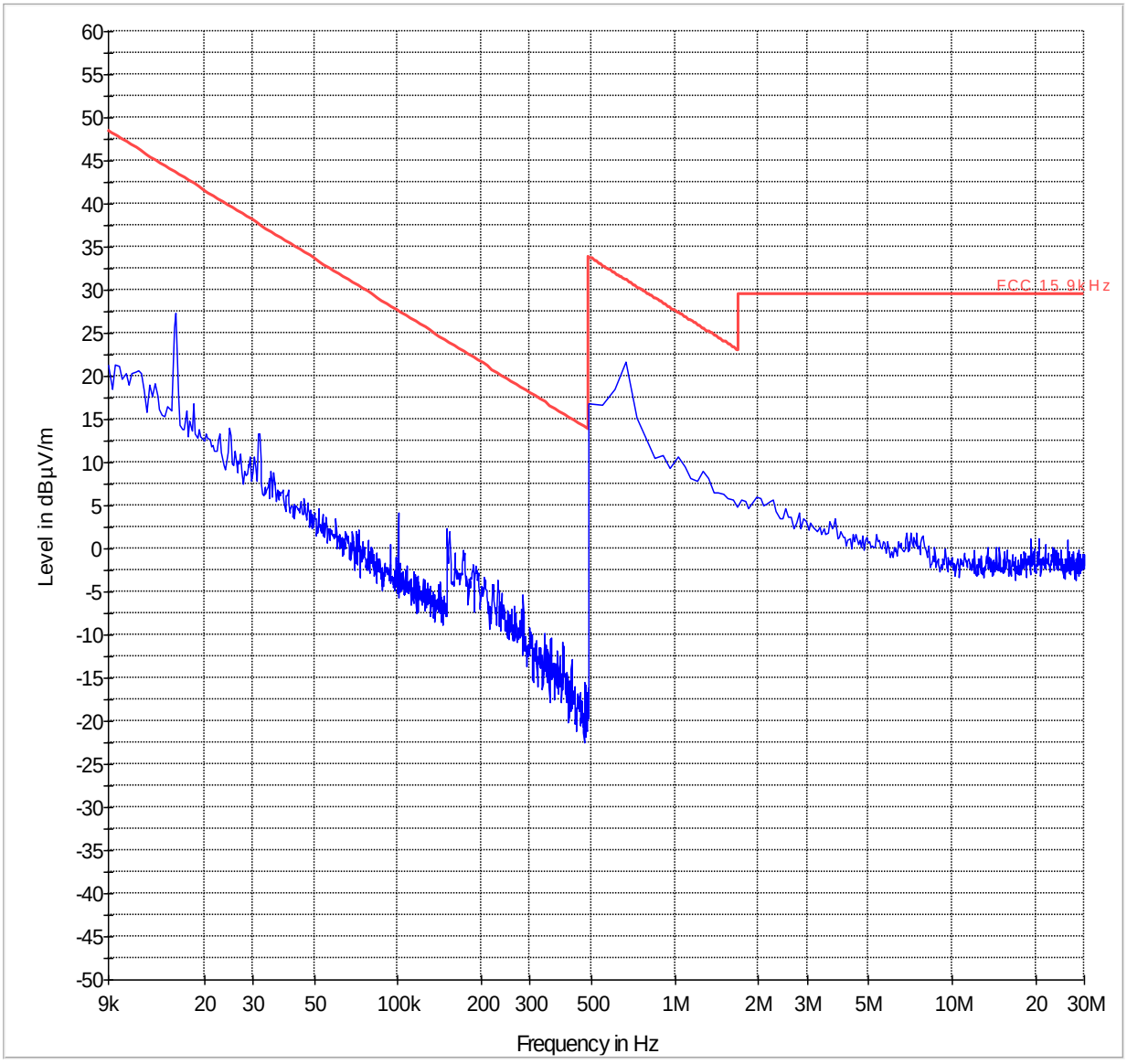
6.9.5 Test Verdict:

Pass

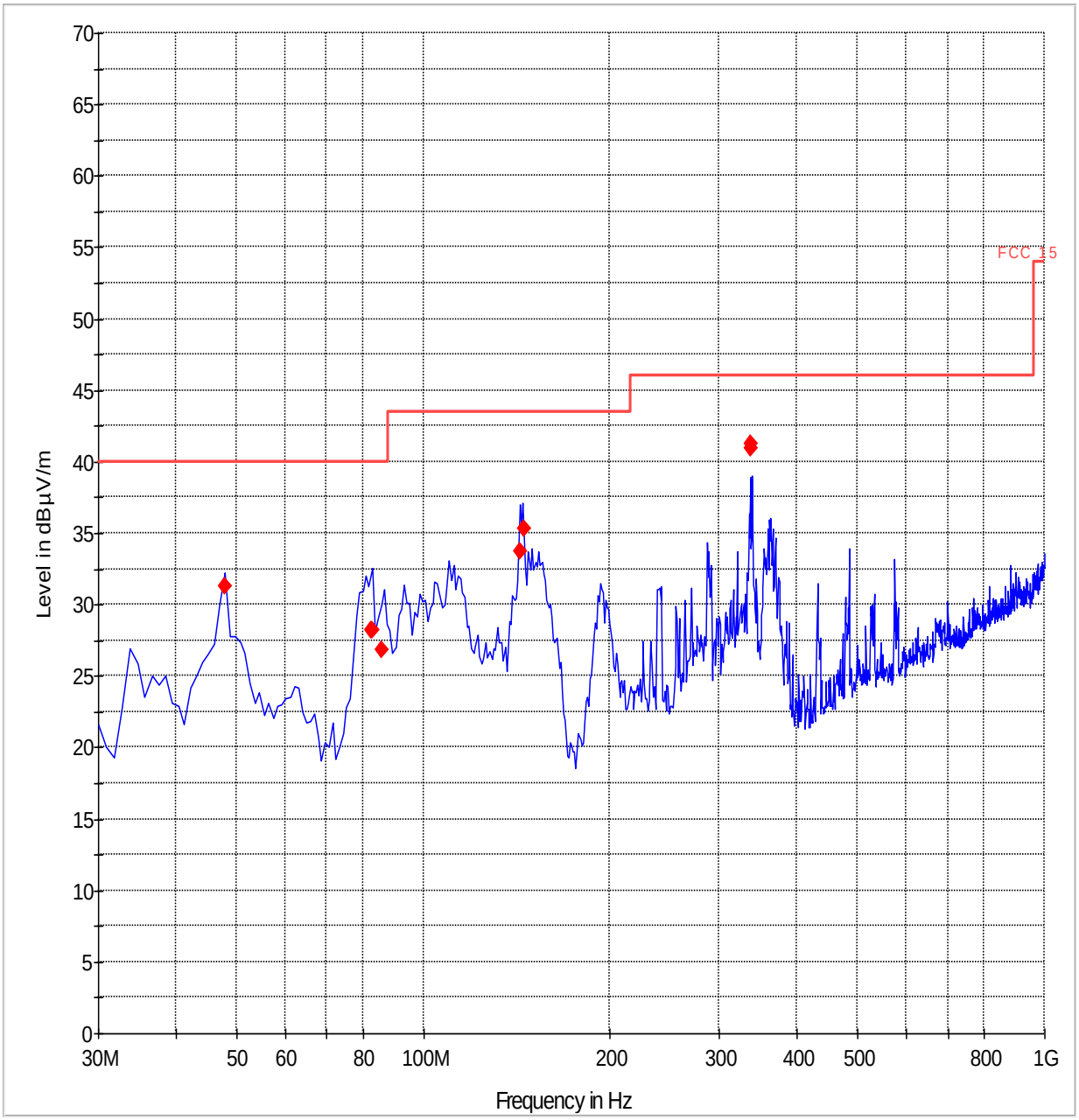
6.9.6 Test data/ plots:

9kHz-30MHz mode: 802.11 a Ch40

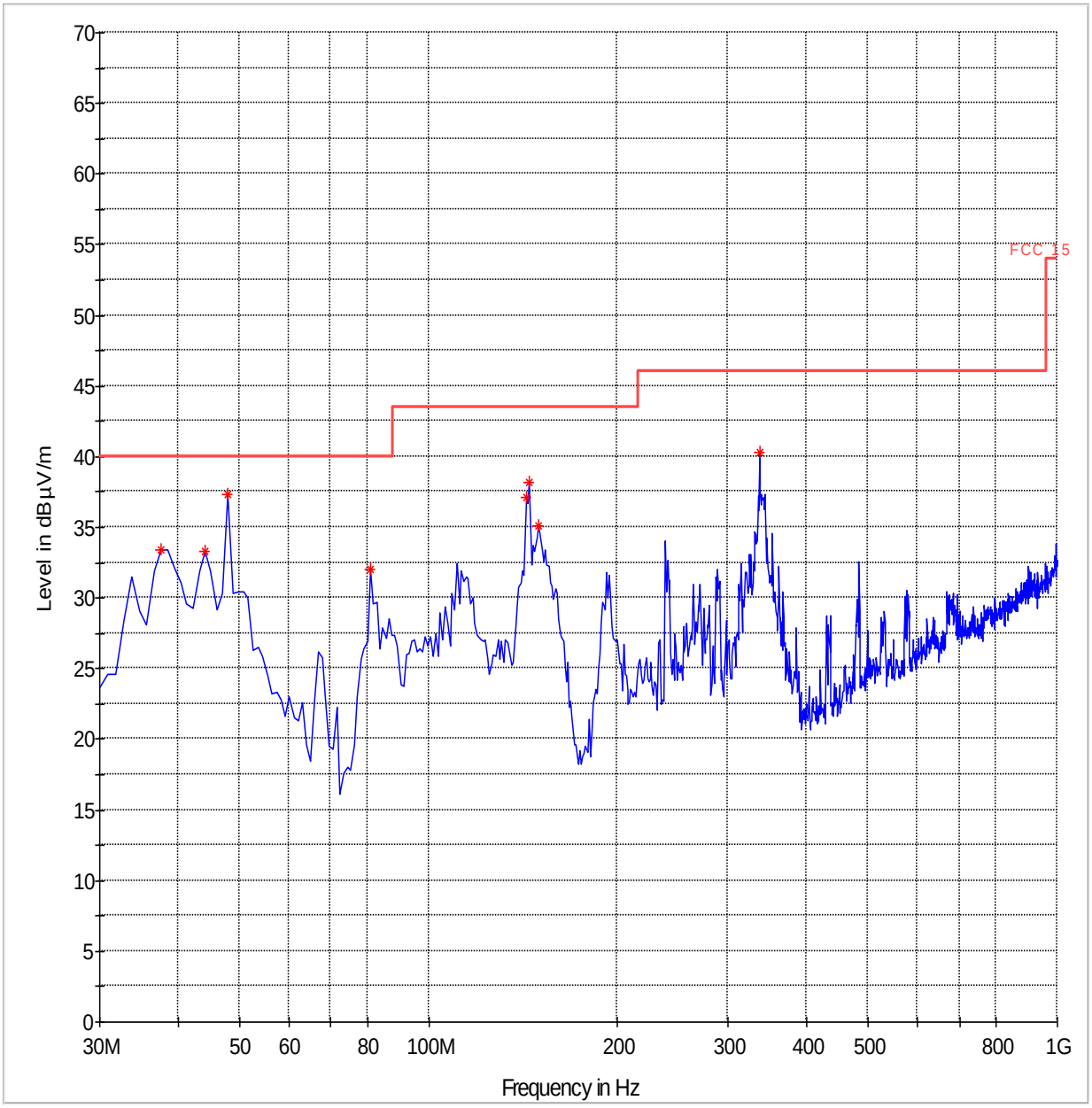
Note: The plot below represents worst case for this frequency range for all modulations.



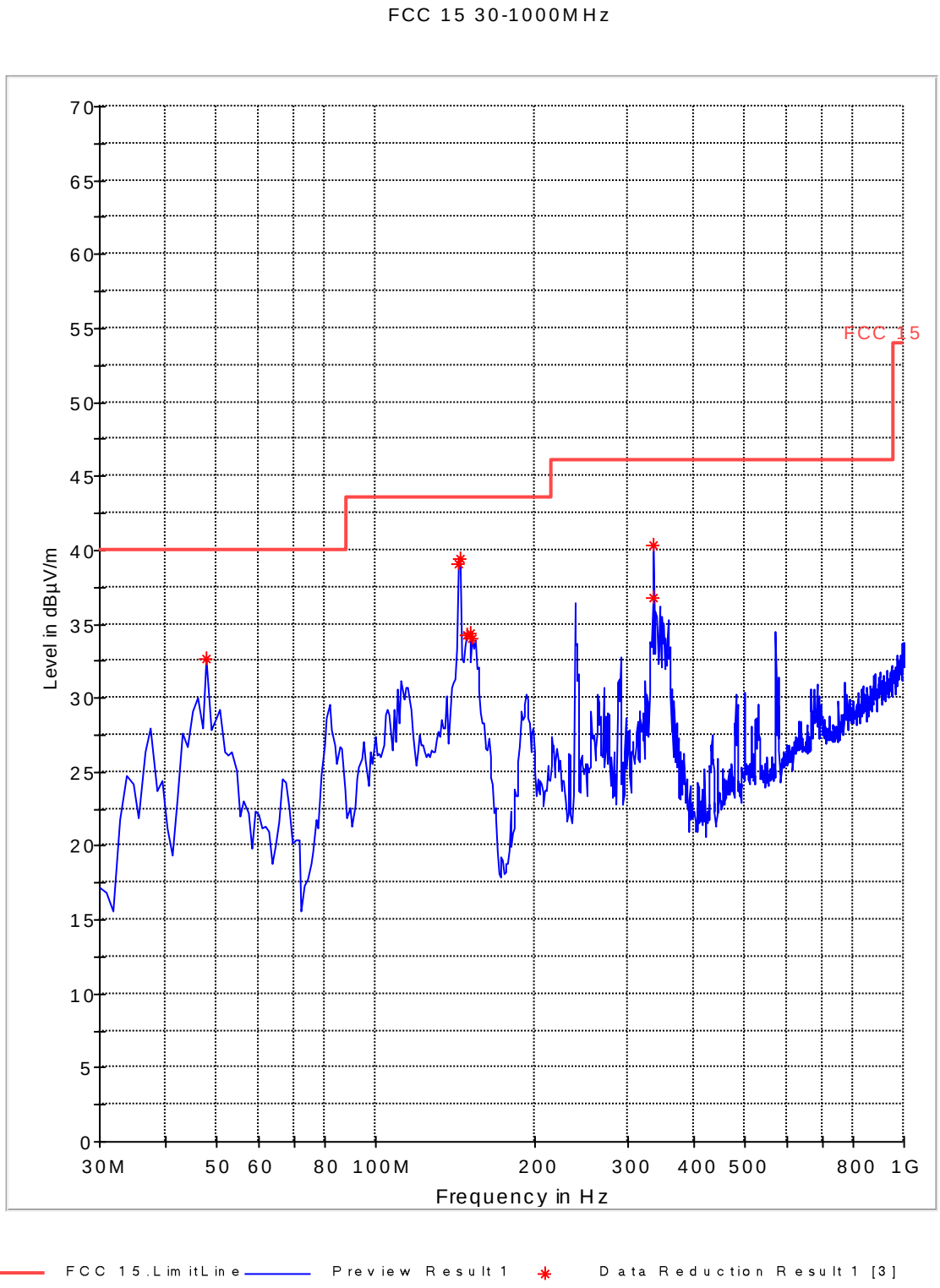
30MHz-1GHz mode: 802.11 a Ch40



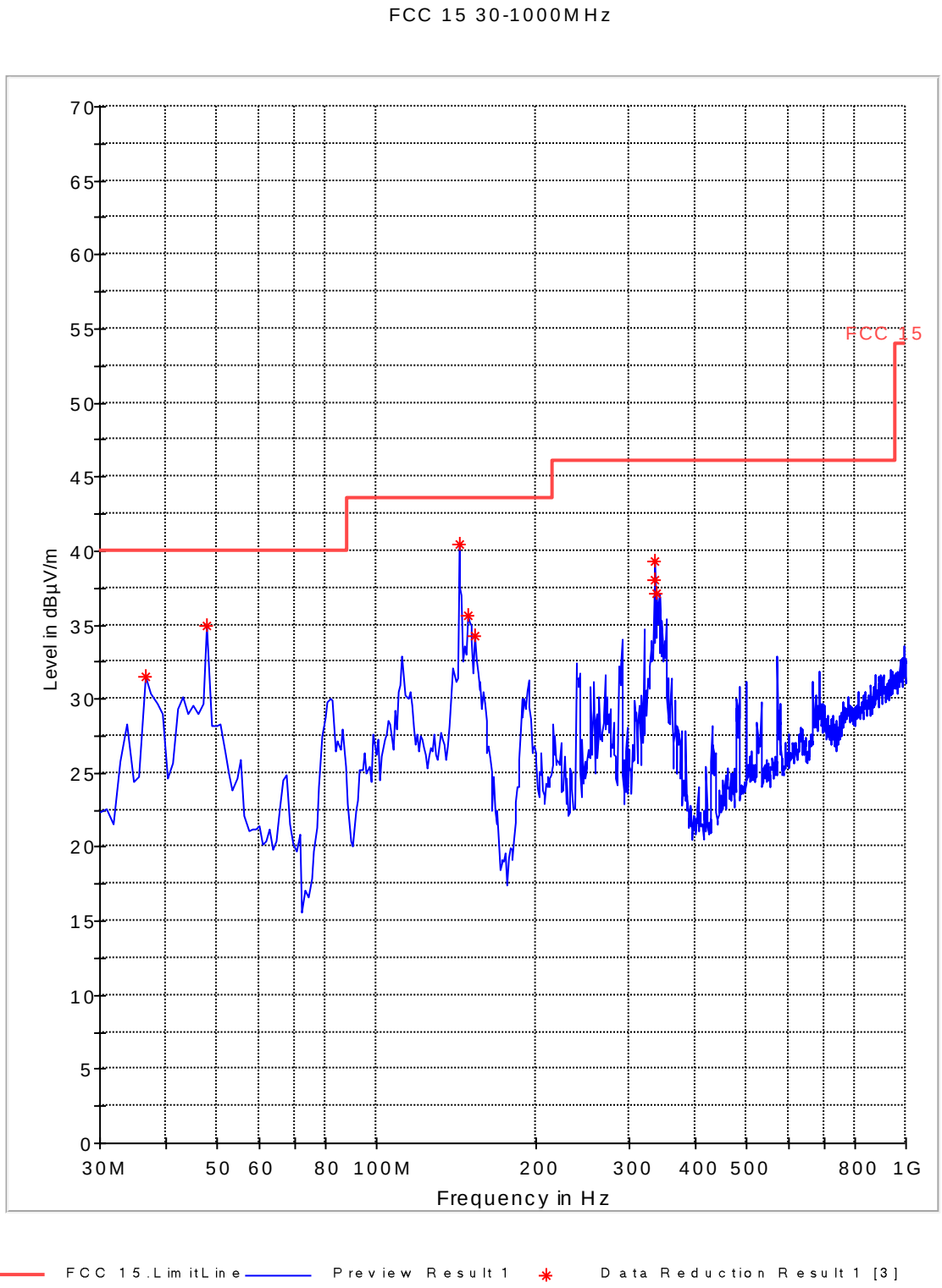
30MHz-1GHz mode: 802.11 n Ch40



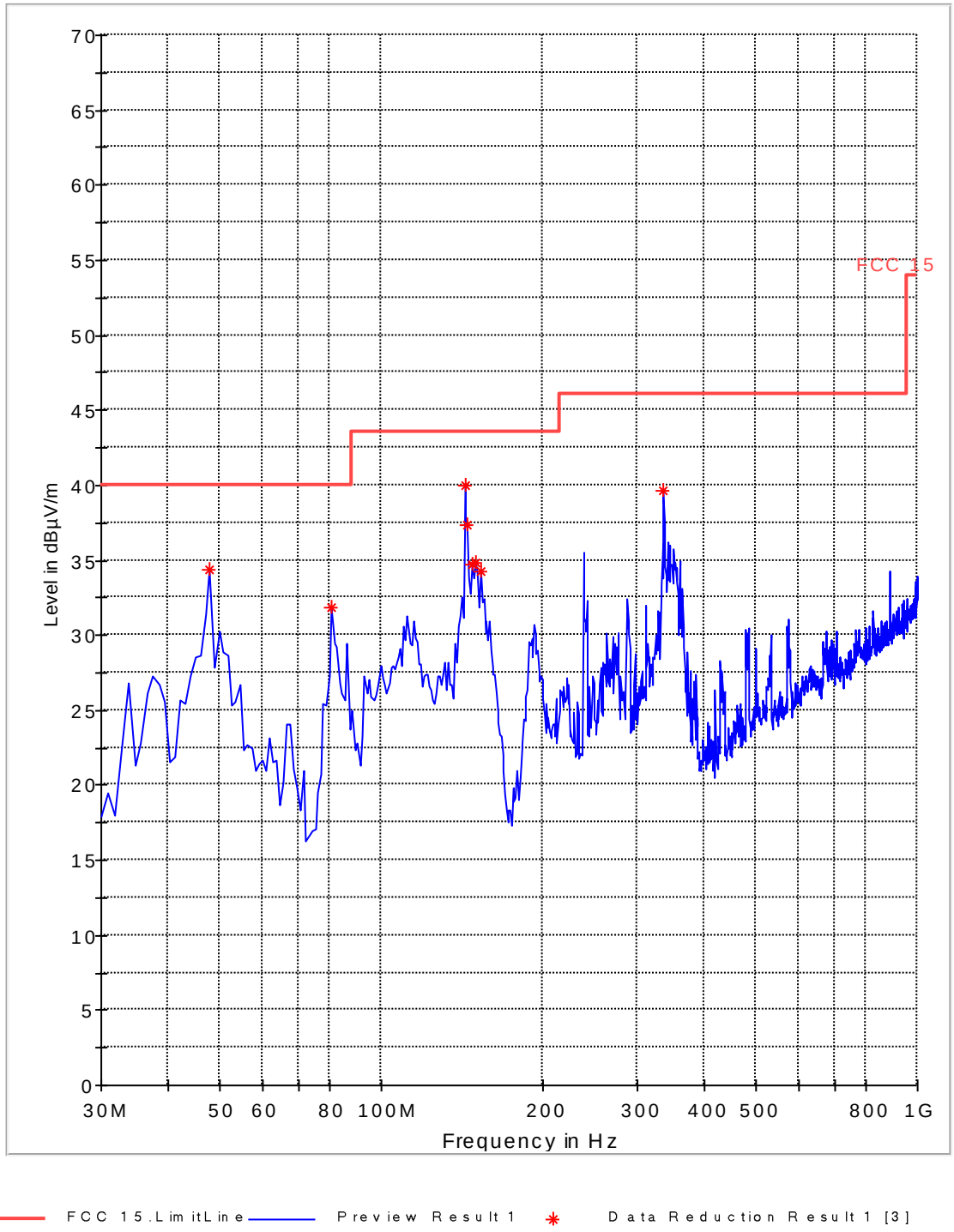
30MHz-1GHz mode: 802.11 a Ch60



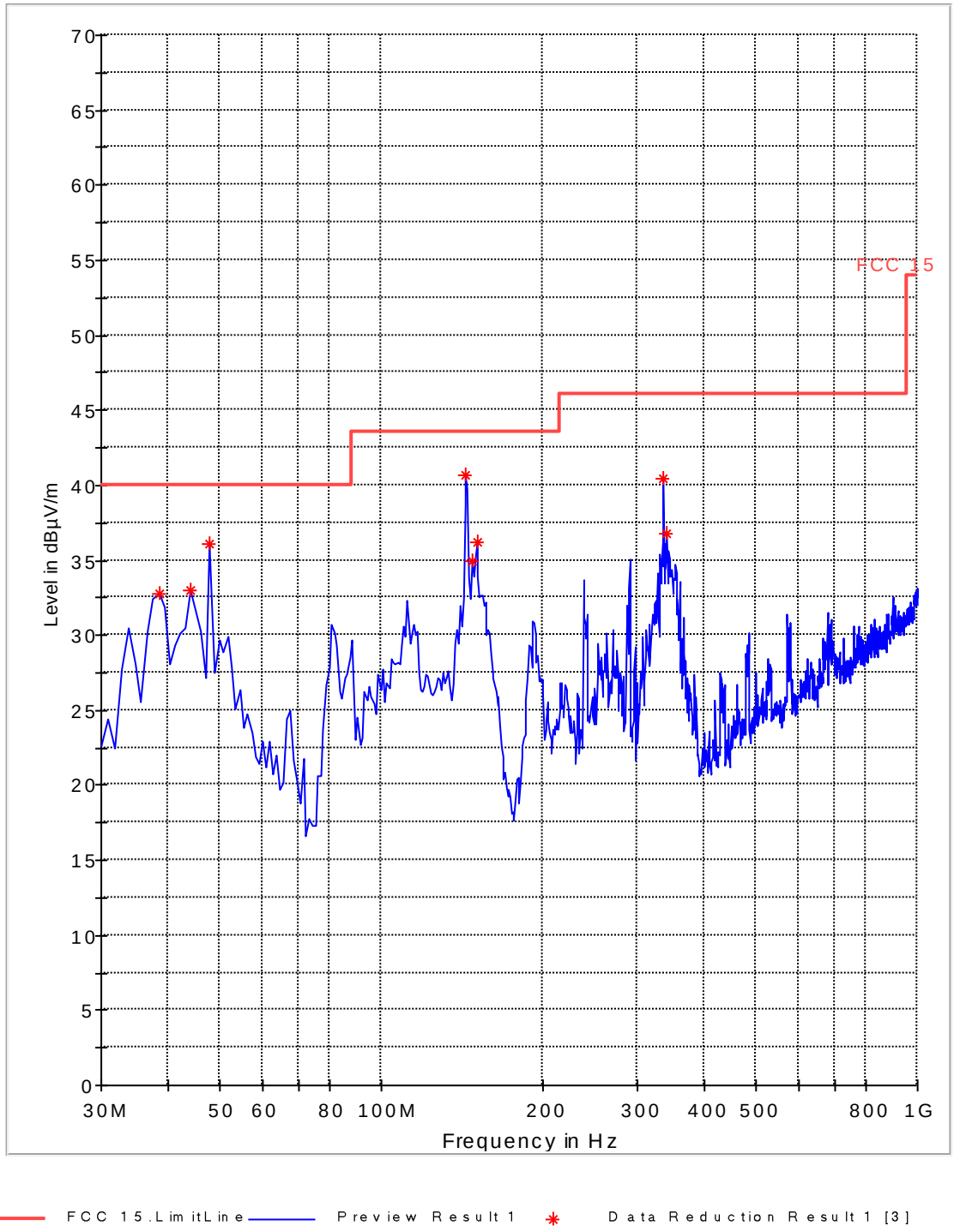
30MHz-1GHz mode: 802.11 n Ch60



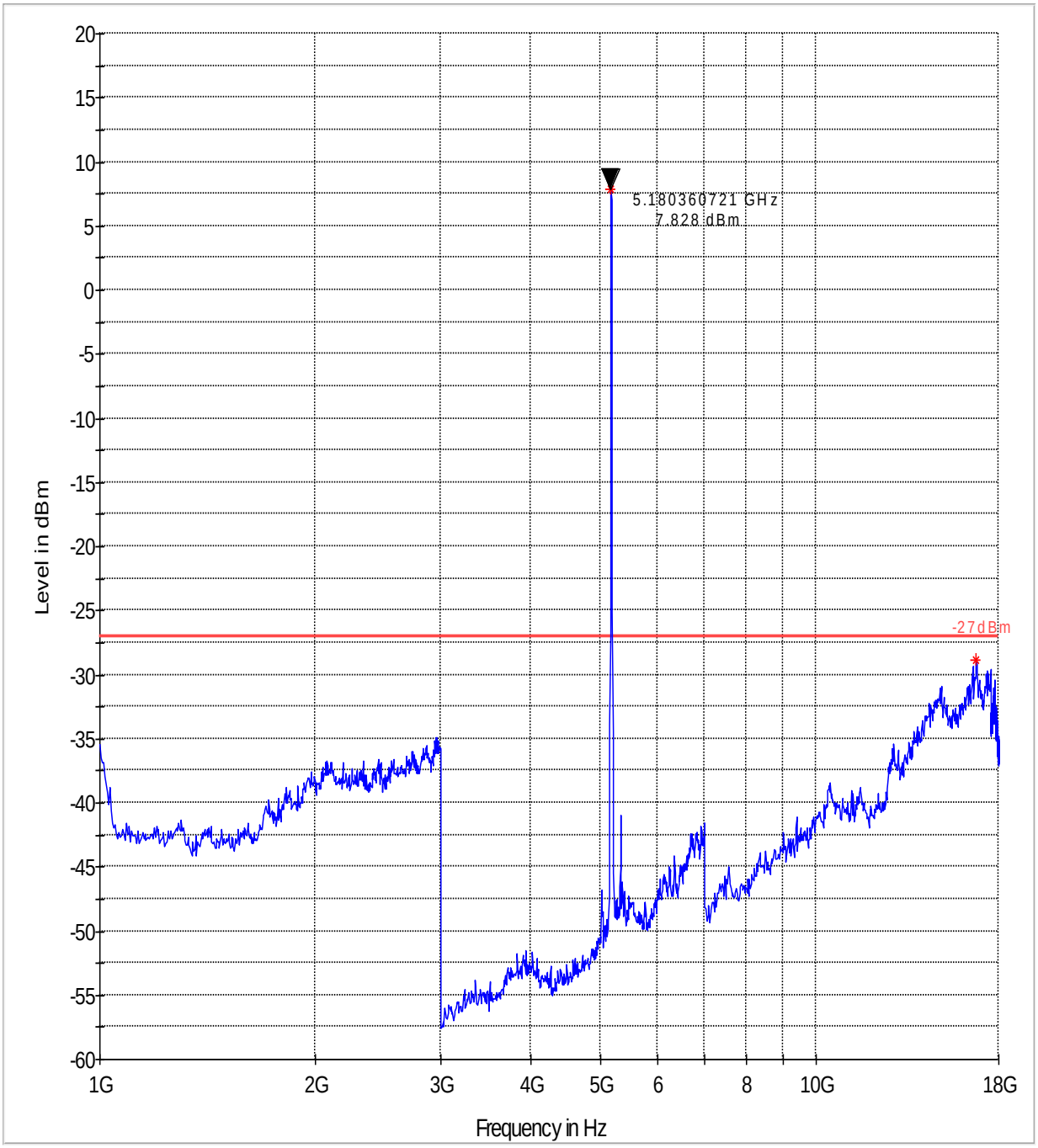
30MHz-1GHz mode: 802.11 a Ch116



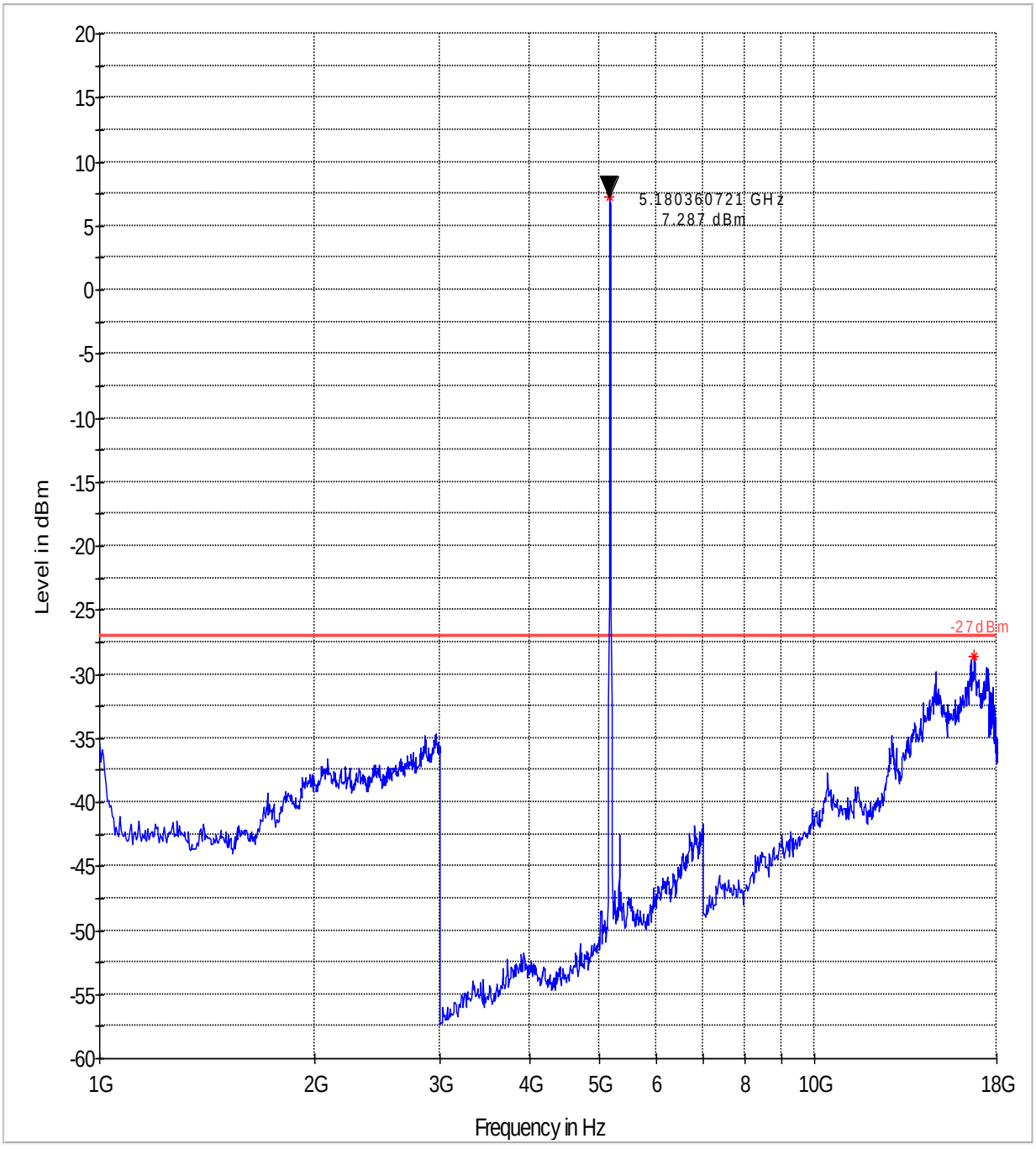
30MHz-1GHz mode: 802.11 n Ch120



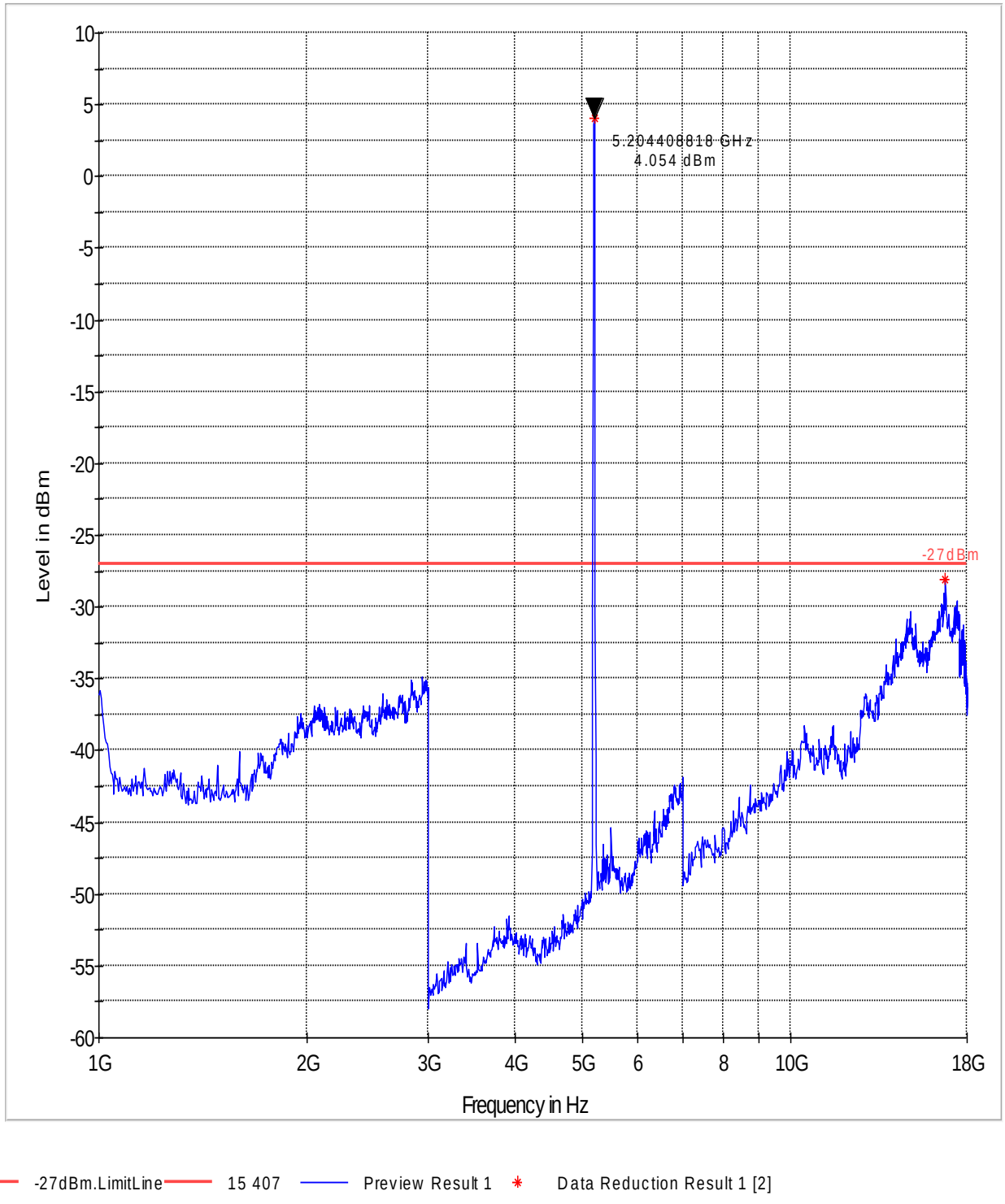
1GHz-18GHz mode: 802.11 a Ch36
Note: Marker is placed on transmit signal



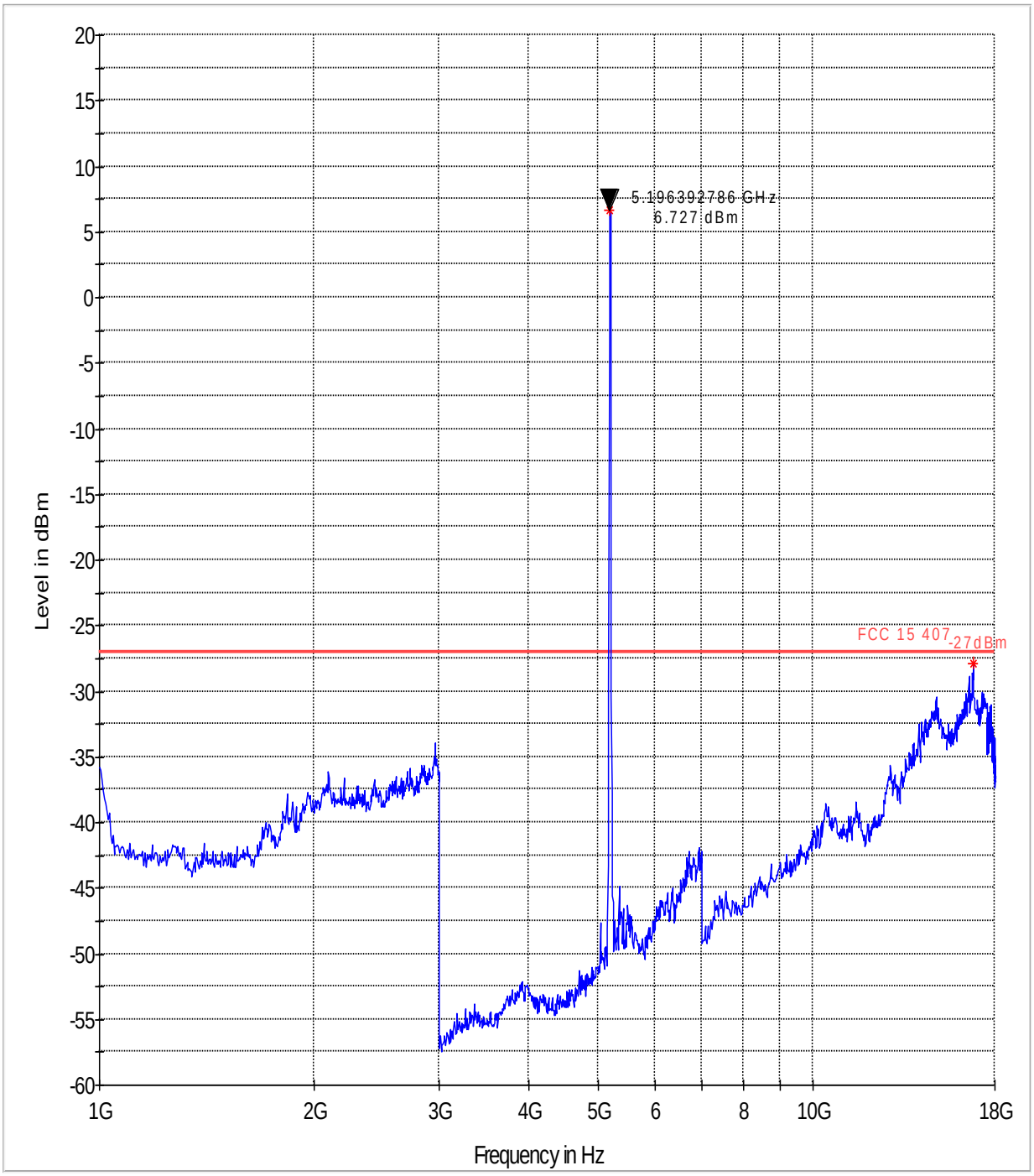
1GHz-18GHz mode: 802.11 n Ch36
Note: Marker is placed on transmit signal



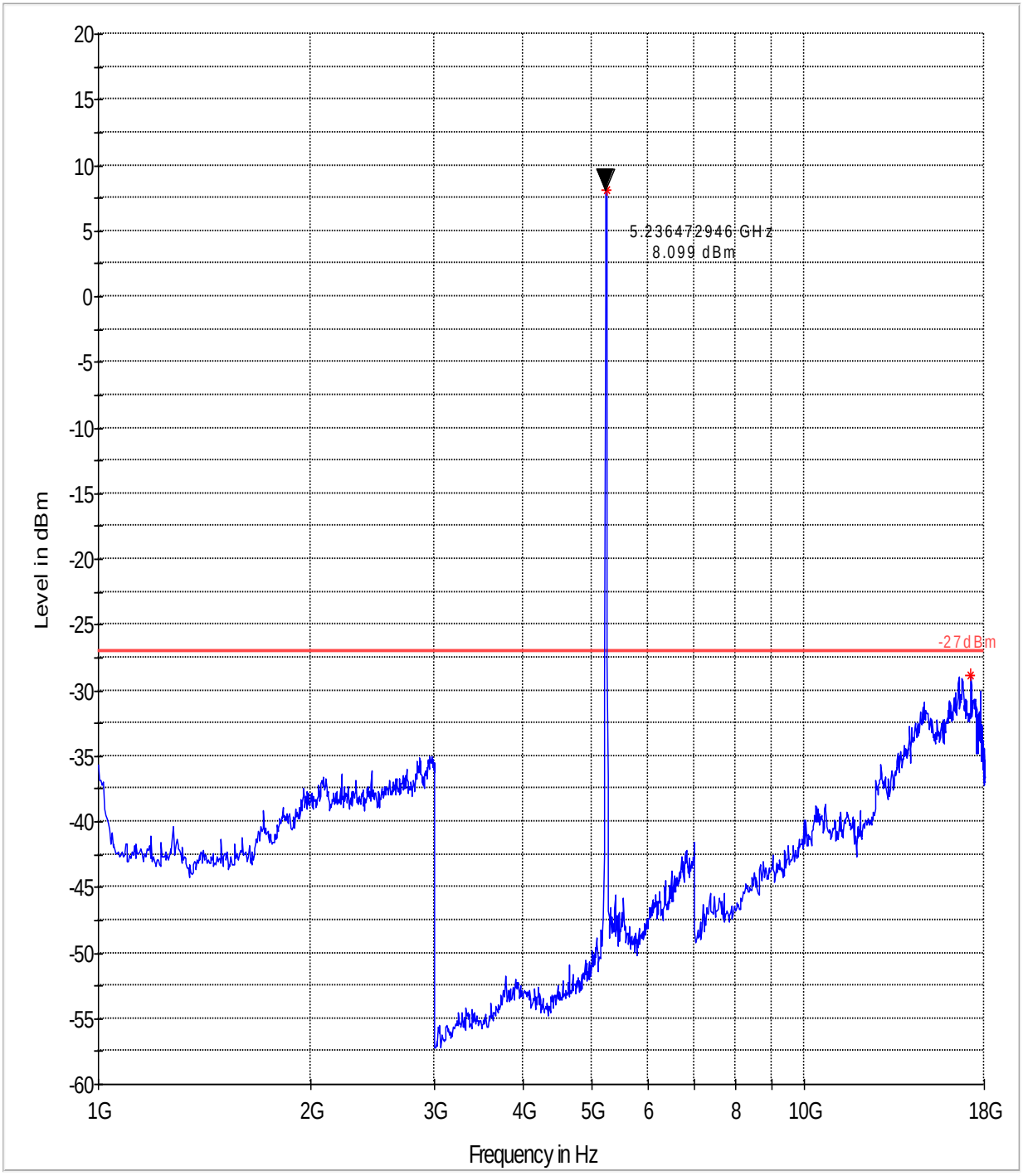
1GHz-18GHz mode: 802.11 a Ch40
Note: Marker is placed on transmit signal



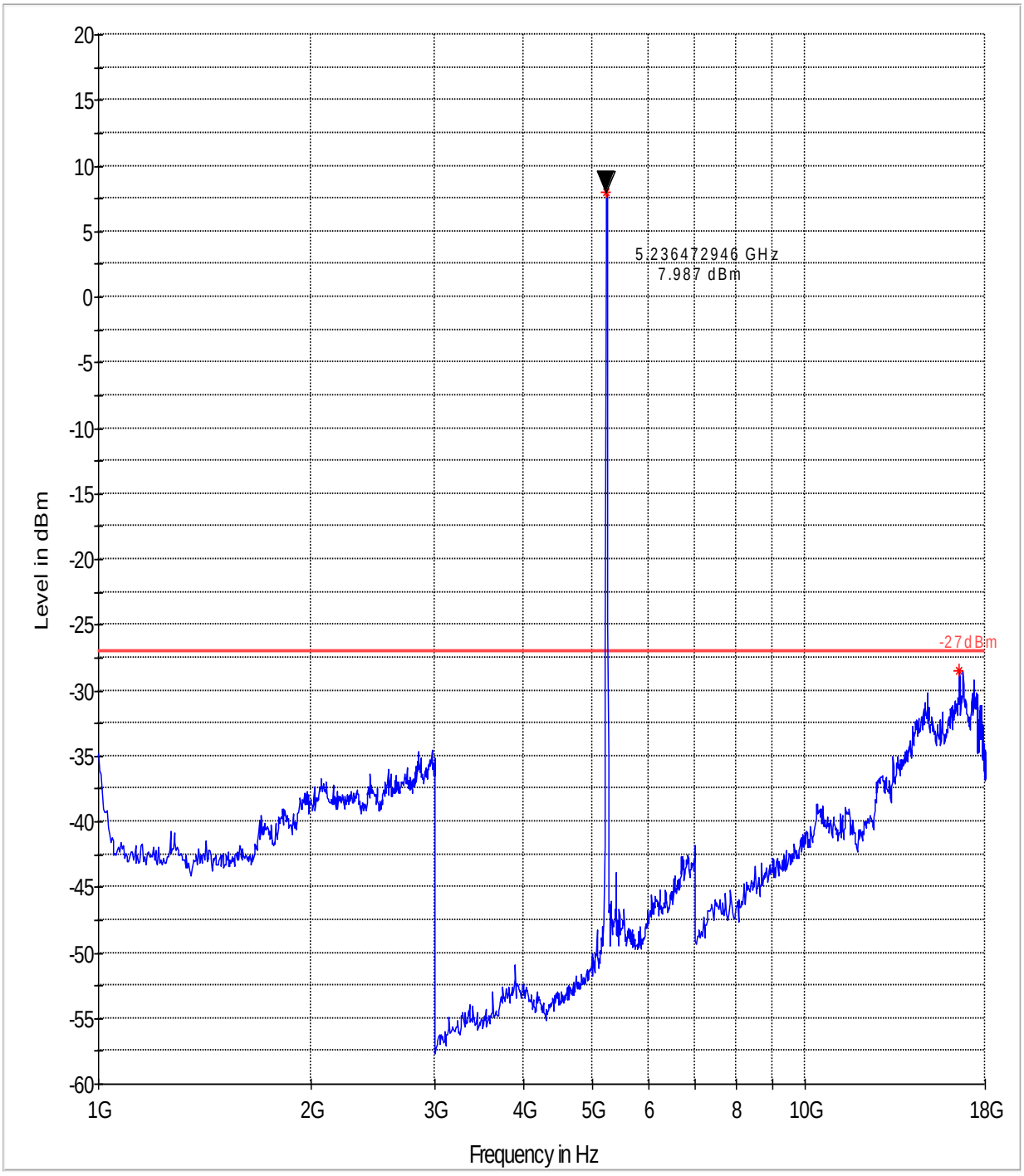
1GHz-18GHz mode: 802.11 n Ch40
Note: Marker is placed on transmit signal



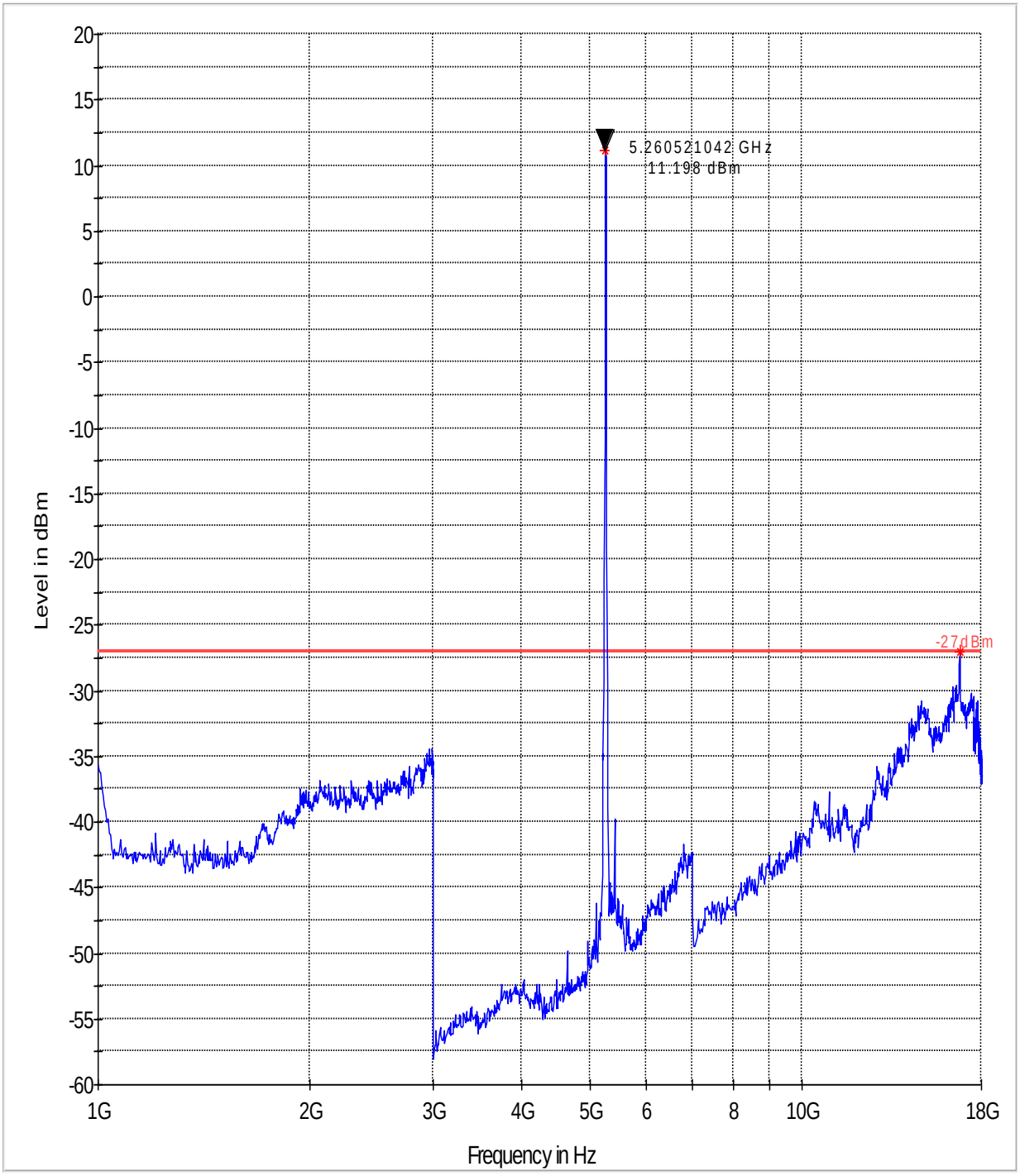
1GHz-18GHz mode: 802.11 a Ch48
Note: Marker is placed on transmit signal



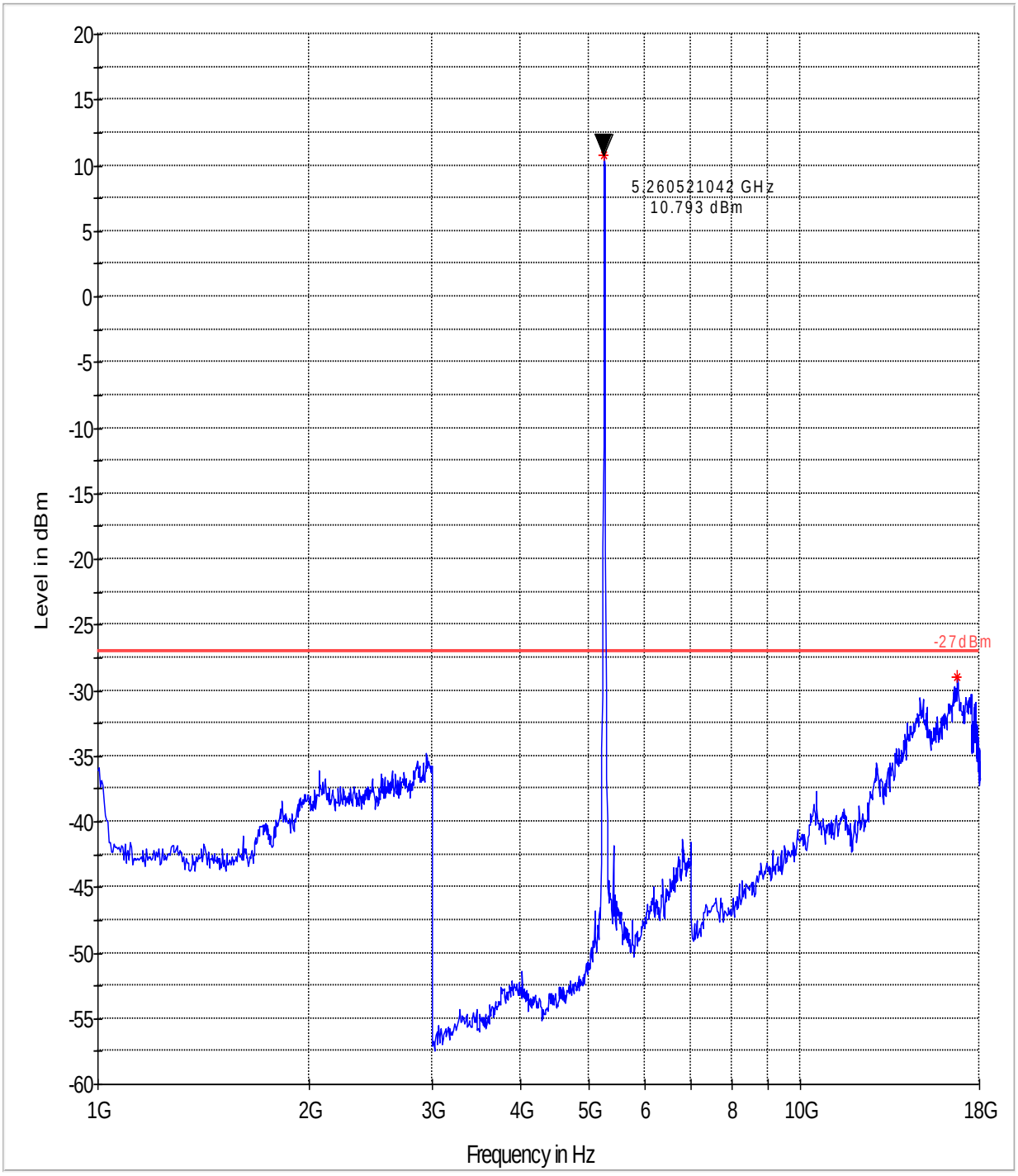
1GHz-18GHz mode: 802.11 n Ch48
Note: Marker is placed on transmit signal



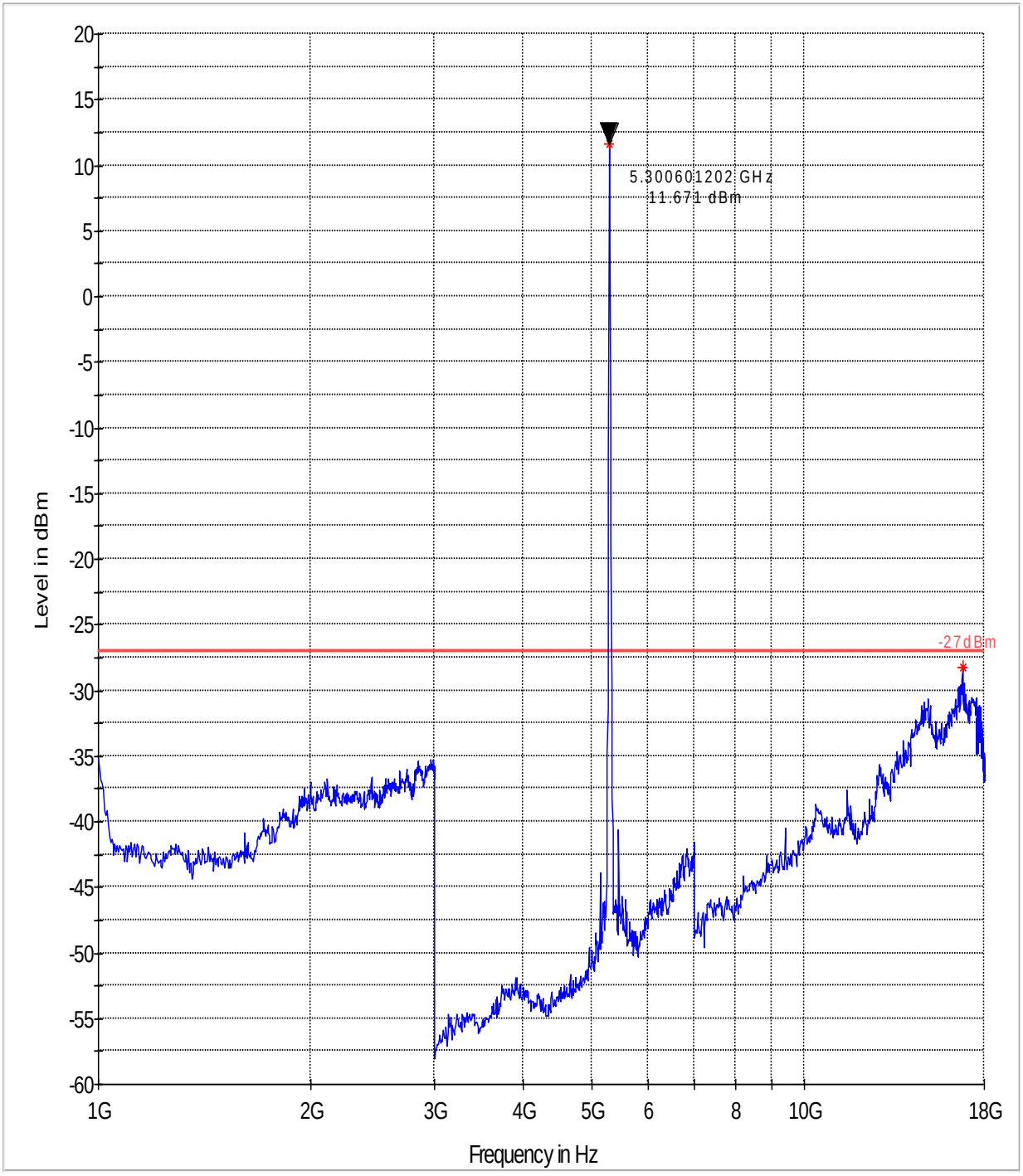
1GHz-18GHz mode: 802.11 a Ch52
Note: Marker is placed on transmit signal



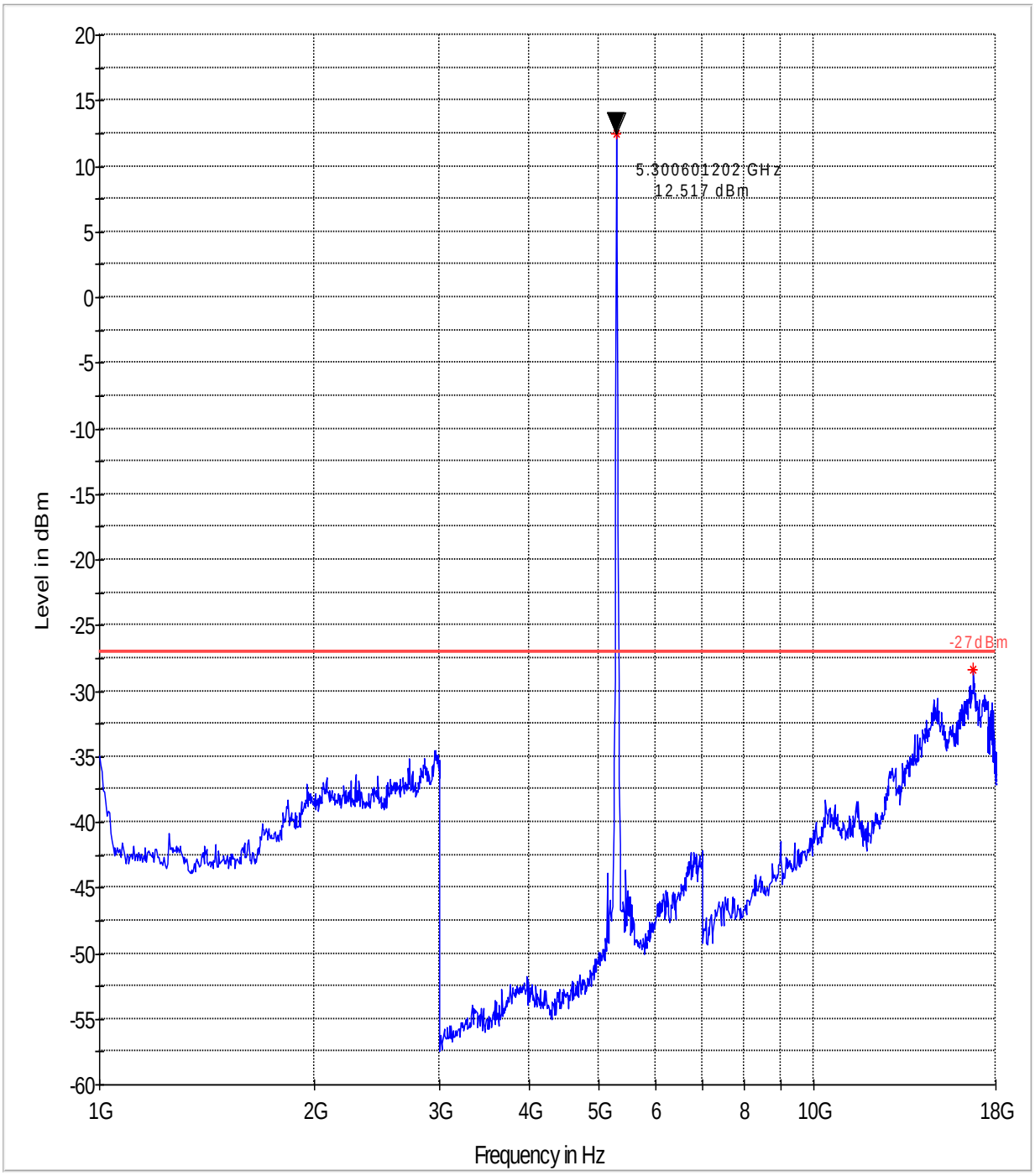
1GHz-18GHz mode: 802.11 n Ch52
Note: Marker is placed on transmit signal



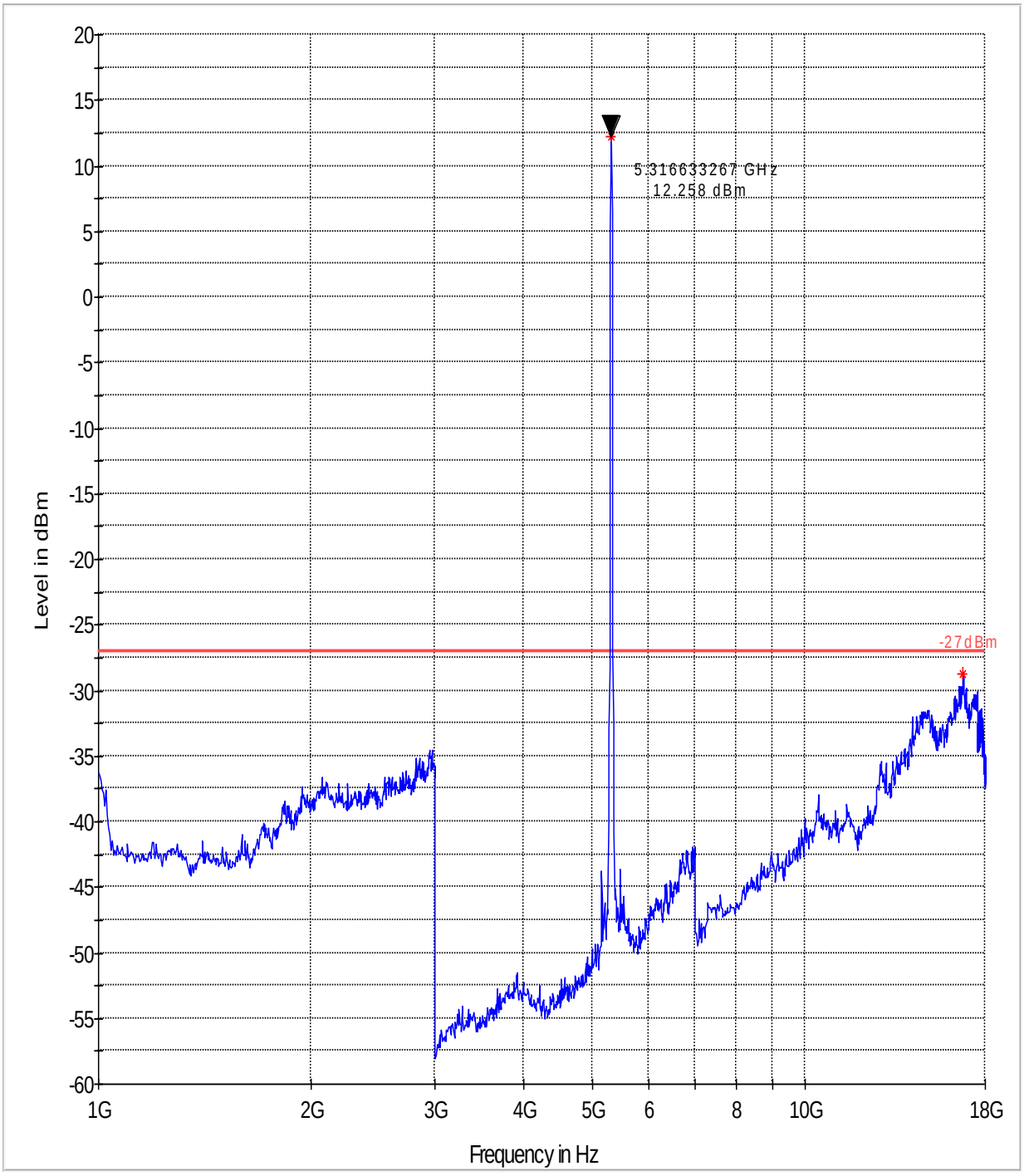
1GHz-18GHz mode: 802.11 a Ch60
Note: Marker is placed on transmit signal



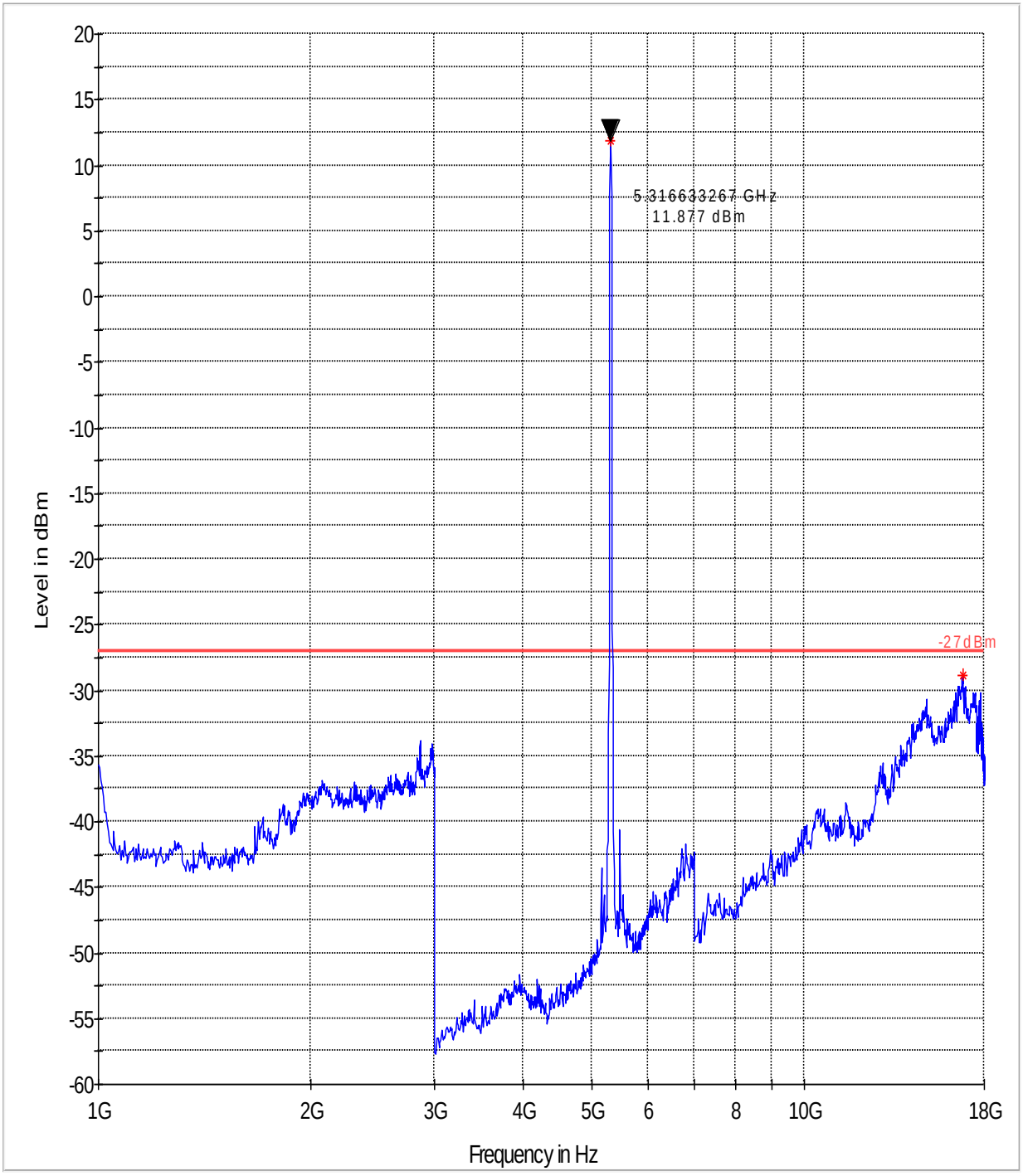
1GHz-18GHz mode: 802.11 n Ch60
Note: Marker is placed on transmit signal



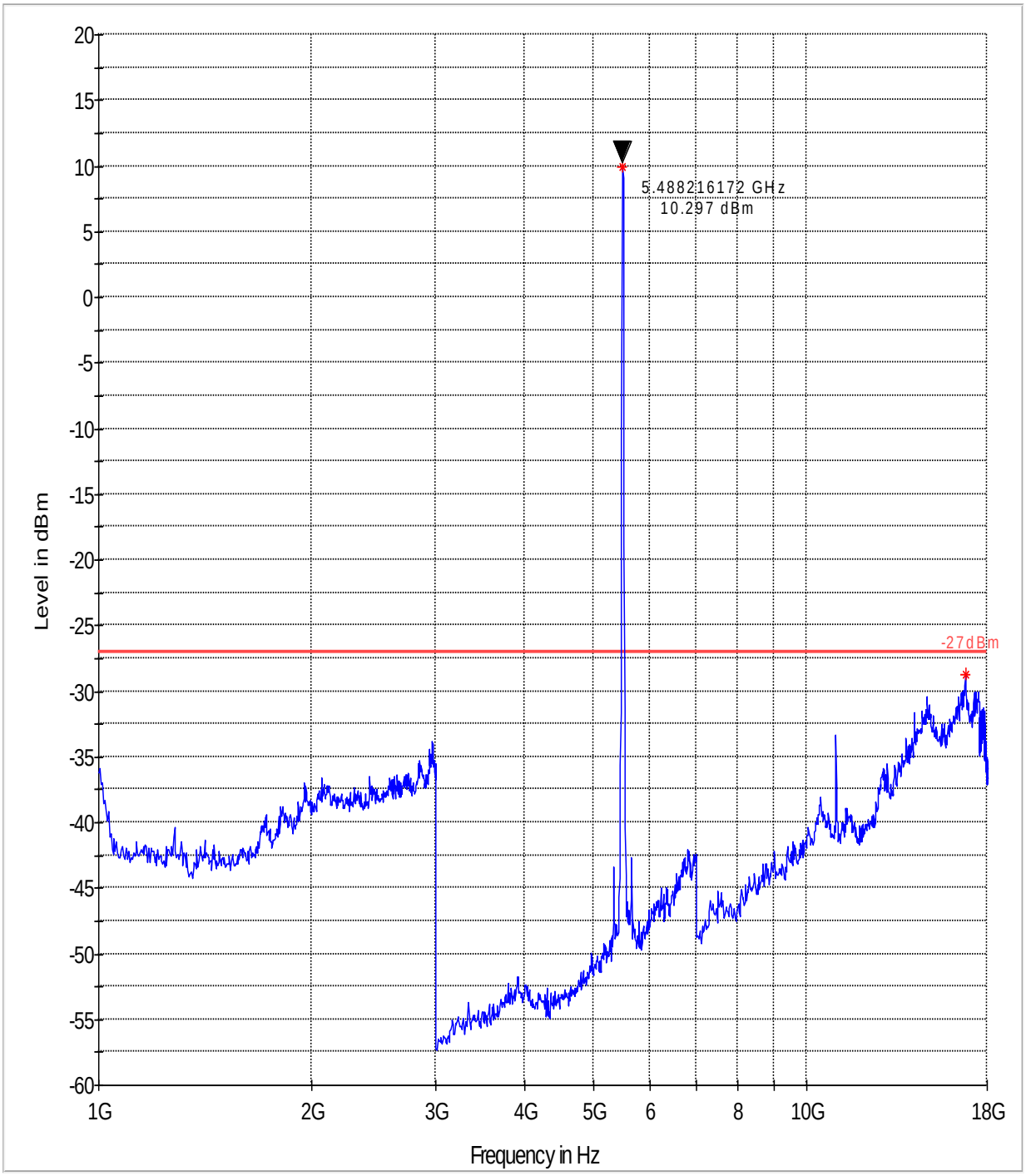
1GHz-18GHz mode: 802.11 a Ch64
Note: Marker is placed on transmit signal



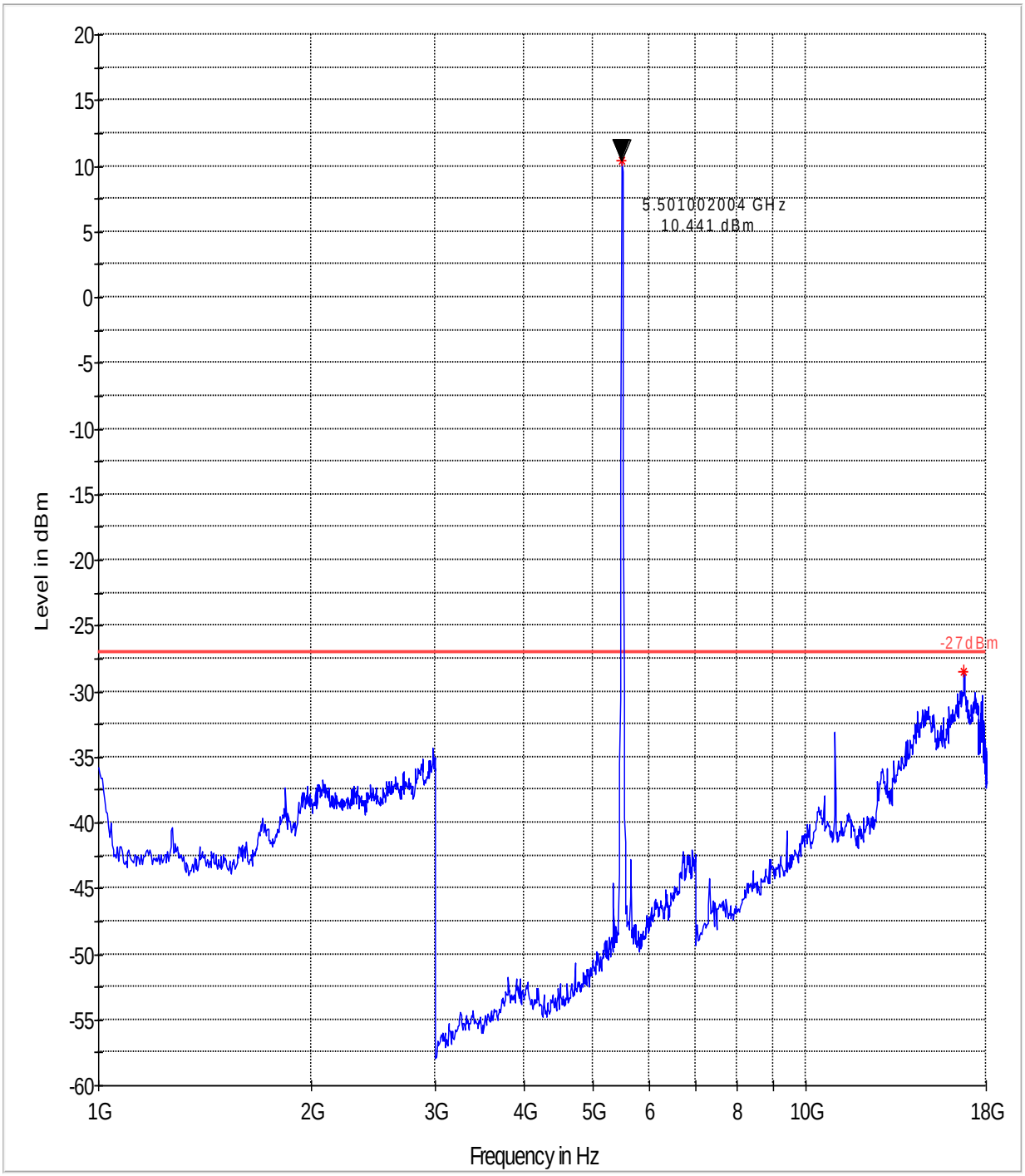
1GHz-18GHz mode: 802.11 n Ch64
Note: Marker is placed on transmit signal



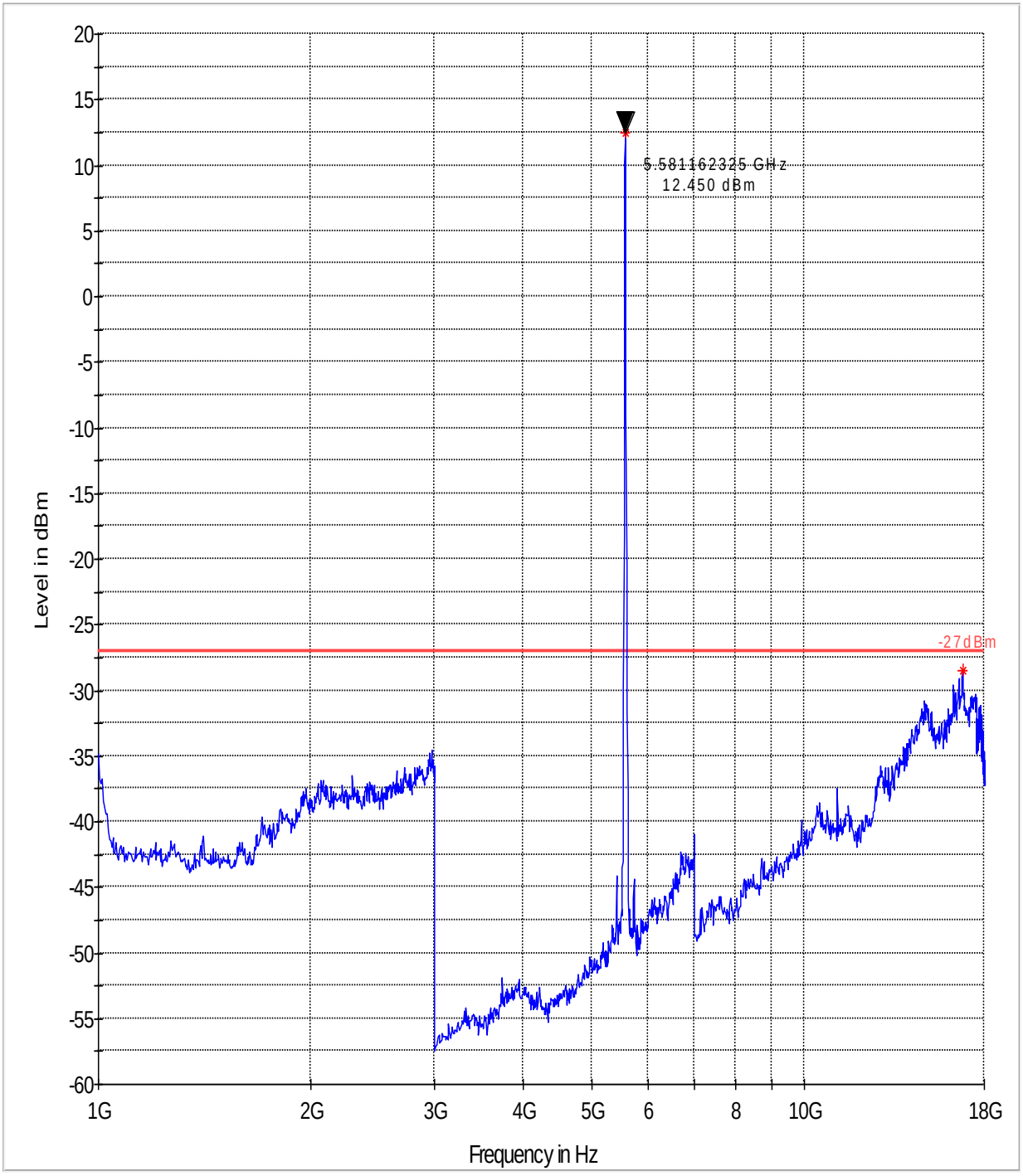
1GHz-18GHz mode: 802.11 a Ch100
Note: Marker is placed on transmit signal



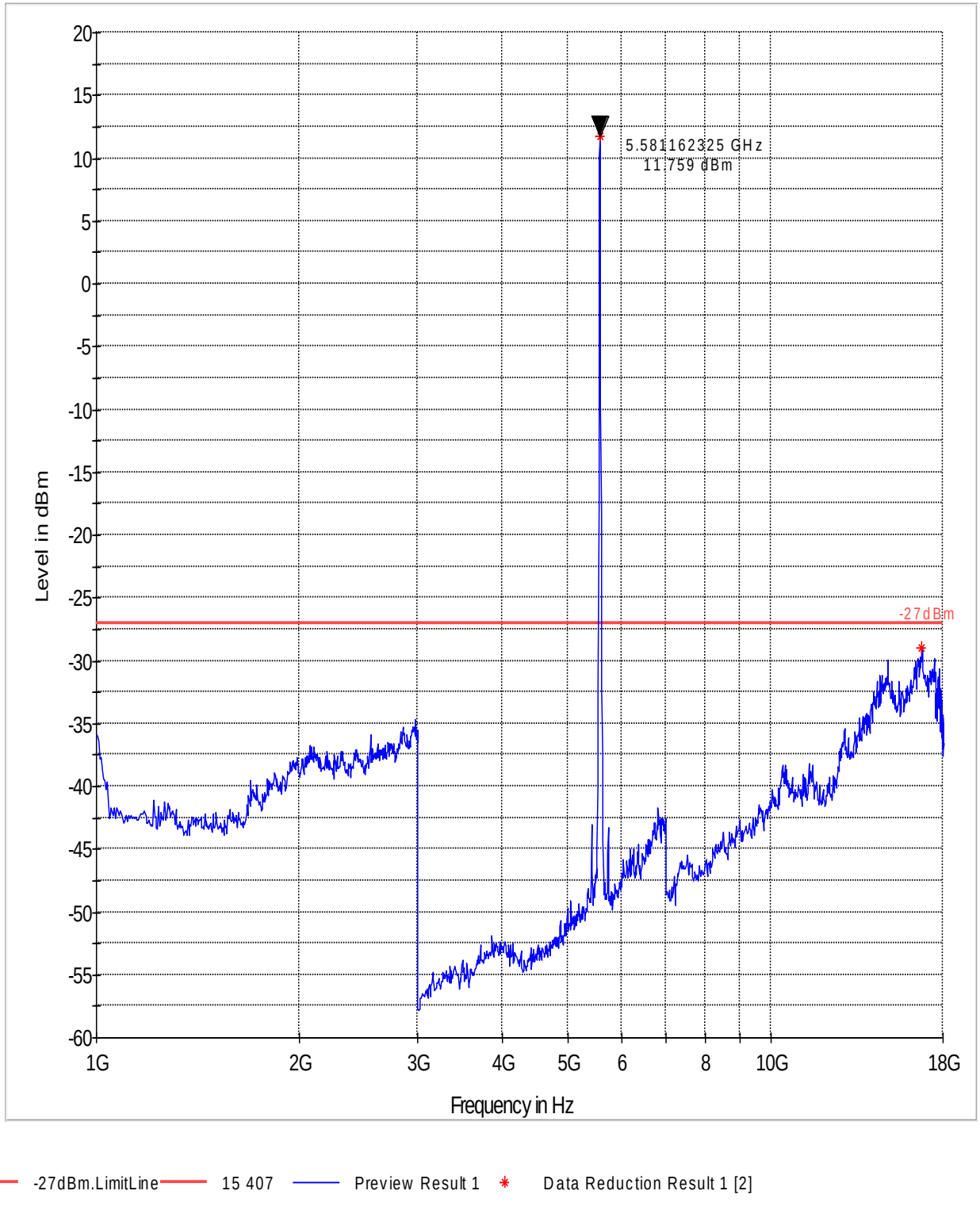
1GHz-18GHz mode: 802.11 n Ch100
Note: Marker is placed on transmit signal



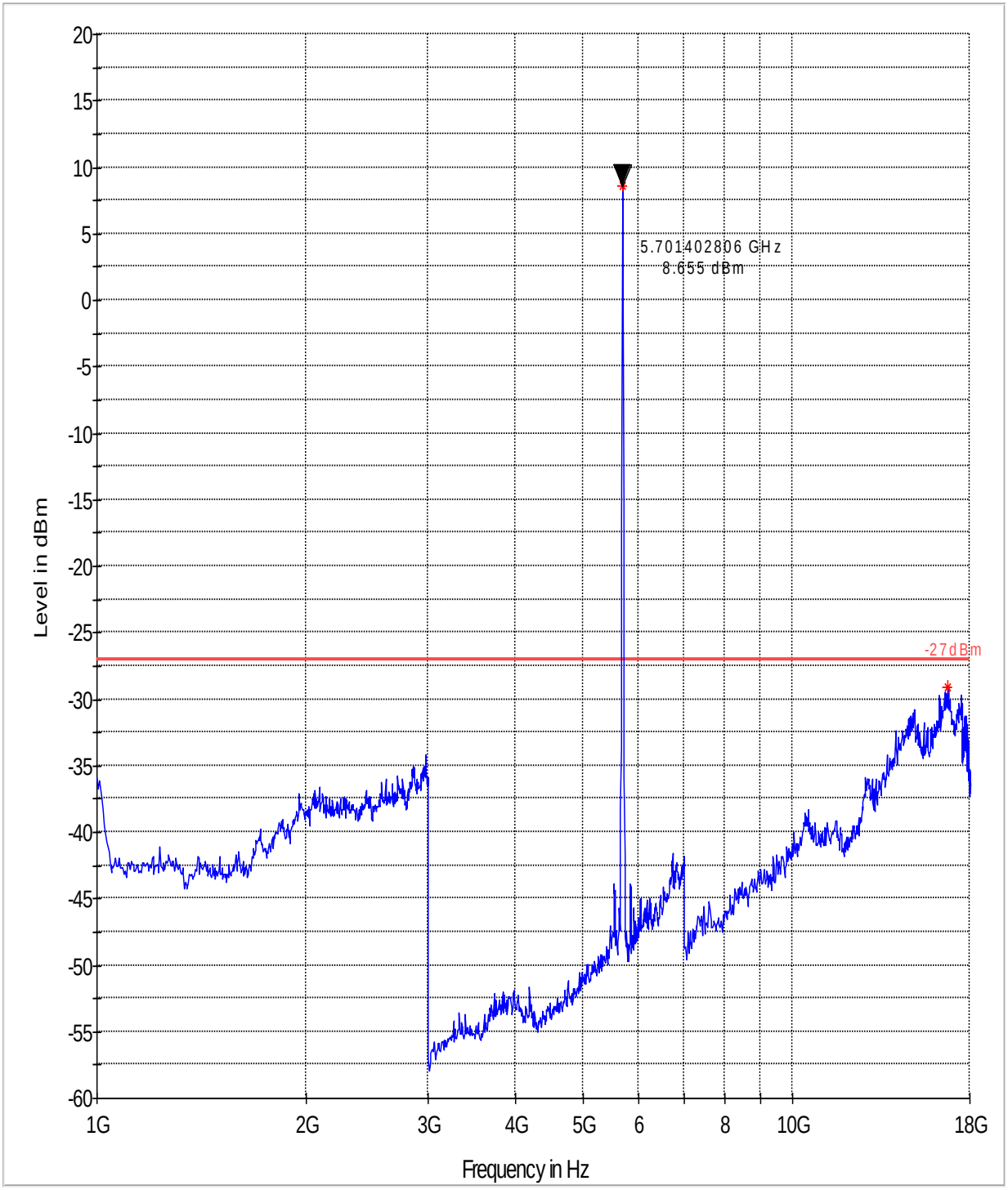
1GHz-18GHz mode: 802.11 a Ch116
Note: Marker is placed on transmit signal



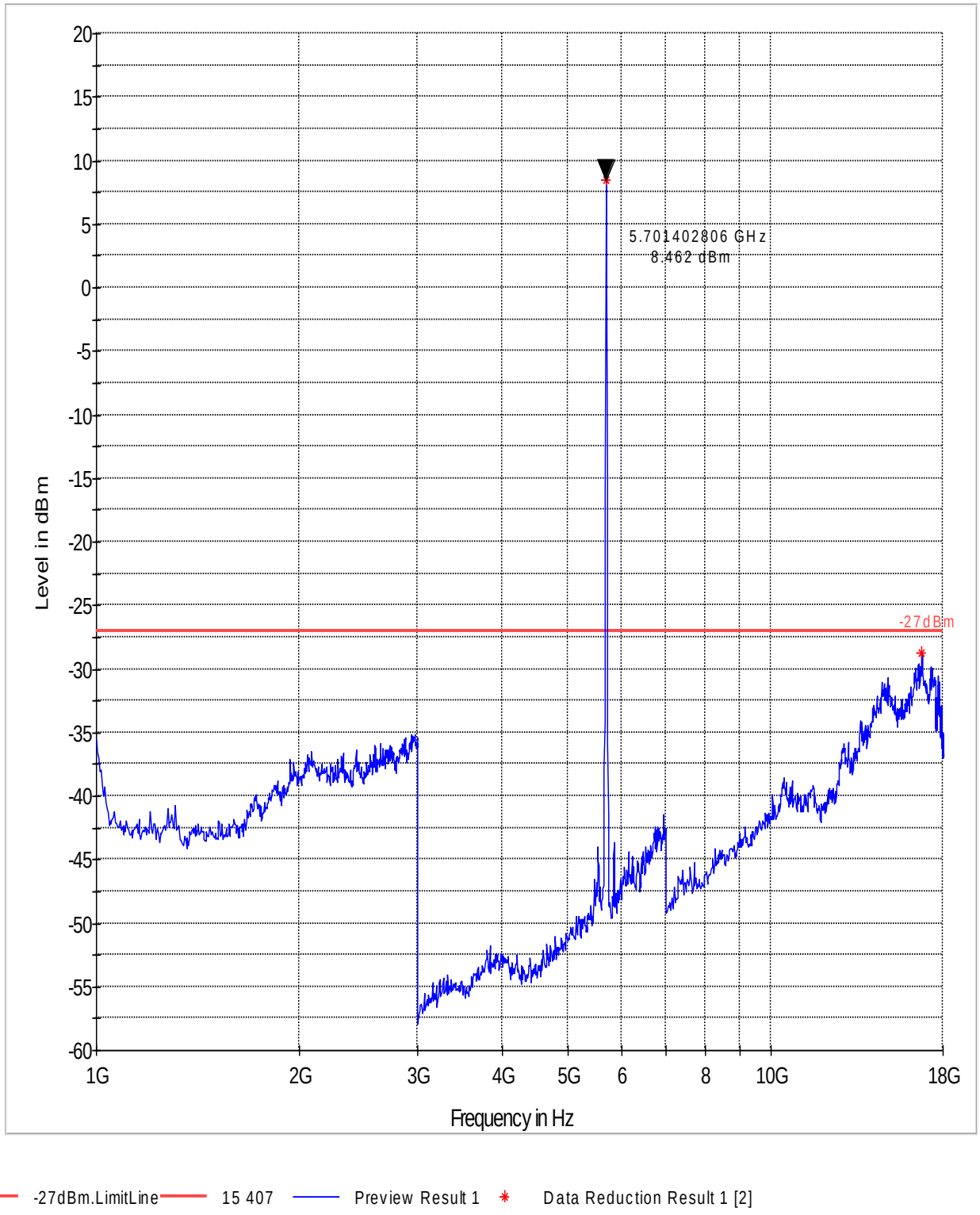
1GHz-18GHz mode: 802.11 n Ch116
Note: Marker is placed on transmit signal



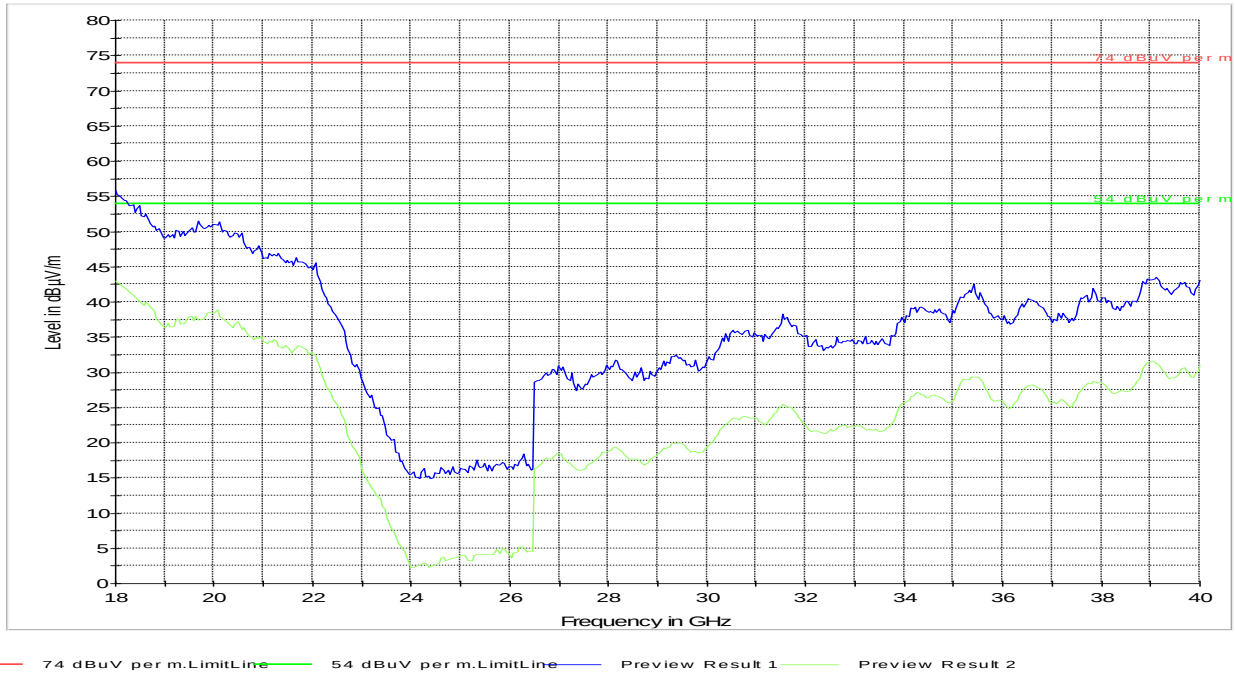
1GHz-18GHz mode: 802.11 a Ch140
Note: Marker is placed on transmit signal



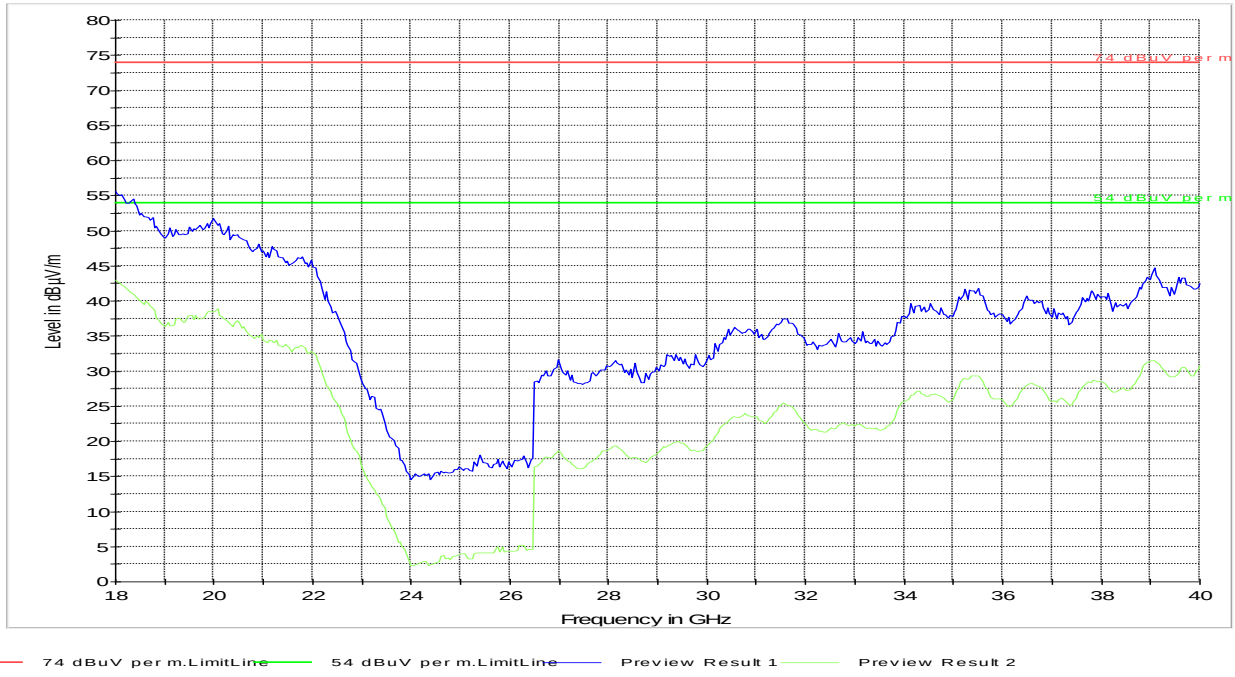
1GHz-18GHz mode: 802.11 n Ch140
Note: Marker is placed on transmit signal



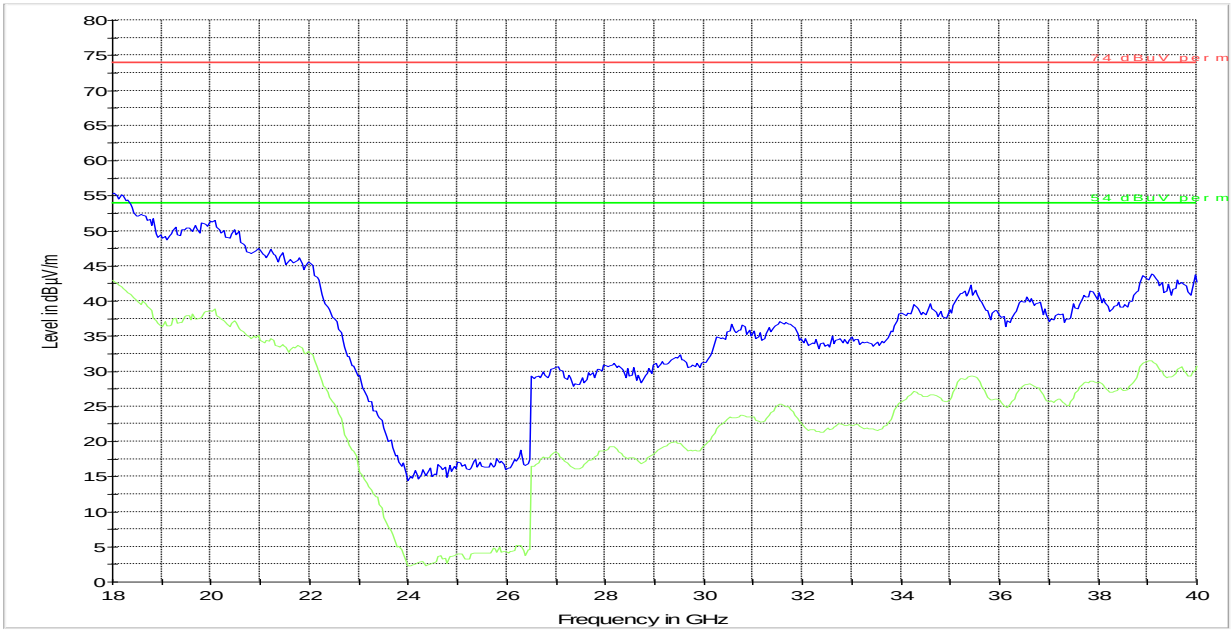
18GHz-40GHz mode: 802.11 a Ch40



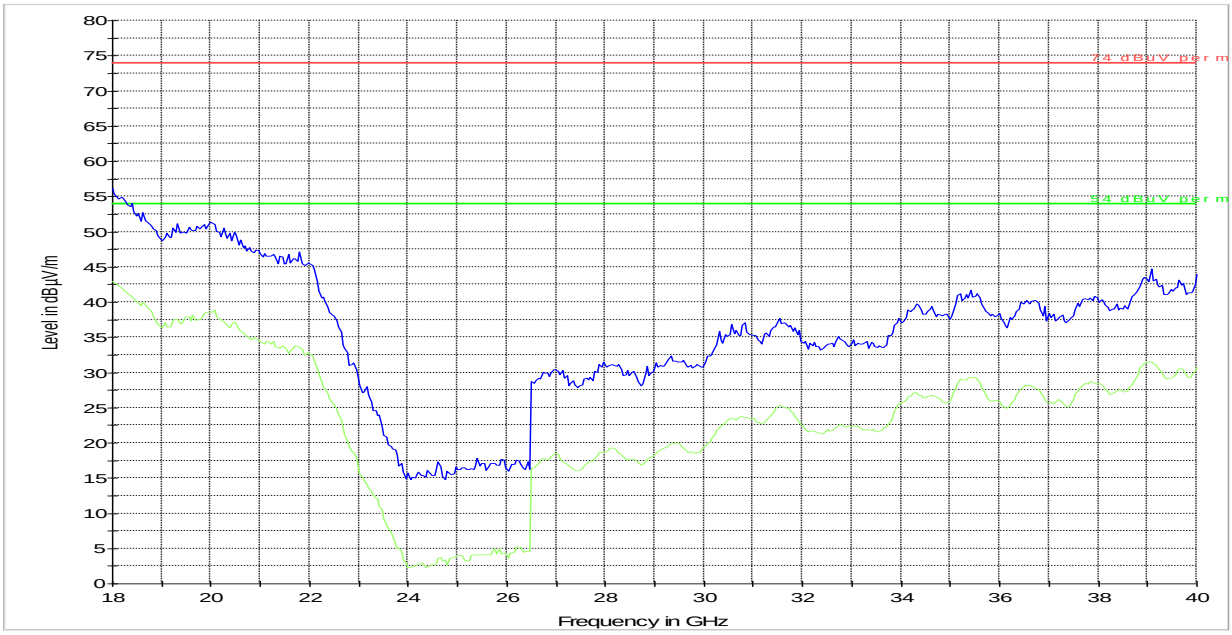
18GHz-40GHz mode: 802.11 n Ch40



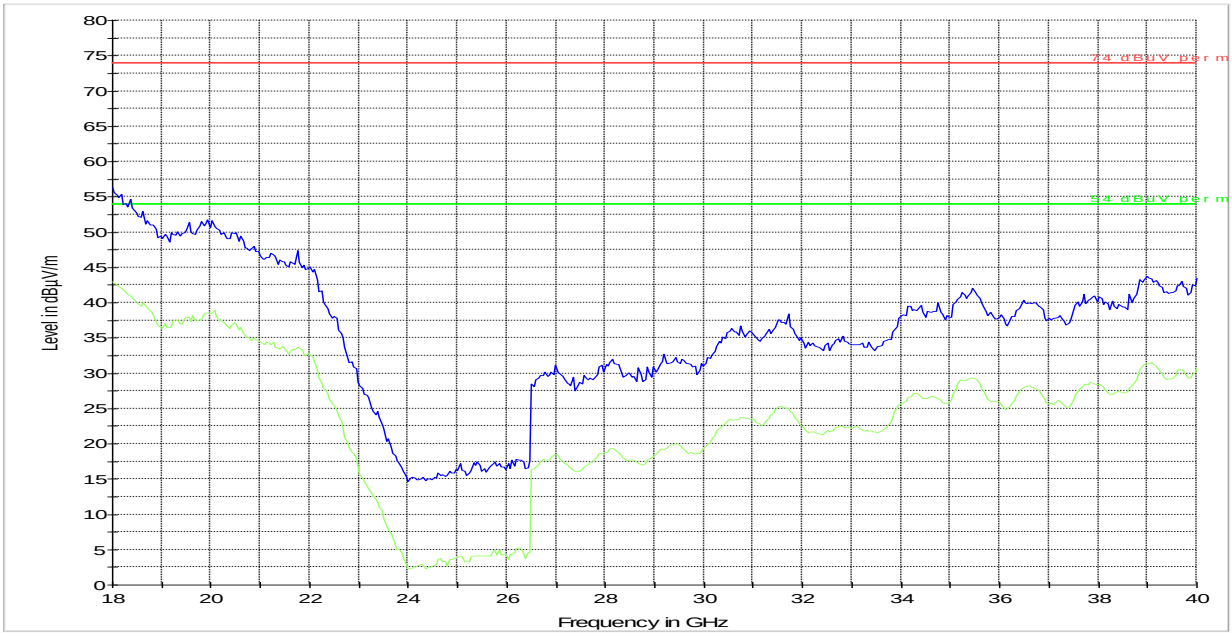
18GHz-40GHz mode: 802.11 a Ch60



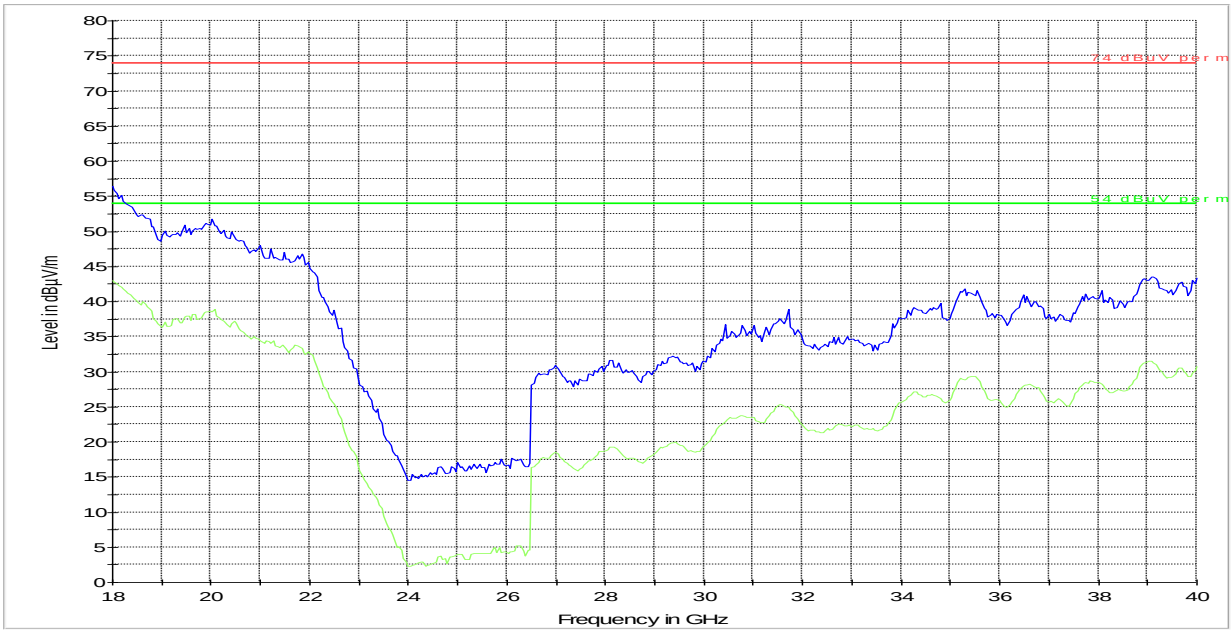
18GHz-40GHz mode: 802.11 n Ch60



18GHz-40GHz mode: 802.11 n Ch116



18GHz-40GHz mode: 802.11 n Ch116

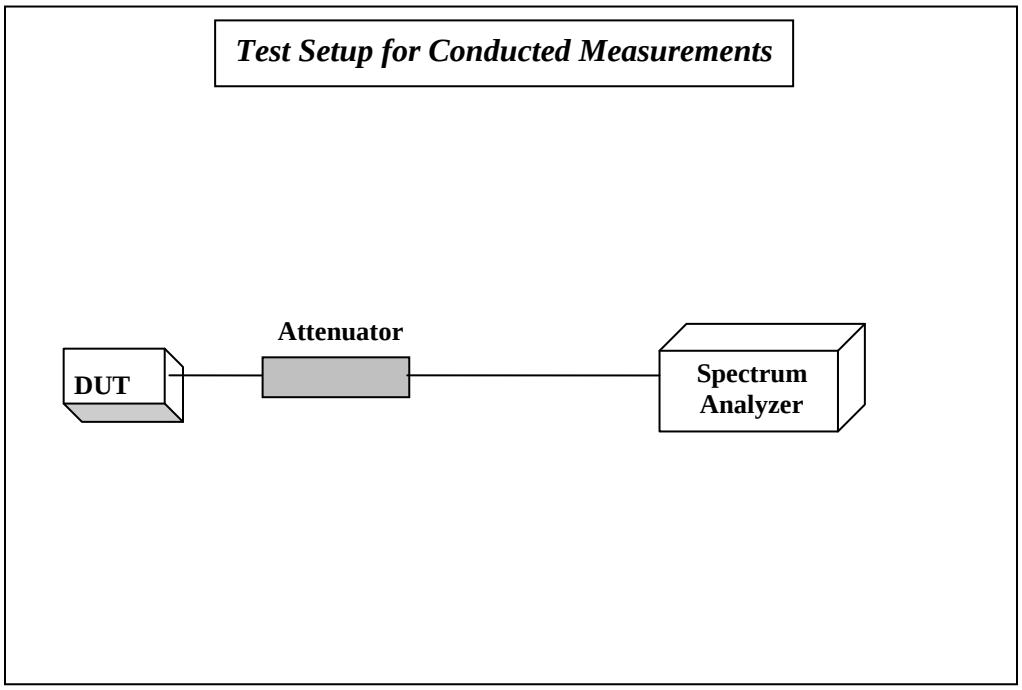


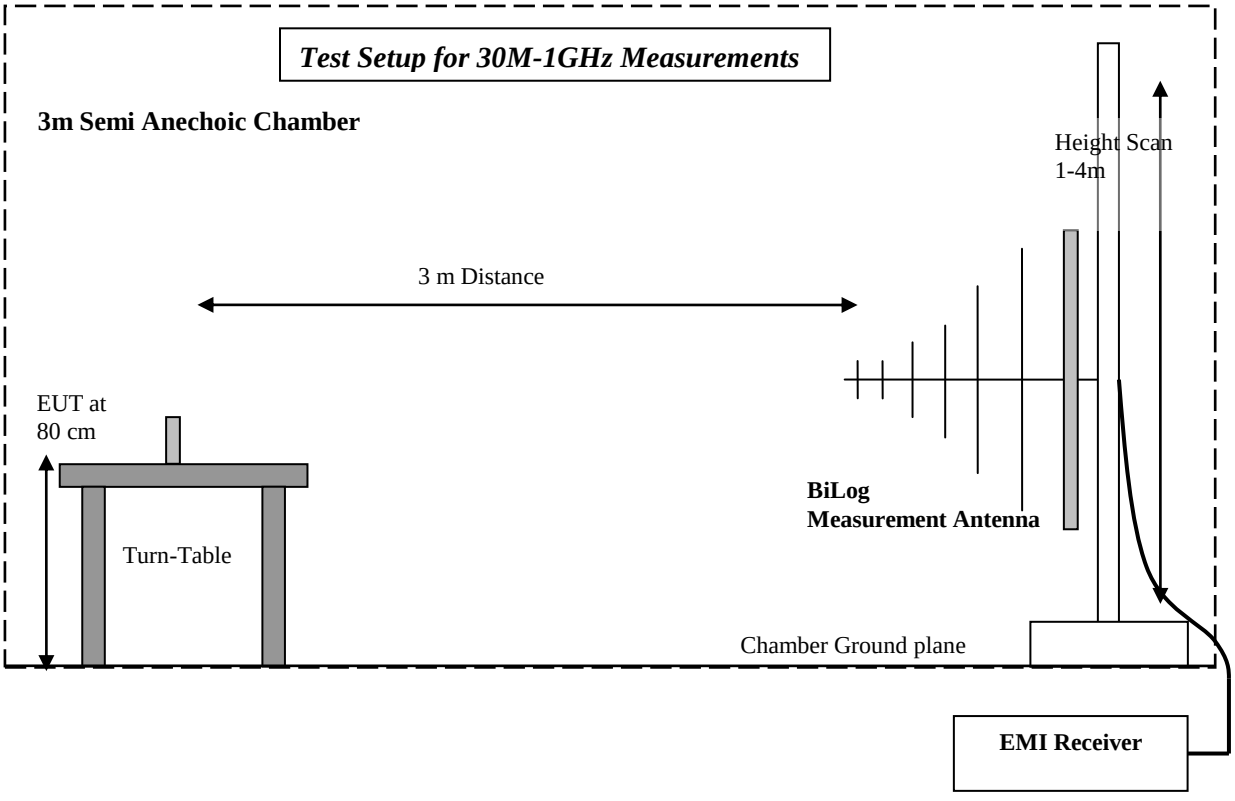
7 Test Equipment and Ancillaries used for tests

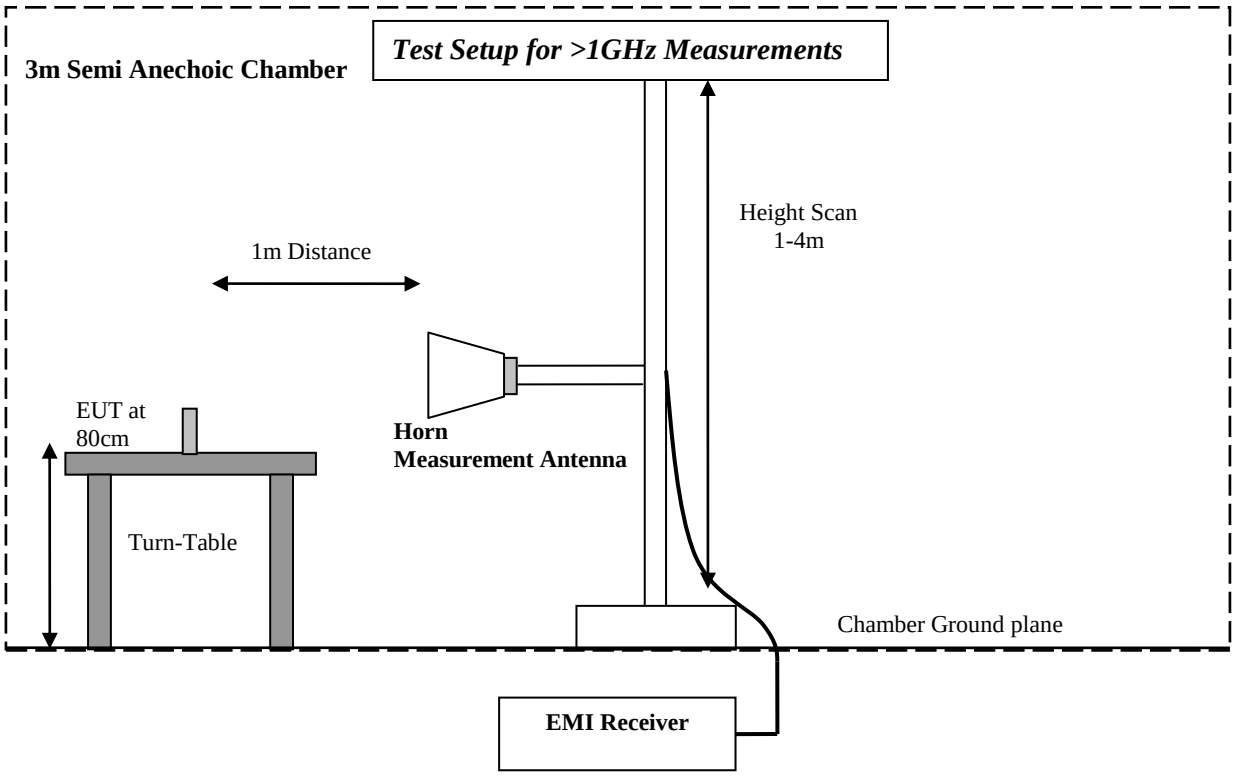
Instrument/Ancillary	Model	Manufacturer	Serial No.	Cal Date	Cal Interval
EMI Receiver/Analyzer	ESIB 40	Rohde & Schwarz	100107	May 2011	1 year
Spectrum Analyzer	FSU	Rohde & Schwarz	200302	May 2011	1 year
Loop Antenna	6512	EMCO	00049838	Oct 2011	3 years
Biconilog Antenna	3141	EMCO	0005-1186	June 2009	3 years
Horn Antenna (1-18GHz)	3115	ETS	00035111	Jan 2009	3 years
Horn Antenna (18-40GHz)	3116	ETS	00070497	Oct 2011	3 years
High Pass Filter	5HC2700	Trilithic Inc.	9926013	Part of system calibration	
High Pass Filter	4HC1600	Trilithic Inc.	9922307	Part of system calibration	
6GHz High Pass Filter	HPM50106	Microtronics	001	Part of system calibration	
Pre-Amplifier	JS4-00102600	Miteq	00616	Part of system calibration	
LISN	50-25-2-08	FCC	08014	June 2011	1 year
Power Smart Sensor	R&S	NRP-Z81	100161	May 2011	1 Year
DC Power Supply	E3610A	Hewlett Packard	KR83021224	n/a	n/a
Multimeter	MM200	Klein	N/A	Apr 2011	1 Year
Temp Hum Logger	TM320	Dickson	03280063	Feb 2011	1 Year
ASCOR Upconverter	7206	National Instruments	N/A	Dec 2010	3 year

Note: Testing on this EUT performed while the equipment calibration status was still valid.

8 BLOCK DIAGRAMS






3m Semi Anechoic Chamber
Test Setup for >1GHz Measurements
Height Scan
1-4m
1m Distance
EUT at
80cm
Horn
Measurement Antenna
Turn-Table
Chamber Ground plane
EMI Receiver

9 Revision History

Date	Report Name	Changes to report	Report prepared by
2012-02-01	EMC_ APPLE_089_11001 _UNII	First Version	Calvin Lee
2012-02-10	EMC_ APPLE_089_11001 _UNII_Rev1	Removed receiver test data from Pg. 95-98. Added calculate EIRP values- Pg.16	Calvin Lee