

Emissions Test Report

EUT Name: NEWCASTLE, NEWPORT

Model No.: FS1E5, FS1E5W, FS2E5, FS2E5W

CFR 47 Part 15.247:2009 and RSS 210:2010

Prepared for:

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Report/Issue Date: November 16, 2011
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Statement of Compliance

Manufacturer: WatchGuard Technologies
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Requester / Applicant: Denny Lim

Name of Equipment: NEWCASTLE, NEWPORT
Model No. FS1E5, FS1E5W, FS2E5, FS2E5W
Type of Equipment: Intentional Radiator
Application of Regulations: CFR 47 Part 15.247:2009 and RSS 210:2010
Test Dates: August 30 - September 26, 2011

Guidance Documents:

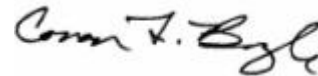
Emissions: ANSI C63.10-2009

Test Methods:

Emissions: ANSI C63.10-2009

The electromagnetic compatibility test and documented data described in this report has been performed and recorded by TUV Rheinland, in accordance with the standards and procedures listed herein. As the responsible authorized agent of the EMC laboratory, I hereby declare that the equipment described above has been shown to be compliant with the EMC requirements of the stated regulations and standards based on these results. If any special accessories and/or modifications were required for compliance, they are listed in the Executive Summary of this report.

This report must not be used to claim product endorsement by NVLAP or any agency of the U.S. Government. This report contains data that are not covered by NVLAP accreditation. This report shall not be reproduced except in full, without the written authorization of TUV Rheinland of North America.



Suresh Kondapalli November 16, 2011

Conan Boyle November 16, 2011

Test Engineer

Date

NVLAP Signatory

Date



500011-0



US5254

Industry Canada

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1 Executive Summary

1.1 Scope

This report is intended to document the status of conformance with the requirements of the CFR 47 Part 15.247:2009 and RSS 210:2010 based on the results of testing performed from August 30 to September 26, 2011 on the NEWCASTLE, NEWPORT Model FS1E5, FS1E5W, FS2E5, FS2E5W manufactured by *Watchguard Technologies, Inc.* This report only applies to the specific samples tested under the stated test conditions. It is the responsibility of the manufacturer to assure that additional production units of this model are manufactured with identical or EMI equivalent electrical and mechanical components. This report is further intended to document changes and modifications to the EUT throughout its life cycle. All documentation will be included as a supplement.

1.2 Purpose

Testing was performed to evaluate the EMC performance of the EUT in accordance with the applicable requirements, procedures, and criteria defined in the application of regulations and application of standards listed in this report.

1.3 Summary of Test Results

Table 1: Summary of Test Results

Test	Test Method ANSI C63.4	Test Parameters (from Standard)	Result
2400 MHz to 2483.5MHz Band			
Spurious Emission in Received Mode	CFR47 15.109, RSS-GEN Sect.7.2.3	Class A	Complied
Spurious Emission in Transmitted Mode	CFR47 15.209, RSS-GEN Sect.7.2.3	Class B	Complied
Restricted Bands of Operation	CFR47 15.205, RSS 210 Sect.2.6	Class B	Complied
AC Power Conducted Emission	CFR47 15.207, RSS-GEN Sect.7.2.2	Class B	Complied
Occupied Bandwidth	CFR47 15.247 (a2), RSS GEN Sect.4.4.1	≥ 500 kHz	Complied
Maximum Transmitted Power	CFR47 15.247 (b3), RSS 210 Sect. A.8.4	30 dBm	Complied
Peak Power Spectral Density	CFR47 15.247 (e), RSS 210 Sect. A.8.2	8 dBm/ 3 kHz.	Complied
Bandedge Measurement	CFR47 15.247 (d), RSS 210 Sect. A.8.5	20 dBr	Complied
5725MHz to 5850 MHz Band			
Spurious Emission in Received Mode	CFR47 15.109, RSS-GEN Sect.7.2.3	Class A	Complied
Spurious Emission in Transmitted Mode	CFR47 15.209, RSS-GEN Sect.7.2.3	Class B	Complied
Restricted Bands of Operation	CFR47 15.205, RSS 210 Sect.2.6	Class B	Complied
AC Power Conducted Emission	CFR47 15.207, RSS-GEN Sect.7.2.2	Class B	Complied
Occupied Bandwidth	CFR47 15.247 (a2), RSS GEN Sect.4.4.1	≥ 500 kHz	Complied
Maximum Transmitted Power	CFR47 15.247 (b3), RSS 210 Sect. A.8.4	30 dBm	Complied
Peak Power Spectral Density	CFR47 15.247 (e), RSS 210 Sect. A.8.2	8 dBm/ 3 kHz.	Complied
Bandedge Measurement	CFR47 15.247 (d), RSS 210 Sect. A.8.5	20 dBr	Complied

Note: Since EUT is portable device where the end user will have the direct contact, RF Exposure/ SAR testing is required. This test completed separately.

1.4 Special Accessories

No special accessories were necessary in order to achieve compliance.

1.5 Equipment Modifications

None

2 Laboratory Information

2.1 Accreditations & Endorsements

2.1.1 US Federal Communications Commission



TUV Rheinland of North America at 1279 Quarry Ln, Pleasanton, CA 94566 is recognized by the commission for performing testing services for the general public on a fee basis. These laboratory test facilities have been fully described in reports submitted to and accepted by the FCC (US5254). The laboratory scope of accreditation includes: Title 47 CFR Parts 15, 18, and 90. The accreditation is updated every 3 years.

2.1.2 NIST / NVLAP



TUV Rheinland of North America is accredited by the National Voluntary Laboratory Accreditation Program, which is administered under the auspices of the National Institute of Standards and Technology. The laboratory has been assessed and accredited in accordance with ISO Guide 17025:2005 and ISO 9002 (Lab Code 500011-0). The scope of laboratory accreditation includes emission and immunity testing. The accreditation is updated annually.

2.1.3 Canada – Industry Canada



TUV Rheinland of North America at the 1279 Quarry Ln, Pleasanton, CA 94566 address is accredited by Industry Canada for performing testing services for the general public on a fee basis. This laboratory test facilities have been fully described in reports submitted to and accepted by Industry Canada (File Number 2932M-1). This reference number is the indication to the Industry Canada Certification Officers that the site meets the requirements of RSS 212, Issue 1 (Provisional). The accreditation is updated every 3 years.

2.1.4 Japan – VCCI



The Voluntary Control Council for Interference by Information Technology Equipment (VCCI) is a group that consists of Information Technology Equipment (ITE) manufacturers and EMC test laboratories. The purpose of the Council is to take voluntary control measures against electromagnetic interference from Information Technology Equipment, and thereby contribute to the development of a socially beneficial and responsible state of affairs in the realm of Information Technology Equipment in Japan. TUV Rheinland of North America at 1279 Quarry Ln, Pleasanton, CA 94566 has been assessed and approved in accordance with the Regulations for Voluntary Control Measures. (Registration Nos. R-3715, G-460, C-4161 and T-1189

).

2.1.5 Acceptance by Mutual Recognition Arrangement



The United States has an established agreement with specific countries under the Asia Pacific Laboratory Accreditation Corporation (APLAC) Mutual Recognition Arrangement. Under this agreement, all TUV Rheinland at 1279 Quarry Ln, Pleasanton, CA 94566 test results and test reports within the scope of the laboratory NIST / NVLAP accreditation will be accepted by each member country.

2.2 Test Facilities

All of the test facilities are located at 1279 Quarry Lane, Pleasanton, California 94566, USA. The 2305 Mission College, Santa Clara, 95054, USA location is considered a Pleasanton annex.

2.2.1 Emission Test Facility

The Semi-Anechoic chamber and AC Line Conducted measurement facility used to collect the radiated and conducted data has been constructed in accordance with ANSI C63.7:1992. The site has been measured in accordance with and verified to comply with the theoretical normalized site attenuation requirements of ANSI C63.4-2009, at a test distance of 3 and 5 meters. The site is listed with the FCC and accredited by NVLAP (Lab Code 500011-0). The 3/5-meter semi-anechoic chamber used to collect the radiated data has been verified to comply with the theoretical normalized site attenuation requirements of ANSI C63.4-2009, at a test distance of 3 meter and 5 meters. A report detailing this site can be obtained from TUV Rheinland of North America.

2.2.2 Immunity Test Facility

ESD, EFT, Surge, PQF: These tests are performed in an environmentally controlled room with a 3.7 m x 4.8 m x 3.175 mm thick aluminum floor connected to PE ground.

For ESD testing, tabletop equipment is placed on an insulated mat with a surface resistivity of 10^9 Ohms/square on a 1.6 m x 0.8 m x 0.8 m high non-conductive table with a 3.175 mm aluminum top (Horizontal Coupling Plane). The HCP is connected to the main ground plane via a low impedance ground strap through two 470-k Ω resistors. The Vertical Coupling Plane consists of an aluminum plate 50 cm x 50 cm x 3.175 mm thick. The VCP is connected to the main ground plane via a low impedance ground strap through two 470-k Ω resistors.

For EFT, Surge, PQF, the HCP and VCP are removed.

RF Field Immunity testing is performed in a 7.3m x 4.3m x 4.1m anechoic chamber.

RF Conducted and Magnetic Field Immunity testing is performed on a 4.8m x 3.7m x 3.175mm thick aluminum ground plane.

All test areas allow a minimum distance of 1 meter from the EUT to walls or conducting objects.

2.3 Measurement Uncertainty

Two types of measurement uncertainty are expressed in this report, per *ISO Guide To The Expression Of Uncertainty In Measurement*, 1st Edition, 1995.

The Combined Standard Uncertainty is the standard uncertainty of the result of a measurement when that result is obtained from the values of a number of other quantities; it is equal to the positive square root of the sum of the variances or co-variances of these other quantities, weighted according to how the measurement result varies with changes in these quantities. The term *standard uncertainty* is the result of a measurement expressed as a standard deviation.

2.3.1 Sample Calculation – radiated & conducted emissions

The field strength is calculated by subtracting the Amplifier Gain and adding the Cable Loss and Antenna Correction Factor to the measured reading. The basic equation is as follows:

$$\text{Field Strength (dB}\mu\text{V/m)} = \text{RAW} - \text{AMP} + \text{CBL} + \text{ACF}$$

Where: RAW = Measured level before correction (dB μ V)

AMP = Amplifier Gain (dB)

CBL = Cable Loss (dB)

ACF = Antenna Correction Factor (dB/m)

$$\mu\text{V/m} = 10^{\frac{\text{dB}\mu\text{V/m}}{20}}$$

Sample radiated emissions calculation @ 30 MHz

Measurement +Antenna Factor–Amplifier Gain+Cable loss=Radiated Emissions (dBuV/m)

$$25 \text{ dBuV/m} + 17.5 \text{ dB} - 20 \text{ dB} + 1.0 \text{ dB} = 23.5 \text{ dBuV/m}$$

2.3.2 Measurement Uncertainty

	U_{lab}	U_{cispr}
Radiated Disturbance		
30 MHz – 40,000 MHz	3.2 dB	5.2 dB
Conducted Disturbance @ Mains Terminals		
150 kHz – 30 MHz	2.4 dB	3.6 dB
Disturbance Power		
30 MHz – 300 MHz	3.92 dB	4.5 dB

Measurement Uncertainty – Immunity Testing

The estimated combined standard uncertainty for ESD immunity measurements is $\pm 4.1\%$.
The estimated combined standard uncertainty for radiated immunity measurements is ± 2.7 dB.
The estimated combined standard uncertainty for conducted immunity measurements is ± 1.4 dB.
The estimated combined standard uncertainty for damped oscillatory wave immunity measurements is $\pm 8.8\%$.
The estimated combined standard uncertainty for harmonic current and flicker measurements is $\pm 0.45\%$.

Measurement Uncertainty – Radio Testing

The estimated combined standard uncertainty for frequency error measurements is ± 3.88 Hz
The estimated combined standard uncertainty for carrier power measurements is ± 1.59 dB.
The estimated combined standard uncertainty for adjacent channel power measurements is ± 1.47 dB.
The estimated combined standard uncertainty for modulation frequency response measurements is ± 0.46 dB.
The estimated combined standard uncertainty for transmitter conducted emission measurements is ± 4.01 dB

The expanded uncertainty at a level of 95% confidence is obtained by multiplying the combined standard uncertainty by a coverage factor of 2. Compliance criteria are not based on measurement uncertainty.

2.4 Calibration Traceability

All measurement instrumentation is traceable to the National Institute of Standards and Technology (NIST). Measurement method complies with ANSI/NCSS Z540-1-1994 and ISO Standard 17025:2005. Equipment calibration records are kept on file at the test facility.

3 Product Information

3.1 Product Description

The WatchGuard XTM 2 series Newport/ Newcastle is network security device with Firewall Access Point (AP) provides 10/100/1000Mb wired and 802.11n wireless network.

3.2 Equipment Configuration

A description of the equipment configuration is given in the Test Plan Section. The EUT was tested as called for in the test standard and was configured and operated in a manner consistent with its intended use. The EUT was connected to rated power and allowed to reach intended operating conditions. The placement of the EUT system components was guided by the test standard and selected to represent typical installation conditions.

In the case of EUT that can operate in more than one configuration, preliminary testing was performed to determine the configuration that produced maximum radiation.

The final configuration was selected to produce the worst case radiation for emissions testing and to place the EUT in the most susceptible state for immunity testing.

3.3 Operating Mode

A description of the operation mode is given in the Test Plan Section. In the case of an EUT that can operate in more than one state, preliminary testing was performed to determine the operating mode that produced maximum radiation.

The final operating mode was selected to produce the worst case radiation for emissions testing and to place the EUT in the most susceptible state for immunity testing.

3.4 Unique Antenna Connector

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this Section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of CFR47 Parts 15.211, 15.213, 15.217, 15.219, or 15.221.

3.4.1 Results

The NEWCASTLE, NEWPORT has 3 External antennas; all antennas use reverse polarity SMA connector.

4 Emission Requirements – 2400 MHz to 2483.5 MHz Band

Testing was performed in accordance with CFR 47 Part 15.247: 2009 and RSS 210 Annex 8: 2010. These test methods are listed under the laboratory's NVLAP Scope of Accreditation. This test measures the levels emanating from the EUT, thus evaluating the potential for the EUT to cause radio frequency interference to other electronic devices. Procedures described in section 8 of the standard were used.

4.1 Output Power Requirements

The maximum output power requirement is the maximum equivalent isotropic radiated power delivering at the transmitting antenna under specified conditions of measurements in the presence of modulation.

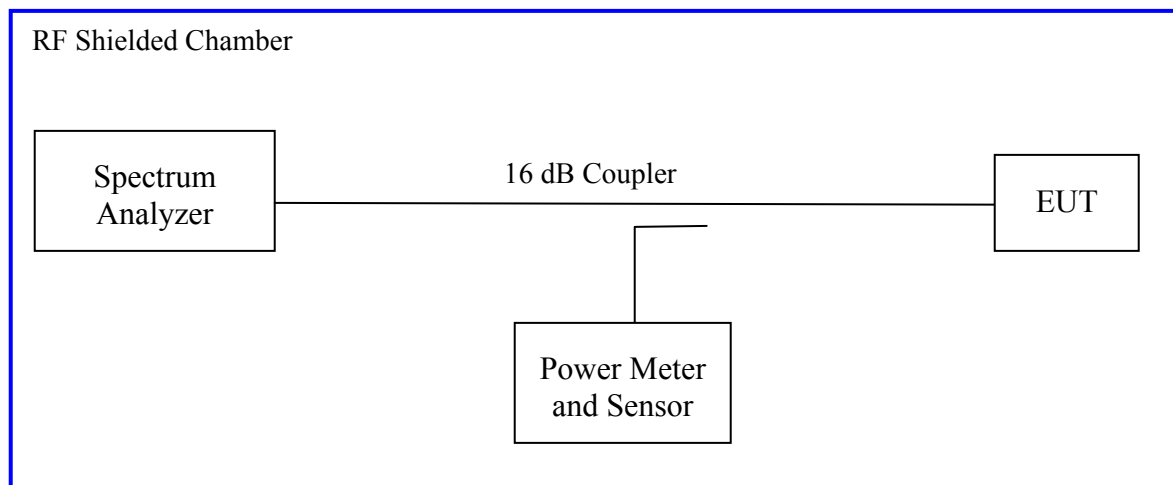
The maximum output power and harmonics shall not exceed CFR47 Part 15.247 (b3):2009 and RSS 210 A.8.4: 2010

The maximum transmitted power is +30 dBm or 1 Watt.

4.1.1 Test Method

The conducted method was used to measure the channel power output according to ANSI C63.10:2009 Section 6.10.3.1. The measurement was performed with modulation per CFR47 Part 15.247 (b3):2009 and RSS 210 A.8.4. This test was conducted on 3 channels in each operating range. The worst mode result indicated below.

Test Setup:



Method #1 of "Measurement of Digital Transmission Systems Operating under Section 15.247" applies since the EUT continuously transmit; where T, Transmission Duration Pulse, is greater than analyzer sweep time. Peak detector was used.

Each chain was measured individually and applied the measure-and-sum approach per KDB662911.

4.1.2 Results

As originally tested, the EUT was found to be compliant to the requirements of the test standard(s).

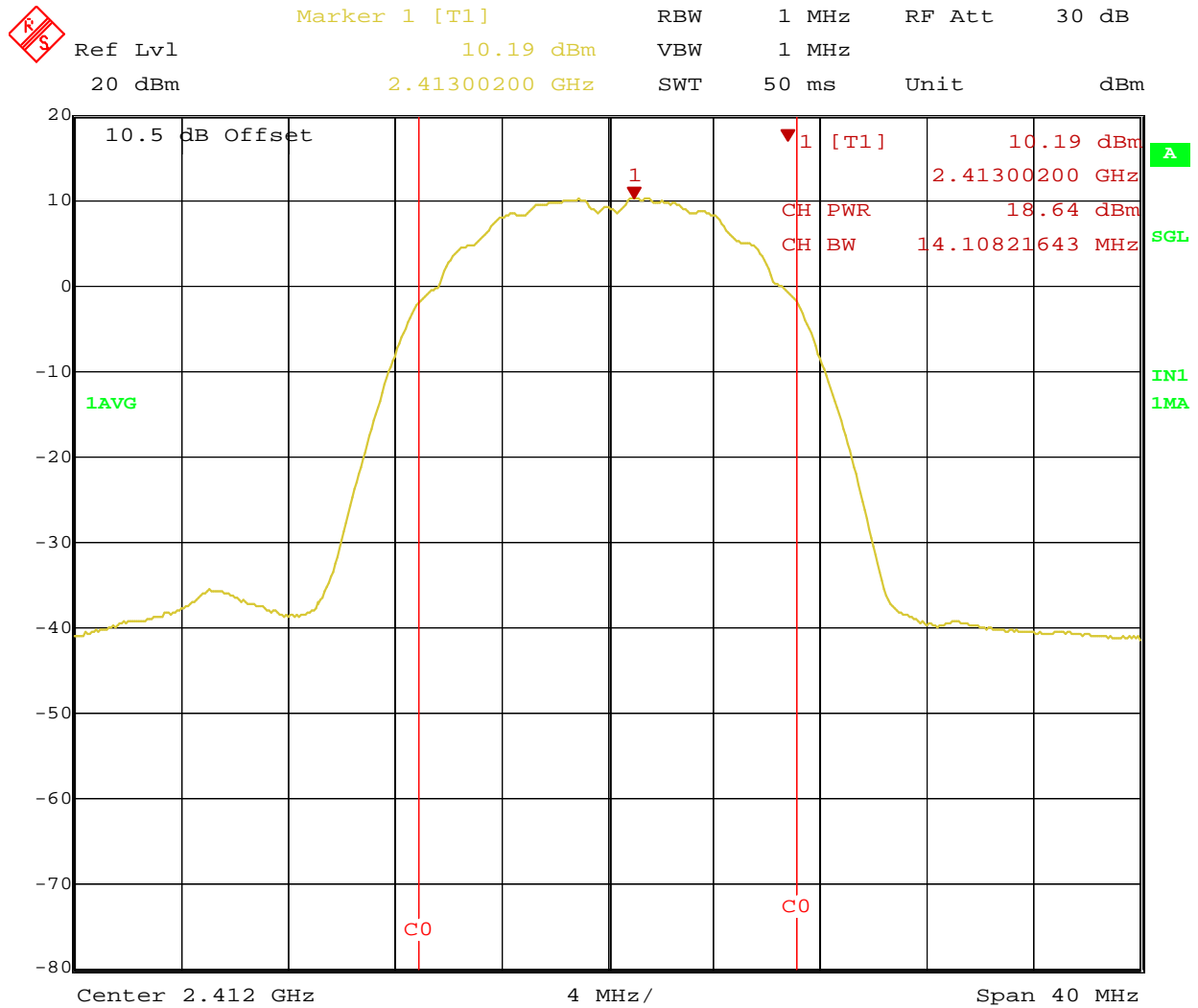
Table 2: RF Output Power at the Antenna Port – Test Results

Test Conditions: Conducted Measurement, Normal Temperature						
Antenna Type: 3 External				Power Setting: See test plan		
Max. Antenna Gain: + 2.0dBi				Signal State: Modulated @ 99%		
Ambient Temp.: 21 °C				Relative Humidity: 39%		
802.11b Mode						
Operating Channel	Limit [dBm]	Chain 0 [dBm]	Chain 1 [dBm]	Chain 2 [dBm]	Total Power [dBm]	Margin [dB]
2412MHz	+30.00	+18.41	+18.35	+18.38		-11.59
2437MHz	+30.00	+18.64	+19.37	+18.37		-10.63
2462MHz	+30.00	+19.10	+18.35	+17.96		-10.90
Note: The highest output power was observed at 1Mbps. Only one chain would be active in this mode.						
802.11g Mode						
Operating Channel	Limit [dBm]	Chain 0 [dBm]	Chain 1 [dBm]	Chain 2 [dBm]	Total Power [dBm]	Margin [dB]
2412MHz	+30.00	+21.73	+22.40	+21.59		-7.60
2437MHz	+30.00	+21.96	+21.96	+21.71		-8.04
2462MHz	+30.00	+22.17	+22.17	+21.33		-7.83
Note: The highest output power was observed at 6 Mbps. Only one chain would be active in this mode.						
802.11n (HT20) Mode, 1x3						
Operating Channel	Limit [dBm]	Chain 0 [dBm]	Chain 1 [dBm]	Chain 2 [dBm]	Total Power [dBm]	Margin [dB]
2412MHz	+30.00	15.43	15.98	15.16		-14.02
2437MHz	+30.00	15.16	15.54	15.05		-14.46
2462MHz	+30.00	15.75	15.52	15.09		-14.25
Note: The highest output power was observed at HT20 6.5 Mbps, 1 Data Stream. Only one chain would be active in this mode.						
802.11n (HT20) Mode, 2x3						

Operating Channel	Limit [dBm]	Chain 0 [dBm]	Chain 1 [dBm]	Chain 2 [dBm]	Total Power [dBm]	Margin [dB]
2412MHz	+30.00	15.17	16.03		19.49	-10.51
2437MHz	+30.00	15.16	15.70		19.38	-10.62
2462MHz	+30.00	15.75	15.84		19.10	-10.90
Note: The highest output power was observed at HT20 13 Mbps, 2 Data Streams.						
802.11n (HT20) Mode, 3x3						
Operating Channel	Limit [dBm]	Chain 0 [dBm]	Chain 1 [dBm]	Chain 2 [dBm]	Total Power [dBm]	Margin [dB]
2412MHz	+30.00	14.22	14.63	14.15	19.10	-10.90
2437MHz	+30.00	13.99	14.07	13.69	18.74	-11.26
2462MHz	+30.00	14.49	14.04	14.03	18.97	-11.03
Note: The highest output power was observed at HT20 19.5 Mbps, 3 Data Streams.						
802.11n (HT40) Mode, 1x3						
Operating Channel	Limit [dBm]	Chain 0 [dBm]	Chain 1 [dBm]	Chain 2 [dBm]	Total Power [dBm]	Margin [dB]
2422MHz	+30.00	14.02	14.59	13.51		-15.41
2437MHz	+30.00	13.94	14.18	13.74		-15.82
2452MHz	+30.00	13.98	14.11	13.59		-15.89
Note: The highest output power was observed at HT40 13.5 Mbps, 1 Data Stream.						
802.11n (HT40) Mode, 2x3						
Operating Channel	Limit [dBm]	Chain 0 [dBm]	Chain 1 [dBm]	Chain 2 [dBm]	Total Power [dBm]	Margin [dB]
2422MHz	+30.00	12.39	13.05		16.82	-13.18
2437MHz	+30.00	12.26	12.57		15.42	-14.58
2452MHz	+30.00	12.64	12.20		15.34	-14.66
Note: The highest output power was observed at HT40 27 Mbps, 2 Data Streams.						
802.11n (HT40) Mode, 3x3						
Operating Channel	Limit [dBm]	Chain 0 [dBm]	Chain 1 [dBm]	Chain 2 [dBm]	Total Power [dBm]	Margin [dB]
2422MHz	+30.00	9.62	9.73	9.97	14.69	-15.31
2437MHz	+30.00	9.68	9.51	9.22	14.24	-15.76

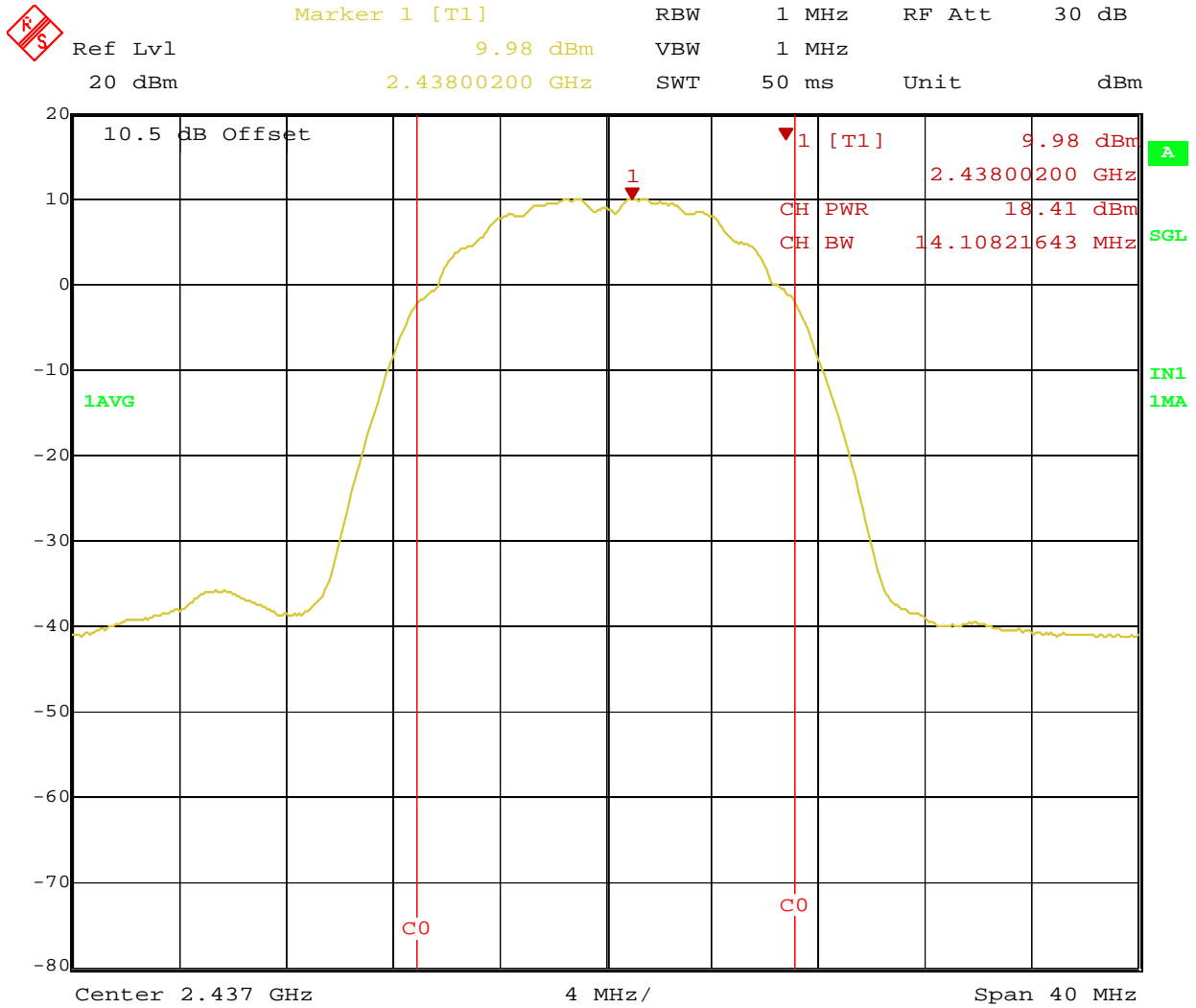
2452MHz	+30.00	9.93	9.39	9.78	14.47	-15.53
Note: The highest peak output power was observed at HT40 40.5 Mbps, 3 Data Stream.						

Note: Power measurements were performed as indicated in the above table. Only worst case/ limited number of plots are placed in the report.



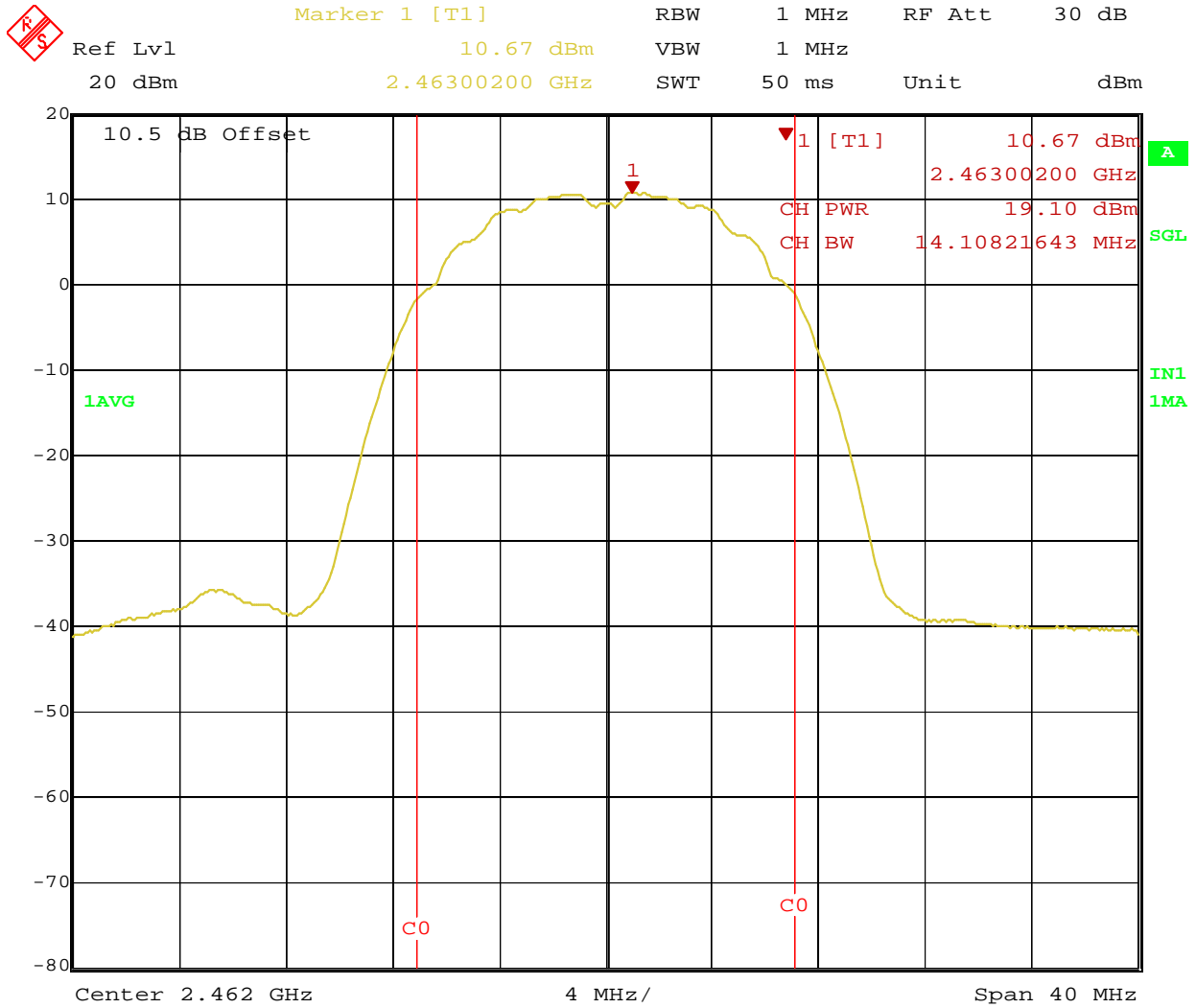
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Figure 1: Maximum Transmitted Power, 2412 MHz at 802.11b, Chain 0 – 1Mbps



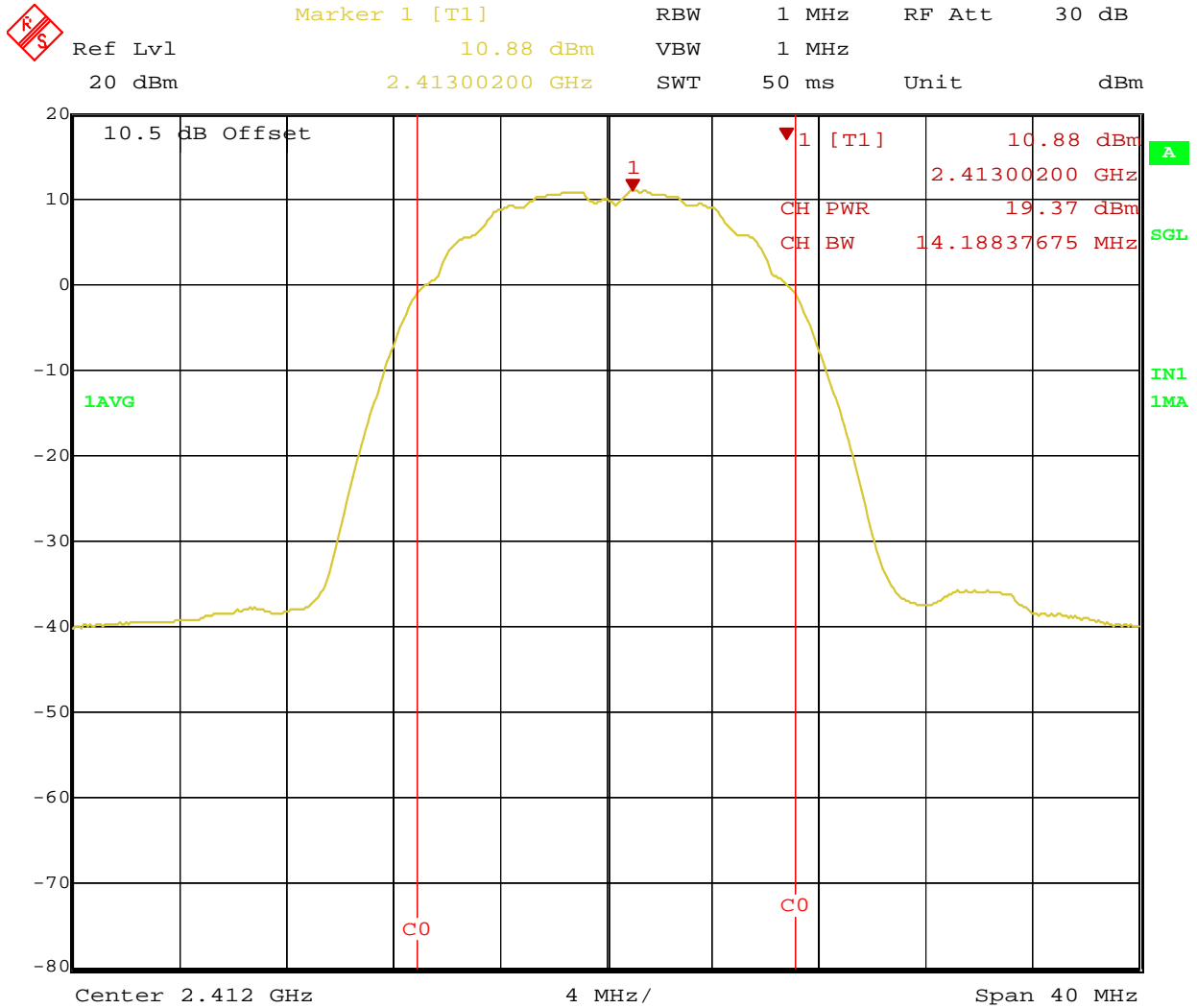
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Figure 2: Maximum Transmitted Power, 2437 MHz at 802.11b, Chain 0 – 1Mbps



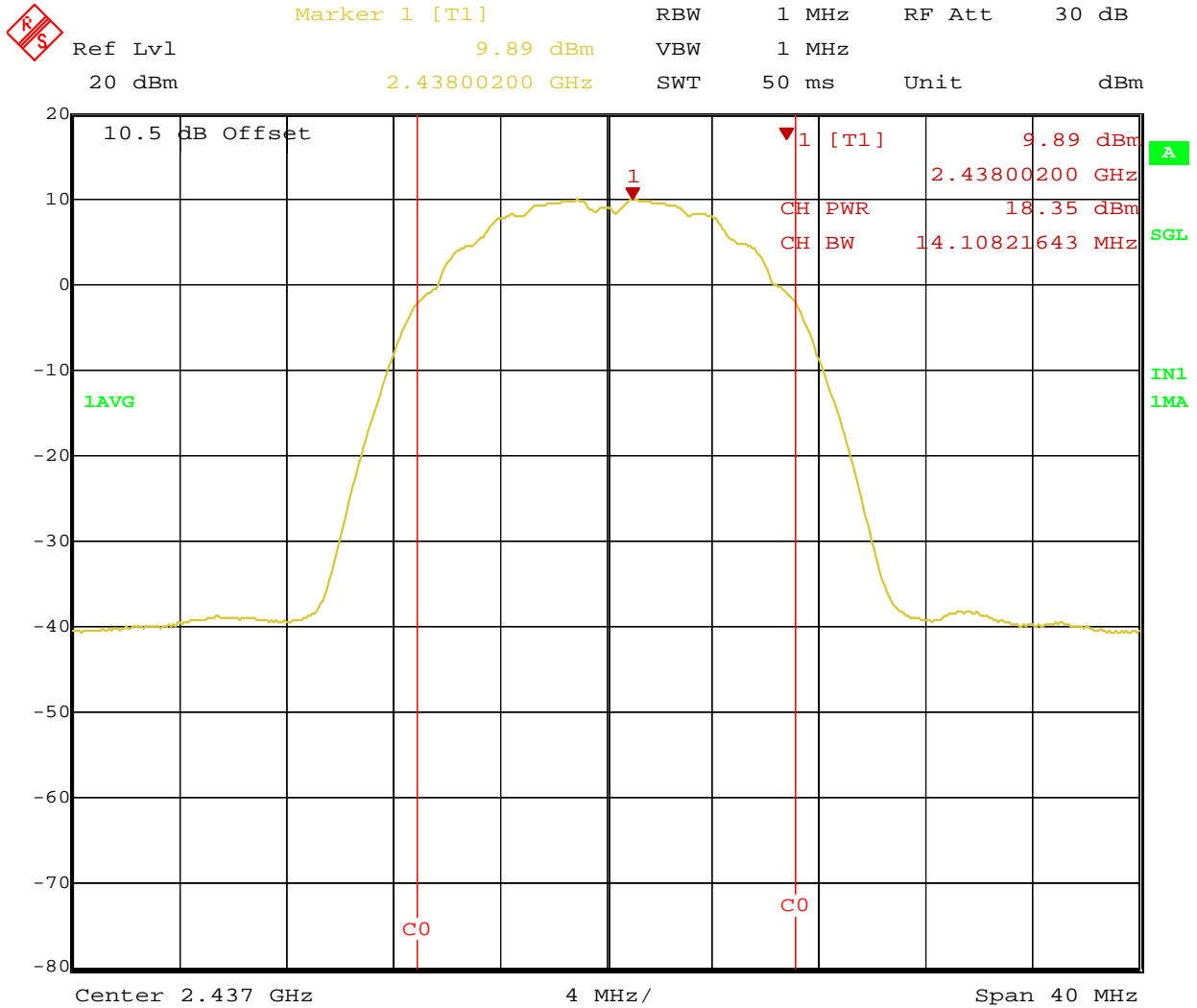
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Figure 3: Maximum Transmitted Power, 2462 MHz at 802.11b, Chain 0 – 1Mbps



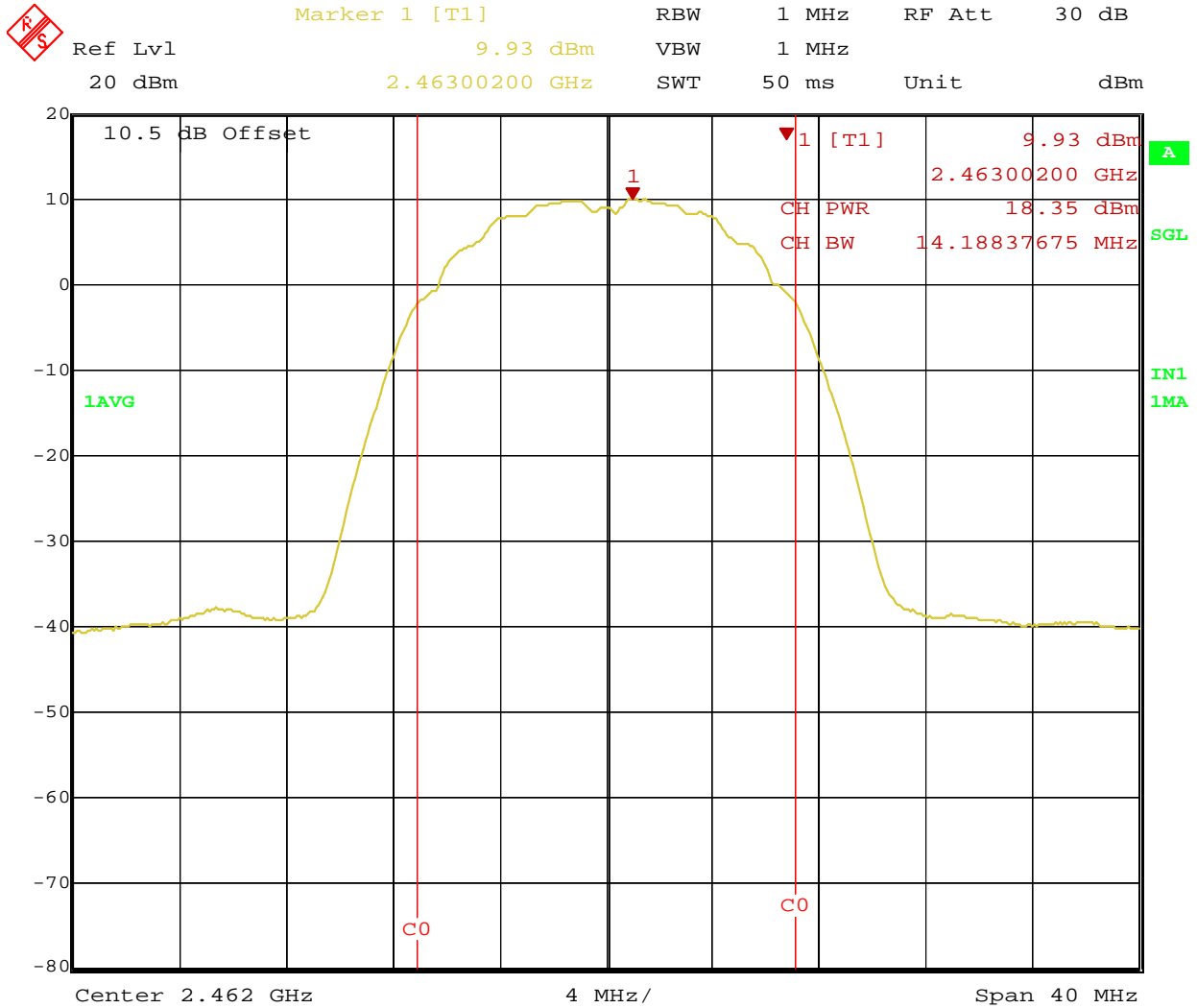
Date: 9.SEP.2011 12:04:20

Figure 4: Maximum Transmitted Power, 2412 MHz at 802.11b, Chain 1 – 1Mbps



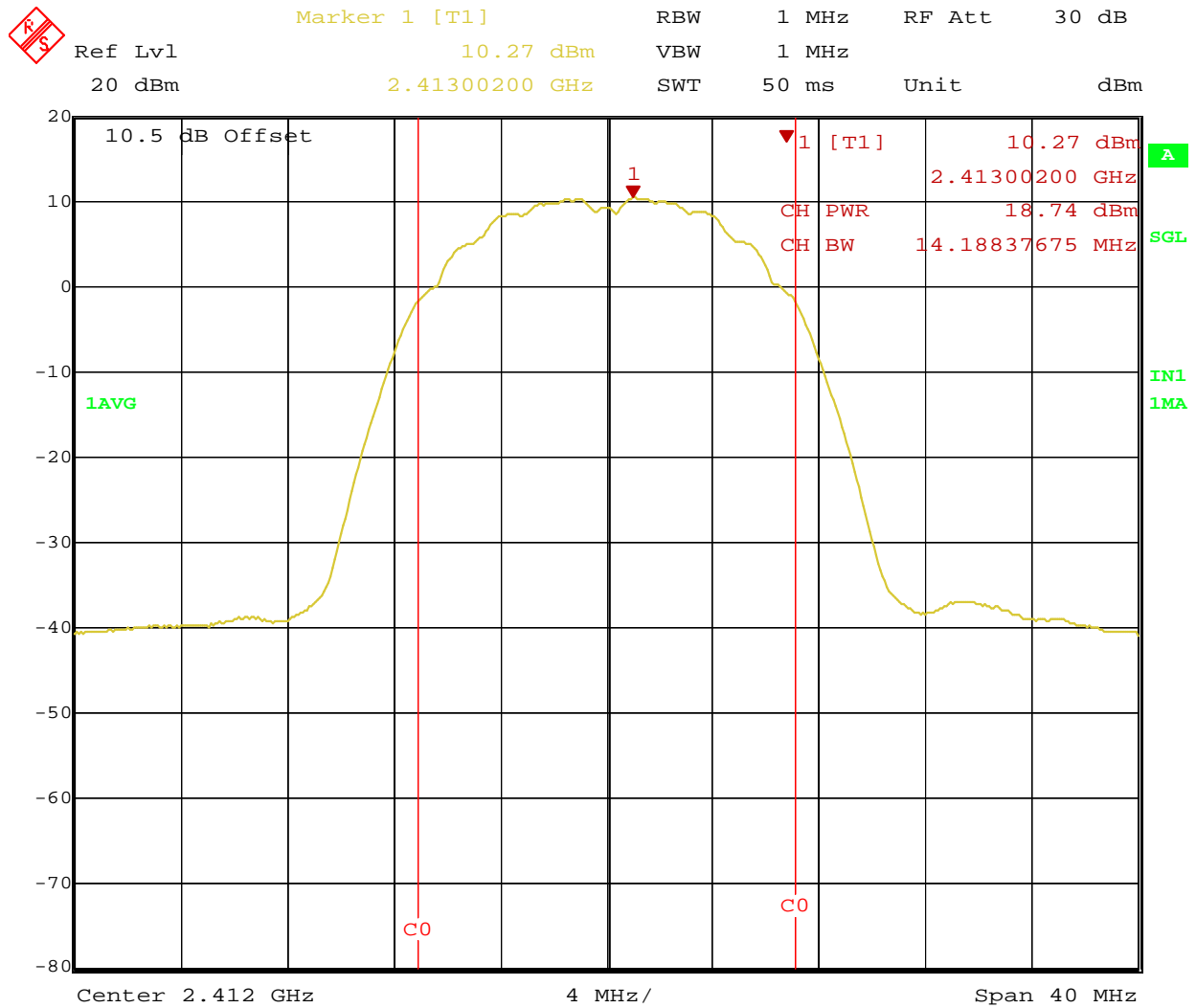
Date: 9.SEP.2011 13:03:52

Figure 5: Maximum Transmitted Power, 2437 MHz at 802.11b, Chain 1 – 1Mbps



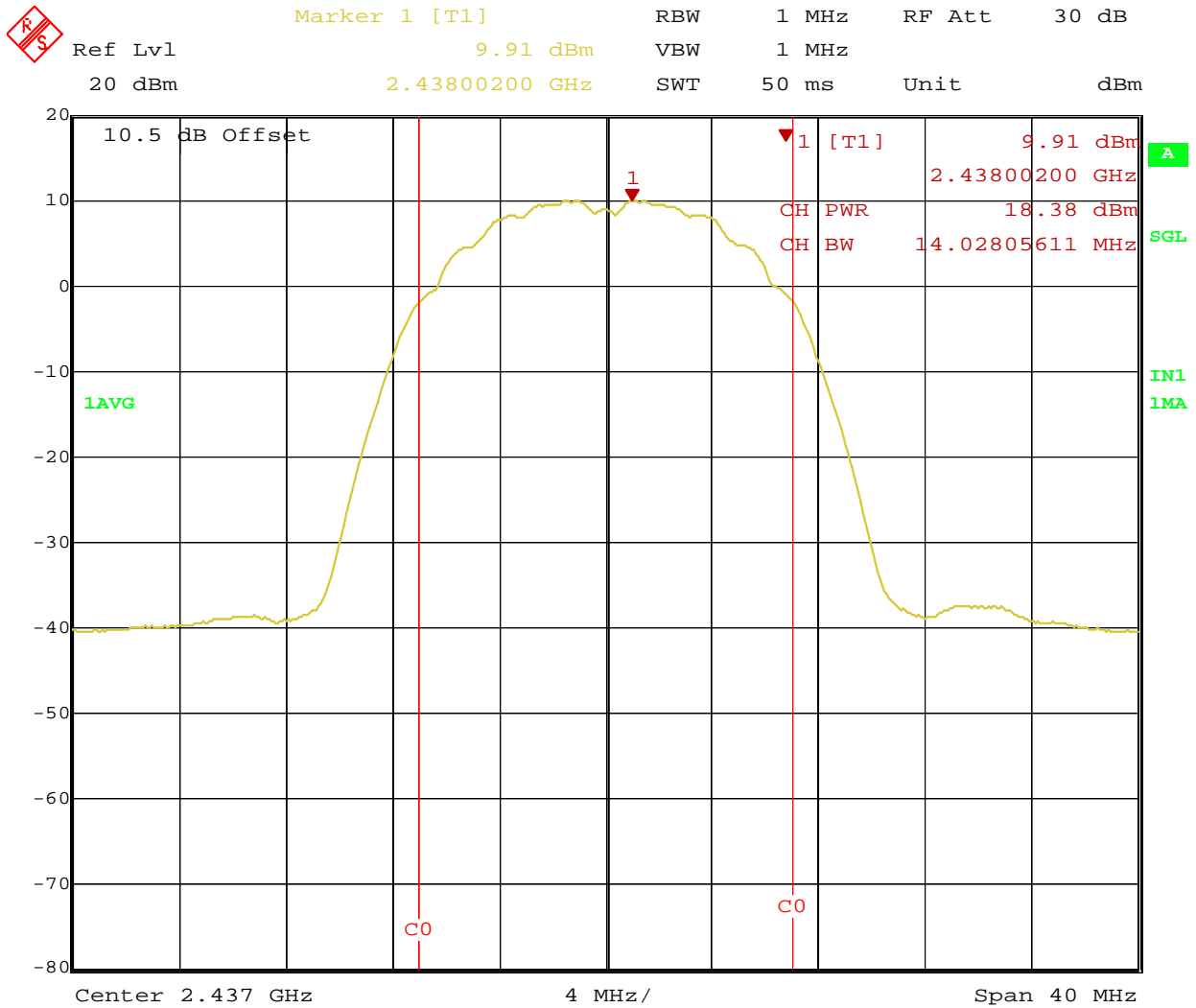
Date: 9.SEP.2011 13:16:56

Figure 6: Maximum Transmitted Power, 2462 MHz at 802.11b, Chain 1 – 1Mbps



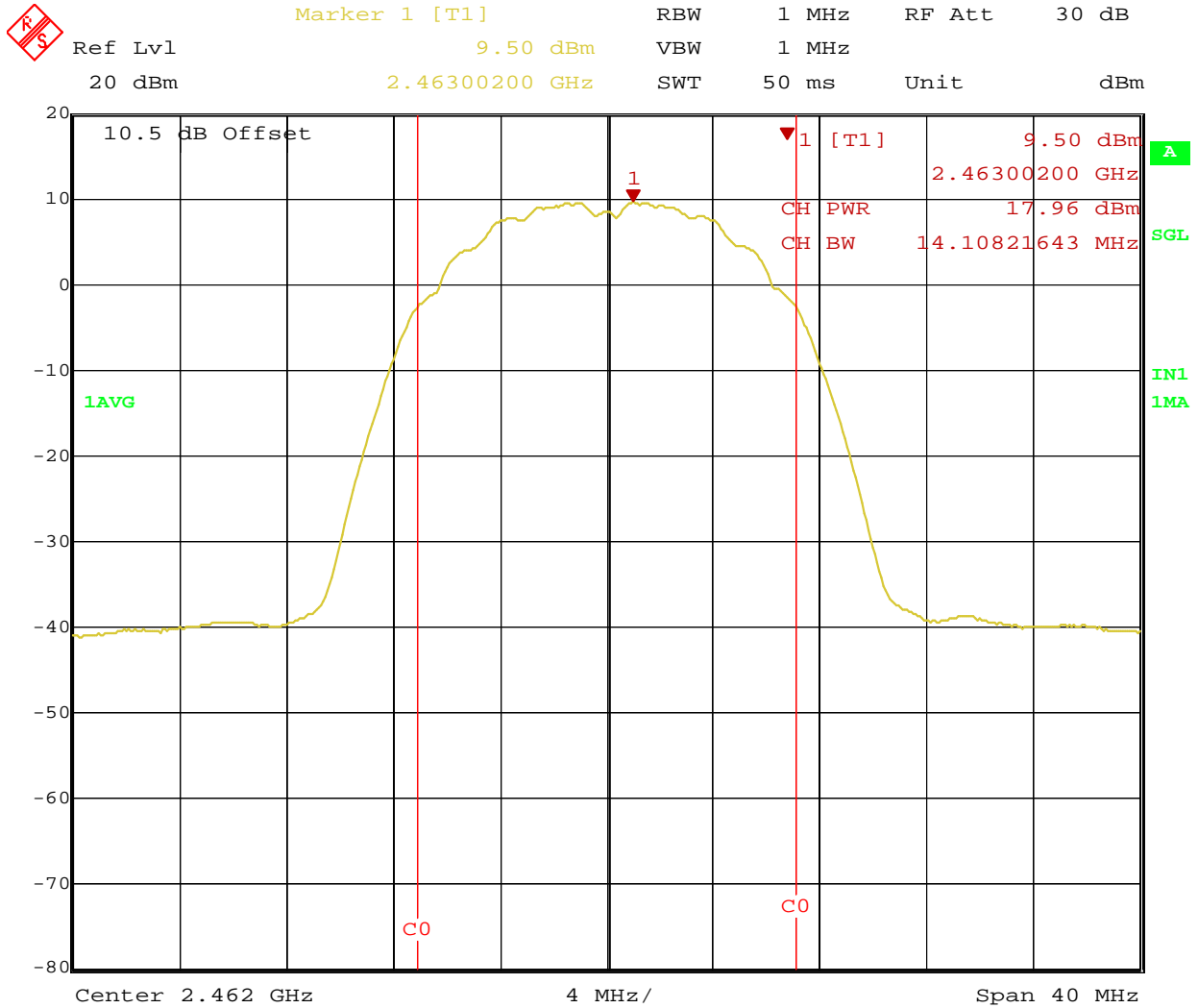
Date: 9.SEP.2011 13:40:15

Figure 7: Maximum Transmitted Power, 2412 MHz at 802.11b, Chain 2 – 1Mbps



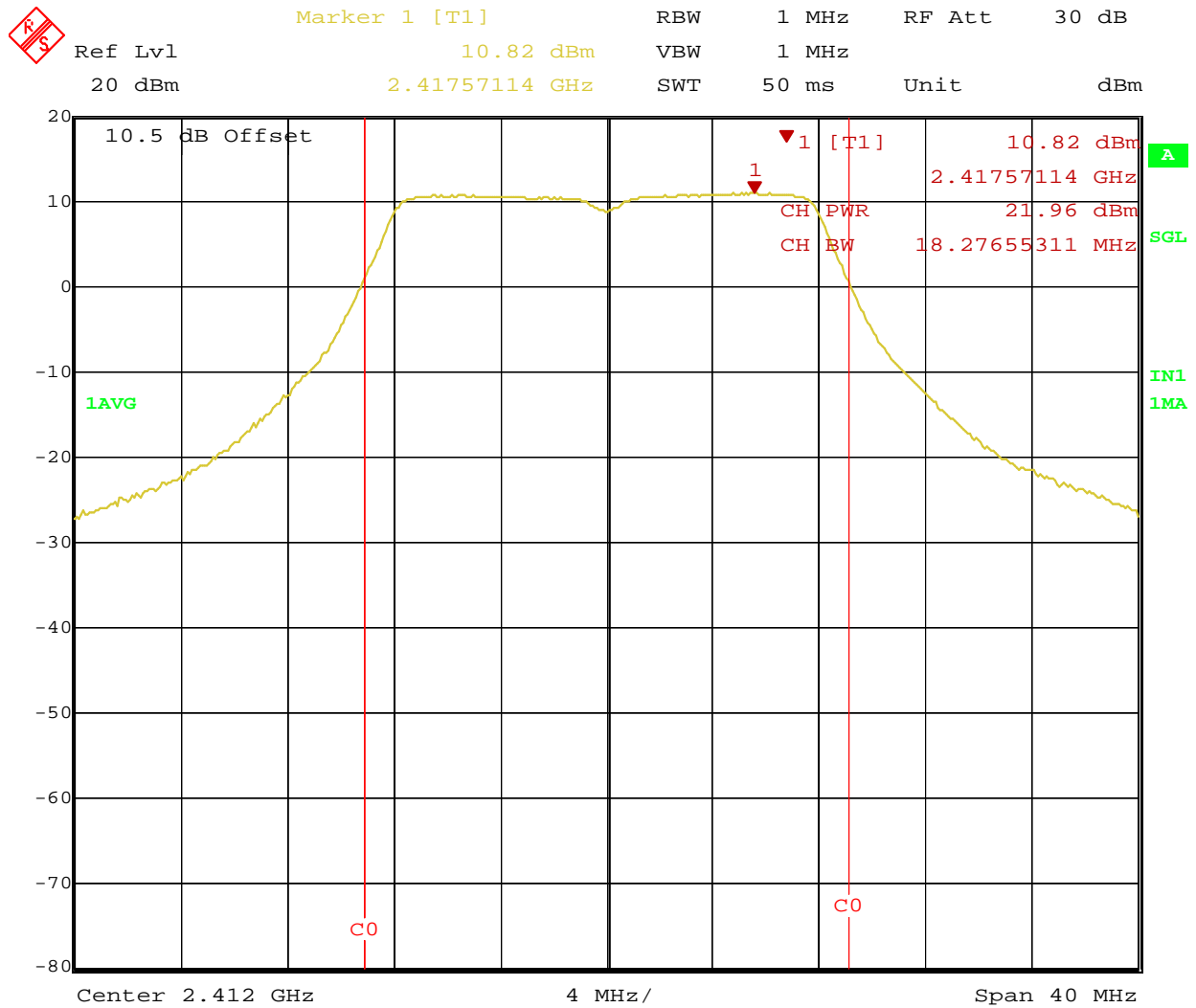
Date: 9.SEP.2011 13:58:43

Figure 8: Maximum Transmitted Power, 2437 MHz at 802.11b, Chain 2 – 1Mbps



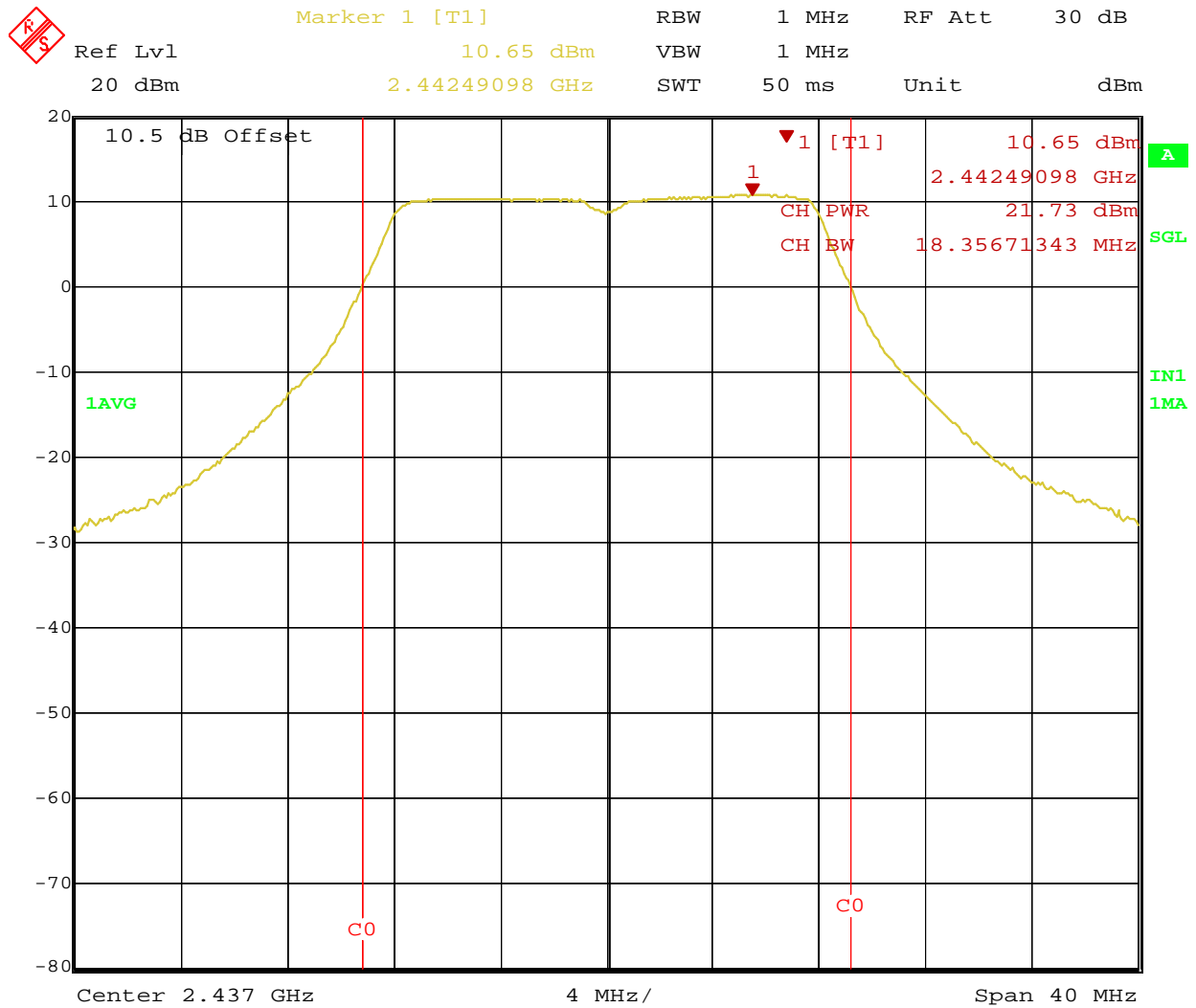
Date: 9.SEP.2011 13:28:07

Figure 9: Maximum Transmitted Power, 2462 MHz at 802.11b, Chain 2 – 1Mbps



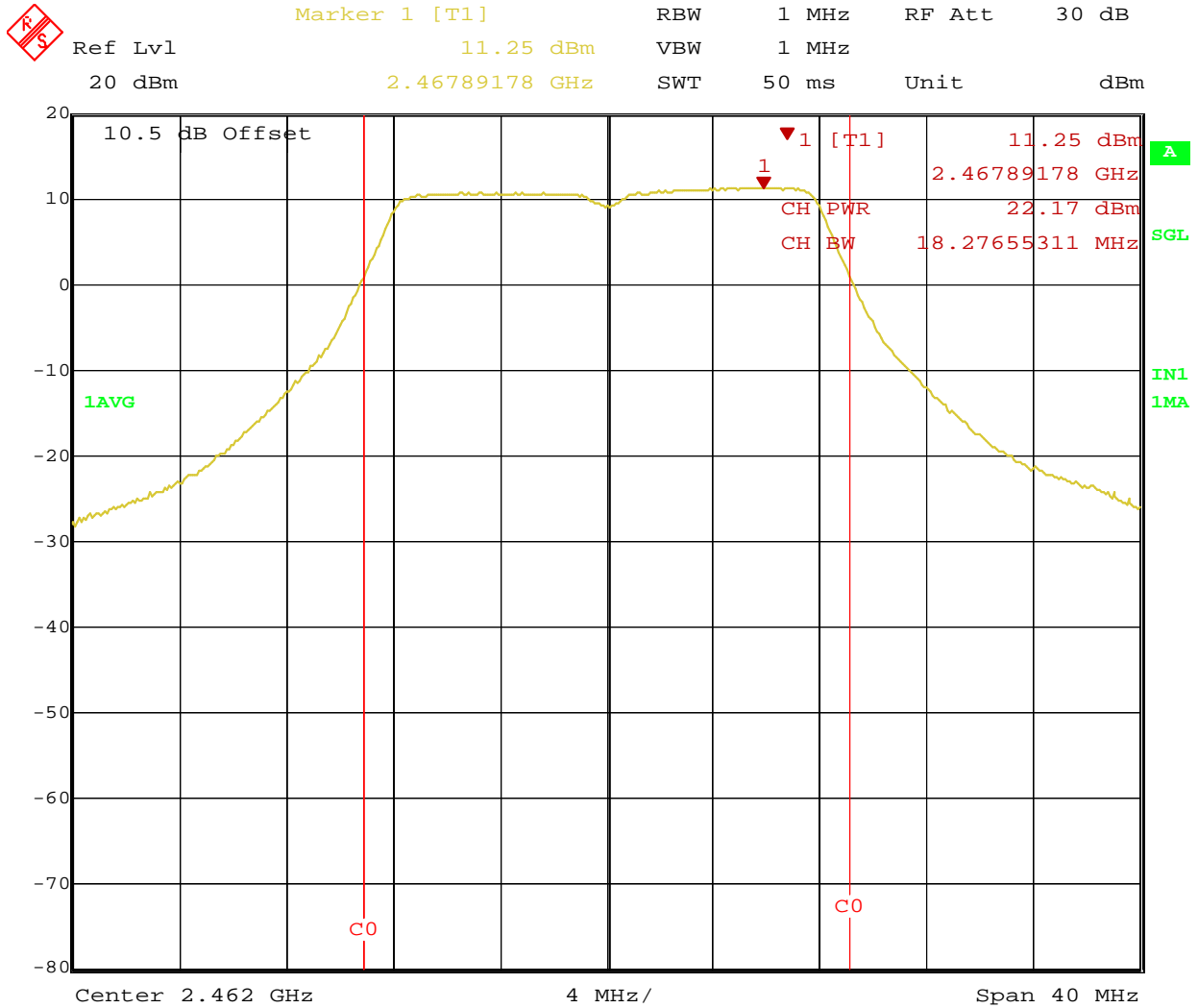
Date: 9.SEP.2011 15:47:01

Figure 10: Maximum Transmitted Power, 2412 MHz at 802.11g, Chain 0 – 6Mbps



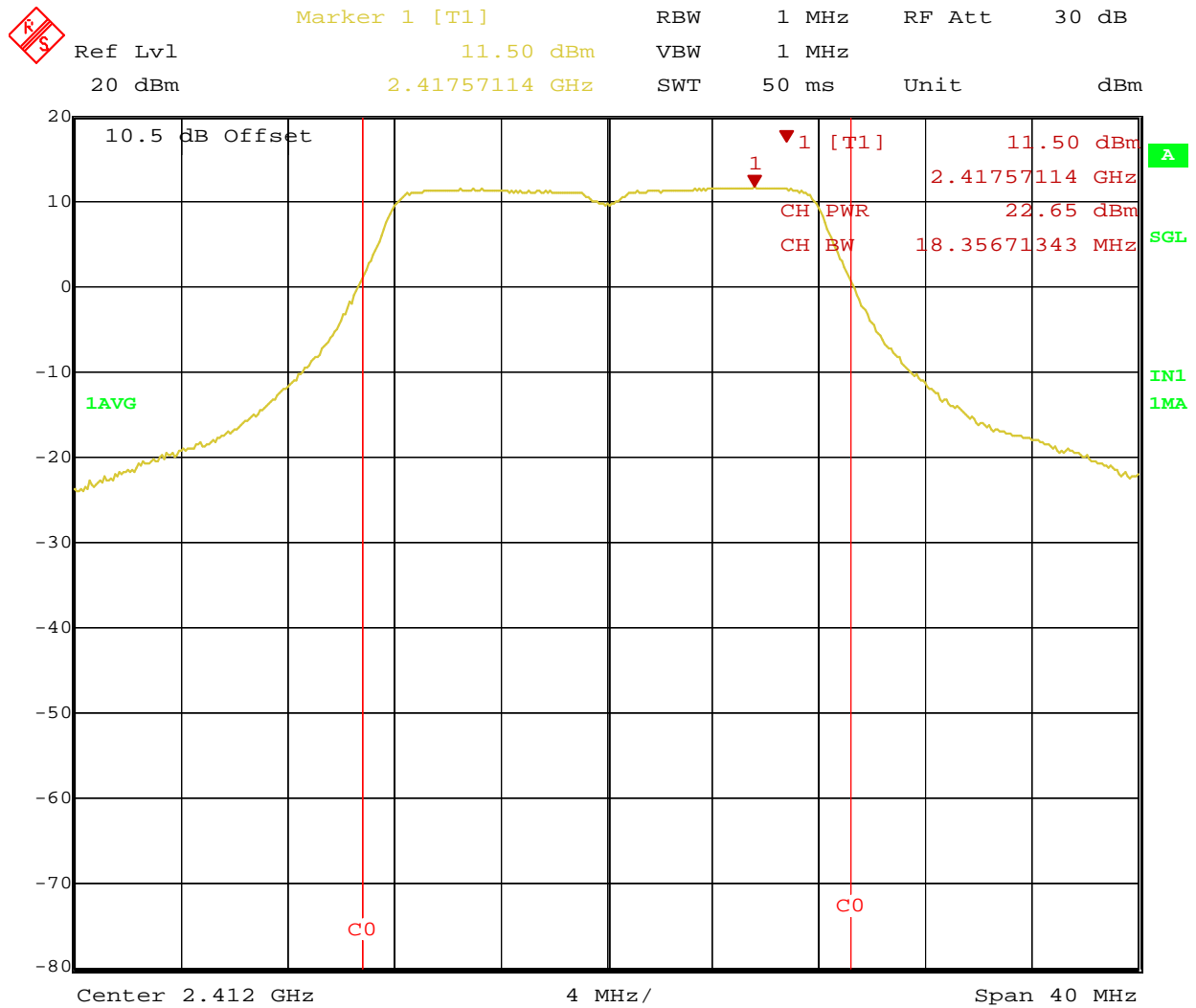
Date: 9.SEP.2011 15:31:40

Figure 11: Maximum Transmitted Power, 2437 MHz at 802.11g, Chain 0 – 6Mbps



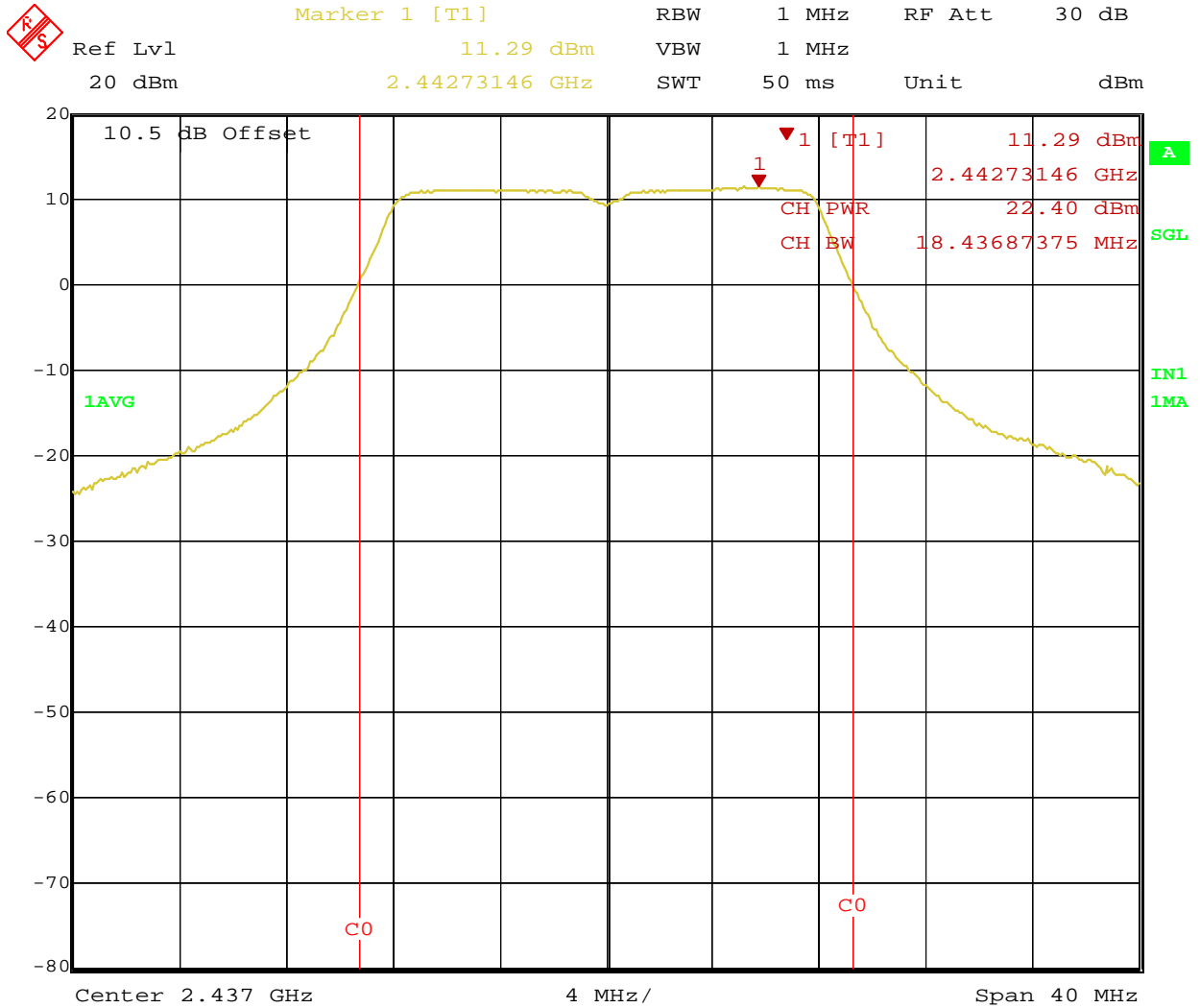
Date: 9.SEP.2011 15:16:33

Figure 12: Maximum Transmitted Power, 2462 MHz at 802.11g, Chain 0 – 6Mbps



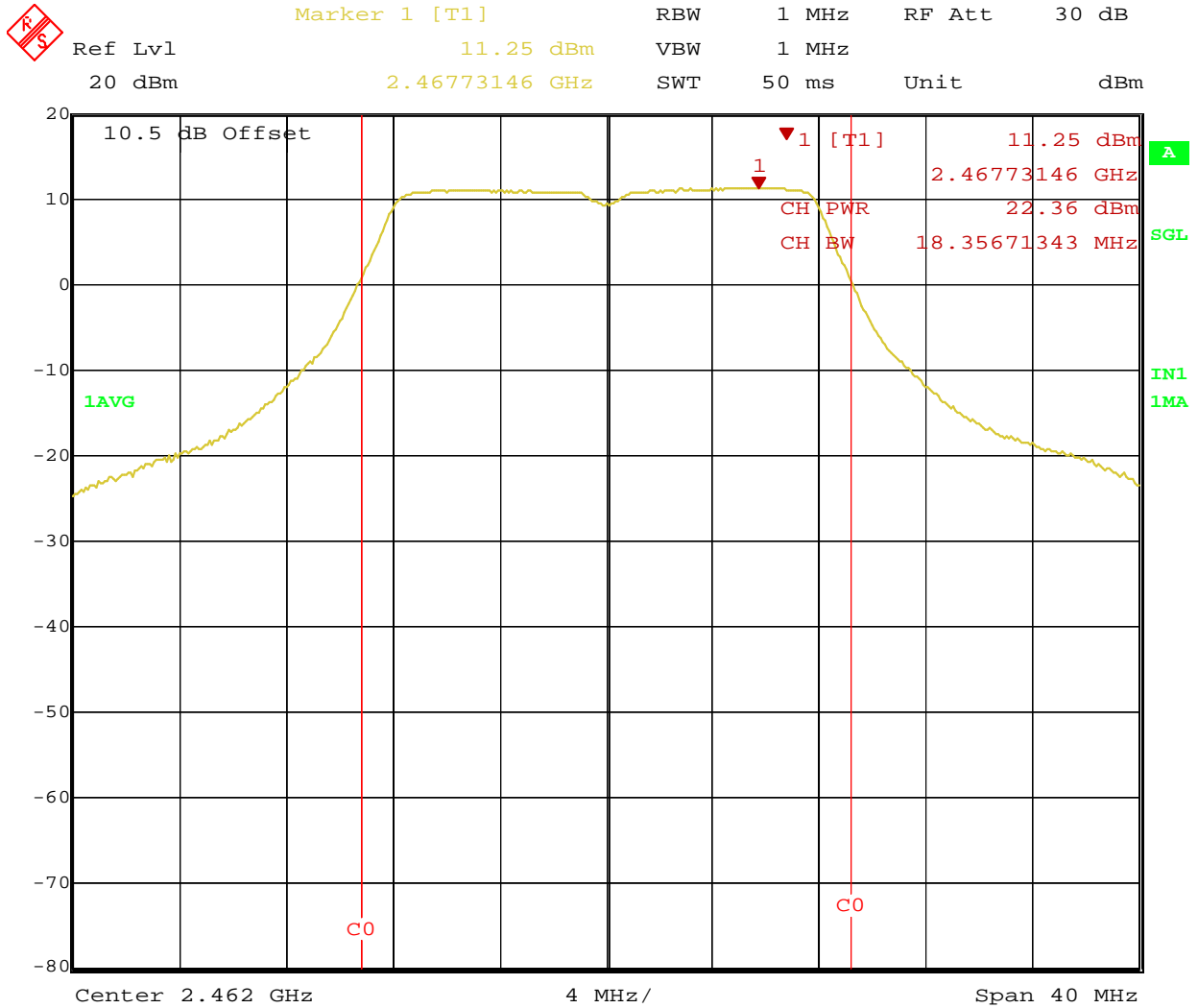
Date: 9.SEP.2011 15:58:41

Figure 13: Maximum Transmitted Power, 2412 MHz at 802.11g, Chain 1 – 6Mbps



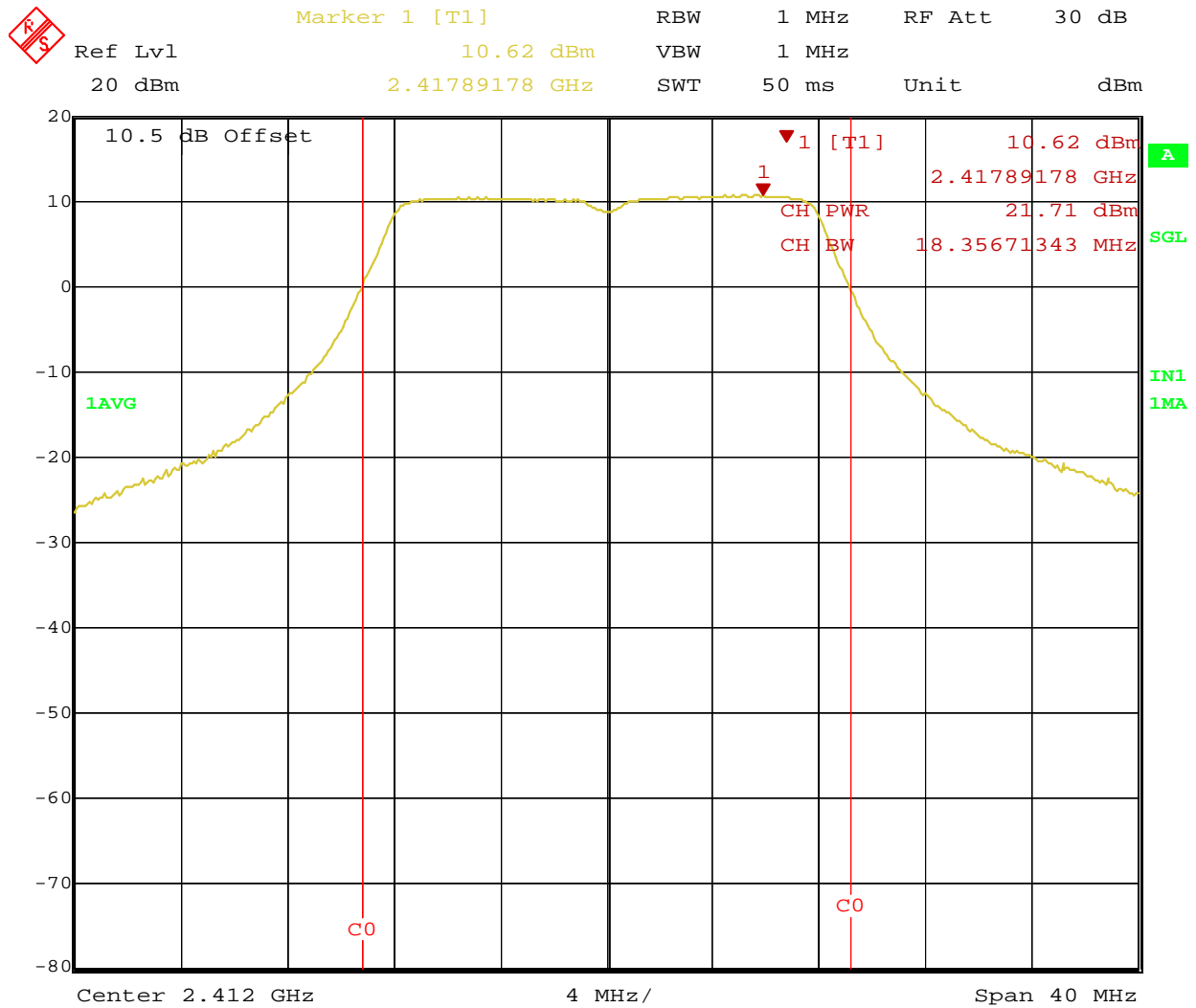
Date: 9.SEP.2011 16:12:26

Figure 14: Maximum Transmitted Power, 2437 MHz at 802.11g, Chain 1 – 6Mbps



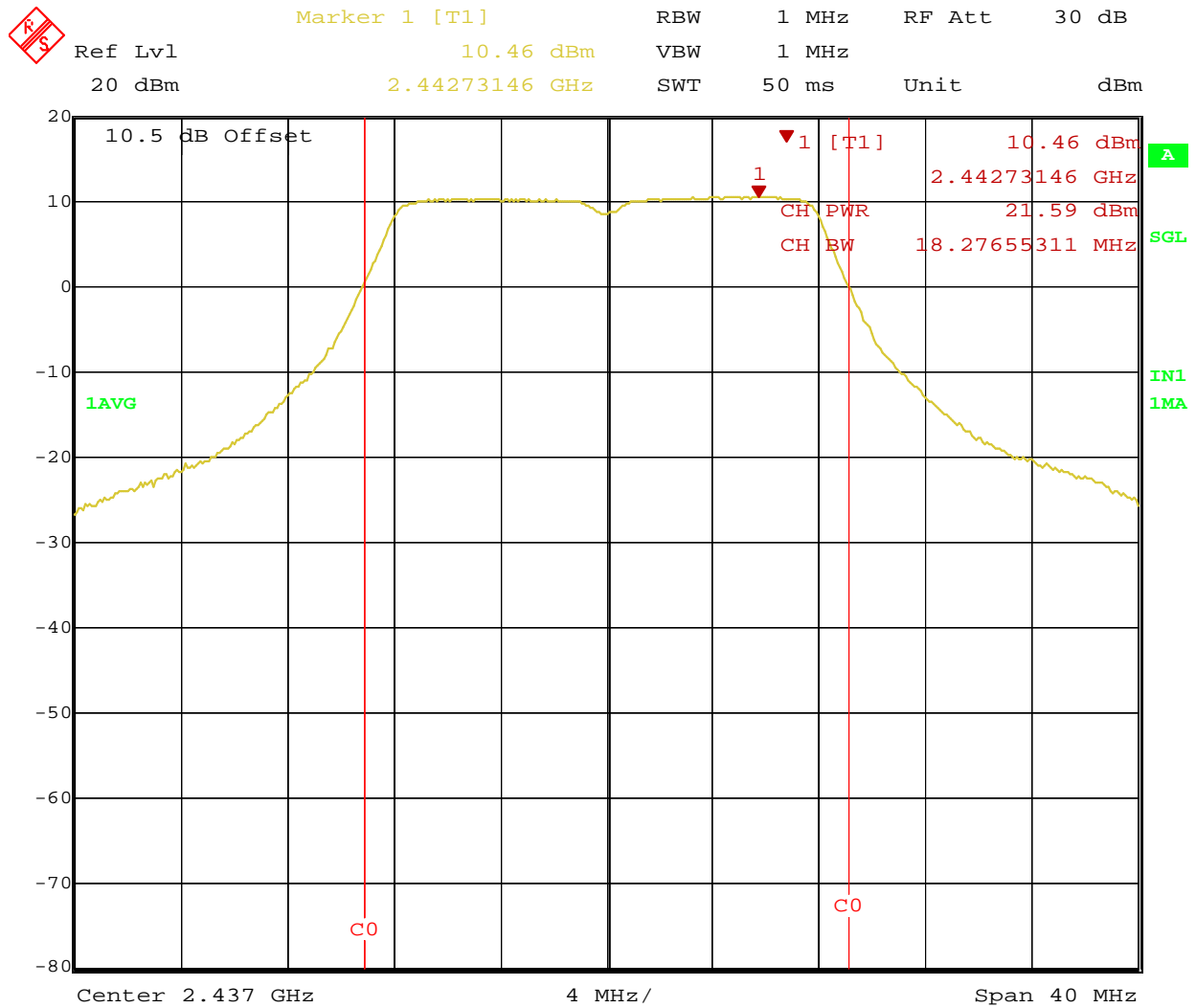
Date: 9.SEP.2011 16:22:35

Figure 15: Maximum Transmitted Power, 2462 MHz at 802.11g, Chain 1 – 6Mbps



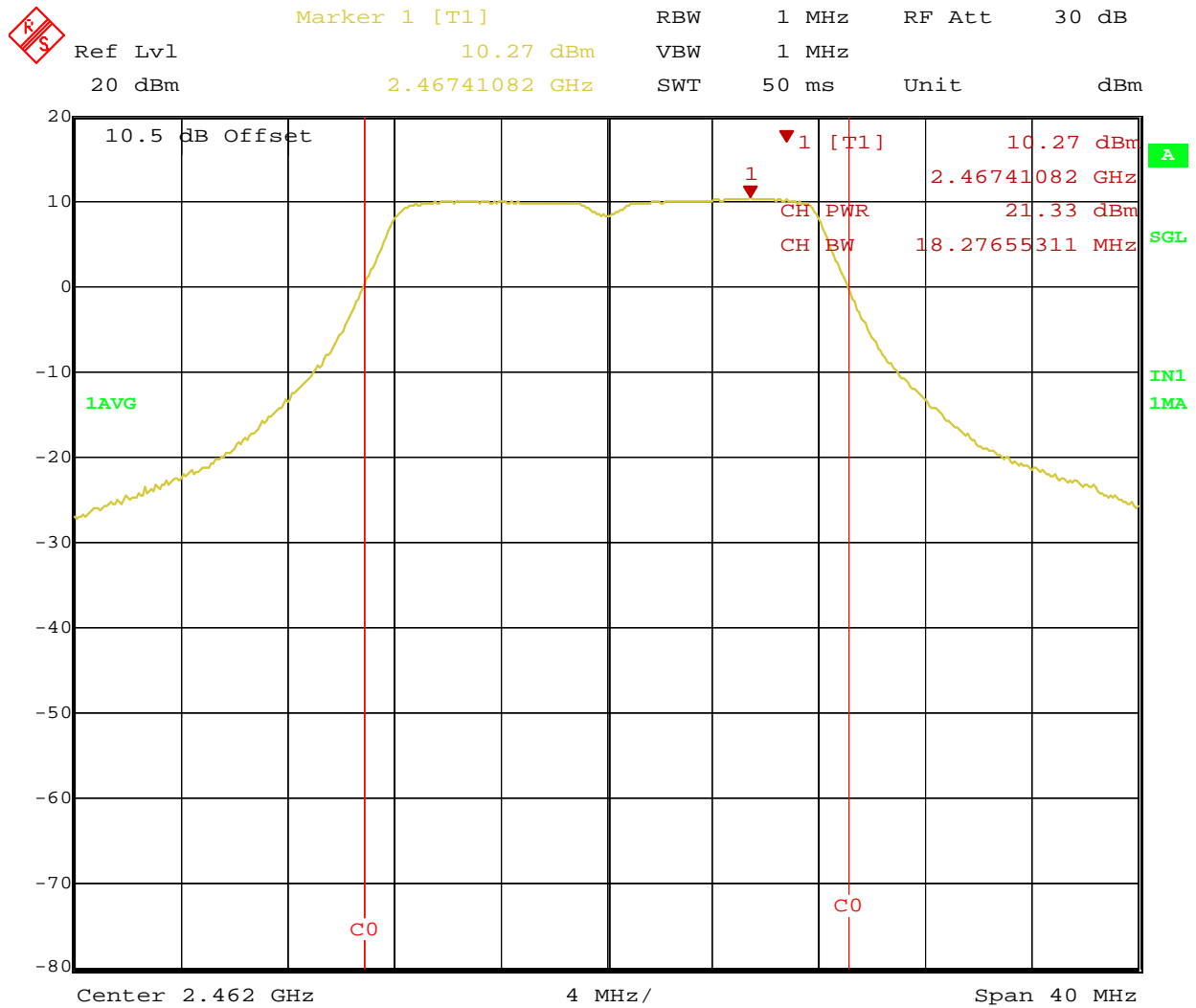
Date: 9.SEP.2011 14:54:33

Figure 16: Maximum Transmitted Power, 2412 MHz at 802.11g, Chain 2 – 6Mbps



Date: 9.SEP.2011 14:29:46

Figure 17: Maximum Transmitted Power, 2437 MHz at 802.11g, Chain 2 – 6Mbps



Date: 9.SEP.2011 15:03:14

Figure 18: Maximum Transmitted Power, 2462 MHz at 802.11g, Chain 2 – 6Mbps

Agilent 09:37:33 Sep 29, 2011

R T

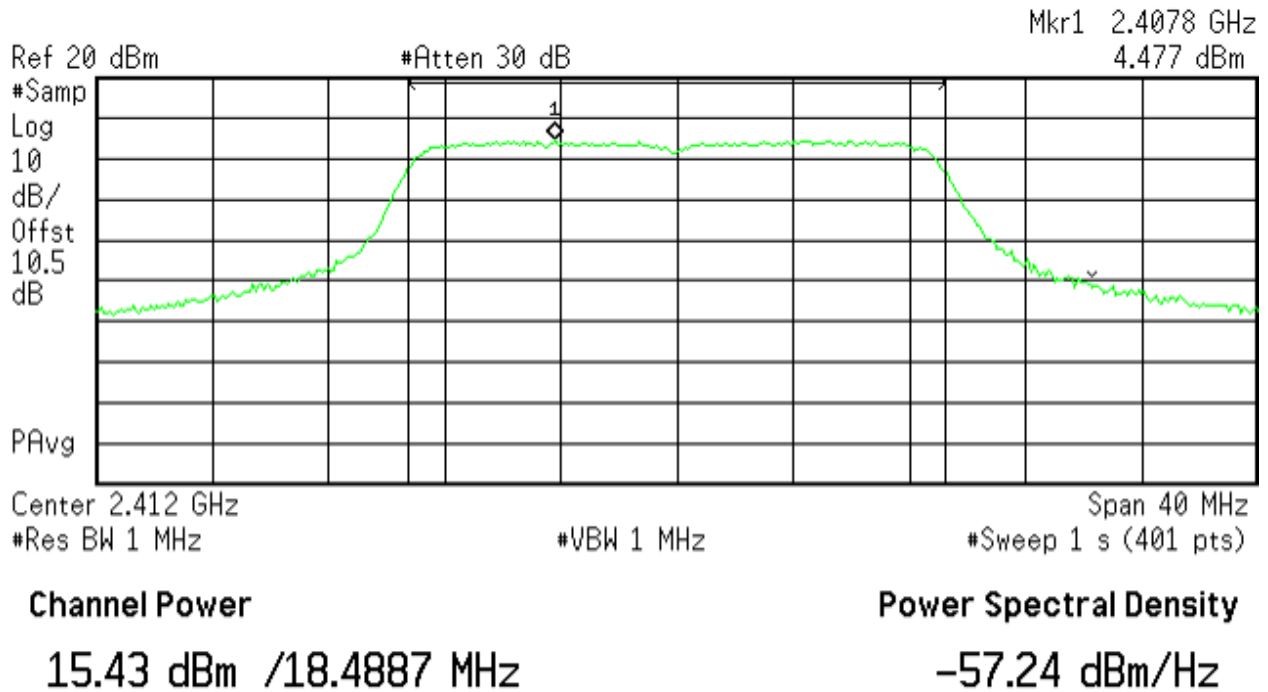


Figure 19: Maximum Transmitted Power, 2412 MHz at 802.11n (HT20), Chain 0 – 6.5Mbps

Agilent 09:26:05 Sep 29, 2011

R T

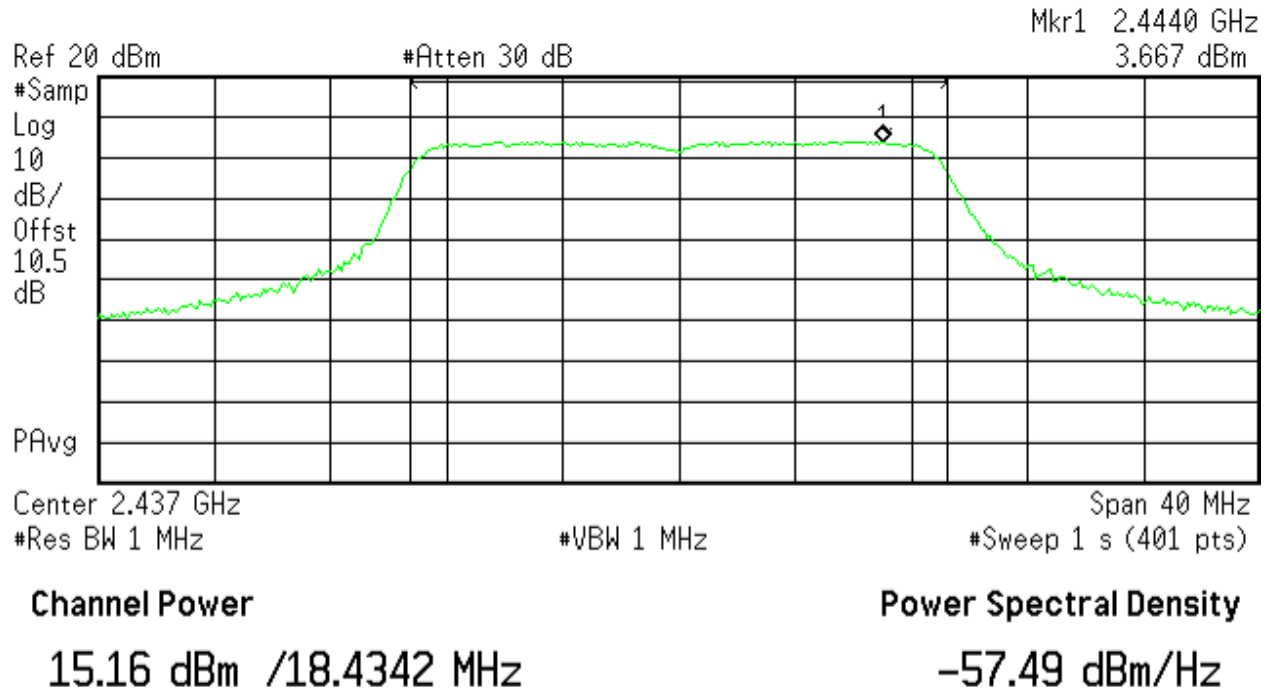


Figure 20: Maximum Transmitted Power, 2437 MHz at 802.11n (HT20), Chain 0 – 6.5Mbps

Agilent 09:21:29 Sep 29, 2011

R T

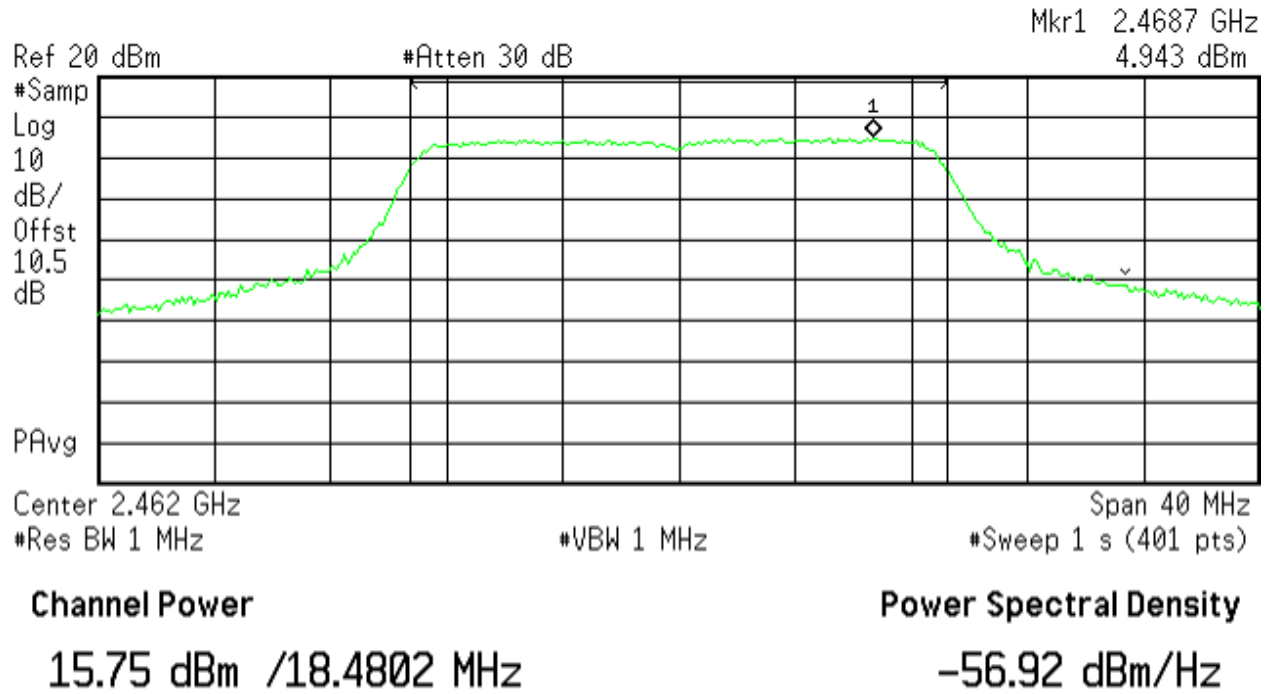


Figure 21: Maximum Transmitted Power, 2462 MHz at 802.11n (HT20), Chain 0 – 6.5Mbps

Agilent 03:06:48 Sep 28, 2011

R T

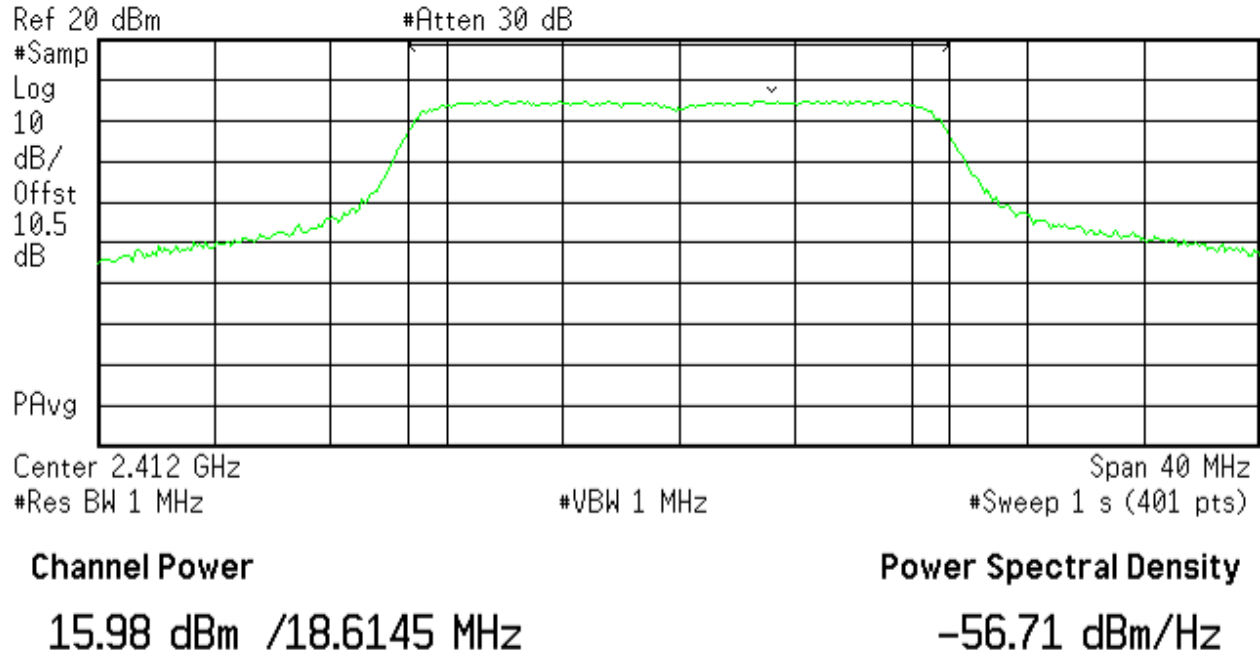


Figure 22: Maximum Transmitted Power, 2412 MHz at 802.11n (HT20), Chain 1 – 6.5Mbps

Agilent 04:05:34 Sep 28, 2011

R T

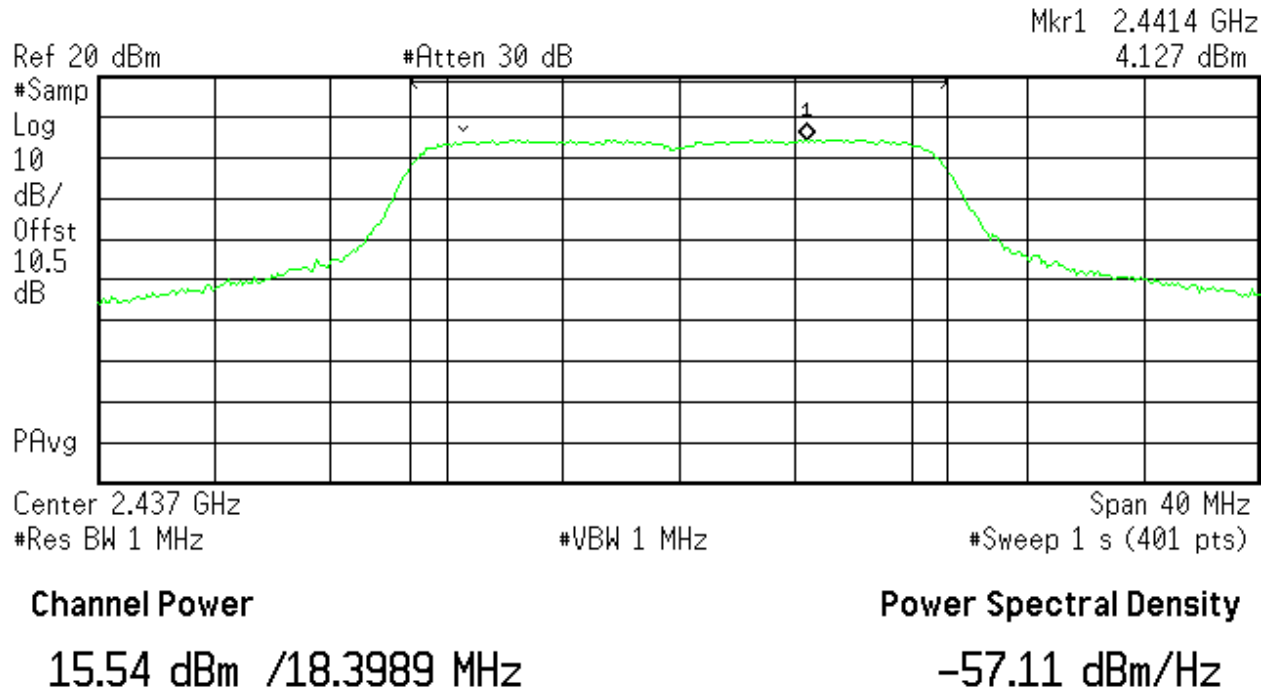


Figure 23: Maximum Transmitted Power, 2437 MHz at 802.11n (HT20), Chain 1 – 6.5Mbps

Agilent 04:08:53 Sep 28, 2011

R T

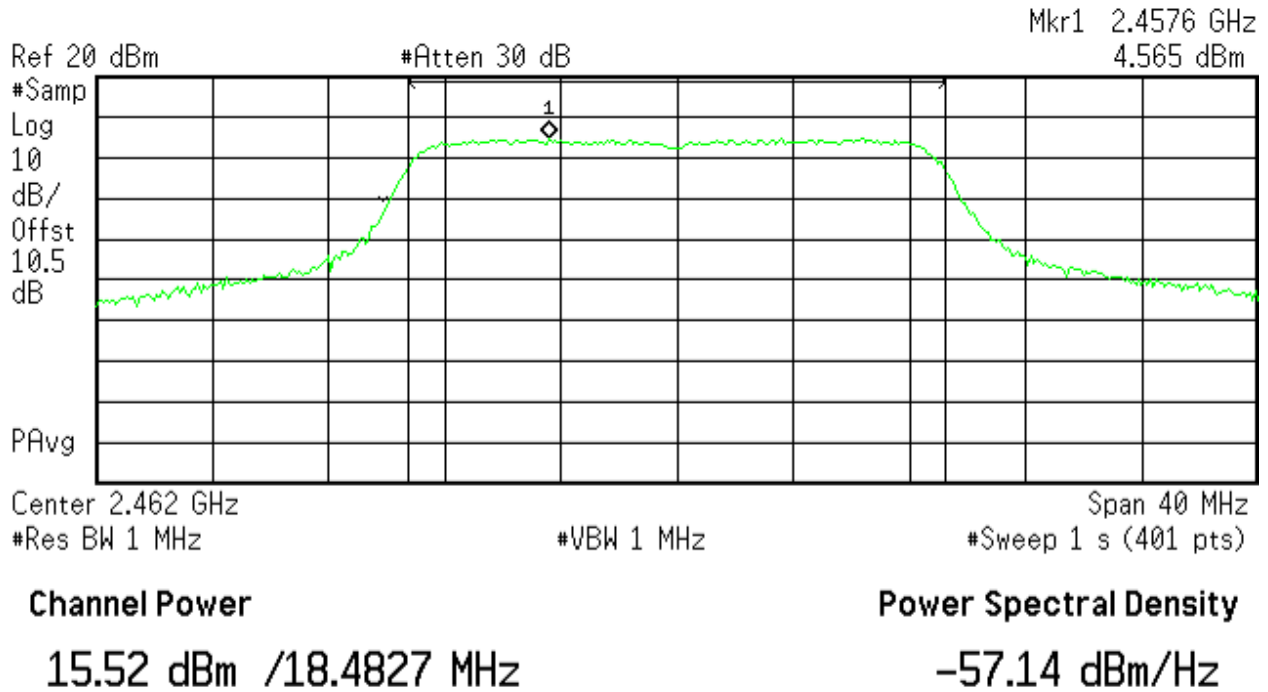


Figure 24: Maximum Transmitted Power, 2462 MHz at 802.11n (HT20), Chain 1 – 6.5Mbps

Agilent 08:19:51 Sep 29, 2011

R T

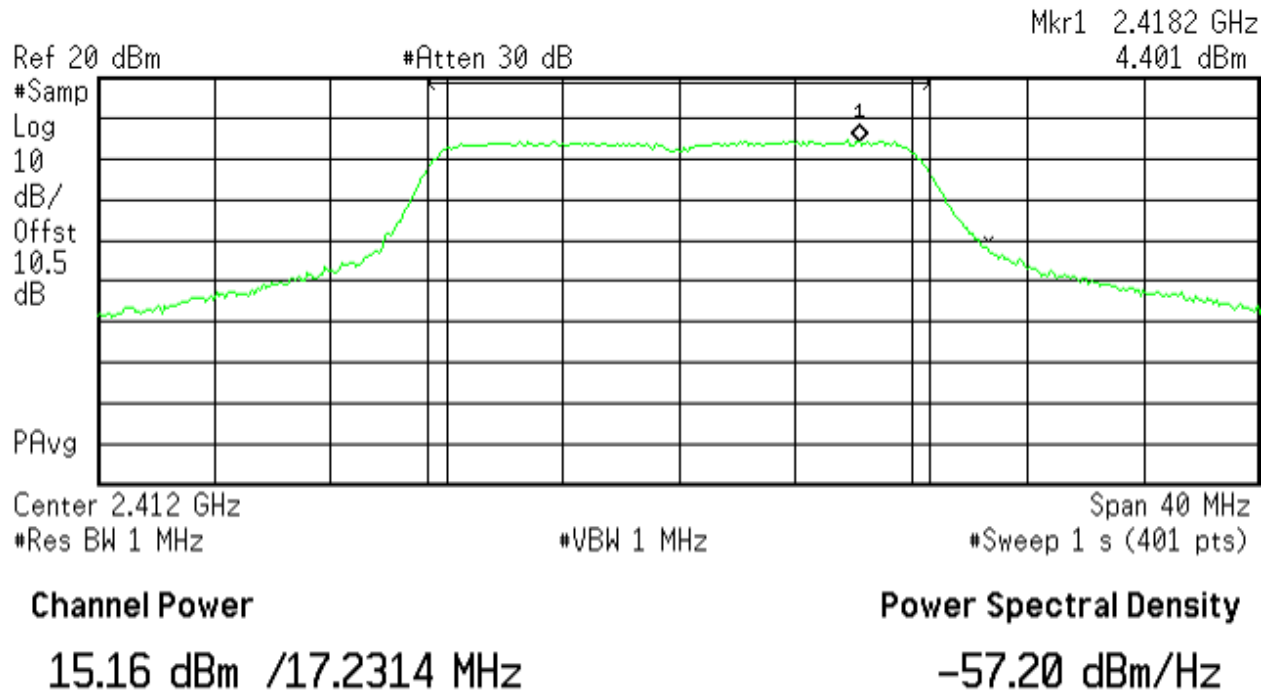


Figure 25: Maximum Transmitted Power, 2412 MHz at 802.11n (HT20), Chain 2 – 6.5Mbps

Agilent 08:00:31 Sep 29, 2011

R T

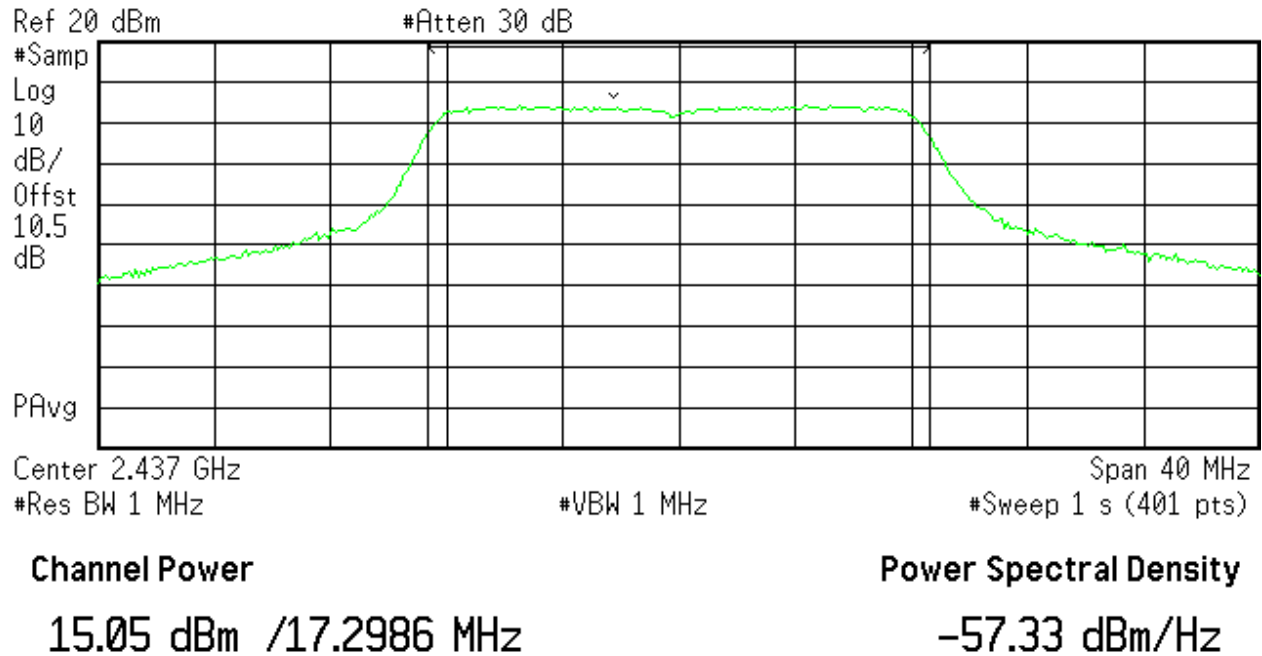


Figure 26: Maximum Transmitted Power, 2437 MHz at 802.11n (HT20), Chain 2 – 6.5Mbps

Agilent 08:15:21 Sep 29, 2011

R T

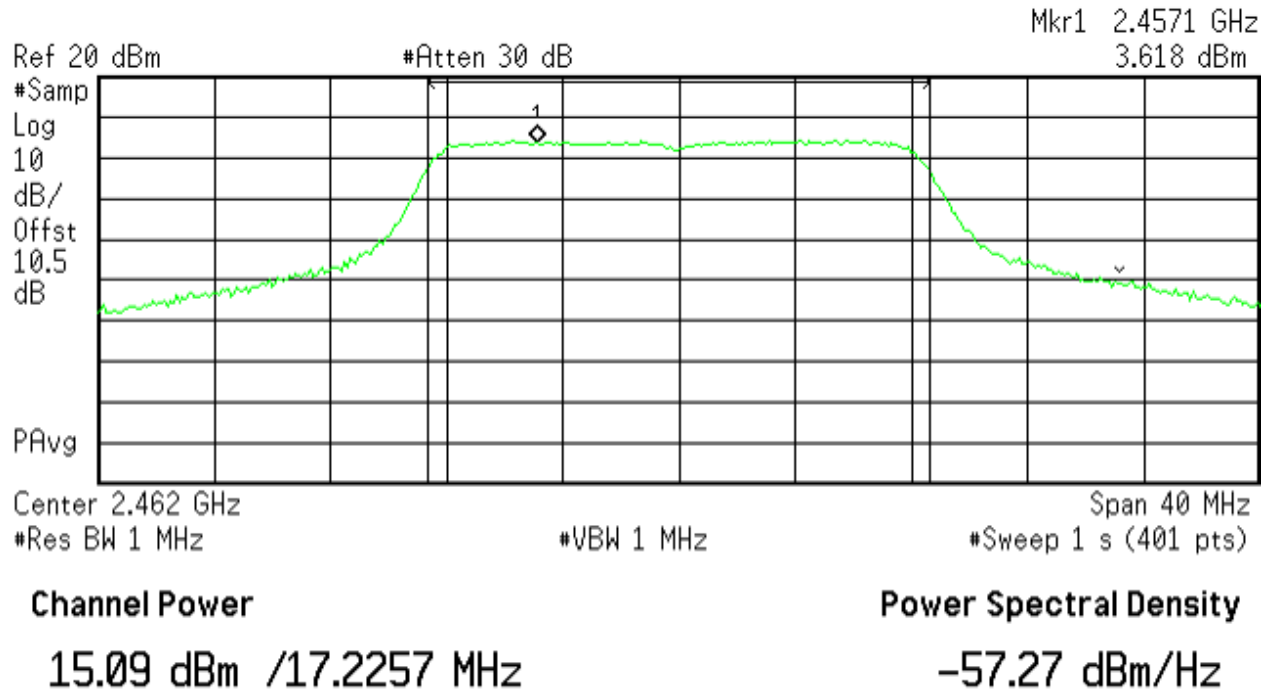


Figure 27: Maximum Transmitted Power, 2462 MHz at 802.11n (HT20), Chain 2 – 6.5Mbps

Agilent 04:58:52 Sep 28, 2011

R T

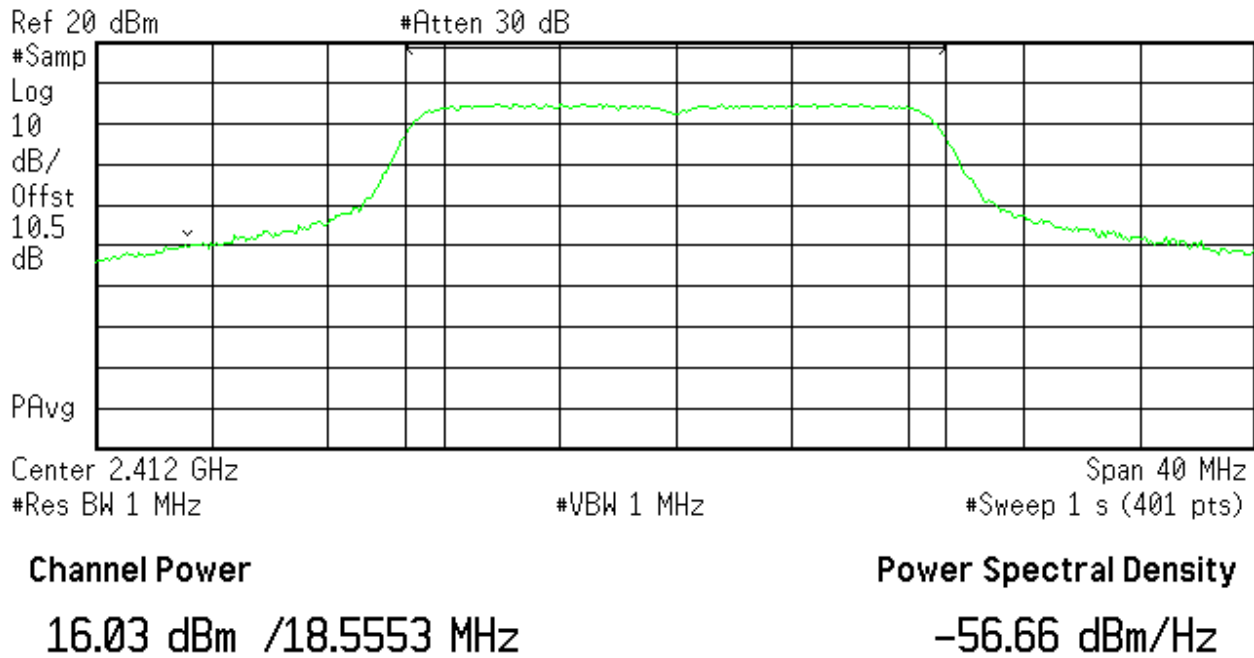


Figure 28: Maximum Transmitted Power, 2412 MHz at 802.11n (HT20), Chain 1 – 13Mbps

Agilent 03:27:21 Sep 30, 2011

R T

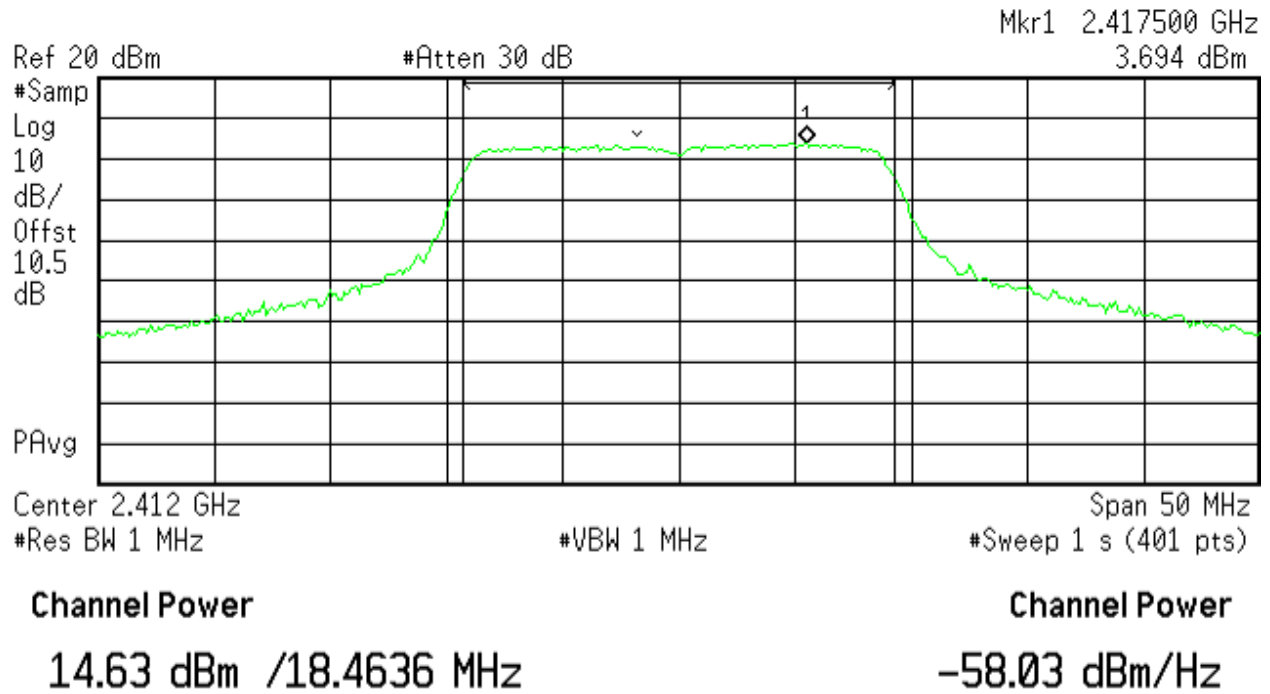


Figure 29: Maximum Transmitted Power, 2412 MHz at 802.11n (HT20), Chain 1 – 19.5Mbps

Agilent 05:41:19 Sep 29, 2011

R T

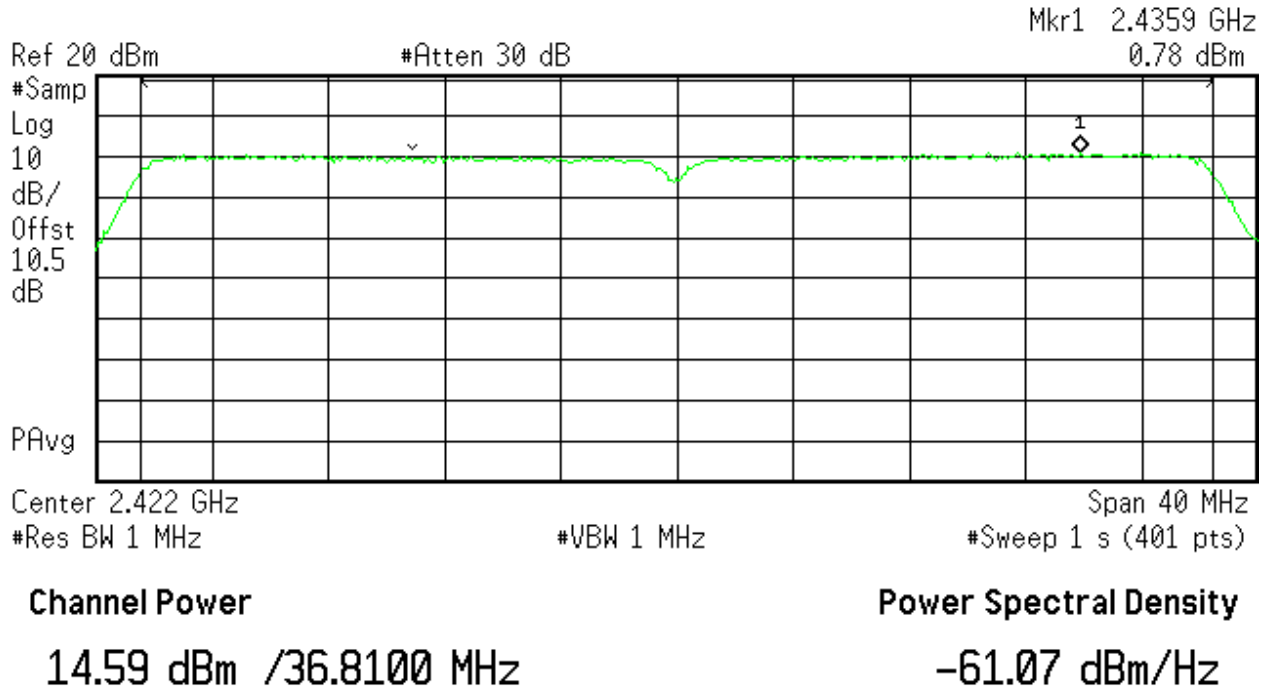


Figure 30: Maximum Transmitted Power, 2422 MHz at 802.11n (HT40), Chain 1 – 13.5Mbps

Agilent 05:52:32 Sep 29, 2011

R T

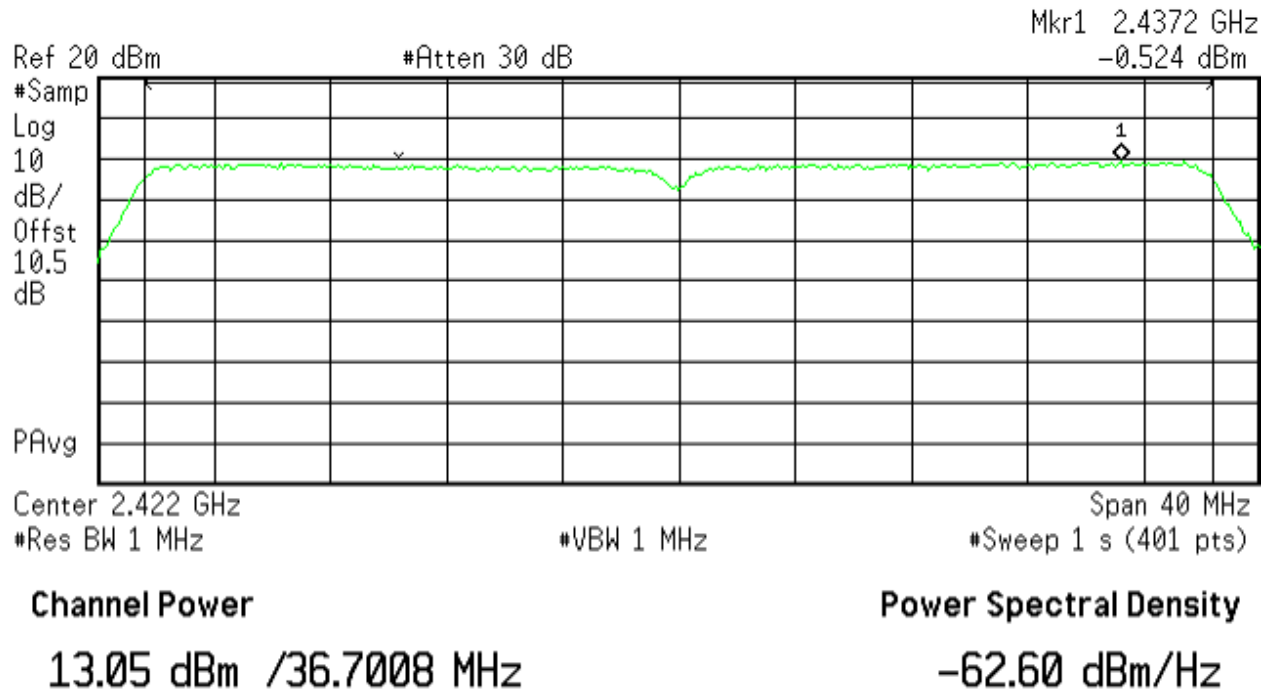


Figure 31: Maximum Transmitted Power, 2437 MHz at 802.11n (HT40), Chain 1 – 27Mbps

Agilent 05:03:43 Sep 28, 2011

R T

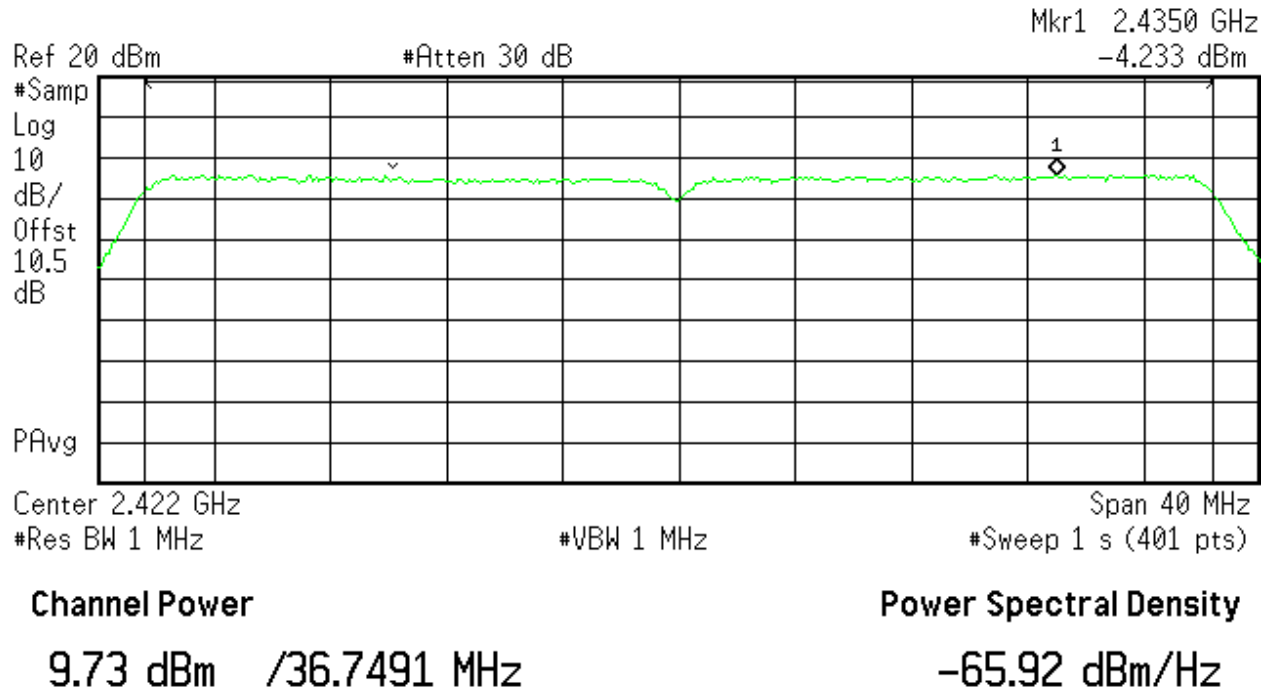


Figure 30: Maximum Transmitted Power, 2437 MHz at 802.11n (HT40), Chain 1 – 40.5Mbps

4.2 Occupied Bandwidth

The occupied bandwidth is measured at an amplitude level reduced from the reference level by a specified ratio. The reference level is the level of the highest amplitude signal observed from the transmitter at the fundamental frequency.

The 99% bandwidth is the bandwidth in which 99% of the transmitted power occupied.

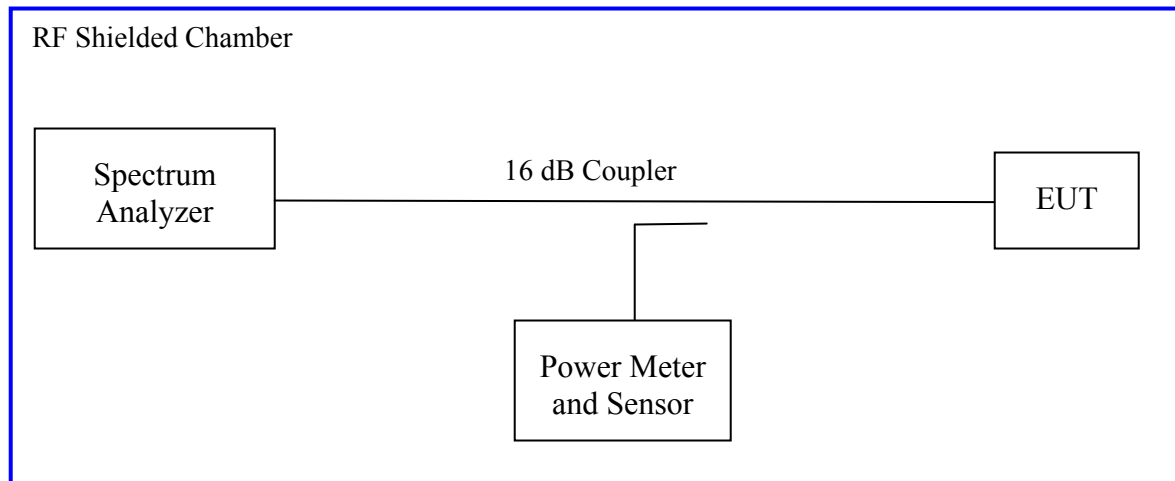
The 6 dB bandwidth is defined the bandwidth of 6 dBr from highest transmitted level of the fundamental frequency.

The bandwidth shall be at least 500 kHz per Section CFR47 15.247(a2) 2009 and RSS Gen Sect. 4.4.1: 2010.

4.2.1 Test Method

The conducted method was used to measure the occupied bandwidth. The measurement was performed with modulation per CFR47 15.247(a2) 2009 and RSS Gen Sect. 4.4.1:2010. Initial investigation was performed at different data rates and TX chains. The narrowest bandwidths at each operational mode were measured on 3 operating channels. The worst sample result indicated below.

Test Setup:



4.2.2 Results

As originally tested, the EUT was found to be compliant to the requirements of the test standard(s).

Table 3: Occupied Bandwidth – Test Results

Test Conditions: Conducted Measurement, Normal Temperature and Voltage only								
Antenna Type: 3 External				Power Setting: See test plan				
Max. Antenna Gain: + 2.0 dBi				Signal State: Modulated				
Ambient Temp.: 21 °C				Relative Humidity: 33%				
Bandwidth (MHz) for 802.11b								
Freq. (MHz)	Limit (kHz)	Ch 0 99% BW	Ch 1 99% BW	Ch 2 99% BW	Ch 0 6 dB BW	Ch 1 6 dB BW	Ch 2 6 dB BW	Results
2412	500	13.90	13.94	13.94	10.24	10.24	10.24	Pass
2437	500	13.94	13.90	13.90	10.24	10.28	10.24	Pass
2462	500	13.90	13.90	13.90	10.24	10.24	10.24	Pass
Note: The bandwidth was measured at 1Mbps for 802.11b mode.								
Bandwidth (MHz) for 802.11g								
Freq. (MHz)	Limit (kHz)	Ch 0 99% BW	Ch 1 99% BW	Ch 2 99% BW	Ch 0 6 dB BW	Ch 1 6 dB BW	Ch 2 6 dB BW	Results
2412	500	16.75	16.48	16.48	16.48	16.75	16.75	Pass
2437	500	16.75	16.48	16.48	16.48	16.75	16.75	Pass
2462	500	16.79	16.48	16.52	16.44	16.71	16.75	Pass
Note: The bandwidth was measured at 6Mbps for 802.11g mode.								
Bandwidth (MHz) for 802.11n HT20								
Freq. (MHz)	Limit (kHz)	Ch 0 99% BW	Ch 1 99% BW	Ch 2 99% BW	Ch 0 6 dB BW	Ch 1 6 dB BW	Ch 2 6 dB BW	Results
2412	500	17.62	17.75	16.46	20.0	20.0	20.0	Pass
2437	500	17.62	17.73	16.47	20.0	20.0	20.0	Pass
2462	500	17.62	17.75	16.46	20.0	20.0	20.0	Pass

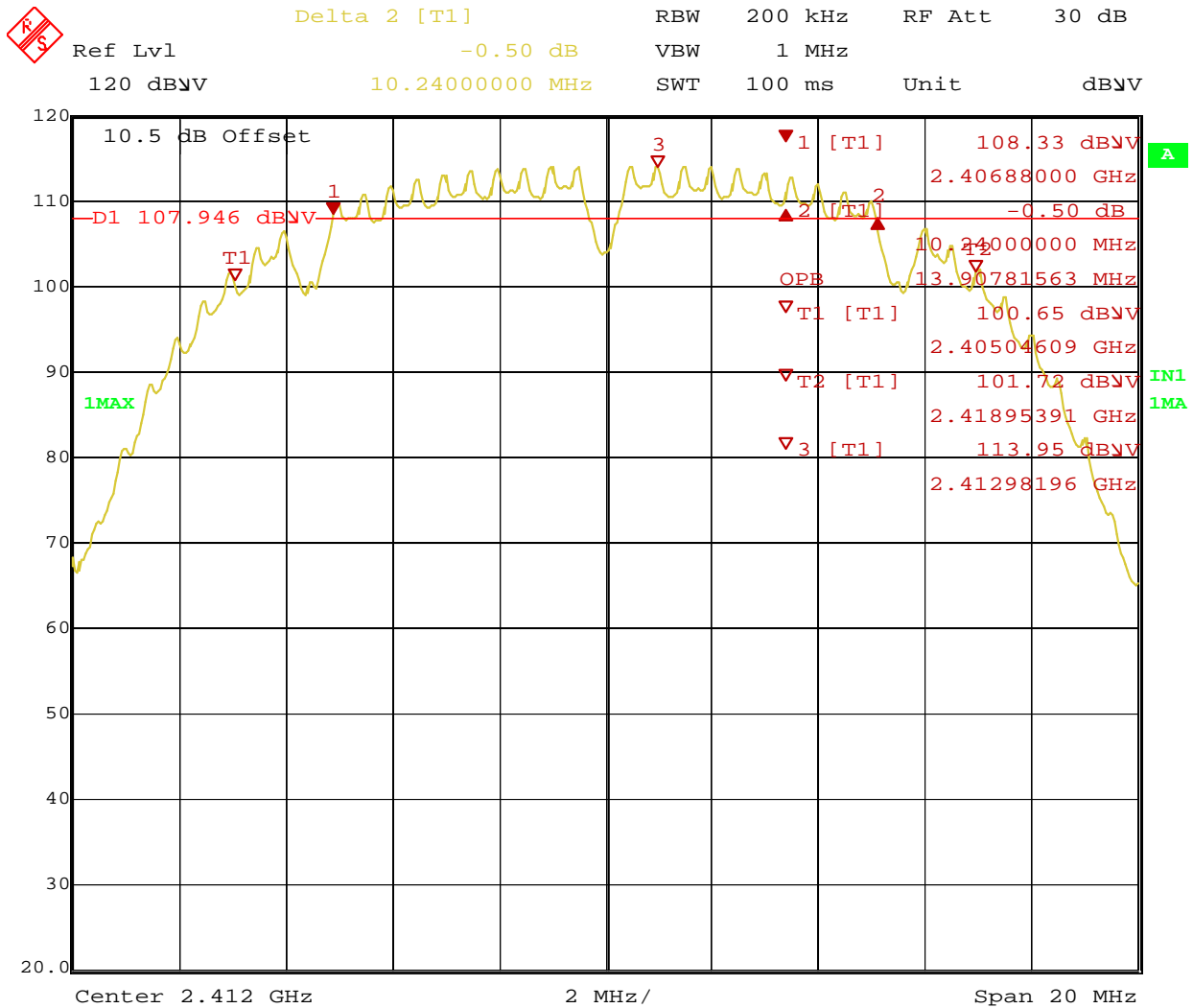
Note: The bandwidth was measured at 6.5Mbps at 1 data stream

Bandwidth (MHz) for 802.11n HT40

Freq. (MHz)	Limit (kHz)	Ch 0 99% BW	Ch 1 99% BW	Ch 2 99% BW	Ch 0 6 dB BW	Ch 1 6 dB BW	Ch 2 6 dB BW	Results
2422	500	36.21	36.21	36.26	40	40	40	Pass
2437	500	36.20	36.18	36.25	40	40	40	Pass
2452	500	36.21	36.24	36.26	40	40	40	Pass

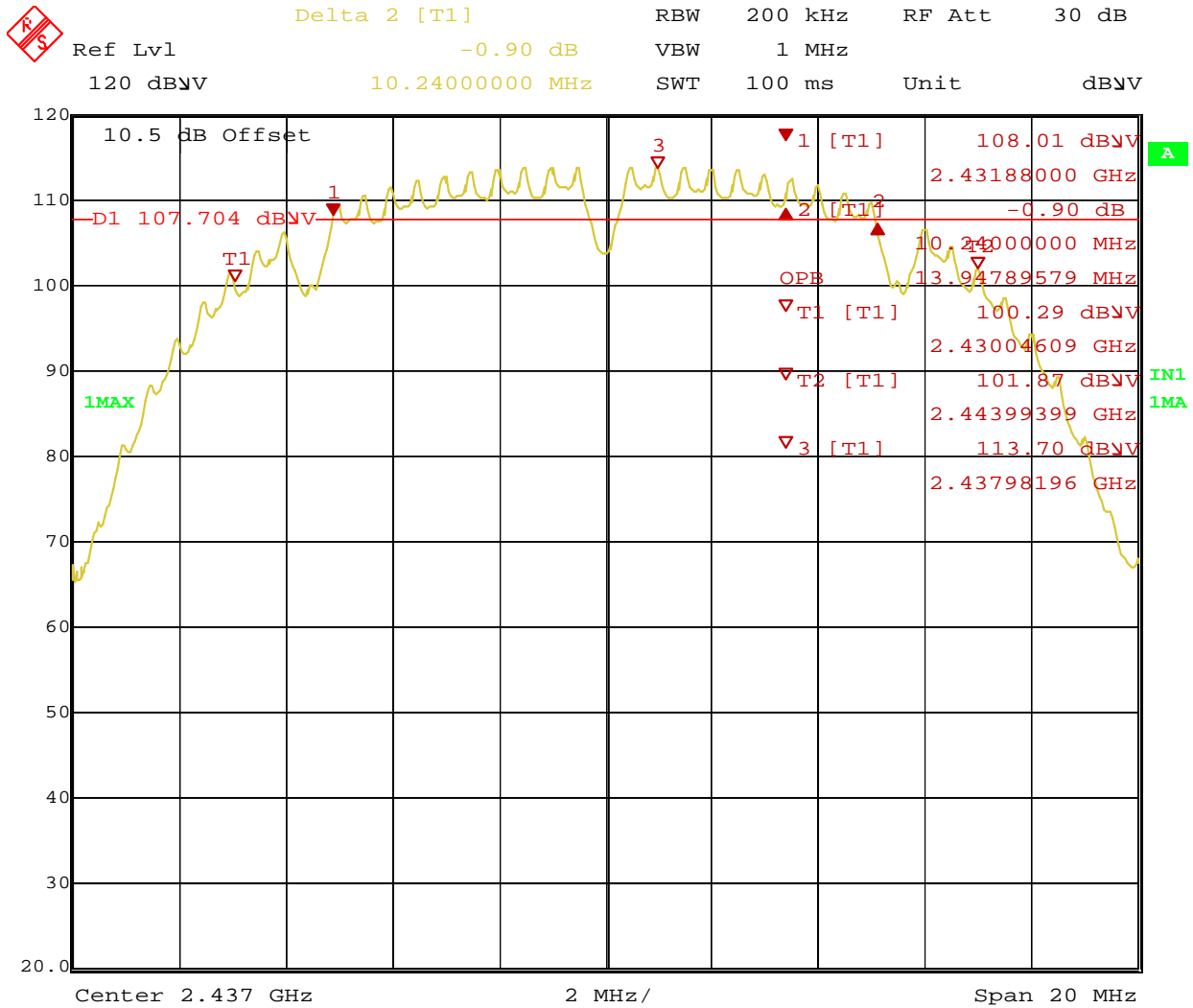
Note: The bandwidth was observed at 13.5Mbps at 1 data stream

Note: All Bandwidth measurements were performed as indicated in the above table. Only worst case/ limited number of plots are placed in the report.



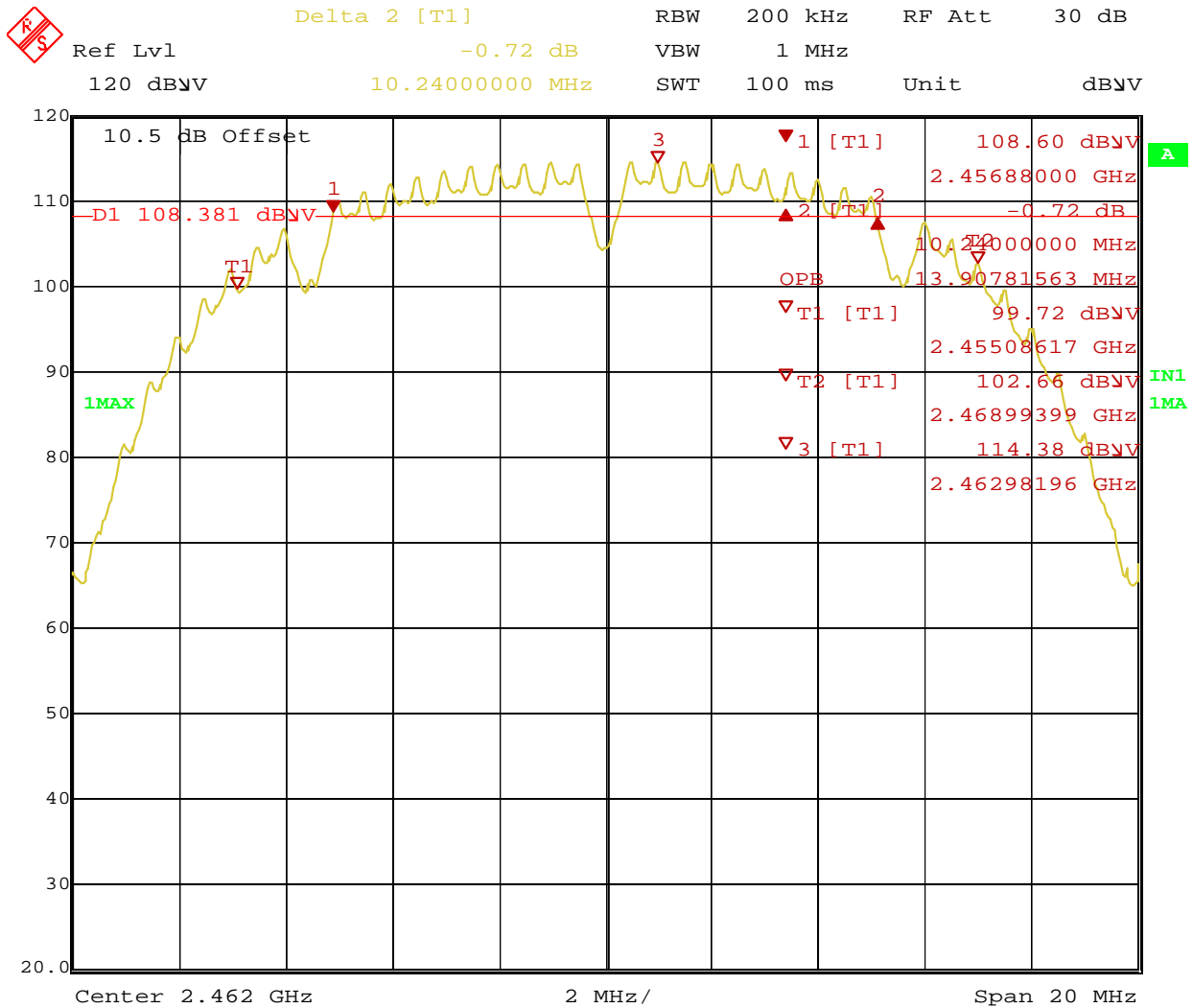
Date: 9.SEP.2011 11:26:42

Figure 31: 6 dB Bandwidth at 1Mbit/s – Operating Channel 2412 MHz, Chain 0



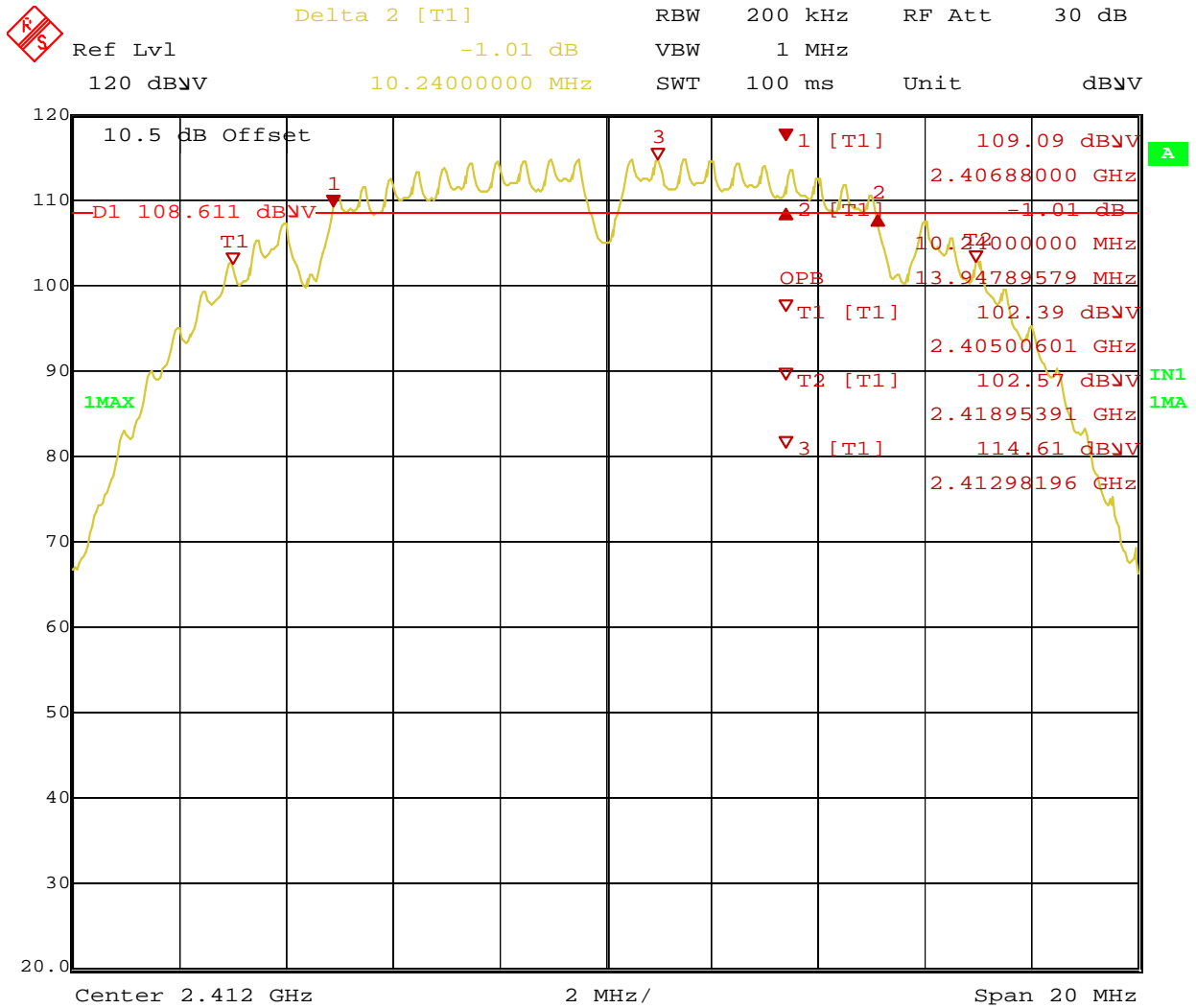
Date: 9.SEP.2011 11:17:56

Figure 32: 6 dB Bandwidth at 1Mbit/s – Operating Channel 2437 MHz, Chain 0



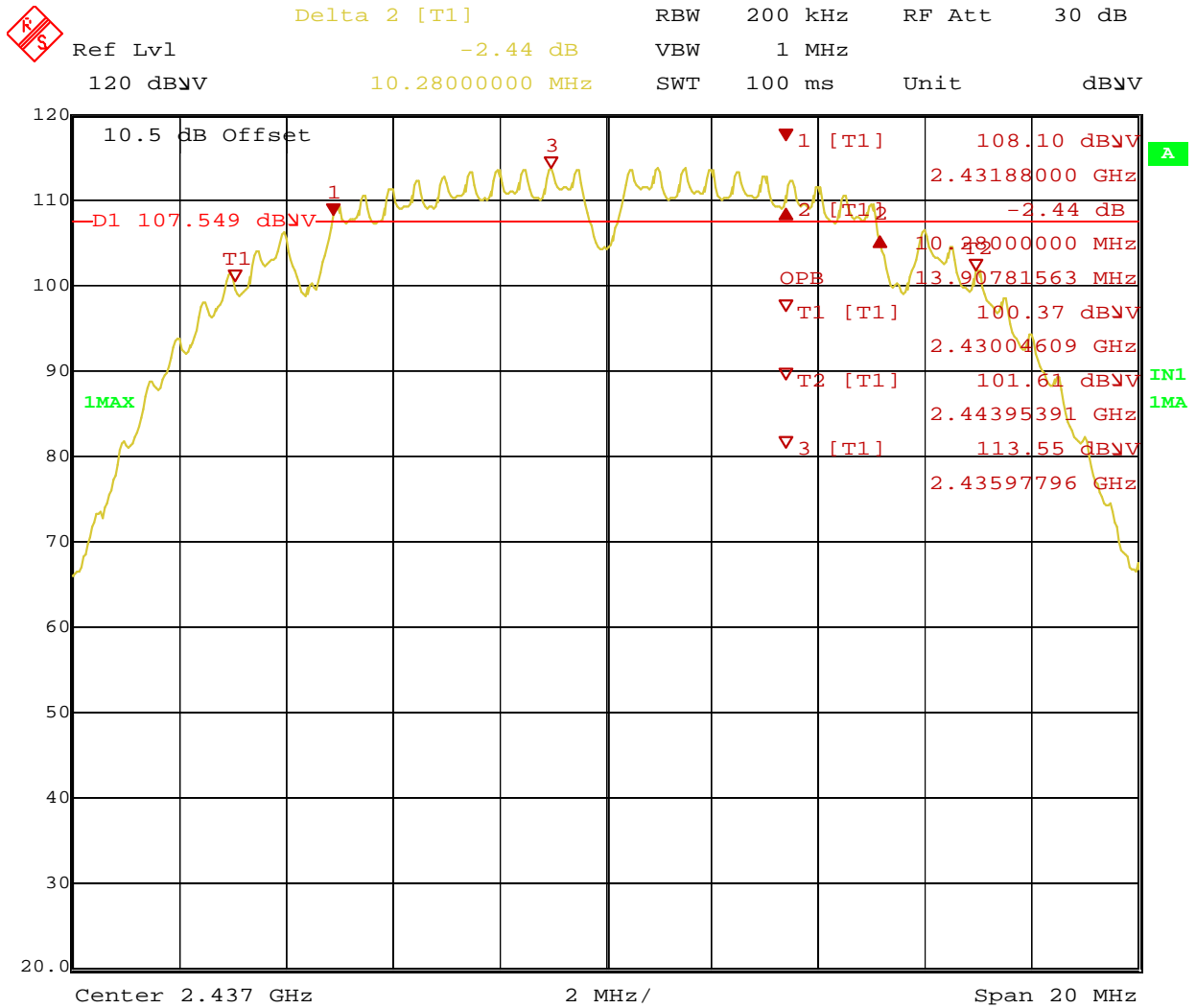
Date: 9.SEP.2011 10:55:29

Figure 33: 6 dB Bandwidth at 1Mbit/s – Operating Channel 2462 MHz, Chain 0



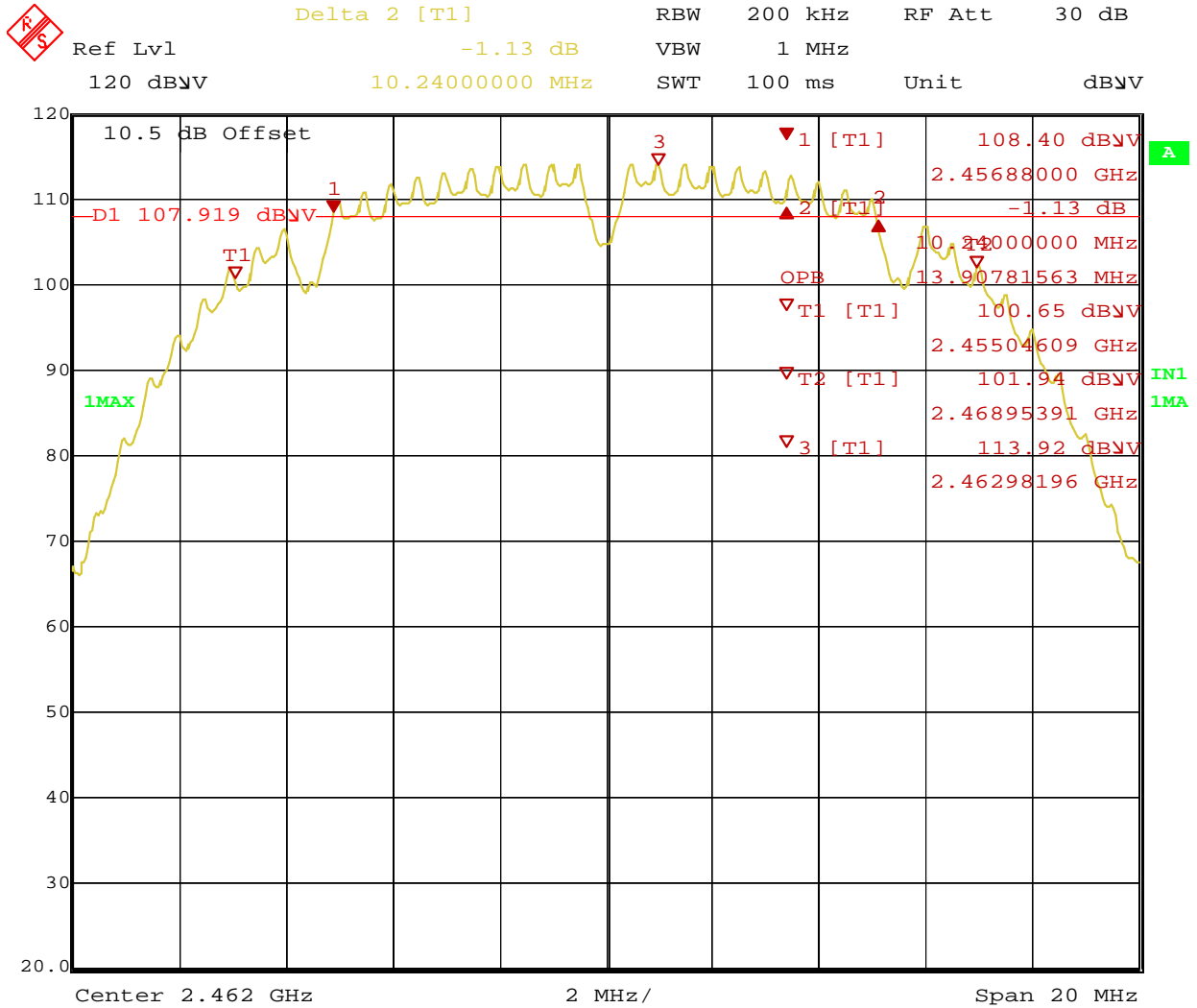
Date: 9.SEP.2011 12:04:35

Figure 34: 6 dB Bandwidth at 1Mbit/s – Operating Channel 2412 MHz, Chain 1



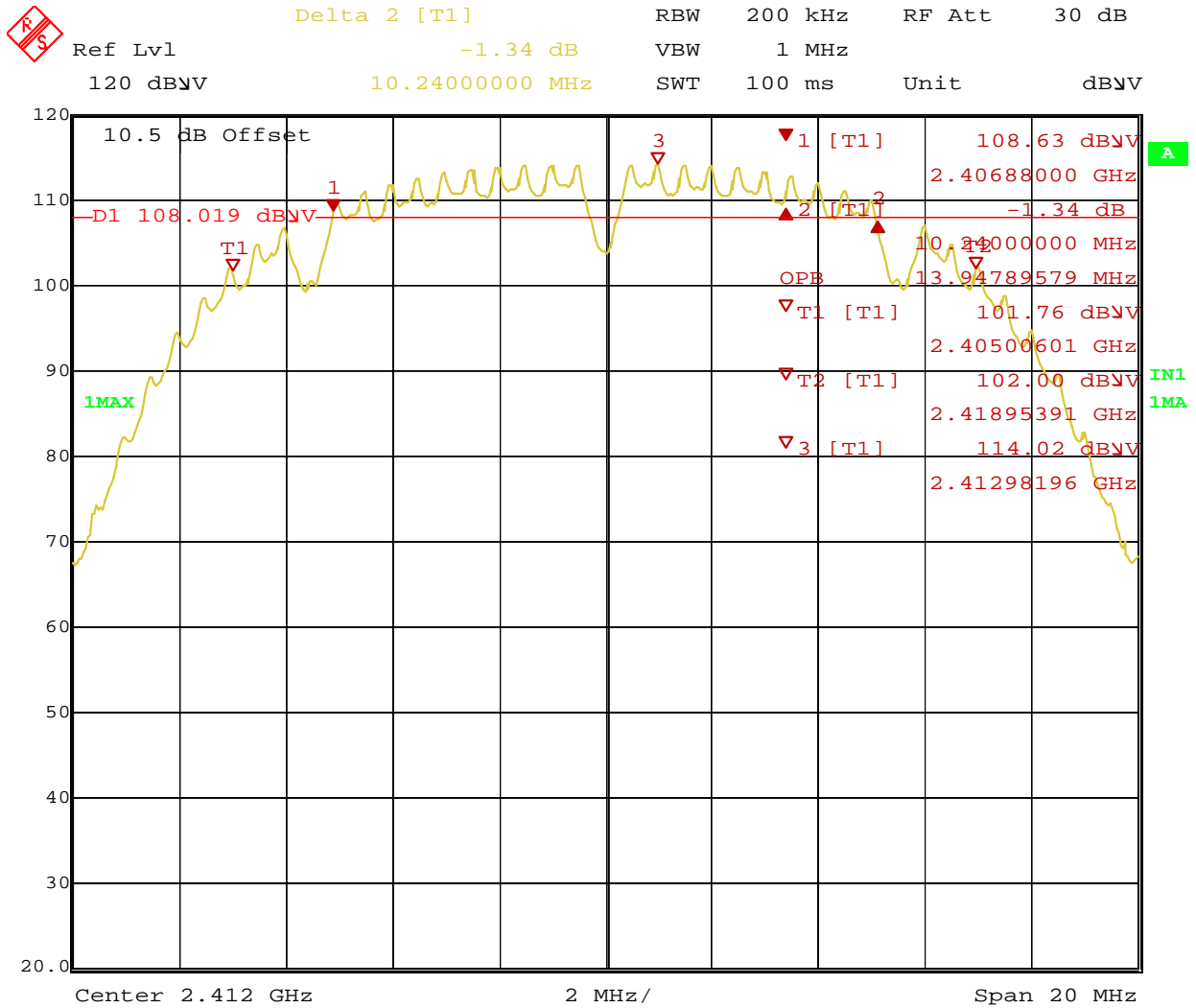
Date: 9.SEP.2011 13:04:08

Figure 35: 6 dB Bandwidth at 1Mbit/s – Operating Channel 2437 MHz, Chain 1



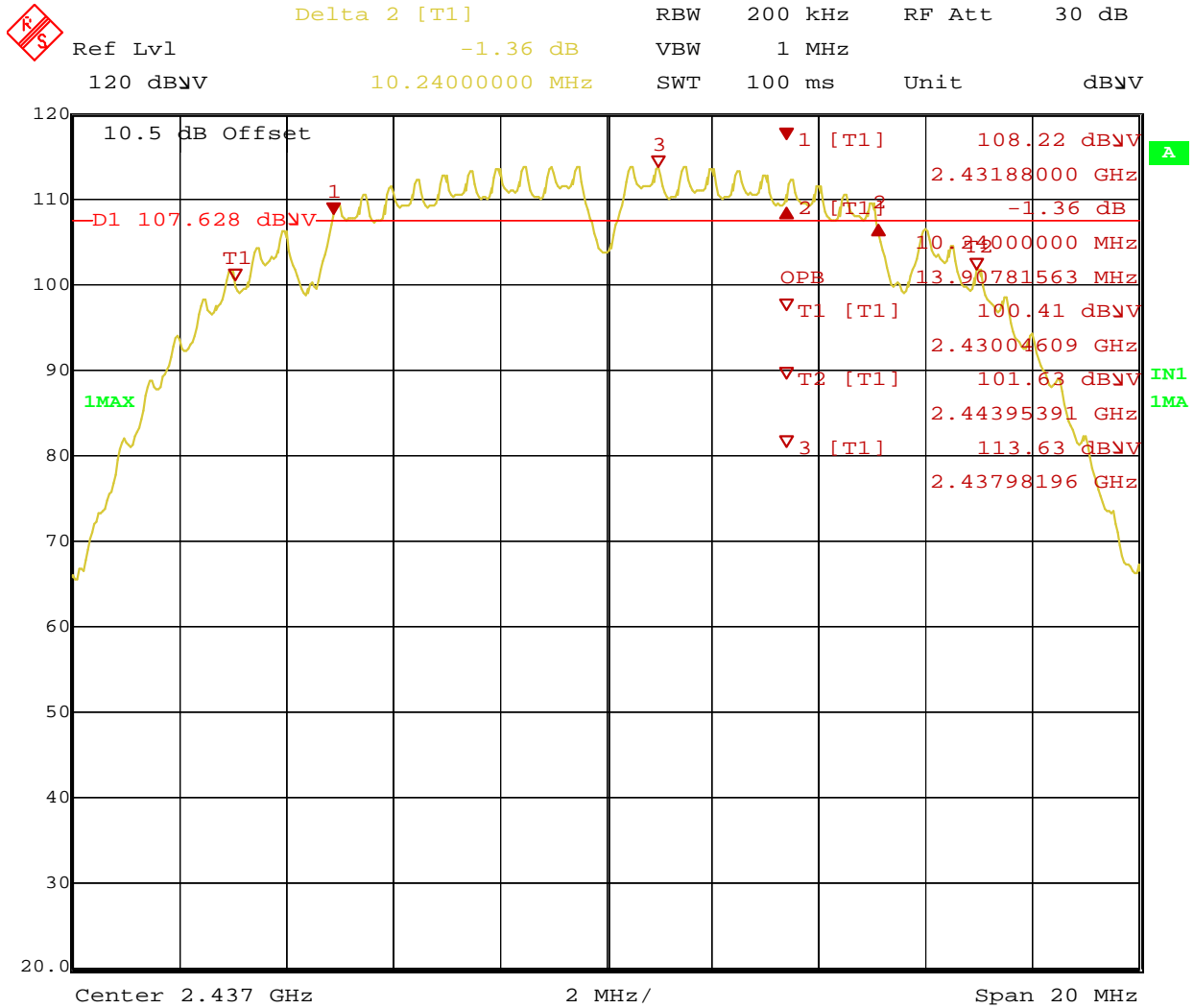
Date: 9.SEP.2011 13:17:11

Figure 36: 6 dB Bandwidth at 1Mbit/s – Operating Channel 2462 MHz, Chain 1



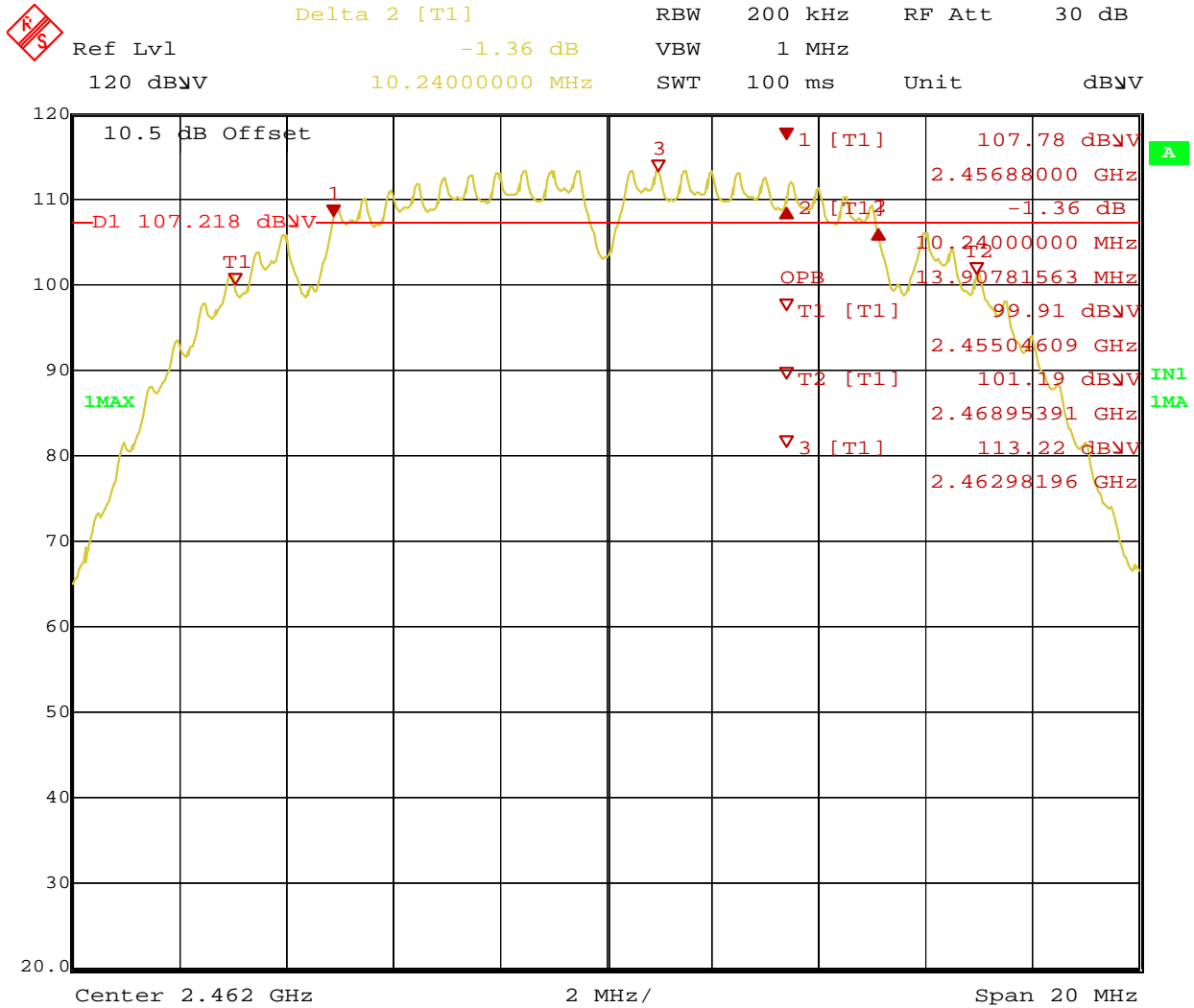
Date: 9.SEP.2011 13:40:30

Figure 37: 6 dB Bandwidth at 1Mbit/s – Operating Channel 2412 MHz, Chain 2



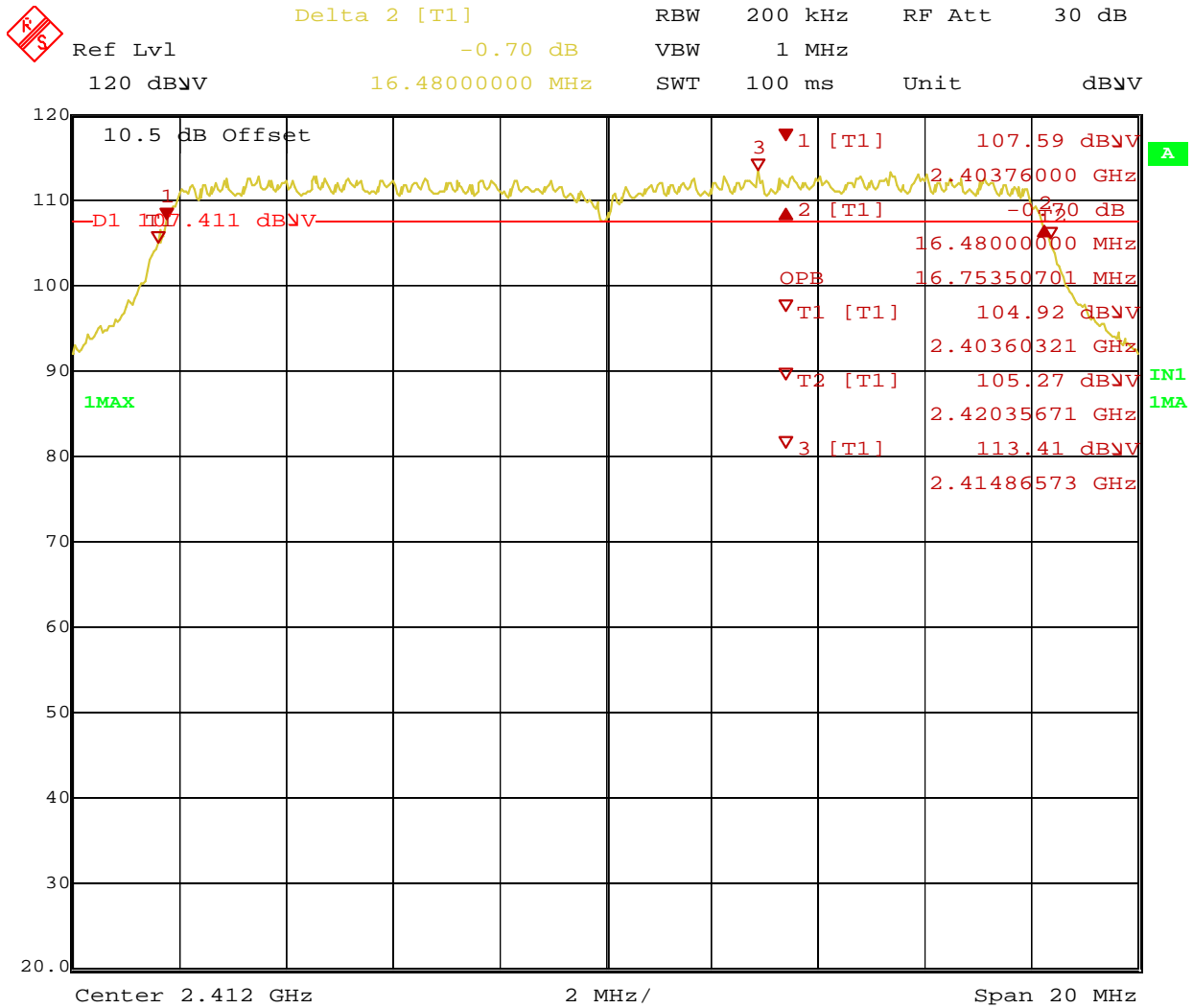
Date: 9.SEP.2011 13:58:58

Figure 38: 6 dB Bandwidth at 1Mbit/s – Operating Channel 2437 MHz, Chain 2



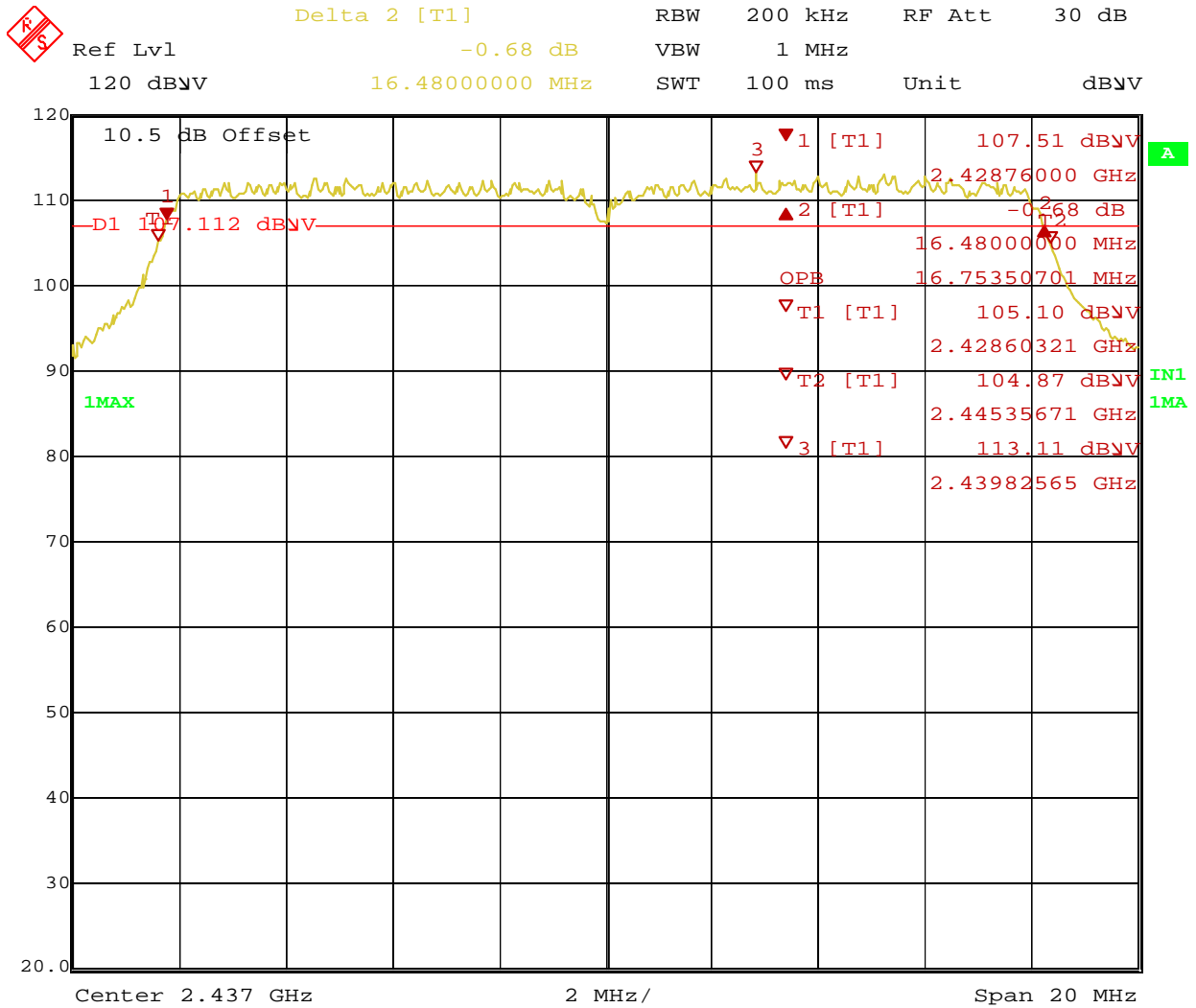
Date: 9.SEP.2011 13:28:22

Figure 39: 6 dB Bandwidth at 1Mbit/s – Operating Channel 2462 MHz, Chain 2



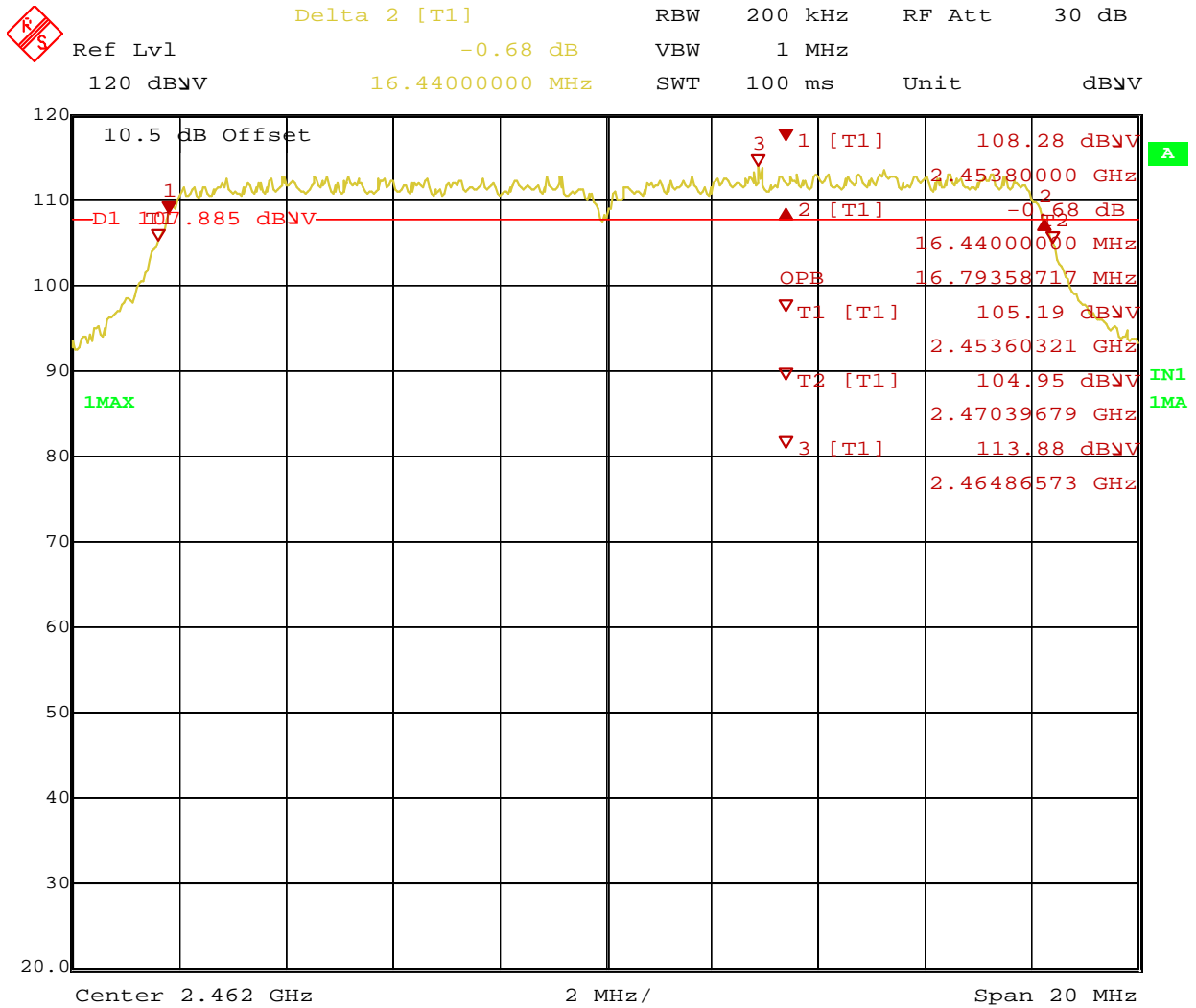
Date: 9.SEP.2011 15:47:16

Figure 40: 6 dB Bandwidth at 6Mbit/s – Operating Channel 2412 MHz, Chain 0



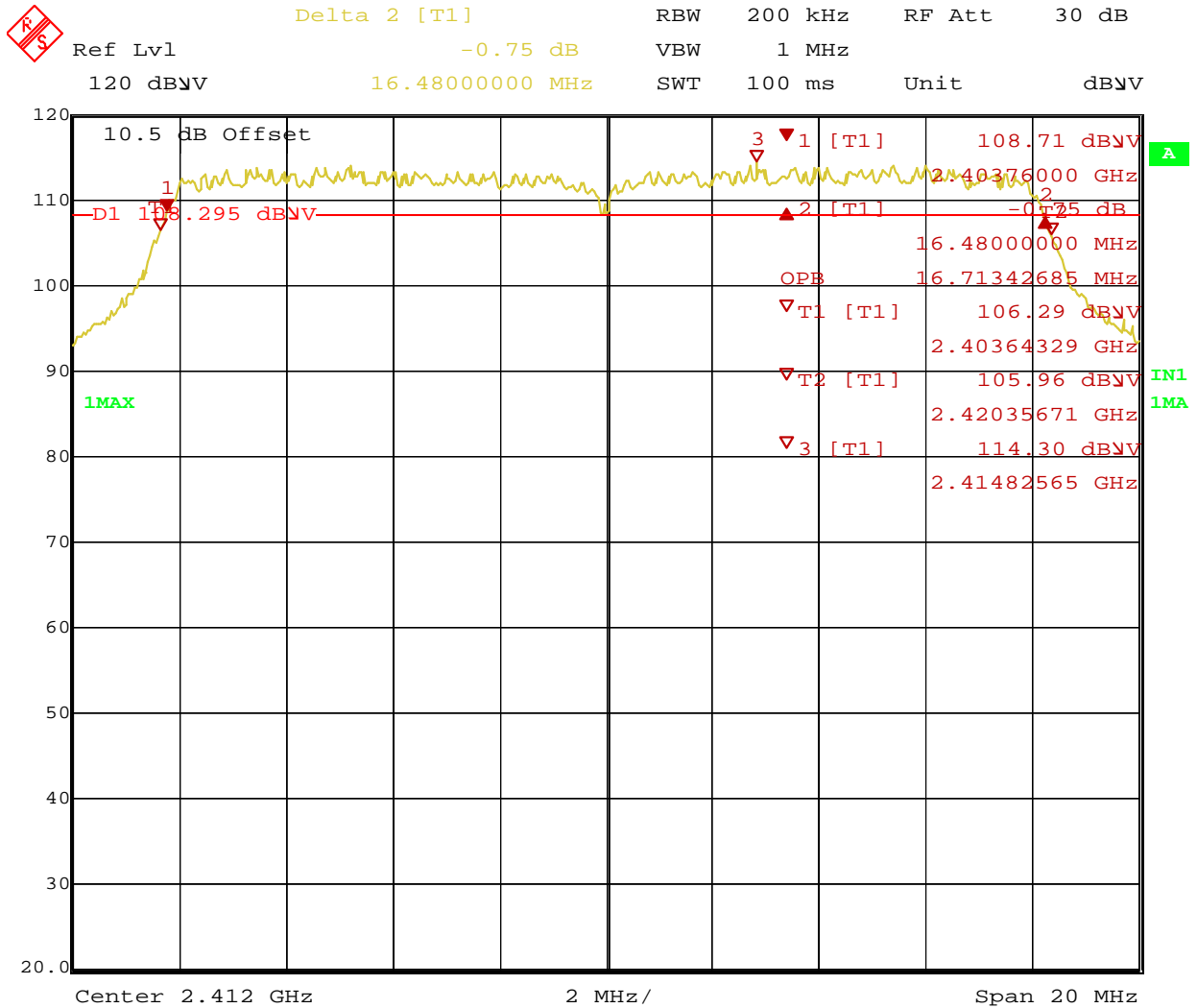
Date: 9.SEP.2011 15:31:55

Figure 41: 6 dB Bandwidth at 6Mbit/s – Operating Channel 2437 MHz, Chain 0



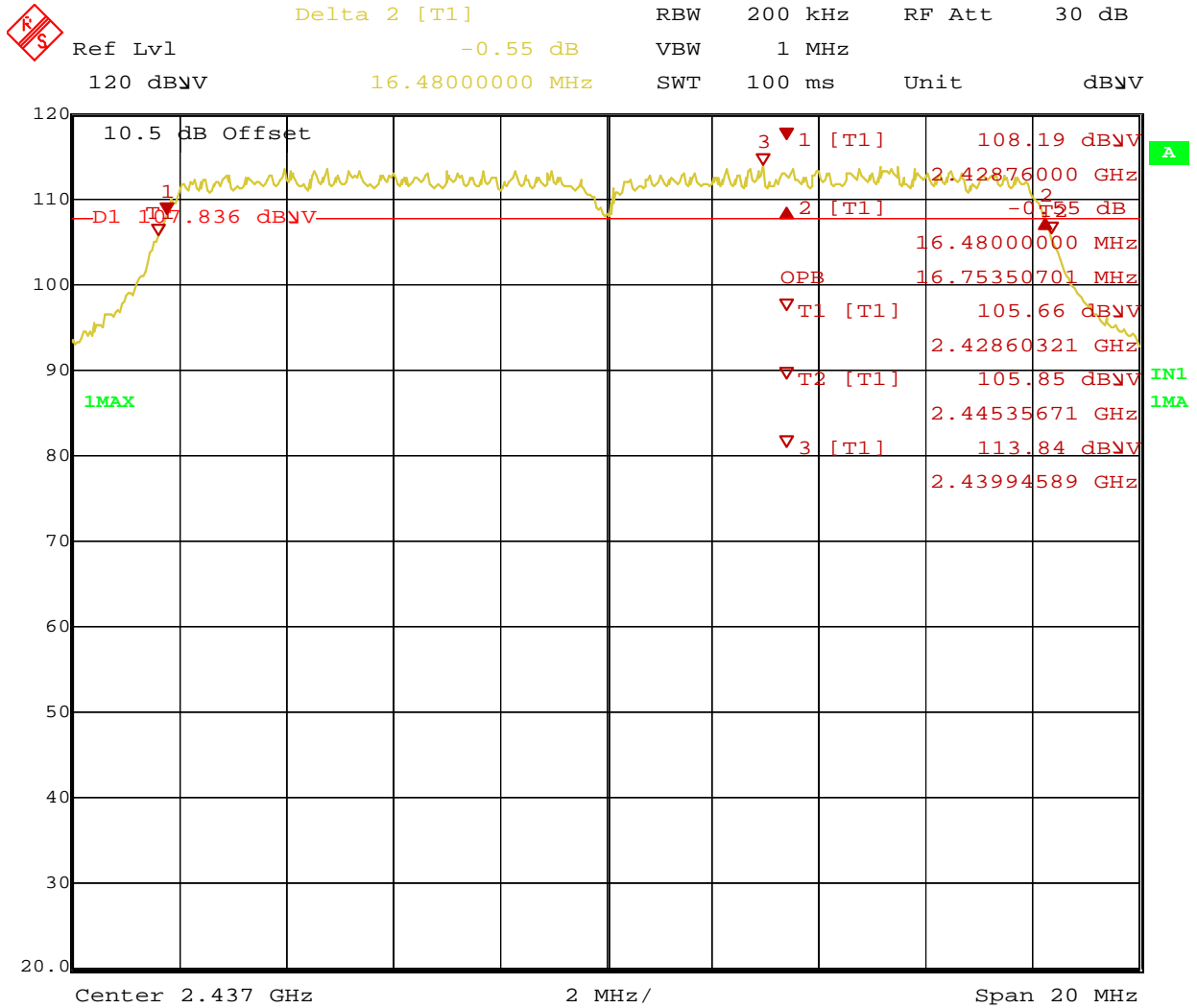
Date: 9.SEP.2011 15:16:47

Figure 42: 6 dB Bandwidth at 6Mbit/s – Operating Channel 2462 MHz, Chain 0



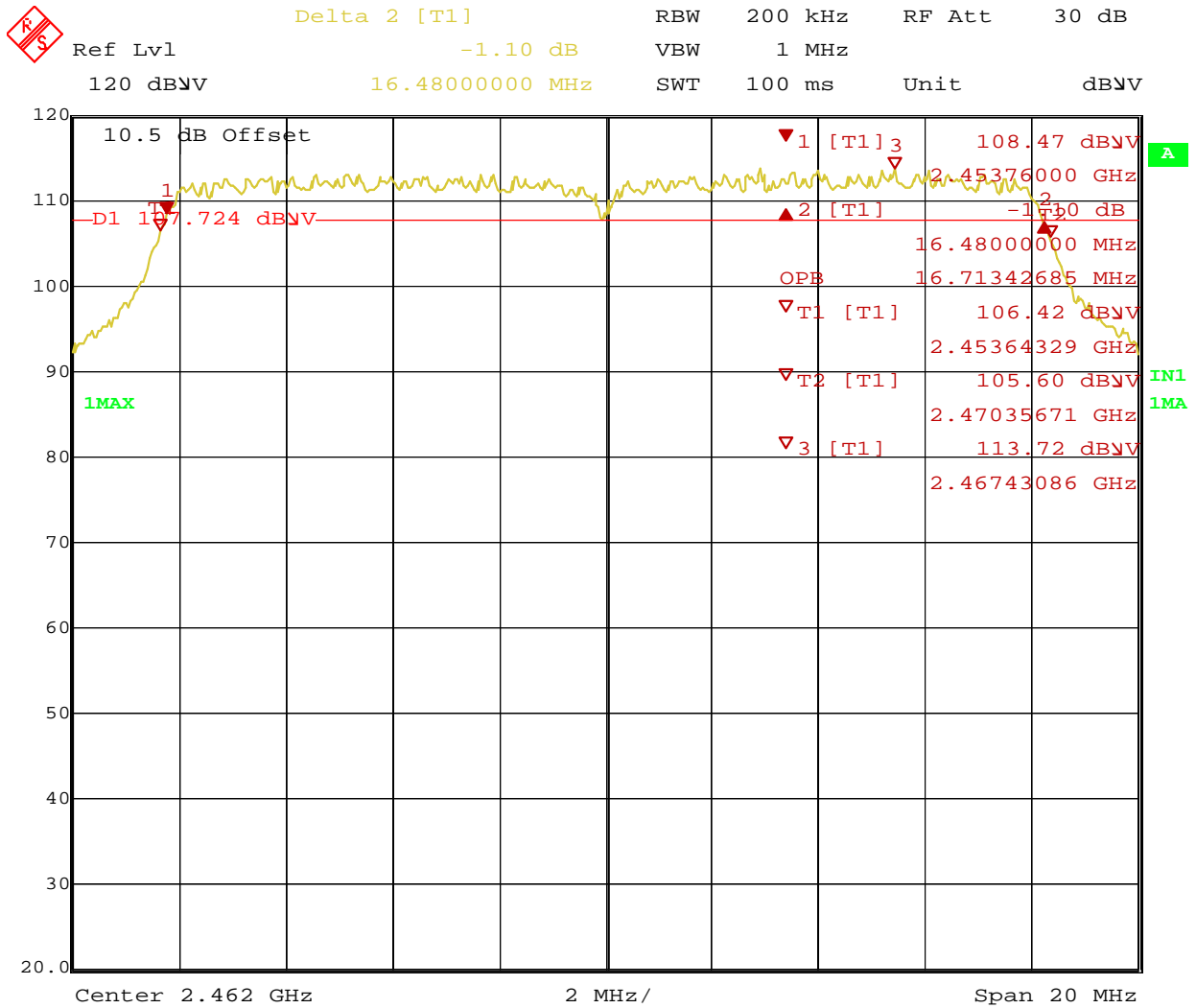
Date: 9.SEP.2011 15:58:56

Figure 43: 6 dB Bandwidth at 6Mbit/s – Operating Channel 2412 MHz, Chain 1



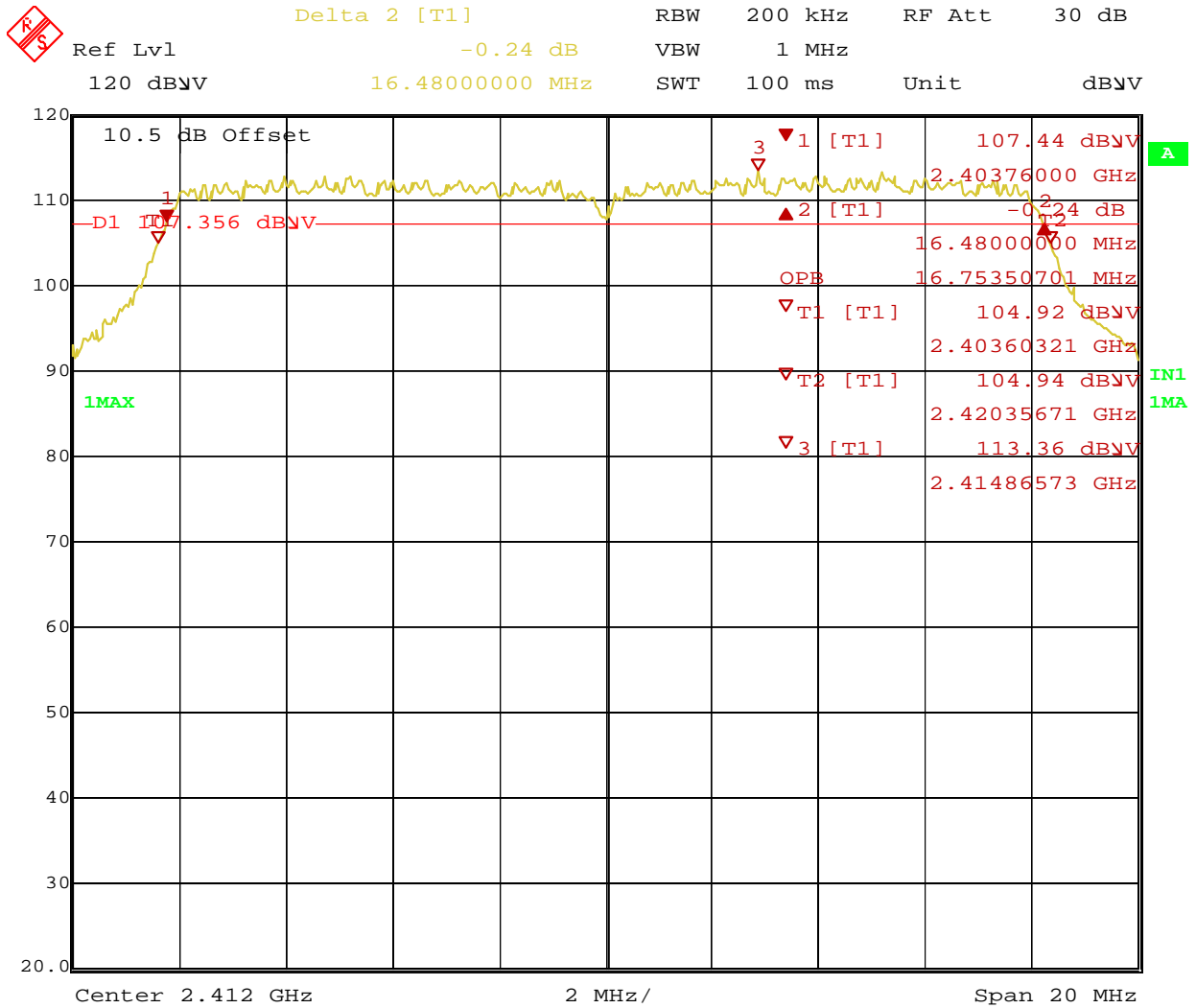
Date: 9.SEP.2011 16:12:41

Figure 44: 6 dB Bandwidth at 6Mbit/s – Operating Channel 2437 MHz, Chain 1



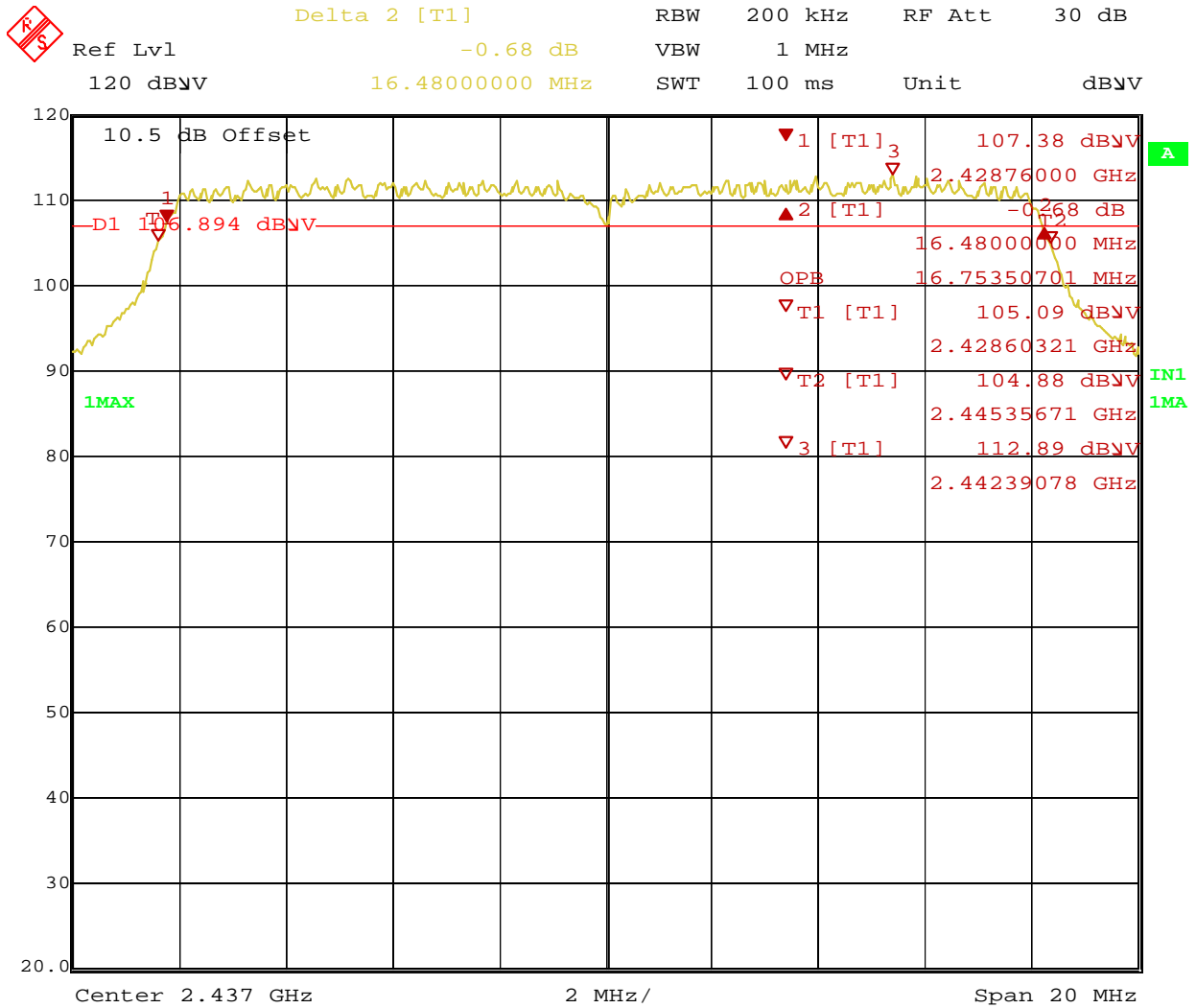
Date: 9.SEP.2011 16:22:50

Figure 45: 6 dB Bandwidth at 6Mbit/s – Operating Channel 2462 MHz, Chain 1



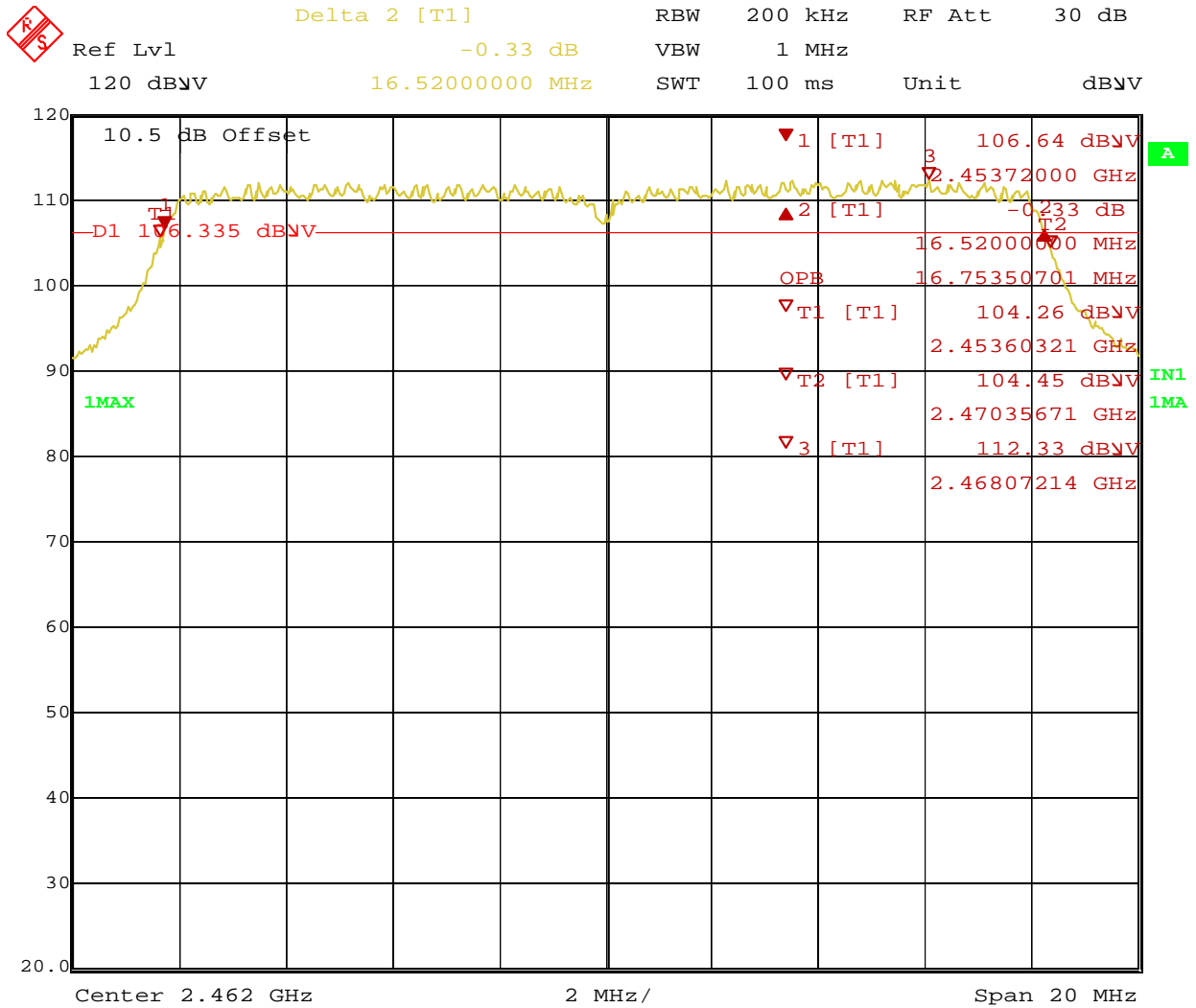
Date: 9.SEP.2011 14:54:48

Figure 46: 6 dB Bandwidth at 6Mbit/s – Operating Channel 2412 MHz, Chain 2



Date: 9.SEP.2011 14:30:01

Figure 47: 6 dB Bandwidth at 6Mbit/s – Operating Channel 2437 MHz, Chain 2

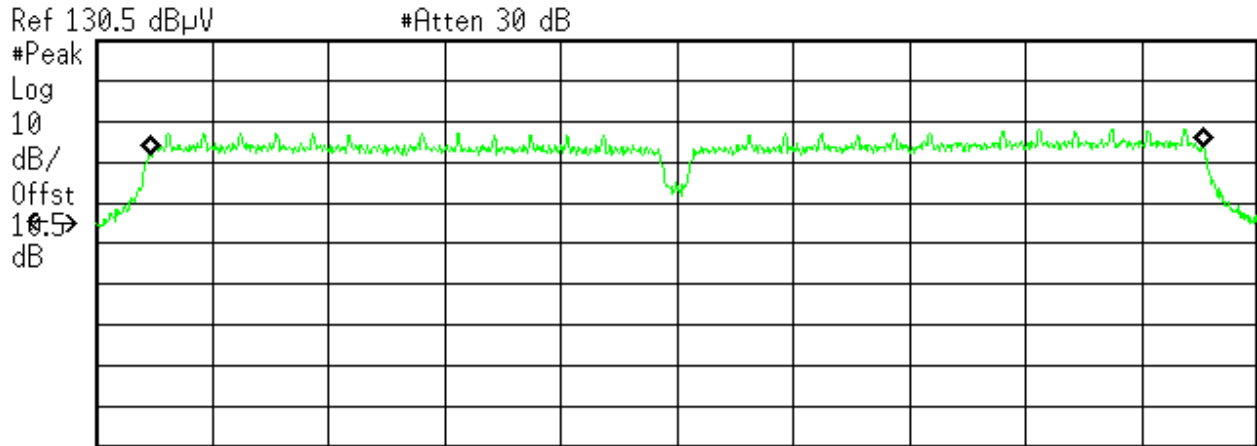


Date: 9.SEP.2011 15:03:29

Figure 48: 6 dB Bandwidth at 6Mbit/s – Operating Channel 2462 MHz, Chain 2

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Center 2.437 GHz Span 40 MHz
#Res BW 100 kHz #VBW 1 MHz #Sweep 100 ms (1000 pts)

Occupied Bandwidth
36.2034 MHz

Occ BW % Pwr 99.00 %
x dB -26.00 dB

Transmit Freq Error 2.901 kHz
x dB Bandwidth 40.000 MHz

Figure 49: 99% Bandwidth at 13.5Mbit/s – Operating Channel 2437MHz, Chain 0

4.3 Band-edge Requirements

The setup was identical to RF output power measurement. Intentional radiators operating under the alternative provisions to the general emission limits, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated. The requirement to contain the designated bandwidth of the emission within the specified frequency band includes the effects from frequency sweeping, frequency hopping and other modulation techniques that may be employed as well as the frequency stability of the transmitter over expected variations in temperature and supply voltage. If the frequency stability is not specified in the regulations, it is recommended that the fundamental emission be kept within at least the central 80% of the permitted band in order to minimize the possibility of out-of-band operation.

Any frequency outside the band of 2400 MHz to 2483.5MHz, the power output level must be below 20 dB from the in-band transmitting signal; CFR 47 Part 15.215, 15.247(d) and RSS 210 A8.5

4.3.1 Results

The Out of band emission was performed on the conducted test Sample.

As originally tested, the EUT was found to be compliant to the requirements of the test standard(s).

Table 4: Band-Edge Requirements – Test Results

Test Conditions: Conducted Measurement, Normal Temperature and Voltage only								
Antenna Type: 3 External				Power Setting: See test plan				
Max. Antenna Gain: + 2.0 dBi				Signal State: Modulated				
Ambient Temp.: 21 °C				Relative Humidity: 39%				
-20 dB Band-Edge Results								
Operating Freq.	Mode	Chain 0		Chain 1		Chain 2		Result
		Level (dBm)	Limit (dBm)	Level (dBm)	Limit (dBm)	Level (dBm)	Limit (dBm)	
2412 MHz	11Mbps	-51.83	-18.84	-49.31	-18.14	-43.67	-18.69	Pass
2437 MHz	11Mbps	-52.53	-18.69	-50.39	-19.07	-44.97	-16.27	Pass
2462 MHz	11Mbps	-52.89	-17.93	-52.12	-18.33	-44.05	-16.42	Pass
2412 MHz	6 Mbps	-31.96	-21.47	-29.28	-20.63	-31.00	-21.34	Pass
2437 MHz	6 Mbps	-51.76	-21.47	-49.71	-20.79	-50.58	-21.96	Pass

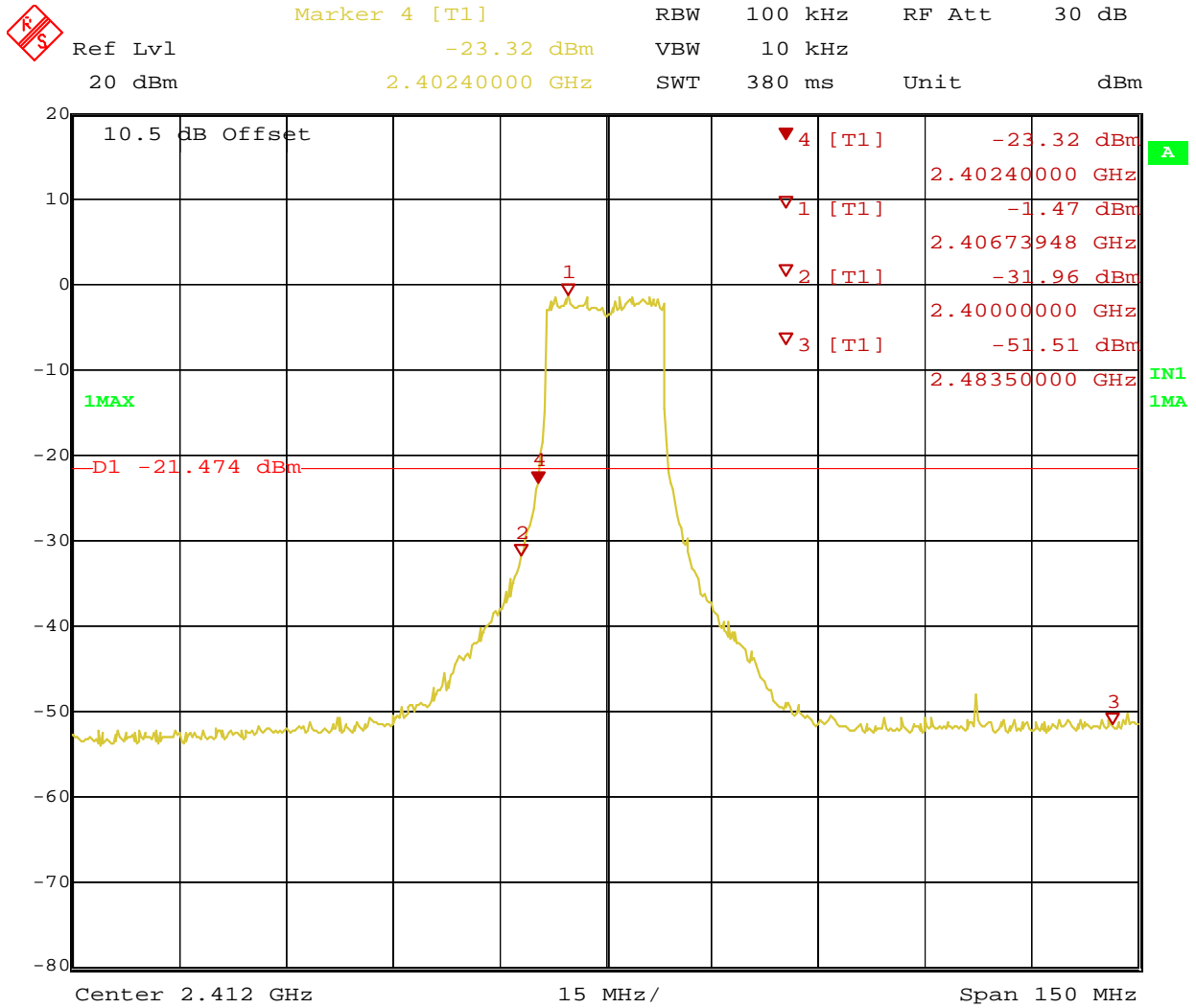
2462 MHz	6 Mbps	-42.59	-20.95	-40.69	-21.06	-44.89	-22.08	Pass
2412 MHz	HT20 65 Mbps	-31.42	-24.48	-22.42	-19.0	-22.04	-19.04	Pass
2437 MHz	HT20 65 Mbps	-44.00	-24.27	-20.55	-19.6	-22.99	-19.5	Pass
2462 MHz	HT20 65 Mbps	-40.85	-21.87	-21.02	-19.4	-19.89	-19.2	Pass
2422 MHz	HT40 13.5 Mbps	-26.36	-25.94	-29.52	-28.0	-18.89	-17.7	Pass
2437 MHz	HT40 13.5 Mbps	-28.04	-26.28	-24.58	-23.6	-24.8	-23.4	Pass
2452 MHz	HT40 13.5 Mbps	-26.15	-25.87	-21.02	-19.4	-25.15	-23.8	Pass
Note: The stated limits for 20 dBm are relative to each individual output per KDB 662911 Method.								

Note: All bandedge measurements were performed as indicated in the above table. Only worst case/ limited number of plots are placed in the report.

Table 5: Out of band Conducted Emission – Test Results

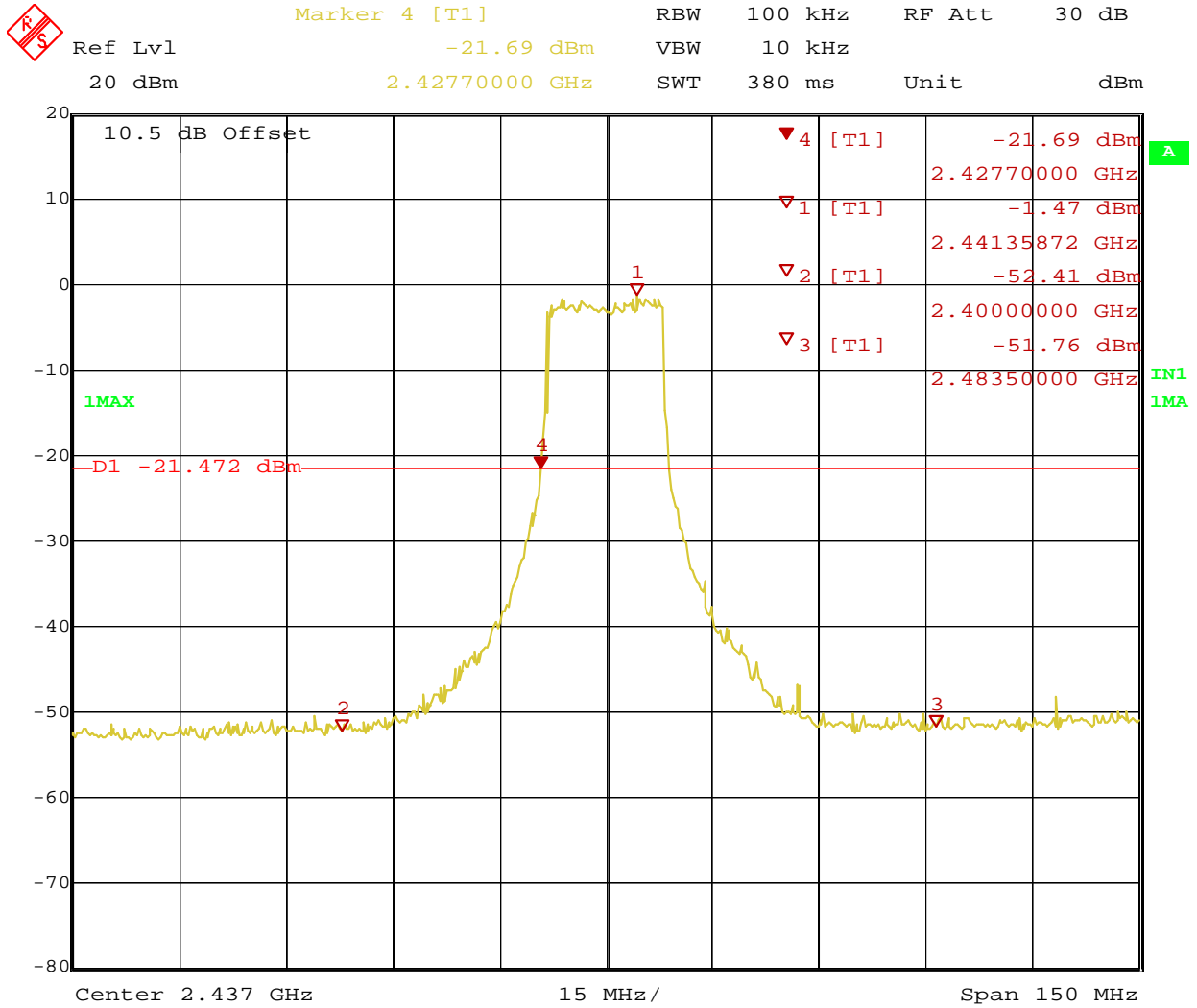
Operating Freq.	Mode	Result
2412 MHz	11Mbps	Pass
2437 MHz	11Mbps	Pass
2462 MHz	11Mbps	Pass
2412 MHz	6 Mbps	Pass
2437 MHz	6 Mbps	Pass
2462 MHz	6 Mbps	Pass
2412 MHz	HT20 65 Mbps	Pass
2437 MHz	HT20 65 Mbps	Pass
2462 MHz	HT20 65 Mbps	Pass
2422 MHz	HT40 13.5 Mbps	Pass
2437 MHz	HT40 13.5 Mbps	Pass
2452 MHz	HT40 13.5 Mbps	Pass

Note: Conducted out of band emissions were performed on all channels for b, g, HT 20 & HT 40 modes. Emissions on chain 1 are higher than chain 0 and chain 2. Only worst case graphs are placed here.



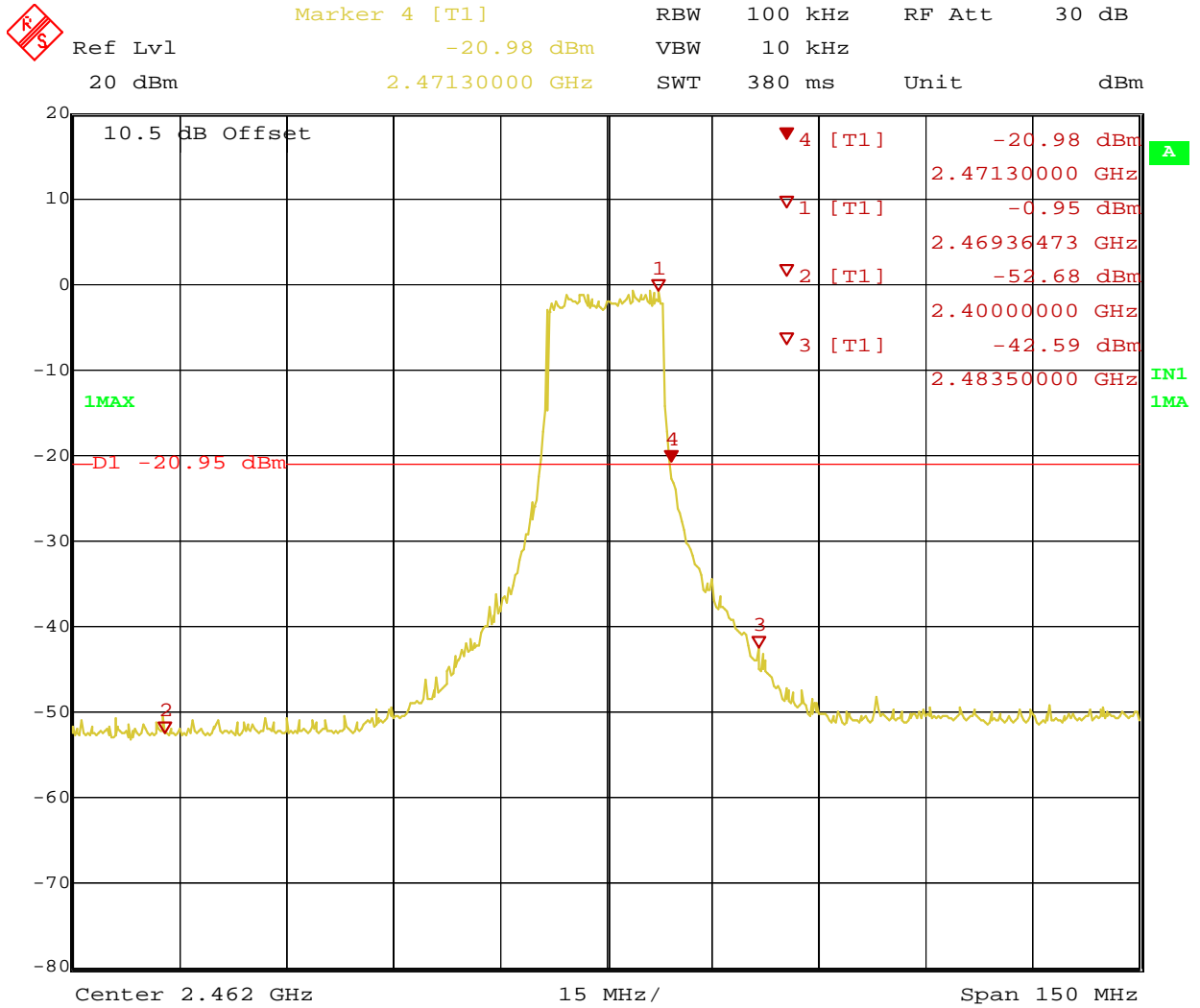
Date: 9.SEP.2011 15:47:30

Figure 50: Band-edge Requirement at Operating Channel 2412 MHz, Chain 0, 6MBit/s



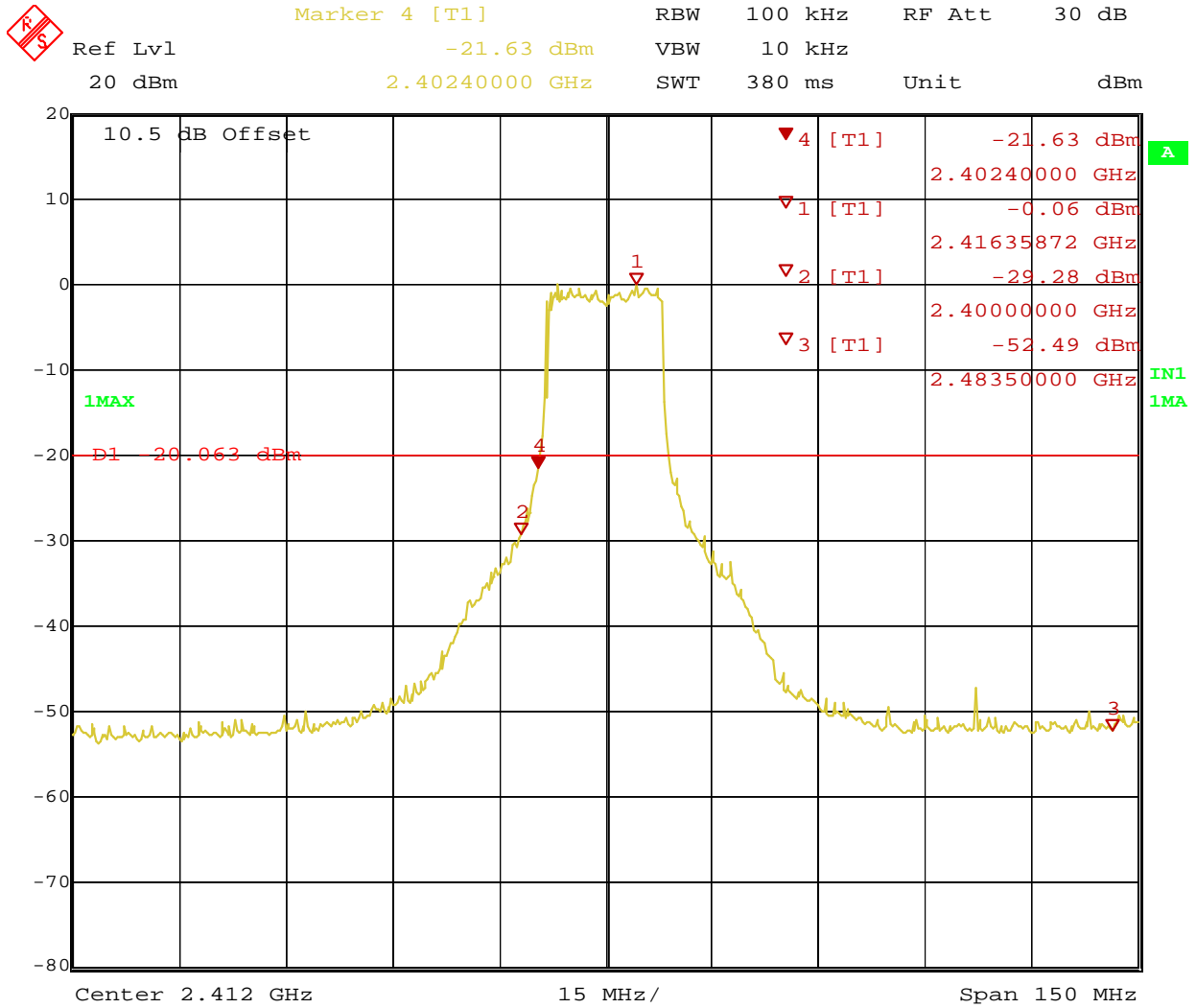
Date: 9.SEP.2011 15:32:09

Figure 51: Band-edge Requirement at Operating Channel 2437 MHz, Chain 0, 6MBit/s



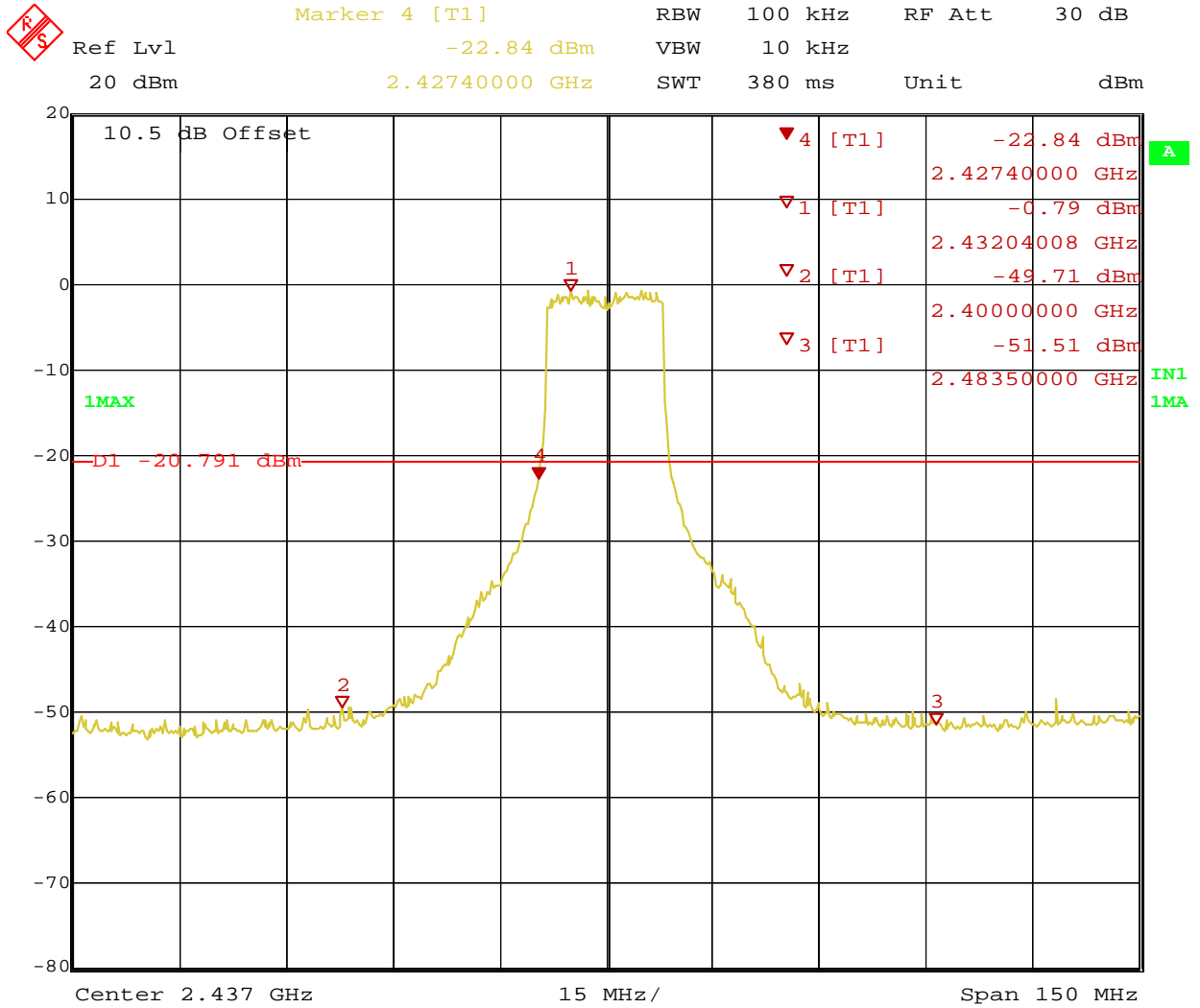
Date: 9.SEP.2011 15:17:01

Figure 52: Band-edge Requirement at Operating Channel 2462 MHz, Chain 0, 6MBit/s



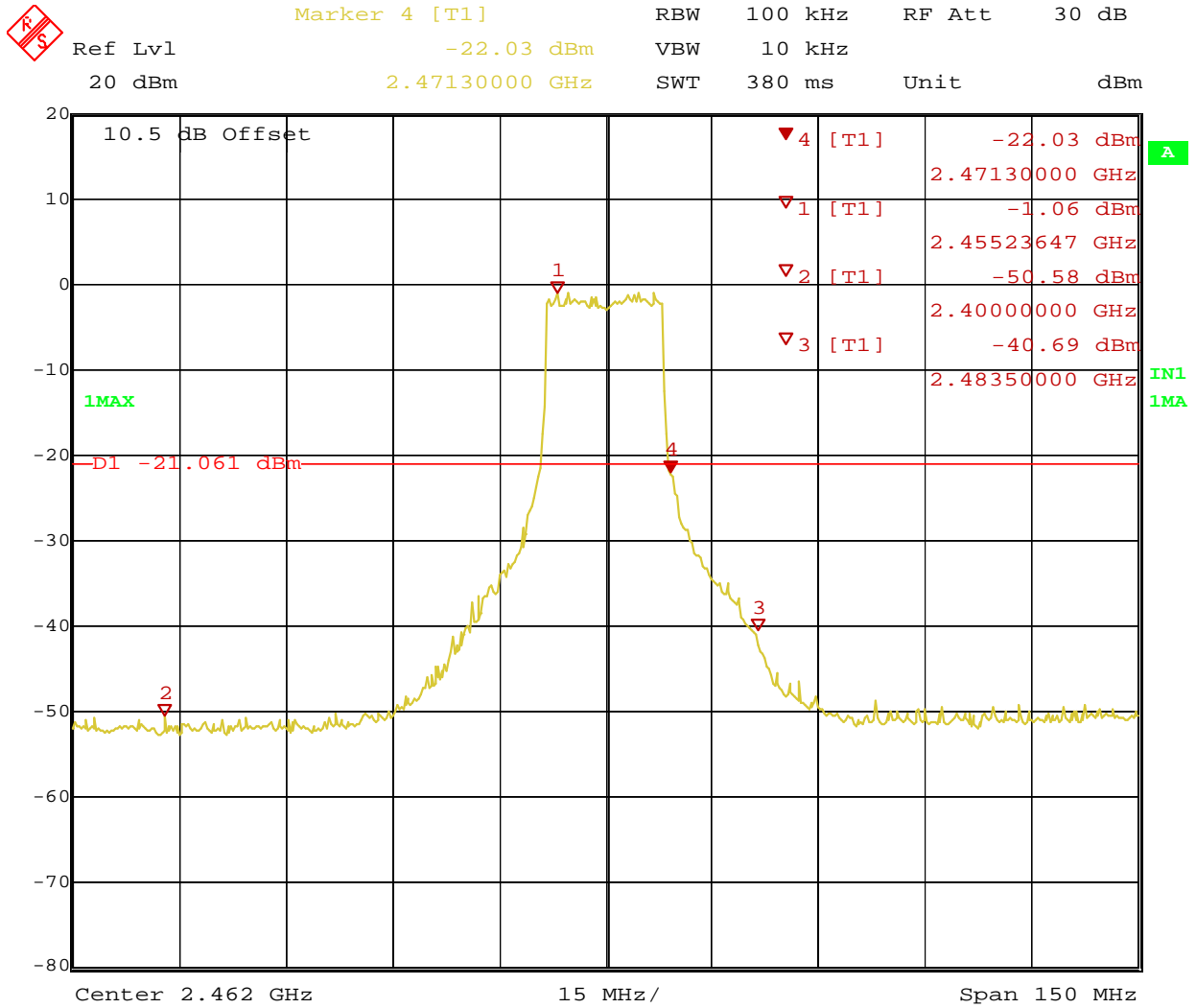
Date: 9.SEP.2011 15:59:10

Figure 53: Band-edge Requirement at Operating Channel 2412 MHz, Chain 1, 6MBit/s



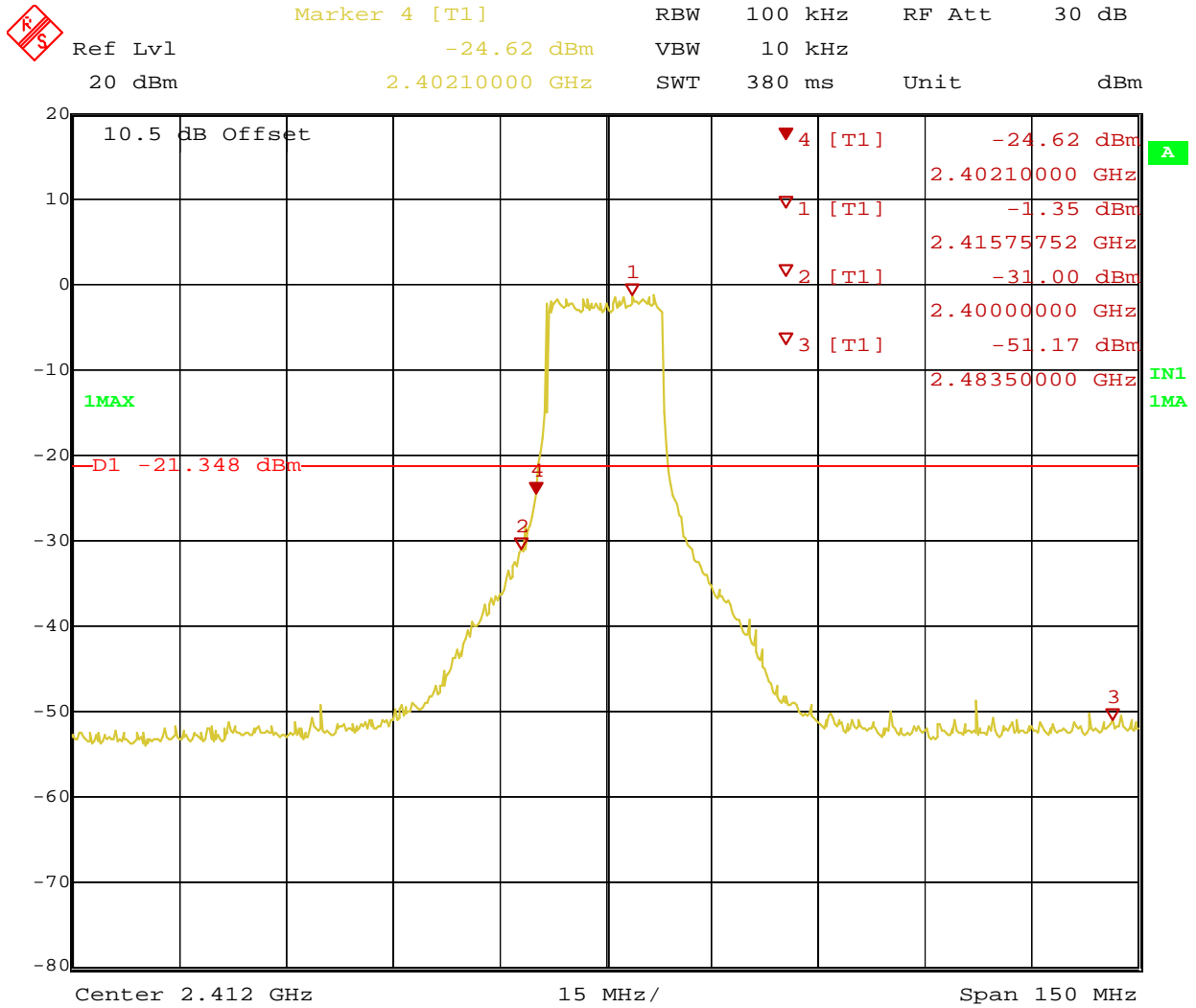
Date: 9.SEP.2011 16:12:55

Figure 54: Band-edge Requirement at Operating Channel 2437 MHz, Chain 1, 6MBit/s



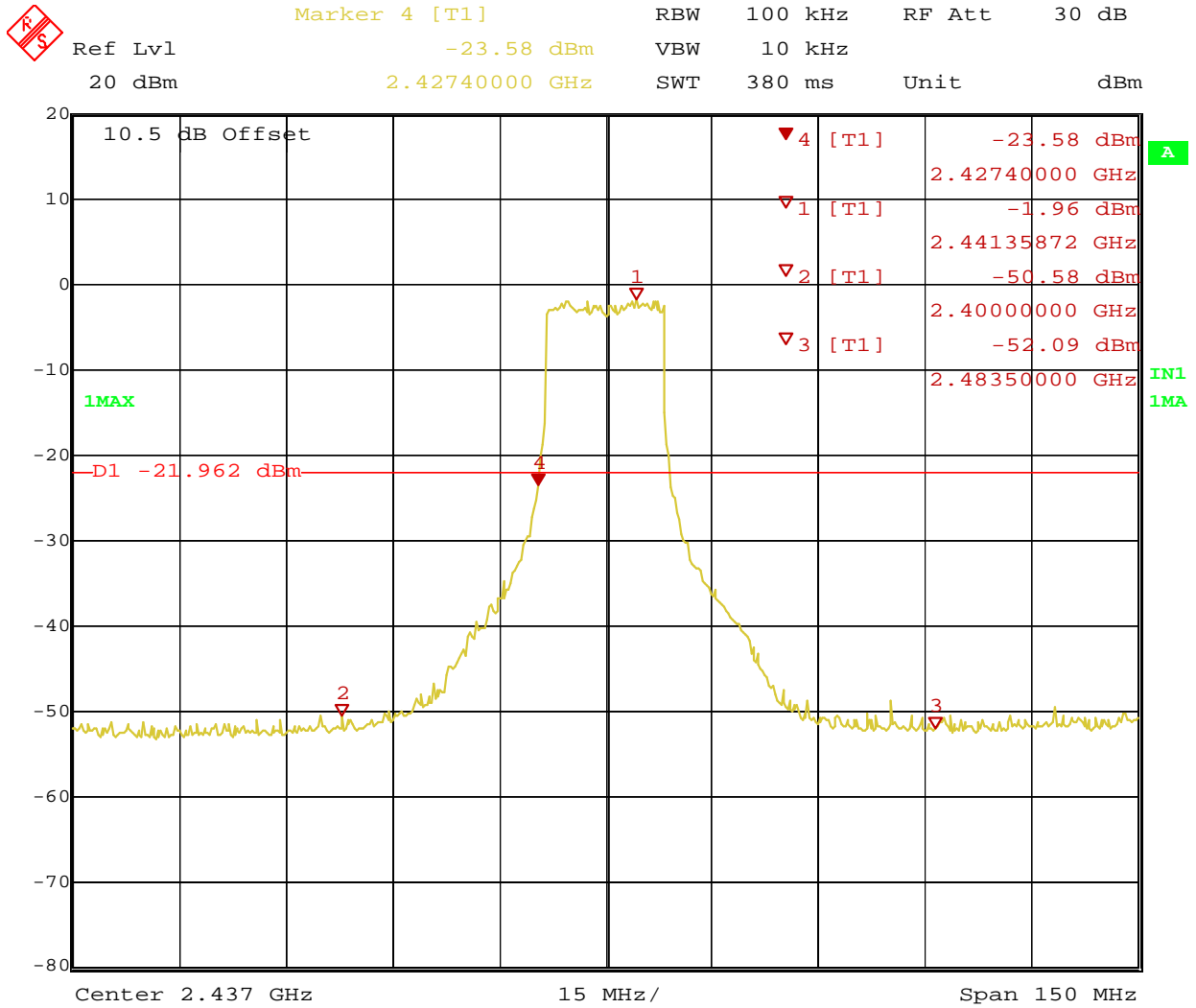
Date: 9.SEP.2011 16:23:04

Figure 55: Band-edge Requirement at Operating Channel 2462 MHz, Chain 1, 6MBit/s



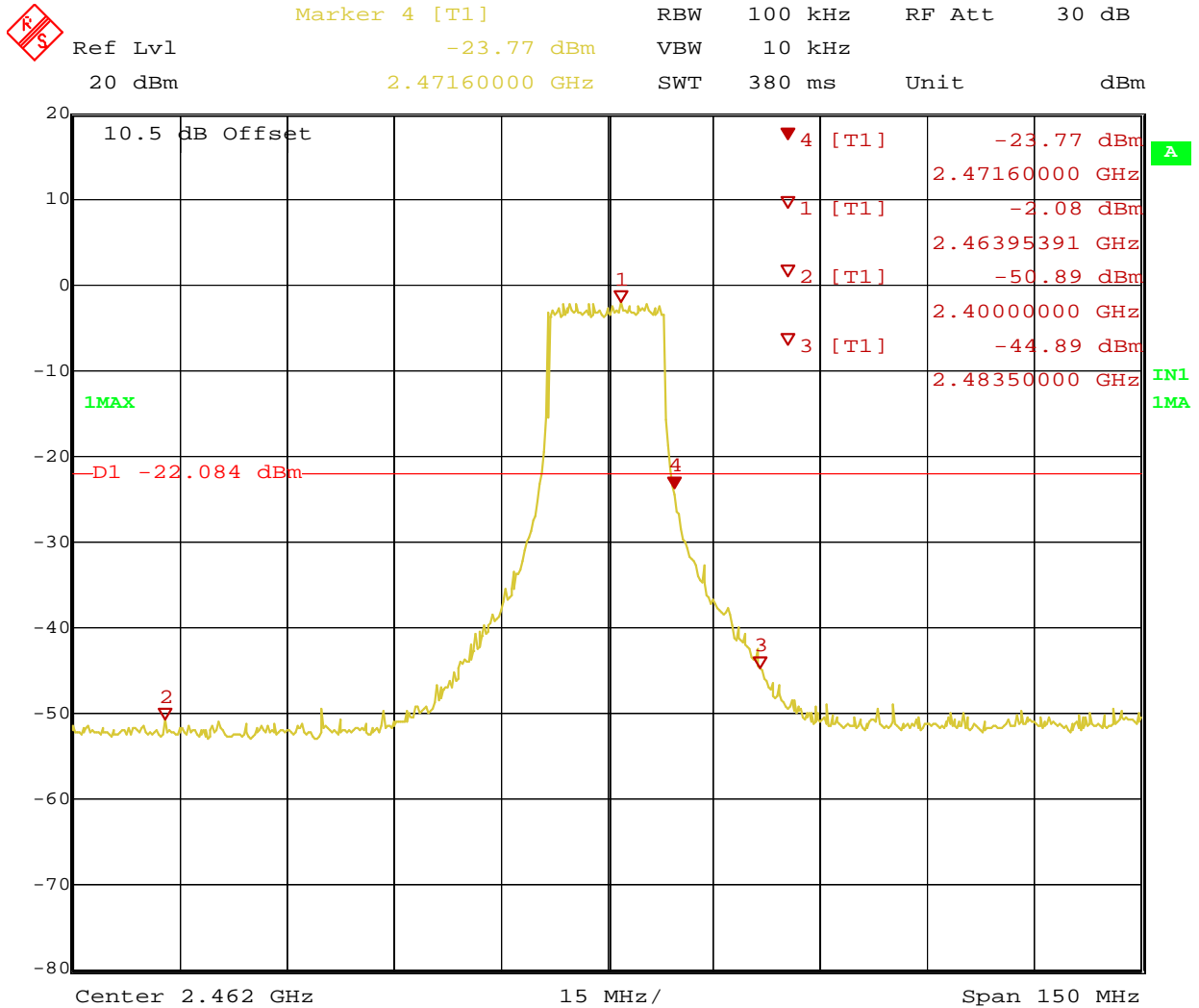
Date: 9.SEP.2011 14:55:02

Figure 56: Band-edge Requirement at Operating Channel 2412 MHz, Chain 2, 6MBit/s



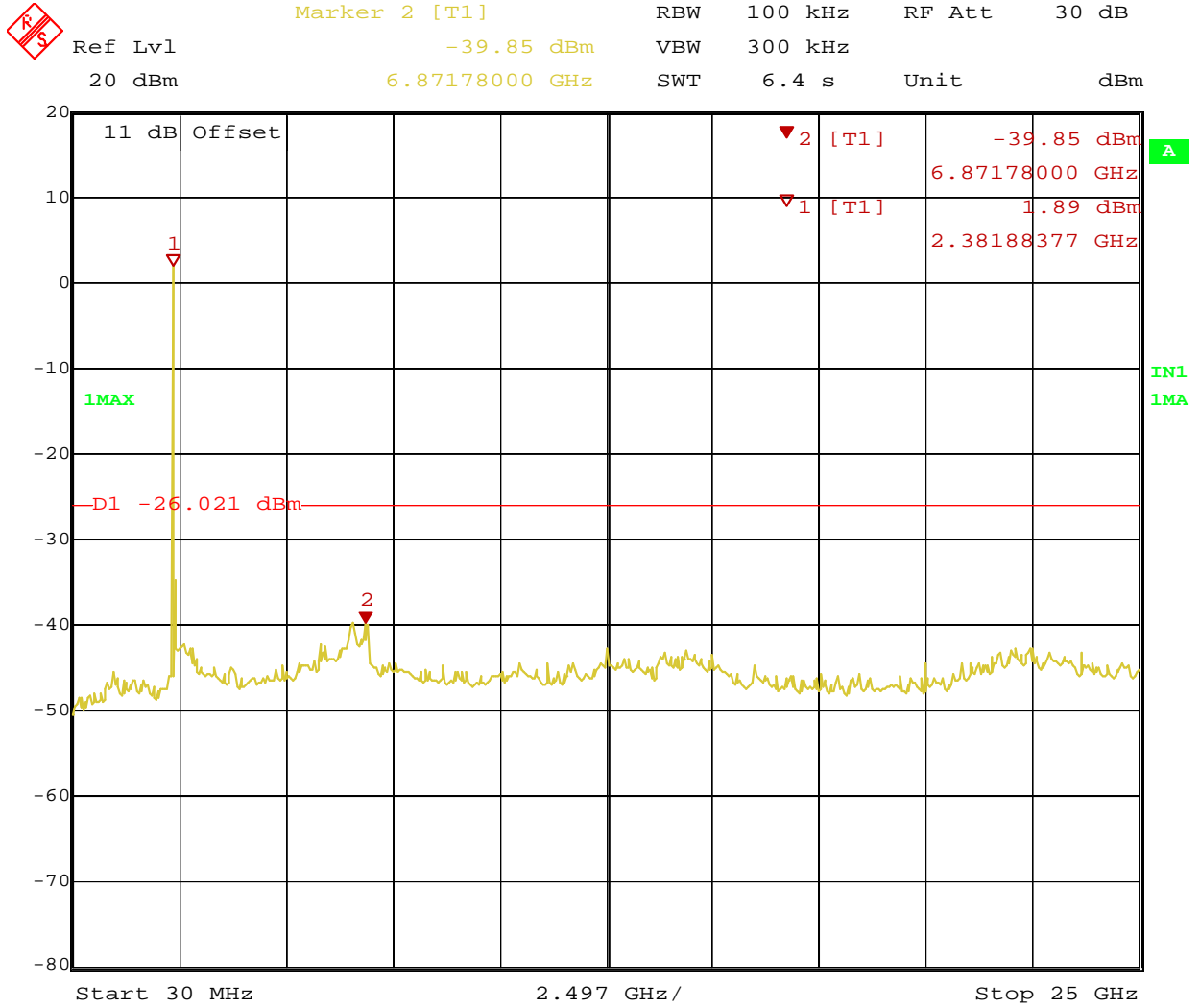
Date: 9.SEP.2011 14:30:15

Figure 57: Band-edge Requirement at Operating Channel 2437 MHz, Chain 2, 6MBit/s



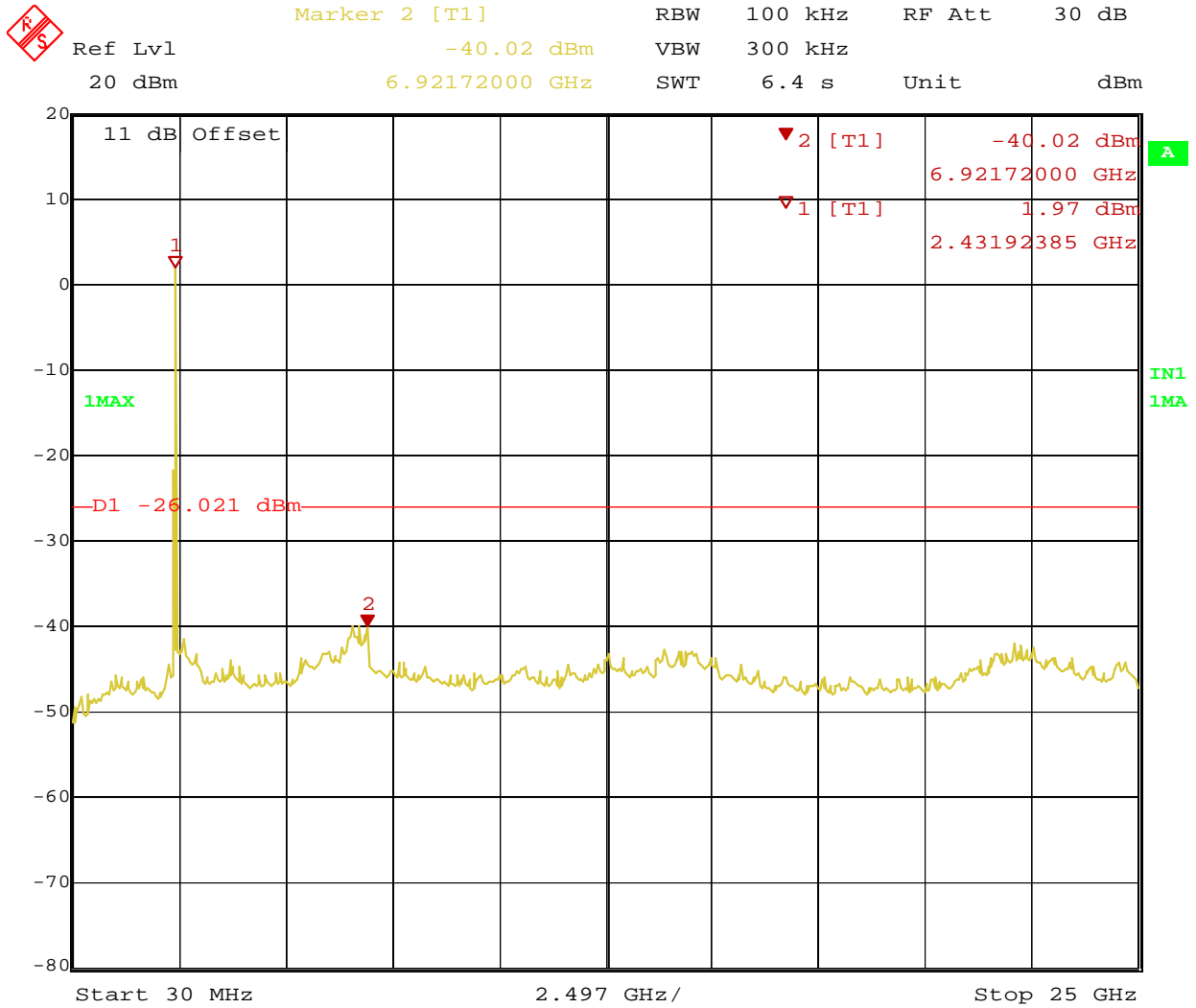
Date: 9.SEP.2011 15:03:43

Figure 58: Band-edge Requirement at Operating Channel 2462 MHz, Chain 2, 6MBit/s



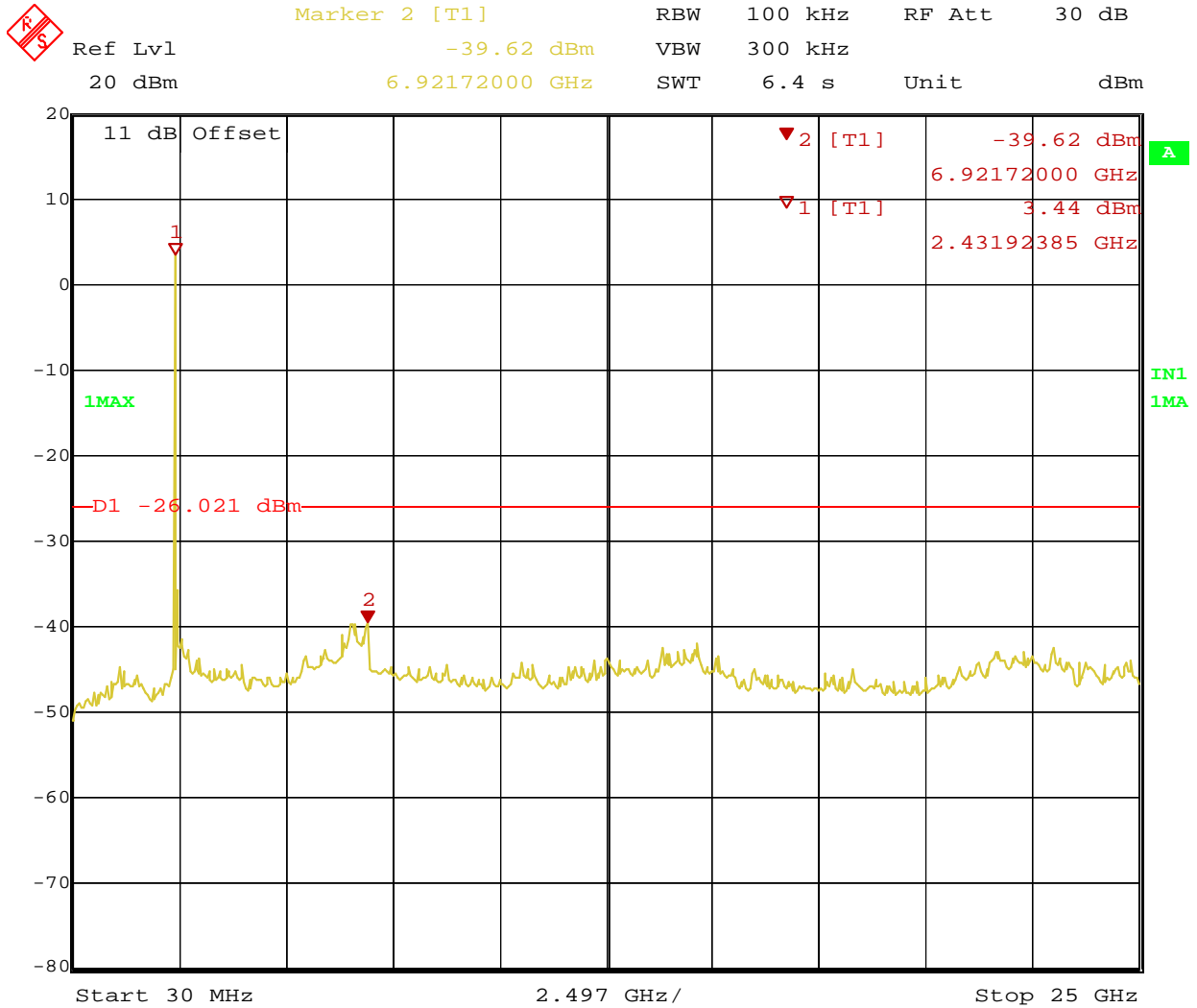
Date: 14.SEP.2011 16:36:33

Figure 59: Band-edge Requirement at Operating Channel 2437 MHz, Chain 2, 6MBit/s



Date: 14.SEP.2011 16:47:52

Figure 60: Out of band Emissions Operating Channel 2412 MHz, Ht 20 Mode , 13MBit/s



Date: 14.SEP.2011 16:55:41

Figure 61: Out of band Emissions Operating Channel 2412 MHz, HT 20 Mode , 13MBit/s

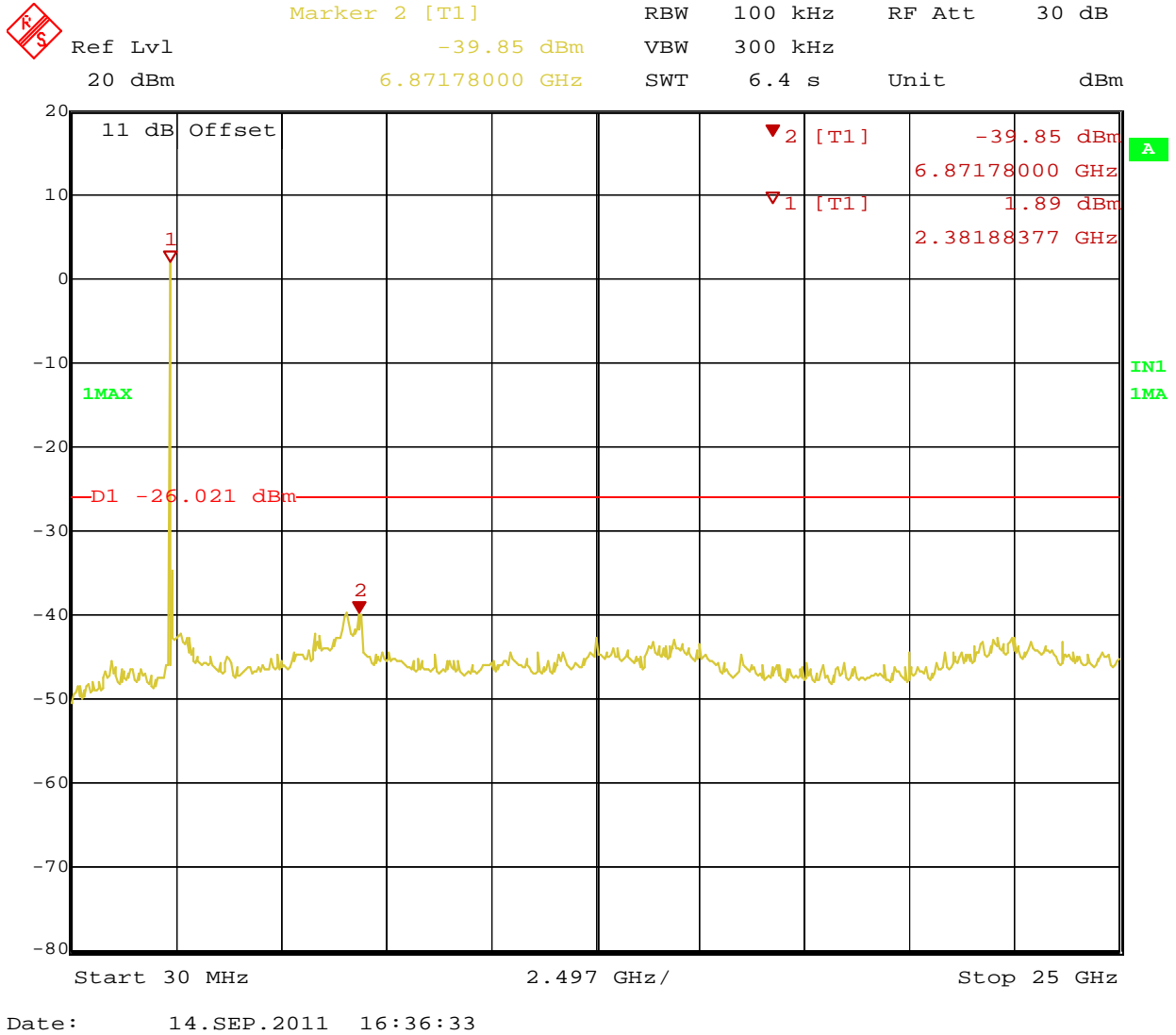
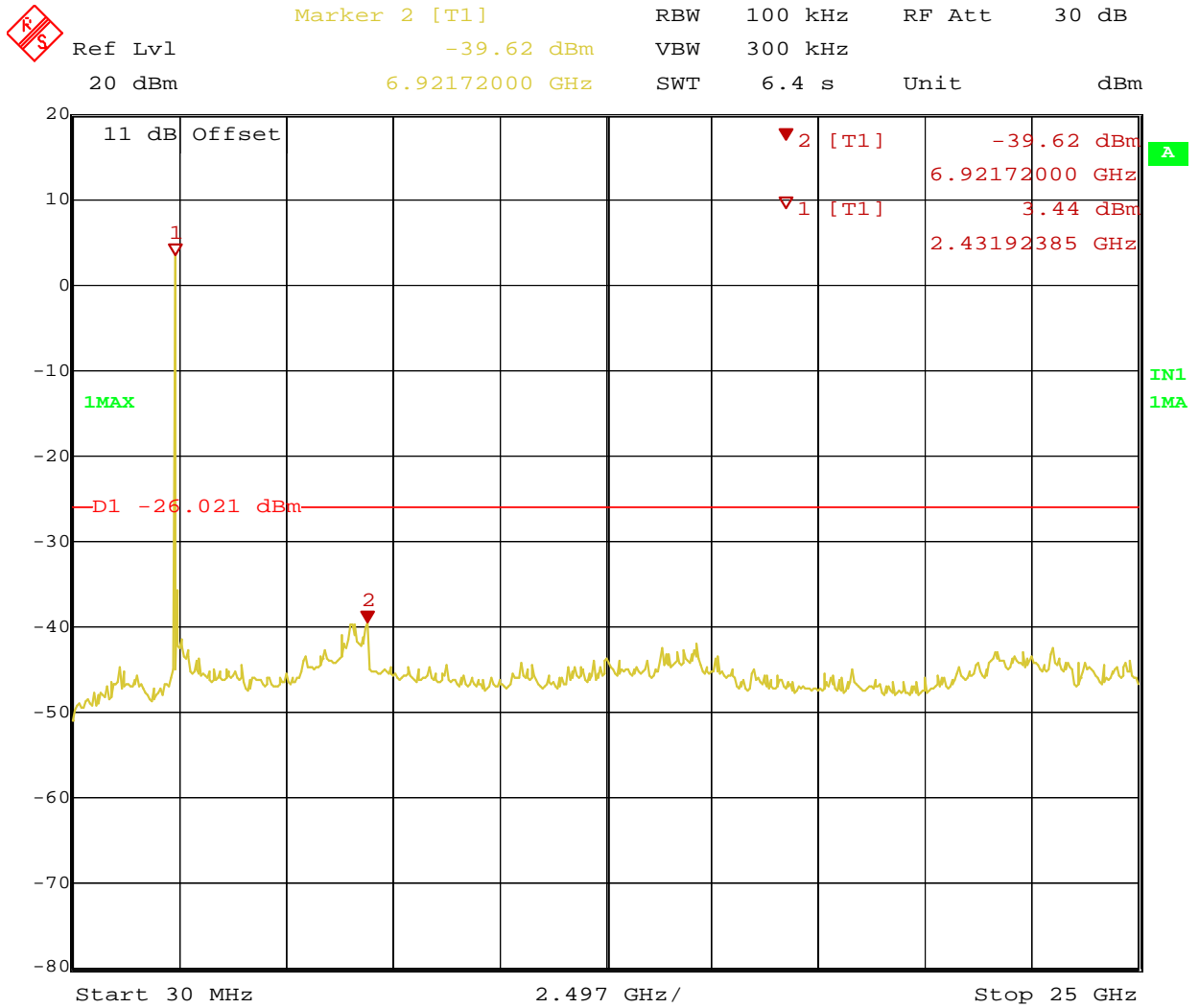


Figure 62: Out of band Emissions Operating Channel 2412 MHz, HT 40 Mode, 40.5MBit/s



Date: 14.SEP.2011 16:55:41

Figure 63 : Out of bandEmissions Operating Channel 2412 MHz, HT 40 Mode, 40.5MBit/s

4.4 Peak Power Spectral Density

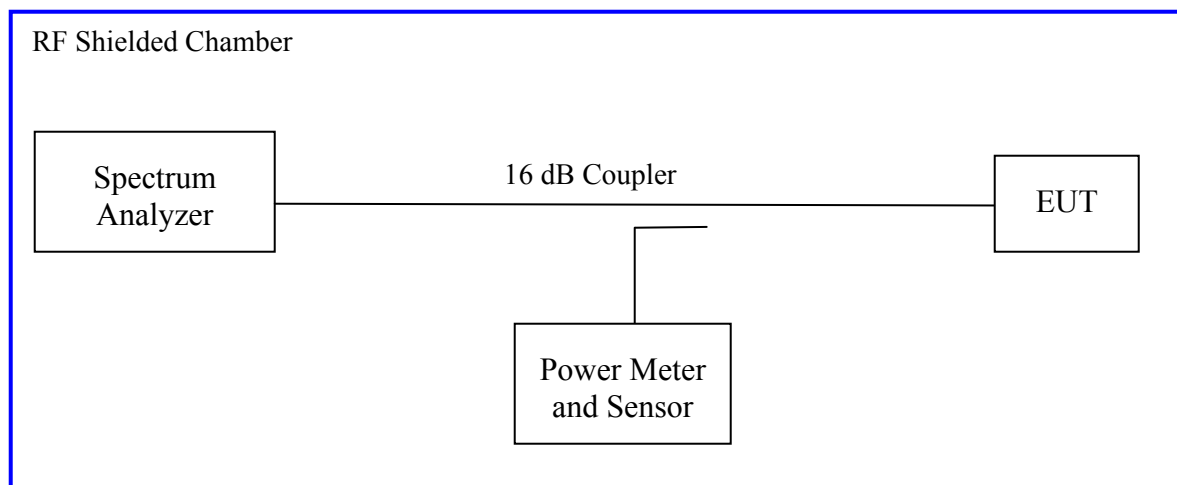
According to the CFR47 Part 15.247 (e) and RSS 210 (A8.2), the spectral power density output of the antenna port shall be less than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

4.4.1 Test Method

The conducted method was used to measure the channel power output per ANSI C63.10:2009 Section 6.11.2

The measurement was performed with modulation per CFR47 Part 15.247 (e) and RSS 210 (A8.2). This test was conducted on 3 channels in each mode. The worst sample result indicated below.

Test Setup:



4.4.2 Results

As originally tested, the EUT was found to be compliant to the requirements of the test standard(s).

Table 6: Peak Power Spectral Density – Test Results

Test Conditions: Conducted Measurement, Normal Temperature and Voltage only								
Antenna Type: 3 External			Power Setting: See test plan					
Max. Antenna Gain: + 2.0dBi			Signal State: Modulated					
Ambient Temp.: 21 °C			Relative Humidity: 39%					
Peak Power Spectral Density								
Freq. (MHz)	Mode	Chain 0 [dBm]	Chain 1 [dBm]	Chain 2 [dBm]	CF [dB]	Max. PPSD [dBm]	Limit [dBm]	Margin [dB]
2412	1Mbps	-8.11	-7.67	-7.16		-7.16	8.00	-15.16
2437	1Mbps	-6.86	-7.85	-8.22		-6.86	8.00	-14.86
2462	1Mbps	-7.85	-8.28	-8.69		-7.85	8.00	-15.85
2412	6 Mbps	-9.19	-9.75	-8.59		-8.59	8.00	-16.59
2437	6 Mbps	-7.67	-8.02	-9.39		-7.67	8.00	-15.67
2462	6 Mbps	-10.2	-10.9	-9.96		-9.96	8.00	-17.96
2412	HT20 6.5 Mbps	-9.26	-9.34	-9.52		-9.26	8.00	-17.26
2437	HT20 6.5 Mbps	-7.66	-8.07	-8.22		-7.66	8.00	-15.66
2462	HT20 6.5 Mbps	-8.09	-12.72	-13.6		-8.09	8.00	-16.09
2412	HT20 13 Mbps	-8.12	-9.64		3.01	-6.64	8.00	-14.64
2437	HT20 13 Mbps	-11.01	-11.20		3.01	-8.00	8.00	-16.00

2462	HT20 13 Mbps	-8.23	-9.96		3.01	-5.23	8.00	-13.23
2412	HT20 19.5 Mbps	-9.01	-9.20	-9.57	4.77	4.24	8.00	-3.76
2437	HT20 19.5 Mbps	-9.92	-8.07	-9.66	4.77	5.15	8.00	-2.85
2462	HT20 19.5 Mbps	-8.83	-9.29	-9.24	4.77	4.47	8.00	-3.53
2422	HT40 13.5 Mbps	-10.41	-12.24	-12.24		-10.41	8.00	-18.41
2437	HT40 13.5 Mbps	-12.91	-13.0	-12.8		-12.8	8.00	-20.8
2452	HT40 13.5 Mbps	-13.29	-13.29	-13.03		-13.29	8.00	-21.29
2422	HT40 27 Mbps	-12.10	-12.26		3.01	-9.25	8.00	-17.25
2437	HT40 27 Mbps	-12.26	-12.29		3.01	-9.25	8.00	-17.25
2452	HT40 27 Mbps	-14.48	-14.42		3.01	-11.40	8.00	-19.40
2422	HT40 40.5 Mbps	-15.16	-15.34	-16.5	4.77	-10.57	8.00	-20.57
2437	HT40 40.5 Mbps	-15.86	-15.21	-14.98	4.77	-10.21	8.00	-18.21
2452	HT40 40.5 Mbps	-13.98	-15.86	-16.7	4.77	-9.21	8.00	-17.21
<p>Note: CF was accounted for the number of data streams being used, $10 \cdot \log(N)$ per KDB 662911; where N is number of outputs.</p>								

Agilent 08:40:33 Sep 29, 2011

R T

Mkr1 2.41446825 GHz
 -9.571 dBm

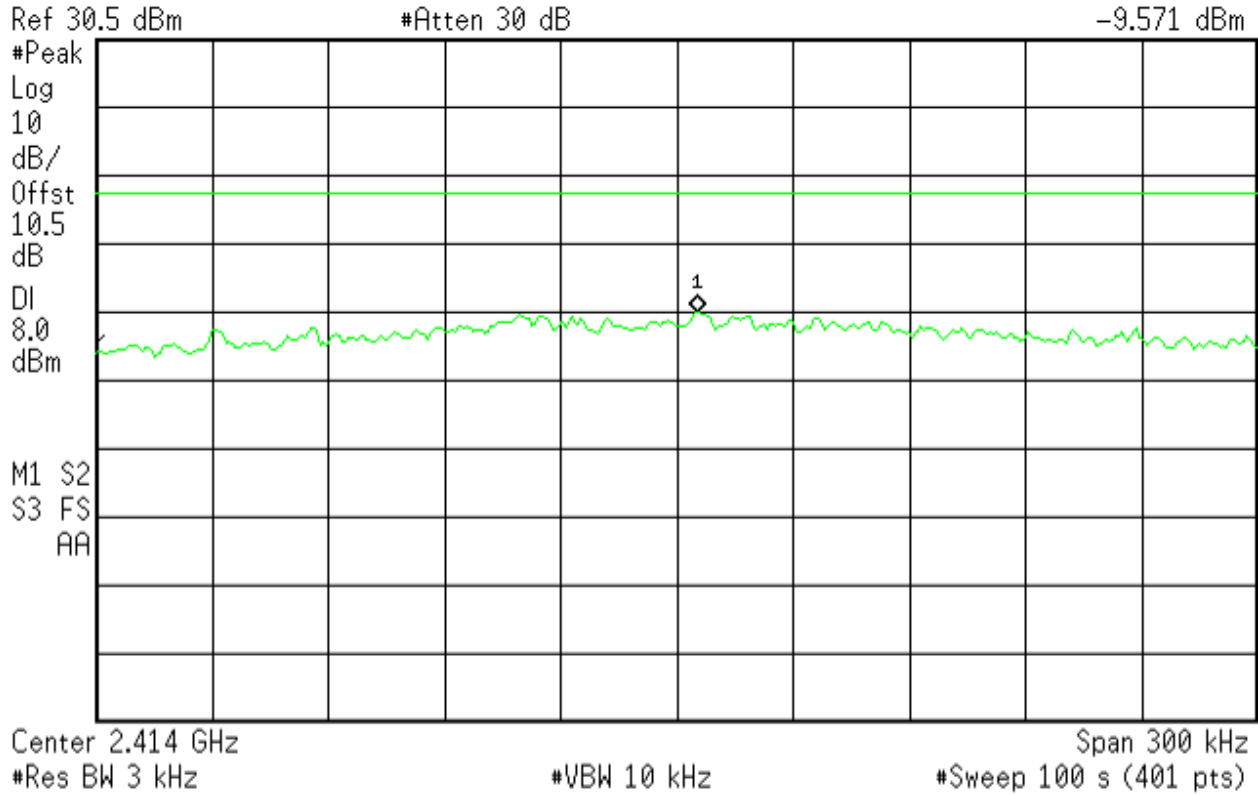


Figure 64: Peak Power Spectral Density for Operating Channel 2412MHz, Chain 2 – 19.5Mbps

Note: Investigation was done on the the channels and mode as indicated in the table only worst case graph is placed in the report

4.5 Transmitter Spurious Emissions

Transmitter spurious emissions are emissions outside the frequency range of the equipment when the equipment is in transmit mode; per requirement of CFR47 15.205, 15.209, 15.247(d), RSS 210 Sect. A.8.5

4.5.1 Test Methodology

4.5.1.1 Preliminary Test

A test program that controls instrumentation and data logging was used to automate the preliminary RF emission test procedure. The frequency range of interest was divided into sub-ranges to yield a frequency resolution of approximately 120 kHz and provide a reading at each frequency for no more than 12° of turntable rotation. For each frequency sub-range the turntable was rotated 360° while peak emission data was recorded and plotted over the frequency range of interest in horizontal and vertical antenna polarization's.

Preliminary emission profile testing was performed inside the anechoic chamber. The EUT was placed on a 1.0m x 1.5m non-conductive table 80cm above the floor. The EUT was positioned as shown in the setup photographs. The receiving antenna was placed at a distance of 3m at a fixed height of 1m. Measurement equipment was located outside of the chamber. A video camera was placed inside the chamber to view the EUT.

4.5.1.2 Final Test

For each frequency measured, the peak emission was maximized by manipulating the receiving antenna from 1 to 4 meters above the ground plane and placing it at the position that produced the maximum signal strength reading. The turntable was then rotated through 360° while observing the peak signal and placing the EUT at the position that produced maximum radiation. The six highest emissions relative to the limit were measured unless such emissions were more than 20 dB below the limit. If less than six emissions are within 20 dB of the limit, than the noise level of the receiver is measured at frequencies where emissions are expected. Multiples of all oscillator and microprocessor frequencies were also checked.

Final testing was performed on an NSA compliant test site. The EUT was placed on a 1.0m x 1.5m non-conductive table 80cm above the ground plane. The placement of EUT and cables were the same as for preliminary testing and is shown in the setup photographs.

The final scans performed on the worst axis, Y-Axis, for three operating channels;

2412MHz, 2437MHz, and 2462MHz at 1Mbit/s for 802.11b mode,

2412MHz, 2437MHz, and 2462MHz at 6Mbit/s for 802.11g mode,

2412MHz, 2437MHz, and 2462MHz at 6.5Mbit/s for 802.11n HT20 mode, and

2422MHz, 2437MHz, and 2452MHz at 13.5Mbit/s for 802.11n HT40 mode.

4.5.1.3 Deviations

None.

4.5.2 Transmitter Spurious Emission Limit

The spurious emissions of the transmitter shall not exceed the values in CFR47 Part 15.205, 15.209: 2009 and RSS 210 A1.1.2 2010.

Frequency (MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
0.009-0.490.....	2400/F (kHz)	300
0.490-1.705.....	24000/F (kHz)	30
1.705-30.0.....	30	30
30-88.....	100 **	3
88-216.....	150 **	3
216-960.....	200 **	3
Above 960.....	500	3

All harmonics and spurious emission which are outside of the restricted band shall be 20 dB below the in-band emission.

4.5.3 Test Results

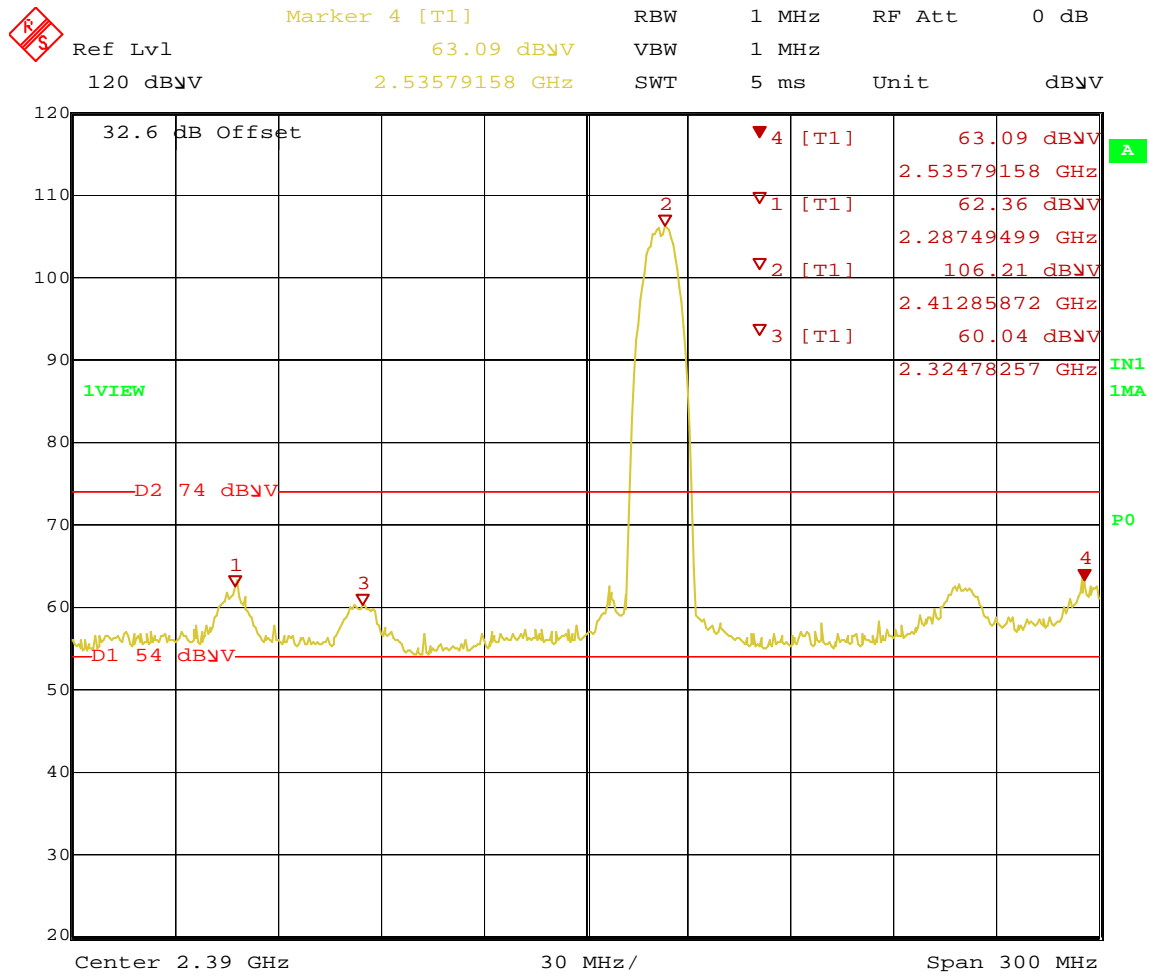
The final measurement data was taken under the worst case operating modes, configurations, and/or cable positions. It also reflects the results including any modifications and/or special accessories listed in Sections 1.4 and Test Plan.

As originally tested, the EUT was found to be compliant to the requirements of the test standard(s).

Table 7: Transmit Spurious Emission at Band-Edge Requirements

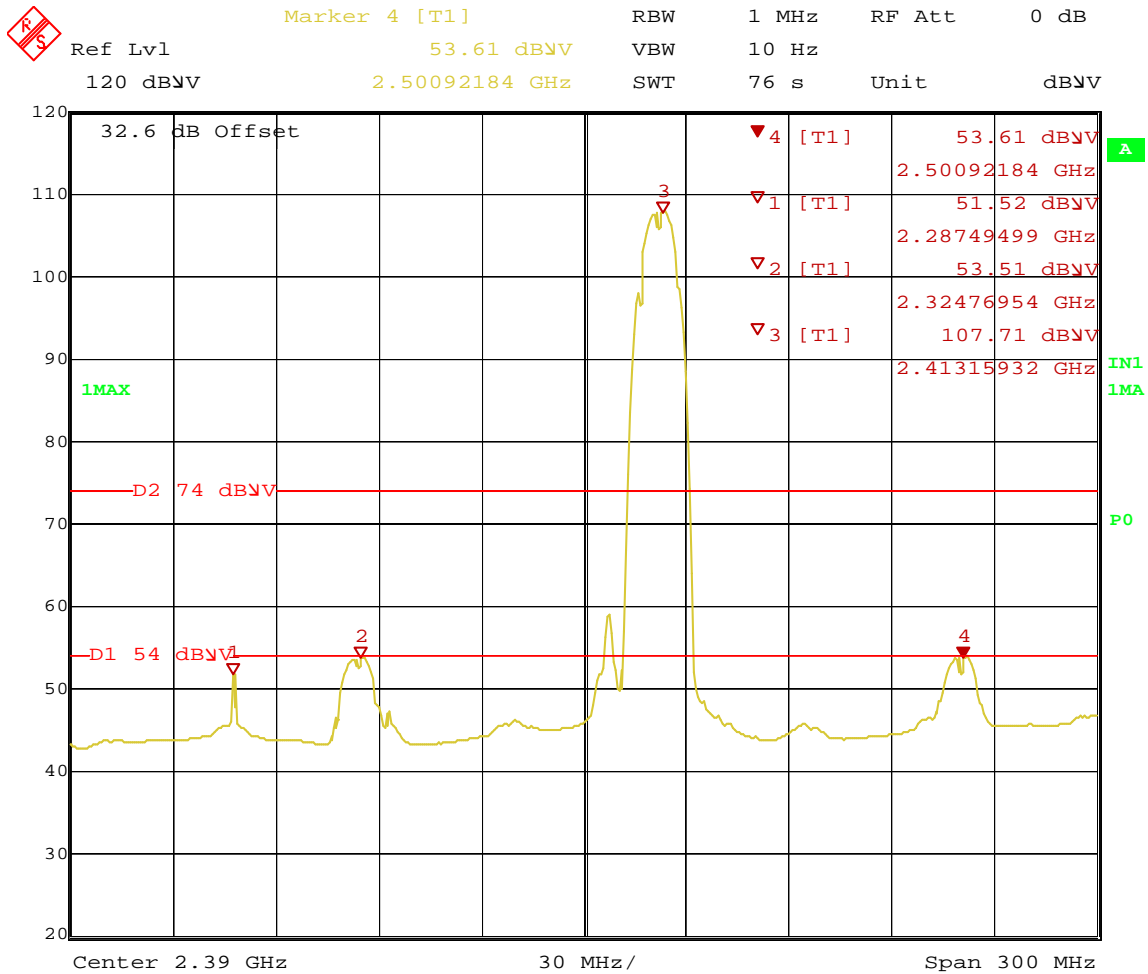
Test Conditions: Radiated Measurement, Normal Temperature and Voltage only							
Antenna Type: 3 External				Power Setting: See test plan			
Max. Antenna Gain: + 2dBi				Signal State: Modulated at 99%			
Ambient Temp.: 22 °C				Relative Humidity: 34%			
Band-Edge Results							
Operating Channel	Mode	Polarity	Pass by dB	Peak Limit	Pass by dB	Ave. Limit	Result
2412 MHz	802.11b 1Mbps	Horz.	-7.4	74.00	-0.49	54.00	Pass
2462 MHz	802.11b 1Mbps	Horz.	-9.2	74.00	-0.16	54.00	Pass
2412 MHz	802.11g 6Mbps	Horz.	-0.39	74.00	-0.49	54.00	Pass
2462 MHz	802.11g 6Mbps	Horz.	-0.45	74.00	-2.70	54.00	Pass
2412 MHz	802.11n (HT20) 1	Horz.	-1.67	74.00	-0.16	54.00	Pass
2462 MHz	802.11n (HT20) 1	Horz.	-2.72	74.00	-3.24	54.00	Pass
2412 MHz	802.11n (HT20) 0,1	Horz.	-2.16	74.00	-0.06	54.00	Pass
2462 MHz	802.11n (HT20) 0,1	Horz.	-1.16	74.00	-0.58	54.00	Pass
2412 MHz	802.11n (HT20) 0,1,2	Horz.	Pass	74.00	Pass	54.00	Pass
2462 MHz	802.11n (HT20) 0,1,2	Horz.	-0.37	74.00	-1.31	54.00	Pass
2422 MHz	802.11n (HT40) 1	Horz.	-4.32	74.00	-0.85	54.00	Pass
2452 MHz	802.11n (HT40) 1	Horz.	Pass	74.00	Pass	54.00	Pass
2422 MHz	802.11n (HT40) 0,1	Horz.	-4.62	74.00	-0.46	54.00	Pass
2452 MHz	802.11n (HT40) 0,1	Horz.	Pass	74.00	Pass	54.00	Pass
2422 MHz	802.11n (HT40) 0,1,2	Horz.	-13.36	74.00	-7.92	54.00	Pass
2452 MHz	802.11n (HT40) 0,1,2	Horz.	-3.53	74.00	-1.63	54.00	Pass

Note: All bandedge measurements were performed as indicated in the above table. Only worst case/ limited number of plots are placed in the report.



Date: 7.SEP.2011 14:02:15

Figure 65: Radiated Emission at the Edge for Channel 2412MHz at 1Mbps – Horizontal (Peak)



Date: 7.SEP.2011 13:35:17

Figure 66: Radiated Emission at the Edge for Channel 2412MHz at 1Mbps – Horizontal (Avg)

G mode

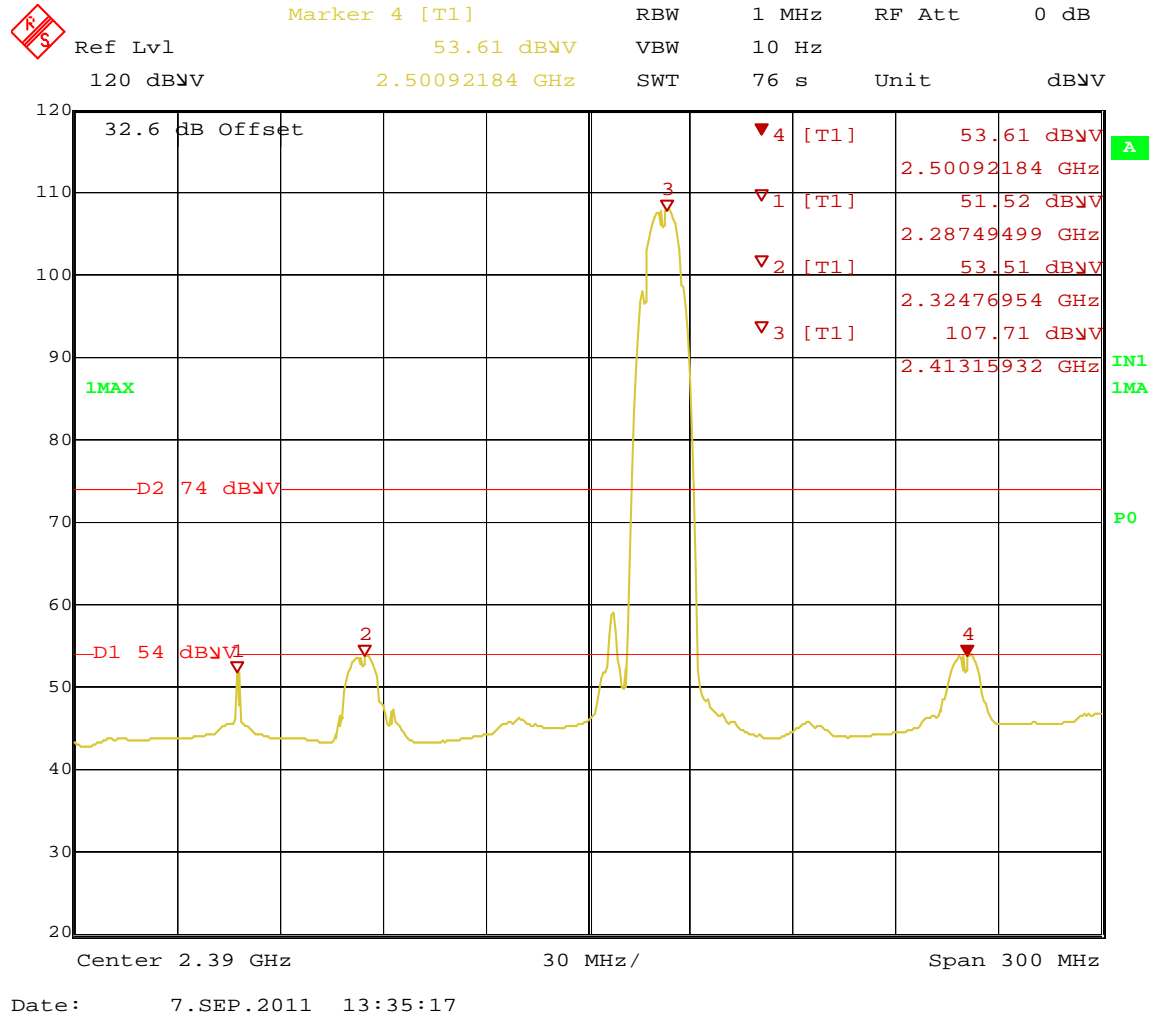
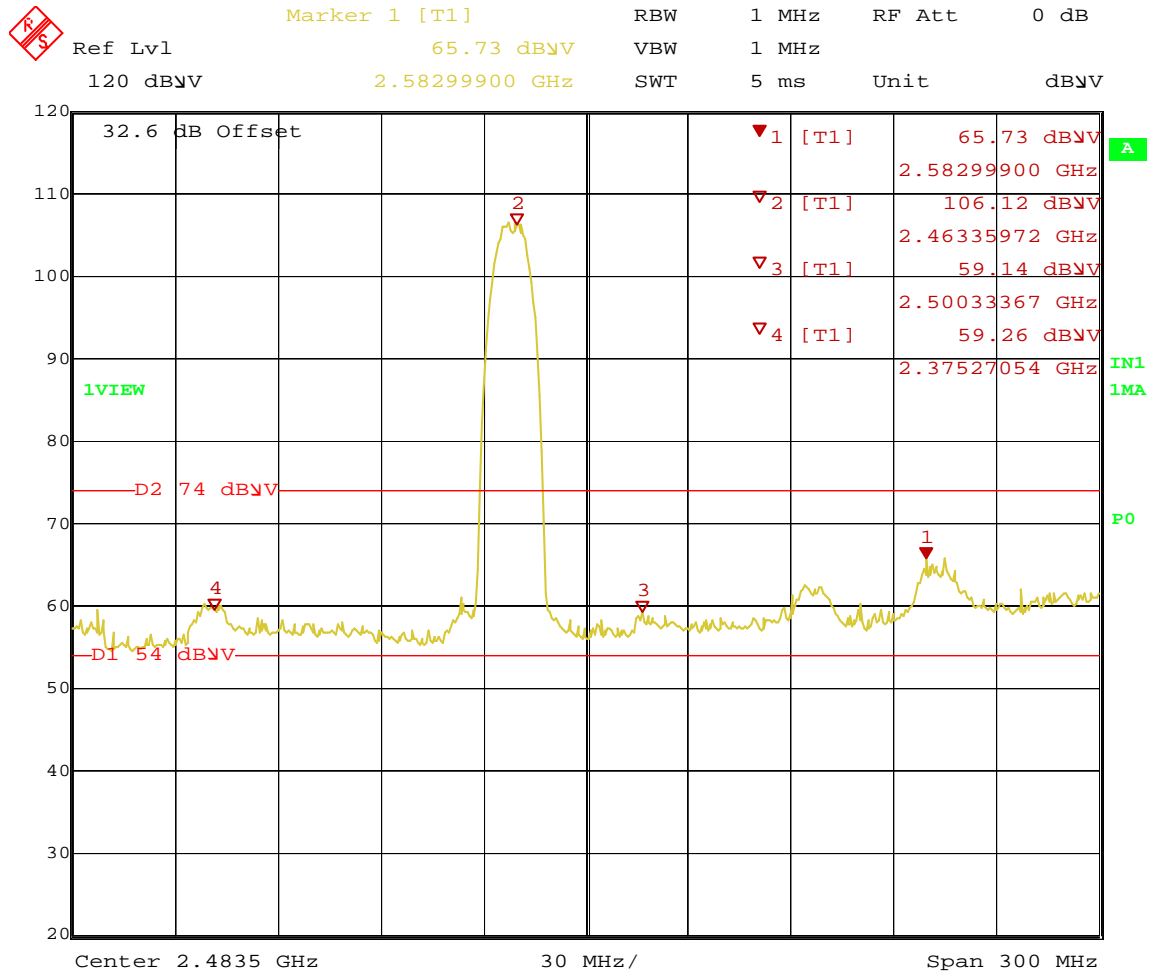
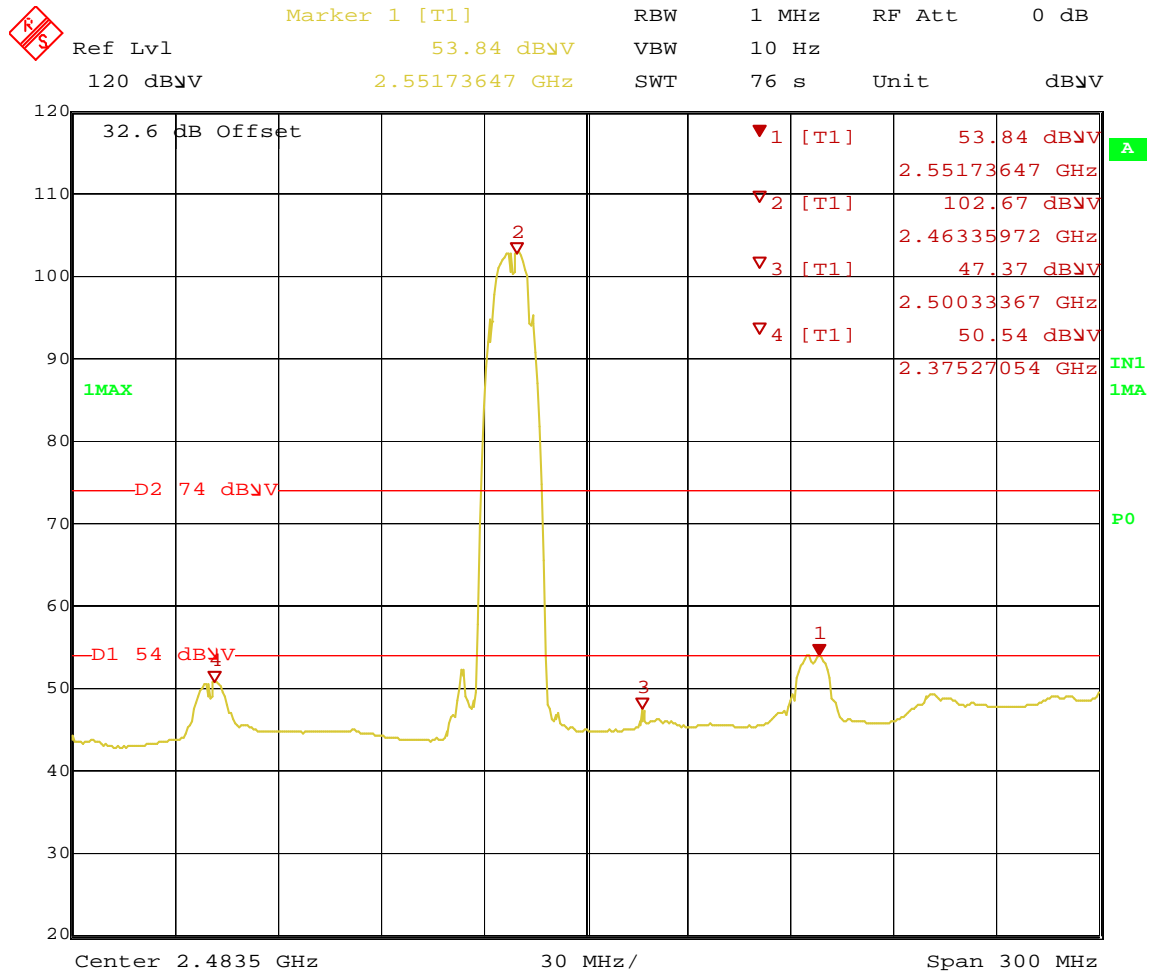


Figure 67: Radiated Emission at the Edge for Channel 2412MHz at 1Mbps – Horizontal (Ave.)



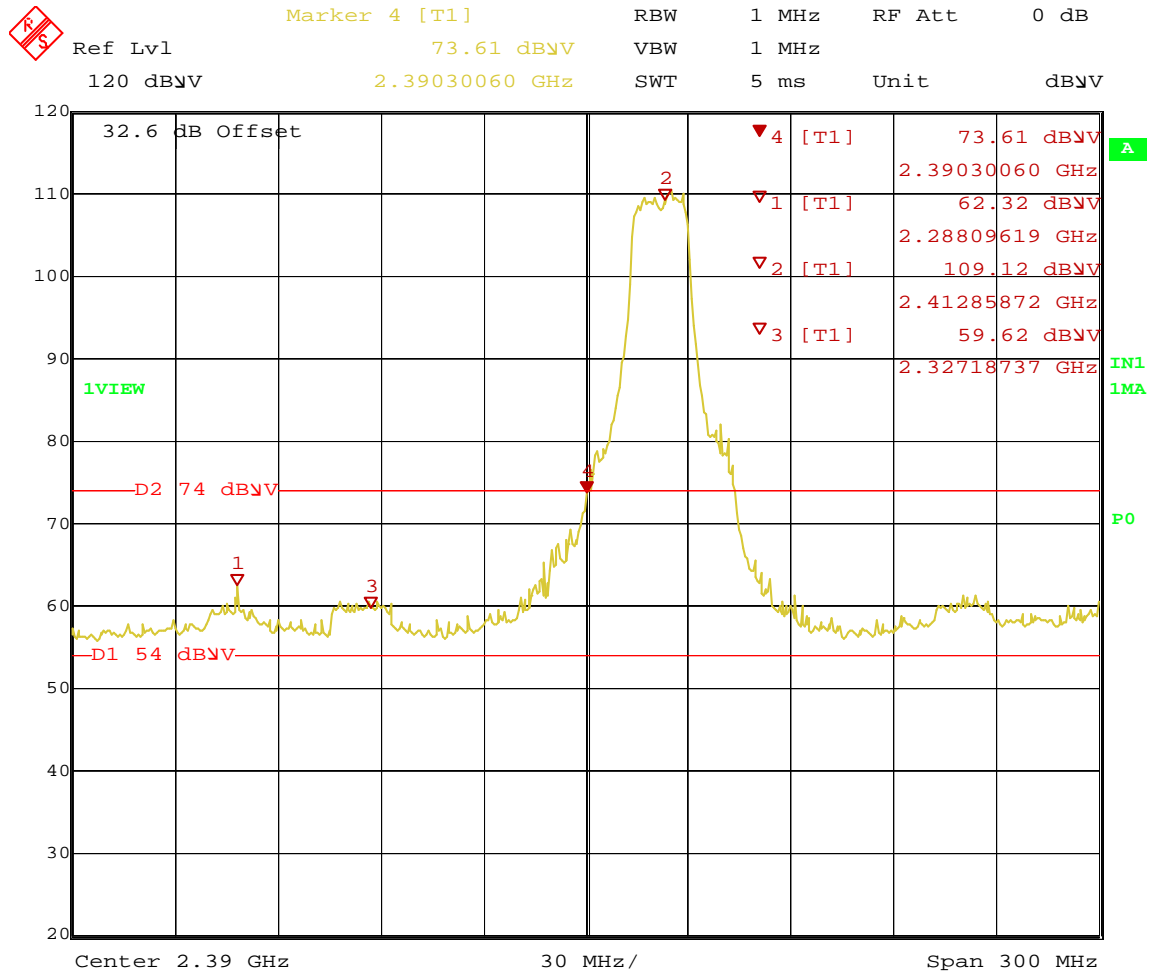
Date: 7.SEP.2011 13:55:41

Figure 68: Radiated Emission at the Edge for Channel 2462MHz at 1Mbps – Horizontal (Peak)



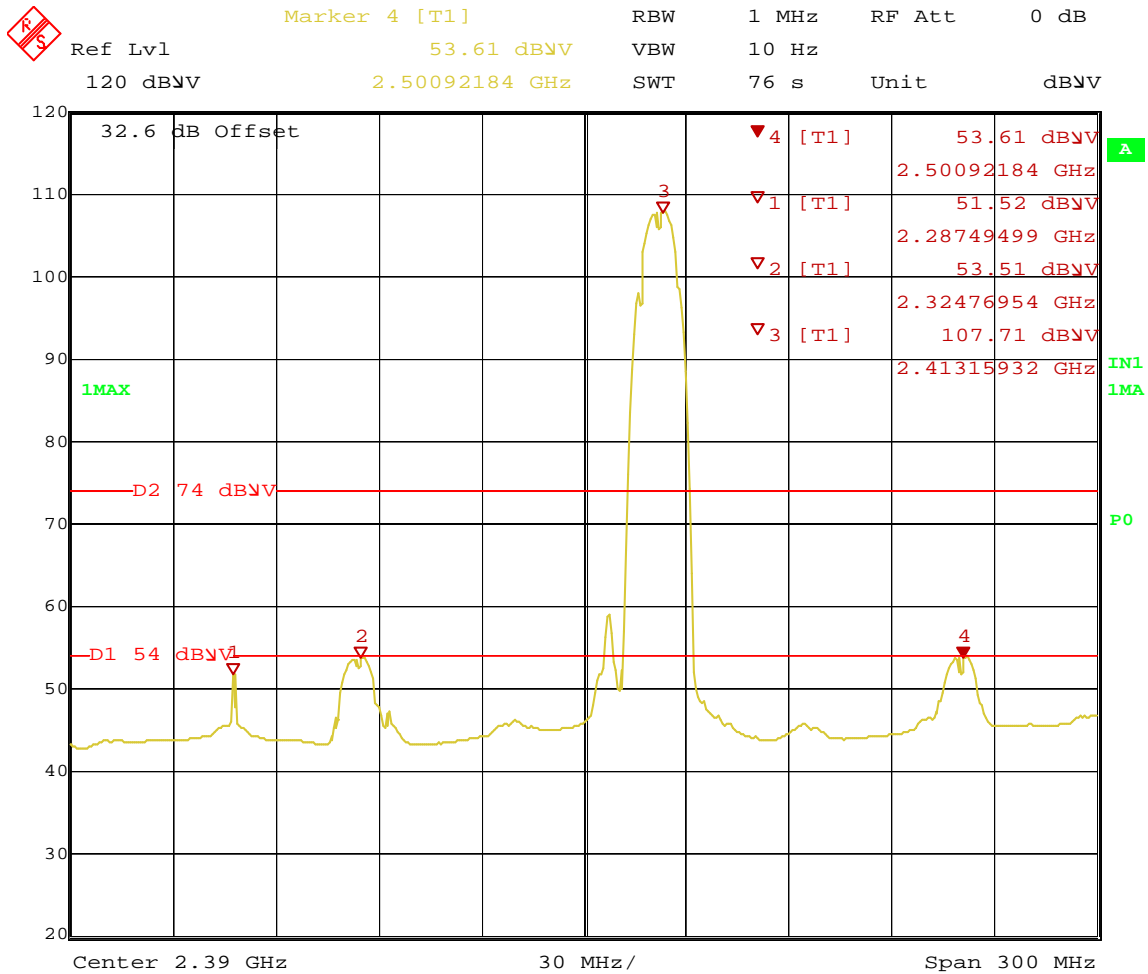
Date: 7.SEP.2011 13:52:13

Figure 69: Radiated Emission at the Edge for Channel 2462MHz at 1Mbps – Horizontal (Ave.)



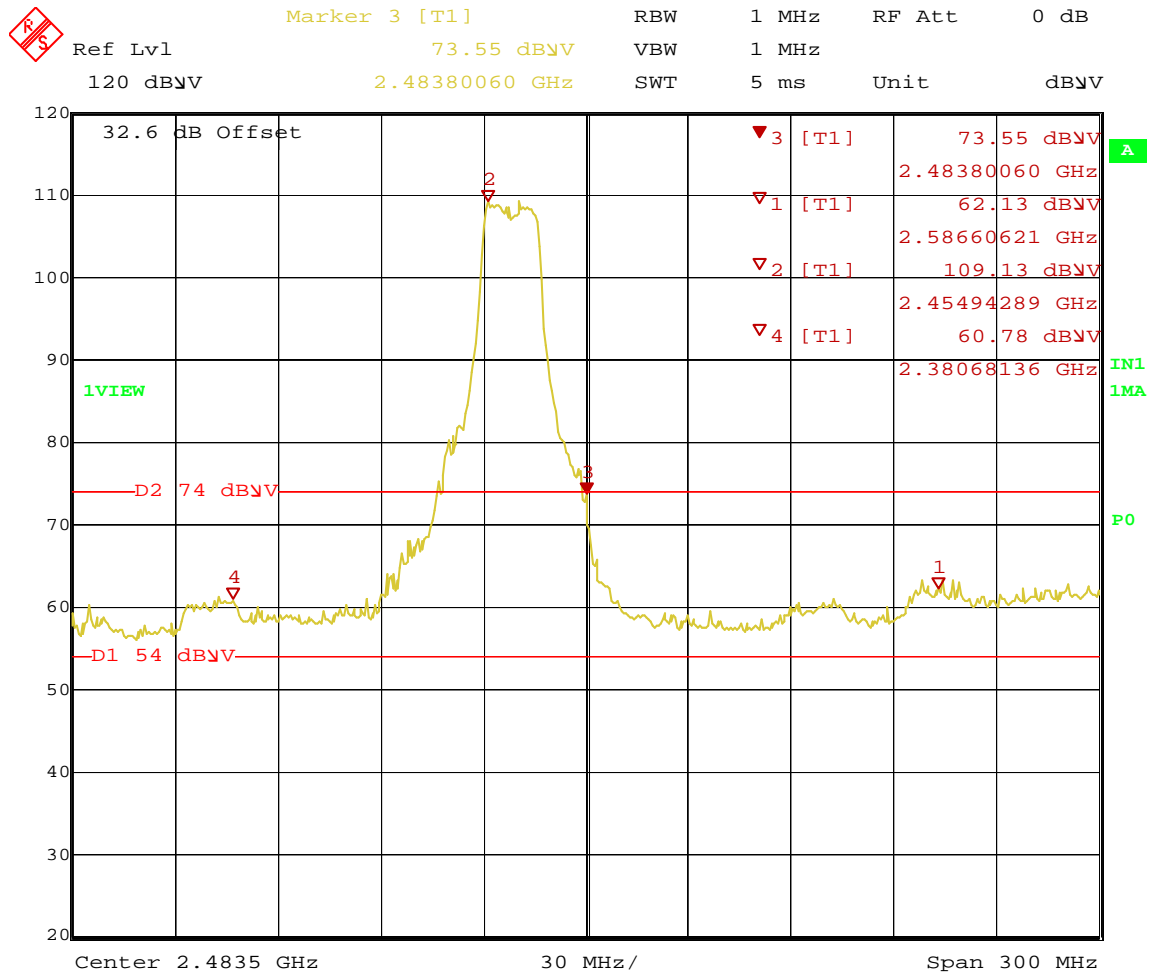
Date: 7.SEP.2011 14:24:52

Figure 70: Radiated Emission at the Edge for Channel 2412MHz at 6Mbps – Horizontal (Peak)



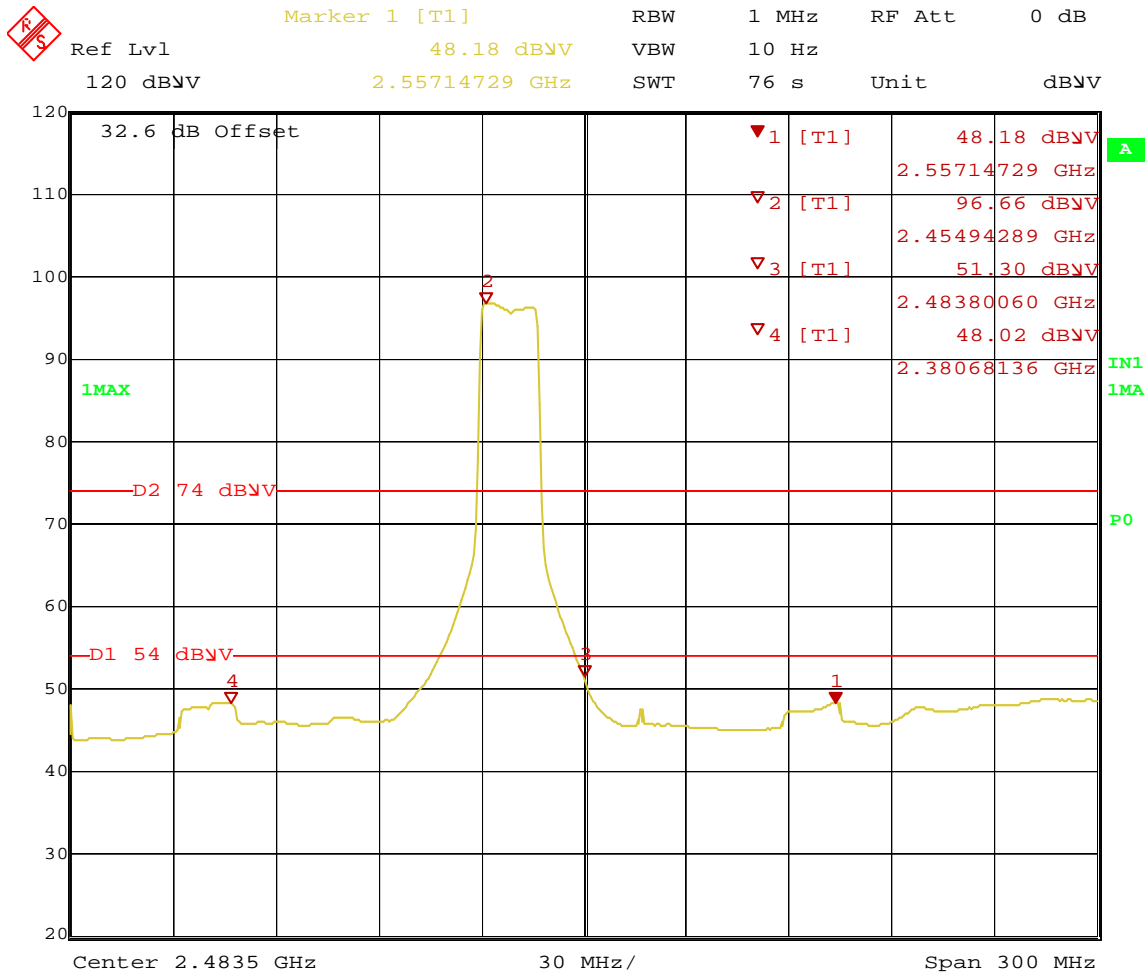
Date: 7.SEP.2011 13:35:17

Figure 71: Radiated Emission at the Edge for Channel 2412MHz at 6 Mbps – Horizontal (Ave.)



Date: 7.SEP.2011 14:29:28

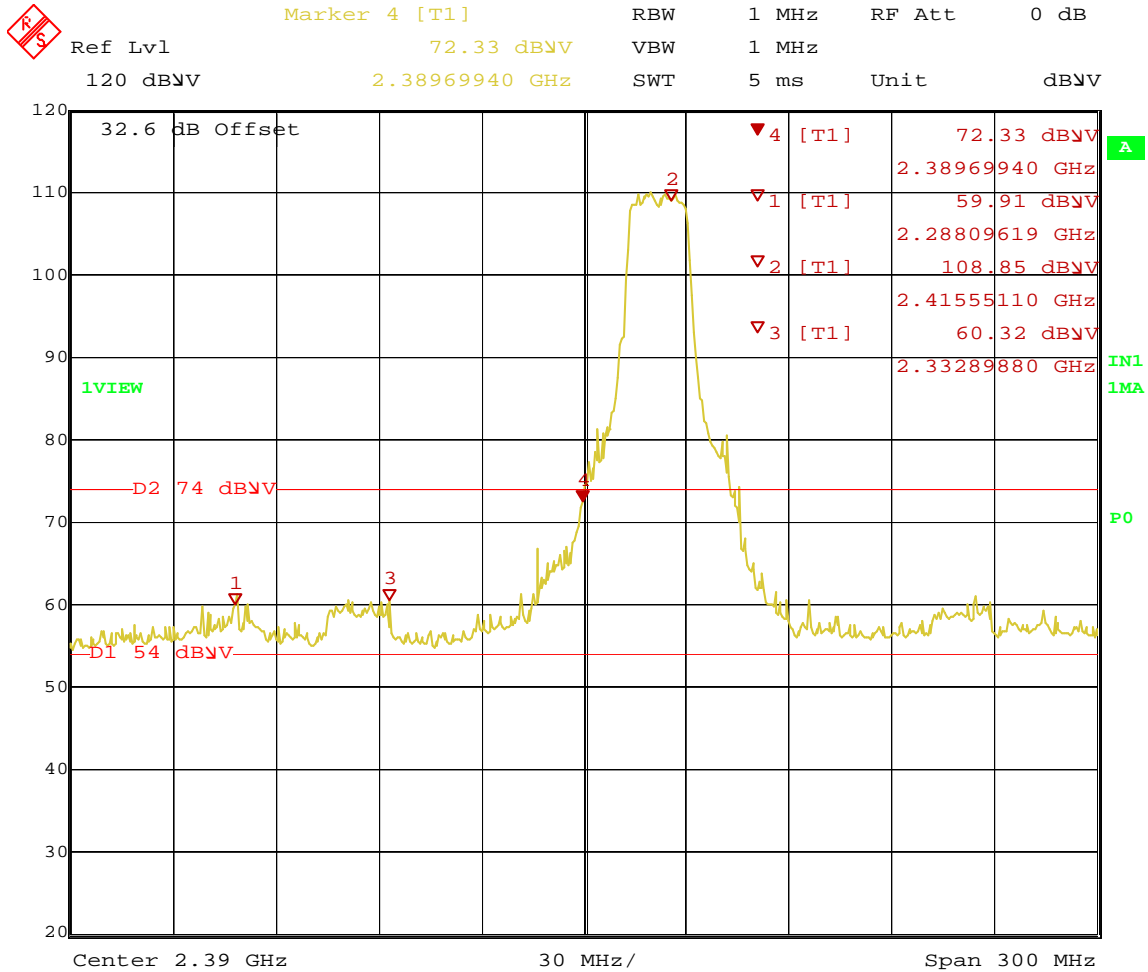
Figure 72: Radiated Emission at the Edge for Channel 2462MHz at 6 Mbps– Horizontal (Peak)



Date: 7.SEP.2011 14:33:49

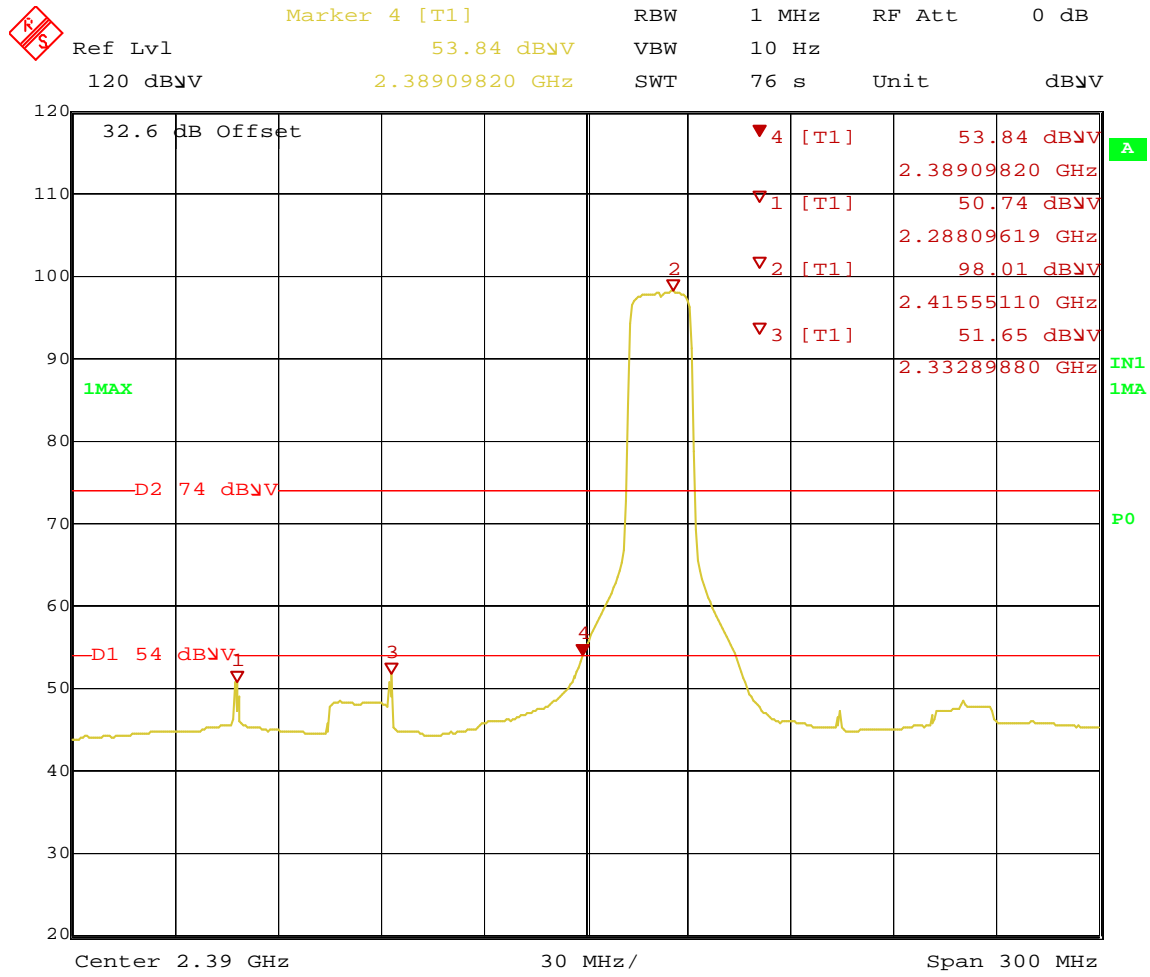
Figure 73: Radiated Emission at the Edge for Channel 2462MHz at 9 Mbps – Horizontal (Ave.)

HT20 mode



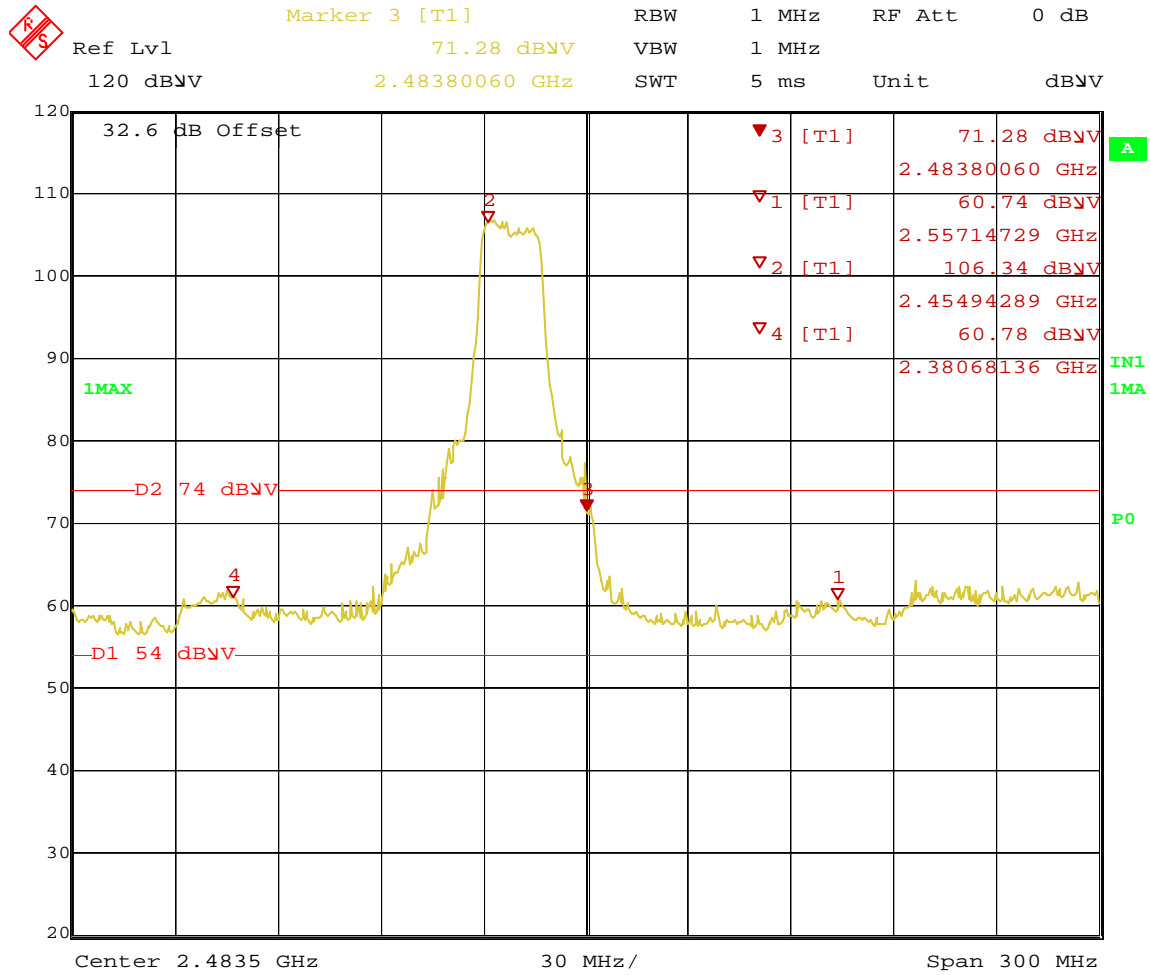
Date: 7.SEP.2011 16:19:23

Figure 74: Radiated Emission at the Edge for Channel 2412MHz at Chain HT 20 13.5Mbps – Horizontal (Peak)



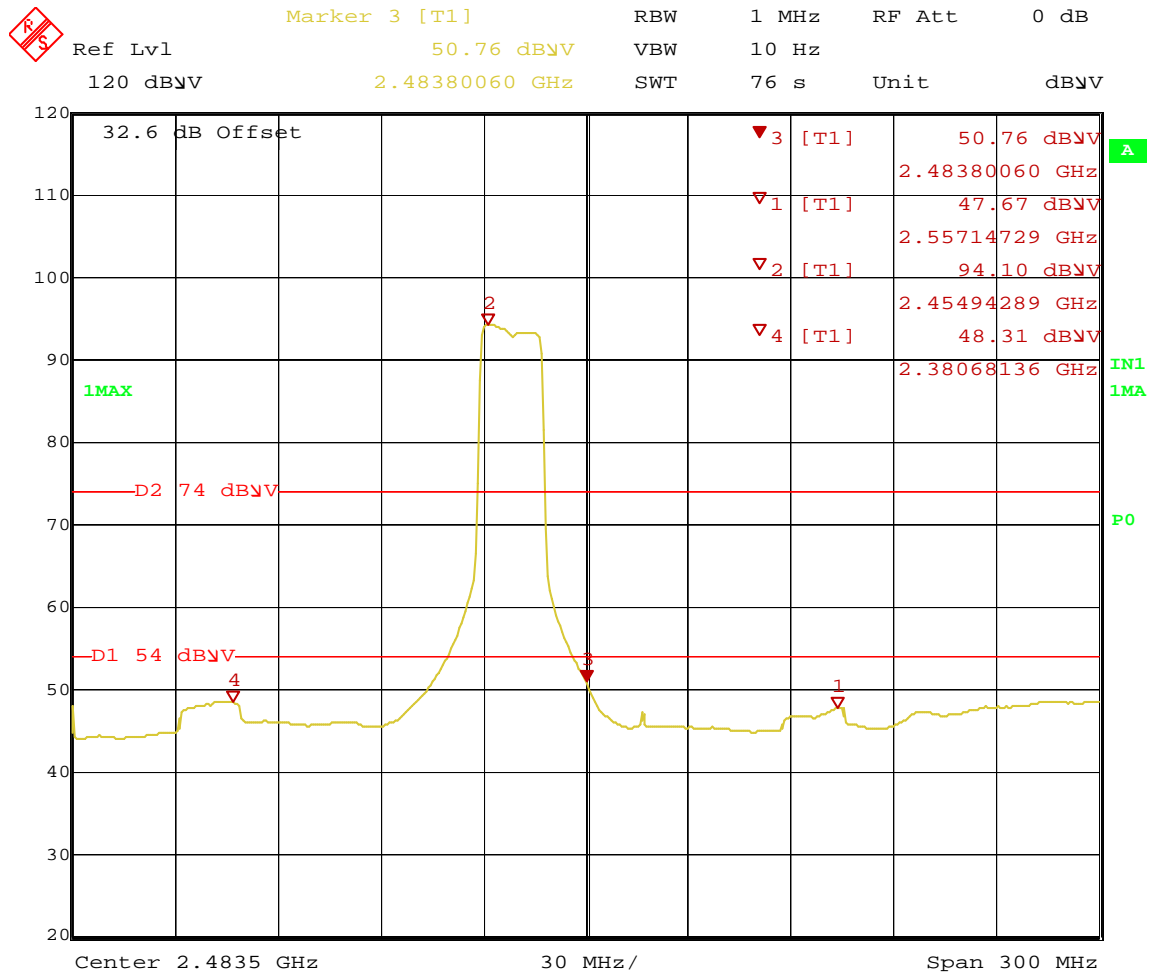
Date: 7.SEP.2011 16:15:33

Figure 75: Radiated Emission at the Edge for Channel 2412MHz at Chain 1 HT 20 13.5Mbps Horizontal -(Ave.)



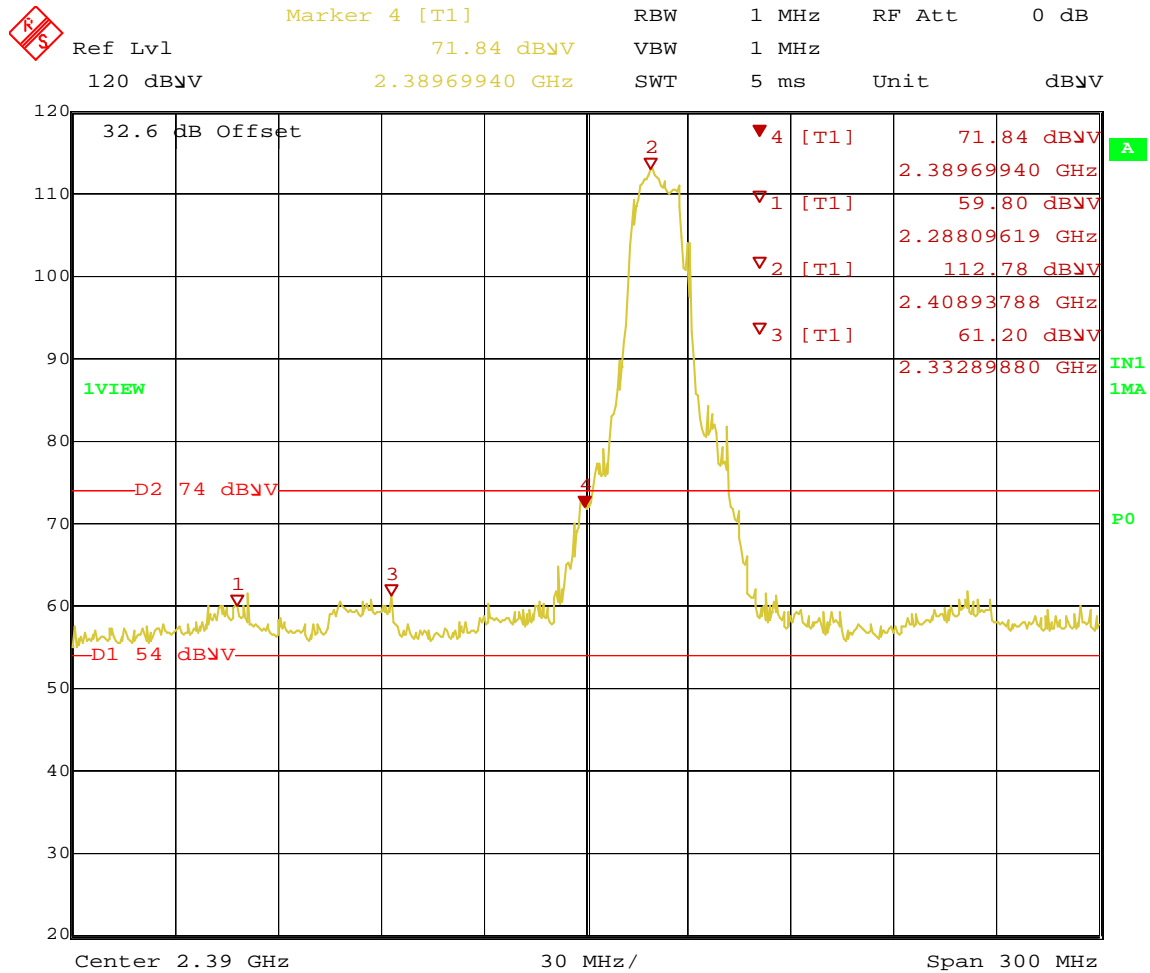
Date: 7.SEP.2011 16:02:48

Figure 76: Radiated Emission at the Edge for Channel 2462MHz at Chain 1 HT 20 13.5Mbps – Horizontal (Pk.)



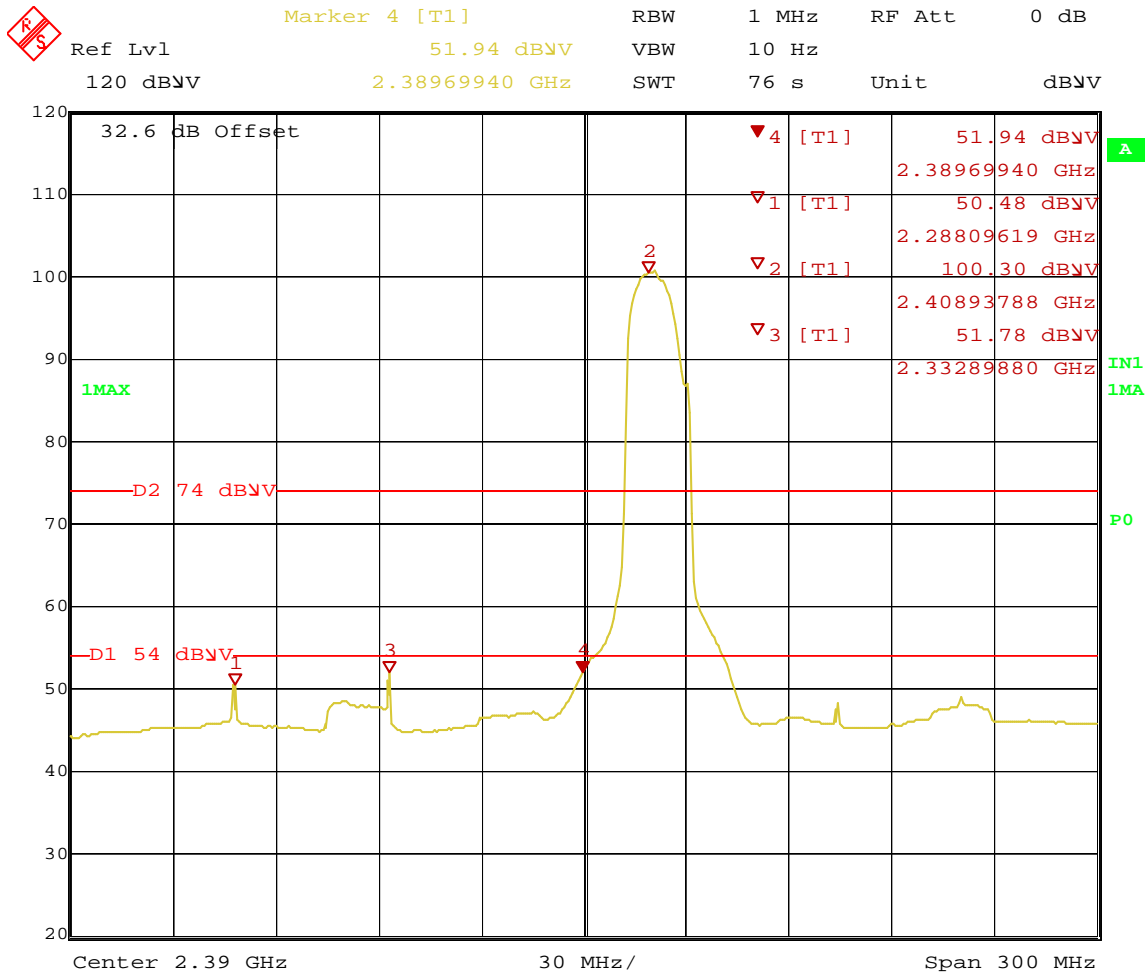
Date: 7.SEP.2011 16:06:24

Figure 77: Radiated Emission at the Edge for Channel 2462MHz at Chain 1 HT 20 13.5Mbps – Horizontal (Avg.)



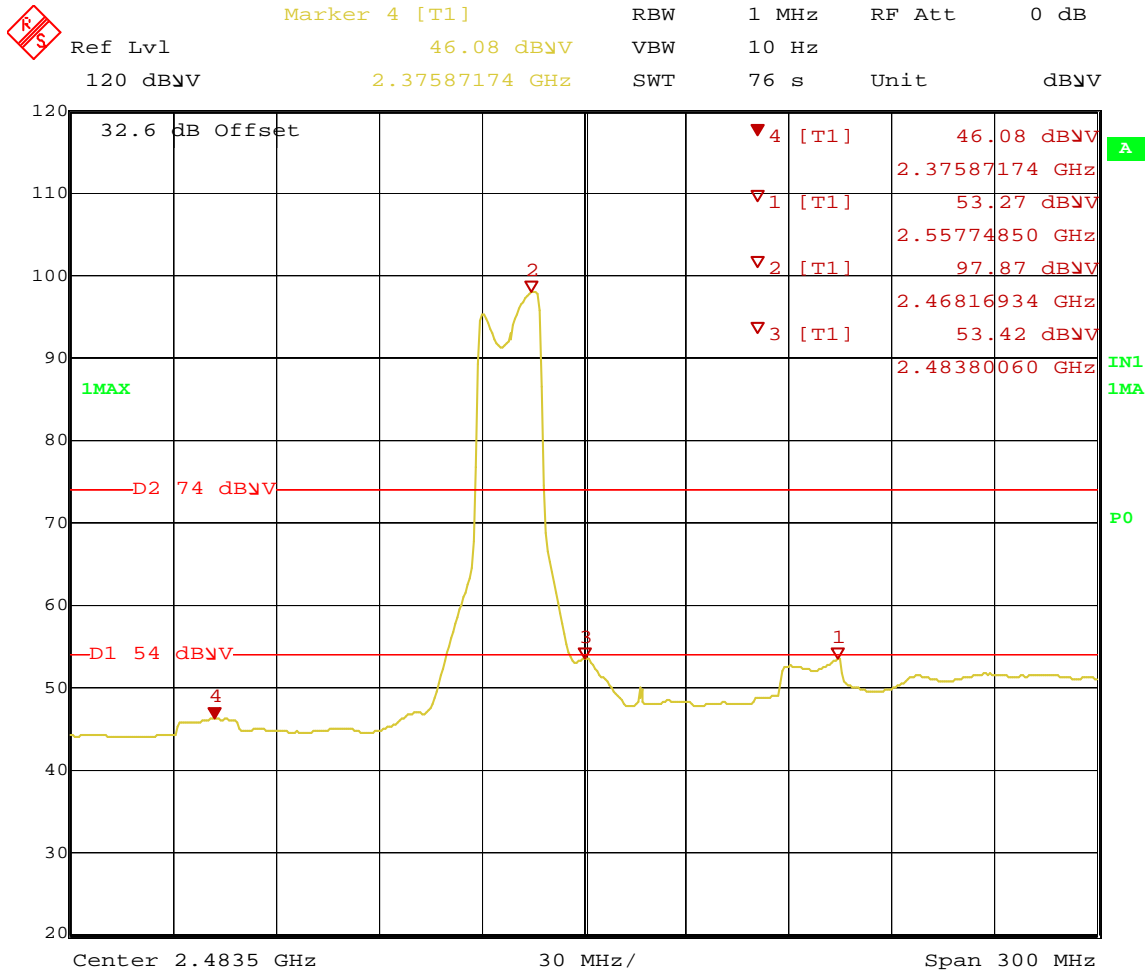
Date: 7.SEP.2011 16:25:53

Figure 78: Radiated Emission at the Edge for Channel 2412MHz at Chain 0 &1 HT20 27Mbps–Horizontal (Peak)



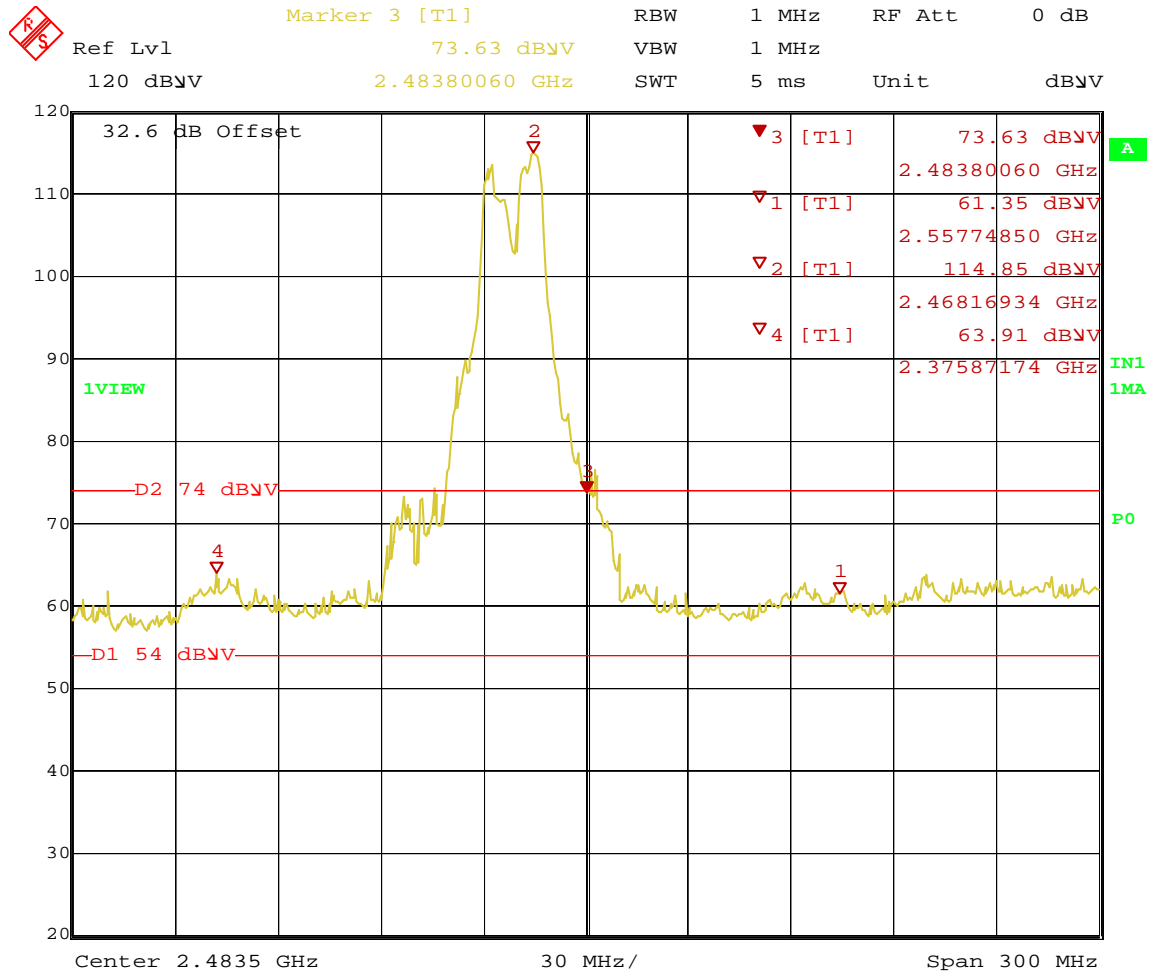
Date: 7.SEP.2011 16:32:28

Figure 79: Radiated Emission at the Edge for Channel 2412MHz Chain 0 &1 HT20 27Mbps – Horizontal (Ave.)



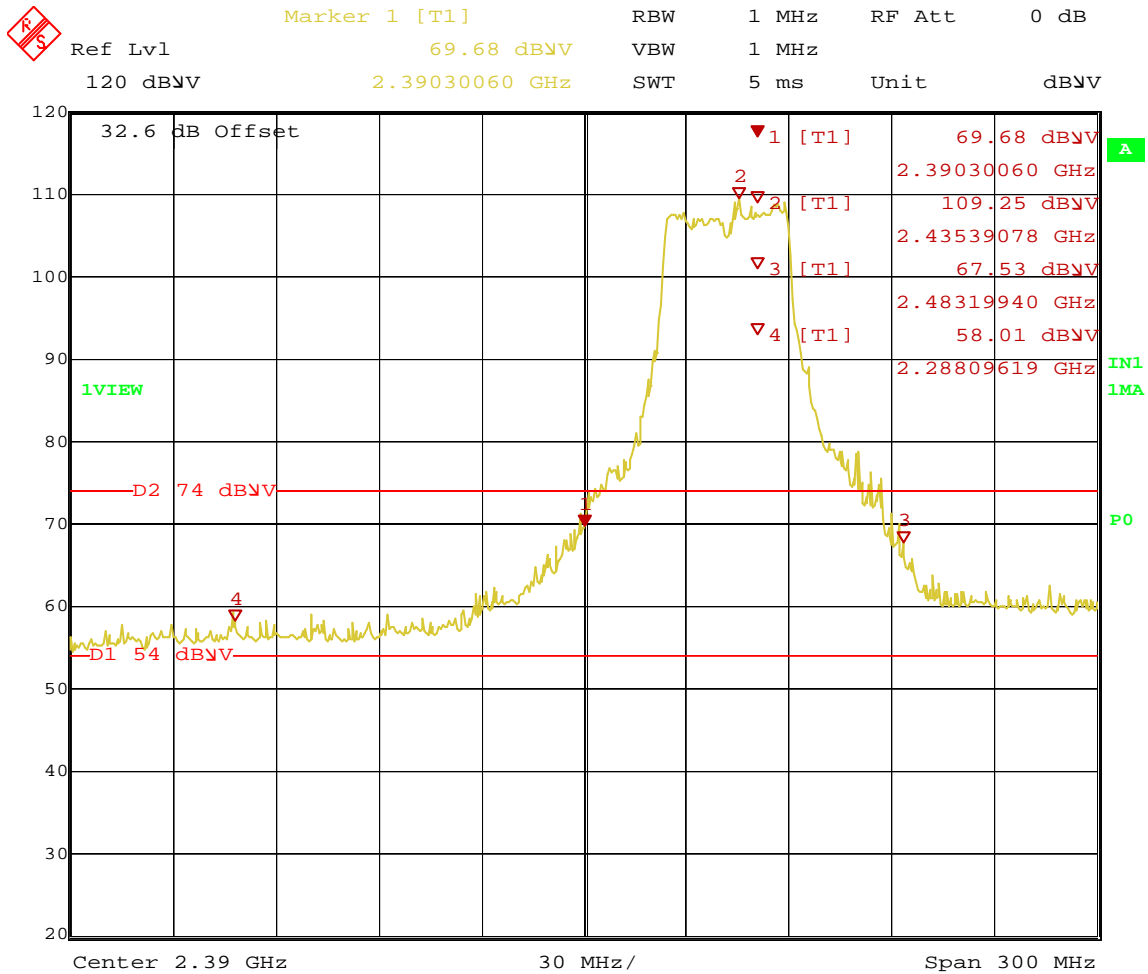
Date: 7.SEP.2011 16:52:12

Figure 80: Radiated Emission at the Edge for Channel 2462MHz at Chain 0, 1, and 2 HT40 27Mbps – Horizontal (Avg)



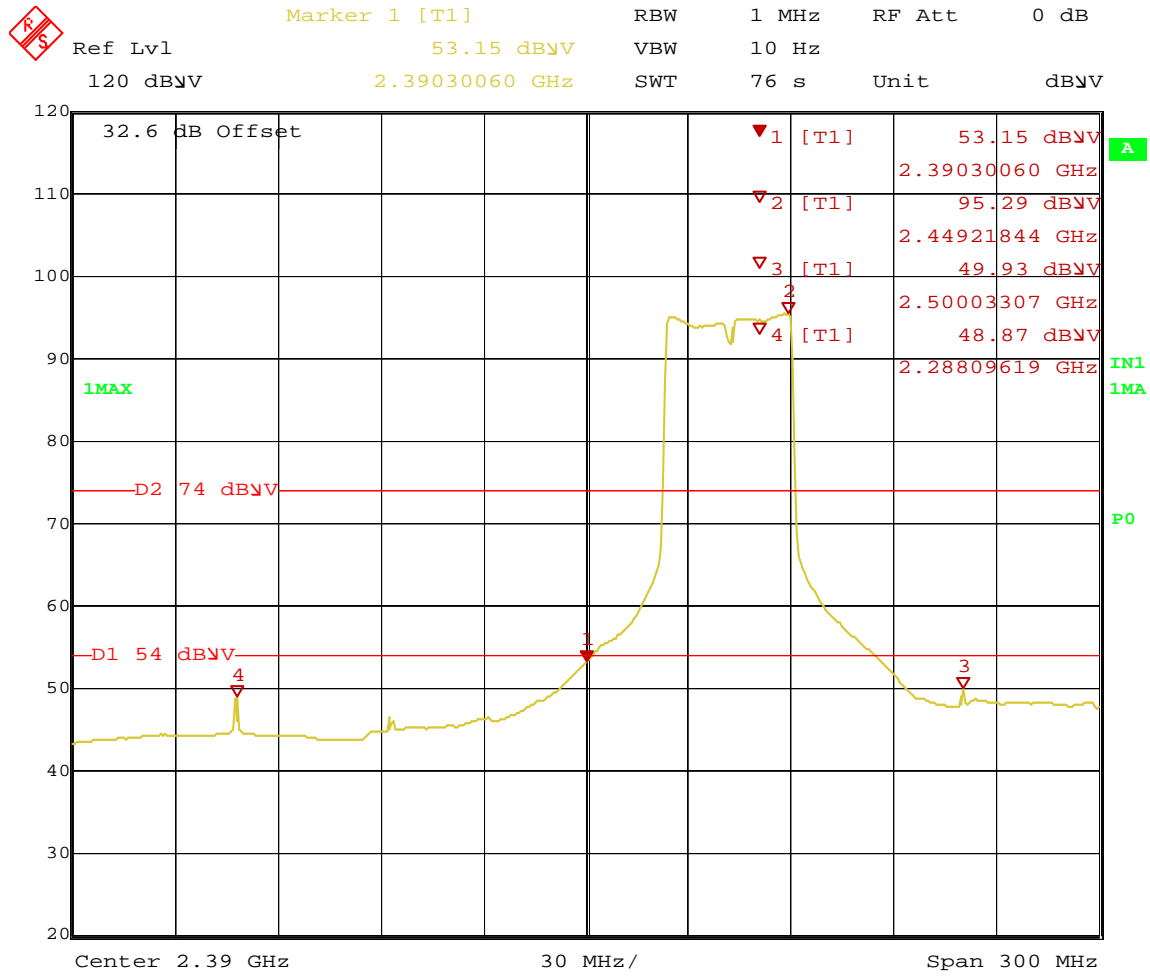
Date: 7.SEP.2011 17:22:51

Figure 81: Radiated Emission at the Edge for Channel 2462MHz at Chain 0, 1, and 2 HT20 27Mbps – Horizontal (Ave.)



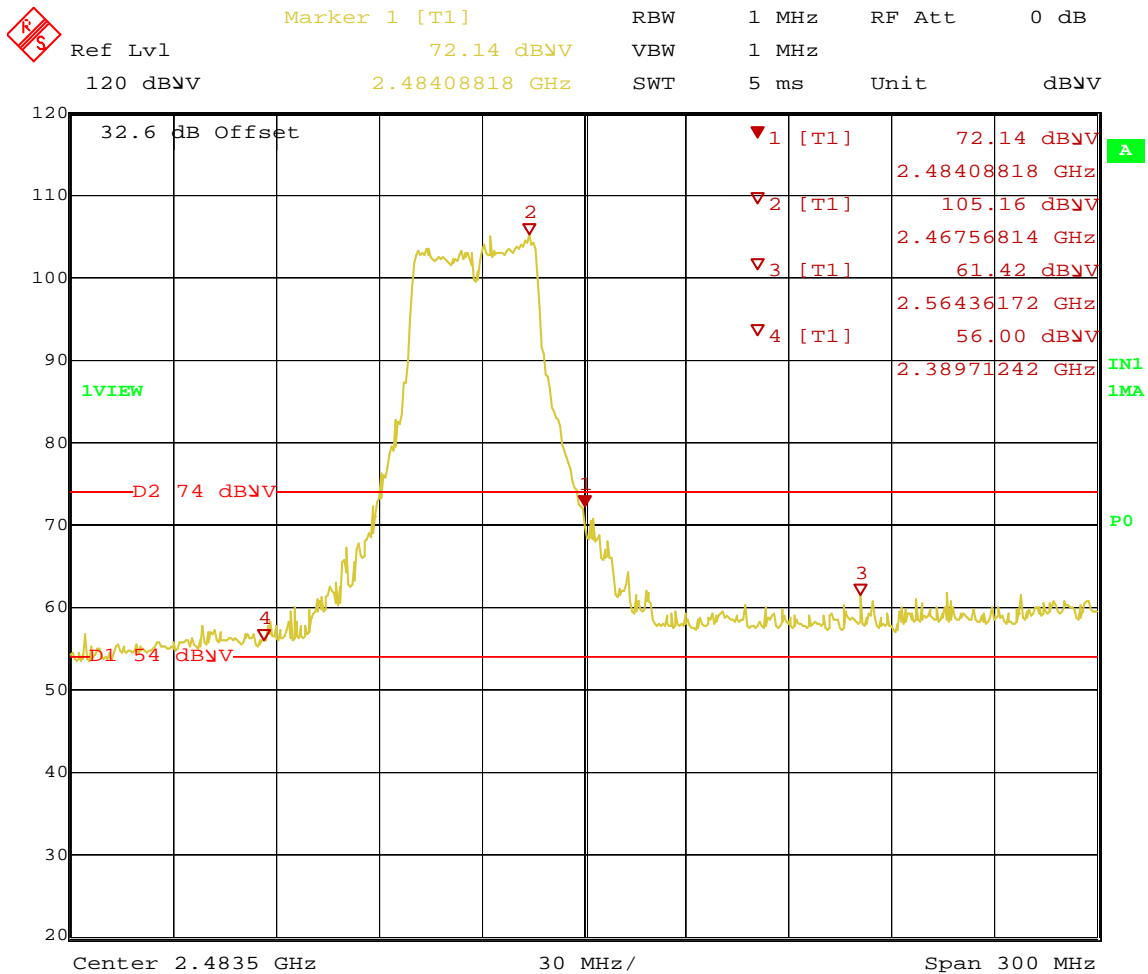
Date: 8.SEP.2011 09:02:31

Figure 82: Radiated Emission at the Edge for Channel 2452MHz at Chain 0, 1, and 2 HT40 405Mbps – Horizontal (Peak)



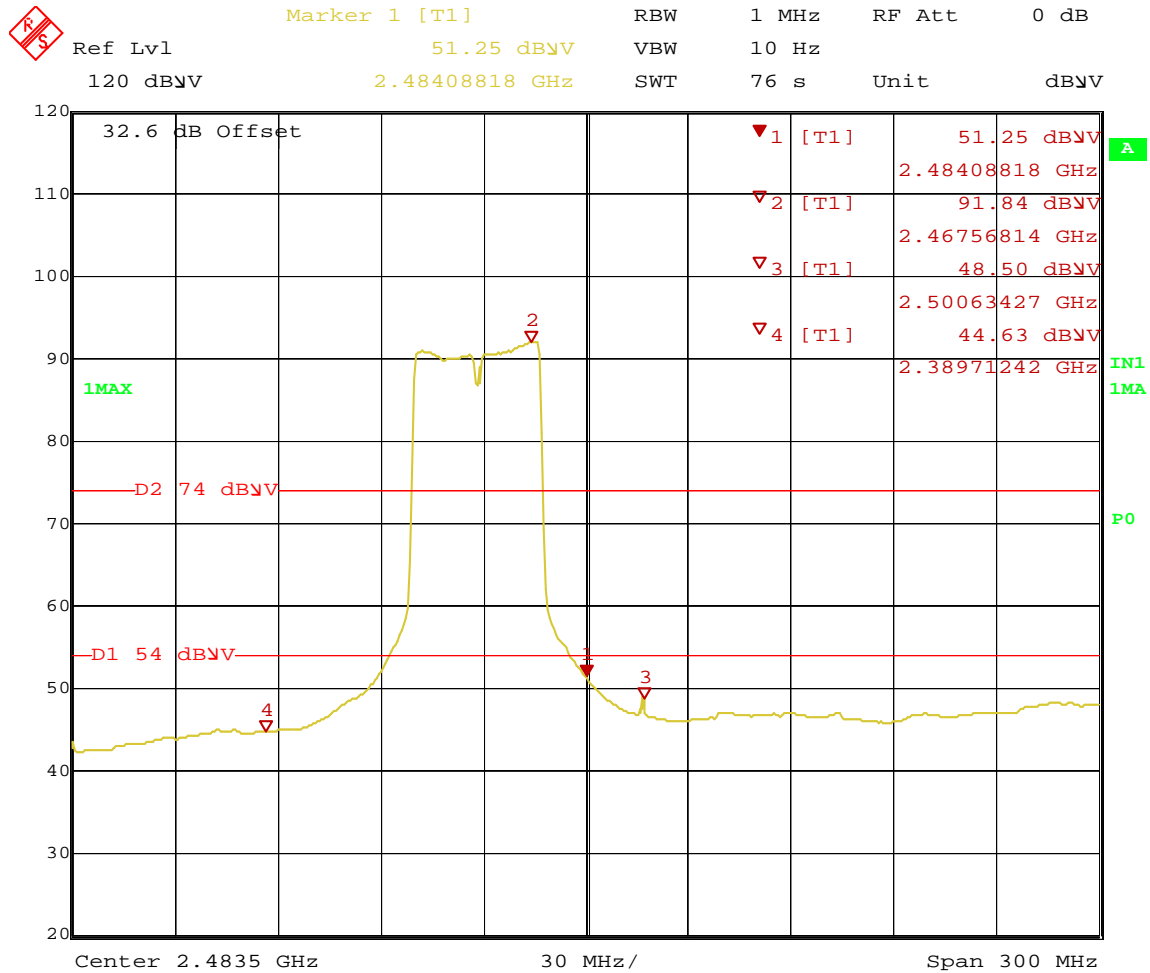
Date: 8.SEP.2011 08:59:18

Figure 83: Radiated Emission at the Edge for Channel 2452MHz at Chain 0, 1, and 2 HT40 405Mbps – Horizontal (Ave.)



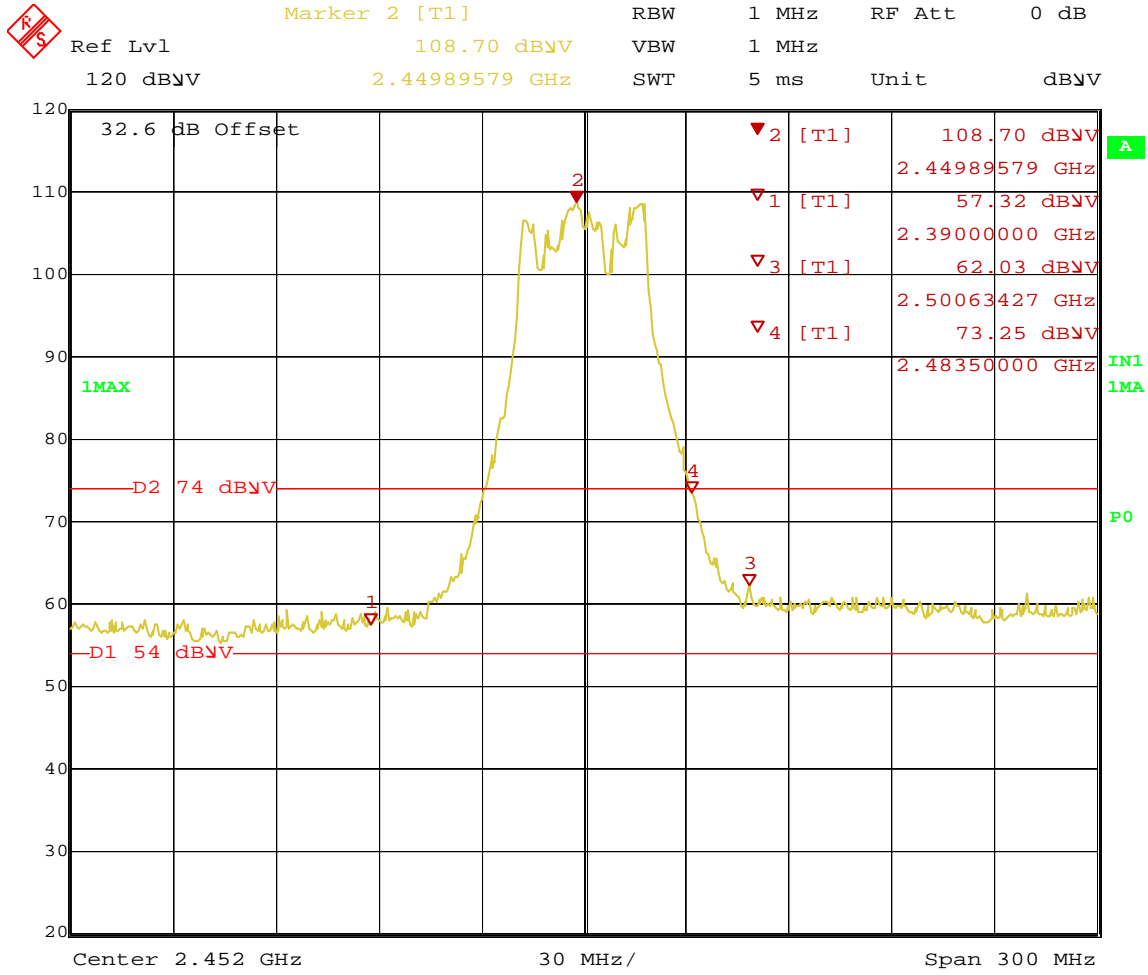
Date: 8.SEP.2011 09:41:10

Figure 84: Radiated Emission at the Edge for Channel 2452MHz at Chain 0, 1, and 2 HT40 405Mbps – Vertical (Peak)

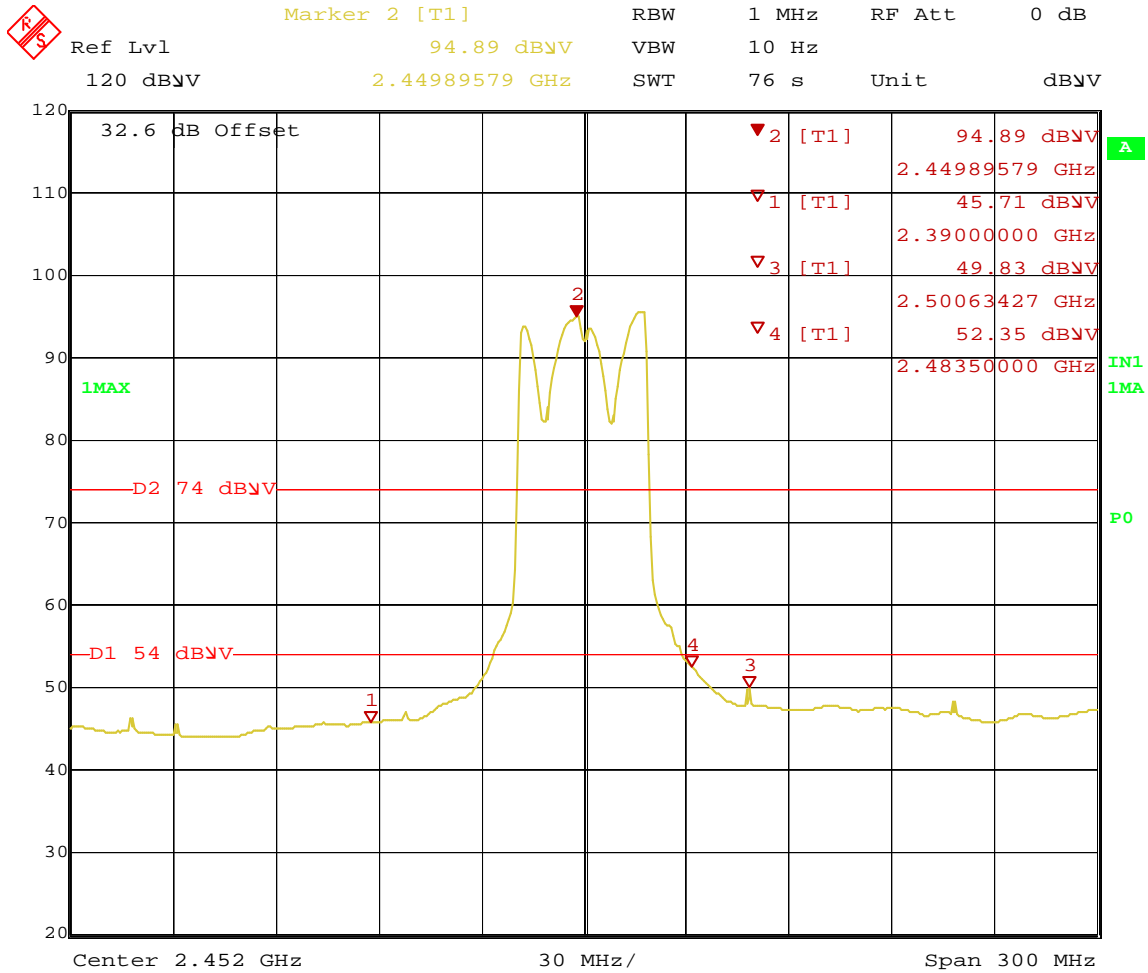


Date: 8.SEP.2011 09:44:38

Figure 85: Radiated Emission at the Edge for Channel 2452MHz at Chain 0, 1, and 2 HT40 405Mbps – Vertical (Ave)



Date: 8.SEP.2011 10:02:22



Date: 8.SEP.2011 10:05:45

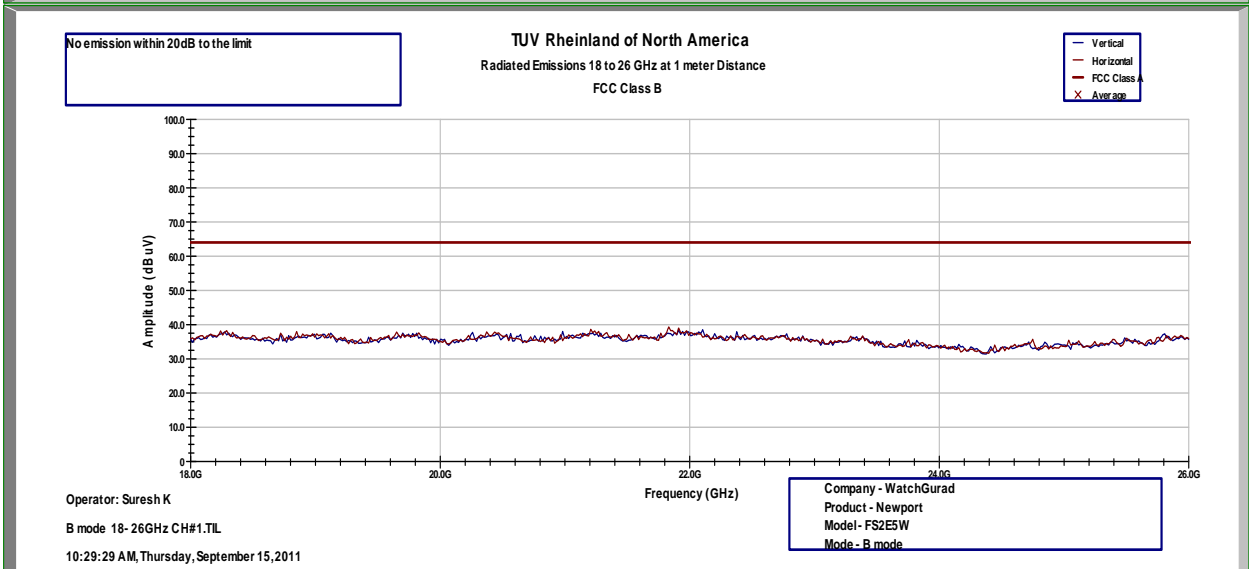
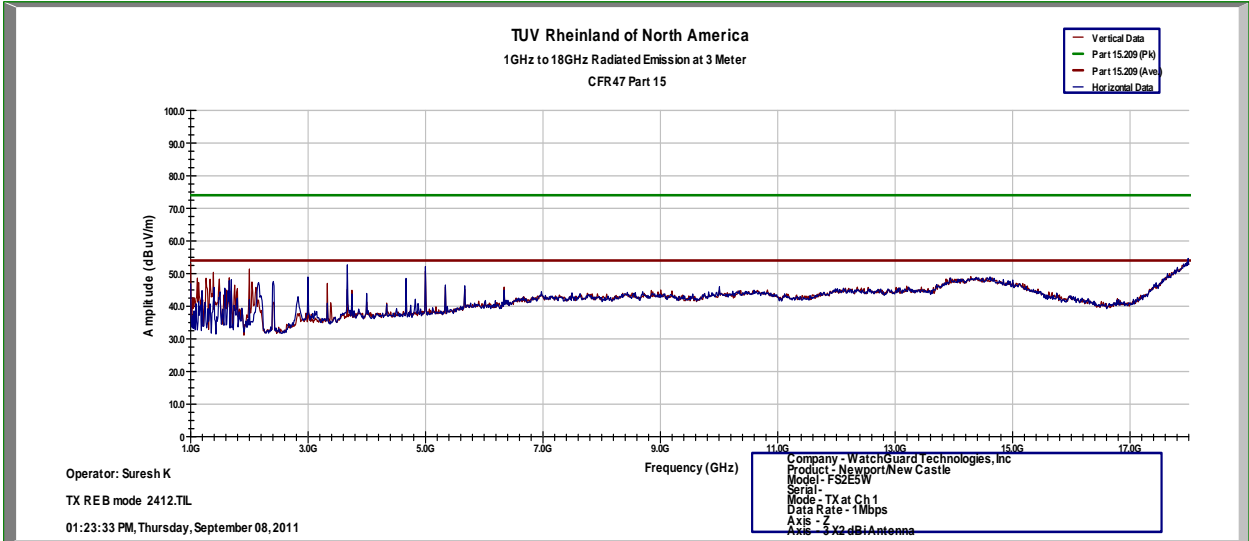
SOP 1 Radiated Emissions						Tracking # 31152150.002 Page 1 of 9					
EUT Name	NEWCASTLE, NEWPORT					Date	September 25 , 2011				
EUT Model	FS1E5, FS1E5W, FS2E5, FS2E5W					Temp / Hum in	23°C / 39%rh				
EUT Serial	70AB00010-8C75					Temp / Hum out	N/A				
EUT Config.	Y-Axis, 18dBm, 802.11b at 1Mbps					Line AC / Freq	120Vac/60Hz				
Standard	CFR47 Part 15 Subpart C					RBW / VBW	1 MHz/ 3 MHz				
Dist/Ant Used	3m / EMCO3115 / 1m - RA42-K-F-4B-C					Performed by	Suresh Kondapalli				
Emission Freq	FIM Pk	FIM Ave	Total CF	E-Field Ave	Spec Limit	Spec Margin	Table Pos	ANT Pos	ANT Pola	Type	
Transmitted Data at 2412MHz											
1374.85	46.46	39.14	-4.81	34.32	53.98	-19.66	4	198	V	Spurious	
1999.93	61.48	50.25	-1.79	48.46	53.98	-5.52	368	202	V	Spurious	
2999.67	51.05	46.65	1.23	47.88	53.98	-6.1	378	132	H	Spurious	
3666.35	53.79	51.02	3.46	54.47	53.98	0.49*	406	153	H	Spurious	
4824.25	41.69	28.77	5.08	33.85	53.98	-20.13	40	160	H	Harmonic	
7240.48	43.28	28.98	10.31	39.29	53.98	-14.69	111	160	H	Harmonic	
Transmitted Data at 2437MHz											
4874.45	36.69	24.73	5.25	29.98	53.98	-24	36	200	V	Harmonic	
4874.45	39.41	29.41	5.25	34.66	53.98	-19.32	-2	120	H	Harmonic	
7308.29	40.97	26.92	10.36	37.28	53.98	-16.7	57	150	H	Harmonic	
Transmitted Data at 2462MHz											
1999.82	59.18	45.39	-1.79	43.6	53.98	-10.38	18	116	V	Spurious	
2162.42	59.76	39.26	-1.2	38.06	53.98	-15.92	113	219	H	Spurious	
4825.9	40.74	26.45	5.09	31.54	53.98	-22.44	67	123	H	Harmonic	
7221.0	38.82	26.6	10.28	36.88	53.98	-17.1	-30	116	H	Harmonic	
Spec Margin = E-Field QP - Limit, E-Field QP = FIM QP+ Total CF ± Uncertainty											
Total CF= Amp Gain + Cable Loss + ANT Factor											
Combined Standard Uncertainty $u_c(y) = \pm 3.2$ dB Expanded Uncertainty $U = ku_c(y)$ $k = 2$ for 95% confidence											
Notes: Worst case was observed on Y-axis, 1Mbps.* Emission at 3666.35MHz is conformed to be from Digital part of the device. This is considered as pass EUT is Class A device											
The output radio was transmitted at +18dBm.											

SOP 1 Radiated Emissions

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EUT Name	NEWCASTLE, NEWPORT	Date	September 26, 2011
EUT Model	FS1E5, FS1E5W, FS2E5, FS2E5W	Temp / Hum in	23°C / 39%rh
EUT Serial	70AB00010-8C75	Temp / Hum out	N/A
EUT Config.	Y-Axis, 18dBm, 1Mbps	Line AC	120Vac 60Hz
Standard	CFR47 Part 15 Subpart C	RBW / VBW	1MHz / 3MHz
Dist/Ant Used	3m - EMCO3115 / 1m - RA42-K-F-4B-C	Performed by	Suresh Kondapalli

Above 1GHz Plots for Transmit Mode at 2412MHz, 802.11b 1Mbit/s



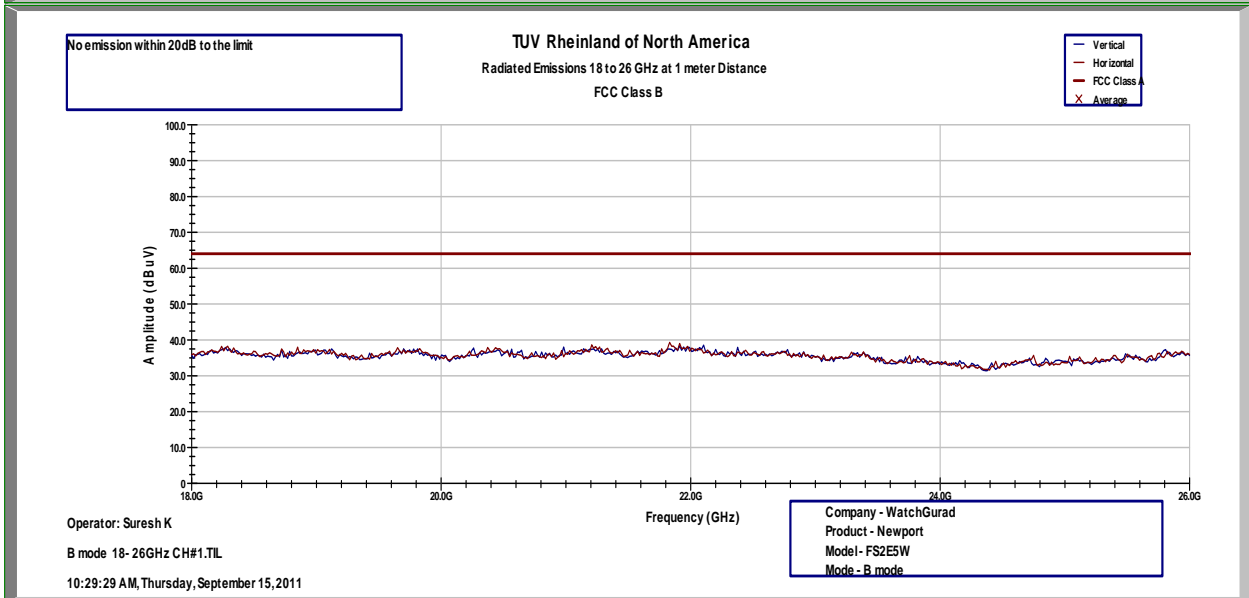
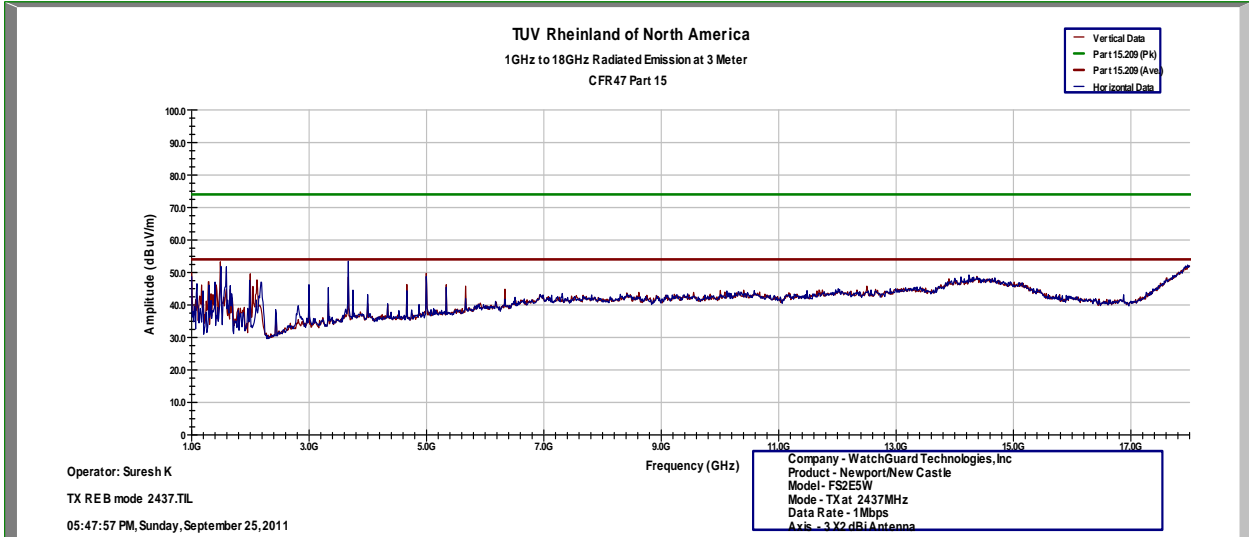
Notes: Limit was extrapolated to 1m distance for 18GHz – 25 GHz range.
 1GHz – 25 GHz Setting: RBW = 1MHz/ VBW = 3MHz

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Tracking # 31152150.002 Page 3 of 9

EUT Name	NEWCASTLE, NEWPORT	Date	September 25, 2011
EUT Model	FS1E5, FS1E5W, FS2E5, FS2E5W	Temp / Hum in	23°C / 39%rh
EUT Serial	70AB00010-8C75	Temp / Hum out	N/A
EUT Config.	Y-Axis, 18dBm, 1Mbps	Line AC	120Vac 60Hz
Standard	CFR47 Part 15 Subpart C	RBW / VBW	1MHz / 3MHz
Dist/Ant Used	3m - EMCO3115 / 1m - RA42-K-F-4B-C	Performed by	Suresh Kondapalli

Above 1GHz Plots for Transmit Mode at 2437MHz, 802.11b 1Mbit/s



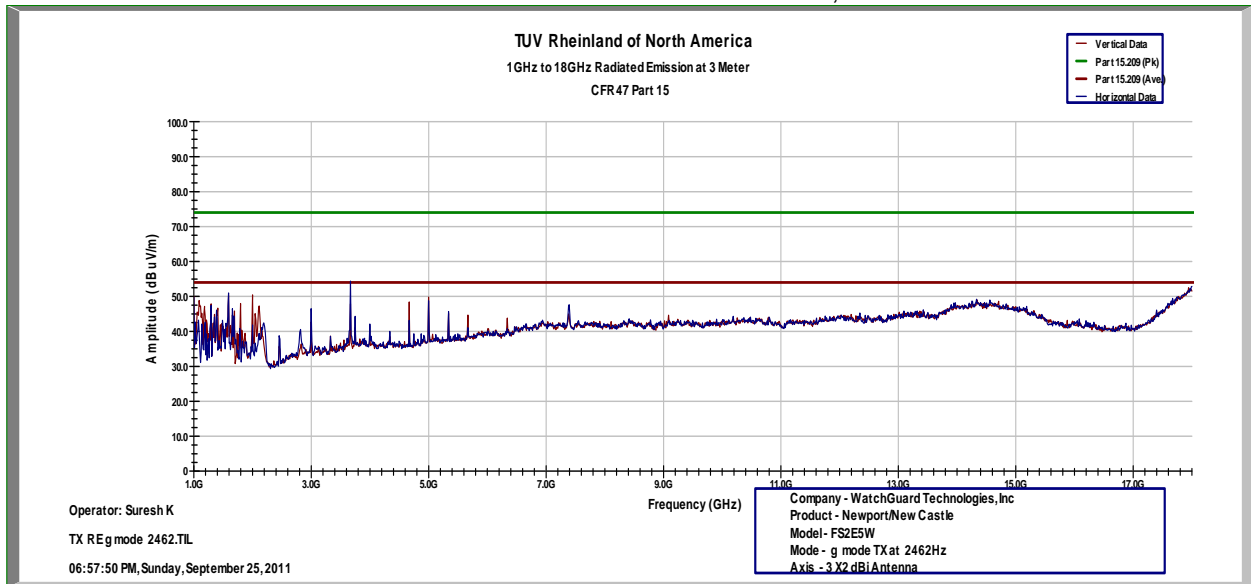
Notes: Limit was extrapolated to 1m distance for 18GHz – 25 GHz range.
 1GHz – 25 GHz Setting: RBW = 1MHz/ VBW = 3MHz

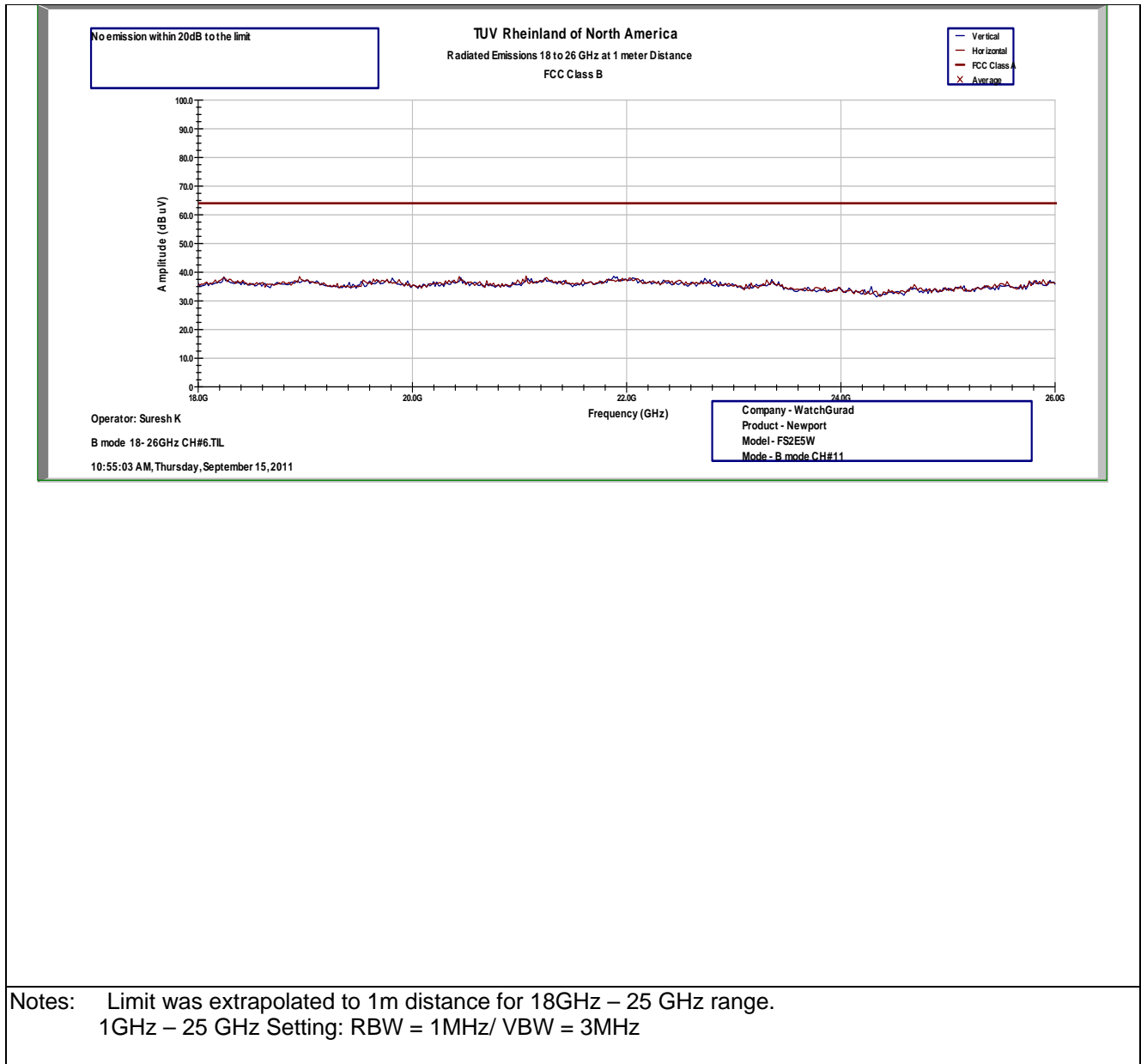
SOP 1 Radiated Emissions

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EUT Name	NEWCASTLE, NEWPORT	Date	September 25, 2011
EUT Model	FS1E5, FS1E5W, FS2E5, FS2E5W	Temp / Hum in	23°C / 40%rh
EUT Serial	70AB00010-8C75	Temp / Hum out	N/A
EUT Config.	Y-Axis, 12dBm, 1Mbps	Line AC	120Vac 60Hz
Standard	CFR47 Part 15 Subpart C	RBW / VBW	1MHz / 3MHz
Dist/Ant Used	3m - EMCO3115 / 1m - RA42-K-F-4B-C	Performed by	Suresh Kondapalli

Above 1GHz Plots for Transmit Mode at 2462MHz, 802.11b 1Mbit/s





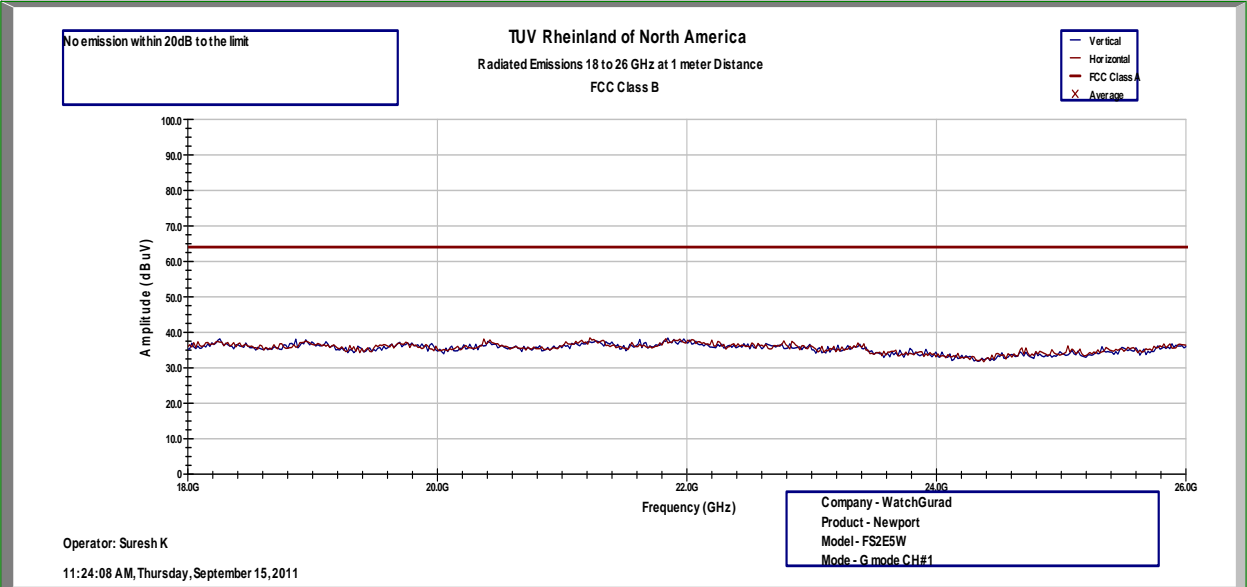
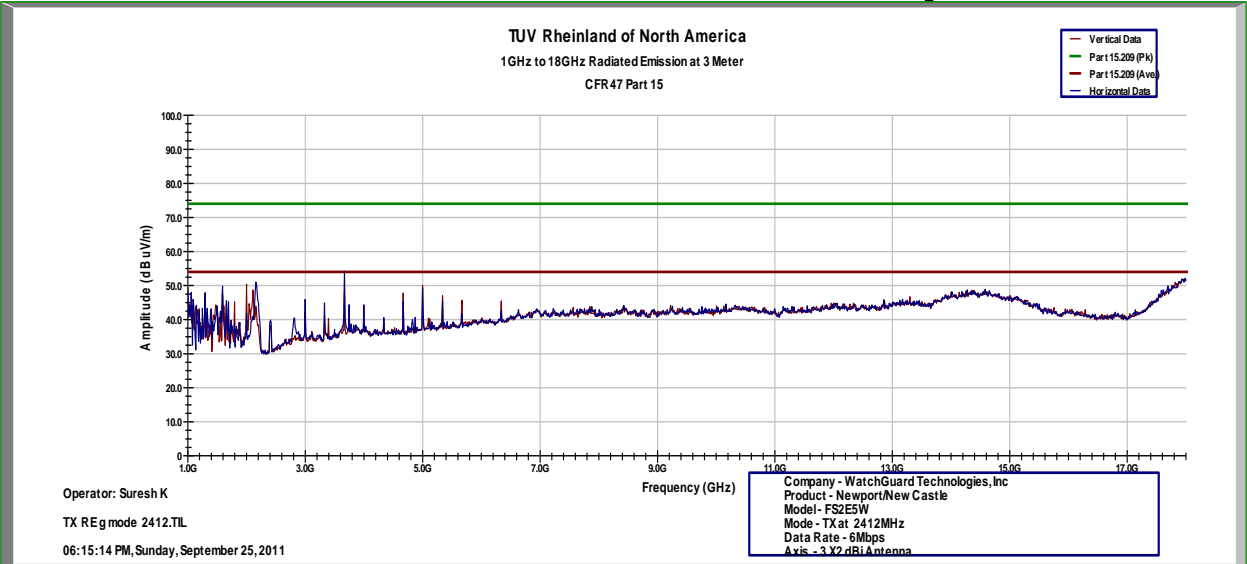
SOP 1 Radiated Emissions											Tracking # 31152150.002 Page 5 of 9	
EUT Name		NEWCASTLE, NEWPORT					Date		September 25 , 2011			
EUT Model		FS1E5, FS1E5W, FS2E5, FS2E5W					Temp / Hum in		23°C / 39%rh			
EUT Serial		70AB00010-8C75					Temp / Hum out		N/A			
EUT Config.		Y-Axis, 16dBm, 802.11g at 6Mbps					Line AC / Freq		120Vac/60Hz			
Standard		CFR47 Part 15 Subpart C					RBW / VBW		1 MHz/ 3 MHz			
Dist/Ant Used		3m / EMCO3115 / 1m - RA42-K-F-4B-C					Performed by		Suresh Kondapalli			
Emission Freq	FIM Pk	FIM Ave	Total CF	E-Field Ave	Spec Limit	Spec Margin	Table Pos	ANT Pos	ANT Pola	Type		
Transmitted Data at 2412MHz												
1999.82	59.18	45.39	-1.79	43.6	53.98	-10.38	18	116	V	Spurious		
2162.42	59.76	39.26	-1.2	38.06	53.98	-15.92	113	219	H	Spurious		
4825.9	40.74	26.45	5.09	31.54	53.98	-22.44	67	123	H	Harmonic		
7221	38.82	26.6	10.28	36.88	53.98	-17.1	-30	116	H	Harmonic		
Transmitted Data at 2437MHz												
1200.01	58.48	41.24	-5.35	35.89	53.98	-18.09	-24	137	V	Spurious		
1595.98	49.85	42.38	-3.91	38.47	53.98	-15.51	434	160	V	Spurious		
1666.53	49.52	46.8	-3.55	43.25	53.98	-10.73	366	139	V	Spurious		
3666.34	55.92	51.57	3.46	55.03	53.98	1.05	387	138	H	Spurious		
4874.51	39.55	29.96	5.25	35.21	53.98	-18.77	-11	129	H	Harmonic		
7311.75	40.99	29.33	10.37	39.7	53.98	-14.28	-90	129	H	Harmonic		
Transmitted Data at 2462MHz												
4924.03	37.83	26.56	5.38	31.94	53.98	-22.04	381	139	H	Spurious		
4999.53	46.34	42.33	5.61	47.94	53.98	-6.04	17	133	V	Spurious		
7383.75	46.15	30.8	10.44	41.24	53.98	-12.74	333	119	H	Harmonic		
Spec Margin = E-Field QP - Limit, E-Field QP = FIM QP+ Total CF ± Uncertainty												
Total CF= Amp Gain + Cable Loss + ANT Factor												
Combined Standard Uncertainty $u_c(y) = \pm 3.2$ dB Expanded Uncertainty $U = ku_c(y)$ $k = 2$ for 95% confidence												
Notes: Worst case was observed on Y-axis, 1Mbps. Emission at 3666.35MHz is conformed to be from Digital part of the device. This is considered as pass EUT is Class A device												
The output of radio was transmitted at +16dBm.												

SOP 1 Radiated Emissions

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EUT Name	NEWCASTLE, NEWPORT	Date	September 25, 2011
EUT Model	FS1E5, FS1E5W, FS2E5, FS2E5W	Temp / Hum in	23°C / 39%rh
EUT Serial	70AB00010-8C75	Temp / Hum out	N/A
EUT Config.	Y-Axis, 16dBm, 802.11g at 6Mbps	Line AC	120Vac 60Hz
Standard	CFR47 Part 15 Subpart C	RBW / VBW	1MHz / 3MHz
Dist/Ant Used	3m - EMCO3115 / 1m - RA42-K-F-4B-C	Performed by	Jeremy Luong

Above 1GHz Plots for Transmit Mode at 2412MHz, 802.11g 6Mbit/s



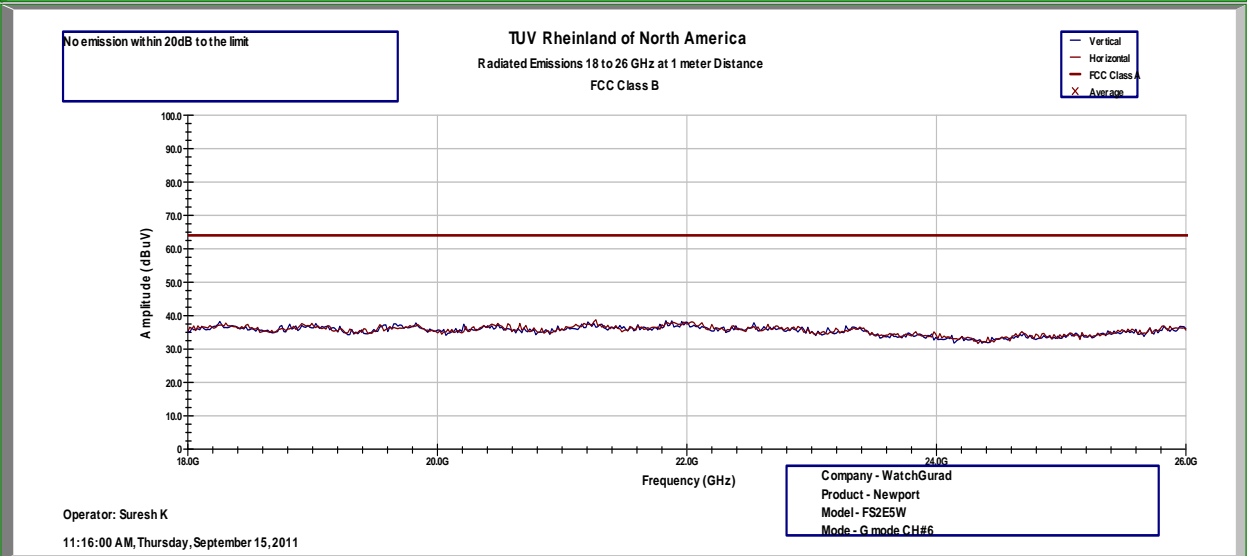
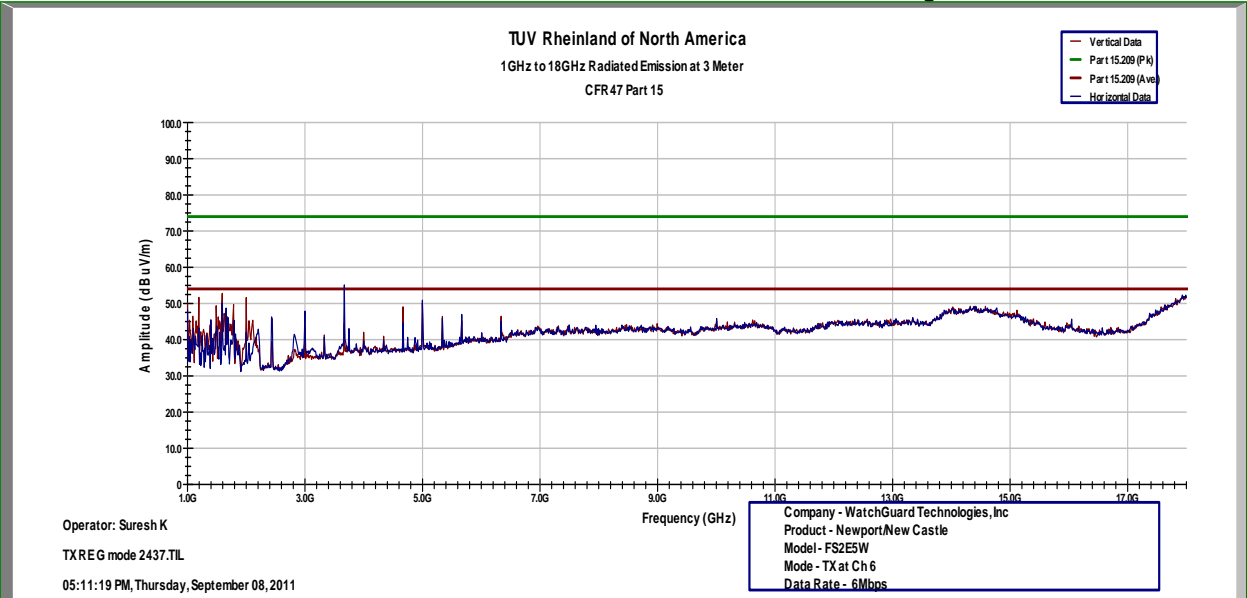
Notes: Limit was extrapolated to 1m distance for 18GHz – 25 GHz range.
 1GHz – 25 GHz Setting: RBW = 1MHz/ VBW = 3MHz

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EUT Name	NEWCASTLE, NEWPORT	Date	September 25, 2011
EUT Model	FS1E5, FS1E5W, FS2E5, FS2E5W	Temp / Hum in	23°C / 39%rh
EUT Serial	70AB00010-8C75	Temp / Hum out	N/A
EUT Config.	Y-Axis, 16dBm, 802.11g at 6Mbps	Line AC	120Vac 60Hz
Standard	CFR47 Part 15 Subpart C	RBW / VBW	1MHz / 3MHz
Dist/Ant Used	3m - EMCO3115 / 1m - RA42-K-F-4B-C	Performed by	Jeremy Luong

Above 1GHz Plots for Transmit Mode at 2437MHz, 802.11g 6Mbit/s



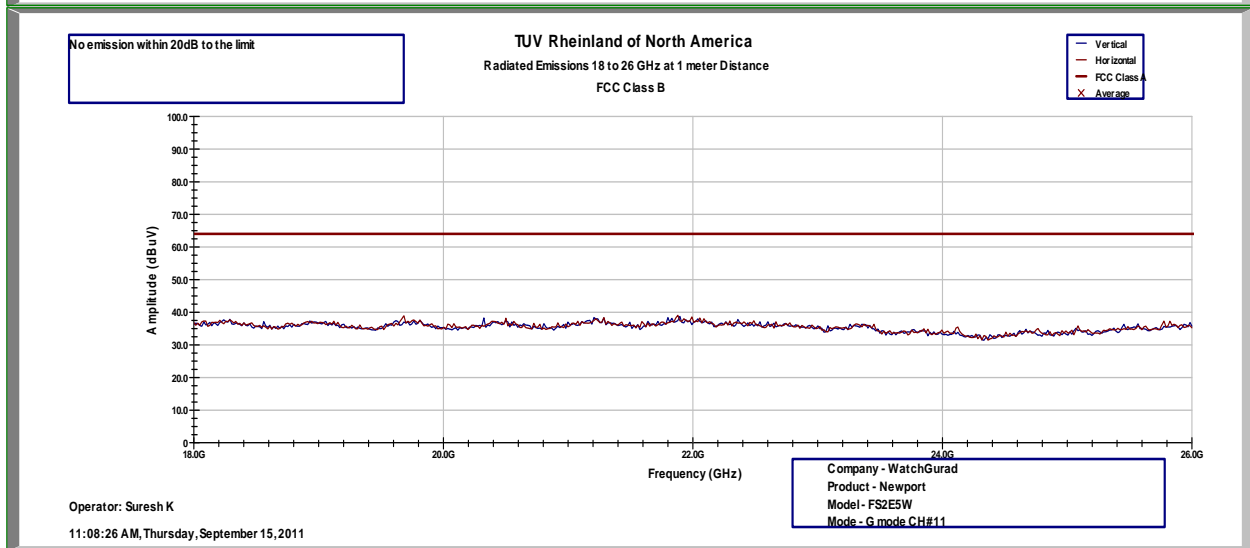
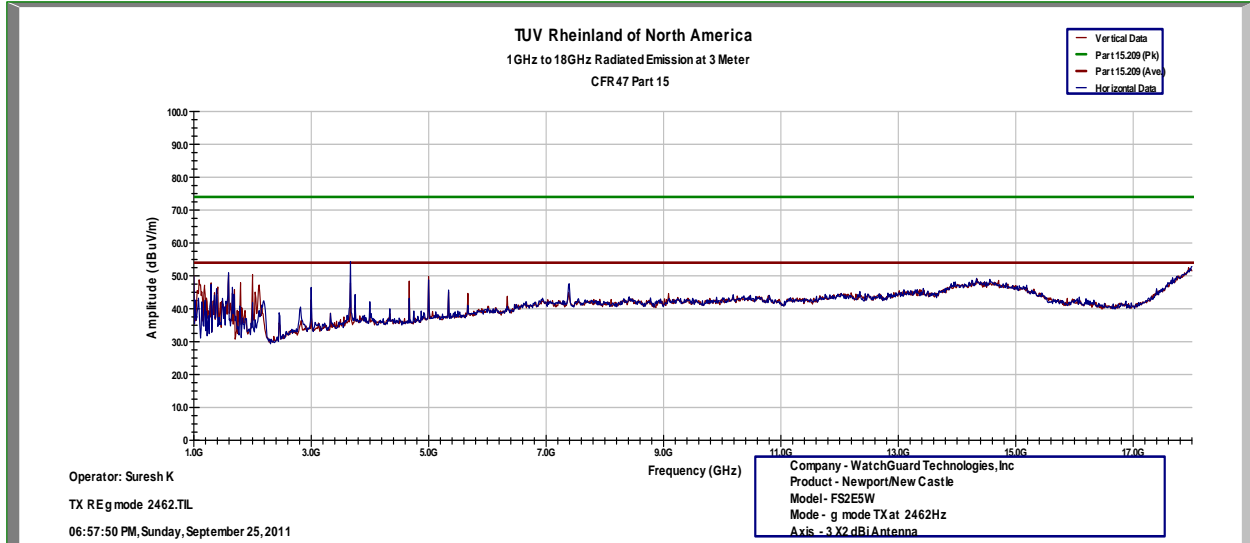
Notes: Limit was extrapolated to 1m distance for 18GHz – 25 GHz range.
 1GHz – 25 GHz Setting: RBW = 1MHz/ VBW = 3MHz

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EUT Name	NEWCASTLE, NEWPORT	Date	September 25, 2011
EUT Model	FS1E5, FS1E5W, FS2E5, FS2E5W	Temp / Hum in	23°C / 40%rh
EUT Serial	70AB00010-8C75	Temp / Hum out	N/A
EUT Config.	Y-Axis, 12dBm, 802.11g at 6Mbps	Line AC	120Vac 60Hz
Standard	CFR47 Part 15 Subpart C	RBW / VBW	1MHz / 3MHz
Dist/Ant Used	3m - EMCO3115 / 1m - RA42-K-F-4B-C	Performed by	Jeremy Luong

Above 1GHz Plots for Transmit Mode at 2462MHz, 802.11b 6Mbit/s



Notes: Limit was extrapolated to 1m distance for 18GHz – 25 GHz range.
 1GHz – 25 GHz Setting: RBW = 1MHz/ VBW = 3MHz

SOP 1 Radiated Emissions				Tracking # 31152150.002 Page 9 of 9			
EUT Name	NEWCASTLE, NEWPORT			Date	September 25 , 2011		
EUT Model	FS1E5, FS1E5W, FS2E5, FS2E5W			Temp / Hum in	23°C / 39%rh		
EUT Serial	70AB00010-8C75			Temp / Hum out	N/A		
EUT Config.	Y-Axis, 16dBm, 802.11g at 6Mbps			Line AC / Freq	120Vac/60Hz		
Standard	CFR47 Part 15 Subpart C			RBW / VBW	1 MHz/ 3 MHz		
Dist/Ant Used	3m / EMCO3115 / 1m - RA42-K-F-4B-C			Performed by	Suresh Kondapalli		

Emission Freq	FIM Pk	FIM Ave	Total CF	E-Field Ave	Spec Limit	Spec Margin	Table Pos	ANT Pos	ANT Pola	Type
Transmitted Data at 2412MHz										
1999.82	59.18	45.39	-1.79	43.6	53.98	-10.38	18	116	V	Spurious
2162.42	59.76	39.26	-1.2	38.06	53.98	-15.92	113	219	H	Spurious
4825.9	40.74	26.45	5.09	31.54	53.98	-22.44	67	123	H	Harmonic
7221	38.82	26.6	10.28	36.88	53.98	-17.1	-30	116	H	Harmonic
Transmitted Data at 2437MHz										
1200.01	58.48	41.24	-5.35	35.89	53.98	-18.09	-24	137	V	Spurious
1595.98	49.85	42.38	-3.91	38.47	53.98	-15.51	434	160	V	Spurious
1666.53	49.52	46.8	-3.55	43.25	53.98	-10.73	366	139	V	Spurious
3666.34	55.92	51.57	3.46	55.03	53.98	1.05*	387	138	H	Spurious
4874.51	39.55	29.96	5.25	35.21	53.98	-18.77	-11	129	H	Harmonic
7311.75	40.99	29.33	10.37	39.7	53.98	-14.28	-90	129	H	Harmonic
Transmitted Data at 2462MHz										
4924.03	37.83	26.56	5.38	31.94	53.98	-22.04	381	139	H	Spurious
4999.53	46.34	42.33	5.61	47.94	53.98	-6.04	17	133	V	Spurious
7383.75	46.15	30.8	10.44	41.24	53.98	-12.74	333	119	H	Harmonic
Spec Margin = E-Field QP - Limit, E-Field QP = FIM QP+ Total CF ± Uncertainty										
Total CF= Amp Gain + Cable Loss + ANT Factor										
Combined Standard Uncertainty $u_c(y) = \pm 3.2$ dB Expanded Uncertainty $U = k u_c(y)$ $k = 2$ for 95% confidence										
Notes: Worst case was observed on Y-axis, 1Mbps. *Emission at 3666.35MHz is confirmed to be from Digital part of the device. This is considered as pass as EUT is Class A device										
The output of radio was transmitted at +16dBm.										

Note: Emissions in HT20 and HT 40 mode were lower than b and g modes. Emissions in HT 20 & HT 40 modes for single channel, two channels and 3 channels were investigated only worst case results are placed here

4.5.4 Sample Calculation

The field strength is calculated by subtracting the Amplifier Gain and adding the Cable Loss and Antenna Correction Factor to the measured reading. The basic equation is as follows:

$$\text{Field Strength (dB}\mu\text{V/m)} = \text{FIM} - \text{AMP} + \text{CBL} + \text{ACF}$$

Where: FIM = Field Intensity Meter (dB μ V)
AMP = Amplifier Gain (dB)
CBL = Cable Loss (dB)
ACF = Antenna Correction Factor (dB/m)

$$\mu\text{V/m} = 10^{\frac{\text{dB}\mu\text{V} / \text{m}}{20}}$$

4.6 Receiver Spurious Emissions

Receiver spurious emissions are emissions at any frequency when the equipment is in receive mode.

The spurious emissions of the receiver shall not exceed the values in CFR47 Part 15.109 and RSS GEN Sect 6.1.

4.6.1 Test Methodology

4.6.1.1 Preliminary Test

A test program that controls instrumentation and data logging was used to automate the preliminary RF emission test procedure. The frequency range of interest was divided into sub-ranges to yield a frequency resolution of approximately 120 kHz and provide a reading at each frequency for no more than 12° of turntable rotation. For each frequency sub-range the turntable was rotated 360° while peak emission data was recorded and plotted over the frequency range of interest in horizontal and vertical antenna polarization's.

Preliminary emission profile testing was performed inside the anechoic chamber. The EUT was placed on a 1.0m x 1.5m non-conductive table 80cm above the floor. The EUT was positioned as shown in the setup photographs. The receiving antenna was placed at a distance of 3m at a fixed height of 1m. Measurement equipment was located outside of the chamber. A video camera was placed inside the chamber to view the EUT.

4.6.1.2 Final Test

For each frequency measured, the peak emission was maximized by manipulating the receiving antenna from 1 to 4 meters above the ground plane and placing it at the position that produced the maximum signal strength reading. The turntable was then rotated through 360° while observing the peak signal and placing the EUT at the position that produced maximum radiation. The six highest emissions relative to the limit were measured unless such emissions were more than 20 dB below the limit. If less than six emissions are within 20 dB of the limit, than the noise level of the receiver is measured at frequencies where emissions are expected. Multiples of all oscillator and microprocessor frequencies were also checked.

Final testing was performed on an NSA compliant test site. The EUT was placed on a 1.0m x 1.5m non-conductive table 80cm above the ground plane. The placement of EUT and cables were the same as for preliminary testing and is shown in the setup photographs.

4.6.1.3 Deviations

None.

4.6.2 Receiver Spurious Emission Limit

The spurious emissions of the receiver shall not exceed the values in CFR47 Part 15.109: 2009 and RSS GEN Sect 6.1 2010.

Frequency (MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	30
30-88	100 **	3
88-216	150 **	3
216-960	200 **	3
Above 960	500	3

4.6.3 Test Results

The final measurement data indicates the worst case operating modes, configurations, and/or cable positions. It also reflects the results including any modifications and/or special accessories listed in Sections 1.4 and 1.5.

As originally tested, the EUT was found to be compliant to the requirements of the test standard(s).

4.6.3.1 Final Data

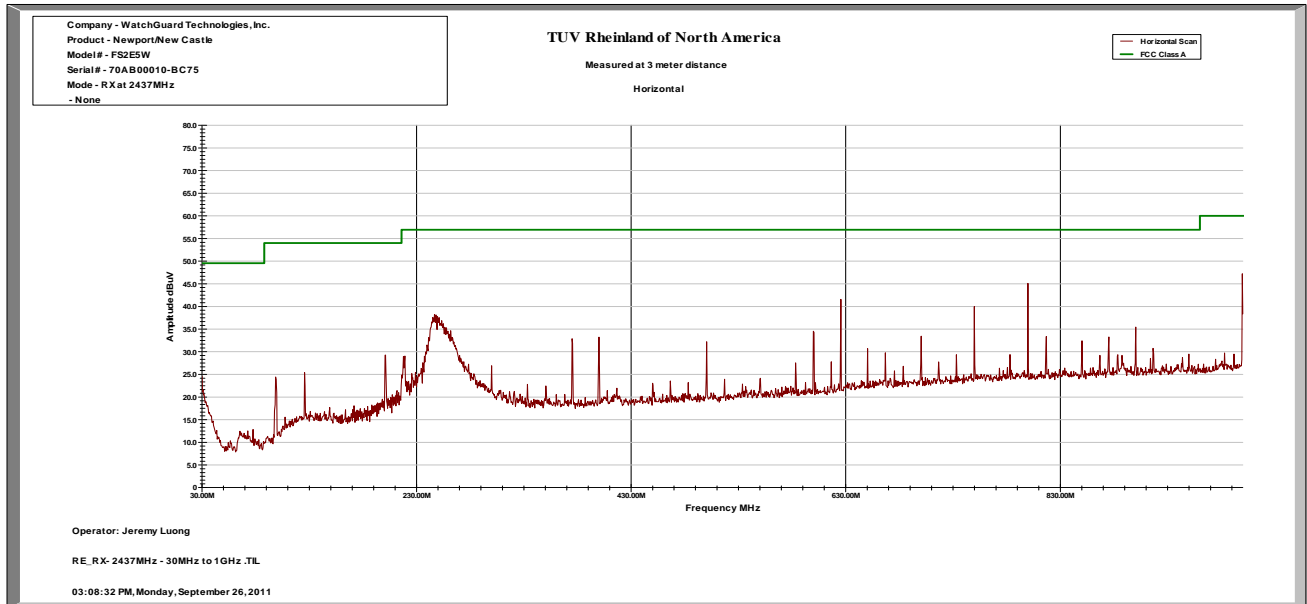
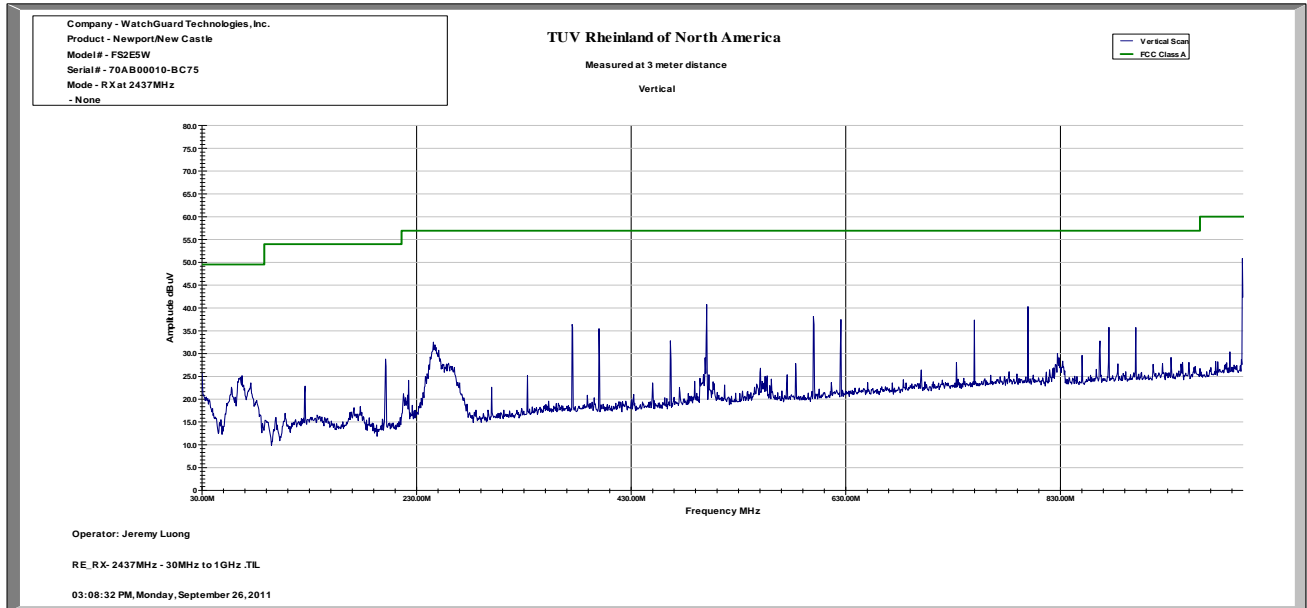
The data recorded in this section contains the final results under the worst-case conditions and without any modifications or special accessories implemented as the manufacturer intends.

SOP 1 Radiated Emissions							Tracking # 31152150.002 Page 1 of 6			
EUT Name	NEWCASTLE, NEWPORT					Date	September 26 , 2011			
EUT Model	FS1E5, FS1E5W, FS2E5, FS2E5W					Temp / Hum in	23°C / 39%rh			
EUT Serial	70AB00010-8C75					Temp / Hum out	N/A			
EUT Config.	Y-Axis, 802.11b, RX at Ch6, 1Mbps					Line AC / Freq	120Vac/60Hz			
Standard	CFR47 Part 15 Subpart C					RBW / VBW	1 MHz/ 3 MHz			
Dist/Ant Used	3m / EMCO3115 / 1m - RA42-K-F-4B-C					Performed by	Suresh Kondapalli			
Emission Freq	FIM Pk	FIM Ave	Total CF	E-Field Ave	Spec Limit	Spec Margin	Table Pos	ANT Pos	ANT Pola	Type
246.49	49.28	45.91	-10.23	35.68	56.90	-21.22	213	126	H	Spurious
624.98	47.17	46.93	-3.09	43.84	56.90	-13.06	346	124	H	Spurious
800.01	45.40	44.70	0.04	44.74	56.90	-12.16	57	105	H	Spurious
999.90	43.77	40.63	2.91	43.54	60.00	-16.46	281	114	H	Spurious
246.45	41.49	39.94	-10.37	29.57	56.90	-27.33	296	122	V	Spurious
499.95	47.60	45.82	-5.66	40.16	56.90	-16.74	5	109	V	Spurious
600.00	42.15	38.94	-4.19	34.75	56.90	-22.15	5	173	V	Spurious
800.00	44.01	43.84	-0.46	43.38	56.90	-13.52	21	131	V	Spurious
999.89	48.86	48.48	2.51	50.99	60.00	-9.01	4	107	V	Spurious
2333.15	54.91	52.88	-0.57	52.31	60.00	-7.69	33	129	V	Spurious
2333.18	57.91	57.32	-0.57	56.75	60.00	-3.25	391	190	H	Spurious
2500.11	50.61	46.63	0.02	46.65	60.00	-13.35	310	129	H	Spurious
2999.77	48.25	44.36	1.23	45.59	60.00	-14.41	29	165	H	Spurious
3666.38	55.01	48.49	3.46	51.95	60.00	-8.05	407	121	H	Spurious
3666.57	52.24	45.52	3.46	48.97	60.00	-11.03	14	203	V	Spurious
4999.59	47.51	41.91	5.61	47.52	60.00	-12.48	12	115	V	Spurious
4999.62	48.97	43.53	5.61	49.14	60.00	-10.86	381	145	H	Spurious
Spec Margin = E-Field QP - Limit, E-Field QP = FIM QP+ Total CF ± Uncertainty										
Total CF= Amp Gain + Cable Loss + ANT Factor										
Combined Standard Uncertainty $u_c(y) = \pm 3.2$ dB Expanded Uncertainty $U = k u_c(y)$ $k = 2$ for 95% confidence										
Notes: Worst case was observed on Y-axis, 1Mbps.										
Notes: Tested on the Y-Axis at Ch 6. 30 MHz – 1GHz: RBW=120 kHz,VBW=300 kHz 1GHz – 25 GHz: RBW=1MHz, VBW=3MHz										

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EUT Name	NEWCASTLE, NEWPORT	Date	September 25, 2011
EUT Model	FS1E5, FS1E5W, FS2E5, FS2E5W	Temp / Hum in	22°C / 40%rh
EUT Serial	70AB00010-8C75	Temp / Hum out	N/A
EUT Config.	Y-Axis, 802.11b, RX at Ch6, 1Mbps	Line AC / Freq	120Vac 60Hz
Standard	CFR47 Part 15.109, Class A	RBW / VBW	See Note
Dist/Ant Used	3m / JB3 & EMCO3115	Performed by	Suresh Kondapalli

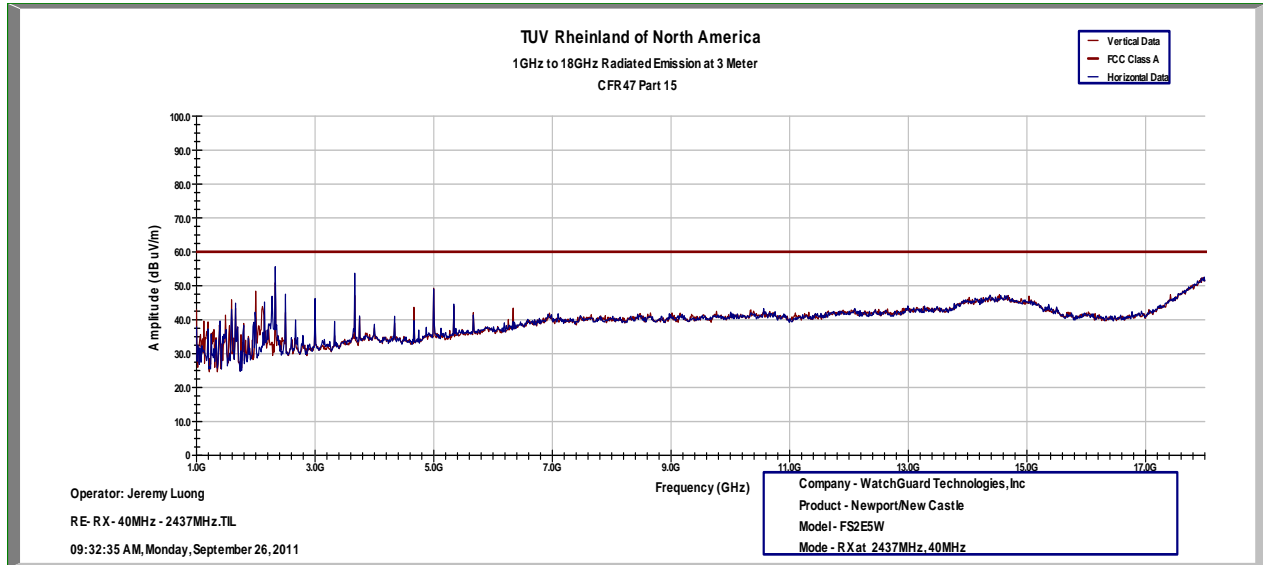


SOP 1 Radiated Emissions

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EUT Name	NEWCASTLE, NEWPORT	Date	September 25, 2011
EUT Model	FS1E5, FS1E5W, FS2E5, FS2E5W	Temp / Hum in	22°C / 40%rh
EUT Serial	70AB00010-8C75	Temp / Hum out	N/A
EUT Config.	Y-Axis, 802.11b, RX at Ch6, 1Mbps	Line AC	120Vac 60Hz
Standard	CFR47 Part 15.109, Class A	RBW / VBW	120 kHz / 300 kHz
Dist/Ant Used	3m / JB3	Performed by	Suresh Kondapali

Above 1GHz Plot for Receive Mode



Notes: All emission above 18GHz are atleast 20dB below the limit

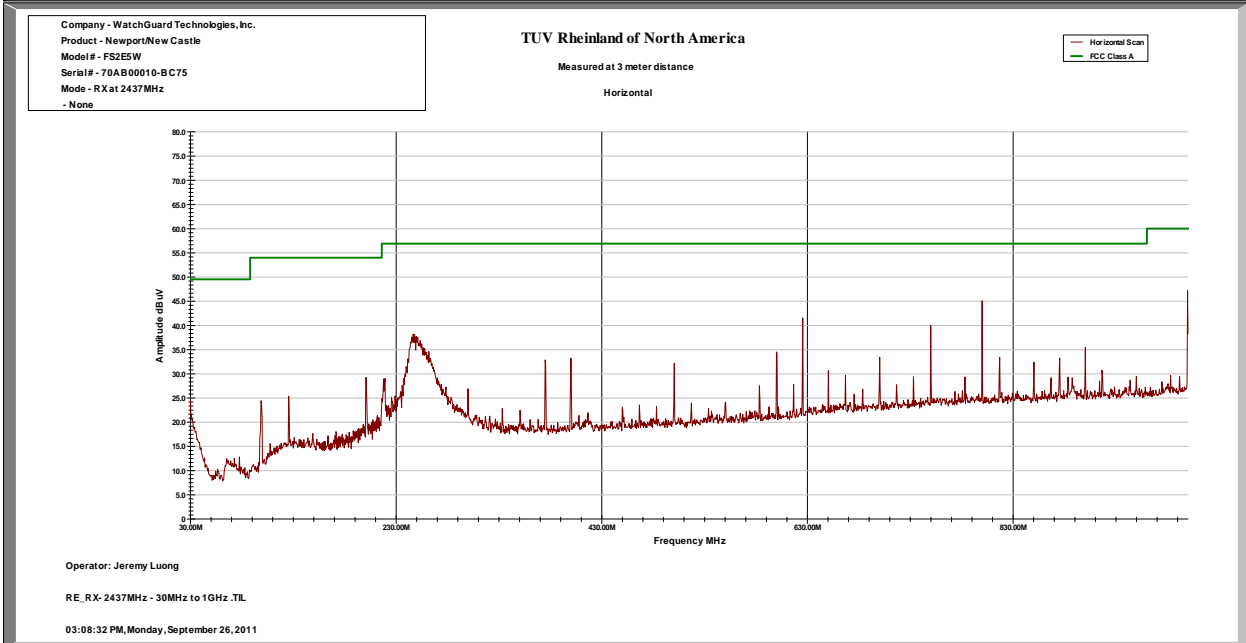
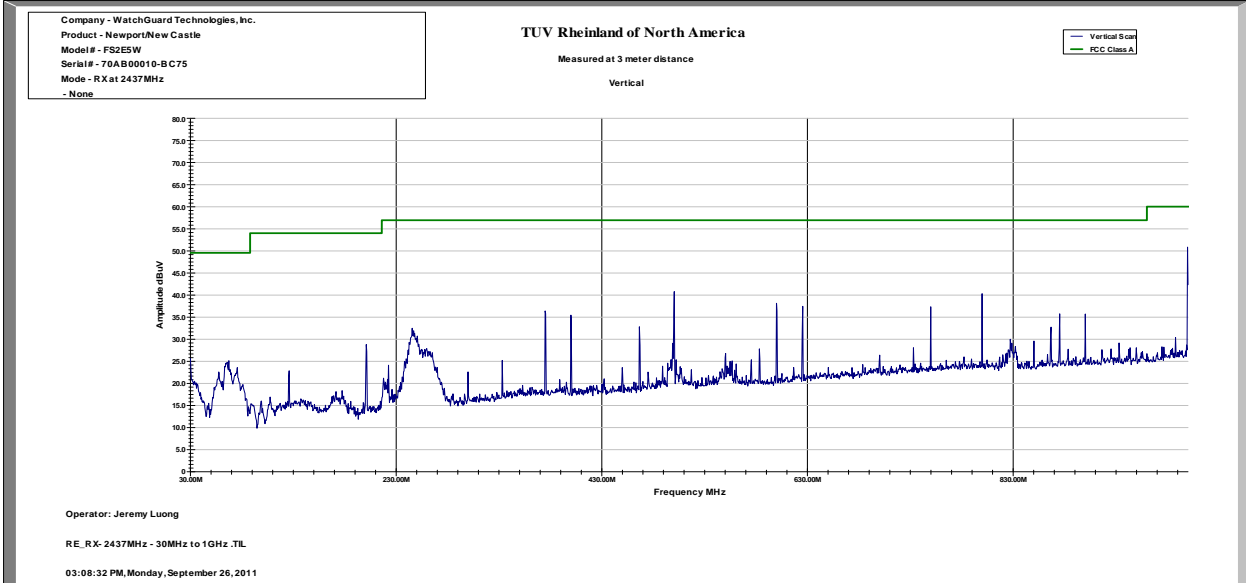
SOP 1 Radiated Emissions							Tracking # 31152150.002 Page 4 of 6				
EUT Name	NEWCASTLE, NEWPORT						Date	September 25, 2011			
EUT Model	FS1E5, FS1E5W, FS2E5, FS2E5W						Temp / Hum in	23°C / 39%rh			
EUT Serial	70AB00010-8C75						Temp / Hum out	N/A			
EUT Config.	Y-Axis, 802.11n HT40, RX at Ch6, 40.5Mbps						Line AC / Freq	120Vac/60Hz			
Standard	CFR47 Part 15 Subpart C						RBW / VBW	1 MHz/ 3 MHz			
Dist/Ant Used	3m / EMCO3115 / 1m - RA42-K-F-4B-C						Performed by	Suresh Kondapalli			
Emission Freq	FIM Pk	FIM Ave	Total CF	E-Field Ave	Spec Limit	Spec Margin	Table Pos	ANT Pos	ANT Pola	Type	
246.49	49.28	45.91	-10.23	35.68	56.90	-21.22	213	126	H	Spurious	
624.98	47.17	46.93	-3.09	43.84	56.90	-13.06	346	124	H	Spurious	
800.01	45.40	44.70	0.04	44.74	56.90	-12.16	57	105	H	Spurious	
999.90	43.77	40.63	2.91	43.54	60.00	-16.46	281	114	H	Spurious	
246.45	41.49	39.94	-10.37	29.57	56.90	-27.33	296	122	V	Spurious	
499.95	47.60	45.82	-5.66	40.16	56.90	-16.74	5	109	V	Spurious	
600.00	42.15	38.94	-4.19	34.75	56.90	-22.15	5	173	V	Spurious	
800.00	44.01	43.84	-0.46	43.38	56.90	-13.52	21	131	V	Spurious	
999.89	48.86	48.48	2.51	50.99	60.00	-9.01	4	107	V	Spurious	
1999.79	55.97	46.46	-1.79	44.67	60.00	-15.33	391	211	V	Spurious	
2333.07	64.83	55.92	-0.57	55.35	60.00	-4.65	355	104	H	Spurious	
2333.16	59.24	52.59	-0.57	52.02	60.00	-7.98	31	213	H	Spurious	
2500.13	48.77	45.14	0.02	45.16	60.00	-14.84	292	98	H	Spurious	
3666.41	55.13	48.26	3.46	51.72	60.00	-8.28	54	172	H	Spurious	
4999.56	47.92	42.78	5.61	48.39	60.00	-11.61	-26	210	V	Spurious	
Spec Margin = E-Field QP - Limit, E-Field QP = FIM QP+ Total CF ± Uncertainty											
Total CF= Amp Gain + Cable Loss + ANT Factor											
Combined Standard Uncertainty $u_c(y) = \pm 3.2\text{dB}$ Expanded Uncertainty $U = ku_c(y)$ $k = 2$ for 95% confidence											
Notes: Tested on the Y-Axis at Ch 6.											
30 MHz – 1GHz: RBW=120 kHz, VBW=300 kHz											
1GHz – 25 GHz: RBW=1MHz, VBW=3MHz											

SOP 1 Radiated Emissions

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EUT Name	NEWCASTLE, NEWPORT	Date	September 25, 2011
EUT Model	FS1E5, FS1E5W, FS2E5, FS2E5W	Temp / Hum in	21°C / 38%rh
EUT Serial	70AB00010-8C75	Temp / Hum out	N/A
EUT Config.	Y-Axis, 802.11n HT40, RX at Ch6, 40.5Mbps	Line AC	120Vac 60Hz
Standard	CFR47 Part 15.109, Class A	RBW / VBW	120 kHz / 300 kHz
Dist/Ant Used	3m / JB3	Performed by	Jeremy Luong

30 MHz to 1000 MHz Plots for Receive Mode



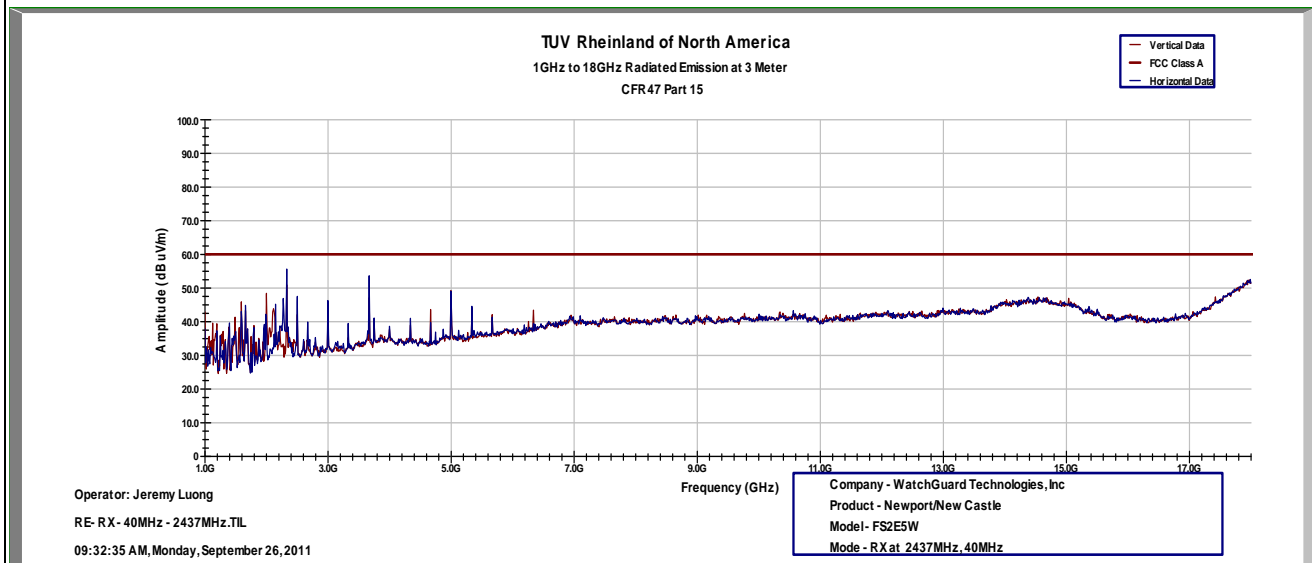
Notes: None.

SOP 1 Radiated Emissions

Tracking # 31152150.002 Page 6 of 6

EUT Name	NEWCASTLE, NEWPORT	Date	September 25, 2011
EUT Model	FS1E5, FS1E5W, FS2E5, FS2E5W	Temp / Hum in	23°C / 40%rh
EUT Serial	70AB00010-8C75	Temp / Hum out	N/A
EUT Config.	Y-Axis, 802.11n HT40, RX at Ch6, 40.5Mbps	Line AC	120Vac 60Hz
Standard	CFR47 Part 15.109, Class A	RBW / VBW	1MHz / 3MHz
Dist/Ant Used	3m / EMCO3115	Performed by	Jeremy Luong

Above 1GHz Plot for Receive Mode



Notes: None.

4.6.4 Sample Calculation

The field strength is calculated by subtracting the Amplifier Gain and adding the Cable Loss and Antenna Correction Factor to the measured reading. The basic equation is as follows:

$$\text{Field Strength (dB}\mu\text{V/m)} = \text{FIM} - \text{AMP} + \text{CBL} + \text{ACF}$$

Where: FIM = Field Intensity Meter (dB μ V)
AMP = Amplifier Gain (dB)
CBL = Cable Loss (dB)
ACF = Antenna Correction Factor (dB/m)

$$\mu\text{V/m} = 10^{\frac{\text{dB}\mu\text{V / m}}{20}}$$

4.7 AC Conducted Emissions

Testing was performed in accordance with ANSI C63.4-2009. These test methods are listed under the laboratory's NVLAP Scope of Accreditation.

This test measures the levels emanating from the EUT's AC input port, thus evaluating the potential for the EUT to cause radio frequency interference to other electronic devices.

The AC conducted emissions of equipment under test shall not exceed the values in CFR47 Part 15.207: 2009 and RSS 210: 2010.

4.7.1 Test Methodology

A test program that controls instrumentation and data logging was used to automate the AC Power Line Conducted emission test procedure. The frequency range of interest was divided into sub-ranges such as to yield a frequency resolution of 9 kHz. Each phase and neutral of the AC power line were measured with respect to ground. Measurements were performed using a set of 50 μ H / 50 Ω LISNs.

Testing is either performed in Lab 5. The setup photographs clearly identify which site was used. The vertical ground plane used in the semi-anechoic chamber is a 2m x 2m solid aluminum frame and panel, and it is bonded to the horizontal ground plane.

In the case of tabletop equipment, the EUT is placed on a 1.0m x 1.5m non-conductive table 80cm above the ground plane and 40cm from a vertical ground reference plane. The rear of the EUT was positioned flush with the backside of the table and directly over the LISNs. The power and I/O cables were routed over the edge of the table and bundled approximately 40cm from the ground plane. Support equipment was powered from a separate LISN.

4.7.1.1 Deviations

There were no deviations from this test methodology.

4.7.2 Test Results

As originally tested, the EUT was found to be compliant to the requirements of the test standard(s).

Table 8: AC Conducted Emissions – Test Results

Test Conditions: Conducted Measurement at Normal Conditions only		
Antenna Type: Attached	Power Level: See Test Plan	
AC Power: 120 Vac/60 Hz	Configuration: Tabletop	
Ambient Temperature: 22° C	Relative Humidity: 38% RH	
Configuration	Frequency Range	Test Result

Line 1 (Hot)	0.15 to 30 MHz	Pass
Line 2 (Neutral)	0.15 to 30 MHz	Pass

Frequency	Quasi-Peak	QP Limit	QP Margin	Average	Ave Limit	Ave Margin
MHz	dBuV	dBuV	dB	dBuV	dBuV	dB
0.150	51.36	33.9	79	66	-27.64	-32.1
0.164	50.28	27.29	79	66	-28.72	-38.71
0.197	44.97	26.93	79	66	-34.03	-39.07
0.485	40.84	36.49	79	66	-38.16	-29.51
6.39	33.62	26.41	73	60	-39.38	-33.59
13.7	31.15	25.19	73	60	-41.85	-34.81

Spec Margin = QP./Ave. - Limit, ± Uncertainty

Combined Standard Uncertainty $u_c(y) = \pm 1.2$ dB Expanded Uncertainty $U = k u_c(y)$ $k = 2$ for 95% confidence

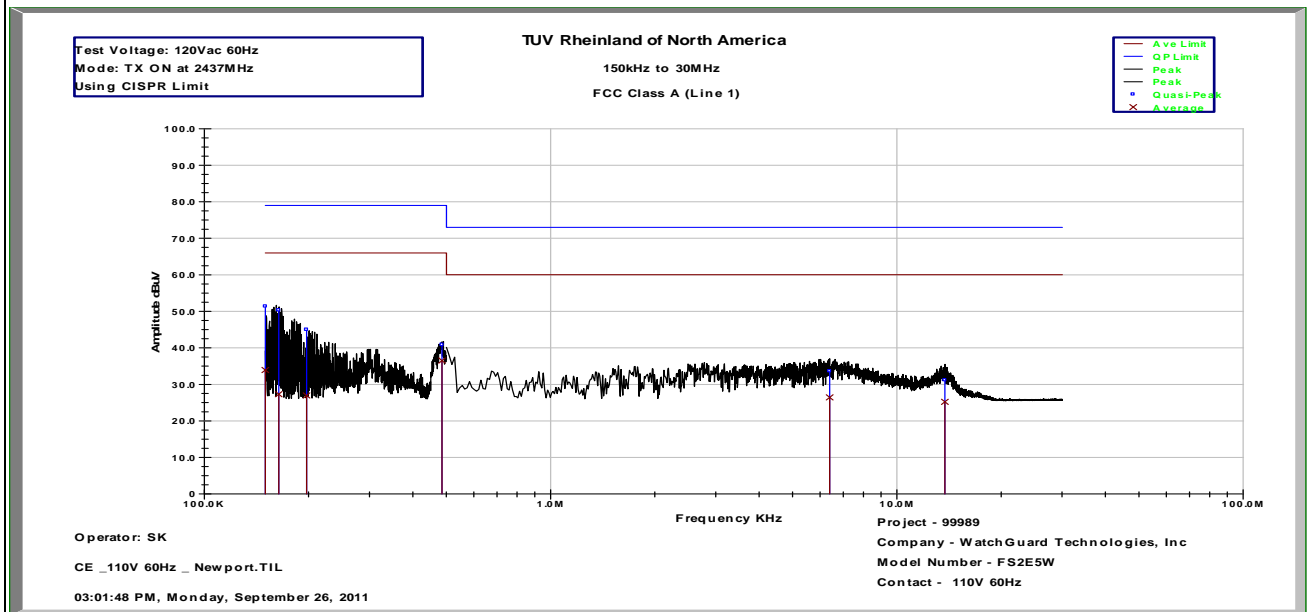
Notes: EUT was setup as table top equipment.

SOP 2 Conducted Emissions

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EUT Name	NEWCASTLE, NEWPORT	Date	September 25, 2011
EUT Model	FS1E5, FS1E5W, FS2E5, FS2E5W	Temp / Hum in	21° C / 38% rh
EUT Serial	70AB00010-8C75	Temp / Hum out	N/A
EUT Config.	Attached Antenna	Line AC	120Vac/60Hz
Standard	CFR47 Part 15.207	RBW / VBW	9kHz / 30 kHz
Lab/LISN	Lab #5 / Solar 9348-50-R-24-BNC, Line 1	Performed by	Suresh Kondapalli

150 kHz to 30 MHz Plot for Line 1 (Hot)



Notes: Meets FCC Class A limit.

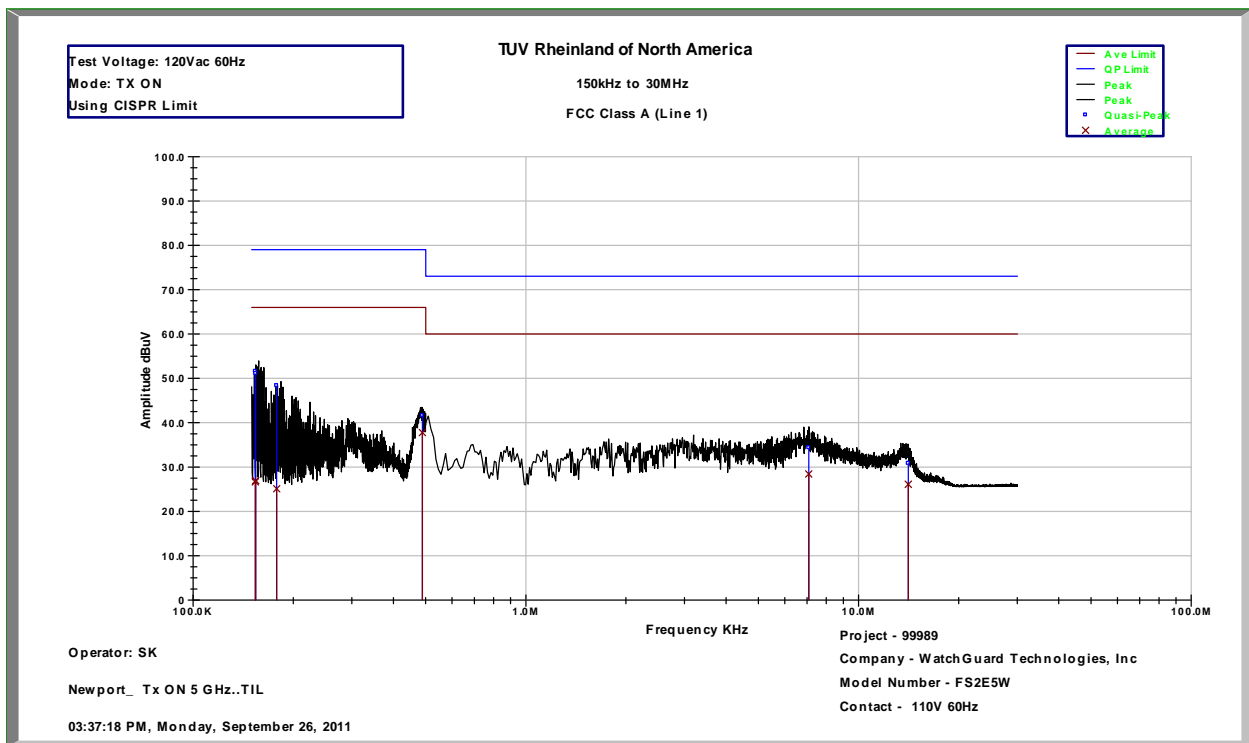
SOP 2 Conducted Emissions				Tracking # 31152150.002 Page 3 of 4		
EUT Name	NEWCASTLE, NEWPORT			Date	September 26, 2011	
EUT Model	FS1E5, FS1E5W, FS2E5, FS2E5W			Temp / Hum in	21° C / 38% rh	
EUT Serial	70AB00010-8C75			Temp / Hum out	N/A	
EUT Config.	3 Extenal Antennas			Line AC / Freq	120Vac/60Hz	
Standard	CFR47 Part 15.107			RBW / VBW	9kHz / 30 kHz	
Lab/LISN	Lab #5 / Solar 9348-50-R-24-BNC, Line 2			Performed by	Suresh Kondapalli	
Frequency	Quasi-Peak	QP Limit	QP Margin	Average	Ave Limit	Ave Margin
MHz	dBuV	dBuV	dB	dBuV	dBuV	dB
0.152	50.92	32.29	79	66	-28.08	-33.71
0.154	53.54	31.57	79	66	-25.46	-34.43
0.168	49.91	26.61	79	66	-29.09	-39.39
0.174	49.32	27.57	79	66	-29.68	-38.43
0.488	41.7	37.36	79	66	-37.3	-28.64
6.34	34.25	26.81	73	60	-38.75	-33.19
Spec Margin = QP./Ave. - Limit, ± Uncertainty						
Combined Standard Uncertainty $u_c(y) = \pm 1.2$ dB Expanded Uncertainty $U = k u_c(y)$ $k = 2$ for 95% confidence						
Notes: EUT was setup as table top equipment.						

SOP 2 Conducted Emissions

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EUT Name	NEWCASTLE, NEWPORT	Date	September 25, 2011
EUT Model	FS1E5, FS1E5W, FS2E5, FS2E5W	Temp / Hum in	21° C / 38% rh
EUT Serial	70AB00010-8C75	Temp / Hum out	N/A
EUT Config.	Attached Antenna	Line AC	120Vac/60Hz
Standard	CFR47 Part 15.107	RBW / VBW	9kHz / 30 kHz
Lab/LISN	Lab #5/ Solar 9348-50-R-24-BNC, Line 2	Performed by	Suresh Kondapalli

150 kHz to 30 MHz Plot for Line 2 (Neutral)



Note: Meets FCC Class A Limit.

5 Emission Requirements – 5725 MHz to 5850 MHz Band

Testing was performed in accordance with CFR 47 Part 15.247: 2009 and RSS 210 Annex 8: 2010. These test methods are listed under the laboratory’s NVLAP Scope of Accreditation. This test measures the levels emanating from the EUT, thus evaluating the potential for the EUT to cause radio frequency interference to other electronic devices. Procedures described in section 8 of the standard were used.

5.1 Output Power Requirements

The maximum output power requirement is the maximum equivalent isotropic radiated power delivering at the transmitting antenna under specified conditions of measurements in the presence of modulation.

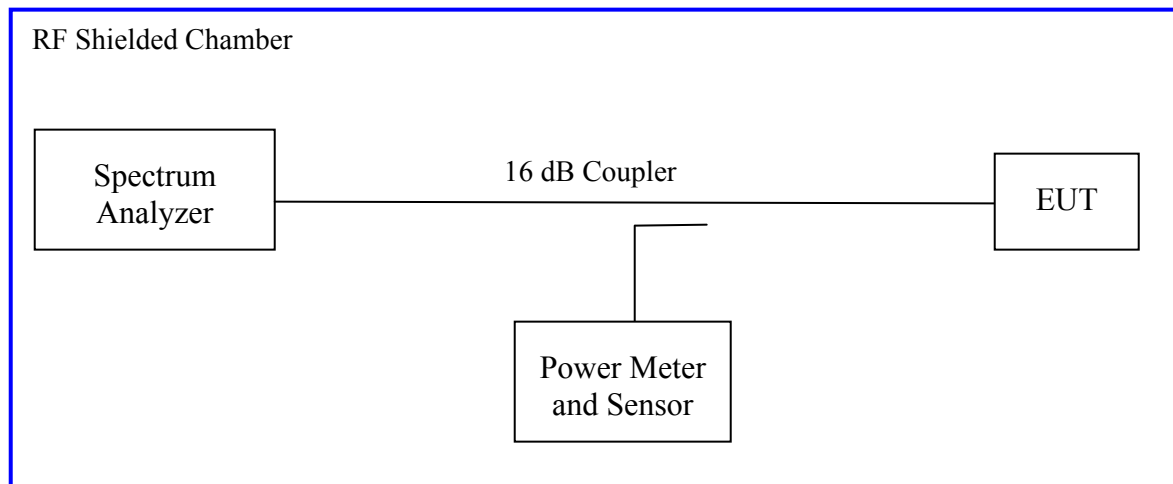
The maximum output power and harmonics shall not exceed CFR47 Part 15.247 (b3):2009 and RSS 210 A.8.4: 2010

The maximum transmitted power is +30 dBm or 1Watt.

5.1.1 Test Method

The conducted method was used to measure the channel power output according to ANSI C63.10:2009 Section 6.10.3.1. The measurement was performed with modulation per CFR47 Part 15.247 (b3):2009 and RSS 210 A.8.4. This test was conducted on 3 channels in each operating mode. The worst mode result indicated below.

Test Setup:



Method #1 of “Measurement of Digital Transmission Systems Operating under Section 15.247” applies since the EUT continuously transmit; where T, Transmission Duration Pulse, is greater than analyzer sweep time. Peak detector was used. Each chain was measured individually and applied the measure-and-sum approach per KDB662911.

5.1.2 Results

As originally tested, the EUT was found to be compliant to the requirements of the test standard(s).

Table 9: RF Output Power at the Antenna Port – Test Results

Test Conditions: Conducted Measurement, Normal Temperature						
Antenna Type: 3 Extenal Antennas				Power Setting: See test plan		
Max. Antenna Gain: + 2.0 dBi				Signal State: Modulated at 100%.		
Ambient Temp.: 21 °C				Relative Humidity: 39%		
802.11a Mode, 1x3						
Operating Channel	Limit [dBm]	Chain 0 [dBm]	Chain 1 [dBm]	Chain 2 [dBm]	Total Power [dBm]	Margin [dB]
5745	30	19.07	19.1	18.81		-10.99
5785	30	18.96	19.35	19.15		-10.65
5825	30	18.86	19.29	19.2		-10.61
Note: The highest output power was observed at 6 Mbps.						
802.11n (HT20) Mode, 1x3						
Operating Channel	Limit [dBm]	Chain 0 [dBm]	Chain 1 [dBm]	Chain 2 [dBm]	Total Power [dBm]	Margin [dB]
5745	30	18.14	17.98	19.15		-10.85
5785	30	17.87	18.05	17.68		-11.95
5825	30	17.62	18.89	18.9		-11.10
Note: The highest output power was observed at HT20 6.5 Mbps, 1 Data Stream.						
802.11n (HT20) Mode, 2x3						
Operating Channel	Limit [dBm]	Chain 0 [dBm]	Chain 1 [dBm]	Chain 2 [dBm]	Total Power [dBm]	Margin [dB]
5745	30	18.13	16.45		20.38	-9.62
5785	30	19.06	16.84		21.08	-8.92
5825	30	18.32	16.64		20.48	-9.52
Note: The highest output power was observed at HT20 13 Mbps, 2 Data Streams.						

802.11n (HT20) Mode, 3x3						
Operating Channel	Limit [dBm]	Chain 0 [dBm]	Chain 1 [dBm]	Chain 2 [dBm]	Total Power [dBm]	Margin [dB]
5745	30	14.65	16.27	15.72	20.36	-9.64
5785	30	14.31	16.84	15.47	20.43	-9.57
5825	30	14.54	16.61	15.48	20.39	-9.61
Note: The highest output power was observed at HT20 19.5 Mbps, 3 Data Streams.						
802.11n (HT40) Mode, 1x3						
Operating Channel	Limit [dBm]	Chain 0 [dBm]	Chain 1 [dBm]	Chain 2 [dBm]	Total Power [dBm]	Margin [dB]
5755	30	17.97	17.82	17.35		-12.05
5795	30	18.19	18.01	18.06		-11.81
Note: The highest output power was observed at HT40 13.5 Mbps, 1 Data Stream.						
802.11n (HT40) Mode, 2x3						
Operating Channel	Limit [dBm]	Chain 0 [dBm]	Chain 1 [dBm]	Chain 2 [dBm]	Total Power [dBm]	Margin [dB]
5755	30	17.95	15.97		20.08	-9.92
5795	30	18.51	16.35		20.57	-9.43
Note: The highest output power was observed at HT40 27 Mbps, 2 Data Streams.						
802.11n (HT40) Mode, 3x3						
Operating Channel	Limit [dBm]	Chain 0 [dBm]	Chain 1 [dBm]	Chain 2 [dBm]	Total Power [dBm]	Margin [dB]
5755	30	18.49	16.13	15.01	21.56	-8.44
5795	30	18.73	16.59	15.65	21.95	-8.05
Note: The highest output power was observed at HT40 40.5 Mbps, 3 Data Streams.						

Note: All power measurements were performed as indicated in the above table. Only worst case/ limited number of plots are placed in the report.

Agilent 05:50:58 Sep 23, 2011

R T S

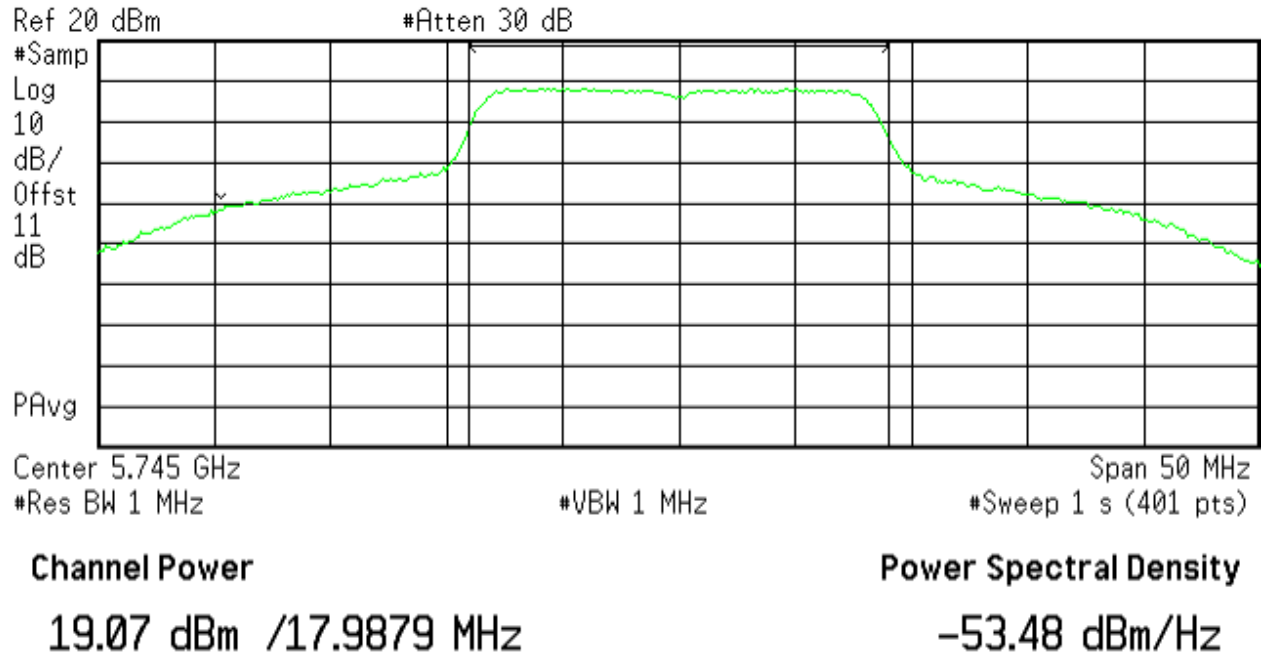


Figure 86: Maximum Transmitted Power, Lowest Channel 5745 MHz of 802.11a, Chain 0

Agilent 06:23:36 Sep 23, 2011

R T S

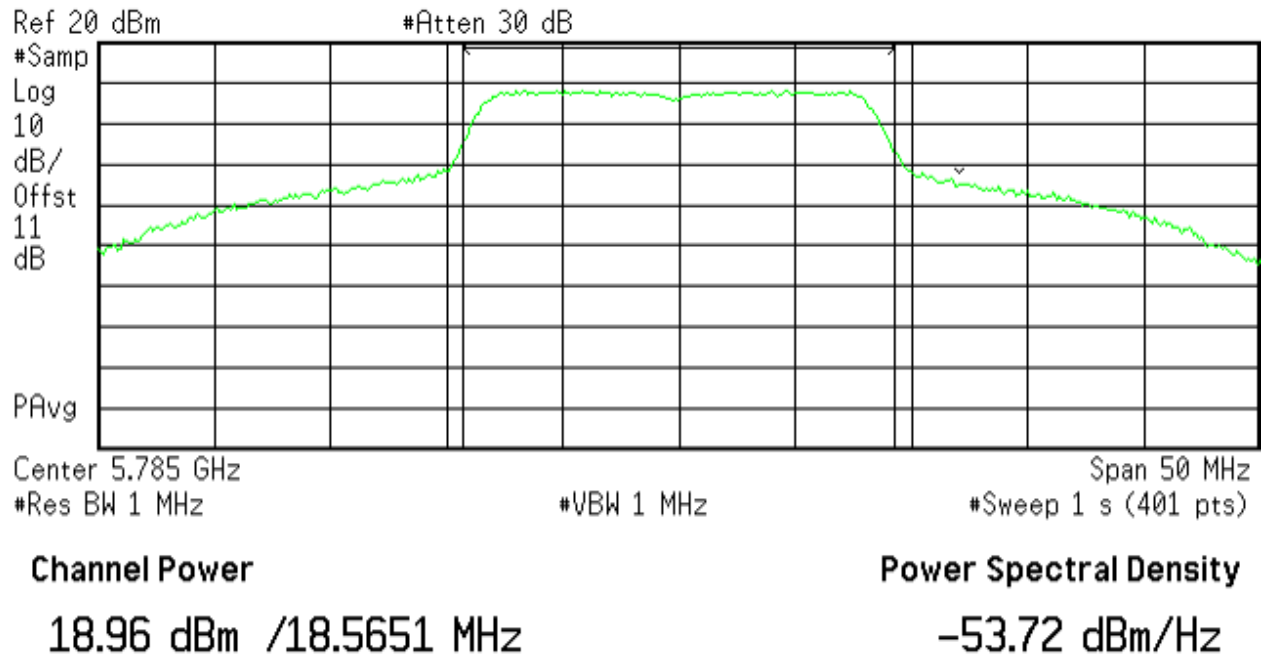
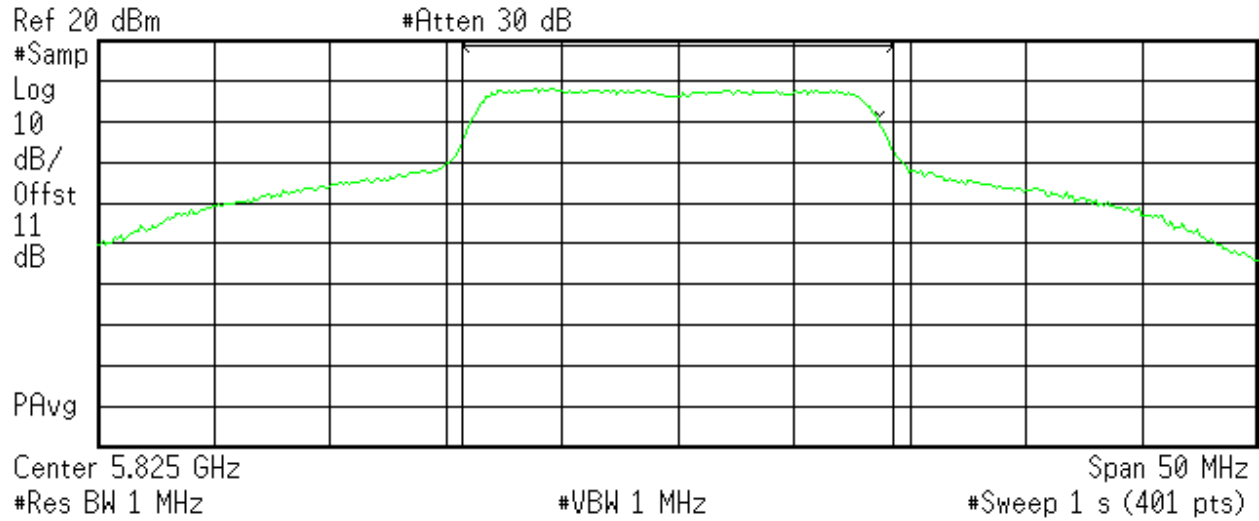


Figure 87: Maximum Transmitted Power, Middle Channel 5785 MHz of 802.11a, Chain 0

Agilent 06:46:53 Sep 23, 2011

R T S



Channel Power

18.86 dBm /18.5744 MHz

Power Spectral Density

-53.83 dBm/Hz

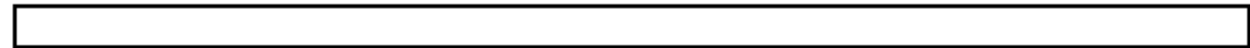


Figure 88: Maximum Transmitted Power, Highest Channel 5825 MHz of 802.11a, Chain 0

Agilent 04:37:58 Sep 24, 2011

R T S

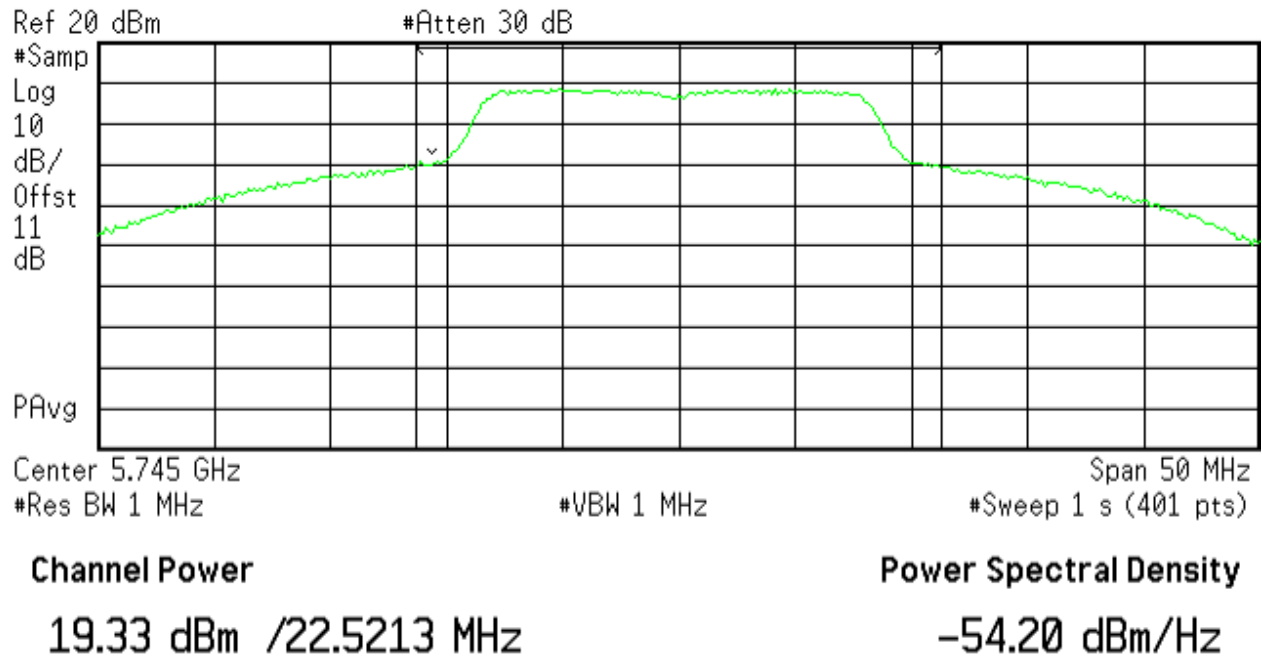
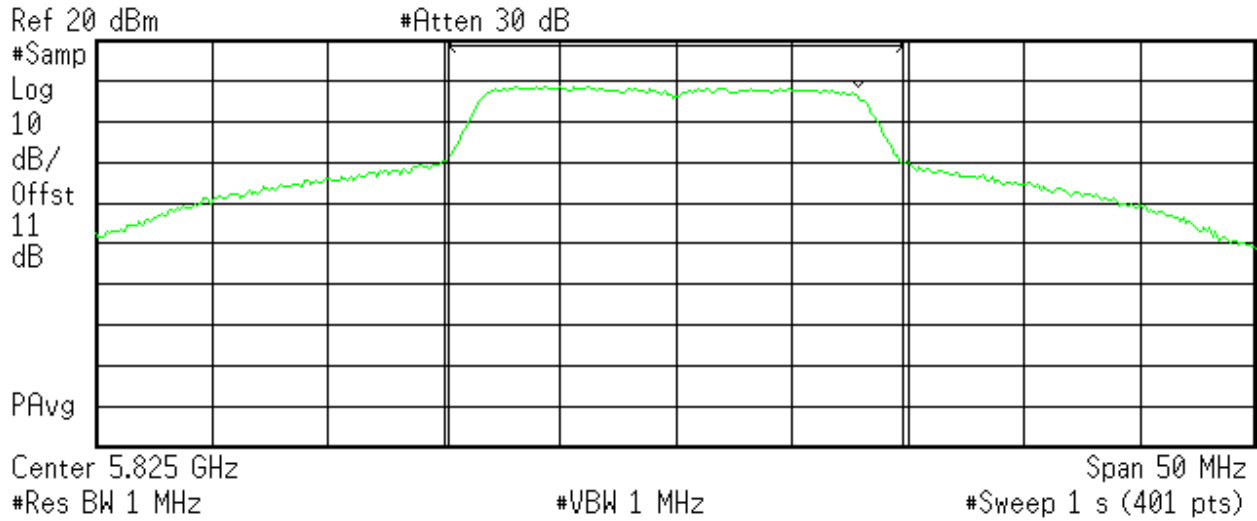


Figure 89: Maximum Transmitted Power, Lowest Channel 5745 MHz of 802.11a, Chain 1

Agilent 05:56:27 Sep 24, 2011

R T S



Channel Power

19.29 dBm /19.5874 MHz

Power Spectral Density

-53.63 dBm/Hz

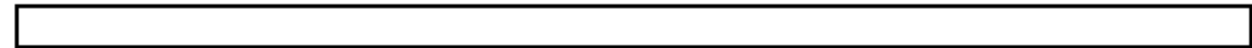
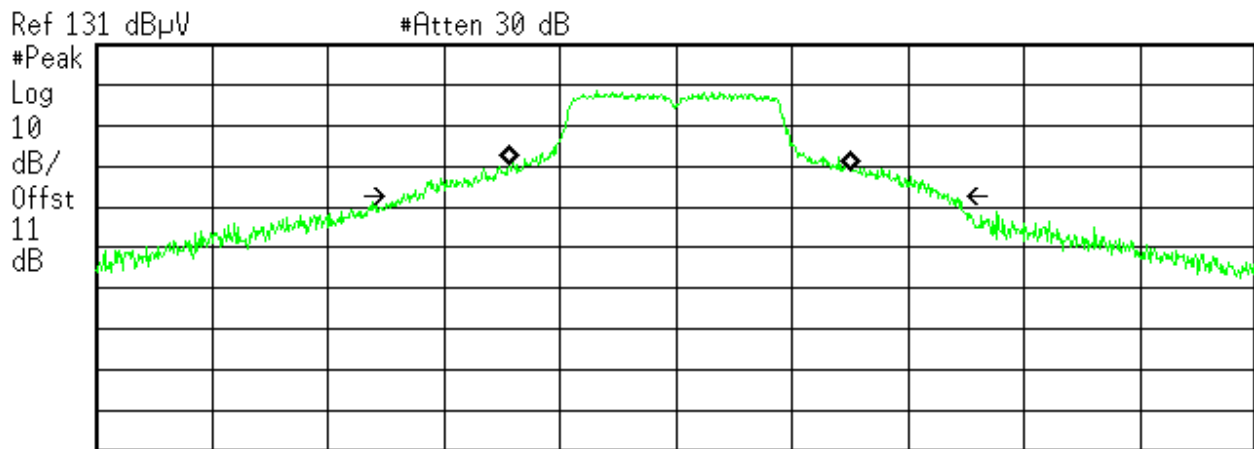


Figure 91: Maximum Transmitted Power, Highest Channel 5825 MHz of 802.11a, Chain 1

Agilent 07:56:53 Sep 24, 2011

R T S



Center 5.785 GHz Span 90 MHz
 #Res BW 300 kHz #VBW 1 MHz #Sweep 100 ms (1000 pts)

Occupied Bandwidth
26.3347 MHz

Occ BW % Pwr 99.00 %
x dB -26.00 dB

Transmit Freq Error 263.831 kHz
x dB Bandwidth 42.281 MHz

Figure 92: Maximum Transmitted Power, Lowest Channel 5745 MHz of 802.11a, Chain 2

Agilent 07:55:39 Sep 24, 2011

R T S

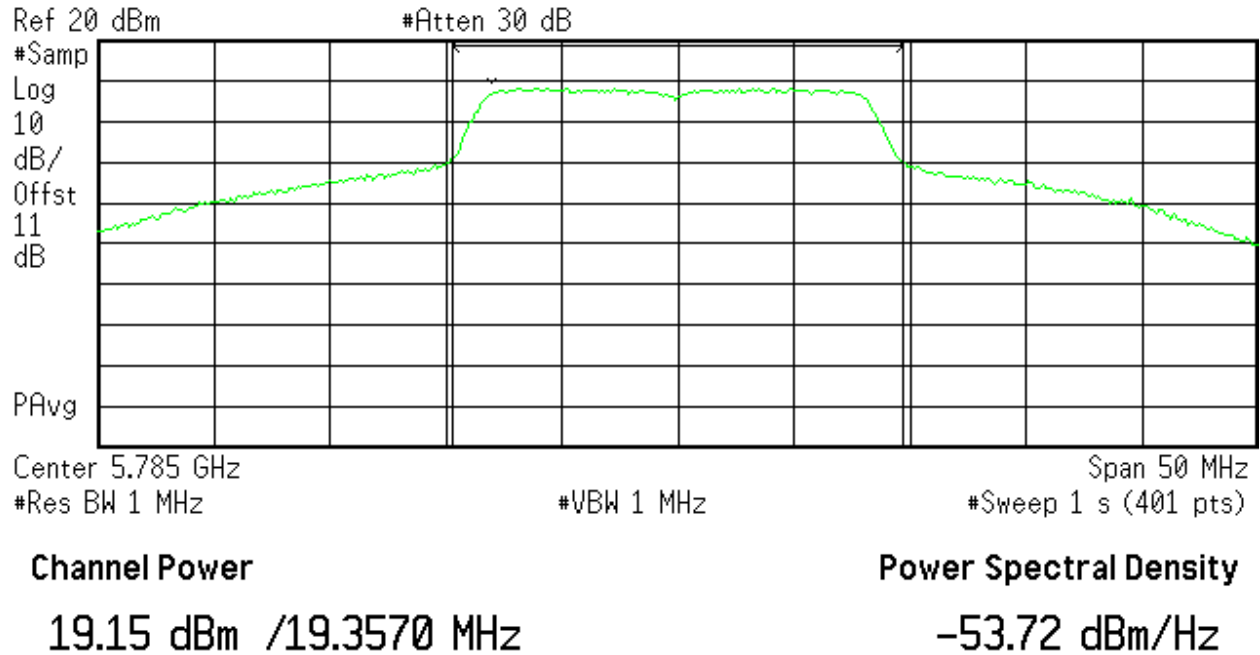
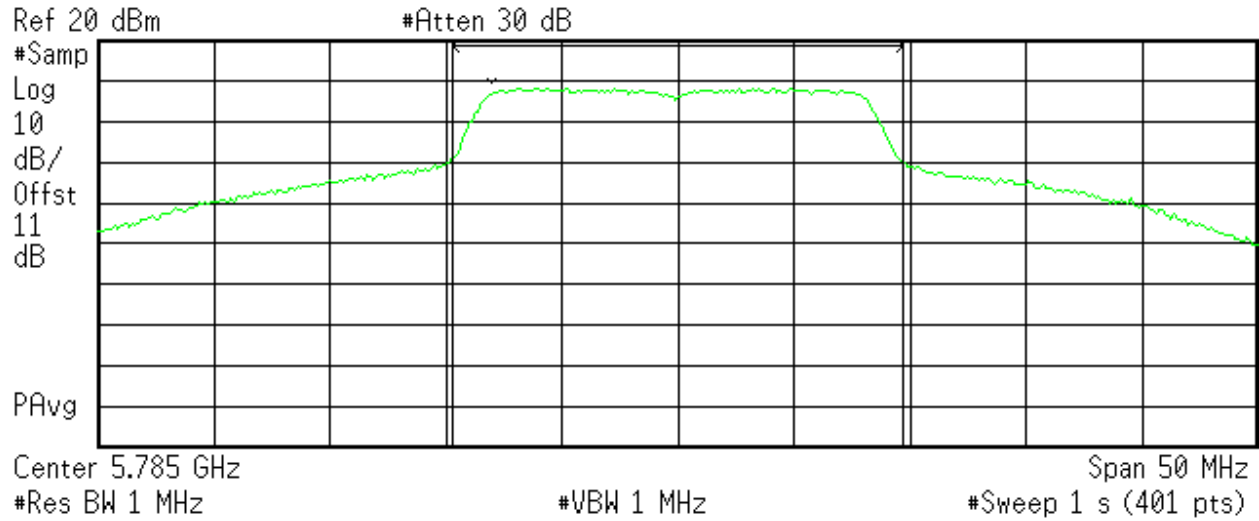


Figure 93: Maximum Transmitted Power, Middle Channel 5785 MHz of 802.11a, Chain 2

Agilent 07:55:39 Sep 24, 2011

R T S



Channel Power

19.15 dBm /19.3570 MHz

Power Spectral Density

-53.72 dBm/Hz

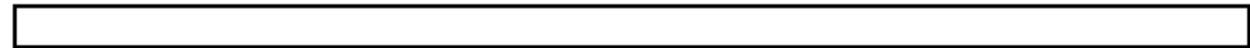
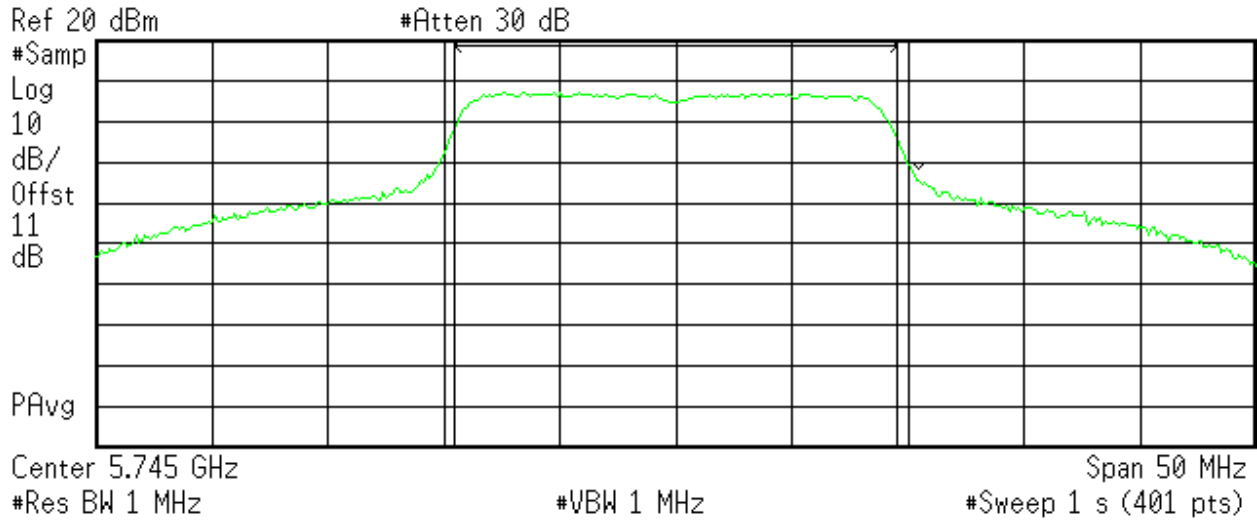


Figure 94: Maximum Transmitted Power, Highest Channel 5825 MHz of 802.11a, Chain 2

Agilent 07:30:23 Sep 23, 2011

R T S



Channel Power

18.14 dBm /18.9624 MHz

Power Spectral Density

-54.64 dBm/Hz

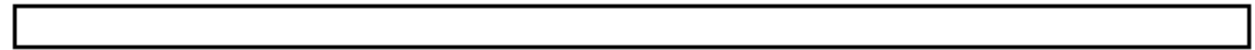
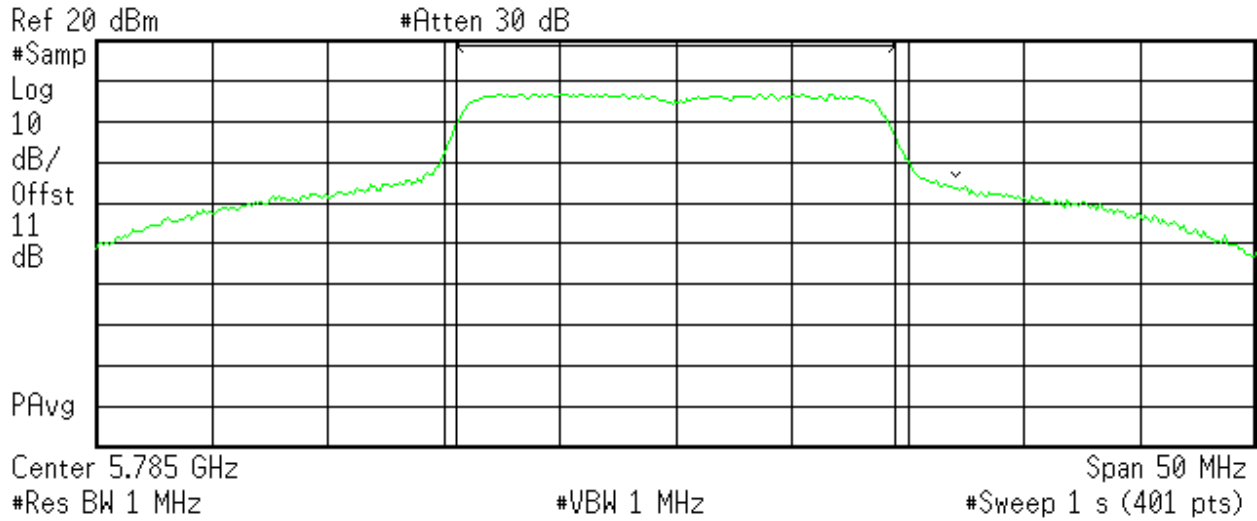


Figure 95: Maximum Transmitted Power, Lowest Channel 5745 MHz of 802.11n HT20, Chain 0 – 6.5 Mbps

Agilent 06:48:03 Sep 24, 2011

R T S



Channel Power

18.05 dBm /18.9556 MHz

Power Spectral Density

-54.72 dBm/Hz

Figure 96: Maximum Transmitted Power, Middle Channel 5785 MHz of 802.11n HT20, Chain 1 – 6.5 Mbps (Chain 1 highest)

Agilent 08:14:13 Sep 24, 2011

R T S

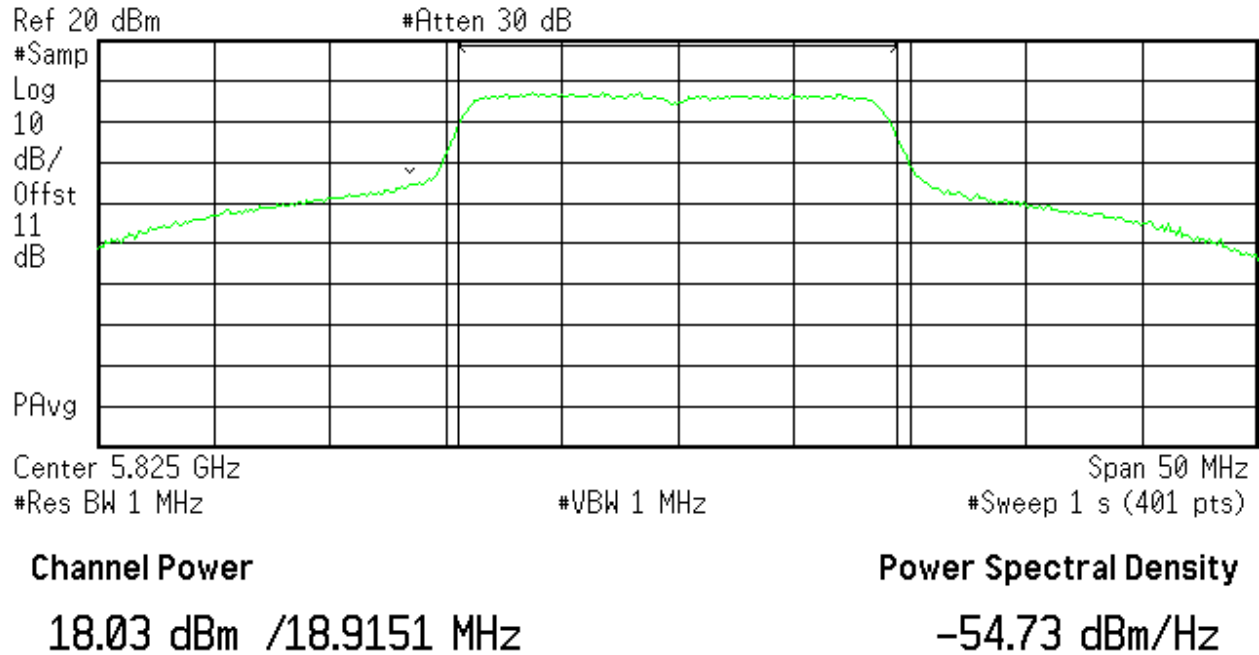


Figure 97: Maximum Transmitted Power, Highest Channel 5825 MHz of 802.11n HT20, Chain 2 – 6.5 Mbps

Agilent 07:46:21 Sep 23, 2011

R T S

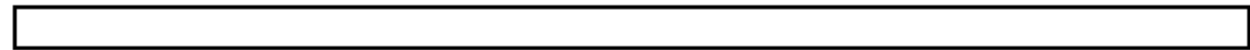
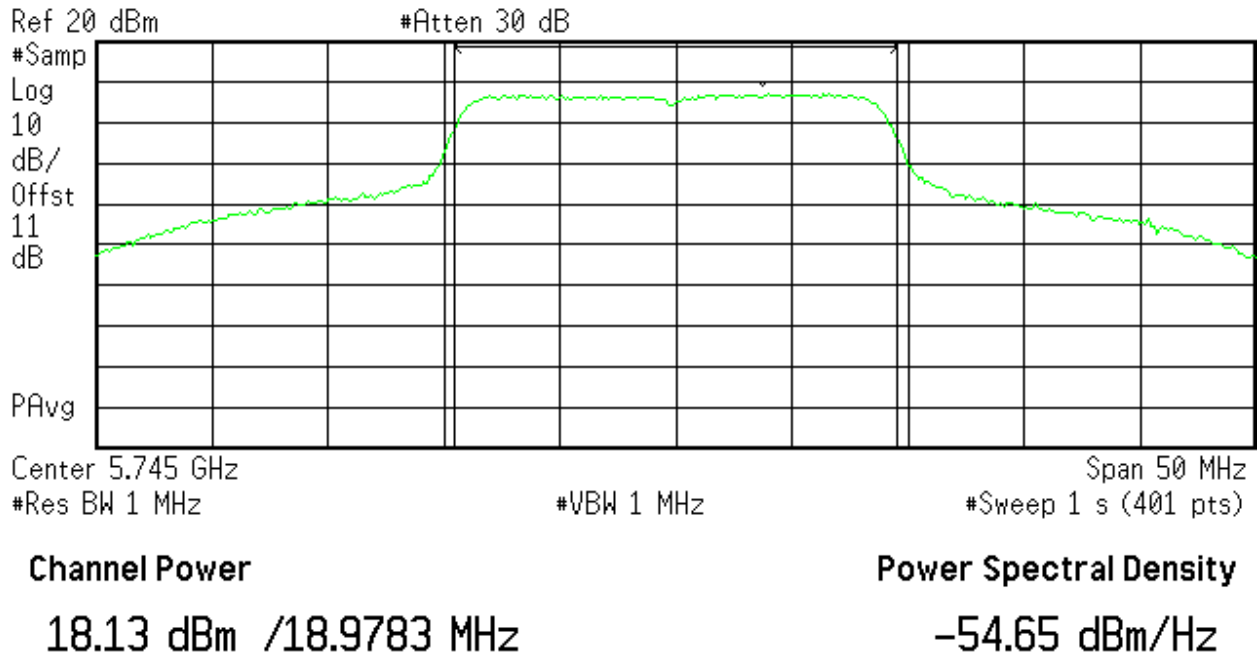
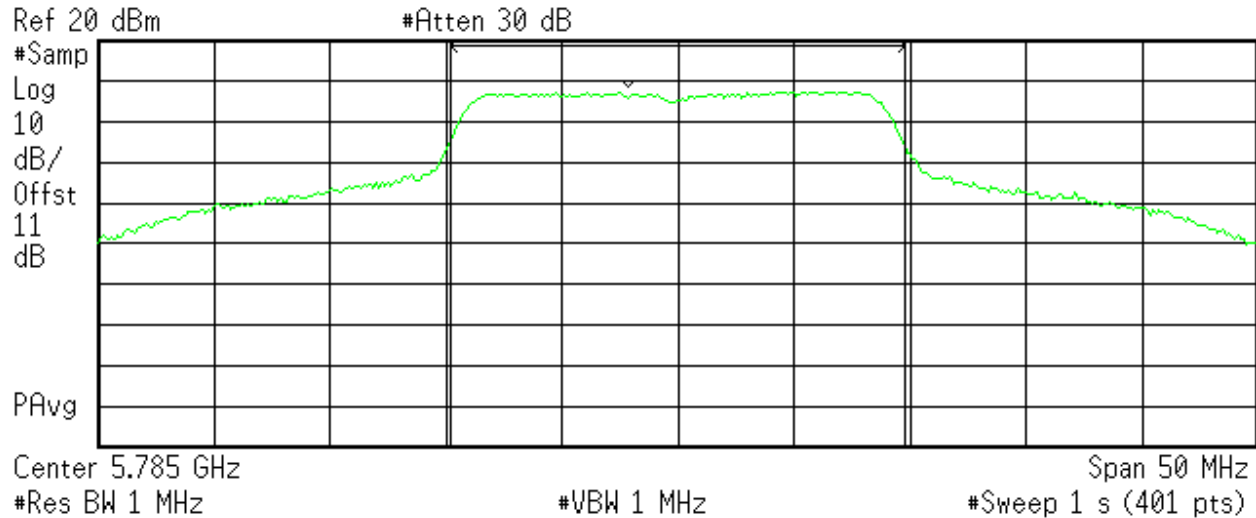


Figure 98: Maximum Transmitted Power, Lowest Channel 5745 MHz of 802.11n HT20, 2 Data Stream, Chain 0

Figure 99: Maximum Transmitted Power, Lowest Channel 5745 MHz of 802.11n HT20, 3 Data Stream, Chain 0

Agilent 08:20:24 Sep 23, 2011

R T S

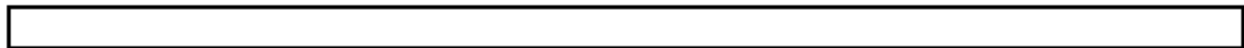


Channel Power

18.42 dBm /19.4858 MHz

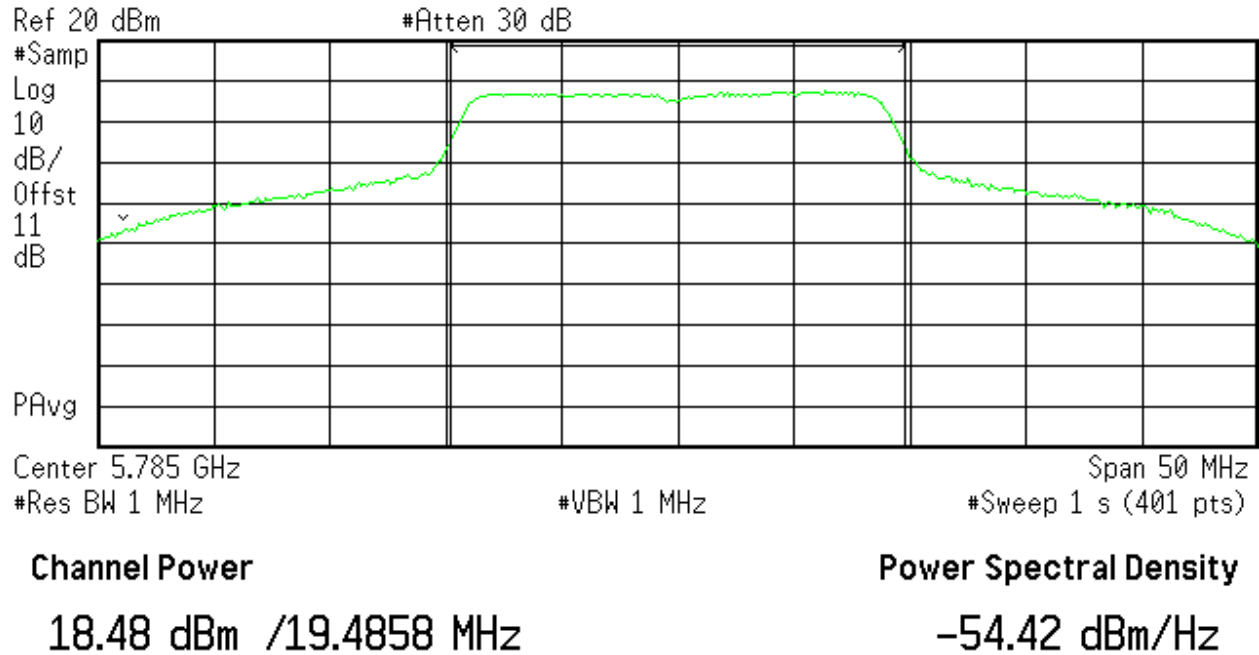
Power Spectral Density

-54.47 dBm/Hz



Agilent 08:22:23 Sep 23, 2011

R T S



C:\TMPIMAGE.GIF file saved

Figure 100: Maximum Transmitted Power, Middle Channel 5785 MHz of 802.11n HT20, 3 Data Stream, Chain 0

Agilent 09:07:39 Sep 23, 2011

R T S

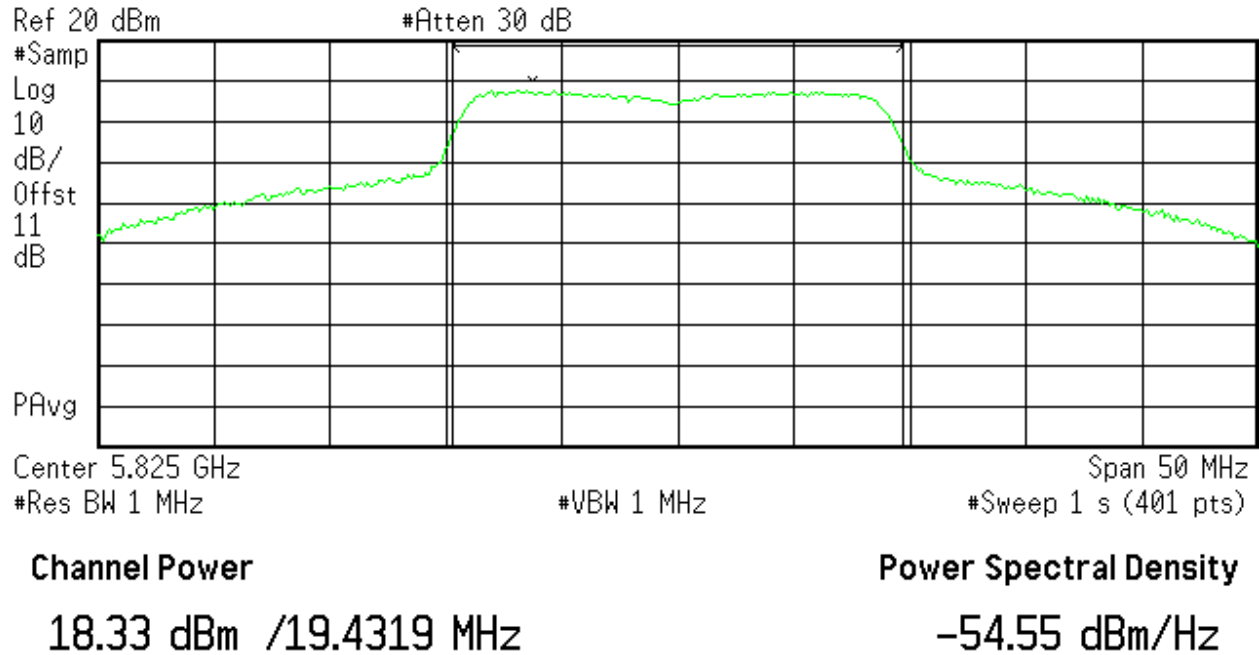
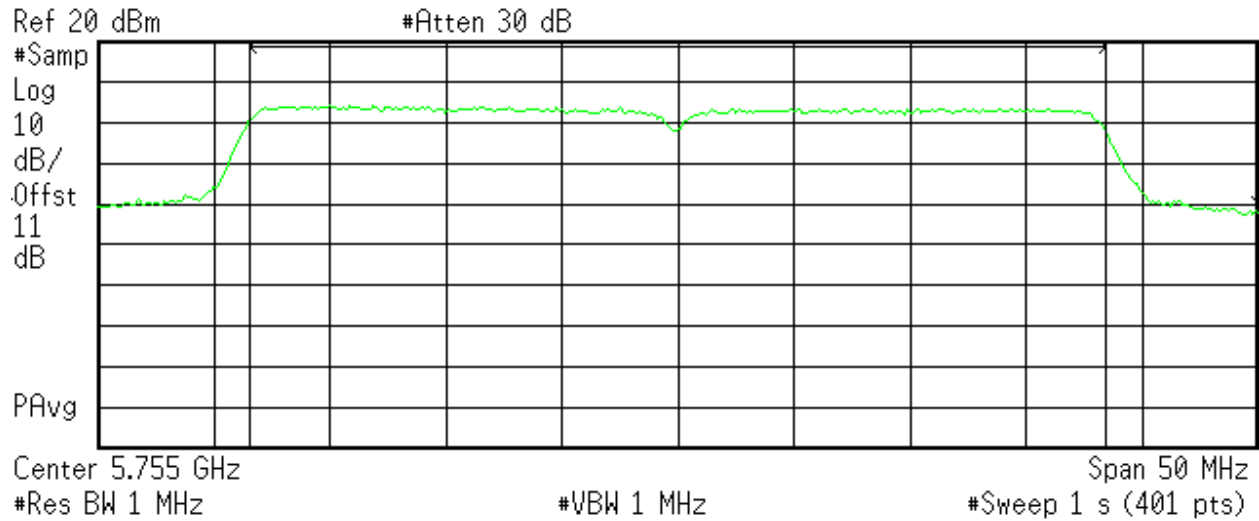


Figure 101: Maximum Transmitted Power, Highest Channel 5825 MHz of 802.11n HT20, 3 Data Stream, Chain 0

Agilent 03:17:12 Sep 24, 2011

R T S



Channel Power

17.97 dBm /36.9064 MHz

Power Spectral Density

-57.71 dBm/Hz

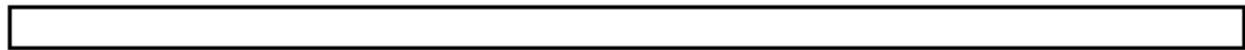
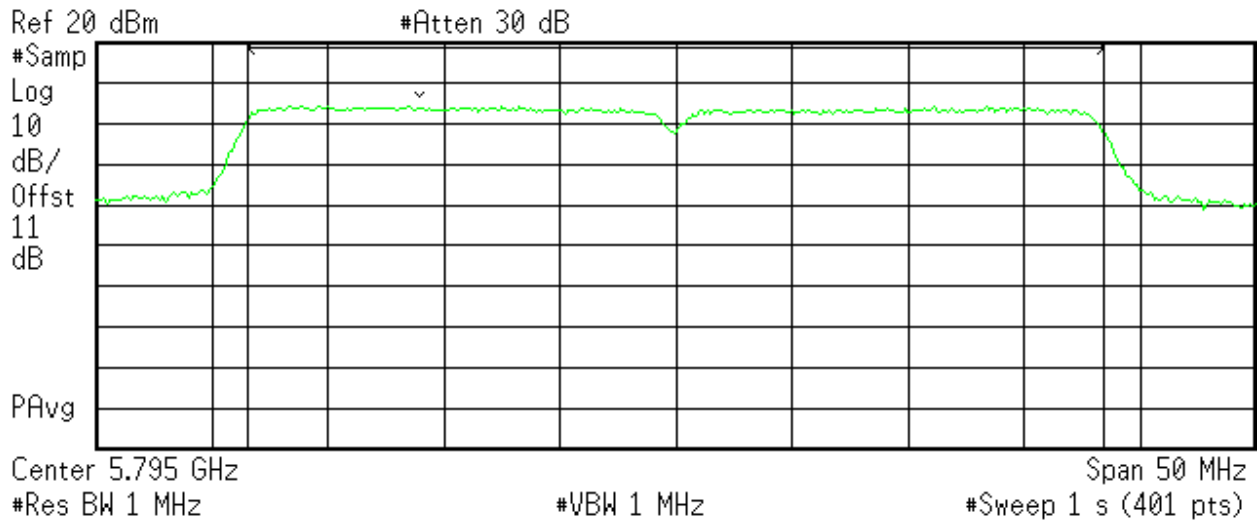


Figure 102: Maximum Transmitted Power, Lowest Channel 5755 MHz of 802.11n HT40, Chain 0 – 81 Mbps

Agilent 04:23:12 Sep 24, 2011

R T S



Channel Power

18.19 dBm /36.7645 MHz

Power Spectral Density

-57.47 dBm/Hz

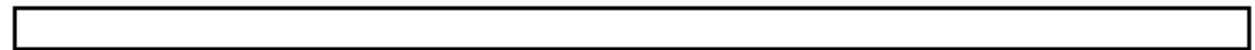
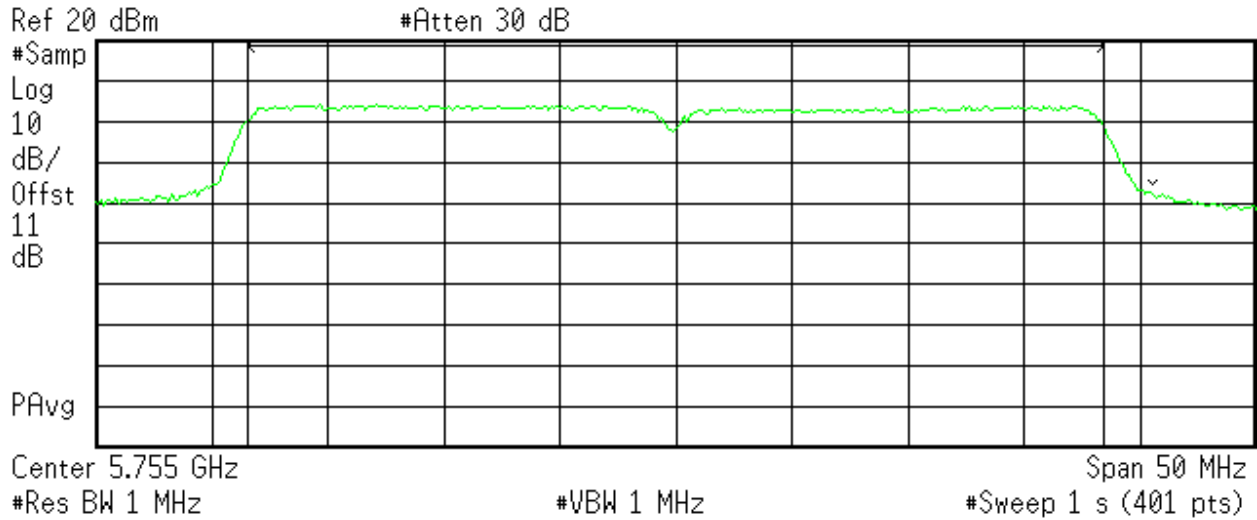


Figure 103: Maximum Transmitted Power, Middle Channel 5795 MHz of 802.11n HT40, Chain 0 – 81 Mbps

Agilent 03:21:26 Sep 24, 2011

R T S



Channel Power

18.08 dBm /36.7677 MHz

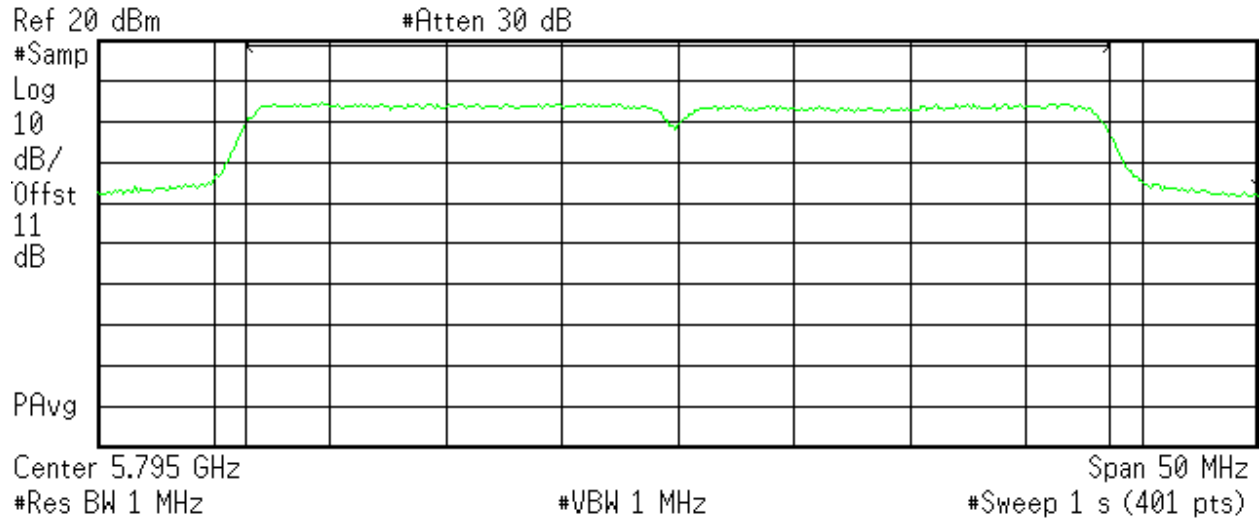
Power Spectral Density

-57.57 dBm/Hz

Figure 104: Maximum Transmitted Power, Lowest Channel 5755 MHz of 802.11n HT40, 2 Data Stream, Chain 1 – 27 Mbps

Agilent 04:18:12 Sep 24, 2011

R T S



Channel Power

18.51 dBm /37.2197 MHz

Power Spectral Density

-57.20 dBm/Hz

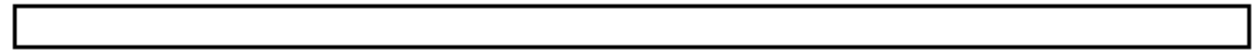
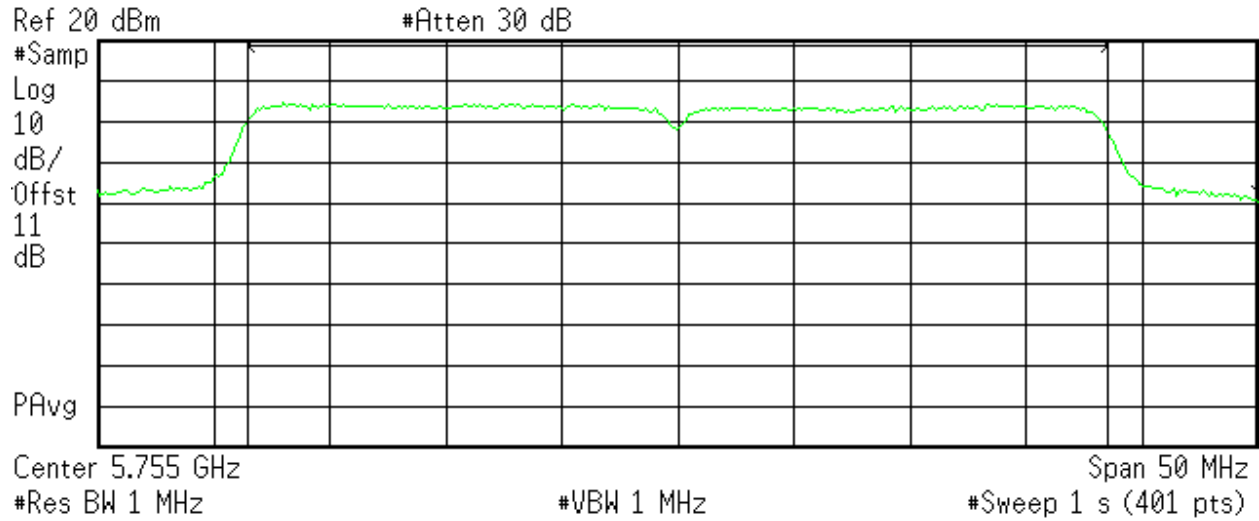


Figure 105: Maximum Transmitted Power, Middle Channel 5795 MHz of 802.11n HT40, 2 Data Stream, Chain 1 – 27 Mbps

Agilent 03:38:33 Sep 24, 2011

R T S



Channel Power

18.49 dBm /36.9907 MHz

Power Spectral Density

-57.20 dBm/Hz

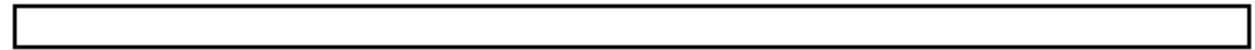
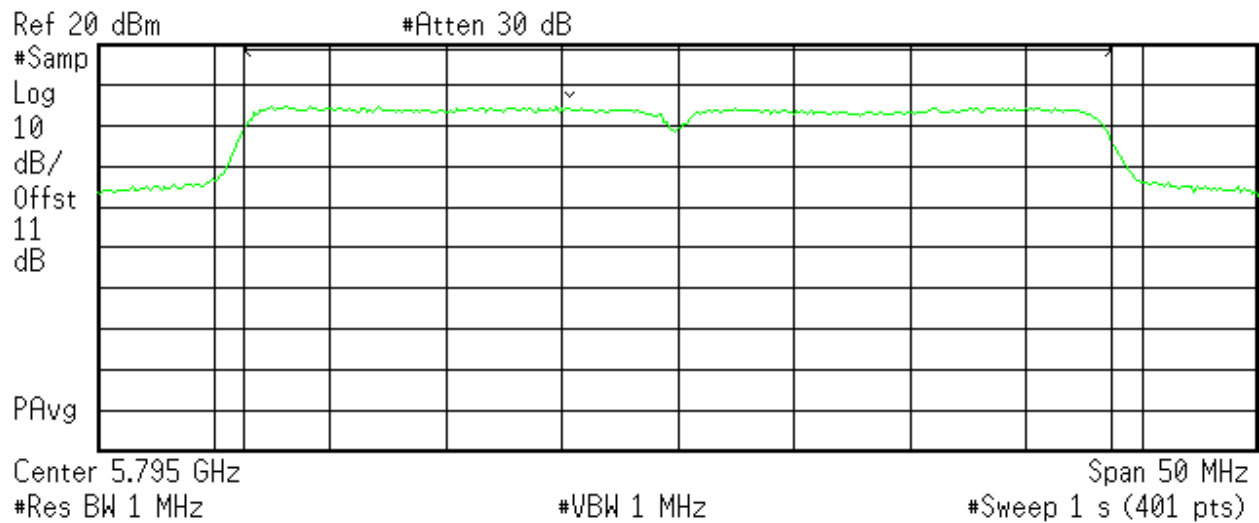


Figure 106: Maximum Transmitted Power, Lowest Channel 5755 MHz of 802.11n HT40, 3 Data Stream, Chain 0 – 40.5 Mbps

Agilent 03:57:10 Sep 24, 2011

R T S



Channel Power

18.73 dBm /37.2997 MHz

Power Spectral Density

-56.99 dBm/Hz

C:\TMPIMAGE.GIF file saved

Figure 107: Maximum Transmitted Power, Middle Channel 5795 MHz of 802.11n HT40, 3 Data Stream, Chain 0 – 40.5 Mbps

5.2 Occupied Bandwidth

The occupied bandwidth is measured at an amplitude level reduced from the reference level by a specified ratio. The reference level is the level of the highest amplitude signal observed from the transmitter at the fundamental frequency.

The 99% bandwidth is the bandwidth in which 99% of the transmitted power occupied.

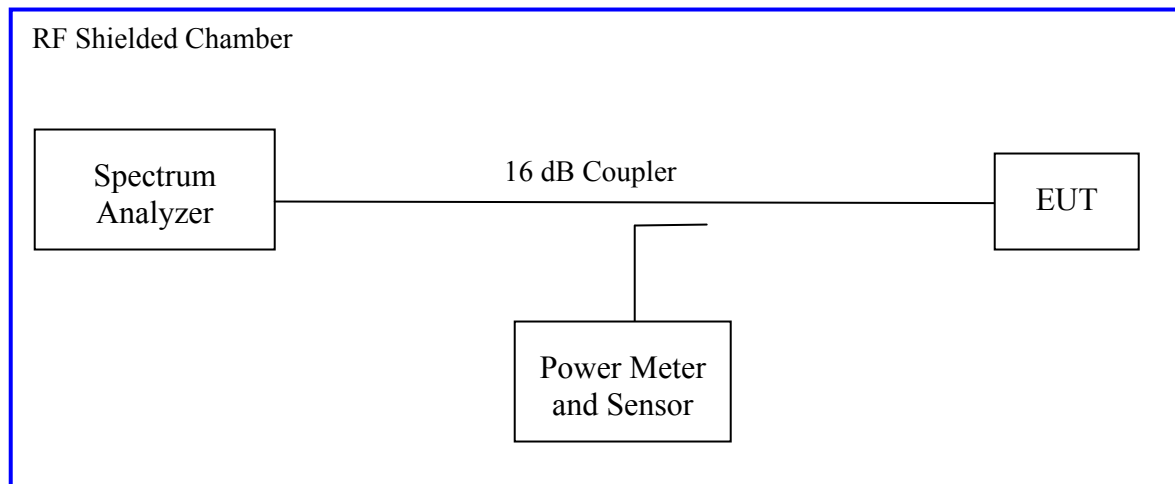
The 6 dB bandwidth is defined the bandwidth of 6 dBr from highest transmitted level of the fundamental frequency.

The bandwidth shall be at least 500 kHz per Section CFR47 15.247(a2) 2009 and RSS Gen Sect. 4.4.1: 2010.

5.2.1 Test Method

The conducted method was used to measure the channel power output. The measurement was performed with modulation per CFR47 15.247(a2) 2009 and RSS Gen Sect. 4.4.1:2010. Initial investigation was performed at different data rates and TX chains. The narrowest bandwidths at each operational mode were measured on 3 operating channels. The worst sample result indicated below.

Test Setup:



5.2.2 Results

As originally tested, the EUT was found to be compliant to the requirements of the test standard(s).

Table 10: Occupied Bandwidth – Test Results

Test Conditions: Conducted Measurement, Normal Temperature and Voltage only								
Antenna Type: # 3 external				Power Setting: See test plan				
Max. Antenna Gain: + 2.0 dBi				Signal State: Modulated				
Ambient Temp.: 21 °C				Relative Humidity: 37%				
Bandwidth (MHz) for 802.11a								
Freq. (MHz)	Limit (kHz)	Ch 0 99% BW	Ch 1 99% BW	Ch 2 99% BW	Ch 0 6 dB BW	Ch 1 6 dB BW	Ch 2 6 dB BW	Results
5745	500	22.24	27.06	26.17	41.00	43.76	43.23	Pass
5785	500	23.32	27.02	26.33	41.90	43.88	27.02	Pass
5825	500	24.89	25.67	26.55	42.52	43.02	42.05	Pass
Note: The narrowest bandwidth was observed at 6Mbps for 802.11a mode.								
Bandwidth (MHz) for 802.11n HT20								
Freq. (MHz)	Limit (kHz)	Ch 0 99% BW	Ch 1 99% BW	Ch 2 99% BW	Ch 0 6 dB BW	Ch 1 6 dB BW	Ch 2 6 dB BW	Results
5745	500	19.95	22.82	26.17	39.5	44.57	43.27	Pass
5785	500	19.97	21.77	19.6	40.12	44.41	38.04	Pass
5825	500	20.38	20.91	20.13	43.85	41.79	39.72	Pass
Note: The narrowest bandwidth was observed at 39Mbps for 802.11n HT20 mode, 1 data stream								
Bandwidth (MHz) for 802.11n HT40								
Freq. (MHz)	Limit (kHz)	Ch 0 99% BW	Ch 1 99% BW	Ch 2 99% BW	Ch 0 6 dB BW	Ch 1 6 dB BW	Ch 2 6 dB BW	Results
5755	500	36.88	37,2	36.96	50	50	50	Pass
5795	500	39.9	37.12	37.01	50	50	50	Pass
Note: The bandwidth was observed at 13.5 Mbps at 1 data stream								

Agilent 04:32:43 Sep 24, 2011

R T S

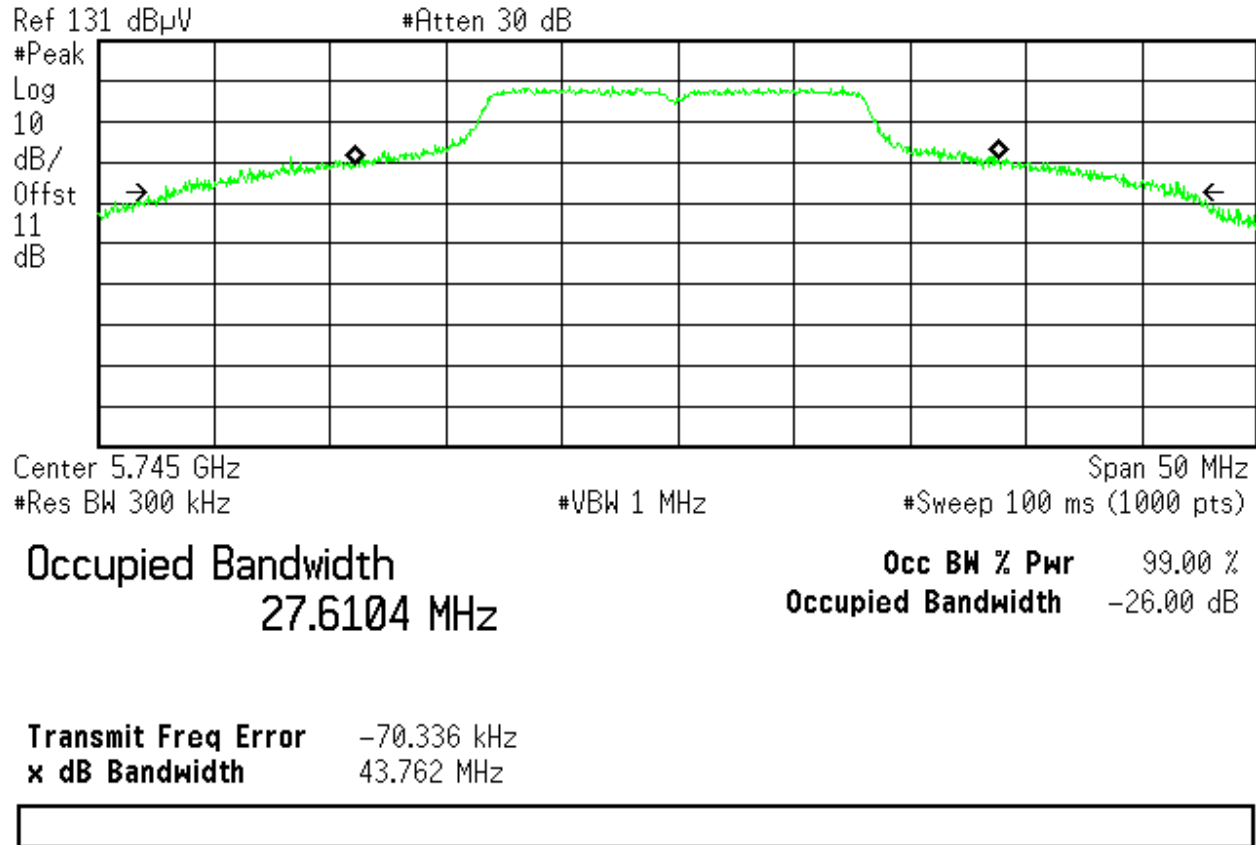
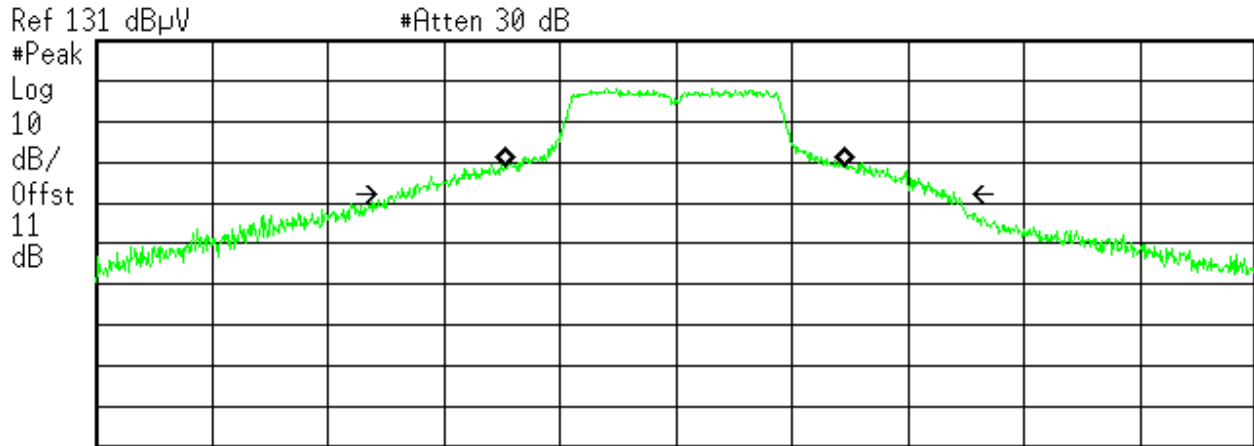


Figure 108: Occupied Bandwidth at 802.11a, 5745MHz - Chain 1 (6Mbps)

Agilent 07:41:43 Sep 24, 2011

R T S



Occupied Bandwidth
 26.1761 MHz

Occ BW % Pwr 99.00 %
x dB -26.00 dB

Transmit Freq Error -55.519 kHz
x dB Bandwidth 43.237 MHz

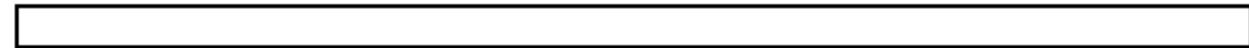
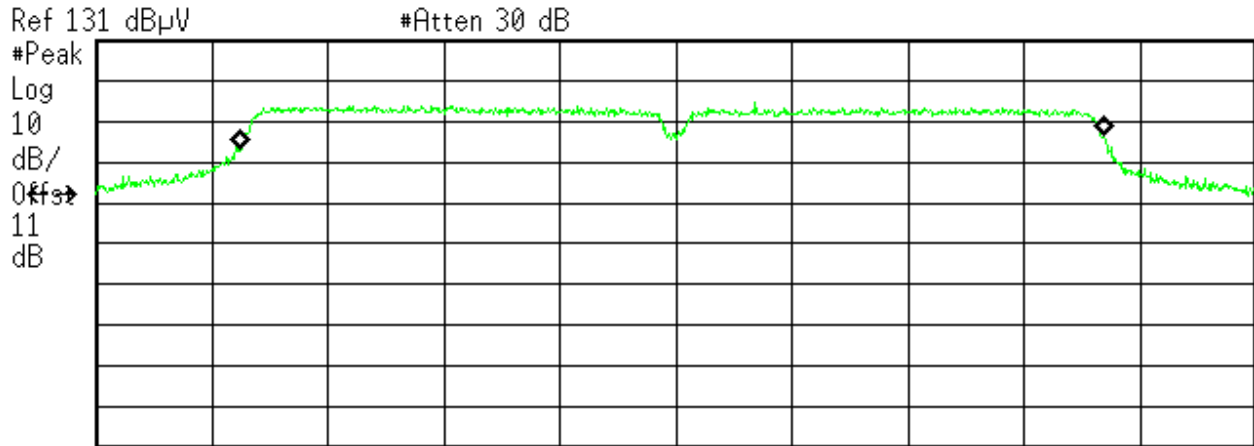


Figure 109: Occupied Bandwidth at 802.11 HT 20, 5785MHz - Chain 1 (6.5Mbps)

Agilent 06:57:06 Sep 24, 2011

R T S



Center 5.755 GHz Span 50 MHz
 #Res BW 300 kHz #VBW 1 MHz #Sweep 100 ms (1000 pts)

Occupied Bandwidth
37.2029 MHz

Occ BW % Pwr 99.00 %
x dB -26.00 dB

Transmit Freq Error -158.026 kHz
x dB Bandwidth 50.000 MHz



Figure 110: Occupied Bandwidth at 802.11a, 5825MHz - Chain 0 (6Mbps)

5.3 Band-edge Requirements

The setup was identical to RF output power measurement. Intentional radiators operating under the alternative provisions to the general emission limits, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated. The requirement to contain the designated bandwidth of the emission within the specified frequency band includes the effects from frequency sweeping, frequency hopping and other modulation techniques that may be employed as well as the frequency stability of the transmitter over expected variations in temperature and supply voltage. If the frequency stability is not specified in the regulations, it is recommended that the fundamental emission be kept within at least the central 80% of the permitted band in order to minimize the possibility of out-of-band operation.

Any frequency outside the band of 2400 MHz to 2483.5MHz, the power output level must be below 20 dB from the in-band transmitting signal; CFR 47 Part 15.215, 15.247(d) and RSS 210 A8.5

5.3.1 Results

The Out of band emissions were measured by conducted methods on test Sample.

As originally tested, the EUT was found to be compliant to the requirements of the test standard(s).

Table 11: Band-Edge Requirements – Test Results

Test Conditions: Conducted Measurement, Normal Temperature and Voltage only								
Antenna Type: 3 external				Power Setting: See test plan				
Max. Antenna Gain: + 2.0 dBi				Signal State: Modulated				
Ambient Temp.: 21° C				Relative Humidity: 39%				
-20 dBr Band-Edge Results								
Operating Freq.	Mode	Chain 0		Chain 1		Chain 2		Result
		Level (dBm)	Limit (dBm)	Level (dBm)	Limit (dBm)	Level (dBm)	Limit (dBm)	
5745 MHz	6 Mbps	-16.36	-15.8	-16.9	-15.8	-17.41	-17.40	Pass
5785 MHz	6 Mbps	-17.02	-15.7	-16.26	-15.4	-15.8	-15.5	Pass
5825 MHz	6 Mbps	-16.45	-16.0	-16.72	-15.3	-15.86	-15.80	Pass
5745 MHz	6.5Mbps	-17.2	-16.5	-17.6	-17.1	-17.07	-16.8	Pass
5785 MHz	6.5Mbps	-17.04	-17.0	-16.53	-16.5	-18.02	-17.6	Pass
5825 MHz	6.5Mbps	-17.31	-17.1	-19.15	-17.3	-19.35	-16.9	Pass
5755 MHz	HT40 13.5 Mbps	-20.1	-19.6	-19.8	-19.6	-21.37	-20.3	Pass

5795 MHz	HT40 13.5 Mbps	-19.98	-19.5	-19.26	-18.8	-20.3	-19.5	Pass
Note: The stated limits for 20 dBm are relative to each individual output per KDB 662911 Method.								

Note: All the modes stated in the above table were evaluated only limited number of graphs are placed in the report.

Table 12: Out of band Conducted Emission – Test Results

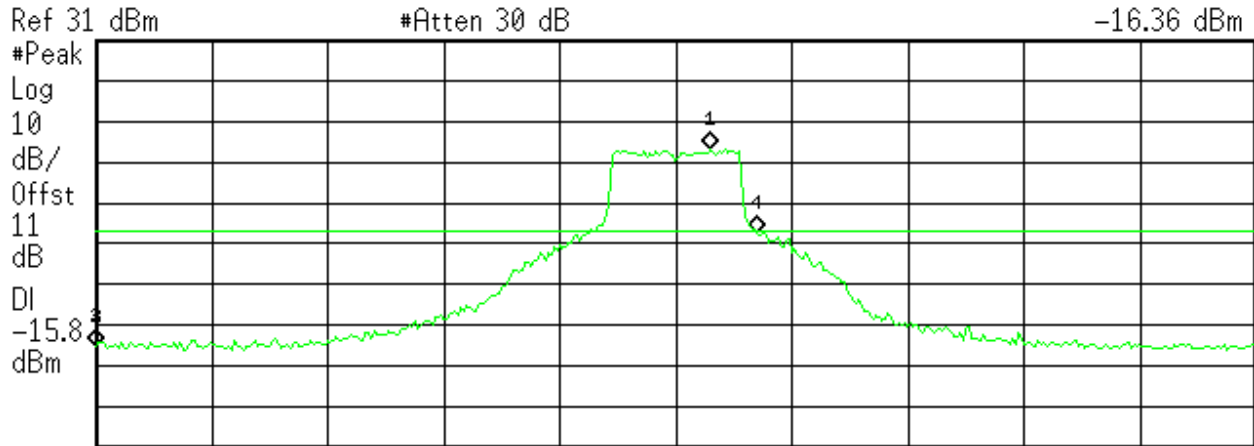
Test Conditions: Conducted Measurement, Normal Temperature and Voltage only								
Antenna Type: Integrated				Power Setting: See test plan				
Max. Antenna Gain: + 2.0 dBi				Signal State: Modulated				
Ambient Temp.: 21° C				Relative Humidity: 39%				
Output of Band Results								
Operating Freq.	Mode	30 MHz to 25 GHz						Result
		Chain 0		Chain 1		Chain 2		
5785 MHz	6 Mbps	Fig.	112	Fig.	119	Fig.	120	Pass
5785 MHz	6.5Mbps	Fig.	121	Fig.	122	Fig.	123	Pass
5755 MHz	HT40 13.5 Mbps	Fig.	124	Fig.	125	Fig.	126	Pass
5795 MHz	HT40 13.5 Mbps	Fig.	127	Fig.	128	Fig.	129	Pass
Note: All Out of Band Emissions are compared to the relative 20 dBr limit of that output, per KDB 662911.								

Note: All the modes stated in the above table were evaluated only Plot munmbers 112 & 113 are placed in the report. Plots with numbers 119 to 129 are available in project folder

Agilent 05:41:15 Sep 23, 2011

R T

Mkr4 5.755661 GHz
 -16.36 dBm



Center 5.745 GHz Span 150 MHz
 #Res BW 100 kHz #VBW 10 kHz Sweep 122.8 ms (401 pts)

Marker	Trace	Type	X Axis	Amplitude
1	(1)	Freq	5.749500 GHz	4.227 dBm
2	(1)	Freq	5.670000 GHz	-44.27 dBm
3	(1)	Freq	5.670000 GHz	-44.27 dBm
4	(1)	Freq	5.755661 GHz	-16.36 dBm

Figure 111: Band-edge Requirement at 802.11a, 6 Mbps 5745 MHz, Chain 0 – Plot 1

Note: All the modes stated in the above table were evaluated only limited number of graphs are placed in the report.

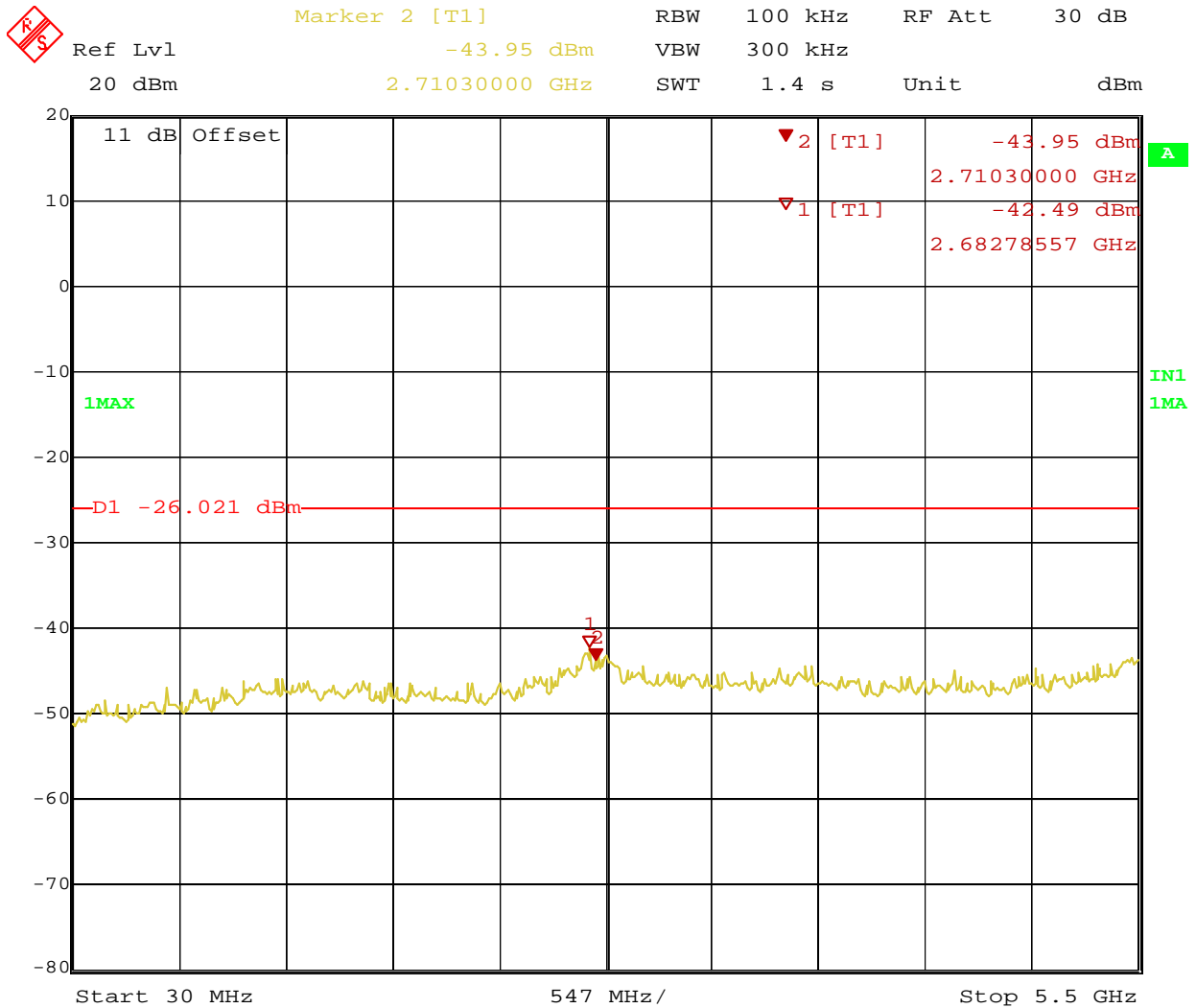


Figure 112 : Out of band emissions at 802.11a, 6 Mbps 5745 MHz, Chain 0 – Plot 1

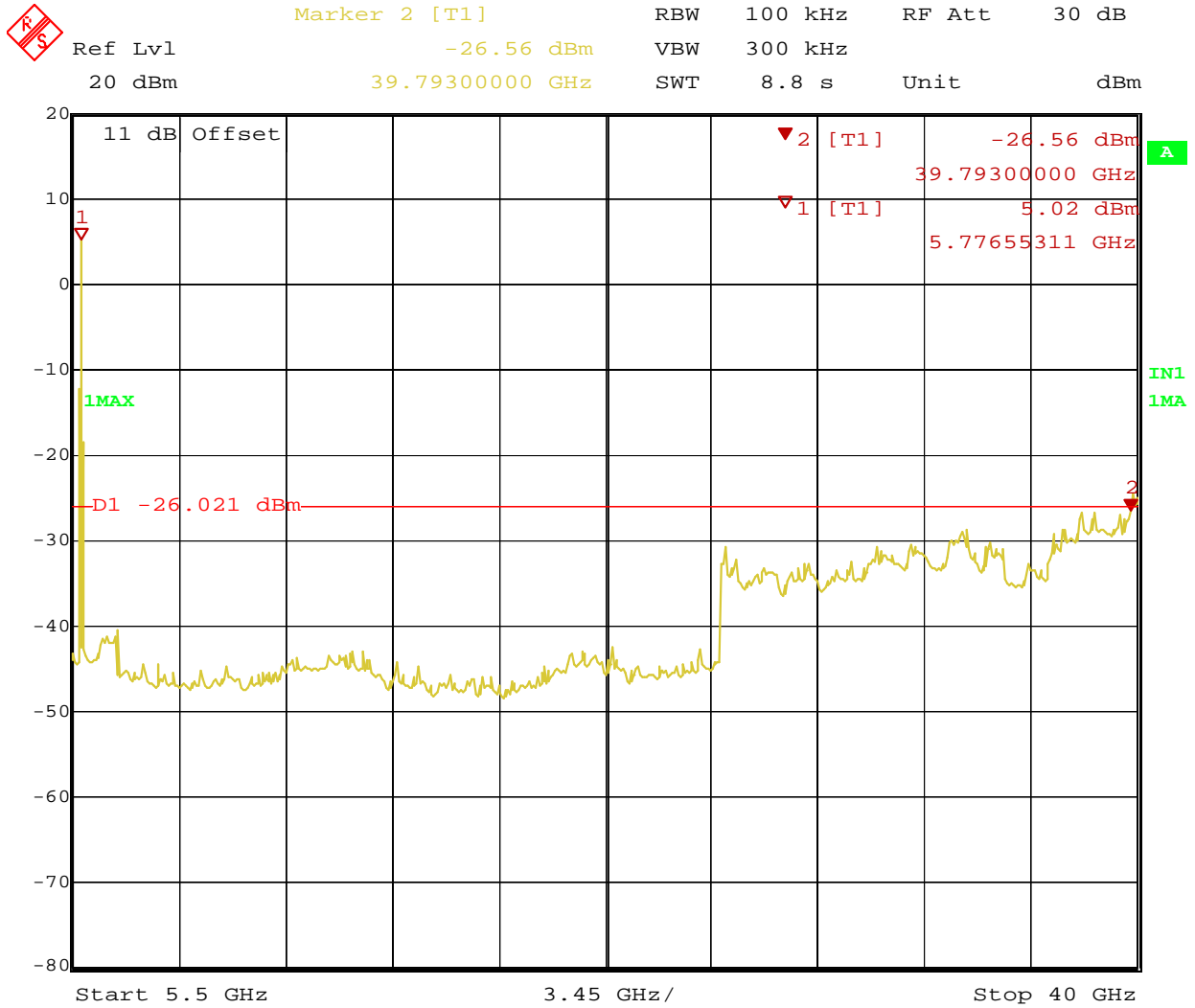


Figure 113 : Out of band emissions at 802.11a, 6 Mbps 5745 MHz, Chain 0 – Plot 2

5.4 Peak Power Spectral Density

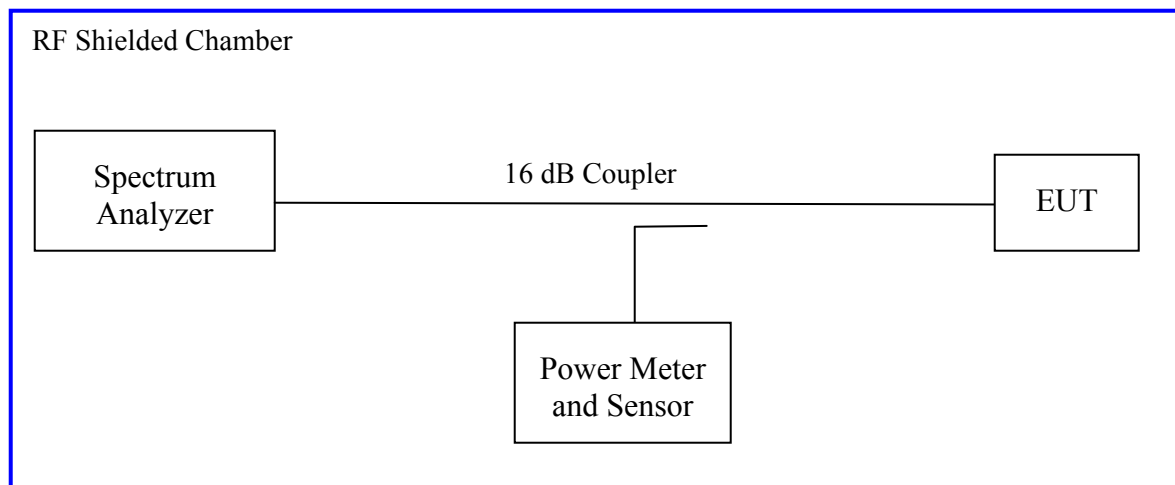
According to the CFR47 Part 15.247 (e) and RSS 210 (A8.2), the spectral power density output of the antenna port shall be less than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

5.4.1 Test Method

The conducted method was used to measure the channel power output per ANSI C63.10:2009 Section 6.11.2

The measurement was performed with modulation per CFR47 Part 15.247 (e) and RSS 210 (A8.2). This test was conducted on 3 channels in each mode. The worst sample result indicated below.

Test Setup:



5.4.2 Results

As originally tested, the EUT was found to be compliant to the requirements of the test standard(s).

Table 13: Peak Power Spectral Density – Test Results

Test Conditions: Conducted Measurement, Normal Temperature and Voltage only								
Antenna Type: Integrated				Power Setting: See test plan				
Max. Antenna Gain: + 2.0 dBi				Signal State: Modulated				
Ambient Temp.: 22 °C				Relative Humidity: 37%				
Peak Power Spectral Density								
Freq. (MHz)	Mode	Chain 0 [dBm]	Chain 1 [dBm]	Chain 2 [dBm]	CF [dB]	Max. PPSD [dBm]	Limit [dBm]	Margin [dB]
5745	6 Mbps	-13.35	-4.806	-10.7		-4.806	8.00	-11.2
5785	6 Mbps	-8.726	-10.78	-8.2		-8.2	8.00	-16.2
5825	6 Mbps	-7.96	-11.2	-8.33		-7.96	8.00	-15.96
5745	HT20 6.5 Mbps	-6.88	-10.47	-11.48		-6.88	8.00	-14.88
5785	HT20 6.5 Mbps	-5.52	-9.58	-10.24		-5.52	8.00	-13.52
5825	HT20 6.5 Mbps	-8.17	-8.81	-10.71		-8.17	8.00	-16.17
5745	HT20 13 Mbps	-7.968	-6.32		3.01	-3.31	8.00	-11.31
5785	HT20 13 Mbps	-11.83	-13.68		3.01	-8.32	8.00	-16.31
5825	HT20 13 Mbps	-13.34	-9.77		3.01	-6.66	8.00	-14.66
5745	HT20 19.5 Mbps	-8.32	-6.45	-8.59	4.77	-1.68	8.00	-9.68
5785	HT20 19.5 Mbps	-6.27	-11.15	-7.76	4.77	-1.5	8.00	-9.5

5825	HT20 19.5 Mbps	-7.07	-6.633	-6.40	4.77	-1.63	8.00	-9.63
5755	HT40 13.5Mbps	-11.62	-10.53	-14.4		-10.53	8.00	-18.53
5795	HT40 13.5Mbps	-8.12	-6.52	-11.7		-6.52	8.00	-14.52
5755	HT40 27 Mbps	-10.53	-10.53		3.01	-7.53	8.00	-15.53
5795	HT40 27 Mbps	-9.33	-6.9		3.01	-3.9	8.00	-11.9
5755	HT40 40.5 Mbps	-9.92	-8.87	-13.4	4.77	-4.1	8.00	-12.1
5795	HT40 40.5 Mbps	-8.25	-6.94	-11.42	4.77	-2.17	8.00	-10.17
Note: CF was accounted for the number of data streams being used, $10 \cdot \log(N)$ per KDB 662911; where N is number of outputs.								

Note: All the modes mentioned in above table were evaluated only worst case plots are placed here

Agilent 10:26:09 Oct 4, 2011

R T

Mkr1 5.74040000 GHz
-13.35 dBm

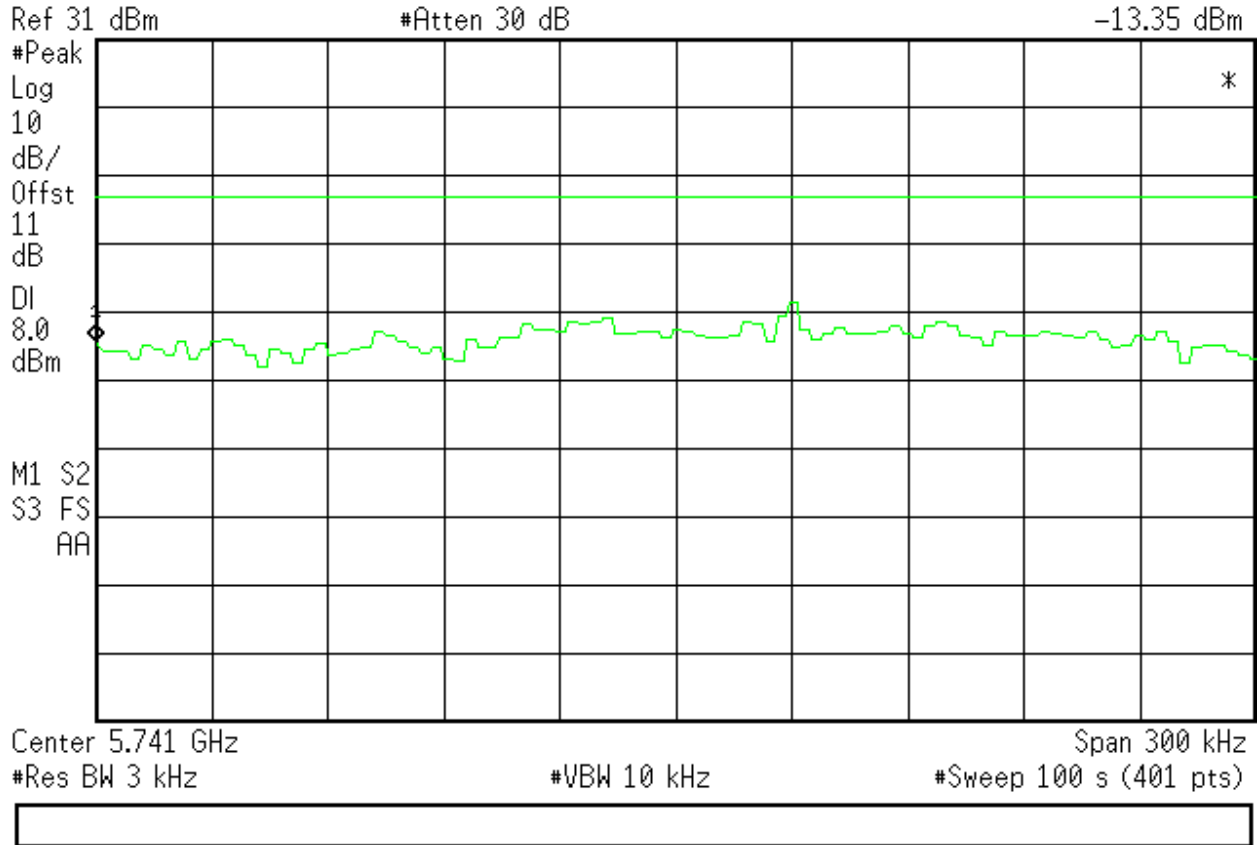


Figure 114: Peak Power Spectral Density, 5745 MHz at 802.11a, Chain 0 – 6 Mbps

Agilent 10:49:22 Oct 4, 2011

R T

Mkr1 5.73991900 GHz
-4.806 dBm

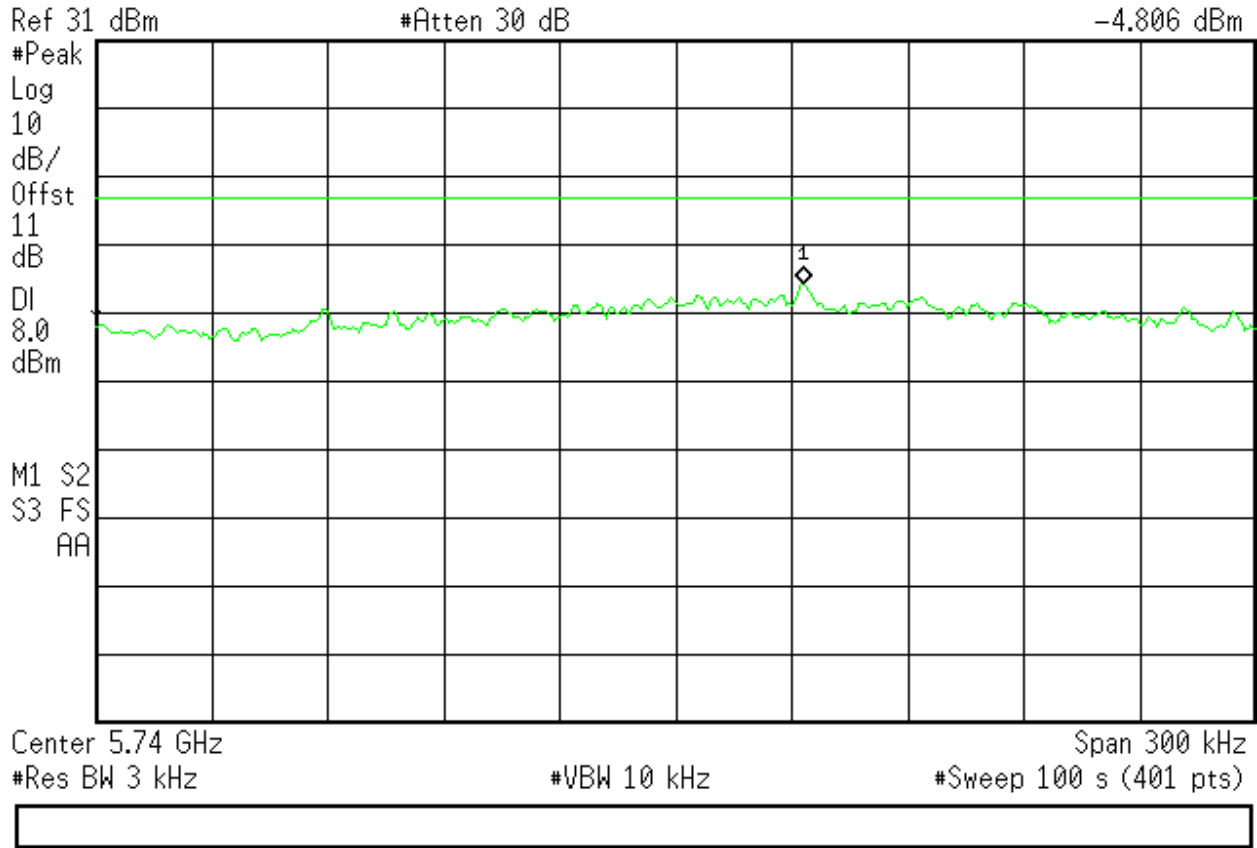


Figure 115: Peak Power Spectral Density, 5785 MHz at 802.11a, Chain 1 – 6 Mbps

Agilent 10:55:26 Oct 4, 2011

R T

Mkr1 5.73714350 GHz
-10.7 dBm

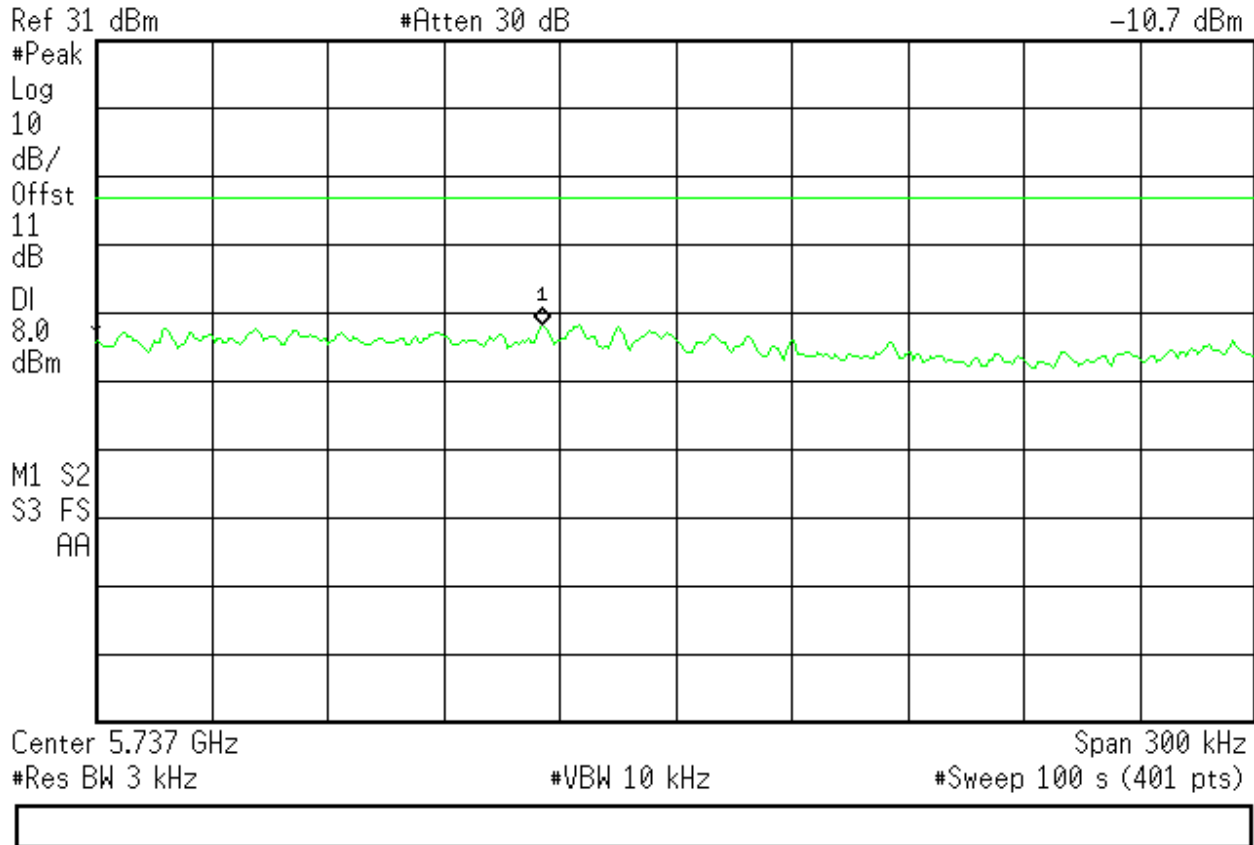


Figure 116: Peak Power Spectral Density, 5825 MHz at 802.11a, Chain 2 – 24 Mbps

Agilent 13:26:39 Oct 4, 2011

R T

Mkr1 5.77866875 GHz
-5.528 dBm

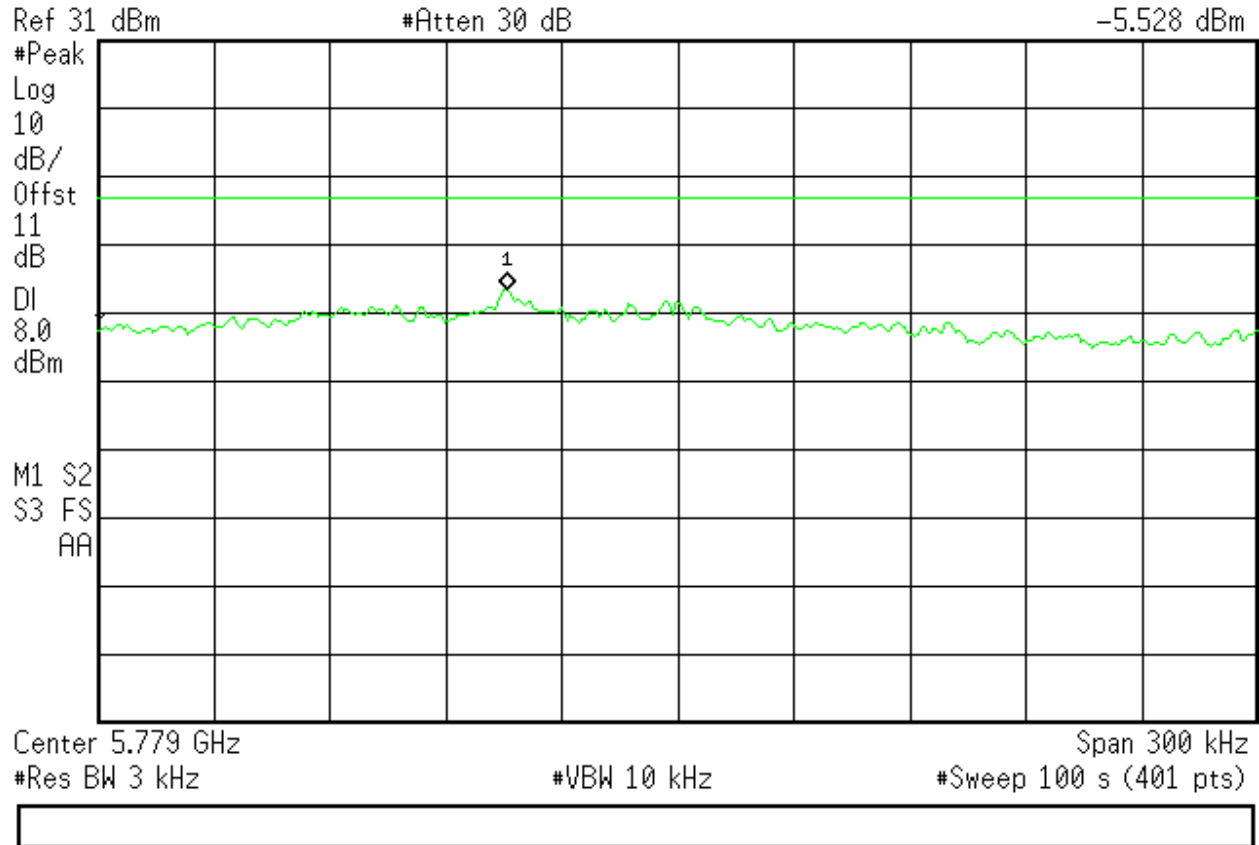


Figure 117: Peak Power Spectral Density, 5785 MHz at 802.11 HT 20, Chain 0 – 6 Mbps

Agilent 16:02:25 Oct 4, 2011

R T

Mkr1 5.73991225 GHz
-8.878 dBm

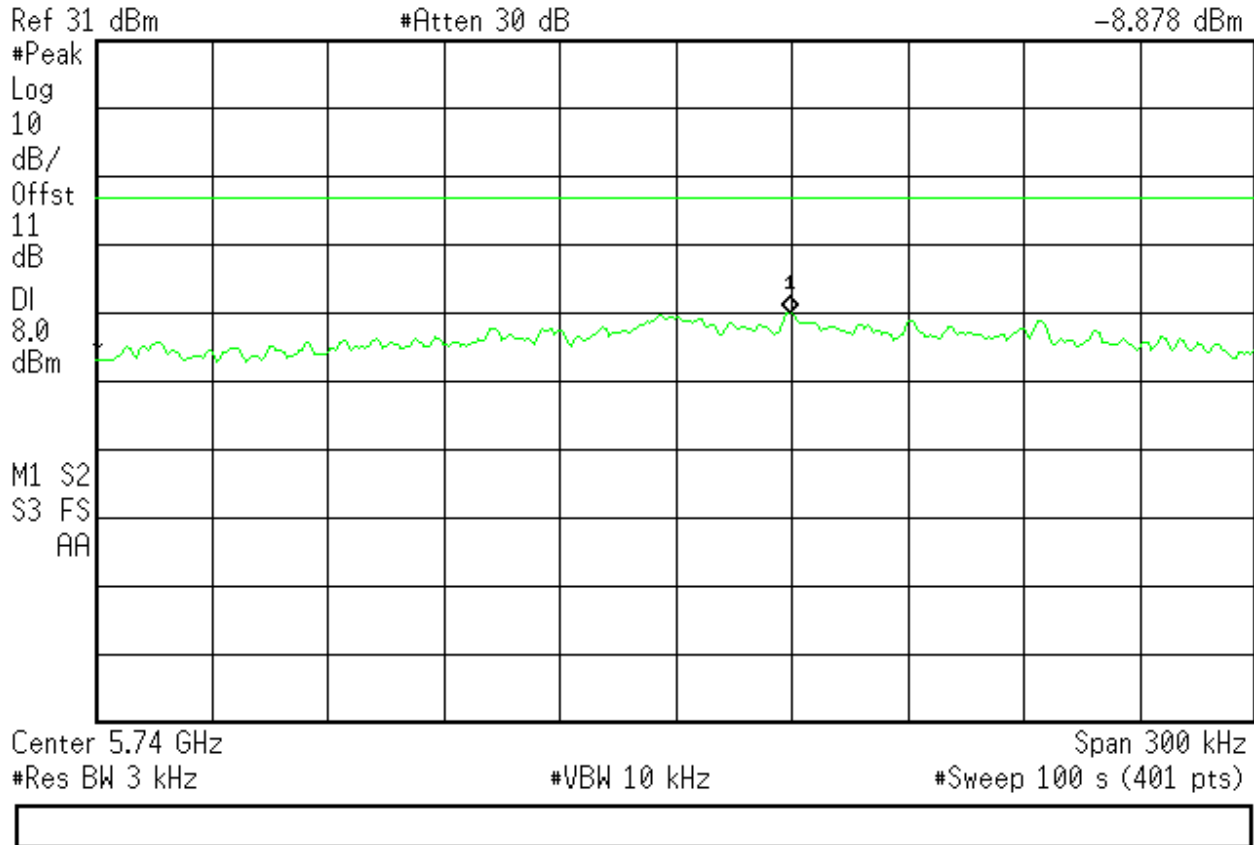


Figure 118: Peak Power Spectral Density, 5785 MHz at 802.11a, Chain 1 – 24 Mbps

5.5 Transmitter Spurious Emissions

Transmitter spurious emissions are emissions outside the frequency range of the equipment when the equipment is in transmit mode; per requirement of CFR47 15.205, 15.209, 15.247(d), RSS 210 Sect. A.8.5

5.5.1 Test Methodology

5.5.1.1 Preliminary Test

A test program that controls instrumentation and data logging was used to automate the preliminary RF emission test procedure. The frequency range of interest was divided into sub-ranges to yield a frequency resolution of approximately 1 MHz and provide a reading at each frequency for no more than 12° of turntable rotation. For each frequency sub-range the turntable was rotated 360° while peak emission data was recorded and plotted over the frequency range of interest in horizontal and vertical antenna polarization's.

Preliminary emission profile testing was performed inside the anechoic chamber. The EUT was placed on a 1.0m x 1.5m non-conductive table 80cm above the floor. The EUT was positioned as shown in the setup photographs. The receiving antenna was placed at a distance of 3m at a fixed height of 1m. Measurement equipment was located outside of the chamber. A video camera was placed inside the chamber to view the EUT.

5.5.1.2 Final Test

For each frequency measured, the peak emission was maximized by manipulating the receiving antenna from 1 to 4 meters above the ground plane and placing it at the position that produced the maximum signal strength reading. The turntable was then rotated through 360° while observing the peak signal and placing the EUT at the position that produced maximum radiation. The six highest emissions relative to the limit were measured unless such emissions were more than 20 dB below the limit. If less than six emissions are within 20 dB of the limit, than the noise level of the receiver is measured at frequencies where emissions are expected. Multiples of all oscillator and microprocessor frequencies were also checked.

Final testing was performed on an NSA compliant test site. The EUT was placed on a 1.0m x 1.5m non-conductive table 80cm above the ground plane. The placement of EUT and cables were the same as for preliminary testing and is shown in the setup photographs.

The final scans performed on the worst axis, Y-Axis, for three operating channels;

6Mbit/s for 802.11a mode: 5745MHz, 5785MHz, and 5825MHz.

6.5Mbit/s for 802.11n HT20 Mode: 5745MHz, 5785MHz, and 5825MHz.

40.5Mbit/s for 802.11n HT40 Mode: 5755MHz, and 5795MHz.

5.5.1.3 Deviations

None.

5.5.2 Transmitter Spurious Emission Limit

The spurious emissions of the transmitter shall not exceed the values in CFR47 Part 15.205, 15.209: 2009 and RSS 210 A1.1.2 2010.

Frequency (MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	30
30-88	100 **	3
88-216	150 **	3
216-960	200 **	3
Above 960	500	3

All harmonics and spurious emission which are outside of the restricted band shall be 20 dB below the in-band emission.

5.5.3 Test Results

The final measurement data was taken under the worst case operating modes, configurations, and/or cable positions. It also reflects the results including any modifications and/or special accessories listed in Sections 1.4 and test plan.

As originally tested, the EUT was found to be compliant to the requirements of the test standard(s).

Table 14: Transmit Spurious Emission at Band-Edge Requirements

Test Conditions: Radiated Measurement, Normal Temperature and Voltage only				
Antenna Type: Integrated			Power Setting: See test plan	
Max. Antenna Gain: + 2.0 dBi			Signal State: Modulated	
Ambient Temp.: 22 °C			Relative Humidity: 34%	
Band-Edge Results				
Operating Channel	Mode	Polarity	Pk Limit (dBr)	Result
5745 MHz	802.11a, 6Mbps	Horz.	20 dB	Pass
5825 MHz	802.11a, 6Mbps	Horz.	20 dB	Pass
5745 MHz	HT20, 19.5Mbps	Horz.	20 dB	Pass
5825 MHz	HT20, 19.5Mbps	Horz.	20 dB	Pass
5755 MHz	HT40, 13.5Mbps	Horz.	20 dB	Pass
5795 MHz	HT40, 13.5Mbps	Horz.	20 dB	Pass
Note:				
<ol style="list-style-type: none"> 1. Since the upper and lower band-edge of 5725 MHz – 5850 MHz are not in the restricted band per Section CFR47 15.205, the out of band emission must be at least 20 dBr below the in-band signal. 2. Worst cases were observed at antenna Horizontally polarized <ul style="list-style-type: none"> 802.11a - 6 Mbps, 1 data stream 802.11n HT20 – 19.5 Mbps, 3 data streams 802.11n HT40 – 13.5 Mbps, 1 data stream 				

Note: Band-edge at 5725MHz is not in the restricted band; therefore 20 dBr is applied.

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EUT Name	NEWCASTLE, NEWPORT					Date	September 2011			
EUT Model	FS1E5, FS1E5W, FS2E5, FS2E5W					Temp / Hum in	23°C / 33%rh			
EUT Serial	70AB00010-8C75					Temp / Hum out	N/A			
EUT Config.	Y-Axis, 802.11a at 6Mbps					Line AC / Freq	120Vac/60Hz			
Standard	CFR47 Part 15 Subpart C					RBW / VBW	1 MHz/ 3 MHz			
Dist/Ant Used	3m / EMCO3115 / 1m - RA42-K-F-4B-C					Performed by	Suresh Kondapalli			
Emission Freq	FIM Pk	FIM Ave	Total CF	E-Field Ave	Spec Limit	Spec Margin	Table Pos	ANT Pos	ANT Pola	Type
Transmitted Data at 5745MHz										
1596.07	52.73	37.53	-3.91	33.62	53.98	-20.36	124	218	V	Spurious
2333.11	43.08	40.31	-0.57	39.74	53.98	-14.24	132	218	V	Spurious
3666.44	49.22	42.73	3.46	46.18	53.98	-7.8	16	180	V	Harmonic
5332.92	45.15	39.24	6.43	45.67	53.98	-8.31	-30	190	H	Harmonic
11490.1	43.93	30.94	13.4	44.34	53.98	-9.64	-32	190	H	Harmonic
17215.00	38.25	24.53	17.45	41.98	53.98	-12.00	15	159	H	Harmonic
Transmitted Data at 5785MHz										
1600.1	45.96	36.5	-3.89	32.61	53.98	-21.37	13	154	V	Spurious
2333.16	59.09	57.08	-0.57	56.51	53.98	2.53*	32	154	H	Spurious
3666.37	54.16	48.92	3.46	52.38	53.98	-1.6	54	203	H	Spurious
4999.89	49.49	40.67	5.61	46.28	53.98	-7.7	-27	173	H	Spurious
5419.94	49.62	36.74	6.65	43.39	53.98	-10.59	441	173	H	Spurious
11566.3	40.65	28.34	13.54	41.88	53.98	-12.1	327	167	H	Harmonic
Transmitted Data at 5825MHz										
11651.5	44.05	29.92	13.74	43.66	53.98	-10.32	75	118	H	Harmonic
11651.5	43.62	30.35	13.74	44.09	53.98	-9.89	74	104	H	Harmonic
17475.9	37.32	24.09	19.87	43.96	53.98	-10.02	56	118	H	Harmonic
Spec Margin = E-Field QP - Limit, E-Field QP = FIM QP+ Total CF ± Uncertainty										
Total CF= Amp Gain + Cable Loss + ANT Factor										
Combined Standard Uncertainty $u_c(y) = \pm 3.2$ dB Expanded Uncertainty $U = ku_c(y)$ $k = 2$ for 95% confidence										
Notes: Worst case was observed on Y-axis, 1Mbps. * Emission at 2333.16MHz is conformed to be from Digital part of the device. This is considered as pass as EUT is Class A device										
The output of radio was transmitted at +16dBm.										

SOP 1 Radiated Emissions							Tracking # 31152150.002 Page 2 of 7			
EUT Name	NEWCASTLE, NEWPORT					Date	September 11, 2011			
EUT Model	FS1E5, FS1E5W, FS2E5, FS2E5W					Temp / Hum in	23°C / 38%rh			
EUT Serial	70AB00010-8C75					Temp / Hum out	N/A			
EUT Config.	Y-Axis, 802.11n HT20 at 6.5Mbps					Line AC / Freq	120Vac/60Hz			
Standard	CFR47 Part 15 Subpart C					RBW / VBW	1 MHz/ 3 MHz			
Dist/Ant Used	3m / EMCO3115 / 1m - RA42-K-F-4B-C					Performed by	Suresh Kondapalli			
Emission Freq	FIM Pk	FIM Ave	Total CF	E-Field Ave	Spec Limit	Spec Margin	Table Pos	ANT Pos	ANT Pola	Type
Transmitted Data at 5745MHz										
2333.11	43.08	40.31	-0.57	39.74	53.98	-14.24	132	218	V	Spurious
3666.44	49.22	42.73	3.46	46.18	53.98	-7.8	16	180	V	Spurious
11493.7	38.02	25.87	13.4	39.27	53.98	-14.71	2	139	H	Harmonic
17234.8	35.16	23.35	19.8	44.15	53.98	-9.73	8	150	H	Harmonic
Transmitted Data at 5785MHz										
11569.3	37.48	23.71	13.55	37.26	53.98	-16.72	378	218	V	Spurious
17345.0	37.11	25.5	19.9	45.41	53.98	-8.57	280	2	H	Spurious
Transmitted Data at 5825MHz										
1124.87	46.49	38.84	-5.6	33.23	53.98	-20.75	345	190	V	Harmonic
1249.87	47.46	41.94	-5.2	36.74	53.98	-17.24	348	165	V	Harmonic
2275.06	43.79	31.73	-0.82	30.91	53.98	-23.07	376	165	V	Spurious
11651.3	38.48	26.85	13.74	40.59	53.98	-13.39	338	109	H	Harmonic
17481.3	39.43	24.02	19.93	43.95	53.98	-10.03	305	116	H	Harmonic
Spec Margin = E-Field QP - Limit, E-Field QP = FIM QP+ Total CF ± Uncertainty										
Total CF= Amp Gain + Cable Loss + ANT Factor										
Combined Standard Uncertainty $u_c(y) = \pm 3.2$ dB Expanded Uncertainty $U = k u_c(y)$ $k = 2$ for 95% confidence										
Notes: Worst case was observed on Y-axis, 1Mbps. Emission at 3666.35MHz is conformed to be from Digital part of the device. This is considered as pass EUT is Class A device										
The output of radio was transmitted at +16dBm.										

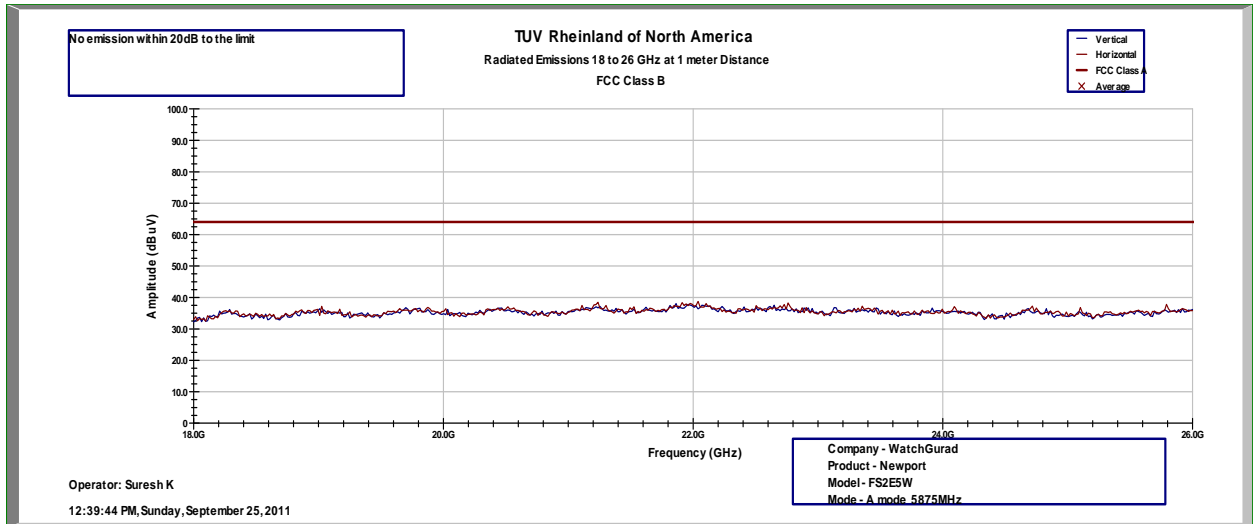
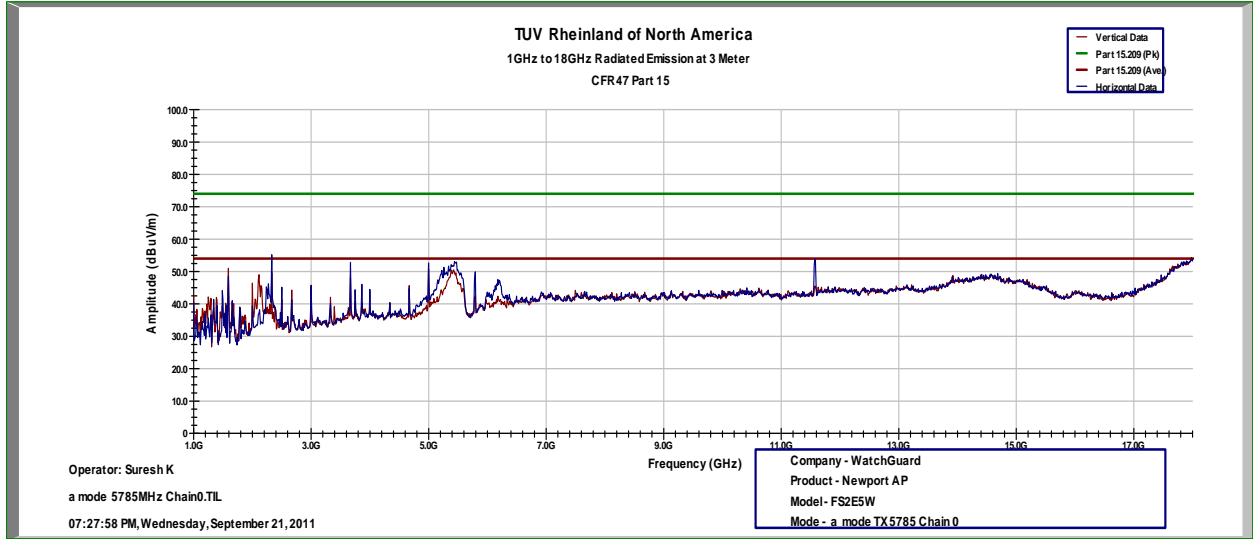
SOP 1 Radiated Emissions							Tracking # 31152150.002 Page 3 of 7			
EUT Name	NEWCASTLE, NEWPORT					Date	September 21, 2011			
EUT Model	FS1E5, FS1E5W, FS2E5, FS2E5W					Temp / Hum in	23°C / 39%rh			
EUT Serial	70AB00010-8C75					Temp / Hum out	N/A			
EUT Config.	Y-Axis, 802.11n HT40 at 40.5Mbps					Line AC / Freq	120Vac/60Hz			
Standard	CFR47 Part 15 Subpart C					RBW / VBW	1 MHz/ 3 MHz			
Dist/Ant Used	3m / EMCO3115 / 1m - RA42-K-F-4B-C					Performed by	Jeremy Luong			
Emission Freq	FIM Pk	FIM Ave	Total CF	E-Field Ave	Spec Limit	Spec Margin	Table Pos	ANT Pos	ANT Pola	Type
Transmitted Data at 5755MHz										
1124.84	46.83	40.42	-5.6	34.81	53.98	-19.17	26	166	V	Spurious
1499.87	43.35	33.89	-4.43	29.46	53.98	-24.52	42	169	V	Spurious
2124.85	50.47	33.83	-1.34	32.49	53.98	-21.49	27	169	V	Spurious
11511.3	38.09	25.88	13.42	39.3	53.98	-14.68	83	126	H	Harmonic
17268.2	37.63	23.21	17.83	41.04	53.98	-12.94	42	126	H	Harmonic
Transmitted Data at 5795MHz										
11591.3	36.89	23.17	13.62	36.79	53.98	-17.19	-33	160	H	Harmonic
17385	38.09	25.63	18.99	44.62	53.98	-9.36	-28	140	H	Harmonic
Spec Margin = E-Field QP - Limit, E-Field QP = FIM QP+ Total CF ± Uncertainty										
Total CF= Amp Gain + Cable Loss + ANT Factor										
Combined Standard Uncertainty $u_c(y) = \pm 3.2$ dB Expanded Uncertainty $U = ku_c(y)$ $k = 2$ for 95% confidence										
Notes: Worst case was observed on Y-axis, 1Mbps. Emission at 3666.35MHz is conformed to be from Digital part of the device. This is considered as pass EUT is Class A device										
The output of radio was transmitted at +16dBm.										

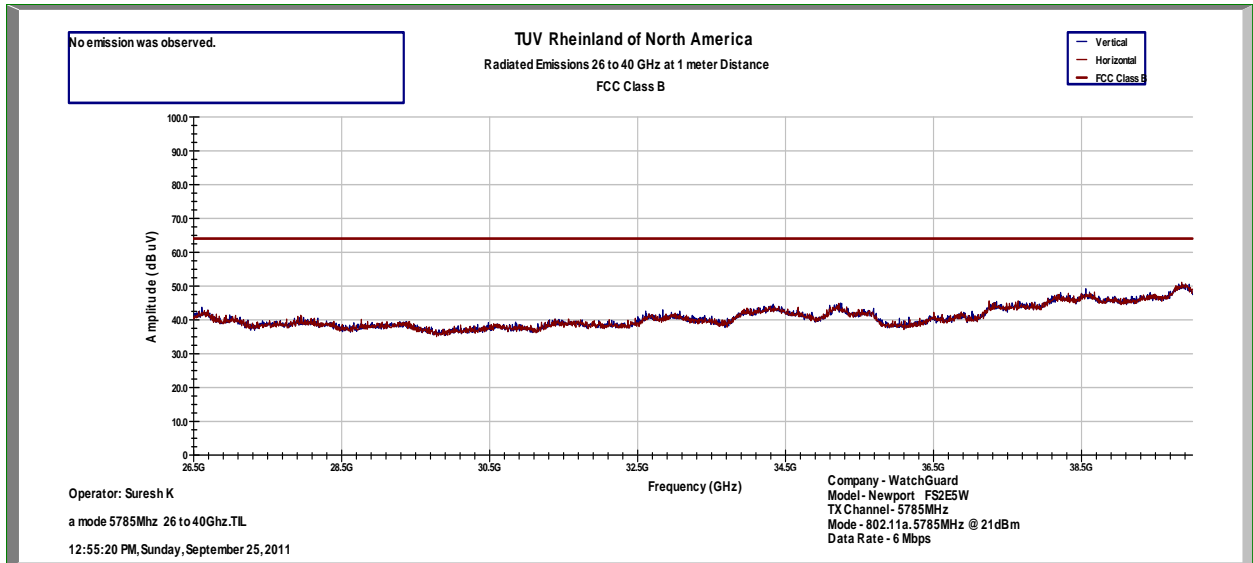
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EUT Name	NEWCASTLE, NEWPORT	Date	September 21, .2011
EUT Model	FS1E5, FS1E5W, FS2E5, FS2E5W	Temp / Hum in	23°C / 40%rh
EUT Serial	70AB00010-8C75	Temp / Hum out	N/A
EUT Config.	Y-Axis, 802.11a at 6Mbps	Line AC	120Vac 60Hz
Standard	CFR47 Part 15 Subpart C	RBW / VBW	1MHz / 3MHz
Dist/Ant Used	3m - EMCO3115 / 1m - RA42-K-F-4B-C	Performed by	Jeremy Luong

Above 1GHz Plots for Transmit Mode at 5785MHz



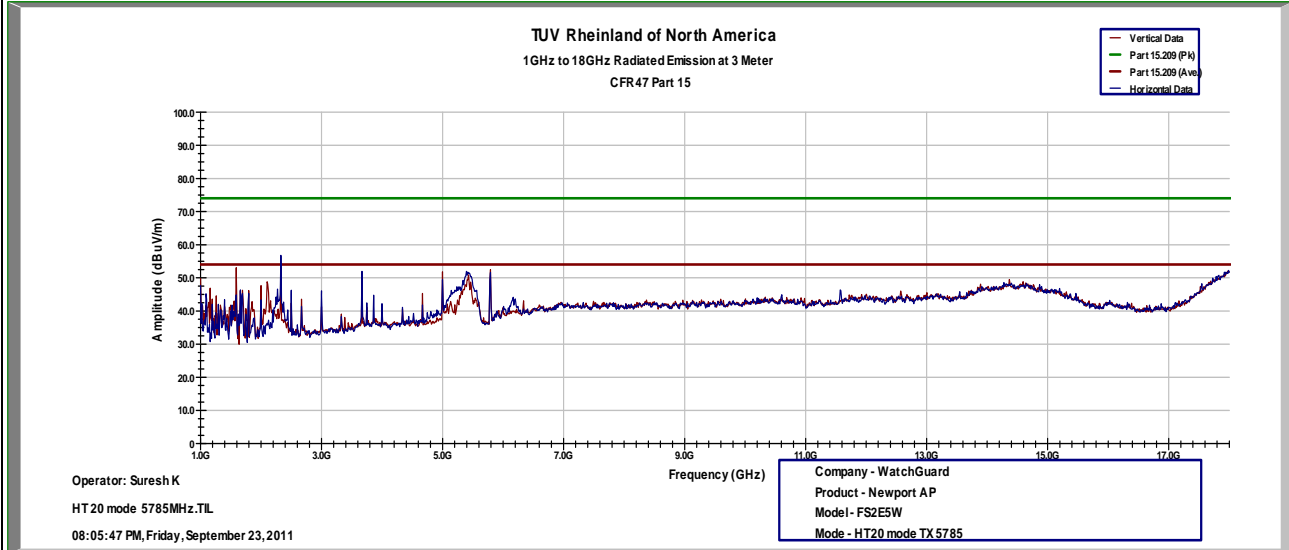


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EUT Name	NEWCASTLE, NEWPORT	Date	September 23, 2011
EUT Model	FS1E5, FS1E5W, FS2E5, FS2E5W	Temp / Hum in	23°C / 39%rh
EUT Serial	70AB00010-8C75	Temp / Hum out	N/A
EUT Config.	Y-Axis, 802.11 HT 20 mode at 6.5Mbps	Line AC	120Vac 60Hz
Standard	CFR47 Part 15 Subpart C	RBW / VBW	1MHz / 3MHz
Dist/Ant Used	3m - EMCO3115 / 1m - RA28-K-F-4B-C	Performed by	Suresh Kondapalli

Above 1GHz Plots for Transmit Mode at 5785MHz



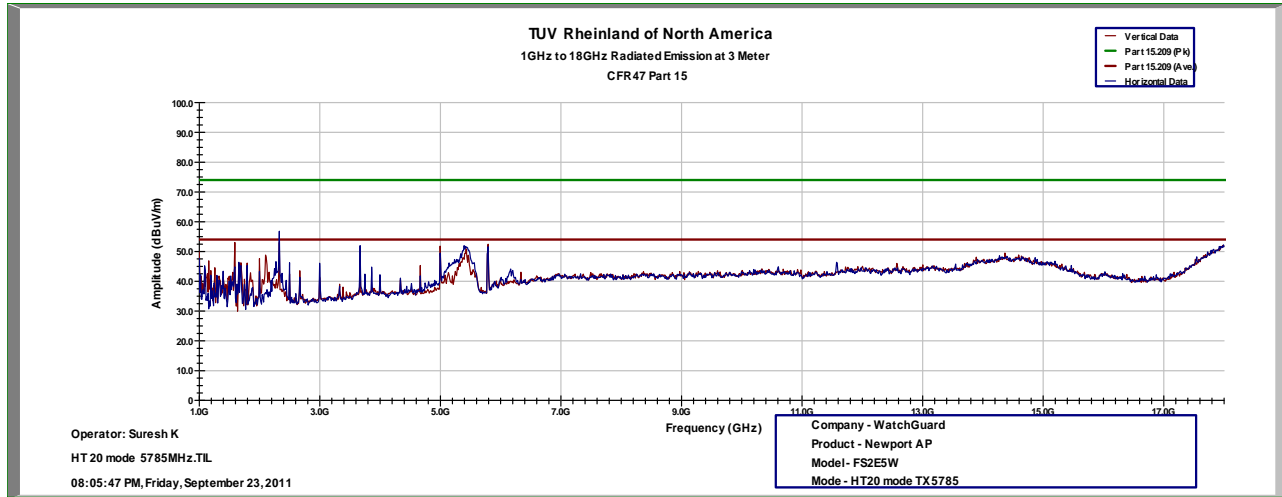
Notes. No emissions found above noise floor for 18 to 40GHz

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EUT Name	NEWCASTLE, NEWPORT	Date	September 23, 2011
EUT Model	FS1E5, FS1E5W, FS2E5, FS2E5W	Temp / Hum in	23°C / 40%rh
EUT Serial	70AB00010-8C75	Temp / Hum out	N/A
EUT Config.	Y-Axis, 802.11n HT20 at 6.5Mbps	Line AC	120Vac 60Hz
Standard	CFR47 Part 15 Subpart C	RBW / VBW	1MHz / 3MHz
Dist/Ant Used	3m - EMCO3115 / 1m - RA42-K-F-4B-C	Performed by	Jeremy Luong

Above 1GHz Plots for Transmit Mode at 5745MHz



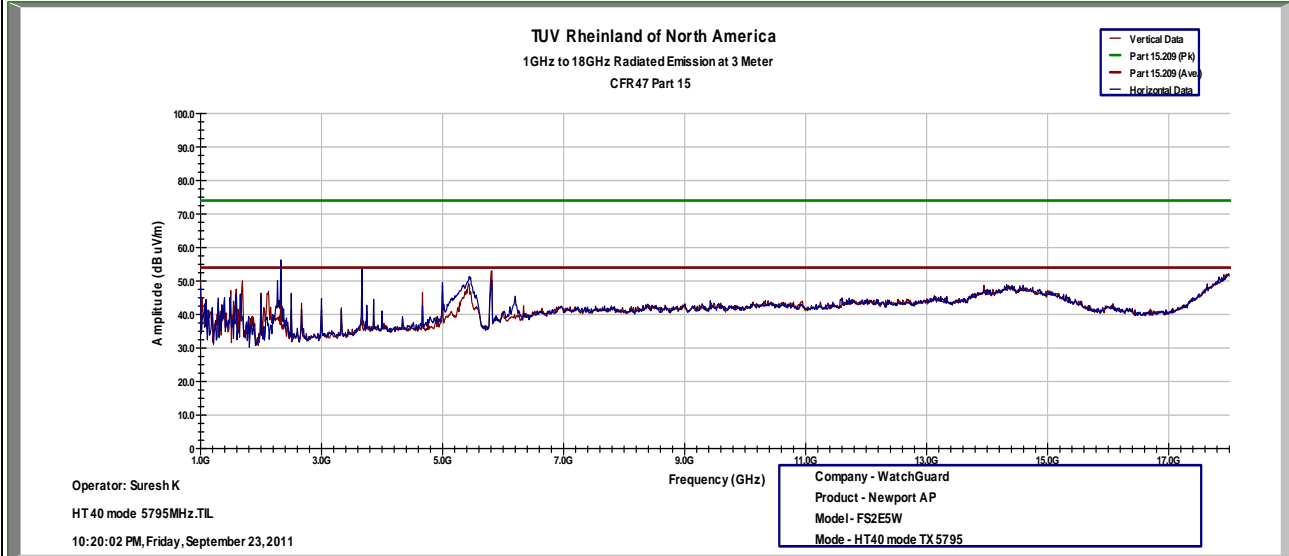
Notes: No emissions found above 18 to 40GHz noise floor for 18 to 40GHz

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EUT Name	NEWCASTLE, NEWPORT	Date	September 23, 2011
EUT Model	FS1E5, FS1E5W, FS2E5, FS2E5W	Temp / Hum in	23°C / 39%rh
EUT Serial	70AB00010-8C75	Temp / Hum out	N/A
EUT Config.	Y-Axis, 802.11n HT40 at 40.5Mbps	Line AC	120Vac 60Hz
Standard	CFR47 Part 15 Subpart C	RBW / VBW	1MHz / 3MHz
Dist/Ant Used	3m - EMCO3115 / 1m - RA42-K-F-4B-C	Performed by	Jeremy Luong

Above 1GHz Plots for Transmit Mode at 5795MHz



Notes: Notes: No emissions found above 18 to 40GHz noise floor for 18 to 40GHz

5.5.4 Sample Calculation

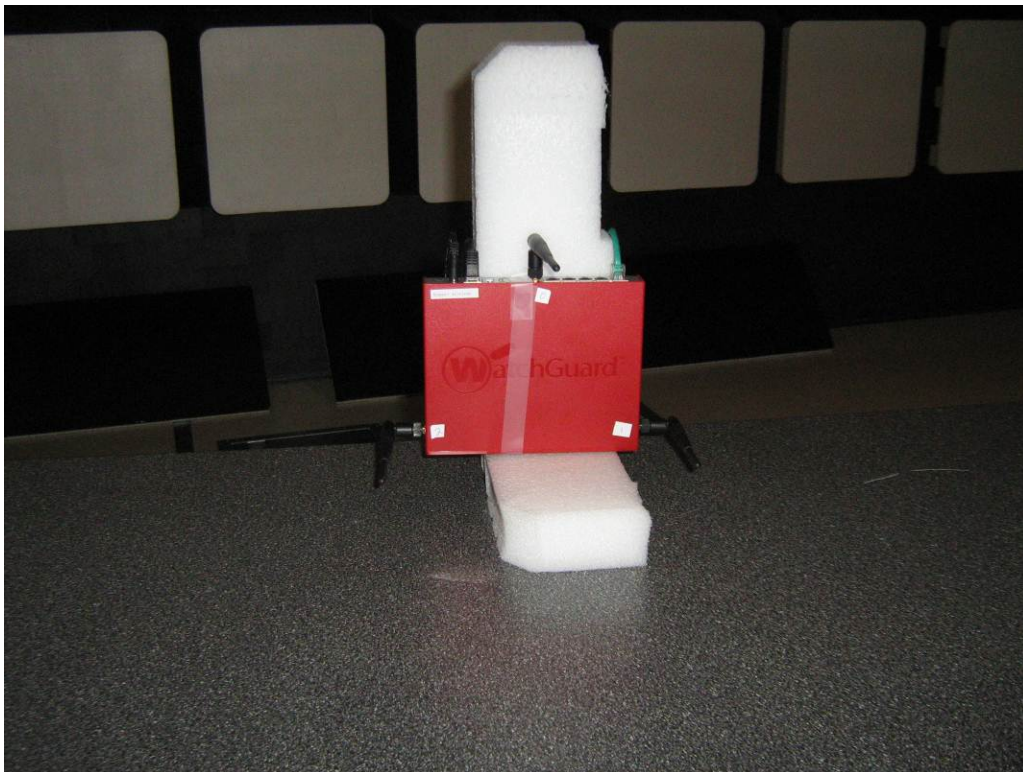
The field strength is calculated by subtracting the Amplifier Gain and adding the Cable Loss and Antenna Correction Factor to the measured reading. The basic equation is as follows:

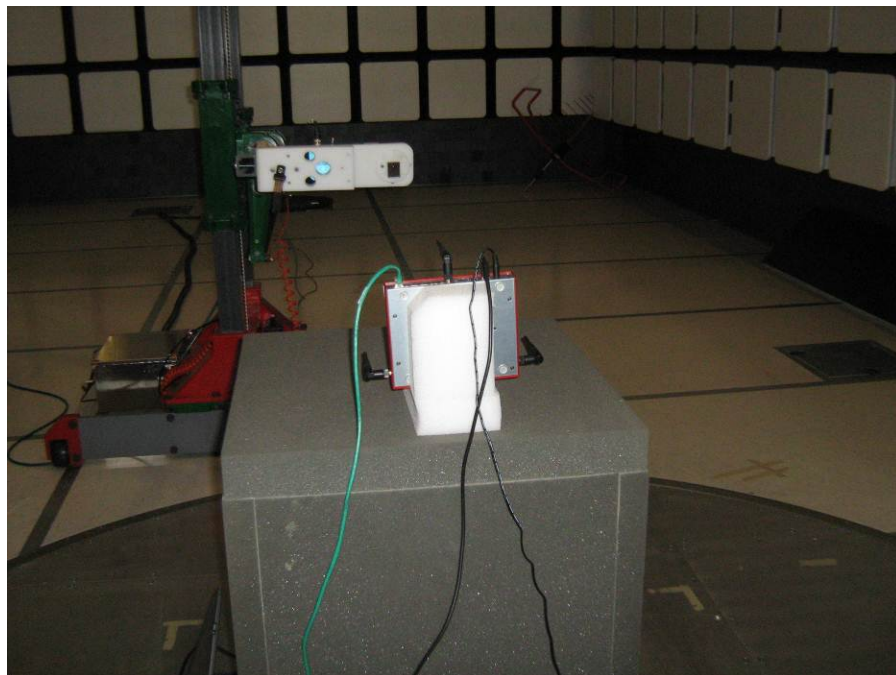
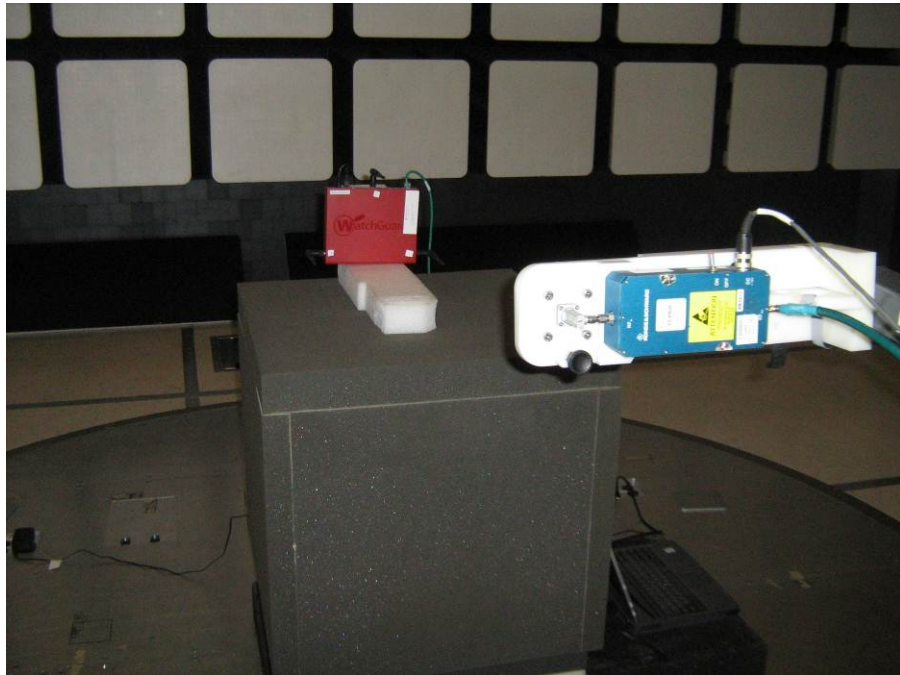
$$\text{Field Strength (dB}\mu\text{V/m)} = \text{FIM} - \text{AMP} + \text{CBL} + \text{ACF}$$

Where: FIM = Field Intensity Meter (dB μ V)
AMP = Amplifier Gain (dB)
CBL = Cable Loss (dB)
ACF = Antenna Correction Factor (dB/m)

$$\mu\text{V/m} = 10^{\frac{\text{dB}\mu\text{V} / \text{m}}{20}}$$

5.5.5 Test Seup Photos





Receiver Spurious Emissions

Receiver spurious emissions are emissions at any frequency when the equipment is in receive mode.

The spurious emissions of the receiver shall not exceed the values in CFR47 Part 15.109 and RSS GEN Sect 6.1.

5.5.6 Test Methodology

5.5.6.1 Preliminary Test

A test program that controls instrumentation and data logging was used to automate the preliminary RF emission test procedure. The frequency range of interest was divided into sub-ranges to yield a frequency resolution of approximately 120 kHz and provide a reading at each frequency for no more than 12° of turntable rotation. For each frequency sub-range the turntable was rotated 360° while peak emission data was recorded and plotted over the frequency range of interest in horizontal and vertical antenna polarization's.

Preliminary emission profile testing was performed inside the anechoic chamber. The EUT was placed on a 1.0m x 1.5m non-conductive table 80cm above the floor. The EUT was positioned as shown in the setup photographs. The receiving antenna was placed at a distance of 3m at a fixed height of 1m. Measurement equipment was located outside of the chamber. A video camera was placed inside the chamber to view the EUT.

5.5.6.2 Final Test

For each frequency measured, the peak emission was maximized by manipulating the receiving antenna from 1 to 4 meters above the ground plane and placing it at the position that produced the maximum signal strength reading. The turntable was then rotated through 360° while observing the peak signal and placing the EUT at the position that produced maximum radiation. The six highest emissions relative to the limit were measured unless such emissions were more than 20 dB below the limit. If less than six emissions are within 20 dB of the limit, than the noise level of the receiver is measured at frequencies where emissions are expected. Multiples of all oscillator and microprocessor frequencies were also checked.

Final testing was performed on an NSA compliant test site. The EUT was placed on a 1.0m x 1.5m non-conductive table 80cm above the ground plane. The placement of EUT and cables were the same as for preliminary testing and is shown in the setup photographs.

The final scans were performed at

5785MHz at 802.11n HT20 (20 MHz Bandwidth)

5795MHz at 802.11n HT40 (40 MHz Bandwidth)

5.5.6.3 Deviations

None.

5.5.7 Receiver Spurious Emission Limit

The spurious emissions of the receiver shall not exceed the values in CFR47 Part 15.109: 2009 and RSS GEN: 2010 Sect 6.1.

Frequency (MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
0.009-0.490	2400/F (kHz)	300
0.490-1.705	24000/F (kHz)	30
1.705-30.0	30	30
30-88	100 **	3
88-216	150 **	3
216-960	200 **	3
Above 960	500	3

5.5.8 Test Results

The final measurement data indicates the worst case operating modes, configurations, and/or cable positions. It also reflects the results including any modifications and/or special accessories listed in Sections 1.4 and 1.5.

As originally tested, the EUT was found to be compliant to the requirements of the test standard(s).

5.5.8.1 Final Data

The data recorded in this section contains the final results under the worst-case conditions and without any modifications or special accessories implemented as the manufacturer intends.

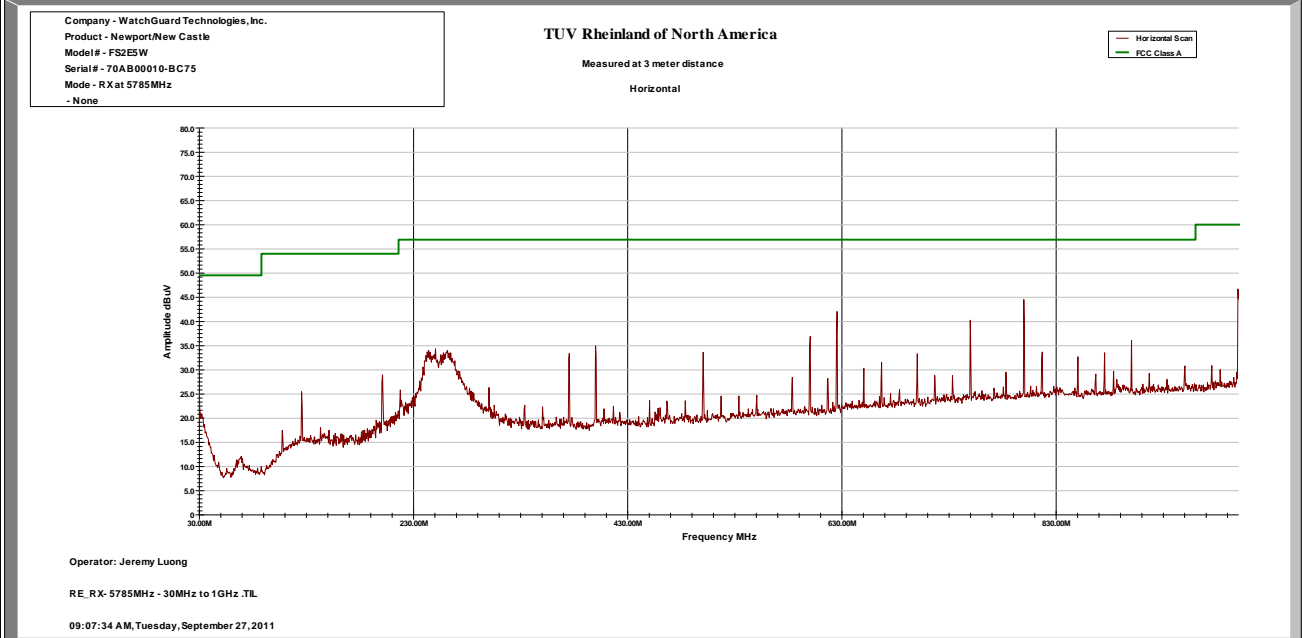
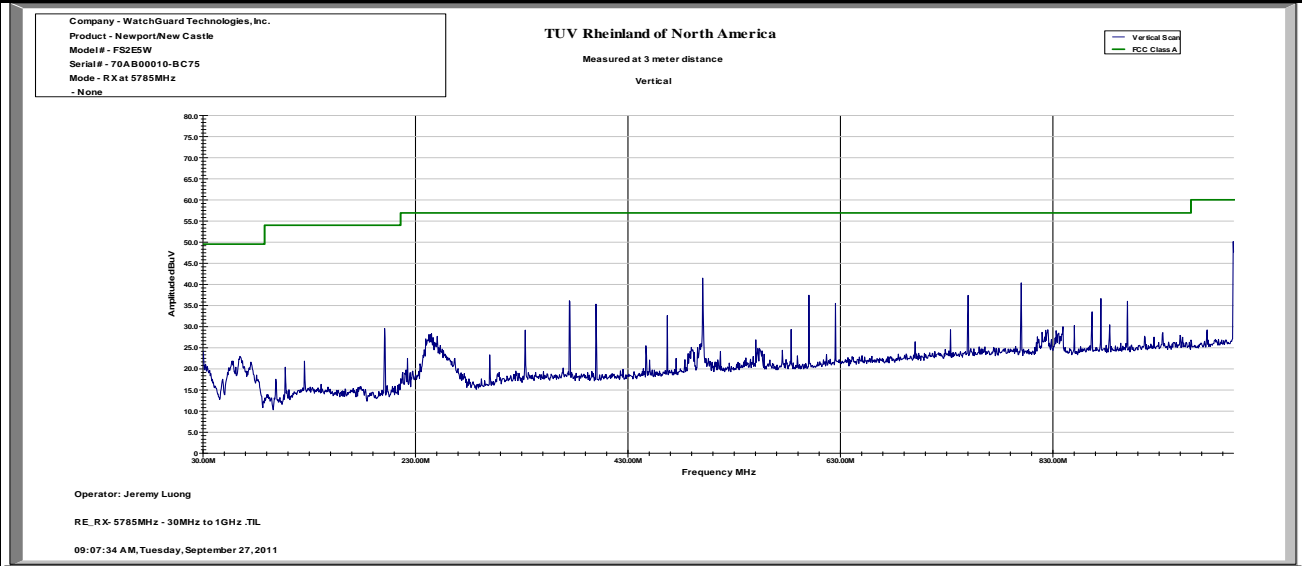
SOP 1 Radiated Emissions							Tracking # 31152150.002 Page 1 of 4			
EUT Name	NEWCASTLE, NEWPORT					Date	September 27, 2011			
EUT Model	FS1E5, FS1E5W, FS2E5, FS2E5W					Temp / Hum in	22°C / 40%rh			
EUT Serial	70AB00010-8C75					Temp / Hum out	N/A			
EUT Config.	Y-Axis, RX at 5785MHz					Line AC / Freq	120Vac 60Hz			
Standard	CFR47 Part 15 Subpart b					RBW / VBW	See Note			
Dist/Ant Used	3m / JB3 & EMCO3115					Performed by	Jeremy Luong			
Emission Freq	FIM Pk	FIM Ave	Total CF	E-Field Ave	Spec Limit	Spec Margin	Table Pos	ANT Pos	ANT Pola	Type
624.97	47.99	47.44	-3.09	44.35	56.90	-12.55	H	126	337	Spurious
749.91	42.50	42.10	-0.63	41.47	56.90	-15.43	H	102	344	Spurious
800.01	45.50	44.91	0.04	44.95	56.90	-11.95	H	104	36	Spurious
999.89	42.76	39.84	2.91	42.75	60.00	-17.25	H	110	279	Spurious
499.95	48.30	47.02	-5.66	41.36	56.90	-15.54	V	111	20	Spurious
800.01	41.90	41.53	-0.46	41.07	56.90	-15.83	V	128	334	Spurious
999.89	48.70	48.32	2.51	50.83	60.00	-9.17	V	106	338	Spurious
624.97	47.99	47.44	-3.09	44.35	56.90	-12.55	H	126	337	Spurious
Spec Margin = E-Field QP - Limit, E-Field QP = FIM QP+ Total CF ± Uncertainty										
Total CF= Amp Gain + Cable Loss + ANT Factor										
Combined Standard Uncertainty $u_c(y) = \pm 3.2$ dB Expanded Uncertainty $U = ku_c(y)$ $k = 2$ for 95% confidence										
Notes: Worst case was observed on Y-axis, 1Mbps. Emission at 3666.35MHz is conformed to be from Digital part of the device. This is considered as pass EUT is Class A device The output of radio was transmitted at +16dBm.										

SOP 1 Radiated Emissions											Tracking # 31152150.002 Page 2 of 4
EUT Name	NEWCASTLE, NEWPORT							Date	September 27, 2011		
EUT Model	FS1E5, FS1E5W, FS2E5, FS2E5W							Temp / Hum in	22°C / 40%rh		
EUT Serial	70AB00010-8C75							Temp / Hum out	N/A		
EUT Config.	Y-Axis, RX at 5795MHz							Line AC / Freq	120Vac 60Hz		
Standard	CFR47 Part 15 Subpart b							RBW / VBW	See Note		
Dist/Ant Used	3m / JB3 & EMCO3115							Performed by	Jeremy Luong		
Emission Freq (MHz)	ANT Polar (H/V)	ANT Pos (cm)	Table Pos (deg)	FIM (Pk) Pk (dBuV/m)	FIM QP (dBuV/m)	Total CF (dBuV)	E-Field QP (dBuV/m)	Spec Limit (dBuV/m)	Spec Margin (dB)	Type	
Receive Mode at 40 MHz Bandwidth											
84.86	H	291	312	61.41	59.56	-18.40	41.16	49.54	-8.38	Spurious	
85.77	H	266	337	62.99	61.26	-18.43	42.83	49.54	-6.71	Spurious	
500.04	H	173	197	48.05	46.19	-7.17	39.02	56.90	-17.88	Spurious	
625.01	H	111	190	47.12	46.11	-5.29	40.82	56.90	-16.08	Spurious	
750.05	H	103	168	44.94	38.79	-3.18	35.61	56.90	-21.29	Spurious	
84.58	V	105	7	65.34	63.53	-18.52	45.01	49.54	-4.53	Spurious	
85.42	V	108	308	65.79	64.15	-18.44	45.71	49.54	-3.83	Spurious	
400.00	V	132	355	48.85	47.64	-9.15	38.49	56.90	-18.41	Spurious	
500.05	V	110	349	46.32	43.10	-7.57	35.53	56.90	-21.37	Spurious	
871.36	V	121	196	46.69	44.79	-1.99	42.80	56.90	-14.10	Spurious	
874.17	V	106	191	46.83	46.24	-1.88	44.36	56.90	-12.54	Spurious	
1200.09	H	113	29	54.77	47.85	-8.00	39.85	53.98	-14.13	Spurious	
1495.19	H	120	143	61.12	41.34	-7.69	33.65	53.98	-20.33	Spurious	
1595.37	H	138	251	61.67	40.66	-6.83	33.83	53.98	-20.15	Spurious	
1861.15	H	142	208	60.41	47.07	-4.94	42.13	53.98	-11.85	Spurious	
2393.03	H	159	130	54.59	35.00	-3.00	32.00	53.98	-21.98	Spurious	
2490.56	H	204	242	53.49	32.56	-2.68	29.88	53.98	-24.10	Spurious	
Spec Margin = E-Field QP - Limit, E-Field QP = FIM QP+ Total CF ± Uncertainty											
Total CF= Amp Gain + Cable Loss + ANT Factor											
Combined Standard Uncertainty $u_c(y) = \pm 3.2\text{dB}$ Expanded Uncertainty $U = ku_c(y)$ $k = 2$ for 95% confidence											
Notes: Tested at 802.11n HT40.											
30 MHz to 1GHz range was tested as FCC Class A device.											

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EUT Name	NEWCASTLE, NEWPORT	Date	September 27, 2011
EUT Model	FS1E5, FS1E5W, FS2E5, FS2E5W	Temp / Hum in	21°C / 42%rh
EUT Serial	70AB00010-8C75	Temp / Hum out	N/A
EUT Config.	Y-Axis, RX at 5785MHz	Line AC	120Vac 60Hz
Standard	CFR47 Part 15 Subpart b	RBW / VBW	120 kHz / 300 kHz
Dist/Ant Used	3m / JB3	Performed by	Jeremy Luong

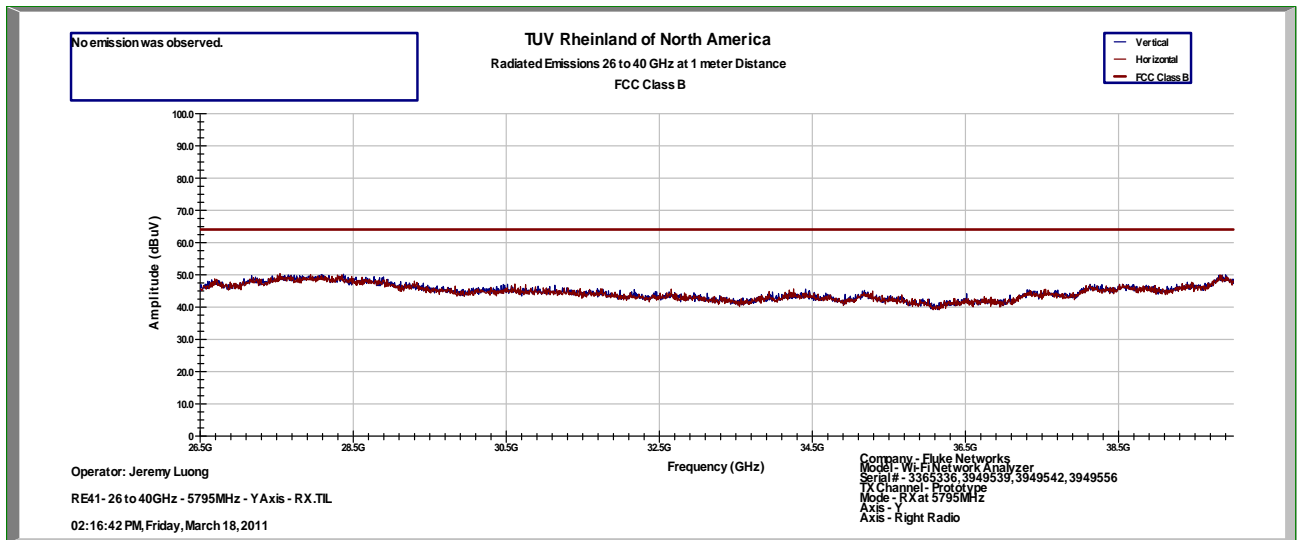


Notes: Tested with a Bandwidth of 20 MHz. FCC Class A Device.

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EUT Name	NEWCASTLE, NEWPORT	Date	September 27, 2011
EUT Model	FS1E5, FS1E5W, FS2E5, FS2E5W	Temp / Hum in	23°C / 40%rh
EUT Serial	70AB00010-8C75	Temp / Hum out	N/A
EUT Config.	Y-Axis, RX at 5795MHz	Line AC	120Vac 60Hz
Standard	CFR47 Part 15 Subpart b	RBW / VBW	1MHz / 3MHz
Dist/Ant Used	3m / RA28-K-F-4B-C	Performed by	Jeremy Luong



Notes: Tested with a Bandwidth of 40 MHz

5.5.9 Sample Calculation

The field strength is calculated by subtracting the Amplifier Gain and adding the Cable Loss and Antenna Correction Factor to the measured reading. The basic equation is as follows:

$$\text{Field Strength (dB}\mu\text{V/m)} = \text{FIM} - \text{AMP} + \text{CBL} + \text{ACF}$$

- Where:
- FIM = Field Intensity Meter (dBµV)
 - AMP = Amplifier Gain (dB)
 - CBL = Cable Loss (dB)
 - ACF = Antenna Correction Factor (dB/m)

$$\mu\text{V/m} = 10^{\frac{\text{dB}\mu\text{V} / \text{m}}{20}}$$

5.6 AC Conducted Emissions

Testing was performed in accordance with ANSI C63.4-2009. These test methods are listed under the laboratory's NVLAP Scope of Accreditation.

This test measures the levels emanating from the EUT's AC input port, thus evaluating the potential for the EUT to cause radio frequency interference to other electronic devices.

The AC conducted emissions of equipment under test shall not exceed the values in CFR47 Part 15.207: 2009 and RSS 210: 2010.

5.6.1 Test Methodology

A test program that controls instrumentation and data logging was used to automate the AC Power Line Conducted emission test procedure. The frequency range of interest was divided into sub-ranges such as to yield a frequency resolution of 9 kHz. Each phase and neutral of the AC power line were measured with respect to ground. Measurements were performed using a set of 50μH / 50Ω LISNs.

Testing is either performed in Lab 5. The setup photographs clearly identify which site was used. The vertical ground plane used in the semi-anechoic chamber is a 2m x 2m solid aluminum frame and panel, and it is bonded to the horizontal ground plane.

In the case of tabletop equipment, the EUT is placed on a 1.0m x 1.5m non-conductive table 80cm above the ground plane and 40cm from a vertical ground reference plane. The rear of the EUT was positioned flush with the backside of the table and directly over the LISNs. The power and I/O cables were routed over the edge of the table and bundled approximately 40cm from the ground plane. Support equipment was powered from a separate LISN.

5.6.1.1 Deviations

There were no deviations from this test methodology.

5.6.2 Test Results

As originally tested, the EUT was found to be compliant to the requirements of the test standard(s).

Table 15: AC Conducted Emissions – Test Results

Test Conditions: Conducted Measurement at Normal Conditions only		
Antenna Type: Attached	Power Level: See Test Plan	
AC Power: 120 Vac/60 Hz	Configuration: Tabletop	
Ambient Temperature: 23° C	Relative Humidity: 34% RH	
Configuration	Frequency Range	Test Result

Line 1 (Hot)	0.15 to 30 MHz	Pass
Line 2 (Neutral)	0.15 to 30 MHz	Pass

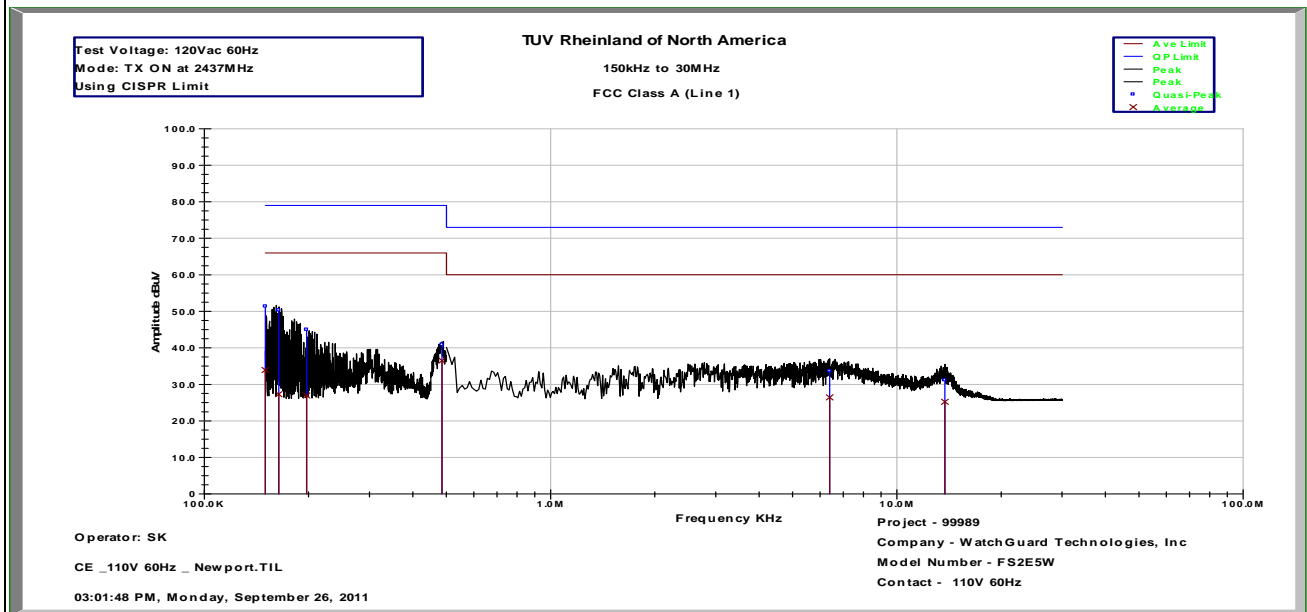
SOP 2 Conducted Emissions				Tracking # 31152150.002 Page 1 of 4		
EUT Name	NEWCASTLE, NEWPORT		Date	September 26, 2011		
EUT Model	FS1E5, FS1E5W, FS2E5, FS2E5W		Temp / Hum in	23° C / 34% rh		
EUT Serial	70AB00010-8C75		Temp / Hum out	N/A		
EUT Config.	3 External Antennas		Line AC / Freq	120Vac/60Hz		
Standard	CFR47 Part 15.207		RBW / VBW	9kHz / 30 kHz		
Lab/LISN	Lab #5 / Solar 9348-50-R-24-BNC, Line 1		Performed by	Jeremy Luong		
Frequency	Quasi-Peak	QP Limit	QP Margin	Average	Ave Limit	Ave Margin
MHz	dBuV	dBuV	dB	dBuV	dBuV	dB
0.150	51.36	33.9	79	66	-27.64	-32.1
0.164	50.28	27.29	79	66	-28.72	-38.71
0.197	44.97	26.93	79	66	-34.03	-39.07
0.485	40.84	36.49	79	66	-38.16	-29.51
6.39	33.62	26.41	73	60	-39.38	-33.59
13.7	31.15	25.19	73	60	-41.85	-34.81
Spec Margin = QP./Ave. - Limit, ± Uncertainty						
Combined Standard Uncertainty $u_c(y) = \pm 1.2$ dB Expanded Uncertainty $U = ku_c(y)$ $k = 2$ for 95% confidence						
Notes: EUT was setup as table top equipment and transmitted at 5785MHz in HT20 at 6.5Mbps						

SOP 2 Conducted Emissions

Tracking # 31152150.002 Page 2 of 4

EUT Name	NEWCASTLE, NEWPORT	Date	September 26, 2011
EUT Model	FS1E5, FS1E5W, FS2E5, FS2E5W	Temp / Hum in	23° C / 34% rh
EUT Serial	70AB00010-8C75	Temp / Hum out	N/A
EUT Config.	Attached Antenna	Line AC	120Vac/60Hz
Standard	CFR47 Part 15.207	RBW / VBW	9kHz / 30 kHz
Lab/LISN	Lab #5 / Solar 9348-50-R-24-BNC, Line 1	Performed by	Jeremy Luong

150 kHz to 30 MHz Plot for Line 1 (Hot)



Notes: Meet FCC Class B limit.

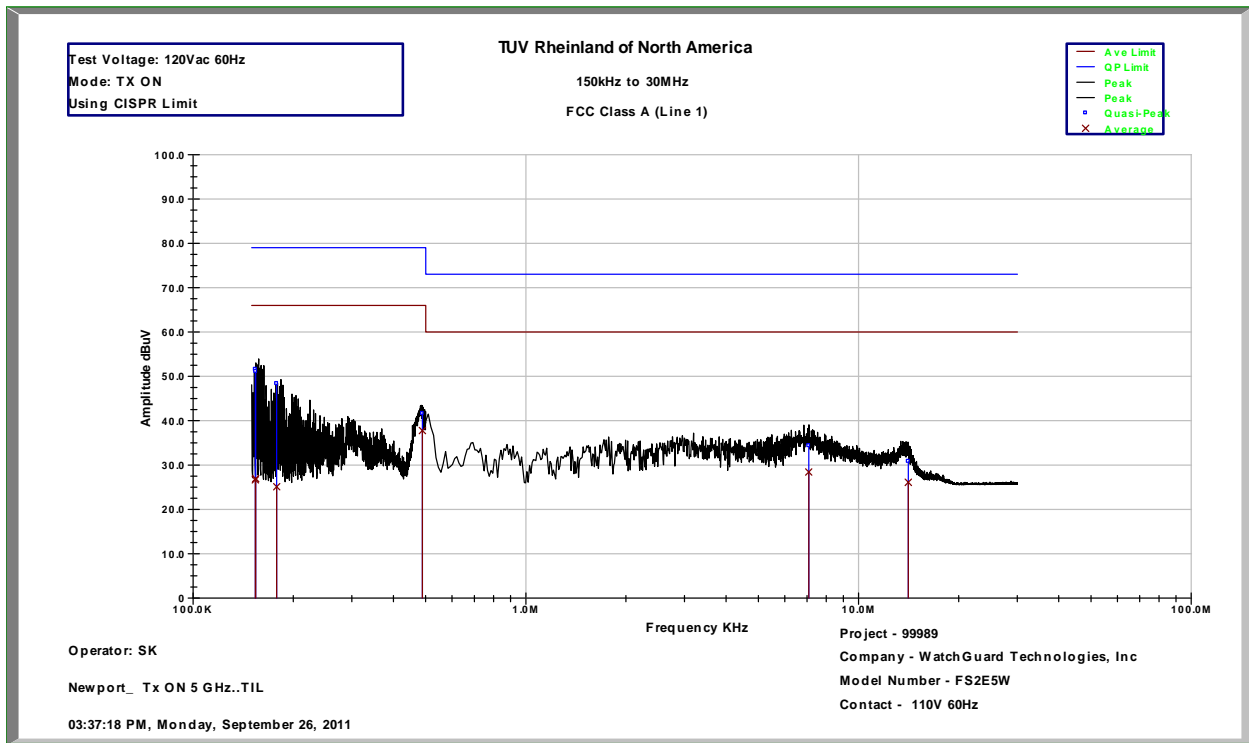
SOP 2 Conducted Emissions				Tracking # 31152150.002 Page 3 of 4		
EUT Name	NEWCASTLE, NEWPORT			Date	September 26, 2011	
EUT Model	FS1E5, FS1E5W, FS2E5, FS2E5W			Temp / Hum in	23° C / 34% rh	
EUT Serial	70AB00010-8C75			Temp / Hum out	N/A	
EUT Config.	3 X External Antennas			Line AC / Freq	120Vac/60Hz	
Standard	CFR47 Part 15.107			RBW / VBW	9kHz / 30 kHz	
Lab/LISN	Lab #5 / Solar 9348-50-R-24-BNC, Line 2			Performed by	Suresh Kondapalli	
Frequency	Quasi-Peak	QP Limit	QP Margin	Average	Ave Limit	Ave Margin
MHz	dBuV	dBuV	dB	dBuV	dBuV	dB
0.150	42.48	66.00	-23.52	25.15	56.00	-30.85
0.197	48.40	64.65	-16.25	23.83	54.65	-30.82
0.197	48.45	64.64	-16.19	23.98	54.64	-30.67
9.832	32.19	60.00	-27.81	26.13	50.00	-23.88
9.951	33.45	60.00	-26.55	27.36	50.00	-22.64
14.815	39.95	60.00	-20.05	34.38	50.00	-15.63
15.064	40.40	60.00	-19.60	34.75	50.00	-15.25
15.756	40.26	60.00	-19.74	34.62	50.00	-15.38
20.486	34.38	60.00	-25.62	28.90	50.00	-21.10
Spec Margin = QP./Ave. - Limit, ± Uncertainty						
Combined Standard Uncertainty $u_c(y) = \pm 1.2$ dB Expanded Uncertainty $U = k u_c(y)$ $k = 2$ for 95% confidence						
Notes: EUT was setup as table top equipment and transmitted at 5785MHz in HT20 at 6.5Mbps						

SOP 2 Conducted Emissions

Tracking # 31152150.002 Page 4 of 4

EUT Name	NEWCASTLE, NEWPORT	Date	September 26, 2011
EUT Model	FS1E5, FS1E5W, FS2E5, FS2E5W	Temp / Hum in	23° C / 34% rh
EUT Serial	70AB00010-8C75	Temp / Hum out	N/A
EUT Config.	Attached Antenna	Line AC	120Vac/60Hz
Standard	CFR47 Part 15.107	RBW / VBW	9kHz / 30 kHz
Lab/LISN	Lab #5/ Solar 9348-50-R-24-BNC, Line 2	Performed by	Suresh Kondapalli

150 kHz to 30 MHz Plot for Line 2 (Neutral)



Note: Meet FCC Class B Limit.

5.6.3 Test Setup Photos



6 Test Equipment Use List

6.1 Equipment List

Equipment	Manufacturer	Model #	Serial/Inst #	Last Cal dd/mm/yy	Next Cal dd/mm/yy
Bilog Antenna	Sunol Science	JB3	A102606	2/18/2010	2/18/2012
Horn Antenna	Sunol Scienece	DRH-118	A040806	9/29/2010	9/29/2012
Antenna (18-26GHz)	CMT	RA42-K-F-4B-C	020131-004	10/15/2010	10/15/2011
Antenna (26-40GHz)	CMT	RA28-K-F-4B-C	011469R-003	10/15/2010	10/15/2011
EMI Receiver	Hewlett Packard	8546A	3807A00445	2/5/2011	2/5/2012
Preselector	Hewlett Packard	85460A	3704A00407	2/5/2011	2/5/2012
Amplifier	Hewlett Packard	8447D	2944A07996	1/17/2011	1/17/2012
Spectrum Analyzer	Rhode&Schwarz	ESIB	832427/002	1/18/2011	1/18/2012
Amplifier	Rhode&Schwarz	TS-PR18	3545.7008.03	9/29/2010	9/29/2012
Amplifier	Rhode&Schwarz	TS-PR26	100011	10/15/2010	10/15/2011
Amplifier	Rhode&Schwarz	TS-PR40	100012	10/15/2010	10/15/2011
Signal Generator	Anritsu	MG3694A	42803	1/26/2011	1/26/2012
Notch Filter	Micro-Tronics	BRM50702	37	1/19/2011	1/19/2012
Notch Filter	Micro-Tronics	BRC50705	9	1/19/2011	1/19/2012
High Pass Filter (3.5 GHz)	Hewlett Packard	84300-80038	820004	1/19/2011	1/19/2012
High Pass Filter (8.5 GHz)	Micro-Tronics	HPM50107	4	1/19/2011	1/19/2012
Power Supplier	Kikosui	PCR8000W	CM000912	1/19/2011	1/19/2012
Digital Multimeter	Fluke	177	92780314	1/18/2011	1/18/2012
Power Meter	Agilent	E4418B	MY45103902	1/18/2011	1/18/2012
Power Sensor	Hewlett Packard	8482A	55-5131	10/27/2010	10/27/2011
EMI Receiver	Hewlett Packard	8546A	3942A00514	11/22/2010	11/22/2011
Preselector	Hewlett Packard	85460A	3704A00485	11/22/2010	11/22/2011
LISN	Solar Electronics	Type 9348-50-R-24-BNC	68509	1/17/2011	1/17/2012
Signal Generator	Anritsu	MG3694A	42803	1/26/2011	1/26/2012
Spectrum Analyzer	Agilent	E4407B	SG43330468	10/05/2011	10/05/2012

* Calibration of equipment past due for re-calibration will be performed expeditiously. If any equipment is found to be out of tolerance at that time, affected customers will be notified accordingly.

7 EMC Test Plan

7.1 Introduction

This section provides a description of the Equipment Under Test (EUT), configurations, operating conditions, and performance acceptance criteria. It is an overview of information provided by the manufacturer so that the test laboratory may perform the requested testing.

7.2 Customer

Table 16: Customer Information

Company Name	WatchGuard Technologies, Inc.
Address	505 Fifth Ave S, Suite 500
City, State, Zip	Seattle, WA 98104
Country	USA
Phone	(206)-521-6600
Fax	None

Table 17: Technical Contact Information

Name	Denny Lim
E-mail	Denny.Lim@watchguard.com
Phone	(206)-521-6600
Fax	None

7.3 Equipment Under Test (EUT)

Table 18: EUT Specifications

EUT Specification	
Newport Dimensions	10.5" x 6.125" x 1.25"
AC Adapter	Input Voltage: 100-240Vac 50-60Hz Input Current: 1200mA Output Voltage: 19VDC Output Current: 4.74A
Environment	Indoor
Operating Temperature Range:	0 to 40 degrees C
Multiple Feeds:	<input type="checkbox"/> Yes and how many <input checked="" type="checkbox"/> No
Hardware Version	Rev. 9
Part Number	None
RF Software Version	ART2.13
Radio Module 802.11-radio module	
Operating Mode	802.11a,b, g, HT20, and HT40
Transmitter Frequency Band	2.400GHz to 2.4835 GHz 5.15 GHz to 5.25 GHz (Indoor Use only) 5.725 GHz to 5.85 GHz
Max. Rated Power Output	See Channel Planning Table.
Power Setting @ Operating Channel	See Channel Planning Table.
Antenna Type	3 External Antenna 2.0dBi Reverse Polarity Connector
Modulation Type	<input type="checkbox"/> AM <input type="checkbox"/> FM <input type="checkbox"/> DSSS <input checked="" type="checkbox"/> OFDM <input checked="" type="checkbox"/> Other describe: CCK, CCK_5 and CCK_11

Date Rate	802.11b: 1, 2, 5.5, 11 Mbps at 1 Spatial Stream 802.11g: 6, 9, 12, 18, 24, 36, 48, 54 Mbps at 1 Spatial Stream 802.11a: 6, 9, 12, 18, 24, 36, 48, 54 Mbps at 1 Spatial Stream 802.11n HT20: 1 Spatial Stream: 6.5, 13, 19.5, 26, 39, 52, 58.5, 65 Mbps 2 Spatial Streams: 13, 26, 39, 58, 78, 104, 117, 130 Mbps 3 Spatial Streams: 19.5, 39, 58.5, 78, 117, 156, 175.5, 195 Mbps 802.11n HT40: 1 Spatial Stream: 13.5, 27, 40.5, 54, 81, 108, 121.5, 135 Mbps 2 Spatial Streams: 27, 54, 81, 108, 162, 216, 243, 270 Mbps 3 Spatial Streams: 40.5, 81, 121.5, 162, 243, 324, 364.5, 405 Mbps
TX/RX Chain (s)	MIMO (3x3)
Directional Gain Type	<input checked="" type="checkbox"/> Uncorrelated <input checked="" type="checkbox"/> No Beam-Forming <input type="checkbox"/> Other describe:
Type of Equipment	<input type="checkbox"/> Table Top <input checked="" type="checkbox"/> Wall-mount <input type="checkbox"/> Floor standing cabinet <input type="checkbox"/> Other <i>describe</i>

Table 19: EUT Channel Power Specifications

No.	Frequency (MHz)	Power Set Value using art								
		802.11b	802.11g	802.11a	802.11 HT20 1 chain	802.11n HT20 2 chains	802.11n HT20 3 chains	802.11n HT40 1 chain	802.11n HT40 2 chains	802.11n HT40 3 chains
1	2412	16.5	16.0		16.0	16.0	14.0	14.0	12.0	9.0
2	2417	16.5	16.0		16.0	16.0	14.0	14.0	12.0	9.0
3	2422	16.5	16.0		16.0	16.0	14.0	14.0	12.0	9.0
4	2427	16.5	16.0		16.0	16.0	14.0	14.0	12.0	9.0
5	2432	16.5	16.0		16.0	16.0	14.0	14.0	12.0	9.0
6	2437	16.5	16.0		16.0	16.0	14.0	14.0	12.0	9.0
7	2442	16.5	16.0		16.0	16.0	14.0	14.0	12.0	9.0
8	2447	16.5	16.0		16.0	16.0	14.0	14.0	12.0	9.0
9	2452	16.5	16.0		16.0	16.0	14.0	14.0	12.0	9.0
10	2457	16.5	16.0		16.0	16.0	14.0	14.0	12.0	
11	2462	16.5	16.0		16.0	16.0	14.0	14.0	12.0	
157	5785			18.0	19.0	19.0	19.0	19.0	19.0	19.0
159	5795			21.0	19.0	19.0	19.0	19.0	19.0	19.0
161	5805			21.0	19.0	19.0	19.0	19.0	19.0	
165	5825			18.0	19.0	19.0	19.0	19.0	19.0	

Note: 1. The center operating frequency is shifted upward by 10 MHz for HT40.
 2. The adjusted power target values are updated at the evaluated frequencies.
 3. This report is only documented for frequency ranges, 2400-2483.5MHz and 5725-5850 MHz.

Table 20: Interface Specifications

Interface Type	Cabled with what type of cable?	Is the cable shielded?	Maximum potential length of the cable?	Metallic (M), Coax (C), Fiber (F), or Not Applicable?
USB	Not used for radio test	<input type="checkbox"/> No	<input type="checkbox"/> Metric: 1.8m	<input checked="" type="checkbox"/> M
RJ45 (x5)	Not used for Radio test	<input checked="" type="checkbox"/> Yes	<input type="checkbox"/> Metric: 10 m	<input checked="" type="checkbox"/> M

Serial	Connected to Laptop	<input type="checkbox"/> No	<input type="checkbox"/> Metric: 3 m	<input checked="" type="checkbox"/> M
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Table 21: Supported Equipment

Equipment	Manufacturer	Model	Serial	Used for
Laptop	Toshiba	Tectra 8200	PT820U-019TU1	TX control
Note: None.				

Table 22: Description of Sample used for Testing

Device	Serial	RF Connection	CFR47 Part 15.247
Newport	70AB00010-8C75 #1	3 Antennas Chains 0, 1 & 2	TX Emission, RX Emission, AC Conducted Emission
	70AB00010-8C75 #2	Direct via SMA	RF Power Output, Out of Band Emission, Peak Power Spectral Density, Occupied Bandwidth

Table 23: Description of Test Configuration used for Radiated Measurement.



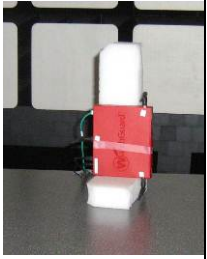
Device	Antenna	Mode	Setup Photo (X-Axis)	Setup Photo (Y-Axis)	Setup Photo (Z-Axis)
Newport	3 External	* Transmit * Receive	 Flat on table Antennas up Vertical	 EUT set on wall laying on longer side. All Antennas Horizontal	 Laying on smaller side
Note: Pre-scans were performed in 3 orthogonal axis and Y-Axis was worst case.					

Table 24: Final Test Mode for 2400 MHz to 2483.5MHz Band

Test	802.11b	802.11g	802.11n HT20	802.11n HT40
Occupied Bandwidth	2412, 2437, 2462 MHz @ 1Mbps	2412, 2437, 2462 MHz @ 6Mbps	2412, 2437, 2462 MHz @ 1 Stream – 6.5Mbps	2422, 2437, 2452 MHz @ 1 Stream – 13.5Mbps
Output Power	2412, 2437, 2462 MHz @ 1Mbps	2412, 2437, 2462 MHz @ 6Mbps	2412, 2437, 2462 MHz @ 1 Stream – 6.5Mbps 2 Streams – 13Mbps 3 Streams – 19.5Mbps	2422, 2437, 2452 MHz @ 1 Stream – 13.5Mbps 2 Streams – 27Mbps 3 Streams – 40.5Mbps
Peak Power Spectral Density	2412, 2437, 2462 MHz @ 1Mbps	2412, 2437, 2462 MHz @ 6Mbps	2412, 2437, 2462 MHz @ 1 Stream – 6.5Mbps 2 Streams – 13Mbps 3 Streams – 19.5Mbps	2422, 2437, 2452 MHz @ 1 Stream – 13.5Mbps 2 Streams – 27Mbps 3 Streams – 40.5Mbps
Out-of-Band (-20 dBr)	2412, 2437, 2462 MHz @ 11Mbps	2412, 2437, 2462 MHz @ 6Mbps	2412, 2437, 2462 MHz @ 1 Stream – 6.5Mbps	2422, 2437, 2452 MHz @ 1 Stream – 13.5Mbps
Band-Edge (Radiated)	2412, 2437, 2462 MHz @ 1Mbps	2412, 2437, 2462 MHz @ 6Mbps	2412, 2437, 2462 MHz @ 1 Stream – 58.5Mbps 2 Streams – 13Mbps 3 Streams – 39Mbps	2422, 2437, 2452 MHz @ 1 Stream – 40.5Mbps 2 Streams – 54Mbps 3 Streams – 405Mbps
Transmitted Spurious Emission	2412, 2437, 2462 MHz @ 1Mbps	2412, 2437, 2462 MHz @ 6Mbps	2412, 2437, 2462 MHz @ 1 Stream – 6.5Mbps	2422, 2437, 2452 MHz @ 1 Stream – 13.5Mbps
Received Spurious Emission	2437 MHz	2437 MHz	2437 MHz	2437 MHz
AC Conducted Emission	2437MHz @ 1Mbps			

Table 25: Final Test Mode for 5725 MHz to 5850 MHz Band

Test	802.11a	802.11n HT20	802.11n HT40
Occupied Bandwidth	5745, 5785, 5825MHz @ 6Mbps	5745, 5785, 5825MHz @ 1 Stream – 6.5Mbps	5755, 5795MHz @ 1 Stream – 13.5Mbps
Output Power	5745, 5785, 5825MHz @ 6Mbps	5745, 5785, 5825MHz @ 1 Stream – 6.5Mbps 2 Streams – 13Mbps 3 Streams – 19.5Mbps	5755, 5795MHz @ 1 Stream – 81Mbps 2 Streams – 27Mbps 3 Streams – 40.5Mbps
Peak Power Spectral Density	5745, 5785, 5825MHz @ 6Mbps	5745, 5785, 5825MHz @ 1 Stream – 6.5Mbps 2 Streams – 13Mbps 3 Streams – 19.5Mbps	5755, 5795MHz @ 1 Stream – 81Mbps 2 Streams – 27Mbps 3 Streams – 40.5Mbps
Out-of-Band (-20 dBr)	5745, 5785, 5825MHz @ 6Mbps	5745, 5785, 5825MHz @ 1 Stream – 6.5Mbps	5755, 5795MHz @ 1 Stream – 13.5Mbps
Band-Edge (Radiated)	5745, 5785, 5825MHz @ 6Mbps	5745, 5785, 5825MHz @ 1 Stream – 6.5Mbps	5755, 5795MHz @ 1 Stream – 13.5Mbps
Transmitted Spurious Emission	5745, 5785, 5825MHz @ 6Mbps	5745, 5785, 5825MHz @ 1 Stream – 6.5Mbps	5755, 5795MHz @ 3 Stream – 40.5Mbps
Received Spurious Emission		5785 MHz	5795 MHz
AC Conducted Emission		5785 MHz @ 1 Stream - 6.5Mbps	

7.4 Test Specifications

Testing requirements

Table 26: Test Specifications

Emissions and Immunity	
Standard	Requirement
CFR 47 Part 15.247: 2009	All
RSS 210 Issue 8, 2010	All

DECLARATION OF CONFORMITY

WatchGuard Technologies, Inc.
 505 Fifth Ave. S., Suite 500
 Seattle, WA 98104-3892
 USA

WatchGuard Technologies Inc. hereby declares that the product(s) listed below conform to the European Union directives and standards identified in this declaration.

Product (s):
 Internet Firewall and VPN (Encryption) Model FS1E5 & FS2E5
 Wireless Internet Firewall and VPN (Encryption) Model FS1E5W & FS2E5W


EU Directive(s):
 Low Voltage (2006/95/EC)
 Electromagnetic Compatibility (2004/108/EC)

Standard(s):

EN60950-1:2006 ed2 + A11:2009	Safety
EN55022:2006 W/A1	Class A Emissions for ITE
EN61000-3-2:2006 W/A1, A2	Harmonics
EN61000-3-3:2008	Flicker
EN55024:1998 W/A1, A2	Immunity for ITE

Wireless Standards(s):

EN 301 489-01 v1.8.1	EMC and Radio Spectrum Matters
EN 301 489-17 v2.1.1	EMC and Radio Spectrum Matters
EN 300 328 v1.7.1	Radio Spectrum Matters
EN 301 893 v1.5.1	Broadband Radio Access Networks

Signature 

Full Name: Steve Zirschky
 Position: Corporate Officer
 Date: 6 July 2011

END OF REPORT