2.4 GHz WLAN (DTS Systems)
FCC/IC Test Report

FOR:

Honeywell

Model Name: 75eL0N and 75eL00

Product Description: Dolphin 75e Handheld Computer

FCC ID: HD5-75EL0N and HD5-75EL00
IC ID: 1693B-75EL0N and 1693B-75EL00

47 CFR Part 15.247

RSS-210 Issue 8

TEST REPORT #: EMC_ HONEY_134_14001_15.247_DTS_WLAN_75E
DATE: 2014-Feb-04

FCC listed
A2LA Accredited

IC recognized #
3462B

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1 Assessment

The following device was evaluated against the applicable criteria specified in FCC rules Parts 15.247 of Title 47 of the Code of Federal Regulations and the relevant IC standard RSS-210 issue 8, Annex 8.

Company	Description	Model #
Honeywell International, Inc	Dolphin 75e Handheld Computer	75eL0N and 75eL00

Responsible for Testing Laboratory:

Date	Section	Name	Signature
2015-02-04	Compliance	Franz Engert (Test Lab Manager)	Digitally signed by Franz Engert DN: cn=Franz Engert, c=US, o=CETECOM, ou=Complience, email=franz.engert@cetecom.com Date: 2015.02.05 19:22:43 -08'00'

Responsible for the Report:

Date	Section	Name	Signature
2015-02-04	Compliance	Danh Le (EMC Engineer)	Digitally signed by Danh Le DN: cn=Danh Le, o=Cetecom, ou=Compliance, email=danh.le@cetecom.com, c=US Date: 2015.02.05 19:50:09 -08'00'

The test results of this test report relate exclusively to the test item specified in Section3.
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2 Administrative Data

2.1 Identification of the Testing Laboratory Issuing the Test Report

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Compliance Manager:	Franz Engert
Responsible Project Leader:	Danh Le

2.2 Identification of the Client

Applicant's Name:	Honeywell International Inc.
Street Address:	9680 Old Bailes Road
City/Zip Code	Fort Mill SC 29707
Country	USA
Contact Person:	Mandana Salahshour
Phone No.	(803)835-8190; (803)835-8097
Fax:	----------
e-mail:	mandana.salahshour@honeywell.com

2.3 Identification of the Manufacturer

Manufacturer's Name:	Same as Applicant
Manufacturers Address:	---
City/Zip Code	---
Country	---

3 Equipment under Test (EUT)

3.1 Specification of the Equipment under Test

Marketing Name / Model No:	75eL0N and 75eL00
HW Version:	2.0
FCC-ID:	HD5-75EL0N/ HD5-75EL00
IC-ID:	1693B-75EL0N and 1693B-75EL00
Product Description:	Dolphin 75e Handheld Computer
Technology/ Type(s) of Modulation:	802.11b/g/n with CCK, DQPSK, DBPSK + DSSS QBSK, BPSK, 16 QAM, 64 QAM + OFDM
Modes of Operation	client, active scan, P2P
Channel Bandwidths	up to 20 MHz
Operating Frequency Ranges (MHz)/ Channels:	Nominal band: 2400 – 2483.5 MHz; Center to center with HT20: 2412(ch 1) – 2462(ch 11), 11 channels
Antenna info:	one internal PIFA antenna, (no MIMO) 2.4 GHz: 2.5 dBi
Maximum Output Powers:	Conducted: 16.81 dBm (47.97 mW) for 802.11b Conducted: 13.39 dBm (21.83 mW) for 802.11g Conducted: 13.64 dBm (23.12 mW) for 802.11n
Rated Operating Voltage / Power Supply:	Li-ion Battery Vmin: 3.3V dc/ Vnom: 3.7V dc / Vmax: 4.2V dc
Operating temperature range:	-20°C – 50°C
Test Sample:	Prototype
Other Radios included in the device:	1. BT Basic/EDR, BT LE (2.4 GHz band of operation) 2. Wi-Fi 802.11a/ac/n (Band of operation: 5.0 GHz) 3. NFC, @ 13.56 MHz, (model 75eL0N only)

Note: For details of model variants, see testing notes in section 3.6

3.2 Identification of the Equipment under Test (EUT)

EUT #	Serial Number	HW Version	SW Version	Notes/Comments
1	14270J002C	2.0	54.0	Radiated RF Sample / model 75eL0N
2	14268J0078	2.0	54.0	Conducted RF Sample / model 75eL0N

3.3 Identification of Accessory equipment

STE #	Type	Manufacturer	Model	Serial Number
1	AC/DC Adapter	PhiHong	PSA105R-050Q	P142302633A1
2	Li-ion Battery	BTEC	70e-BTEC	TGMX142071852

3.4 Environmental conditions during Test:

The following environmental conditions were maintained during the course of testing:
Ambient Temperature: 20-25^{o}C
Relative humidity: 40-60%

3.5 Dates of Testing:

10/28/2014 – 12/30/2014

3.6 Testing Notes:

Two model variants are covered from this test report, models 75eL0N and 75eL00. Radiated testing was performed on model 75eL0N only, based on the manufacturer's declaration that the 75eL00 has identical hardware, software and maximum output power tune up limits and only differ in the addition of the NFC hardware in model 75eL0N.

3.7 Test modes of operation:

The table below contains modes of operation, modulations, data rates which are supported by the equipment, associates with all the listed test cases:

Test Cases	Output Power	PSD	OBW	Band Edge/ Restricted Bands	Radiated Spurious EMI
Mode	802.11b 802.11g 802.11n(HT20)	802.11b 802.11g 802.11n(HT20)	802.11b 802.11g 802.11n(HT20)	802.11b 802.11g 802.11n(HT20)	802.11b
Modulation	CCK BPSK BPSK	CCK BPSK BPSK	CCK BPSK BPSK	CCK BPSK BPSK	CCK
Data Rate (Mbps)	1 11 7.2	1 11 7.2	1 11 7.2	1 11 7.2	1

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

The Device was set to continuous framed Tx (burst) mode per test SW and could thus be operated with > 98% duty cycle during testing. When 98% duty cycle cannot be achieved, duty cycle correction factor shall be added to the measurement results.

For radiated spurious emissions, the EUT was tested on low, mid and high channels (2.4GHz) in 802.11b, mode only which represents the worst case mode taken from the output data table.

4 Subject Of Investigation

The objective of the evaluation documented in this report was to assess if the performance of the EUT meets the relevant requirements specified in FCC rules Part 15.247 of Title 47 of the Code of Federal Regulations and Radio Standard Specification RSS-210 Issue 8, Annex 8 of Industry Canada.

This test report is to support a request for new equipment authorization under the FCC ID **HD5-75EL0N and HD5-75EL00.**

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

5 Summary of Measurement Results

Test Specification	Test Case	Temperature and Voltage Conditions	Mode	Pass	Fail	NA	NP	Result
§15.247(e) RSS210 A8.2(b)	Power Spectral Density	Nominal	802.11b 802.11g 802.11n	■	☐	☐	☐	Complies
§15.247(a)(1) RSS210 A8.2(a)	Emission Bandwidth	Nominal	802.11b 802.11n	■	☐	☐	☐	Complies
§15.247(b)(3) RSS210 A8.4(4)	Maximum Peak Conducted Output Power	Nominal	802.11b 802.11g 802.11n	■	☐	☐	☐	Complies
§15.247(d) RSS210 A8.5	Band Edge & Restricted Band Edge compliance	Nominal	802.11b 802.11g 802.11n	■	☐	☐	☐	Complies
§15.247(d) §15.209(a) RSS210 A8.5 RSS Gen 6.13	TX Spurious emissions-Radiated	Nominal	802.11b	■	☐	☐	☐	Complies
§15.207(a) RSS Gen 8.8	AC Conducted Emissions	Nominal	802.11b	■	☐	☐	☐	Complies
§15.207(a) RSS Gen 8.10	Restricted Bands	Nominal	802.11b	■	☐	☐	☐	Complies

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

6 Measurements

6.1 Radiated Measurement Procedure

Ref: ANSI C63.10 (2013)

Section 5.4: Measurements around the EUT

Measurements shall be made at a test site that incorporates a turntable allowing EUT rotation of 0° through 360°, except where the EUT is so large that a suitable turntable is not readily available. A remotely controlled turntable shall be installed at the test site to support the EUT and facilitate determination of the direction of maximum radiation for each EUT emission frequency. Continuous azimuth searches shall be made. The maximum field strength at the frequency being measured shall be reported in the test report.32 See ANSI C63.4 for details of the test site, turntable, and antenna positioner. Where a continuous azimuth search cannot be made, as is the case for example where the EUT is so large that a suitable turntable is not readily available, frequency scans of the EUT field strength with both polarizations of the measuring antenna shall be made, starting with a minimum of 16 azimuth angles around the EUT, nominally spaced by 22.5°, in characterizing the EUT radio-noise profile. If directional EUT radiation patterns are suspected, especially above 1 GHz then additional and smaller azimuth angles shall be examined.

Section 5.3.2: Test distance for frequencies below 30 MHz

Radiated emissions limits are usually defined at a specific distance from the EUT. Where possible, measurements shall be made at the distance specified in the limits. This might not be possible in all cases, however, due to the physical limitations of the test facility, physical access problems at the required distance (especially for measurements that must be made in situ or on-site), or levels of ambient noise or other radiated signals present at the time and location where measurements are made. See 6.4.3 for more information about antenna selection, location, and test distance. If measurements cannot practically be made at the EUT limit distance, then they may be made at a different distance (usually closer) and extrapolated to the limit distance using one of the procedures described in 6.4.4, 6.4.5, or 7.7, depending on the EUT source and size.31 The test report shall specify the extrapolation method used to determine compliance of the EUT.

Section 5.3.3: Test distance for frequencies at or above 30 MHz

Measurements may be performed at a distance other than the limit distance provided they are not performed in the near field and the emissions to be measured can be detected by the measurement equipment (see 4.3.4). Measurements shall not be performed at a distance greater than 30 m for frequencies above 30 MHz, unless it can be further demonstrated that measurements at a distance of 30 m or less are impractical. Measurements from 18 GHz to 40 GHz are typically made at distances significantly less than 3 m from the EUT. When performing measurements at a distance other than that specified, the results shall be extrapolated to the specified distance using an extrapolation factor of 20 dB/decade of distance (inverse of linear distance for field-strength measurements or inverse of linear distance-squared for power-density measurements).

ANSI C63.10 (2013)

Section 6.6.4.2: Exploratory radiated emissions measurements

Exploratory radiated measurements shall be performed at the measurement distance or at a closer distance than that specified for compliance to determine the emission characteristics of the EUT and, if applicable, the EUT configuration that produces the maximum level of emissions. The frequencies of maximum emission may be determined by manually positioning the antenna close to the EUT, and then moving the antenna over all sides of the EUT while observing a spectral display. It is advantageous to have prior knowledge of the frequencies of emissions, although this may be determined from such a near-field scan. The near-field scan shall only be used to determine the frequency but not the amplitude of the emissions. Where exploratory measurements are not adequate to determine the worst-case operating modes and are used only to identify the frequencies of the highest emissions, additional preliminary tests can be required.

Preliminary tests shall be performed following the procedures in 6.3 on a site meeting the requirements of 5.2. For emissions from the EUT, the maximum level shall be determined by rotating the EUT and its antenna through 0° to 360°. For each mode of operation required to be tested, the frequency spectrum (based on findings from exploratory measurements) shall be monitored.

Section 6.6.4.3: Final radiated emissions measurements

The final measurements are performed on a site meeting the requirements of 5.2. Using the orientation and equipment arrangement of the EUT based on the measurement results found during the preliminary (exploratory) measurements per 6.6.4.2, the EUT arrangement, appropriate modulation, and modes of operation that produce the emissions that have the highest amplitude relative to the limit shall be selected for the final measurement. The final measurement shall follow all the procedures in 6.3 with the EUT operating on frequencies per 5.6. For each mode selected, record the frequency and amplitude of the highest fundamental emission (if applicable), as well as the frequency and amplitude of the six highest spurious emissions relative to the limit. Emissions more than 20 dB below the limit do not need to be reported.

Measurements are performed with the EUT rotated from 0° to 360°; the antenna height scanned in accordance with 6.6.3.1, 6.6.3.2, or 6.6.3.3, as appropriate; and the antenna rotated to repeat the measurements for both the horizontal and vertical antenna polarizations. Variations in cable or wire placement shall be explored to maximize the measured emissions.

NOTES

1— Where limits are specified by agencies for both average and peak (or quasi-peak) detection, if the peak (or quasi-peak) measured value complies with the average limit, it is unnecessary to perform an average measurement.

2—Use of waveguide and flexible waveguide may be necessary at frequencies above 10 GHz to achieve usable signal-to noise ratios at required measurement distances. If so, it may be necessary to restrict the height search of the antenna, and special care should be taken to ensure that maximum emissions are correctly measured.

3—All presently known devices causing emissions above 10 GHz are physically small compared with the beam-widths of typical horn antennas used for EMC measurements. For such EUTs and frequencies, it may be preferable to vary the height and polarization of the EUT instead of the receiving antenna to maximize the measured emissions.

6.2 Sample Calculations for Radiated Measurements

Measurements from the Spectrum Analyzer/ Receiver are used to calculate the Field Strength, taking into account the following parameters:

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

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

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

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

Radiated Measurement Uncertainty: ±3dB

6.3 Conducted Emissions Procedure

Ref: ANSI C63.10 (2013)

Section 6.2: Standard test method for ac power-line conducted emissions from unlicensed wireless devices

Section 6.2.1: General considerations

AC power-line conducted emission measurements shall be made, unless otherwise specified, over the frequency range from 150 kHz to 30 MHz, to determine the line-to-ground radio-noise voltage that is conducted from all of the EUT current-carrying power input terminals that are directly (or indirectly via separate transformers or power supplies) connected to a public power network. These measurements may also be required between 9 kHz and 150 kHz.

If the EUT normally receives power from another device that in turn connects to the public utility ac power lines, measurements shall be made on that device with the EUT in operation to demonstrate that the device continues to comply with the appropriate limits while providing the EUT with power. If the EUT is operated only from internal or dedicated batteries, with no provisions for connection to the public utility ac power lines (600 VAC or less) to operate the EUT (such as an adapter), then ac power-line conducted measurements are not required.

For direct current (dc) powered devices where the ac power adapter is not supplied with the device, an "off-the-shelf" unmodified ac power adapter shall be used. If the device is supposed to be installed in a host (e.g., the device is a module or PC card), then it is tested in a typical compliant host (see also 5.10.3).

Section 6.2.2: Measurement requirements

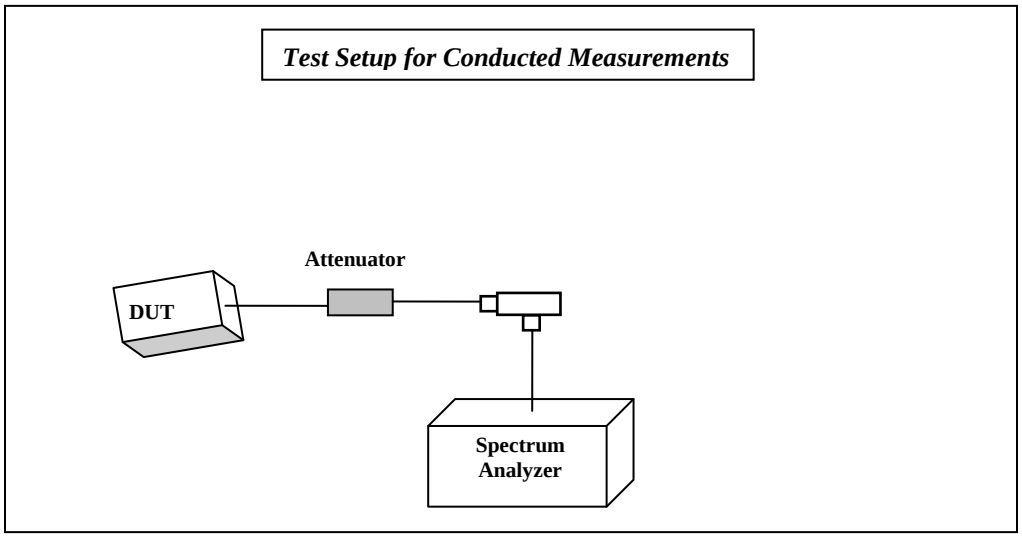
The LISN housing, measuring instrument case, reference ground plane, vertical conducting plane, if used, shall be bonded together.

Measured levels of ac power-line conducted emission shall be the emission voltages from the voltage probe, where permitted, or across the 50 Ω LISN port (to which the EUT is connected), where permitted, terminated into a 50 Ω measuring instrument. All emission voltage and current measurements shall be made on each current-carrying conductor at the plug end of the EUT power cord by the use of mating plugs and receptacles on the LISN, if used. Equipment shall be tested with power cords that are normally supplied or recommended by the manufacturer and that have electrical and shielding characteristics that are the same as those cords normally supplied or recommended by the manufacturer. For those measurements using a LISN, the 50 Ω measuring port is terminated by a measuring instrument having 50 Ω input impedance. All other ports are terminated in 50 Ω loads.

Measurement Uncertainty: ±3.0dB

6.4 RF Conducted Measurement Procedure

Measurement according to FCC KDB 558074 D01 DTS Meas Guidance v03r02:2014
(Guidance for Performing Compliance Measurements on Digital Transmission System (DTS) Operating Under §15.247)



1. Connect the equipment as shown in the above diagram.
2. Adjust the settings by entering test commands for TX/RX mode on/off, changing channels, modulations and data rates.
3. Measurements are to be performed with the EUT set to the low, middle and high channels.

Measurement Uncertainty: ±0.5dB

6.5 Maximum Conducted Output Power and EIRP

6.5.1 Limits:

Maximum Conducted Output Power:
FCC §15.247 (b)(3): 1W
IC RSS-210 Issue 8, annex 8.4(2): 1W

EIRP:
IC RSS-210 Issue 8, annex 8.4(2): 4W

6.5.2 Test Conditions:
Tnom: 21°C; Vnom: 3.7V

6.5.3 Test Procedure
Measurement according to FCC KDB 558074 D01 DTS Meas Guidance v03r02 section 9.2.2.4

Maximum conducted (average) output power
Method AVGSA-2 (trace averaging across on and off times of the EUT transmissions, followed by duty cycle correction)

Span ≥ 1.5 times the OBW.
RBW = 1-5% of the OBW, not to exceed 1 MHz.
VBW ≥ 3 x RBW
Sweep points ≥ 2 × span / RBW. (This gives bin-to-bin spacing ≤ RBW/2, so that narrowband signals are not lost between frequency bins.)
Sweep time = auto.
Detector = RMS (*i.e.*, power averaging), if available. Otherwise, use sample detector mode.
Trace = average at least 100 traces in power averaging (*i.e.*, RMS) mode; however, the number of traces to be averaged shall be increased above 100 as needed such that the average accurately represents the true average over the on and off periods of the transmitter.
- Do not use sweep triggering. Allow the sweep to "free run".
- Compute power by integrating the spectrum across the OBW of the signal using the instrument's band power measurement function with band limits set equal to the OBW band edges..
- Add 10 log (1/x), where x is the duty cycle, to the measured power in order to compute the average power during the actual transmission times (because the measurement represents an average over both the on and off times of the transmission). For example, add 10 log (1/0.62) = 2 dB if the dc is 62 %.

6.5.4 Test Result: 2.4 GHz Band

Maximum Conducted Output Power (dBm)							
FCC Limit = 30 dBm RSS Limit = 30 dBm		Frequency (MHz)					
		2412 Channel 1		2437 Channel 6		2462 Channel 11	
Mode	Duty Cycle CF (dB)	Measured	Corrected	Measured	Corrected	Measured	Corrected
802.11b	0	16.81	16.81	16.29	16.29	16.05	16.05
802.11g	0.22	13.17	13.39	12.90	13.12	12.94	13.16
802.11n20	0.22	13.42	13.64	12.59	12.81	12.96	12.18

Calculated Radiated Output Power EIRP (dBm)				
FCC Limit = 36 dBm RSS Limit = 36 dBm		Frequency (MHz)		
Mode	Antenna G (dBi)	2412 Channel 1	2437 Channel 6	2462 Channel 11
802.11b	2.5	19.31	18.79	18.55
802.11g		15.89	15.62	15.66
802.11n20		16.14	15.30	14.68

Note: EIRP is calculated as
Conducted Measurement + Antenna Gain
Declared Antenna Gain in the 2.4GHz band: 2.5 dBi

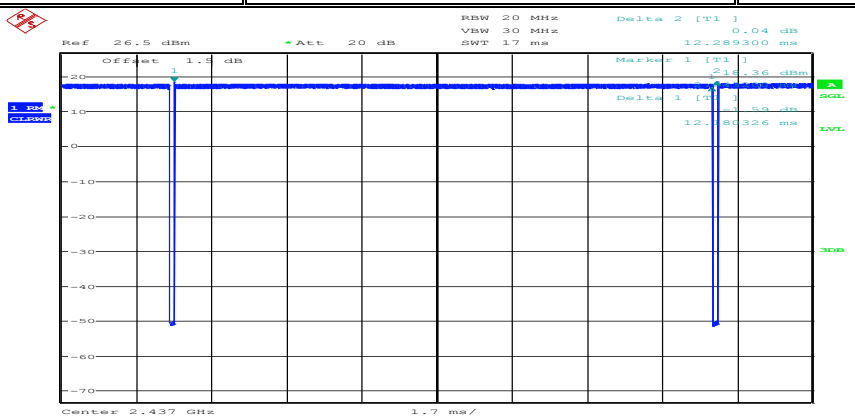
6.5.4.1 Measurement Result

Pass.

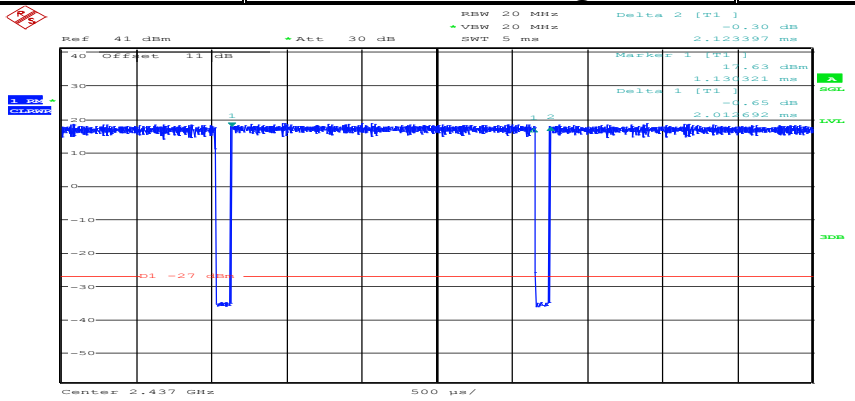
6.5.5 Measurement Plots:

Duty Cycle

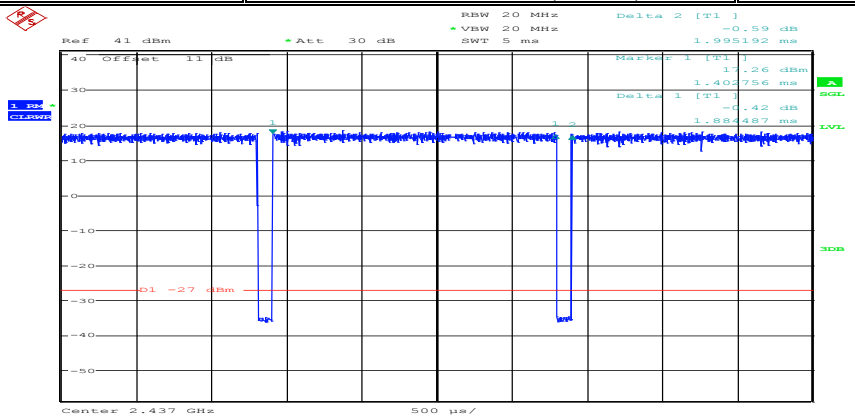
Ch.6 / 2437 MHz	Mode: 802.11b	Data Rate: 1 Mbps



Ch.6 / 2437 MHz	Mode: 802.11g	Data Rate: 6 Mbps

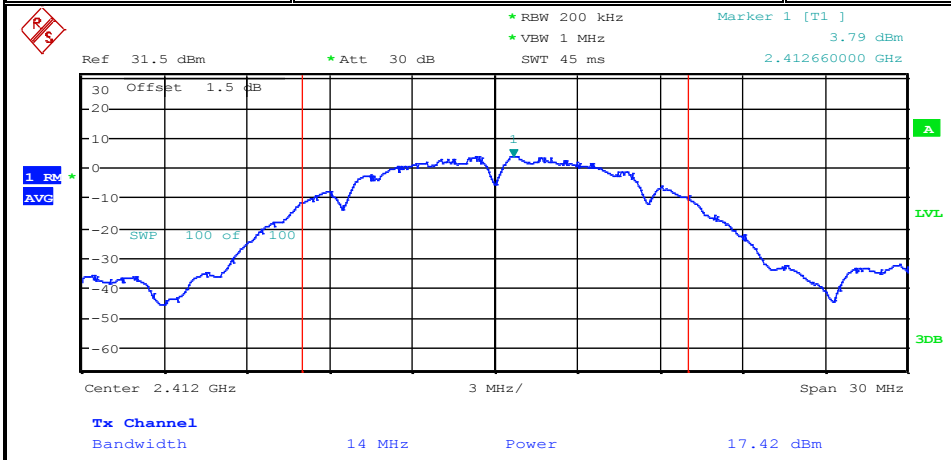


Ch.6 / 2437 MHz	Mode: 802.11n (HT20)	Data Rate: 7.2 Mbps

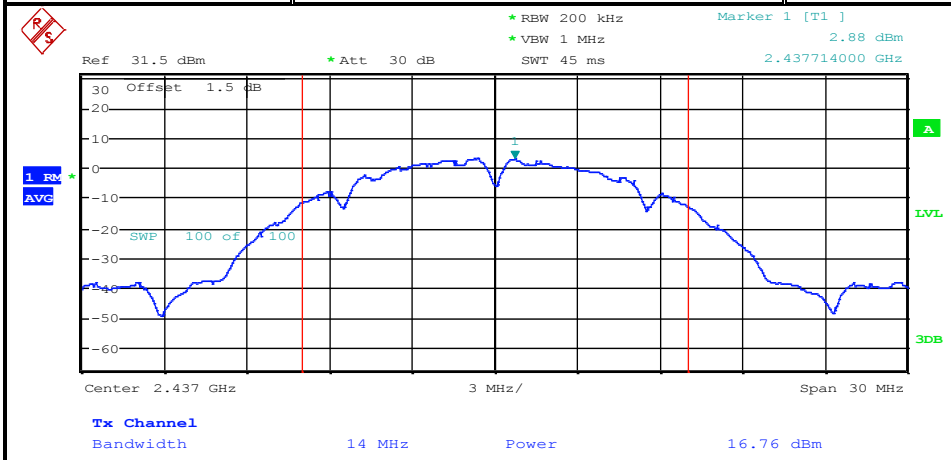


Maximum Conducted Output Power

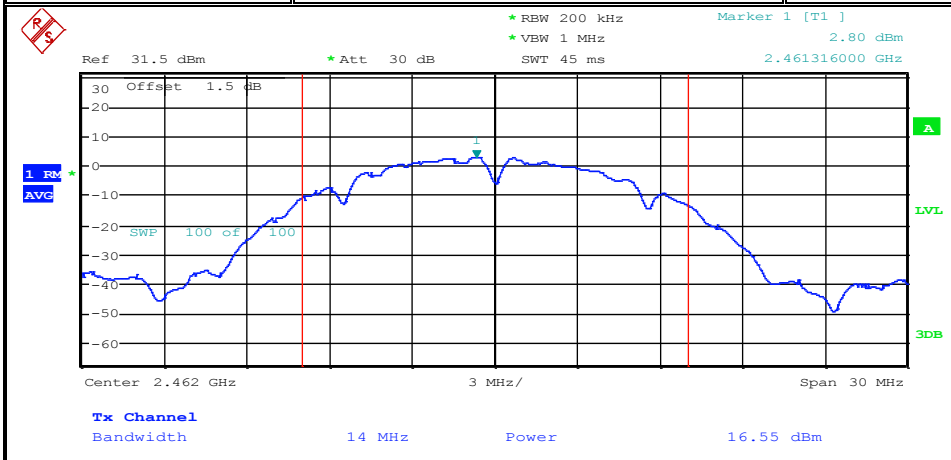
Ch.1 / 2412 MHz	Mode: 802.11b	Data Rate: 1 Mbps



Ch.6 / 2437 MHz	Mode: 802.11b	Data Rate: 1 Mbps

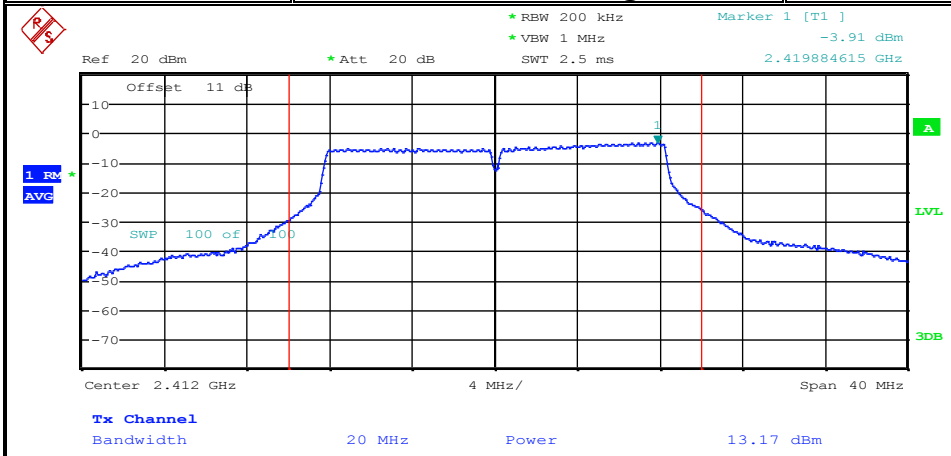


Ch.11 / 2462 MHz	Mode: 802.11b	Data Rate: 1 Mbps

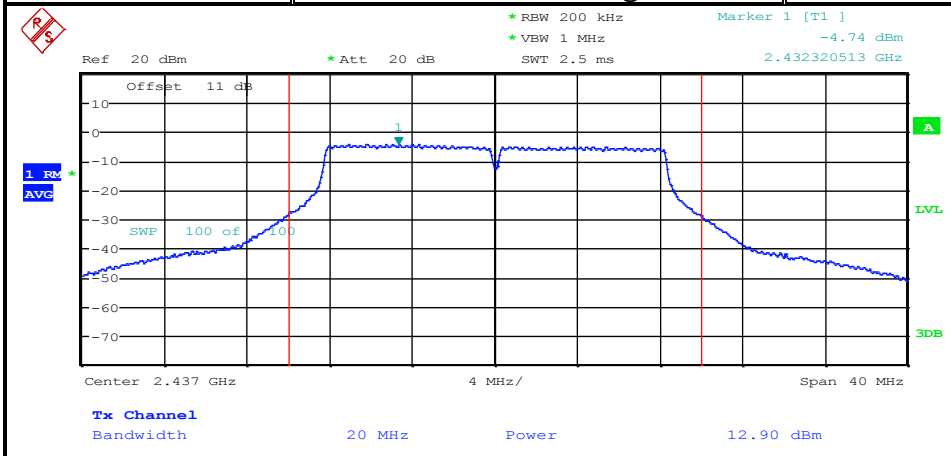


Maximum Conducted Output Power

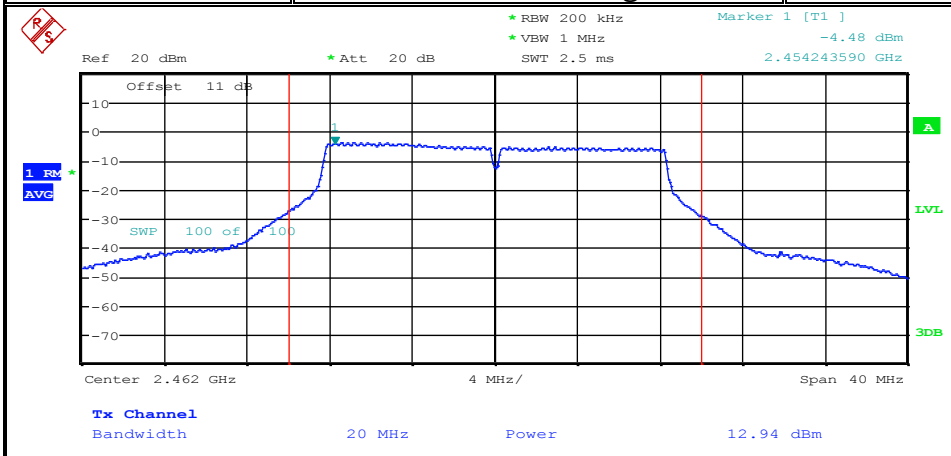
Ch.1 / 2412 MHz	Mode: 802.11g	Data Rate: 11 Mbps



Ch.6 / 2437 MHz	Mode: 802.11g	Data Rate: 11 Mbps

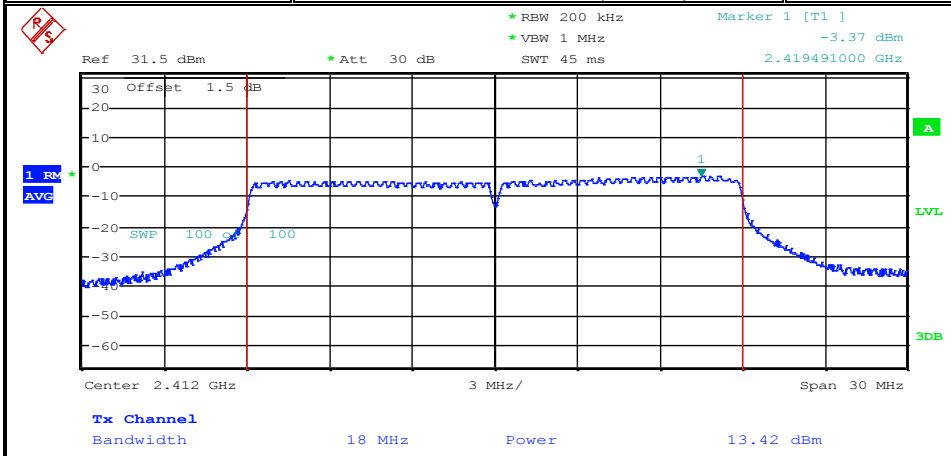


Ch.11 / 2462 MHz	Mode: 802.11g	Data Rate: 11 Mbps

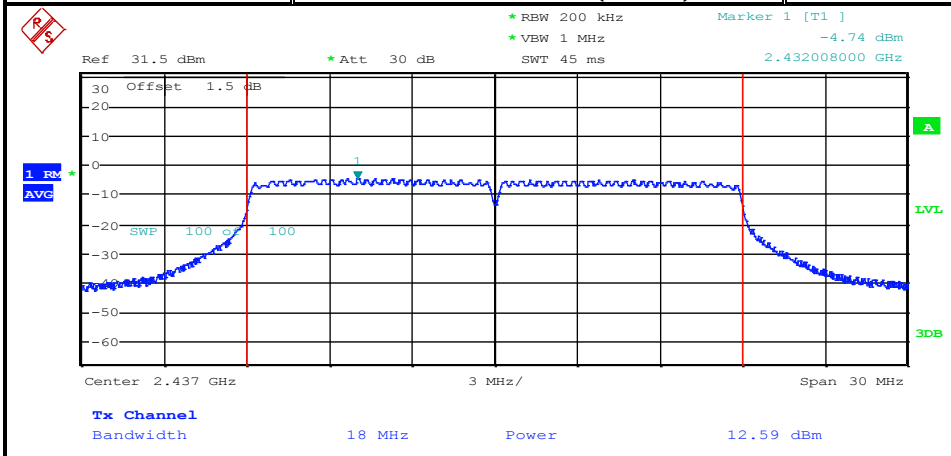


Maximum Conducted Output Power

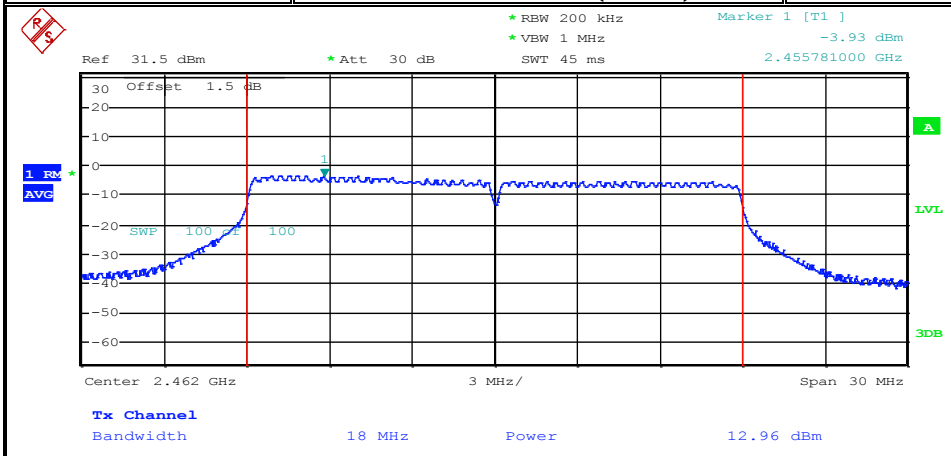
Ch.1 / 2412 MHz	Mode: 802.11n (HT20)	Data Rate: 7.2 Mbps



Ch.6 / 2437 MHz	Mode: 802.11n (HT20)	Data Rate: 7.2 Mbps



Ch.11 / 2462 MHz	Mode: 802.11n (HT20)	Data Rate: 7.2 Mbps



6.6 Power Spectral Density

6.6.1 Limits:

§ 15.247 (e) & RSS-210 A8.2 (b)

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

6.6.2 Test Conditions:

Tnom: 20 °C; Vnom: 3.7V

6.6.3 Measurement procedure:

Measurement according to FCC KDB 558074 D01 DTS v03r02 section 10.5

The PSD results are taken from the output power measurement for which the same principle test method was applied.

Since a RBW of 200kHz has been used the below PSD result table lists the original readings from the power measurement plots in section 6.5.5 as well as its corrected value, adjusted to the reference RBW of 3kHz per the Correction Factor of 10 log (3 KHz / 200 KHz) = -18.24 dB.

Due to the high margins the duty cycle correction factor of less than 0.5dB determined in section 6.5 is not taken into account.

6.6.4 Test Data:

PSD readings taken from output power measurment plots in section 6.5.5

Power Spectral Density (dBm)							
Limit = 8 dBm/3kHz		Frequency (MHz)					
		2412 Channel 1		2437 Channel 6		2462 Channel 11	
Mode	CF (dB)	Measured	Corrected @3KHz BW	Measured	Corrected @3KHz BW	Measured	Corrected @3KHz BW
802.11b	-18.24	2.53	-15.71	2.25	-15.99	2.0	-16.24
802.11g	-18.24	-3.91	-22.15	-4.74	-22.98	-4.48	-22.72
802.11n20	-18.24	-3.37	-21.61	-4.74	-22.98	-3.93	-22.17

6.6.4.1 Measurement Result

Pass.

6.7 Compliance at Restricted and Non-Restricted Bandedges

6.7.1 Limits:

§15.209/15.205 & RSS-Gen 8.9/ 8.10

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

MHz	MHz	MHz	GHz
0.090 - 0.110	16.42 - 16.423	399.9 - 410	4.5 - 5.15
[1]0.495 - 0.505	16.69475 - 16.69525	608 - 614	5.35 - 5.46
2.1735 - 2.1905	16.80425 - 16.80475	960 - 1240	7.25 - 7.75
4.125 - 4.128	25.5 - 25.67	1300 - 1427	8.025 - 8.5
4.17725 - 4.17775	37.5 - 38.25	1435 - 1626.5	9.0 - 9.2
4.20725 - 4.20775	73 - 74.6	1645.5 - 1646.5	9.3 - 9.5
6.215 - 6.218	74.8 - 75.2	1660 - 1710	10.6 - 12.7
6.26775 - 6.26825	108 - 121.94	1718.8 - 1722.2	13.25 - 13.4
6.31175 - 6.31225	123 - 138	2200 - 2300	14.47 - 14.5
8.291 - 8.294	149.9 - 150.05	2310 - 2390	15.35 - 16.2
8.362 - 8.366	156.52475 - 156.52525	2483.5 - 2500	17.7 - 21.4
8.37625 - 8.38675	156.7 - 156.9	2690 - 2900	22.01 - 23.12
8.41425 - 8.41475	162.0125 - 167.17	3260 - 3267	23.6 - 24.0
12.29 - 12.293	167.72 - 173.2	3332 - 3339	31.2 - 31.8
12.51975 - 12.52025	240 - 285	3345.8 - 3358	36.43 - 36.5
12.57675 - 12.57725	322 - 335.4	3600 - 4400	([2])
13.36 - 13.41			

(b) Except as provided in paragraphs (d) and (e) of this section, the field strength of emissions appearing within these frequency bands shall not exceed the limits shown in § 15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in § 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in § 15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in § 15.35 apply to these measurements.

FCC15.247 (d)

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

RSS-210 A8.5

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the

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

6.7.2 Measurement Procedure:

Measurement according to FCC KDB 558074 D01 v03r02
section 11.1 b.), c.) has been applied for non-restricted band edge testing;
for the conducted restricted band edge measurements sections 12.2.2 a.), b.), 12.2.4 (for peak) and 12.2.5.2 (for average);

6.7.2.1 Measurement Result

Pass.

6.7.3 Test Data:

Since restricted band edge tests have been performed by the conducted method the readings shown in the plots are adjusted by the duty cycle correction factor (average readings only) and the declared antenna gain for the comparison with the dBm value of the restricted band limits for 3m distance (peak = 74dBµV/m relates to -21.2 dBm; average = 54dBµV/m raltes to -41.2 dBm), as shown below.

802.11b

Mode: 802.11b		Modulation: CCK		Data Rate: 1 Mbps		Test Channel: 1	
Lower Restricted Band / Frequency Range: 2310 MHz – 2390 MHz							
Measured Frequency (MHz)	**Emission level Peak/Average (dBm)**	**Cable Loss/ ext. attenuator (dB)**	**Duty Cycle C F (dB)**	**Antenna Gain (dBi)**	**Calculated Emission Level (dBm)**	**Limit Peak/Average (dBm)**	**Margin**
2389.8	-44.05 Pk	Compensated in offset function	n.a.	2.5	-41.55	-21.2	-20.35
2390.0	-57.17 Av	Compensated in offset function	0	2.5	-54.67	-41.2	-13.47
Upper Restricted Band / Frequency Range: 2483.5 MHz – 2500 MHz							
Mode: 802.11b		**Modulation: CCK**		**Data Rate: 1 Mbps**		**Test Channel: 11**	
2483.6	-36.09 Pk	Compensated in offset function	n.a.	2.5	-33.59	-21.2	-12.39
2486.0	-61.79 Av	Compensated in offset function	0	2.5	-59.29	-41.2	-18.09

802.11g

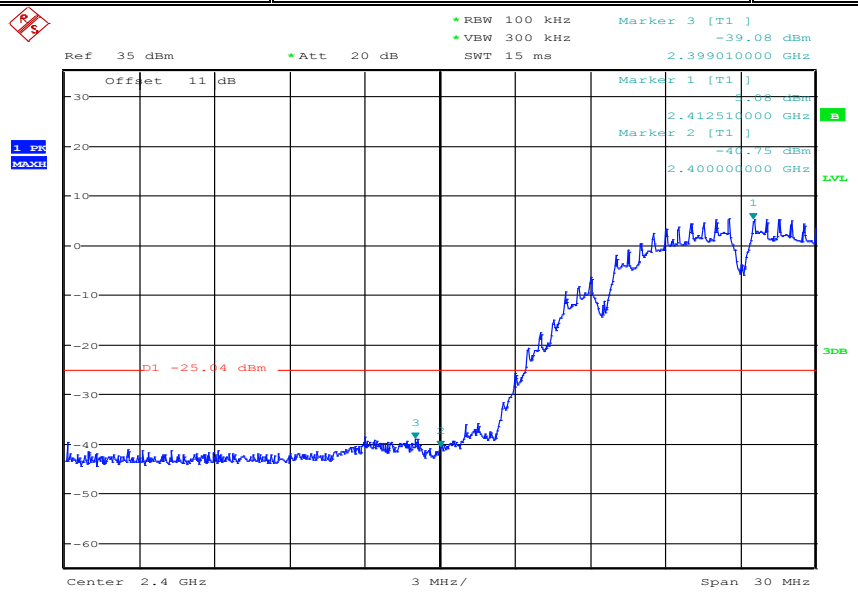
Mode: 802.11g		Modulation: BPSK		Data Rate: 6 Mbps		Test Channel: 1	
Lower Restricted Band / Frequency Range: 2310 MHz – 2390 MHz							
Measured Frequency (MHz)	**Emission Lvl Peak/Average (dBm)**	**Cable Loss/ ext. attenuator (dB)**	**Duty Cycle C F (dB)**	**Antenna Gain (dBi)**	**Calculated Emission Level (dBm)**	**Limit Peak/Average (dBm)**	**Margin (dB)**
2390.0	-28.07 Pk	Compensated in offset function	n.a.	2.5	-25.57	-21.2	-4.37
2390.0	-49.69 Av	Compensated in offset function	0.22	2.5	-46.97	-41.2	-5.77
Upper Restricted Band / Frequency Range: 2483.5 MHz – 2500 MHz							
Mode: 802.11g		**Modulation: BPSK**		**Data Rate: 6 Mbps**		**Test Channel: 11**	
2483.5	-31.07 Pk	Compensated in offset function	n.a.	2.5	-28.57	-21.2	-7.37
2483.5	-48.14 Av	Compensated in offset function	0.22	2.5	-45.42	-41.2	-4.22

802.11n (HT20)

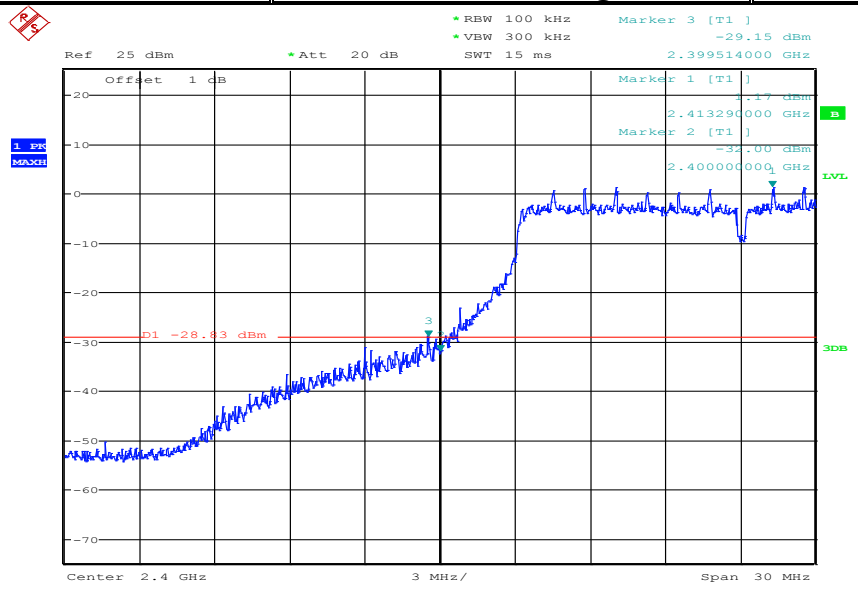
Mode: 802.11n (HT20)		Modulation: BPSK		Data Rate: 7.2 Mbps		Test Channel: 1	
Lower Restricted Band / Frequency Range: 2310 MHz – 2390 MHz							
Measured Frequency (MHz)	**Emission Lvl Peak/Average (dBm)**	**Cable Loss/ ext. attenuator (dB)**	**Duty Cycle C F (dB)**	**Antenna Gain (dBi)**	**Calculated Emission Level (dBm)**	**Limit Peak/Average (dBm)**	**Margin (dB)**
2390.0	-27.48 Pk	Compensated in offset function	n.a.	2.5	-24.98	-21.2	-3.78
2390.0	-46.06 Av	Compensated in offset function	0.22	2.5	-43.34	-41.2	-2.14
Upper Restricted Band / Frequency Range: 2483.5 MHz – 2500 MHz							
Mode: 802.11n (HT20)		**Modulation: BPSK**		**Data Rate: 7.2 Mbps**		**Test Channel: 11**	
2483.7	-24.82 Pk	Compensated in offset function	n.a.	2.5	-22.32	-21.2	-1.12
2483.5	-46.34 Av	Compensated in offset function	0.22	2.5	-43.62	-41.2	-2.42

6.7.4 Band Edge Measurement Plots:

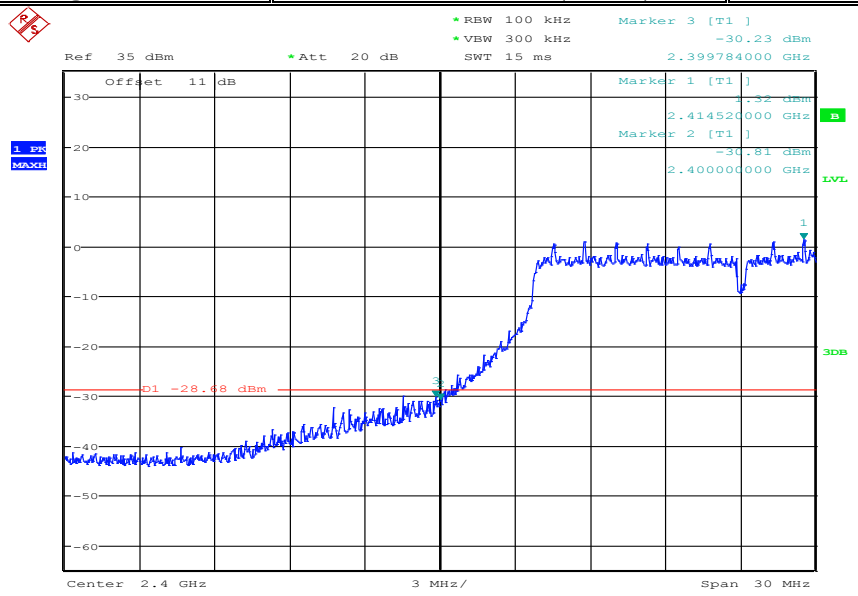
lower, non-restricted band edge (2.4GHz)		
Ch. High / 2412 MHz	**Mode: 802.11b**	**Data rate: 1 Mbps**



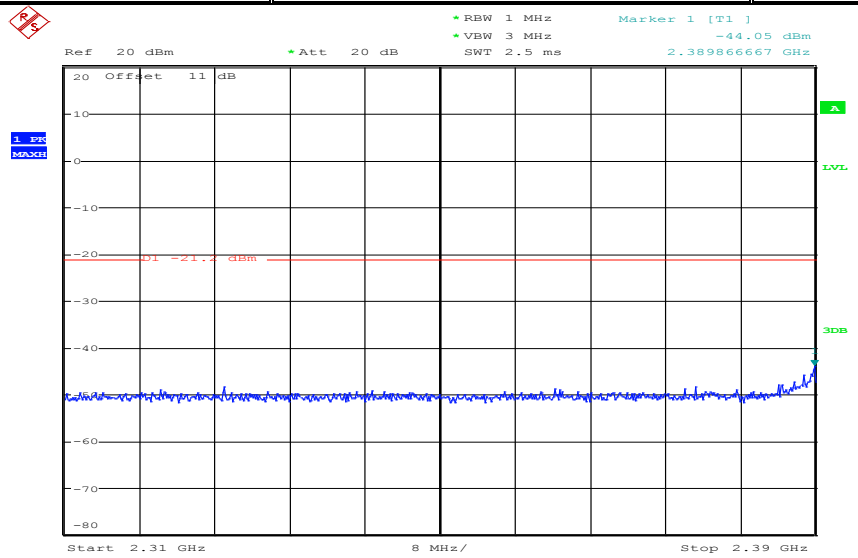
lower, non-restricted band edge (2.4GHz)		
Ch. Low / 2412 MHz	**Mode: 802.11g**	**Data rate: 6 Mbps**



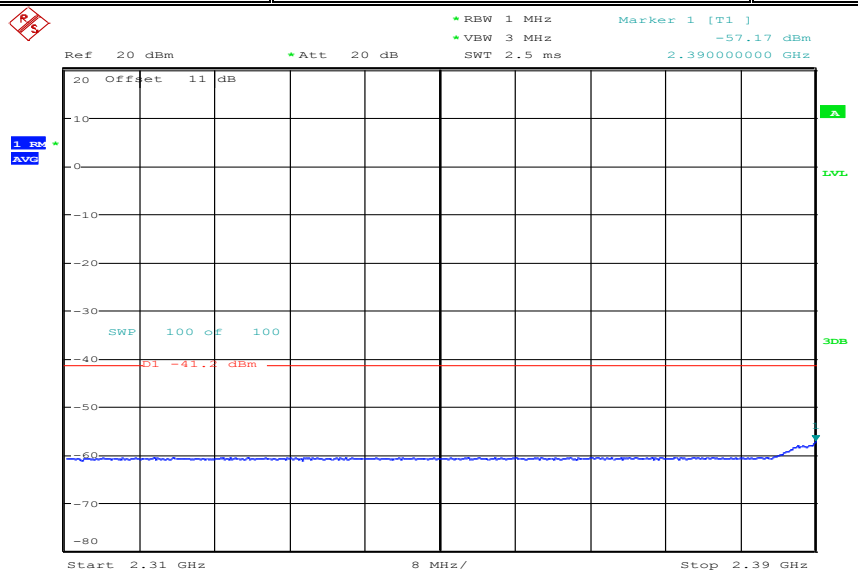
lower, non-restricted band edge (2.4GHz)		
Ch. High / 2462 MHz	**Mode: 802.11n (HT20)**	**Data rate: 7.2 Mbps**



lower, restricted band edge (2310 MHz – 2390 MHz) - peak		
Ch. Low / 2412 MHz	**Mode: 802.11b**	**Data rate: 1 Mbps**

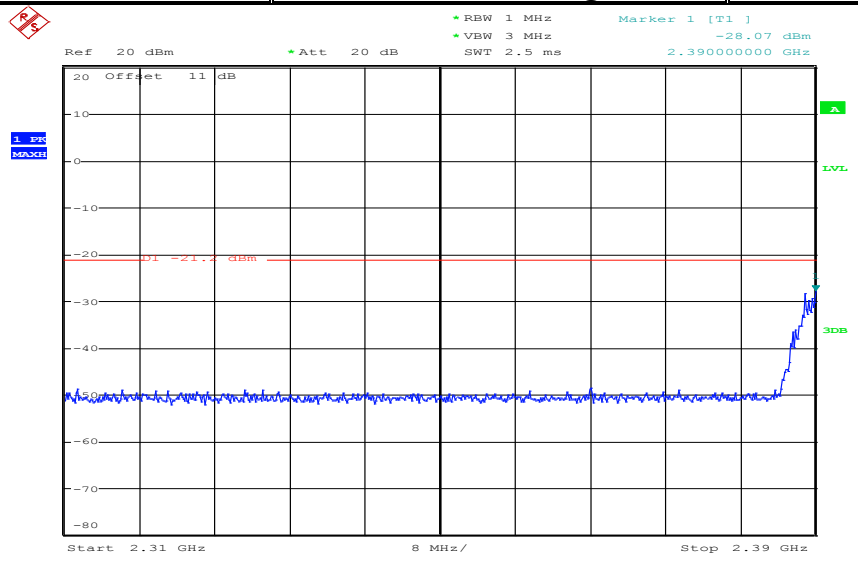


lower, restricted band edge (2310 MHz – 2390 MHz) - average		
Ch. Low / 2412 MHz	**Mode: 802.11b**	**Data rate: 1 Mbps**



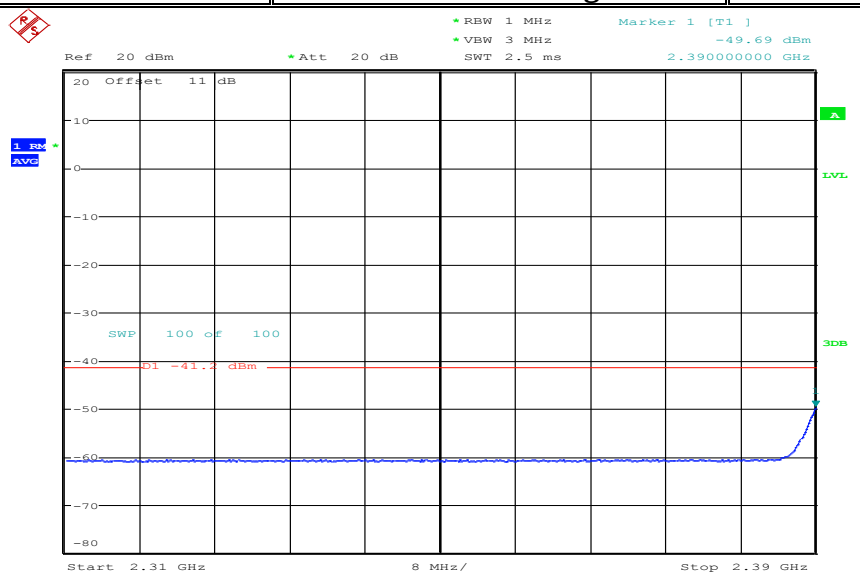
Date: 23.DEC.2014 17:45:49

lower, restricted band edge (2310 MHz – 2390 MHz) - peak		
Ch. Low / 2412 MHz	**Mode: 802.11g**	**Data rate: 6 Mbps**



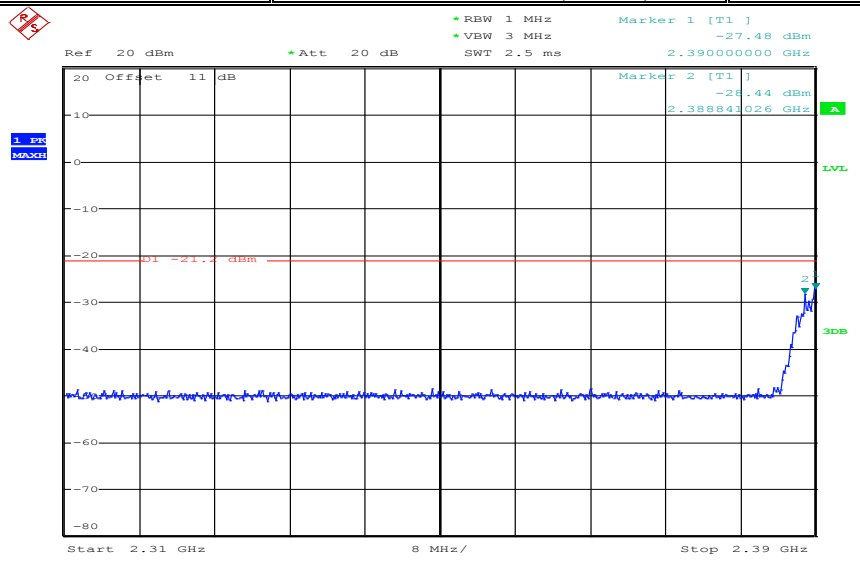
Date: 23.DEC.2014 17:51:19

lower, restricted band edge (2310 MHz – 2390 MHz) - average		
Ch. Low / 2412 MHz	**Mode: 802.11g**	**Data rate: 6 Mbps**



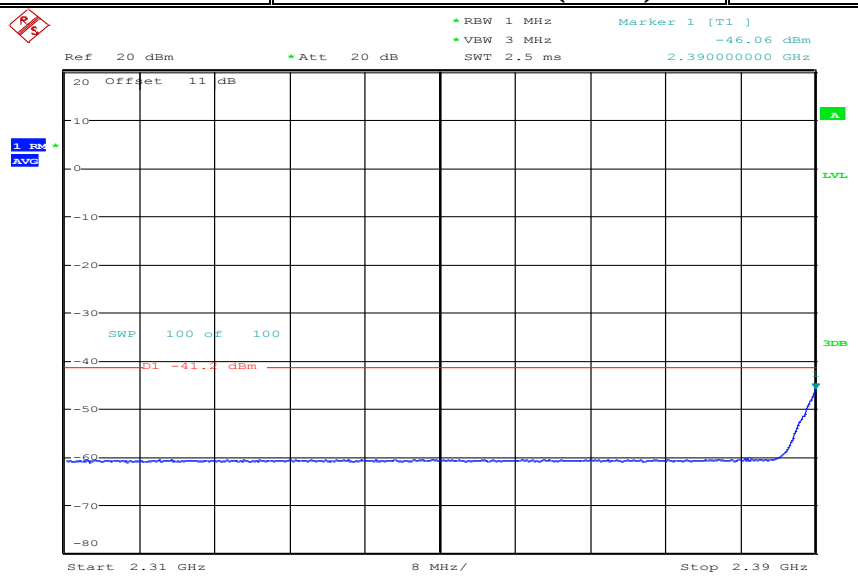
Date: 23.DEC.2014 17:38:16

lower, restricted band edge (2310 MHz – 2390 MHz) - peak		
Ch. Low / 2412 MHz	**Mode: 802.11n (HT20)**	**Data rate: 6.5 Mbps**



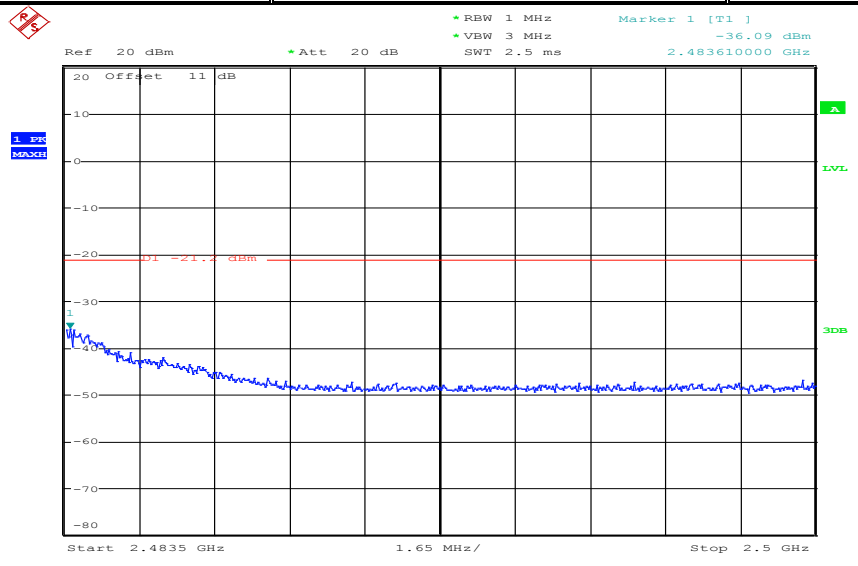
Date: 23.DEC.2014 17:51:50

lower, restricted band edge (2310 MHz – 2390 MHz) - average		
Ch. Low / 2412 MHz	**Mode: 802.11n (HT20)**	**Data rate: 6.5 Mbps**



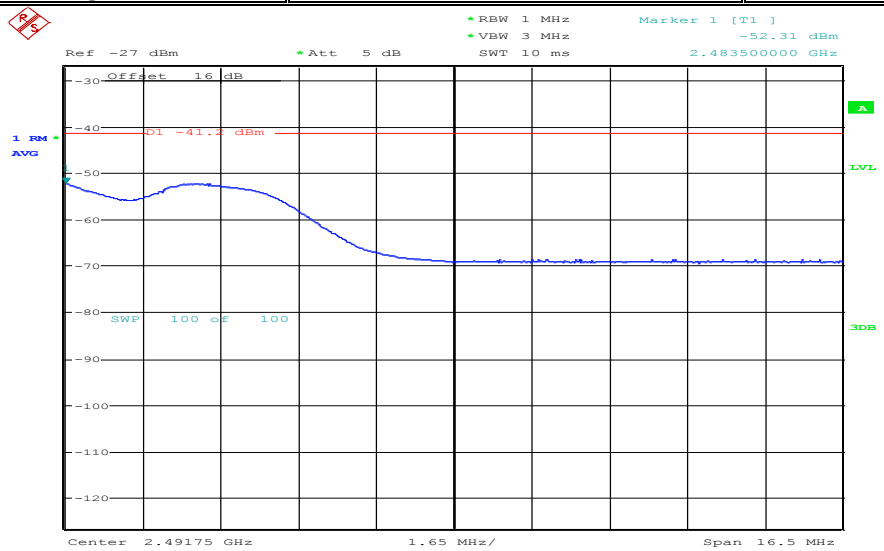
Date: 23.DEC.2014 17:40:30

upper, restricted band edge 2483.5 MHz – 2500 MHz - peak		
Ch. High / 2462 MHz	**Mode: 802.11b**	**Data rate: 1 Mbps**



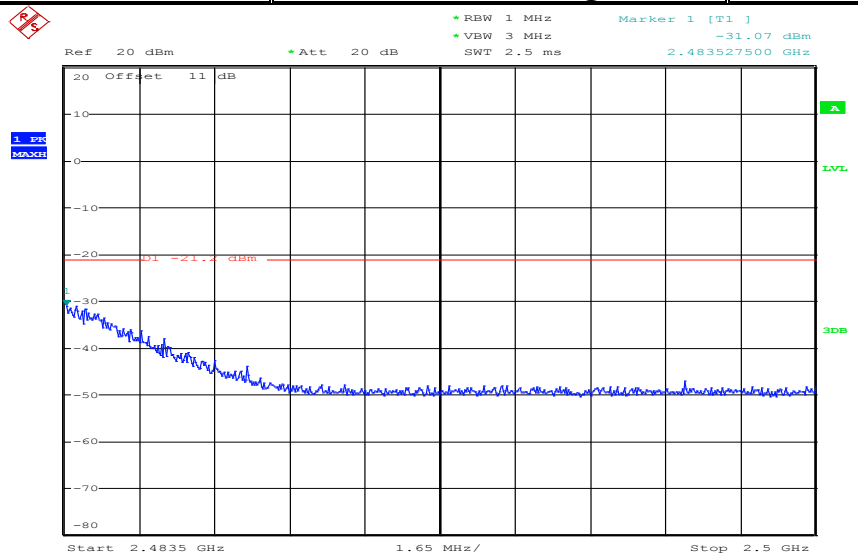
Date: 23.DEC.2014 18:01:27

upper, restricted band edge 2483.5 MHz – 2500 MHz - average		
Ch. High / 2462 MHz	**Mode: 802.11b**	**Data rate: 1 Mbps**



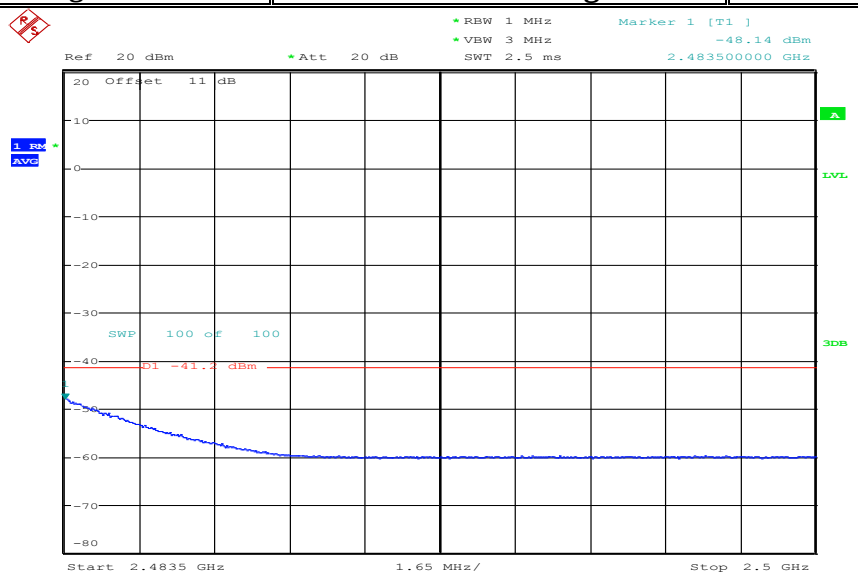
low
Date: 5.FEB.2015 17:57:31

upper, restricted band edge 2483.5 MHz – 2500 MHz - peak		
Ch. High / 2462 MHz	**Mode: 802.11g**	**Data rate: 6 Mbps**



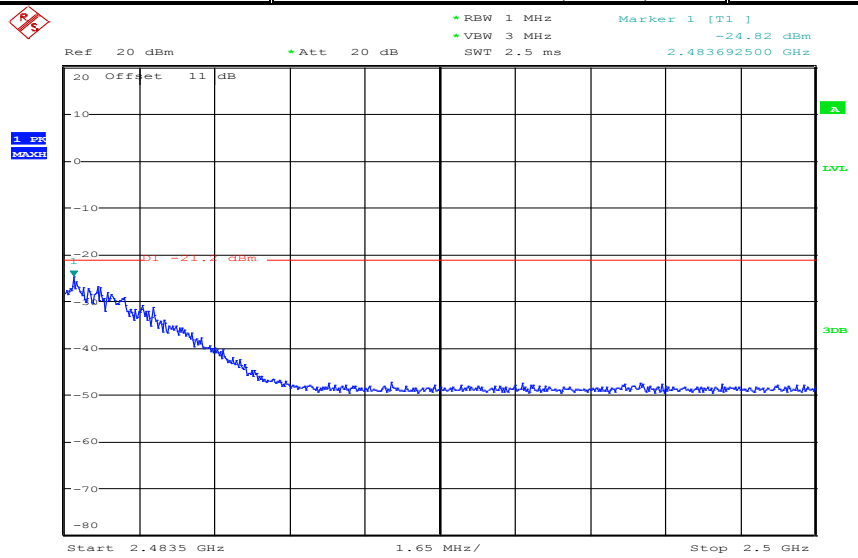
Date: 23.DEC.2014 17:27:41

upper, restricted band edge 2483.5 MHz – 2500 MHz - average		
Ch. High / 2462 MHz	**Mode: 802.11g**	**Data rate: 6 Mbps**



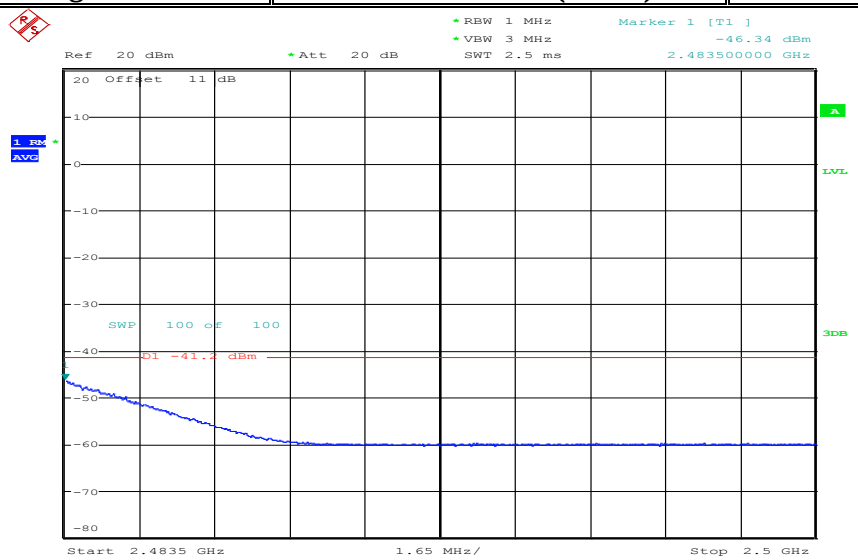
Date: 23.DEC.2014 17:35:11

upper, restricted band edge 2483.5 MHz – 2500 MHz - peak		
Ch. High / 2462 MHz	**Mode: 802.11n (HT20)**	**Data rate: 7.2 Mbps**



Date: 23.DEC.2014 17:32:54

upper, restricted band edge 2483.5 MHz – 2500 MHz - average		
Ch. High / 2462 MHz	**Mode: 802.11n (HT20)**	**Data rate: 7.2 Mbps**



Date: 23.DEC.2014 17:34:02

6.8 Occupied Bandwidth (6dB & 99%)

6.8.1 Limits:

§15.247 (a) (2) & RSS-210 A8.2 (a)

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

6.8.2 Test Conditions:

Tnom: 22 ºC; Vnom: 3.7V

6.8.3 Measurement procedure:

Measurement according to FCC KDB 558074 D01 v03r02 section 8.1

For 6 dB bandwidth:

Spectrum Analyzer settings:

Span= Wide enough to capture the entire emission bandwidth
RBW= 100 KHz
VBW≥ 3xRBW
Detector: Peak-
Sweep Time: Auto
Trace = Max Hold
Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the peak level measured in the fundamental emission.

For 99% bandwidth:

Use the occupied bandwidth in the measurement function of the spectrum analyzer with power bandwidth setting at 99%

6.8.4 Test Result: 2.4 GHz Band

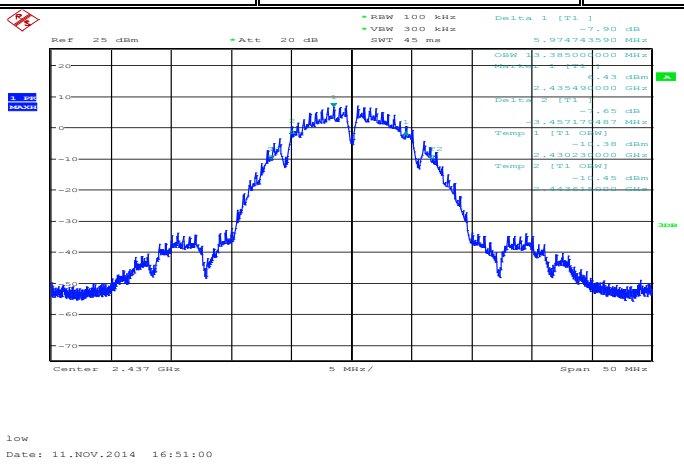
Occupied Bandwidth (MHz)						
Mode	**Frequency (MHz)**					
	2412 Channel 1		**2437 Channel 6**		**2462 Channel 11**	
	6dB	**99%**	**6dB**	**99%**	**6dB**	**99%**
802.11b	4.52	13.63	9.43	13.39	9.54	13.46
802.11g	16.41	16.71	16.47	16.56	16.47	16.62
802.11n (20 MHz)	17.63	17.99	17.51	17.68	17.61	17.77

6.8.5 Measurement Result

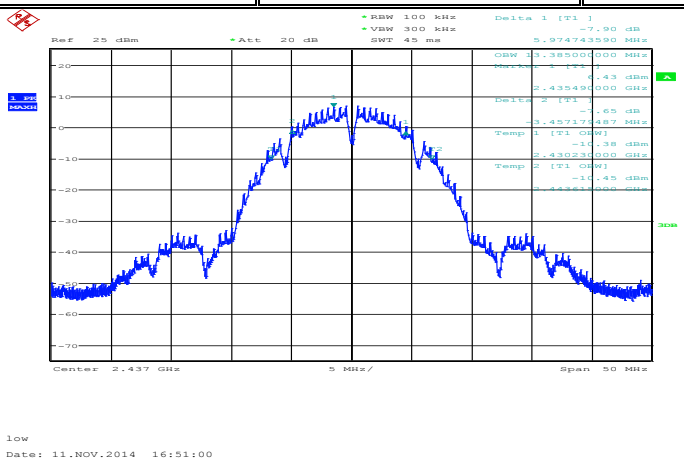
Pass.

6.8.6 Measurement Plots

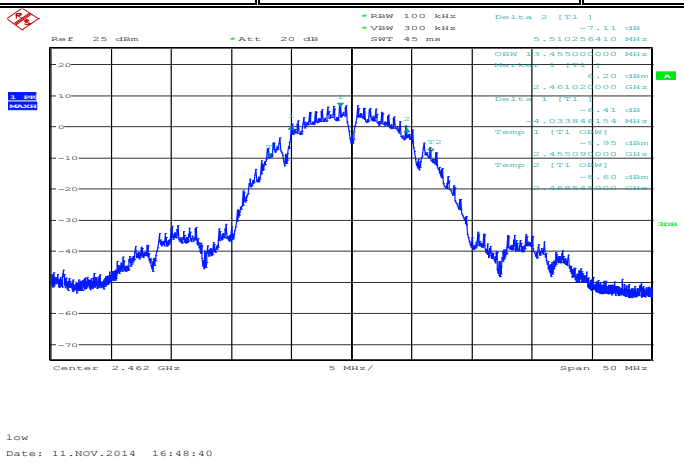
Occupied Bandwidth		
Ch. 1 / 2.412 MHz	**Mode: 802.11b**	**Data Rate: 1 Mbps**



Ch. 6 / 2.437 MHz	**Mode: 802.11b**	**Data Rate: 1 Mbps**

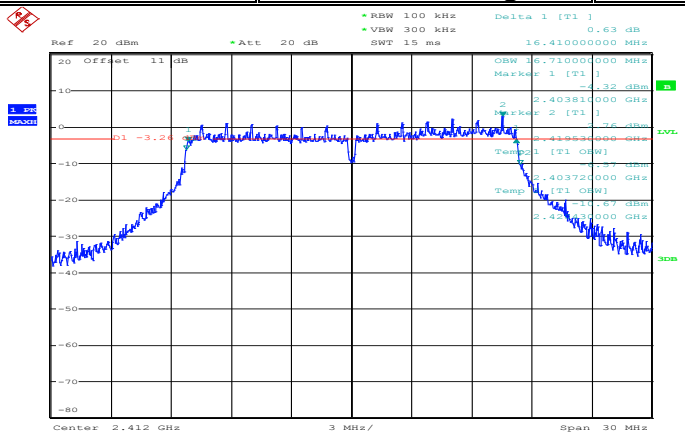


Ch. 11 / 2.462 MHz	**Mode: 802.11b**	**Data Rate: 1 Mbps**

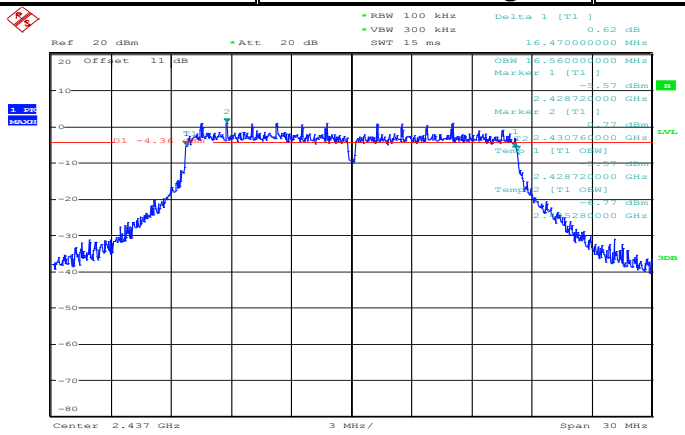


Occupied Bandwidth

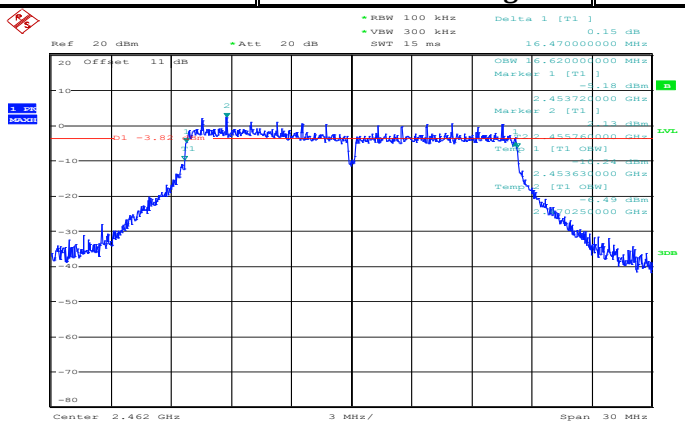
Ch. 1 / 2.412 MHz	Mode: 802.11g	Data Rate: 6 Mbps



Ch. 6 / 2.437 MHz	Mode: 802.11g	Data Rate: 6 Mbps

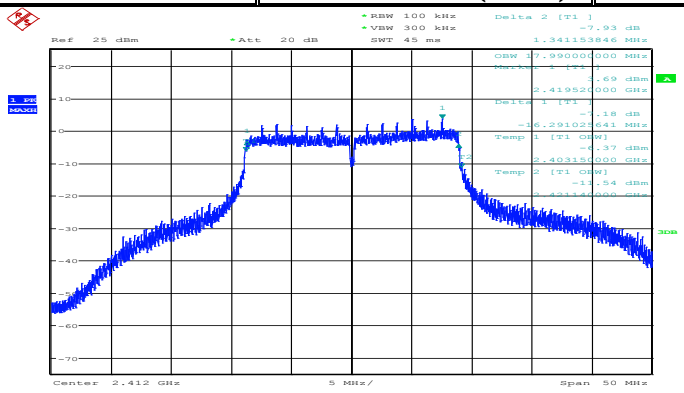


Ch. 11 / 2.462 MHz	Mode: 802.11g	Data Rate: 6 Mbps



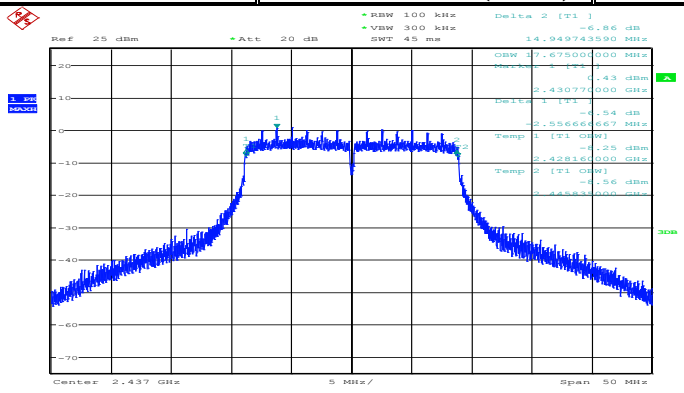
Occupied Bandwidth

Ch. 1 / 2.412 MHz	Mode: 802.11n (HT20)	Data Rate: 7.2 Mbps



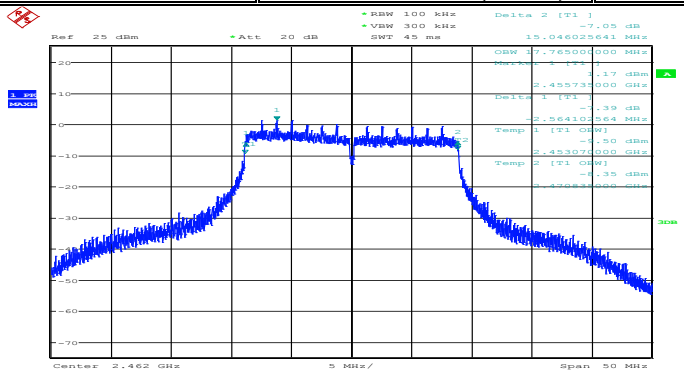
low
Date: 11.NOV.2014 16:27:29

Ch. 6 / 2.437 MHz	Mode: 802.11n (HT20)	Data Rate: 7.2 Mbps



low
Date: 11.NOV.2014 16:35:24

Ch. 11 / 2.462 MHz	Mode: 802.11n (HT20)	Data Rate: 7.2 Mbps



low
Date: 11.NOV.2014 16:43:35

6.9 Radiated Transmitter Spurious Emissions & Restricted Bands

6.9.1 Limits:

§15.247/15.205/15.209 & RSS-210 A8.5 / RSS-Gen 8.9/ 8.10 (restricted bands)

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

MHz	MHz	MHz	GHz
0.090 - 0.110	16.42 - 16.423	399.9 - 410	4.5 - 5.15
[1]0.495 - 0.505	16.69475 - 16.69525	608 - 614	5.35 - 5.46
2.1735 - 2.1905	16.80425 - 16.80475	960 - 1240	7.25 - 7.75
4.125 - 4.128	25.5 - 25.67	1300 - 1427	8.025 - 8.5
4.17725 - 4.17775	37.5 - 38.25	1435 - 1626.5	9.0 - 9.2
4.20725 - 4.20775	73 - 74.6	1645.5 - 1646.5	9.3 - 9.5
6.215 - 6.218	74.8 - 75.2	1660 - 1710	10.6 - 12.7
6.26775 - 6.26825	108 - 121.94	1718.8 - 1722.2	13.25 - 13.4
6.31175 - 6.31225	123 - 138	2200 - 2300	14.47 - 14.5
8.291 - 8.294	149.9 - 150.05	2310 - 2390	15.35 - 16.2
8.362 - 8.366	156.52475 - 156.52525	2483.5 - 2500	17.7 - 21.4
8.37625 - 8.38675	156.7 - 156.9	2690 - 2900	22.01 - 23.12
8.41425 - 8.41475	162.0125 - 167.17	3260 - 3267	23.6 - 24.0
12.29 - 12.293	167.72 - 173.2	3332 - 3339	31.2 - 31.8
12.51975 - 12.52025	240 - 285	3345.8 - 3358	36.43 - 36.5
12.57675 - 12.57725	322 - 335.4	3600 - 4400	([2])
13.36 - 13.41			

Radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

*PEAK LIMIT= 74dBµV/m
*AVG. LIMIT= 54dBµV/m

Table 1: Field strength limits table above 30 MHz

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

Table 2: Field strength limits table below 30 MHz

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

Radiated spurious emissions shall be measured for the transmit frequencies, transmit power, and data rate for the lowest, middle and highest channel in each frequency band of operation and for the highest gain antenna for each antenna type, and using the appropriate parameters and test requirements described in 5.4.
The highest (or worst-case) data rate shall be recorded for each measurement.

6.9.2 Test Conditions:
Tnom: 23 °C; Vnom: 3.7V

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

Analyzer Settings:
From 9 KHz – 30 MHz
RBW = 9 KHz
Detector: Peak

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

Above 1 GHz
Detector = Peak / Average
RBW= 1MHz

The combination of test mode 802.11b with CCK modulation at 1 Mbps produces the highest conducted output power.

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

6.9.4 Test Result:
Test mode: *Modulation:* 802.11b - according to the table in section 3 of this test report.
Unless mentioned otherwise, the emissions outside the limit lines in the plots are from the transmit signal.

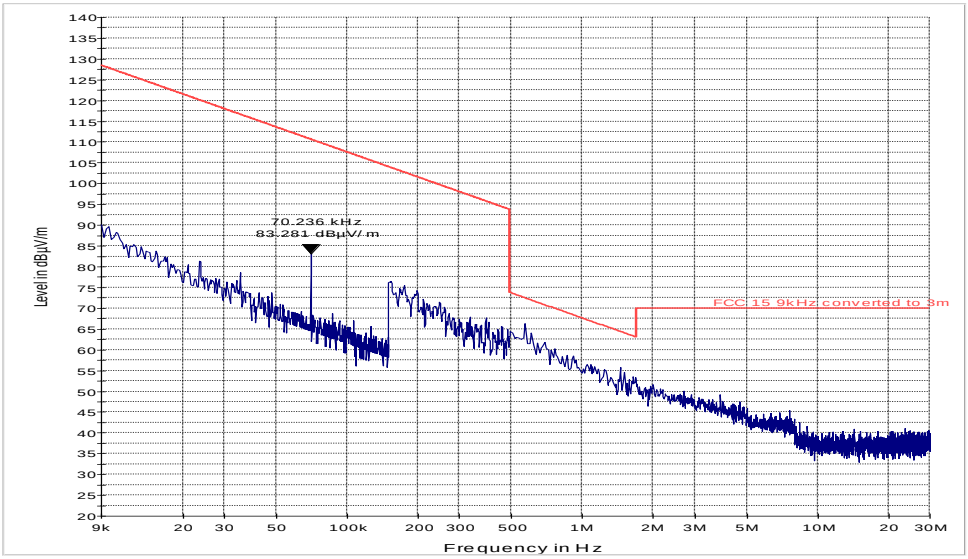
Plots reported here represent the worst case emissions for horizontal and vertical antenna polarizations and for three orientations of the EUT.

6.9.4.1 Measurement Result

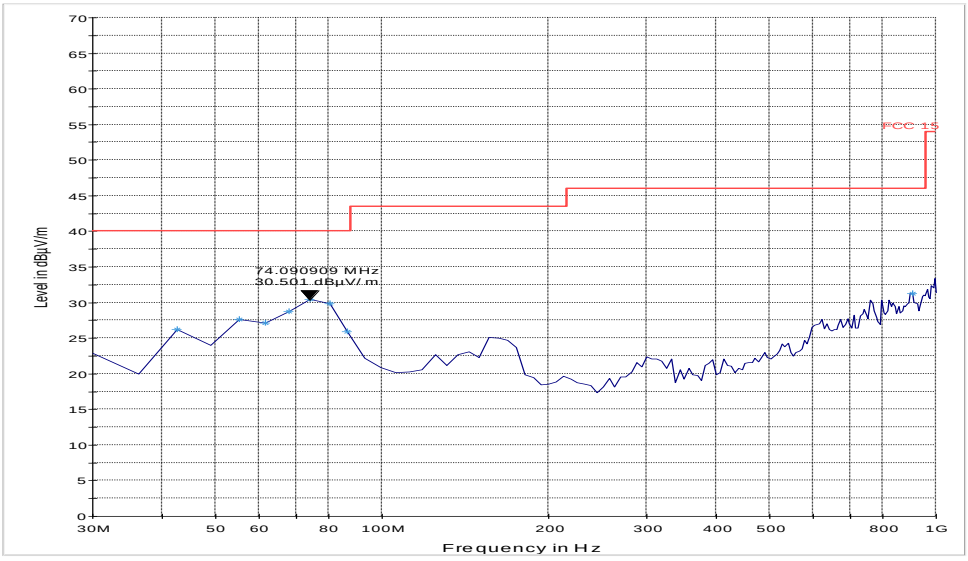
Pass.

6.9.5 Test data/ plots: 2.4 GHz Band

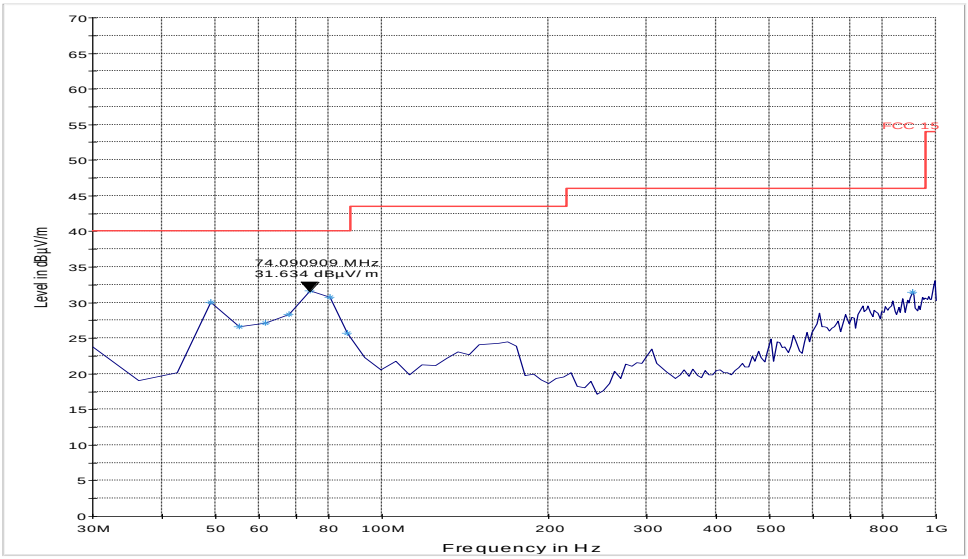
TX Radiated Spurious Emissions: 9kHz – 30MHz		
Ch. Mid	**Mode: 802.11b**	**Data Rate: 1 Mbps**



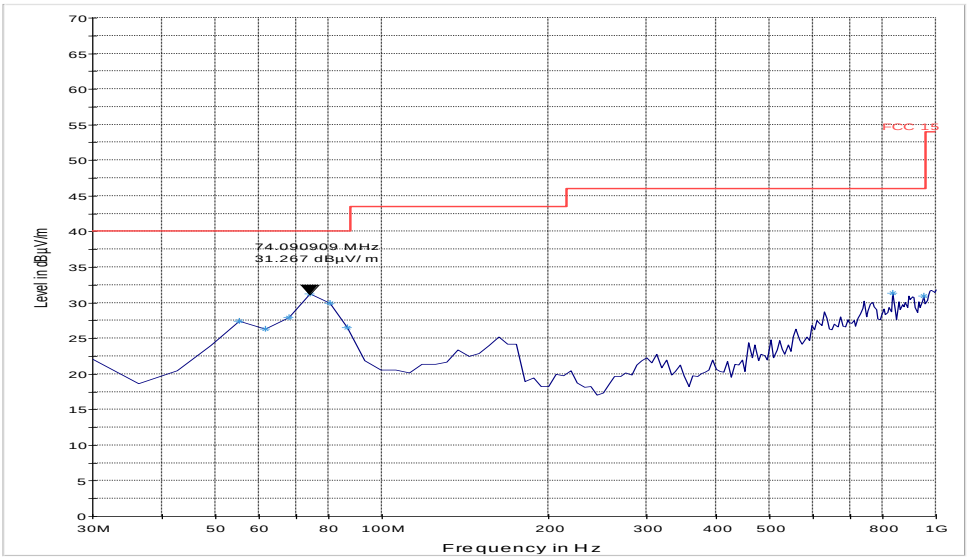
Radiated Emissions: 30 MHz- 1 GHz		
Ch. Low	**Mode: 802.11b**	**Data Rate: 1 Mbps**



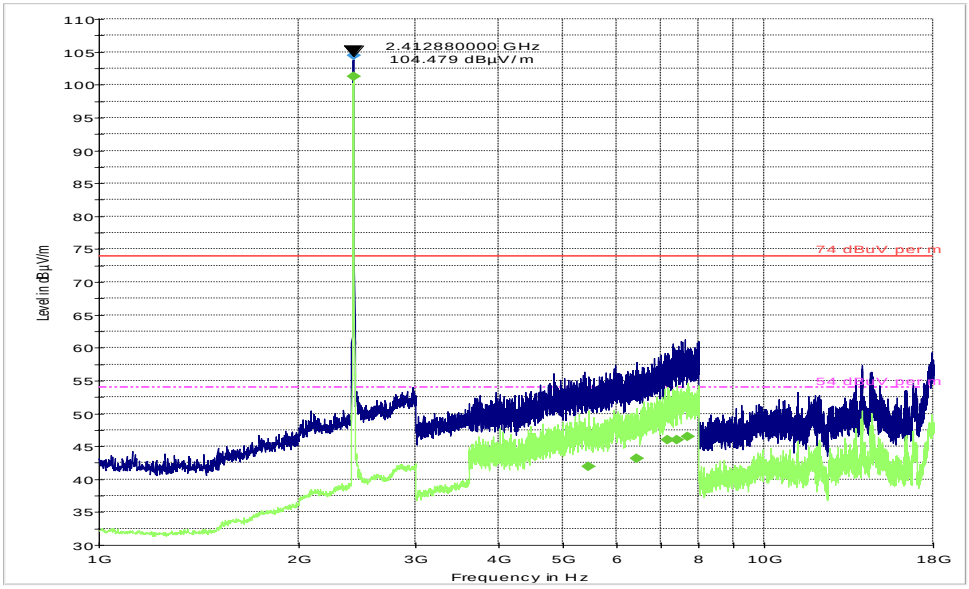
Radiated Emissions: 30 MHz- 1 GHz		
Ch. Mid	**Mode: 802.11b**	**Data Rate: 1 Mbps**



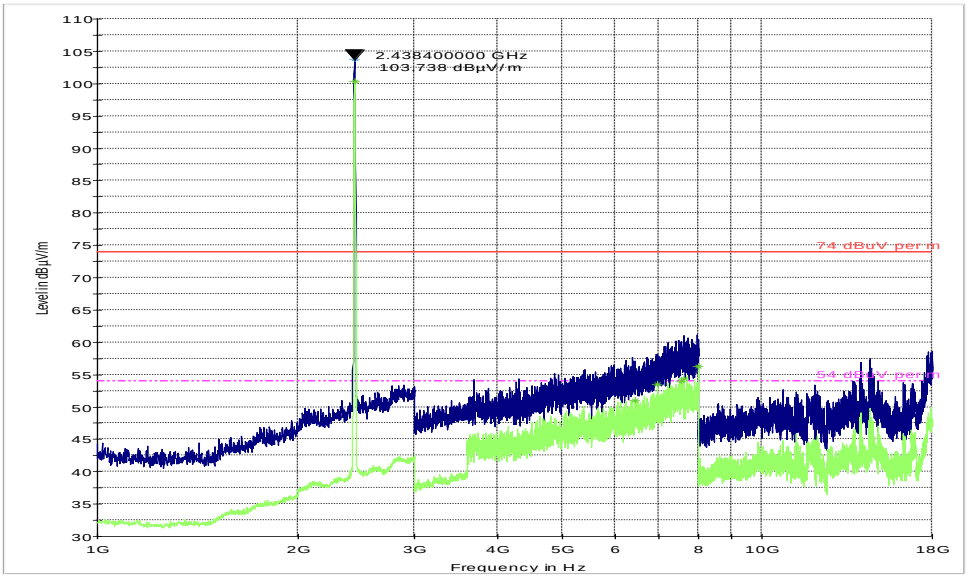
Radiated Emissions: 30 MHz- 1 GHz		
Ch. High	**Mode: 802.11b**	**Data Rate: 1 Mbps**



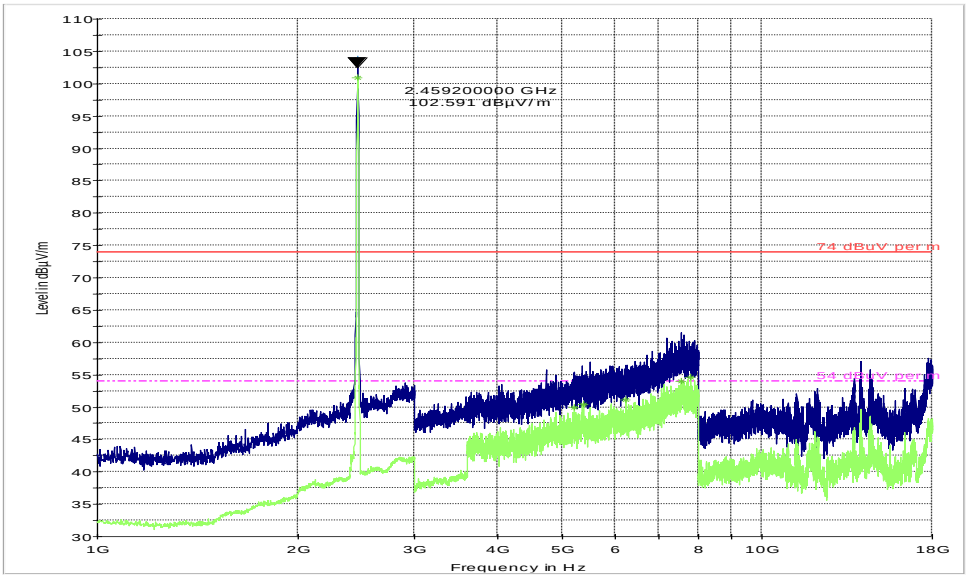
Radiated Emissions: 1 GHz – 18 GHz		
Ch. Low	**Mode: 802.11b**	**Data Rate: 1 Mbps**



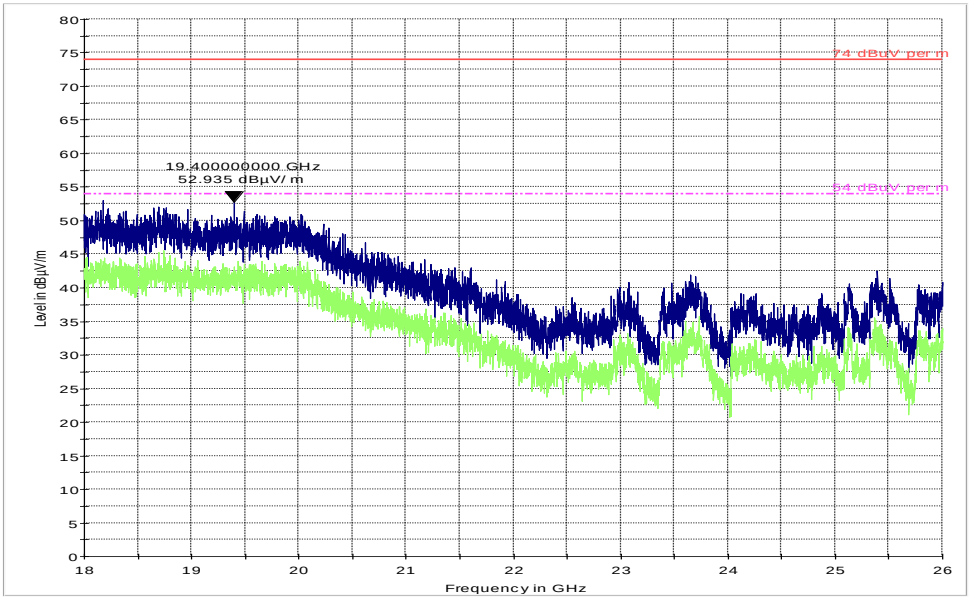
Radiated Emissions: 1 GHz – 18 GHz		
Ch. Mid	**Mode: 802.11b**	**Data Rate: 1 Mbps**



Radiated Emissions: 1 GHz – 18 GHz		
Ch. High	**Mode: 802.11b**	**Data Rate: 1 Mbps**



Radiated Emissions: 18 GHz – 26 GHz		
Ch. Mid	**Mode: 802.11b**	**Data Rate: 1 Mbps**



6.10 AC Power Line Conducted Emissions

6.10.1 References:

FCC: CFR Part 15.207/ RSS-Gen 8.8

The purpose of this test is to measure unwanted radio frequency currents induced in any AC conductor external to the equipment which could conduct interference to other equipment via the AC electrical network.

6.10.2 Limits:

§15.207 & RSS-Gen 8.8

(a) Except as shown in paragraphs (b) and (c) of this section of the CFR, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table (1), as measured using a 50 μH/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

Table 1:

Frequency of emission (MHz)	Conducted limit (dBμV)	
	Quasi-peak	Average
0.15–0.5	66 to 56*	56 to 46*
0.5–5	56	46
5–30	60	50

*Decreases with the logarithm of the frequency.

6.10.3 Test Conditions:

Tnom: 22 °C; Vnom: 3.7V

Modulation: 2.4GHz: 802.11b- Transmit and Receive modes of operation.

6.10.4 Measurement procedure:

Measurement according to ANSI C63.10:2013 section 6.2 and 4.1 (also refer to section 6, 6.3 in this test report)

Analyzer Settings:

CISPR Bandwidth- 9KHz.

Detector = Qusi-peak / Average

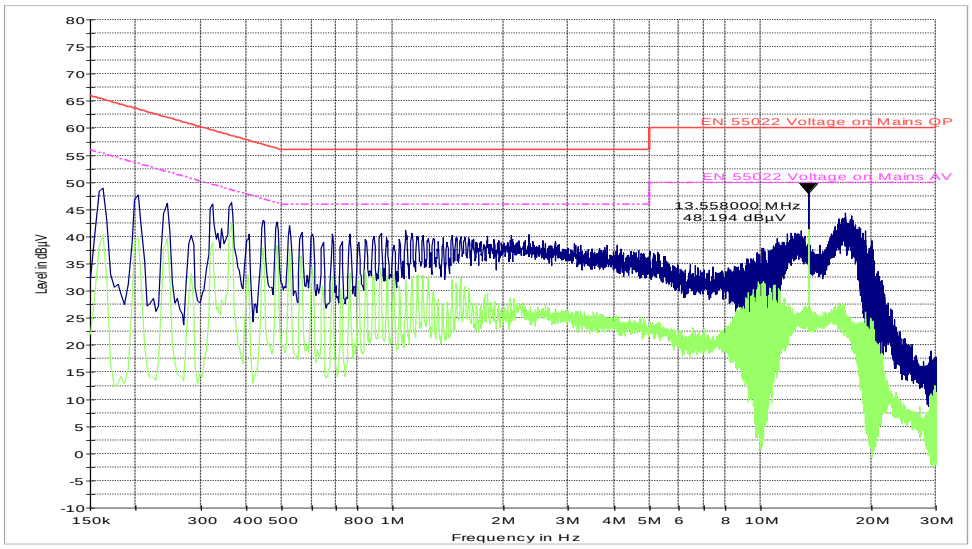
6.10.5 Results

Plots shown here represent the combined worse case emissions for phases and neutral line.

Pass.

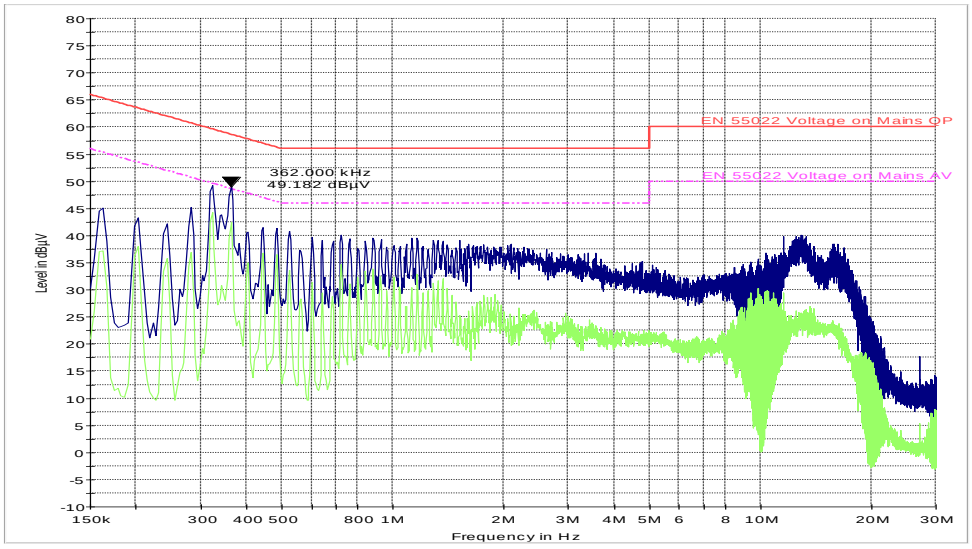
6.10.6 Test Results:

Conducted Emissions: 150 kHz – 30 MHz		
Ch. Mid	**Mode: 802.11b**	**Data Rate: 1 Mbps**



MaxPeak-ClearWrite Average-ClearWrite Voltage on Mains QP Voltage on Mains AV

Conducted Emissions: 150 kHz – 30 MHz
RX/Idle mode

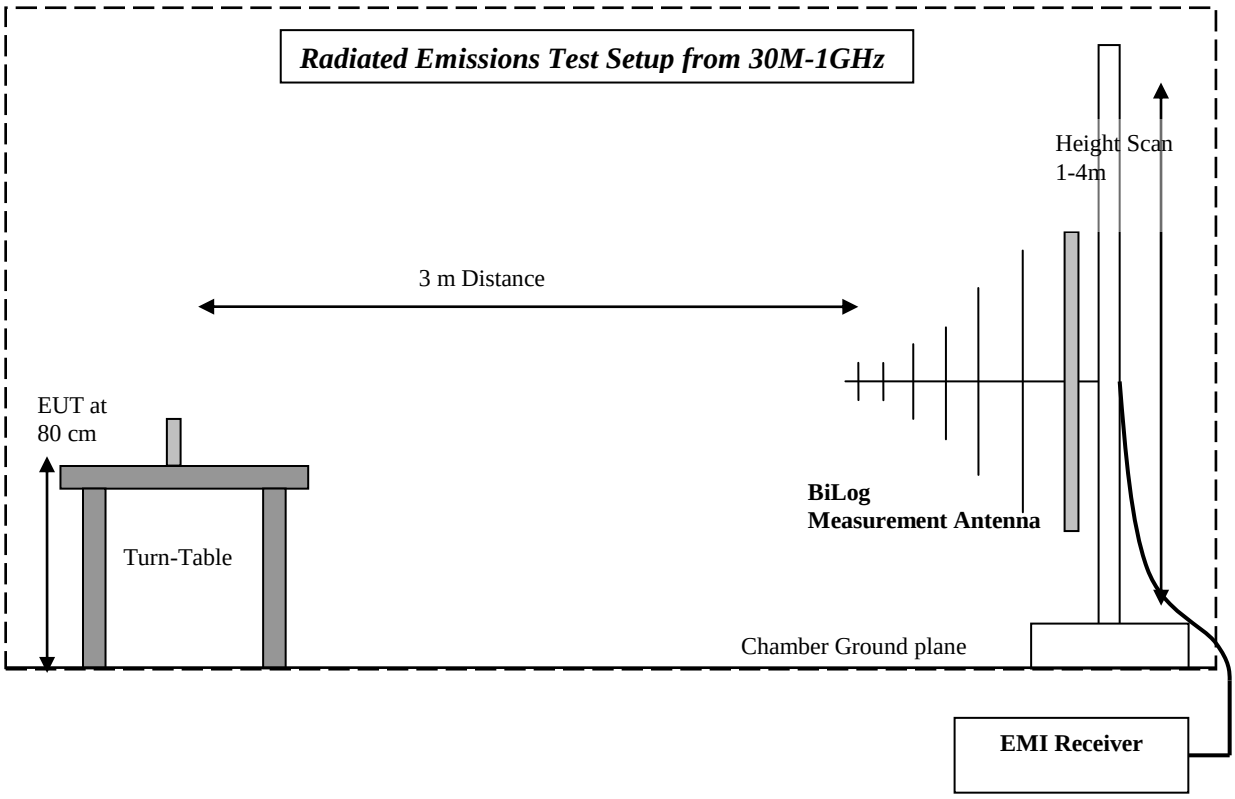


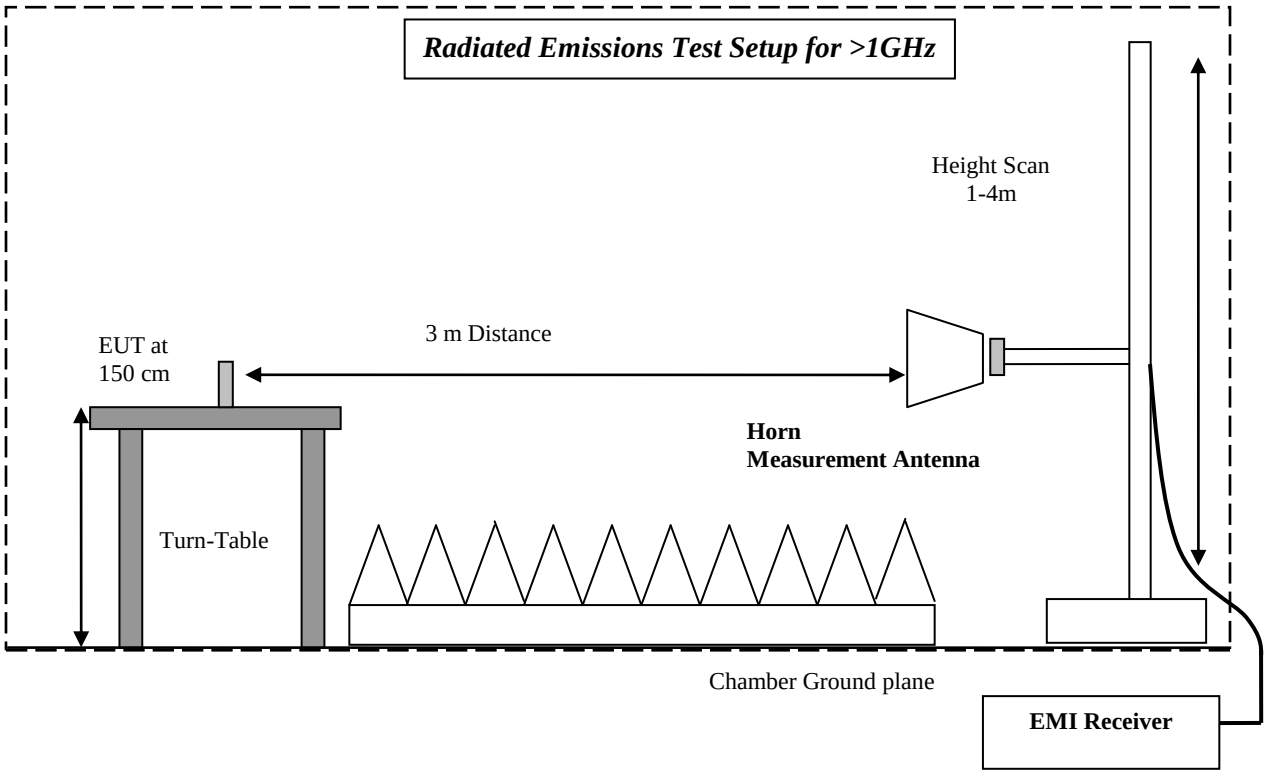
MaxPeak-ClearWrite Average-ClearWrite Voltage on Mains QP Voltage on Mains AV

7 Test Equipment and Ancillaries used for tests

No.	Equipment Name	Manufacturer	Type/model	Serial No.	Cal Date	Cal Interval
	Turn table	EMCO	2075	N/A	N/A	N/A
	MAPS Position Controller	ETS Lindgren	2092	0004-1510	N/A	N/A
	Antenna Mast	EMCO	2075	N/A	N/A	N/A
	High Pass Filter	5HC2700	Trilithic Inc.	9926013	Part of system calibration	
	High Pass Filter	4HC1600	Trilithic Inc.	9922307	Part of system calibration	
	6GHz High Pass Filter	HPM50106	Microtronics	001	Part of system calibration	
	Pre-Amplifier	JS4-00102600	Miteq	00616	Part of system calibration	
	Relay Switch Unit	Rohde&Schwarz	RSU	338964/001	N/A	N/A
	EMI Receiver/Analyzer	Rohde&Schwarz	ESU 40	100251	Sept 2013	2 Year
	Spectrum Analyzer	Rohde&Schwarz	FSU	200302	Jun 2013	2 Years
	1500MHz HP Filter	Filtek	HP12/1700	14c48	N/A	N/A
	2800 MHZ HP Filter	Filtek	HP12/2800	14C47	N/A	N/A
	Pre-Amplifier	Miteq	JS40010260	340125	N/A	N/A
	Binconilog Antenna	EMCO	3141	0005-1186	Apr 2012	3 Years
	Binconilog Antenna	ETS	3149	J000123908	Feb 2012	3 years
	Horn Antenna	EMCO	3115	35114	Mar 2012	3 Years
	Loop Antenna	EMCO	6512	00049838	Apr 2012	3 years
	LISN	R&S	ESH3-Z5	836679/003	Jun 2013	3 Years

8 Test Setup Diagram:





9 Revision History

Date	Report Name	Changes to report	Report prepared by
2015-02-04	EMC_HONEY_134_14001_15.247_DTS_WLAN_75E	First official version	Danh Le