

FCC/IC TEST REPORT

Test report No.: EMC- FCC- R0141
FCC ID: TQ8-AV2302TAN
IC: 5074A-AV2302TAN
Type of equipment: DIGITAL CAR AVN SYSTEM
Basic Model Name: AV2302TAN
Variant Model Name: AV2312TAN, AV230TBAN, AV231TBAN
Applicant: Hyundai Mobis Co., Ltd.
Max.RF Output Power: 19.73 dBm
FCC Rule Part(s): FCC Part 15 Subpart C 15.247
IC Rule: RSS-210, RSS-GEN
Frequency Range: 2 412 MHz ~ 2 462 MHz
Test result: Complied

The above equipment was tested by EMC compliance Testing Laboratory for compliance with the requirements of FCC Rules and Regulations.

The results of testing in this report apply to the product/system which was tested only. Other similar equipment will not necessarily produce the same results due to production tolerance and measurement uncertainties.

Date of test: 2014. 01. 14 ~ 20

Issued date: 2014. 02. 03

Tested by:



SON, MIN GI

Approved by:



YU, SANG HOON

[Contents]

1. Client information	3
2. Laboratory information	4
3. Description of E.U.T.	5
3.1 Basic description.....	5
3.2 General description.....	5
3.3 Test frequency.....	6
3.4 Test Voltage.....	6
4. Summary of test results.....	7
4.1 Standards & results	7
4.2 Uncertainty	7
5. Test results.....	8
5.1 Antenna Requirement	8
5.2 Maximum Peak Output Power.....	9
5.3 Peak Power Spectral Density	11
5.4 6 dB Bandwidth(DTS Channel Bandwidth)	16
5.5 Spurious Emission, Band Edge, and Restricted bands.....	24
5.6 RF Exposure	48
6. Test equipment used for test	50

1. Client information

Applicant: Hyundai Mobis Co., Ltd.
Address: 203, Teheran-ro, Gangnam-gu, Seoul, Korea (135-977)
Telephone number: +82-31-260-0092
Facsimile number: +82-31-899-1788
Contact person: Jong Tae Kim / dounu@mobis.co.kr

Manufacturer: Hyundai Mobis Co., Ltd.
Address: 95, Sayang 2-Gil, Munbaek-Myeon, Jincheon-Gun,
Chungcheongbuk-Do 365-862 Korea

2. Laboratory information

Address

EMC compliance Ltd.

65, Sinwon-ro, Yeongtong-gu, Suwon- si, Gyeonggi-do, 443-390, Korea

Telephone Number: 82-31-336-9919 Facsimile Number: 82-505-299-8311

Certificate

KOLAS No.: 231

FCC Site Registration No.: 687132

VCCI Site Registration No.: R-3327, G-198, C-3706, T-1849

IC Site Registration No.:8035A-2

SITE MAP



EMC compliance Ltd.

65, Sinwon-ro, Yeongtong-gu, Suwon- si, Gyeonggi-do, 443-390, Korea

82-31-336-9919 (Main) 82-505-299-8311 (Fax)

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3. Description of E.U.T.

3.1 Basic description

Applicant:	Hyundai Mobis Co., Ltd.
Address of Applicant	203, Teheran-ro, Gangnam-gu, Seoul, Korea (135-977)
Manufacturer	Hyundai Mobis Co., Ltd.
Address of Manufacturer	95, Sayang 2-Gil, Munbaek-Myeon, Jincheon-Gun, Chungcheongbuk-Do 365-862 Korea
Type of equipment	DIGITAL CAR AVN SYSTEM
Basic Model	AV2302TAN
Variant Model	AV2312TAN, AV230TBAN, AV231TBAN
Serial number	Proto Type

* Variant model names are different only for the marketing area, and all model names are electrically identical in construction, radio characteristics, and features.

3.2 General description

Frequency Range	2 412 ~ 2 462 MHz(802.11b/g/n_HT20)
Communication	IEEE 802.11b/g/n_HT20
Type of Modulation	CCK, OFDM
Number of Channels	11 ch
Type of Antenna	Monopole type
Antenna Gain	2.46 dBi
Transmit Power	19.73 dBm
Power supply	DC 12 V

3.3 Test frequency

For all test items, the low, middle and high channels of the modes were tested with above worst case data rate.

	Frequency
Low frequency	2 412 MHz
Middle frequency	2 437 MHz
High frequency	2 462 MHz

3.4 Test Voltage

mode	Voltage
Normal voltage	DC 12 V

4. Summary of test results

4.1 Standards & results

FCC Rule Reference	IC Rule Reference	Parameter	Report Section	Test Result
15.203, 15.247(b)(4)	RSS-GEN, 7.1.2	Antenna Requirement	5.1	C
15.247(b)(3)	RSS-210, A8.4(2)	Maximum Peak Output Power	5.2	C
15.247(e)	-	Peak Power Spectral Density	5.3	C
15.247(a)(2)	RSS-GEN, 4.6.2	6 dB Channel Bandwidth	5.4	C
-	RSS-210, A1.1	Occupied Bandwidth	5.4	C
15.247(d), 15.205(a), 15.209(a)	RSS-210, A8.5 RSS-210, A2.9 RSS-GEN, 7.2.3	Spurious Emission, Band Edge, and Restricted bands	5.5	C
15.207(a)	RSS-GEN, 7.2.4	Conducted Emissions	-	N/A
15.247(i), 1.1307(b)(1)	-	RF Exposure	5.6	C
Note: C = complies NC = Not complies NT = Not tested NA = Not Applicable				

4.2 Uncertainty

Measurement Item	Combined Standard Uncertainty U _c	Expanded Uncertainty U = KU _c (K = 2)
Conducted RF power	± 0.29 dB	± 0.58 dB
Radiated disturbance	30 MHz ~ 300 MHz : + 2.43 dB, - 2.44 dB 300 MHz ~ 1 000 MHz : + 2.49 dB, - 2.50 dB 1 GHz ~ 6 GHz : + 3.10 dB, - 3.10 dB 6 GHz ~ 18 GHz : + 3.21 dB, - 3.27 dB	30 MHz ~ 300 MHz : + 4.86 dB, - 4.88 dB 300 MHz ~ 1 000 MHz : + 4.98 dB, - 4.99 dB 1 GHz ~ 6 GHz : + 6.19 dB, - 6.20 dB 6 GHz ~ 18 GHz : + 6.41 dB, - 6.53 dB

5. Test results

5.1 Antenna Requirement

5.1.1 Regulation

According to §15.203, 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.

And according to §15.247(b)(4), the conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

5.1.2 Result

- Complied

The transmitter has an monopole type of antenna. The directional peak gain of the antenna is 2.46 dBi.

5.2 Maximum Peak Output Power

5.2.1 Regulation

According to §15.247(b)(3), For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

According to §15.247(b)(4) The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

5.2.2 Measurement Procedure

These test measurement settings are specified in section 9.0 of 558074 D01 DTS Meas Guidance.

5.2.2.1 PKPM1 Peak power meter method

The maximum peak conducted output power may be measured using a broadband peak RF power meter. The power meter shall have a video bandwidth that is greater than or equal to the DTS bandwidth and shall utilize a fast-responding diode detector.

5.2.3 Test Result

- Complied

*** 802.11b**

Channel	Frequency (MHz)	Result (dBm)	Limit (dBm)	Margin (dB)
Low	2412	19.73	30.00	10.27
Middle	2437	19.51	30.00	10.49
High	2462	19.57	30.00	10.43

*** 802.11g**

Channel	Frequency (MHz)	Result (dBm)	Limit (dBm)	Margin (dB)
Low	2412	19.50	30.00	10.50
Middle	2437	19.49	30.00	10.51
High	2462	19.53	30.00	10.47

*** 802.11n HT20**

Channel	Frequency (MHz)	Result (dBm)	Limit (dBm)	Margin (dB)
Low	2412	19.44	30.00	10.56
Middle	2437	19.36	30.00	10.64
High	2462	19.33	30.00	10.67

-NOTE:

1. Since the directional gain of the integral antenna declared by the manufacturer ($G_{ANT} = 2.46$ dBi), does not exceed 6.0 dBi, there was no need to reduce the output power.
2. We took the insertion loss of the cable loss into consideration within the measuring instrument.

5.3 Peak Power Spectral Density

5.3.1 Regulation

According to §15.247(e), for digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

5.3.2 Measurement Procedure

These test measurement settings are specified in section 10.0 of 558074 D01 DTS Meas Guidance.

5.3.2.1 Method PKPSD (peak PSD)

This procedure shall be used if maximum peak conducted output power was used to demonstrate compliance, and is optional if the maximum conducted (average) output power was used to demonstrate compliance.

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

5.3.3 Test Result

- Complied

*** 802.11b**

Channel	Result [dBm]	Limit [dBm]	Margin [dBm]
Low	1.76	8.00	6.24
Middle	2.74	8.00	5.26
High	1.11	8.00	6.89

*** 802.11g**

Channel	Result [dBm]	Limit [dBm]	Margin [dBm]
Low	-3.26	8.00	11.26
Middle	-4.00	8.00	12.00
High	-4.20	8.00	12.20

*** 802.11n HT20**

Channel	Result [dBm]	Limit [dBm]	Margin [dBm]
Low	-2.60	8.00	10.60
Middle	-3.51	8.00	11.51
High	-3.11	8.00	11.11

-NOTE:

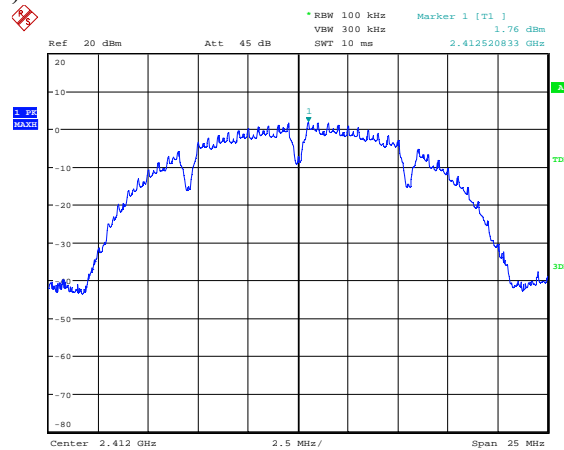
1. Since the directional gain of the integral antenna declared by the manufacturer ($G_{ANT} = 2.46$ dBi), does not exceed 6.0 dBi, there was no need to reduce the output power.
2. We took the insertion loss of the cable loss into consideration within the measuring instrument.

5.3.4 Test Plot

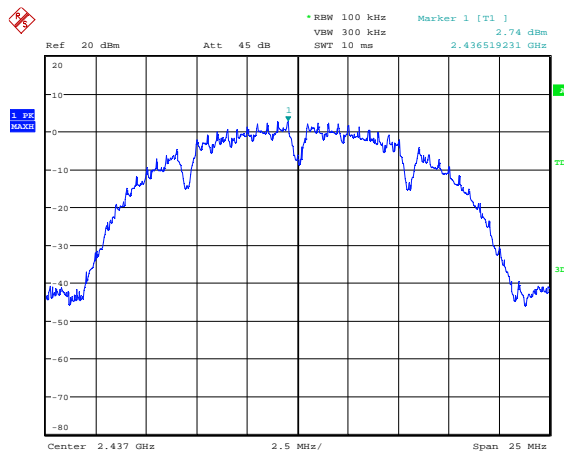
Figure 3. Plot of the Power Density (Conducted)

*** 802.11b**

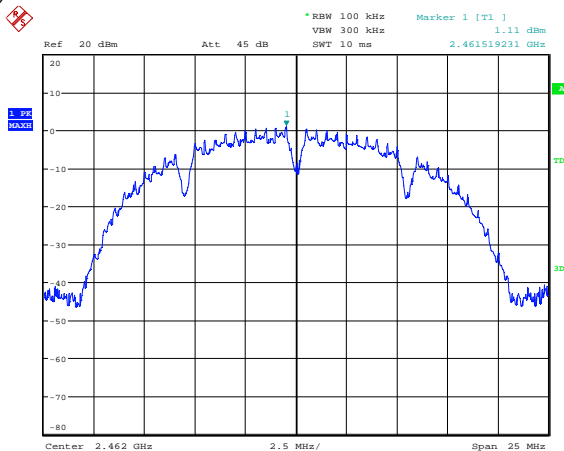
Lowest Channel(2 412 MHz)



Middle Chnnel (2 437 MHz)

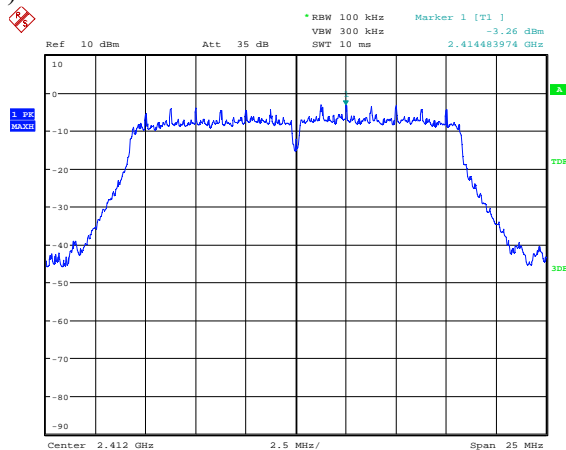


Highest Chnnel (2 462 MHz)

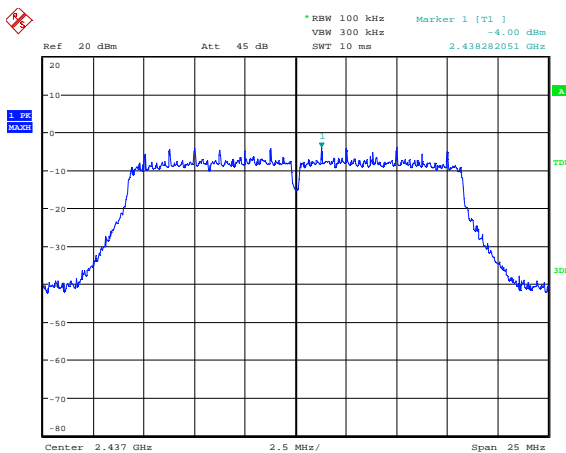


*** 802.11g**

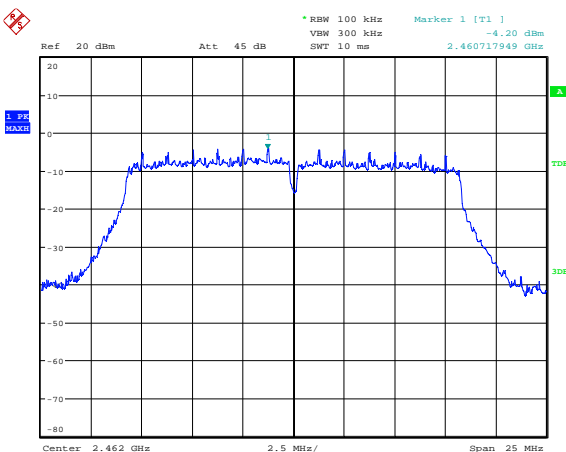
Lowest Channel(2 412 MHz)



Middle Chnnel (2 437 MHz)

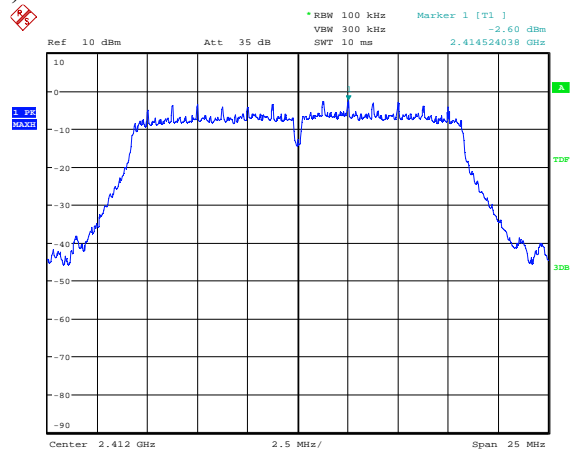


Highest Chnnel (2 462 MHz)

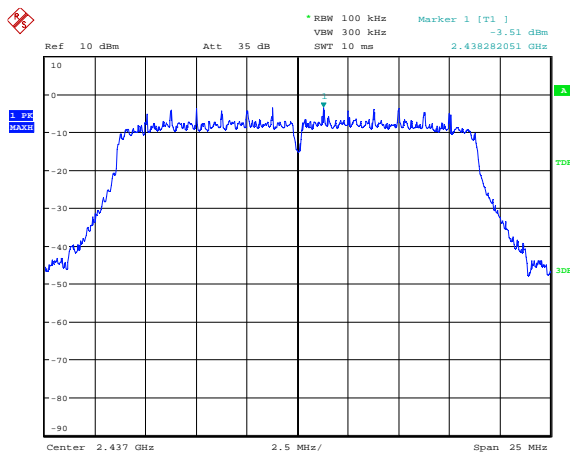


*** 802.11n HT20**

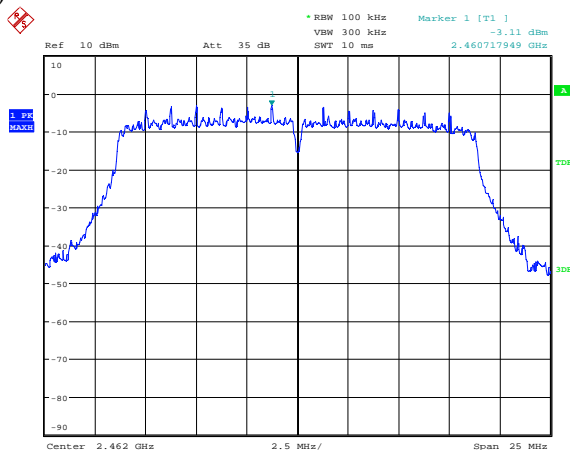
Lowest Channel(2 412 MHz)



Middle Chnnel (2 437 MHz)



Highest Chnnel (2 462 MHz)



5.4 6 dB Bandwidth(DTS Channel Bandwidth)

5.4.1 Regulation

According to §15.247(a)(2) Systems using digital modulation techniques may operate in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

5.4.2 Measurement Procedure

These test measurement settings are specified in section 8.0 of 558074 D01 DTS Meas Guidance.

5.4.2.1 DTS Channel Bandwidth-Option 1

- 1) Set RBW = 100 kHz.
- 2) Set the video bandwidth (VBW) $\geq 3 \times$ RBW.
- 3) Detector = Peak.
- 4) Trace mode = max hold.
- 5) Sweep = auto couple.
- 6) Allow the trace to stabilize.
- 7) 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 maximum level measured in the fundamental emission.

5.4.2.2 DTS Channel Bandwidth Measurement Procedure-Option 2

The automatic bandwidth measurement capability of an instrument may be employed using the X dB bandwidth mode with X set to 6 dB, if the functionality described above (i.e., RBW = 100 kHz, VBW $\geq 3 \times$ RBW, peak detector with maximum hold) is implemented by the instrumentation function. When using this capability, care shall be taken so that the bandwidth measurement is not influenced by any intermediate power nulls in the fundamental emission that might be ≥ 6 dB.

5.4.3 Test Result

- Complied

*** 802.11b**

Channel	Frequency (MHz)	6dB Bandwidth (MHz)	Min. Limit (kHz)	Occupied Bandwidth (99% BW)(MHz)
Low	2 412	10.050	500	15.280
Middle	2 437	10.978	500	15.240
High	2 462	11.018	500	15.280

*** 802.11g**

Channel	Frequency (MHz)	6dB Bandwidth (MHz)	Min. Limit (kHz)	Occupied Bandwidth (99% BW)(MHz)
Low	2 412	16.306	500	16.600
Middle	2 437	16.400	500	16.680
High	2 462	16.066	500	16.600

*** 802.11n HT20**

Channel	Frequency (MHz)	6dB Bandwidth (MHz)	Min. Limit (kHz)	Occupied Bandwidth (99% BW)(MHz)
Low	2 412	16.867	500	17.600
Middle	2 437	17.188	500	17.600
High	2 462	16.667	500	17.600

-NOTE:

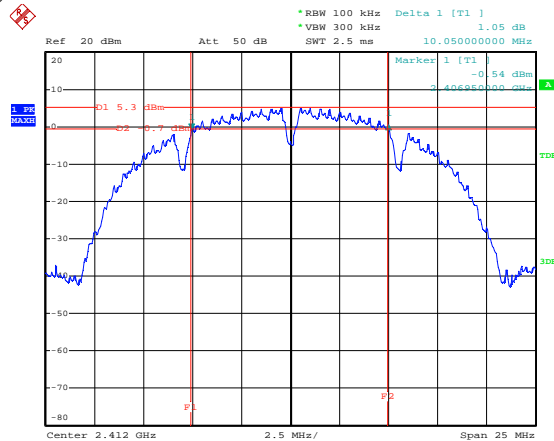
1. We took the insertion loss of the cable loss into consideration within the measuring instrument.

5.4.4 Test Plot

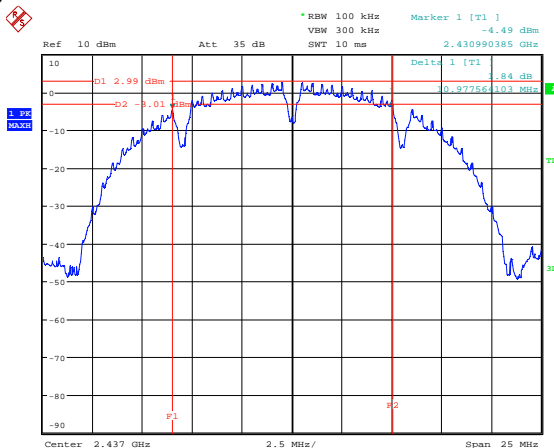
Figure 4. Plot of the 6dB Bandwidth & Occupied Bandwidth (Conducted)

* 802.11b (6dB Bandwidth)

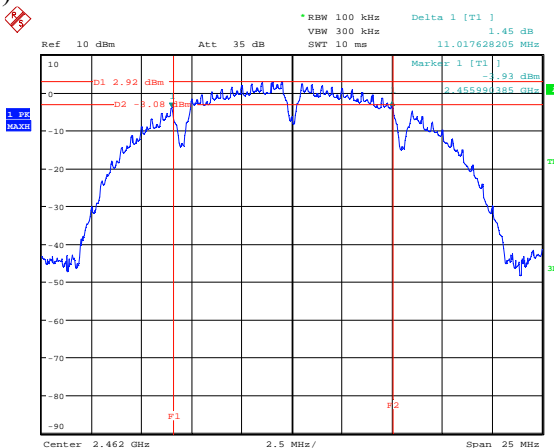
Lowest Channel (2 412 MHz)



Middle Channel (2 437 MHz)

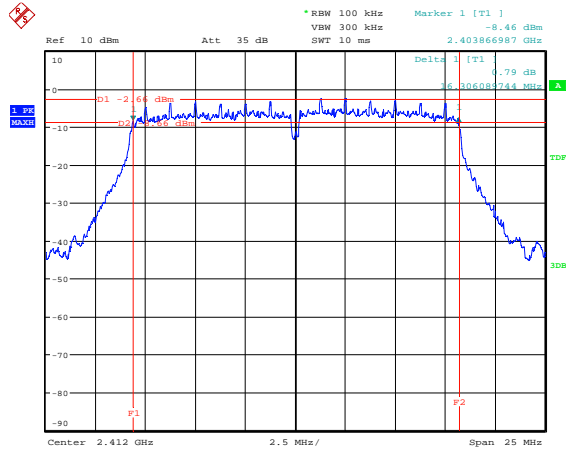


Highest Channel (2 462 MHz)

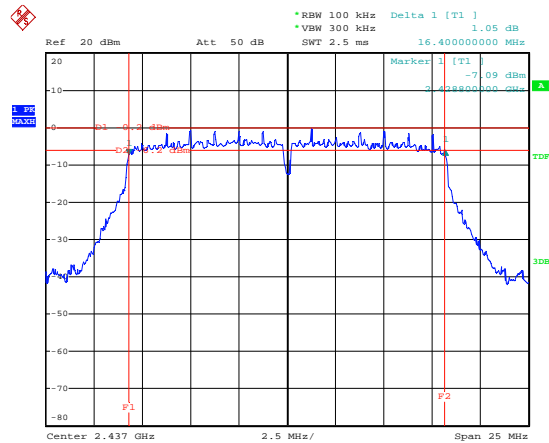


*** 802.11g (6dB Bandwidth)**

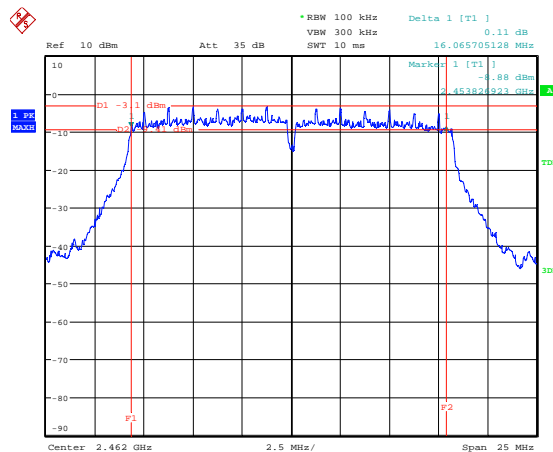
Lowest Channel (2 412 MHz)



Middle Channel (2 437 MHz)

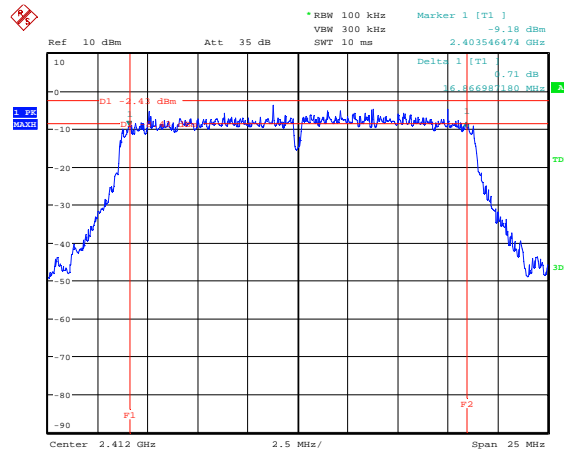


Highest Channel (2 462 MHz)

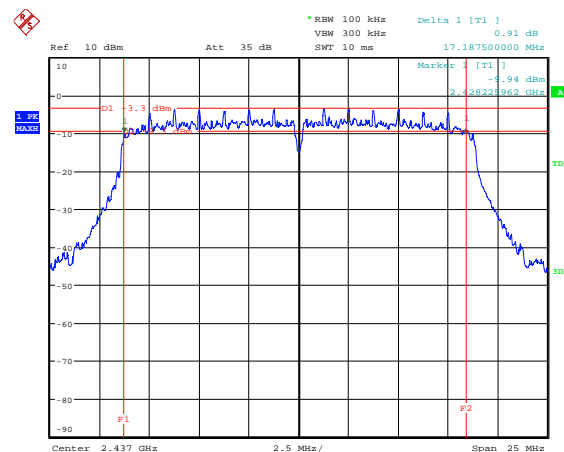


*** 802.11n HT20 (6dB Bandwidth)**

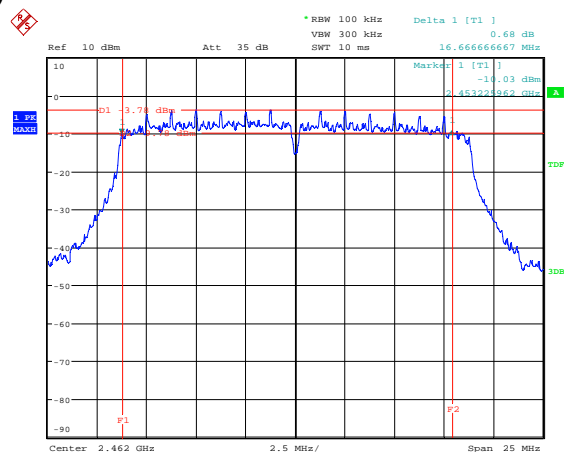
Lowest Channel (2 412 MHz)



Middle Channel (2 437 MHz)

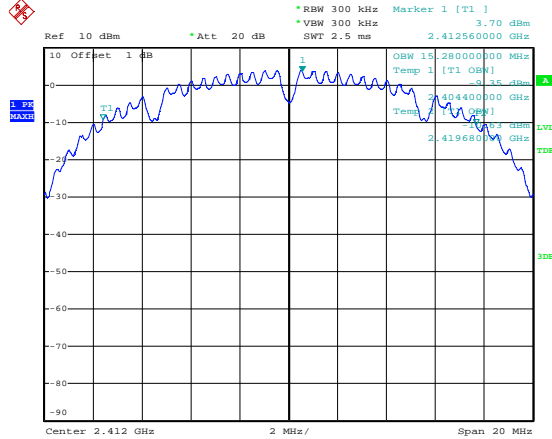


Highest Channel (2 462 MHz)

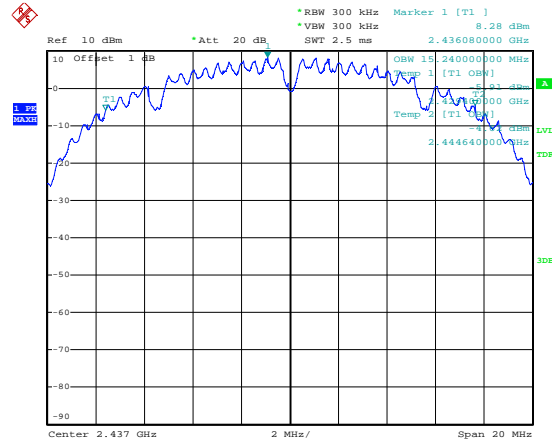


*** 802.11b (Occupied Bandwidth)**

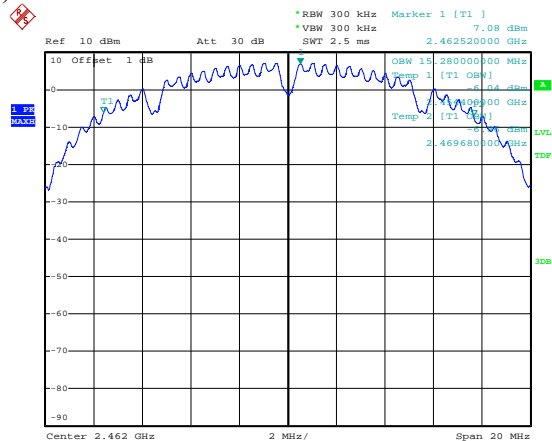
Lowest Channel (2 412 MHz)



Middle Channel (2 437 MHz)

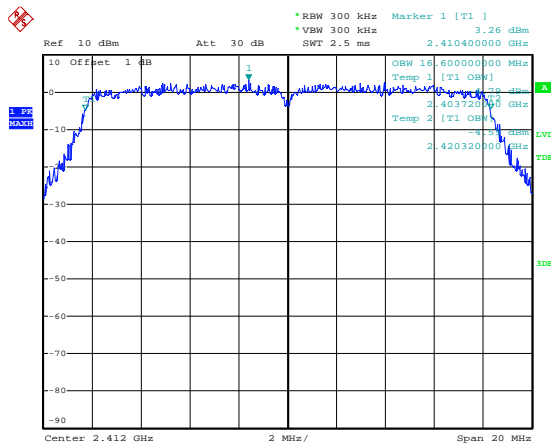


Highest Channel (2 462 MHz)

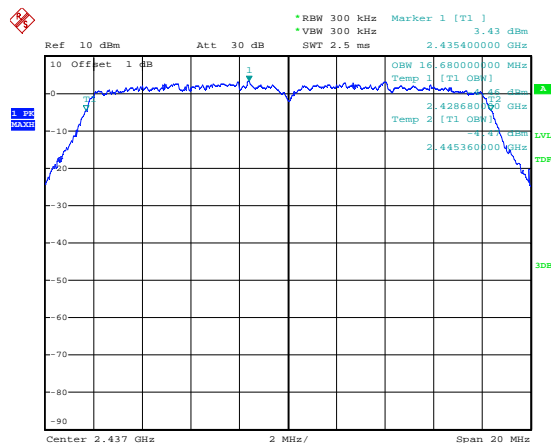


*** 802.11g (Occupied Bandwidth)**

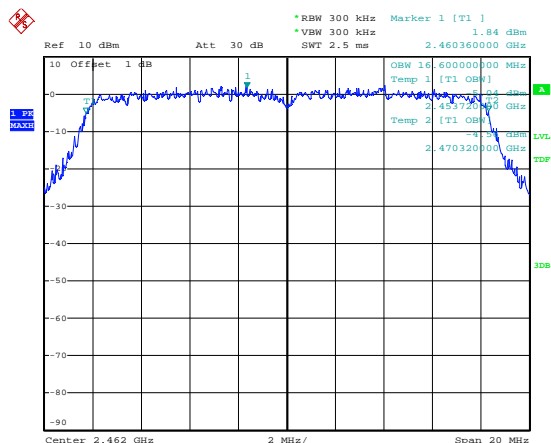
Lowest Channel (2 412 MHz)



Middle Channel (2 437 MHz)

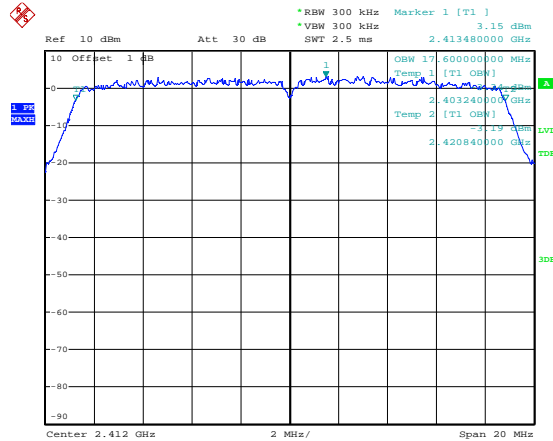


Highest Channel (2 462 MHz)

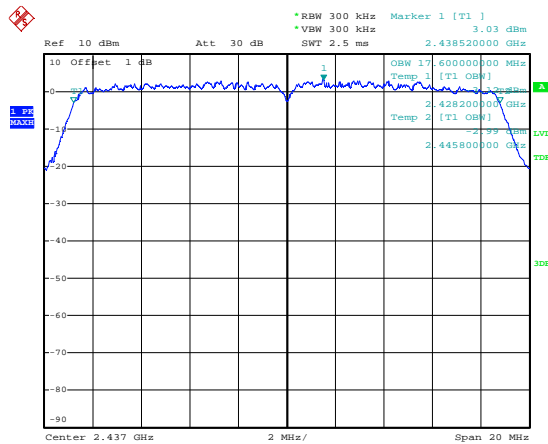


*** 802.11n HT20 (Occupied Bandwidth)**

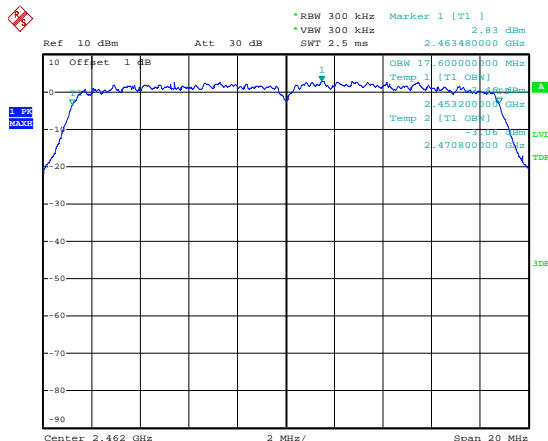
Lowest Channel (2 412 MHz)



Middle Channel (2 437 MHz)



Highest Channel (2 462 MHz)



5.5 Spurious Emission, Band Edge, and Restricted bands

5.5.1 Regulation

According to §15.247(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 Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

According to §15.209(a), for an intentional device, the general requirement of field strength of radiated emissions from intentional radiators at a distance of 3 meters shall not exceed the following values:

Frequency (MHz)	Field strength ($\mu\text{V/m}$ @ 3m)	Field strength (dB $\mu\text{V/m}$ @ 3m)
30–88	100	40.0
88–216	150	43.5
216–960	200	46.0
Above 960	500	54.0

According to §15.109(a), for an unintentional device, except for Class A digital devices, the field strength of radiated emissions from unintentional radiators at a distance of 3 meters shall not exceed the above table.

** The emission limits shown in the above table are based on measurement instrumentation employing a CISPR quasi-peak detector and above 1000 MHz are based on the average value of measured emissions.

5.5.2 Measurement Procedure

5.5.2.1 Band-edge Compliance of RF Conducted Emissions

5.5.2.1.1 Reference Level Measurement

Establish a reference level by using the following procedure:

- 1) Set instrument center frequency to DTS channel center frequency.
- 2) Set the span to ≥ 1.5 times the DTS bandwidth.
- 3) Set the RBW = 100 kHz.
- 4) Set the VBW $\geq 3 \times$ RBW.
- 5) Detector = peak.
- 6) Sweep time = auto couple.
- 7) Trace mode = max hold.
- 8) Allow trace to fully stabilize.
- 9) Use the peak marker function to determine the maximum PSD level.

5.5.2.1.2 Emissions Level Measurement

- 1) Set the center frequency and span to encompass frequency range to be measured.
- 2) Set the RBW = 100 kHz.
- 3) Set the VBW $\geq 3 \times$ RBW.
- 4) Detector = peak.
- 5) Ensure that the number of measurement points $\geq \text{span/RBW}$
- 6) Sweep time = auto couple.
- 7) Trace mode = max hold.
- 8) Allow trace to fully stabilize.
- 9) Use the peak marker function to determine the maximum amplitude level.

Ensure that the amplitude of all unwanted emissions outside of the authorized frequency band (excluding restricted frequency bands) are attenuated by at least the minimum requirements specified in 11.1 a) or 11.1 b). Report the three highest emissions relative to the limit.

5.5.2.2 Conducted Spurious Emissions

Set the spectrum analyzer as follows:

- 1) Span = wide enough to capture the peak level of the in-band emission and all spurious emissions (e.g., harmonics) from the lowest frequency generated in the EUT up through the 10th harmonic.
Typically, several plots are required to cover this entire span.
- 2) RBW = 100 kHz
- 3) VBW \geq RBW
- 4) Sweep = auto
- 5) Detector function = peak
- 6) Trace = max hold
- 7) Allow the trace to stabilize. Set the marker on the peak of any spurious emission recorded.
- 8) Each frequency found during preliminary measurements was re-examined and investigated.
The test-receiver system was set up to average, peak, and quasi-peak detector function with specified bandwidth.

5.5.2.3 Radiated Spurious Emissions

- 1) The preliminary and final radiated measurements were performed to determine the frequency producing the maximum emissions in at a 10m anechoic chamber. The EUT was tested at a distance 3 meters.
- 2) The EUT was placed on the top of the 0.8-meter height, 1 \times 1.5 meter non-metallic table. To find the maximum emission levels, the height of a measuring antenna was changed and the turntable was rotated 360°.
- 3) The antenna polarization was also changed from vertical to horizontal. The spectrum was scanned from 9 kHz to 30 MHz using the loop antenna, and from 30 to 1000 MHz using the TRILOG broadband antenna, and from 1 000 MHz to 26 500 MHz using the horn antenna.
- 4) Each frequency found during preliminary measurements was re-examined and investigated. The test-receiver system was set up to average, peak, and quasi-peak detector function with specified bandwidth.

- Sample calculation

The field strength is calculated adding the antenna Factor, cable loss and, Antenna pad adding, subtracting the amplifier gain from the measured reading.

** The sample calculation is as follow:

$$\text{Result} = \text{M.R} + \text{C.F}(\text{A.F} + \text{C.L} + 3 \text{ dB Att} - \text{A.G})$$

M.R = Meter Reading

C.F = Correction Factor

A.F = Antenna Factor

C.L = Cable Loss

A.G = Amplifier Gain

3 dB Att = 3 dB Attenuator

5.5.3 Test Result

- Complied

1. Conducted Spurious Emissions was shown in figure 5.
Note: We took the insertion loss of the cable into consideration within the measuring instrument.
2. Band edge compliance of Radiated Emissions(Restricted Bands) was shown in figure 6.
3. Measured value of the Field strength of spurious Emissions (Radiated)

* 802.11b

Low channel (2 412 MHz)

Frequency [MHz]	Receiver Bandwidth [kHz]	Pol. [V/H]	Reading [dB(μV)]	Factor [dB]	Result [dB(μV/m)]	Limit [dB(μV/m)]	Margin [dB]
Quasi-Peak DATA. Emissions below 30 MHz (3m Distance)							
Below 30.000	Not Detected	-	-	-	-	-	-
Quasi-Peak DATA. Emissions below 1 GHz							
114.754	120	V	43.9	-16.1	27.8	43.5	15.7
829.886	120	H	40.8	-2.1	38.7	54.0	15.3
Above 900.000	Not Detected	-	-	-	-	-	-
Peak DATA. Emissions above 1 GHz							
Above 1 000.000	Not Detected	-	-	-	-	-	-
Average DATA. Emissions above 1 GHz							
Above 1 000.000	Not Detected	-	-	-	-	-	-

Middle channel (2 437 MHz)

Frequency [MHz]	Receiver Bandwidth [kHz]	Pol. [V/H]	Reading [dB(μV)]	Factor [dB]	Result [dB(μV/m)]	Limit [dB(μV/m)]	Margin [dB]
Quasi-Peak DATA. Emissions below 30 MHz (3m Distance)							
Below 30.000	Not Detected	-	-	-	-	-	-
Quasi-Peak DATA. Emissions below 1 GHz							
113.420	120	V	43.8	-15.9	27.9	43.5	15.6
Above 200.000	Not Detected	-	-	-	-	-	-
Peak DATA. Emissions above 1 GHz							
Above 1 000.000	Not Detected	-	-	-	-	-	-
Average DATA. Emissions above 1 GHz							
Above 1 000.000	Not Detected	-	-	-	-	-	-

High channel (2 462 MHz)

Frequency [MHz]	Receiver Bandwidth [kHz]	Pol. [V/H]	Reading [dB(μV)]	Factor [dB]	Result [dB(μV/m)]	Limit [dB(μV/m)]	Margin [dB]
Quasi-Peak DATA. Emissions below 30 MHz (3m Distance)							
Below 30.000	Not Detected	-	-	-	-	-	-
Quasi-Peak DATA. Emissions below 1 GHz							
113.541	120	V	43.7	-15.9	27.8	43.5	15.7
Above 200.000	Not Detected	-	-	-	-	-	-
Peak DATA. Emissions above 1 GHz							
Above 1 000.000	Not Detected	-	-	-	-	-	-
Average DATA. Emissions above 1 GHz							
Above 1 000.000	Not Detected	-	-	-	-	-	-

*** 802.11g**

Low channel (2 412 MHz)

Frequency [MHz]	Receiver Bandwidth [kHz]	Pol. [V/H]	Reading [dB(μV)]	Factor [dB]	Result [dB(μV/m)]	Limit [dB(μV/m)]	Margin [dB]
Quasi-Peak DATA. Emissions below 30 MHz (3m Distance)							
Below 30.000	Not Detected	-	-	-	-	-	-
Quasi-Peak DATA. Emissions below 1 GHz							
114.511	120	V	44.3	-16.0	28.3	43.5	15.2
Above 200.000	Not Detected	-	-	-	-	-	-
Peak DATA. Emissions above 1 GHz							
Above 1 000.000	Not Detected	-	-	-	-	-	-
Average DATA. Emissions above 1 GHz							
Above 1 000.000	Not Detected	-	-	-	-	-	-

Middle channel (2 437 MHz)

Frequency [MHz]	Receiver Bandwidth [kHz]	Pol. [V/H]	Reading [dB(μV)]	Factor [dB]	Result [dB(μV/m)]	Limit [dB(μV/m)]	Margin [dB]
Quasi-Peak DATA. Emissions below 30 MHz (3m Distance)							
Below 30.000	Not Detected	-	-	-	-	-	-
Quasi-Peak DATA. Emissions below 1 GHz							
112.935	120	V	44.1	-15.9	28.2	43.5	15.3
Above 200.000	Not Detected	-	-	-	-	-	-
Peak DATA. Emissions above 1 GHz							
Above 1 000.000	Not Detected	-	-	-	-	-	-
Average DATA. Emissions above 1 GHz							
Above 1 000.000	Not Detected	-	-	-	-	-	-

High channel (2 462 MHz)

Frequency [MHz]	Receiver Bandwidth [kHz]	Pol. [V/H]	Reading [dB(μV)]	Factor [dB]	Result [dB(μV/m)]	Limit [dB(μV/m)]	Margin [dB]
Quasi-Peak DATA. Emissions below 30 MHz (3m Distance)							
Below 30.000	Not Detected	-	-	-	-	-	-
Quasi-Peak DATA. Emissions below 1 GHz							
114.269	120	V	44.2	-16.0	28.2	43.5	15.3
Above 200.000	Not Detected	-	-	-	-	-	-
Peak DATA. Emissions above 1 GHz							
Above 1 000.000	Not Detected	-	-	-	-	-	-
Average DATA. Emissions above 1 GHz							
Above 1 000.000	Not Detected	-	-	-	-	-	-

*** 802.11n HT20**

Low channel (2 412 MHz)

Frequency [MHz]	Receiver Bandwidth [kHz]	Pol. [V/H]	Reading [dB(μV)]	Factor [dB]	Result [dB(μV/m)]	Limit [dB(μV/m)]	Margin [dB]
Quasi-Peak DATA. Emissions below 30 MHz (3m Distance)							
Below 30.000	Not Detected	-	-	-	-	-	-
Quasi-Peak DATA. Emissions below 1 GHz							
114.996	120	V	44.5	-16.1	28.4	43.5	15.1
Above 200.000	Not Detected	-	-	-	-	-	-
Peak DATA. Emissions above 1 GHz							
Above 1 000.000	Not Detected	-	-	-	-	-	-
Average DATA. Emissions above 1 GHz							
Above 1 000.000	Not Detected	-	-	-	-	-	-

Middle channel (2 437MHz)

Frequency [MHz]	Receiver Bandwidth [kHz]	Pol. [V/H]	Reading [dB(μV)]	Factor [dB]	Result [dB(μV/m)]	Limit [dB(μV/m)]	Margin [dB]
Quasi-Peak DATA. Emissions below 30 MHz (3m Distance)							
Below 30.000	Not Detected	-	-	-	-	-	-
Quasi-Peak DATA. Emissions below 1 GHz							
114.269	120	V	44.1	-16.0	28.1	43.5	15.4
Above 200.000	Not Detected	-	-	-	-	-	-
Peak DATA. Emissions above 1 GHz							
Above 1 000.000	Not Detected	-	-	-	-	-	-
Average DATA. Emissions above 1 GHz							
Above 1 000.000	Not Detected	-	-	-	-	-	-

High channel (2 462 MHz)

Frequency [MHz]	Receiver Bandwidth [kHz]	Pol. [V/H]	Reading [dB(μV)]	Factor [dB]	Result [dB(μV/m)]	Limit [dB(μV/m)]	Margin [dB]
Quasi-Peak DATA. Emissions below 30 MHz (3m Distance)							
Below 30.000	Not Detected	-	-	-	-	-	-
Quasi-Peak DATA. Emissions below 1 GHz							
114.269	120	V	41.6	-16.0	25.6	43.5	17.9
Above 200.000	Not Detected	-	-	-	-	-	-
Peak DATA. Emissions above 1 GHz							
Above 1 000.000	Not Detected	-	-	-	-	-	-
Average DATA. Emissions above 1 GHz							
Above 1 000.000	Not Detected	-	-	-	-	-	-

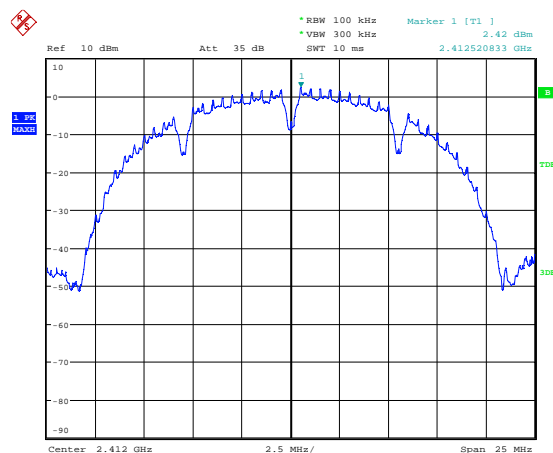
5.5.4 Test Plot

Figure 5. Plot of the Band-edge & Conducted Spurious Emissions

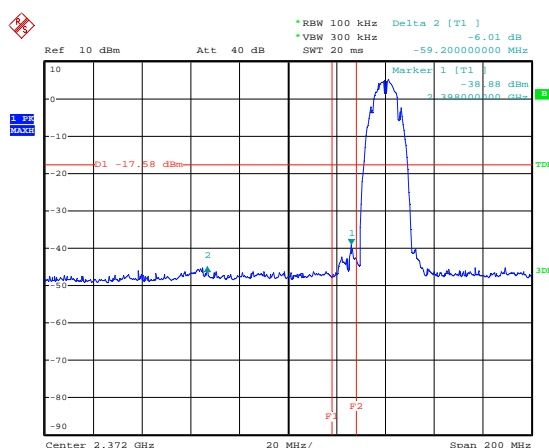
*** 802.11b**

Lowest Channel (2 412 MHz)

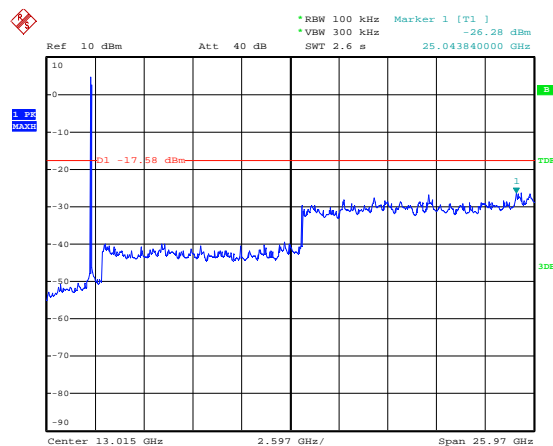
Reference



Band-edge

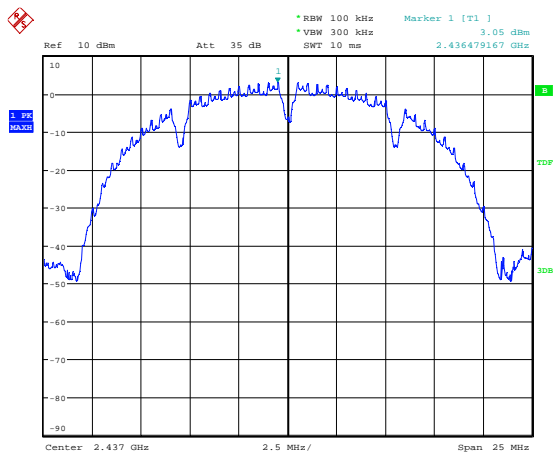


Conducted Spurious Emissions

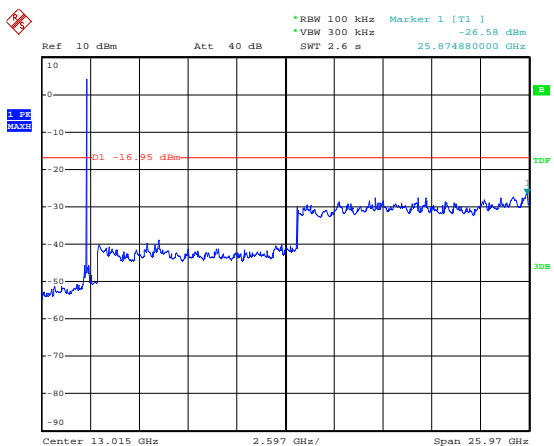


Middle Channel (2 437 MHz)

Reference

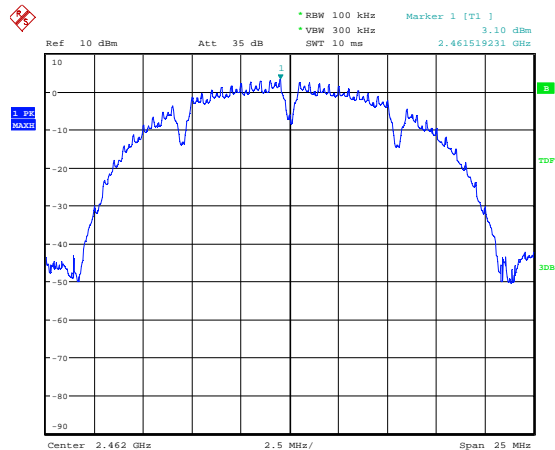


Conducted Spurious Emissions

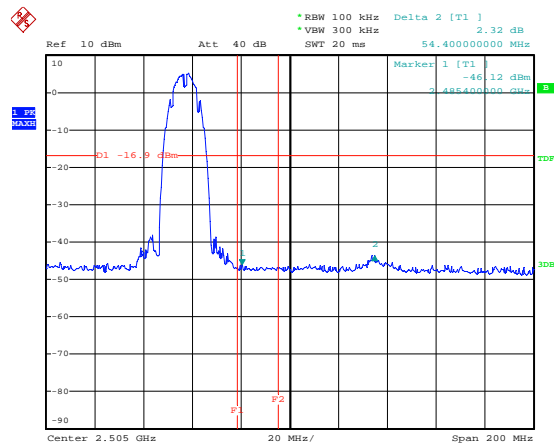


Highest Channel (2 462 MHz)

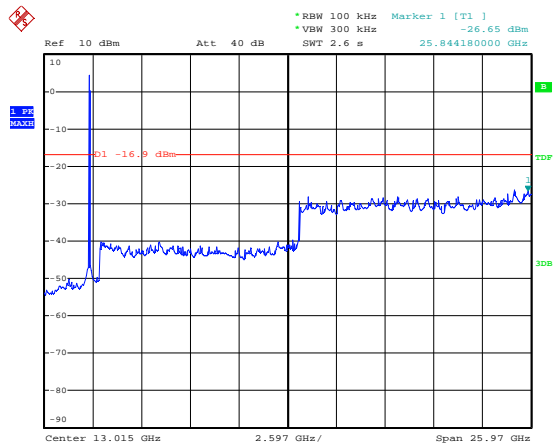
Reference



Band-edge



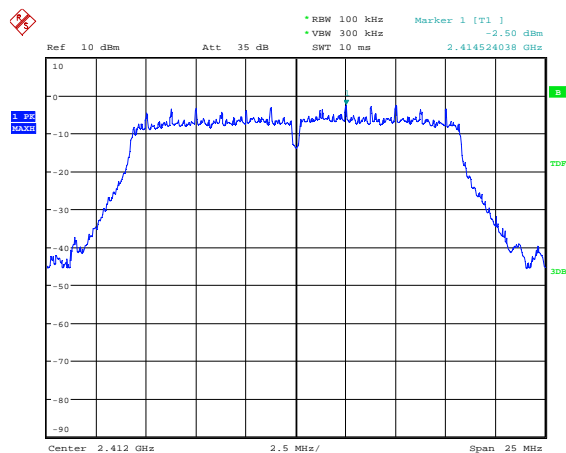
Conducted Spurious Emissions



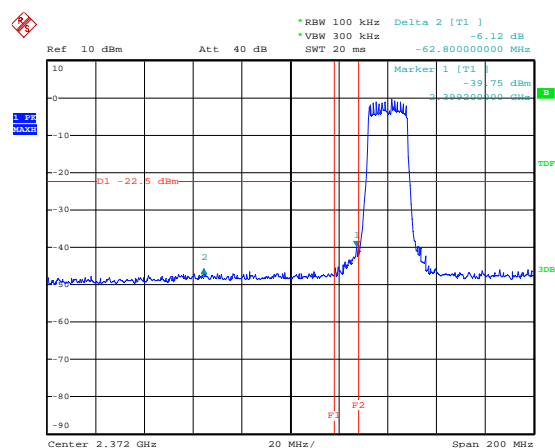
* 802.11g

Lowest Channel (2 412 MHz)

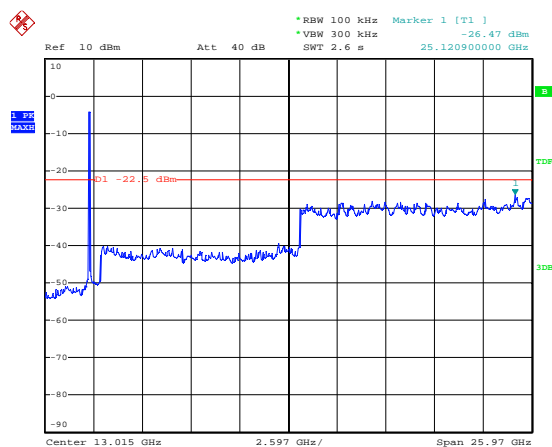
Reference



Band-edge

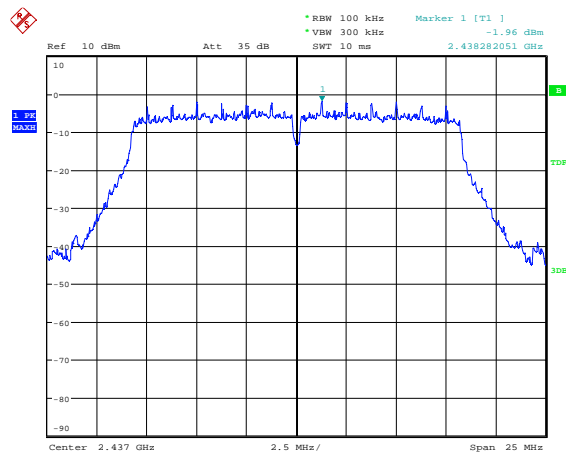


Conducted Spurious Emissions

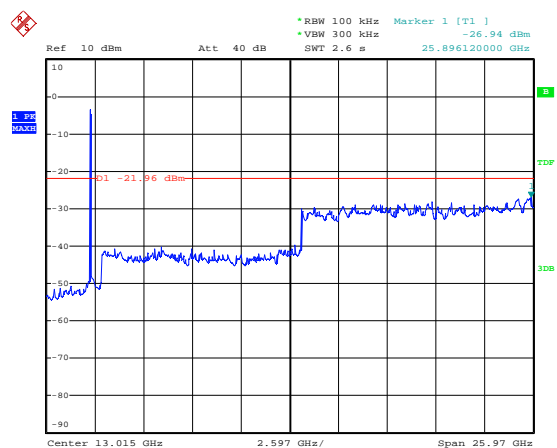


Middle Channel (2 437 MHz)

Reference

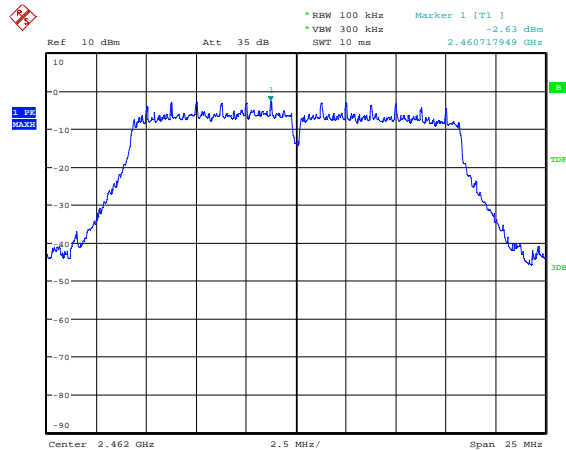


Conducted Spurious Emissions

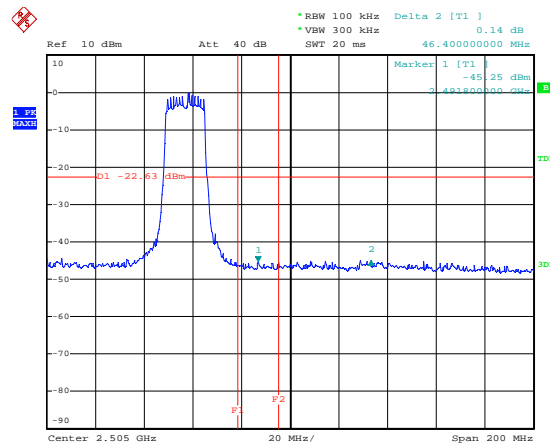


Highest Channel (2 462 MHz)

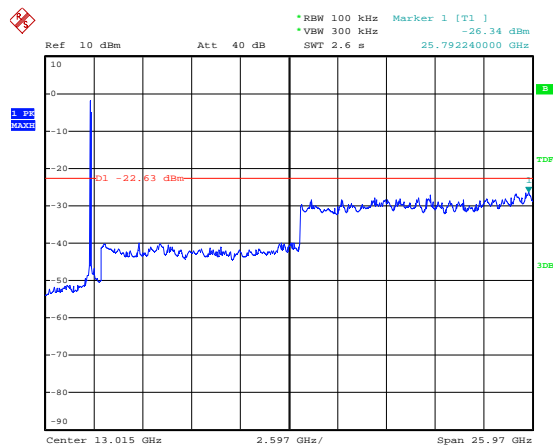
Reference



Band-edge



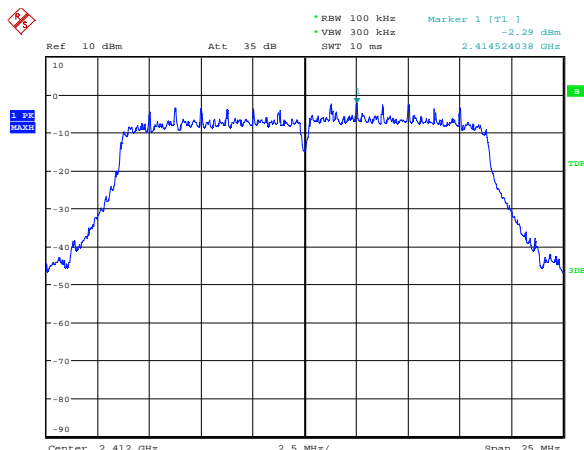
Conducted Spurious Emissions



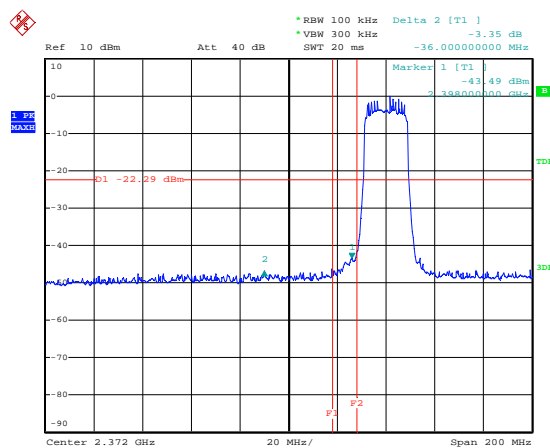
*** 802.11n HT20**

Lowest Channel (2 412 MHz)

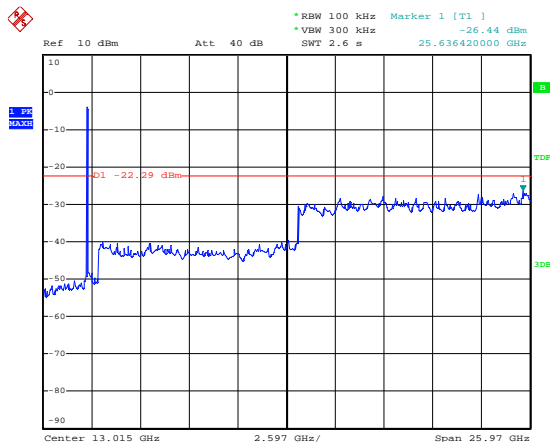
Reference



Band-edge

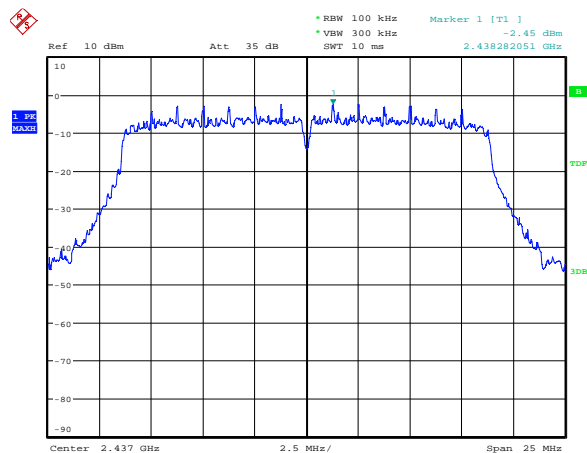


Conducted Spurious Emissions

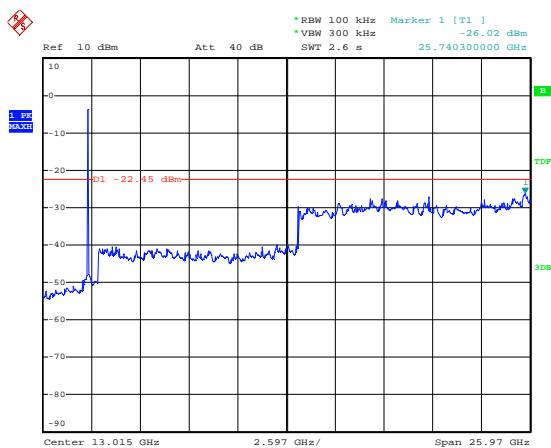


Middle Channel (2 437 MHz)

Reference

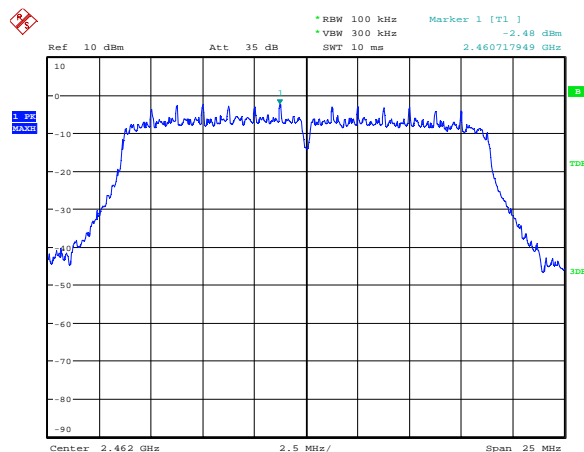


Conducted Spurious Emissions

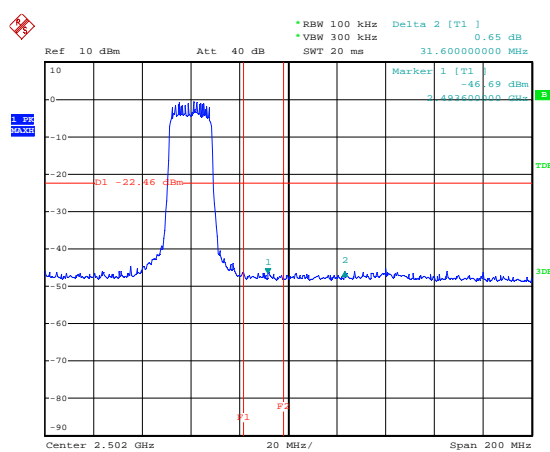


Highest Channel (2 462 MHz)

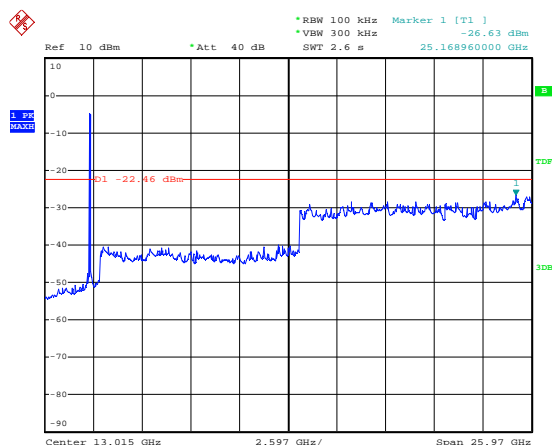
Reference



Band-edge



Conducted Spurious Emissions

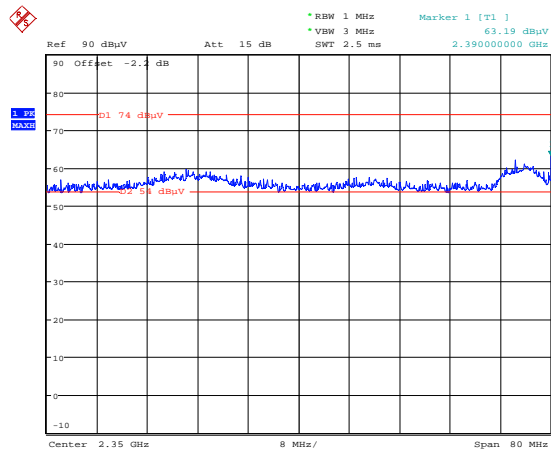


5.5.4 Test Plot (Continue)

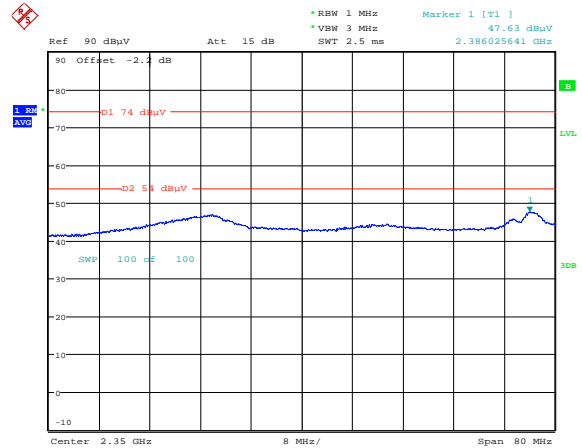
Figure 6. Plot of the Band Edge (Radiated Restricted Bands)

*** 802.11b**

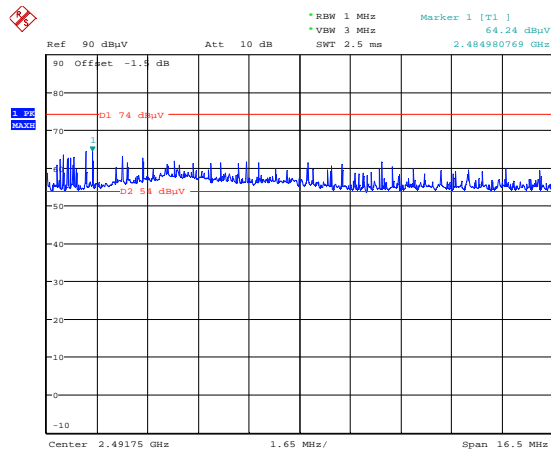
Lowest Channel(2 412 MHz): Peak



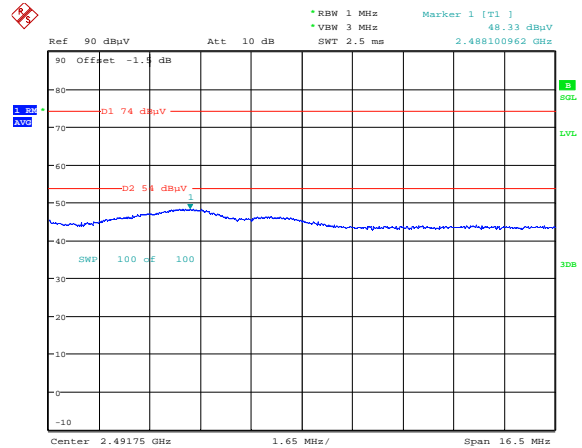
Lowest Channel(2 412 MHz): Average



Highest Channel(2 462 MHz): Peak



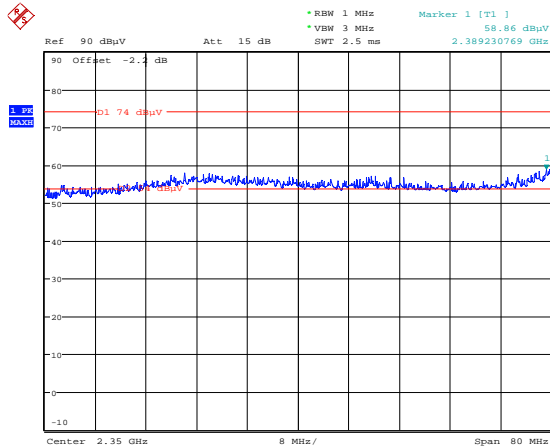
Highest Channel(2 462 MHz): Average



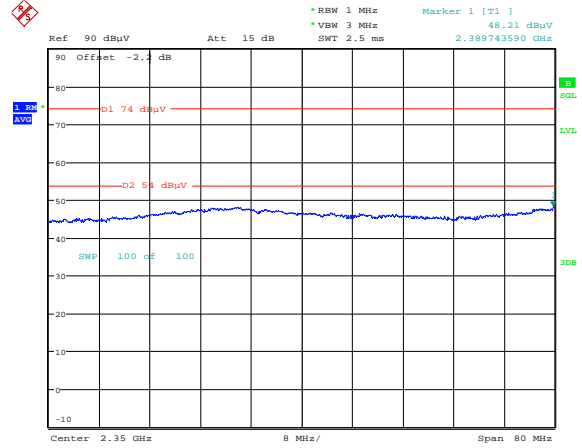
* offset = Factor (ANT Factor+ Amp Gain + Cable Loss) [dB]
= -2.2 dB (2 412 MHz)
= -1.5 dB (2 462 MHz)

*** 802.11g**

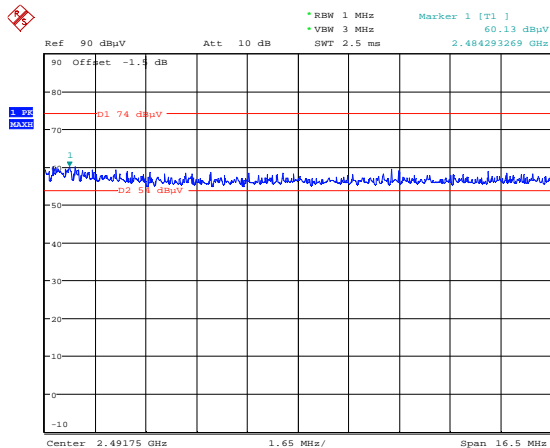
Lowest Channel(2 412 MHz): Peak



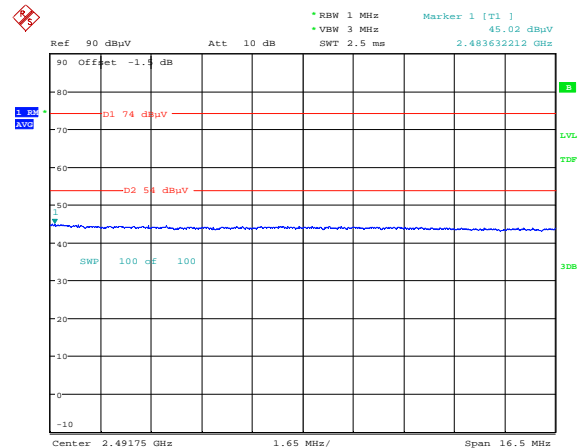
Lowest Channel(2 412 MHz): Average



Highest Channel(2 462 MHz): Peak



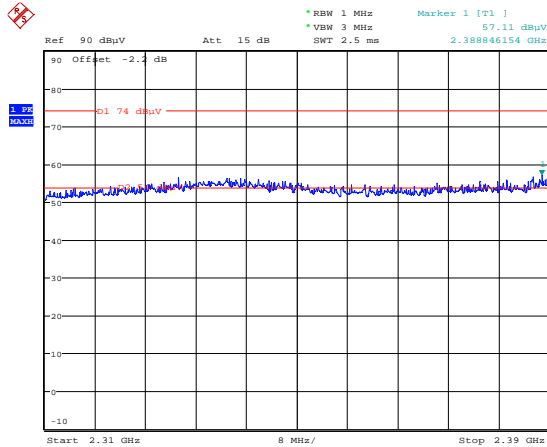
Highest Channel(2 462 MHz): Average



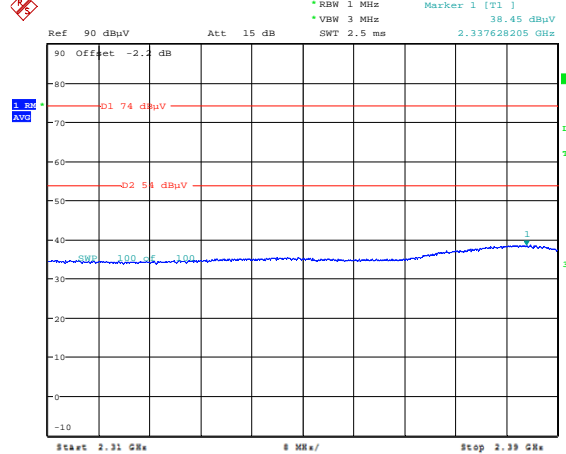
* offset = Factor (ANT Factor+ Amp Gain + Cable Loss) [dB]
= -2.2 dB (2 412 MHz)
= -1.5 dB (2 462 MHz)

*** 802.11n HT20**

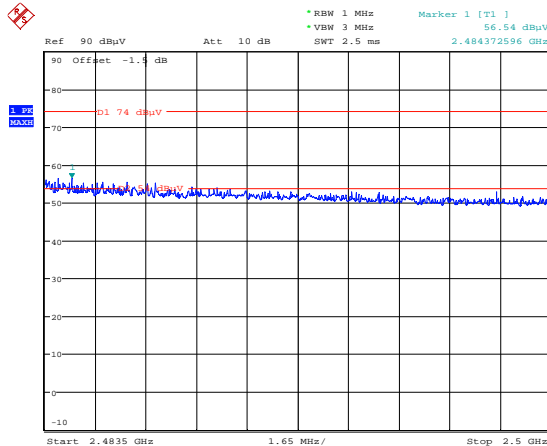
Lowest Channel(2 412 MHz): Peak



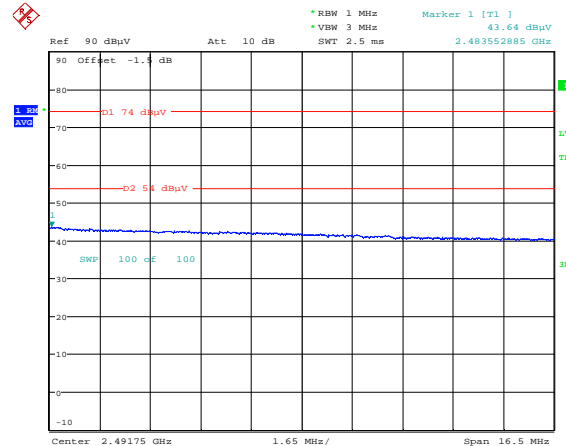
Lowest Channel(2 412 MHz): Average



Highest Channel(2 462 MHz): Peak



Highest Channel(2 462 MHz): Average



* offset = Factor (ANT Factor+ Amp Gain + Cable Loss) [dB]
= -2.2 dB (2 412 MHz)
= -1.5 dB (2 462 MHz)

5.6 RF Exposure

5.6.1 Regulation

According to §15.247(i), systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines. See § 1.1307(b)(1) of this Chapter.

Limits for Maximum Permissible Exposure: RF exposure is calculated.

Frequency Range	Electric Field Strength [V/m]	Magnetic Field Strength [A/m]	Power Density [mW/cm ²]	Averaging Time [minute]
Limits for General Population / Uncontrolled Exposure				
0.3 ~ 1.34	614	1.63	*(100)	30
1.34 ~ 30	824/f	2.19/f	*(180/f ²)	30
30 ~ 300	27.5	0.073	0.2	30
300 ~ 1 500	/	/	f/1 500	30
1 500 ~ 15 000	/	/	1.0	30

f=frequency in MHz, * = plane-wave equivalent power density

MPE (Maximum Permissible Exposure) Prediction

Prediction of MPE limit at a given distance: Equation from page 18 of OET Bulletin 65, Edition 97-01

$$S = PG/4\pi R^2 \quad (\Rightarrow R = \sqrt{PG/4\pi S})$$

S = power density [mW/cm²]

P = Power input to antenna [mW]

G = Power gain of the antenna in the direction of interest relative to an isotropic radiator

R = distance to the center of radiation of the antenna [cm]

EUT: Maximum peak output power = 93.97 [mW] (19.73 dBm) Antenna gain = 1.76 (2.46 [dBi])	
100 mW, at 20 cm from an antenna 6 [dBi]	$S = PG/4\pi R^2 = 100 \times 3.98 / (4 \times \pi \times 400)$ $= 0.07918 \text{ [mW/cm}^2\text{]} < 1.0 \text{ [mW/cm}^2\text{]}$
43.954 mW, at 20 cm from an antenna 2.46 [dBi]	$S = PG/4\pi R^2 = 0.03294 \text{ [mW/cm}^2\text{]} < 1.0 \text{ [mW/cm}^2\text{]}$

5.6.2 RF Exposure Compliance Issue

The information should be included in the user's manual:

This appliance and its antenna must not be co-located or operation in conjunction with any other antenna or transmitter. A minimum separation distance of 20 cm must be maintained between the antenna and the person for this appliance to satisfy the RF exposure requirements.

5.6.3 Calculation Result of RF Exposure

*** 802.11b**

Channel	Frequency [MHz]	Ant Gain [mW]	power [dBm]	power [mW]	Power Density at 20 cm [mW/cm ²]
Lowest	2 412	1.76	19.73	93.97	0.032 90
Middle	2 437	1.76	19.51	89.33	0.031 28
Highest	2 462	1.76	19.57	90.57	0.031 71

*** 802.11g**

Channel	Frequency [MHz]	Ant Gain [mW]	power [dBm]	power [mW]	Power Density at 20 cm [mW/cm ²]
Lowest	2 412	1.76	19.50	89.13	0.031 21
Middle	2 437	1.76	19.49	88.92	0.031 13
Highest	2 462	1.76	19.53	89.74	0.031 42

*** 802.11n HT20**

Channel	Frequency [MHz]	Ant Gain [mW]	power [dBm]	power [mW]	Power Density at 20 cm [mW/cm ²]
Lowest	2 412	1.76	19.44	87.90	0.030 78
Middle	2 437	1.76	19.36	86.30	0.030 22
Highest	2 462	1.76	19.33	85.70	0.030 01

6. Test equipment used for test

	Description	Manufacture	Model No.	Serial No.	Next Cal Date.
■	Spectrum Analyzer	R&S	FSG13	100051	14.02.15
■	DC Power Supply	Agilent	E3632A	MY51220373	14.12.24
■	Signal Generator	R&S	SMR40	100007	14.06.11
■	Test Receiver	R&S	ESCI7	100732	14.02.18
■	Spectrum Analyzer	R&S	FSP40	100209	14.10.21
■	Loop Antenna	R&S	HFH2-Z2	100355	15.06.19
■	Bi-Log Antenna	Schwarzbeck	VULB9163	552	14.07.18
■	Horn Antenna	ETS-Lindgren	3115	86706	14.08.20
■	Horn Antenna	ETS-Lindgren	3116	00086632	15.11.15
■	Amplifier	Sonoma	310N	186280	14.02.15
■	Amplifier	Schwarzbeck	BBV9718	233	14.05.03
■	Amplifier	Schwarzbeck	BBV9721	2	14.05.09
■	Attenuator	HP	8491A	16861	14.07.08
■	Antenna Mast	Innco Systems	MA4000-EP	303	-
■	Turn Table	Innco Systems	DT2000S-1t	79	-