FCC Test Report
(2.4GHz WLAN)

Report No.: RF200709D02-3

FCC ID: 2AK5B-HB1

Test Model: HB1LW1NA1

Received Date: Jul. 9, 2020

Test Date: Jul. 10 to Aug. 17, 2020

Issued Date: Aug. 20, 2020

Applicant: Latchable, Inc.

Address: 508 West 26th Street Suite 6G New York, NY 10001

Issued By: Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch Lin Kou Laboratories

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FCC Registration / Designation Number: 198487 / TW2021

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Release Control Record

Issue No.	Description	Date Issued
RF200709D02-3	Original release.	Aug. 20, 2020

1 Certificate of Conformity

Product: Hub

Brand: LATCH

Test Model: HB1LW1NA1

Sample Status: Engineering sample

Applicant: Latchable, Inc.

Test Date: Jul. 10 to Aug. 17, 2020

Standards: 47 CFR FCC Part 15, Subpart C (Section 15.247)
ANSI C63.10: 2013

The above equipment has been tested by **Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch**, and found compliance with the requirement of the above standards. The test record, data evaluation & Equipment Under Test (EUT) configurations represented herein are true and accurate accounts of the measurements of the sample's RF characteristics under the conditions specified in this report.

Prepared by : _____ , **Date:** Aug. 20, 2020
Celia Chen / Supervisor

Approved by : _____ , **Date:** Aug. 20, 2020
Rex Lai / Associate Technical Manager

2 Summary of Test Results

47 CFR FCC Part 15, Subpart C (Section 15.247)			
FCC Clause	Test Item	Result	Remarks
15.207	AC Power Conducted Emission	Pass	Meet the requirement of limit. Minimum passing margin is -13.83dB at 0.34141MHz.
15.205 / 15.209 / 15.247(d)	Radiated Emissions and Band Edge Measurement	Pass	Meet the requirement of limit. Minimum passing margin is -1.01dB at 2483.50MHz.
15.247(d)	Antenna Port Emission	Pass	Meet the requirement of limit.
15.247(a)(2)	6dB bandwidth	Pass	Meet the requirement of limit.
15.247(b)	Conducted power	Pass	Meet the requirement of limit.
15.247(e)	Power Spectral Density	Pass	Meet the requirement of limit.
15.203	Antenna Requirement	Pass	Antenna connector is I-PEX not a standard connector.

Note:
1. Determining compliance based on the results of the compliance measurement, not taking into account measurement instrumentation uncertainty.
2. For 2.4GHz band compliance with rule 15.247(d) of the band-edge items, the test plots were recorded in Annex A. Test Procedures refer to report 4.1.3.

2.1 Measurement Uncertainty

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the EUT as specified in CISPR 16-4-2:

Measurement	Frequency	Expanded Uncertainty (k=2) (±)
Conducted Emissions at mains ports	150kHz ~ 30MHz	3.00 dB
Conducted Emissions	9kHz ~ 40GHz	2.63 dB
Radiated Emissions up to 1 GHz	9kHz ~ 30MHz	2.61 dB
	30MHz ~ 1GHz	5.43 dB
Radiated Emissions above 1 GHz	Above 1GHz	5.42 dB

2.2 Modification Record

There were no modifications required for compliance.

3 General Information

3.1 General Description of EUT

Product	Hub
Brand	LATCH
Test Model	HB1LW1NA1
Status of EUT	Engineering sample
Power Supply Rating	12Vdc from adapter or 7.5Vdc from battery
Modulation Type	CCK, DQPSK, DBPSK for DSSS 64QAM, 16QAM, QPSK, BPSK for OFDM
Modulation Technology	DSSS,OFDM
Transfer Rate	802.11b:11/5.5/2/1Mbps 802.11g: 54/48/36/24/18/12/9/6Mbps 802.11n: up to 300Mbps
Operating Frequency	2412MHz ~ 2462MHz
Number of Channel	802.11b, 802.11g, 802.11n (20MHz): 11 802.11n (40MHz): 7
Output Power	591.16mW
Antenna Type	Ant. 4: Dipole Antenna with 2.5dBi gain Ant. 5: Dipole Antenna with 3.2dBi gain
Antenna Connector	I-PEX
Accessory Device	Adapter
Data Cable Supplied	N/A

Note:

1. The EUT provides 2 completed transmitter and 2 receiver.

Modulation Mode	TX Function
802.11b	2TX
802.11g	2TX
802.11n (20MHz)	2TX
802.11n (40MHz)	2TX

2. The EUT was pre-tested with the following modes:
   - ✧ Operating Mode (EUT + Battery)
   - ✧ Operating + Charging Mode (EUT + Adapter)

   The worst emission level was found when the EUT tested under **Operating + Charging Mode (EUT + Adapter)**, therefore, only its test data was recorded in this report.
3. The EUT uses following adapter or battery.

Item	Adapter	Battery
Brand	APD	Simplo
Model	WB-24J12FU	NA50X
AC I/P Rating	100-240V, 50-60Hz, 0.7A	-
DC O/P Rating	12V, 2A	7.5V, 2500mAh, 18Wh
Power cord	AC 2 Pin, Non-shielded DC cable (1.5m)	-

4. 2.4GHz & 5GHz WLAN technologies cannot transmit at same time.

   WCDMA & LTE technologies cannot transmit at same time.

   WLAN, WWAN, Bluetooth, Zigbee & Z-Wave technologies can transmit at same time.
5. The above Antenna information is declared by manufacturer and for more detailed features description, please refer to the manufacturer's specifications, the laboratory shall not be held responsible.
6. The above EUT information is declared by manufacturer and for more detailed features description, please refer to the manufacturer's specifications or user's manual.

3.2 Description of Test Modes

11 channels are provided for 802.11b, 802.11g and 802.11n (20MHz):

Channel	Frequency	Channel	Frequency
1	2412MHz	7	2442MHz
2	2417MHz	8	2447MHz
3	2422MHz	9	2452MHz
4	2427MHz	10	2457MHz
5	2432MHz	11	2462MHz
6	2437MHz		

7 channels are provided for 802.11n (40MHz):

Channel	Frequency	Channel	Frequency
3	2422MHz	7	2442MHz
4	2427MHz	8	2447MHz
5	2432MHz	9	2452MHz
6	2437MHz		

3.2.1 Test Mode Applicability and Tested Channel Detail

EUT Configure Mode	Applicable To				Description
	RE≥1G	RE<1G	PLC	APCM	
-	√	√	√	√	Operating + Charging Mode (EUT + Adapter)

Where **RE≥1G:** Radiated Emission above 1GHz & Bandedge Measurement **RE<1G:** Radiated Emission below 1GHz
PLC: Power Line Conducted Emission **APCM:** Antenna Port Conducted Measurement

NOTE: The EUT had been pre-tested on the positioned of each 3 axis. The worst case was found when positioned on **Z-plane**.

Radiated Emission Test (Above 1GHz):

☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).
☒ Following channel(s) was (were) selected for the final test as listed below.

EUT Configure Mode	Mode	Available Channel	Tested Channel	Modulation Technology	Modulation Type	Data Rate (Mbps)
-	802.11b	1 to 11	1, 6, 11	DSSS	DBPSK	1
-	802.11g	1 to 11	1, 6, 11	OFDM	BPSK	6
-	802.11n (20MHz)	1 to 11	1, 6, 11	OFDM	BPSK	6.5
-	802.11n (40MHz)	3 to 9	3, 6, 9	OFDM	BPSK	13.5

Radiated Emission Test (Below 1GHz):

☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).
☒ Following channel(s) was (were) selected for the final test as listed below.

EUT Configure Mode	Mode	Available Channel	Tested Channel	Modulation Technology	Modulation Type	Data Rate (Mbps)
-	802.11g	1 to 11	6	OFDM	BPSK	6

Power Line Conducted Emission Test:

☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).
☒ Following channel(s) was (were) selected for the final test as listed below.

EUT Configure Mode	Mode	Available Channel	Tested Channel	Modulation Technology	Modulation Type	Data Rate (Mbps)
-	802.11g	1 to 11	6	OFDM	BPSK	6

Antenna Port Conducted Measurement:

☒ This item includes all test value of each mode, but only includes spectrum plot of worst value of each mode.

☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).

☒ Following channel(s) was (were) selected for the final test as listed below.

EUT Configure Mode	Mode	Available Channel	Tested Channel	Modulation Technology	Modulation Type	Data Rate (Mbps)
-	802.11b	1 to 11	1, 6, 11	DSSS	DBPSK	1
-	802.11g	1 to 11	1, 6, 11	OFDM	BPSK	6
-	802.11n (20MHz)	1 to 11	1, 6, 11	OFDM	BPSK	6.5
-	802.11n (40MHz)	3 to 9	3, 6, 9	OFDM	BPSK	13.5

Test Condition:

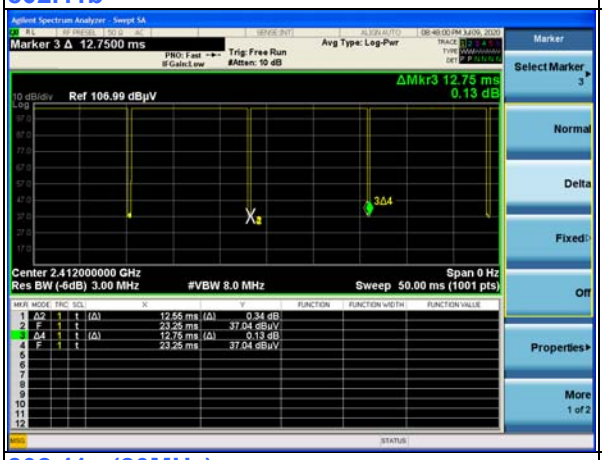
Applicable To	Environmental Conditions	Input Power	Tested By
RE≥1G	25deg. C, 75%RH	120Vac, 60Hz	Ian Chang
RE<1G	22deg. C, 69%RH	120Vac, 60Hz	Ian Chang
PLC	25deg. C, 75%RH	120Vac, 60Hz	Ian Chang
APCM	25deg. C, 76%RH	120Vac, 60Hz	Saxon Lee

3.3 Duty Cycle of Test Signal

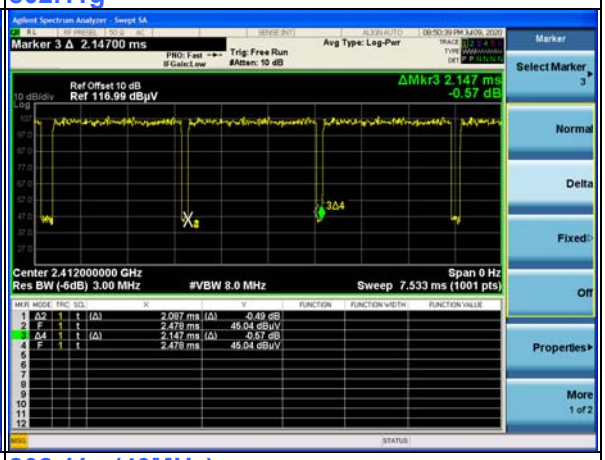
If duty cycle of test signal is ≥ 98 %, duty factor is not required.
If duty cycle of test signal is < 98%, duty factor shall be considered.

802.11b: Duty cycle = 12.55/12.75 = 0.984
802.11g: Duty cycle = 2.087/2.147 = 0.972, Duty factor = 10 * log(1/0.972) = 0.12
802.11n (20MHz): Duty cycle = 1.951/2.057 = 0.948, Duty factor = 10 * log(1/0.948) = 0.23
802.11n (40MHz): Duty cycle = 0.957/1.146 = 0.835, Duty factor = 10 * log(1/0.835) = 0.78

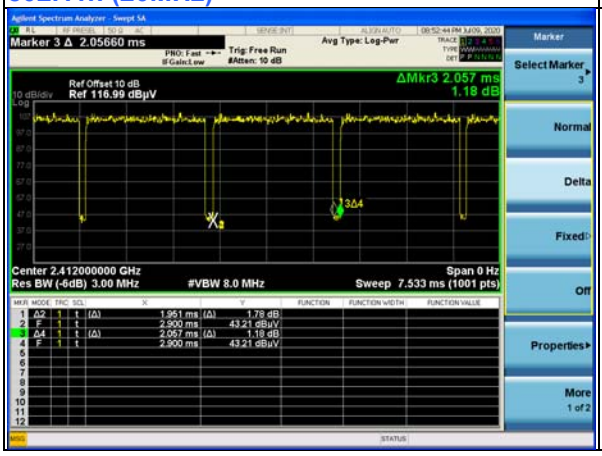
802.11b



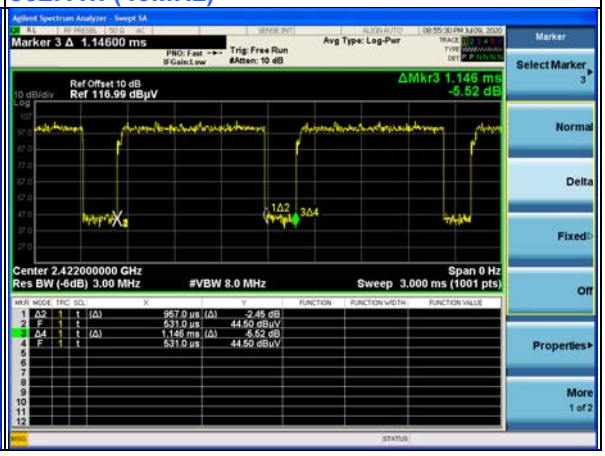
802.11g



802.11n (20MHz)



802.11n (40MHz)



3.4 Description of Support Units

The EUT has been tested as an independent unit together with other necessary accessories or support units. The following support units or accessories were used to form a representative test configuration during the tests.

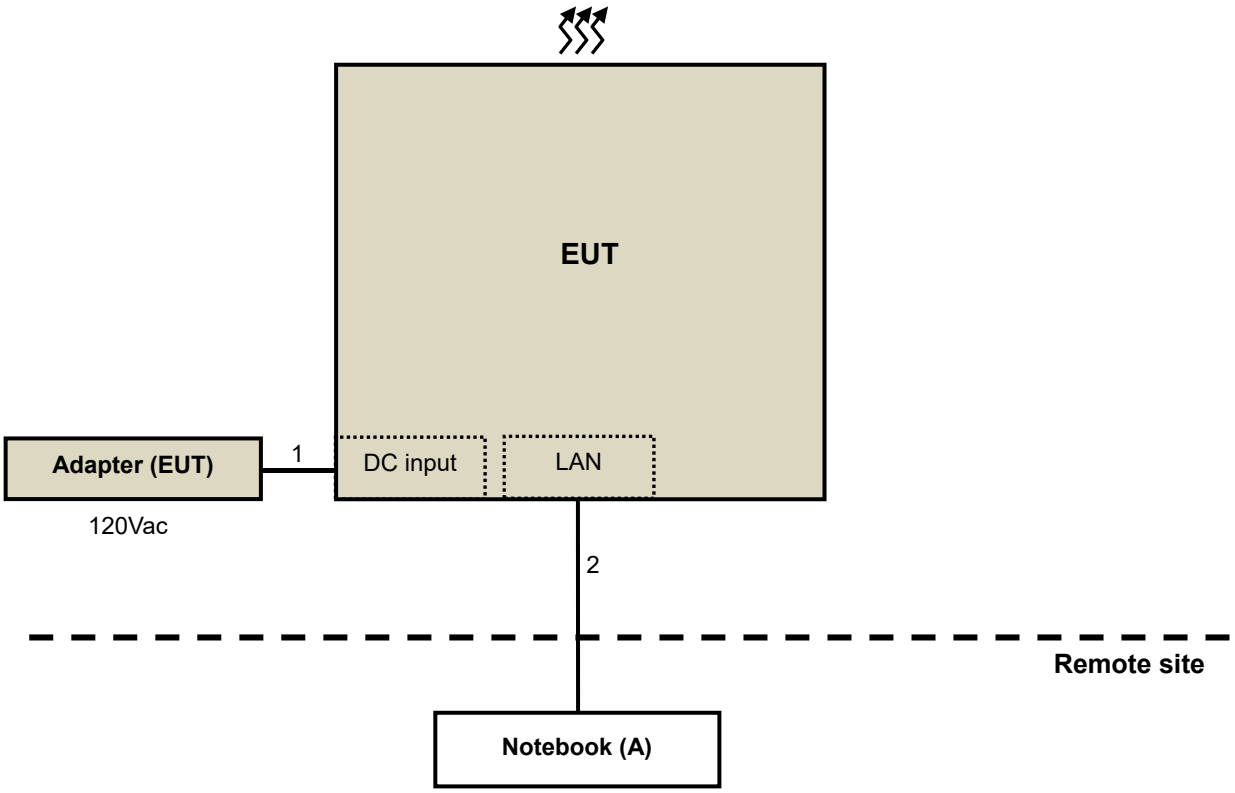
ID	Product	Brand	Model No.	Serial No.	FCC ID	Remarks
A.	Notebook PC	ASUS	PU401L	E9NXBC002007372	NA	Provided by Lab

Note:
1. All power cords of the above support units are non-shielded (1.8m).
2. Item A acted as communication partners to transfer data.

ID	Cable Descriptions	Qty.	Length (m)	Shielding (Yes/ No)	Cores (Qty.)	Remarks
1.	DC cable	1	1.5	N	0	Supplied by client
2.	LAN cable	1	10	N	0	Provided by Lab (RJ45, Cat.5e)

Note: The core(s) is(are) originally attached to the cable(s).

3.4.1 Configuration of System under Test



3.5 General Description of Applied Standards and References

The EUT is a RF Product. According to the specifications of the manufacturer, it must comply with the requirements of the following standards and references:

Test standard:

FCC Part 15, Subpart C (15.247)
ANSI C63.10-2013

All test items have been performed and recorded as per the above standards.

References Test Guidance:

KDB 558074 D01 15.247 Meas Guidance v05r02
KDB 662911 D01 Multiple Transmitter Output v02r01

All test items have been performed as a reference to the above KDB test guidance.

4 Test Types and Results

4.1 Radiated Emission and Bandedge Measurement

4.1.1 Limits of Radiated Emission and Bandedge Measurement

Radiated emissions which fall in the restricted bands must comply with the radiated emission limits specified as below table. Other emissions shall be at least 20dB below the highest level of the desired power:

Frequencies (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)
0.009 ~ 0.490	2400/F(kHz)	300
0.490 ~ 1.705	24000/F(kHz)	30
1.705 ~ 30.0	30	30
30 ~ 88	100	3
88 ~ 216	150	3
216 ~ 960	200	3
Above 960	500	3

NOTE:

1. The lower limit shall apply at the transition frequencies.
2. Emission level (dBuV/m) = 20 log Emission level (uV/m).
3. For frequencies above 1000MHz, the field strength limits are based on average detector, however, the peak field strength of any emission shall not exceed the maximum permitted average limits, specified above by more than 20dB under any condition of modulation.

4.1.2 Test Instruments

DESCRIPTION & MANUFACTURER	MODEL NO.	SERIAL NO.	CALIBRATED DATE	CALIBRATED UNTIL
HP Preamplifier	8447D	2432A03504	Feb. 19, 2020	Feb. 18, 2021
HP Preamplifier	8449B	3008A01201	Feb. 20, 2020	Feb. 19, 2021
MITEQ Preamplifier	AMF-6F-260400-33-8P	892164	Feb. 19, 2020	Feb. 18, 2021
Agilent TEST RECEIVER	N9038A	MY51210129	Mar. 18, 2020	Mar. 17, 2021
Schwarzbeck Antenna	VULB 9168	139	Nov. 7, 2019	Nov. 6, 2020
Schwarzbeck Antenna	VHBA 9123	480	Jun. 3, 2019	Jun. 2, 2021
Schwarzbeck Horn Antenna	BBHA-9170	212	Nov. 24, 2019	Nov. 23, 2020
Schwarzbeck Horn Antenna	BBHA 9120-D1	D130	Nov. 24, 2019	Nov. 23, 2020
ADT. Turn Table	TT100	0306	NA	NA
ADT. Tower	AT100	0306	NA	NA
Software	Radiated_V7.6.15.9.5	NA	NA	NA
SUHNER RF cable With 4dB PAD	SF102	Cable-CH6-01	Jul. 9, 2020	Jul. 8, 2021
SUHNER RF cable With 3/4dB PAD	SF102	Cable-CH8-3.6m	Jul. 9, 2020	Jul. 8, 2021
KEYSIGHT MIMO Powermeasurement Test set	U2021XA	U2021XA-001	Jun. 16, 2020	Jun. 15, 2021
KEYSIGHT Spectrum Analyzer	N9030A	MY54490260	Jul. 22, 2019	Jul. 21, 2020
			Jul. 22, 2020	Jul. 21, 2021
Loop Antenna EMCI	LPA600	270	Aug. 23, 2019	Aug. 22, 2021
EMCO Horn Antenna	3115	00028257	Nov. 24, 2019	Nov. 23, 2020
Highpass filter Wainwright Instruments	WHK 3.1/18G-10SS	SN 8	NA	NA
ROHDE & SCHWARZ Spectrum Analyzer	FSV40	101042	Sep. 23, 2019	Sep. 22, 2020
Anritsu Power Sensor	MA2411B	0738404	Apr. 13, 2020	Apr. 12, 2021
Anritsu Power Meter	ML2495A	0842014	Apr. 13, 2020	Apr. 12, 2021

NOTE: 1. The calibration interval of the above test instruments is 12/24 months. And the calibrations are traceable to NML/ROC and NIST/USA.
2. The horn antenna and HP preamplifier (model: 8449B) are used only for the measurement of emission frequency above 1GHz if tested.
3. The test was performed in Chamber No. 6.

4.1.3 Test Procedures

For Radiated emission below 30MHz

a. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter chamber room. The table was rotated 360 degrees to determine the position of the highest radiation.
b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
c. Parallel, perpendicular, and ground-parallel orientations of the antenna are set to make the measurement.
d. For each suspected emission, the EUT was arranged to its worst case and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
e. The test-receiver system was set to Quasi-Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.

NOTE:

1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 9kHz at frequency below 30MHz.

For Radiated emission above 30MHz

a. The EUT was placed on the top of a rotating table 0.8 meters (for 30MHz ~ 1GHz) / 1.5 meters (for above 1GHz) above the ground at 3 meter chamber room for test. The table was rotated 360 degrees to determine the position of the highest radiation.
b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
c. The height of antenna is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
d. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
e. The test-receiver system was set to quasi-peak detect function and specified bandwidth with maximum hold mode when the test frequency is below 1 GHz.
f. The test-receiver system was set to peak and average detects function and specified bandwidth with maximum hold mode when the test frequency is above 1 GHz. If the peak reading value also meets average limit, measurement with the average detector is unnecessary.

Note:

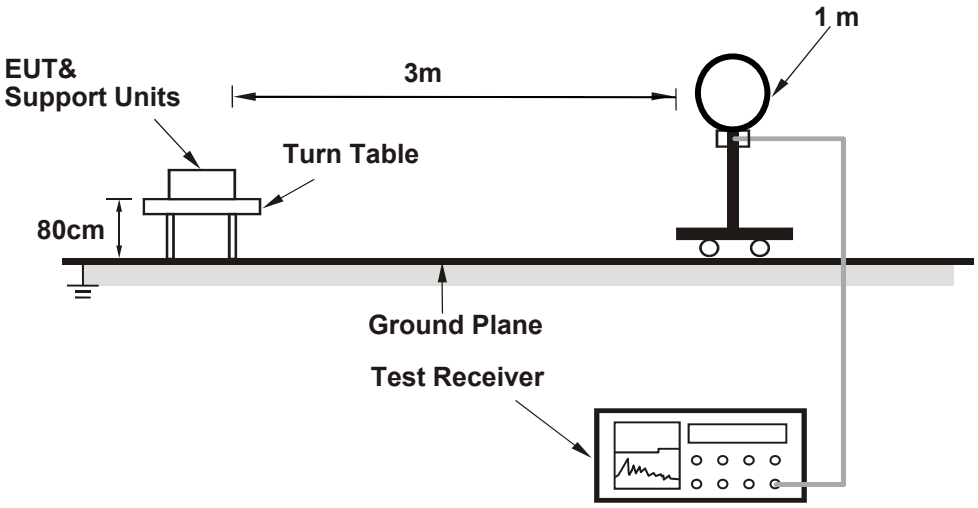
1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120kHz for Quasi-peak detection (QP) at frequency below 1GHz.
2. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 3 MHz for Peak detection (PK) at frequency above 1GHz.
3. The resolution bandwidth of test receiver/spectrum analyzer is 1MHz and the video bandwidth is ≥ 1/T (Duty cycle < 98%) or 10Hz (Duty cycle ≥ 98%) for Average detection (AV) at frequency above 1GHz. (802.11b: RBW = 1MHz, VBW = 10Hz; 802.11g: RBW = 1MHz, VBW = 510Hz;
802.11n (20MHz): RBW = 1MHz, VBW = 560Hz; 802.11n (40MHz): RBW = 1MHz, VBW = 1.1kHz)
4. All modes of operation were investigated and the worst-case emissions are reported.

4.1.4 Deviation from Test Standard

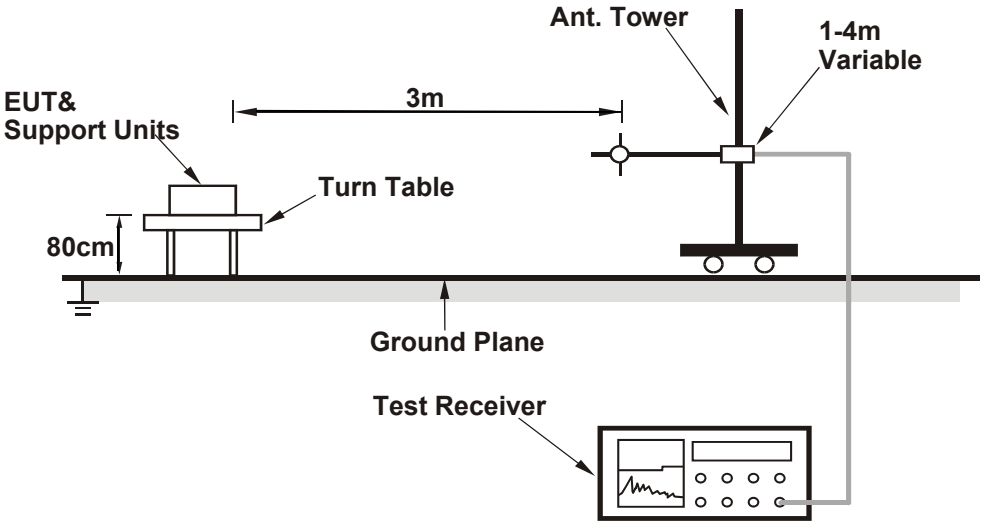
No deviation.

4.1.5 Test Setup

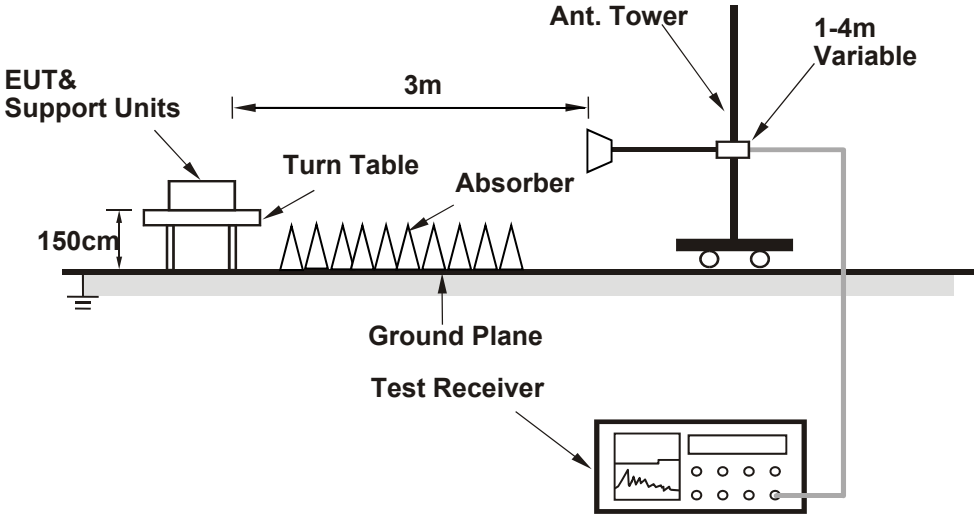
For Radiated emission below 30MHz



For Radiated emission 30MHz to 1GHz



For Radiated emission above 1GHz



For the actual test configuration, please refer to the attached file (Test Setup Photo).

4.1.6 EUT Operating Conditions

a. Placed the EUT on the testing table.
b. Prepared notebook to act as communication partner and placed it outside of testing area.
c. The communication partner connected with EUT via a RJ45 cable and ran a test program (provided by manufacturer) to enable EUT under transmission condition continuously at specific channel frequency.
d. The necessary accessories enable the system in full functions.

4.1.7 Test Results

ABOVE 1GHz DATA

802.11b

Channel	TX Channel 1	**Detector Function**	Peak (PK) Average (AV)
Frequency Range	1GHz ~ 25GHz		

Antenna Polarity & Test Distance : Horizontal at 3 m								
No	**Frequency (MHz)**	**Emission Level (dBuV/m)**	**Limit (dBuV/m)**	**Margin (dB)**	**Antenna Height (m)**	**Table Angle (Degree)**	**Raw Value (dBuV)**	**Correction Factor (dB/m)**
1	2390.00	61.06 PK	74.00	-12.94	2.36 H	262	60.67	0.39
2	2390.00	52.91 AV	54.00	-1.09	2.36 H	262	52.52	0.39
3	*2412.00	113.88 PK			2.36 H	262	113.43	0.45
4	*2412.00	109.92 AV			2.36 H	262	109.47	0.45
5	4824.00	54.33 PK	74.00	-19.67	1.87 H	255	46.53	7.80
6	4824.00	47.91 AV	54.00	-6.09	1.87 H	255	40.11	7.80
Antenna Polarity & Test Distance : Vertical at 3 m								
No	**Frequency (MHz)**	**Emission Level (dBuV/m)**	**Limit (dBuV/m)**	**Margin (dB)**	**Antenna Height (m)**	**Table Angle (Degree)**	**Raw Value (dBuV)**	**Correction Factor (dB/m)**
1	2390.00	56.16 PK	74.00	-17.84	2.28 V	111	55.77	0.39
2	2390.00	43.97 AV	54.00	-10.03	2.28 V	111	43.58	0.39
3	*2412.00	105.15 PK			2.28 V	111	104.70	0.45
4	*2412.00	100.75 AV			2.28 V	111	100.30	0.45
5	4824.00	52.72 PK	74.00	-21.28	1.52 V	261	44.92	7.80
6	4824.00	45.25 AV	54.00	-8.75	1.52 V	261	37.45	7.80

Remarks:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. Margin value = Emission Level – Limit value
4. The other emission levels were very low against the limit.
5. " * ": Fundamental frequency.

Channel	TX Channel 6	Detector Function	Peak (PK) Average (AV)
Frequency Range	1GHz ~ 25GHz		

Antenna Polarity & Test Distance : Horizontal at 3 m								
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Correction Factor (dB/m)
1	*2437.00	118.56 PK			2.32 H	270	118.07	0.49
2	*2437.00	113.53 AV			2.32 H	270	113.04	0.49
3	4874.00	56.82 PK	74.00	-17.18	1.53 H	250	49.08	7.74
4	4874.00	52.56 AV	54.00	-1.44	1.53 H	250	44.82	7.74
Antenna Polarity & Test Distance : Vertical at 3 m								
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Correction Factor (dB/m)
1	*2437.00	109.65 PK			2.31 V	119	109.16	0.49
2	*2437.00	104.78 AV			2.31 V	119	104.29	0.49
3	4874.00	54.32 PK	74.00	-19.68	1.59 V	229	46.58	7.74
4	4874.00	48.03 AV	54.00	-5.97	1.59 V	229	40.29	7.74

Remarks:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. Margin value = Emission Level – Limit value
4. The other emission levels were very low against the limit.
5. " * ": Fundamental frequency.

Channel	TX Channel 11	Detector Function	Peak (PK) Average (AV)
Frequency Range	1GHz ~ 25GHz		

Antenna Polarity & Test Distance : Horizontal at 3 m								
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Correction Factor (dB/m)
1	*2462.00	115.21 PK			2.72 H	250	114.63	0.58
2	*2462.00	110.86 AV			2.72 H	250	110.28	0.58
3	2483.50	62.18 PK	74.00	-11.82	2.72 H	250	61.49	0.69
4	2483.50	52.87 AV	54.00	-1.13	2.72 H	250	52.18	0.69
5	4924.00	54.39 PK	74.00	-19.61	1.00 H	249	46.66	7.73
6	4924.00	48.43 AV	54.00	-5.57	1.00 H	249	40.70	7.73
Antenna Polarity & Test Distance : Vertical at 3 m								
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Correction Factor (dB/m)
1	*2462.00	106.23 PK			2.21 V	115	105.65	0.58
2	*2462.00	101.73 AV			2.21 V	115	101.15	0.58
3	2483.50	57.34 PK	74.00	-16.66	2.21 V	115	56.65	0.69
4	2483.50	48.03 AV	54.00	-5.97	2.21 V	115	47.34	0.69
5	4924.00	52.58 PK	74.00	-21.42	1.48 V	264	44.85	7.73
6	4924.00	45.10 AV	54.00	-8.90	1.48 V	264	37.37	7.73

Remarks:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. Margin value = Emission Level – Limit value
4. The other emission levels were very low against the limit.
5. " * ": Fundamental frequency.

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Channel	TX Channel 1	Detector Function	Peak (PK) Average (AV)
Frequency Range	1GHz ~ 25GHz		

Antenna Polarity & Test Distance : Horizontal at 3 m								
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Correction Factor (dB/m)
1	2390.00	69.57 PK	74.00	-4.43	2.58 H	260	69.18	0.39
2	2390.00	52.97 AV	54.00	-1.03	2.58 H	260	52.58	0.39
3	*2412.00	114.00 PK			2.58 H	260	113.55	0.45
4	*2412.00	103.90 AV			2.58 H	260	103.45	0.45
5	4824.00	49.27 PK	74.00	-24.73	1.23 H	251	41.47	7.80
6	4824.00	36.07 AV	54.00	-17.93	1.23 H	251	28.27	7.80
Antenna Polarity & Test Distance : Vertical at 3 m								
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Correction Factor (dB/m)
1	2390.00	64.51 PK	74.00	-9.49	2.31 V	115	64.12	0.39
2	2390.00	46.95 AV	54.00	-7.05	2.31 V	115	46.56	0.39
3	*2412.00	105.02 PK			2.31 V	115	104.57	0.45
4	*2412.00	94.81 AV			2.31 V	115	94.36	0.45
5	4824.00	48.15 PK	74.00	-25.85	1.62 V	332	40.35	7.80
6	4824.00	35.14 AV	54.00	-18.86	1.62 V	332	27.34	7.80

Remarks:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. Margin value = Emission Level – Limit value
4. The other emission levels were very low against the limit.
5. " * ": Fundamental frequency.

Channel	TX Channel 6	Detector Function	Peak (PK) Average (AV)
Frequency Range	1GHz ~ 25GHz		

Antenna Polarity & Test Distance : Horizontal at 3 m								
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Correction Factor (dB/m)
1	2390.00	69.41 PK	74.00	-4.59	2.33 H	265	69.02	0.39
2	2390.00	52.75 AV	54.00	-1.25	2.33 H	265	52.36	0.39
3	*2437.00	121.96 PK			2.33 H	265	121.47	0.49
4	*2437.00	112.15 AV			2.33 H	265	111.66	0.49
5	2483.50	69.75 PK	74.00	-4.25	2.33 H	265	69.06	0.69
6	2483.50	52.19 AV	54.00	-1.81	2.33 H	265	51.50	0.69
7	4874.00	54.10 PK	74.00	-19.90	1.54 H	239	46.36	7.74
8	4874.00	40.99 AV	54.00	-13.01	1.54 H	239	33.25	7.74
Antenna Polarity & Test Distance : Vertical at 3 m								
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Correction Factor (dB/m)
1	2390.00	64.98 PK	74.00	-9.02	2.29 V	120	64.59	0.39
2	2390.00	48.24 AV	54.00	-5.76	2.29 V	120	47.85	0.39
3	*2437.00	113.01 PK			2.29 V	120	112.52	0.49
4	*2437.00	102.88 AV			2.29 V	120	102.39	0.49
5	2483.50	65.54 PK	74.00	-8.46	2.29 V	120	64.85	0.69
6	2483.50	46.54 AV	54.00	-7.46	2.29 V	120	45.85	0.69
7	4874.00	52.32 PK	74.00	-21.68	1.58 V	229	44.58	7.74
8	4874.00	39.02 AV	54.00	-14.98	1.58 V	229	31.28	7.74

Remarks:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. Margin value = Emission Level – Limit value
4. The other emission levels were very low against the limit.
5. " * ": Fundamental frequency.

Channel	TX Channel 11	Detector Function	Peak (PK) Average (AV)
Frequency Range	1GHz ~ 25GHz		

Antenna Polarity & Test Distance : Horizontal at 3 m								
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Correction Factor (dB/m)
1	*2462.00	114.43 PK			2.96 H	266	113.85	0.58
2	*2462.00	103.77 AV			2.96 H	266	103.19	0.58
3	2483.50	72.84 PK	74.00	-1.16	2.96 H	266	72.15	0.69
4	**2483.50**	**52.99 AV**	**54.00**	**-1.01**	**2.96 H**	**266**	**52.30**	**0.69**
5	4924.00	49.21 PK	74.00	-24.79	1.34 H	225	41.48	7.73
6	4924.00	36.07 AV	54.00	-17.93	1.34 H	225	28.34	7.73
Antenna Polarity & Test Distance : Vertical at 3 m								
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Correction Factor (dB/m)
1	*2462.00	104.94 PK			2.24 V	118	104.36	0.58
2	*2462.00	94.86 AV			2.24 V	118	94.28	0.58
3	2483.50	69.18 PK	74.00	-4.82	2.24 V	118	68.49	0.69
4	2483.50	49.58 AV	54.00	-4.42	2.24 V	118	48.89	0.69
5	4924.00	48.09 PK	74.00	-25.91	2.25 V	147	40.36	7.73
6	4924.00	35.09 AV	54.00	-18.91	2.25 V	147	27.36	7.73

Remarks:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. Margin value = Emission Level – Limit value
4. The other emission levels were very low against the limit.
5. " * ": Fundamental frequency.

802.11n (20MHz)

Channel	TX Channel 1	Detector Function	Peak (PK) Average (AV)
Frequency Range	1GHz ~ 25GHz		

Antenna Polarity & Test Distance : Horizontal at 3 m								
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Correction Factor (dB/m)
1	2390.00	70.40 PK	74.00	-3.60	2.36 H	260	70.01	0.39
2	2390.00	52.90 AV	54.00	-1.10	2.36 H	260	52.51	0.39
3	*2412.00	113.80 PK			2.36 H	260	113.35	0.45
4	*2412.00	103.91 AV			2.36 H	260	103.46	0.45
5	4824.00	49.32 PK	74.00	-24.68	1.52 H	226	41.52	7.80
6	4824.00	36.23 AV	54.00	-17.77	1.52 H	226	28.43	7.80
Antenna Polarity & Test Distance : Vertical at 3 m								
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Correction Factor (dB/m)
1	2390.00	66.63 PK	74.00	-7.37	2.30 V	115	66.24	0.39
2	2390.00	49.18 AV	54.00	-4.82	2.30 V	115	48.79	0.39
3	*2412.00	105.02 PK			2.30 V	115	104.57	0.45
4	*2412.00	94.81 AV			2.30 V	115	94.36	0.45
5	4824.00	48.16 PK	74.00	-25.84	2.14 V	158	40.36	7.80
6	4824.00	35.49 AV	54.00	-18.51	2.14 V	158	27.69	7.80

Remarks:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. Margin value = Emission Level – Limit value
4. The other emission levels were very low against the limit.
5. " * ": Fundamental frequency.

Channel	TX Channel 6	Detector Function	Peak (PK) Average (AV)
Frequency Range	1GHz ~ 25GHz		

Antenna Polarity & Test Distance : Horizontal at 3 m								
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Correction Factor (dB/m)
1	2390.00	63.15 PK	74.00	-10.85	2.75 H	260	62.76	0.39
2	2390.00	47.80 AV	54.00	-6.20	2.75 H	260	47.41	0.39
3	*2437.00	121.29 PK			2.75 H	260	120.80	0.49
4	*2437.00	111.48 AV			2.75 H	260	110.99	0.49
5	2483.50	68.95 PK	74.00	-5.05	2.75 H	260	68.26	0.69
6	2483.50	52.62 AV	54.00	-1.38	2.75 H	260	51.93	0.69
7	4874.00	50.95 PK	74.00	-23.05	1.54 H	214	43.21	7.74
8	4874.00	40.37 AV	54.00	-13.63	1.54 H	214	32.63	7.74
Antenna Polarity & Test Distance : Vertical at 3 m								
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Correction Factor (dB/m)
1	2390.00	57.65 PK	74.00	-16.35	2.25 V	116	57.26	0.39
2	2390.00	44.02 AV	54.00	-9.98	2.25 V	116	43.63	0.39
3	*2437.00	112.05 PK			2.25 V	116	111.56	0.49
4	*2437.00	102.03 AV			2.25 V	116	101.54	0.49
5	2483.50	65.27 PK	74.00	-8.73	2.25 V	116	64.58	0.69
6	2483.50	47.97 AV	54.00	-6.03	2.25 V	116	47.28	0.69
7	4874.00	49.33 PK	74.00	-24.67	1.95 V	248	41.59	7.74
8	4874.00	36.40 AV	54.00	-17.60	1.95 V	248	28.66	7.74

Remarks:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. Margin value = Emission Level – Limit value
4. The other emission levels were very low against the limit.
5. " * ": Fundamental frequency.

Channel	TX Channel 11	Detector Function	Peak (PK) Average (AV)
Frequency Range	1GHz ~ 25GHz		

Antenna Polarity & Test Distance : Horizontal at 3 m								
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Correction Factor (dB/m)
1	*2462.00	112.51 PK			2.96 H	262	111.93	0.58
2	*2462.00	102.86 AV			2.96 H	262	102.28	0.58
3	2483.50	72.66 PK	74.00	-1.34	2.96 H	262	71.97	0.69
4	2483.50	51.73 AV	54.00	-2.27	2.96 H	262	51.04	0.69
5	4924.00	48.96 PK	74.00	-25.04	1.45 H	266	41.23	7.73
6	4924.00	36.07 AV	54.00	-17.93	1.45 H	266	28.34	7.73
Antenna Polarity & Test Distance : Vertical at 3 m								
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Correction Factor (dB/m)
1	*2462.00	104.13 PK			2.31 V	115	103.55	0.58
2	*2462.00	94.14 AV			2.31 V	115	93.56	0.58
3	2483.50	68.18 PK	74.00	-5.82	2.31 V	115	67.49	0.69
4	2483.50	48.58 AV	54.00	-5.42	2.31 V	115	47.89	0.69
5	4924.00	48.14 PK	74.00	-25.86	2.03 V	231	40.41	7.73
6	4924.00	35.08 AV	54.00	-18.92	2.03 V	231	27.35	7.73

Remarks:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. Margin value = Emission Level – Limit value
4. The other emission levels were very low against the limit.
5. " * ": Fundamental frequency.

802.11n (40MHz)

Channel	TX Channel 3	Detector Function	Peak (PK) Average (AV)
Frequency Range	1GHz ~ 25GHz		

Antenna Polarity & Test Distance : Horizontal at 3 m								
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Correction Factor (dB/m)
1	2390.00	69.39 PK	74.00	-4.61	3.06 H	262	69.00	0.39
2	2390.00	52.54 AV	54.00	-1.46	3.06 H	262	52.15	0.39
3	*2422.00	110.03 PK			3.06 H	262	109.56	0.47
4	*2422.00	100.47 AV			3.06 H	262	100.00	0.47
5	4844.00	49.34 PK	74.00	-24.66	1.57 H	241	41.57	7.77
6	4844.00	36.51 AV	54.00	-17.49	1.57 H	241	28.74	7.77
Antenna Polarity & Test Distance : Vertical at 3 m								
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Correction Factor (dB/m)
1	2390.00	64.65 PK	74.00	-9.35	2.23 V	119	64.26	0.39
2	2390.00	47.28 AV	54.00	-6.72	2.23 V	119	46.89	0.39
3	*2422.00	101.01 PK			2.23 V	119	100.54	0.47
4	*2422.00	90.86 AV			2.23 V	119	90.39	0.47
5	4844.00	48.30 PK	74.00	-25.70	1.78 V	45	40.53	7.77
6	4844.00	35.39 AV	54.00	-18.61	1.78 V	45	27.62	7.77

Remarks:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. Margin value = Emission Level – Limit value
4. The other emission levels were very low against the limit.
5. " * ": Fundamental frequency.

Channel	TX Channel 6	Detector Function	Peak (PK) Average (AV)
Frequency Range	1GHz ~ 25GHz		

Antenna Polarity & Test Distance : Horizontal at 3 m								
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Correction Factor (dB/m)
1	2390.00	67.01 PK	74.00	-6.99	2.75 H	257	66.62	0.39
2	2390.00	52.86 AV	54.00	-1.14	2.75 H	257	52.47	0.39
3	*2437.00	110.29 PK			2.75 H	257	109.80	0.49
4	*2437.00	100.97 AV			2.75 H	257	100.48	0.49
5	2483.50	63.36 PK	74.00	-10.64	2.75 H	257	62.67	0.69
6	2483.50	46.16 AV	54.00	-7.84	2.75 H	257	45.47	0.69
7	4874.00	49.29 PK	74.00	-24.71	1.28 H	225	41.55	7.74
8	4874.00	36.13 AV	54.00	-17.87	1.28 H	225	28.39	7.74
Antenna Polarity & Test Distance : Vertical at 3 m								
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Correction Factor (dB/m)
1	2390.00	62.75 PK	74.00	-11.25	2.23 V	116	62.36	0.39
2	2390.00	49.16 AV	54.00	-4.84	2.23 V	116	48.77	0.39
3	*2437.00	100.78 PK			2.23 V	116	100.29	0.49
4	*2437.00	90.97 AV			2.23 V	116	90.48	0.49
5	2483.50	59.40 PK	74.00	-14.60	2.23 V	116	58.71	0.69
6	2483.50	42.25 AV	54.00	-11.75	2.23 V	116	41.56	0.69
7	4874.00	48.07 PK	74.00	-25.93	1.64 V	235	40.33	7.74
8	4874.00	35.12 AV	54.00	-18.88	1.64 V	235	27.38	7.74

Remarks:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. Margin value = Emission Level – Limit value
4. The other emission levels were very low against the limit.
5. " * ": Fundamental frequency.

Channel	TX Channel 9	Detector Function	Peak (PK) Average (AV)
Frequency Range	1GHz ~ 25GHz		

Antenna Polarity & Test Distance : Horizontal at 3 m								
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Correction Factor (dB/m)
1	*2452.00	108.26 PK			2.95 H	264	107.74	0.52
2	*2452.00	98.86 AV			2.95 H	264	98.34	0.52
3	2483.50	72.26 PK	74.00	-1.74	2.95 H	264	71.57	0.69
4	2483.50	52.51 AV	54.00	-1.49	2.95 H	264	51.82	0.69
5	4904.00	49.02 PK	74.00	-24.98	1.28 H	258	41.30	7.72
6	4904.00	36.14 AV	54.00	-17.86	1.28 H	258	28.42	7.72
Antenna Polarity & Test Distance : Vertical at 3 m								
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Correction Factor (dB/m)
1	*2452.00	99.26 PK			2.33 V	117	98.74	0.52
2	*2452.00	89.13 AV			2.33 V	117	88.61	0.52
3	2483.50	68.10 PK	74.00	-5.90	2.33 V	117	67.41	0.69
4	2483.50	47.04 AV	54.00	-6.96	2.33 V	117	46.35	0.69
5	4904.00	48.24 PK	74.00	-25.76	2.21 V	181	40.52	7.72
6	4904.00	35.41 AV	54.00	-18.59	2.21 V	181	27.69	7.72

Remarks:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. Margin value = Emission Level – Limit value
4. The other emission levels were very low against the limit.
5. " * ": Fundamental frequency.

BELOW 1GHz WORST-CASE DATA

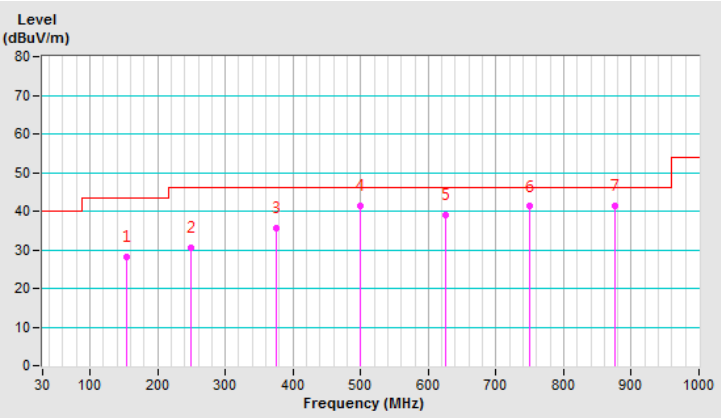
802.11g

Channel	TX Channel 6	Detector Function	Quasi-Peak (QP)
Frequency Range	9kHz ~ 1GHz		

Antenna Polarity & Test Distance : Horizontal at 3 m								
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Correction Factor (dB/m)
1	154.89	28.19 QP	43.50	-15.31	2.45 H	256	34.51	-6.32
2	250.00	30.54 QP	46.00	-15.46	2.61 H	114	36.97	-6.43
3	374.98	35.52 QP	46.00	-10.48	2.08 H	223	38.00	-2.48
4	500.01	41.41 QP	46.00	-4.59	1.86 H	176	41.43	-0.02
5	625.00	39.09 QP	46.00	-6.91	1.75 H	253	36.06	3.03
6	749.98	41.24 QP	46.00	-4.76	1.66 H	212	36.26	4.98
7	875.02	41.31 QP	46.00	-4.69	1.92 H	236	34.43	6.88

Remarks:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. Margin value = Emission Level – Limit value
4. The other emission levels were very low against the limit of frequency range 30MHz~1000MHz.
5. The emission levels were very low against the limit of frequency range 9kHz~30MHz: the amplitude of spurious emissions attenuated more than 20 dB below the permissible value to be report.

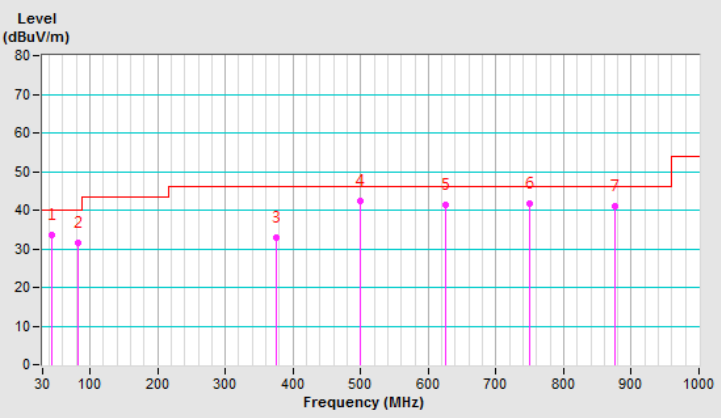


Channel	TX Channel 6	Detector Function	Quasi-Peak (QP)
Frequency Range	9kHz ~ 1GHz		

Antenna Polarity & Test Distance : Vertical at 3 m								
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Correction Factor (dB/m)
1	44.31	33.48 QP	40.00	-6.52	1.21 V	310	40.70	-7.22
2	81.60	31.64 QP	40.00	-8.36	1.04 V	267	43.42	-11.78
3	374.98	32.81 QP	46.00	-13.19	1.34 V	183	35.29	-2.48
4	500.01	42.29 QP	46.00	-3.71	1.85 V	130	42.31	-0.02
5	625.00	41.32 QP	46.00	-4.68	1.15 V	158	38.29	3.03
6	750.03	41.66 QP	46.00	-4.34	1.26 V	146	36.68	4.98
7	875.02	41.02 QP	46.00	-4.98	1.48 V	151	34.14	6.88

Remarks:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. Margin value = Emission Level – Limit value
4. The other emission levels were very low against the limit of frequency range 30MHz~1000MHz.
5. The emission levels were very low against the limit of frequency range 9kHz~30MHz: the amplitude of spurious emissions attenuated more than 20 dB below the permissible value to be report.



4.2 Conducted Emission Measurement

4.2.1 Limits of Conducted Emission Measurement

Frequency (MHz)	Conducted Limit (dBuV)	
	Quasi-peak	Average
0.15 - 0.5	66 - 56	56 - 46
0.50 - 5.0	56	46
5.0 - 30.0	60	50

Note: 1. The lower limit shall apply at the transition frequencies.
2. The limit decreases in line with the logarithm of the frequency in the range of 0.15 to 0.50MHz.

4.2.2 Test Instruments

Description & Manufacturer	Model No.	Serial No.	Cal. Date	Cal. Due
ROHDE & SCHWARZ TEST RECEIVER	ESCS30	100276	Apr. 16, 2020	Apr. 15, 2021
SCHWARZBECK Artificial Mains Network (for EUT)	NSLK 8128	8128-244	Nov. 11, 2019	Nov. 10, 2020
LISN With Adapter (for EUT)	AD10	C05Ada-001	Nov. 11, 2019	Nov. 10, 2020
ROHDE & SCHWARZ Artificial Mains Network (for peripheral)	ESH3-Z5	100220	Nov. 18, 2019	Nov. 17, 2020
Software	Cond_V7.3.7.4	NA	NA	NA
RF cable (JYEBAO) With 10dB PAD	5D-FB	Cable-C05.01	Jan. 30, 2020	Jan. 29, 2021
LYNICS Terminator (For R&S LISN)	0900510	E1-01-305	Feb. 17, 2020	Feb. 16, 2021

Note: 1. The calibration interval of the above test instruments is 12 months and the calibrations are traceable to NML/ROC and NIST/USA.
2. The test was performed in Shielded Room No. 5. (Conduction 5)

4.2.3 Test Procedures

a. The EUT was placed 0.4 meters from the conducting wall of the shielded room with EUT being connected to the power mains through a line impedance stabilization network (LISN). Other support units were connected to the power mains through another LISN. The two LISNs provide 50 ohm/ 50uH of coupling impedance for the measuring instrument.

b. Both lines of the power mains connected to the EUT were checked for maximum conducted interference.

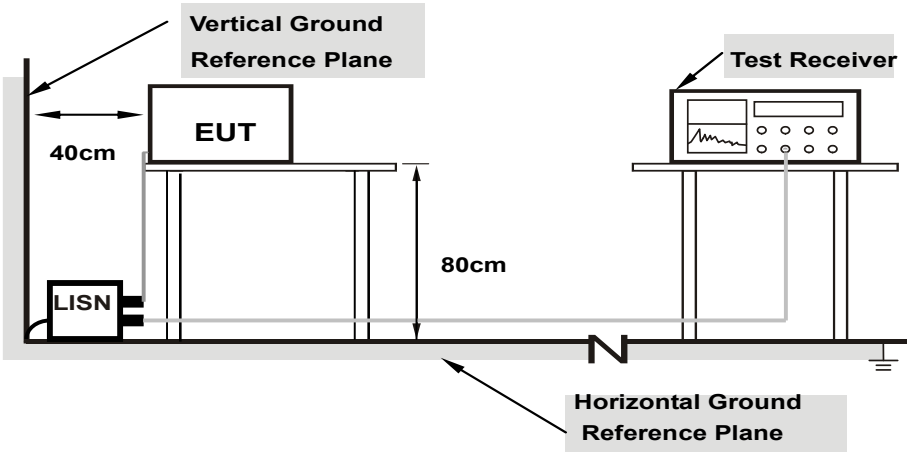
c. The frequency range from 150kHz to 30MHz was searched. Emission levels under (Limit - 20dB) was not recorded.

NOTE: The resolution bandwidth and video bandwidth of test receiver is 9kHz for quasi-peak detection (QP) and average detection (AV) at frequency 0.15MHz-30MHz.

4.2.4 Deviation from Test Standard

No deviation.

4.2.5 Test Setup



Note: 1.Support units were connected to second LISN.

For the actual test configuration, please refer to the attached file (Test Setup Photo).

4.2.6 EUT Operating Conditions

Same as Item 4.1.6.

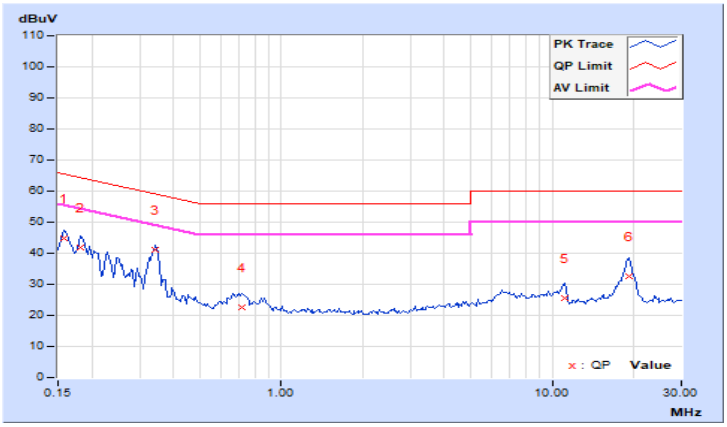
4.2.7 Test Results

Frequency Range	150kHz ~ 30MHz	Detector Function & Resolution Bandwidth	Quasi-Peak (QP) / Average (AV), 9kHz

Phase Of Power : Line (L)										
No	Frequency (MHz)	Correction Factor (dB)	Reading Value (dBuV)		Emission Level (dBuV)		Limit (dBuV)		Margin (dB)	
			Q.P.	AV.	Q.P.	AV.	Q.P.	AV.	Q.P.	AV.
1	0.15781	9.88	34.83	21.47	44.71	31.35	65.58	55.58	-20.87	-24.23
2	0.18125	9.88	31.88	19.71	41.76	29.59	64.43	54.43	-22.67	-24.84
3	**0.34141**	**9.89**	**31.31**	**25.45**	**41.20**	**35.34**	**59.17**	**49.17**	**-17.97**	**-13.83**
4	0.71641	9.92	12.70	6.94	22.62	16.86	56.00	46.00	-33.38	-29.14
5	11.15625	10.39	15.24	7.25	25.63	17.64	60.00	50.00	-34.37	-32.36
6	19.14063	10.78	21.80	11.66	32.58	22.44	60.00	50.00	-27.42	-27.56

Remarks:

1. Q.P. and AV. are abbreviations of quasi-peak and average individually.
2. The emission levels of other frequencies were very low against the limit.
3. Margin value = Emission level – Limit value
4. Correction factor = Insertion loss + Cable loss
5. Emission Level = Correction Factor + Reading Value

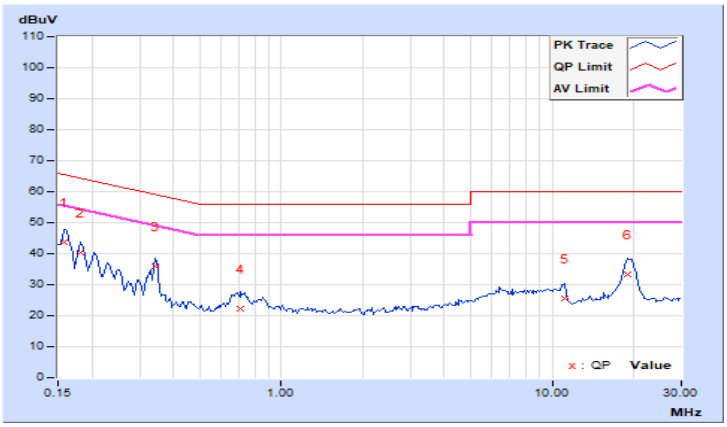


Frequency Range	150kHz ~ 30MHz	Detector Function & Resolution Bandwidth	Quasi-Peak (QP) / Average (AV), 9kHz

Phase Of Power : Neutral (N)										
No	Frequency (MHz)	Correction Factor (dB)	Reading Value (dBuV)		Emission Level (dBuV)		Limit (dBuV)		Margin (dB)	
			Q.P.	AV.	Q.P.	AV.	Q.P.	AV.	Q.P.	AV.
1	0.15781	9.89	33.65	19.72	43.54	29.61	65.58	55.58	-22.04	-25.97
2	0.18125	9.88	30.35	18.41	40.23	28.29	64.43	54.43	-24.20	-26.14
3	0.34141	9.89	26.02	19.31	35.91	29.20	59.17	49.17	-23.26	-19.97
4	0.70859	9.93	12.37	6.45	22.30	16.38	56.00	46.00	-33.70	-29.62
5	11.11719	10.45	14.94	6.98	25.39	17.43	60.00	50.00	-34.61	-32.57
6	19.01172	10.92	22.49	12.11	33.41	23.03	60.00	50.00	-26.59	-26.97

Remarks:

1. Q.P. and AV. are abbreviations of quasi-peak and average individually.
2. The emission levels of other frequencies were very low against the limit.
3. Margin value = Emission level – Limit value
4. Correction factor = Insertion loss + Cable loss
5. Emission Level = Correction Factor + Reading Value

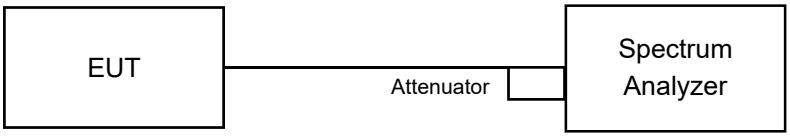


4.3 6dB Bandwidth Measurement

4.3.1 Limits of 6dB Bandwidth Measurement

The minimum of 6dB Bandwidth Measurement is 0.5 MHz.

4.3.2 Test Setup



4.3.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.3.4 Test Procedure

a. Set resolution bandwidth (RBW) = 100kHz
b. Set the video bandwidth (VBW) ≥ 3 x RBW, Detector = Peak.
c. Trace mode = max hold.
d. Sweep = auto couple.
e. Measure the maximum width of the emission that is constrained by the frequencies associated with the two amplitude points (upper and lower) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission

4.3.5 Deviation fromTest Standard

No deviation.

4.3.6 EUT Operating Conditions

The software provided by client to enable the EUT under transmission condition continuously at lowest, middle and highest channel frequencies individually.

4.3.7 Test Result

802.11b

Channel	Frequency (MHz)	6dB Bandwidth (MHz)		Minimum Limit (MHz)	Pass / Fail
		Chain 0	Chain 1		
1	2412	10.11	10.13	0.5	Pass
6	2437	10.13	10.13	0.5	Pass
11	2462	10.13	10.13	0.5	Pass

802.11g

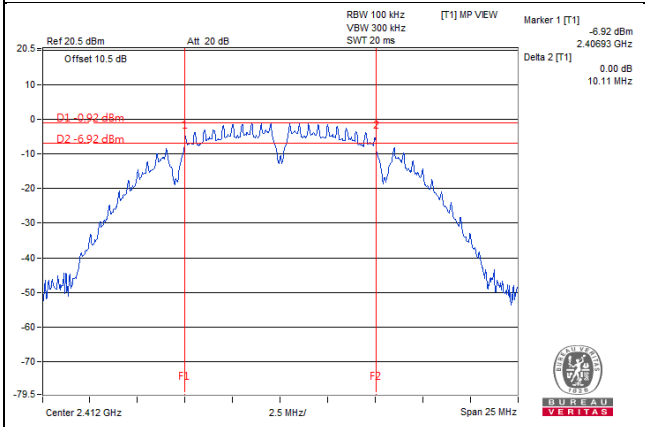
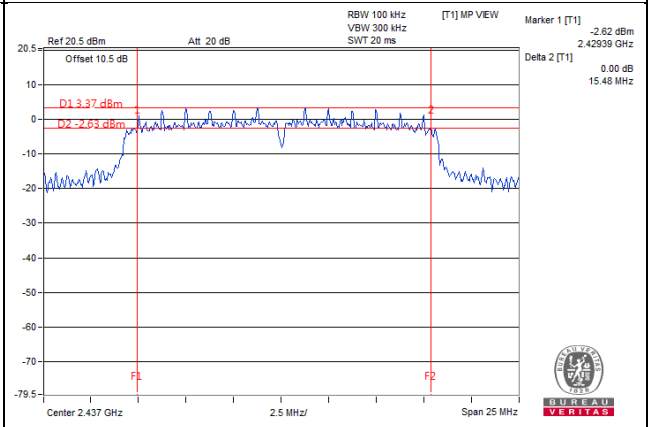
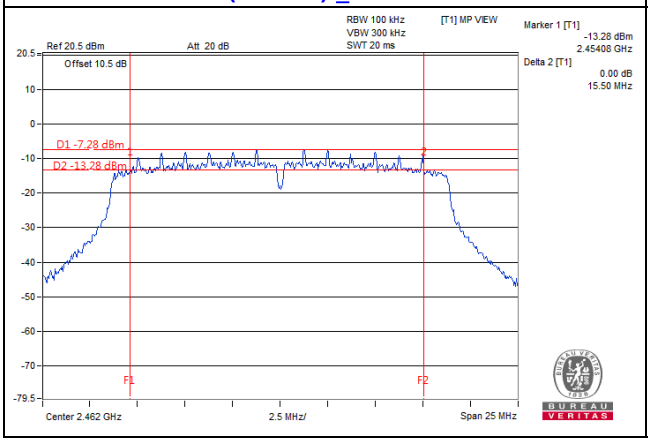
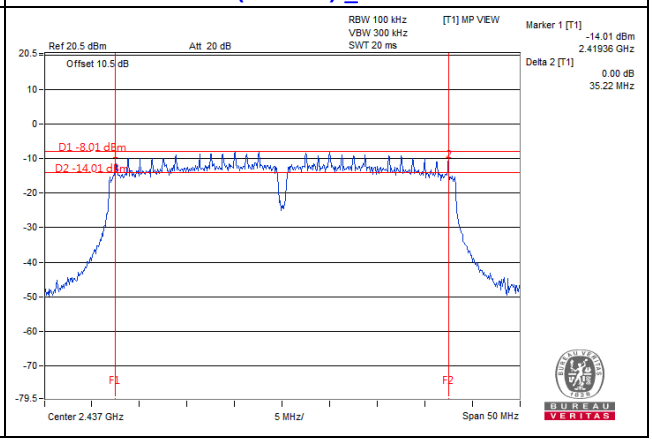
Channel	Frequency (MHz)	6dB Bandwidth (MHz)		Minimum Limit (MHz)	Pass / Fail
		Chain 0	Chain 1		
1	2412	15.86	16.10	0.5	Pass
6	2437	15.49	15.48	0.5	Pass
11	2462	15.87	15.87	0.5	Pass

802.11n (20MHz)

Channel	Frequency (MHz)	6dB Bandwidth (MHz)		Minimum Limit (MHz)	Pass / Fail
		Chain 0	Chain 1		
1	2412	16.84	16.58	0.5	Pass
6	2437	16.03	16.06	0.5	Pass
11	2462	15.50	15.76	0.5	Pass

802.11n (40MHz)

Channel	Frequency (MHz)	6dB Bandwidth (MHz)		Minimum Limit (MHz)	Pass / Fail
		Chain 0	Chain 1		
3	2422	35.26	35.25	0.5	Pass
6	2437	35.22	35.27	0.5	Pass
9	2452	35.25	35.24	0.5	Pass

Spectrum Plot of Worst Value	
802.11b_Chain0 / CH1	**802.11g_Chain1 / CH6**
	
802.11n (20MHz) _Chain0 / CH11	**802.11n (40MHz) _Chain0 / CH6**
	

4.4 Conducted Output Power Measurement

4.4.1 Limits of Conducted Output Power Measurement

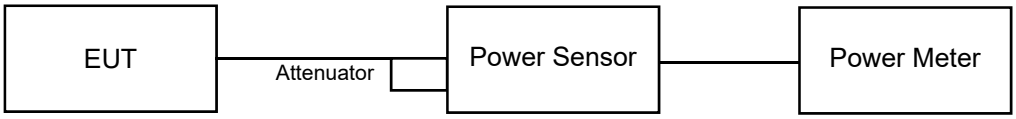
For systems using digital modulation in the 2400–2483.5 MHz bands: 1 Watt (30dBm)

Per KDB 662911 D01 Multiple Transmitter Output Method of conducted output power measurement on IEEE 802.11 devices,

Array Gain = 0 dB (i.e., no array gain) for $N_{ANT} \leq 4$;
Array Gain = 0 dB (i.e., no array gain) for channel widths ≥ 40 MHz for any N_{ANT};
Array Gain = 5 log(N_{ANT}/N_{SS}) dB or 3 dB, whichever is less for 20-MHz channel widths with $N_{ANT} \geq 5$.

For power measurements on all other devices: Array Gain = 10 log(N_{ANT}/N_{SS}) dB.

4.4.2 Test Setup



4.4.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.4.4 Test Procedures

A peak power sensor was used on the output port of the EUT. A power meter was used to read the response of the peak power sensor. Record the power level.

Average power sensor was used to perform output power measurement, trigger and gating function of wide band power meter is enabled to measure max output power of TX on burst. Duty factor is not added to measured value.

4.4.5 Deviation from Test Standard

No deviation.

4.4.6 EUT Operating Conditions

Same as Item 4.3.6.

4.4.7 Test Results

FOR PEAK POWER

802.11b

Channel	Frequency (MHz)	Peak Power (dBm)		Total Power (mW)	Total Power (dBm)	Limit (dBm)	Pass / Fail
		Chain 0	Chain 1				
1	2412	20.37	20.09	210.987	23.24	30	Pass
6	2437	22.59	22.33	352.554	25.47	30	Pass
11	2462	22.19	21.84	318.334	25.03	30	Pass

802.11g

Channel	Frequency (MHz)	Peak Power (dBm)		Total Power (mW)	Total Power (dBm)	Limit (dBm)	Pass / Fail
		Chain 0	Chain 1				
1	2412	23.19	22.23	375.558	25.75	30	Pass
6	2437	25.12	24.25	**591.16**	27.72	30	Pass
11	2462	23.16	22.30	376.838	25.76	30	Pass

802.11n (20MHz)

Channel	Frequency (MHz)	Peak Power (dBm)		Total Power (mW)	Total Power (dBm)	Limit (dBm)	Pass / Fail
		Chain 0	Chain 1				
1	2412	24.33	23.31	485.308	26.86	30	Pass
6	2437	25.04	24.02	571.502	27.57	30	Pass
11	2462	22.21	21.36	303.114	24.82	30	Pass

802.11n (40MHz)

Channel	Frequency (MHz)	Peak Power (dBm)		Total Power (mW)	Total Power (dBm)	Limit (dBm)	Pass / Fail
		Chain 0	Chain 1				
3	2422	21.57	20.56	257.312	24.10	30	Pass
6	2437	24.12	23.26	470.062	26.72	30	Pass
9	2452	21.54	20.69	259.781	24.15	30	Pass

FOR AVERAGE POWER

802.11b

Chan.	Frequency (MHz)	Avg. Power (dBm)		Total Power (mW)	Total Power (dBm)
		Chain 0	Chain 1		
1	2412	18.31	18.32	135.684	21.33
6	2437	20.52	20.47	224.149	23.51
11	2462	20.17	20.15	207.506	23.17

802.11g

Chan.	Frequency (MHz)	Avg. Power (dBm)		Total Power (mW)	Total Power (dBm)
		Chain 0	Chain 1		
1	2412	19.25	19.18	166.934	22.23
6	2437	21.72	21.72	297.188	24.73
11	2462	19.21	19.19	166.353	22.21

802.11n (20MHz)

Chan.	Frequency (MHz)	Avg. Power (dBm)		Total Power (mW)	Total Power (dBm)
		Chain 0	Chain 1		
1	2412	21.02	20.93	250.354	23.99
6	2437	21.67	21.67	293.786	24.68
11	2462	19.02	19.01	159.415	22.03

802.11n (40MHz)

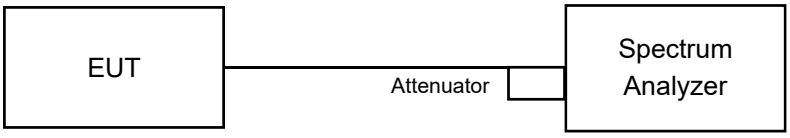
Chan.	Frequency (MHz)	Avg. Power (dBm)		Total Power (mW)	Total Power (dBm)
		Chain 0	Chain 1		
3	2422	18.62	18.63	145.724	21.64
6	2437	20.85	20.83	242.679	23.85
9	2452	18.61	18.59	144.888	21.61

4.5 Power Spectral Density Measurement

4.5.1 Limits of Power Spectral Density Measurement

The Maximum of Power Spectral Density Measurement is 8dBm in any 3 kHz.

4.5.2 Test Setup



4.5.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.5.4 Test Procedure

a. Set analyzer center frequency to DTS channel center frequency.
b. Set the span to 1.5 times the DTS bandwidth.
c. Set the RBW to: 3 kHz ≤ RBW ≤ 100 kHz.
d. Set the VBW ≥ 3 × RBW.
e. Detector = peak.
f. Sweep time = auto couple.
g. Trace mode = max hold.
h. Allow trace to fully stabilize.
i. Use the peak marker function to determine the maximum amplitude level within the RBW.

4.5.5 Deviation from Test Standard

No deviation.

4.5.6 EUT Operating Condition

Same as Item 4.3.6

4.5.7 Test Results

802.11b

TX chain	Channel	Freq. (MHz)	PSD (dBm/3kHz)	10 log (N=2) dB	Total PSD (dBm/3kHz)	Limit (dBm/3kHz)	Pass /Fail
0	1	2412	-15.14	3.01	-12.13	7.79	Pass
	6	2437	-9.86	3.01	-6.85	7.79	Pass
	11	2462	-13.20	3.01	-10.19	7.79	Pass
1	1	2412	-14.70	3.01	-11.69	7.79	Pass
	6	2437	-9.10	3.01	-6.09	7.79	Pass
	11	2462	-13.94	3.01	-10.93	7.79	Pass

Note:
1. Method E) 2) c) of power density measurement of KDB 662911 is using for calculating total power density.
2. Directional gain = 3.2dBi + 10log(2) = 6.21dBi > 6dBi , so the power density limit shall be reduced to 8-(6.21-6) = 7.79dBm.

802.11g

TX chain	Channel	Freq. (MHz)	PSD (dBm/3kHz)	10 log (N=2) dB	Total PSD (dBm/3kHz)	Limit (dBm/3kHz)	Pass /Fail
0	1	2412	-19.70	3.01	-16.69	7.79	Pass
	6	2437	-10.85	3.01	-7.84	7.79	Pass
	11	2462	-20.63	3.01	-17.62	7.79	Pass
1	1	2412	-20.11	3.01	-17.10	7.79	Pass
	6	2437	-11.74	3.01	-8.73	7.79	Pass
	11	2462	-20.49	3.01	-17.48	7.79	Pass

Note:
1. Method E) 2) c) of power density measurement of KDB 662911 is using for calculating total power density.
2. Directional gain = 3.2dBi + 10log(2) = 6.21dBi > 6dBi , so the power density limit shall be reduced to 8-(6.21-6) = 7.79dBm.

802.11n (20MHz)

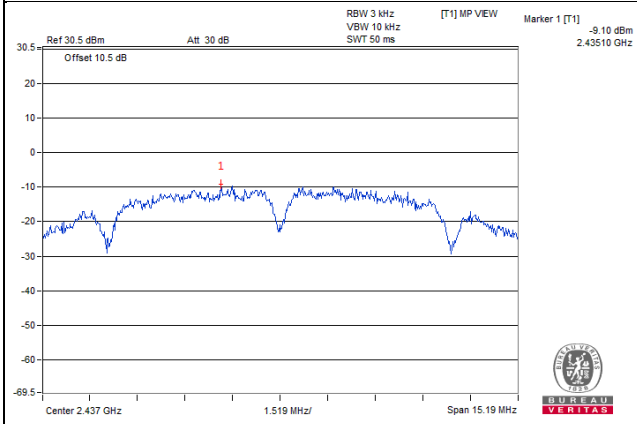
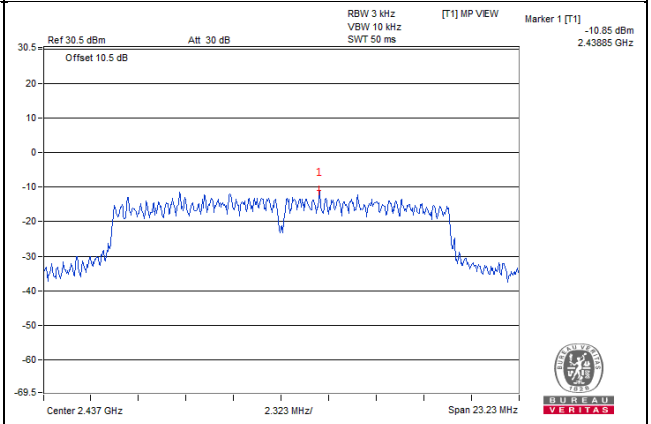
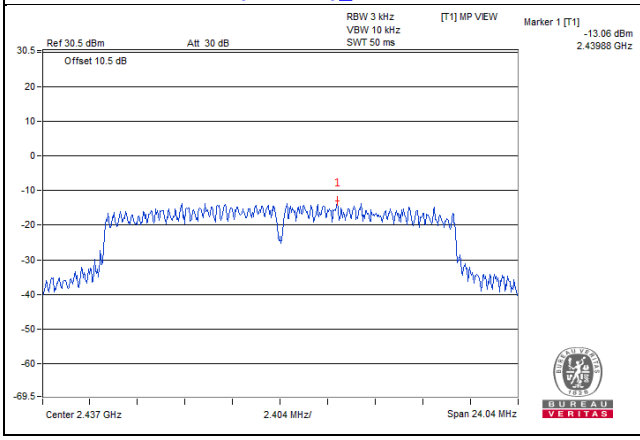
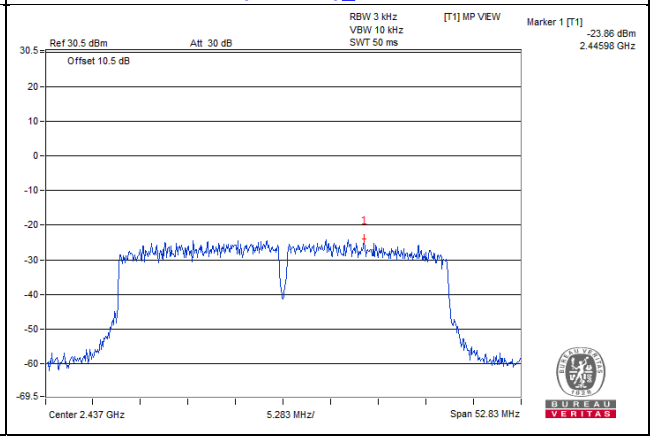
TX chain	Channel	Freq. (MHz)	PSD (dBm/3kHz)	10 log (N=2) dB	Total PSD (dBm/3kHz)	Limit (dBm/3kHz)	Pass /Fail
0	1	2412	-20.91	3.01	-17.90	7.79	Pass
	6	2437	-13.06	3.01	-10.05	7.79	Pass
	11	2462	-21.98	3.01	-18.97	7.79	Pass
1	1	2412	-21.38	3.01	-18.37	7.79	Pass
	6	2437	-13.39	3.01	-10.38	7.79	Pass
	11	2462	-21.71	3.01	-18.70	7.79	Pass

Note:
1. Method E) 2) c) of power density measurement of KDB 662911 is using for calculating total power density.
2. Directional gain = 3.2dBi + 10log(2) = 6.21dBi > 6dBi , so the power density limit shall be reduced to 8-(6.21-6) = 7.79dBm.

802.11n (40MHz)

TX chain	Channel	Freq. (MHz)	PSD (dBm/3kHz)	10 log (N=2) dB	Total PSD (dBm/3kHz)	Limit (dBm/3kHz)	Pass /Fail
0	3	2422	-26.29	3.01	-23.28	7.79	Pass
	6	2437	-23.86	3.01	-20.85	7.79	Pass
	9	2452	-26.05	3.01	-23.04	7.79	Pass
1	3	2422	-25.95	3.01	-22.94	7.79	Pass
	6	2437	-23.99	3.01	-20.98	7.79	Pass
	9	2452	-25.84	3.01	-22.83	7.79	Pass

Note:
1. Method E) 2) c) of power density measurement of KDB 662911 is using for calculating total power density.
2. Directional gain = 3.2dBi + 10log(2) = 6.21dBi > 6dBi , so the power density limit shall be reduced to 8-(6.21-6) = 7.79dBm.

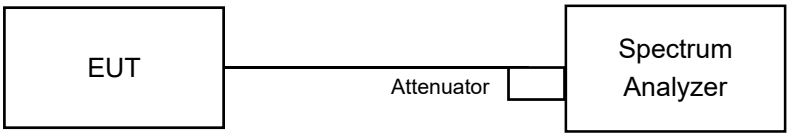
Spectrum Plot of Worst Value	
802.11b_Chain1 / CH6	**802.11g_Chain0 / CH6**
	
802.11n (20MHz)_Chain0 / CH6	**802.11n (40MHz)_Chain0 / CH6**
	

4.6 Conducted Out of Band Emission Measurement

4.6.1 Limits of Conducted Out of Band Emission Measurement

Below -20dB of the highest emission level of operating band (in 100kHz Resolution Bandwidth).

4.6.2 Test Setup



4.6.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.6.4 Test Procedure

MEASUREMENT PROCEDURE REF

1. Set the RBW = 100 kHz.
2. Set the VBW ≥ 300 kHz.
3. Detector = peak.
4. Sweep time = auto couple.
5. Trace mode = max hold.
6. Allow trace to fully stabilize.
7. Use the peak marker function to determine the maximum power level in any 100 kHz band segment within the fundamental EBW.

MEASUREMENT PROCEDURE OOBE

1. Set RBW = 100 kHz.
2. Set VBW ≥ 300 kHz.
3. Detector = peak.
4. Sweep = auto couple.
5. Trace Mode = max hold.
6. Allow trace to fully stabilize.
7. Use the peak marker function to determine the maximum amplitude level.

4.6.5 Deviation from Test Standard

No deviation.

4.6.6 EUT Operating Condition

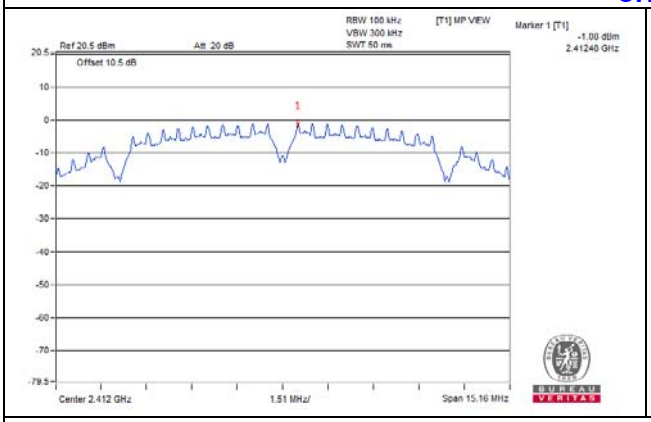
Same as Item 4.3.6

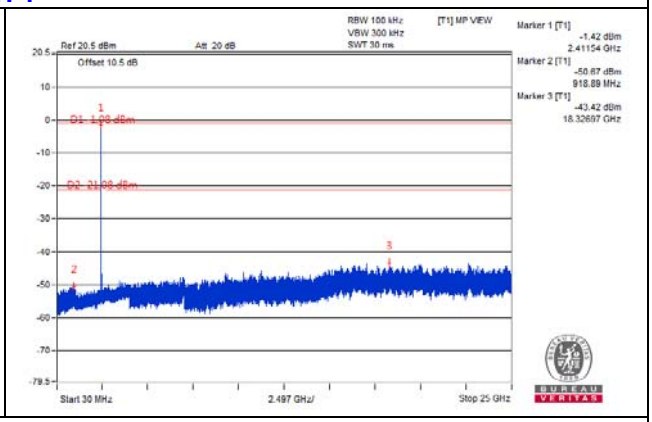
4.6.7 Test Results

The spectrum plots are attached on the following pages. D1 line indicates the highest level, and D2 line indicates the 20dB offset below D1. It shows compliance with the requirement.

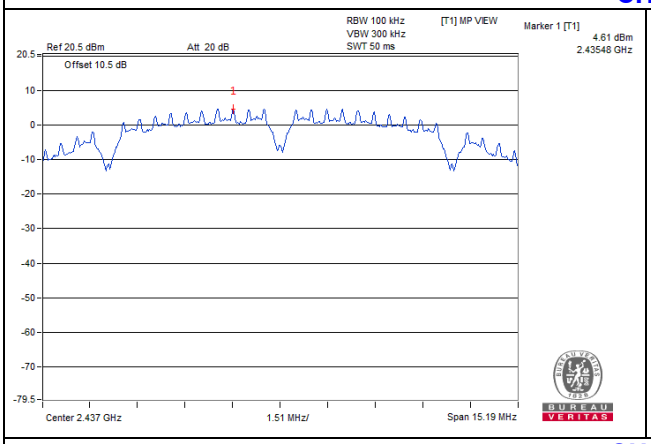
802.11b: Chain 0

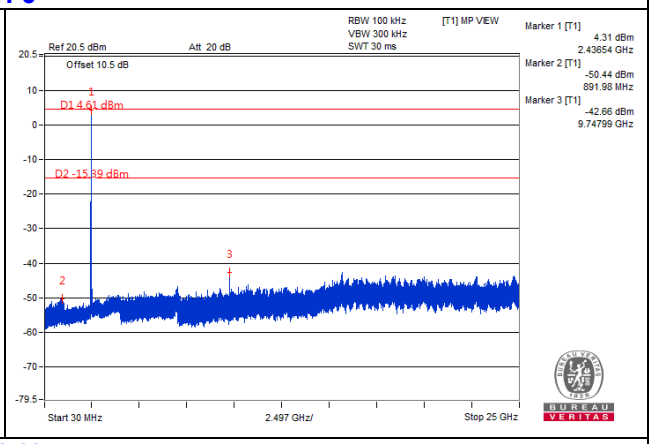
CH 1



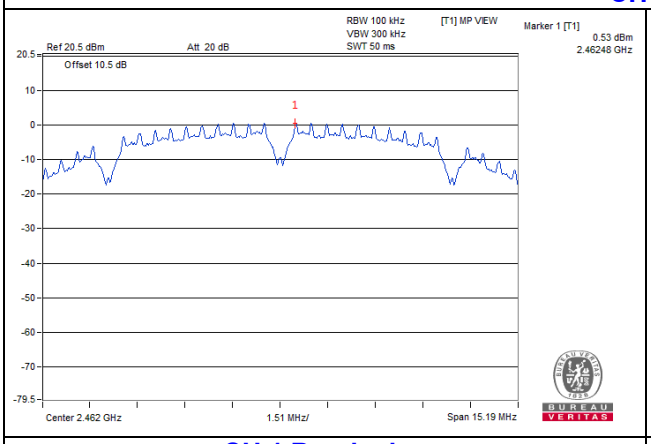


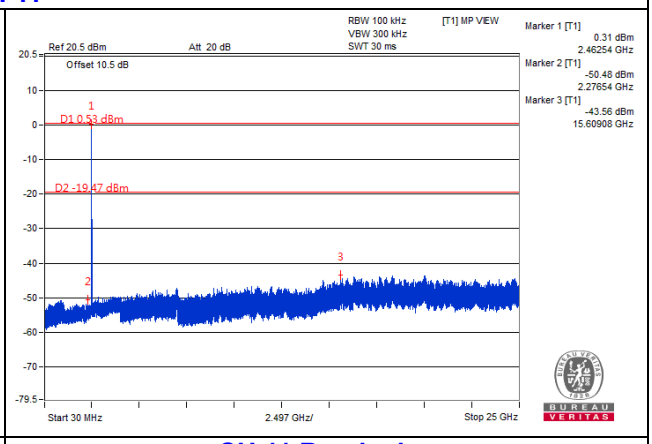
CH 6



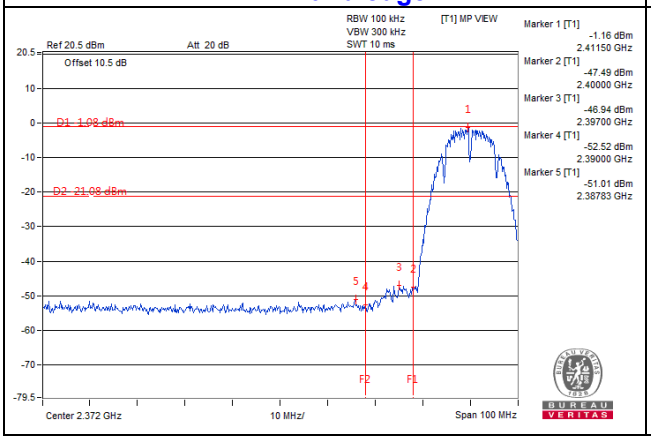


CH 11

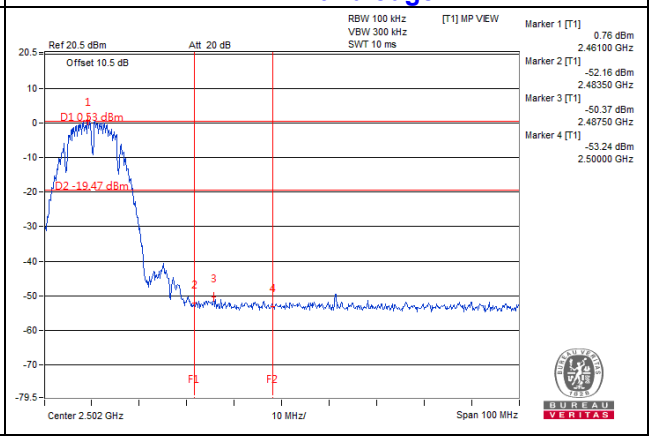




CH 1 Band edge

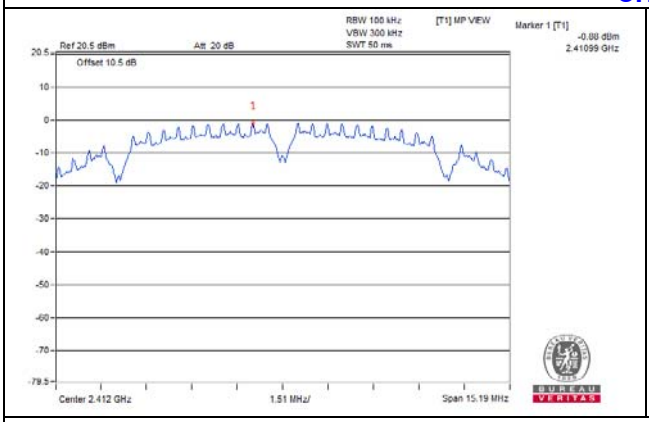


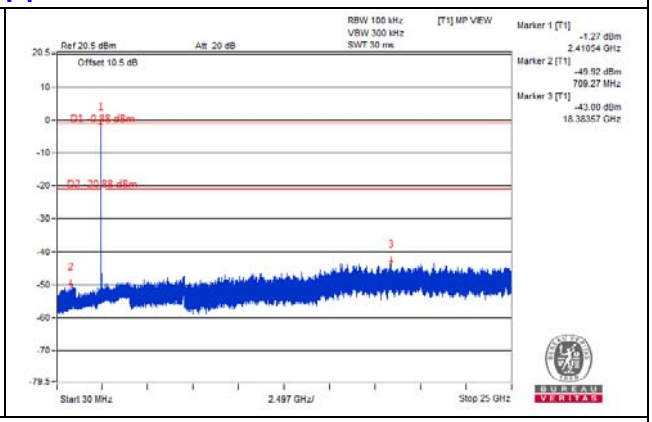
CH 11 Band edge



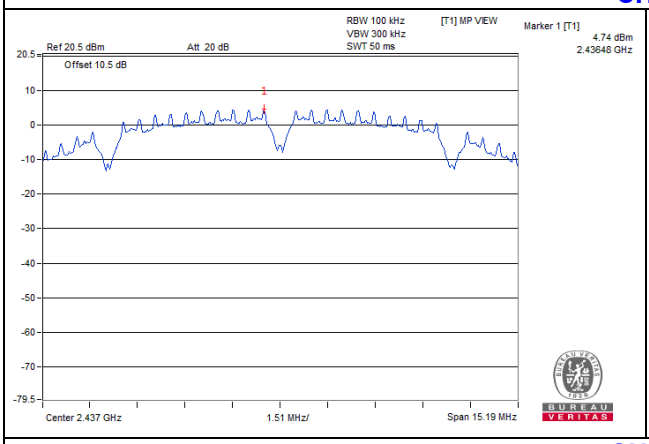
802.11b: Chain 1

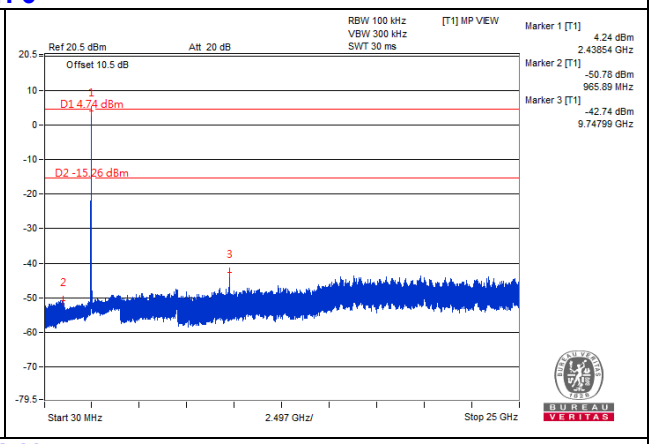
CH 1



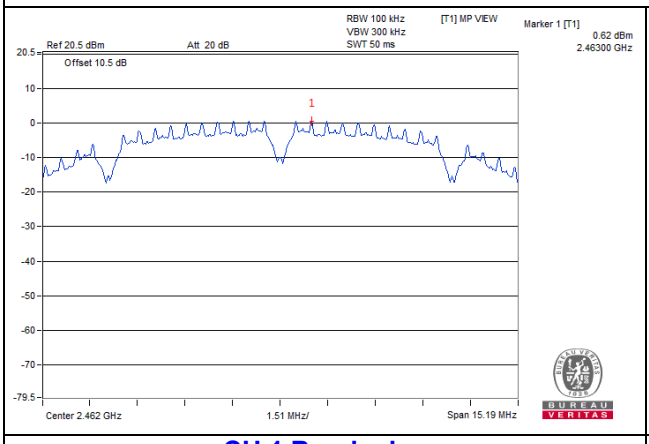


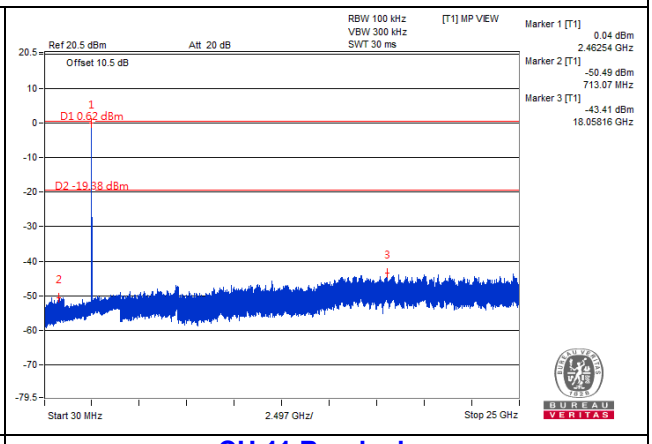
CH 6



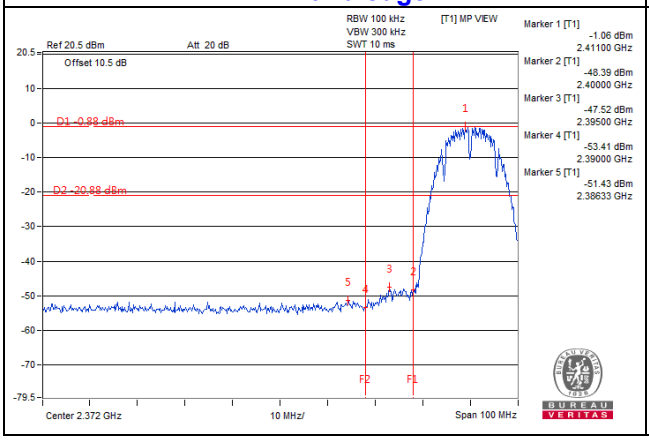


CH 11

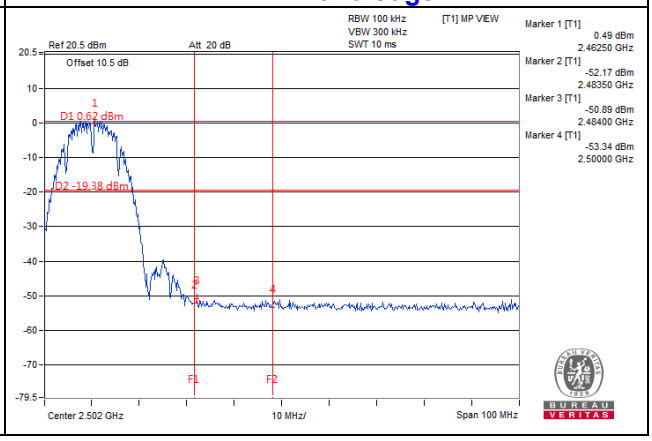




CH 1 Band edge

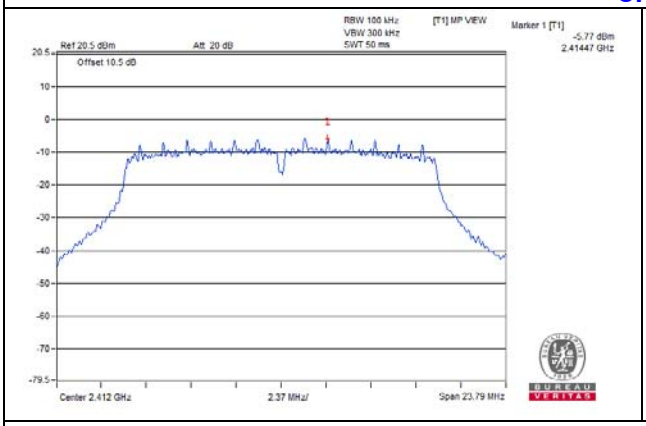


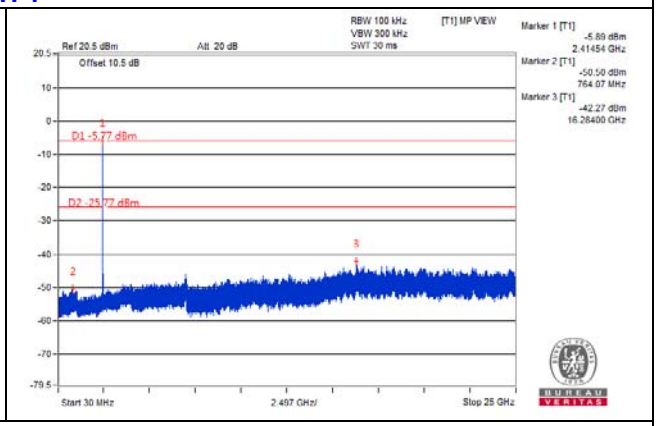
CH 11 Band edge



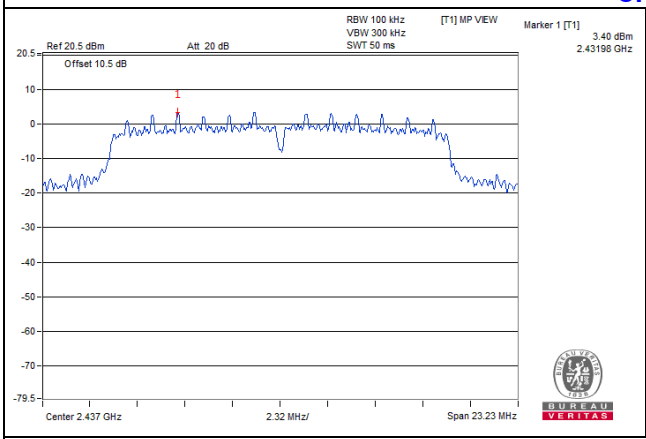
802.11g: Chain 0

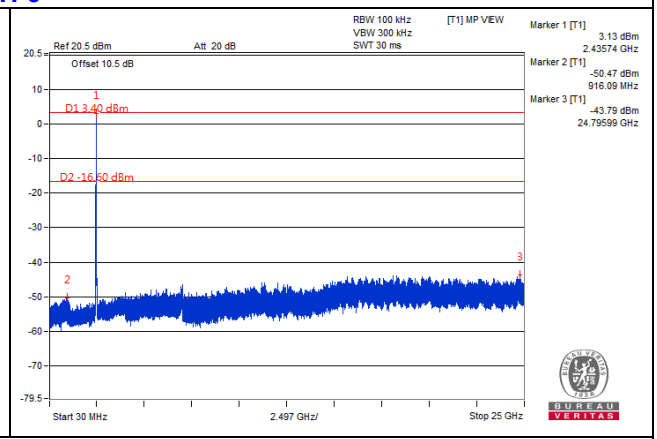
CH 1



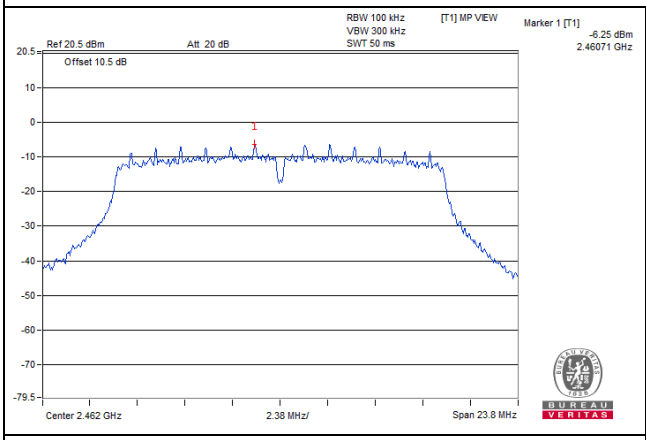


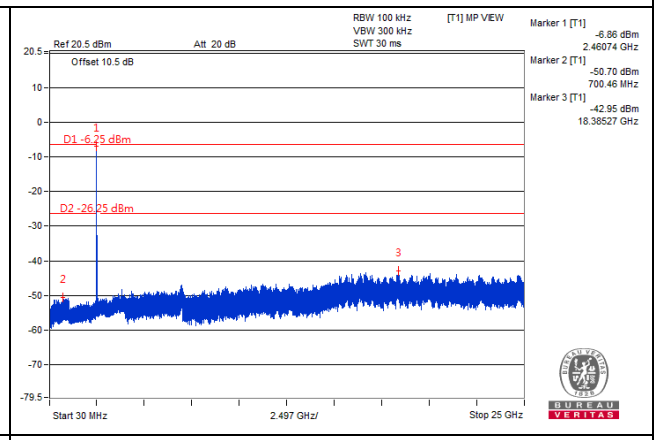
CH 6



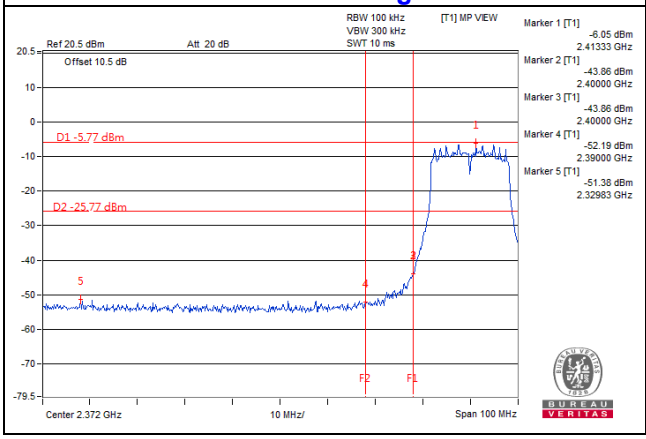


CH 11

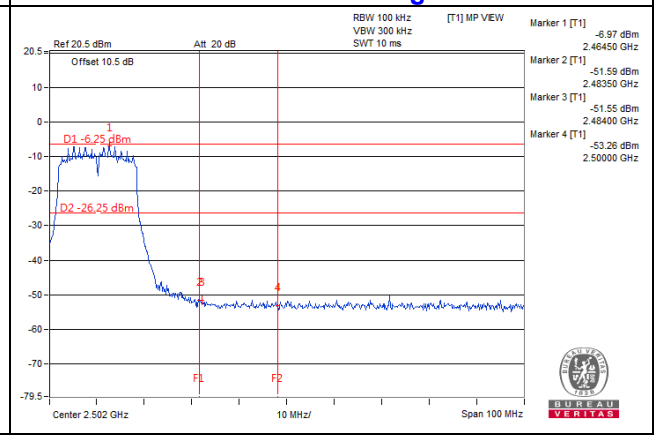




CH 1 Band edge

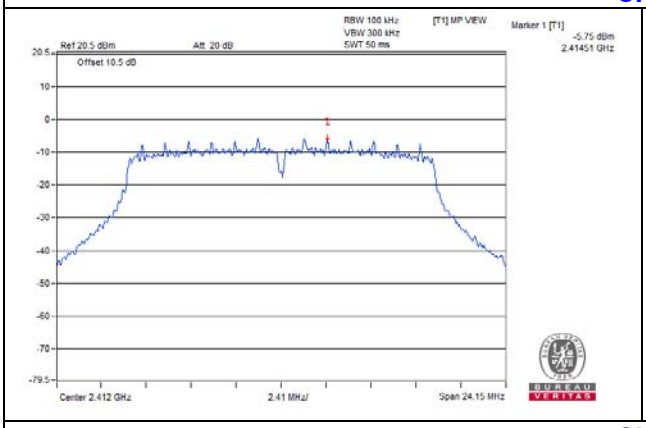


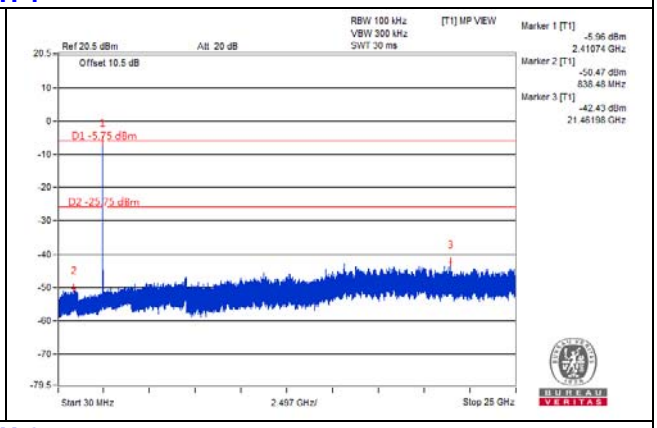
CH 11 Band edge



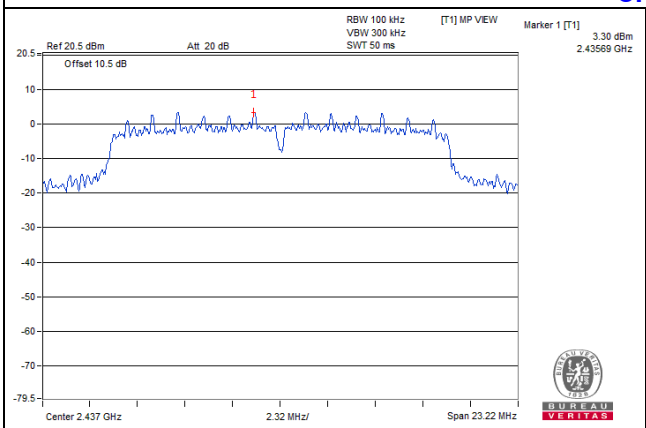
802.11g: Chain 1

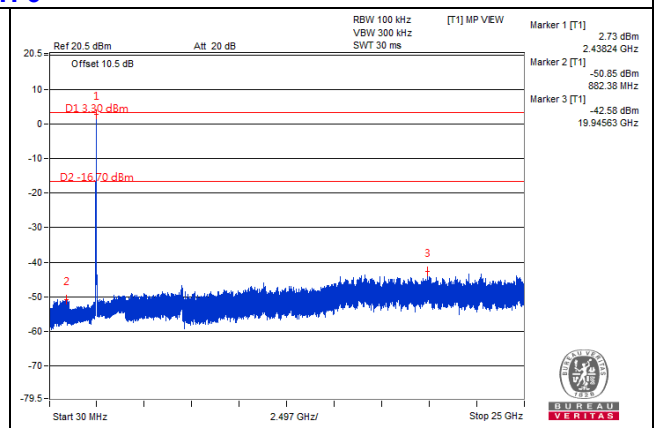
CH 1



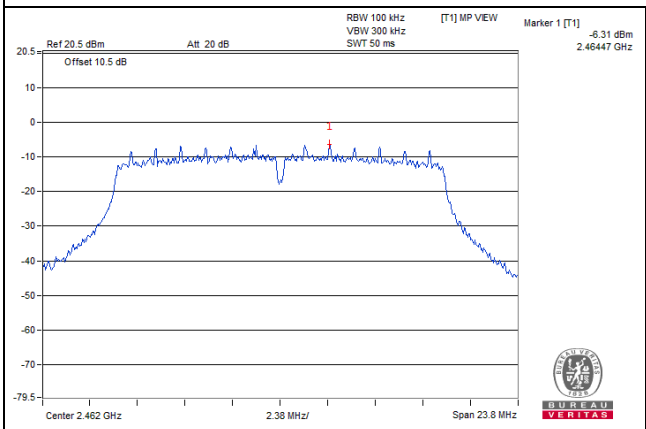


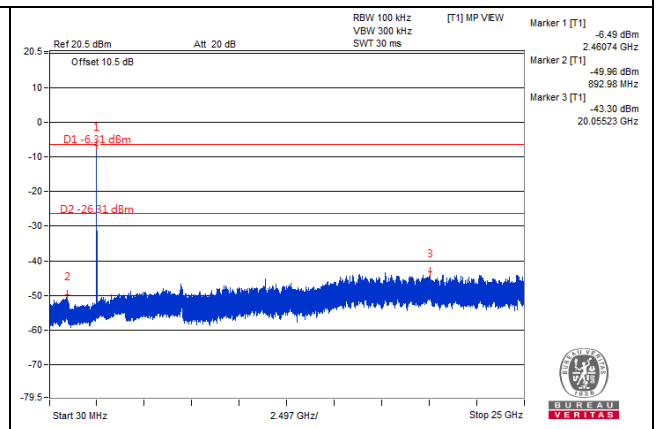
CH 6



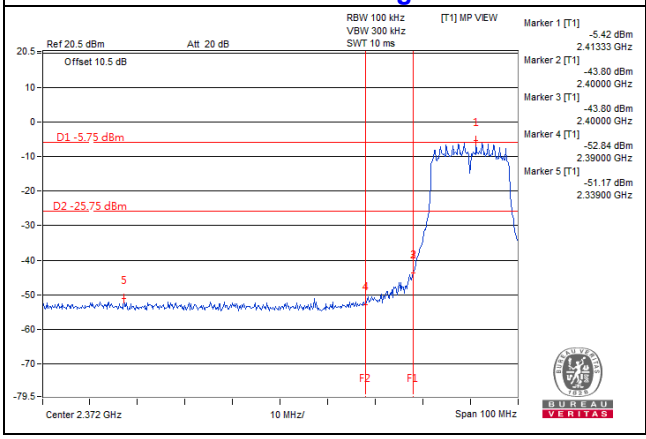


CH 11

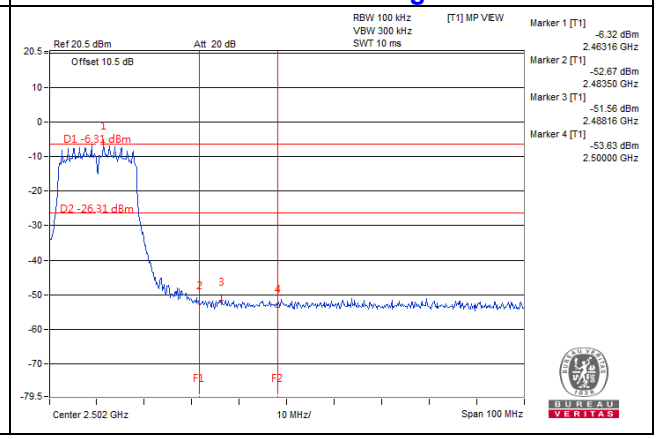




CH 1 Band edge

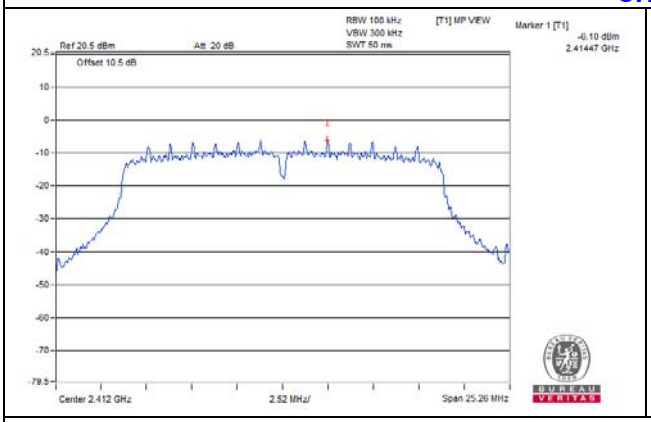


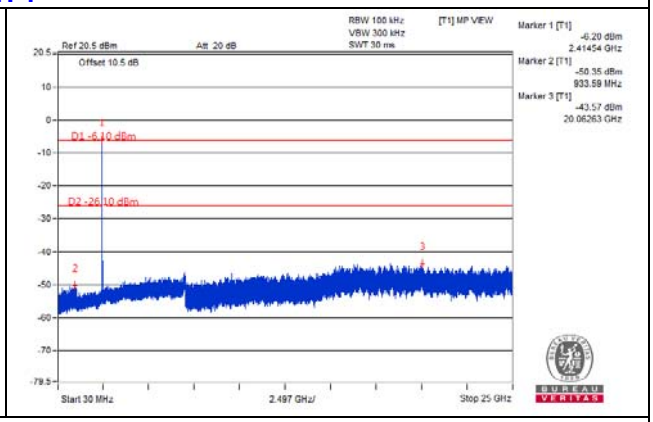
CH 11 Band edge



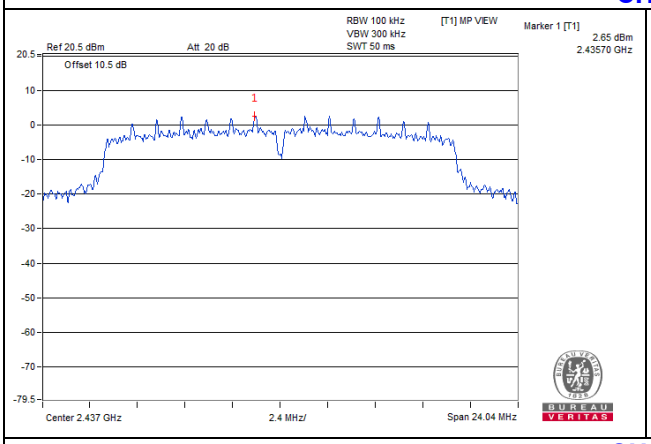
802.11n (20MHz): Chain 0

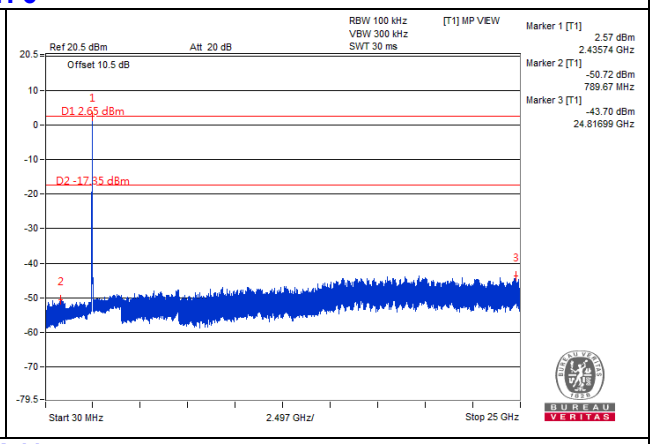
CH 1



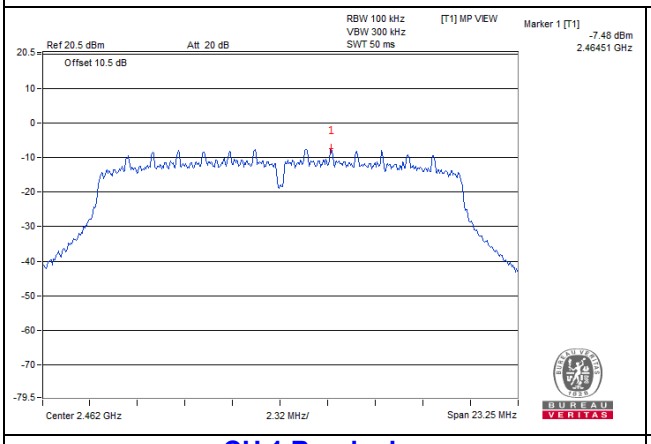


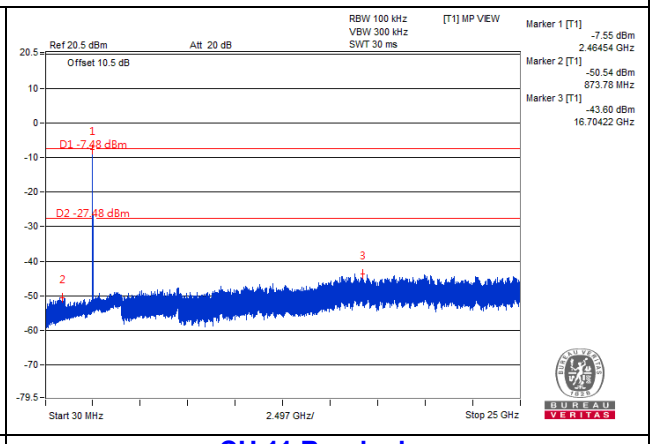
CH 6



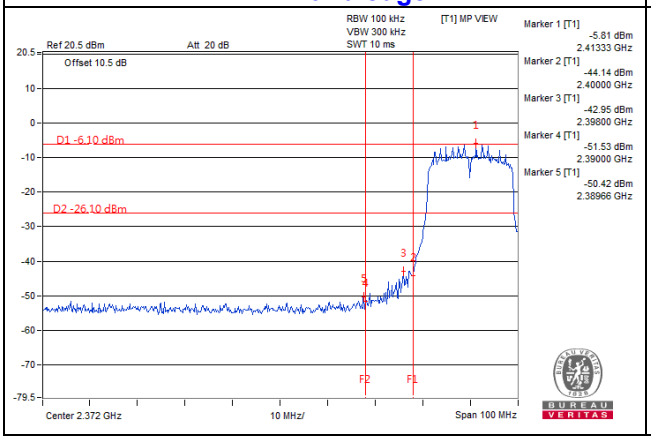


CH 11

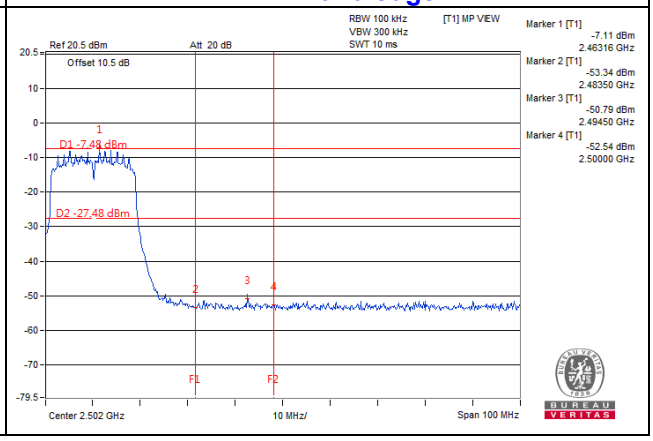




CH 1 Band edge

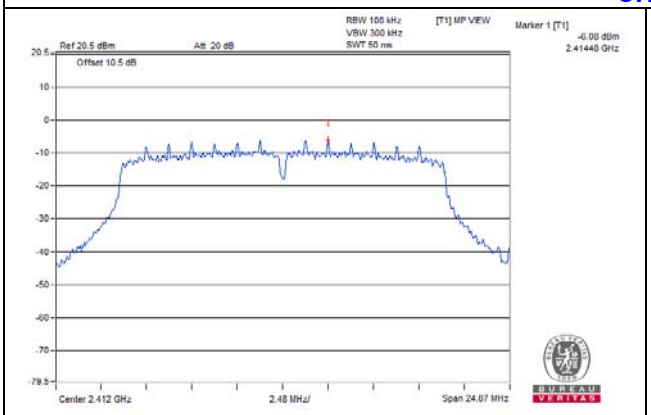


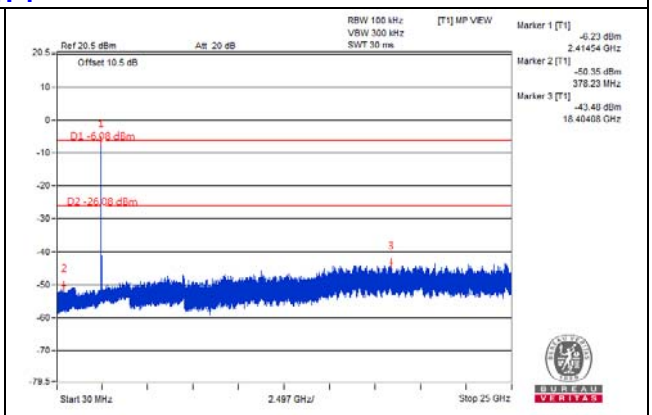
CH 11 Band edge



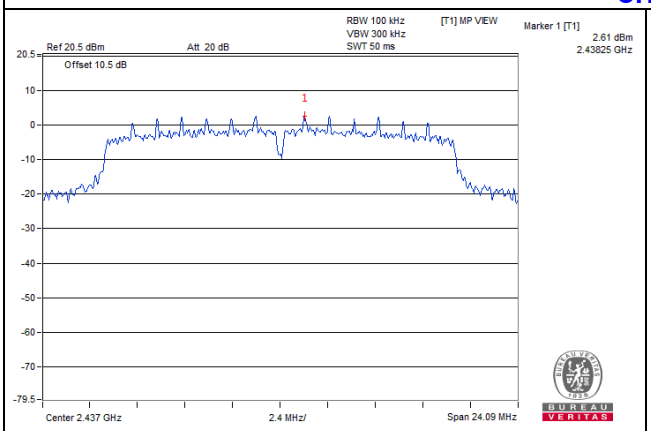
802.11n (20MHz): Chain 1

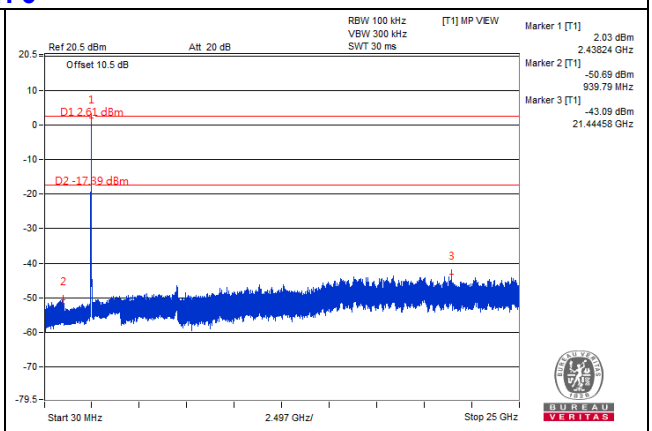
CH 1



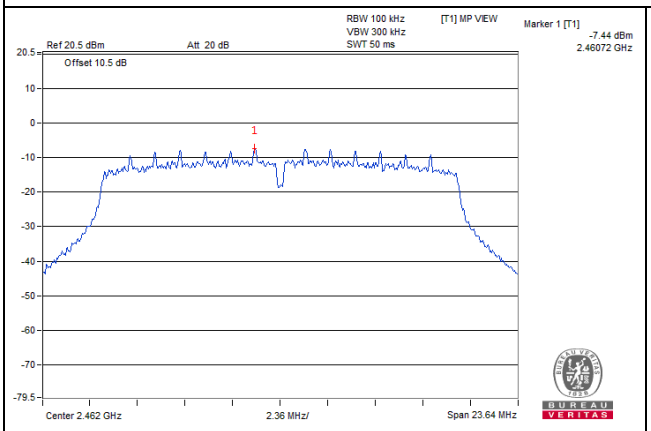


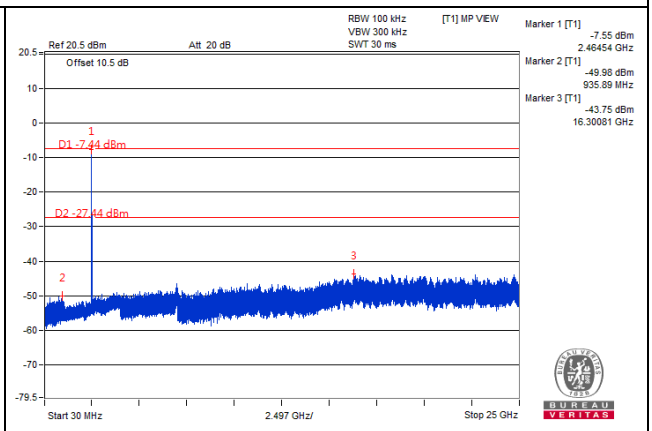
CH 6



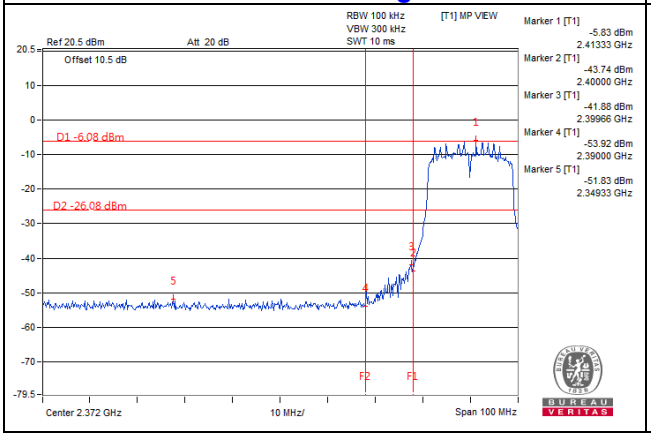


CH 11

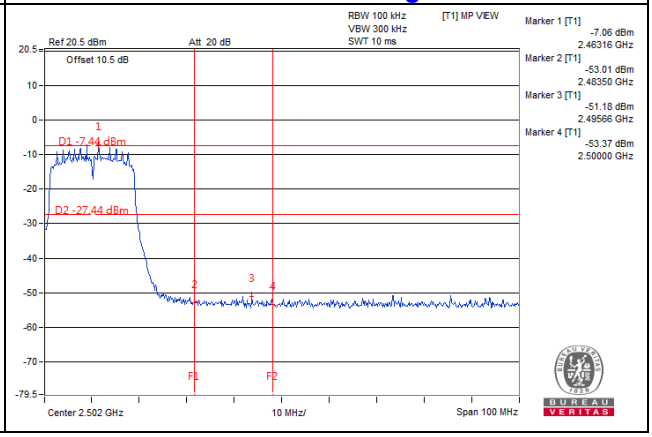




CH 1 Band edge

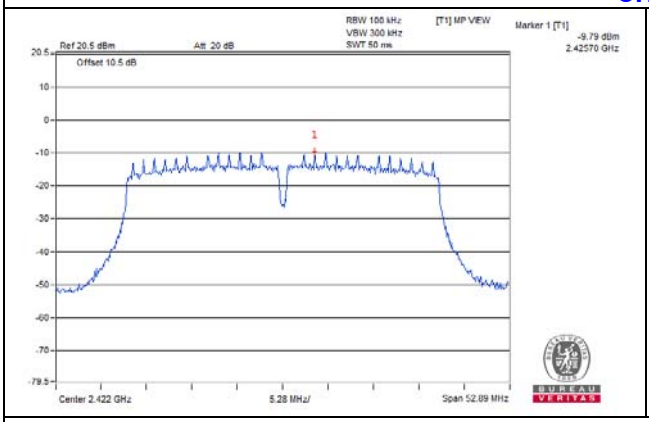


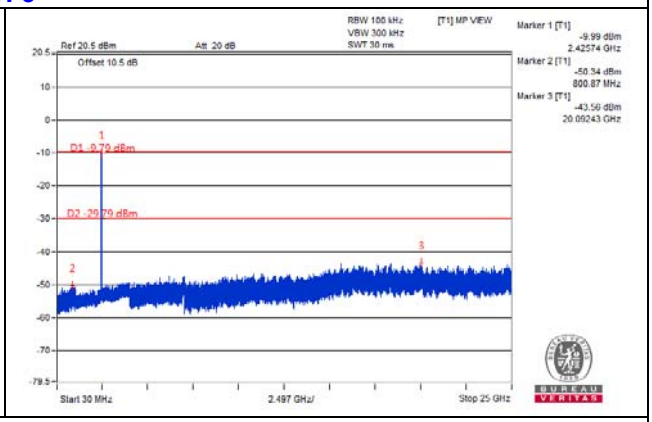
CH 11 Band edge



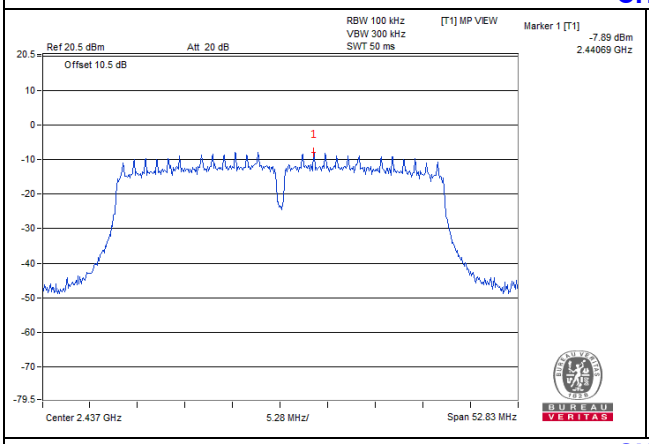
802.11n (40MHz): Chain 0

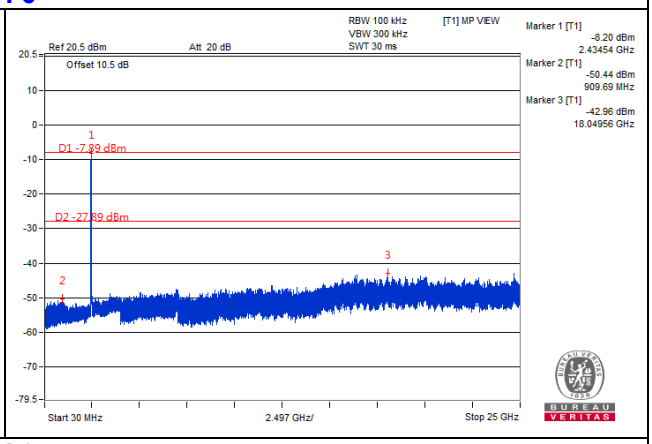
CH 3



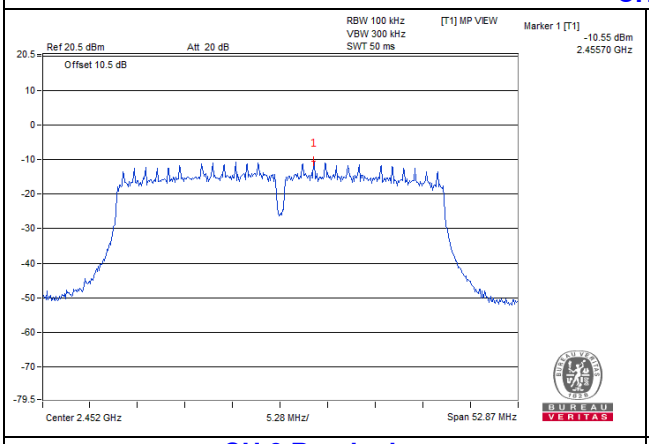


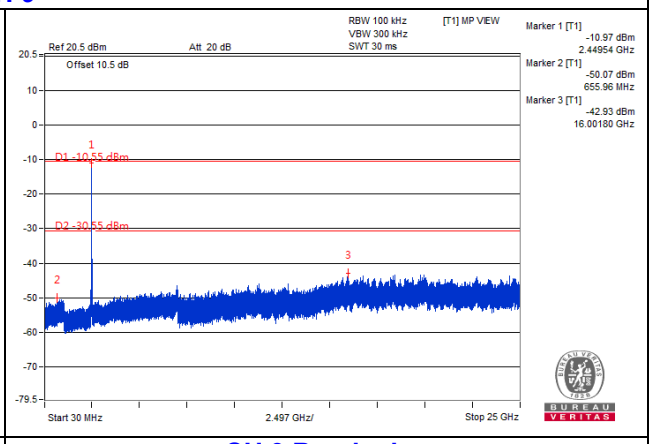
CH 6



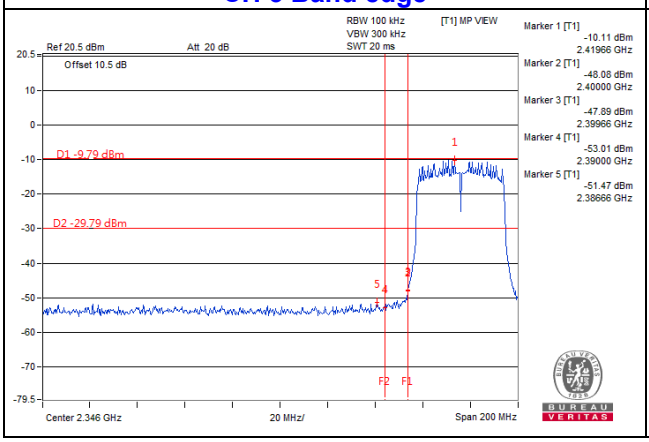


CH 9

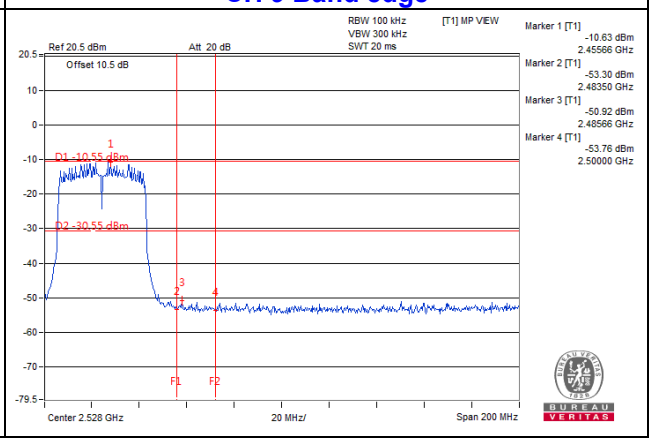




CH 3 Band edge

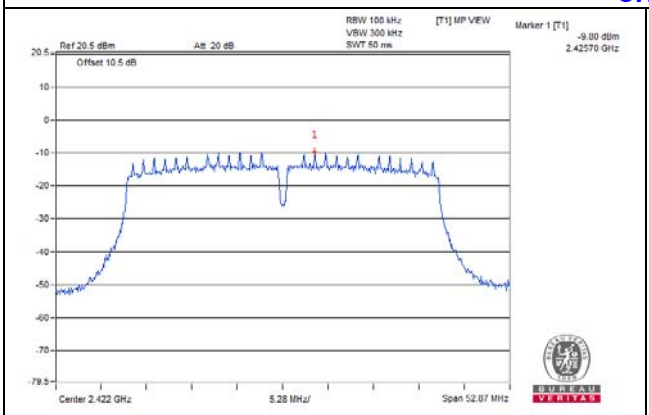


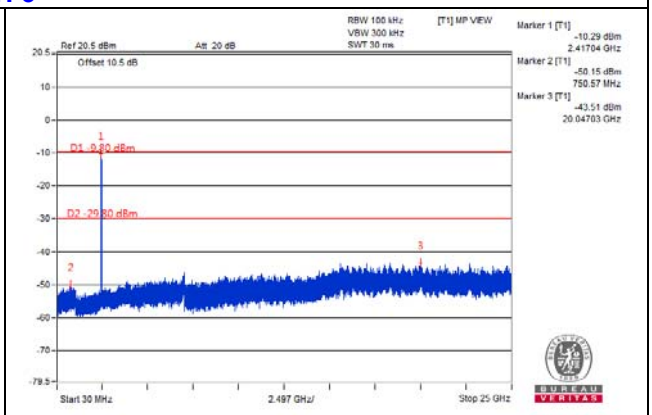
CH 9 Band edge



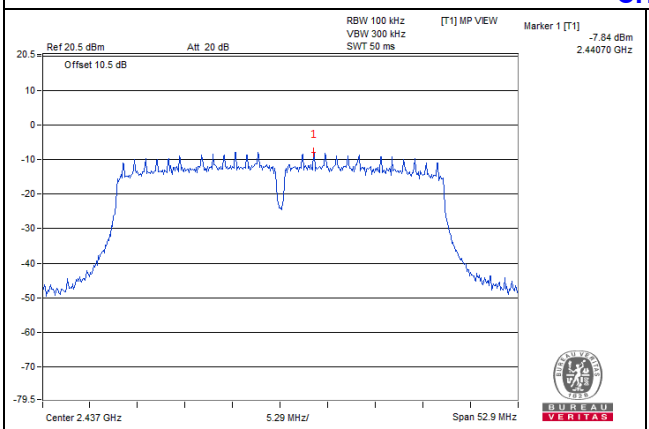
802.11n (40MHz): Chain 1

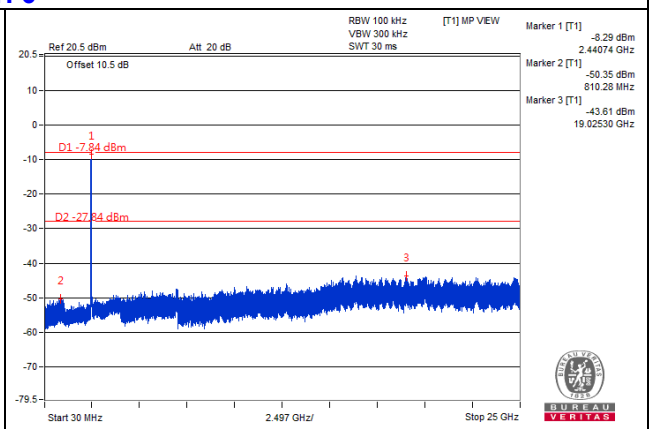
CH 3



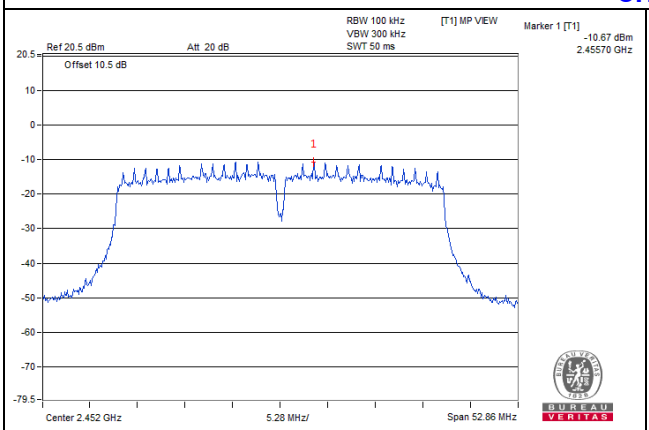


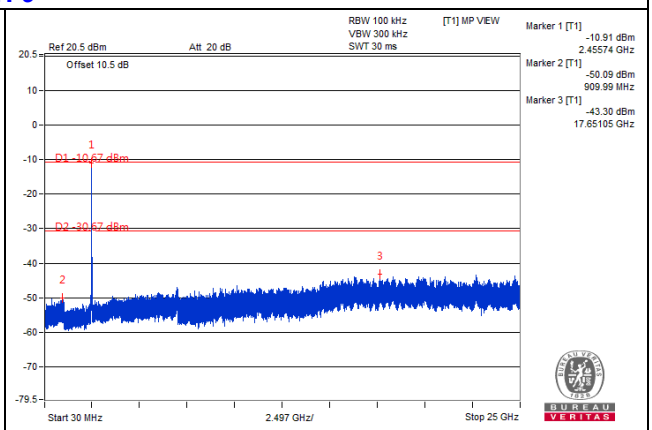
CH 6



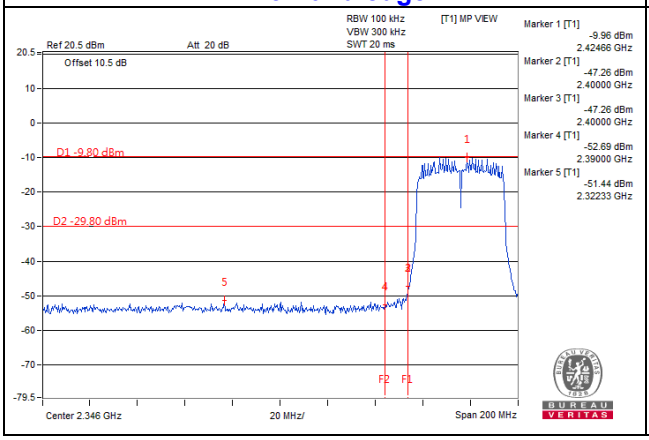


CH 9

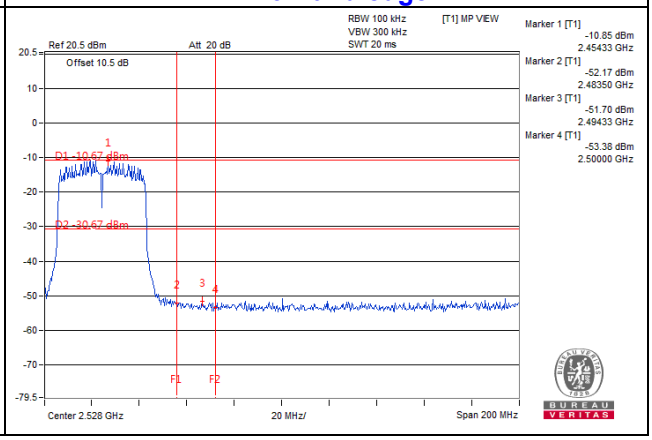




CH 3 Band edge



CH 9 Band edge



5 Pictures of Test Arrangements

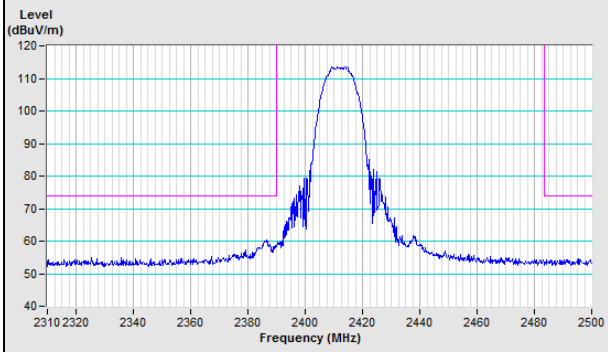
Please refer to the attached file (Test Setup Photo).

Annex A- Band Edge Measurement

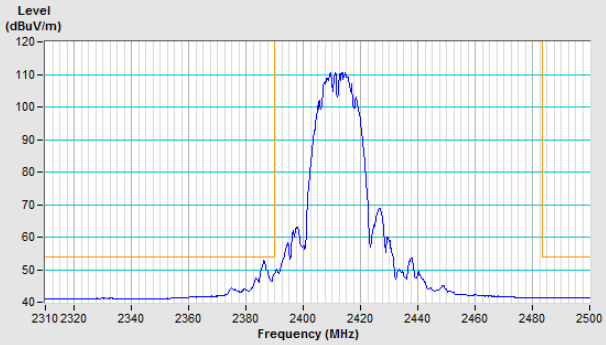
802.11b

Channel 1

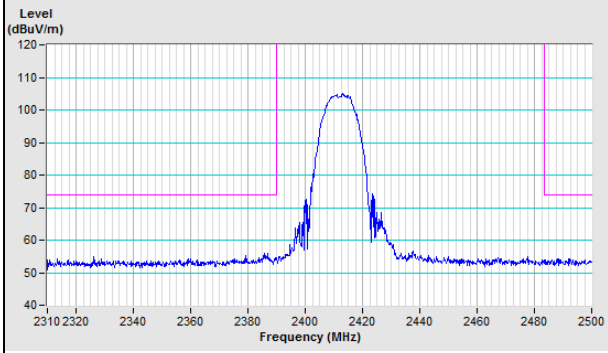
Horizontal (Peak)



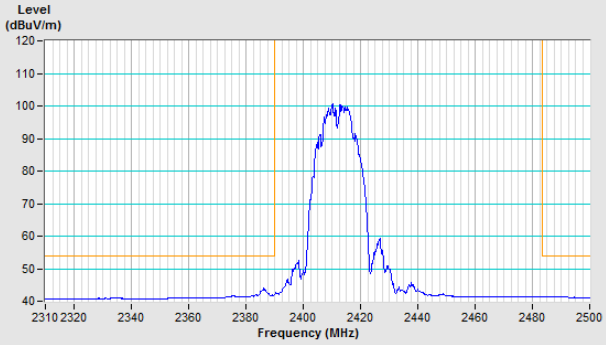
Horizontal (Average)



Vertical (Peak)

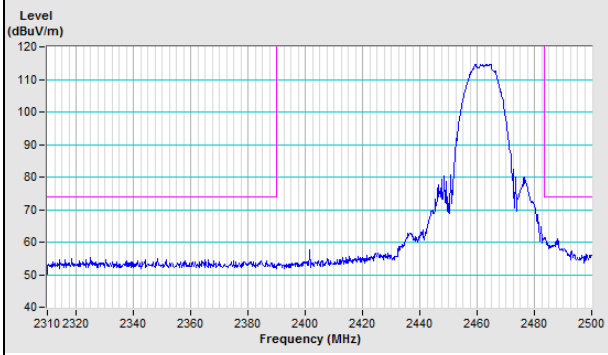


Vertical (Average)

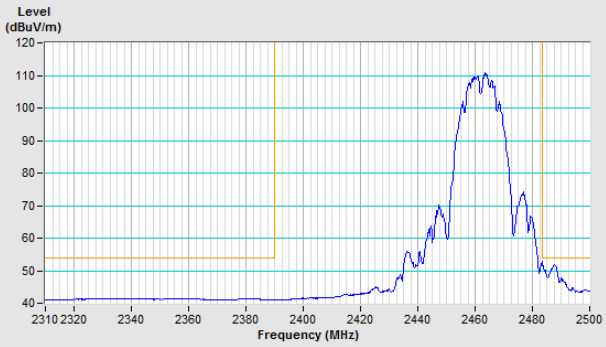


Channel 11

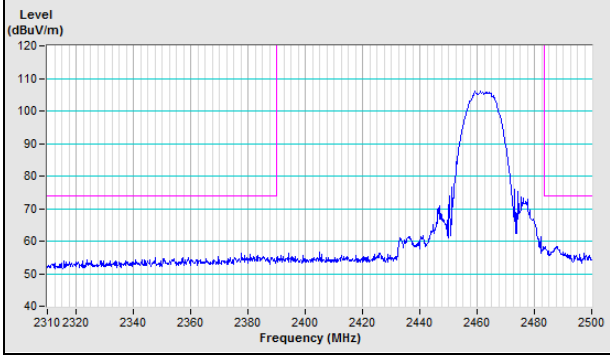
Horizontal (Peak)



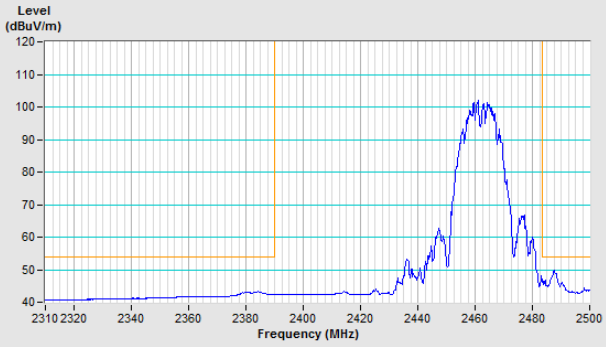
Horizontal (Average)



Vertical (Peak)



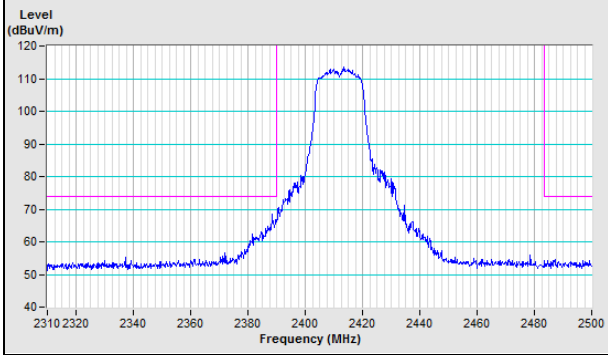
Vertical (Average)



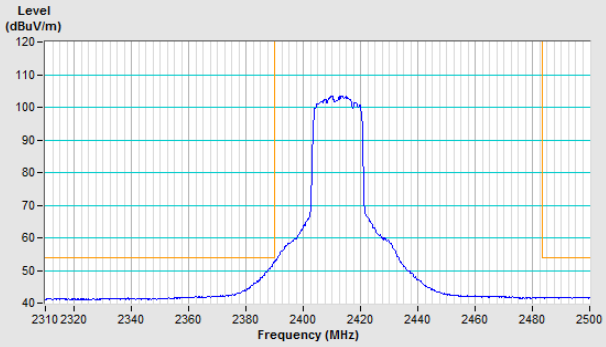
802.11g

Channel 1

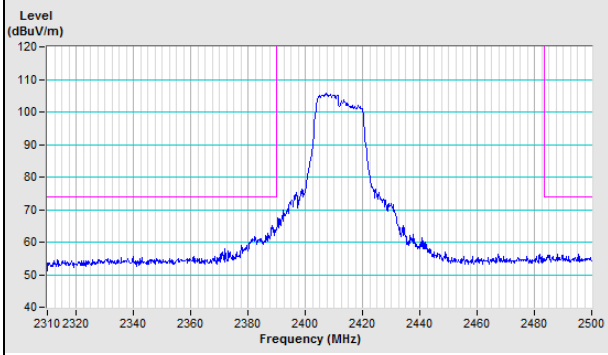
Horizontal (Peak)



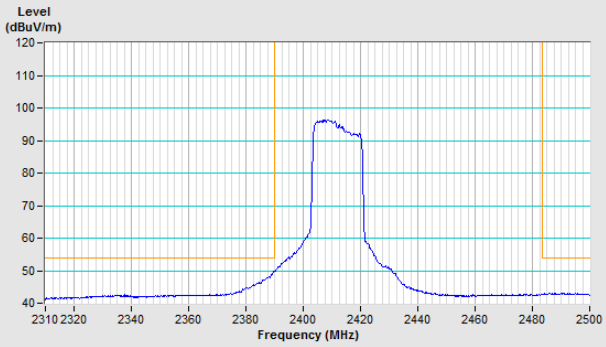
Horizontal (Average)



Vertical (Peak)

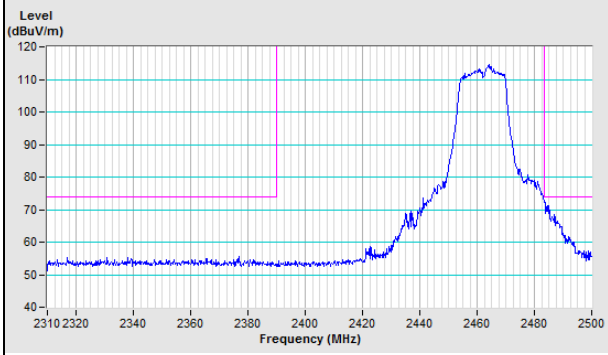


Vertical (Average)

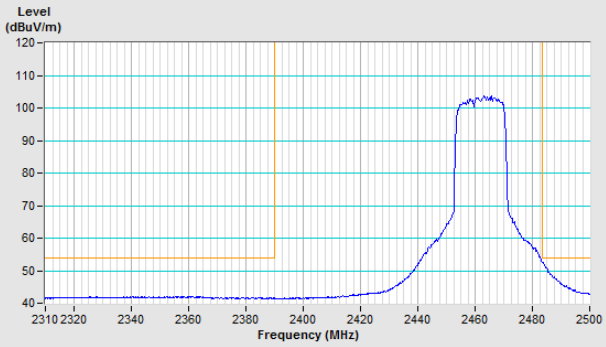


Channel 11

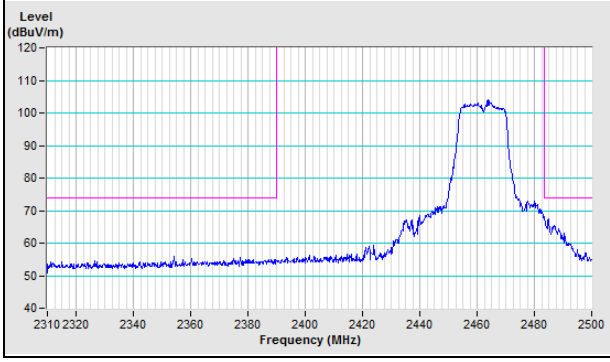
Horizontal (Peak)



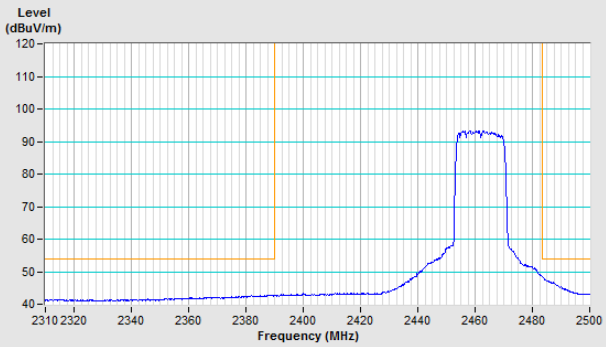
Horizontal (Average)



Vertical (Peak)



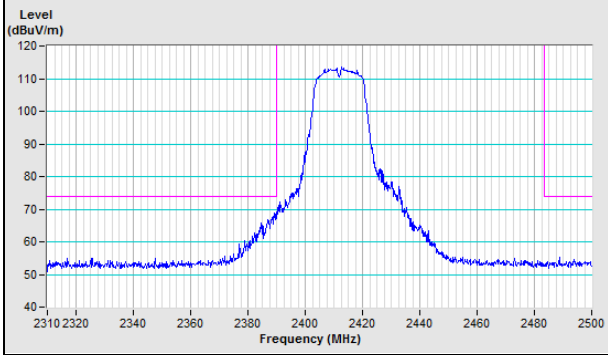
Vertical (Average)



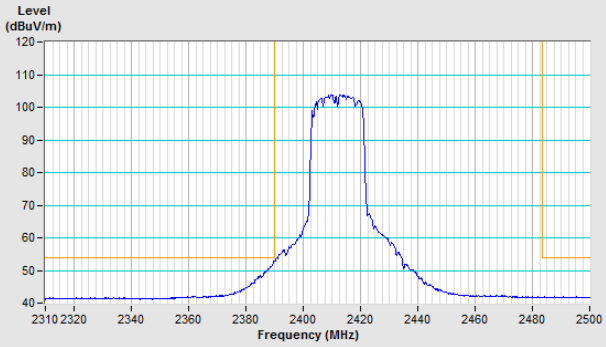
802.11n (20MHz)

Channel 1

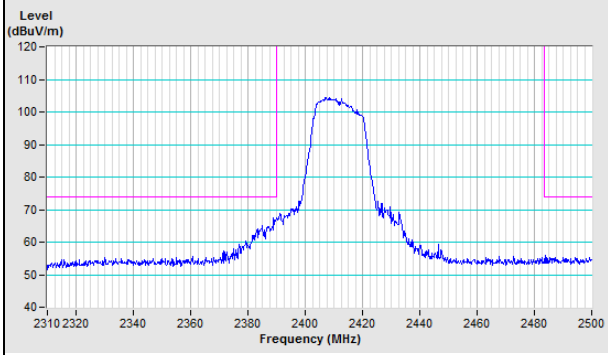
Horizontal (Peak)



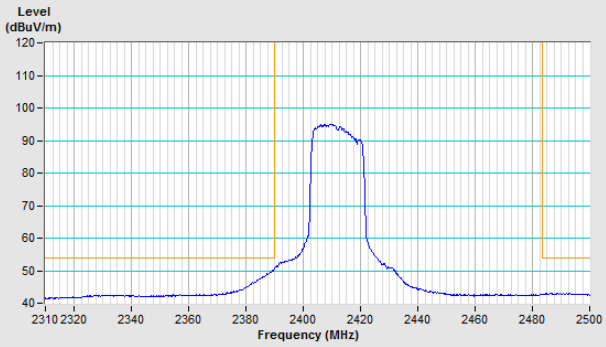
Horizontal (Average)



Vertical (Peak)

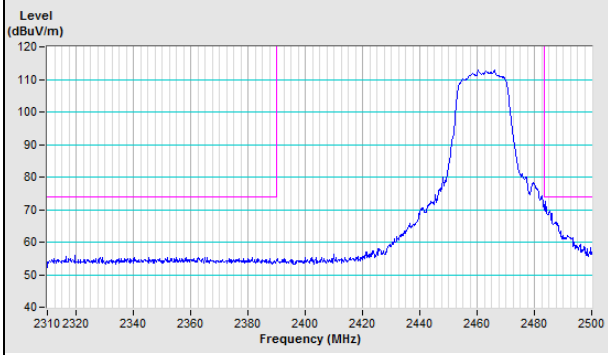


Vertical (Average)

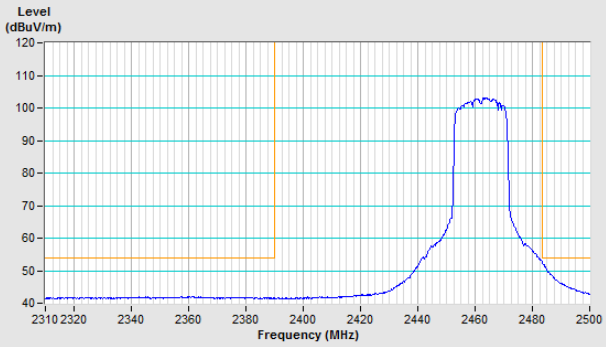


Channel 11

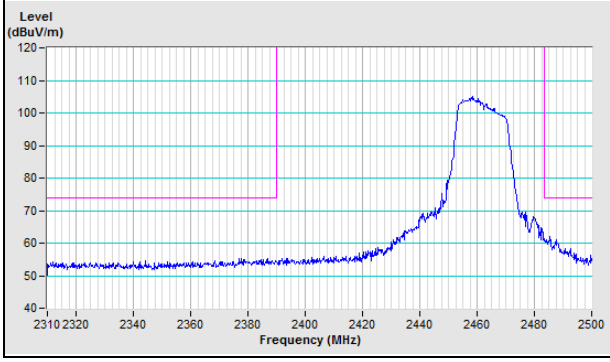
Horizontal (Peak)



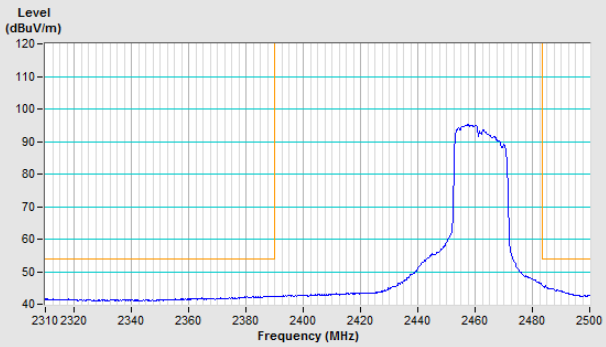
Horizontal (Average)



Vertical (Peak)



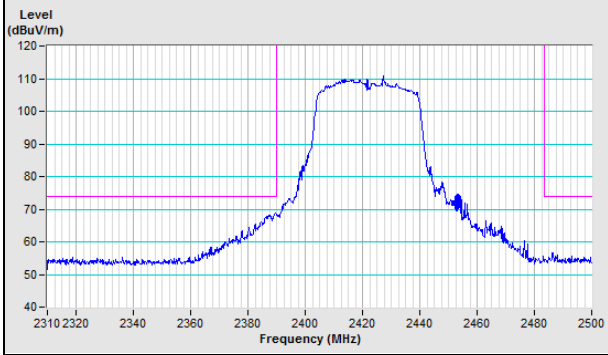
Vertical (Average)



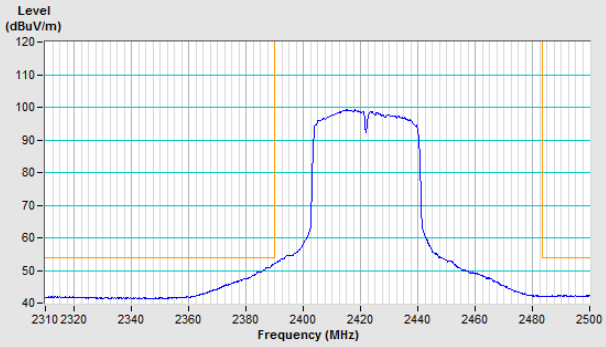
802.11n (40MHz)

Channel 3

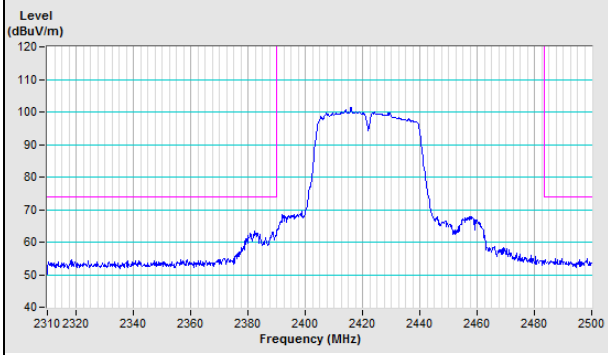
Horizontal (Peak)



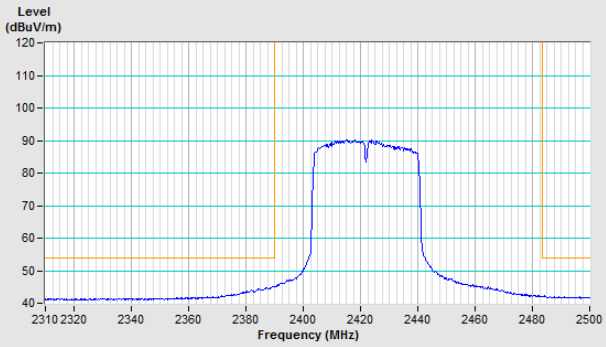
Horizontal (Average)



Vertical (Peak)

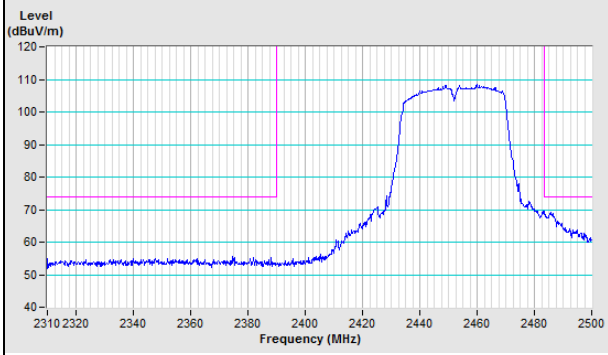


Vertical (Average)

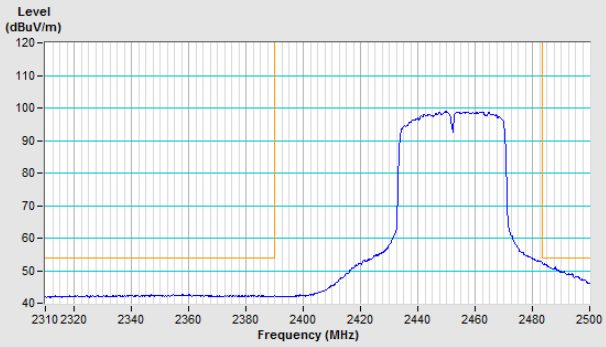


Channel 9

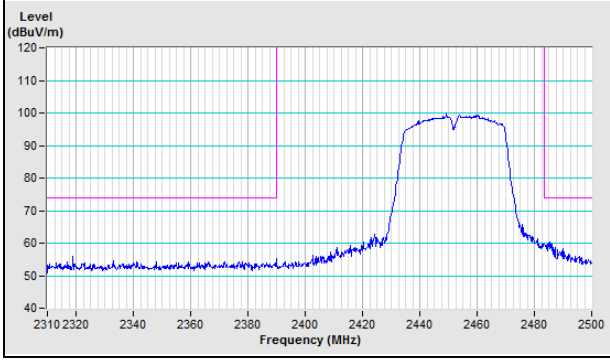
Horizontal (Peak)



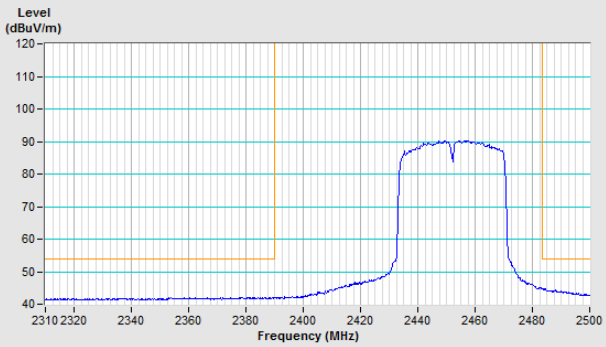
Horizontal (Average)



Vertical (Peak)



Vertical (Average)



Appendix – Information of the Testing Laboratories

We, Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch, were founded in 1988 to provide our best service in EMC, Radio, Telecom and Safety consultation. Our laboratories are FCC recognized accredited test firms and accredited according to ISO/IEC 17025.

If you have any comments, please feel free to contact us at the following:

Lin Kou EMC/RF Lab
Tel: 886-2-26052180
Fax: 886-2-26051924

Hsin Chu EMC/RF/Telecom Lab
Tel: 886-3-6668565
Fax: 886-3-6668323

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Fax: 886-3-3270892

Email: service.adt@tw.bureauveritas.com
Web Site: www.bureauveritas-adt.com

The address and road map of all our labs can be found in our web site also.

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